4. SITE 261

The Shipboard Scientific Party[1]

SITE DATA

Date Occupied: 17 November 1972

Date Departed: 22 November 1972

Time on Site: 129.5 hours

Position:
lat 12°56.83′S
long 117°53.56′E

Water Depth (from sea level): 5667 corrected meters (echo sounding)

Water Depth (from drill floor): 5677 corrected meters (echo sounding)

Bottom Felt At: 5687 meters (drill pipe)

Penetration: 579.5 meters

Number of Holes: 1

Number of Cores: 39

Total Length of Cored Section: 342 meters

Total Core Recovered: 125.8 meters

Percentage Core Recovery: 36.78

Oldest Sediment Cored:
Depth below sea floor: 532.2 meters
Nature: Nanno claystone
Age: Late Oxfordian
Measured velocity: 1.7-2.0 km/sec

Basement:
Depth below sea floor:
0.61 sec DT (seismic profiler)
47 meters (drilled)
Inferred velocity to basement: 1.74 km/sec
Nature: Top 10 meters a sill, the rest oceanic basalt

Principal Results: The basement age is early late Oxfordian at the base of a Cretaceous section of claystone. The uppermost part of the drilled section is upper Miocene and lower Pliocene displaced carbonate oozes, and the surface layer is a Quaternary radiolarian clay.

BACKGROUND AND OBJECTIVES

Site 261 was originally proposed to test the suggestion (Veevers et al., 1971) that the Argo Abyssal Plain faced the Tethyan Ocean for an unknown period of time before the Cretaceous phase of drifting, and thus has had a continuous record of open-sea deposition for an unknown interval before the Cretaceous. This area was thus contrasted with the area to the south which formed by spreading that began in the Cretaceous. This was a more specific notion than that of Dietz and Holden (1971), who suggested that the entire Wharton Basin was pre-Cretaceous. The presence of pre-Cretaceous sediments at Site 261 was suggested by reflectors 0.25-sec deep beneath the acoustic section seen at Site 260. The occurrence in the neighborhood of Site 261 of vertical cylindrical structures, presumably diapirs, added further interest.

Falvey (1972) countered the notion of Veevers et al., (1971) with a model, based on sea-floor magnetic anomalies, of Cretaceous spreading of the entire eastern Indian Ocean including the Argo Abyssal Plain, which he dated as no older than Upper Cretaceous (Santonian or 75-80 m.y.). One of Falvey's anomalies (no. 31, presumed age Campanian or 72 m.y.) was drilled at Site 260. The basement age of Lower Cretaceous (~135 m.y.) found in drilling shows that Falvey's magnetic anomalies were misidentified or that they are not due to sea-floor spreading. Site 261 is located on an anomaly that Falvey identified as no. 27 (late Maestrichtian or 67 m.y.). If the basement age here is correspondingly younger than that of Site 260, the magnetic anomalies may represent isochrons. If the age is older or considerably younger, the magnetic anomalies are probably due to a cause other than sea-floor spreading.

SITE SURVEY

Site 261 is located on the northeast side of the Argo Abyssal Plain (Figures 1, 2). Basic information about this site was provided by *Vema*-28 and *Glomar Challenger* Leg 22 profiles (Figure 3). Further information was provided by a *Vema*-20 profile although that profile is to the south of the area shown in Figure 3.

These profiles show a surface transparent layer, a layered sequence of reflectors, and a major transparent layer conformable with the underlying prominent reflector. Figure 3 shows the depths to the bottom of the conformable layer (i.e., to the prominent reflector) and to the bottom of the layered sequence (top of major transparent layer). Data from an on-site sonobuoy measurement and from *Glomar Challenger's* track leaving the site are included on this figure.

On *Vema*-28 cruise records and on the sonobuoy record made on this station, there is an indication of one or more reflectors deeper than the prominent reflector. The nature of these deeper reflectors is unknown because drilling showed the prominent reflector to be basement or a sill probably close to basement. It is probable that these faint deeper reflectors are due to internal reflections between layers.

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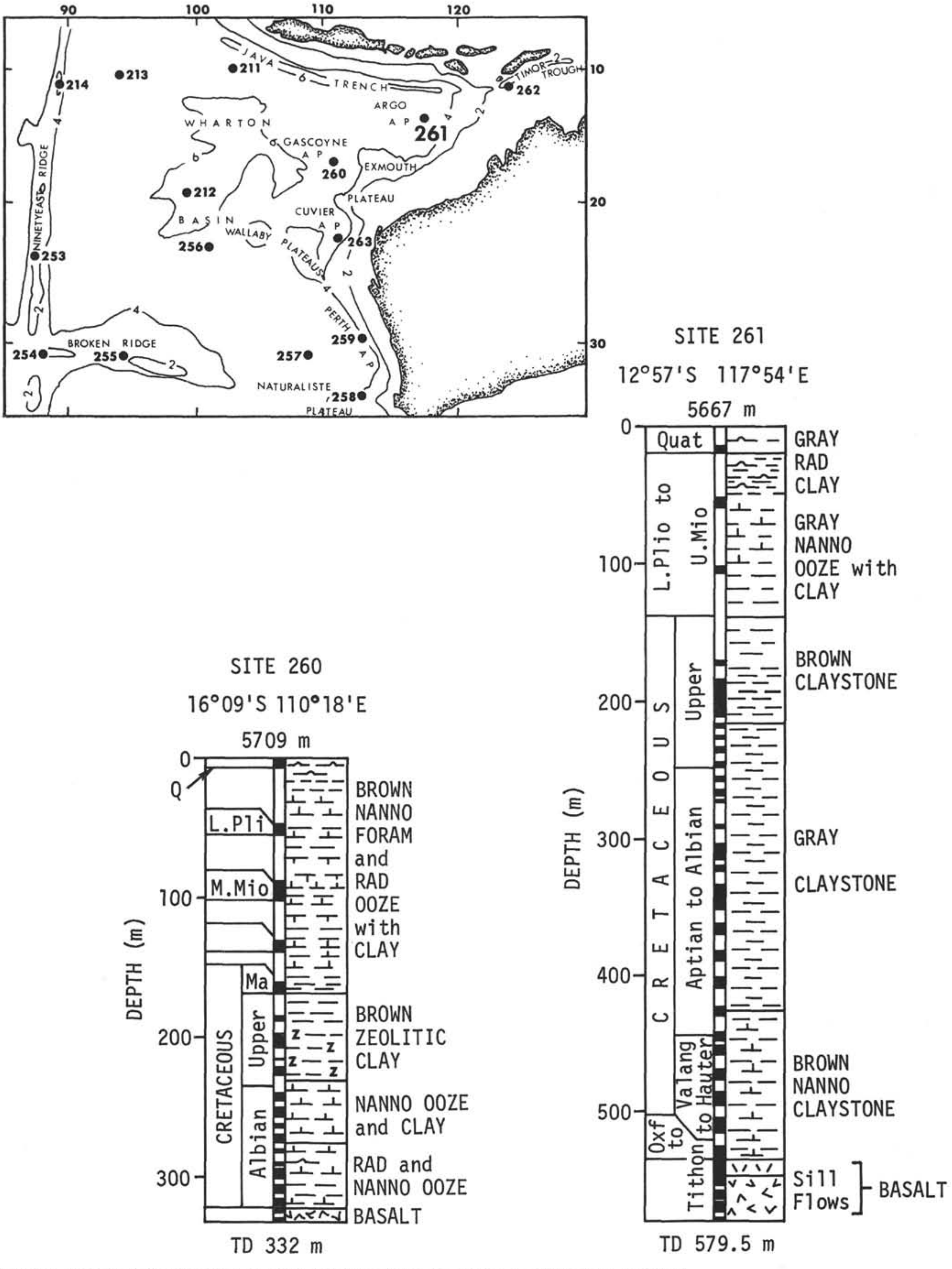


Figure 1. *Location of Site 261 and generalized stratigraphic columns of Sites 261 and 260.*

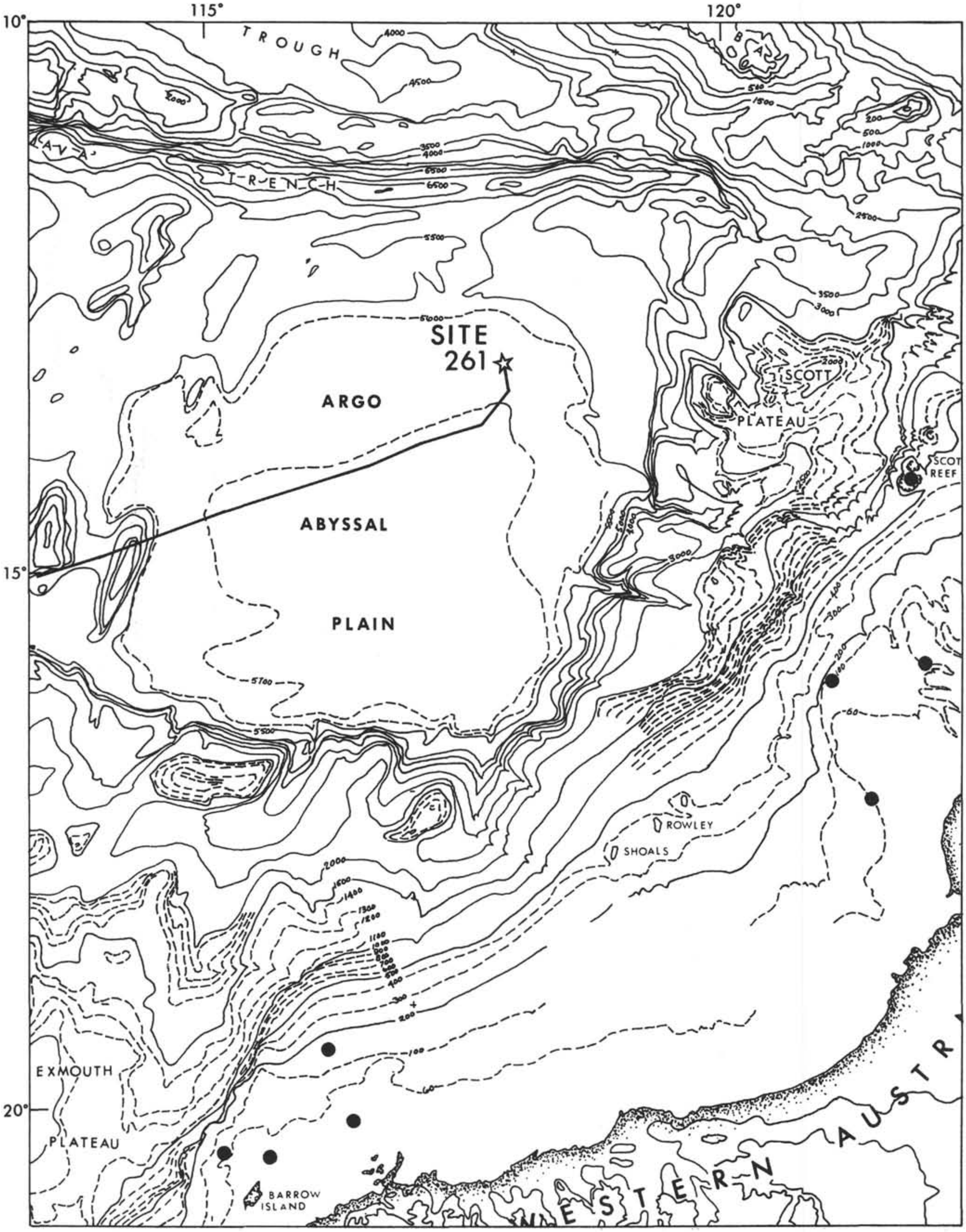


Figure 2. *Regional setting of Site 261. Dots show locations of recent offshore drillings.*

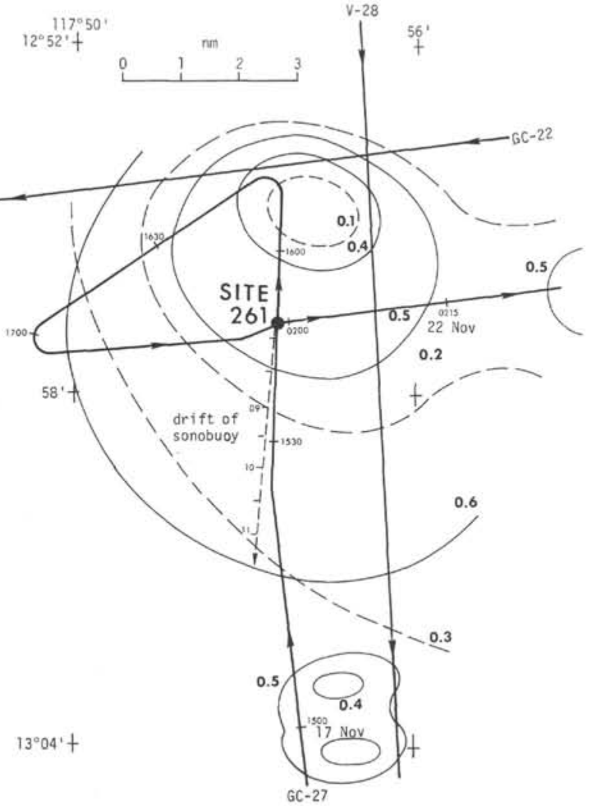


Figure 3. *Site survey for Site 261. Dashed-line contours are two-way travel times to bottom of layered sediments. Solid-line contours are two-way travel times to bottom of conformable transparent layers. Two diapiric structures are located at the bottom of the figure. The depth of the sea floor is 5411 meters uncorrected. Times in GMT.*

There are numerous vertical cylindrical structures in the eastern Argo Abyssal Plain. Two such features are located about 10 km (6 mi) south of the site drilled. Characteristically, these structures penetrate the horizontal layered reflectors, but do not reach the sea floor.

OPERATIONS

The approach to Site 261 was from the south, along *Vema*-28's track. The beacon was dropped at 0000, 17 November 1972, while underway at over 9 km/hr (5 knots) on the first pass over the site. Approximately 2 hr were spent in additional site profiling while attempting repairs to the computer which failed just prior to beacon release. After retrieving survey gear, the ship was positioned over the beacon by operating in manual mode, using relative position mode bypassing the computer for PPI presentation. We delayed running in the drill string for 1½ hr until we were assured of our ability to hold position manually. The positioning difficulties were compounded by not having any wind or current to hold against.

By 0400, the Captain was confident that we could maintain our position and we began running in the drill string. The computer was returned to service at 1200 permitting us to position on automatic mode before reaching the sea floor. An indefinite bottom was apparent at 5678 meters and the first core barrel was retrieved. Recovery was a small sample of mud which indicated that bottom was at 5687 meters.

The hole was spudded at 1430, 17 November 1972. Drilling and coring continued without significant difficulty to a total depth of 6266.5 meters or 579.5 meters below sea floor. Details of the coring are included in the coring summary, Table 1. Basalt was encountered at 6219 meters with 532 meters penetration, and 47.0 meters of basalt were cored before the hole was terminated. After deciding to terminate the hole, we discovered that the bit was plugged, apparently by basalt lost from Core 39. The "plug" fell out while pulling drill pipe and no additional basalt was recovered.

Weather conditions were excellent and positioning was satisfactory. We again lost the computer for 4 hr after spudding in and operated without difficulty for 8.5 hr in manual mode. Coring was completed at 1800, 21 November.

The drill collars were inspected while being pulled out of the hole and we got underway to Site 262 at 0930, 22 November.

LITHOLOGY

At Site 261, 532 meters of sediment and 47 meters of basalt were drilled with a recovery at only 23%. Two of the 39 cores recovered are represented by core catcher samples only. The sediments, which consist chiefly of clay and nanno ooze, have been divided into four major units and two subunits, based on composition and color (Table 2). Three units have been recognized in basalt; a coarse-grained sill at the top of the sequence, a thin unit of fine-grained flows (?), and a basal sequence of basalt breccia.

Unit 1 (0.0-19.0 m)

Unit 1 is a soft, greenish-gray clay containing siliceous fossils. It contains 20% Radiolaria, 15% diatoms, 1%-15% Volcanic glass, 2%-3% sponge spicules and silicoflagellates, and traces of nannofossils, quartz, feldspar, iron oxide, and micarb fragments.

Unit 2 (19.0-142.0 m)

This unit consists chiefly of stiff greenish-gray nanno ooze and nannorich clay, with a few beds of clay. The nanno ooze has an average composition of 80% nannos, 15% clay, 3% quartz, 1% feldspar, and traces of opaques, iron oxides, volcanic glass, and dolomite rhombs. A few specimens have abundant detrital forams.

Clay layers are predominantly light gray to olive gray in color, becoming greenish-gray towards the base. They consist chiefly of clay, with 5%-15% nannos and trace amounts of quartz, heavy minerals, volcanic glass, and dolomite rhombs.

Only 11 cm of sediment were recovered from the interval between 104.5 meters and 170.4 meters. These consist of highly brecciated olive-gray and greenish-gray clay similar to the higher sediments and containing a mixed foraminiferal fauna whose age is not older than upper Miocene. The seismic reflection profile at this site shows a distinct reflector at 142 meters which is interpreted as the upper boundary of the acoustically trans-

TABLE 1
Coring Summary, Site 261

Core	Date (Nov)	Time	Depth From Drill Floor (m)	Depth Below Sea Floor (m)	Cored (m)	Recovered (m)	Recovery (%)
1	17	1420	5687.0-5687.0	0.0-0.0	CC	CC	–
2		1640	5696.5-5706.0	9.5-19.0	9.5	1.9	20
3		1845	5734.5-5744.0	47.5-57.0	9.5	5.0	52
4		2105	5782.0-5791.5	95.0-104.5	9.5	2.3	24
5		2355	5848.5-5858.0	161.6-171.0	9.5	1.0	11
6	18	0205	5858.0-5867.5	171.0-180.5	9.5	9.0	95
7		0400	5867.5-5877.0	180.5-190.0	9.5	4.3	47
8		0600	5877.0-5886.5	190.0-199.5	9.5	7.7	81
9		0745	5886.5-5896.0	199.5-209.0	9.5	5.1	54
10		0955	5896.0-5905.5	209.0-218.5	9.5	0.4	4
11		1155	5905.5-5915.0	218.5-228.0	9.5	0.5	5
12		1450	5915.0-5924.5	228.0-237.5	9.5	1.6	17
13		1705	5924.5-5934.0	237.5-247.0	9.5	0.2	2
14		1955	5934.0-5943.5	247.0-256.5	9.5	1.3	14
15		2150	5943.5-5953.0	256.5-266.0	9.5	1.4	15
16	19	0000	5953.0-5952.5	266.0-275.5	9.5	0.9	10
17		0200	5962.5-5972.0	275.5-285.0	9.5	CC	1
18		0400	5972.0-5981.5	285.0-294.5	9.5	0.2	2
19		0615	5991.0-6000.5	304.0-313.5	9.5	6.5	68
20		0805	6000.5-6010.0	313.5-323.0	9.5	1.8	19
21		1030	6019.5-6029.0	332.5-342.0	9.5	4.2	44
22		1240	6029.0-6038.5	342.0-351.5	9.5	7.3	77
23		1445	6048.0-6057.5	361.0-370.5	9.5	4.5	47
24		1715	6067.0-6076.5	380.0-389.5	9.5	2.3	24
25		1950	6086.0-6095.5	399.0-408.5	9.5	3.3	35
26		2245	6105.0-6114.5	418.0-427.5	9.5	2.8	30
27		0140	6124.0-6133.5	437.0-446.5	9.5	2.8	30
28		0405	6133.5-6143.0	446.5-456.0	9.5	4.2	44
29		0650	6152.5-6162.0	465.5-475.0	9.5	3.2	34
30	20	0915	6171.5-6181.0	484.5-494.0	9.5	5.0	53
31		1220	6190.5-6200.0	503.5-513.0	9.5	6.2	65
32		1440	6209.5-6219.0	522.5-532.0	9.5	4.6	48
33		1725	6219.0-6221.0	532.0-534.0	2.0	1.7	85
34		2100	6221.0-6228.5	534.0-541.5	7.5	3.7	49
35	21	0200	6228.5-6238.0	541.5-551.0	9.5	7.0	74
36		0450	6238.0-6239.5	551.0-552.5	1.5	1.3	87
37		0820	6239.5-6247.5	552.5-560.5	8.0	3.6	45
38		1210	6247.5-6257.0	560.5-570.0	9.5	6.1	63
39		1755	6257.0-6266.5	570.0-579.5	9.5	0.9	10

Note: Echo-sounding depth = 5677 meters; echo-sounding depth at bottom = 5687 meters.

parent Cretaceous sequence. On this basis the top 11 cm of Core 5 represents a displaced sample of Unit 2 and the boundary between Units 2 and 3 is placed at 142 meters.

Unit 3 (142.0-427.5 m)

Unit 3 consists of stiff brown clay and brown and gray claystone. Two discrete subunits are recognizable and are described separately.

Subunit 3A (142.0-209.0 m)

This subunit consists of stiff clay varying in color from dark yellowish brown to moderate brown. It contains 2%-15% zeolites, and these are most abundant in sections where calcium carbonate is absent. The zeolite content is generally in the 1%-5% range, but in Core 8 it rises to 15%-20%. A thin interval of iron-oxide clay lacking both zeolite and calcium carbonate occurs near the top of this subunit in Core 5.

Subunit 3A contains a fauna of arenaceous foraminifera of Upper Cretaceous age, no Radiolaria and only one rare species of indigenous nannofossil.

Subunit 3B (209.0-427.5 m)

This thick subunit consists of very uniform semilithified dark-gray layered claystone.

The top 10 meters, represented by Core 10, are brown clay with trace amounts of quartz, feldspar, and iron oxide. The remainder of the unit is predominantly dark-gray claystone layered on a small-to-microscopic scale. The layering is reflected in conspicuous horizontal streaks having a thickness of about 1 mm and, in some cores, there is a regular alteration of light and dark streaks. In the upper part of the unit (particularly in Cores 11 and 15) light-gray streaks occur in a darker-gray groundmass, whereas in the lower part of the subunit (particularly in Cores 19, 21, 22, and 24-26), dark-gray to black streaks occur in a lighter-gray groundmass. Cores 14, 16-18, 20, and 23 lack laminae or streaks; in Cores 12 and 15, the clay is speckled.

The claystone consists of 96%-100% clay and contains a wide variety of minor components including quartz, feldspar, heavy minerals, carbonate fragments, dolomite, chlorite, barite, and iron oxide. Thin intervals,

TABLE 2
Major Lithologic Units of Site 261

Interval (m)	Unit	Description	Age	Thickness (including gaps) (m)	Cores
0.0-19.0	1	Soft gray radiolarian and diatom-rich clay	Quaternary	19.0	1, 2
19.0-142.0	2	Soft-to-stiff gray nanno ooze and clay	Upper Miocene or younger	123.0	3, 4
142.0-209.0	3A	Stiff brown zeolite bearing clay with minor iron-oxide clay at top	Upper Cretaceous (Probably Coniacian or younger)	67.0	5-9
209.0-427.5	3B	Semilithified gray claystone	Cretaceous (probably lower)	218.5	10-26
427.5-532.5	4	Semilithified intermittently calcareous claystone becoming increasingly nanno rich towards base	Lower Cretaceous-Upper Jurassic (Upper Oxfordian to Hauterivian, Cores 28-33)	105.0	27-33
532.5-579.5		Basalt		47.0	33-39

rich in carbonate fragments, occur in Cores 15, 19, 22, and 23. They may be turbidites and warrant further investigation.

The whole subunit is devoid of nannofossils. Arenaceous foraminifera occur in Cores 11-13 and 20 and Radiolaria occur throughout the subunit, except in Core 20. Limonite-filled horizontal burrows occur in Sample 11-1, 145-150 cm.

Unit 4 (427.5-532.5 m)

Unit 4 consists of semilithified brown claystone, intermittently calcareous due to the presence of nannofossils, but with barren intervening clay. A spectacular burrow occurs in Sample 30-3, 110-111 cm (Figure 4). Nannofossils are present, up to 65% by volume (Sample 29, CC), primitive arenaceous foraminifera occur in Core 29, diverse arenaceous foraminifera in Cores 29 and 30 and *Nannoconus colomi* in Cores 30 and 31. Barite is present in Sample 33, CC.

The lowermost 5 meters of Unit 5 consist of semilithified brown nanno claystone, intermittently calcareous. Nodules are also locally present and biogenic sedimentary structures occur in Sample 32-2, 56-74 cm; a single burrow occurs in Sample 32-4, 148 cm.

Basalt

Basalt was first encountered at a depth of 532.5 meters. The contact with the overlying sediments is steep, approximately 40° from vertical, and the sediments are clearly baked and discolored. The basalt itself is fresh, relatively coarse grained, and compact. These features all indicate an intrusive origin for the uppermost basalt. At a depth of approximately 10 meters below the contact, the coarse-grained basalt passes sharply into a darker, finer-grained, and more highly altered basalt. Although not brecciated, it is highly fractured and cut by numerous veinlets of calcite. This basalt, about 3 meters thick, is separated from a lower fine-grained basalt by about 2 meters of soupy breccia composed of fragments of basalt and mudstone. Sedimentary fragments in the breccia contain fossils from all younger units in this hole, strongly suggesting that they represent material slumped into the hole during drilling rather than a sedimentary interbed in the basalt sequence.

Below this soupy breccia is a sequence of basalt breccia typical of oceanic basement. Individual fragments range from 10 to 25 cm across and have generally rounded margins. Most of the fragments are separated by zones of dark, altered glass. Veins and masses of white and red calcite are abundant and chlorite and clay are locally present.

Based on the above relationships, the basalt at this site is divided into 3 units; a basal pillow breccia which passes upward into fine-grained, highly fractured basalt and a medium-grained basalt sill, about 10 meters thick, which was intruded between the underlying basalt and the overlying sediments.

The sill consists of dark-greenish-gray, fine- to coarse-grained nonporphyritic basalt with an intergranular to subophitic texture. Sparse vesicles rarely exceed 0.5 mm in diameter and are filled with clay and calcite. Plagioclase makes up 50%-60% of typical specimens; the remainder consists of augite, magnetite, and clay minerals with traces of calcite. The plagioclase occurs in subhedral laths up to 1.5 mm long. Most of it is labradorite and only the larger crystals show noticeable zoning. Augite has a wide range in grain size. In fine-grained portions of the basalt, it occurs in sheaf-like masses associated with plagioclase in variolitic clusters. In coarser-grained areas, the augite occurs as small interstitial granules which, with increasing grain size, grade into subophitic plates up to 1 mm across. All the clinopyroxene is pale-brown to pinkish-brown augite with a $2V_z$ of 35°-45°. Magnetite occurs as tiny octahedra generally interstitial to the other minerals. The clay, which is greenish-gray birefringent montmorillonite, occurs in interstitial patches and probably formed by alteration of glass. A few larger masses have shapes suggestive of olivine crystals and may be pseudomorphs.

Both the clinopyroxene and the plagioclase are fresh with no significant replacement by clay.

The pillow basalt is fine grained and nonporphyritic with an intersertal to intergranular texture. The average grain size is about 0.3 mm and no crystals are larger than 0.5 mm. Vesicles are rare and never exceed 0.5 mm in diameter. This basalt is mineralogically similar to that of the overlying sill, being composed chiefly of labradorite, augite, iron oxide, and clay. A typical mode is labradorite 45%, augite 10%, iron oxide 15%, and clay 30% with trace amounts of calcite. The abundant clay in these rocks is due to extensive alteration of both clinopyroxene and plagioclase. The clinopyroxene is most extensively altered with small crystals being completely replaced and larger crystals being marginally altered. Alteration of plagioclase is generally restricted to the cores of larger crystals, suggesting some original compositional zoning. The iron oxide occurs in small octahedra and in subhedral laths up to 0.4 mm long, suggesting the presence of both magnetite and ilmentite. Most of the clay is very pale green and fairly coarsely crystalline. A few patches of bright-green finely crystalline "bowlingite" are probably pseudomorphs after olivine. These patches range from 0.2 to 0.3 mm across and are euhedral and subhedral in shape. They make up less than 1% of the specimens examined. Calcite occurs chiefly as veinlets and vesicle fillings where it is associated with clay but it also forms masses up to 5 cm across between individual fragments.

The lowest sequence is considered to be typical tholeiitic oceanic basement. The middle sequence, either a flow or sill, is somewhat alkaline in character. The upper sequence of coarser-grained sill is tholeiitic.

Preliminary Interpretations

Unit 1, the Quaternary sediments of the area, are greenish-gray clay containing chiefly Radiolaria but also other siliceous fossils. Calcareous nannofossils are present in trace amounts. The unit is interpreted as an abyssal pelagic sediment which formed below the calcium carbonate compensation depth.

Unit 2 is a stiff greenish-gray nanno ooze and nanno-rich clay. It is represented by 7-8 meters of core in an interval of 52.5 meters. The age of Unit 2 is not older than lower Pliocene at its top and not older than lower Pliocene-upper Miocene at its base.

The high calcium carbonate content of Unit 2 is in marked contrast to Unit 1. Unit 2 consists chiefly of nanno ooze with some detrital foram ooze and clay, indicating a predominantly pelagic sequence with a few calcareous turbidite layers.

The zeolite-bearing brown clay of Subunit 3A contains allochthonous Quaternary nannofossils, whereas the predominantly gray claystone of Unit 3B contains Radiolaria. The clays are probably pelagic sediments formed below the carbonate compensation depth (CCD). The minor calcareous beds may represent turbidite intercalations.

The claystone of Unit 4 resembles that of Subunit 3B in some respects, but it is predominantly brown in color and intermittently calcareous, with the calcareous content in the form of nannofossils increasing towards the base. Biogenic sedimentary structures are also common in Unit 4, again particularly near the base (Figure 4). The clay is probably a pelagic sediment deposited in a gradually deepening environment, until finally the sea bed lay below the CCD. After this time, the radiolarian-bearing gray claystone of Subunit 3B was formed.

The sedimentary sequence on the whole has the character of abyssal clays, some of which appear to have been deposited above the calcium carbonate compensation depth, and some below it. Whether this level in the ocean has fluctuated with time or whether there have been changes in the depth of water cannot be determined at present.

Glomar Challenger approached Site 261 from the southwest. As the ship approached the site the Sonar Reflection Profile (SRP) showed a decline in the intensity of reflectivity of the sediment layer immediately below the sea bottom. Before Site 261 was reached, this reflecting horizon had virtually disappeared. The absence of turbidite sands in the late Cenozoic of Site 261 suggests that this site lies beyond the limit of turbidity current transport of sand and silt on the abyssal plain. It apparently lies in an area where only the clay fraction of turbidites and pelagic clays are deposited.

This situation has persisted since the Upper Jurassic.

Figure 4. *Sample 30-3, 110-111 cm. Strongly burrowed claystone of Unit 4.*

BIOSTRATIGRAPHY AND PALEONTOLOGY

General

Quaternary radiolarian ooze was recovered from the two top cores (0.0-19.0 m). Cores 3 (47.5-57.0 m) and 4 (95.0-104.5 m) yielded rich but heterogeneous planktonic foraminiferal oozes from turbiditic sediments not older than lower Pliocene and upper Miocene, respectively. Core 5, (161.5-171 m) is Upper Cretaceous in age. The Tertiary at Site 261 is thus just as incomplete as the sections at Sites 259 and 260, where some Paleogene was recovered in addition to the Neogene.

The characteristic agglutinated foraminiferal fauna in the brown clays of Cores 5-8 (161.5-199.5 m) are indicative for Upper Cretaceous sediments deposited below the lysocline. The Cretaceous sequence of Cores 9-27 (199.5-446.5 m) carries a very poor, monotonous arenaceous foraminiferal fauna, but is virtually void of nannoplankton; Radiolaria vary from rare to abundant, but only permit a Cretaceous s.l. age determination because of poor preservation. Dinoflagellates abound in most of Cores 14-26. They give an Aptian age for Cores 21-26 and upper Aptian or lower Albian age for Cores 14-17.

A distinct faunal change takes place in the interval of Cores 28-33 (446.5-534.0 m) where basement was encountered. Arenaceous and also calcareous benthonic foraminifera become increasingly more frequent with depth, nannoplankton are abundant, and dinoflagellates are absent to rare. Calcisphaerulidae and prisms of Inoceramus are present in Cores 31-33, both as floods in Cores 32 and 33. The age based on nannoplankton of this lowermost part of Site 261 is Hauterivian or Valanginian for Core 28, Valanginian for Cores 29-31, Tithonian-Kimmeridgian for Core 32, and upper Oxfordian for Core 33. The fairly rich and diverse foraminiferal fauna does not contain good index fossils, although some species are indicative for Upper Jurassic. The scarce dinoflagellates in Core 32 are reported to be diagnostic for a Kimmeridgian-Tithonian age.

Figure 5 summarizes the biostratigraphy of Site 261.

Biostratigraphy

Quaternary: Cores 1, 2 (0.0-19.0 m). Diagnostic radiolarian ooze, with high diversity of species. Foraminifera are virtually absent. The scarce heterogeneous nannoplankton in Core 1 indicate the *Emiliania huxleyi* Zone.

Lower Pliocene or younger: Core 3 (47.5-57.0 m). Assemblage of abundant, minute, and well-sorted planktonic foraminifera, somewhat heterogeneous, including the lower Pliocene zonal marker *Globorotalia margaritae.* Nannoplankton and Radiolaria are absent.

Upper Miocene or younger: Core 4 (95.0-104.5 m). Rich, heterogeneous planktonic foraminiferal assemblage. *Globogerina nepenthes, Globigerinoides obliquus extremus,* and a mixture of nannoplankton species are indicative for this age. Radiolaria are absent.

Upper Cretaceous (probably Coniacian or younger): Cores 5-8 (161.5-199.5 m). The brown clays of this interval can be subdivided into two units based on the characteristic agglutinated (siliceous) foraminifera. The upper unit, Cores 5 and 6, include foraminifera of an upper assemblage with *Praecystammina globigerinaeformis*; the lower unit, Cores 7, 8, is characterized by a lower assemblage with *Haplophragmoides lueckei.* Calcareous foraminifera, nannoplankton, and Radiolaria are absent. The interval is considered to have been deposited below the lysocline. The arenaceous fauna is the same as in Core 6 at Site 260, where it occurs with planktonic foraminifera, and on which the age interpretation is based.

Cretaceous (Coniacian to Albian): Cores 9-12 (199.5-237.5 m). The age is based on frequent Radiolaria. Arenaceous foraminifera are very rare; nannoplankton and dinoflagellates are absent.

Cretaceous s.l.: Core 13 (237.5-247.0 m). The age is based on Radiolaria.

Lower Cretaceous: Cores 14-27 (247.0-446.5 m). Upper Aptian to lower Albian, based on dinoflagellates. Very poor arenaceous foraminiferal faunas; Radiolaria are present in variable frequency and nannoplankton are virtually absent.

Lower Cretaceous: Core 28-Core 31, Section 3 (446.5-513.0 m). Valanginian-Hauterivian, based on nannoplankton., Valanginian, based on benthonic foraminifera. Arenaceous foraminifera become gradually more frequent downward from Core 28. Calcareous benthonic foraminifera appear first in Core 30 and become common in Cores 31-33. The frequency of Radiolaria is variable and dinoflagellates are absent.

Upper Jurassic: Core 31, Section 4-Core 33, Section 1 (522.5-532.2 m) Core 31, Section 4-Core 32, Section 2, Tithonian. Core 32, Section 3-Core 32, CC, Kimmeridgian. Core 33, Section 1, Oxfordian. Based on nannoplankton. The foraminiferal assemblage with common arenaceous and calcareous benthonic foraminifera does not contain really diagnostic species for either the Upper Jurassic or Lower Cretaceous, though some Upper Jurassic species do occur. A poor dinoflagellate assemblage in Core 32 is dated as Kimmeridgian-Tithonian, the same age as indicated by the nannoplankton. The abundant Inoceramus prisms and the few ostracods do not permit an age assignment; Radiolaria are absent. The faunal evidence of the bottom cores points to a fairly shallow environment, with a rapid deepening, probably below lysocline level, from Core 30 upward. Deep-water conditions apparently prevailed until Core 5.

Paleontology

For more information on the individual fossil groups briefly discussed below, refer to the special reports in this volume.

Foraminifera

Cores 1 and 2 (0.0-19.0 m) contain radiolarian ooze with only very rare *Milionella* sp. Cores 3 and 4 (47.5-57, 95-104.5 m, respectively) have abundant heterogeneous planktonic foraminifera. Present are species of the genera *Globigerina, Globigerinita, Globigerinoides, Globorotalia* with *G. margaritae* in Core 3. *Globigerina nepenthes* and *Globigerinoides obliquus extremus* are present in Core 4. Core 5 to Core 8, Section 5, (161.5-

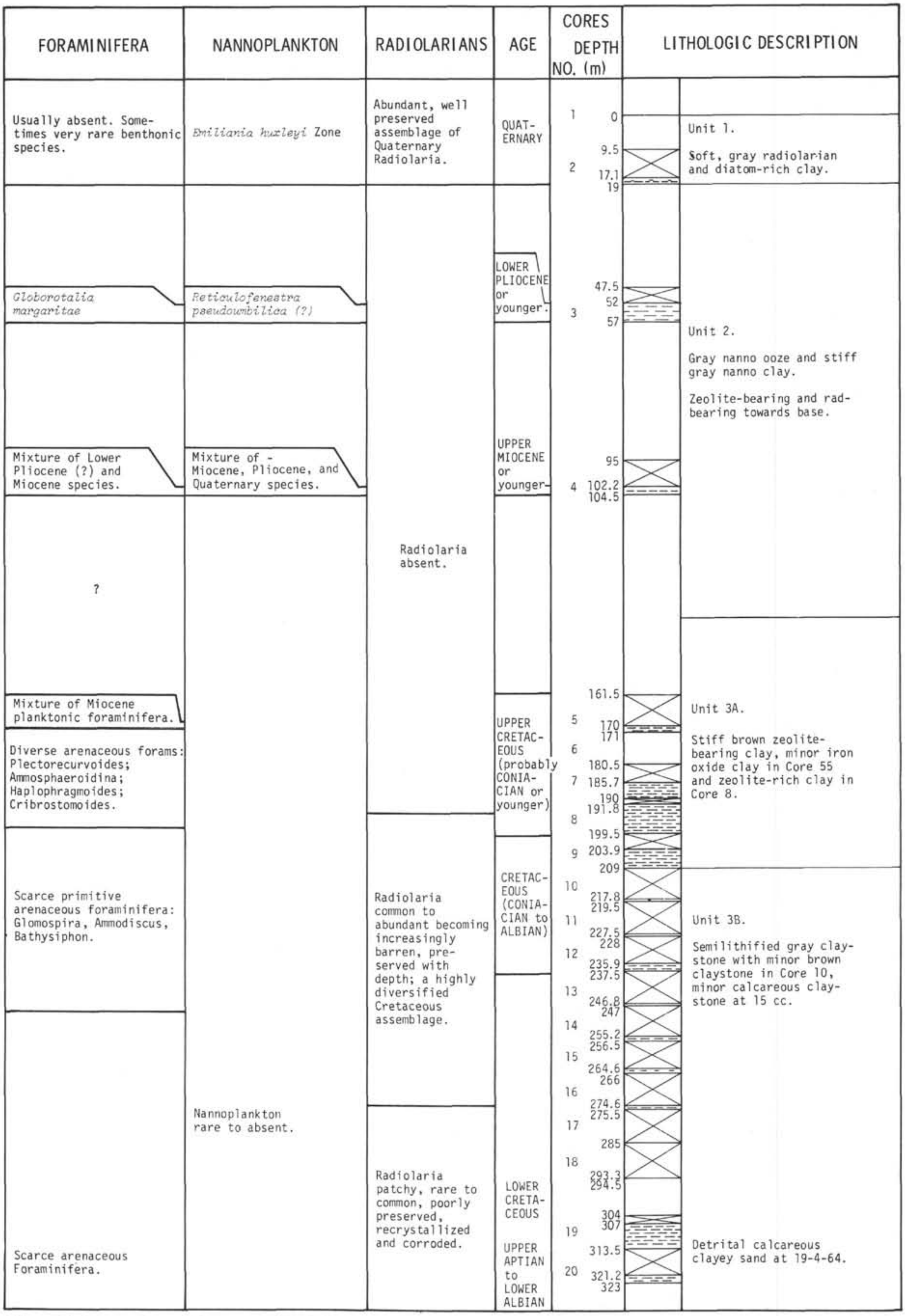


Figure 5. *Biostratigraphic zones, Site 261.*

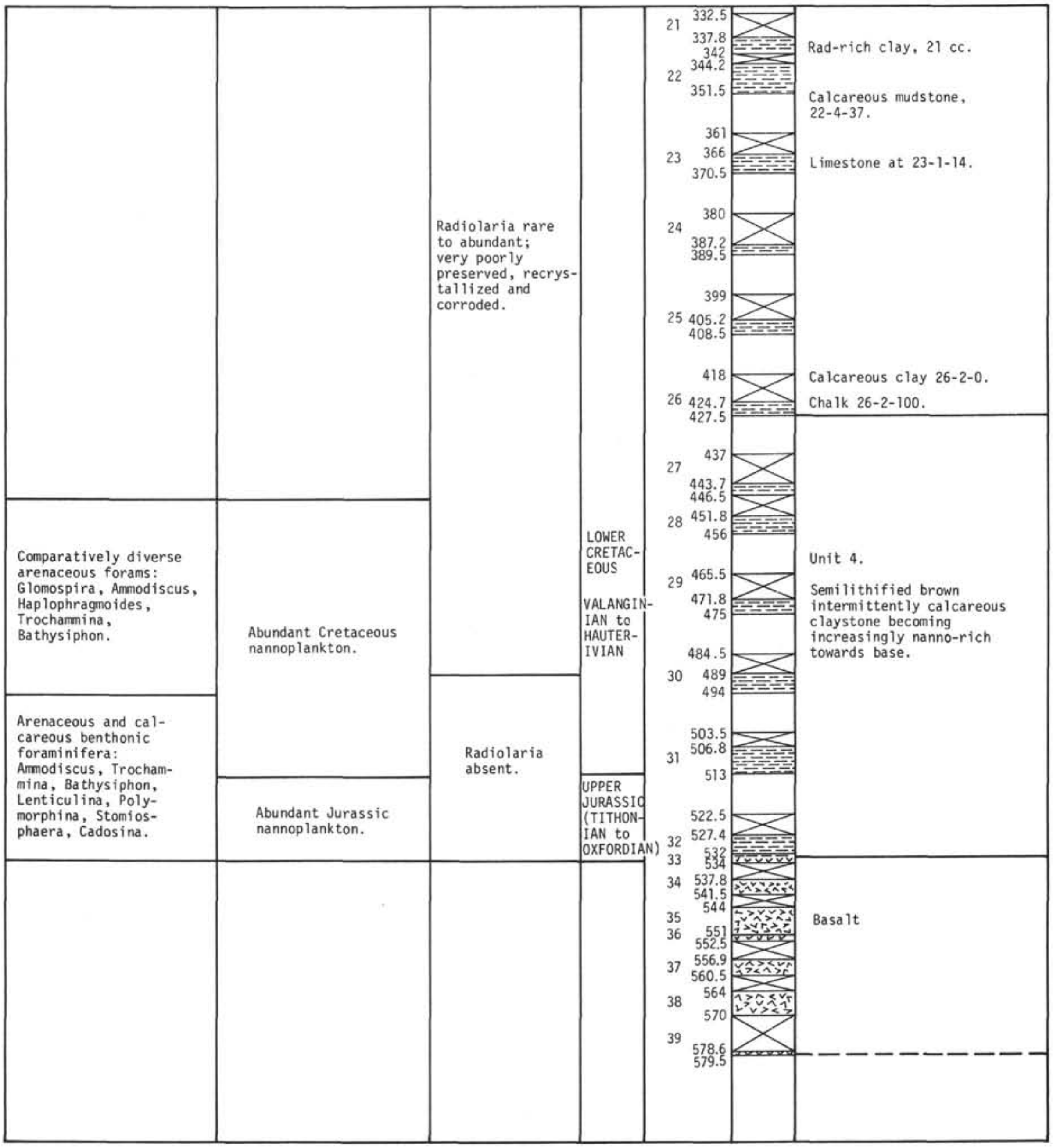


Figure 5. *(Continued).*

197.5 m): the characteristic small arenaceous siliceous foraminifera of this interval are subdivided into two assemblages. An upper (Cores 5, 6) containing *Praecystammina globigerinaeformis*, accompanied by such species as *Plectorecurvoides parvus*, *Labrospira pacifica*, and *Trochammina gyroidinaformis*. The lower assemblage with *Haplophragmium lueckei* contains *Plectorecurvoides rotundus*, *Labrospira inflata*, and *Trochammina insueta*.

Cores 9-27 are characterized by very poor arenaceous foraminifera that are distinct from those of the above interval. Present are *Ammodiscus* sp., *Glomospira* sp., *Bathysiphon* sp., and *Hyperammina* sp.

Beginning with Core 28, the arenaceous fauna becomes increasingly rich and diversified. The first calcareous benthonic species occur in Core 30. These, together with the arenaceous forms, are also common in Cores 31-33. The most frequent genera of arenaceous foraminifera are *Bathysiphon*, *Kalamopsis*, *Hyperammina*, *Glomospira*, *Ammodiscus*, *Haplophragmoides*, *Trochammina*, and *Textularia Lenticulina*, *Astacolus*, *Vaginulina*, and *Nodosaria* are the common calcareous benthonic forms present.

Nannoplankton

Core 1, CC contains scarce but well-preserved calcareous nannoplankton. The assemblage composed of *Gephyrocapsa oceanica*, *Emiliania huxleyi*, *Pseudoemiliania lacunosa*, *Reticulofenestra pseudoumbilica*, and *Discoaster brouweri* is mixed in age and is referred to the Holocene *Emiliania huxleyi* Zone.

Core 2 (9.5-19.0 m) is barren of calcareous nannoplankton. A mixture of Pliocene and Miocene taxa in Cores 3 and 4 (47.5-57.0 m, 95.0-104.5 m, respectively) is interpreted as a result of Pliocene turbidite sedimentation.

Calcareous nannoplankton are absent in Cores 5 and 27 (161.5-446.5 m).

Cores 28-33 (446.5 m to the sediment-basalt contact at 532.0 m) contain a continuous sequence of homogeneous nannoplankton assemblages from Hauterivian or Valanginian to upper Oxfordian. The diagnostic upper Oxfordian species are *Watznaueria manivitae* (= *Coccolithus deflandrei Auct.*), *W. britannica*, *Zygodiscus salillum*, and *Stephanolithion bigoti* in Core 33.

Radiolaria

Samples of the top two cores contain a very well preserved assemblage of Quaternary radiolarians in which species diversity is high (100 species) and specimens are abundant. Typical species, in order of decreasing abundance are, *Ommatartus tetrathalamus*, Pyloniidae group, *Stylodictya* sp. aff. *S. multispina*, *Euchitonia mülleri*, *Dictyocoryne profunda*, *Spongaster tetras tetras*, *Spongotrochus multispinus*, *Pterocanium praetextum*, *P. trilobum*, *Lamprocyclas maritalis*, *Lithopera bacca*, *Carpocanistrum* spp., and *Centrobotrys thermophila*.

Radiolaria are generally absent in samples from Cores 3-8 although an abundant assemblage appears in Core 8, Sections 3-5. The preservation of these specimens is extremely poor, making an age determination impossible. Three radiolarian assemblages of particular interest occur in the interval between Cores 9-23. In this interval radiolarians are most abundant and diverse and show the best preservation in Cores 12-16.

The three assemblages from youngest to oldest are:

1) *Bathropyramis timorensis* assemblage. It is characterized by the presence of *Eucyrtidium*(?) *boodes*, *Theocapsa elata*, and *Bathropyramis timorensis* and is based on four samples from Core 9. All three species have their lowest occurrence in Core 9, CC.

2) *Eucyrtis columbarius* assemblage. Associated species are *Eucyrtis hanni*, *E. bulbosus*, *E. columbarius*, *Lithocampe chenodes*, *Dictyophimus gracilis*, *Crucella espartoensis*, *Spongocyclia trachodes*, *?Tripodictya elegantissima*, *Stylosphaera pusilla*, *Eucyrtidium vermiculatum* with several species of *Spongopyle* and *Dictyomitra*. The assemblage has its highest occurrence in Core 12 and its lowest in Core 23. Most of the ten species mentioned above reach the top of their ranges in Core 12, a few in Core 10. Core 11 is a silicified claystone.

3) *Spongocyclia lanigera* assemblage. Characteristic species include Hagiastrid 1 gen. and sp. indet., *Lithocyclia* (?) sp. A, and *Spongocyclia lanigera*. These three species reach the top of their range in Core 15 and cooccur with the species of the *E. columbarius* assemblage through Core 23.

All three assemblages have these interesting aspects: (1) a complete absence of the family Artostrobiidae; (2) a complete absence of the family Pseudoaulophacidae; (3) a paucity of species in the families Willieriedellidae (1) and Amphipyndacidae (3).

Samples from Cores 24-35 (except 25, 26, 33, and 34 where the material is lithified) generally contain sparse, recrystallized, and badly corroded Radiolaria. Age is indeterminate.

Palynomorphs

Dinoflagellates are abundant in Cores 14-16 and 21-26, and present also in Core 32.

The assemblage in Cores 14-16, with the joint occurrence of *Odontochinata costata* and *Cleistosphaeridium ancoriferum* suggestive for Albian, and with *Muderongia mcwhaei* and *M. tetracantha* indicative for Aptian, poses some age problems. Reworking of the older forms must be considered, but it is also possible that the total ranges of these species may not yet be fully established.

Cores 21-26 contain a typical Aptian assemblage with *Pterodinium cornutum*, *Broomea micropoda*, and others. Core 32, Section 3 contains one specimen of a Kimmeridgian-Tithonian dinoflagellate, and Core 32, Section 2 some Upper Jurassic forms. These rare occurrences may be due to reworking and the age indicated by them has therefore to be regarded with some caution.

Recovery of pollen and spores was low, those from Cores 16, 24 and 26 are consistent with a Lower Cretaceous age.

Calcisphaerulidae

Three of the described *Pithonella* species occur only in Cores 31-34 (503.5-532.2 m), which are dated on nannoplankton as Valanginian, Kimmeridgian/Tithonian, and upper Oxfordian, respectively. One of the three species, *Pithonella thayeri*, a characteristic species whose test is formed by large, irregularly shaped calcite crystals, occurs in floods in Cores 32 and 33.

Ostracods

The only Cretaceous ostracod fauna is from Core 33, just above basement, from beds dated by nannoplankton as upper Oxfordian. The fauna consists of seven poorly preserved microforms, each obviously belonging to a different species left in open nomenclature here.

Molluscs

Numerous small prisms of disintegrated *Inoceramus* sp. indet. occur in Cores 31-33 (503.5-532.2 m).

Fish debris

Fish debris is abundant to common in Cores 5-9 (161.5-209.0 m), the Upper Cretaceous and Cretaceous s.l. sediments presumably deposited below the lysocline. It is virtually absent in Cores 10-28 (209.0-456.0 m), but again becomes common to frequent in Cores 29-31 (465.5-513.0 m).

GEOCHEMICAL MEASUREMENTS

Interstitial water samples were collected from seven cores at Site 261. Results are given in Table 3 and illustrated in Figure 6. Analytical methods used are detailed in the summary for Site 259.

*p*H

Because only three "punch-in" *p*H values were obtained, this discussion is limited to the "flow-through" results. There is no systematic change in *p*H down the hole, however, there is a correlation between lithology and *p*H, with high *p*H values (8.41-8.47) being restricted to semilithified, noncalcareous claystone. It is probable that the high *p*H values are primarily the result of diagenesis because this unit contains a diverse assemblage of authigenic minerals (see section on Lithology for Site 261, above).

Alkalinity

Alkalinity values at Site 261 are consistently low; this is compatible with the slow sedimentation rate which is evident at this site. The gradual decrease of alkalinity down the hole is probably a diagenetic feature.

Salinity

Most salinity values in the sediments are slightly higher than those in seawater, reaching a maximum of 37.1‰ at a depth of 456 meters below the sea floor. These values are unlikely to be environmentally significant and were probably developed post-depositionally. However, the data from this site are insufficient for any positive conclusions to be reached.

PHYSICAL PROPERTIES

Bulk-density, sound-velocity, porosity, and vane shear-strength measurements were made on sediments recovered at Site 261. A non-continuous coring program and poor recovery within the upper 160 meters limited physical-properties testing in this sequence to sediments recovered at 50 and 100 meters. The behavior of physical properties at shallow depth is therefore largely masked. Continuous coring began at 160 meters, but recovery was exceptionally poor, evidently the result of alternating layers of soft and indurated clays. Density, porosity, and sonic velocity are plotted alongside the site summary sheets. Continuous GRAPE density (and porosity) are plotted alongside the core photographs. A description of the testing procedures, and discussion of wet bulk-density determinations and vane shear-strength results are included in later chapters in Part IV.

Density and Porosity

Wet bulk density was measured by continuous GRAPE, water-displacement, and syringe methods. Static GRAPE measurements were also made on sample cylinders in soft material and on cubes cut from lithified sediment. Clay density increases moderately from 1.45 g/cc at 50 meters to 1.70 g/cc at 200 meters. A higher bulk density of nanno ooze than clay at the same depth is again evident at Site 261. Ooze density increases from 1.70 to 1.76 g/cc between 50 and 100 meters, and is approximately 0.2 g/cc higher than clay density at these depths. Some radiolarian clay (at 18 m) and coarse detrital foram ooze (at 56 m) was found in layers too heavily disturbed for testing. Between 104 and 200 meters only soft clays, with traces of several minerals and up to 20% nannofossils, were recovered. Below 209 meters density shows considerable variation between adjacent clays, depending on degree of lithification. The claystone is consistently 0.1-0.3 g/cc more dense than adjacent hard clay. Density increases erratically from 230 to 430 meters but changes little after this level until basalt is encountered at 532 meters. The density of recovered basalt varies from 2.6 to 2.9 g/cc with lower densities corresponding to basalt specimens with larger calcite veins.

The true in situ density profile is likely to appear "stepped" over the depth range where alternating clay and ooze layers are present, and where claystone is interbedded with softer clay layers. The high and low measured values, in fact, probably underestimate the true range of density variation.

Porosity data plotted on the site summary sheets were determined from continuous GRAPE readings and from syringe samples. Syringe porosity data are biased towards the high values since the test can only be made in the softer materials. Porosity variation follows variation in bulk density very closely. A continuous plot of porosity is available from the GRAPE data by using the variable porosity scale to read the GRAPE density trace. The sediment mineral grain density determines the appropriate porosity scale.

Sonic Velocity

Sound velocity in the softer clay and ooze increases steadily from 1.50 km/sec at 18 meters to 1.80 km/sec above the basalt. However, a large number of measurements on stiff or indurated clays yielded sonic velocities considerably higher, many as high as 2.4 km/sec. Between 390 and 455 meters all measurements were above 1.9 km/sec. Basalt sonic velocity varied from 4.0 to 6.0 km/sec, with lower values corresponding to basalt specimens with large calcite veins.

Velocity measurements made in the horizontal and vertical directions on four trimmed claystone specimens showed velocity parallel to bedding to be higher by 4-8%. This behavior has been identified in other materials recovered on Legs 25 and 26 where similar strong horizontal bedding is present. It is also present at Site 263, where a larger number of comparisons were made.

CORRELATION OF SEISMIC REFLECTION PROFILE WITH DRILLING RESULTS

The seismic profile of Site 261 and environs is given by the vertical incidence profile (Figure 7) and the on-site drifting sonobuoy profile (Figure 8), both taken from *Glomar Challenger* on Leg 27, augmented by the nearby profile of *Vema*-28. A profile from *Glomar Challenger* Leg 22 passes within two miles to the north. The positions of all the tracks are given in Figure 3.

Reflectors at Site 261 are given in Table 4.

Veevers, et al. (1972) subdivided the *Vema*-28 profile of the Argo Abyssal Plain into three parts:

1) A bundle of regular fine reflectors, up to 0.7-sec thick, that laps unconformably over L and M reflectors;

2) An interval of less reflective sediment, bounded by L and M, and up to 0.3-sec thick, that drapes M; and

3) An obscure interval between M and N. M is a strong reflector that consequently passes little energy for reflection to and from N. Of the reflections, L and M, and possibly N, were identified in *Glomar Challenger* records, and additional reflectors 1, 3, 4, and 5 were distinguished (Table 4).

The first indurated sediment, at 215 meters, is correlated with reflector 3 at a reflection time of 0.29 sec, which gives an interval velocity for the overlying sediment of 1.5 km/sec, and, with allowance for the

TABLE 3
Summary of Shipboard Geochemical Data, Site 261

Sample (Interval in cm)	Depth Below Sea Floor (m)	pH Punch-in	pH Flow-through	Alkalinity (meq/kg)	Salinity (‰)	Remarks
		8.33	8.25	2.35	34.4	Reference seawater
3-2, 0-10	52.5-52.6	7.79	7.38	2.54	35.2	
4-2, 0-10	103.0-103.1	7.56	7.37	2.25	34.9	
6-5, 0-6	177.5-177.56	6.98	6.98	2.05	34.4	
19-4, 0-6	310.5-310.56	–	8.41	1.27	34.9	
23-3, 0-6	369.0-369.06	–	8.47	1.56	36.0	
28, CC	456	–	7.29	0.49	37.1	
31-5, 0-6	511.5-511.56	–	7.54	0.98	35.2	
		8.26	8.20	2.54	34.6	Reference seawater

different conditions, this corresponds with the velocity measured in the laboratory (see section on Physical Properties, above). Reflector 2 (L) is computed to lie at a depth of 142 meters, near a lithological boundary (though little coring was done in this interval), and reflector 1 at 45 meters, corresponding to the surface transparent layer of siliceous ooze. All these depths give internally consistent interval velocities of 1.5 km/sec.

Between reflectors 3 and 6 (M), two reflectors (4 and 5) are visible, but they do not correlate obviously with boundaries in the drilled section. The scatter of measured acoustic velocities in the interval 220-532 meters does not assist in interpreting the seismic record.

Reflector 6 (M) is positively correlated with the drilling break at 532 meters, at the boundary between brown nanno clay and a basalt sill, that lies at the top of a volcanic basement complex penetrated to a depth of 47.5 meters. The deeper reflector 7(?N) must therefore be regarded as an internal multiple.

The vertical cylindrical or sheet-like bodies seen in this part of the Argo Abyssal Plain have no obvious source, such as salt, in the section penetrated at Site 261. Their shape and structural relations suggest that they are diapirs, and high plasticity and flowage under differential sediment load are probably responsible for the diapiric behavior of the transparent layer in some locations.

SUMMARY AND CONCLUSIONS

Site 261 is located in 5667 meters of water in the eastern part of the Argo Abyssal Plain, about 200 km distant from the foot of the Scott Plateau. Seismic profiles of Lamont-Doherty Geological Laboratory show two principal layers near the site: a transparent layer, up to 0.4-sec thick, that drapes an irregular-shaped reflector, unconformably overlain by a flat-lying well-stratified layer, up to 0.6-sec thick. An obscure reflector (N) lies below the sediment-basalt interface and is considered an internal multiple. The well-stratified layer is locally cut by vertical cylinders or sheets of transparent material.

One hole was drilled at Site 261 near the contact between the principal layers where only the upper part of the stratified layer is present. A total of 532.2 meters of sediment, including all of the transparent layer, and 47 meters of basalt were drilled. The oldest sediment is upper Oxfordian immediately above the basalt.

Four sedimentary units are recognized. The top 19 meters consist of Quaternary Radiolaria- and diatom-rich clay that appears in seismic profile as a surface transparent layer. It overlies a unit of nanno ooze and clay, which extends to a depth of 142 meters. The youngest elements of a heterogeneous assemblage of microfossils indicate that this interval is upper Miocene or younger. The boundary between this sequence and the underlying Upper Cretaceous brown zeolite-bearing clay is a local hiatus spanning the entire Paleogene.

The boundary was found at 170.4 meters in Core 5 but is believed to lie at 142 meters based on the presence of a major reflector at this depth. This interpretation assumes that the Miocene or younger clay in Core 5 was displaced from above.

The Cretaceous and Upper Jurassic sediments are stiff to semilithified brown to gray claystone, with nannofossils and foraminifera near the base. Most of these units are fairly pure claystone, and are characteristically layered in alternating darker- and lighter-gray bands about 1-mm thick. Rare burrows are present. The claystone ranges in age from Upper Cretaceous to upper Oxfordian.

The basalt penetrated at the bottom of the hole is divided into three units. The uppermost 10 meters is fresh, relatively coarse-grained, and compact, and the overlying sediment is baked; hence, this basalt is interpreted as a sill. The basalt below is darker, finer-grained and chemically distinct. This rests on basalt breccia interpreted to be typical oceanic basement.

Fossils show that the top one-fourth of the sediment column is upper Miocene to Quaternary, and the lower three-fourths Cretaceous and Upper Jurassic. Radiolaria occur in the uppermost unit of siliceous ooze and clay, and throughout the Cretaceous section but are sparse below Core 23. Small foraminifera and nannofossils are abundant in the lower Pliocene to upper Miocene, with only arenaceous foraminifera in the top 50 meters of the Cretaceous section. Arenaceous and calcareous benthonic foraminifera and nannofossils are present in the lowest 80 meters.

A graph of sediment thickness versus age (Figure 9) shows an average rate of deposition of about 14 m/m.y. both during the Quaternary-upper Miocene and the Cretaceous.

Deposition at Site 261 began in the late Oxfordian with the accumulation above the lysocline of brown nanno claystone on oceanic pillow basalt. After an

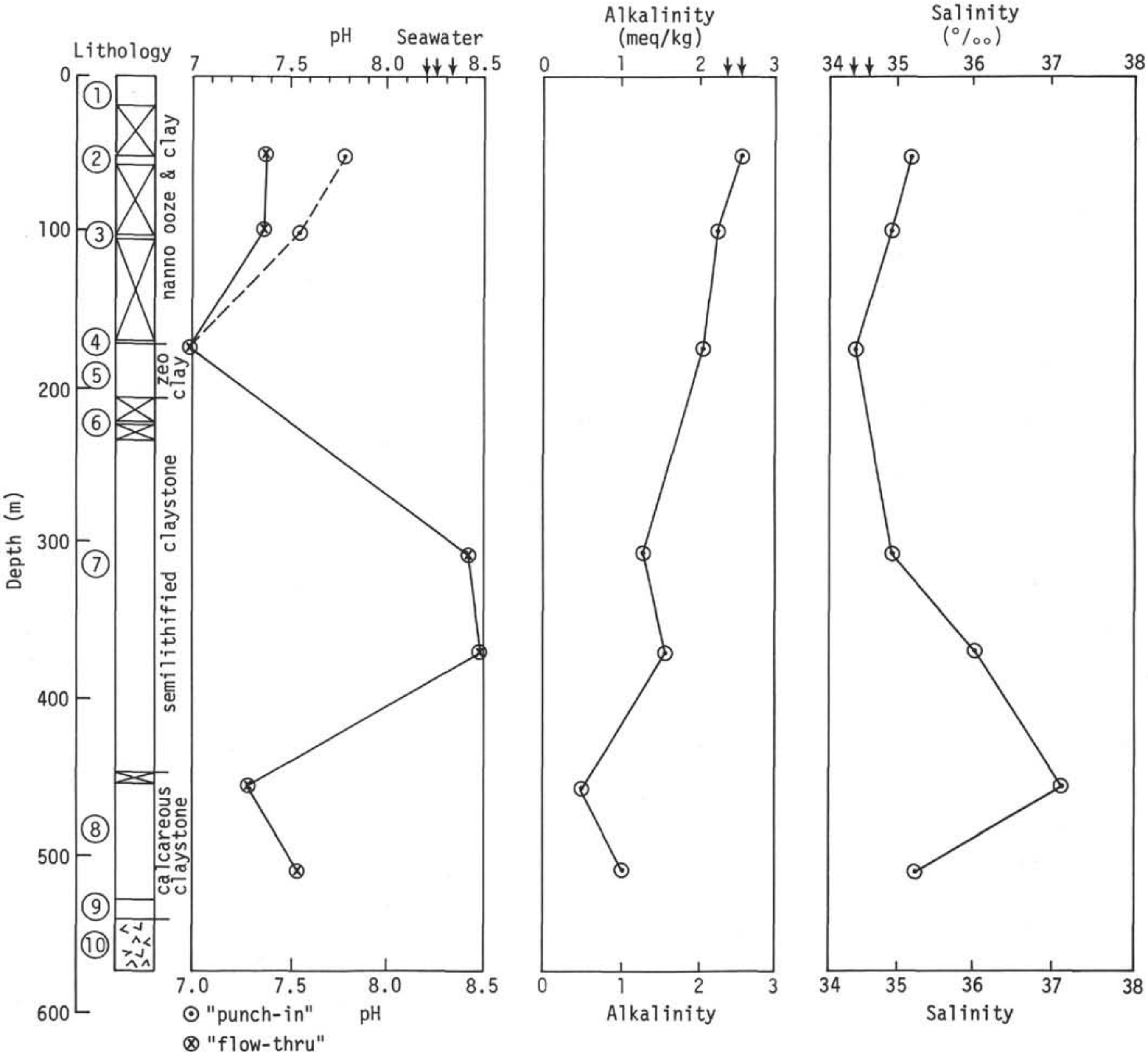


Figure 6. *Geochemical analysis of interstitial water at Site 261.*

unknown interval of time, the basalt/sediment boundary was intruded by a basalt sill.

Higher in the Lower Cretaceous, presumably above the Berriasian, the sea floor subsided beneath the lysocline, and gray claystone with Radiolaria accumulated. Rare calcareous intervals were possibly deposited from bottom currents. Similar sediments accumulated throughout the rest of the Cretaceous, except for a zeolitic clay with arenaceous forams in the top part.

Probably most of the Cenozoic section is represented elsewhere in the region by the complete section of the well-stratified layer seen in the seismic profiles. At Site 261, only the uppermost part of the well-stratified layer is present, and it dates from the upper Miocene. No obvious graded foraminiferal sands were found in the three cores recovered from this layer, but the heterogeneous assemblage of microfossils in the sediment indicates its derivation from a region above the lysocline, presumably the nearby Australian margin. The sorting of foraminifera makes these sediments similar in having about 150-170 meters of upper Miocene and younger sediment (von der Borch, Sclater, et al., 1974). During the Quaternary the area of Site 261 was not subject to deposition by gravity currents, possibly because of a slight uplift of the northern Argo Abyssal Plain in front of the lip of the Java Trench. This prevented deposition of calcareous material and allowed the accumulation of almost exclusively siliceous microfossils and clay.

The results of drilling at Site 261 disprove the notion of Veevers et al. (1971) that the Argo Abyssal Plain faced the Tethyan Ocean for an unknown period of time before the Cretaceous phase of rifting. Because the basement age is Upper Jurassic, this part of the Argo Abyssal Plain was generated at approximately the same time as the rest of the sea floor off Western Australia. The only possible difference is that the Argo Abyssal

TABLE 4
Details of Reflectors at Site 261

Acoustic Sequence	Reflector[a]	Reflection Time (sec)	Depth (m)	Interval Velocity (km/sec) Overlying Sediment	Interval Velocity (km/sec) Intermediate Layer
Surface transparent	Sea floor	0.00	0		
	1	0.06	45	1.5	1.5
Highly reflective well-stratified					1.5
	2 (L)	0.19	142	1.5	
Less reflective					1.5
	3	0.29	215[b]	1.5	
	4	0.40	–		
	5	0.51	–		2.0
Obsure	6 (M)	0.61	532[b]	1.74	
	7 (?N)	0.80			

[a] Reflectors in brackets after Veevers et al. (1970).
[b] Clearly recognized by drilling.

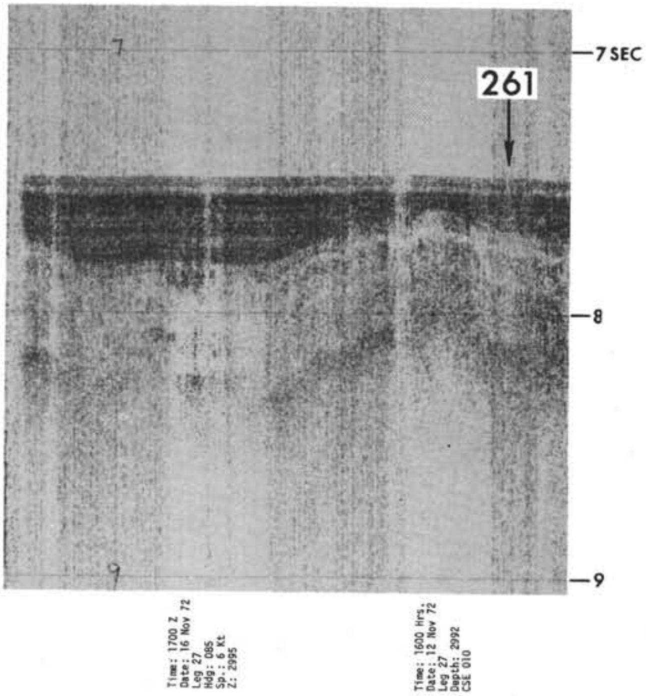


Figure 7. *Seismic profile in area of Site 261.*

Plain was initiated slightly earlier than areas southward. The apparently deeper sequence below reflector M at Site 261 was shown to be due to internal multiples.

The estimated basement age at Site 261 (~150 m.y.) is definitely older than that at Site 260 (~105 m.y.) supporting the idea that the basalt at Site 260 is a sill intruded relatively high in the section.

The sheet-like or cylindrical structures seen in seismic profiles of parts of the Argo Abyssal Plain are presumably due to flowage in the clay of the transparent layer.

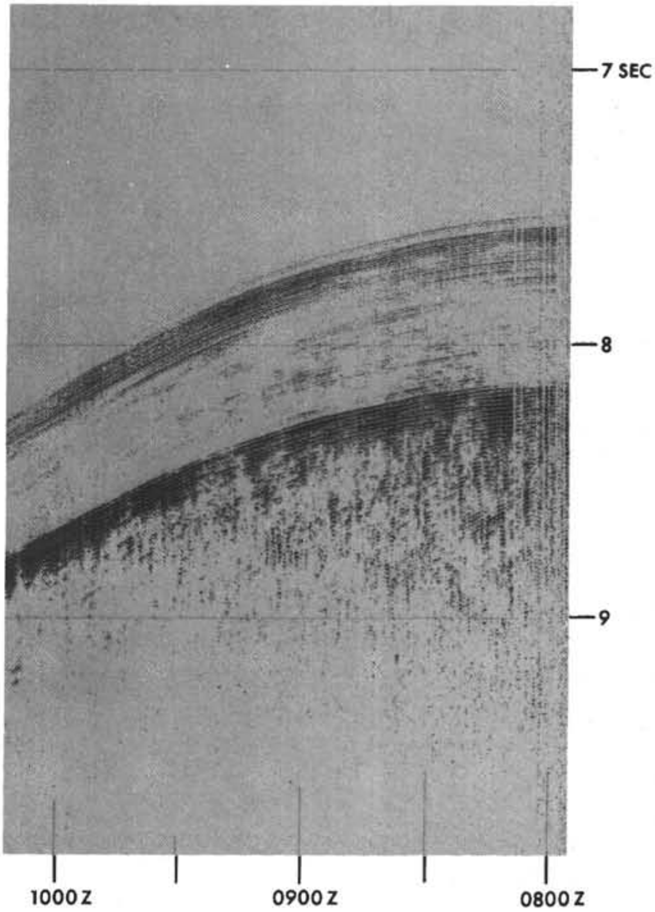


Figure 8. *Sonobuoy record, Site 261.*

REFERENCES

Dietz, R. S. and Holden, J. C., 1971. Pre-Mesozoic oceanic crust in the eastern Indian Ocean (Wharton Basin) ?: Nature, v. 229, p. 309-312.

Falvey, D. A., 1972. Sea-floor spreading in the Wharton Basin (northeast Indian Ocean) and the break-up of eastern Gondwanaland: Australian Petrol. Expl. Assoc. J., v. 12, p. 86-88.

Veevers, J. J., Jones, J. G., and Talent, J. A., 1971. Indo-Australian stratigraphy and the configuration and dispersal of Gondwanaland: Nature, v. 229, p. 383-388.

von der Borch, C. C., Sclater, J. G., et al., 1974. Hole Summaries, Leg 22, Darwin, Australia to Colombo, Ceylon, January to March, 1972. *In* Initial Reports of the Deep Sea Drilling Project, Volume 22: Washington (U.S. Government Printing Office).

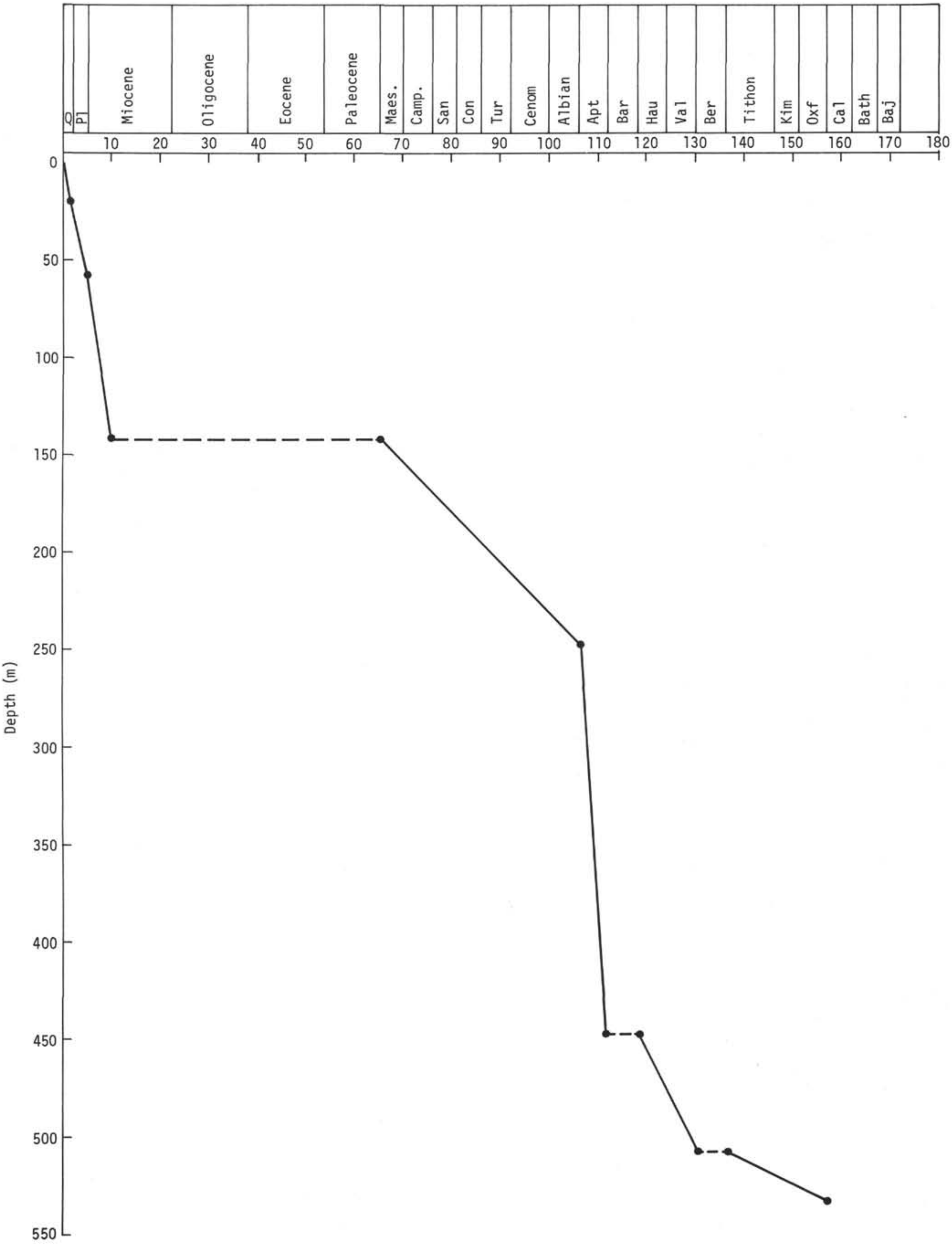
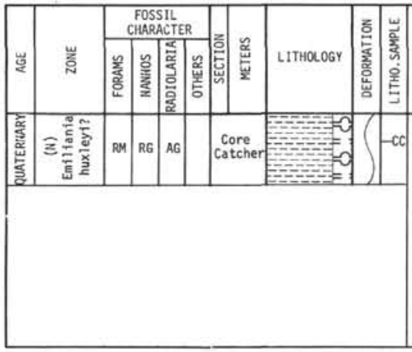


Figure 9. *Sediment accumulation rates, Site 261.*

Site 261 Hole Core 1 Cored Interval:0 m



5GY4/1

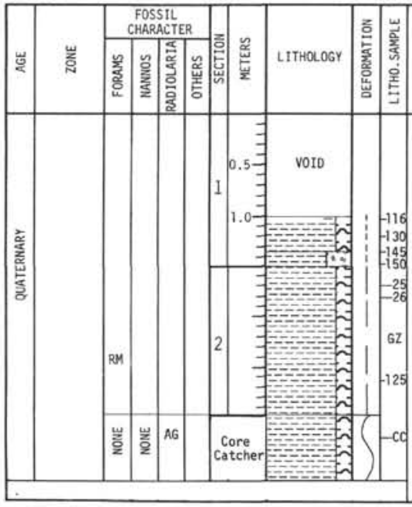
LITHOLOGIC DESCRIPTION

Soft, dark greenish gray clay, rich in diatoms and radiolaria

RADIOLARIA AND DIATOM RICH CLAY
Smear slide CC

Composition	
Clay	60%
Radiolaria	20%
Diatoms	14%
Silicoflag.	3%
Sponge Spicules	2%
Fe Oxides	1%
Nannos	Tr.
Quartz; Carb.	Tr.
Volcanic Glass	Tr.

Site 261 Hole Core 2 Cored Interval:9.5-19.0 m



5Y6/1
10YR6/2
10R6/2
5YR6/4
10R2/2
10YR6/2
5G6/1
5Y6/1
74
5Y5/2
5Y6/1
10YR6/2

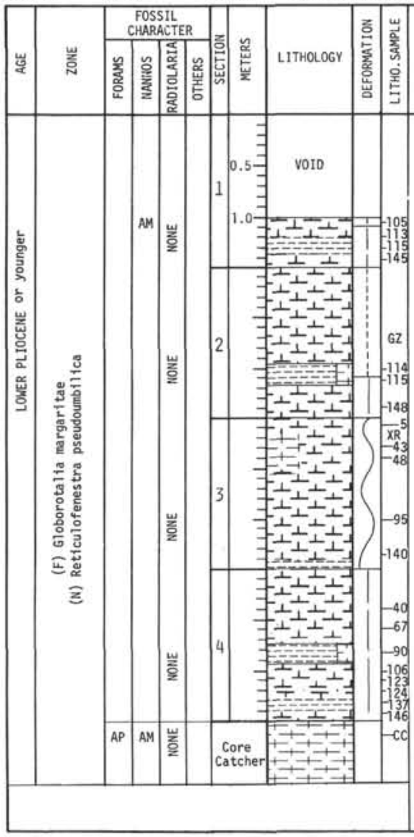
LITHOLOGIC DESCRIPTION

Light brown and greenish gray clay, variable in color, also including dusky red and medium bluish gray. No visible lithological changes accompany these color changes. The clay is rich in Radiolaria throughout and also in Diatoms at the bottom and at the top. Volcanic ash up to 15% is present at the base of Section 1. Slight to moderate deformation is present throughout.

RAD RICH CLAY
Smear slides 1-116, 1-130, 1-145, 1-150, 2-25, 2-26, 2-125, CC

Texture		Composition	
Clay	80%	Clay	60-87%
Silt	20%	Rads	10-20%
		Diatoms	2-14%
		Volcanic Glass	Tr.-15%
		Sponge Spicules, Silicoflag.	Tr.- 2%
		Fe Oxides	Tr.- 1%
		Opaques, Carb. Frag., Nannos, Quartz, and Feldspar	Tr.

Site 261 Hole Core 3 Cored Interval:47.5-57 m



5Y8/1
5N5
5Y5/2
5Y8/1
5GY6/1
74
3N3
5G6/1
5GY6/1
5G6/1
26-28
5GY7/1
5GY6/1
5B6/1
5B7/1
5B6/1
5Y8/1
5GY6/1
5Y5/1
5Y5/1
5Y7/1
5Y8/1
5Y6/1
5GY5/1
5G7/1
5B8/1
5GY5/1
5B6/1
5Y8/2
5Y8/1

LITHOLOGIC DESCRIPTION

Predominantly stiff greenish gray clay, rich in nannos and also foraminifera in one sample. However, some samples, e.g. at 1-115, are almost devoid of these fossils. There is considerable variation in color in the bluish gray, olive gray and yellowish gray range. Detrital foraminifera are conspicuous at one level and clays devoid of carbonate occur at two levels.

NANNO OOZE
Smear Slides 1-113, 1-115, 1-145, 3-95, 4-40, 4-67, 4-106, 4-123, 4-146

Texture		Composition	
Clay	84%	Nannos	85-90%
Silt	16%	Clay	10-15%
		Quartz	2- 5%
		Feldspar	Tr.- 3%
		Heavy Minerals, Fe Oxides, Dolomite, and Carb. Frag.	Tr.

NANNO RICH TO NANNO BEARING CLAY
Smear slides 2-115, 4-90

Composition	
Clay	85-90%
Nannos	5-15%

DETRITAL FORAM NANNO OOZE
Smear slides 4-123, 4-124

Composition	
Nannos	50-60%
Forams	40-50%

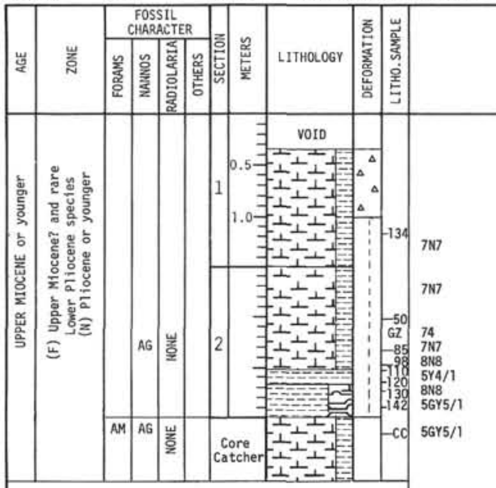
CLAY
Smear slides 3-140, 4-137

Comoosition	
Clay	98%
Nannos	1%

BULK X-RAY (50.8 m)	
Calcite	68%
Mica	10%
Montmorillonite	10%
Kaolinite	7%
Quartz	5%

Explanatory notes in chapter 1

Site 261 Hole Core 4 Cored Interval:95-104.5 m



LITHOLOGIC DESCRIPTION

Stiff clay, predominantly light gray to olive gray in color. Smear slides show abundant nannos in most cases, and detrital forams. In some samples clay increases towards the base, where the greenish tint of the sediment becomes more evident. The first zeolite in this core occurs at 2-110 (2%).

NANNO OOZE
Smear slides 1-134, 2-50, 2-85, 2-98, 2-130, CC

Texture		Composition	
Clay	66%	Nannos	70-95%
Silt	34%	Clay	5-20%
		Quartz	Tr.- 5%
		Opaques, Fe Oxide, Volcanic Glass, Dolomite and Heavy Minerals	Tr.

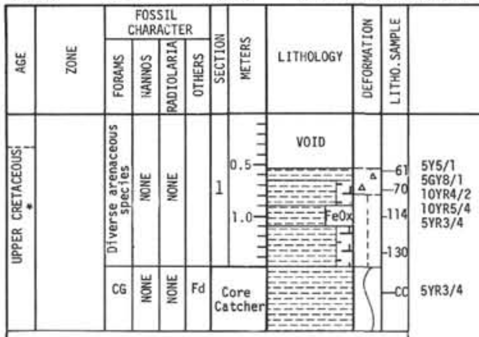
CLAY
Smear slides 2-110, 2-120

Composition	
Clay	96-98%
Nannos	Tr.- 2%
Zeolite	0- 2%
Quartz	Tr.- 2%
Heavy Minerals, Volcanic Glass	Tr.

RAD AND NANNO BEARING CLAY
Smear slide 2-142

Composition	
Clay	70%
Diatom, Sponge Spicules, Silicoflag.	13%
Rads	10%
Nannos	5%
Quartz and Feldspar	Tr.- 1%

Site 261 Hole Core 5 Cored Interval: 161.5-171 m



LITHOLOGIC DESCRIPTION

Stiff clay, olive gray and greenish gray (59-66 cm) and yellowish brown to moderate brown 66-150 cm and cc. The relatively undeformed part of the core contains nannos and iron oxide. Zeolite is present, but not in association with iron oxide. Core brecciated 61-70; deformation slight 70-150 cm.

CLAY
Smear slides 1-61, CC

Composition	
Clay	97-99%
Zeolite	1%
Heavy Minerals	Tr.- 1%
Quartz	0- 1%
Nannos	0-Tr.
Fe Oxide	Tr.

NANNO BEARING AND NANNO RICH CLAY
Smear slides 1-70, 1-130

Composition	
Clay	81-87%
Nannos	10-15%
Quartz & Feldspar	2%
Zeolite	1- 2%
Fe Oxide	Tr.

IRON OXIDE CLAY
Smear slide 1-114

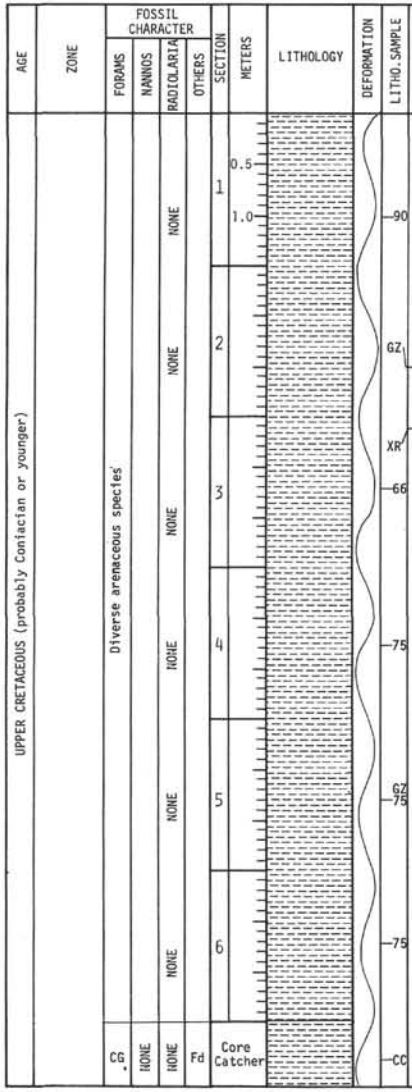
Composition	
Clay	64%
Fe Oxide	35%
Feldspar	1%

Coarse fractions contain nodules, carbonate sand, and in the core catcher an abundance of fish debris.

Explanatory notes in chapter 1

*(probably Coniacian or younger)

Site 261 Hole Core 6 Cored Interval:171-180.5 m



LITHOLOGIC DESCRIPTION

5YR3/4 with mottlings of 5YR3/2 and 5YR4/4

5YR3/2 with mottlings of 5YR3/4 and patches of 5YR5/6

-74

-26-28

5YR3/2 with mottlings of 5YR3/4 and 5YR5/6

5YR3/2 with occasional patches of 5YR5/6

5YR3/2 with mottlings of 5YR5/6

74

5YR3/2 with mottlings of 5YR5/6

5YR3/2

Strongly deformed, uniform and compact, stiff clay, which is uniform in color throughout, grayish brown predominating, with light brown mottlings. The nanno content is low except in the core catcher. Only one section (No. 4) shows no nannos. There is a zeolite content of 1-2% except in sections 1 and 4. Fish debris is unusually abundant in coarse washings from the core catcher.

QUARTZ RICH CLAY
Smear slides 1-90, 4-75, 6-75

Texture		Composition	
Clay	90%	Clay and Micro-crystalline Quartz	97-99%
Silt	10%	Nannos	0- 2%
		Heavy Minerals	Tr.- 1%
		Feldspar	Tr.- 1%
		Zeolite	0- 1%
		Fe Oxide	0- 1%

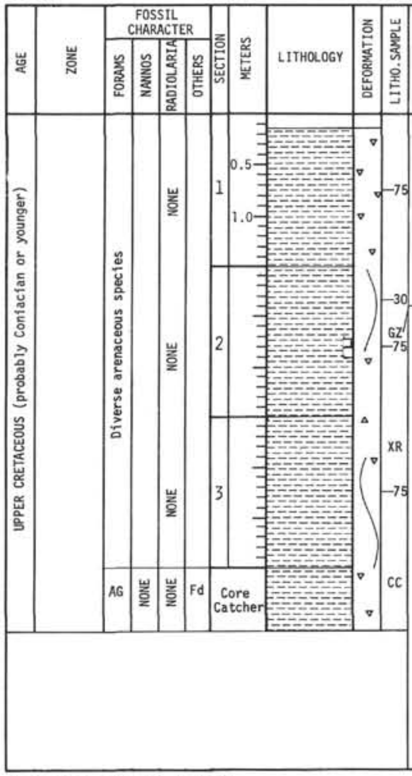
NANNO RICH AND NANNO BEARING CLAY
Smear slides 3-66, 5-75, CC

Texture		Composition	
Clay	90%	Clay	73-93%
Silt	10%	Nannos	5-20%
		Feldspar	0- 3%
		Zeolite	1- 2%
		Fe Oxide	Tr.- 1%
		Heavy Minerals	Tr.- 1%

BULK X-RAY (174.8 m)

Palygorskite	35%
Montmorillonite	18%
Quartz	16%
Mica	12%
K-feldspar	11%
Gypsum	3%
Chlorite	2%
Plagioclase	2%
Kaolinite	1%

Site 261 Hole Core 7 Cored Interval:180.5-190 m



LITHOLOGIC DESCRIPTION

5YR3/4 to 5YR3/2 with mottlings of 5YR5/6

-74

5YR3/2 with mottlings of 5YR3/4 and 5YR5/6

5YR3/4
26-28

5YR3/4 with mottlings of 5YR3/4 and 5YR5/6

5YR3/2

Strongly deformed, stiff clay. The predominant color is grayish brown, with frequent mottlings of very light brown and light brown. This color difference does not seem to accompany any lithological difference. Zeolite (1-3%) is present. In only one smear slide does the $CaCO_3$ content approach zero. Foraminifera, Radiolaria and fish debris are present in coarse washings from the CC.

QUARTZ AND K-FELDSPAR RICH CLAY
Smear slides 2-30, 2-75, 3-75

Texture		Composition	
Clay	90%	Clay and Micro-crystalline Quartz and K-feldspar	96-99%
Silt	10%	Nannos	Tr.- 2%
		Zeolite	Tr.- 2%
		Fe Oxide	Tr.- 1%
		Dolomite, Heavy Minerals, Feldspar	Tr.

NANNO BEARING CLAY
Smear slides 1-75, CC

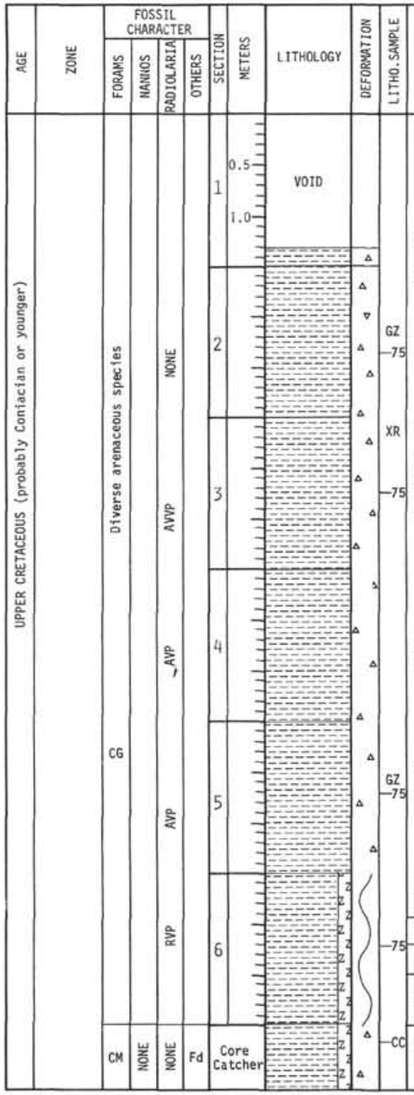
Composition	
Clay	88-93%
Nannos	5%
Zeolite	1- 3%
Fe Oxide	Tr.- 4%
Feldspar	Tr.- 1%
Heavy Minerals	0-Tr.

BULK X-RAY (184.4 m)

K-feldspar	25%
Palygorskite	23%
Mica	15%
Montmorillonite	14%
Quartz	14%
Gypsum	5%
Kaolinite	4%

Explanatory notes in chapter 1

Site 261 Hole Core 8 Cored Interval: 190-199.5 m



mottled
5YR3/2
5YR3/4
5YR5/6

74
as above

26-28
mottled
5YR3/2
5YR3/4
5YR5/6
10YR7/4

mottled
5YR3/2
5YR3/4
5YR4/4
5YR5/6

mottled
74
5YR3/2
5YR3/4
5YR5/6

5YR4/4
streaked
5YR3/2
5YR3/2 streaked
5YR4/4
5YR4/4 streaked
5YR3/2
5YR3/2
with patch
5YR4/4
5YR3/2
5YR3/2

LITHOLOGIC DESCRIPTION

Stiff clay, brecciated by drilling. Mottled grayish brown, moderate brown and light brown. In Section 6 and the core catcher, the zeolite content rises to 15%.

QUARTZ AND ZEOLITE BEARING CLAY
Smear slides 3-75, 5-75, 6-75, CC

Texture		Composition	
Clay	85%	Clay and Microcrystalline Quartz	84-89%
Silt	15%	Zeolite	5-10%
		Nannos	0- 4%
		Fe Oxide	0- 1%
		Feldspar	0- 1%
		Heavy Minerals	0-Tr.

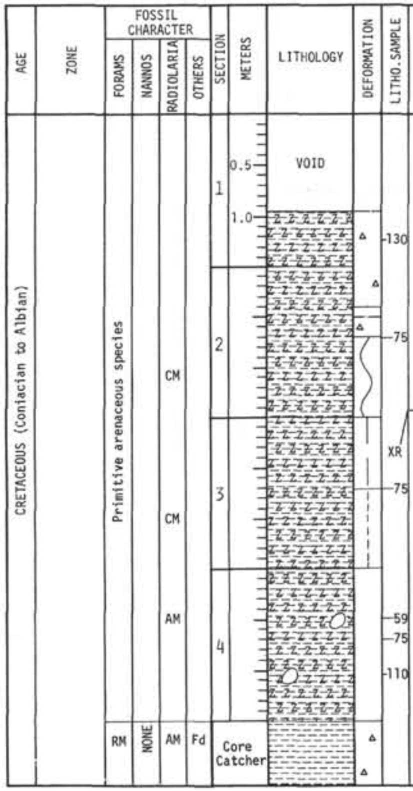
CLAY
Smear slide 2-75

Texture		Composition	
Clay	90%	Clay	99%
Silt	10%	Zeolite	1%
		Quartz, Feldspar, Heavy Minerals, Fe Oxide	Tr.

BULK X-RAY (193.9 m)

Palygorskite	29%
Montmorillonite	24%
Gypsum	14%
Quartz	12%
Mica	11%
K-feldspar	8%
Kaolinite	2%

Site 261 Hole Core 9 Cored Interval: 199.5-209.0 m



mottled
5YR3/2
5YR3/4
5YR4/4
5YR5/6
10YR7/4

5YR3/2
5YR3/4
5YR5/6

26-28
5YR2/2
5YR3/4
5YR3/2
5YR3/4
5YR4/4

5YR3/2

5YR3/2
5YR5/6
10Y7/4

5YR2/2

5YR2/2

LITHOLOGIC DESCRIPTION

This core is brecciated at the top with decreasing deformation with depth. Color mottling is present in the upper part of the core, but in Sections 3 and 4 it is replaced by a broad banding. Colors are chiefly grayish brown (5YR3/2) light brown (5YR5/6) and moderate brown (5YR4/4). The light yellowish patch at 4-59 is due to a yellow mineral tentatively identified as collophane. Coarse washings from the core catcher contain foraminifera and radiolaria.

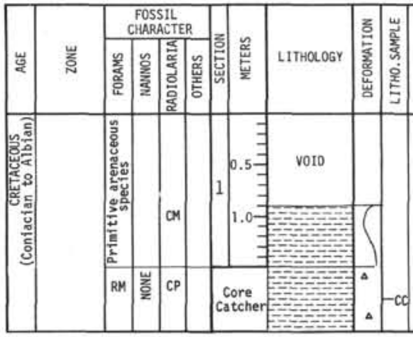
ZEOLITE RICH CLAY
Smear slides 1-130, 2-75, 3-75, 4-75, 4-110

Composition	
Clay	85-95%
Zeolite	10-14%
Heavy Minerals	Tr.- 2%
Feldspar	Tr.- 1%
Nannos	Tr.

BULK X-RAY (203.4 m)

Mica	20%
Palygorskite	18%
Montmorillonite	16%
Clinoptilolite	14%
Cristobalite	11%
Quartz	8%
Plagioclase	5%
Gypsum	4%
K-feldspar	4%

Site 261 Hole Core 10 Cored Interval: 209-218.5 m



5Y2/1
5YR3/1
5Y2/1
5YR5/2

10YR5/4
10YR6/6

LITHOLOGIC DESCRIPTION

Gray, semi-lithified claystone. The very bottom of Core 1 consists of chips of soft light brown clay (5YR5/2) in breccia, whereas the core catcher contains hard claystone, slightly darker in color (5YR5/4).

CLAYSTONE
Smear slide CC

Composition	
Clay	100%
Quartz, Feldspar, and Fe Oxide	Tr.

Explanatory notes in chapter 1

Site 261 Hole Core 11 Cored Interval: 218.5-228 m

AGE	ZONE	FOSSIL CHARACTER				SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		FORAMS	NANNOS	RADIOLARIA	OTHERS						
CRETACEOUS (Coniacian to Albian)		Primitive arenaceous species			RP	1	0.5 1.0	VOID			6N6 3N3 2N2 7N7
		RP	NONE			Core Catcher				CC	4N4 5G4/1 5GY3/2 10Y4/2

Dark gray claystone. Thin (1 mm) alternations of light gray and dark gray clay in rapidly lensing beds. Transverse burrows, about 0.8 cm in diameter and filled with limonitic siltstone, color dark yellowish orange (10YR6/6) occur in core catcher.

CLAYSTONE
Smear slide CC

Composition	
Clay	99%
Heavy Minerals	1%

Site 261 Hole Core 12 Cored Interval: 228-237.5 m

AGE	ZONE	FOSSIL CHARACTER				SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		FORAMS	NANNOS	RADIOLARIA	OTHERS						
CRETACEOUS (Coniacian to Albian)		Primitive arenaceous species		AG		1	0.5 1.0	VOID			
						2				10 XR	5Y2/1 5GY3/2 4N4 26-28 3N3 5GY4/1 3N3 5GY3/2 5GY4/1 6N6 4N4
		RM	NONE	AG		Core Catcher				CC	5G4/1 5GY5/2 5GY3/2 3N3

Dark gray, semi-lithified claystone. In the bottom 18 cm of Section 2, the dark gray claystone is speckled and laminated with light colored inclusions.

CLAYSTONE
Smear slide 2-10, CC

Composition	
Clay	96-99%
Feldspar	0- 2%
Quartz	0- 1%
Nannos	0-Tr.

BULK X-RAY (232.7 m)	
Rhodonite	59%
Cristobalite	25%
Montmorillonite	8%
Gypsum	3%
Mica	3%
Quartz	2%

Site 261 Hole Core 13 Cored Interval: 237.5-247 m

AGE	ZONE	FOSSIL CHARACTER				SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		FORAMS	NANNOS	RADIOLARIA	OTHERS						
*		RP **	NONE	CM	Fd	Core Catcher				CC	5GY4/1

Dark greenish gray, semi-lithified claystone.

CLAYSTONE
Smear slide CC

Composition	
Clay	99%
Carbonate	1%
Heavy Minerals	Tr.

* CRETACEOUS
**Primitive arenaceous species

Site 261 Hole Core 14 Cored Interval: 247-256.5 m

AGE	ZONE	FOSSIL CHARACTER				SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		FORAMS	NANNOS	RADIOLARIA	OTHERS						
LOWER CRETACEOUS, UPPER APTIAN TO LOWER ALBIAN		NONE		FP	D	1	0.5 1.0		Δ	70 71	5GY4/1 5Y4/1 5YR2/1 5YR2/1 4N4 5GY4/1 3N3
		NONE	NONE	FP	Fd	Core Catcher				CC	5GY4/1

Semi-lithified claystone, generally dark greenish gray in color. Drilling breccia occurs 50-70 cm.

CLAYSTONE
Smear slides 1-70, 1-71, CC

Composition	
Clay	90-99%
?Opal	0-10%
Feldspar	Tr.- 2%
Heavy Minerals	Tr.- 1%
Zeolite, Quartz, and Carbonate	Tr.

Site 261 Hole Core 15 Cored Interval: 256.5-266.0 m

AGE	ZONE	FOSSIL CHARACTER				SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		FORAMS	NANNOS	RADIOLARIA	OTHERS						
LOWER CRETACEOUS, UPPER APTIAN TO LOWER ALBIAN		RP		AG	D	1	0.5 1.0		Δ	33	3N3 2N2 3N3 2N2 5GY4/1
		RP	NONE	CM		Core Catcher				CC1 CC2	3N3

Semi-lithified claystone, predominantly dark gray in color with light gray speckles and streaks. Some sections of the core are brecciated.

CLAYSTONE
Smear slides 1-33, CC

Composition	
Clay	100%
Feldspar, Carbonate, Heavy Minerals, and Micro. nodules	Tr.

CALCAREOUS CLAYSTONE
Smear slide CC

Composition	
Clay	50%
Calc. Frag.	50%

Site 261 Hole Core 16 Cored Interval: 266-275.5 m

AGE	ZONE	FOSSIL CHARACTER				SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		FORAMS	NANNOS	RADIOLARIA	OTHERS						
LOWER CRETACEOUS, UPPER APTIAN TO LOWER ALBIAN		RM		AM	D Pm	1	0.5 1.0	VOID	Δ	100	3N3 2N2 3N3 4N4 5G6/1
		RM	NONE	CVP		Core Catcher				CC	5G4/1 2N2

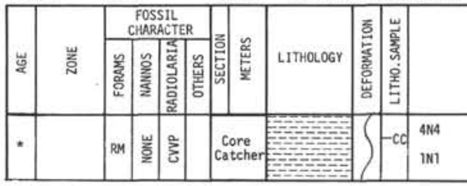
Semi-lithified claystone, predominantly dark gray in color. Some of the core is brecciated.

CLAYSTONE
Smear slide 1-100, CC

Composition	
Clay	88-98%
Carb. Frag.	0-10%
Heavy Minerals	1- 2%
Feldspar	0- 1%

Explanatory notes in chapter 1

Site 261 Hole Core 17 Cored Interval: 275.5-285 m



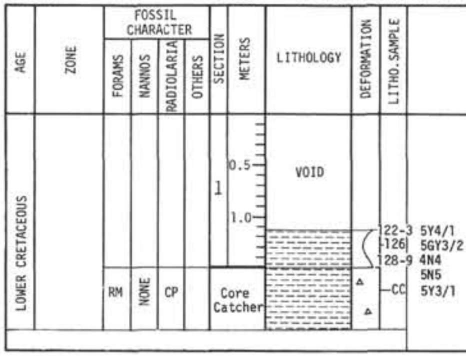
LITHOLOGIC DESCRIPTION

Semi-stiff clay; dark gray and black in color.

CLAYSTONE

*LOWER CRETACEOUS

Site 261 Hole Core 18 Cored Interval: 285.0-294.5 m



LITHOLOGIC DESCRIPTION

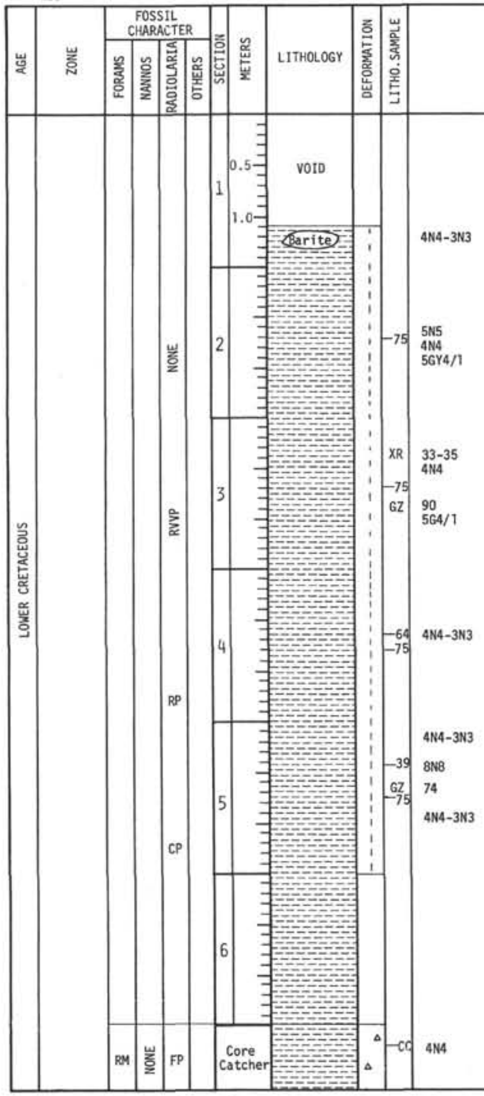
Stiff clay, dark greenish gray and medium gray in color. Slightly calcareous.

CLAY

Smear slides 1-122, 1-123, 1-126, 1-128, 1-129, CC

Composition	
Clay	90-100%
Carb. Frag.	0- 10%
Heavy Minerals	Tr.- 1%
Feldspar	0- 1%
Quartz, Dolomite, Nannos, ?Opal, and ?Cristobalite	Tr.

Site 261 Hole Core 19 Cored Interval: 304-313.5 m



LITHOLOGIC DESCRIPTION

Semi-lithified claystone, predominantly medium dark gray in color, with intercalated dark laminations. Darker color probably due to greater content of organic carbon. In Section 1 (117-122) there is a dense mineralized nodule, possibly barite.

QUARTZ CLAYSTONE

Smear slides 2-75, 3-75, 4-75, 5-39, 5-75.

Texture		Composition	
Clay	87%	Clay and Microcrystalline Quartz	98-99%
Silt	13%	Feldspar	1%
		Heavy Minerals	1%
		?Chlorite, Carbonate, and Nannos	Tr.

DETRITAL CALCAREOUS CLAYEY SAND

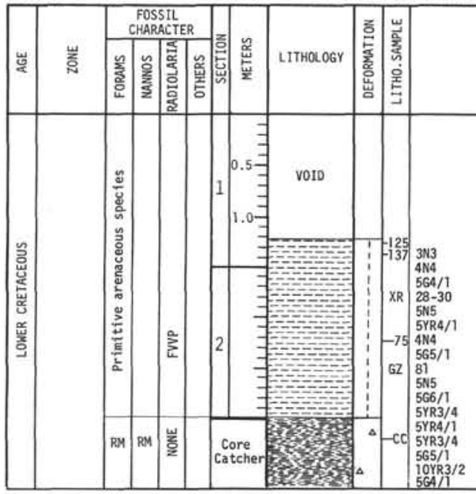
Smear slide 4-64

Composition	
Carbonate	60%
Clay	40%
Heavy Minerals	Tr.

BULK X-RAY (307.3 m)	
Quartz	56%
Montmorillonite	28%
Mica	9%
K-feldspar	4%
Gypsum	3%

Explanatory notes in chapter 1

Site 261 Hole Core 20 Cored Interval: 313.5-323.0 m



LITHOLOGIC DESCRIPTION

Semi-lithified claystone. Predominant color is dark gray; becoming brownish gray below 2-100.

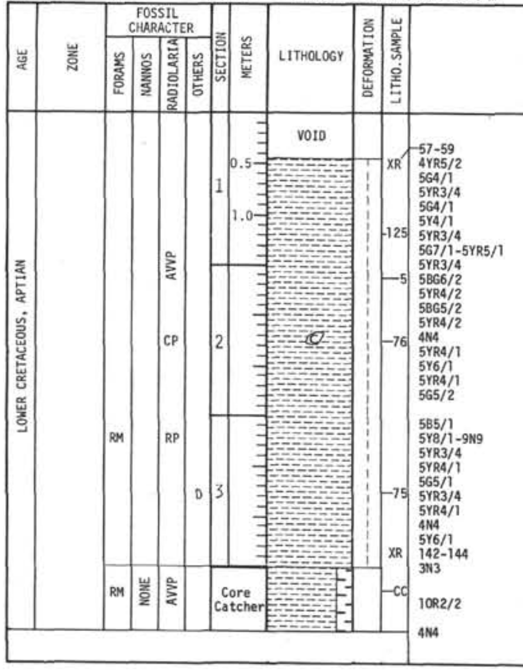
QUARTZ CLAYSTONE
Smear slides 1-137, 2-75, CC

Texture		Composition	
Clay	86%	Clay and Micro-crystalline Quartz	98-100%
Silt	14%	Heavy Minerals	Tr.- 1%
		Feldspar	0- 1%
		Carbonate	0- Tr.
		Nannos	0- Tr.

BULK X-RAY (315.3 m)

Quartz	55%
Montmorillonite	27%
Mica	8%
K-feldspar	7%
Gypsum	3%

Site 261 Hole Core 21 Cored Interval: 332.5-342.0 m



LITHOLOGIC DESCRIPTION

Semi-lithified claystone, predominantly brown, but containing sections which are dark gray, greenish gray and light gray. In the lower half of Section 1 the light gray matrix contains black streaks whereas in Section 3, the brown core is streaked with white. Nodule of limestone at 2-76.

QUARTZ CLAYSTONE
Smear slide 1-125, 2-5, 2-76, 3-75.

Composition	
Clay and Micro-crystalline Quartz	98-100%
Heavy Minerals	Tr.- 1%
Nannos	0- 1%
Feldspar	Tr.
Chlorite	0- Tr.
Silica	0- Tr.

RAD RICH CLAY
Smear slide CC

Composition	
Clay	80%
Rads	20%

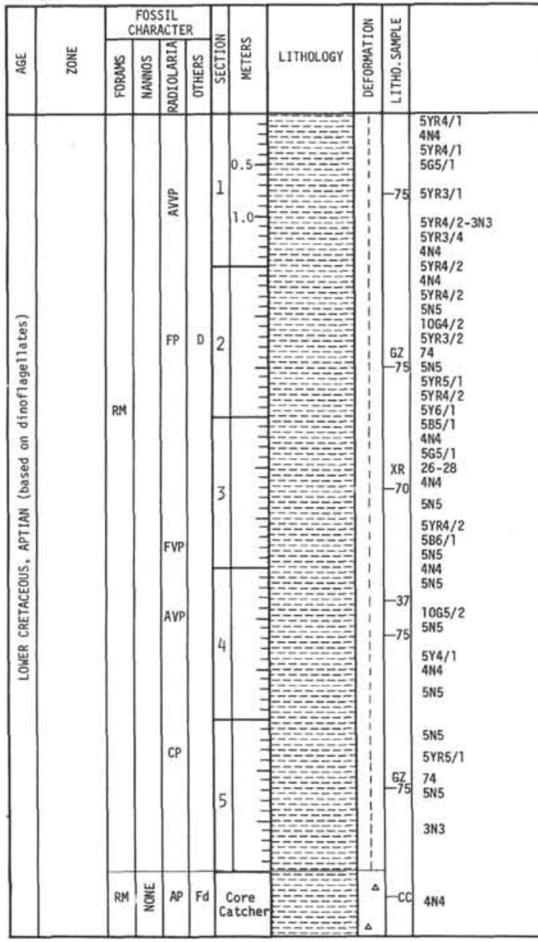
BULK X-RAY (336.9 m)

Quartz	74%
Montmorillonite	15%
K-feldspar	6%
Mica	5%

BULK X-RAY (342.1 m)

Quartz	89%
Montmorillonite	8%
Mica	3%

Site 261 Hole Core 22 Cored Interval: 342.0-351.5 m



LITHOLOGIC DESCRIPTION

Semi-lithified claystone. Predominantly dark gray, with a distinct brownish tinge in Sections 1 and 2. Areas with dark streaks occur throughout this core. The carbonate-rich interval 4 (34-41) is crushed, in contrast to the firmness of other parts of the core.

QUARTZ CLAYSTONE
Smear slides 1-75, 2-75, 3-70, 4-75, 5-75, CC

Texture		Composition	
Clay	86%	Clay and Micro-crystalline Quartz	97-100%
Silt	14%	Heavy Minerals	Tr.- 1%
		Feldspar	0- Tr.
		Nannos	0- Tr.

CALCAREOUS MUDSTONE
Smear slide 4-37

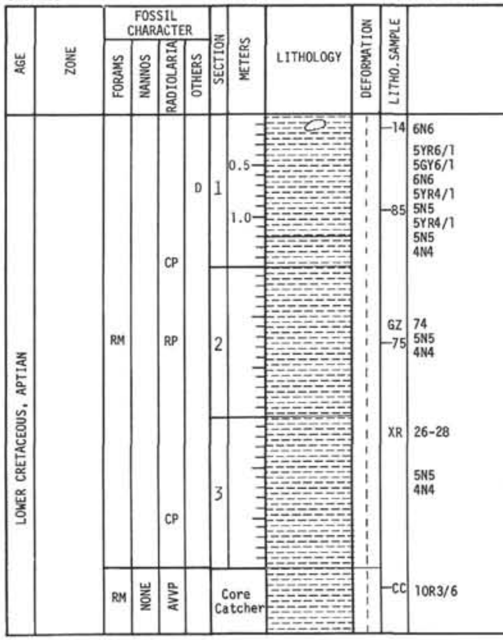
Composition	
Clay	50%
Carbonate frag.	50%

BULK X-RAY (345.3 m)

Quartz	82%
Montmorillonite	10%
Mica	4%
K-feldspar	2%
Gypsum	2%

Explanatory notes in chapter 1

Site 261 Hole Core 23 Cored Interval: 361.0-370.5 m



LITHOLOGIC DESCRIPTION

Semi-lithified claystone, predominantly dark gray, though Section 1 has some brown tints. Dark reddish brown claystone in the core catcher.

QUARTZ SILTY CLAYSTONE
Smear slides 1-85, 2-75, CC

Texture		Composition	
Clay	68%	Clay and Micro-crystalline Quartz	99-100%
Silt	32%	Heavy Minerals	Tr.
		Feldspar	0- Tr.
		Carbonate, Chlorite	Tr.

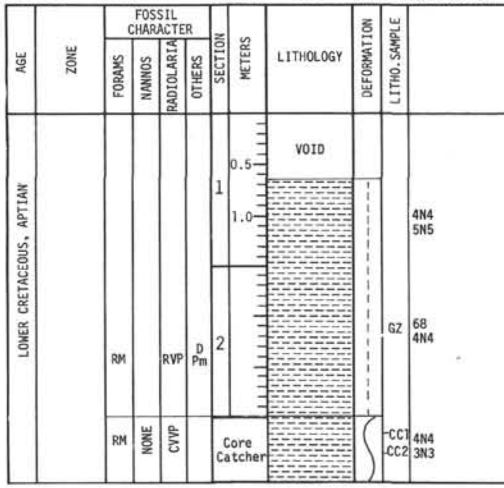
LIMESTONE
Smear slide 1-14

Composition	
Carb. Frag.	100%

BULK X-RAY (364.3 m)

Quartz	42%
Montmorillonite	21%
Mica	12%
Palygorskite	9%
Barite	9%
K-feldspar	6%
Pyrite	1%

Site 261 Hole Core 24 Cored Interval: 380.0-389.5 m



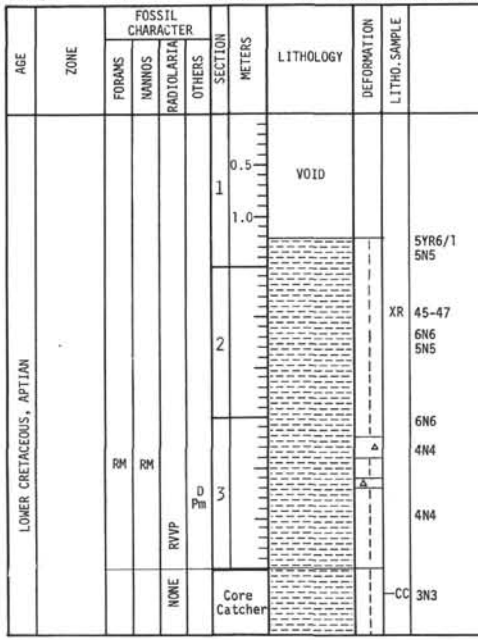
LITHOLOGIC DESCRIPTION

Semi-lithified claystone, predominantly dark gray in color. The rock is uniformly streaked with black throughout. Slickensided areas within the core occur at 2 (96-100) and 2 (115-122).

QUARTZ CLAYSTONE
Smear slides CC1, CC2

Texture		Composition	
Clay	94%	Clay and Micro-crystalline Quartz	99-100%
Silt	6%	Heavy Minerals	Tr.- 1%
		Quartz	0- Tr.
		Feldspar, Carbonate	Tr.

Site 261 Hole Core 25 Cored Interval: 399.0-408.5 m



LITHOLOGIC DESCRIPTION

Semi-lithified claystone, predominantly dark gray, with darker gray and black horizontal streaks throughout.

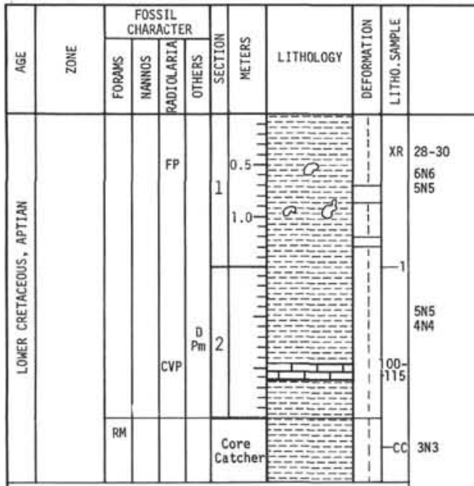
QUARTZ CLAYSTONE
Smear slide CC

Composition	
Clay and Micro-crystalline Quartz	100%
Chlorite, Feldspar, Heavy Minerals	Tr.

BULK X-RAY (401.0 m)

Quartz	86%
Montmorillonite	5%
Mica	4%
K-feldspar	4%
Barite	1%

Site 261 Hole Core 26 Cored Interval: 418.0-427.5 m



LITHOLOGIC DESCRIPTION

Lithified claystone, predominantly dark gray throughout, with darker gray and black horizontal streaks. Nodules occur at 1-56 (dark in color), several, light in color, at 1-95 and several very light gray nodules at 2 (53-67). The carbonate rich clay and the chalk are not distinguishable megascopically.

QUARTZ CLAYSTONE
Smear slide CC

Composition	
Clay and Micro-crystalline Quartz	98%
Heavy Minerals	2%
Fe Oxide	Tr.

CARBONATE RICH CLAY
Smear slide 2-1

Composition	
Clay	78%
Carbonate	20%
Heavy Minerals	1%
Feldspar	Tr.

CHALK
Smear slide 2 - (100-115)

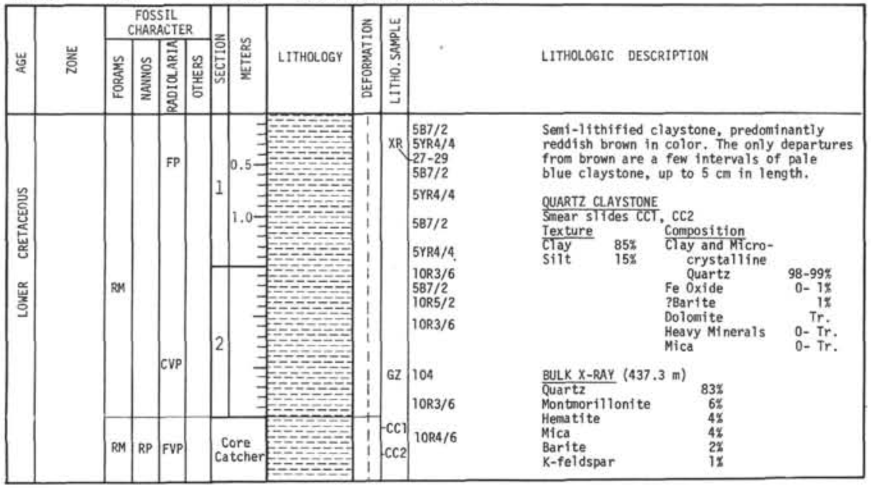
Composition	
Carbonate	100%

BULK X-RAY (418.3 m)

Quartz	91%
Montmorillonite	5%
Mica	2%
Barite	1%
Pyrite	1%

Explanatory notes in chapter 1

Site 261 Hole Core 27 Cored Interval:437.0-446.5 m



Semi-lithified claystone, predominantly reddish brown in color. The only departures from brown are a few intervals of pale blue claystone, up to 5 cm in length.

QUARTZ CLAYSTONE

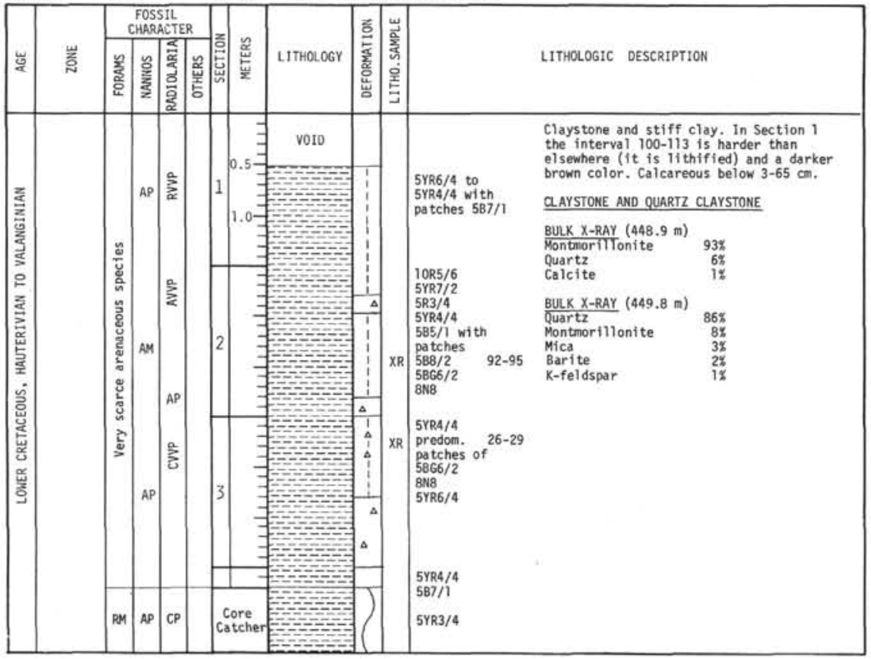
Smear slides CC1, CC2

Texture		Composition	
Clay	85%	Clay and Micro-crystalline Quartz	98-99%
Silt	15%	Fe Oxide	0- 1%
		?Barite	1%
		Dolomite	Tr.
		Heavy Minerals	0- Tr.
		Mica	0- Tr.

BULK X-RAY (437.3 m)

Quartz	83%
Montmorillonite	6%
Hematite	4%
Mica	4%
Barite	2%
K-feldspar	1%

Site 261 Hole Core 28 Cored Interval:446.5-456.0 m



Claystone and stiff clay. In Section 1 the interval 100-113 is harder than elsewhere (it is lithified) and a darker brown color. Calcareous below 3-65 cm.

CLAYSTONE AND QUARTZ CLAYSTONE

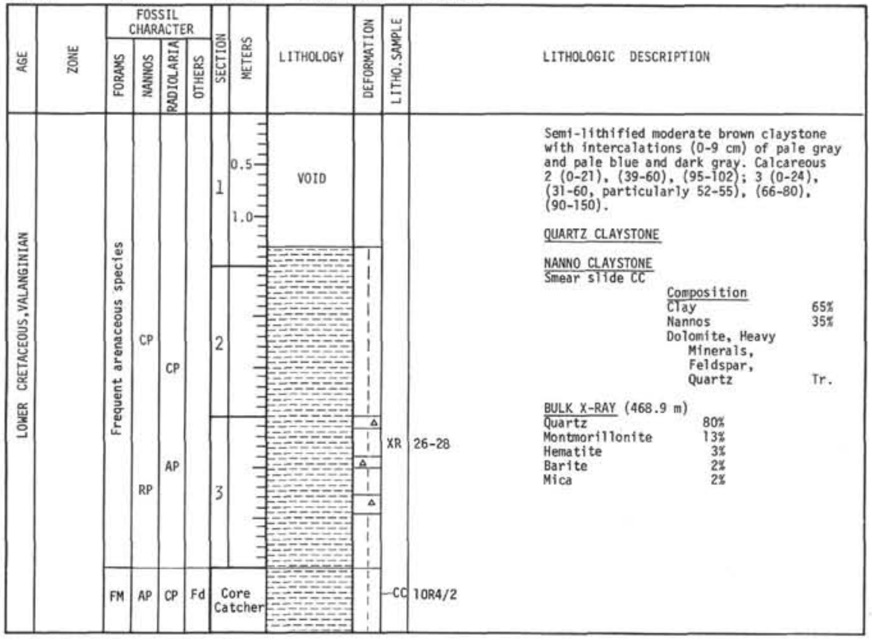
BULK X-RAY (448.9 m)

Montmorillonite	93%
Quartz	6%
Calcite	1%

BULK X-RAY (449.8 m)

Quartz	86%
Montmorillonite	8%
Mica	3%
Barite	2%
K-feldspar	1%

Site 261 Hole Core 29 Cored Interval:465.5-475.0 m



Semi-lithified moderate brown claystone with intercalations (0-9 cm) of pale gray and pale blue and dark gray. Calcareous 2 (0-21), (39-60), (95-102); 3 (0-24), (31-60, particularly 52-55), (66-80), (90-150).

QUARTZ CLAYSTONE

NANNO CLAYSTONE

Smear slide CC

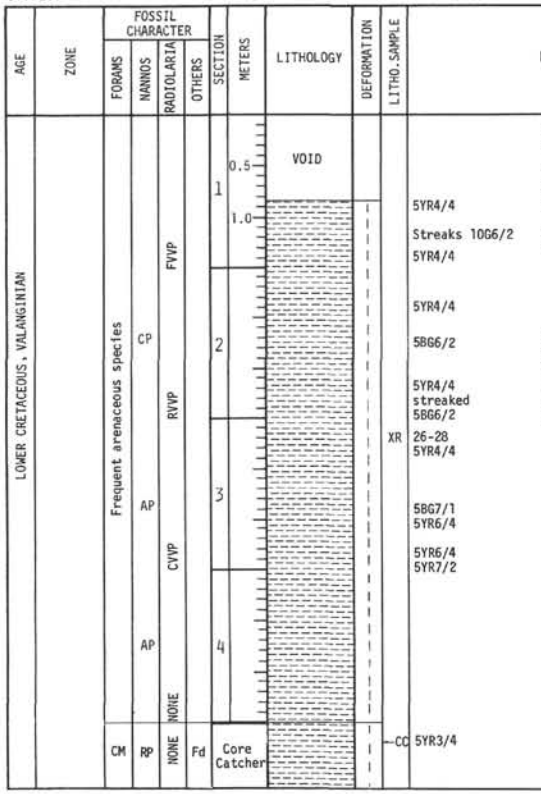
Composition	
Clay	65%
Nannos	35%
Dolomite, Heavy Minerals, Feldspar, Quartz	Tr.

BULK X-RAY (468.9 m)

Quartz	80%
Montmorillonite	13%
Hematite	3%
Barite	2%
Mica	2%

Explanatory notes in chapter 1

Site 261 Hole Core 30 Cored Interval: 484.5-494.0 m



LITHOLOGIC DESCRIPTION

Semi-lithified claystone. Color is predominantly moderate brown with patches and streaks of light brown and light bluish gray. There is no calcareous material in Section 1; Sections 2, 3 & 4 are calcareous throughout.

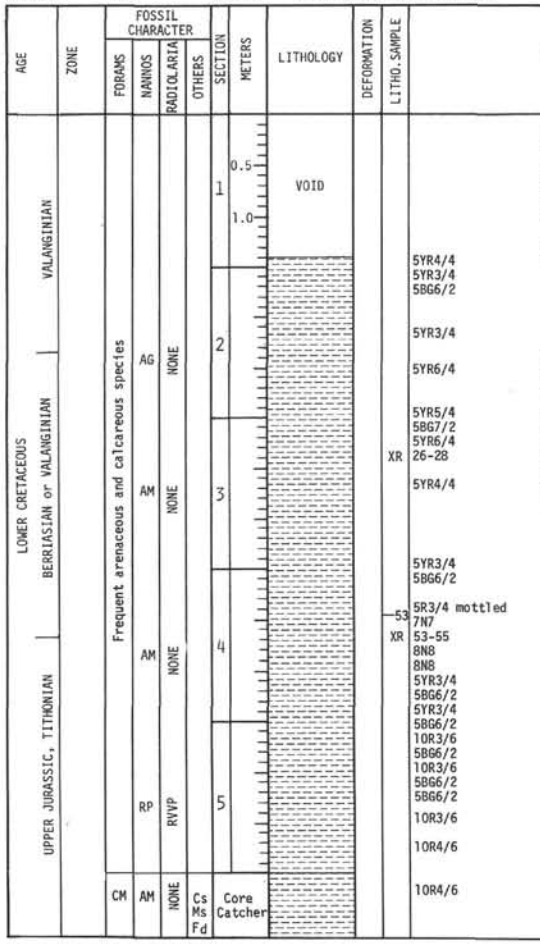
<u>CLAYSTONE</u>
Smear slide CC

Composition	
Clay	88%
Barite	10%
Feldspar	2%

BULK X-RAY (487.8 m)

Calcite	65%
Quartz	21%
Montmorillonite	6%
Mica	3%
Hematite	3%
K-feldspar	2%

Site 261 Hole Core 31 Cored Interval: 503.5-513.0 m



LITHOLOGIC DESCRIPTION

Semi-lithified claystone, predominantly moderate brown; moderate reddish brown in core catcher. The brown color is broken by occasional streaks and patches of pale blue green and light gray. The following intervals are calcareous: 2 (107-150), 3 (0-59), 4 (55-106), 5 (90-150).

<u>CLAYSTONE</u>
Smear slide 4-53

Composition	
Clay	98%
Heavy Minerals	2%
Quartz, Feldspar, Fe Oxide	Tr.

BULK X-RAY (506.8 m)

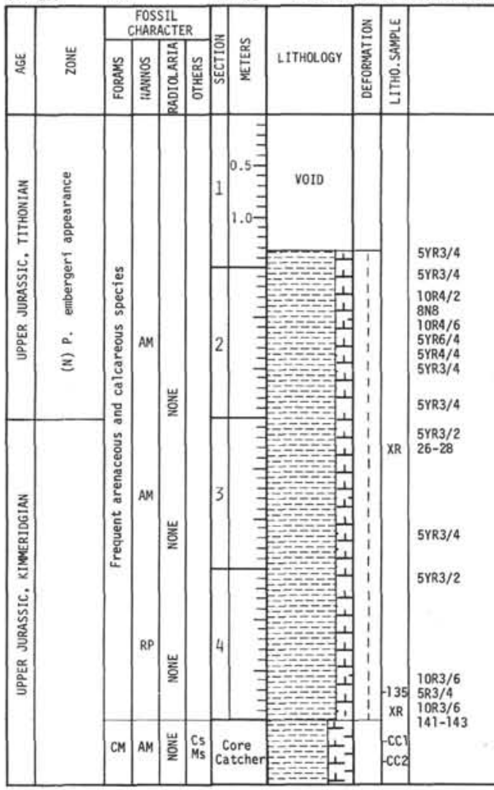
Quartz	47%
Calcite	24%
Montmorillonite	14%
Mica	7%
K-feldspar	5%
Barite	3%

BULK X-RAY (508.5 m)

Montmorillonite	98%
Quartz	2%

Explanatory notes in chapter 1

Site 261 Hole Core 32 Cored Interval:522.5-532.0 m



LITHOLOGIC DESCRIPTION

Semi-lithified claystone, predominantly dark moderate brown in color, with short intercalations of grayish red, dusky red, light gray. The following sections are calcareous: Section 1, Section 2 (weakly 100-150) (strongly 0-100), Section 3 throughout, Section 4 throughout. Nodules are present 3-13, 3 (66-68), 3-100, 3 (120-123), 3-147. Biogenic sedimentary structures are present in the interval 2 (56-74) and a burrow at 4-148.

NANNO RICH QUARTZ CLAYSTONE
Smear slides 4-135, CC1, CC2

Composition	
Clay and Micro-crystalline Quartz	33-80%
Nannos	20-65%
Feldspar	Tr.- 1%
Heavy Minerals	0- 1%

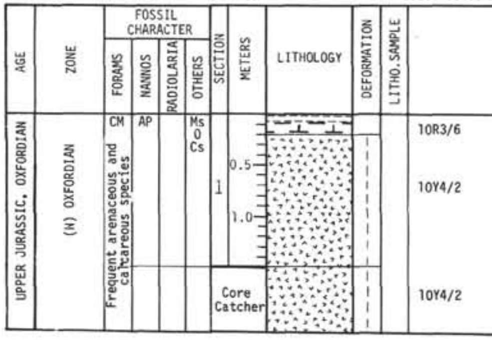
BULK X-RAY (525.8 m)

Quartz	35%
Montmorillonite	27%
Calcite	12%
Mica	11%
Hematite	8%
K-feldspar	7%

BULK X-RAY (528.4 m)

Calcite	53%
Quartz	18%
K-feldspar	8%
Hematite	8%
Montmorillonite	7%
Mica	6%

Site 261 Hole Core 33 Cored Interval:532.0-534.0 m



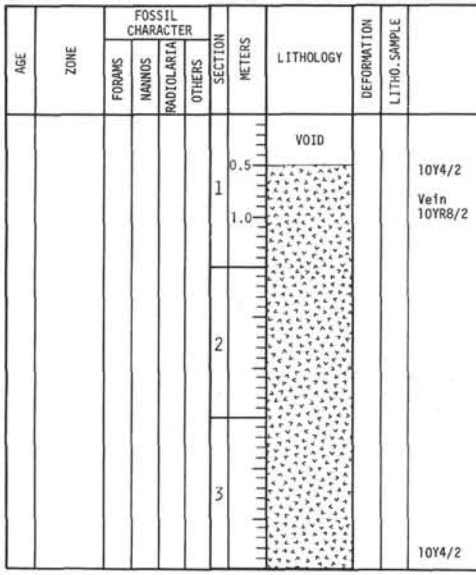
LITHOLOGIC DESCRIPTION

Semi-lithified nanno claystone, dark reddish brown in color, forms 0-20 cm of Section 1. Below the claystone is basalt. The upper 18 cm of the basalt is weathered, and calcified shale is cemented to it.

NANNO CLAYSTONE

BASALT

Site 261 Hole Core 34 Cored Interval:534.0-541.5 m



LITHOLOGIC DESCRIPTION

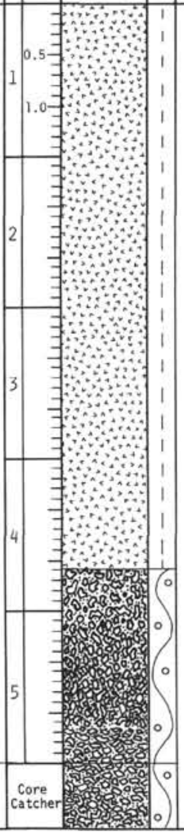
Basalt, containing some decomposed patches and calcite veins.

BASALT

Explanatory notes in chapter 1

Site 261 Hole Core 35 Cored Interval: 541.5-551.0 m

AGE | ZONE | FOSSIL CHARACTER: FORAMS, NANNOS, RADIOLARIA, OTHERS | SECTION | METERS | LITHOLOGY | DEFORMATION | LITHO. SAMPLE | LITHOLOGIC DESCRIPTION



10Y4/2

calcite vein
5R3/4

10Y4/2

10Y4/2

5YR3/4

5YR3/4

5YR3/4

Basalt, containing calcite veins. The surface texture of the rock suggests slight decomposition and possibly a grain size coarser than that occurring elsewhere in the basalt. A finer-textured and seemingly fresher basalt occurs in Section 2 (117-150). In Section 3 the basalt contains dusky red calcite and white calcite veins and some limestone breccia. In the lower part of this core below 4-111 and all of Section 5 and the core catcher. The core consists of soft breccia, which is almost certainly drilling breccia, containing fresh chips of basalt and pink clay and fragments of calcite in a brown clay matrix.

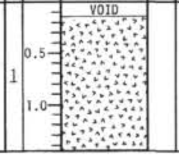
BASALT

LIMESTONE

BRECCIA

Site 261 Hole Core 36 Cored Interval: 551.0-552.5 m

AGE | ZONE | FOSSIL CHARACTER: FORAMS, NANNOS, RADIOLARIA, OTHERS | SECTION | METERS | LITHOLOGY | DEFORMATION | LITHO. SAMPLE | LITHOLOGIC DESCRIPTION



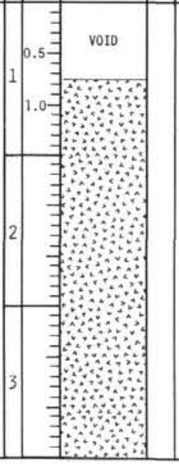
10Y4/2
calcite
10R5/4

Fourteen pieces of basalt, dark greenish gray in color.

BASALT

Site 261 Hole Core 37 Cored Interval: 552.5-560.5 m

AGE | ZONE | FOSSIL CHARACTER: FORAMS, NANNOS, RADIOLARIA, OTHERS | SECTION | METERS | LITHOLOGY | DEFORMATION | LITHO. SAMPLE | LITHOLOGIC DESCRIPTION



10Y4/2

10YR4/2

10G4/2

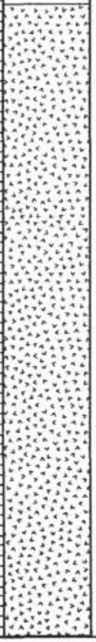
Eight pieces of basalt and decomposed basalt in Section 1. Eleven pieces in Section 2 and seventeen pieces in Section 3. The basalt is weathered to a fine grained hard yellowish brown rock, and also to a grayish green mineral. There are numerous calcite-filled cracks in the basalt.

BASALT

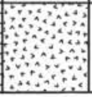
DECOMPOSED BASALT

Explanatory notes in chapter 1

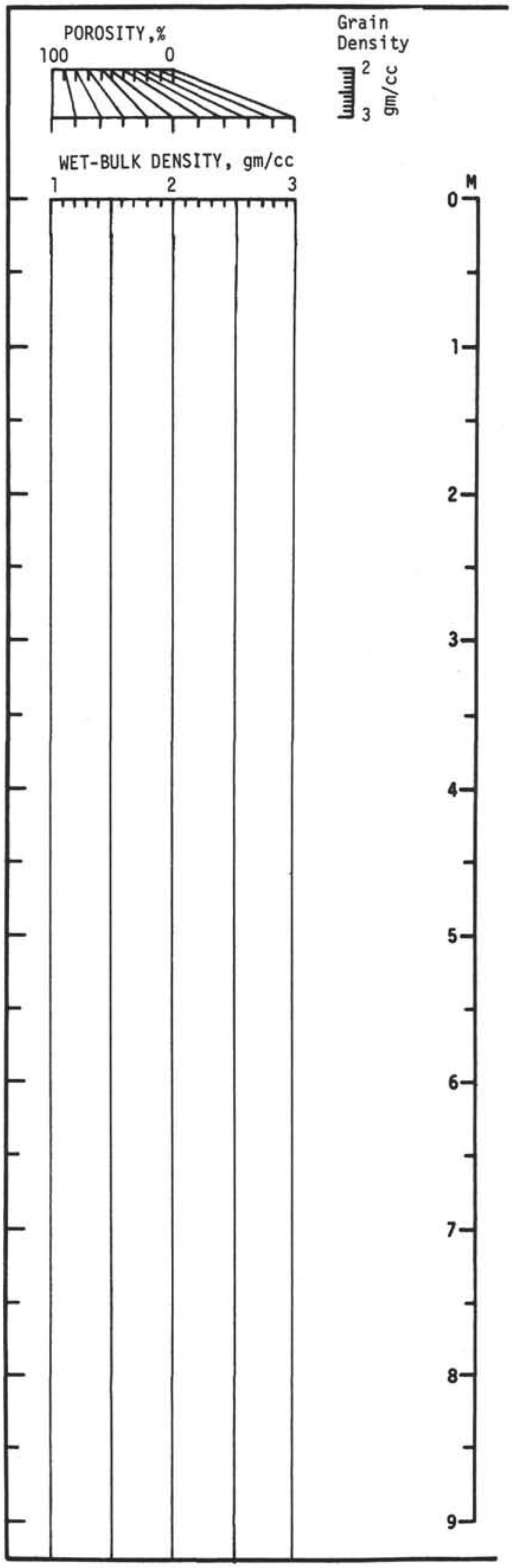
Site 261 Hole Core 38 Cored Interval: 560.5-570.0 m

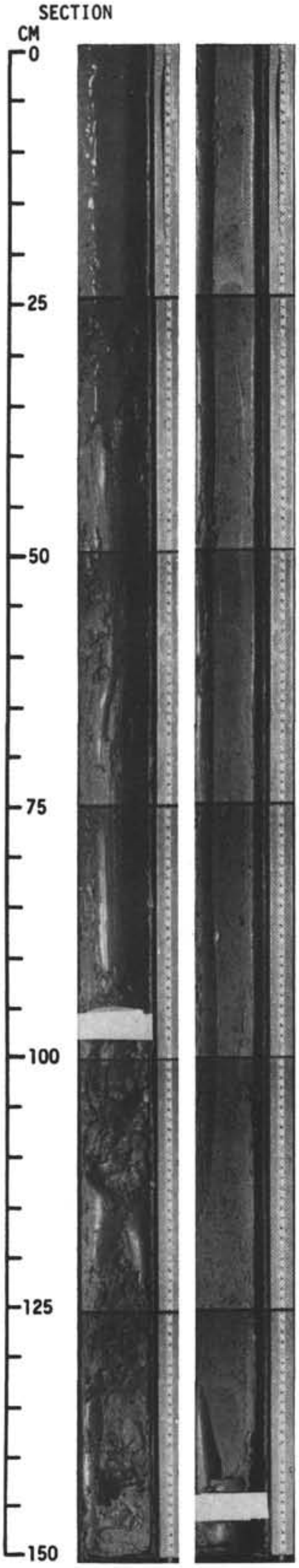
AGE	ZONE	FOSSIL CHARACTER				SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE		LITHOLOGIC DESCRIPTION
		FORAMS	NANNOS	RADIOLARIA	OTHERS							
						1	0.5 1.0	VOID 			10YR4/2	The basalt in this core is largely decomposed to a yellowish brown fine grained rock and a green waxy mineral. Numerous calcite veins are present. BASALT DECOMPOSED BASALT
						2					10YR3/2 10G4/2 10Y4/2	
						3					5R3/4	
						4					colors repeat	
						5						

Site 261 Hole Core 39 Cored Interval: 570.0-579.5 m

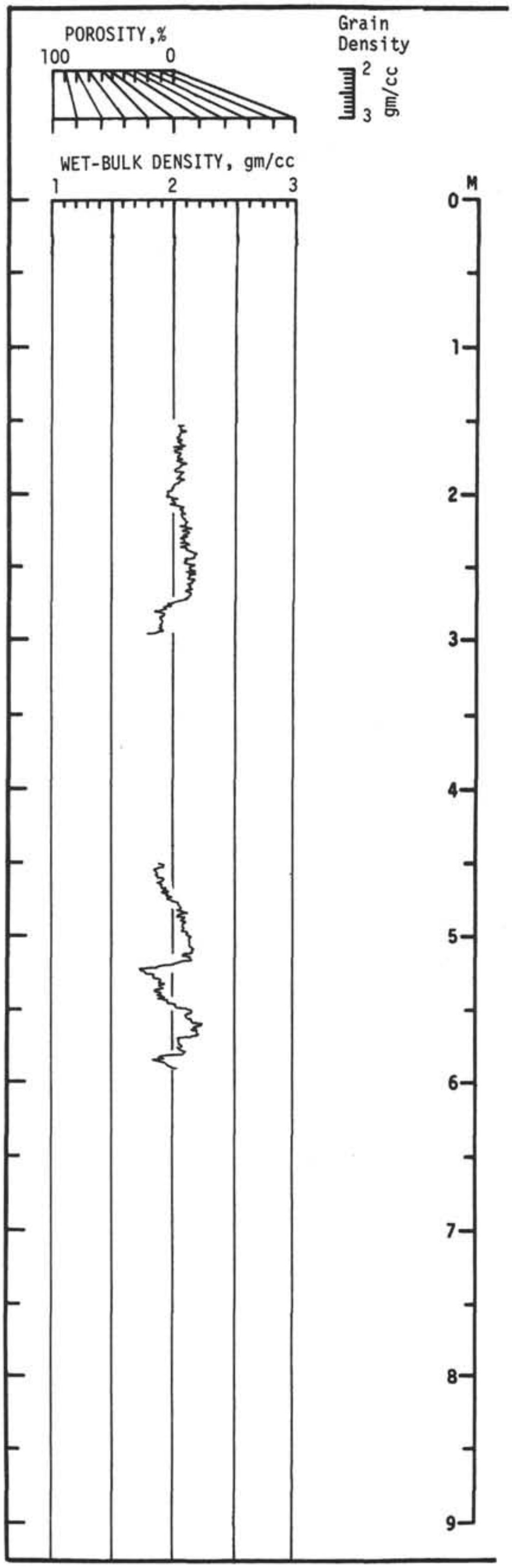
AGE	ZONE	FOSSIL CHARACTER				SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE		LITHOLOGIC DESCRIPTION
		FORAMS	NANNOS	RADIOLARIA	OTHERS							
						1	0.5				10Y4/2 10YR4/2 10G4/2	Fresh and decomposed basalt, containing inclusions of green secondary mineral and veins of calcite. BASALT

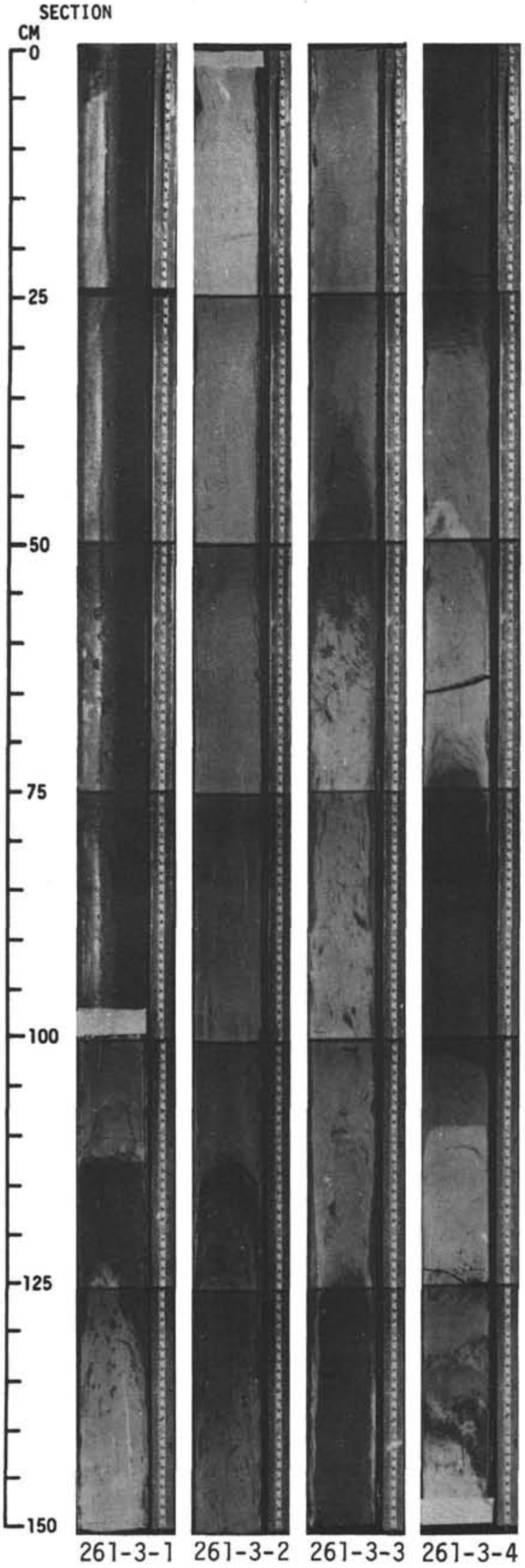
Explanatory notes in chapter 1


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


SECTION
CM
0
25
50
75
100
125
150

261-2-1 261-2-2


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


SECTION
CM
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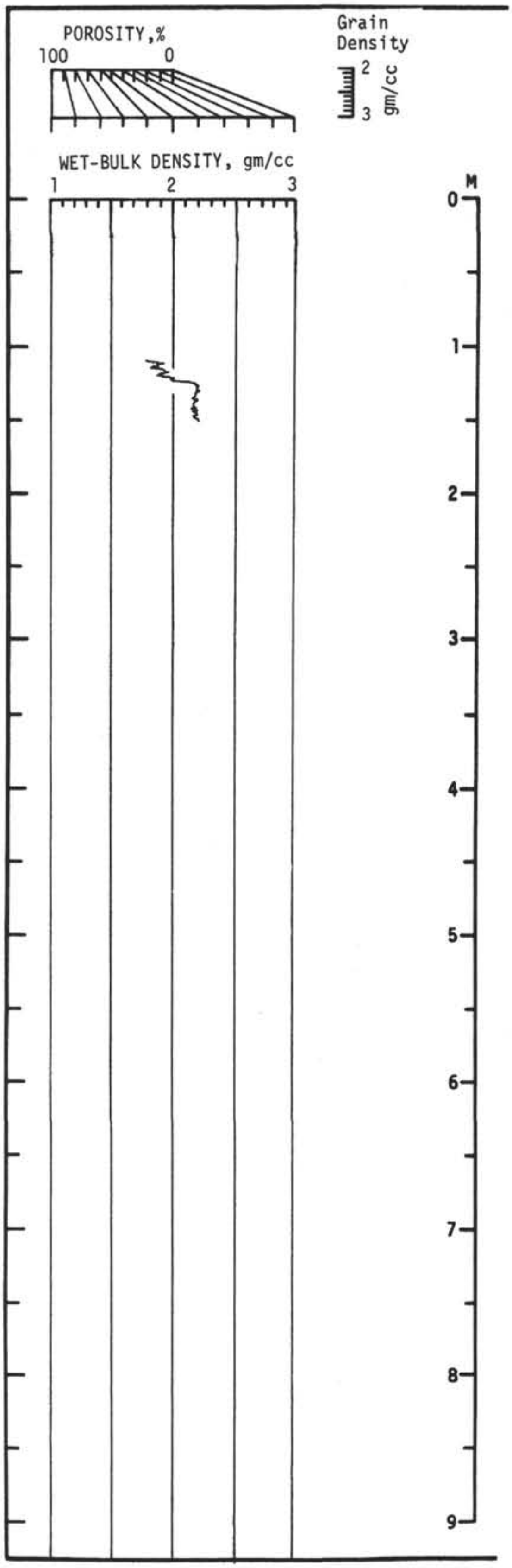
25
50
75
100
125
150
261-3-1
261-3-2
261-3-3
261-3-4


POROSITY,%
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0
Grain Density
2
3
gm/cc
WET-BULK DENSITY, gm/cc
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2
3
M
0
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2
3
4
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8
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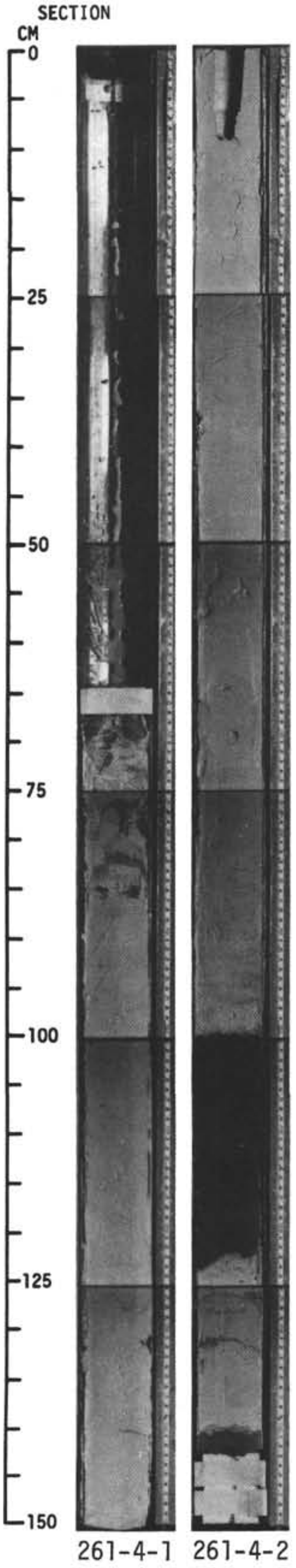
SECTION
CM
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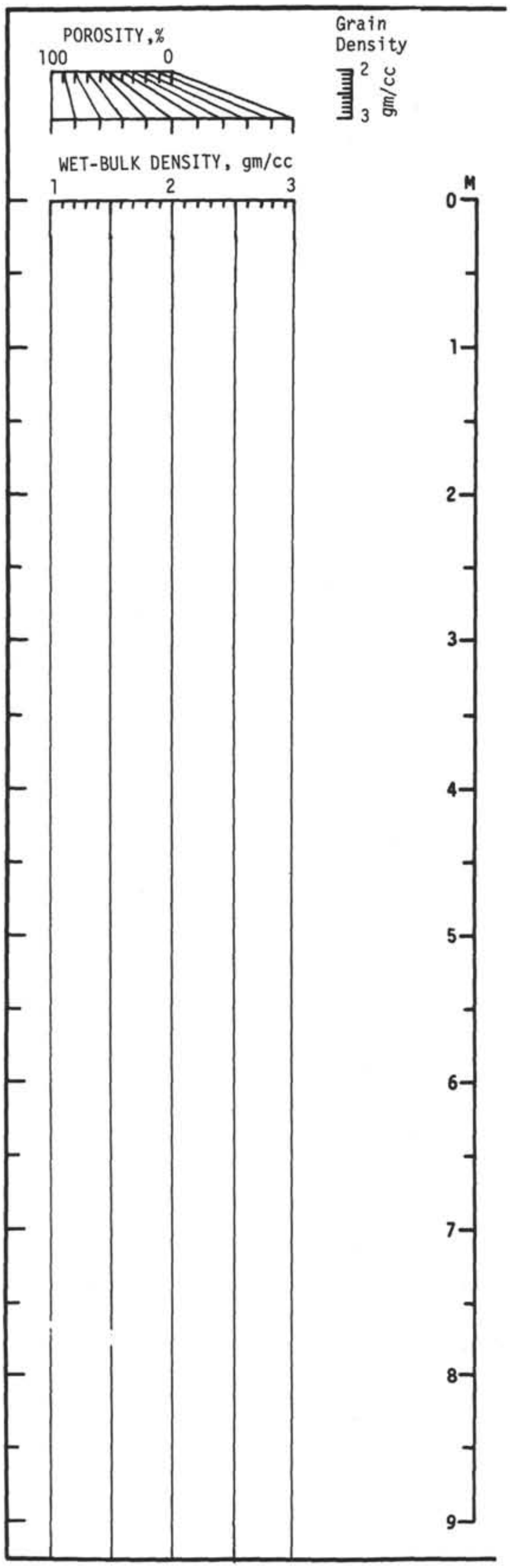
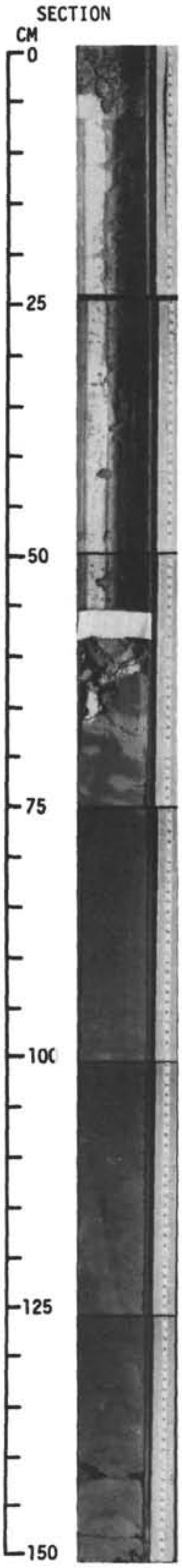
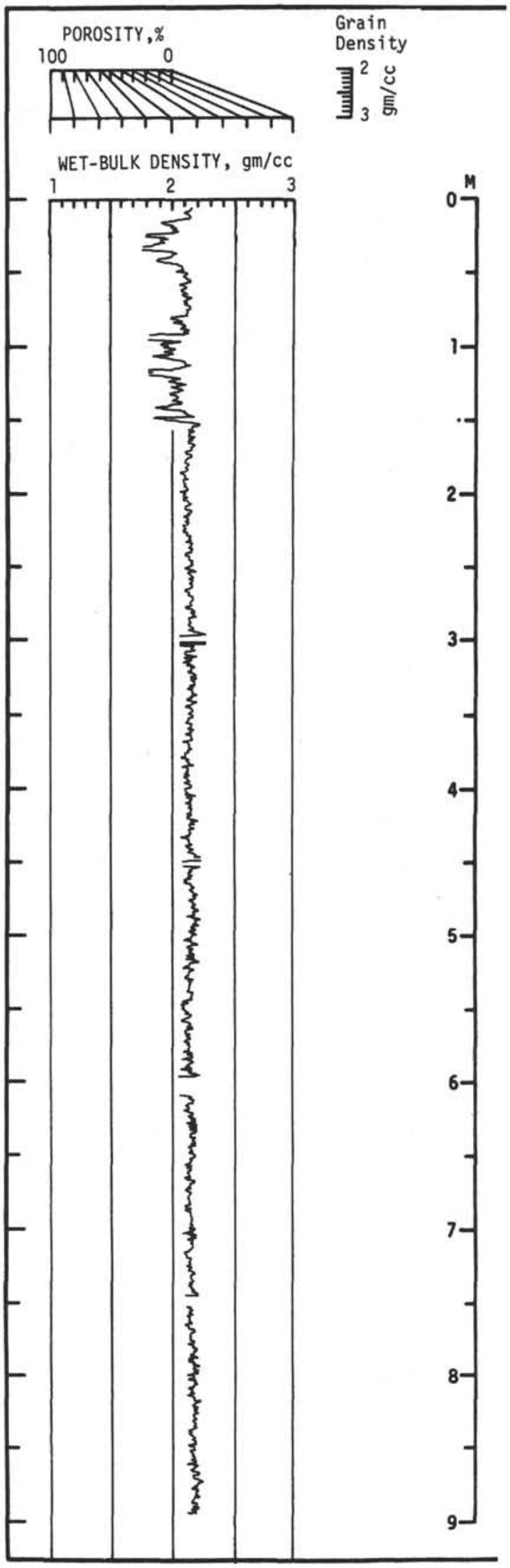
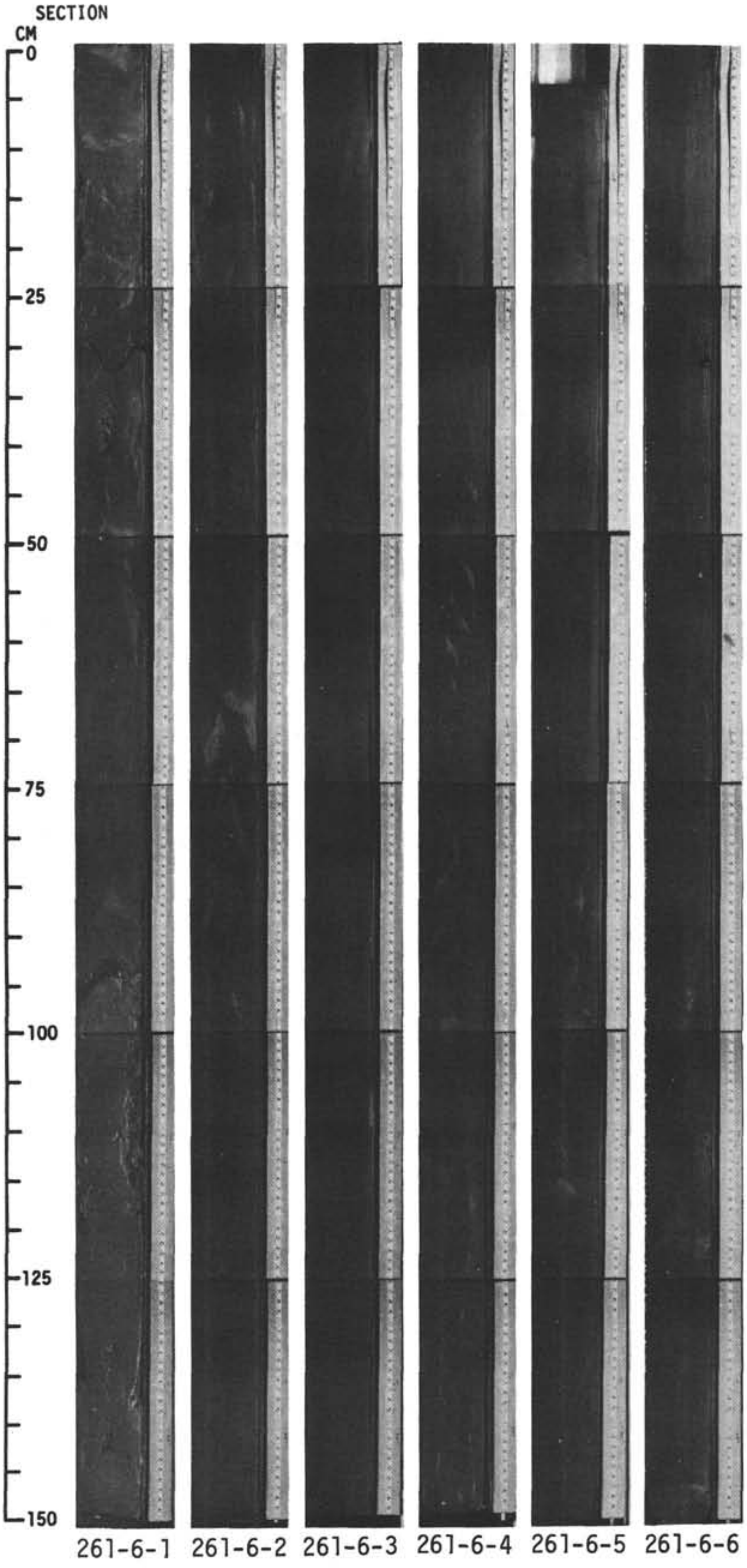
25
50
75
100
125
150
261-4-1
261-4-2


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


SECTION
CM
0
25
50
75
100
125
150

261-5-1


POROSITY,%
100
0
Grain Density
2
3
gm/cc
WET-BULK DENSITY, gm/cc
1
2
3
M
0
1
2
3
4
5
6
7
8
9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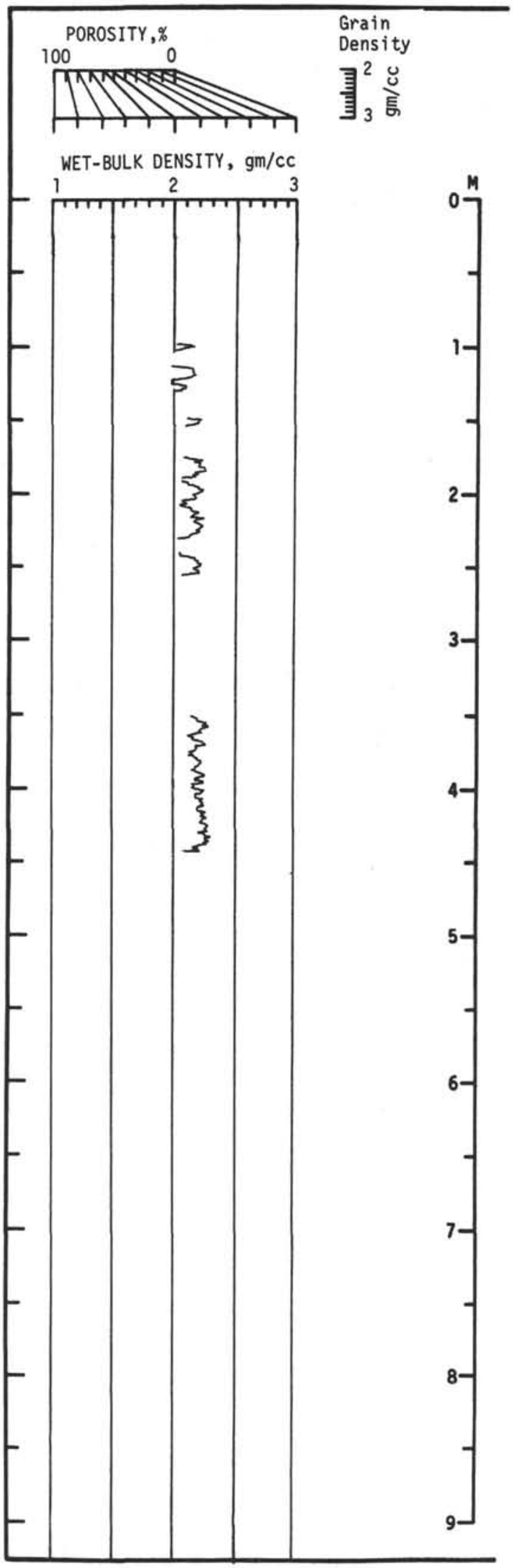
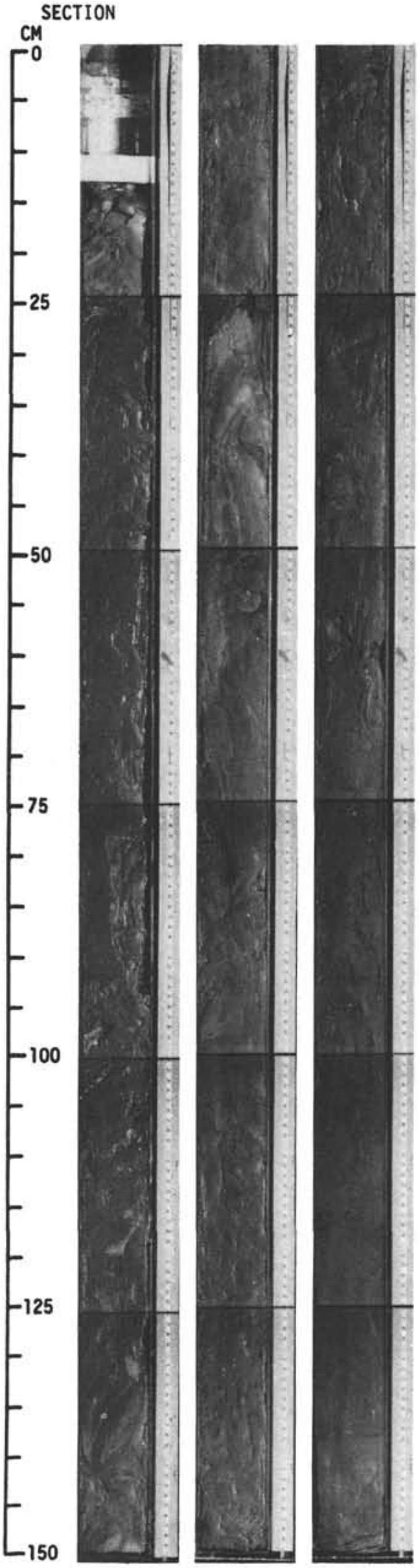
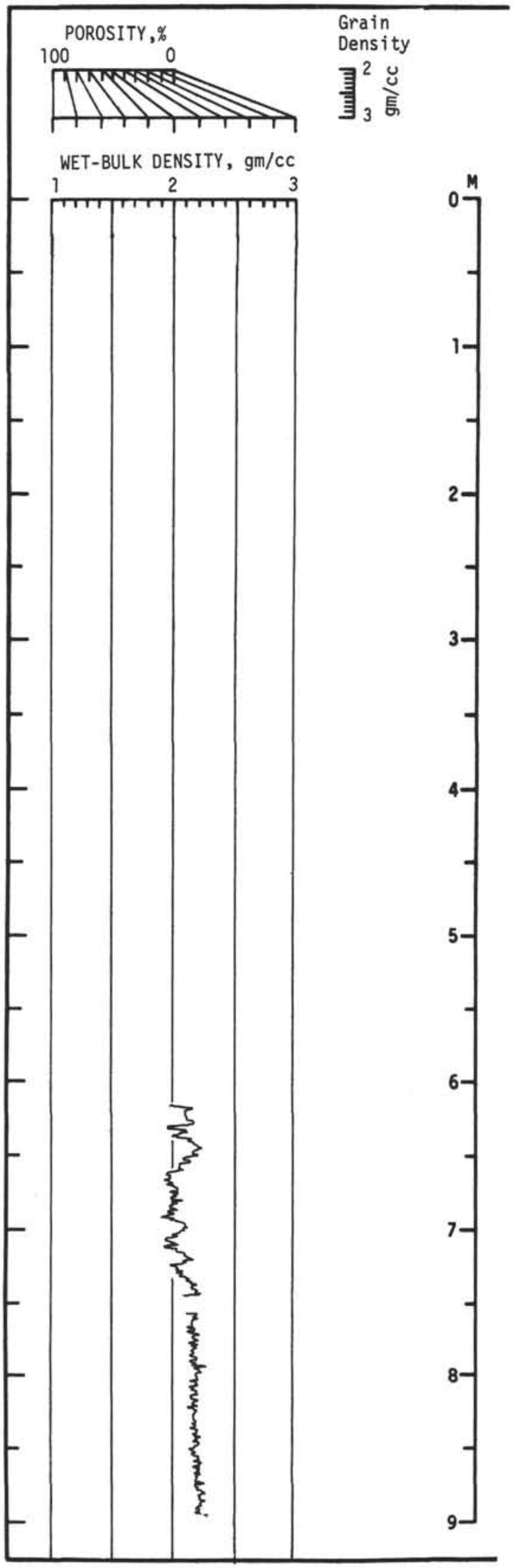
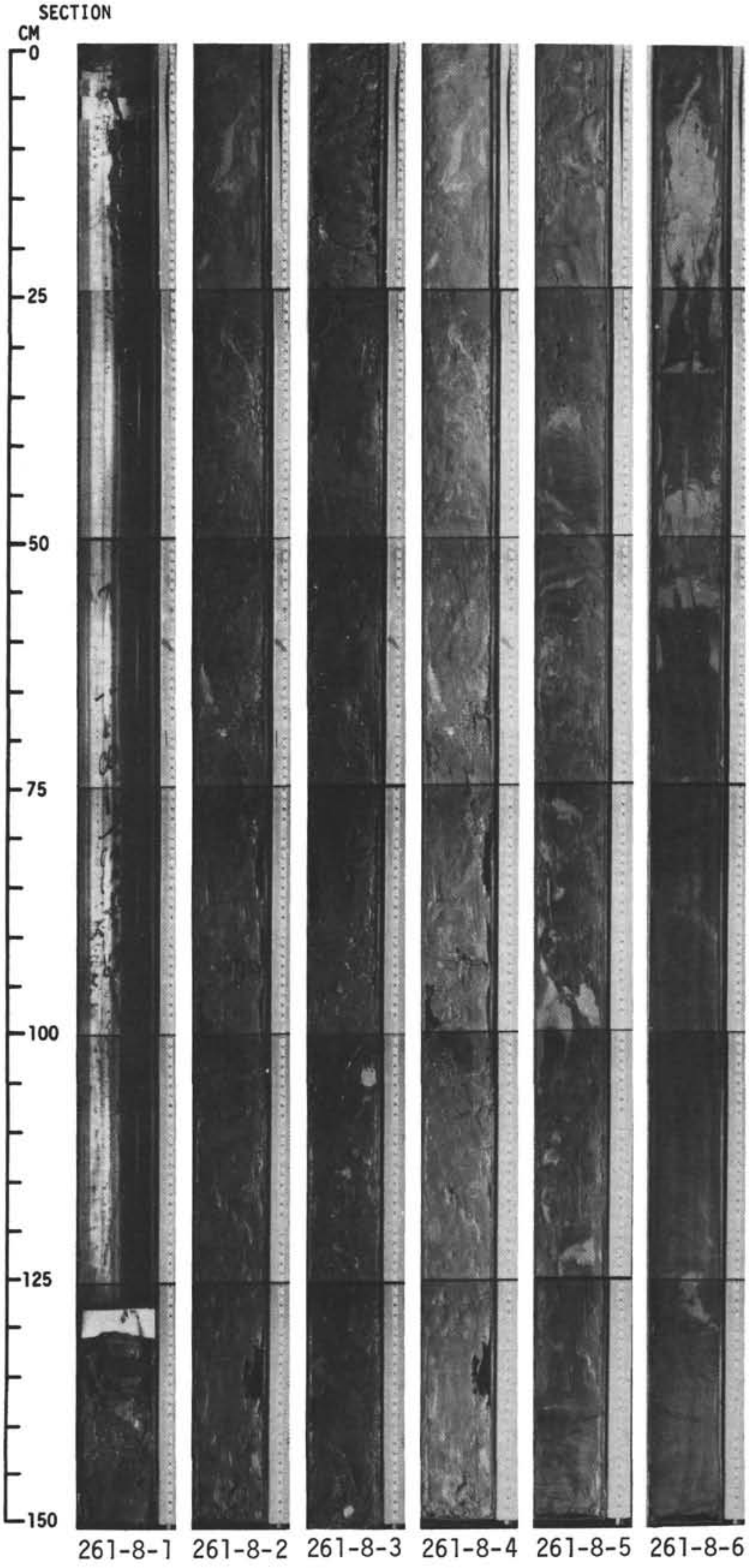
100
125
150
261-6-1
261-6-2
261-6-3
261-6-4
261-6-5
261-6-6





261-7-1 261-7-2 261-7-3


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


SECTION
CM
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75
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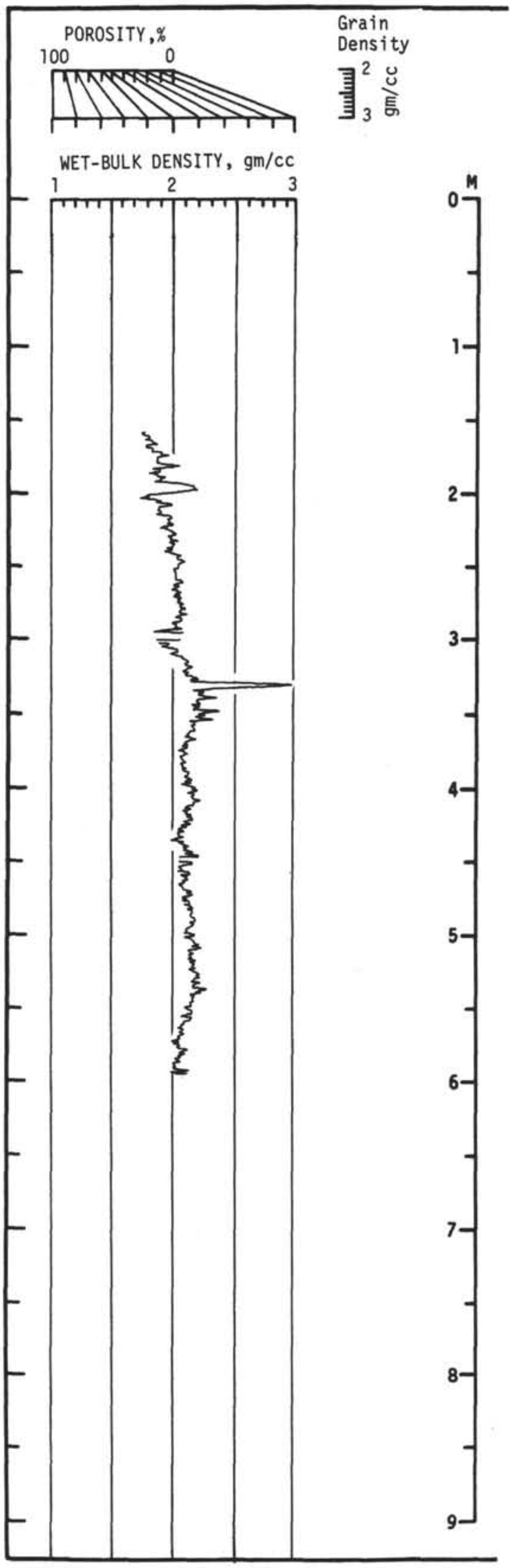
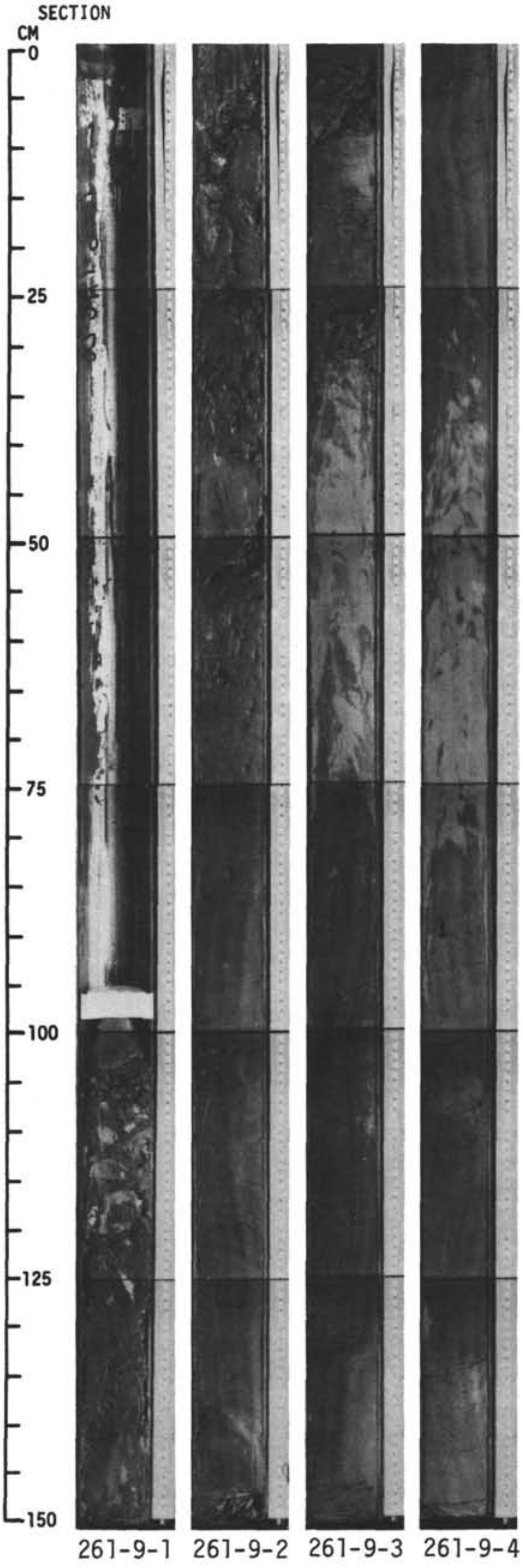
125
150
261-8-1
261-8-2
261-8-3
261-8-4
261-8-5
261-8-6


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


SECTION
CM
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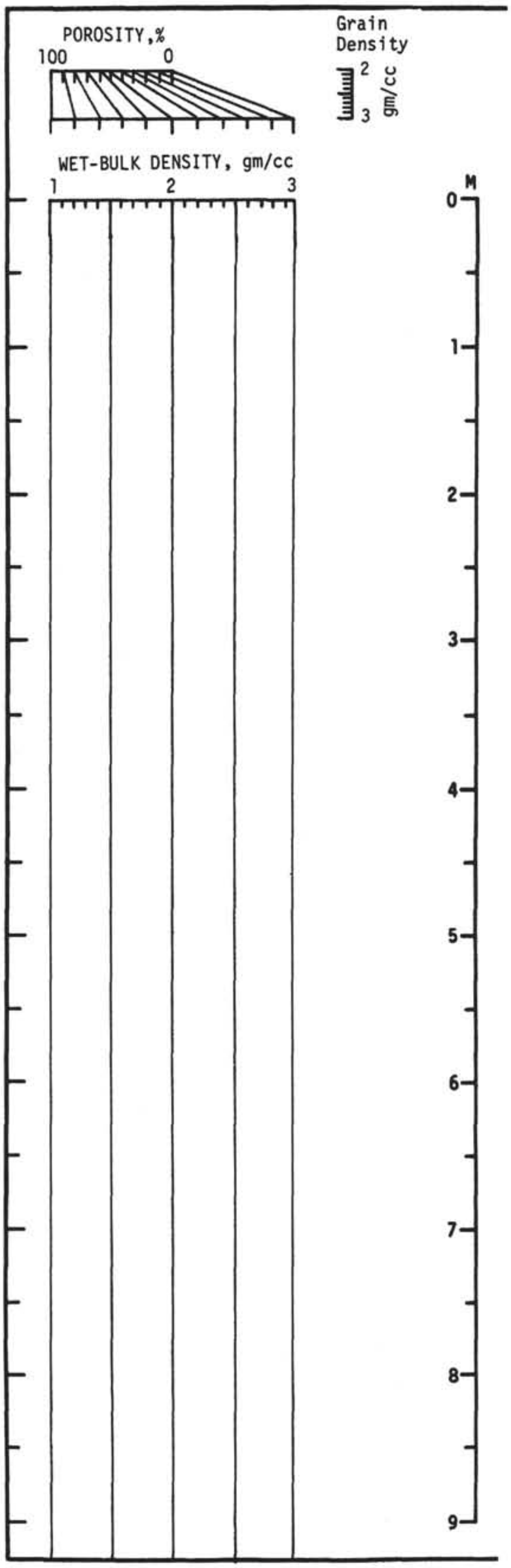
100
125
150
261-9-1
261-9-2
261-9-3
261-9-4


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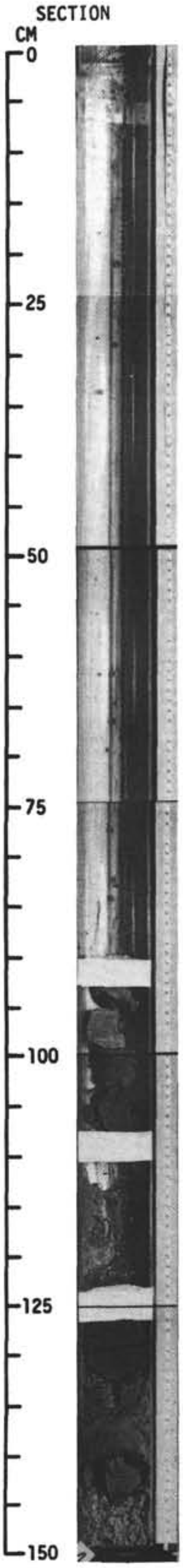
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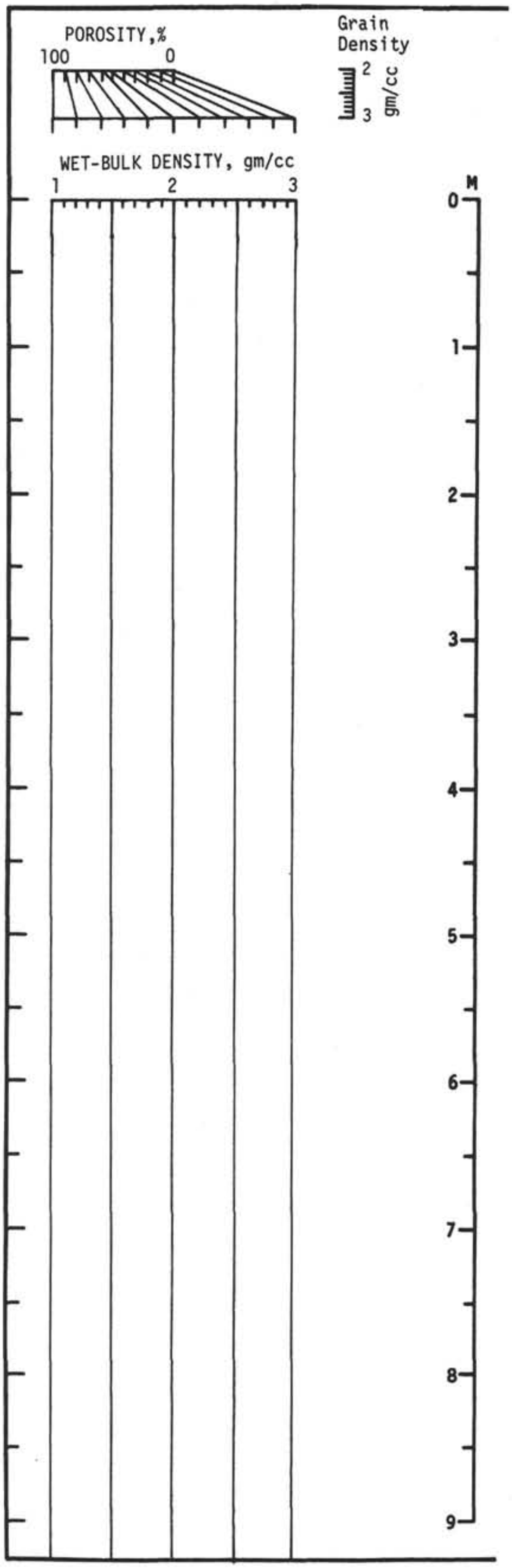
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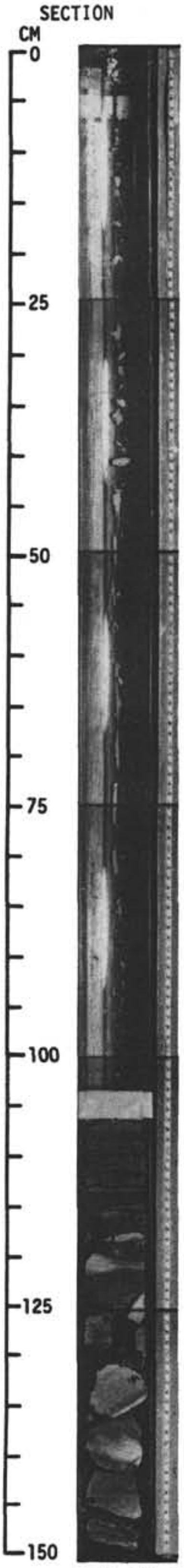
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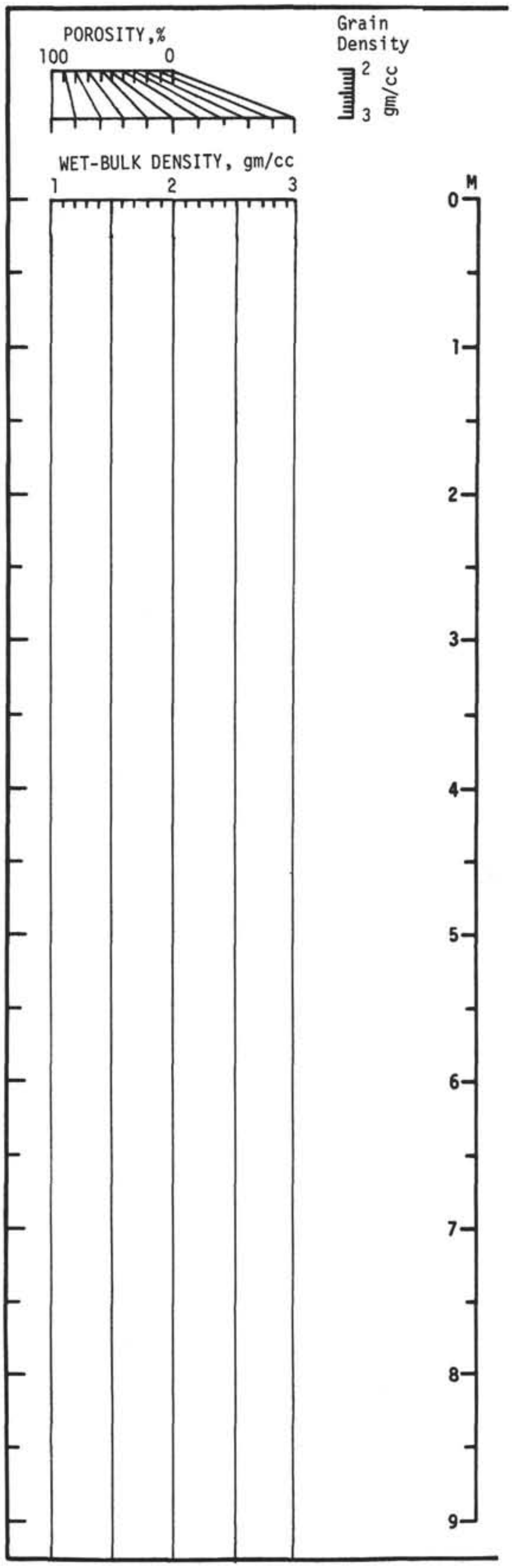

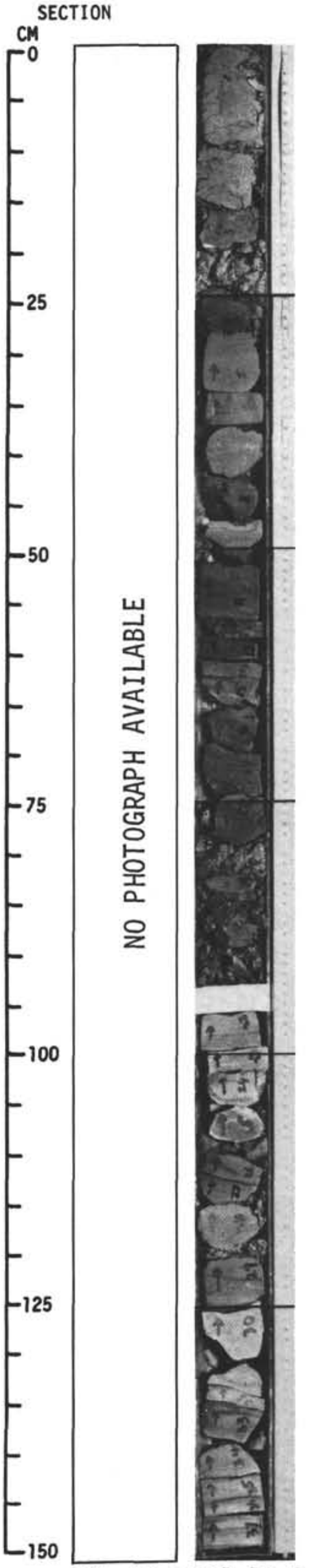

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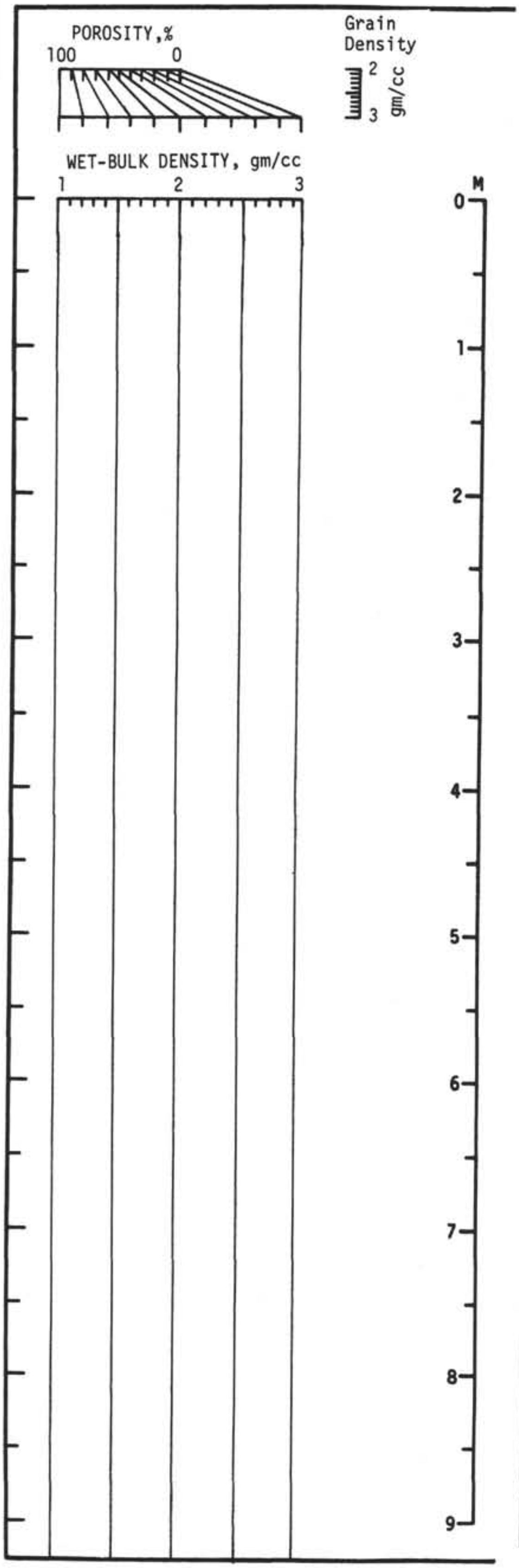
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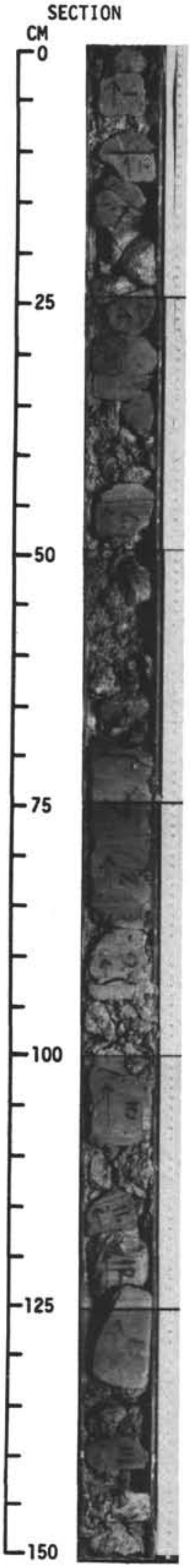
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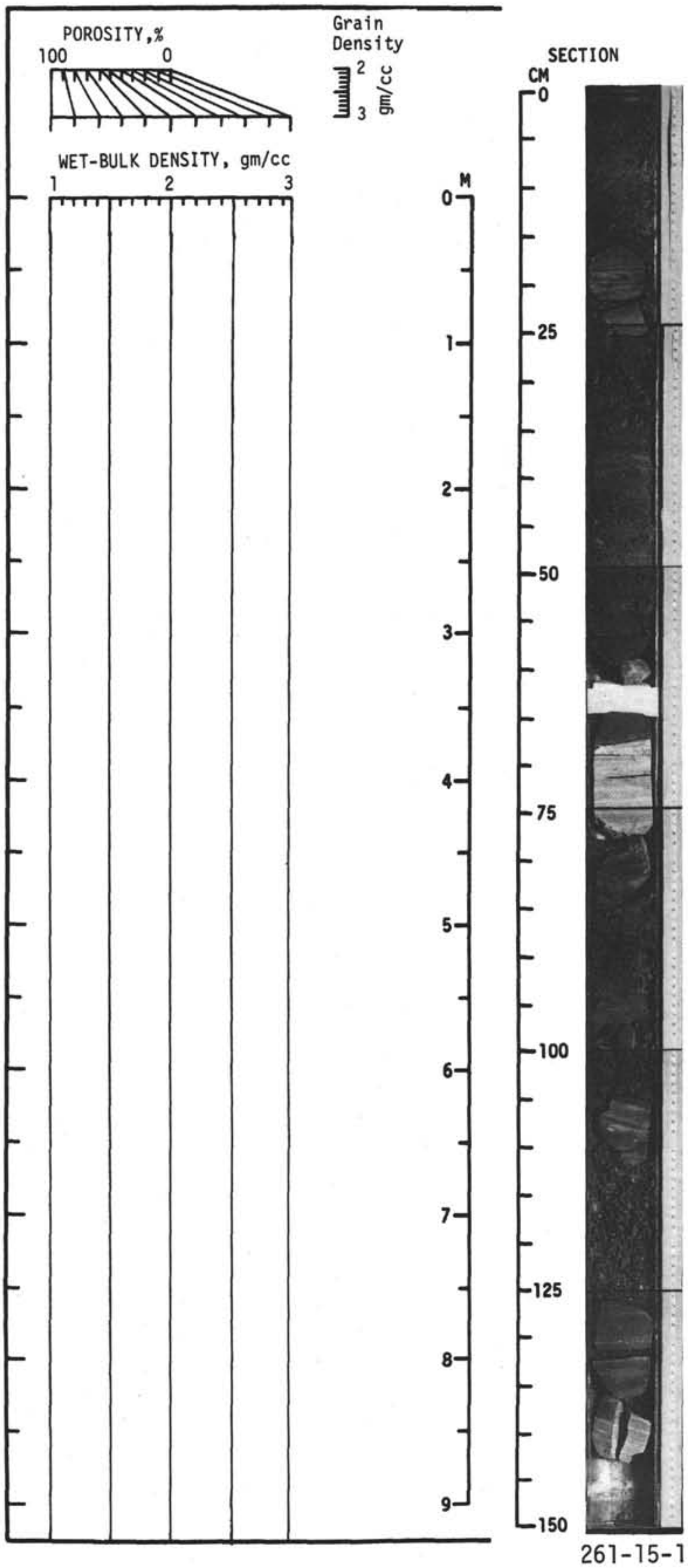
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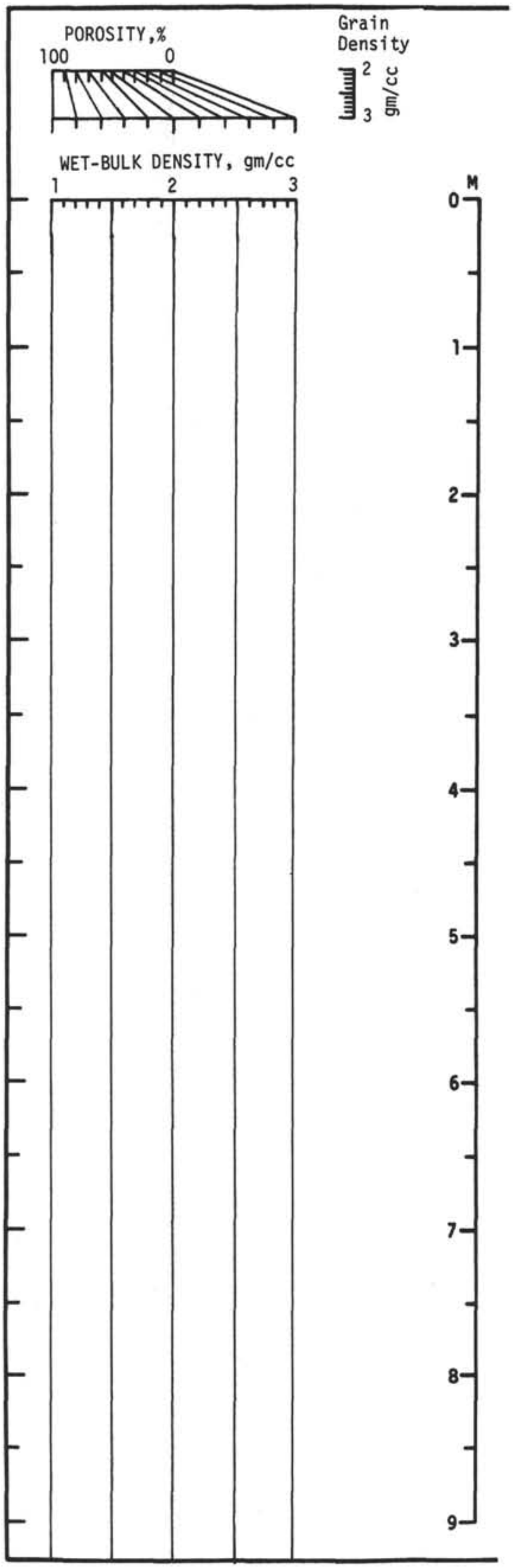
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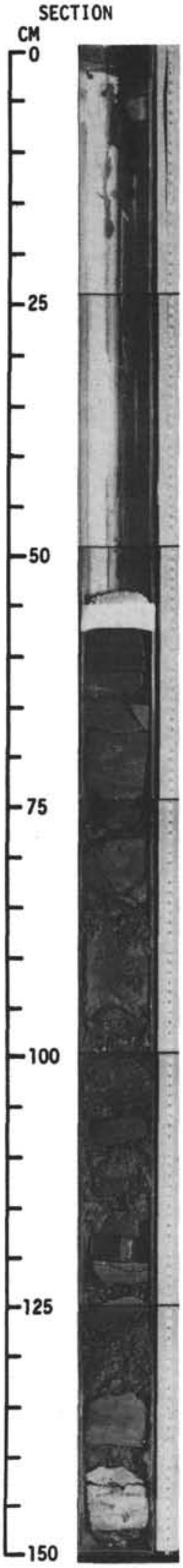
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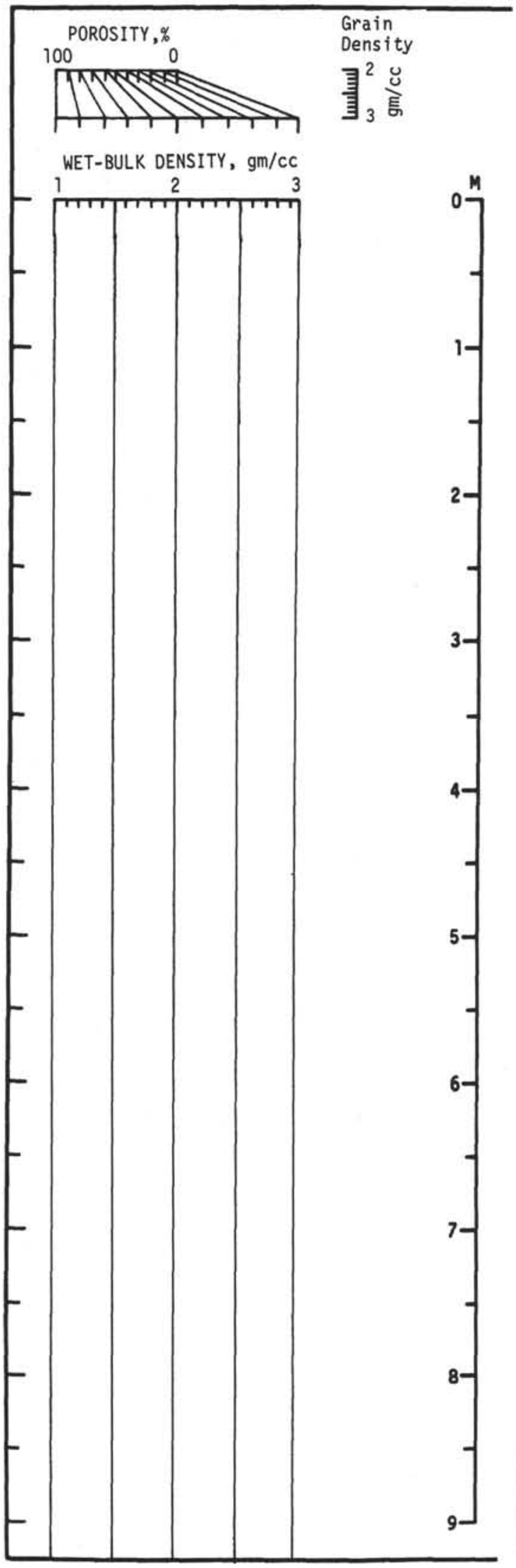
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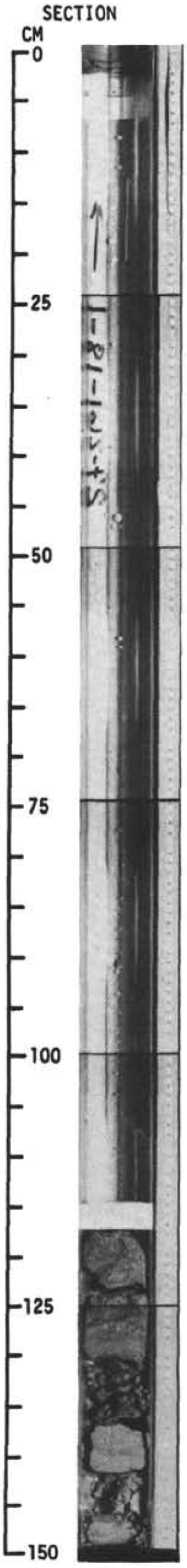
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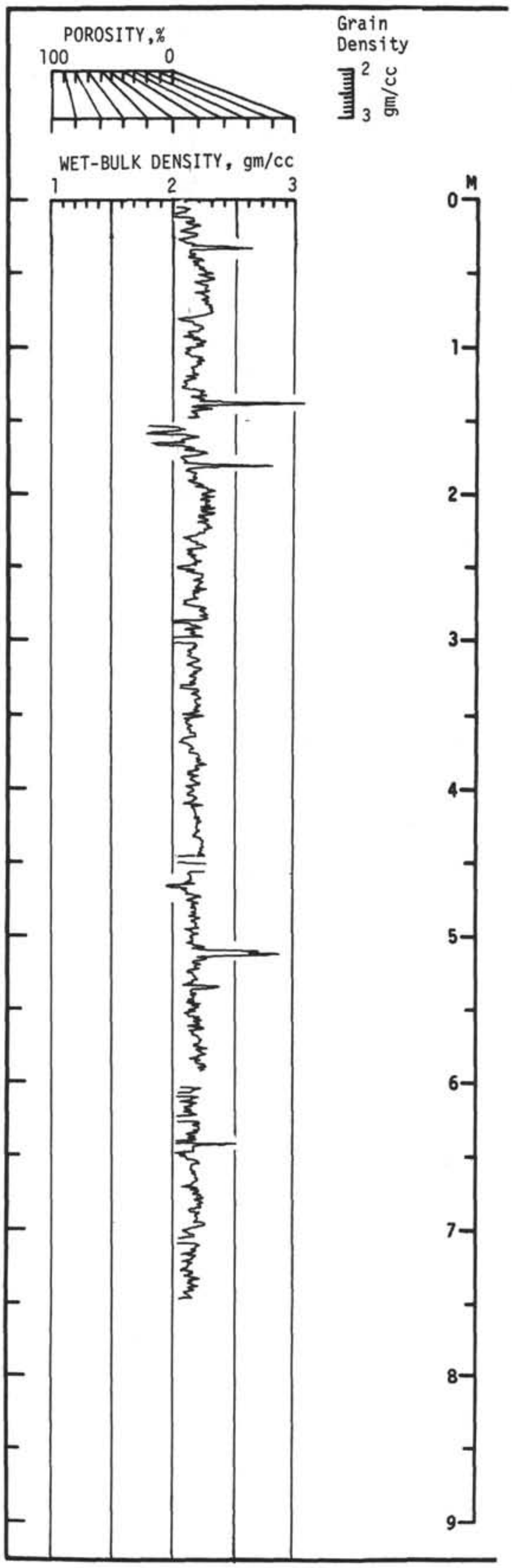
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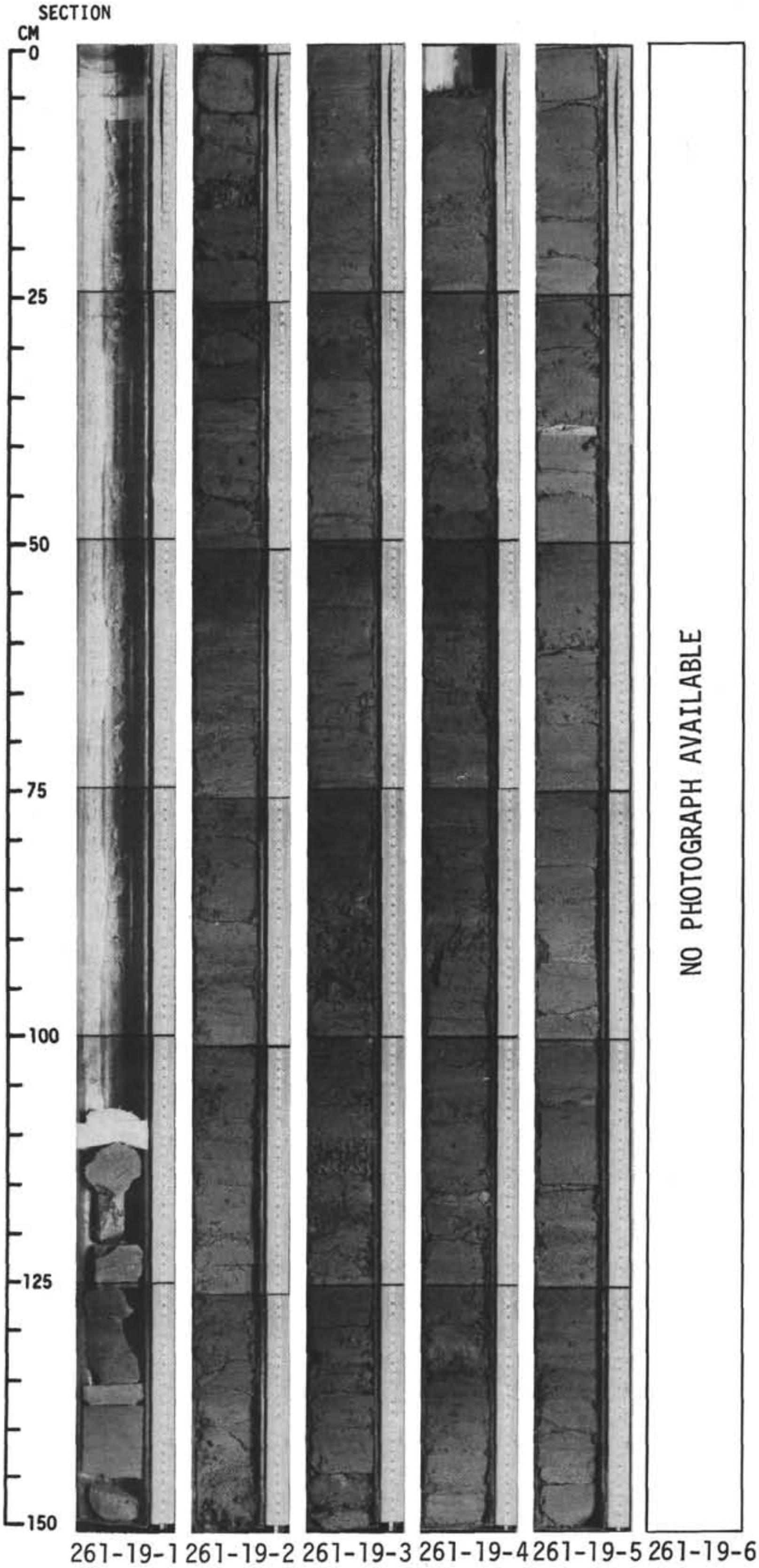
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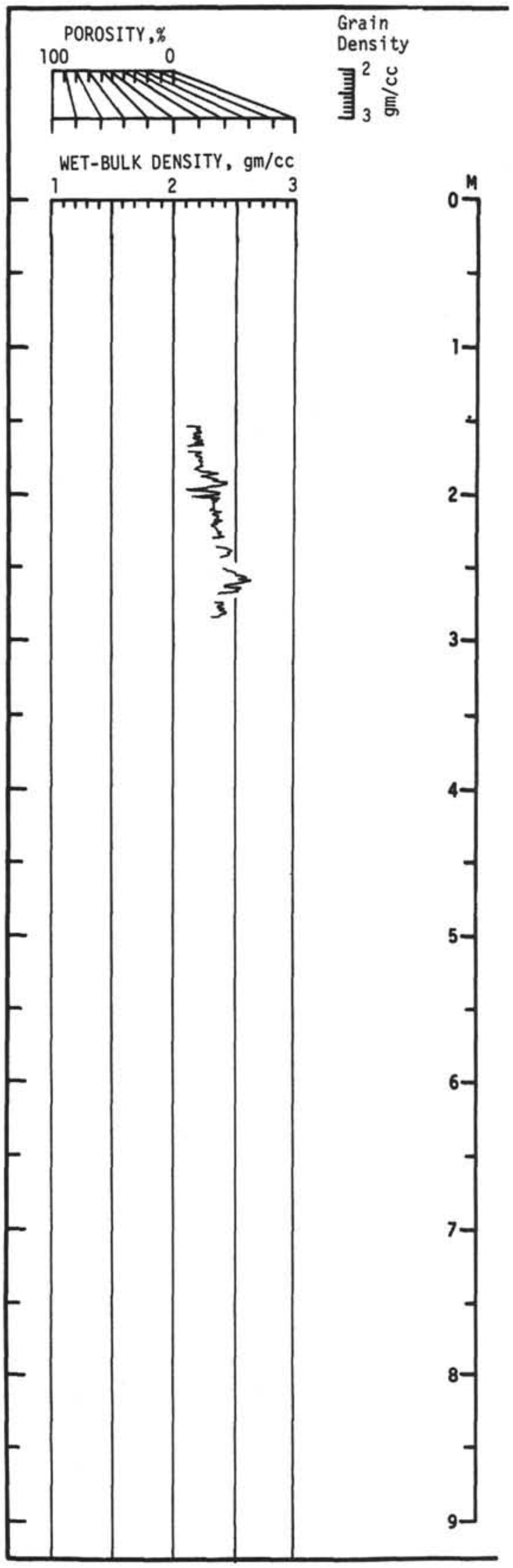
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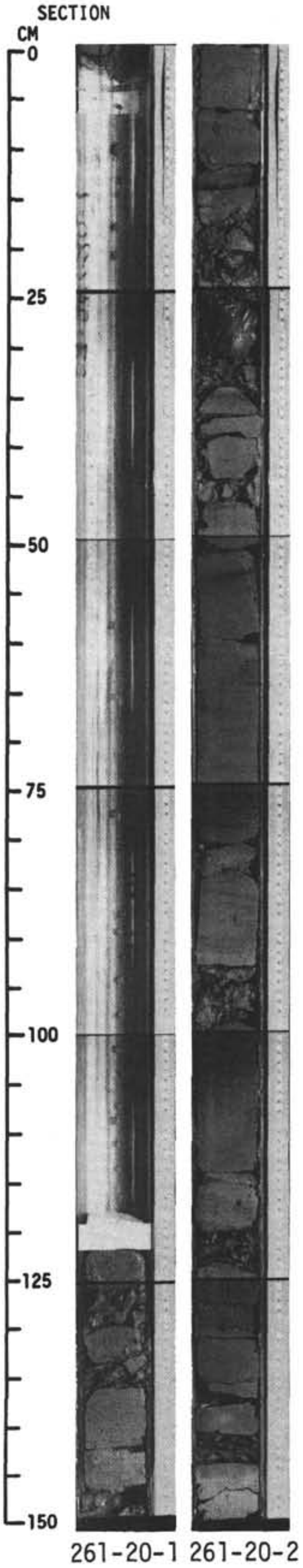
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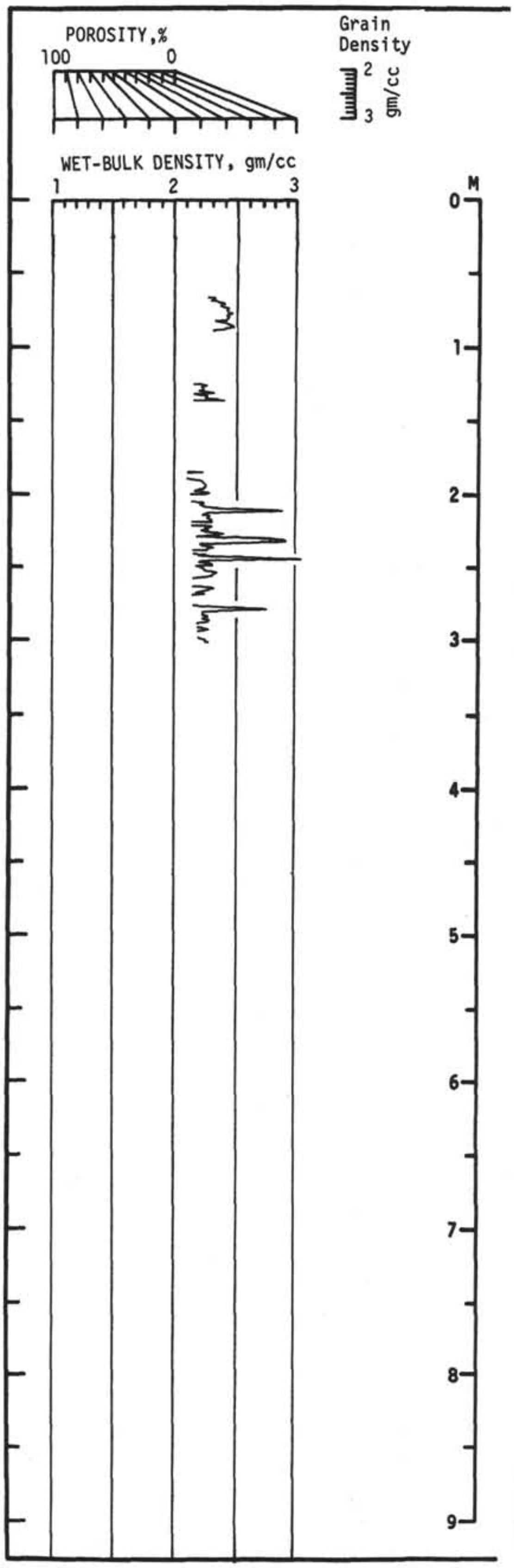
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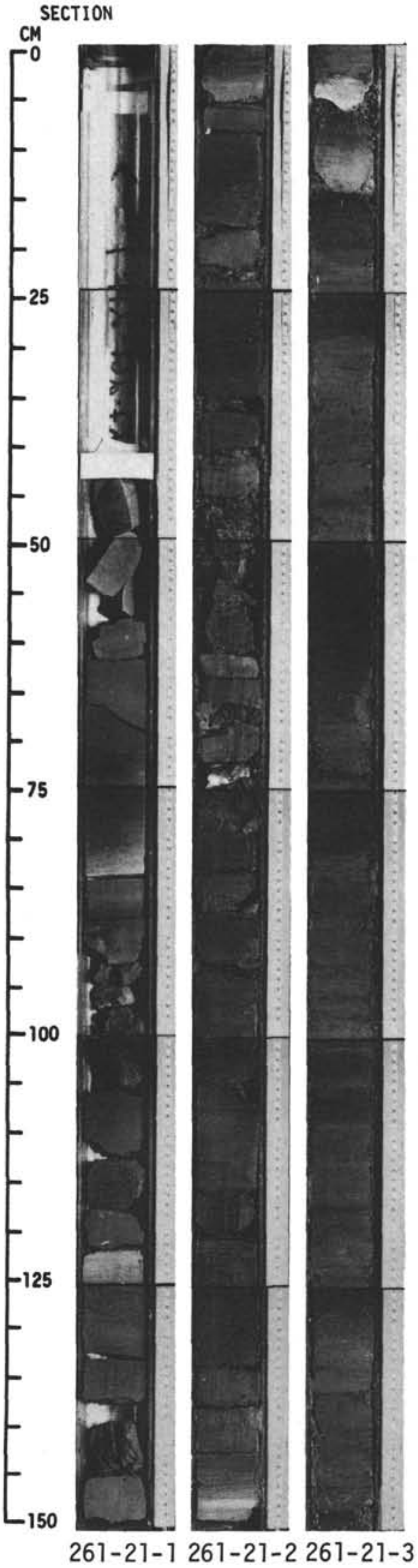
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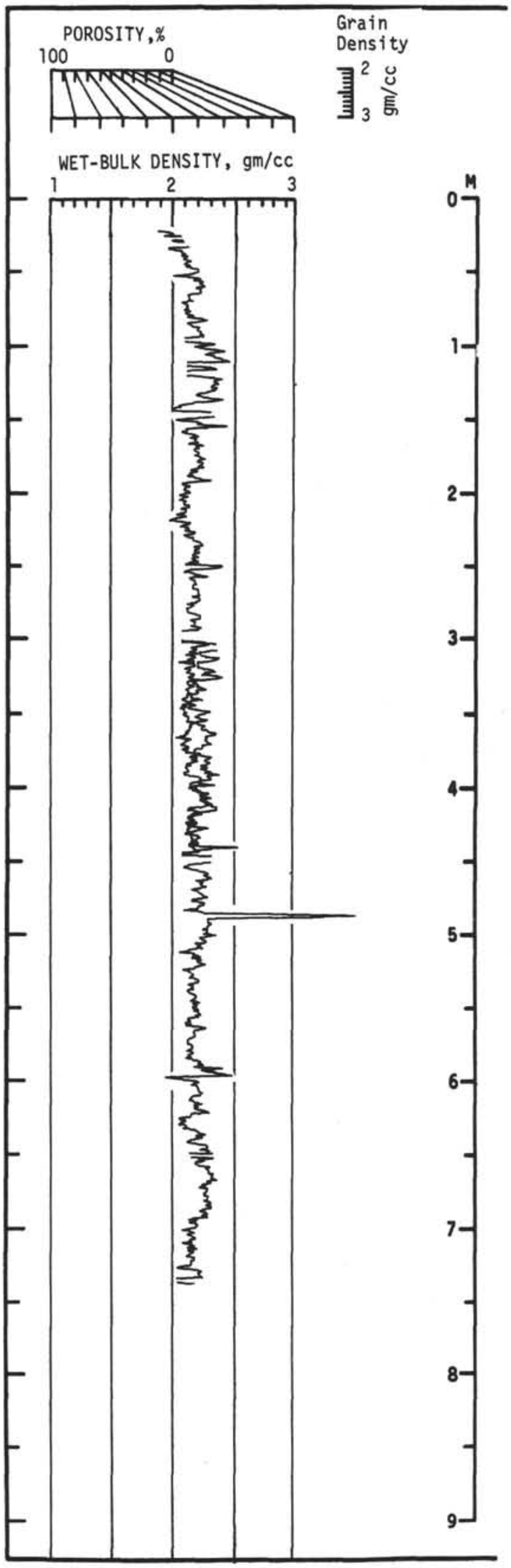
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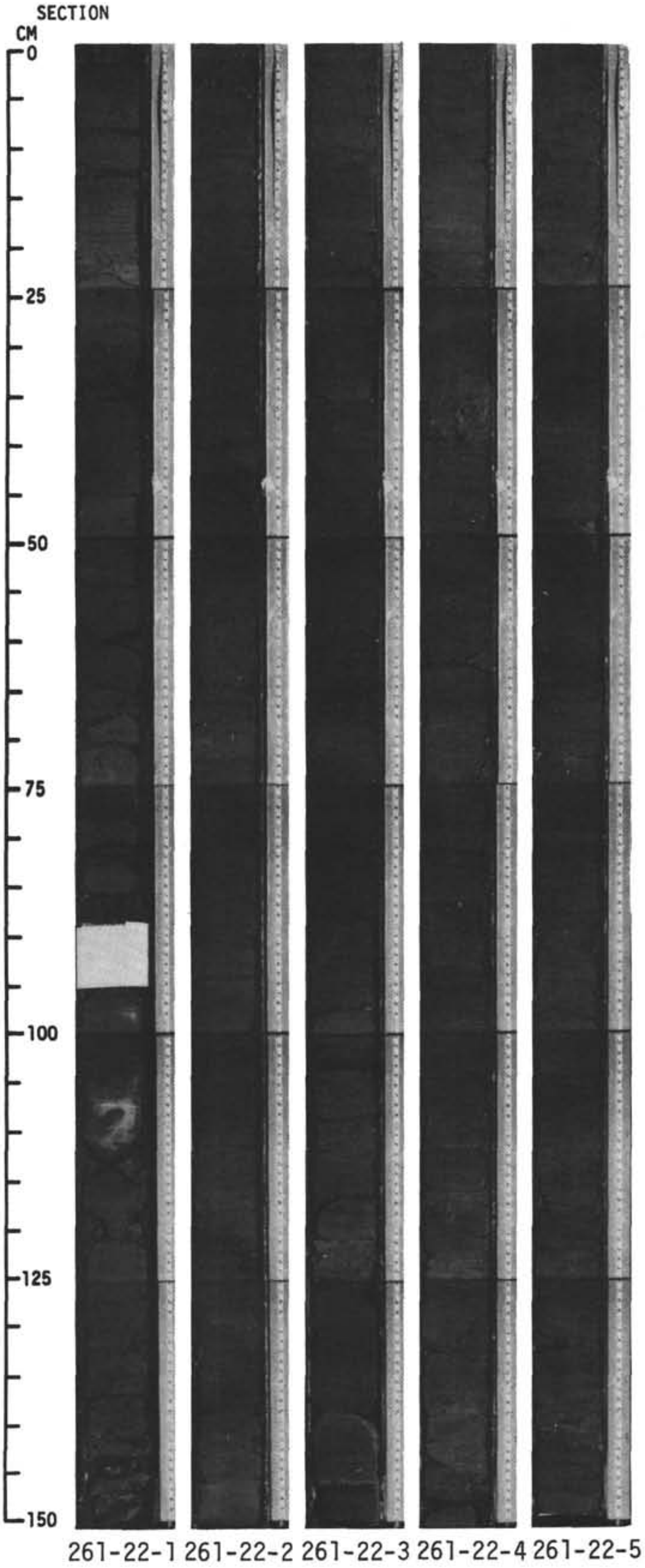
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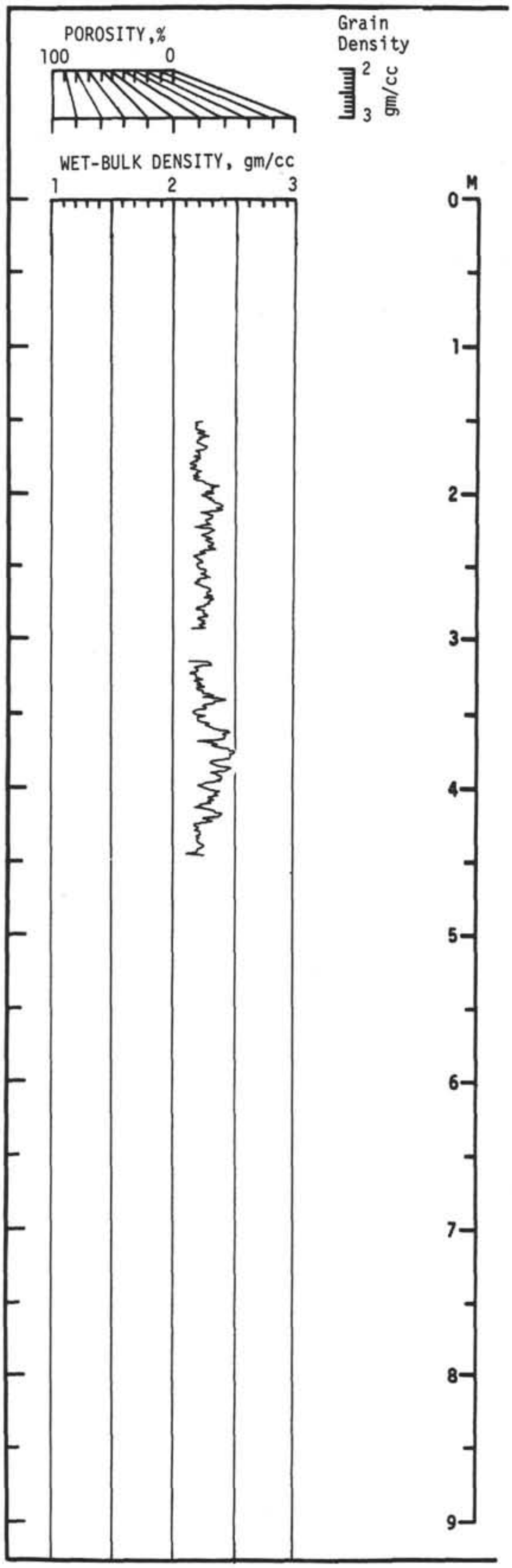
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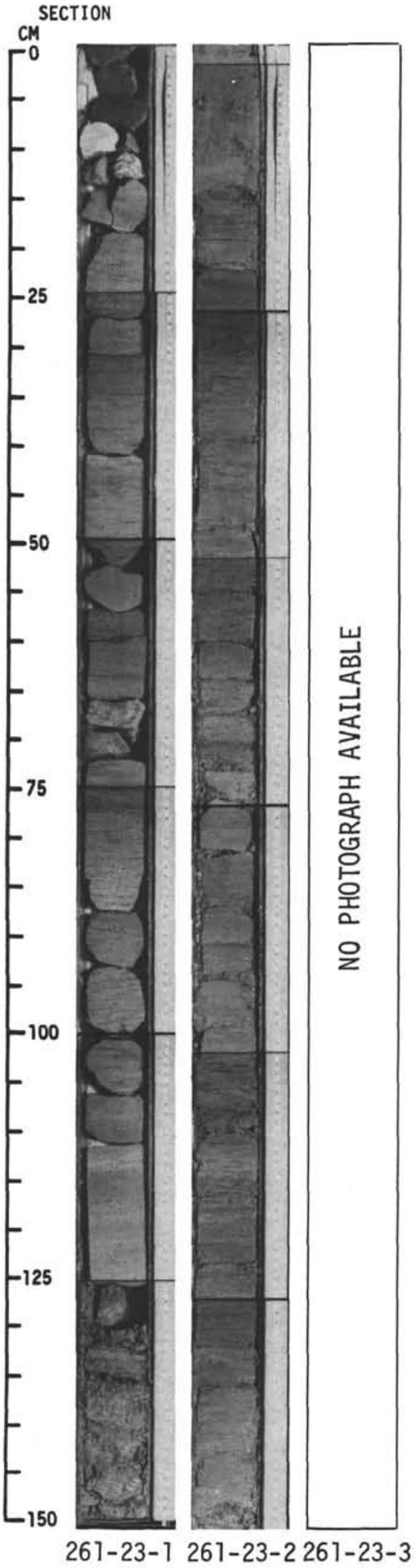
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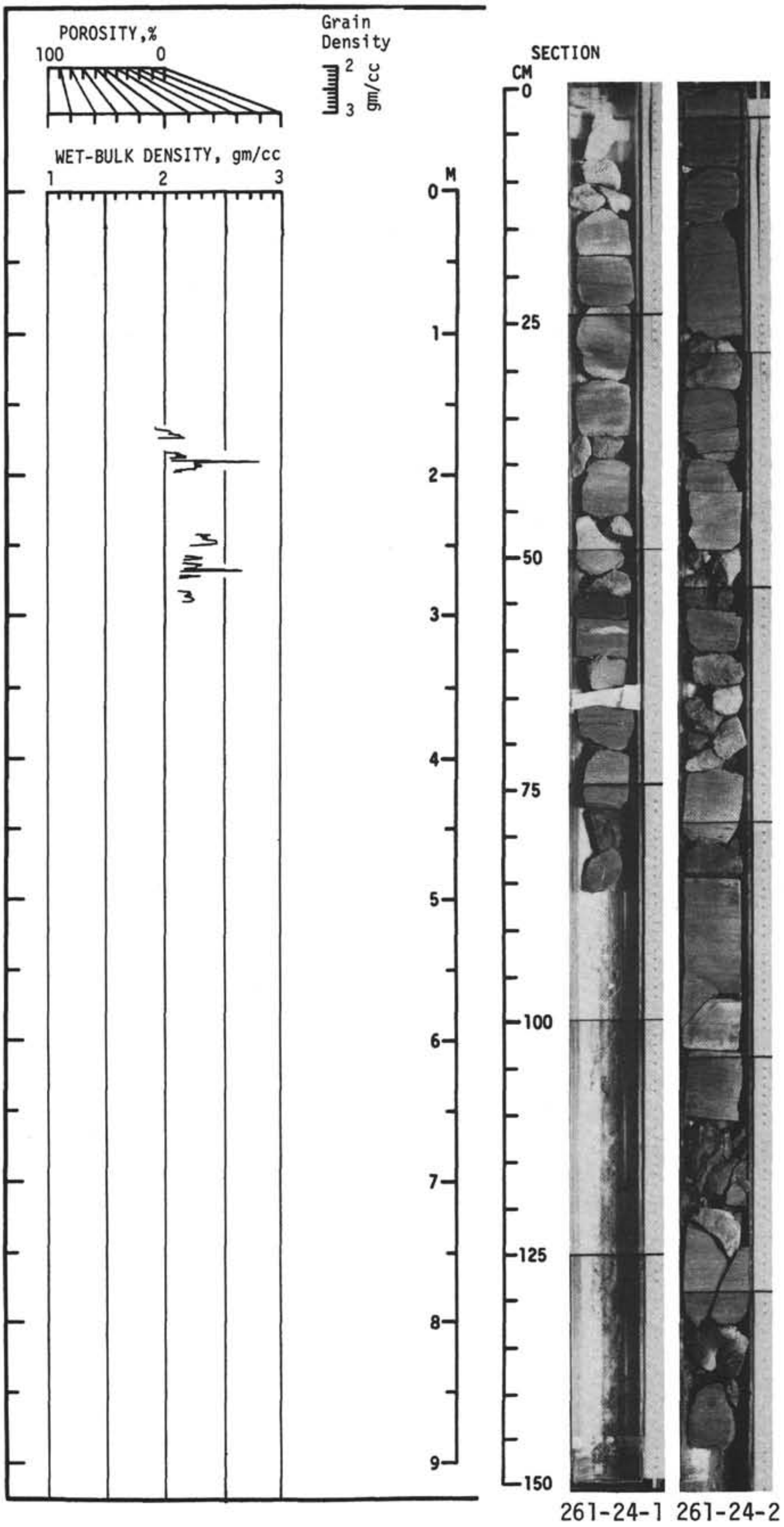
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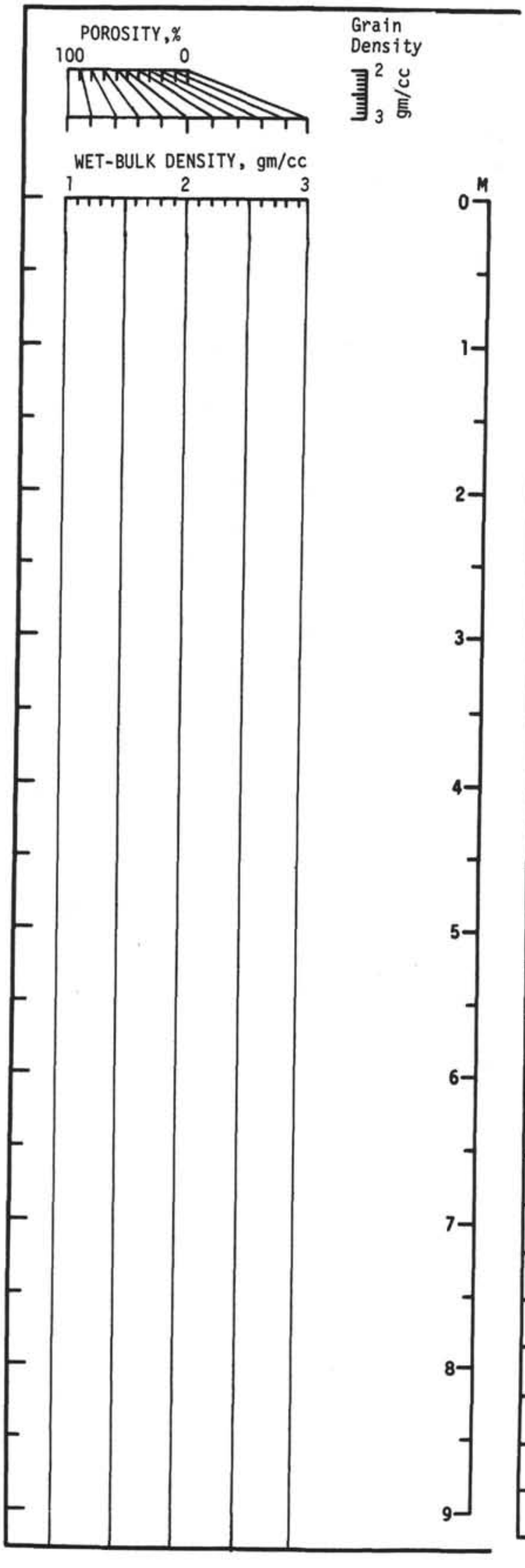

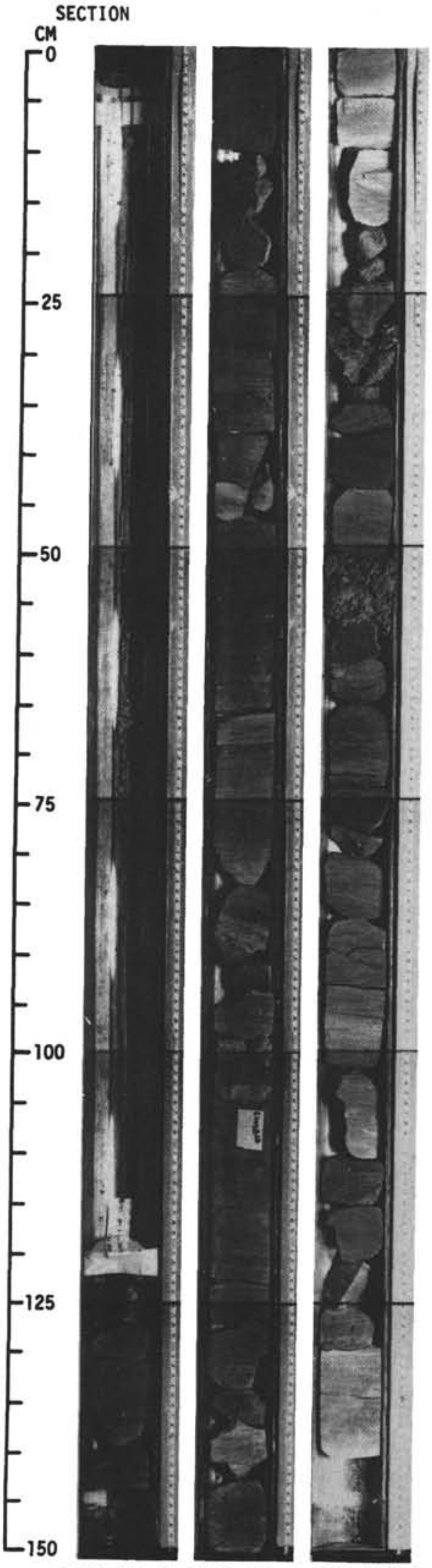

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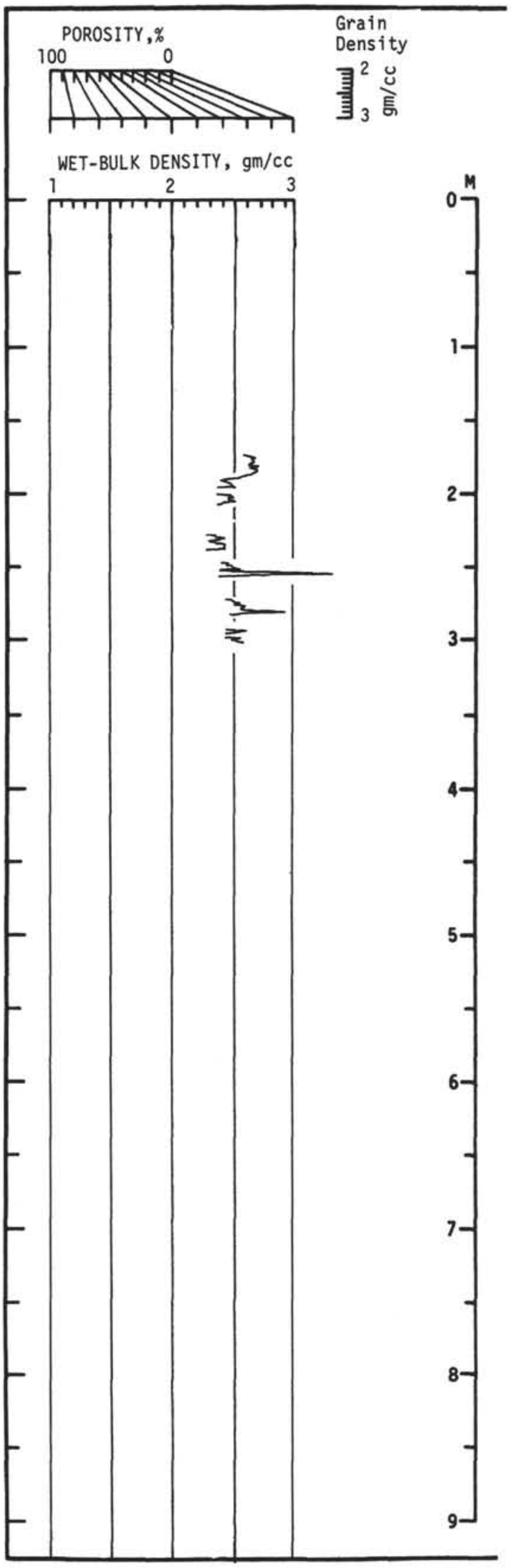

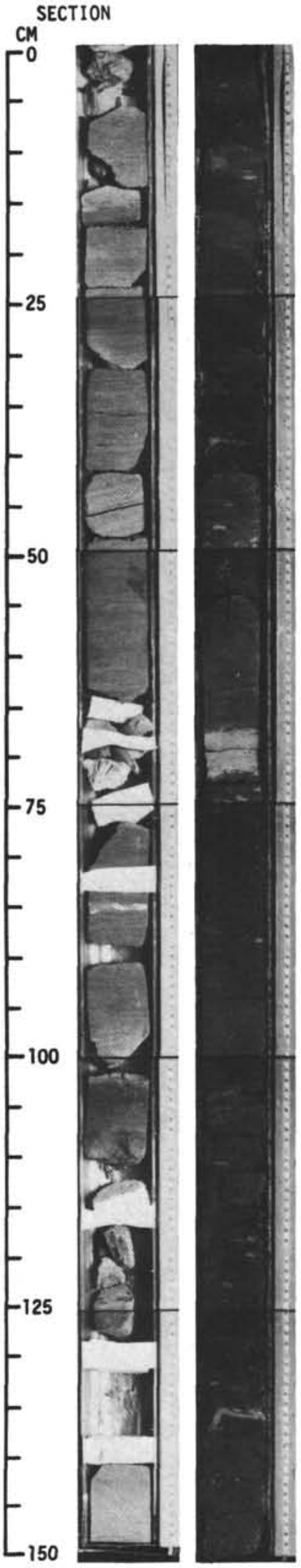

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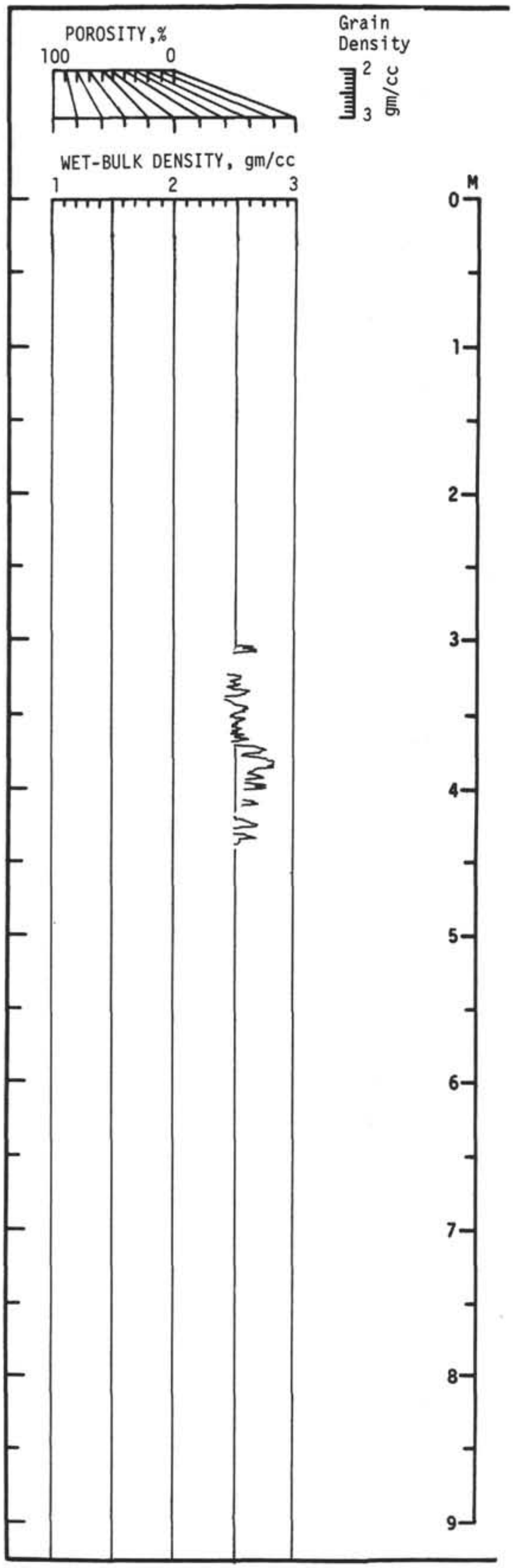

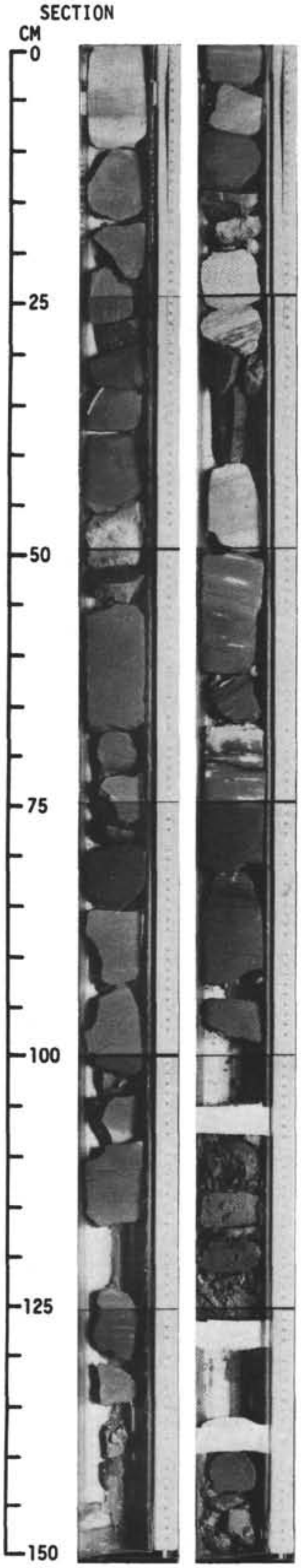

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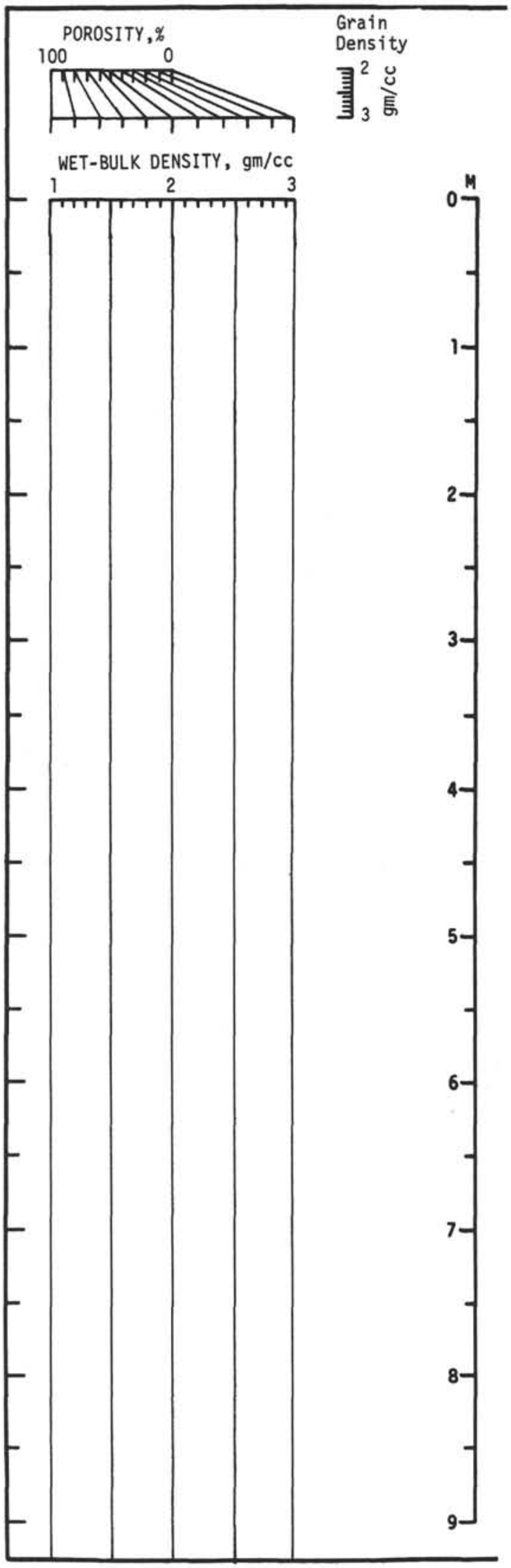
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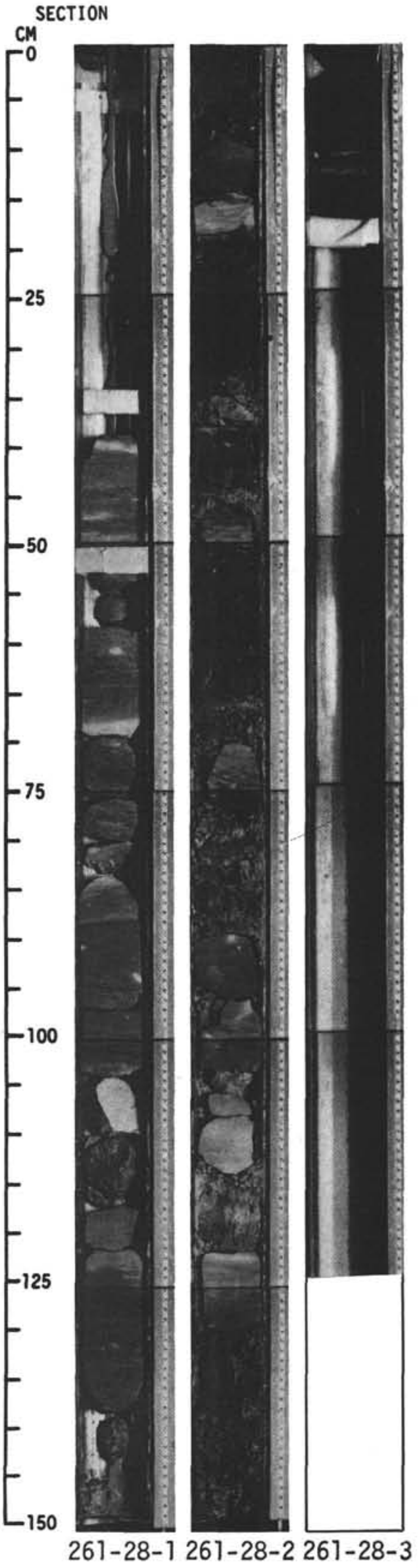
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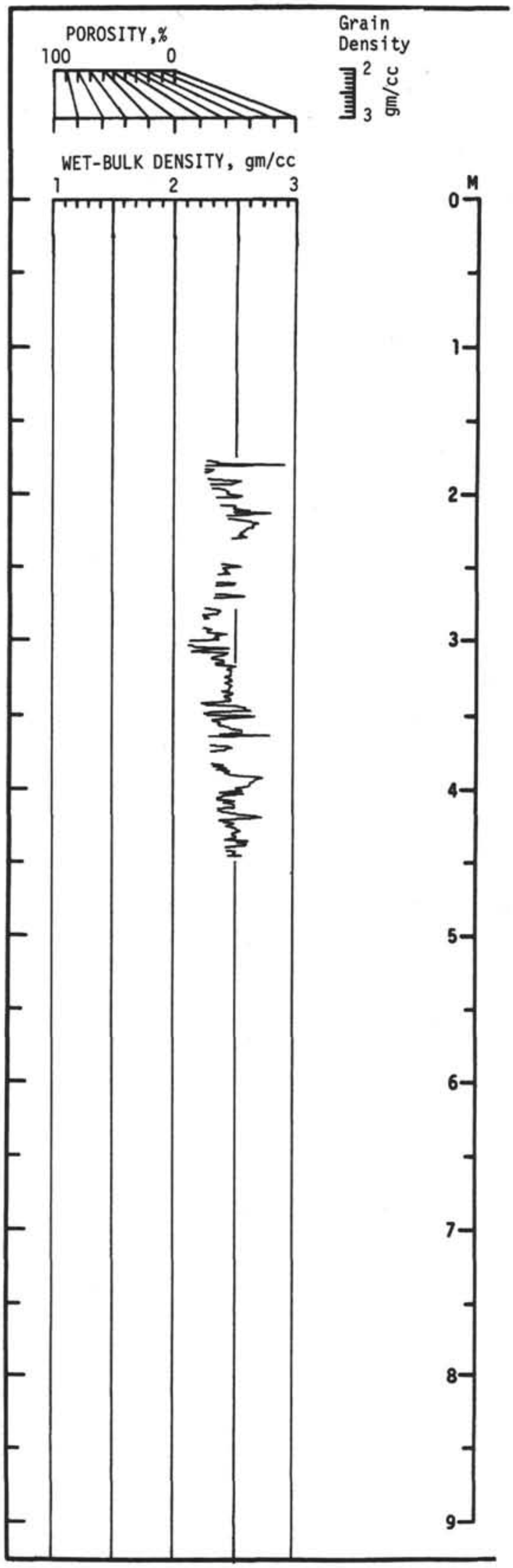
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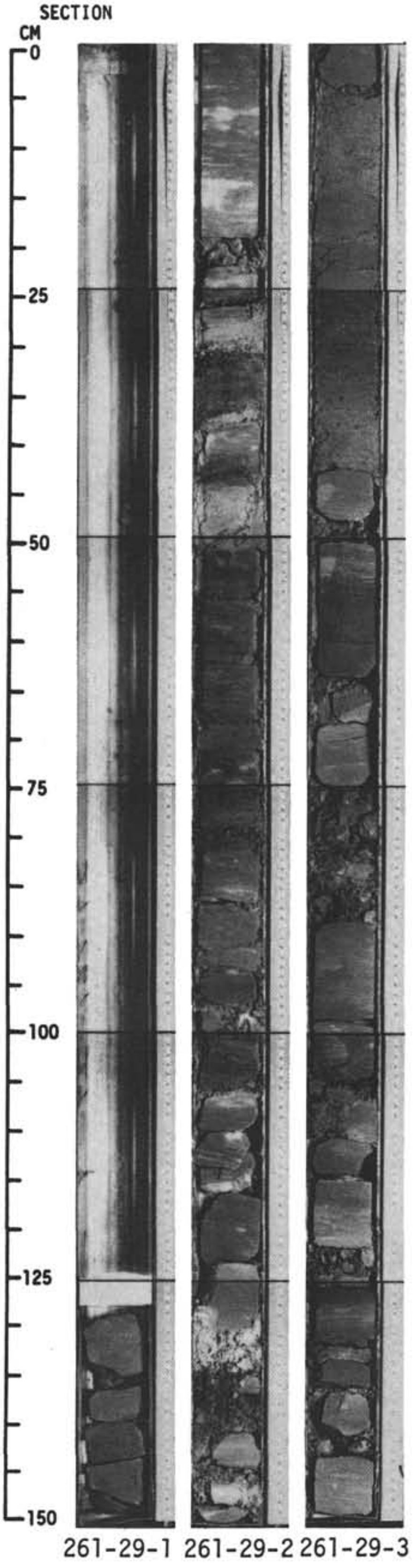
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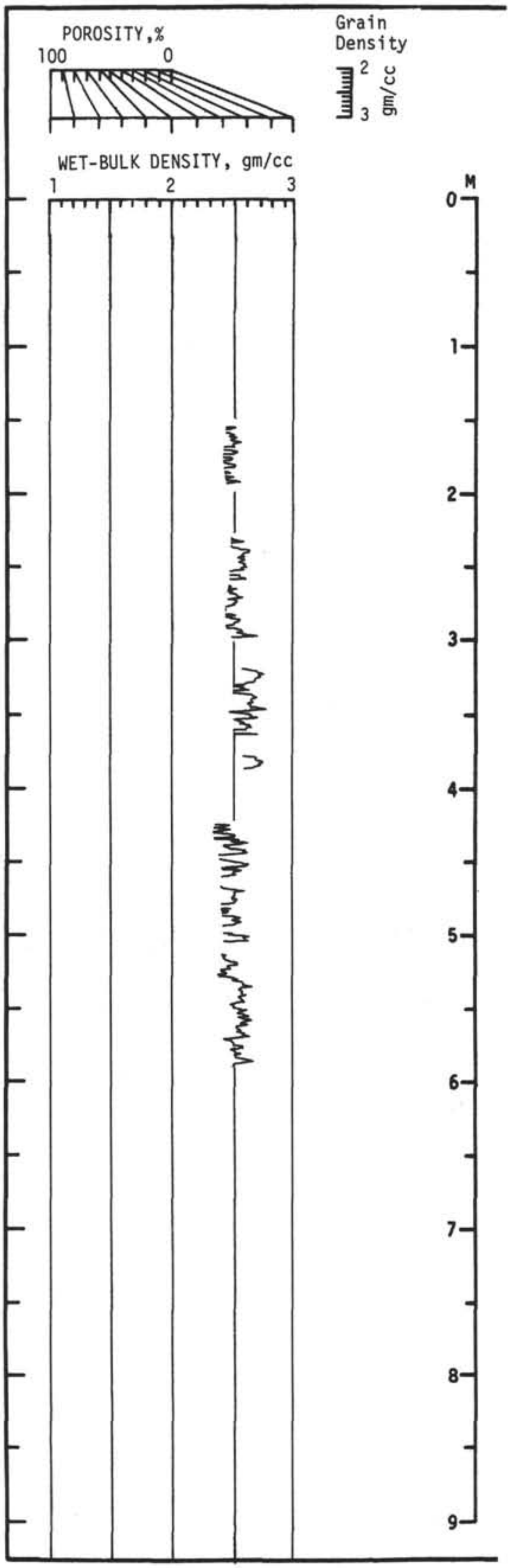
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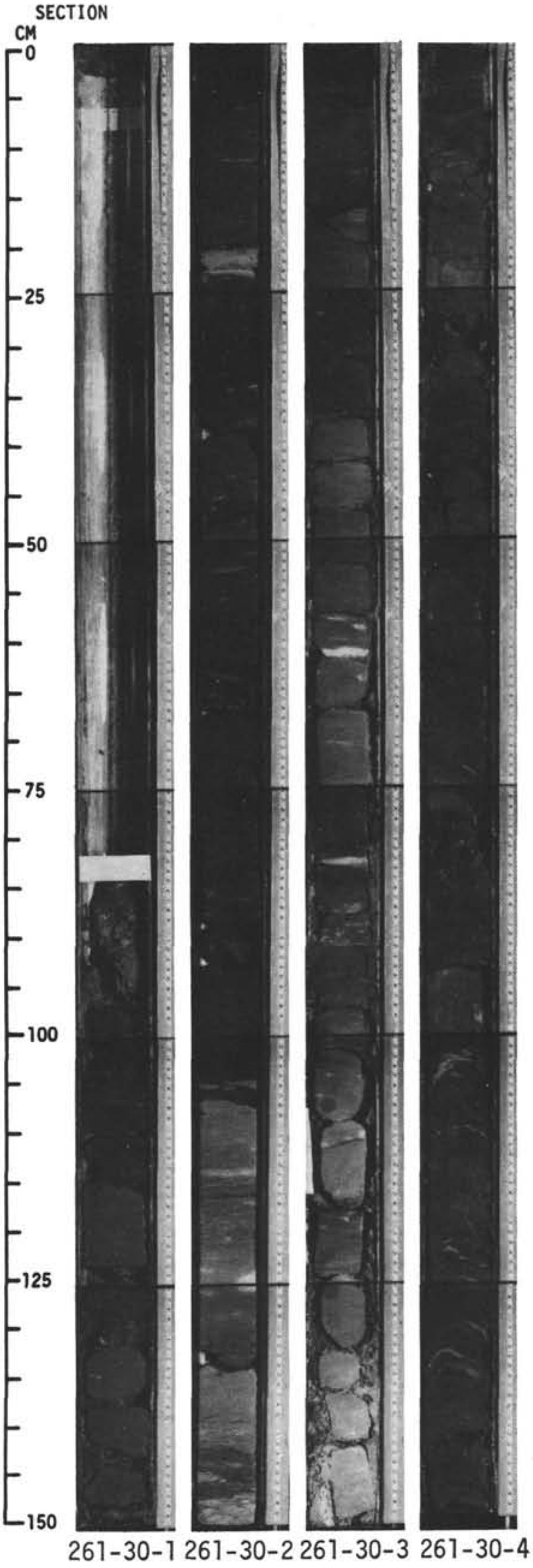
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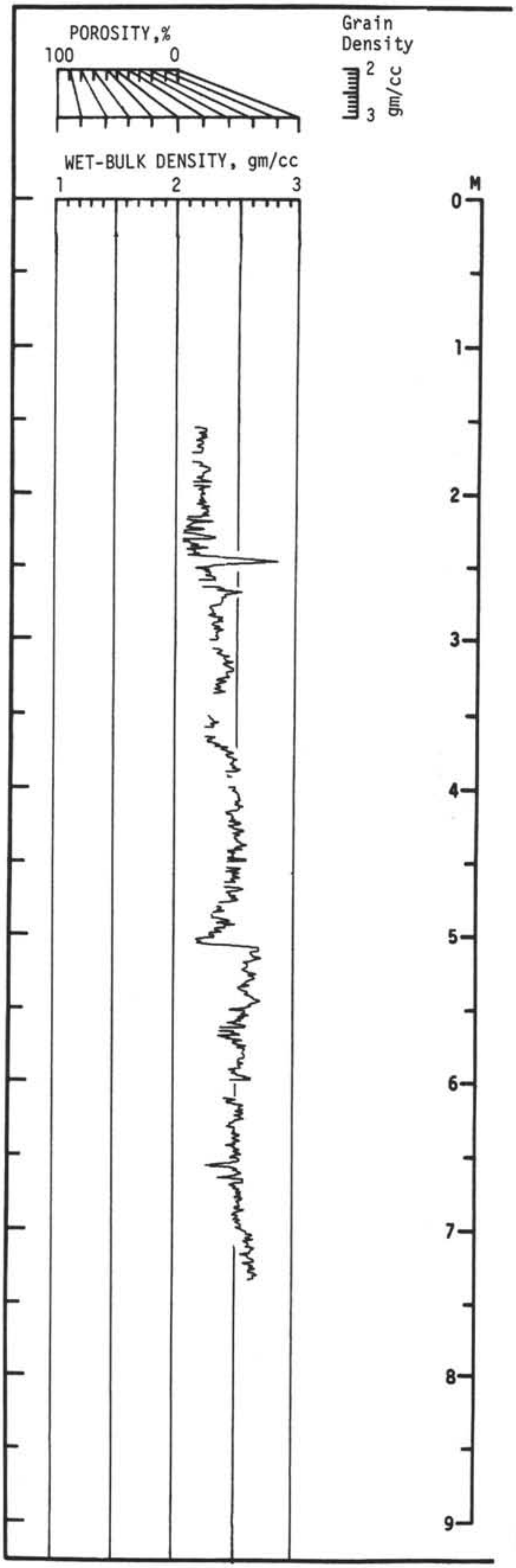
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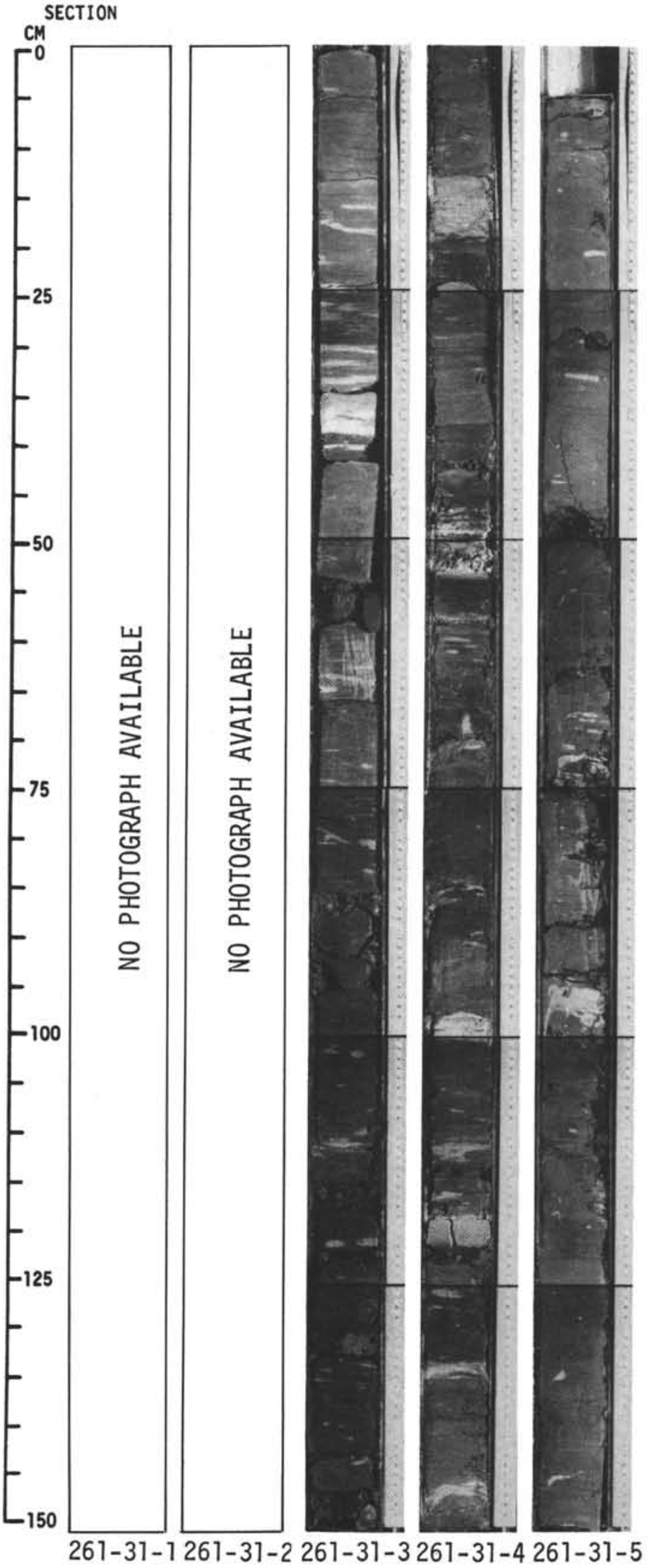
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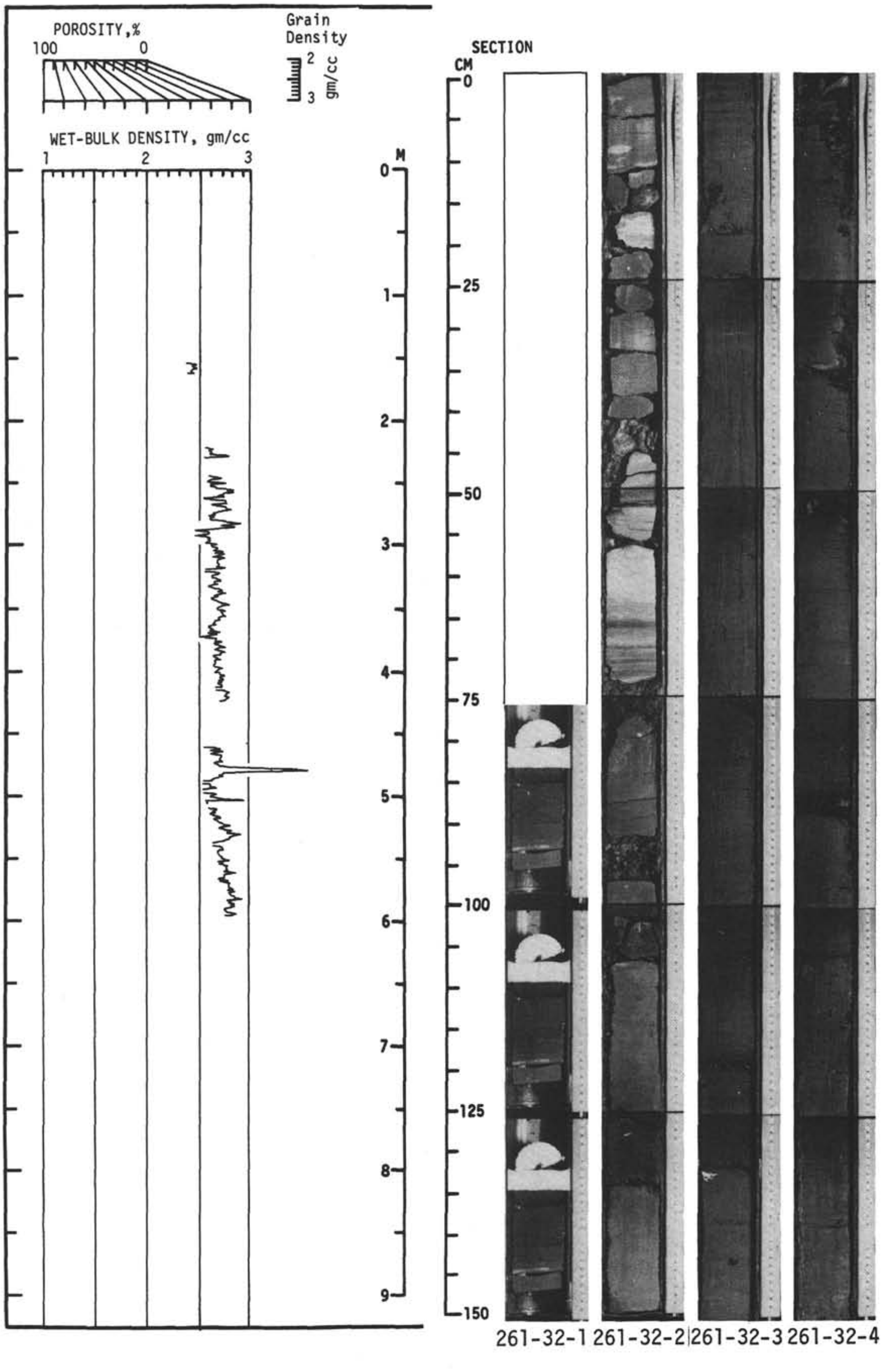
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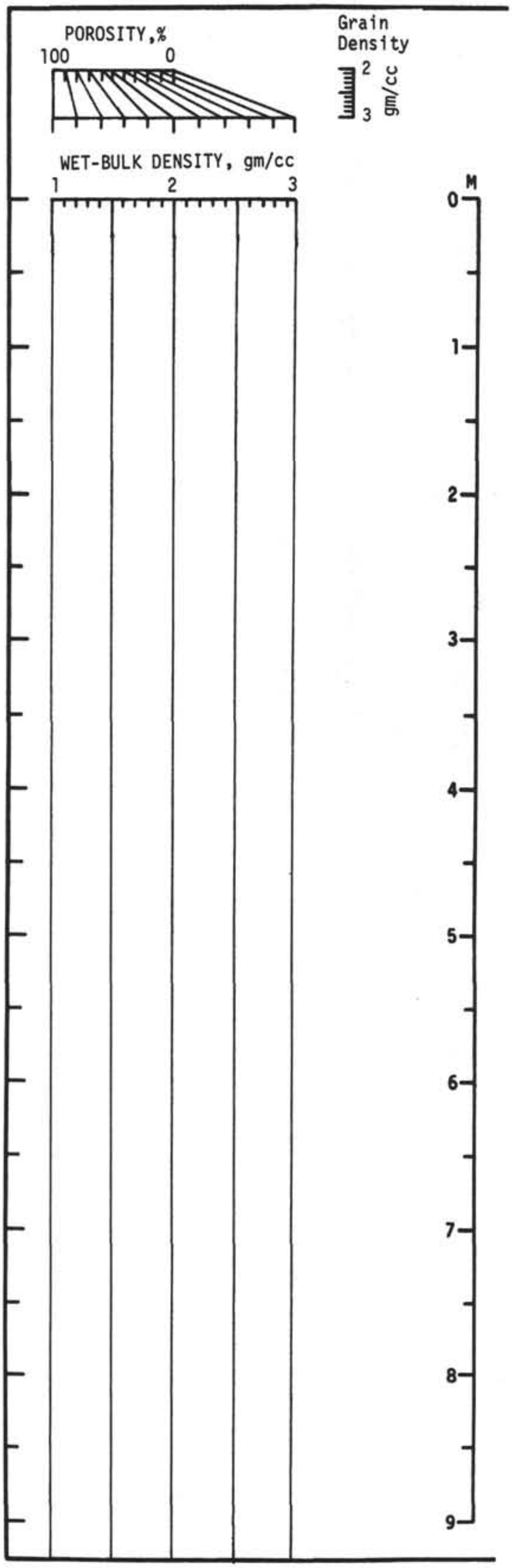
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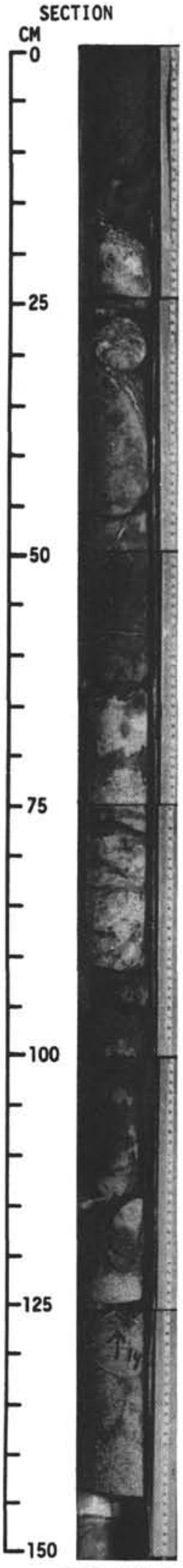
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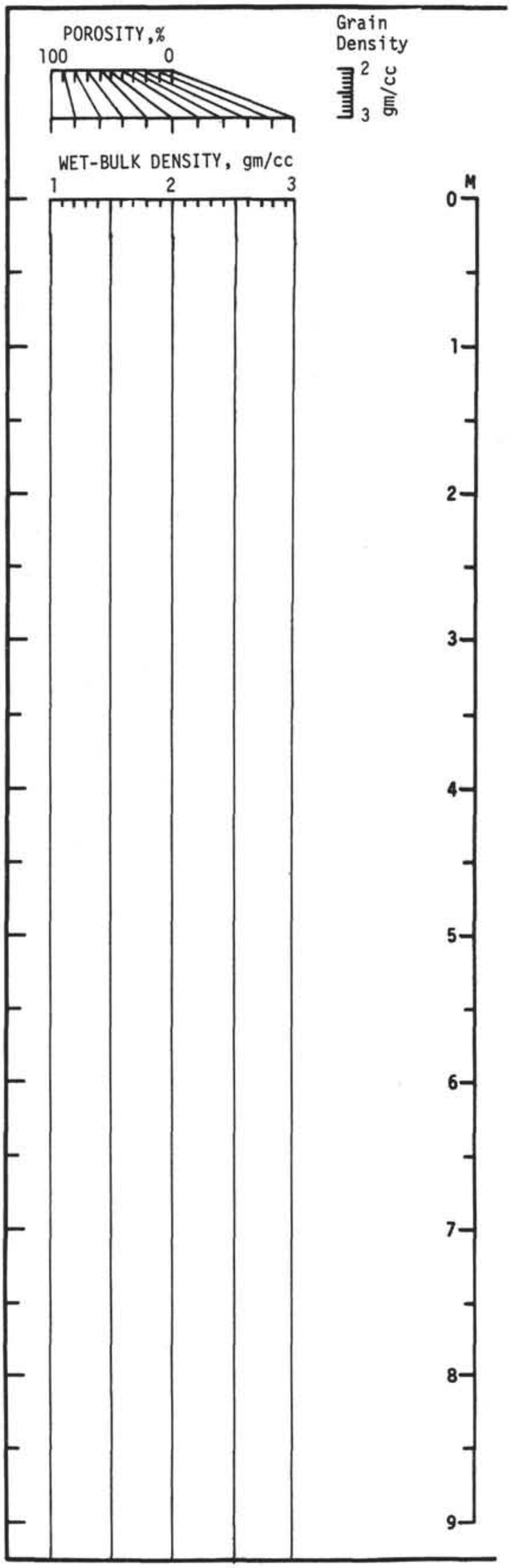
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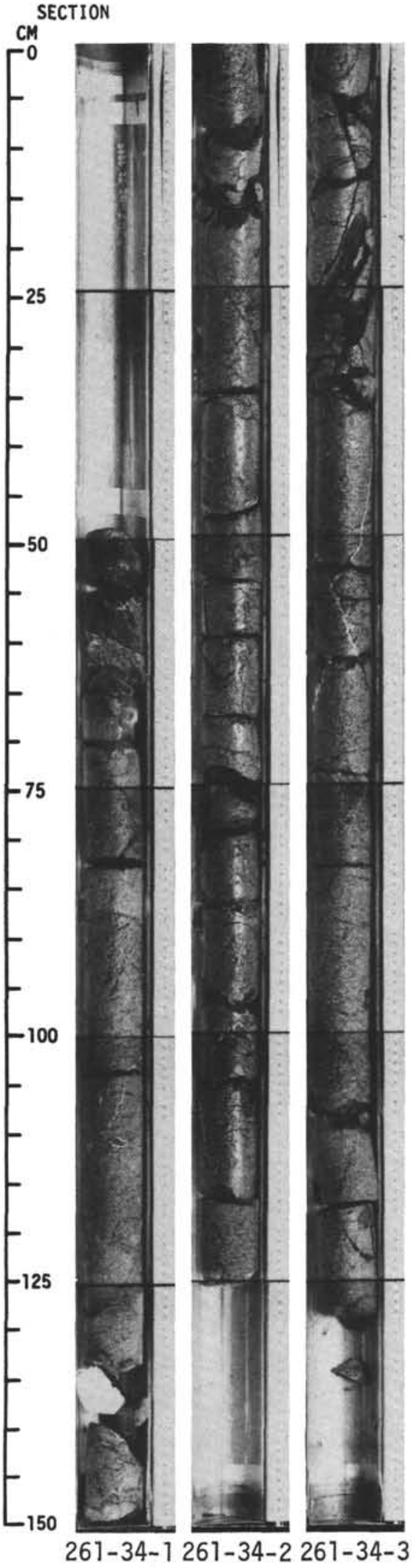
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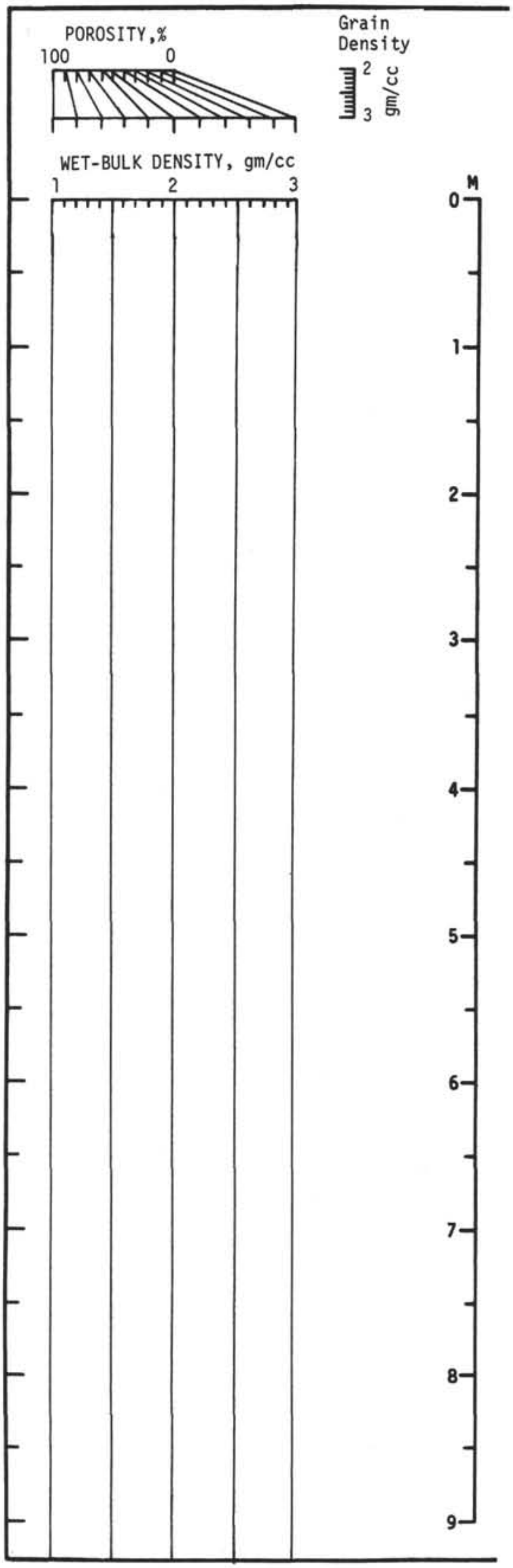

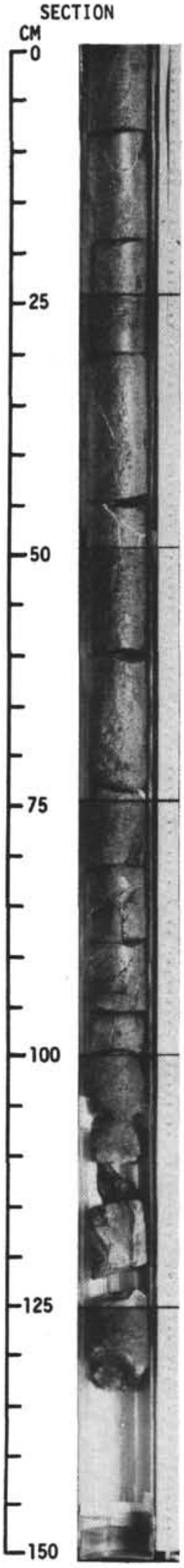

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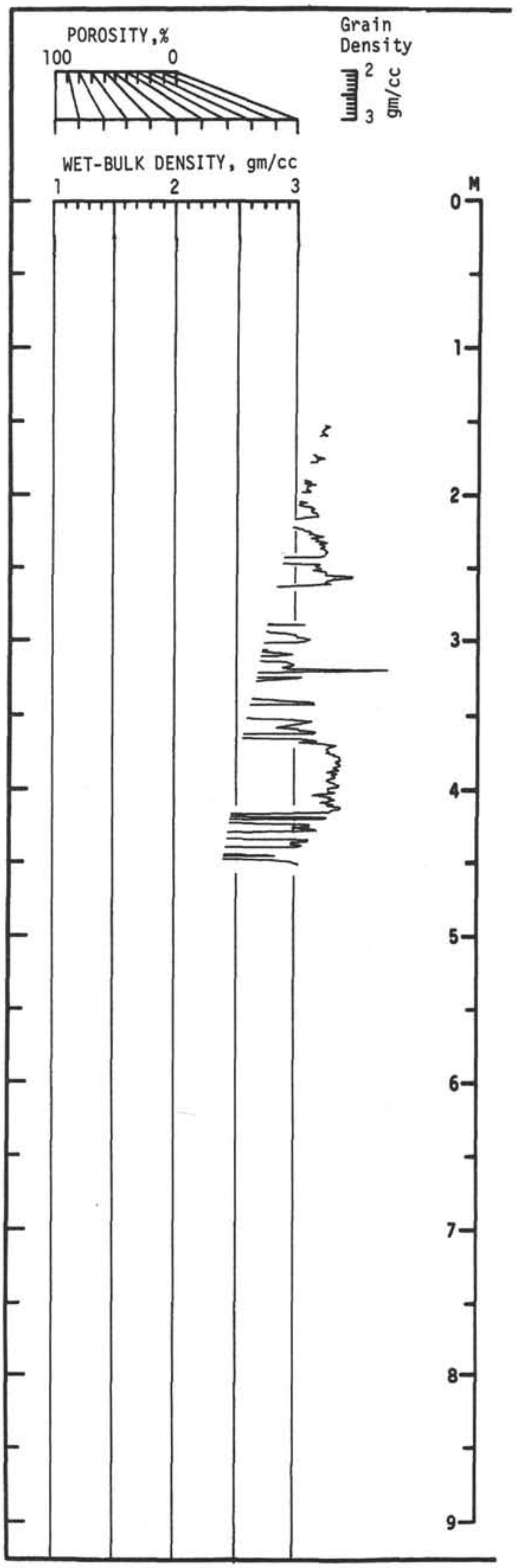
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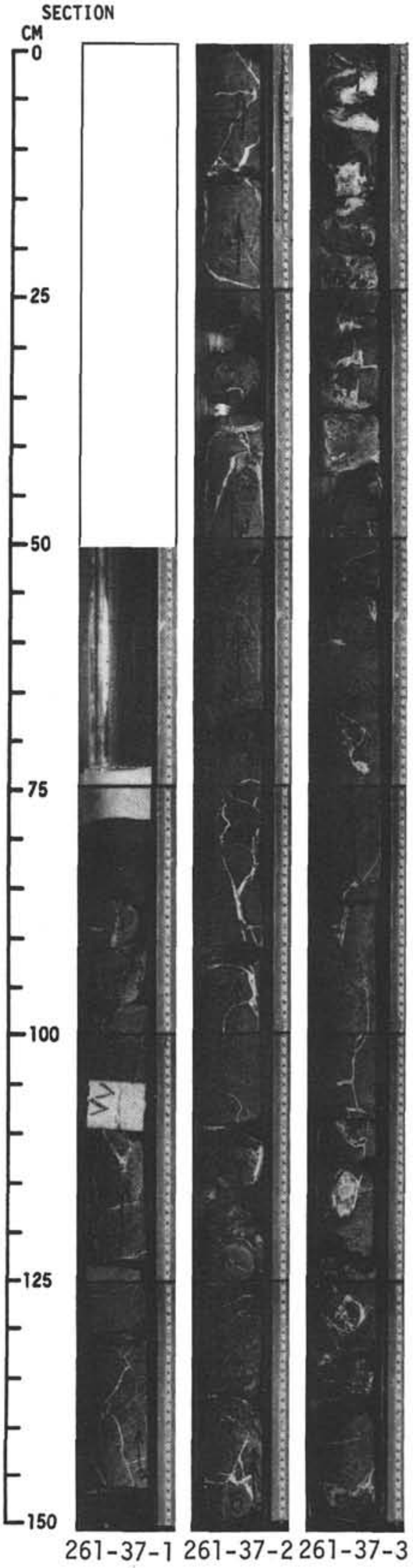
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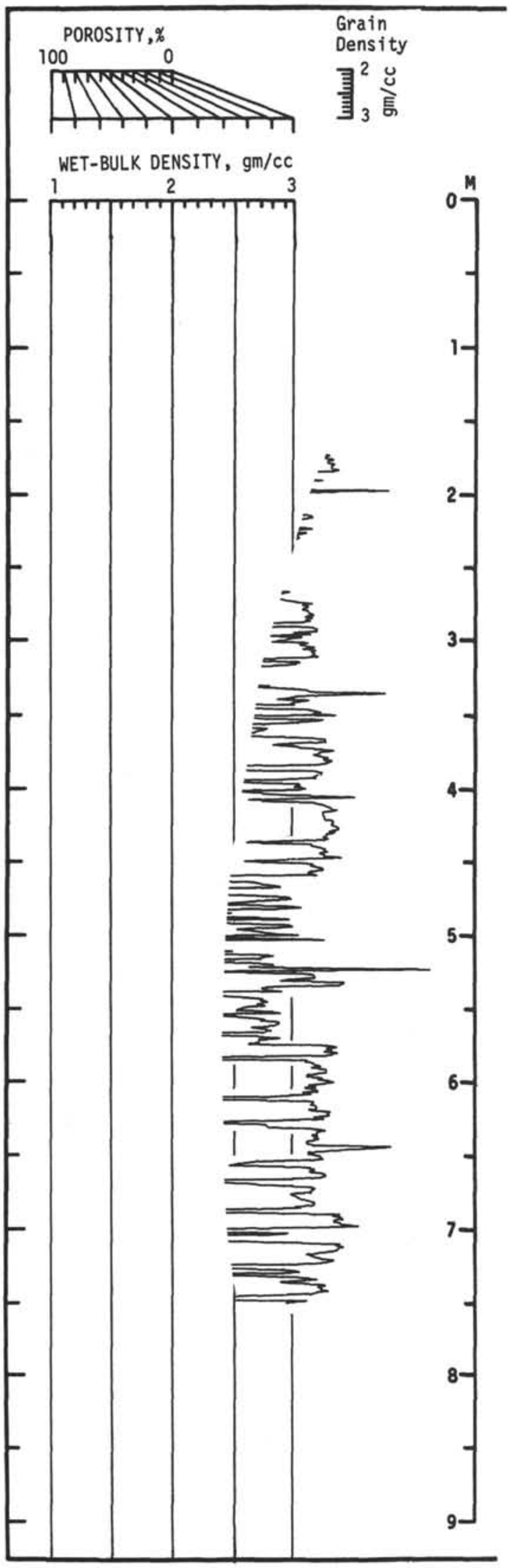
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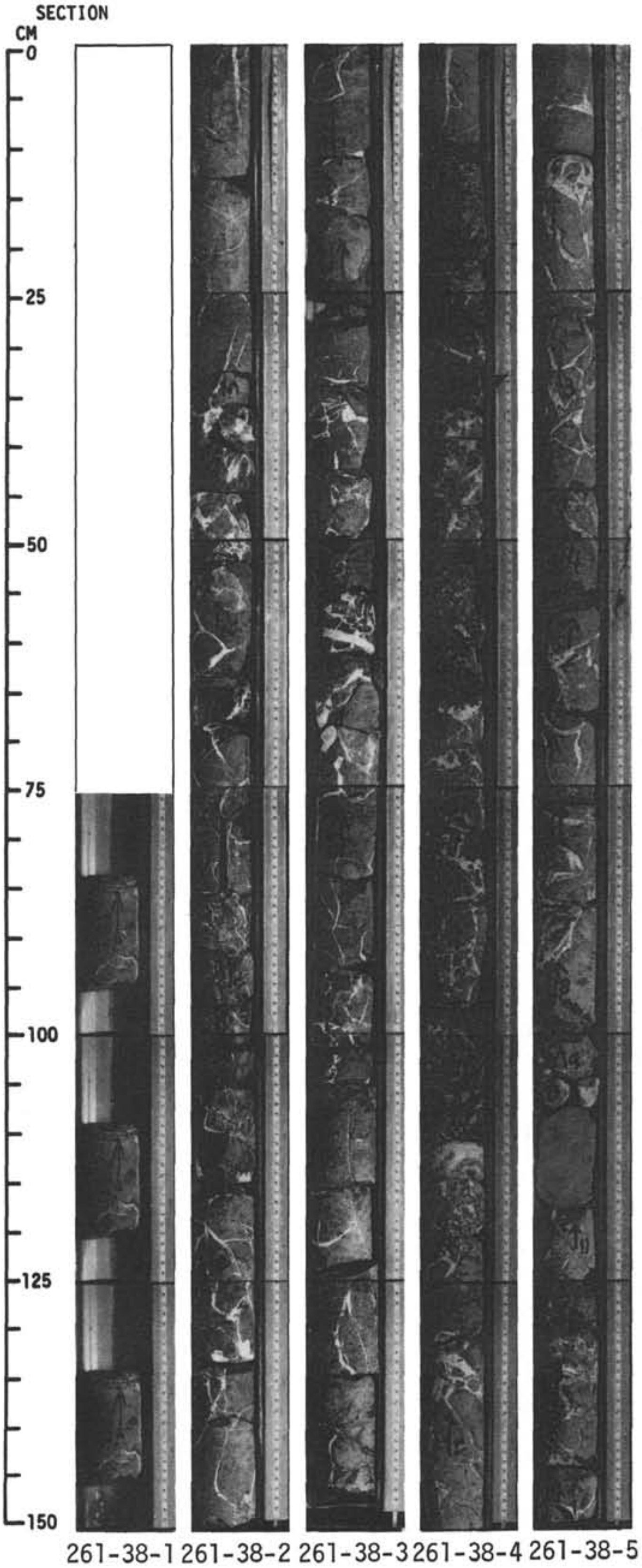
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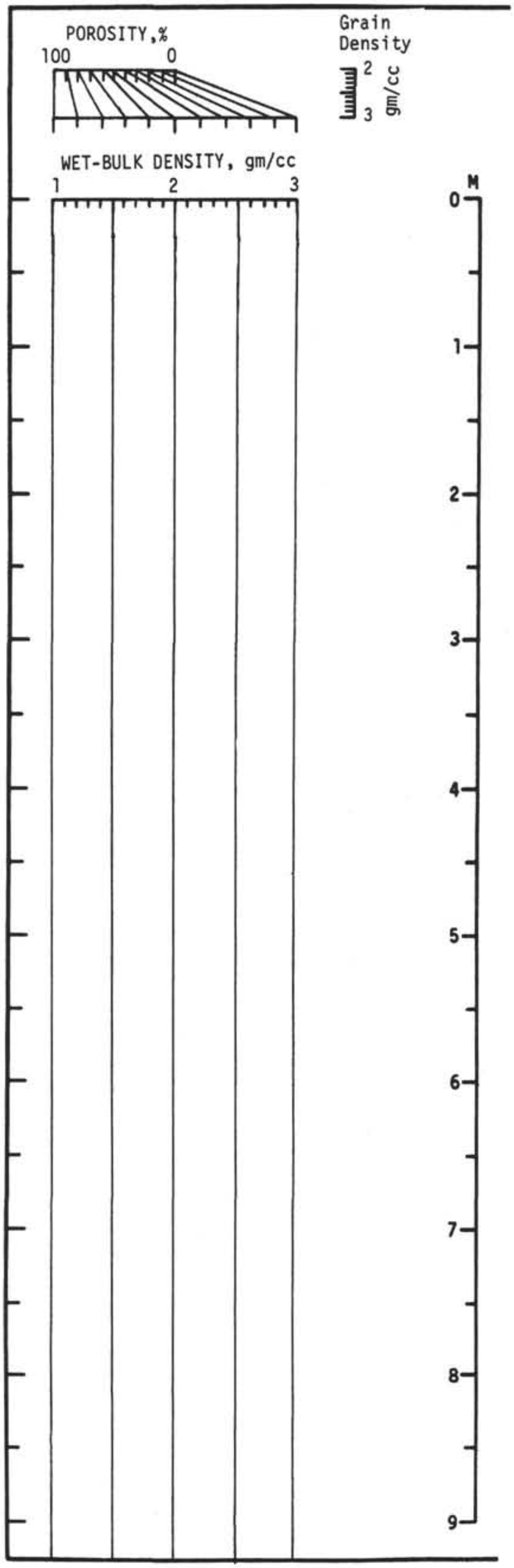
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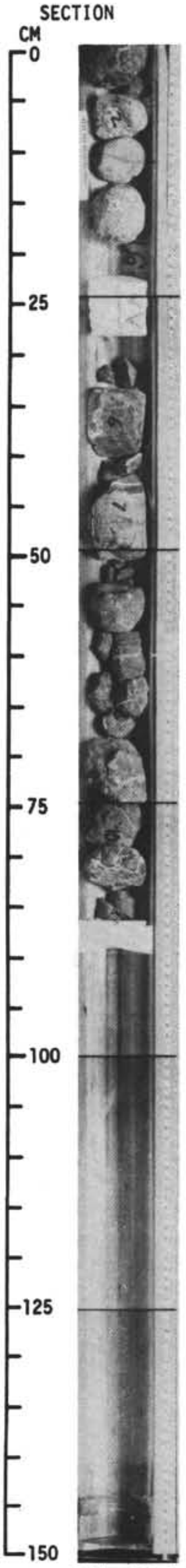
9


SECTION
CM
0
25
50
75
100
125
150

261-39-1