3. SITE 86

The Shipboard Scientific Party[1]

SITE DATA

Occupied: February 25-26, 1970.

Position: 22°52.48'N; 90°57.75'W.

Water Depth: 1462 meters.

Total Depth: 686 meters.

Holes Drilled: One.

Cores Taken: Fourteen.

BACKGROUND AND OBJECTIVES

A brief description of the Yucatan shelf has been presented by Logan et al. (1969) and is as follows:

> The Yucatan shelf is the submerged part of a low limestone plateau which also includes the Peninsula de Yucatan. The plateau slopes gently from south to north and is bounded on the west, north, and east by precipitous continental slopes which plunge from the submerged plateau margin to the abyssal depths of the Gulf of Mexico and the Caribbean Sea. The plateau margin normally is at depth of 550-900 ft, but in places it is shallower; minimum depths of 240 ft are recorded on the western margin, southwest of the Triangulos reefs. Much of the northern part of the plateau has been the site of limestone deposition dating from Tertiary time. During the late Quaternary, sedimentary conditions on the Yucatan shelf have been broadly analogous to those of the Tertiary and early Pleistocene, i.e., carbonate sediments have been deposited on the older limestone in much of the 22,000 sq mi shelf area. The hinterland adjacent to the shelf is a region of karst topography devoid of surface drainage systems; thus, river-borne detrital materials are not found in the sediments on the northern shelf.

The origin of the Campeche Escarpment has been attributed to several causes. Some suggest that the scarp represents a fault scarp, others suggest that its origin is a function of upbuilding and outbuilding likened, in some cases, to that of delta building. Still others suggest that the scarp represents the detrital accumulation seaward of a barrier or reef complex.

There is no direct evidence to support the theory that the scarp is the result of faulting. The idea that a major barrier reef separates the evaporite-carbonates of both the Florida and Yucatan banks from the Gulf of Mexico has long been held by many petroleum geologists operating in the Gulf.

No direct evidence for such a reef complex bordering the edge of the Yucatan shelf was found until very recently. Bryant et al. (1969) reported the recovery of early Albian shallow-water algal and pelletal limestone along the eastern edge of the Yucatan shelf at a depth of approximately 1500 fathoms. This led them to suggest that a lower Cretaceous reef trend bordered the east, north, and west portions of the scarp. The extension of the lower Cretaceous reef trend to the western sectors of the bank was inferred from arcer profiles.

Ewing and Ewing (1966) were the first to infer that a drowned barrier reef underlies the edge of the escarpment. Their evidence was also taken from seismic reflection profiles. Uchupi and Emery (1969) also suggested the existence of such a barrier.

Although Bryant et al. (1969) found direct evidence for the existence of Albian age shallow-water limestone on the Campeche Scarp, the exact depth of the barrier was unknown, but seismic profiles of the eastern bank indicated that the barrier was located at a depth of about 1300 meters.

Site 86 is located on a bench at a depth of 780 fathoms (PDR) where the profiler shows a sediment cover of about 350 meters over a reflector which returns a strong diffuse reflection. No deeper reflectors are visible on the profiler records. The principal objective was to determine the nature of the strong reflector at about 350 meters and, if possible, the age of the scarp by determining the ages of the overlying sediments and, perhaps, the nature and ages of any layers which may exist beneath this major reflector. If further penetration beneath the major reflector could be achieved, further information about the scarp, Campeche Bank, and the Gulf of Mexico Basin might be obtained.

Site 86 was drilled and cored on February 25-26. The hole was terminated in Lower Cretaceous (?) dolomite 686 meters below the seafloor. Fourteen cores were attempted. Coring results are given in the Core Inventory (Table 1).

NATURE OF SEDIMENTS

General Description

Sediments recovered from Site 86 are dominated by carbonate constituents and can be considered basically as, and have the common attributes of, pelagites (i.e., pelagic sediments). Nannofossil remains form the major framework constituent. Lesser amounts of planktonic foraminifera and terrigenous clay minerals comprise the remainder. Burrowing is common, ranging from moderate to severe. In addition, microburrows are common and characteristically contain fecal remains, giving the cores a speckled appearance on fresh exposure.

Within this general lithic framework, variability in consolidation, recrystallization, clay content, volcanic ash

[1]J. Lamar Worzel, Marine Biomedical Institute, University of Texas, Galveston; William Bryant, Texas A&M University (co-chief scientists); Arthur O. Beall, Jr., Continental Oil Company (lead sedimentologist); Kendell Dickinson, United States Geological Survey; Robert Laury, Southern Methodist University; Lee Anderson Smith, ESSO Production Research (lead paleontologist); Blake McNeely, Shell Oil Company; Helen P. Foreman, Oberlin College; Roy Capo, Lamont-Doherty Geological Observatory.

TABLE 1
Core Inventory – Site 86

Core	No. Sections	Date	Time	Cored[a] Interval (m)	Cored (m)	Recovered (m)	Subbottom Penetration (m) Top	Subbottom Penetration (m) Bottom	Lithology	Age
1	3	2/25	1000	1475-1479.5	4.5	4.5	13.0	17.5	Foram nanno ooze	Late Pleistocene
2	1	2/25	1130	1514-1523	9.0	1.0	52.0	61.0	Foram nanno ooze	Early Pleistocene
3	6	2/25	1400	1623-1632	9.0	9.0	161.0	170.0	Nanno ooze	Mid-Late Pliocene
4	6	2/25	1630	1719-1728	9.0	7.5	257.0	266.0	Nanno ooze	Middle Pliocene
5	4	2/25	2030	1833-1842	9.0	5.3	371.0	380.0	Nanno chalk	Early Oligocene
6	–	2/25	2330	1902-1911	9.0	0.5	440.0	444.0	–	–
7	5	2/26	0315	1960-1969	9.0	6.5	498.0	507.0	Nanno chalk	Late Paleocene
8	4	2/26	0500	1970-1979	9.0	5.0	508.0	517.0	Nanno chalk	Late Paleocene
9	2	2/26	0900	2013-2022	9.0	3.0	551.0	560.0	Nanno chalk	Early Paleocene
10	–	2/26	1300	2072-2081	9.0	0.3	610.0	619.0	Dolomite	Early Cretaceous (?)
11	–	2/26	1630	2131-2140	9.0	0.0[b]	669.0	678.0	Dolomite	Early Cretaceous (?)
12	–	2/26	1800	2140-2141	1.0	0.0[b]	678.0	679.0	Dolomite	Early Cretaceous (?)
13	–	2/26	2130	2141-2148	7.0	0.0	679.0	686.0	–	–
14	–	2/26	2230	2148-2148	0.0	0.0[b]	686.0	686.0	Dolomite	Early Cretaceous (?)
Total	31				102.5	42.6		686.0		
% Cut					14.9%					
% Recovered						41.5%				

[a] Drill pipe measurement from derrick floor.
[b] Core catcher recovery only.

content, and color provide the only basis for differentiation of the various stratigraphic horizons penetrated. Aragonite is present in the upper three cores and absent below that point (ca 200 meters), Glass shards, ranging up to 350 microns in diameter with a mean size in the silt-to-fine-sand range, were found in all sediments cored. The most significant volcanic glass accumulations were encountered in Cores 5 and 8. The abundance of siliceous microorganisms (sponge spicules and radiolaria) usually increases with increasing ash content of the sediment.

Cores 1, 2, 3, and 4 are quite similar, consisting of greenish gray (5G7/1), sparsely to severely burrowed, slightly foraminiferal, sometimes laminated to banded, clayey nannofossil ooze (texturally clay). Local fecal (?) stain occurs throughout as isolated points. The upper 35 cm of Core 1 consist of foraminiferal ooze with subsidiary pteropods and a clayey nannofossil matrix. This latter sediment type is very similar to that described as Holocene in many parts of the Gulf of Mexico.

Cores 5, 7, 8, and 9, while consisting basically of clayey & nannofossil ooze, could be more appropriately described as chalks. Primary differences consist of color variation and the presence of volcanic ash laminae at various horizons. Core 5 is white, greenish gray (5GY9/1-8/1), moderate to severely burrowed, foraminiferal, slightly clayey, nannofossil chalk. Burrow fill often consists of concentrated volcanic ash. Core 7 is very pale orange (10YR8/2), vaguely laminated to banded chalk, similar to Core 5. No obvious ash zones were noted in Core 7.

Core 8 is a darker reddish brown (10R5/6), moderately burrowed, clayey, nannofossil chalk with occasional volcanic ash laminae sharply overlying buff (10YR8/2) to orange buff (10YR7/2), moderate to strongly burrowed, slightly clayey, foraminiferal, radiolaria-rich, nannofossil chalk with minor laminae of volcanic ash. Core 9 represents still darker hues, consisting of intercalated brown (10YR6/2) and rose (10R7/6), intensely burrowed, clayey

nannofossil chalk with scattered concretions and abundant micro burrows stained with fecal (?) remains. It was noted that the fecal material was largely confined to brown (less oxidized) zones. The concretionary aspect of Core 9 is reminiscent of deep-sea red clays recovered from Sites 6 and 7 of Leg 1, DSDP.

Cores 10, 11, 12, and 14, limited in recovery to fragments, consists uniformly of yellowish brown (10YR7/2) dolomite. Core 10 shows mottling or more organic or clay-rich zones. The form and distribution of moldic porosity suggest a foraminiferal calcarenite prior to recrystallization to dolomite. Cores 11, 12, and 14 are progressively finer-grained dolomite with lesser amounts of moldic porosity. Their original fabric and textural composition apparently have been destroyed by recrystallization.

Sedimentologic Interpretation

The presence of carbonate biogenic debris as a dominant constituent, the planktonic aspect of the faunal elements represented, the intensity of burrowing, and the absence of terrigenous clastic elements support a pelagic origin for the sediments described from Cores 1 through 9 (Cenozoic). Variation in introduction of pelagically derived terrigenous clay minerals accounts for at least part of the variability in color noted.

Variation in introduction of volcanic ash or volcanogenic components apparently corresponds somewhat to variability in coloration, although it may be a combination of volcanogenic contributions and slow depositional rates during early Tertiary time. The presence of iron-rich (?) concretions in Core 9 is comparable to volcanogenic deep-sea red clays from the Atlantic, interpreted as pelagic on the basis of paleontologically determined sedimentation rates. The reddish hues noted in Core 9 are thus most logically related to slow depositional rates.

The basal sequence of brown dolomites is somewhat problematical in terms of age and environmental/depositional setting. By analogy and by comparison with similar rock types recovered at subsequent sites (Sites 94 and 95), these rocks are considered to be Early (?) Cretaceous in age. On the basis of these same comparisons, it may be concluded that the dolomites represent initially shallow-water carbonate rock types, subsequently altered and recrystallized in dolomitization.

In summary, this portion of the Campeche/Yucatan slope has been the site of pelagic sedimentation since at least the start of Tertiary time. No apparent changes in water depth are evident on the basis of sediment type within the Tertiary section, and, indeed, the basal Paleocene sediments resemble deep-sea red clays in many respects. Origin of the Early (?) Cretaceous dolomites appears related to an earlier period of shallow-water carbonate sedimentation and subsequent alteration. The presence of Cretaceous shallow-water skeletal calcarenites can be demonstrated on the basis of clasts recovered at Site 85 as well as at Sites 94 and 95. On the basis of superposition, it can thus be postulated that a general period of subsidence has occurred on the outer Yucatan platform following Early Cretaceous time.

Physical Properties

Penetrometer determinations on sediments from Site 86 show a progressive increase in consolidation with depth. From Core 4 downward, reliable penetrometer readings support a "stone" classification. Note that disturbed segments of cores give anomalously low values, whereas values determined on undisturbed samples are considered to give the correct trend.

GRAPE and sonic velocity determinations correspond well with progressive consolidation with depth. Core 8 is anomalous within that trend, apparently reflecting severe mechanical disturbance during coring. Both bulk density and sonic velocity values thus appear to be anomalously low as compared with other data.

Gamma-ray readings are quite consistent for the sequence as a whole, apparently reflecting the relatively small variations in composition previously described. High gamma-ray counts correlate positively with increasing clay content and inversely with carbonate content. Overall, the values recorded by gamma-ray counting are within the range of carbonate-dominated pelagic sediments noted from other sites. No determinations were made regarding the lower dolomites because of the limited amount of recovered sediment. These latter samples would undoubtedly show low gamma-ray values, high bulk densities, high sonic velocities, and penetrometer readings of nil.

BIOSTRATIGRAPHY

As interpreted from fossil plankton (foraminifera and calcareous nannofossils) the biostratigraphy of Site 86 is shown in Figure 1. The faunal lists are not complete, since only the stratigraphically or environmentally significant forms are listed. Apparently, most of the Cenozoic is represented by pelagic sediments at this site.

Sample 1 (10-86-1, CC):

Globigerinoides ruber (pink), *G. conglobata, Globorotalia inflata, G. menardii, G. truncatulinoides, G. flexuosa, G. tumida, Gephyrocapsa kamptneri, G. oceanica, Discosphaera tubifer, Scapholithus fossilis, Helicopontosphaera sellii, Cyclococcolithus leptoporus leptoporus, Ceratolithus timesus.*

Age: Late Pleistocene (early Wisconsinan): *Globorotalia truncatulinoides* Zone; *Pulleniatina finalis* Subzone.

Environment: Bathyal.

Remarks: The samples contains abundant pteropods (planktonic mollusks), a few large miliolid foraminifers, and rare radiolarians. Rare reworked Cretaceous calcareous nannofossils also were noted.

Sample 2 (10-86-2, CC):

Sphaeroidinella dehiscens (abundant), *Globorotalia menaraii, G. scitula, G. crassiformis, G. truncatulinoides, Globigerinoides, ruber, Discoaster brouweri* (rare), *Cyclococcolitus leptoporus macintyrei, Scyphosphaera pulcherrima, S. aequitorialis, Pseudoemiliania lacunosa, Helicopontosphaera sellii.*

Age: Early Pleistocene (Aftonian): *Globorotalia truncatulinoides* Zone; *Globorotalia tosaensis* Subzone.

Environment: Bathyal.

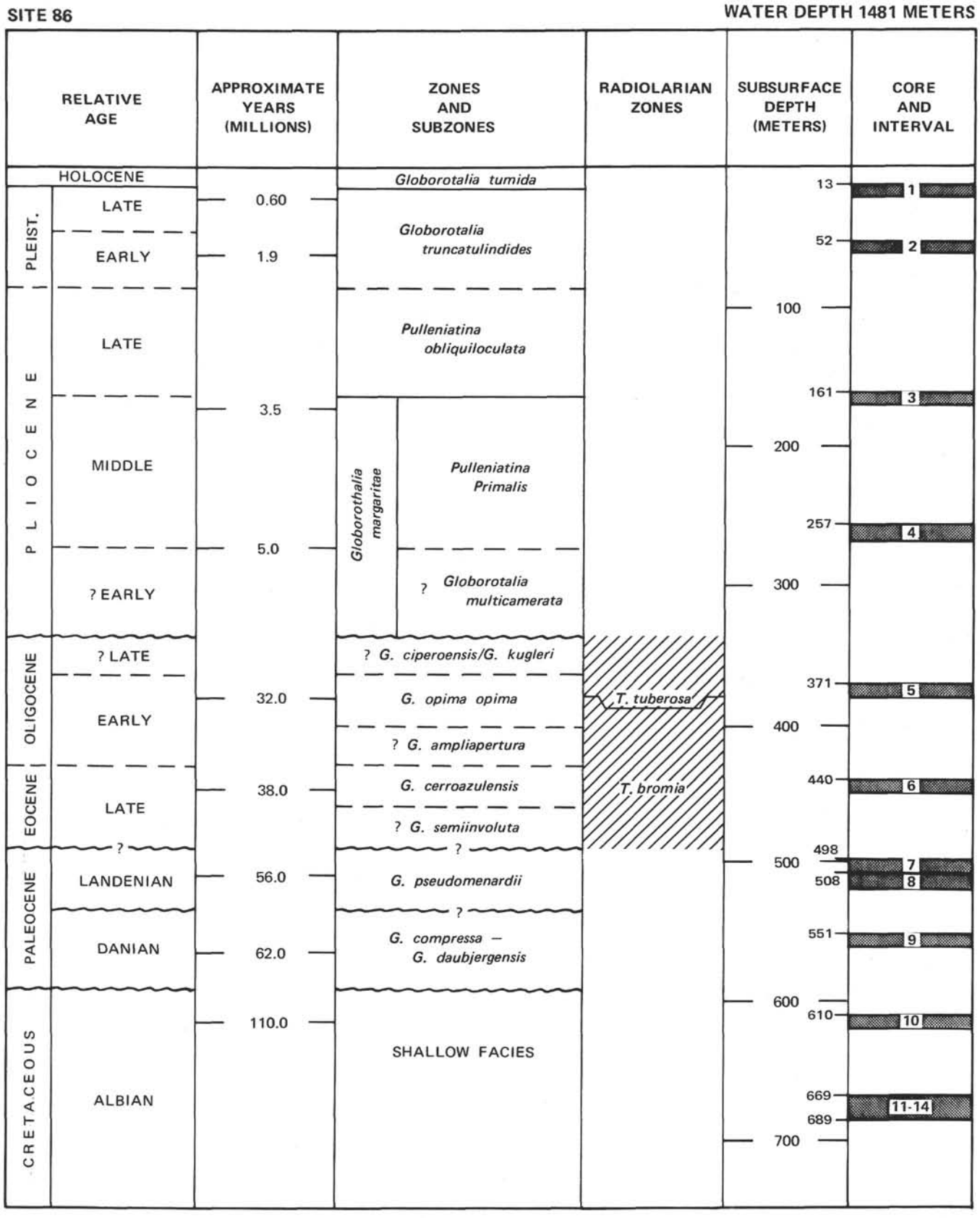


Figure 1. *Biostratigraphic summary of Site 86.*

Sample 3 (10-86-3, CC):
Globoquadrina altispira, G. venezuelana, Globorotalia multicamerata, G. margaritae, G. crassiformis, G. miocenica, G. pseudomiocenica, Globigerinoides obliqua, G. quadrilobata, Discoaster brouweri, D. pentaradiatus, D. surculus, Ceratolithus rugosus, Sphenolithus neoabies, Reticulofenestra pseudoumbilica.
Age: Middle Pliocene: *Globorotalia margaritae* Zone; *Pulleniatina primalis* Subzone.
Environment: Bathyal.

Sample 4 (10-86-4, CC):
Globoquadrina altispira, Globigerina nepenthes, Globigerinoides obliqua, Globorotalia margaritae, G. menardii, G. miocenica, Discoaster quinqueramus, D. brouweri, D. pentaradiatus, D. surculus, D. variabilis, D. challengeri, Reticulofenestra pseudoumbilica.
Age: early Middle Pliocene: *Globorotalia margaritae* Zone; *Pulleniatina primalis* Subzone.
Environment: Bathyal.
Remarks: The sample also contains several bathyal benthonic foraminifers including species of *Gyroidina, Cassidulina,* and *Siphogenerina.*

Sample 5 (10-86-5, CC):
Globigerina ciperoensis ciperoensis, G. angulisuturalis, Globorotalia opima, G. nana, Globoquadrina venezuelana, Catapsydrax dissimilis, Reticulofenestra scissura, Cyclococcolithus neogammation, Helicopontosphaera truncata, H. parallela, H. compacta, Sphenolithus distentus, Triquetrorhabdulus carinatus, and radiolarians of the *Theocyrtis tuberosa* Zone.
Age: late Early Oligocene (P 21). The fauna and flora are very similar to that recovered from the late "type" *Globorotalia opima opima* Zone of Trinidad.
Environment: Bathyal.
Remarks: The sample also was noted to contain abundant glass shards (volcanic).

Sample 6 (10-86-6, CC):
Hantkenina alabamensis, Globorotalia centralis, Hastigerina micra, Catapsydrax dissimilis, Globigerina yeguaenis, Globoquadrina venezuelana, Discoaster saipanensis, Bramletteius serraculoides, Leptodiscus larvalis, Cyclococcolithus reticulatus, C. orbis, and radiolarians of the *Thyrsocyrtis bromia* Zone.
Age: Late Eocene *(Globorotalia cerroazulensis* Zone).
Environment: Bathyal.

Sample 7 (10-86-7, CC):
Globorotalia pseudomenardii, G. velascoensis, G. gracilis, G. aequa, G. laevigata, G. occlusa, G. actua, G. elongata, Globigerina linaperta, G. triangularis, Zygodiscus sigmoides, Heliolithus kleinpelli, Ellipsolithus macellus, Chiasmolithus consuetus, C. bidens, C. californicus, Discoaster multiradiatus, and radiolarians *Bekoma campechensis* n. sp., *Buryella pentadica* n. sp., *B. tetradica* n. sp., *Lamptonium pennatum* n. sp., *Orbula ducalis* n. sp., and *Phormocyrtis striata exquisita.*
Age: Late Paleocene (*Globorotalia pseudomenardii* Zone) (P 4)
Environment: Bathyal.

Sample 8 (10-86-8, CC):
Globorotalia pseudomenardii, G. velascoensis, G. laevigata, G. marginodentata, G. acuta, Ellipsolithus distichus, E. macellus, Heliolithus kleinpelli, Fasciculithus involutus, F. mitreus, Cruciplacolithus tenuis, Zygodiscus sigmoides, and radiolarians *Bekoma campechensis* n. sp., *Buryella pentadica* n. sp., *B. tetradica* n. sp., *Lamptonium pennatum* n. sp., *Orbula ducalis* n. sp., and *Phormocyrtis striata exquisita.*
Age: Late Paleocene *(Globorotalia pseudomenardii* Zone) (P 4)
Environment: Bathyal.
Remarks: Small fragments of volcanic glass are present in abundance in this sample.

Sample 9 (10-86-9, CC):
Globorotalia trinidadensis, G. pseudobulloides, G. compressa, Globigerina triloculinoides, Chiasmolithus danicus, C. consuetus, C. bidens, Cruciploacolithus tenuis, Heliothus concinnus, Zygodiscus sigmoides, Braarudosphaera sp. cf. *B. turbinae.*
Age: Early Paleocene (Danian) (P 1)
Environment: Bathyal.
Remarks: There is an increase in the number and diversity of benthonic foraminifers in this sample.

Sample 10 (10-86-10, CC):
Ostracod carapaces, one embedded Miliolid?
Age: Cretaceous (Late Albian to Early Cenomanian)
Environment: Shallow-water carbonate shelf.
Remarks: Insofar as could be told from the sample prepared by us, the carbonates in this sample have been recrystallized and there was an absence of nannofossils.

Sample 11 (10-86-11, CC):
Ostracods (rare), possible *Inoceramus* prisms.
Age: Cretaceous (Late Albian to Early Cenomanian)
Environment: Shallow-water carbonate shelf.
Remarks: No nannofossils were noted in this sample. All carbonate sediment observed by the paleontologists was recrystallized.

Sample 14 (10-86-14, CC):
Ostracods (frequent), Miliolids (frequent), Cf. *Orbitoides* (one specimen), unidentified benthonic foraminifers (rare), Cf. *Arkhangelskiella* sp., Cf. *Kamptnerius* sp., *Zygodiscus* sp., Cf. *Tetrolithus* sp.
Age: Cretaceous (Late Albianian to Early Cenomanian)
Environment: Shallow-water carbonate shelf.
Remarks: Most of the carbonates observed in this sample have been recrystallized. The few calcareous nannofossils observed are in poor condition. The sample contains pelagic plankton (fauna and flora) from Paleocene to Pleistocene in age.

DISCUSSION AND INTERPRETATION

All ages of sediment from Recent to Cretaceous, except Miocene, were recovered in Site 86. Variability in consolidation, recrystallization, clay content, volcanic ash content and color provided the only physical basis for differentiation of the various stratigraphic horizons penetrated.

The sediments recovered were basically pelagites. Calcareous nannofossil ooze was found to be the most abundant sediment and comprised approximately 63 per cent of the sediment. Ashy muds and sands containing a strong calcareous component made up about 22 per cent of the sediment. Coccoliths were the most abundant component with discoasters occasionally present in abundance.

Foraminifers and plant fibers were present. Quartz and clay minerals were found in all samples, but only in small amounts.

Volcanic ash, present in Late Pleistocene sediments, was found most abundantly in Late Paleocene sections, and was associated with a strong showing of radiolaria. The origin of the shallow-water Cretaceous dolomite recovered in Site 86 cannot be resolved at this time. It may reflect a gradual subsidence of the shelf since Cretaceous times.

The rates of deposition of the sediments comprising the upper scarp are unusually low, at least relative to other areas of the Gulf of Mexico and some areas of the major ocean basins. These slow rates of deposition favor the stability characteristics of such pelagic sediments and allow rather steep slopes to be constructed. Calculated average rates of deposition, uncorrected for consolidation, were found to be as follows:

Late Pleistocene	5.0 cm/10^3y
Late Pliocene-Early Pleistocene	6.0 cm/10^3y
Early Pliocene	4.0 cm/10^3y
Oligocene	0.7 cm/10^3y
Eocene	0.3 cm/10^3y
Paleocene	0.6 cm/10^3y

The average rate of deposition from the Paleocene to the present was 0.9 cm/10^3y.

Due to the complete nature of the section cored, it is suggested that little reworking, or slumping, has taken place in this area. Thus, the average rates of deposition given above can be considered fairly reliable.

Examination of the material suggests that the bank margin is comprised of accumulating pelagic sediments. All the sediments cored, except the Cretaceous dolomite, were of deep-water origin (bathyal depths), indicating that the bank has been in the same relative environment since at least Paleocene or Late Cretaceous.

An examination of the cored material did not indicate the presence of any reef structure or barriers, at least to the depth drilled (686 meters below bottom).

A series of strong reflectors, similar to those suggested by Bryant et al. (1969) on the eastern scarp as being reefal structures, were found to be the top of the Oligocene chalk. The average measured sonic velocity of 1600 m/sec was used to determine the top of the chalk in the seismic profiles, Figure 2.

REFERENCES

Bryant, W.R., Meyerhoff, A.A., Brown, N.K., Furrer, M., Pyle, T., and Antoine, J.W., 1969. Escarpments, reef trends, and diapiric structures, eastern Gulf of Mexico. Bull. Am. Assoc. Petrol. Geologists. **53** (12), 2506.

Ewing, M. and Ewing, J., 1966. Geology of the Gulf of Mexico. In Exploiting the Oceans. Mar. Tech. Soc. 2nd Ann. Conf. and Exhibit Trans. Suppl. Wash. D.C., 145.

Logan, B.W., Harding., J.L., Ahr, W.M., Williams, J.D. and Snead, R.G., 1969. Introduction. *In Carbonate Sediments and Reefs, Yucatan Shelf, Mexico.* Memoir 11, Am. Assoc. Petrol. Geologist, Menasha, Wis. (The Collegiate Press), Part 1, chap 1, p.7.

Uchupi, E. and Emery, K.O., 1968. Structure of Continental Margins off Gulf Coast of United States, Bull. Am. Assoc. Petrol. Geologists. (7), 1162.

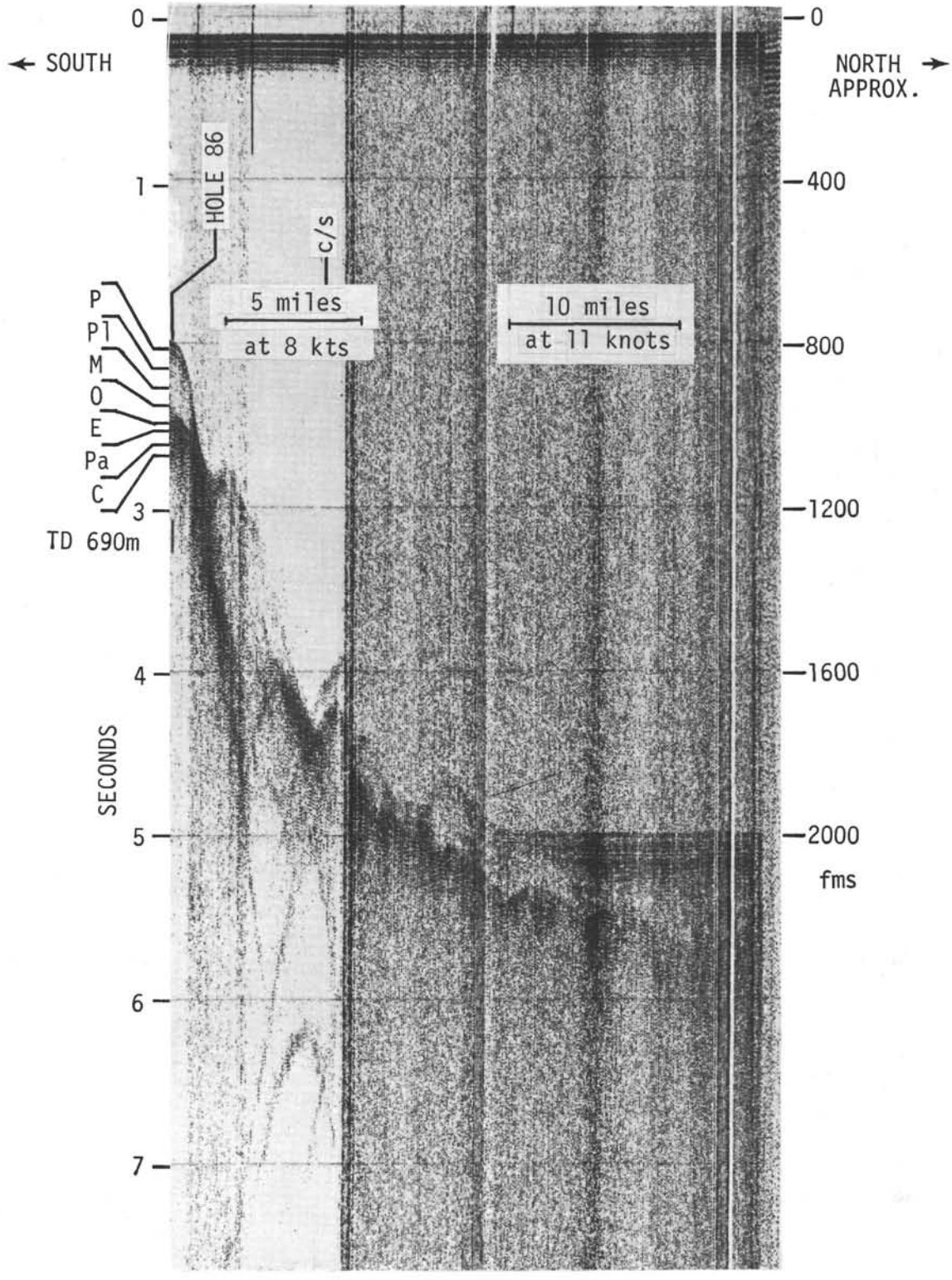
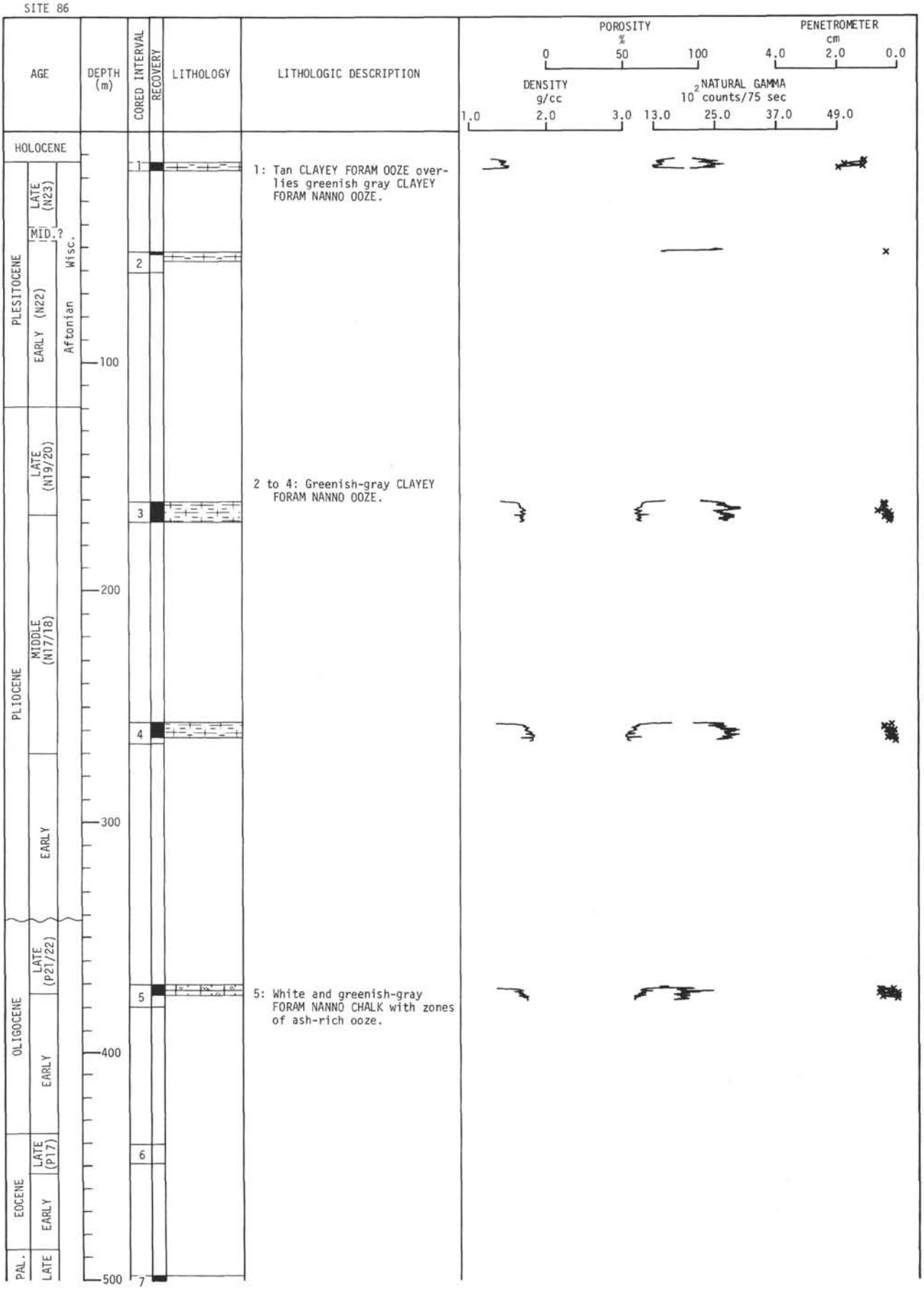
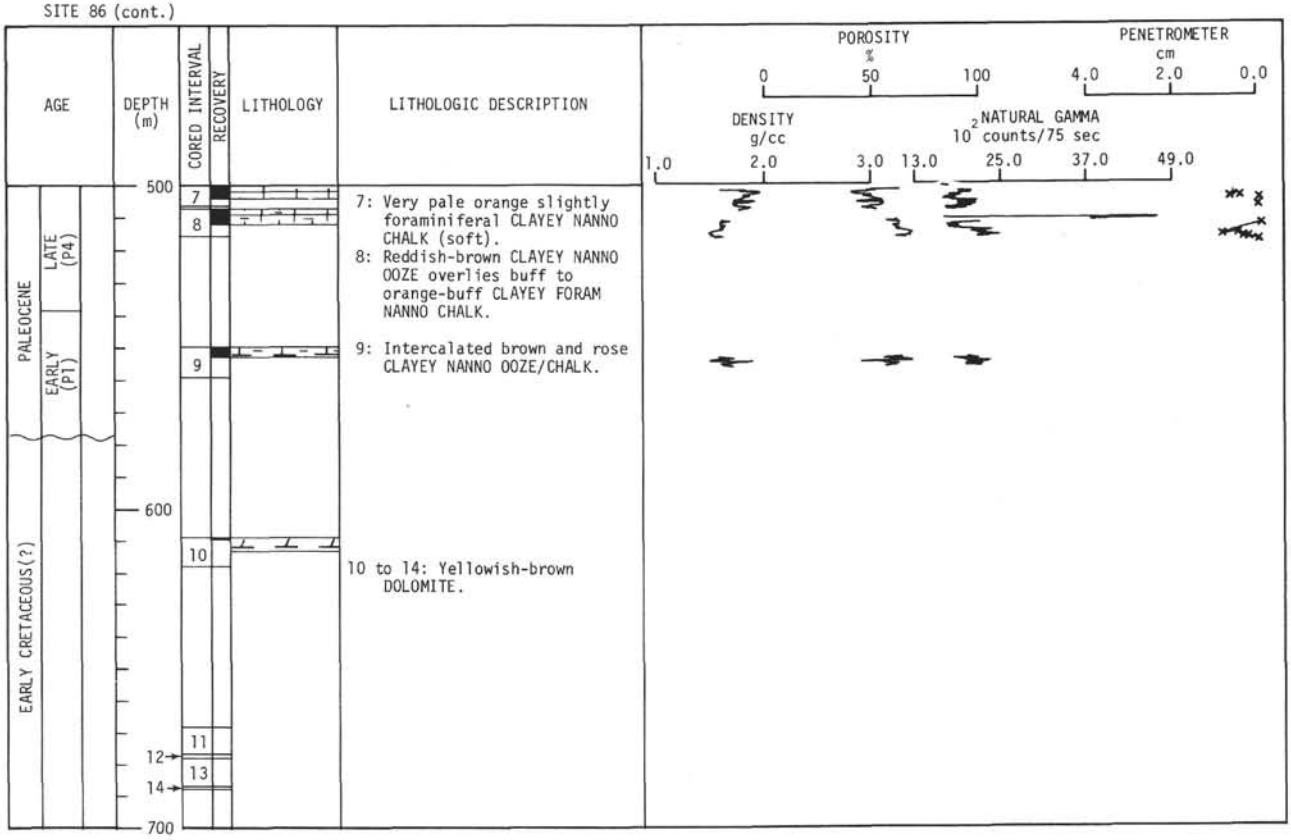


Figure 2. *Profile record, Site 86.*

SITE 86


AGE
DEPTH (m)
CORED INTERVAL
RECOVERY
LITHOLOGY
LITHOLOGIC DESCRIPTION
POROSITY %
0
50
100
PENETROMETER cm
4.0
2.0
0.0
DENSITY g/cc
1.0
2.0
3.0
NATURAL GAMMA 10² counts/75 sec
13.0
25.0
37.0
49.0
HOLOCENE
PLEISTOCENE
LATE (N23)
MID.?
EARLY (N22)
Aftonian
Wisc.
PLIOCENE
LATE (N19/20)
MIDDLE (N17/18)
EARLY
OLIGOCENE
LATE (P21/22)
EARLY
EOCENE
LATE (P17)
EARLY
PAL.
LATE
100
200
300
400
500
1
2
3
4
5
6
7
1: Tan CLAYEY FORAM OOZE overlies greenish gray CLAYEY FORAM NANNO OOZE.
2 to 4: Greenish-gray CLAYEY FORAM NANNO OOZE.
5: White and greenish-gray FORAM NANNO CHALK with zones of ash-rich ooze.

SITE 86 (cont.)


AGE
DEPTH (m)
CORED INTERVAL
RECOVERY
LITHOLOGY
LITHOLOGIC DESCRIPTION
POROSITY
%
0
50
100
PENETROMETER
cm
4.0
2.0
0.0
DENSITY
g/cc
1.0
2.0
3.0
NATURAL GAMMA
10² counts/75 sec
13.0
25.0
37.0
49.0
PALEOCENE
LATE (P4)
EARLY (P1)
EARLY CRETACEOUS(?)
500
600
700
7
8
9
10
11
12
13
14
7: Very pale orange slightly foraminiferal CLAYEY NANNO CHALK (soft).
8: Reddish-brown CLAYEY NANNO OOZE overlies buff to orange-buff CLAYEY FORAM NANNO CHALK.
9: Intercalated brown and rose CLAYEY NANNO OOZE/CHALK.
10 to 14: Yellowish-brown DOLOMITE.

Site 86 Hole Core 1 Cored Interval: 13-17.5 m

AGE	ZONE	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION	GRAIN SIZE WEIGHT % SAND	SILT	CLAY
LATE PLEISTOCENE (Wisconsin) Holocene	*Globorotalia truncatulinoides (Pulleniatina finalis* Subzone)	1	0.5				5YR5/4 tan massive, clayey Foram ooze.	14.2	21.3	64.6
			1.0					6.8	17.1	76.0
		2					CLAYEY FORAM NANNO OOZE Greenish-gray (5G7/1); moderately to sparsely mottled with possible burrows and thin laminae of 5B5/1 (fecal?)			
							Volcanic ash			
		3		VOID				6.1	21.7	72.2
		Core Catcher								

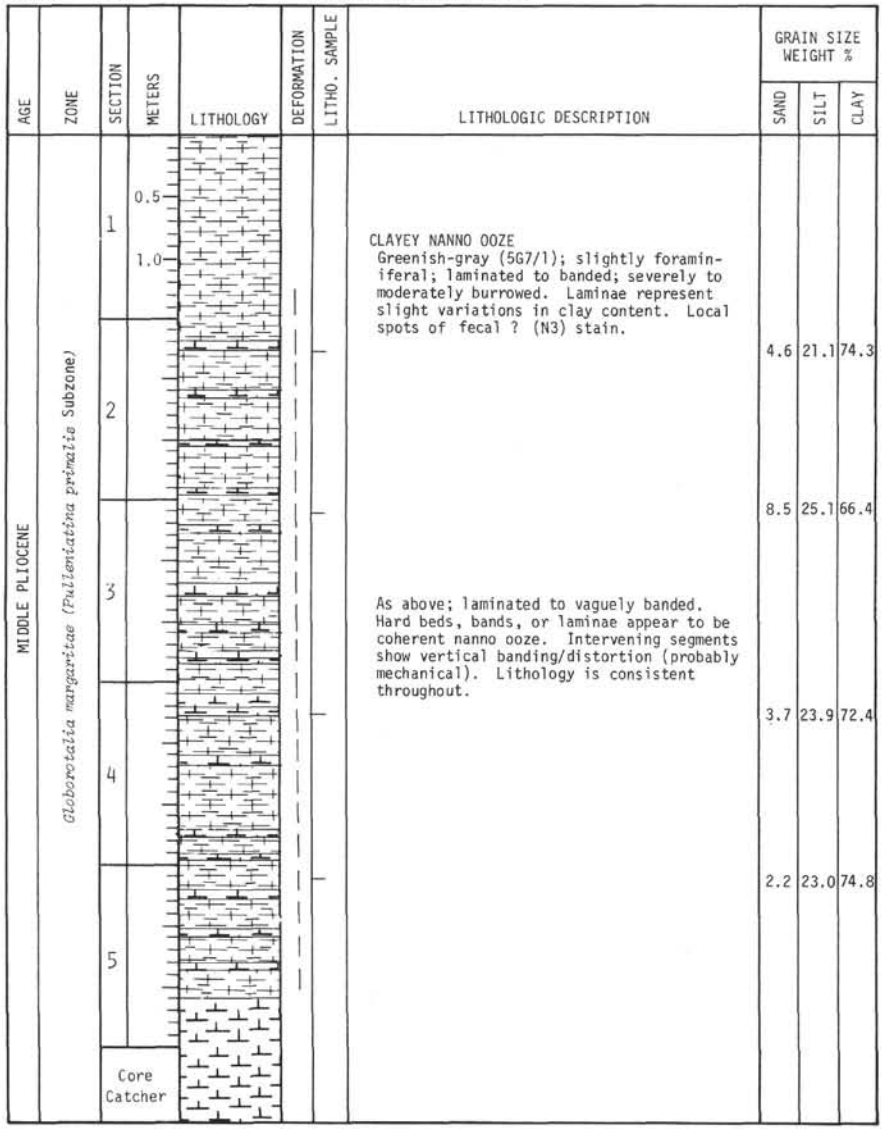
Site 86 Hole Core 2 Cored Interval: 52-61 m

AGE	ZONE	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION	GRAIN SIZE WEIGHT % SAND	SILT	CLAY
EARLY PLEISTOCENE (Aftonian)	*Globorotalia truncatulinoides (Globorotalia tosaensis* Subzone)	1	0.5	UNKNOWN			Core extruded in disoriented fragments; top and sequence unknown.			
			1.0					4.9	21.7	73.5
		Core Catcher					CLAYEY FORAM NANNO OOZE Greenish gray (5G6/1, 5G7/1, 5GY6/1); color mottled with probable burrows of moderate intensity. Minor fecal(?) stain (N3).			

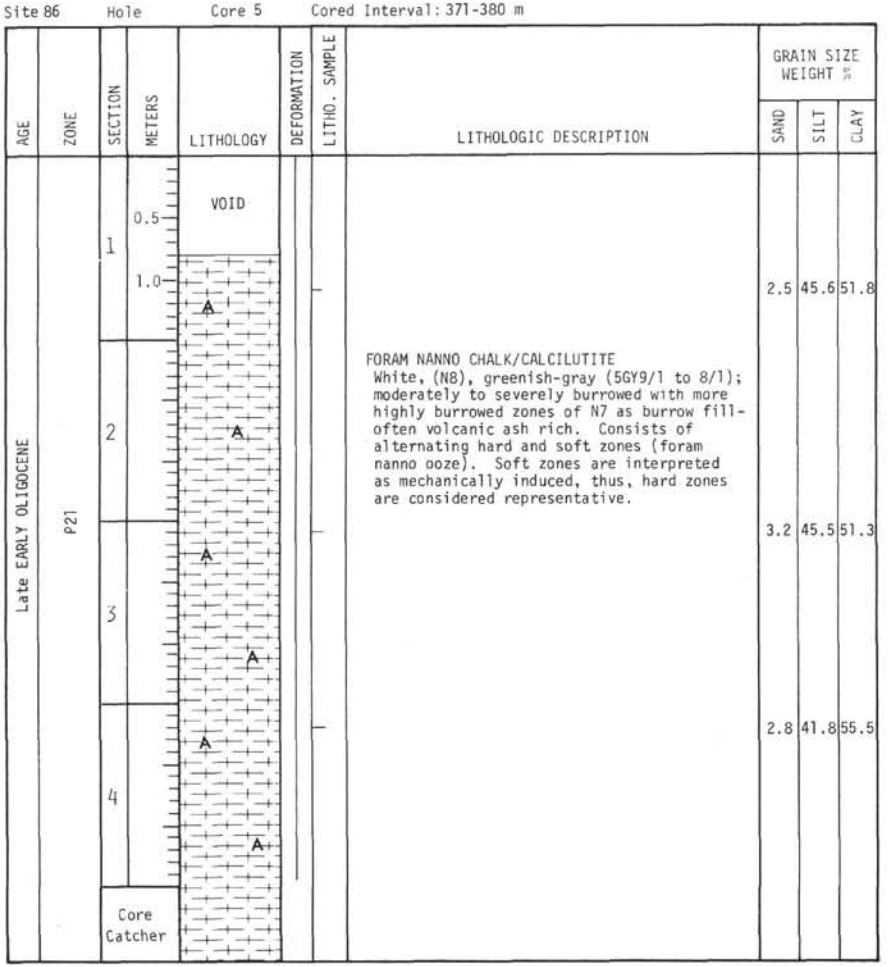
Site 86 Hole Core 3 Cored Interval: 161-170 m

AGE	ZONE	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION	GRAIN SIZE WEIGHT % SAND	SILT	CLAY
MIDDLE TO LATE PLIOCENE	*Globorotalia margaritae (Pulleniatina primalis* Subzone)	1	0.5							
			1.0					6.4	20.9	72.7
		2					CLAYEY NANNO OOZE Greenish-gray (5G7/1); slightly foraminiferal with moderate to severe burrow-mottles (5G6/1). Local spots of probable faecal (N3) staining.	7.1	25.2	67.6
		3								
		4						9.4	22.7	67.9
		5					As above; laminated to banded. Color laminae appear to represent varying amounts of clay. (5G7/1 - less; 5G6/1 - more).	7.4	20.9	71.7
		6					Laminae of varying thicknesses alternating successively from 5G7/1 to 5G6/1.	5.2	21.4	73.5
		Core Catcher								

Site 86 Hole Core 4 Cored Interval: 257-266 m



Site 86 Hole Core 5 Cored Interval: 371-380 m



Site 86 Hole Core 7 Cored Interval: 498-507 m

AGE	ZONE	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION	GRAIN SIZE WEIGHT % SAND	SILT	CLAY
LATE PALEOCENE	P4	1	0.5–1.0	UNOPENED			Section not opened-very watery and disturbed			
		2					NANNO CHALK/CALCILUTITE very pale orange (10YR 8/2); slightly foraminiferal, slightly clayey to clayey (in several thin zones). Moderately to severely burrowed, vaguely laminated/ banded. Alternating hard and soft layers as in previous core. Soft zones are interpreted as mechanical disturbance	12.3	43.3	44.4
		3								
		4					Mottled with 5Y6/1 and minor N3 (more argillaceous).	15.9	29.7	54.4
							Zones of N3 fecal ? stain.			
		5					Zone mottled with N3 fecal ? stain.	8.2	39.9	52.0
		Core Catcher								

Site 86 Hole Core 8 Cored Interval: 508-517 m

AGE	ZONE	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION	GRAIN SIZE WEIGHT % SAND	SILT	CLAY
LATE PALEOCENE	P4	1	0.5–1.0	VOID			CALCAREOUS CLAY Reddish brown (10R5/6); nanno-rich; moderately burrowed with common glass at several levels as laminae. Sharp contact. concretion/nodule with band of Fe stain surrounding.	11.2	79.8	9.0
		2					FORAMINIFERAL NANNO CHALK Buff (10YR8/2); moderate to strongly burrowed with minor mottling of 5Y6/1 and N3. Alternating hard and soft layers as in above barrels.	22.9	48.3	28.8
		3					color change to 10YR7/4			
		4					Orange buff (10YR7/2); somewhat clayey; moderate to severely burrowed. Alternating hard and soft layers.	3.4	42.3	54.3
							Minor laminae of volcanic ash. Sparse vague laminae/bands of slightly varying clay content.			
		Core Catcher								

Site 86 Hole Core 9 Cored Interval: 551-560 m

AGE	ZONE	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION	GRAIN SIZE WEIGHT % SAND	SILT	CLAY
EARLY PALEOCENE	P1	1*	0.5				CLAYEY NANNO CHALK Intercalated brown (10YR6/2) and rose (10R7/6); intensly burrowed with scattered concretions and abundant microburrows with fecal (FeS?) stain (N3). Fecal material appears to be largely confined to brown (unoxidized?) zones. Alternating hard and soft zones as in above barrels. *See Section Summary for more detail.	2.3	46.3	51.4
			1.0							
		2*								
		Core Catcher								

Site 86 Hole Core 10 Cored Interval: 610-619 m

AGE	ZONE	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION	GRAIN SIZE WEIGHT % SAND	SILT	CLAY
EARLY CRETACEOUS (?)		Core Catcher					Core Catcher only. Mottled (burrowed) yellowish brown (10YR7/2) DOLOMITE with molds of fossil debris partially filled with calcite.			

Site 86 Hole Core 11 Cored Interval: 669-678 m

AGE	ZONE	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION	GRAIN SIZE WEIGHT % SAND	SILT	CLAY
EARLY CRETACEOUS (?)		Core Catcher					Core Catcher only. Two types of carbonate. 1) Yellowish-brown (10YR7/2) DOLOMITE, similar to core catcher of Core 10, but finer grained and less fossil molds. 2) Buff colored (10YR8/2) CALCILUTITE, probably a recrystallized chalk. Induration and degree of recrystallization suggests that it represents in-place sediment.			

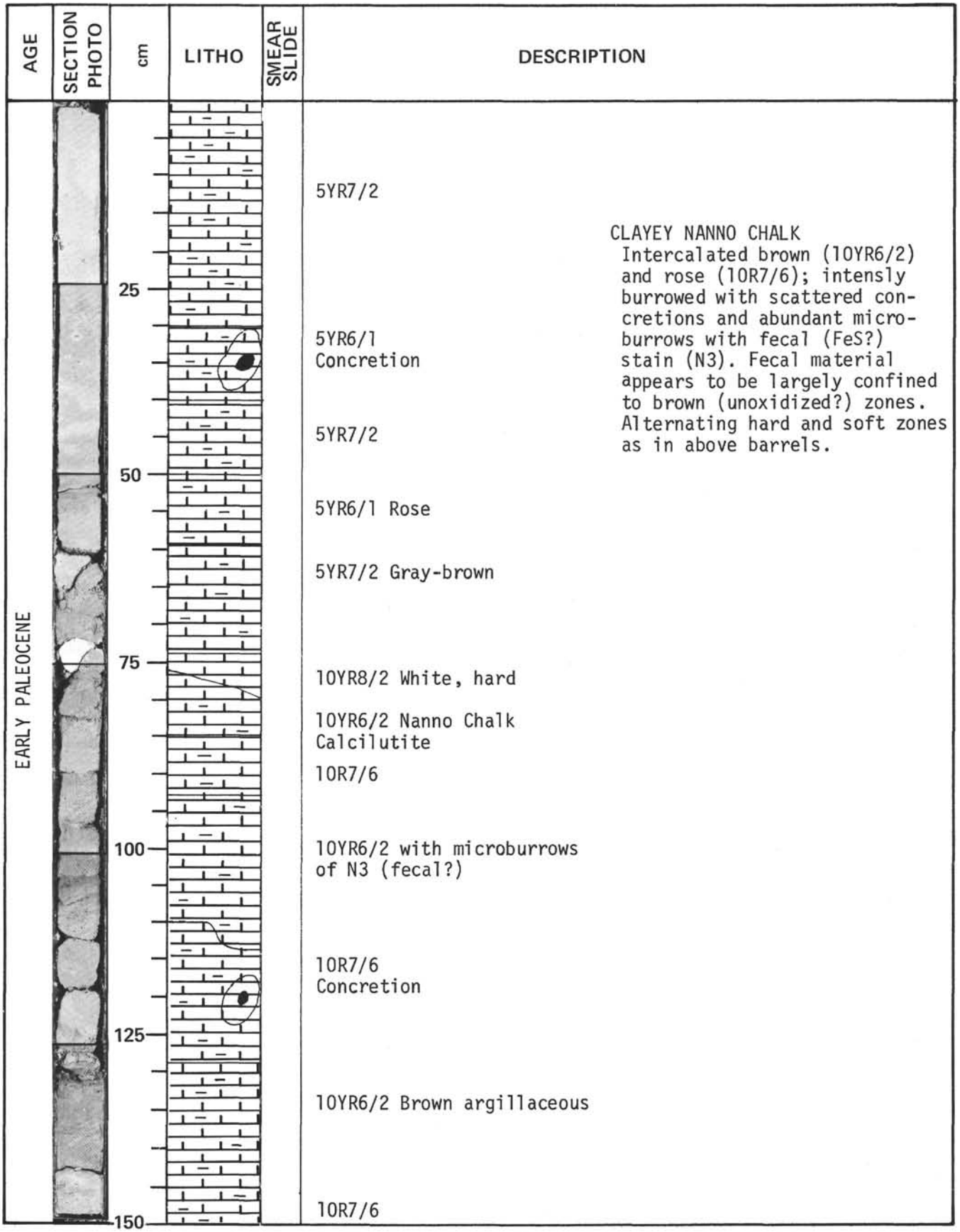
Site 86 Hole Core 12 Cored Interval: 678-679 m

AGE	ZONE	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION	GRAIN SIZE WEIGHT % SAND	SILT	CLAY
EARLY CRETACEOUS (?)		Core Catcher					Core Catcher only. Yellowish-brown (10YR5/2) very fine grained DOLOMITE with sparse calcite-filled fossil molds. Low porosity. Core 13: No recovery; cored interval: 679-684 m.			

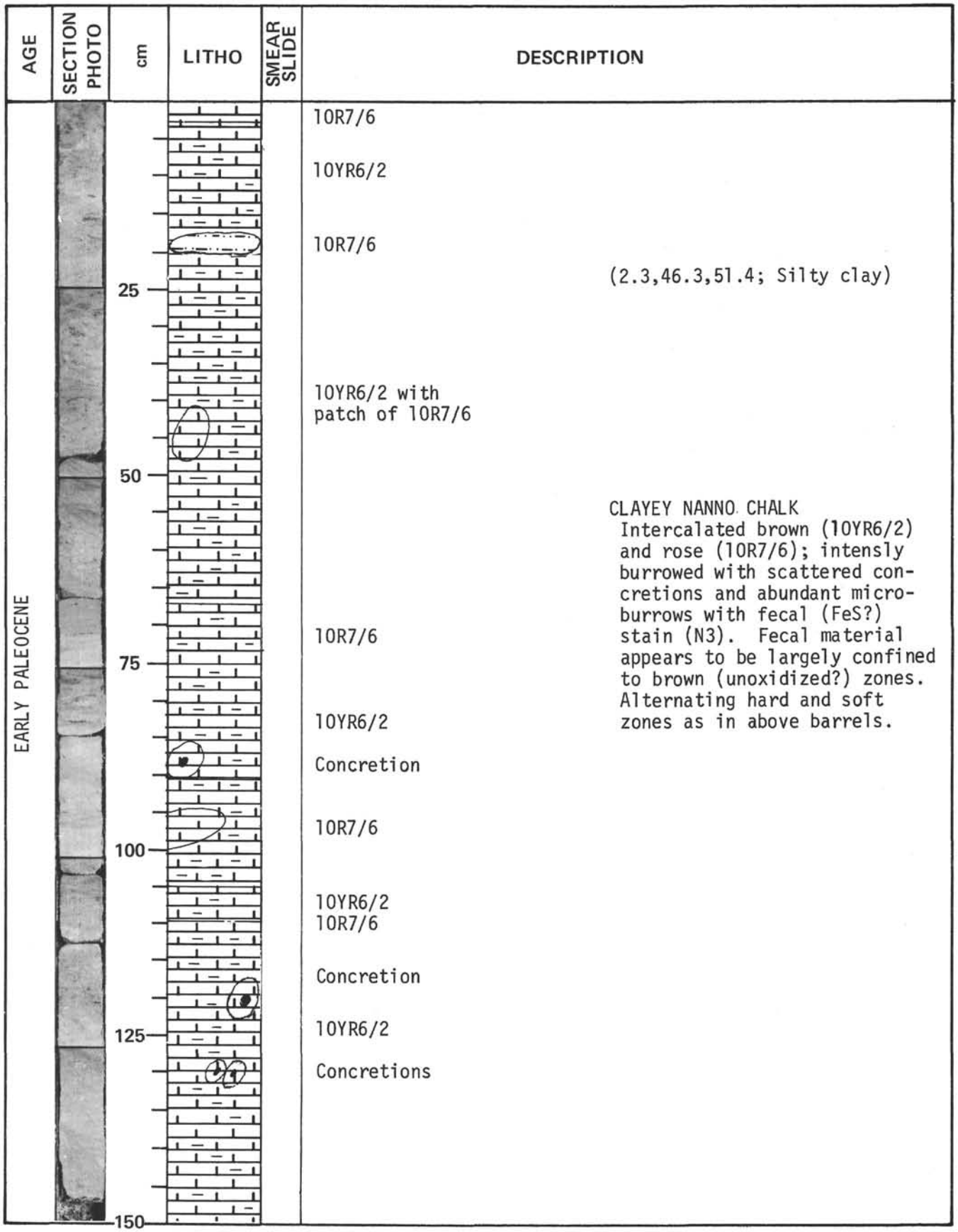
Site 86 Hole Core 14 Cored Interval: 686-686 m

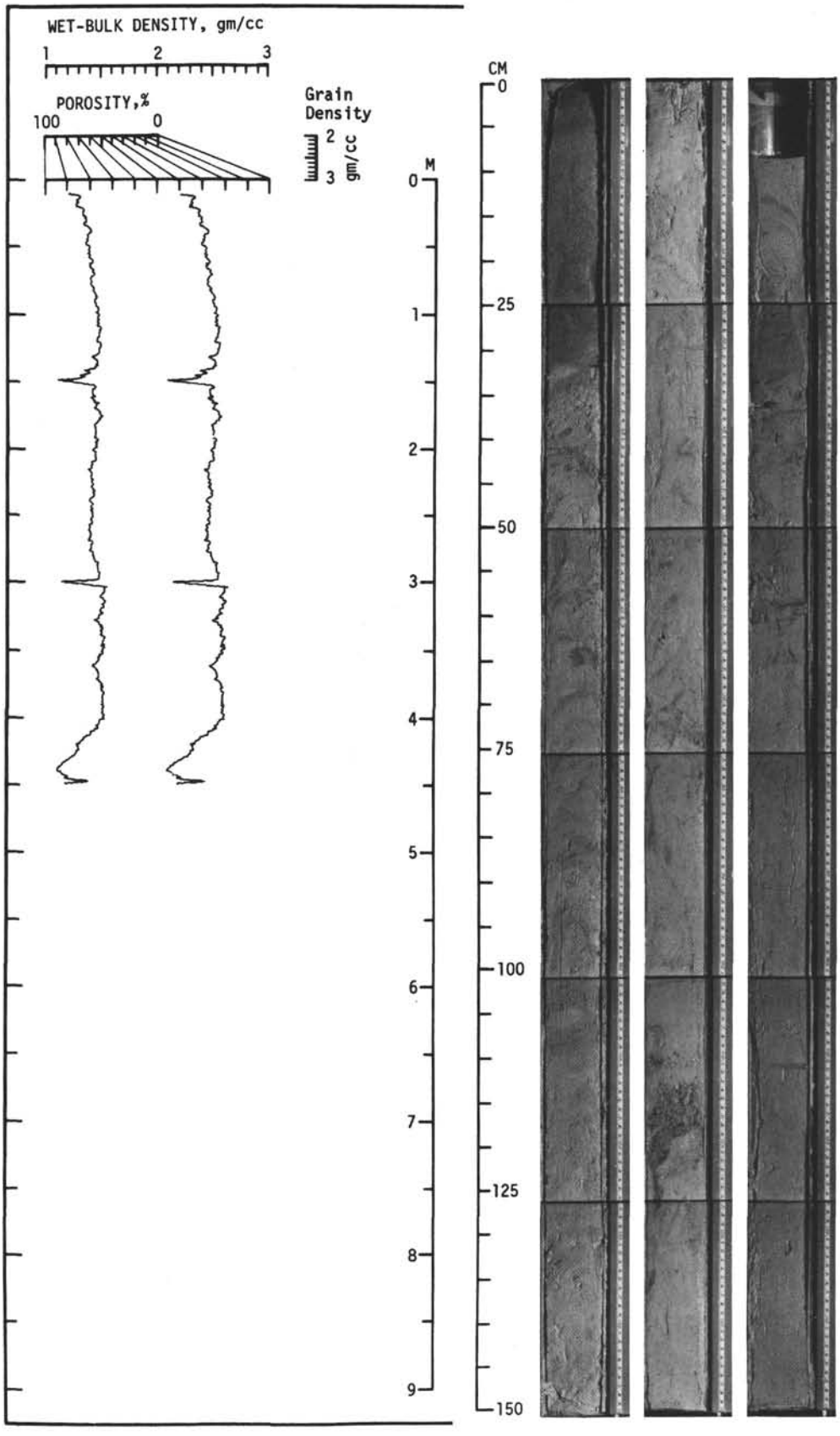
AGE	ZONE	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION	GRAIN SIZE WEIGHT % SAND	SILT	CLAY
EARLY CRETACEOUS (?)		Core Catcher					2 pebbles of brown, dense, very fine grained DOLOMITE, similar to clasts in Core 12.			

SITE 86 CORE 9 SECTION 1



SITE 86 CORE 9 SECTION 2

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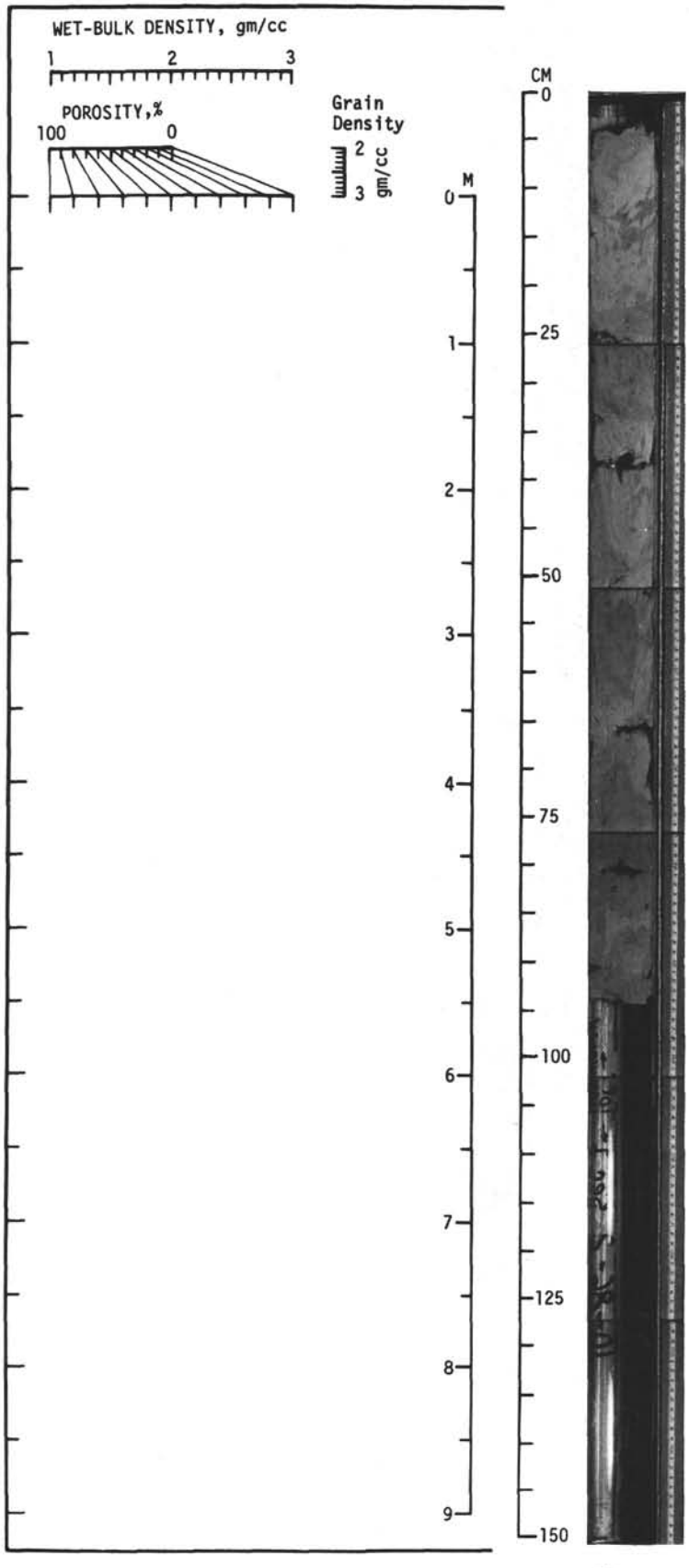
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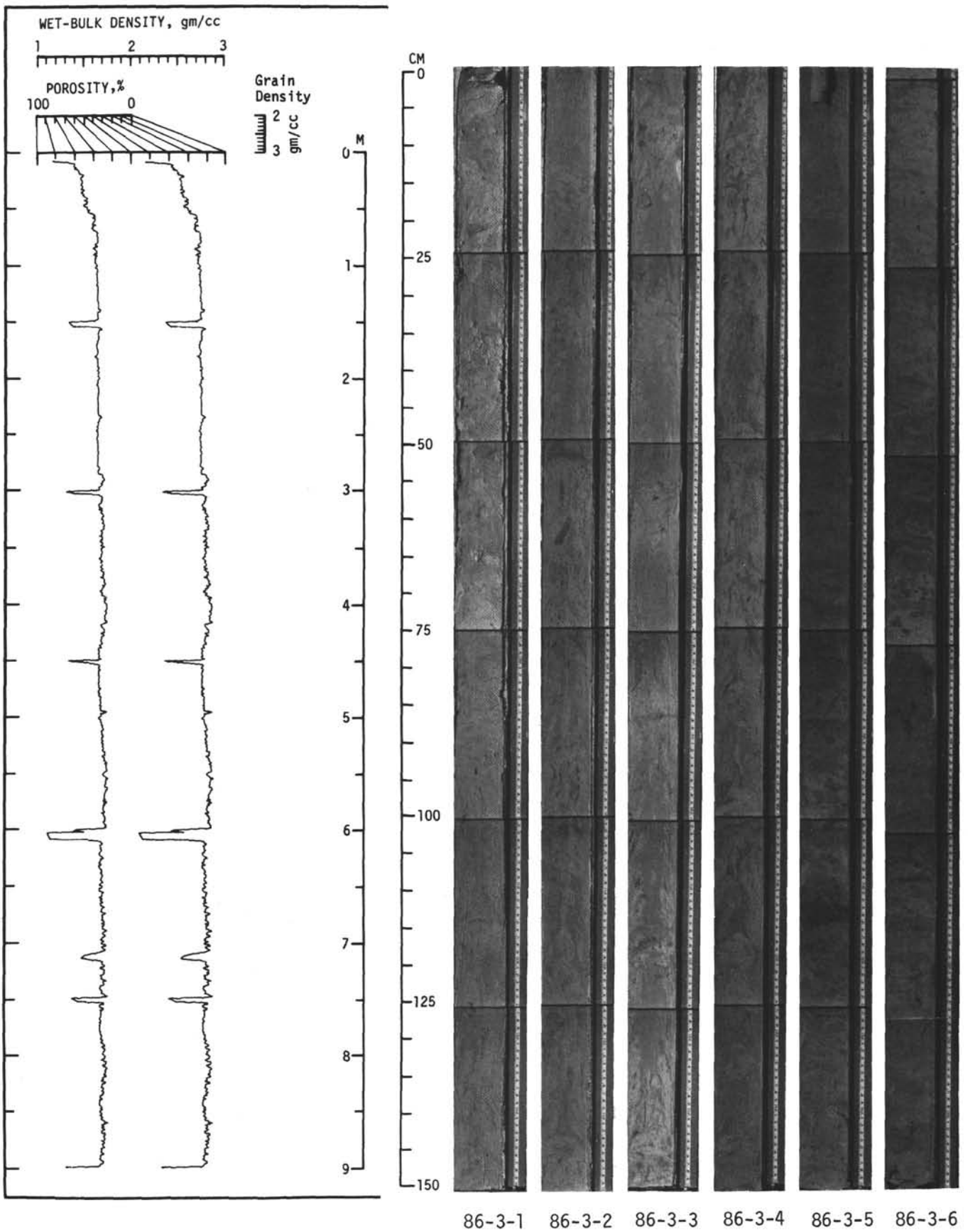
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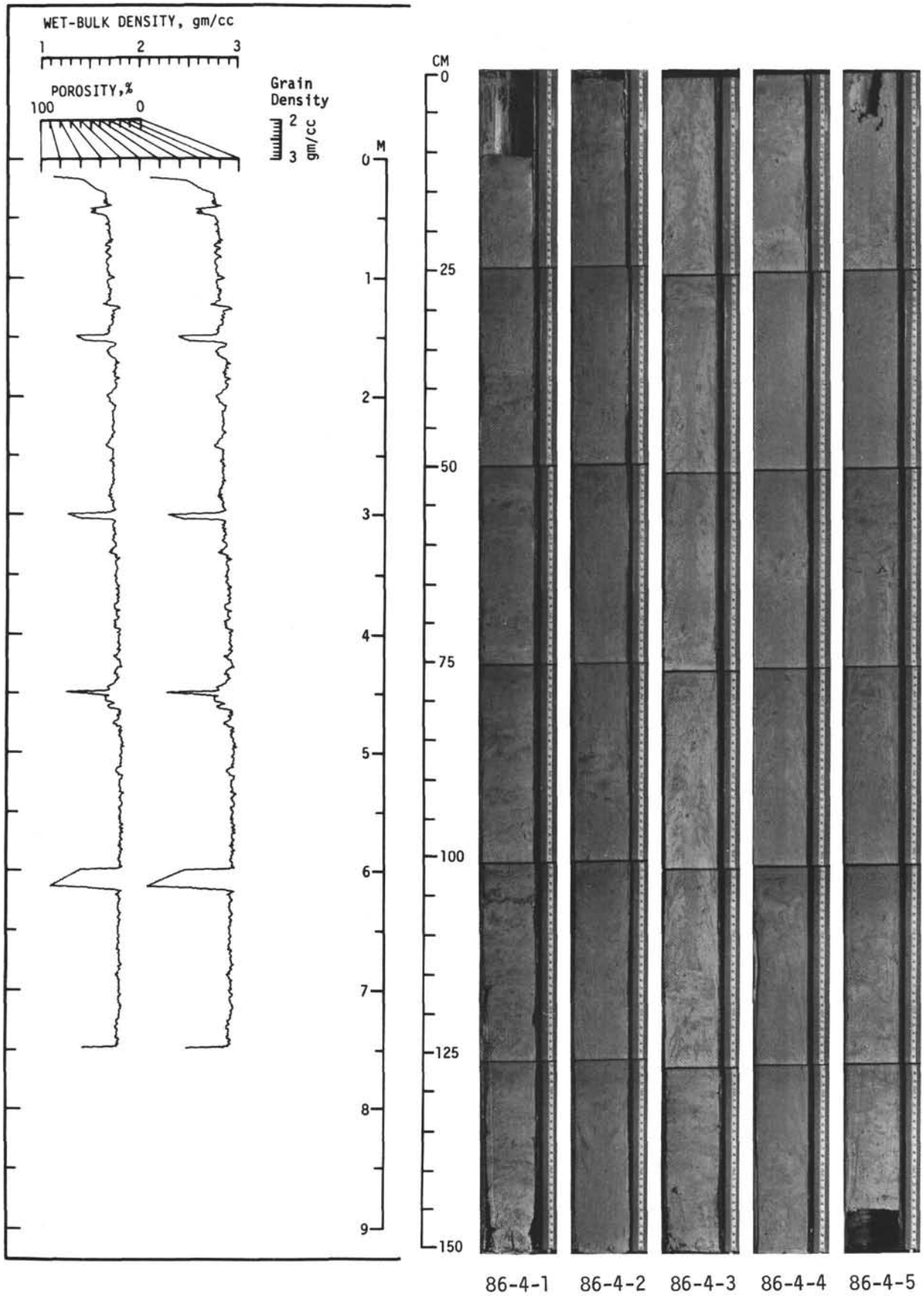
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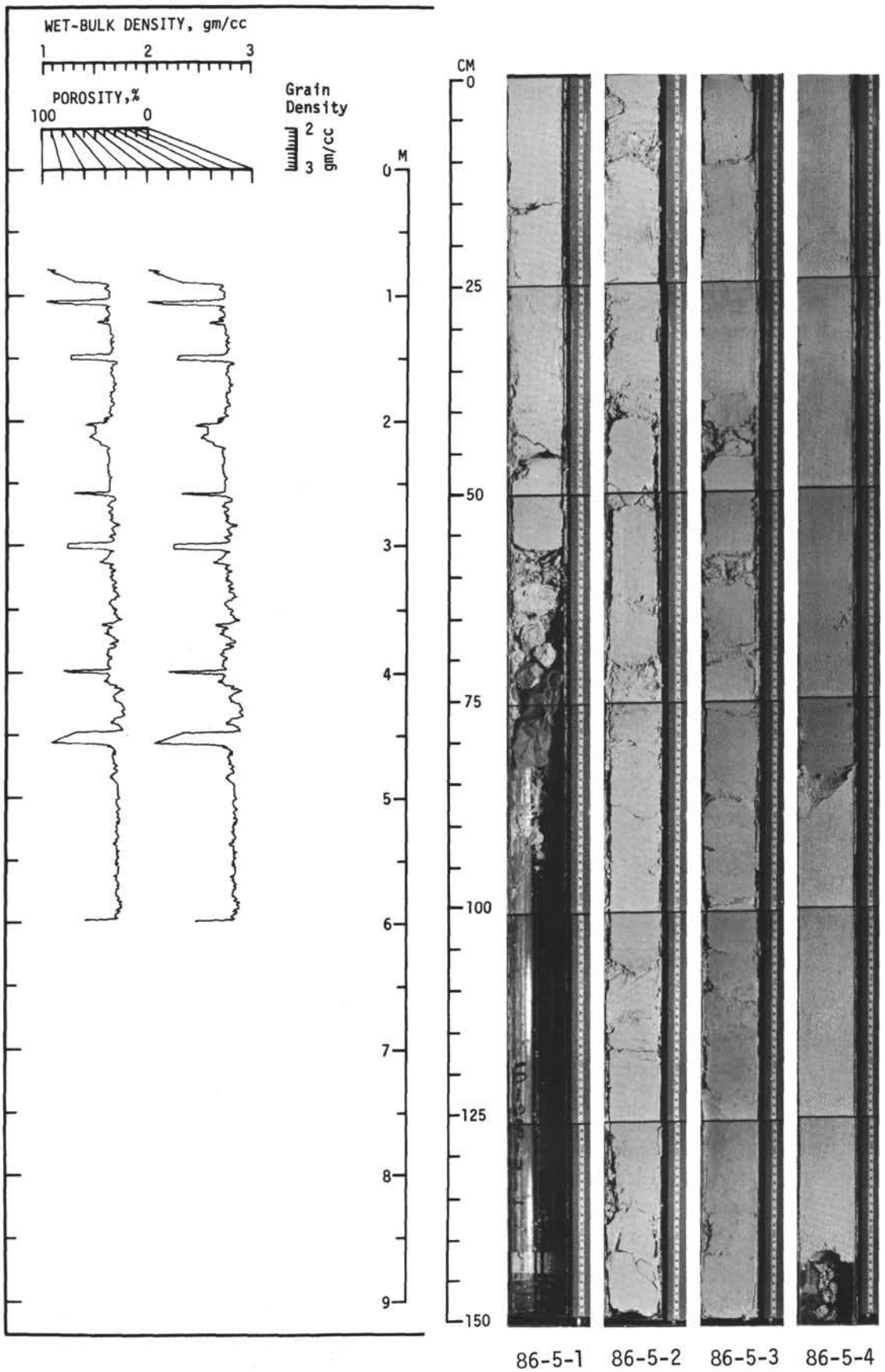
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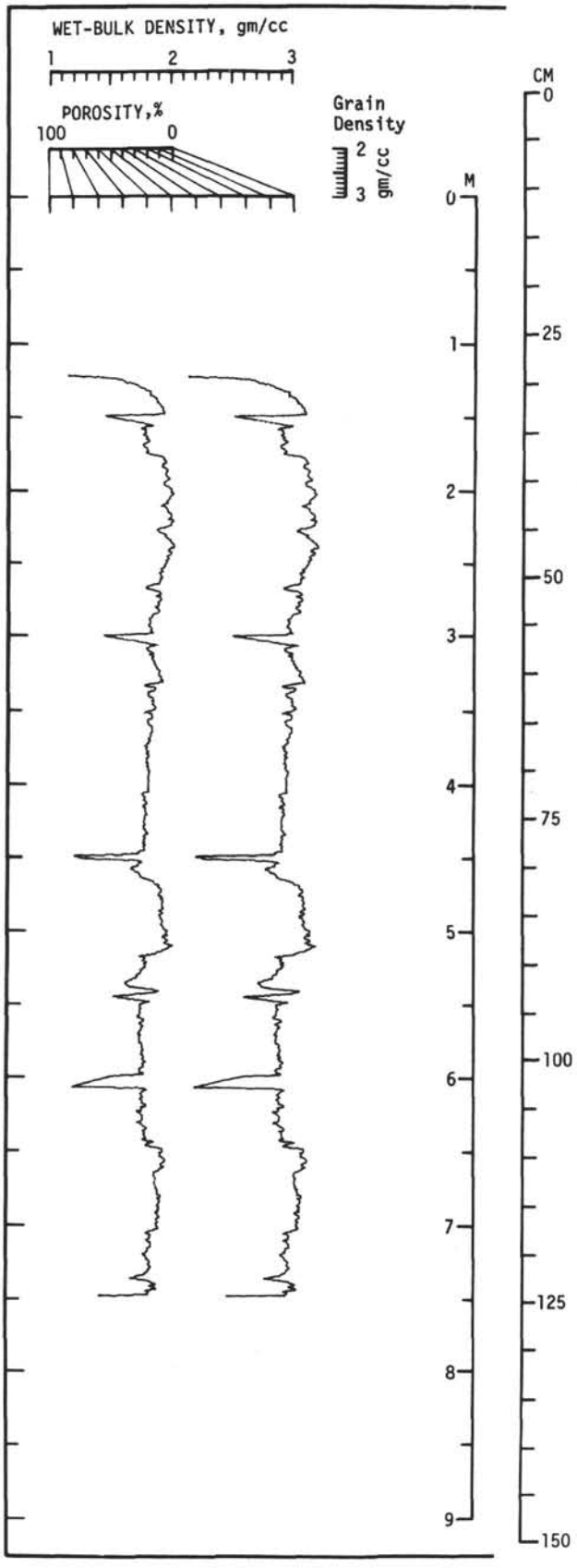

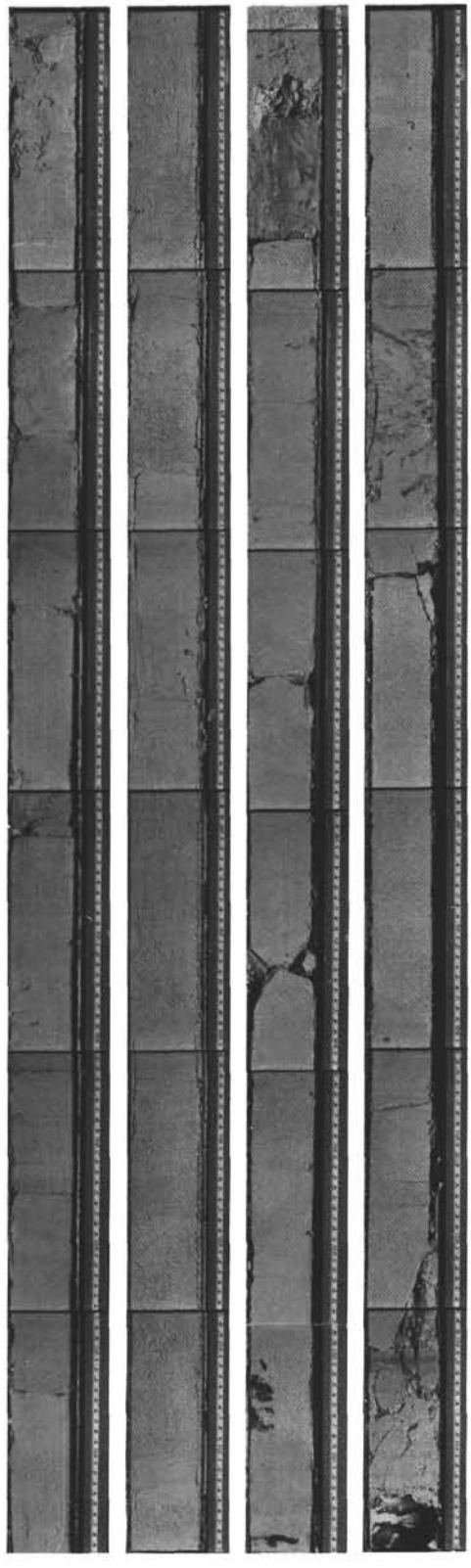

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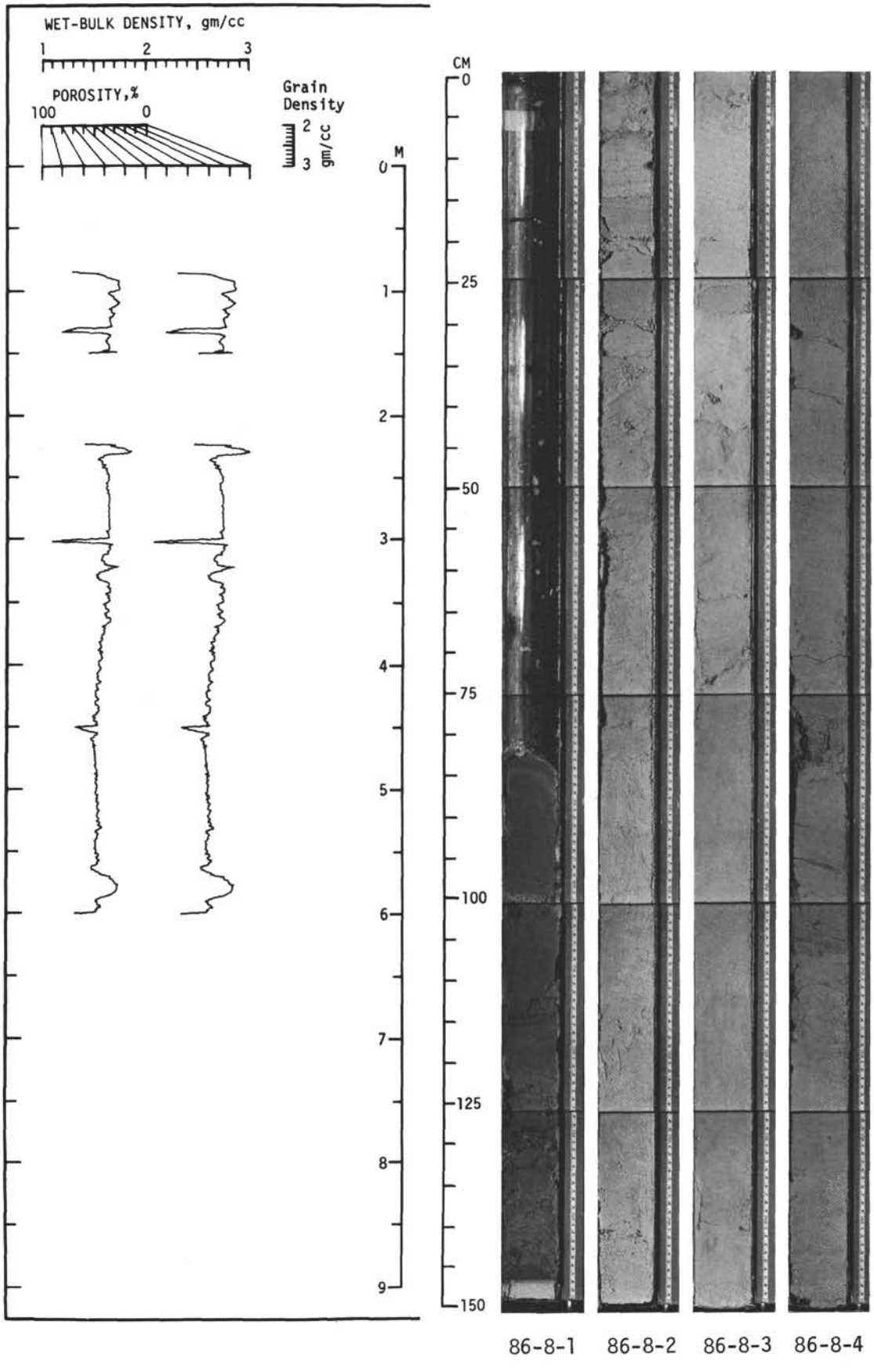
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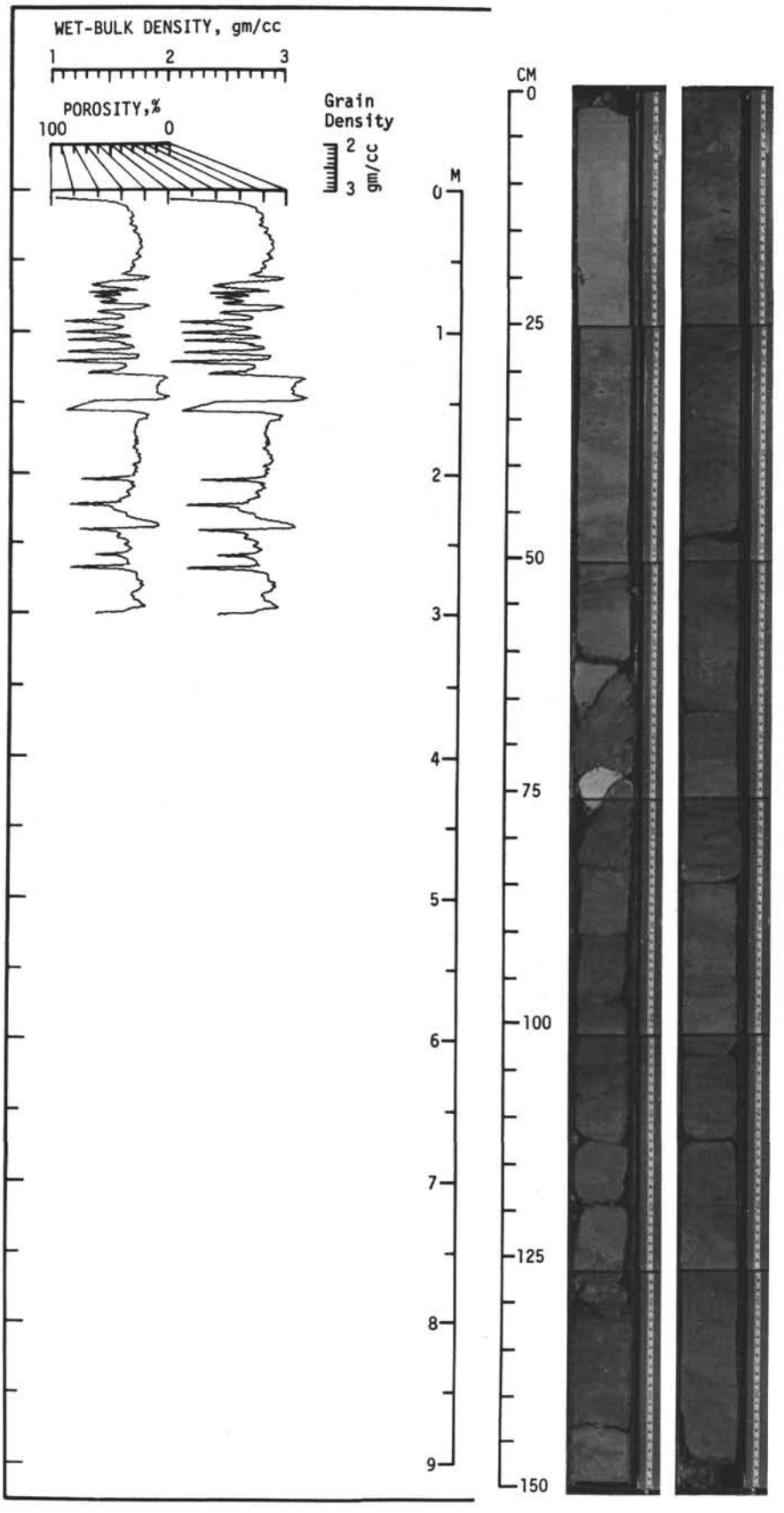
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