5. SITE 88

The Shipboard Scientific Party[1]

SITE DATA

Occupied: March 4, 1970.

Position: 21° 22.93′N; 94°00.21′W.

Water Depth: 2532 meters.

Total depth: 135 meters.

Holes Drilled: One.

Cores Taken: Five.

BACKGROUND AND OBJECTIVES

The Sigsbee Basin of the Gulf of Mexico lies between the Sigsbee Scarp to the north (about 200 miles off the Texas-Louisiana coast) the Campeche Scarp to the south (about 150 miles off the Yucatan Peninsula) the West Florida Escarpment to the east (about 120 miles west of the Florida coast) and the foot of the Mexican continental slope to the west (about 180 miles east of the Mexican coast). The Sigsbee Basin includes the Mississippi Cone to the east, and the Sigsbee Abyssal Plain to the west and south. The Sigsbee Abyssal Plain is interrupted only by the Sigsbee Knolls, the first three of which were discovered by M. Ewing in 1954 (Ewing, Ericson, and Heezen, 1958).

In 1961, with the introduction of seismic profiling in deep water, the Sigsbee Knolls were shown to be three diapiric structures in a group of twenty-one; these three being the only ones of the group having a surface expression (Ewing, Worzel, and Ewing, 1962). At that time, it was concluded that they were probably salt domes because: (1) They were subcircular in plan, (2) They were clearly intrusive, (3) They were 6 to 11 kms in diameter, (4) The reflecting horizons were upwarped along the flanks, (5) In many cases, there were rim synclines, (6) Gravity and magnetic data ruled out the possibility of igneous intrusion, and (7) Gas at these depths would have inadequate volume to supply the effects of buoyancy or lubrication important in mud or shale domes.

It was also suggested that petroleum accumulations were likely to be associated with these structures. These data were fully substantiated and the number of knolls (those with surface expression) and domes (those without surface expression) was increased to forty-four as reported by Ewing and Antoine (1966) and Talwani and Ewing (1966). These reports also indicated a trend to the southwest and south of the original structures.

Bryant and Pyle (1965) took a sediment core which contained Tertiary fossils from the top of one of the knolls. They attributed this discovery to the slumping of sediments off the knoll, uncovering older deposits.

Along the Mexican continental slope, long linear fold-type features were reported by Bryant et al. (1968). These could be attributed alternatively to (1)gravity sliding on a decollement surface, (2) folding associated with compressional tectonic stresses, (3) vertical movements of shale or salt masses related to static loading, or (4) folding related to faulting. The authors gave the third alternative as their preference because of the apparent continuity with the Texas-Louisianan continental slope and the salt features in the surrounding areas.

In the early part of 1967, *Vema* cruise 24 outlined the zone in which knolls and domes were found and demonstrated that the zone joined the known salt dome fields of Tabasco-Campeche. Figure 1 shows the zone outlined (after Worzel, Leyden, and Ewing, 1968). Further work substantiating this zone of domes was reported by Uchupi and Emery (1968) and by Ballard and Feden in 1968 at the Mexico City meeting of the Geological Society of America (Ballard and Feden, 1970).

On Leg 1 of the GLOMAR CHALLENGER CRUISE, one of these knolls, now called Challenger Knoll was drilled, recovering cap rock, petroleum, and sulfur (Ewing et al., 1969). Thus, the northerly group of domes and knolls was shown to be salt diapirs.

Nevertheless, many geologists believed that the more numerous structures to the south and west, with their much greater surface expression, could not be salt domes, even though the zone in which they occur appeared to connect to the known salt dome oil fields in Campeche, Mexico (Fig. 1). The structure outlined in the large circle was chosen from *Vema* cruise 24 profiler record 1127 as Site 88 for drilling on Leg 10 because it was about halfway between Challenger Knoll and the "Campeche-Salt Dome Province", it had a relief of about 500 fathoms, and it showed about 350 meters of sediment above the presumed salt.

The object of drilling this hole was to demonstrate that this feature, like Challenger Knoll, is a salt dome, and find out whether or not there is associated petroleum and sulfur. If this were so, it would be quite conclusive that all of the features in the zone outlined in the above figure are salt domes. Of course, there would have to be many more salt domes within the area as the track coverage is not yet sufficient to have encountered all of those present.

[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.

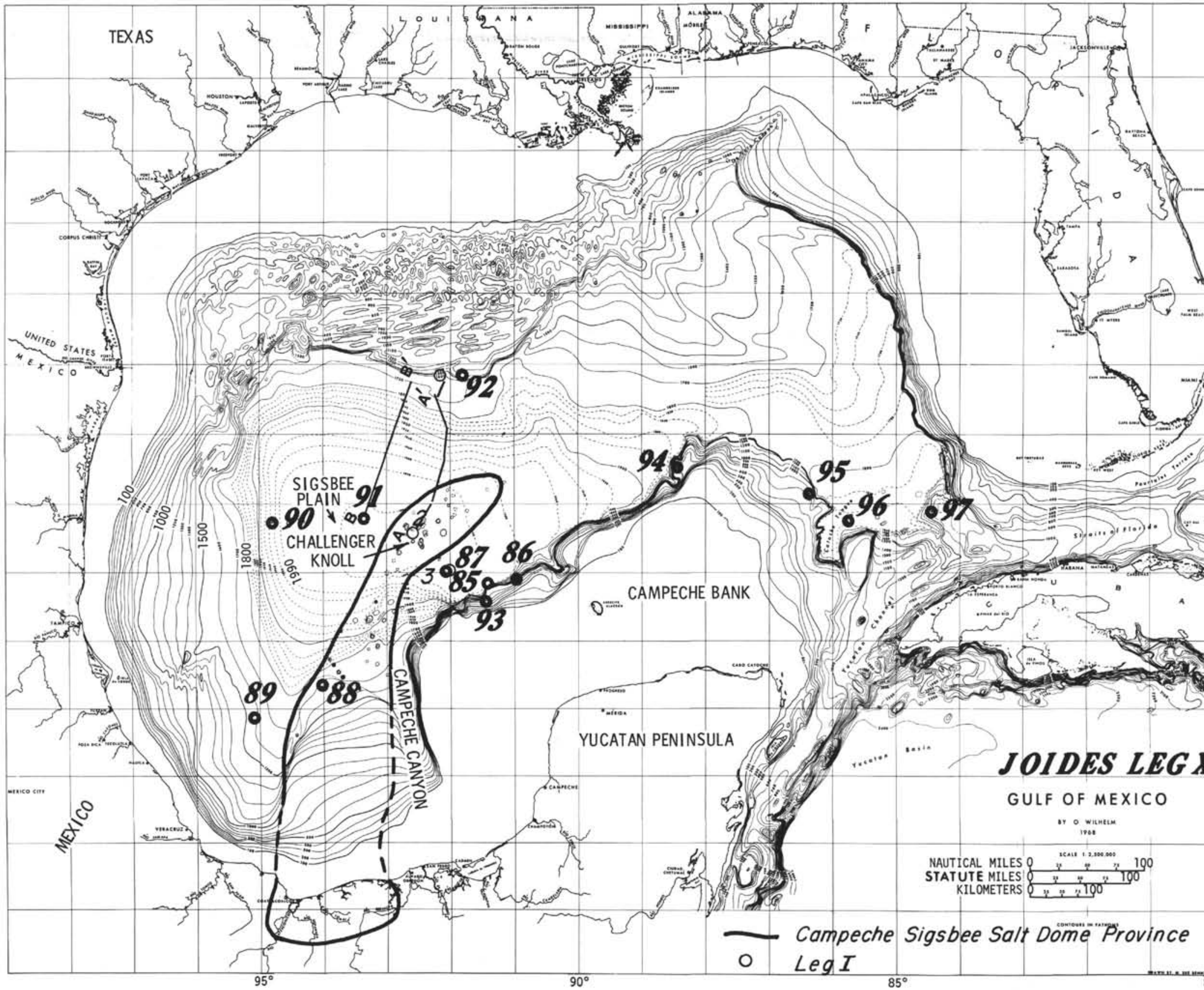


Figure 1. *Outline of the zone containing knolls and domes discovered during* Vema *cruise 24 (after Worzel, Leyden, and Ewing, 1968).*

Site 88 was drilled and cored to a depth of 135 meters on March 4. The site was abandoned after the recovery of five cores of Pleistocene nanno ooze. A core inventory is presented in Table 1.

NATURE OF SEDIMENTS

General Description

Sediments encountered at Site 88 are apparently pelagic in origin, with the sedimentological attributes normally ascribed to sediments of that type. With the exception of tan foraminiferal ooze at the surface (of probable Holocene age), the sequence consists of greenish gray (5G6/1-7/1) moderate to strongly burrowed, foraminiferal, nannofossil-rich clay or clayey nannofossil ooze. Variations in the amount of volcanic glass and a tendency to become slightly darker greenish gray and more carbonate-rich with depth provide the only modifying elements.

In detail, the sediments at Site 88 are seldom vaguely laminated and almost totally homogenized by burrowing. Microburrows are common, and burrow fill of dark fecal/FeS material results in a somewhat speckled appearance throughout. Clay and silt-size opaque grains, probably pyrite, are present but rare in all slides. An authigenic origin for the pyrite is suggested by the fairly common occurrence of pyrite in chambers of foraminifera tests.

Occasional laminae or bands of ash-rich ooze, often occurring as burrow fill and then totally mixed with the normal nannofossil-rich matrix, appear to be most common in Cores 1 and 2. The presence of volcanic glass shards, minor amounts of plagioclase, rather high relative amounts of montmorillonite, mica, and brown hornblende is suggestive of volcanic derivation for most of the inorganic detritus.

Sedimentological Interpretation

As at Site 86, the presence of carbonate biogenic debris as a dominant constituent, the planktonic aspect of the faunal elements represented, the intensity of burrowing, and the general absence of normal terrigenous clastic elements support a pelagic origin for the sediments described.

Comparison of this hole with Site 2 of Leg 1, also on the crest of a bathymetric high (probable salt diapir), suggests strong similarities in depositional setting. The only important difference in sediment appears to be in the greater abundance of volcanogenic debris at Site 88. It should also be pointed out that the sediment type at Site 88 is quite comparable to that recovered from Site 86.

Site 88 has apparently been the site of pelagic sedimentation since at least Early Pliocene time. On the basis of the profiler record and the lack of other sediment types, it can be concluded that little, if any, change in water depth or setting has taken place since that time. In view of the undrilled sediment evident from the profiler record, it can be postulated that the record of pelagic sedimentation may ultimately extend considerably further back in time at Site 88.

Physical Measurements

The conventional suite of physical measurements were made on cores from Site 88. All determinations appear fairly reliable in the upper segment of the hole (Cores 1 and possibly 2), whereas the lower three cores are so disturbed by expansion as to make determinations questionable. Gas odor was detected in all cores, being dominated by H_2S in Core 1 and natural gas in Cores 2, 3, 4, and to lesser extent in Core 5. These latter cores are dominated by methane with a lesser ethane component. Ethane reaches a maximum percentage in Cores 3 and 4, declining in Core 5.

TABLE 1
Core Inventory – Site 88

Core	No. Sections	Date	Time	Cored[a] Interval (m)	Cored (m)	Recovered (m)	Subbottom Penetration (m)		Lithology	Age
							Top	Bottom		
1	4	3/4	1130	2532-2538	6.0	6.0	0	6.0	Foram nanno ooze	Late Pleistocene
2	6	3/4	1330	2583-2592	9.0	9.0	51.0	60.0	Nanno ooze	Early Pleistocene
3	4	3/4	1600	2630-2636	6.0	9.0	98.0	104.0	Nanno ooze	Late Pleistocene
4	5	3/4	1730	2636-2640	4.0	5.0	104.0	108.0	Nanno ooze	Late Pleistocene
5	6	3/4	2100	2660-2667	7.0	4.0	128.0	135.0	Nanno ooze	Early Pleistocene
Total	25				32.0	33.0		135.0		
% Cut					23.7%					
% Recovered						103.1%				

[a]Drill pipe measurement from derrick floor.

Penetrometer readings decrease from Cores 1 to 2, whereas bulk density increases. Below Core 2, bulk density measurements appear to be more or less consistent, suggesting that the gassy nature of the cores, along with mechanical disturbance, has destroyed the normal relationship of consolidation with depth. Penetrometer readings are abnormally low for such depths and reflect the disturbed nature of the sediment. Both GRAPE and natural gamma measurements have been corrected by allowing for voids and poor sediment recovery.

Natural gamma determinations are more or less consistent with depth, reflecting the lack of important compositional variation within the sequence. The mean gamma-ray count is approximately 500 counts higher than the comparable sequence at Site 86 and 2. This is interpreted as reflecting the higher volcanogenic component present as a background constituent at Site 88, which results in a higher gamma-ray emission.

The presence of natural gas is intriguing, in that two (or more) origins can be hypothesized. The first hypothesis might be that these hydrocarbons represent simple diffusion from an underlying cap rock through the low permeability pelagic ooze to the sediment surface. In such a case, however, one might expect a continuous increase in the amount of gas detected as well as continuous increase in the proportion of heavier hydrocarbons. Such does not appear to be the case. The second hypothesis, and the one favored here, is that these natural gases represent the generation of in situ natural gas through organogenic processes—probably bacterial. Evidence of reducing conditions is taken from the greenish gray pigmentation of the sediment as well as the presence of fecal/FeS material throughout. The occurrence of pyrite throughout the sequence could also be cited as support of diffusion. The decline in ethane in Core 5 suggests that natural gas volume is decreasing below that level. Thus, it would appear that maximum generation of natural gas at Hole 88 may be at sediments depths of 100 meters or so. This appears to be a conceivable depth for bacterial generation of methane as determined from other studies.

Few indications of proximity to cap rock or salt were obtained during preliminary study of the sediments. The presence of pyrite throughout the sequence might be cited as supportive of sulfur-rich fluids below. Interstitial water analysis on board ship indicated about 15 per cent increase in salinity over normal seawater. This can be compared with Site 3, where an increase of approximately 100 per cent was noted just above cap rock. In view of the thickness of undrilled sediment remaining at Site 88, such an increase in pore water salinity is conceivable and probably would have been detected had drilling been allowed to continue.

In summary, it is suggested that the pelagic sediments cored at Site 88 are situated on the crest of a salt diapir. Hydrocarbons within the sediment resulted in disturbance of recovered sediment, and resulting physical measurements are somewhat inaccurate. The volume of natural gas in these cores must be small, while the low permeability of such sediments suggests that vertical diffusion is a slow process. In view of the overall decrease in gas volume with depth and lack of increase in heavier hydrocarbon components, it is our opinion that the gas is biogenic in origin.

BIOSTRATIGRAPHY

The biostratigraphy of Site 88 is summarized in Figure 2. This interpretation is based on examination of the foraminifers and calcareous nannofossils. The samples also were examined for radiolarians, but no significant occurences were noted.

Sample 1 (10-88-1, CC):

Globorotalia truncatulinoides, G. flexuosa, G. menardii (sinistral), *G. scitula, Globigerina inflata, Globigerinoides ruber* (pink), *Hastigerinella digitata, Gephyrocapsa oceanica, G. kamptneri, Cyclococcolithus leptoporus leptoporus, Scapholithus fossilis, Rhabdosphaera claviger, R. stylifer,* Cf. *Pseudoemiliana* sp., and *Helicopontosphaera sellii.*

Age: Late Pleistocene (probable Late Sangamonian): *Globorotalia truncatulinoides* Zone; *Pulleniatina finalis* Subzone.

Environment: Bathyal.

Remarks: Among the calcareous nannofossils, rare reworked *Marthasterites tribrachiatus* (Eocene) and *Helicopontosphaera parallela* (Oligocene) were noted.

Sample 2 (10-88-2, CC):

Globigerina inflata, G. calida, Globorotalia truncatulinoides, G. scitula, G. menardii (sinistral), *Sphaeroidinella dehiscens, Globigerinoides ruber* (white), *Scyphosphaera pulcherrima, Pseudoemiliania lacunosa, Helicopontosphaera sellii, Discolithina millepuncta, Gephyrocapsa oceanica, Coccolithus pataecus, Scyphosphaera recurvata,* and *Cyclococcolithus leptoporus macintyrei.*

Age: early Late Pleistocene (probable Late Kansan): *Globorotalia truncatulinoides* Zone; *Globoquadrina dutertrei* Subzone.

Environment: Bathyal.

Remarks: Reworked calcareous nannofossils, including *Triquetrorhabdulus carinatus* (Oligo-Miocene), *Cyclococcolithus neogammation* (Miocene), *Sphenolithus heteromorphus* (Miocene), and *Sphenolithus abies* (Mio-Pliocene).

Sample 3 (10-88-3, CC);

Globoratalia miocenica, G. multicamerata, Globoquadrina venezuelana, G. altispira (rare), *Sphaeroidinella subdehiscens, Globigerinoides obliqua, Discoaster brouweri, D. pentaradiatus, Pseudoemiliania lacunosa, Helicopontosphaera sellii, Coccolithus minutulus,* and *Discolithina sparsiforata.*

Age: Late Pliocene: *Pulleniatina obliquiloculata* Zone. The sample is very close to the Pliocene-Pleistocene boundary as used by the present authors for the Gulf of Mexico (extinction of *Globoquadrina altispira).* A single specimen was noted of a rather low spired *G. altispira,* but *Globorotalia multicamerata* was very common.

Environment: Bathyal.

Remarks: Rare reworked Cretaceous calcareous nannofossils were noted, including *Zygodicus pseudanthroporus.*

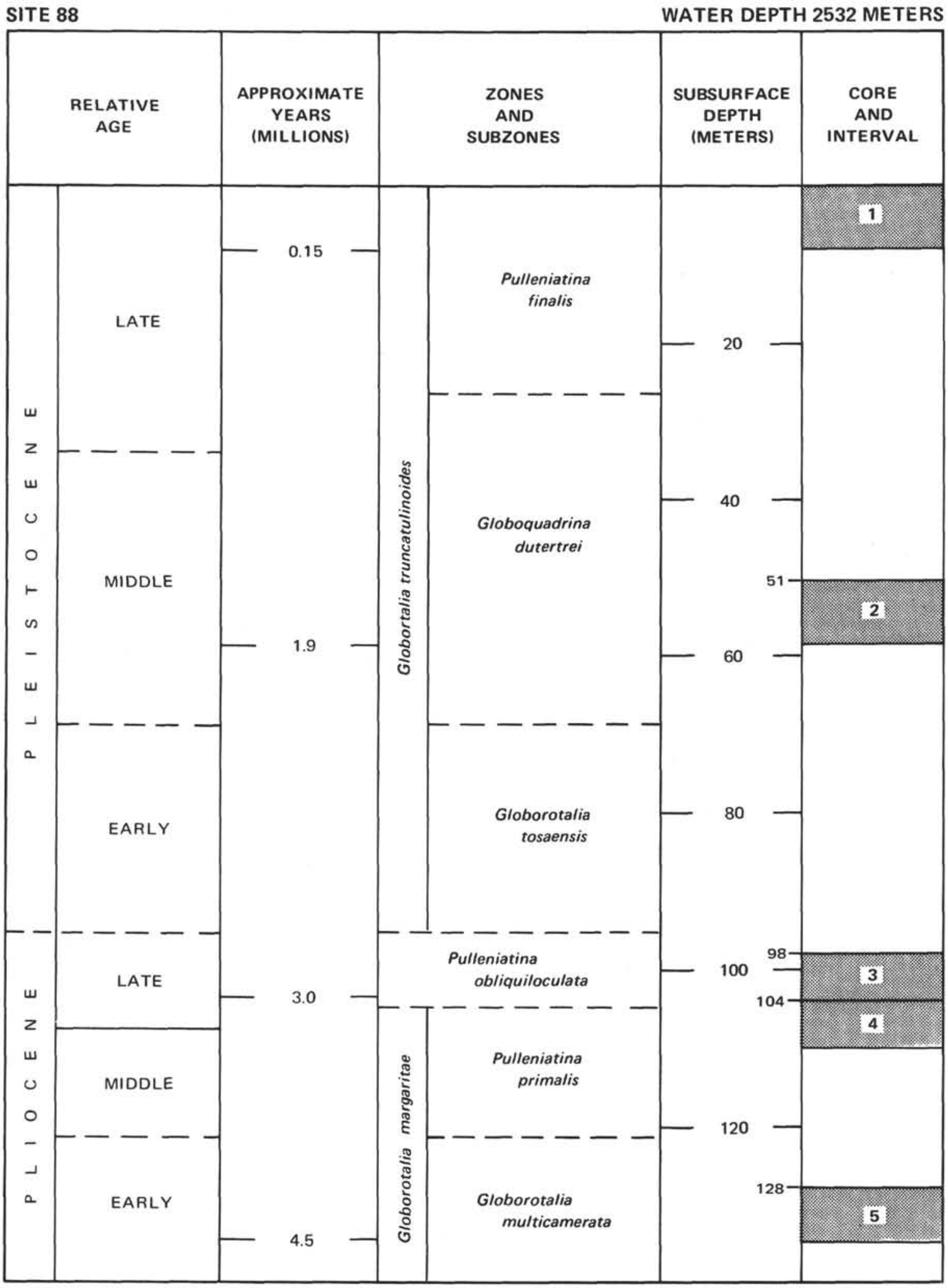


Figure 2. *Biostratigraphic summary of Site 88.*

Sample 4 (10-88-4, CC):

Globigerina nepenthes, Globoquadrina altispira, G. venezuelan, Globorotalia multicamerata, G. pertenuis, G. miocenica, G. crassiformis, Sphaeroidinella sp. cf. *S. immatura, Discoaster brouweri, D. pentaradiatus, D. surculus, D.* sp. cf. *D. asymmetricus,* and *Ceratolithus* sp. cf. *C. rugosus.*

Age: Late Pliocene: *Globorotalia margaritae* Zone; *Pulleniatina primalis* Subzone.

Environment: Bathyal.

Remarks: An increase in benthonic foraminifers was noted. They include *Laticarinina pauperata,* and species of *Cassidulina, Bulimina, Cibicides, Urigerina,* and *Bolivina* (striate).

Sample 5 (10-88-5 CC):

Globorotalia acostaensis, G. sp. aff. *G. margaritae, Globoquadrina altispira, Sphaeroidinella subdehiscens, Globigerina nepenthes, Globigerinoides obliqua, Discoaster brouweri, D. exilis, D. surculus, D. asymmetricus, D. pentaradiatus, Sphenolithus abies, Ceratolithus rugosus,* and *C.* sp. cf. *C. tricornulatus.*

Age: Early Pliocene: *Globorotalia margaritae* zone; *Globorotalia multicamerata* subzone.

Environment: Bathyal.

Remarks: Abundant organic material and pyrite were noted in the residues.

DISCUSSION AND INTERPRETATION

The sediments at Site 88 are mainly pelagic in nature and consist of greenish gray, burrowed, clayey, foraminiferal, nannofossil ooze.

The only modifying element which results in variations is the amount of volcanic glass contained in any given section. The majority of sediments are almost totally homogenized by burrowing. Few other sedimentary structures are present except occasional sections of laminae. There is a strong similarity between cored sections of Site 88 and Site 2 of Leg 1, suggesting that both locations have had a similar depositional history consisting mainly of deep-water pelagic sedimentation. Site 88 has been the site of pelagic deposition since at least Middle Pliocene times and little change in water depth or setting has taken place since then.

Terrigenous-derived material, such as an amphibole-rich, heavy mineral assemblage; volcanic rock fragments; and volcanic glass occur in many sections of cores. The fairly large (fine-grain sand) size of the amphibole-rich assemblage precludes a pelagic form of transport. A possible method of transporting, of course, is by turbidity currents. If this is true, then the turbidity current that deposited such a section on top of a rather large and high knoll was either extremely thick or the knoll did not have the relief, at the time of the turbidity currents, that it does at present.

The calculated rates of deposition for this site, which would characterize the conditions on the knoll only and not the surrounding area are as follows:

Late Pleistocene	7.5 cm/10^3y
early-Middle Pleistocene	2.4 cm/10^3y
Pliocene	1.7 cm/10^3y

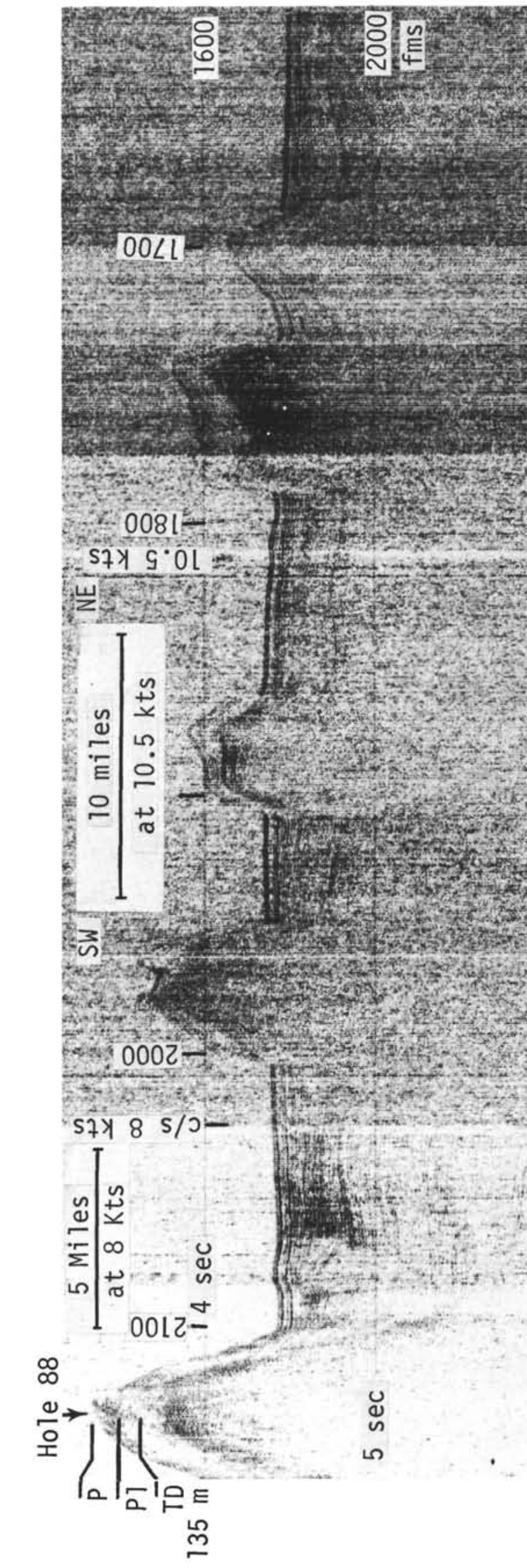


Figure 3. *Profile record, Site 88.*

Gas and odors were detected in all cores. A strong H_2S odor was the dominant gas in Core 1, while odors of methane were the strongest in Cores 2, 3, 4, and less in Core 5. The following table summarizes the analyses of the gases from Cores 2, 3, 4, and 5. Included for comparison purposes, is the result of gas analyses for sections of Cores at Site 89. The analyses were accomplished by the use of a gas chromatograph. The values obtained were determined by measuring the peak heights on the chart and are to be considered as estimates only.

Sample	Core Depth (meters)	Methane (%)	Ethane (%)
88-2-4	54	70	Trace
88-3-5	102.5	55	>1
88-4-6	113	65	>1
88-4-4	110	62	>4
88-5-5A	134.5	64	>1.5
88-5-5B	135	66	>1.5
88-5-6	137	66	>1.5
89-4-BTM	220	64-68	Trace
89-4-BTM	220	65	Trace
89-6-5A	376	72	Trace
89-6-5B	376	69	Trace

The relatively constant percentages of methane in the gas with depth and the estimated increase and then decrease with depth of the volume of gas in the sediments, indicate that the gases present are generated through organogenic processes probably bacterial. These processes are most active at intermediate depths within the section cored.

No evaporite minerals could definitely be recognized in any of the smear slides. No indication of proximity to cap rock or salt was obtained. Analysis of interstitial water from the cores indicated a 15 percent increase in salinity over normal seawater with depth, but this was believed to be not sufficient for a definite conclusion to be drawn.

Although no evidence could be found in the sediments to support the theory that the knoll of Site 88 is a salt diapir, one must remember that the last reflector of the profiler record (Figure 3) of the knoll was at a depth of 330 meters. In accordance with the instructions from the Deep Sea Drilling Project and the National Science Foundation, the drilling at Site 88 was discontinued at 135 meters due to the presence of natural gas. Had drilling continued to the 330 meter depth, material probably would have been encountered suggesting a salt origin of the knoll. The profiler records also suggest that the section above the top of the basal reflector at Site 88 is much thicker than that found at Hole 2, Leg 1.

The origin of the knoll at Site 88 is still in question. The answer must await future technological developments.

REFERENCES

Ballard, J.A., and Feden, R.H., 1970. Diapiric structures on the Campeche shelf, western Gulf of Mexico. Bull. Geol. Soc. Am. **81,** 505.

Bryant, W.R., Antoine, J., Ewing, M., and Jones, B., 1968. Structure of Mexican continental shelf and slope, Gulf of Mexico. Bull. Am. Assoc. Petrol. Geologists. **52** (7), 1204.

Bryant, W.R., and Pyle, T.E., 1965. Tertiary sediments from Sigsbee Knolls, Gulf of Mexico; Bull. Am. Assoc. Petrol. Geologists. **49,** 1517.

Ewing, J.I., Worzel, J.L. and Ewing, M., 1962. Sediments and oceanic structural history of the Gulf of Mexico. Jr. Geophys. Res. **67** (6), 2509.

Ewing, M., and Antoine, J., 1966. New seismic data concerning sediments and diapiric structures in Sigsbee Deep and upper continental slope, Gulf of Mexico. Bull. Am. Assoc. Petrol. Geologists. **50** (3), 479.

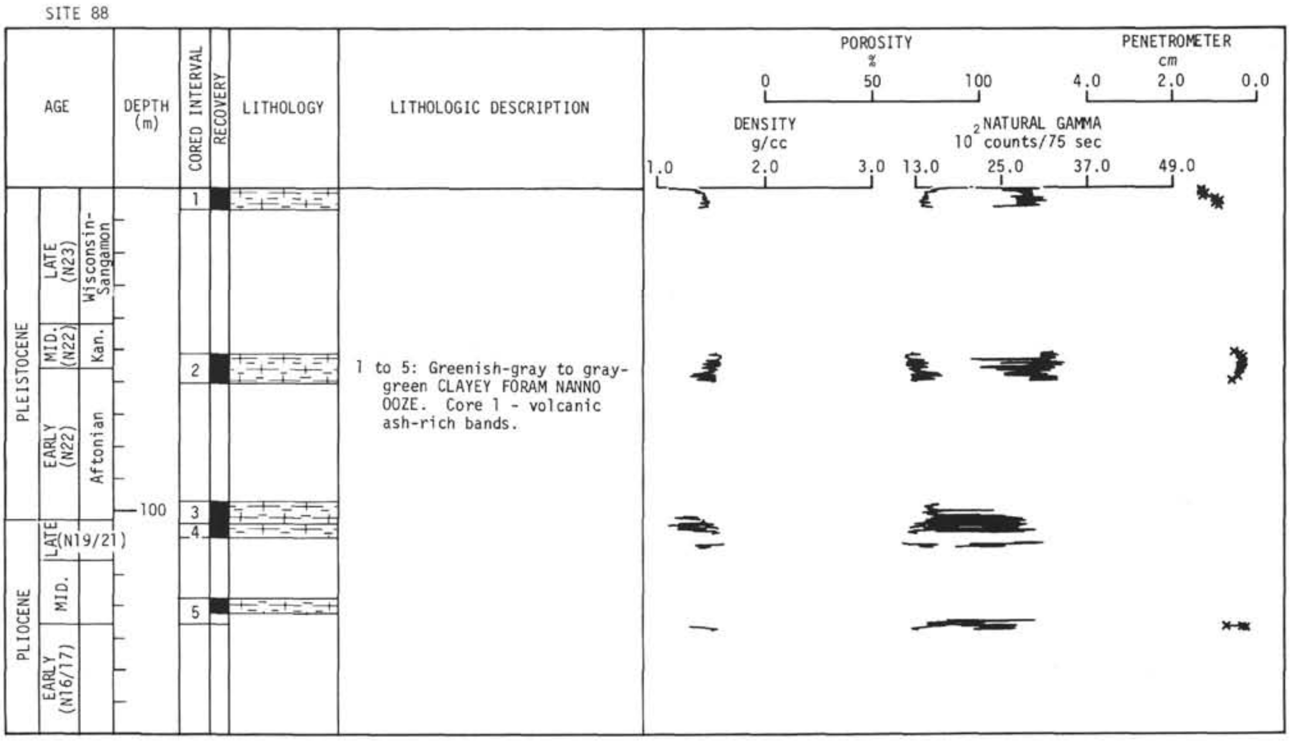
Ewing, M., Ericson, D.B., and Heezen, B.C., 1958. Sediments and topography of the Gulf of Mexico. In Habitat of Oil, Tulsa. Am. Assoc. Petrol. Geologists. 995.

Ewing, M., Worzel, J.L., Beall, A.O., Berggren, W.A., Bukry, D., Burk, C.A., Fischer, A.G., Pessagno, E.A., Jr., 1969. Initial Reports of the Deep Sea Drilling Project, volume 1. Washington (U.S. Government Printing Office). 84

Talwani, M., and Ewing, M., 1966. A continuous gravity profile over the Sigsbee Knolls. Jr. Geophys. Res. **71** (18), 4434.

Uchupi, E., and Emery, K.O., 1968. Structure of continental margin off Gulf coast of United States. Bull. Am. Assoc. Petrol. Geologists. **52,** 1162.

Worzel, J.L., Leyden, R., and Ewing, M., 1968. Newly discovered diapirs in Gulf of Mexico. Bull. Am. Assoc. Petrol. Geologists. **52** (7), 1194.


SITE 88
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
PLEISTOCENE
LATE (N23)
Wisconsin-Sangamon
MID. (N22)
Kan.
EARLY (N22)
Aftonian
PLIOCENE
LATE (N19/21)
MID.
EARLY (N16/17)
100
1
2
3
4
5
1 to 5: Greenish-gray to gray-green CLAYEY FORAM NANNO OOZE. Core 1 - volcanic ash-rich bands.

Site 88 Hole Core 1 Cored Interval: 0-6 m

AGE	ZONE	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION	SAND	SILT	CLAY
(Sangamon) LATE PLEISTOCENE (Wisconsin)	*Globorotalia truncatulinoides (Pulleniatina finalis Subzone)*	1	0.5, 1.0							
		2				—	CLAYEY FORAM NANNO OOZE Greenish-gray (5G6/1); sometimes vaguely laminated to banded; moderate to strongly burrowed. Occasional laminae/bands of ash-rich ooze, often burrow mixed. H_2S odor throughout. Scattered dark (N3) spots of fecal/FeS stain.	6.9	15.0	78.1
		3				—		3.7	16.4	79.9
		4				—		3.5	17.1	79.4
		Core Catcher								

Site 88 Hole Core 2 Cored Interval: 51-60 m

AGE	ZONE	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION	SAND	SILT	CLAY
MIDDLE (Kansan)	*Globorotalia truncatulinoides (Globoquadrina dutertrei Subzone)*	1	0.5, 1.0				Core expanded by gas in sediment. Physical measurements corrected for voids.			
EARLY PLEISTOCENE (Aftonian)		2		VOID		—	CLAYEY NANNO OOZE Gray-green (5G6/1); somewhat foraminiferal; mottled with 5B5/1,N4,5GY6/1-5/1, and 5G5/1; moderately to strongly burrowed; rarely vaguely laminated to banded. Occassional fecal/FeS spot stains and rare volcanic ash zones.	6.1	17.1	76.8
		3		VOID		—		2.4	16.7	80.9
		4				— VOID —		5.1	18.6	76.4
		5		VOID		— — VOID		5.8	30.9	63.3
		6				—		3.5	18.0	78.5
		Core Catcher								

GRAIN SIZE WEIGHT %

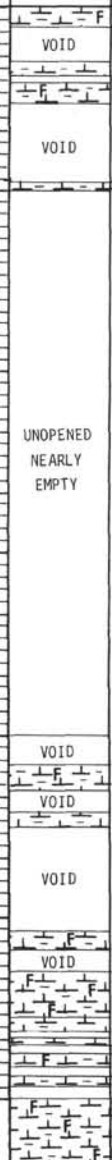
Site 88 Hole Core 3 **Cored Interval: 98-104 m**

AGE	ZONE	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION	GRAIN SIZE WEIGHT %		
								SAND	SILT	CLAY
LATE PLIOCENE	*Pulleniatina obliquiloculata*	1	0.5, 1.0	VOID, VOID			**Physical measurements corrected for voids- probably low.**			
							VOID			
		2		VOID, VOID			CLAYEY NANNO OOZE Gray-green (5G6/1 **with minor 5B5/1,N4, and** 5GY6/1); somewhat **foraminiferal to** foraminiferal; moderately **to strongly** burrowed. Occasional **fecal/FeS stain.**			
		3					VOID			
							Expanded from gas drive.			
							VOID	5.8	**18.3**	**75.9**
							VOID	2.7	**24.4**	**72.9**
							VOID			
							VOID	3.2	24.4	72.3
		4		VOID, VOID			VOID			
							VOID			
		Core Catcher								

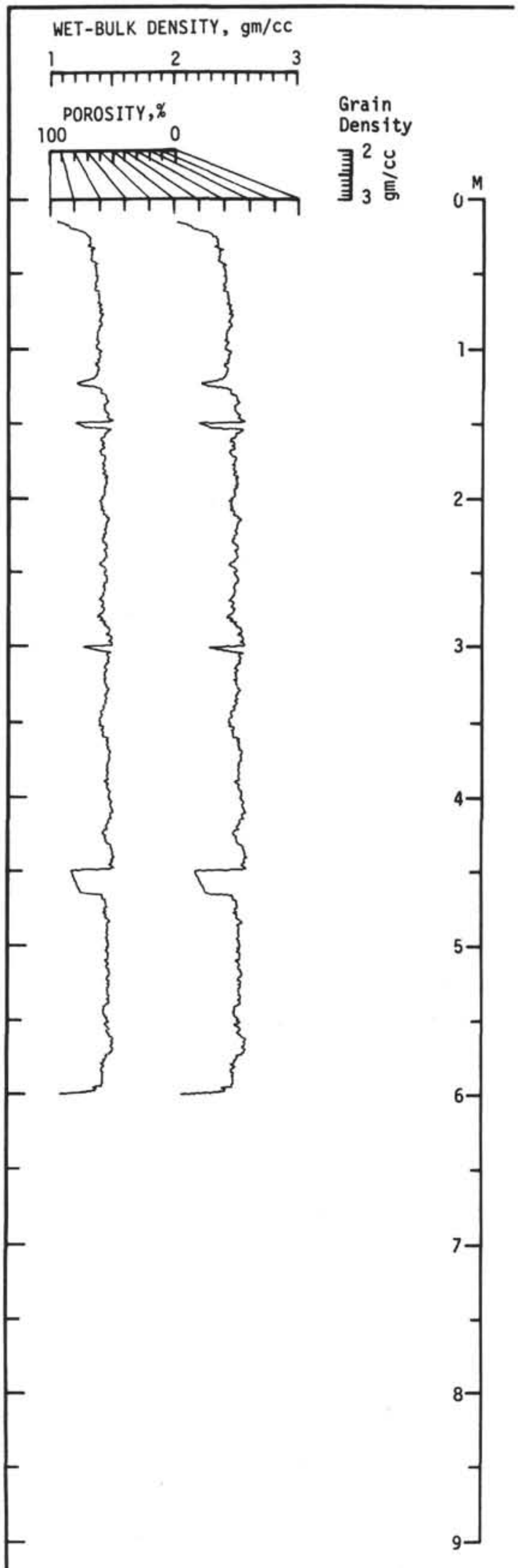
Site 88 Hole Core 4 Cored Interval: 104-108 m

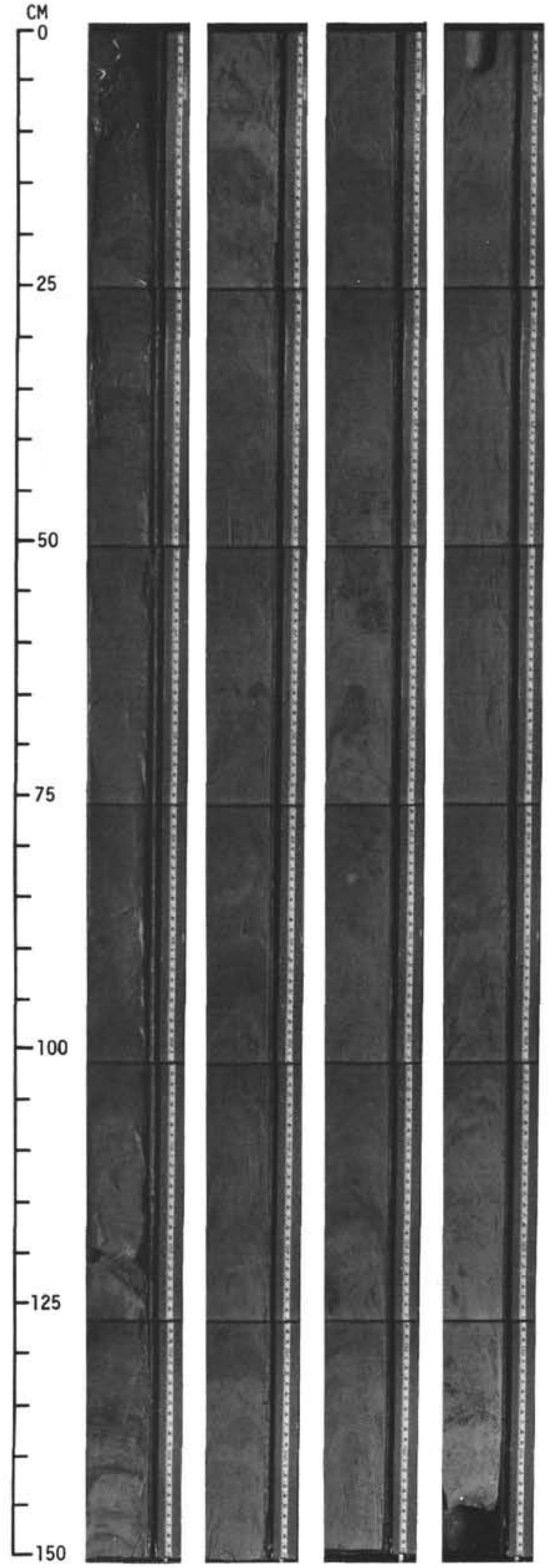
AGE	ZONE	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION	GRAIN SIZE WEIGHT %		
								SAND	SILT	CLAY
LATE PLIOCENE	*Globorotalia* ***margaritae (Pulleniatina primalis Subzone)***	1	0.5, 1.0				Physical measurements corrected for voids - probably low.			
		2		VOID			**CLAYEY FORAM NANNO OOZE** **Greenish-gray (5G6/1-7/1 with subsidiary 5GY6/1, 5B5/1, N3); strongly burrowed local fecal/FeS spot stains (N3).**			
		3		VOID, VOID			**Expanded from gas drive.**			
							VOID			
							VOID	**2.7**	**18.4**	**78.9**
		4		VOID, VOID			**VOID**	**1.0**	**12.9**	**86.1**
		5					**VOID**			
							Many small voids.			
							VOID			
		Core Catcher								

Site 88 Hole Core 5 Cored Interval: 128-135 m

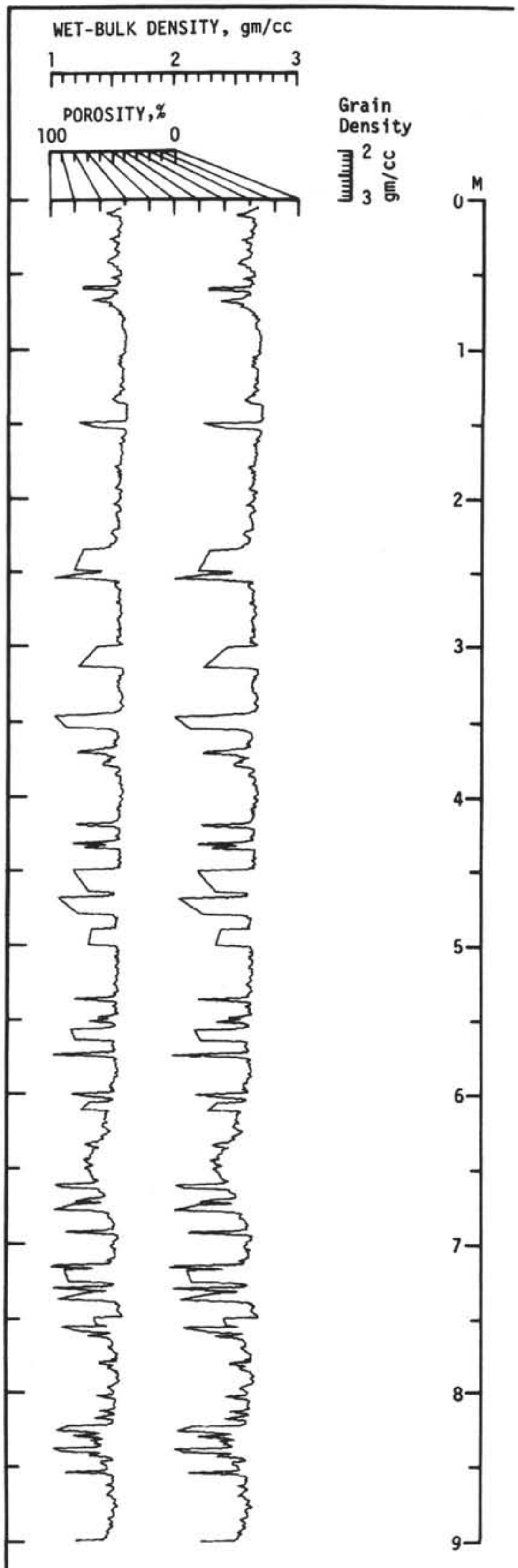


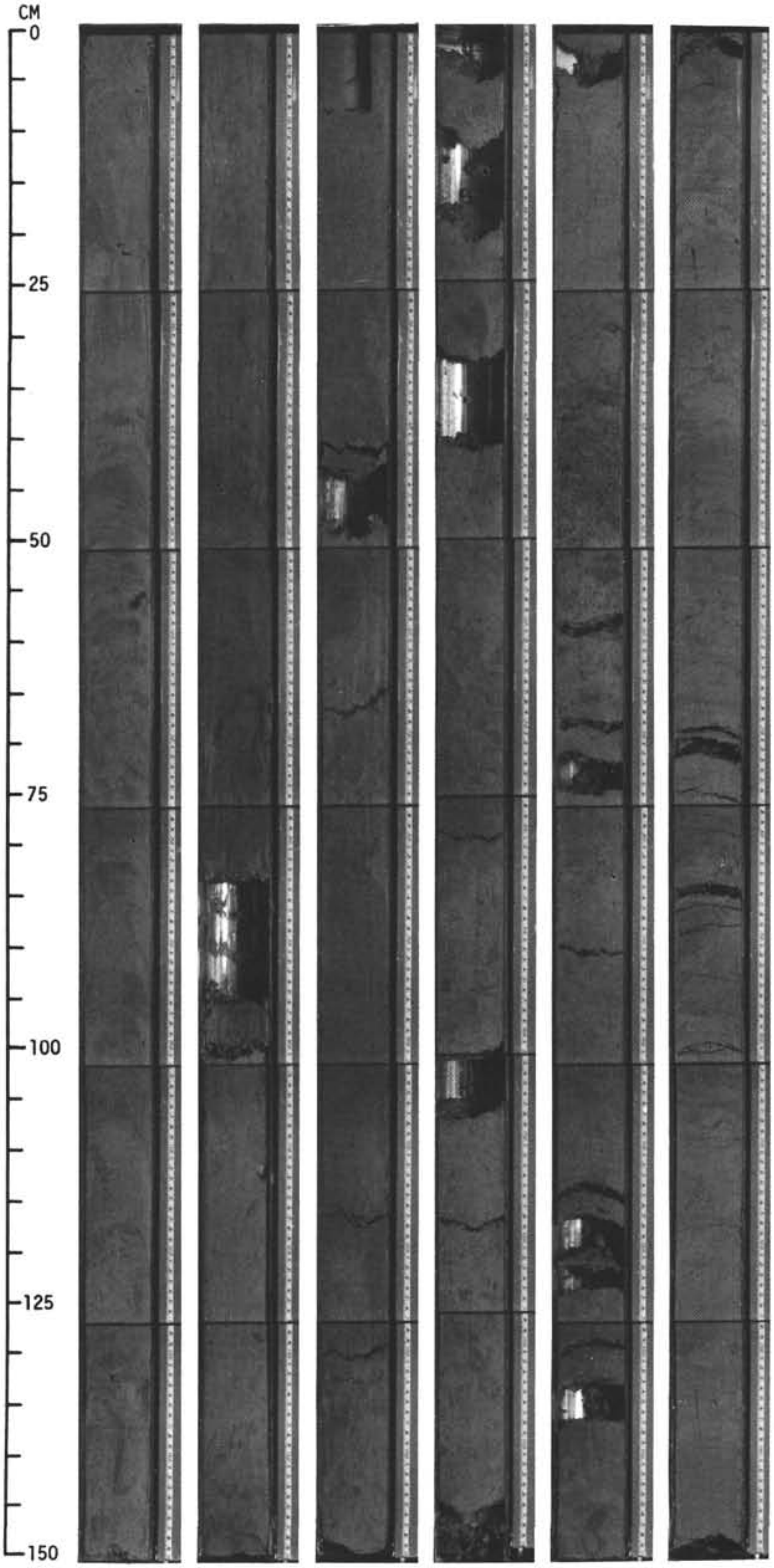
AGE	ZONE	SECTION	METERS	LITHOLOGIC DESCRIPTION	GRAIN SIZE WEIGHT % SAND	SILT	CLAY
EARLY PLIOCENE	*Globorotalia margaritae* (*Globorotalia multicamerata* Subzone)	1	0.5, 1.0	—VOID			
		2		CLAYEY NANNO OOZE Gray-green (5G7/1 with minor 5GY6/1, 5B5/1 and N3); somewhat foraminiferal; moderately to strongly burrowed (?). Occasional fecal/FeS spot stain. Possible few vague laminae.			
		3		Expanded by gas.			
		4					
		5			1.1	16.0	82.8
		6		—VOID —VOID —VOID —VOID	.7	15.7	83.6
		Core Catcher					



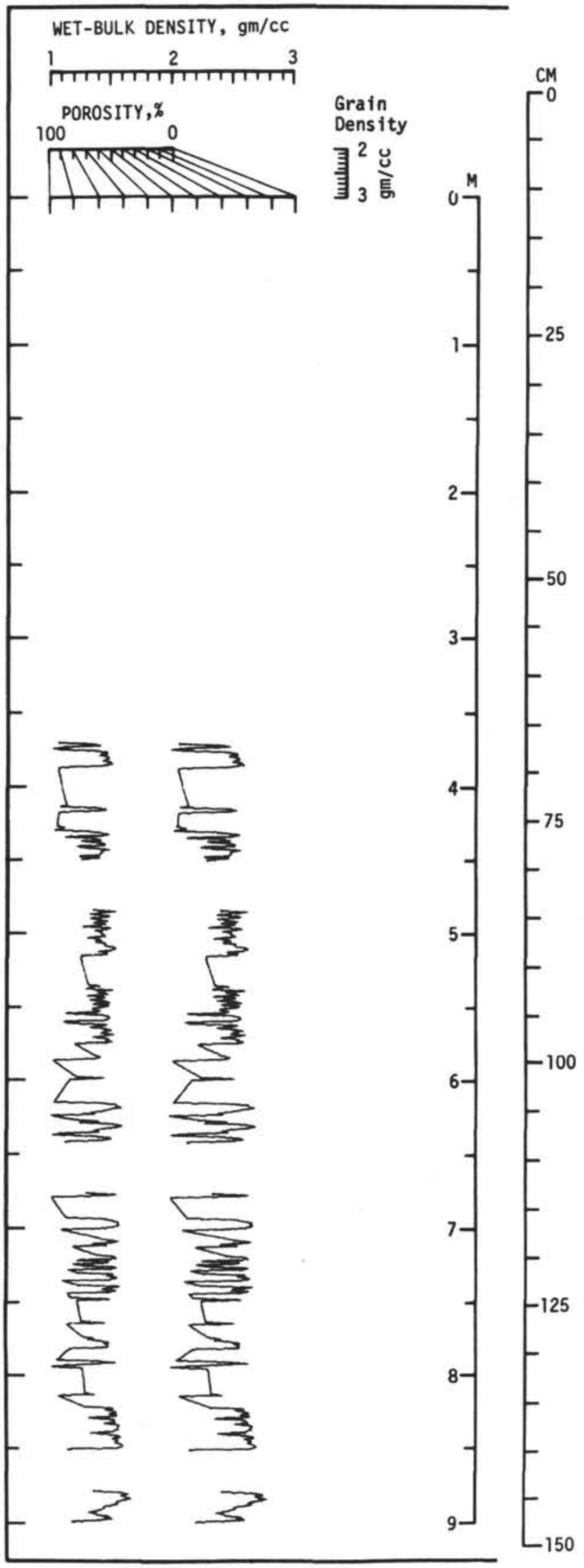


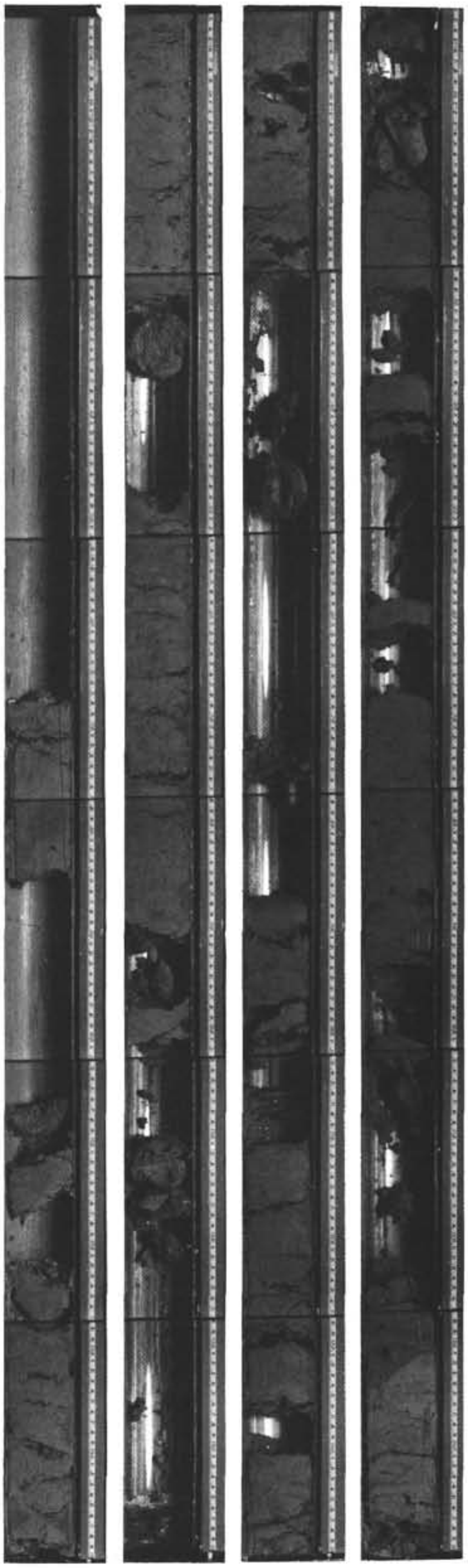
88-1-1 88-1-2 88-1-3 88-1-4



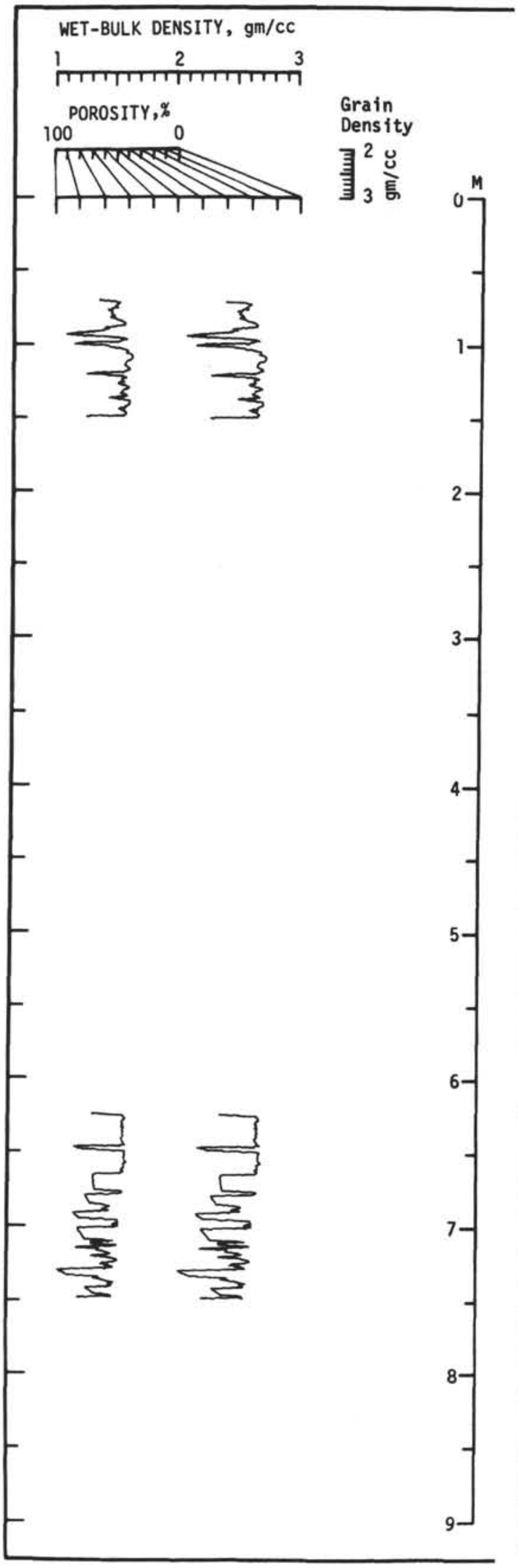


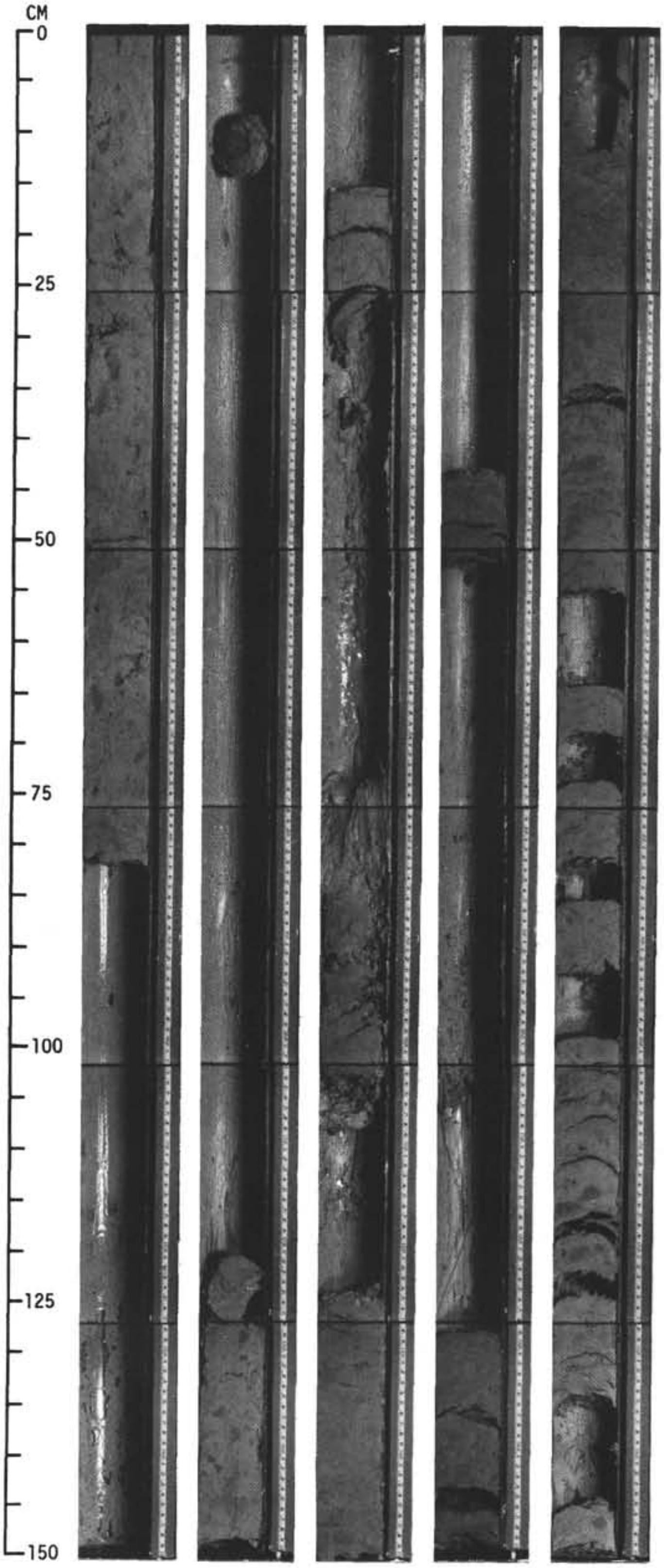
88-2-1 88-2-2 88-2-3 88-2-4 88-2-5 88-2-6



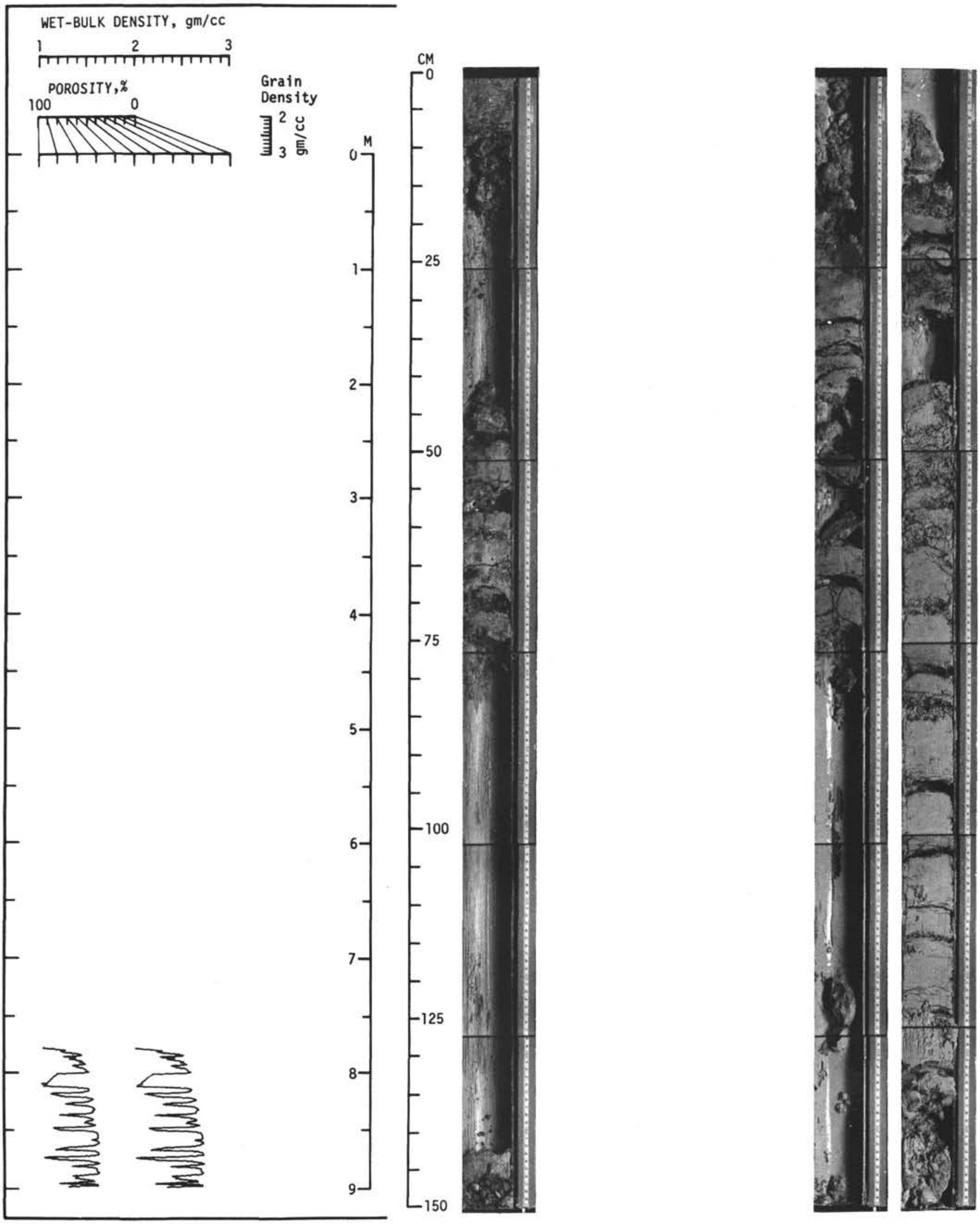


88-3-3 88-3-4 88-3-5 88-3-6





88-4-1 88-4-2 88-4-3 88-4-4 88-4-5



88-5-1 88-5-5 88-5-6