7. SITE 280

The Shipboard Scientific Party[1]
With Additional Contribution From
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SITE DATA

Location: South of South Tasman Rise

Position: 48°57.44'S; 147°14.08'E

Water Depth:
PDR, from sea level: 4176 meters
From drill pipe measurement from derrick floor: 4191 meters (adopted)

Dates Occupied: 26-31 March 1973

Depth of Maximum Penetration:
Hole 280: 10 meters
Hole 280A: 524 meters

Number of Holes: 2

Number of Cores:
Hole 280: 1
Hole 280A: 23

Total Length of Cored Section:
Hole 280: 6.0 meters
Hole 280A: 201 meters

Total Recovery:
Length:
Hole 280: 5.5 meters
Hole 280A: 97.2 meters
Percentage:
Hole 280: 92
Hole 280A: 48.4

Age of Oldest Sediment Cored: early to mid Eocene

Summary: Pavement of manganese nodules resting on a veneer (1 m) of Pleistocene foraminiferal nannofossil ooze, unconformably underlain by 5 meters of early Pliocene or late Miocene siliceous nannofossil ooze and detrital clay. A probable major unconformity separates this from at least 100 meters of underlying Oligocene and late Eocene silty diatom ooze, which is underlain by early to mid Eocene glauconitic clayey silt with chert, and highly organic silty claystone with almost no biogenic material. Cored 5 meters of multiple body, intruded basalt, which is acoustic basement. The Paleogene sedimentary sequence apparently represents change from highly restricted circulation and terrigenous deposition in early rift phase of continental separation, to oceanic biogenic sedimentation, to active bottom currents related to development of circumpolar current south of Australia. Excellent Oligocene diatom biostratigraphy.

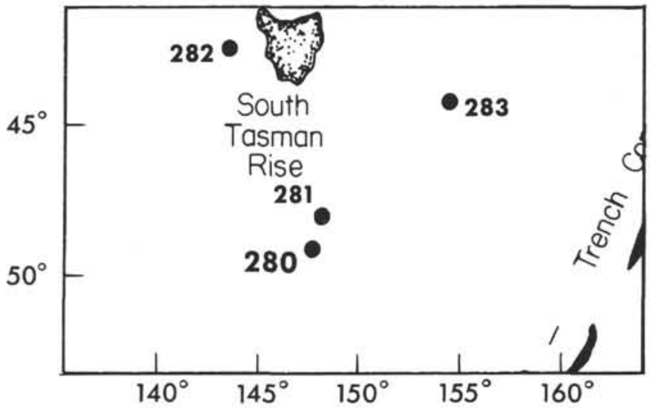

Figure 1. *Location of Site 280, DSDP Leg 29.*

BACKGROUND AND OBJECTIVES

Site 280 was drilled in approximately 470 meters of sediment overlying basement, 100 km (60 mi) south of the South Tasman Rise in 4200 meters of water (Figures 1 and 2). The site was selected primarily to examine the latest stages of the rifting phase between Australia and Antarctica during the early Cenozoic and the paleo-oceanographic effects of this oceanic evolution.

Interpretation of magnetic anomaly patterns south of Australia shows that Australia began its separation from Antarctica in the early Eocene (55 m.y.B.P.), and has drifted northwards from a relatively fixed Antarctica throughout the Cenozoic. The Antarctic circumpolar current did not assume its present day position south of Australia until separation from Antarctica was complete in the early Cenozoic. Although Eocene marine sequences are recorded from the southern Australian region west of Tasmania, none occur before the late Oligocene in the western Bass Strait area. This suggests an eastward marine transgression on the eastern part of southern Australia. Although the Australian continent was well separated from Antarctica by the Oligocene, Tasmania and its assumed southern counterpart, the South Tasman Rise, may well have

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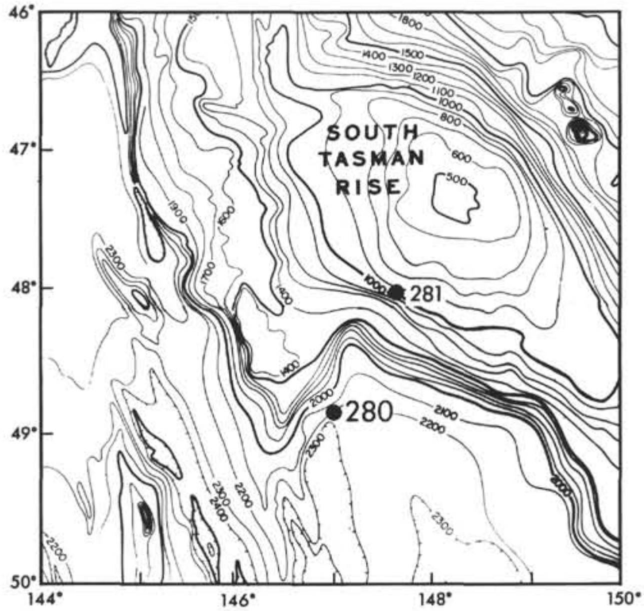

Figure 2. *Bathymetry at Site 280.*

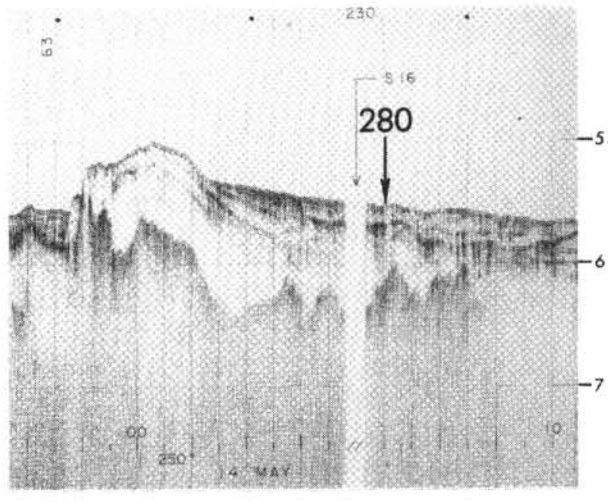

Figure 3. *Profiler section at Site 280.*

blocked circumpolar flow until within the Oligocene because of its much greater southward extension and possible later separation from Antarctica.

Although no magnetic lineations are present, Site 280 is possibly in the zone formed by the initial separation of the two continents. Hence the basement at this site (Figure 3) could be as old as that found anywhere between Australia and Antarctica. Establishing the age of the first oceanic sediments at Site 280 will also establish the initial development of the Antarctic circumpolar current south of Australia. Evidence from deep-drilled sites of Leg 21 in the Tasman Sea and from Sites 277, 278, and 279 (Leg 29) indicates that a fundamental change in paleocirculation took place in the southwest Pacific during the Oligocene. It has been hypothesized that this reflects the final breakthrough of the circumpolar current.

Other major objectives of Site 280 included: (1) Determining the environment of deposition of the earliest marine sediments. During the earliest stages of development of the circumpolar current, very-high-energy currents probably swept between Tasmania, and Antarctica yielding sedimentological evidence. (2) Determining the paleo-oceanography of the region as it was affected by increasing width of the oceanic region between Australia and Antarctica. (3) Determining the effects of Antarctic paleoglacial history on paleocirculation. Bottom waters are known to have been very active in the area during the latest Cenozoic, but questions remain on their activity during the middle and early late Cenozoic. (4) Determining the effects on planktonic microfossil biogeography and biostratigraphy and ice-rafted sediment history by the northward movement of oceanic crust during the Cenozoic. During the early Cenozoic when the region was closely adjacent to Antarctica, faunas were almost certainly cooler than during the late Cenozoic when the area had moved to lower latitudes. Early Cenozoic sediments may also show higher concentrations of ice-rafted debris than in late Cenozoic sediments due to the same causes.

OPERATIONS

The approach to Site 280 south of the South Tasman Rise was from the southwest following an *Eltanin*-53 track (Figure 4). The beacon was dropped on the first pass over the site while underway at 7.5 km/hr (4 knots). The bottom hole assembly and drill pipe were run in and a firm definite sea floor tagged at 4191 meters. Hole 280 was spudded, and one 6-meter mud line punch core was taken. As the second core was being obtained at 4201 meters with 10,000 pound bit weight, the bit appeared to break into extremely soft sediment, and dropped rapidly down to an apparent depth of 4206.5 meters. It was impossible to recover the inner barrel, and it was evident that there was a failure in the core barrel assembly.

A new core barrel was assembled and the drill string was run back in. Hole 280A was spudded and washed down to 4229 meters. From this depth coring and drilling proceeded to a total depth of 4715 meters or 524 meters penetration. Core recoveries varied considerably from core to core with an overall recovery of 48.4%. Basement was encountered at 4710 meters and 5 meters was cored with full recovery. Details of the coring are found in Table 1.

LITHOLOGY

A 519-meter-thick sediment sequence as well as 5 meters of an underlying intrusive basalt were cored at Site 280. The cored section consists of six lithostratigraphic units (Figure 5). Units 1-3 were cored at Hole 280; the remaining units were cored at Hole 280A.

Unit 1

Unit 1 is a soft, very-pale-brown, moderately mottled (upper portion) to sparsely laminated and slightly mottled (lower portion) siliceous fossil-rich foraminiferal nannofossil ooze. The unit is late Pleistocene, and disconformably overlies Unit 2. Large black-brown manganese and phosphate nodules occur sporadically at the

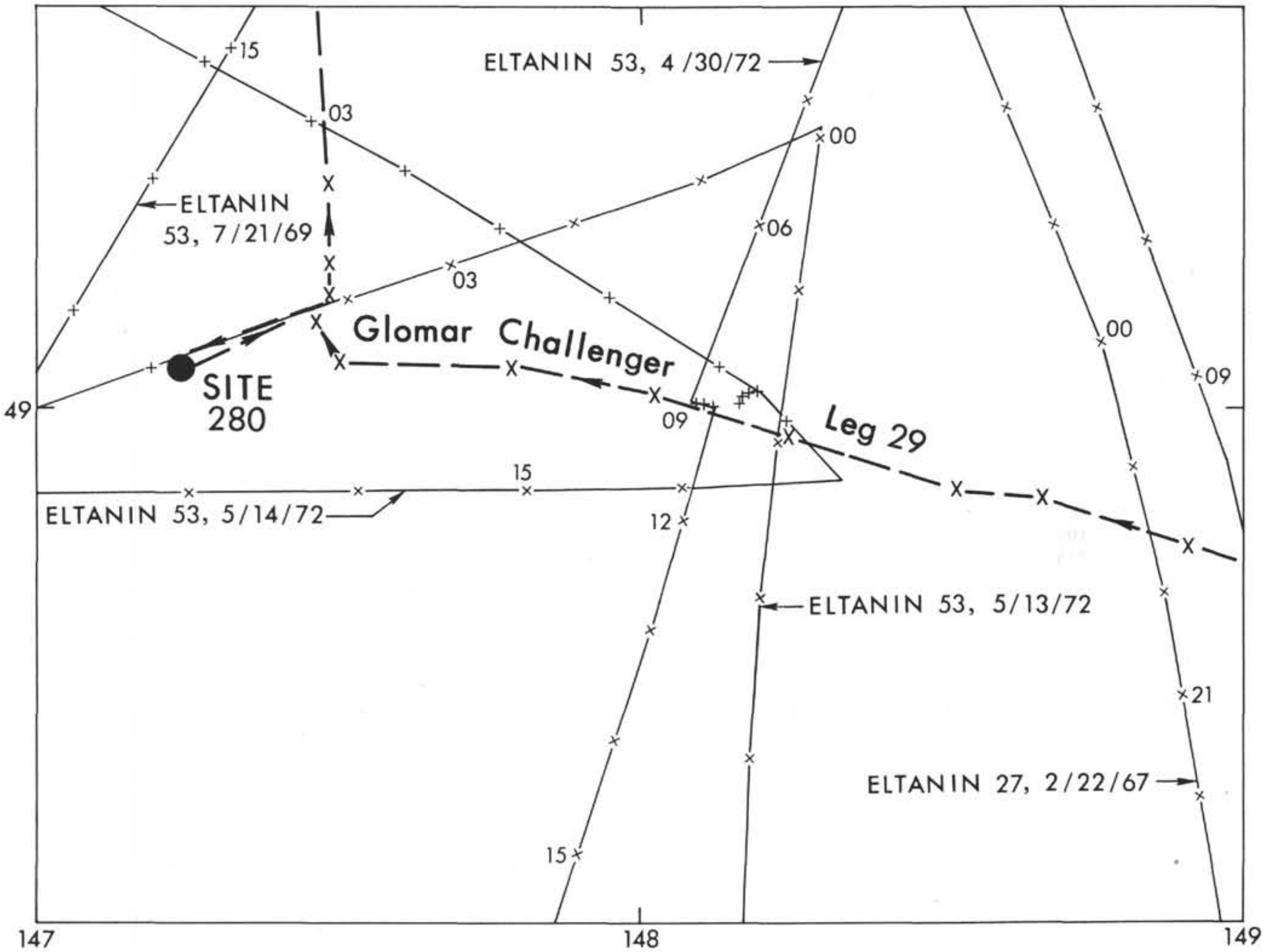

Figure 4. *Track chart.*

top of many cores, contain adhering Recent foraminifera, and indicate that a nodule pavement covers the sea floor.

Unit 2

Unit 2 is a soft, dark-brown, and speckled, generally massive, micronodule-bearing siliceous detrital clay. The speckled appearance of the unit is caused by uniformly distributed sand-size nodules of manganese, phosphate, and glauconite. Siliceous fossils (diatoms, Radiolaria, sponge spicules, and silicoflagellates) are abundant throughout (Table 2). Beds (10 cm) of a soupy siliceous fossil and foraminifera-rich nannofossil ooze occur at 1-2 meter intervals. The detrital fraction is dominated by quartz, mica, montmorillonite, potassium feldspar, and plagioclase, and lesser amounts of kaolinite. Two types of sand-size quartz (rounded and fractured) occur at several horizons throughout the unit. The unit is late Miocene to early Pliocene in age.

Unit 3

Unit 3 is a stiff, pinkish gray, slightly mottled (upper portion) to massive (lower portion), siliceous-rich nannofossil ooze. The siliceous component consists of small amounts of diatoms, Radiolaria, and sponge spicules. The trace amount of detrital material present is dominated by montmorillonite. Rare burrows of *Zoophycos* occur. The unit is late Miocene to early Pliocene in age.

The full thickness of Unit 3 is unknown. The unit comprises the lower part of Core 1, Hole 280, but is not present in Core 1, Hole 280A, the top of which is at 38 meters subbottom. The 6-38 meters interval which was not cored in Hole 280A apparently represents the interval from mid Oligocene to late Miocene or early Pliocene. Part of that time span may be accounted for by a major disconformity.

Unit 4

Unit 4 is more than 1 meter thick. It consists of soft, yellowish-gray, slightly mottled silt-rich diatom ooze. The mottles contain sparse micronodules. The biogenic fraction includes small amounts of radiolarians and trace amounts of sponge spicules, silicoflagellates, and nannofossils. The detrital fraction is dominated by mica, quartz, plagioclase, and montmorillonite. The unit is early Oligocene and is conformably underlain by Unit 5.

TABLE 1
Coring Summary, Site 280

Core	Cored Interval Below Bottom (m)	Cored (m)	Recovery (m)	Recovery (%)
Hole 280				
1	0.0-6.0	6.0	5.5	92
Total		6.0	5.5	92
Hole 280A				
1	38.0-44.0	6.0	5.4	90
2	53.5-63.0	9.5	8.6	91
3	72.5-82.0	9.5	7.4	78
4	82.0-91.5	9.5	6.1	64
5	91.5-101.0	9.5	2.6	27
6	101.0-110.5	9.5	3.9	41
7	120.0-129.5	9.5	5.4	57
8	139.0-148.5	9.5	3.0	32
9	167.5-177.0	9.5	1.0	11
10	196.0-205.5	9.5	4.5	47
11	215.0-224.5	9.5	4.1	43
12	234.0-243.5	9.5	1.0	11
13	262.5-272.0	9.5	4.1	42
14	291.0-300.5	9.5	2.4	25
15	319.5-329.0	9.5	3.5	37
16	348.0-357.5	9.5	0.5	5
17	376.5-386.0	9.5	9.5	100
18	405.0-414.5	9.5	1.3	14
19	443.0-452.5	9.5	9.5	100
20	481.0-490.5	9.5	4.3	45
21	509.5-512.5	3.0	3.0	100
22	512.5-519.0	6.5	1.1	17
23	519.0-524.0	5.0	5.0	100
Total		201.0	97.2	48.4

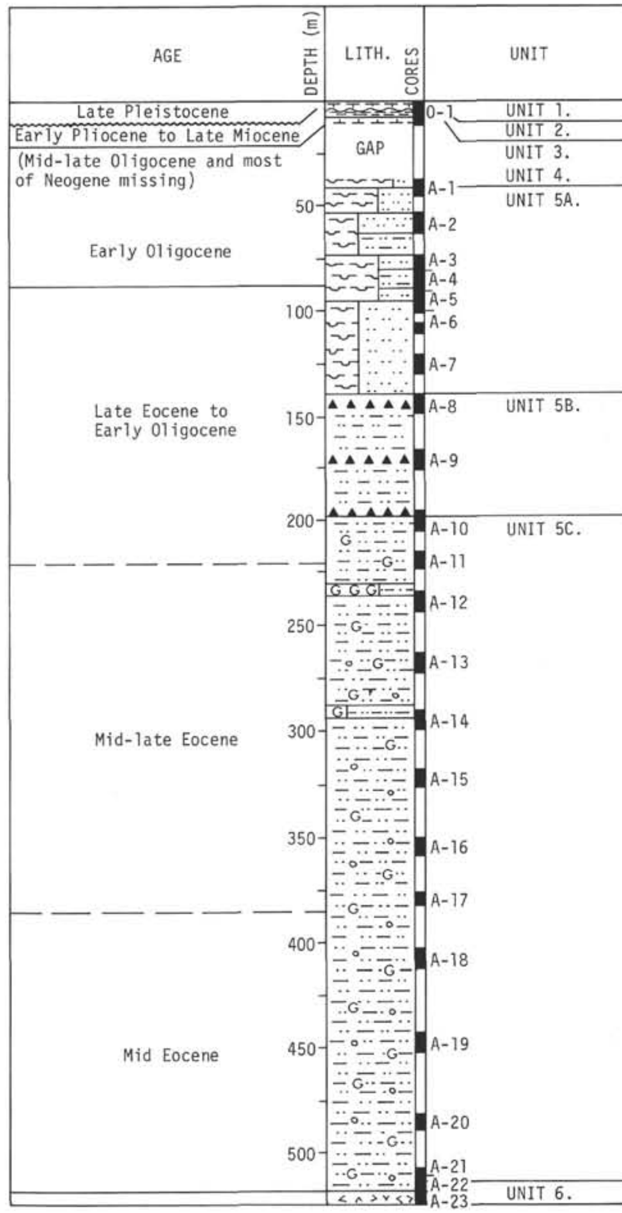

Figure 5. *Stratigraphic sequence, Site 280.*

Unit 5

Superficially uniform throughout, Unit 5 is divisible into three subunits.

Subunit 5A. Subunit 5A is 100 meters thick, and consists of soft to stiff, dark-greenish-gray to green-gray to grayish-green, slightly fine mottled, massive, silty, or clayey silt diatom ooze, or diatom detrital clayey silt or silt. The diatom and detrital components are subequal throughout and a small change in the proportion of one produces a change in the sediment nomenclature (Table 2). The unit is relatively uniform throughout; however, zones of diatom ooze alternate with zones of detrital sediment. There are four zones, varying in thickness from 13 to 40 meters.

Mottling commonly takes the form of small spots and streaks (≤1 cm) in which either glauconite or micronodules are concentrated; or, in some, manganese-filled diatom tests which give the dark color to the mottles. Large patch mottling (≤10 cm), and horizontal laminae or thin beds, some discontinuous and possibly of burrow origin, occur, but are rare.

Small amounts (≤5%) of Radiolaria, sponge spicules, and silicoflagellates occur throughout. The detrital fraction consists mostly of mica and quartz, plagioclase, chlorite, and montmorillonite. Potassium-feldspar also occurs in significant amounts. A small number of sand-size quartz grains occur in the upper half of the unit (44-82 m) and comprise the only sand-size detrital grains seen in washed fractions. Authigenic minerals, glauconite, pyrite, and micronodules are sporadically distributed throughout in small amounts (≤5%). The subunit is late Eocene to early Oligocene in age.

The base of Subunit 5A and the top of Subunit 5B coincides with the top of the uppermost chert horizon. Subunits 5B and 5C are distinguished from Subunit 5A by the complete absence of pelagic microfossils.

Subunit 5B. The subunit is 58 meters thick. It consists of stiff, dark-greenish-gray, slight to moderately mottled or irregularly wavy laminated, glauconite-bearing clayey silt or silty clay (sparse siltstone), with a few apparently thin beds of dark-greenish-gray to black microcrystalline chert. Three zones (less than 20 cm thick) consist of fragments or short lengths of chert; a fourth

TABLE 2
Sediment Composition (Percentage) Based on Smear Slide Descriptions for Site 280

Sample (Interval in cm)	Diatoms	Radiolaria	Sponge Spicules	Silicoflagellates	Nannofossils	Foraminifera	Quartz	Feldspar	Mica	Heavy Minerals	Clay Minerals	Glauconite	Micronodules	Authigenic Calcite	Others[a]	Sand	Silt Detrital	Clay	Lithologic Unit
Hole 280																			
1-1, 70	8	4	2		48	32	2		1	1	2		tr			15	60	25	1
1-1, 137	10	15	13		tr	2	2			5	40		5		8	2	23	75	
1-2, 90 (washed zone)	1	10	3	tr	48	21	3				4		5		4	5	20	75	2
1-3, 121	1	22	5	1			5	1		2	54		3		6	2	40	58	
1-4, 105	4	2	5		87	1	tr								1	–	–	–	3
1, CC	2	tr	tr		96										2	–	–	–	
Hole 280A																			
1-1, 132	66	10	tr	tr	tr		10	2		tr	12					5	75	20	4
1-2, 20	58	tr	2	3			35	tr	tr	tr	2		tr		tr	20	65	15	
1-3, 72	50	tr					40			tr	10					2	80	18	
1, CC	45	tr	2	2			25	5	tr	tr	20					10	40	50	
2-1, 95	50		tr				37				10	tr	3			2	90	8	
2-1, 107	50	2	3	1			35		5	tr	5				tr	2	60	38	
2-4, 38	38	2	1	2			35	2	1	3	5	15				15	55	30	
2, CC	42			1			43	2	tr		5	tr				15	65	20	
3-1, 106	55	4	2	2			20	2	1	tr	13	2				5	75	20	5A
3-5, 111	50	1	3	tr			30	tr	tr		5	4	5		tr	5	75	20	
3, CC	50	tr	tr				35	tr			15	tr	tr			10	60	30	
4-3, 144	50	1	1				30	tr	tr		5	10	3			20	50	30	
4, CC	50	3	tr				45			tr			2			2	90	8	
5, 140	50	5					44			tr		tr	1			2	90	8	
5, CC	43	5	tr				50					tr	2			2	90	8	
6-2, 100	46	3	tr				50		tr	tr		tr				2	90	8	
6, CC	47	2	tr	tr			50		tr	tr			1			2	90	8	
7, CC	47	1	1	tr			50		tr	tr			1			2	90	8	
8-2, 142							53	5	5	2	30	5				5	55	40	
8, CC							60	tr	5	tr	30	tr			3	2	48	50	5B
9, CC	tr				tr		60	tr	5	tr	30	1			3	2	50	48	
10, CC	tr						22	11		2	48	tr	tr		17	tr	36	65	
11, CC							48	2	10		35	5				5	60	35	
12-1, 95							2			tr	50	45	3			40	10	50	
12, CC							18		12			69			1	50	25	25	
13, CC							40	5	20	5	20	5	5			5	50	45	
14-1, 75							30	15	10	5	24	15			1	45	30	25	
14, CC							50	5	5		30	5	5			15	60	25	
15, CC							45	5	10	5	20	5	10			10	60	30	
16, CC					tr		28	2	10	5	35	5	15			5	30	65	
17-2, 64							43	2	5	tr	25	5	20			10	25	65	5C
17-4, 132							10		1	tr	82	2	5			2	20	78	
17, CC							30	3	10	5	25	2	25			10	35	55	
18, CC							48	7	3	5	20	2	5		10	5	65	30	
19, CC							15	2	1	tr	75	tr	7			10	30	60	
20, CC							40	2	tr	tr	53	tr	5			10	40	50	
21, CC							50	5	5	tr	25	5	10			15	60	25	
22-1, 70							50		tr	tr	40	tr	7	2		7	43	50	
22, CC							50		tr		38		7	5		10	40	50	
22, CC							29	tr	tr	tr	60		10		1	–	–	–	

Note: tr = trace.

[a]Pyrite, phosphate nodules, volcanic glass, indeterminate organic, opaque minerals.

zone contains a short section, showing gradational chertification of siltstone. Wavy lamination (probably of burrow origin rather than current origin), scattered small elliptical burrows, and sparse small spot and wisp-like mottles, occur in both the cherts and the detrital sediments. Some mottles are rich in glauconite and less commonly in micronodules. A fragment of pyritized siltstone occurs near the top of the unit.

The detrital fraction consists predominantly of silt and clay size quartz, plagioclase, and mica, and lesser amounts of potassium-feldspar, montmorillonite, chlorite, pyrite, and heavy minerals. Rare sand-size grains consist of quartz, biotite, and muscovite. Glauconite is present ($\leq$5%), and micronodules were recognized.

Silicification distinguishes this unit, and it is evidenced by chertification of the siltstone, and by the presence of noticeable cristobalite observed in the X-ray analyses. Associated clinoptilolite may also reflect silicification. This silicification extends at least 100 meters into Subunit 5C. These diagenetic minerals appear to develop at the expense of siliceous microorganisms, especially diatoms, and to some extent their appearance immediately precedes, and coincides with the onset of lithification of the sediments. The subunit is late Eocene to early Oligocene in age.

Subunit 5C. The subunit is 302 meters thick and consists of dark-green-gray, greenish-gray, and (occasionally) olive-gray, variably massive to intensely mottled, glauconite-bearing and micronodule-bearing (or -rich) clayey siltstone and silty claystone. Zones of stiff silty clay and clayey silt are dominant in the upper 20 meters, while the remainder of the unit is semilithified. Most of the upper 130 meters of the unit is partially cemented by disseminated silica (cristobalite and tridymite). Silicification is much less advanced over the lower 170 meters of the subunit.

The sediments commonly are mottled with diverse mottle types. In some zones the sediment is massive; at many others it is slightly to moderately mottled, to intensely mottled. Rarely it is entirely homogeneous. Fine (<1 cm) spot or wisp-like mottling and elliptical burrow-like (1.5-2 cm) mottling predominate. The latter, at places, are filled with dark pellets. Irregular patch mottling up to 2 cm in diameter also occurs. Mottling is commonly emphasized by concentrations of glauconite and micronodules.

Horizontal/subhorizontal, plane and lenticular lamination occurs widely. The lenticular lamination is probably the product of overlapping elliptical burrows and not a current lamination, although a differentiation between the two origins is difficult. One thin zone low in the subunit is rich in lenticular lamination of undoubted current origin.

Two prominent greensands occur in the upper part of the sequence. The upper, at 235 meters, is 34-cm thick and consists of black, silicified silty clay greensand grading upwards to a black clayey greensand, and then to an olive-black, glauconitic sandy claystone. The glauconite is uniform in size throughout, bright green and botryoidal, and appears to have diagenetically replaced the clay/silt matrix.

The lower greensand, at 292 meters, is approximately 20-cm thick. It is a dark-green-gray, intensely coarse-mottled, glauconite-rich detrital silty claystone, and is underlain by a thin sequence where olive-gray, glauconitic detrital clay siltstone alternates with dark-green-gray glauconite-rich detrital sandy siltstone.

Agglutinating foraminifera are first recognized at 266 meters, and occur sporadically, though concentrated at places, almost to the base of the unit. The tubiform *Bathysiphon* sp. occurs throughout, whereas *Cyclammina* sp. occurs sparsely, and apparently only in the lower 75 meters of the subunit. *Bathysiphon* tubes are 2-4 mm in diameter, circular in cross-section where oriented vertically or obliquely, and flattened where horizontal.

The silicified upper part of the subunit overlaps the lower portion between 266 and 327 meters. Otherwise the two zones are mutually exclusive. This suggests that originally, a lower foraminifera-bearing silty clay was overlain by a very thick diatom clayey silt (Subunits 5A, 5B, and the upper third of 5C). The diatoms in the lower 185 meters of Subunit 5C subsequently were dissolved, and cristobalite and tridymite crystallized, leading to the formation of chert at selected horizons.

From 320 meters to the base of the unit, the sediment shows a faint brown color (the sediment is variously very dark grayish brown, dark olive gray, olive gray, and light olive gray), and contains a high amount (0.6%-2.2%) of organic carbon. From 348 meters to the base, the subunit is predominantly a silty claystone, with thin horizontal lenticular mottling prominent over the lower part of the subunit. Two additional distinctive mottle types occur in stratigraphic succession in the zone between 445 and 448 meters. The upper one is very dark gray, coarse, angular, subhorizontal, and stratiform; some mottles have eroded tops. This mottle type may represent deformed very thin beds of clay. The underlying zone contains, vertical or oblique, elliptical burrows (1-cm diameter) with horizontal galleries off either side.

The subunit is essentially devoid of fossils other than the agglutinating foraminifera. An early-middle Eocene age is indicated by sparse nannofossils, and a middle-late Eocene age by rare dinoflagellates. A mid-late Eocene age is adopted. Authigenic glauconite and micronodules occur throughout in amounts ranging up to 5% and 25%, respectively. Otherwise the unit is dominated by silt and clay-size detrital quartz, mica, montmorillonite, plagioclase, chlorite, potassium feldspar, lesser amounts of heavy minerals and pyrite, and very rare kaolinite (Table 2). Sand-size detritals (quartz, muscovite, biotite, rock fragments, especially schistose and sedimentary rock fragments, chlorite, and feldspar) are sparsely distributed throughout, with significant amounts occurring between 300 and 490 meters. Sand-size to small pebble-size rock fragments including granite and quartzite also occur at 490 meters.

Large fragments (1-3 cm) of brecciated pale-gray to light-olive-gray micrite occur at 122 meters (Subunit 5A), and at 322 meters (Subunit 5C). No such rock was seen in the entire cored sequence, but it is possible that a thin bed of micrite occurred higher, possibly in one of the noncored intervals.

The basal 38 meters of Subunit 5C shows increasing effects of the intrusion of the underlying basalt. A discordant thin calcite-pyrite? vein and vein network occurs at 481 meters. At 511-512 meters the sediment shows considerable soft-sediment deformation, such as truncation, foundering, and faulting of the laminated sediment. This thin zone originally may have consisted of a series of very thin graded beds. At 512 meters, a discordant calcite vein and a patch of pyritized siltstone occur, while below 512 meters short discrete streaks of calcite are widespread and the claystone is patchily cemented by calcite. Horizontal burrow mottling in the same zone is ragged and distorted and crossed by a few small calcite veins. At 514 meters, parallel but steeply-inclined lineation/stratification(?) occurs; it is interpreted as a deformational fabric.

The contact with the intrusive basalt was not recovered, but the lowest sediment recovered (1 meter above the contact) consists of olive-black semilithified calcified silty claystone underlain by lithified calcified sandy siltstone. No obviously baked sediment was cored.

The upper 340 meters of Unit 5 is low in $CaCO_3$ (0.2%-0.8%), but carbon/carbonate analyses show that the lower 140 meters is relatively enriched in $CaCO_3$ (1%-3.2%). The increased content low in the sequence is interpreted to further reflect intrusion of the underlying basalt.

Unit 6

Five meters of intrusive basalt forms the lowest rock cored; however, neither the upper nor the lower contacts were recorded in the cores. Three layers of basalt, separated by detrital sediments, either represent three separate but subparallel intrusives of basalt, or, more likely, represent three apophyses (tongues) at the margin of a single large intrusive mass. The intrusives are 2.0, 0.5, and 1.1 meters thick (top to bottom).

The intrusives are greenish-black, holocrystalline, subophitic, fine-grained, magnetite-bearing pyroxene-plagioclase (labradorite) basalts. The base, at least of the lowest basalt is olivine-bearing (in phenocrysts) but otherwise the same as the upper two. The basalts are extensively altered to serpentine group minerals, and are cut by close-spaced, thick (2-8 mm), and very thin ($\cong$1 mm) veins of calcite and serpentine group minerals. Some thicker veins are also pyrite-bearing. Where mineralized, the rock expands and disintegrates on wetting. Only the upper part of the top unit and the lower part of the lower unit are relatively fresh.

Sedimentary layers (0.7 and 0.8 m thick, respectively) between the basalt layers consist of greenish-gray quartz-mica silty claystone, olive-black mica-quartz sandy siltstone, and light-olive-gray to grayish-olive clay siltstone. Most are extensively calcified and intensively veined (crinkle-veining), and part of the lower layer is chertified and pyritized. The upper contact of each basalt layer is gradational, but curiously the lower contact is sharp and clearcut. The basalt is no older than middle Eocene, indicated by the enclosing sediments.

Conclusions

The sequence cored represents a very thick lower detrital unit (Subunits 5B and 5C) and a thin mixed biogenic and detrital clay upper unit (Unit 1 through Subunit 5A).

The predominance of detrital minerals in the very thick Unit 5 suggests deposition at the basin margin rather than near its center. The lack of primary sedimentary structures, the poor sediment sorting, and the very restricted nature of the benthonic fauna in the lower half of the unit all suggest that circulation was restricted, but not such to restrict all bottom life. The widespread occurrence of four types of burrow mottling suggests that a moderately diverse infauna inhabited the bottom sediments.

Within Unit 5 there is a gradation downwards from diatom/clay silt (Subunit 5A), to clayey silt/silty clay with thin chert beds (Subunit 5B), to clayey siltstone and silty claystone partially lithified by disseminated silica (upper part of 5C), and semilithified siltstone and claystone (lower part of 5C). This gradation suggests that Subunit 5B and at least the upper part of 5C were originally rich in diatoms which have subsequently been dissolved. The silica migrated upsection where it crystallized as cristobalite and tridymite to silicify the sediment. Still higher in the section crystallization of tridymite and cristobalite converted suitable horizons to chert. If this interpretation of the diagenetic history of Unit 5 is correct, at no stage during accumulation, at least of the upper half of the unit, was circulation so restricted within the basin that all siliceous microorganisms were excluded. It is possible, however, that during accumulation of the lower half of Unit 5, circulation was markedly restricted and siliceous microorganisms were excluded completely.

The absence of planktonic calcareous microfossils suggests that sediment accumulation occurred below the carbonate compensation depth. The sediments accumulated relatively rapidly for a deep-ocean situation (an average sedimentation rate of $\cong$3.9 cm per 1000 years). However, sedimentation was not too rapid to inhibit the formation of authigenic micronodules and glauconite.

The relatively abrupt change upward into thin sequences of silt-rich diatom ooze (Unit 4), then alternations of nannofossil ooze and detrital clay (Units 1-3) at the end of the early Oligocene suggests relatively rapid movement (by ocean-floor spreading) of the depositional site away from the source area of the detrital sediments. The alternate appearance and disappearance of nannofossils and foraminifera suggests that the site lay approximately at carbonate compensation depths. Further, slow rates of sedimentation indicate relatively low rates of biogenic productivity.

The mineralogy of the coarse detritus (quartz, muscovite, biotite, schistose and sedimentary rock fragments, chlorite, and feldspar) suggest that low-grade schist, fine-grained detrital sedimentary rocks, and to a lesser extent, acid igneous rocks, predominated in the source area.

GEOCHEMICAL MEASUREMENTS

Table 3 and Figure 6 show the variations in geochemical data in lithologic units at this site. Average pH in the sediments are slightly lower than the surface seawater reference. Cores 10 and 13 have the highest

TABLE 3
Shipboard Geochemical Data, Site 280

Core	Section	Sample Interval Top (m)	Sample Interval Avg (m)	pH Punch-in	pH Flow-thru	Alkalinity (meq/kg)	Salinity (°/oo)	Lithologic Unit
Surface Seawater Reference				7.81	7.96	2.35	35.2	
Hole 280								
1	3	0.0	3.05	7.51	7.51	2.54	35.2	2
Hole 280A								
1	4	38.0	42.53	7.70	7.86	3.13	35.5	5A
4	5	82.0	90.03[a]	–	7.86	3.03	35.5	5A
7	4	120.0	128.93	–	7.89	2.54	35.5	5A
10	6	196.0	204.04[a]	–	8.30	2.74	36.6	5C
13	2	262.5	268.45[a]	–	8.32	2.05	34.6	5C
15	3	319.5	327.53	7.13(?)	7.86	2.44	34.6	5C
17	4	376.5	381.53	–	7.57	1.96	34.4	5C
19	4	443.0	448.03	–	7.79	2.15	35.2	5C
20	3	481.0	489.03[a]	–	7.47	1.76	37.1	5C
Average				7.41	7.90	2.39	35.6	

[a]Two analyses were run, the second on #50 Whatman filter paper.
Values are: Core 4, Section 5, *p*H=7.85, Alk=2.83, and S=35.5 °/oo;
Core 10, Section 6, *p*H=8.09, Alk=2.54, and S=37.4 °/oo;
Core 13, Section 2, *p*H=8.39, Alk=1.86, and S=35.2 °/oo;
Core 20, Section 3, *p*H=7.42, Alk=2.05, and S=36.3 °/oo.

values (8.30 to 8.34). Average alkalinity values in the sediments are slightly higher than the surface seawater values, but vary from 3.13 meq/kg in Core 1, to 1.79 meq/kg in Core 20. Salinity values have an average slightly higher than the reference surface seawater. The highest value (37.1°/oo) is found in Core 20.

BIOSTRATIGRAPHY

The sequence cored consists of a late Pleistocene veneer abruptly underlain by thin early Pliocene or late Miocene, which, after a 32 meter sampling gap, is underlain by thicker Oligocene, and very thick late and mid Eocene. The lowest sediments obtained are of undifferentiated early to mid Eocene age. The entire sequence appears to have been deposited at depths close to the calcite compensation depth.

Paleontologically, the Site 280 sequence is most notable for the consistent common occurrence of Eocene dinoflagellates in Cores 280A-12 to 22, and for the abundant and diverse Oligocene diatoms and silicoflagellates present in Cores 280A-1 to 6.

Hole 280 yielded only one surficial core, in which the upper meter contains slightly dissolved low-diversity Pleistocene planktonic foraminifera, abundant moderately well-preserved but low-diversity late Pleistocene calcareous nannofossils, and sparse late Pleistocene diatoms. A late Pleistocene age is adopted. Samples taken from the two other lithologies in this core yielded low-diversity (probably much dissolved) mid Miocene and reworked early Miocene planktonic foraminifera; very rare (reworked) to abundant (in situ) poorly preserved and low diversity early Pliocene to late Miocene calcareous nannofossils and common to abundant late Miocene to late Pliocene diatoms. An early Pliocene to late Miocene age is adopted.

The base of this succession is separated by 32 meters from the top of the interval cored at Hole 280A. The biostratigraphy of these two holes indicates that this interval approximates a substantial change in the deposition rate.

Hole 280A yielded 22 cores, the age assignments of which are summarized in Figure 7.

Foraminifera

The present water depth of 4191 meters is probably responsible for the paucity of planktonic foraminifera in Core 1 and the lack of taxa in other cores apart from a few early Oligocene forms in Core 5, CC. It is assumed that for most of the Eocene to Recent the site was below the lysocline. The presence of only *Bathysiphon* and *Cyclammina* in Cores 15 to 19 indicates deposition in deep water.

Globorotalia (G.) truncatulinoides Zone

A sample from the top of Core 1 yielded mostly *Globigerina (G.) bulloides* with fewer specimens of *Globorotalia (G.) truncatulinoides, G. (T.) inflata, G. (T.) pachyderma,* and a few *Globigerina (G.) juvenilis* and *G. (G.) bradyi* in the fine fraction. Tests show signs of solution and this probably accounts for the low diversity and the low frequency of thin-walled species.

A major unconformity exists between the Pleistocene to Recent, *G. (G.) truncatulinoides* Zone in Sample 1-1, 3 cm and the probable middle Miocene in Sample 1-4, 43 cm, and below (to include 1, CC).

Globorotalia (T.) mayeri mayeri Zone

The presence of *Orbulina saturalis* and a few specimens of *G. (T.) mayeri mayeri* in Core 1, CC suggests that the age of the sample is middle Miocene *G. (T.) mayeri mayeri* Zone. Most species have probably gone into solution and the diversity is consequently low. Some specimens have been replaced by manganese.

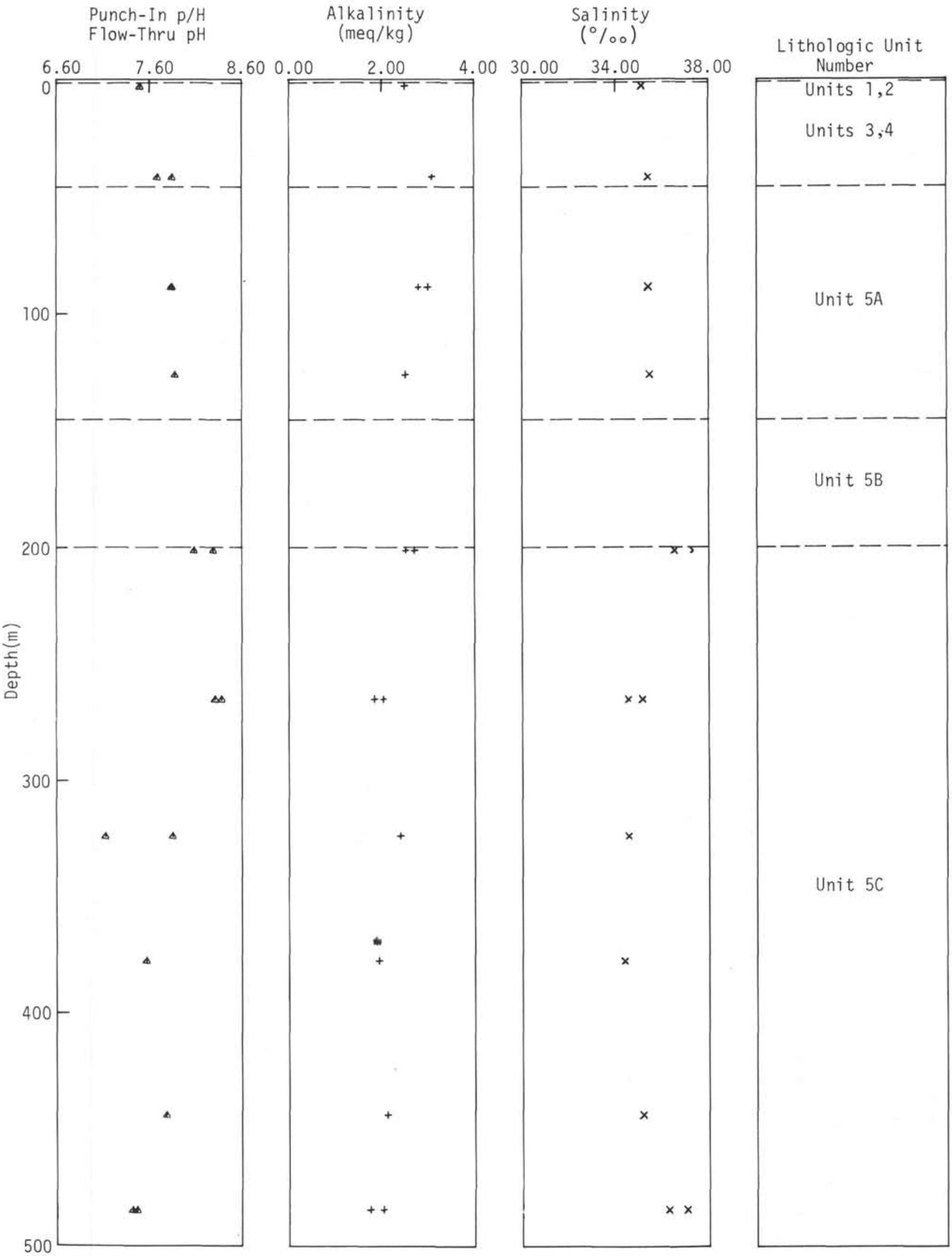

Figure 6. *Shipboard geochemical data versus depth, Site 280.*

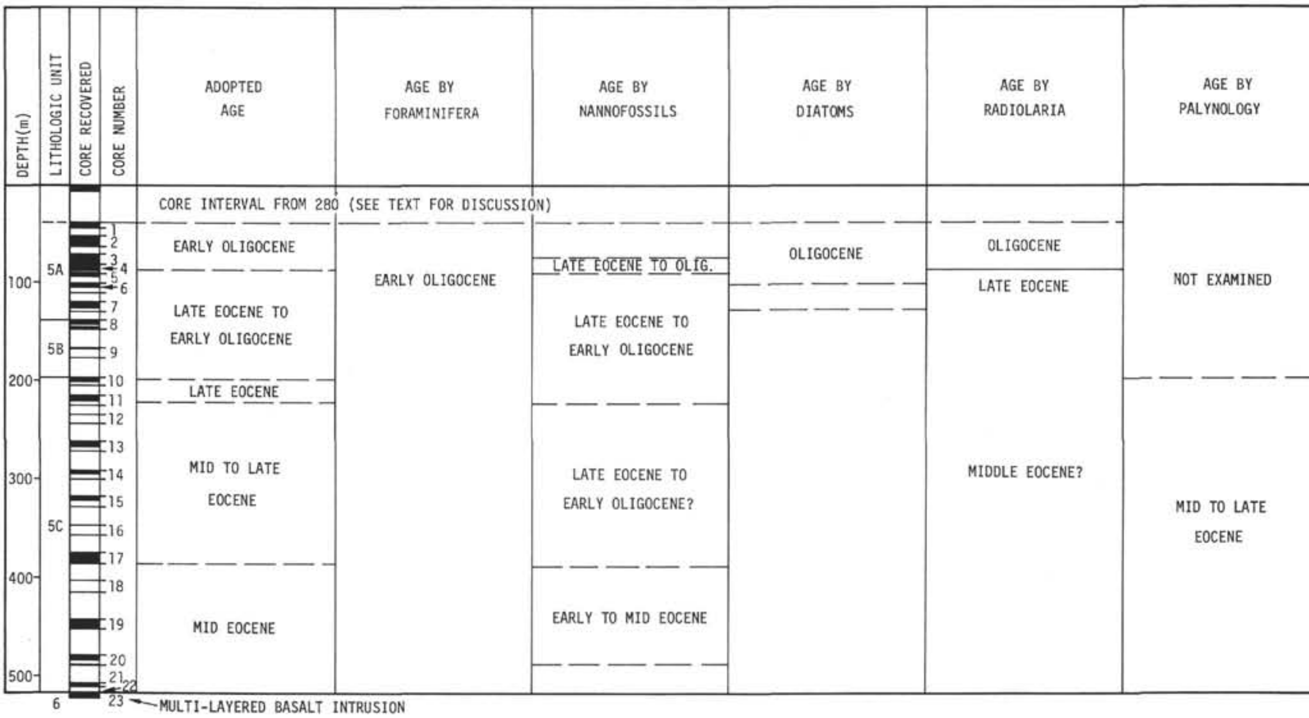

Figure 7. *Ages suggested for Site 280 cores by different microfossil groups and adopted ages.*

Sample 280-1-4, 43 cm, yielded a mixed fauna of possible *G. (T.) mayeri mayeri* age, with a number of reworked species from the early Miocene.

Globigerina (S.) angiporoides angiporoides Zone

From Hole 280A core catcher samples of Cores 1-22 and one sample from Core 1 were examined. Only Sample 5, CC yielded planktonic foraminifera. Although it only yielded three species, the stratigraphic overlap of *Globigerina (S.) angiporoides angiporoides* and *Globorotaloides testurugosa* occurs in the upper part of the early Oligocene *G. (S.) angiporoides angiporoides* Zone in New Zealand (Jenkins, 1965).

A few samples of Hole 280A contained very rare specimens of benthonic foraminifera with calcareous taxa down to Core 9 and only agglutinated forms below Core 14; these include: 6, CC, *Pullenia* sp.; 8, CC, ?*Stainforthia* sp. and *Bolivina* sp., 9, CC, *Nonion* sp., 15, CC, *Bathysiphon* sp.; 16, CC, *Cyclammina* sp.; 17, CC, *Bathysipyon;* 18, CC, *Cyclammina* sp. and *Bathysiphon* sp.; and 22, CC, an irregular tube which could be a *Bathysiphon* sp. In Core 19, *Bathysiphon* sp. is common throughout, with tubes having a maximum length of 5 mm. Only one *Cyclammina* sp. was recovered.

Calcareous Nannofossils

This site provided very sparse, poorly preserved, and very low-diversity nannofloras throughout all but the uppermost few meters where abundant, but poor assemblages occur. The entire sequence appears to have been deposited at depths close to the calcite compensation depth.

The late Pleistocene *Coccolithus pelagicus* Zone is represented by about 1 meter of nannofossil ooze at the top of Core 1 in Hole 280. The nannofloras are abundant and moderately well preserved, but have rather low diversities. Taxa present include questionable *Emiliania huxleyi, Gephyrocapsa aperta, G. caribbeanica, G. oceanica* (Sample 280-1-1, 10 cm only), *Coccolithus pelagicus, C.* cf. *C. neohelis, Cyclococcolithina leptopora, Helicopontosphaera kamptneri,* and *Syracosphaera hystrica* (Sample 280-1-1, 10 cm only). A latest Pleistocene age seems likely.

The early Pliocene to late mid Miocene *Reticulofenestra pseudoumbilica* Zone is represented by about 4 meters of clay plus the underlying 1 meter of nannofossil ooze. Nannofloras are very rare to absent through most of the clay, but are abundant in the basal 60 cm plus the underlying nannofossil ooze. All assemblages are poorly preserved and have low diversity. This situation is attributed to a combination of original low diversity and substantial dissolution; these assemblages were almost certainly laid down close to the calcite compensation depth. This pattern has probably been additionally complicated by reworking as the upper assemblages consist of very low numbers of battered *R. pseudoumbilica,* and small *Reticulofenestra* spp. indeterminate. Thus the majority of the clay could conceivably be of late Pliocene or Pleistocene age. The abundant assemblages are dominated by *R. pseudoumbilica* and nannofossil fragments. Also present are *Cyclococcolithina macintyrei* (mostly single shields), *Coccolithus pelagicus, Sphenolithus neoabies,* and occasional specimens of *Discoaster variabilis panus.* The presence of the latter taxon in Samples 280A-1-4, 45 cm, and 105 cm implies an early Pliocene or late Miocene age for at least part of this interval (Bukry and Percival, 1971).

Hole 280A sediments more or less consistently contain extremely small, poorly preserved, and very low diversity nannofloras. These essentially consist of small indeterminate *Reticulofenestra*, *Ericsonia ovalis s.l.*, and small forms of *Cyclicargolithus neogammation s.l.*, all long-ranging taxa. Other taxa observed include *Chiasmolithus* sp. indeterminate, *Reticulofenestra bisecta*, *Chiasmolithus oamaruensis*, *Chiasmolithus altus*, *Reticulofenestra placomorpha*, and *Chiasmolithus solitus*. Single specimens of *C. oamaruensis*, *R. bisecta*, and *R. placomorpha* were additionally observed in Sample 15, CC. The richest nannoflora ("few") was obtained from Sample 5, CC which also includes *Transversopontis obliquipons* and *Zygrhablithus bijugatus*. The ages are given in Table 4. These suggested ages must be treated with caution as they are mostly based on very few specimens per assemblage. However, the ages given for Samples 5, CC; 6, CC to 8-2; and 17, CC are considered to be reliable: first, because the nannoflora is relatively rich; second, because of the overlap of three useful species; and third, because over 25 specimens of *C. solitus* were observed. The possibility of downhole and/or laboratory contamination was considered but it is more likely that the nannofossil content is primary.

The low diversity in the few assemblages present is not surprising. It reflects a hostile depositional and diagenetic environment for nannofossils in addition to dilution by clastic detritus.

Diatoms

All cores in Holes 280 and 280A were studied. They yielded late Pleistocene, late Miocene to early Pliocene (Hole 280) and Oligocene (Hole 280A) assemblages. The Oligocene assemblages are very rich in new species.

Hole 280

Sample 1-1, 10 cm contains some moderately to poorly preserved specimens. These include *Actinocyclus ellipticus*, *A. oculatus*, *Coscinodiscus lentiginosus*, *Fragilariopsis kerguelensis*, *F.* sp., *Hemidiscus cuneiformis*, *Nitzschia cylindrica*, *N.* sp., *Thalassionema nitzschioides*, and *Thalassiotrix longissima*. The age of this sediment is late Pleistocene.

Samples 1-1, 135 cm, and 1, CC contain *Actinocyclus ellipticus*, *A. ingens*, *Denticula dimorpha*, *D. seminae*, *D.* sp., *Rhaphoneis sachalinensis*, and *Thalassionema nitzschioides*. The presence of *Actinocyclus ellipticus*, *A. octonarius*, *Coscinodiscus marginatus*, *C. tabularis*, and *Denticula dimorpha*, but the absence of *Nitzschia miocenica* indicates that the age of this sediment is late Miocene to early Pliocene.

Hole 280A

Diatoms are abundant and the species diversity was high in Cores 1-7 and poor in Sample 8-1, 120 cm. They are less common in the lower part of this core. The other cores were barren of diatoms.

Cores 1 to 7 are very rich in undocumented forms including species of *Pyxilla*, *Trinacria*, *Triceratium*, *Rhizosolenia*, *Asterolampra*, *Stephanopyxis*, *Pterotheca*, and *Hemiaulus*. These assemblages are considered Oligocene. Sample 8-1, 120 cm shows a reduction in the abundance of the diatoms as well as a lower species diversity. This is probably due to solution which has resulted in poorer preservation of the diatoms. Sample 8, CC is barren of diatoms.

Silicoflagellates

Few to common silicoflagellates occur in the Oligocene and late Eocene of Hole 280A. Throughout this interval, the assemblages are rich and are dominated by

TABLE 4
Calcareous Nannofossil Biostratigraphy of Site 280

Interval	Suggested Age	Evidence for Age
Hole 280		
Core 1, Section 1, 0 cm to 110 cm	Late Pleistocene	Presence of ?*Emiliania huxleyi*, and *Gephyrocapsa oceanica* and absence of *Pseudoemiliania lacunosa*
Core 1, Section 4, 45 cm to Core 1, CC	Late mid Miocene to early Pliocene	Presence of *Reticulofenestra pseudoumbilica* and absence of *Cyclicargolithus neogammation*
Hole 280A		
Core 3, Section 1 to Core 4, Section 4	Late Eocene to Oligocene	Presence of *Reticulofenestra bisecta* and *Chiasmolithus* sp.
Core 4, Section 5 to Core 4, CC	Late Eocene to Oligocene (possibly mid to late Oligocene)	Presence of *Reticulofenestra bisecta* and *Chiasmolithus oamaruensis.* No *Reticulofenestra placomorpha.*
Core 5, Section 1 to Core 8, Section 2	Late Eocene to early Oligocene	Presence of *Reticulofenestra bisecta, Chiasmolithus oamaruensis* and *Reticulofenestra placomorpha.*
Core 8, CC to Core 11, CC	Late Eocene to early Oligocene	Presence of *Reticulofenestra bisecta* plus sequential position.
Core 15, CC	Late Eocene to early Oligocene?	Presence (isolated) of *Reticulofenestra bisecta, Chiasmolithus oamaruensis* and *Reticulofenestra placomorpha.*
Core 17, CC to Core 20, CC	Early to mid Eocene	Presence of *Chiasmolithus solitus.*

Dictyocha medusa (20%-50%), *Distephanus crux*, and *Septainesocena apiculata*. Using the ratio of *Dictyocha* to *Distephanus*, (Mandra, 1969), the near-surface temperatures were warmest during the Oligocene. Lower temperatures are indicated for the Core 280A-5 assemblages, the only part of the Paleogene sequence in which coccoliths are relatively common. Diversity is relatively high (6-11 species) throughout the sequence. Very rare *Cannopilus* were found in Core 280A-6.

Palynology

Thirty-five palynological samples were examined from 13 cores (10-22) of Hole 280A. The cores are from the lowest 300 meters of the hole. This part of the sequence belongs to Unit 5C. Palynofloras are generally rich, although the diversity is fairly low.

Core 10 (5 samples) has poor assemblages and contains fairly sparse specimens of the Antarctic-South American Eocene dinoflagellate cysts *Deflandrea macmurdoensis* Wilson, *D. antarctica* Wilson, *Turbiosphaera* cf. *filosa* (Wilson), *Spinidinium aperturum* Wilson, and *S. rotundum* Wilson (Wilson, 1967; Archangelsky, 1968, 1969; Archangelsky and Fasola, 1971). Other dinoflagellate species include *Deflandrea phosphoritica* Eis., *Cleistosphaeridium* sp., *Areosphaeridium dictyoplokus* (Klumpp), and ?*Chlamydophorella* sp. Miospores include several species of podocarp pollen, *Nothofagus* (*brassi* and *fusca* groups), trilete spores, and several reworked upper Paleozoic and Mesozoic palynomorphs including specimens of *Striatites* and *Classopollis*. The palynological age is mid to late Eocene.

Core 11 (3 samples) contains poor assemblages which are indistinguishable from those of Core 10. Core 12 (1 sample) is dominated by *Spinidinium* spp. and also contains *Deflandrea* cf. *antarctica* and *D. distincta*. Pollen is relatively rare and dominated by *Nothofagus* (*fusca* group). Core 13 (3 samples) is dominated by *Spinidinium rotundum* Wilson which comprises over 80% of the total rich palynofloras. Associated species include *Deflandrea asymmetrica* Wilson, *D.* aff. *phosphoritica* Eis., *D. antarctica* Wilson, *D. macmurdoensis* Wilson, *Cyclonephelium* cf. *australis* Pöthe de Baldis (similar to specimens described by Pöthe de Baldis, 1966, from the lower Tertiary of southernmost South America), *Spiniferites ramosus* (Ehr.), *Thalassiphora* sp., *Leptodinium* sp., *Cleistosphaeridium* sp., *Palaeoperidinium* sp. 1, *Palaeoperidinium* sp. 2, *Areosphaeridium dictyoplokus* (Klumpp), and a probable reworked specimen of *Deflandrea* cf. *diebeli* Alberti. Miospores are rare and comprise mainly *Nothofagus* (*fusca* group) pollen. The palynological age is mid to late Eocene.

Core 14 (2 samples) is very similar to Core 13 with *Spinidinium* still the dominant form, although in Section 2 *Deflandrea antarctica* and *Areosphaeridium dictyoplokus* are also abundant. Other dinoflagellate species include *Thalassiphora pelagica* (Eis.), *Aiora fenestrata* (Deflandre and Cookson), *Hystrichosphaeridium tubiferum* (Ehr.), *Cleistosphaeridium* sp., *D. phosphoritica*, *Spiniferites ramosus* (Ehr.), *S. cingulatus* (O. We.), and ?*Membranilarnacia* sp. Pollen is very rare. The age is mid to late Eocene.

Core 15 (2 samples) is dominated by the dinoflagellate *Areosphaeridium dictyoplokus* (Klumpp) which comprises over 75% of the palynoflora. *Deflandrea* cf. *antarctica* and *D.* cf. *phosphoritica*, are also fairly common but *Spinidinium* is rare. Other rare species are *Aiora fenestrata*, *Thalassiphora* cf. *pelagica*, and a small distinctive species of the netromorph acritarch *Leiofusa*. The age is mid to late Eocene. Core 16 (1 sample) is very similar to Core 15 and dominated by *A. dictyoplokus*.

Core 17 (6 samples) shows a remarkable fluctuation in the dominant dinoflagellate species throughout the various sections. The top sample (Section 1) is dominated by *Spinidinium rotundum* (60%), with *A. dictyoplokus* also abundant (30%). In Section 2 the codominants are *D.* aff. *phosphoritica* and *S. rotundum* (each about 45%). In Section 3 the dominant species is *D.* aff. *phosphoritica* (35%), while *Thalassiphora pelagica* and *Spinidinium* are also abundant. Section 4 is similar. In Section 5 *S. rotundum* is again dominant (50%), whereas in Section 6, *D.* aff. *phosphoritica* is dominant (over 75%). The strange fluctuation in dominant species is probably related both to environmental variation and particle-size differences since *Spinidinium* is somewhat smaller than the other dominant forms. In all sections the qualitative species list is similar, and it is only in the quantitative sense that marked differences occur. Pollen is very rare. The age is mid to late Eocene.

Core 18 (1 sample) is dominated by *Deflandrea* cf. *antarctica* although *Spinidinium rotundum*, *A. dictyoplokus* and *Palaeoperidinium* sp. are all abundant. Other species include *Horologinella* sp., *D.* cf. *phosphoritica*, *Cleistosphaeridium* sp., *Aiora fenestrata*, and the acritarchs *Micrhystridium* sp., *Veryhachium* sp., and *Leiofusa* sp. Pollen is relatively rare with beech pollen (*fusca* type) being the most common species.

Core 19 (6 samples) shows the same kind of variation in the dominant species as Core 17. Sections 1 and 2 do not have forms that are particularly dominant, with *D.* aff. *antarctica*, *Palaeoperidinium* sp., *A. dictyoplokus*, *Spinidinium rotundum* and *Deflandrea asymmetrica* all being fairly abundant. Section 3 is dominated by *D.* cf. *antarctica*, while in Section 4 the codominants are *D.* cf. *antarctica* and *A. dictyoplokus*. In Section 5 *D.* cf. *antarctica*, *A. dictyoplokus*, and *Spinidinium rotundum* are all abundant, while in Section 6 the dominant species is *Areosphaeridium dictyoplokus*. Other marine palynomorphs present in Core 19 include: *Aiora fenestrata* (fairly common), *Turbiosphaera filosa*, *D. phosphoritica*, *Cleistosphaeridium* sp., "*Dictyosphaeridium deflandrei*" W. Wetzel, *Deflandrea asymmetrica*, *Palaeoperidinium* spp., *Spiniferites ramosus*, *Hystrichosphaeridium tubiferum*, *Leiofusa* sp., *Veryhachium* sp., and *Micrhystridium* sp.

Core 20 (3 samples) is dominated by *Deflandrea* cf. *antarctica*, with *A. dictyoplokus* also abundant. The lowest sample contains abundant *Leiofusa* and *Spinidinium*. Qualitatively the core assemblages are similar to those of Core 19 and the age is mid to late Eocene. Core 21 (2 samples) is dominated by *Leiofusa* sp. and *Spinidinium*. Qualitatively the core is similar to Core 20. Pollen is very rare.

Core 22 (1 sample) is dominated by *Spinidinium* cf. *aperturum* with *D.* cf. *phosphoritica* and *D.* cf. *antarctica* also abundant. Qualitatively the core resembles the overlying cores and the presence of cysts of the *phosphoritica* type indicates that the lowest core is no older than early Eocene. One probable specimen of *Deflandrea denticulata* Alberti may confirm an early Eocene age for the lowest core.

SEISMIC DATA

The profiler section (Figure 3) shows that a dominant characteristic of the lower sequence of sediments at this site is their acoustic transparency. The transparent sequence often attains a thickness of nearly 2 km where it fills deep clefts which apparently result from fractures. The lithologic description of this sequence indicates massive and uniform non-bedded sediments.

Acoustic basement was reached at 519 meters where an indurated silty claystone was cored with a sound velocity of 4.0 km/sec, followed immediately by basalt sills. The total depth to basement may not have been drilled.

SEDIMENTATION RATES

Biostratigraphic control is rather poor in Site 280 because of the paucity of microfossils. Sedimentation rates cannot be determined with any accuracy, although the sedimentation curve (Figure 8) does illustrate the major changes of sedimentation. A thin veneer of late Pleistocene is separated unconformably by a sequence of early Pliocene or late Miocene in Core 280-1. No samples were obtained between 6 meters (Hole 280) and 38 meters (Hole 280A), although it is almost certain that nearly the entire Miocene is absent in a major disconformity within this interval. The sequence at Site 280 seems to represent very rapid deposition of detrital fine sediments during the middle and late Eocene.

Accurate sedimentation rates could not be determined for the latest Eocene and Oligocene. This is when siliceous oozes were deposited, and it is not known if a change in rate occurred relative to earlier sediments. Deposition of Oligocene sediments was followed by extensive erosion that occurred throughout almost the entire Neogene. Thin sequences of late Miocene or early Pliocene and late Pleistocene were deposited during times of decreased bottom erosion.

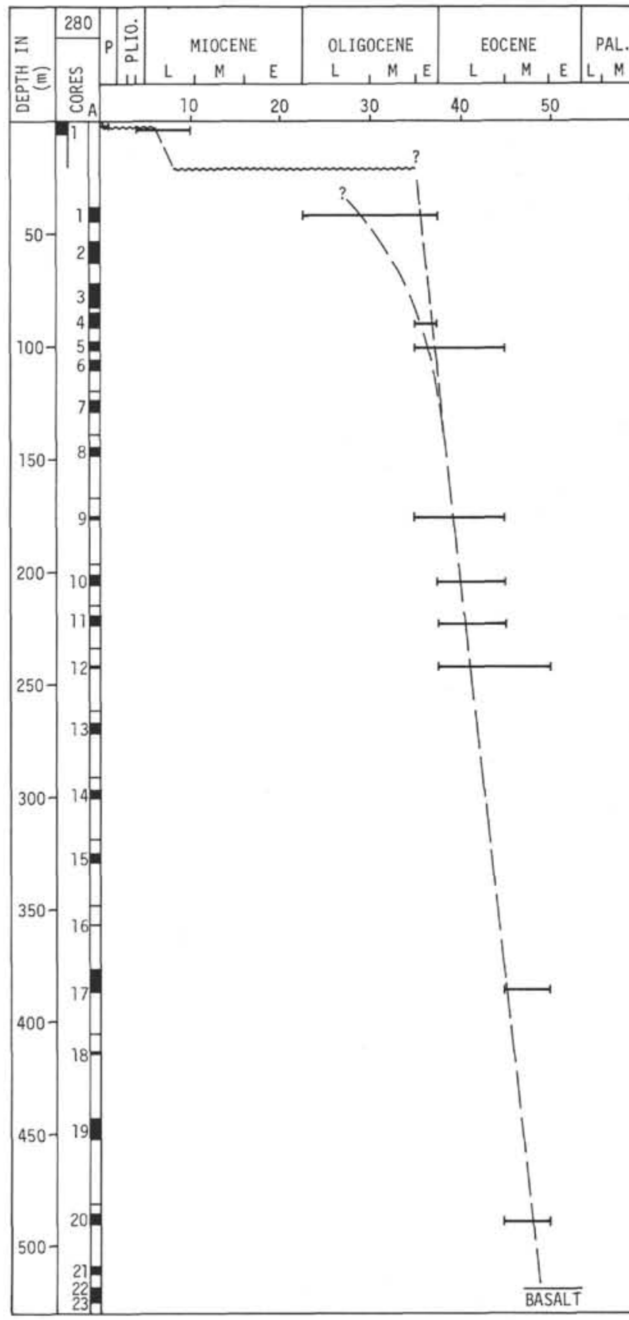

Figure 8. *Sedimentation rate curve at Site 280.*

SUMMARY AND CONCLUSIONS

Site 280 was drilled in a basin 60 miles south of the South Tasmanian Ridge in 4191 meters of water (Figures 1 and 2). The profiler data (Figure 3) show that this site is located in a region that is marked by a very rough and fractured basement. Up to 2 km of acoustically transparent sediment has buried the basement topography to produce a relatively smooth surface. The upper several hundred meters of sediment are well stratified. Refraction data from nearby Lamont-Doherty sonobuoys indicate a typical oceanic crust.

The magnetic pattern is too scrambled by numerous fracture zones to yield a coherent signal at the site. The nearest readable magnetic anomaly is 400 km to the south (anomaly 10; middle Oligocene). The Tasman fracture zone to the west of the site may have as much as 650 km of offset, so that the sea floor to the west is much younger, and is practically barren of sediment (Houtz and Markl, 1972). The Tasman fracture zone along the western boundary of the Tasman Plateau strongly supports the possibility that the Plateau detached from Antarctica by means of a ridge-ridge transform which separated the Tasman Plateau from Victoria Land. Site 280 is located in an area that appears to be in the region of initial separation. The existence of intense fracturing, the consequent lack of magnetic coherence, and the intrusive nature of the basement, make precise dating of true basement difficult. However, close examination of

Figure 3 and the sonobuoy data (Houtz, Chapter 41, this volume) indicate that the multiple basalt intrusive encountered is very near true basement, and there is little likelihood of deeper sediment. A middle Eocene age for true oceanic basement is likely.

Twenty-four cores were obtained with total penetration of 524 meters, of which 5 meters consists of a multilayered intruded basalt which is acoustic basement. The upper part (~40 m) of the sedimentary sequence consists of thin units of biogenic sediments and detrital clay of late Pleistocene, early Pliocene or late Miocene, and early Oligocene age (Units 1 to 4). The remaining and thickest part of the sequence (474 m) consists of a distinctive, diversely burrow-mottled clayey siltstone and silty claystone of early Oligocene to middle Eocene age.

Five sedimentary units have been distinguished: A Pleistocene veneer (1.1 m) of siliceous fossil-rich foraminiferal nannofossil ooze (Unit 1) disconformably overlies a thin layer (4.2 m) of micronodule-bearing siliceous detrital clay of late Miocene or early Pliocene age (Unit 2). This unit in turn conformably overlies at least 0.7 meters of siliceous-rich nannofossil ooze of late Miocene or early Pliocene age. The base of the unit is missing in a sampling gap between 6 and 38 meters, suggesting that much of the Oligocene-Miocene is missing in a major unconformity within this sampling gap. At the top of the underlying sequence is 1 meter of silt-rich diatom ooze of early Oligocene age (Unit 4). This is underlain by 479 meters of silty claystone and clay siltstone of early Oligocene to middle Eocene age (Unit 5). Unit 5 has been subdivided into three subunits. The upper subunit (Subunit 5A, 100 m thick) is diatom detrital clayey silt or silt and silty diatom ooze; the middle subunit (Subunit 5B, 58 m thick) contains thin chert layers; while the lower subunit (Subunit 5C, 302 m thick) contains glauconite, pyrite, and micronodules. Biogenic material is almost absent in the lower 360 meters of Unit 5, although a restricted agglutinated benthonic foraminiferal fauna is present, including *Bathysiphon* and *Cyclammina*. The lower part of Subunit 5C is rich in organic material.

A gradation exists downward within Unit 5 from diatom-rich sediments of Subunit 5A to clayey siltstone and silty claystone partially lithified by disseminated silica (upper 5C) to semilithified siltstone and claystone (lower 5C). This suggests that Subunits B and the upper part of 5C originally contained diatoms that have been diagenetically dissolved and redistributed within the sediment.

Biostratigraphic control is rather poor in Site 280 because of general paucity of microfossils. During the middle-late Eocene, deposition of the sediments was rather rapid (4 cm/1000 yr) followed by a conspicuous decrease in the rate of sedimentation during late Eocene and early Oligocene (0.7 cm/1000 yr) when siliceous oozes were deposited. The depositional phase within the Paleogene changed to an essentially erosional phase during the late Paleogene and Neogene with much of the sequence missing or assumed missing.

Paleontologically, the Site 280 sequence is most notable for the persistent occurrence of dinoflagellates in the middle-late Eocene and for the abundant and diverse early Oligocene diatoms.

Unit 6 consists of 5 meters of greenish black, fine-grained intrusive basalt forming three layers separated by claystones and siltstones. The three basalt layers may represent three separate but subparallel intrusives of basalt, or, more likely, three tongues at the margin of a single intrusive mass. The basalt is no older than the middle Eocene age of the enclosing sediments.

Conclusions

The sedimentary history at Site 280 clearly reflects the environmental changes that occurred as a result of basin enlargement due to ocean-floor spreading and major paleooceanographic changes resulting from the complete separation of the Tasmanian-Antarctic continental areas. The exact time sedimentation began at Site 280 is not certain because acoustic basement is intruded basalt.

The predominance of detrital minerals in the very thick Unit 5, and their relatively high rate of accumulation, suggest deposition occurred close to a basin margin and relatively near a source of detrital sediments rather than near the center of the basin. Depths of deposition are difficult to determine because of the lack of biogenic material. The absence of planktonic calcareous microfossils suggests deposition below the calcium carbonate compensation depth. The presence of *Cyclammina* and *Bathysiphon*, good indicators of lower bathyal-abyssal depths in the late Cenozoic, may not necessarily indicate such depths in the early Cenozoic because of different depth tolerances at that time.

The lack of primary sedimentary structures and the poor sediment sorting suggest that bottom-water circulation was rather restricted, but not so restricted as to exclude all bottom life. The widespread occurrence of burrow mottling of at least four types suggests that a moderately diverse infauna inhabited the bottom sediments. High organic content and the presence of pyrite and glauconite indicate that the basin was also poorly oxygenated during deposition of at least the lower part of Unit 5. This also indicates the absence of bottom-water production in the Antarctic area at this time, hence no sea-ice formation. Micromanganese nodules and glauconite, however, indicate that deposition was not particularly rapid. Two greensand layers within Subzone 5C reflect temporary decreases in sedimentation rates.

The absence of siliceous biogenic components in the lower part of Unit 5C is regarded as original and not due to diagenetic removal. However, the silicified nature of the upper part of 5C and the chertified nature of Unit 5B are believed to represent precipitation of silica formed by dissolution of siliceous microfossils originally present at this level, and present still higher. In this view siliceous productivity was negligible during middle Eocene, and considerable during middle-late Eocene and early Oligocene. This productivity increase may have resulted from the development of open ocean circulation and upwelling which commenced in mid-late Eocene and continued into the Oligocene. At the same time detrital sediments deposition decreased, reflecting the depositional site moving away from the supply source.

The continuous sedimentation record is abruptly terminated near the end of the Paleogene. The absence of most of the Neogene is probably due to high velocity deep-sea bottom current development in the area. This in turn probably reflects the development of intense circumpolar flow south of the South Tasman Rise; the exact timing is not certain from the evidence of Site 280, but evidence from other sites in the southwest Pacific implies that it occurred toward the end of the Oligocene. Deposition of very thin sequences of late Miocene to early Pliocene and late Pleistocene sediments occurred during phases of decreased bottom water activity. The appearance of nannofossils and planktonic foraminifera at this time indicates that either the calcium carbonate dissolution level was deeper or that deposition occurred at shallower depths than during the middle/late Eocene to early Oligocene.

The basal sediments and intrusive basalts at Site 280 suggest that by the middle Eocene, rifting had developed to a stage comparable to the modern Red Sea; i.e., a central volcanic ridge had begun to form. Initially, deposition of the Paleogene sequence occurred in a basin with highly restricted circulation and terrigenous deposition. During the later half of the Eocene and the Oligocene, a basin had developed so that oceanic conditions were less restrictive and more biogenically productive. Near the end of the Oligocene very active deep bottom currents were developed south of Australia as the result of initial circumpolar current development. Consequently the Neogene sequence is poorly represented because of extensive deep-sea erosion.

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APPENDIX A
Summary of X-Ray[a], Grain Size, and Carbon-Carbonate Results, Site 280

				X-Ray									Grain Size				Carbon Carbonate			
				Bulk Sample Major Constituent			2-20 μ Fraction Major Constituent			$<2\mu$ Fraction Major Constituent										
Section	Sample Depth Below Sea Floor (m)	Lithology	Age	1	2	3	1	2	3	1	2	3	Sand (%)	Silt (%)	Clay (%)	Classification	Total (%)	Organic (%)	CaCO3 (%)	Comments
280-1-1	0.7	Unit 1 Siliceous fossil-rich foraminifera nannofossil ooze	Late Pleistocene										20.3	43.6	36.2	Sand-silt-Clay	9.7	0.1	81	
280-1-2	1.9	Unit 2 Micron-bearing siliceous detrital silty clay	Late Miocene to e. pliocene	Mica	Quar.	Mont.	Quar.	Mica	Plag.	Mont.	Quar.	Plag.	12.7	30.7	56.5	Silty clay	0.2	0.1	1	Amph. in 2-20μ Gyps. in $<2\mu$
280-1-4	5.7-5.8	Unit 3 Siliceous rich nannofossil ooze	Late Miocene to e. Pliocene	Calc.	–	–	Quar.	Mica	Plag.	Mont.	Mica	Quar.	0.2	47.9	51.9	Silty clay	11.4	0.0	95	*Amph. in 2-20μ Gyps. Hali. in $<2\mu$
280A-1-2	39.5-39.6	Unit 4 Silt-rich diatom ooze	Early Oligocene	Mica	Quar.	Plag.	Quar.	Plag.	Mica	Mont.	Mica	Quar.	0.1	34.5	65.4	Silty clay	0.3	0.0	2	
280A-1-2	40.7-40.8	Unit 5	Late	Mica	Quar.	Mont.	Quar.	Plag.	Mica	Mont.	Mica	Quar.	0.2	42.5	57.3	Silty clay	0.4	0.0	3	
280A-2-2	55.2	A Silty clayey	Eocene	Mica	Quar.	Plag.	Quar.	Plag.	Mica	Mica	Quar.	Plag.	0.1	40.2	59.6	Silty clay	2.0	0.3	14	
280A-3-2	74.7	silt diatom	to	Mica	Quar.	Plag.	Quar.	Plag.	Mica	Mica	Quar.	Mont.	0.1	43.0	59.6	Silty clay	1.9	0.3	13	
280A-5-2	93.9	ooze & detrital	early	Mica	Quar.	Plag.	Quar.	Mica	Plag.	Mica	Quar.	Mont.	0.1	42.2	57.7	Silty clay	1.7	0.3	12	
280A-7-2	122.5-122.6	clayey silt/silt	Oligocene	Mica	Quar.	Plag.	Quar.	Mica	Plag.	Mica	Quar.	Plag.	0.2	45.6	54.2	Silty clay	1.7	0.3	12	Gyps. in bulk
280A-8-2	141.5-141.6	B Silty clay w/chert.	Late Eocene to e. Olig.	Quar.	Cris.	Mica	Quar.	Plag.	Mica	Cris.	Quar.	Plag.	43.7	14.5	41.7	Clayey sand	2.0	0.4	13	Clin. in bulk 2-20 and $<2\mu$
280A-10-6	204.1	C Glauconite	Middle	Mica	Quar.	Plag.	Quar.	Mica	Plag.	Mica	Cris.	Quar.	0.1	40.9	59.0	Silty clay	1.6	0.3	11	
280A-14-1	291.8	bearing	Eocene	Quar.	Cris.	Mica	Mica	Cris.	Quar.	Cris.	Mica	Trid.	27.8	19.5	52.7	Sandy clay	1.2	0.2	8	Clin. in bulk and 2-20μ-
280A-17-1	377.3-377.4	silty clay	to	Mica	Mont.	Quar.	Mica	Quar.	Mont.	Mont.	Quar.	Mica	0.7	33.2	66.2	Silty clay	2.3	2.2	1	Gyps. in $<2\mu$
280A-18-1	406.1	stone	late	Quar.	Mica	Mont.	Quar.	Mica	Mont.	Quar.	Mont.	Mica	1.3	32.6	66.0	Silty clay	3.3	0.6	23	Pyri bulk, 2-20μ
280A-19-3	446.8		Eocene	Quar.	Mica	Mont.	Quar.	Mica	Mont.	Quar.	Mont.	Hali.	4.1	35.1	60.8	Silty clay	3.4	0.6	23	Hali. in $<2\mu$
280A-21-2	512.1-512.2			Quar.	Mica	Mont.	Quar.	Mica	K-Fe.	Quar.	Mont.	Mica	1.1	29.8	69.1	Silty clay	5.0	0.7	36	

Note: *=Comment column.

[a]Complete results of X-Ray, Site 280 will be in Table 6 and 7 of Appendix I.

[b]Legend in Appendix A, Chapter 2, Site 275.

[c]Broad peaks at 10.1Å, 3.34Å, 2.58Å, 1.995Å, 1.513Å, and 1.656Å among others: Mineral is a mixed-layer mica-montmorillonite.

Site 280 Hole Core 1 Cored Interval: 0.0-6.0 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHO. SAMPLE
LATE PLEISTOCENE	P. lacunosa	N	A	M	1	0.5	70
		N	A	M		1.0	
		N	R	P			137
LATE MIOCENE TO EARLY PLIOCENE	R. pseudoumbilica Zone	N	R	P	2		
		N	R	P			90
		N			3		
		N	R	P			121
		N	A	P	4		
		N	A	P			105
		F D S N	F C R A	M M P M	Core Catcher		CC

LITHOLOGY

LITHOLOGIC DESCRIPTION

Unit 1. Soft, very pale brown (10YR 7/4) SILICEOUS FOSSIL-RICH FORAM NANNO OOZE. Moderately mottled upper 30 cm; pale, sparsely laminated and slightly mottled lower half. The boundary to Unit 2 originally sharp - lithologies mixed by drilling. Unit 2. Soft, dark brown (7.5YR 3/2) MICRO NODULE-BEARING SILICEOUS DETRITAL SILTY CLAY. Abundant sand-size, smooth rounded, botryoidal manganese (black) and phosphate (medium brown) nodules; lower down glauconite nodules; generally massive. Slightly mottled (small) nodules give speckled appearance: 10 cm soupy beds of SILICEOUS FOSSIL AND FORAM-RICH NANNO OOZE (yellowish brown) at 1-2 meter spacings (SS 2-90). Lower third of unit: dark brown DETRITAL SILTY CLAY: lower 60 cm of unit in Sec. 4 interbedded lithologies of units 2 and 3, intermixed by drilling above contact. Unit 3 (Sec. 4, 80-150 cm) stiff, pinkish gray (5YR 8/1) slightly mottled (upper) to massive (lower half) SILICEOUS-RICH NANNO OOZE with rare burrows cf. Zoophycos. In Core Catcher Unit 3 is a SILICEOUS-BEARING NANNO OOZE.

SS 1-70		SS 1-137		SS 2-90		SS 3-121		SS 4-105	
N	-48%	D	-20%	F	-21%	CM	-94%	N	-87%
D	- 8%	R	-10%	N	-50%	HM	- 2%	D	- 5%
SS	- 2%	S	-15%	R	-10%	G	- 1%	R	- 2%
R	- 4%	F	- 2%	D	- 1%	R	- 1%	F	- 1%
HM	- 1%	N	-TR	S	- 2%	S	- 2%	S	- 5%
F	-32%	MicroN	- 5%	CM	- 4%			Q	-TR
Q	- 2%	P-N	- 2%	Q	- 3%	Sd	- 2%		
CM	- 2%	CM	-42%	MN	- 5%	ST	-40%	SS CC	
Mi	- 1%	Q	- 2%	P-N	- 4%	CL	-58%	R	-TR
		HM	- 2%					D	- 2%
Sd	-15%			Sd	- 5%			S	-TR
ST	-60%	Sd	- 2%	ST	-20%			N	-96%
CL	-25%	ST	-23%	CL	-75%			OP	- 2%
		CL	-75%						

X-ray 2-36 (Bulk)
Quar - P Mica - P
K-Fe - P Chlo - TR
Plag - P Mont - P
Kaol - P

X-ray 4-120 (Bulk)
Calc - M

Grain Size 1-68 (20.3, 43.6, 36.2)

Grain Size 2-38 (12.7, 30.7, 56.5)

Grain Size 4-131 (0.2, 47.9, 51.9)

Carbon Carbonate 1-70 (9.7, 0.1, 81)

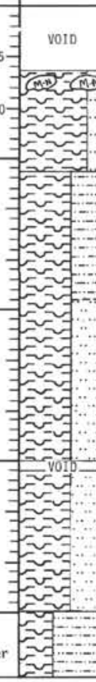
Carbon Carbonate 2-35 (0.2, 0.1, 1)

Carbon Carbonate 4-130 (11.9, 0.0, 95)

Site 280 Hole A Core 1 Cored Interval: 38.0-44.0 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHO. SAMPLE
OLIGOCENE		N	–		1	0.5	
		N	–	–		1.0	132
		N	–				20
		N	–		2		
		N	–	–			
		N	–		3		
		N	–	–			72
		N	–		4		
		N	–	–			
		F D S N	– A C R	– G G M	Core Catcher		CC

LITHOLOGY



LITHOLOGIC DESCRIPTION

Unit 4. Soft, yellowish gray (5Y 7/2), slightly mottled SILT-RICH DIATOM OOZE. Mottles are round to elliptical, up to 3 cm diameter, contain scattered MN/P-N; dusky yellow. Sharp contact at 15 cm (Sec. 2) to Unit 5A, a soft to stiff, grayish green (5G 5/2), slightly fine mottled (2-4 mm) and with very sparse discontinuously laminated SILTY CLAY DIATOM OOZE: sand-size glauconite gives color (screened samples contain bright green glauconite): Secs. 3 and 4 represent change to a SILTY DIATOM OOZE which towards base of Sec. 4 and core catcher changes to SILTY CLAY DIATOM OOZE. MN nodules elongate and rounded, black, slight botryoidal surface; <4.5 cm diameter coating of Holocene forams; i.e. incorporated from sea-bottom during drilling.

SS 1-132		SS 2-20		SS 3-72		SS CC	
D	-66%	D	-58%	D	-50%	D	-45%
S	-TR	SI	- 3%	R	-TR	S	- 2%
R	-10%	S	- 2%	CM	-10%	Si	- 2%
CM	-12%	R	-TR	HM	-TR	R	-TR
Fd	- 2%	Q	-35%	Q	-40%	Q	-25%
HM	-TR	CM	- 2%			Fd	- 5%
Q	-10%	Fd	-TR	Sd	- 2%	Mi	-TR
		Mi	-TR	ST	-80%	HM	-TR
Sd	-10%	VG	-TR	CL	-18%	CM	-20%
ST	-75%	MicroN	-TR			G (washed fraction >62μ)	
CL	-15%	$DetCO_3$	-TR				
						Sd	-10%
		Sd	-20%			ST	-45%
		ST	-65%			CL	-50%
		CL	-15%				

X-ray 2-5 (Bulk)
Quar - A Chlo - TR
K-Fe - P Mont - P
Plag - P Mica - A

X-ray 2-122 (Bulk)
Quar - A Mica - A
K-Fe - P Chlo - TR
Plag - P Mont - P

Grain Size 2-0 (0.1, 34.5, 65.4)

Grain Size 2-120 (0.2, 42.5, 57.3)

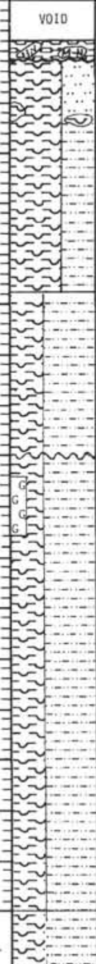
Carbon Carbonate 2-7 (0.3, 0.0, 2)

Carbon Carbonate 2-127 (0.4, 0.0, 3)

Explanatory notes in chapter 1

Site 280 Hole A Core 2 Cored Interval: 53.5-63.0 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
OLIGOCENE		N	—		1	0.5, 1.0	VOID		95, 107
		N	—	—					
		N	—	—	2				
		N	—	—					
		N	R	P	3				
		N	—	—					
		N	R	P	4		G		38
		N	—	—					
		N	—		5				
		N	—	—					
		N	R	P	6				
		N	R	P					
		F	—	—					
		D S N	A C R	G G P	Core Catcher				



LITHOLOGIC DESCRIPTION

Sec. 1 (40-60 cm) MN nodules (to 8 cm) in pale brown yellow micarb ooze from sea floor; stiff, gray (5Y 5/1) slight fine irregularly mottled MN BEARING SILTY DIATOM OOZE, with patches yellow-gray DIATOM OOZE incorporated from Unit 4. Sec. 2 contains dark colors and reflects MN-filled diatom tests; rare thin beds (to 7 cm); massive; and rare, irregular patches (1 cm) of gray brown sediment in Sec. 3 - probably segregations of Micro Nodules; also in Sec. 4; at base of Sec. 3 gradual change to: dark greenish gray (5GY 4/1), slightly mottled GLAUCONITE-RICH DIATOM DETRITAL CLAYEY SILT, which also occurs in core catcher: In Sec. 6, fine mottles of dark brown gray and dark gray; with a wispy nature.

SS 1-95		SS 1-107		SS 4-38		SS CC	
D	-50%	D	-50%	D	-38%	D	-42%
SS	-TR	R	- 2%	R	- 2%	SI	- 2%
Q	-37%	SI	- 3%	SS	- 1%	Q	-43%
CM	-10%	Q	-35%	SI	- 1%	Fd	- 2%
HM	-TR	Mi	- 5%	Q	-35%	Mi	-TR
G	-TR	CM	- 5%	Fd	- 2%	HM	- 3%
MicroN	- 3%	VG	-TR	Mi	- 1%	CM	- 5%
				HM	-TR	G	-TR
Sd	- 2%	Sd	- 2%	CM	- 5%		
ST	-90%	ST	-60%	G	-15%	Sd	-15%
CL	- 8%	CL	-38%			ST	-65%
				Sd	-15%	CL	-20%
				ST	-55%		
				CL	-30%		

X-ray 2-22 Bulk

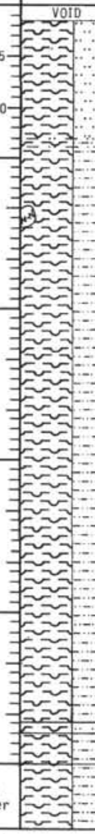
Quar	- P	Mica	- A
K-Fe	- TR	Chlo	- P
Plag	- P	Mont	- P

Grain Size 2-20 (0.1, 40.2, 59.6)

Carbon Carbonate 2-19 (2.0, 0.3, 14)

Site 280 Hole A Core 3 Cored Interval: 72.5-82.0 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
OLIGOCENE		N	—		1	0.5, 1.0	VOID		106
		N	—	—					
		N	R	P					
		N	—	—	2				
		N	—	—					
		N	R	P	3				
		N	R	P					
		N	R	P	4				
		N	—	—					
		N	R	P	5				
		N	R	P					111, 113
		F D S N	— A C R	— G G P	Core Catcher				CC



LITHOLOGIC DESCRIPTION

Sec. 1 shows stiff, dark greenish gray changing to olive gray (5Y 2/1) at 80 cm, massive SILTY DIATOM OOZE; also occurring are thin laminae (2) of yellowish gray or dark gray SILTY CLAY low in section. In Sec. 2 are small oblique elliptical burrows near top of Sec. 2 (in stiff parts); deformed zone (50-80 cm) is a yellow gray DIATOM OOZE with MN nodule (2 cm). The dark greenish gray (5GY 4/1) color near top of Sec. 2 gets paler at base. Sec. 3 shows glauconite concentrations as layers, spots and patches up to 10 cm in diameter; largely random orientation and moderately mottled appearance. Sec. 4 has variable colors of dark greenish gray to olive gray and only slight mottling; Mn occurs as aggregates and fillings of diatoms. Sec. 5 contains discontinuous to continuous subhorizontal laminae (1.5 cm thick) - (dark gray); scattered fine mottling, SILTY DIATOM OOZE. The core catcher is a CLAYEY SILT DIATOM OOZE (the >62μ residue is rich in glauconite and quartz).

SS 1-106		SS 5-111		SS CC	
D	-55%	D	-50%	D	-50%
R	- 4%	R	- 1%	Siliceous	-TR
SS	- 2%	SS	- 3%	Q	-35%
SI	- 1%	SI	- 2%	Fd	-TR
Q	-20%	Q	-30%	CM	-15%
Fd	- 2%	Fd	-TR	G	-TR
Mi	- 1%	Mi	-TR	MicroN	-TR
CM	-13%	CM	- 5%		
G	- 2%	G	- 4%	Sd	-10%
		HM	-TR	ST	-60%
Sd	- 5%	MicroN	- 5%	CL	-30%
ST	-75%	VG	-TR		
CL	-20%				
		Sd	- 5%		
		ST	-75%		
		CL	-20%		

X-ray 2-70 (Bulk)

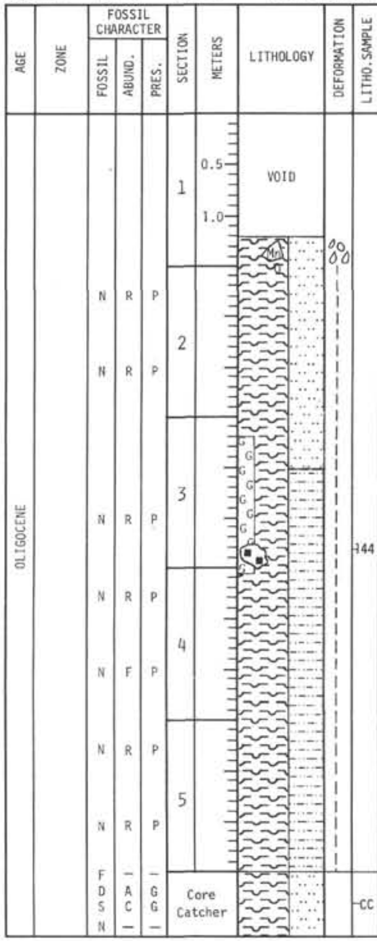
Quar	- A	Chlo	- P
K-Fe	- P	Mont	- P
Plag	- P	Pyri	- TR
Mica	- A		

Grain Size 2-73 (0.1, 43.0, 56.9)

Carbon Carbonate 2-69 (1.9, 0.3, 13)

Explanatory notes in Chapter 1

Site 280 Hole A Core 4 Cored Interval: 82.0-91.5 m

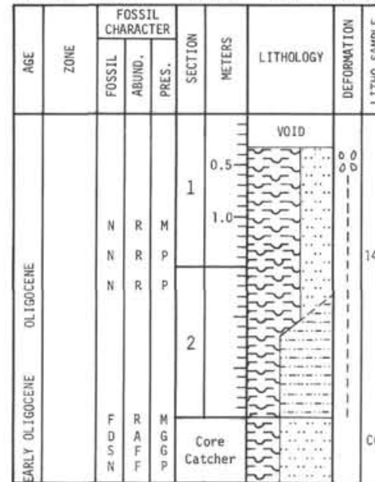


LITHOLOGIC DESCRIPTION

Stiff, greenish black to greenish gray (5GY 3/1) to dark green gray (5GY 4/1) to base of Section 2; slightly mottled (patches <1 cm) to massive SILTY DIATOM OOZE; manganese nodules incorporated from sea floor. Alternating stiff and softer bands occur in Sec. 2. Change to olive gray (5Y 4/1) at 115 cm in Section 3; partially mottled GLAUCONITE-BEARING DETRITAL CLAYEY SILT DIATOM OOZE, pyritized patch (7 CM) at 140 cm. Sec. 4 is moderately mottled with some irregular patches (≤3 cm), rich in MN: upper levels of section speckled with glauconite. Sec. 5 shows scattered glauconite and well-defined sparse subhorizontal mottles. The core catcher lithology is a MICRO-N-BEARING SILTY DIATOM OOZE.

SS 3-144		SS CC	
D	-50%	D	-50%
R	- 1%	R	- 3%
S	- 1%	S	-TR
Q	-30%	Q	-45%
Fd	-TR	HM	-TR
Mi	-TR	MicroN- 2%	
CM	- 5%	Sd	- 2%
G	-10%	ST	-90%
MicroN- 3%		CL	- 8%
Sd	-20%		
ST	-50%		
CL	-30%		

Site 280 Hole A Core 5 Cored Interval: 91.5-101.0 m



LITHOLOGIC DESCRIPTION

Slurry to slight deformation. Sec. 1 contains a soft, dark green gray to green gray (5GY 5/1) slightly mottled (fine and irregular: ≤0.5 cm) SILTY DIATOM OOZE: Sec. 2 is stiff, top 30 cm massive; the rest slightly to moderately mottled (irregular ≤5 cm; most 1 cm), DIATOM DETRITAL SILTY CLAY There are horizontal mottles in lower half section, and random mottles in the upper half. The core catcher is also a DIATOM DETRITAL SILT.

SS 1-140		SS CC		
D	-50%	D	-43%	
R	- 5%	R	- 5%	
Q	-44%	S	-TR	
HM	-TR	Q	-50%	
G	-TR	G	-TR	G
MicroN- 1%		MicroN- 2%		Q
		washed fraction >62μ		Fd
Sd	- 2%			Mi
ST	-90%	Sd	- 2%	
CL	- 8%	ST	-90%	
		CL	- 8%	

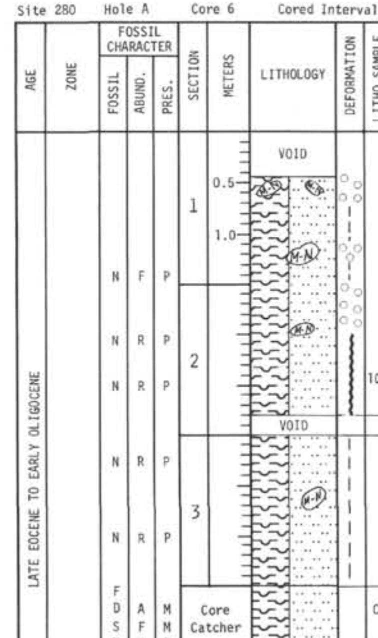
X-ray 2-92 (Bulk)

Quar	- A	Mica	- A
K-Fe	- P	Chlo	- P
Plag	- P	Mont	- P

Grain Size 2-90 (0.1, 42.2, 57.7)

Carbon Carbonate 2-88 (1.7, 0.3, 12)

Site 280 Hole A Core 6 Cored Interval: 101.0-110.5 m



LITHOLOGIC DESCRIPTION

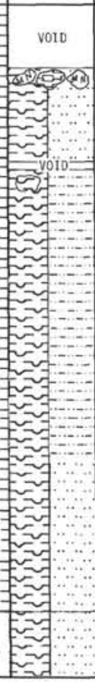
Drilling slurry to intense deformation: Secs. 1 and 2 thoroughly disturbed by drilling. Dark green gray to green gray (5GY 5/1) DIATOM DETRITAL SILT with MN nodules: in Sec. 3 abundant scattered GLAUCONITE occurs in top 30 cm ; moderately mottled with color and composition as in Sec. 2.

SS 2-100		SS CC		
D	-46%	D	-47%	
R	- 3%	R	- 2%	
S	-TR	S	-TR	
Q	-50%	SI	-TR	
Mi	-TR	Q	-50%	
HM	-TR	MicroN- 1%		
G	-TR	Mi	-TR	
		HM	-TR	Q
Sd	- 2%	washed residue >62μ		G
ST	-90%			Pyrite
CL	- 8%	Sd	- 2%	MN
		ST	-90%	Limonite fragments
		CL	- 8%	

Explanatory notes in Chapter 1

Site 280 Hole A Core 7 Cored Interval: 120.0-129.5 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
LATE EOCENE TO EARLY OLIGOCENE		N	R	P	1	0.5, 1.0	VOID		
		N	R	P					
		N	R	P			VOID		
		N	R	P	2				
		N							
		N	R	P	3				
		N	R	P					
		N	R	P	4				
		F / D / S / N	C / F / R	P / M / P	Core Catcher				CC



LITHOLOGIC DESCRIPTION

Drilling slurry to slight deformation; Sec. 1 contains MN nodules and fragment of DIATOM MICARB LIMESTONE: generally of dark greenish gray (5GY 4/1), slightly fine mottled (wispy), with rare discontinuous horizontal lamination; DIATOM DETRITAL SILT: a pebble of pale gray MICRITE occurs in Sec. 2 which is otherwise soft, massive, and grading into a stiff, massive greenish gray (5GY 6/1) lithology (DIATOM DETRITAL SILTY CLAY) in Sec. 3. Sec. 4 is stiff, green gray to dark green gray (5GY 5/1); slightly fine mottled (mottles <0.5 cm) DIATOM DETRITAL SILT.

SS CC
D -47%
R - 1%
S - 1%
SI -TR
Q -50%
Mi -TR
HM -TR
MicroN-TR

Sd - 2%
ST -90%
CL - 8%

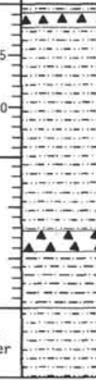
X-ray 2-109 (Bulk)
Quar - A Chlo - P
K-Fe - P Mont - P
Plag - P Pyri - TR
Mica - A Gyps - TR

Grain Size 2-107 (0.2, 45.6, 54.2)

Carbon Carbonate 2-95 (1.7, 0.3, 12)

Site 280 Hole A Core 8 Cored Interval: 139.0-148.5 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
LATE EOCENE TO EARLY OLIGOCENE		N	R	P	1	0.5, 1.0			
		N	R	P					
		N	R	P	2				
		F / D / S / N	— / R / — / R	— / P / — / P	Core Catcher				CC



LITHOLOGIC DESCRIPTION

Unit 5B a dark green gray (5GY 4/1) and green gray (5GY 6/1) 5 cm long fragments of microcrystalline chert, at top; succeeded by stiff, dark green gray (5GY 4/1), moderately fine mottled GLAUCONITE-BEARING CLAYEY SILT (SS 2-142). Also occurring are elongate patches (≤3 cm) which are Micro-N-rich, both horizontal and oblique; 2 cm fragment pyritized siltstone: at top Sec. 2 there are some zones of CLAYEY SAND: Sec. 2 (75-95 cm) contains 2 fragments (3-4 cm) of black and dark green gray (5GY 4/1) moderately mottled microcrystalline CHERT. The core catcher is a SILTY CLAY.

SS 2-142		SS CC	
Q	-53%	Q	-60%
Fd	- 5%	Fd	-TR
Mi	- 5%	Mi	- 5%
HM	- 2%	HM	-TR
G	- 5%	CM	-30%
CM	-30%	G	-TR
		OP	- 3%
Sd	- 5%	Sd	- 2%
ST	-55%	ST	-48%
CL	-40%	CL	-50%

X-ray 2-100 (Bulk)
Quar - A Chlo - TR
Cris - P Mont - P
K-Fe - P Clin - TR
Plag - P Pyri - TR
Mica - P

Grain Size 2-104 (43.7, 14.5, 41.7)

Carbon Carbonate 2-102 (2.0, 0.4, 13)

Site 280 Hole A Core 9 Cored Interval: 167.5-177.0 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
LATE EOCENE TO EARLY OLIGOCENE		N	R	P	1	0.5, 1.0	VOID		
		N	R	P					
		F / D / S / N	— / — / — / R	— / — / — / P	Core Catcher				CC

LITHOLOGIC DESCRIPTION

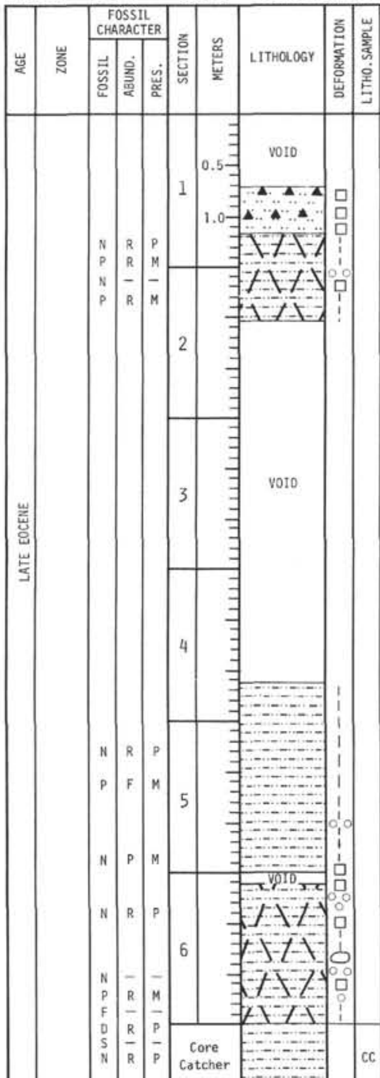
Sec. 1 (35-65 cm) dark green gray, irregularly wavy laminated SILTSTONE some showing transition to chert (chertification) and chert. At 65 cm begins a soft to stiff dark green gray CLAYEY SILT: the core catcher contains a CLAYEY SILT and some glauconitic CLAYEY SILTSTONE.

SS CC
Q -60%
CM -30%
Mi - 5%
G - 1%
OP - 3%
HM -TR (hornblende, epidote)
D -TR
N -TR

Sd - 2%
ST -50%
CL -48%

Explanatory notes in Chapter 1

Site 280 Hole A Core 10 Cored Interval: 196.0-205.5 m



LITHOLOGIC DESCRIPTION

Sec. 1 (70-120 cm) is dark green gray (5GY 4/1) and green gray (5GY 5/1) CHERTIFIED SILTSTONE, some with wavy 1 cm laminae. Elliptical burrows (1 cm diameter) in others; sparse fine spots and wispy patches which are Micro-N or glauconite-rich. At 120 cm Unit 5C is a stiff CLAY SILT with slight wispy mottling. Semilithified CLAYEY SILTSTONE as above, with 1.5 cm burrow-like mottles and stiff CLAYEY SILT/SILTY CLAY; slight fine mottling with Micro-N concentrations: Sec. 4 (115 cm) is a stiff, dark green gray, slight very fine mottled SILTY CLAY, grading to a dark green gray, stiff, moderately mottled SILTY CLAY/CLAYEY SILT with zones of SILTSTONE/CLAYSTONE; semilithified. Mottles: thin, wispy, dark brown black, commonly horizontal (2-5 mm thick and 2-20 mm long); small patches are glauconite rich: most mottles are Micro-N-rich. Elliptical burrow sections in semilithified zones. The core catcher consists of a SILTY CLAY.

SS CC
Q -22%
Fd -11%
HM - 2%
ORG -10%
CM -48%
Phos.?- 7%
G -TR
MicroN-TR
D -TR

Sd -TR
ST -35%
CL -65%

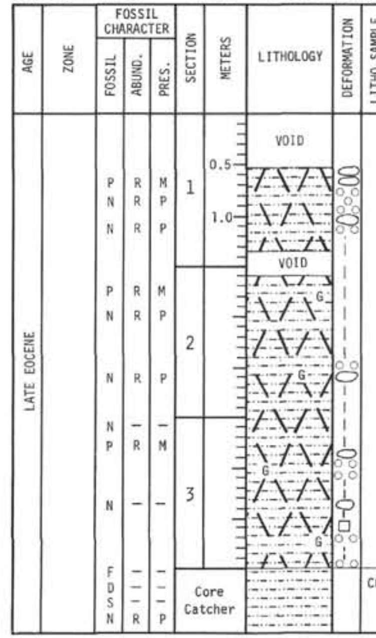
X-ray 6-60 (Bulk)

Quar	- A	Mica	- A
Cris	- P	Chlo	- P
K-Fe	- P	Mont	- TR
Plag	- P		

Grain Size 6-57 (0.1, 40.9, 59.0)

Carbon Carbonate 6-55 (1.6, 0.3, 11)

Site 280 Hole A Core 11 Cored Interval: 215.0-224.5



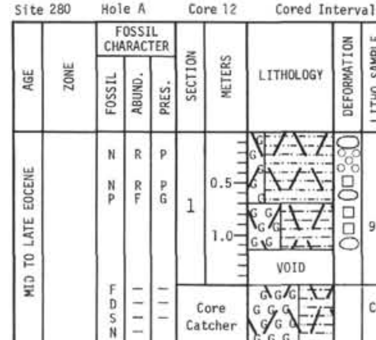
LITHOLOGIC DESCRIPTION

Sec. 1. Semilithified CLAYSTONE as in core catcher 10 moderately very fine mottled (glauconite or MN-rich). Sec. 2, is dark greenish gray (5GY 4/1), stiff, intensely fine mottled zones being MN AND GLAUCONITE-RICH: some long elliptical (burrows) to 2 cm long, latter packed with pellets. GLAUCONITE-BEARING CLAYEY SILT (SS CC); and moderate very fine mottled CLAYEY SILTSTONE.

SS CC
Q -48%
CM -35%
Mi -10%
G - 5%
Fd - 2%

Sd - 5%
ST -60%
CL -35%

Site 280 Hole A Core 12 Cored Interval: 234.0-243.5 m



LITHOLOGIC DESCRIPTION

Greenish gray (5GY 6/1), semilithified, intensely mottled (1-2 cm elliptical and elongate; some irregular to patchy at 70-85 cm), GLAUCONITE-BEARING SILTY CLAYSTONE: sharp contact at 70 cm (Sec. 1) to a olive black (5Y 2/1) grading down to greenish black (5G 2/1) GLAUCONITE GREENSAND with the following divisions noted: Top 20 cm: olive black GLAUCONITE SANDY CLAYSTONE, Lower 10 cm: green black GLAUCONITE DETRITAL CLAYEY SANDSTONE, Core Catcher 4 cm: green black DETRITAL SAND-SILT-CLAY GREENSAND. Generally the greensand medium to fine sand-size bright green, color consists of botryoidal pellets of glauconite; lower part, clay appears to be in form of clasts, but evidence further up core indicate that glauconite gradually formed in detrital sediment.

SS 1-95		SS CC	
CM	-50%	Q	-18%
G	-45%	CM	-12%
MicroN-	3%	G	-69%
Q	- 2%	OP	- 1%
HM	-TR		
		Sd	-50%
Sd	-40%	ST	-25%
ST	-10%	CL	-25%
CL	-50%		

Explanatory notes in Chapter 1

Site 280 Hole A Core 13 Cored Interval: 262.5-272.0 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MID TO LATE EOCENE		N	—		1	0.5	VOID			Olive gray (5Y 4/1), semilithified, with lenticular lamination and elliptical mottles (1-1.5 cm); the latter are glauconite -rich; glauconite abundant over top 15 cm especially in the laminae at 80 cm. GLAUCONITE-RICH CLAYEY SILTSTONE: also rare, scattered, 2-4 mm diameter white-walled (aggregation of quartz silt) tubes of BATHYSIPHON - agglutinating foram; flattened in plane of bedding. The glauconite is sand-size and abundant upper and lower thirds Sec. 3; in Sec. 3 also has a number of BATHYSIPHON. The core catcher consists of GLAUCONITE and MICRO-N-BEARING CLAYEY SILTSTONE.
		N	—	—		1.0				
		P	A	G						
		N	—		2					
		P	A	G						
		N	—	—						
		N	R	P	3				80	
		P	A	G						
		N	—	—						
		B	—	—	Core Catcher				CC	
		D	—	—						
		S	—	—						
		N	R	P						

SS CC

Q	-40%
Mi	-20%
Fd	- 5%
HM	- 5%
CM	-20%
G	- 5%
MicroN	- 5%
Sd	- 5%
ST	-50%
CL	-45%

Site 280 Hole A Core 14 Cored Interval: 291.0-300.5 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MID TO LATE EOCENE		N	—		1	0.5	VOID		75	Dark green gray (5GY 4/1) intensely coarse-mottled (2-15 mm) GLAUCONITE-RICH SILTY SANDSTONE and SANDY CLAYSTONE. Some mottles of green silt/clay; other segregations of coarse quartz and glauconite; Sec. 1 (90-105 cm) is olive gray, GLAUCONITE-BEARING to GLAUCONITE-RICH CLAY SILTSTONE, moderately mottled. Glauconite very abundant in large burrows (0.5-1 cm). Sec. 2 is mainly alternation of above, i.e. (a) GLAUCONITE-RICH SANDY SILTSTONE (b) fine-mottled GLAUCONITE-BEARING CLAYEY SILTSTONE. The core catcher lithology is a GLAUCONITE AND MICRO-N-BEARING CLAYEY SILTSTONE.
		P	A	G		1.0				
		N	R	P						
		N	—		2					
		P	A	G						
		N	—							
		F	—	—	Core Catcher				CC	
		D	—	—						
		S	—	—						
		N	R	P						

SS 1-75		SS CC	
Q	-30%	Q	-50%
Fd	-15%	MiClay	-20%
Mi	-10%	CM	-15%
HM	- 5%	Fd	- 5%
G	-15%	G	- 5%
PY	- 1%	MicroN	- 5%
CM	-24%	Sd	-15%
Sd	-45%	ST	-60%
ST	-30%	CL	-25%
CL	-25%		

X-ray 1-80 (Bulk)

Quar	- A	Chlo	- TR
Cris	- P	Mont	- P
K-Fe	- P	Trid	- TR
Plag	- P	Clin	- TR
Mica	- P		

Grain Size 1-78 (27.8, 19.5, 52.7)

Carbon Carbonate 1-77 (1.2, 0.2, 8)

Site 280 Hole A Core 15 Cored Interval: 319.5-329.0 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MID TO LATE EOCENE		N	—		1	0.5	VOID			Breccia deformation in Sec. 1 (75-150 cm) and in areas of Secs. 2 and 3. Generally Sec. 1 consists of a light gray CLAY SILTSTONE, green gray SILTSTONE, and light olive brown GLAUCONITE-BEARING SILTSTONE, with dark brown black MN and P-N nodules - mostly from up hole and the seafloor. Sec. 2 is a very dark gray (5Y 3/1) or olive gray (5Y 4/1) massive to slightly very fine mottled GLAUCONITE and MICRO-N-BEARING CLAYEY SILTSTONE AND CLAYEY SILT (stiff) with brown (5Y 3/1) cast to color. At 120 cm Sec. 2 is a breccia of light olive gray MICARB LIMESTONE plus green gray SILTSTONE. Sec. 3 and core catcher is a stiff, olive gray, massive GLAUCONITE and MICRO-NODULE-BEARING CLAYEY SILT. Drilling breccia at base of Sec. 3 includes material from higher units plus MN nodules from seafloor.
		P	A	G		1.0				
		N	—	—						
		P	A	G						
		N	—		2		VOID			
		N	—	—						
					3					
		F	—	—	Core Catcher				CC	
		D	R	P						
		S	—	—						
		N	R	M						

SS CC

Q	-45%
CM	-20%
MicroN	-10%
Mi	-10%
Fd	- 5%
HM	- 5%
G	- 5%
Sd	-10%
ST	-60%
CL	-30%

Site 280 Hole A Core 16 Cored Interval: 348.0-357.5 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MID TO LATE EOCENE					1	0.5	VOID			Dark olive gray (5Y 3/2) semilithified, intensely mottled (very thin lenticularly parallel laminated), GLAUCONITE-BEARING MICRO-N-RICH SILTY CLAYSTONE.
		N	R	P		1.0	MICRON			
		P	A	G						
		F	—	—	Core Catcher		MICRON		CC	
		D	—	—						
		S	—	—						
		N	—							

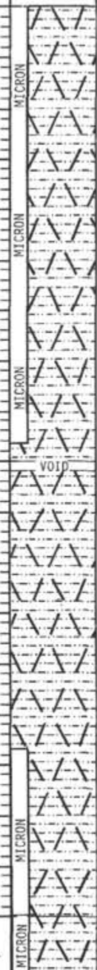
SS CC

Q	-28%
CM	-35%
M	-10%
HM	- 5%
Fd	- 2%
MicroN	-15%
G	- 5%
N	- TR
Sd	- 5%
ST	-30%
CL	-65%

Explanatory notes in Chapter 1

Site 280 Hole A Core 17 Cored Interval: 376.5-386.0 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
MID TO LATE EOCENE		P N N	A – –	G –	1	0.5 1.0	MICRON		
		P N N	A – –	G –	2		MICRON		64
		P N N	A – –	G – –	3		MICRON		
		N P N	– A –	 G –	4		VOID		132
		N P N	– A –	 G –	5				
		P N F	A – –	G –	6		MICRON		
MID EOCENE		D S N	– – R	– – M	Core Catcher		MICRON		CC



LITHOLOGIC DESCRIPTION

Sec. 1. Upper and lower 20 cm: dark olive gray while remainder is a semilithified, very dark grayish brown (2.5Y 3/2), intensely fine-mottled (spots, lenticules, angular blebs 1-3 mm), GLAUCONITE-BEARING, MICRO-N-RICH SILTY CLAYSTONE with scattered BATHYSIPHON ; mottling mostly subhorizontal; occurs in patches 2-3 cm diameter. Sec. 2 contains a semilithified GLAUCONITE-BEARING MICRO-N-RICH SILTY CLAYSTONE with BATHYSIPHON; highly organic. Sec. 4 contains alternate zones of (a) slightly fine mottle to massive (b) very intensely fine mottling of a GLAUCONITE and MICRO-N-BEARING SILTY CLAYSTONE. At 130 cm is a 4-5 cm zone of coarse mottled dark gray brown and grayish blue green (5BG 5/2) to dusky blue green (5BG 3/2). Sec. 5 begins a temporary change to olive gray, sparse, horizontal-subhorizontal burrows, pellet-filled and ≤0.5 cm wide and ≤2 cm long. Rare patches blue-gray CLAYSTONE. Sec. 6 is a very dark gray brown (2.5Y 3/2) in color with a petroliferous odor and pyrite/marcasite-cemented patches. The core catcher is a MICRO-N-RICH SILTY CLAYSTONE.

SS 2-64		SS 4-132		SS CC	
Q	-43%	Q	-10%	Q	-30%
Fd	- 2%	CM	-82%	Fd	- 3%
Mi	- 5%	Mi	- 1%	Mi	-10%
CM	-25%	HM	-TR	HM	- 5%
HM	-TR	G	- 2%	CM	-25%
G	- 5%	MicroN-	5%	G	- 2%
MicroN-	20%			MicroN-	25%
		Sd	- 2%		
Sd	-10%	ST	-20%	Sd	-10%
ST	-25%	CL	-78%	ST	-35%
CL	-65%			CL	-55%

X-ray 1-82 (Bulk)

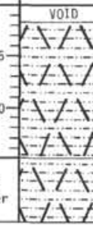
Quar	- A	Chlo	- P
K-Fe	- TR	Mont	- A
Plag	- TR	Pyri	- TR
Mica	- A		

Grain Size 1-88 (0.7, 33.2, 66.2)

Carbon Carbonate 1-80 (2.3, 2.2, 1)

Site 280 Hole A Core 18 Cored Interval: 405.0-414.5 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
MID EOCENE		N N P	R R A	P P G	1	0.5 1.0	VOID		
		F D S N	 R	 P	Core Catcher				CC



LITHOLOGIC DESCRIPTION

Olive gray (5Y 3/2), moderately fine-medium mottled, dense, semilithified MICRO-N-BEARING SILTY CLAYSTONE with scattered BATHYSIPHON mottles thin and elliptical. The core catcher consists of a MICRO-N and VOLCANIC GLASS-BEARING CLAYEY SILTSTONE.

SS CC	
Q	-48%
Fd	- 7%
Mi	- 3%
HM	- 5%
CM	-20%
VG	-10%
G	- 2%
MicroN-	5%
Sd	- 5%
ST	-65%
CL	-30%

X-ray 1-107 (Bulk)

Quar	- A	Chlo	- TR
K-Fe	- TR	Mont	- P
Plag	- P	Pyri	- TR
Mica	- A		

Grain Size 1-105 (1.3, 32.6, 66.0)

Carbon Carbonate 1-108 (3.3, 0.6, 23)

Explanatory notes in Chapter 1

Site 280 Hole A Core 19 Cored Interval: 443.0-452.5 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS
MID EOCENE		N	—		1	0.5, 1.0
		P	A	G		
		N	—	—		
		P	A	G	2	
		N	R	P		
		N	—	—		
		P	A	G	3	
		N	R	P		
		N	—	—		
		P	A	G	4	
		N	R	P		
		N	—	—		
		P	A	G	5	
		N	—			
		N	—	—		
		P	A	G	6	
		N	—			
		N	R	P		
		F	—	—	Core Catcher	
		D	—	—		
		S	—	—		
		N	R	M		

LITHOLOGY

LITHO. SAMPLE: 64 70 (mottle); CC

LITHOLOGIC DESCRIPTION

Core is dominately olive gray (5Y 3/2) semilithified intensely fine mottled (lenticular burrows, some with pellet fillings); sparse mottles forms cf. lenticular bedding of Wanderlich and Reinich, which extend horizontally full diameter of core; a CLAYEY SILTSTONE with scattered BATHYSIPHON. The upper 82 cm. of Sec. 2 contains coarse, angular and stratiform, subhorizontal mottles of very dark gray coarse MICRO-N-RICH SILTY CLAYSTONE, in a dark gray VG-BEARING CLAY SILTSTONE. Two mottles with eroded tops. Lower 70 cm as in Sec. 1 with mottles - micaceous on split surfaces; sparse aggultinated forams include CYCLAMMINA. Sec. 3 is semilithified stiff; dark gray (5Y 3/1) with laminar mottling as in Sec. 1 and scattered BATHYSIPHON. Sec. 4 is olive gray (5Y 3/2); with laminar mottling and burrows ≤1 cm wide which cut across laminar mottling. Sec. 5 is as Sec. 4 with rare burrows with galleries and scattered BATHYSIPHON and CYCLAMMINA throughout. Sec. 6 is like Sec. 3 but with olive gray and with scattered forams. The core catcher consists of a MICRO-N-BEARING SILTY CLAYSTONE.

SS CC
Q -15%
Fd - 2%
Mi - 1%
HM -TR
CM -75%
G -TR
MicroN- 7%

Sd -10%
ST -30%
CL -60%

X-ray 3-79 (Bulk)
Quar - A Chlo - TR
K-Fe - TR Mont - P
Plag - TR Pyri - TR
Mica - A

Grain Size 3-80 (4.1, 35.1, 60.8)

Carbon Carbonate 3-77 (3.4, 0.6, 23)

Site 280 Hole A Core 20 Cored Interval: 481.0-490.5 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS
MID EOCENE?		P	A	G	1	0.5, 1.0
		N	—	—		
		N	—	—		
		P	A	G	2	
		N	—			
		N	—			
		P	A	G	3	
		N	—			
		N	—	—		
		F	—	—	Core Catcher	
		D	—	—		
		S	—	—		
		N	R	P		

LITHOLOGY

LITHO. SAMPLE: CC

LITHOLOGIC DESCRIPTION

Light olive gray to olive gray (5Y 4/2), semilithified, intensely mottled (very fine subhorizontal) to homogeneous. Not coarse mottling of Core 19. Rare oblique to vertical burrows which cut and are cut by horizontal burrows. Scattered forams. Semilithified, SILTY CLAYSTONE: calcite-pyrite (?) vein and vein network in Sec. 2 (40-60 cm), plus rare agglutinating forams and color change to gray (5Y 5/1) at 110-130 cm. Sec. 3 is a gray (5Y 5/1), semilithified, moderately mottled (elliptical burrows, horizontal) MICRO-N-BEARING SILTY CLAYSTONE.

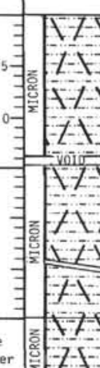
SS CC
Q -40%
Fd - 2%
Mi -TR
HM -TR
CM -53%
G -TR
MicroN- 5%

Sd -10%
ST -40%
CL -50%

Site 280 Hole A Core 21 Cored Interval: 509.5-512.5 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS
MID EOCENE		P	A	G	1	0.5, 1.0
		N	—			
		N	—	—		
		N	R	P	2	
		P	C	G		
		N	R	P		
		F	—	—	Core Catcher	
		D	—	—		
		S	—	—		
		N	R	P		

LITHOLOGY



LITHO. SAMPLE: CC

LITHOLOGIC DESCRIPTION

Sec. 1 is similar to Sec. 3 Core 20. Sec. 2 is an intensely fine mottled (horizontal) MICRO-N-BEARING SILTY CLAYSTONES in the upper 30 cm: 30-103 cm: soft-sediment deformed (truncations, foundered layers, faulted contacts) laminated SILTSTONE: Note: may be related to intrusion of BASALT below. 80-100 cm: may originally have been series of graded beds. Vein; pyritized SILTSTONE at 100 cm. Lower 35 cm of Sec. 2 has scattered horizontal short white streaks (2mm wide) - related to intrusion. The core catcher is a GLAUCONITE and MICRO-N-BEARING SILTY CLAYSTONE.

SS-CC
Q -50%
Fd - 5%
Mi - 5%
HM -TR
CM -25%
G - 5%
MicroN-10%

Sd -15%
ST -60%
CL -25%

X-ray 2-114 (Bulk)
Quar - M Mica - P
K-Fe - TR Chlo - TR
Plag - TR Mont - P
Kaol - TR Pyri - TR

Grain Size 2-116 (1.1, 29.8, 69.1)

Carbon Carbonate 2-113 (5.0, 0.7, 36)

Explanatory notes in Chapter 1

Site 280 Hole A Core 22 Cored Interval: 512.5-519.0 m

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
MID EOCENE		N	–		1	0.5	VOID 		70
		P	A	G		1.0			
		N	R	P					
		F	–	–	Core Catcher				CC[1]
		D	–	–					
		S	–	–					
		N	–	–					CC[2]

LITHOLOGIC DESCRIPTION

Gray (5Y 5/1) semilithified to lithified, patchly mineralized (3-4 cm blotches) with authigenic calcite in a MICRO-N-BEARING SILTY CLAYSTONE: blotches irregularly and sparsely distributed; calcite-rich. Ragged/distorted horizontal burrow mottling throughout - distortion is deformation produced by intrusion of BASALT below. Basal 10 cm has inclined fabric-diagenetic/deformational related to intrusion. The core catcher lithology is a authigenic calcite and MICRO-N-BEARING SILTY CLAYSTONE olive black (5Y 2/1), lithified; underlain by 3 cm olive black (5Y 2/1) lithified calcite mineralized MICRO-N-BEARING SANDY SILTSTONE which is a baked sediment.

SS 1-70		SS CC[1]		SS CC[2]	
Q	-50%	Q	-50%	Q	-29%
Mi	-TR	Mi	-TR	Fd	-TR
HM	-TR	CM	-38%	Mi	-TR
CM	-40%	MicroN-	7%	HM	-TR
G	-TR	Auth. Cal.	- 5%	CM	-60%
MicroN-	7%	Sd	-10%	Py	- 1%
Auth. Cal.	- 2%	ST	-40%	MicroN-	10%
Sd	- 7%	CL	-50%	Auth. CO_3 as veins	
ST	-43%				
CL	-50%				

Site 280 Hole A Core 23 Cored Interval: 519.0-524.0 m

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
					1	0.5, 1.0	VOID, MN 		
					2				140
		N	–		3				46
		N	–		4				

LITHOLOGIC DESCRIPTION

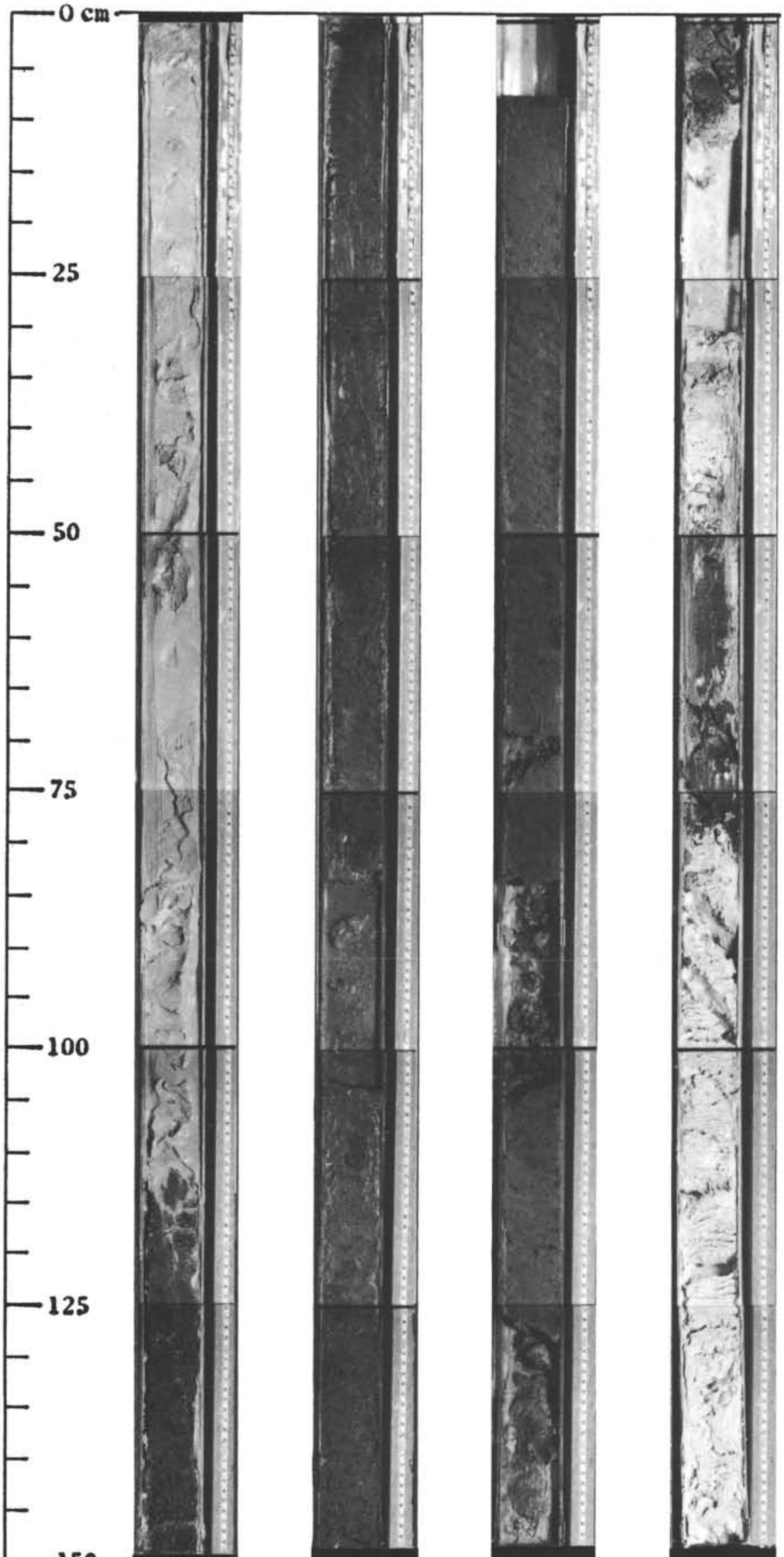
Greenish black (5GY 2/1) holocrystalline, subophitic fine-grained pyroxene-plagioclase INTRUSIVE BASALT. Extensive serpentinization also serpentine group mineralization + calcite mineralization in veins: lower veins include pyrite. The top of the core is the least altered. Rock (where mineralized) breaks up through swelling on contact with water. Highly serpentinized contact (Sec. 2, 135 cm) with close-spaced very fine veining to a greenish gray (5GY 6/1) quartz mica SILTY CLAYSTONE; lithified olive black calcite-mineralized mica-quartz SANDY SILTSTONE and a light olive gray to grayish olive intensely veined and extensively mineralized CLAYEY SILTSTONE. At 55 cm, Sec. 3 is a gradational contact to a greenish black, extensively veined and mineralized (altered) fine-grained pyroxene-plagioclase BASALT. At 110 cm, Sec. 3 is a sharp contact to very light gray chertified and pyritized SILTY CLAYSTONE, grading to olive gray, lithified, massive SANDY SILTSTONE grading to grayish olive, crinkle-veined (calcite) SANDY SILTSTONE which is lithified; olive gray again at the base. Below is a gray/very light gray chertified SILTY CLAYSTONE with abundant calcite-pyrite veins and a gradational contact to fine grained, greenish black, holocrystalline, subophitic intrusive BASALT; close-spaced veins of calcite and serpentine group minerals near top; wider spaced lower down. Lowest part (>10 cm) is a relatively fresh, fine-grained OLIVINE BASALT with olivine phenocrysts with serpentinized veins.

= calcite veins

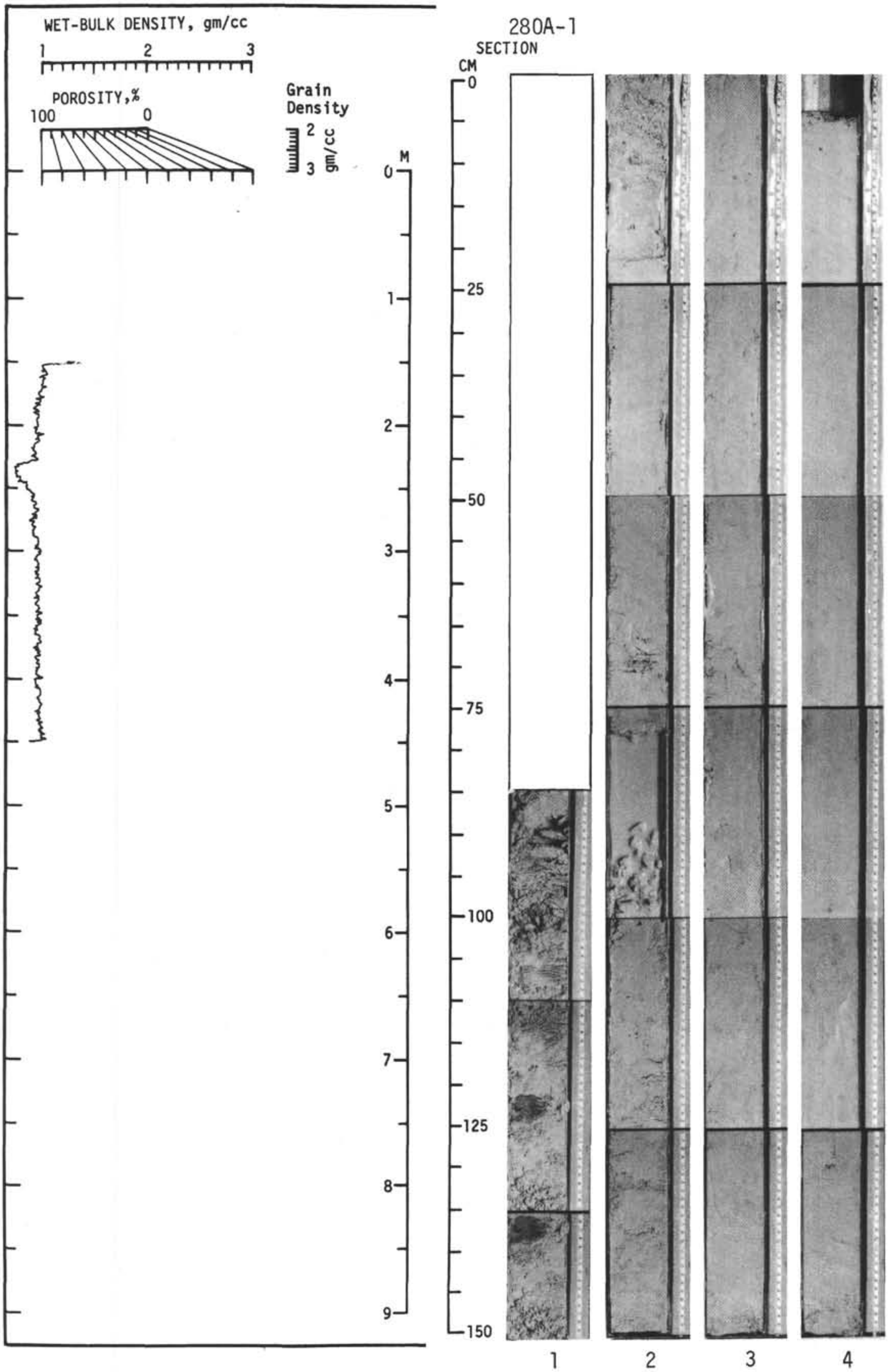
= serpentine group veins

MN nodule - from seafloor?

Explanatory notes in Chapter 1



280-1-1 280-1-2 280-1-3 280-1-4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Grain Density
2 3 gm/cc
M
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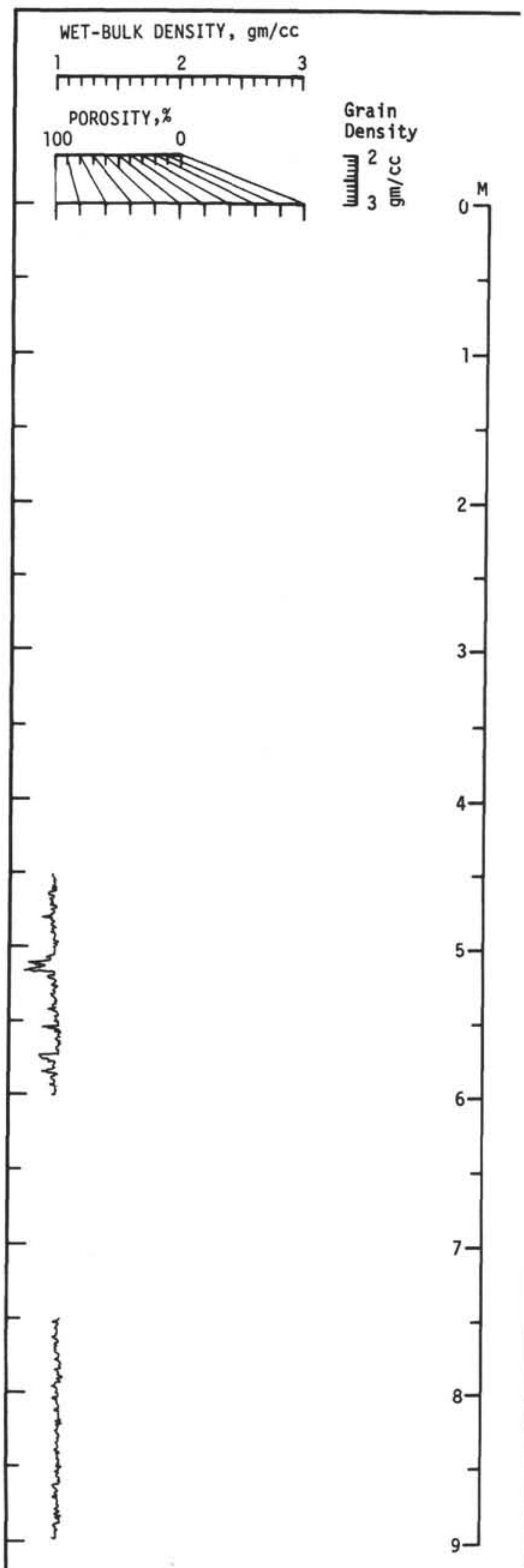
SECTION
CM
1 2 3 4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Grain Density
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M
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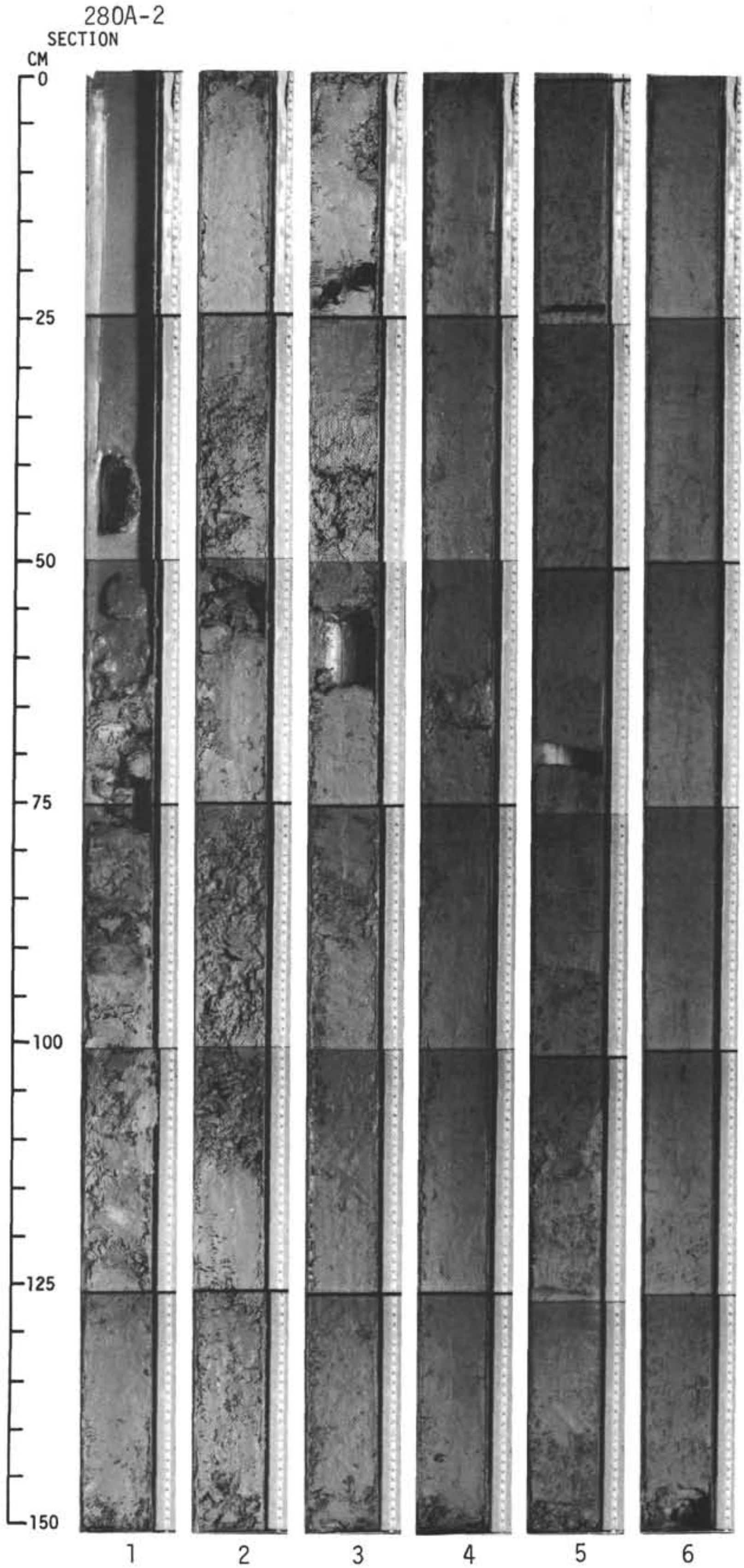
6
7
8
9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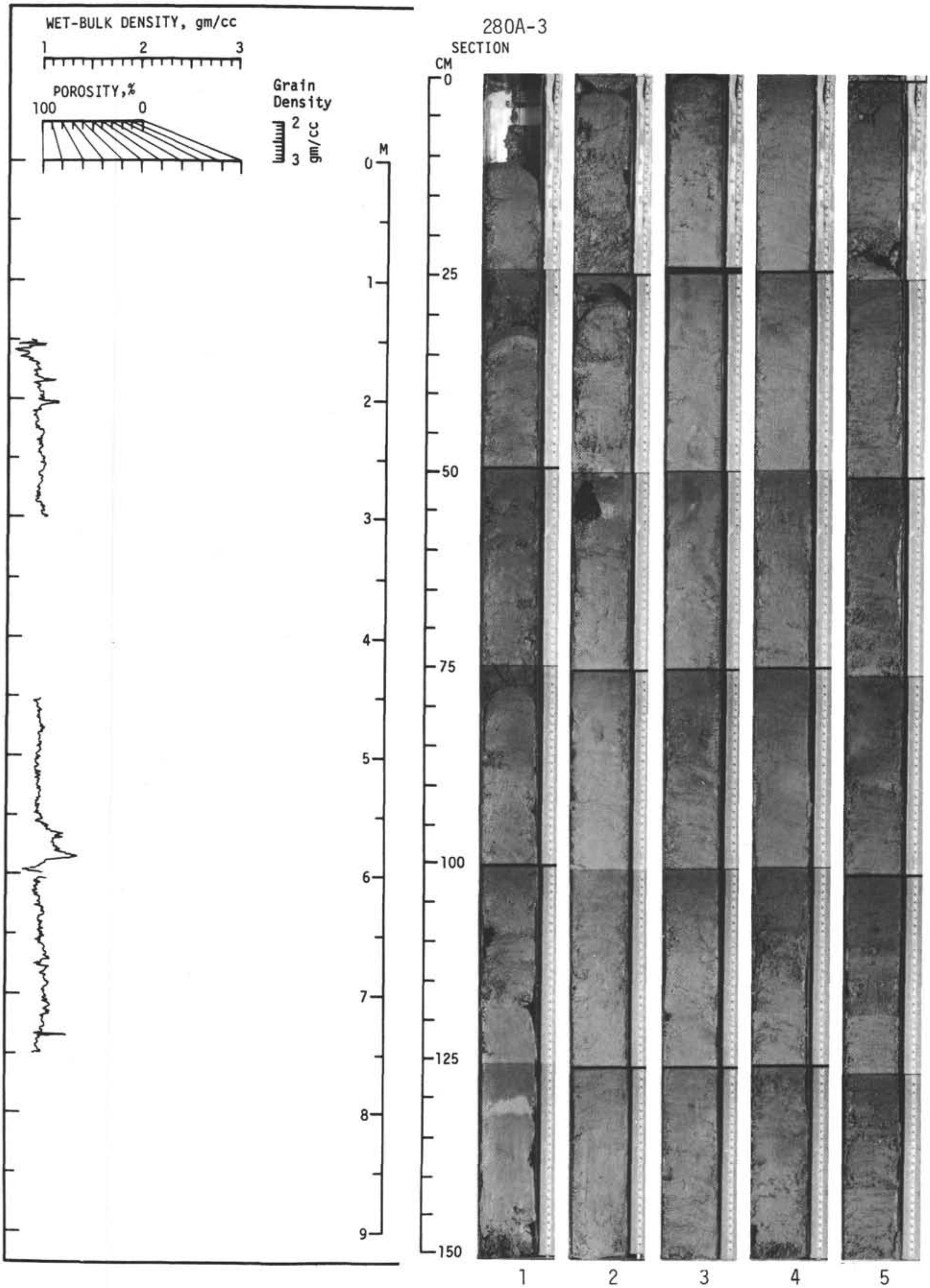
50
75
100
125
150
1 2 3 4 5 6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3
POROSITY,%
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Grain Density
2
3
gm/cc
M
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1
2
3
4
5
6
7
8
9
280A-3
SECTION
CM
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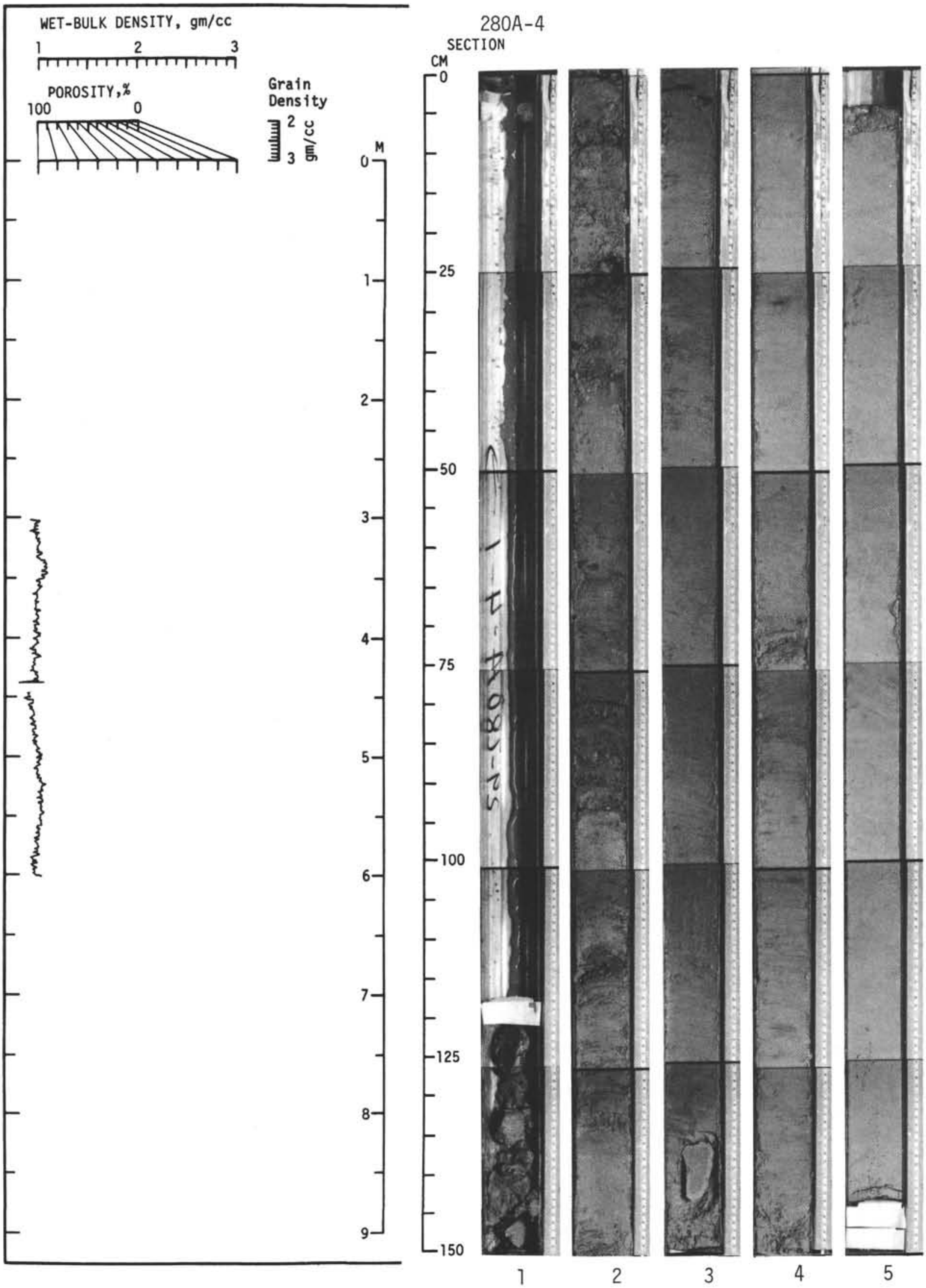
50
75
100
125
150
1
2
3
4
5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Grain Density
2
3
gm/cc
M
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2
3
4
5
6
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9
280A-4
SECTION
CM
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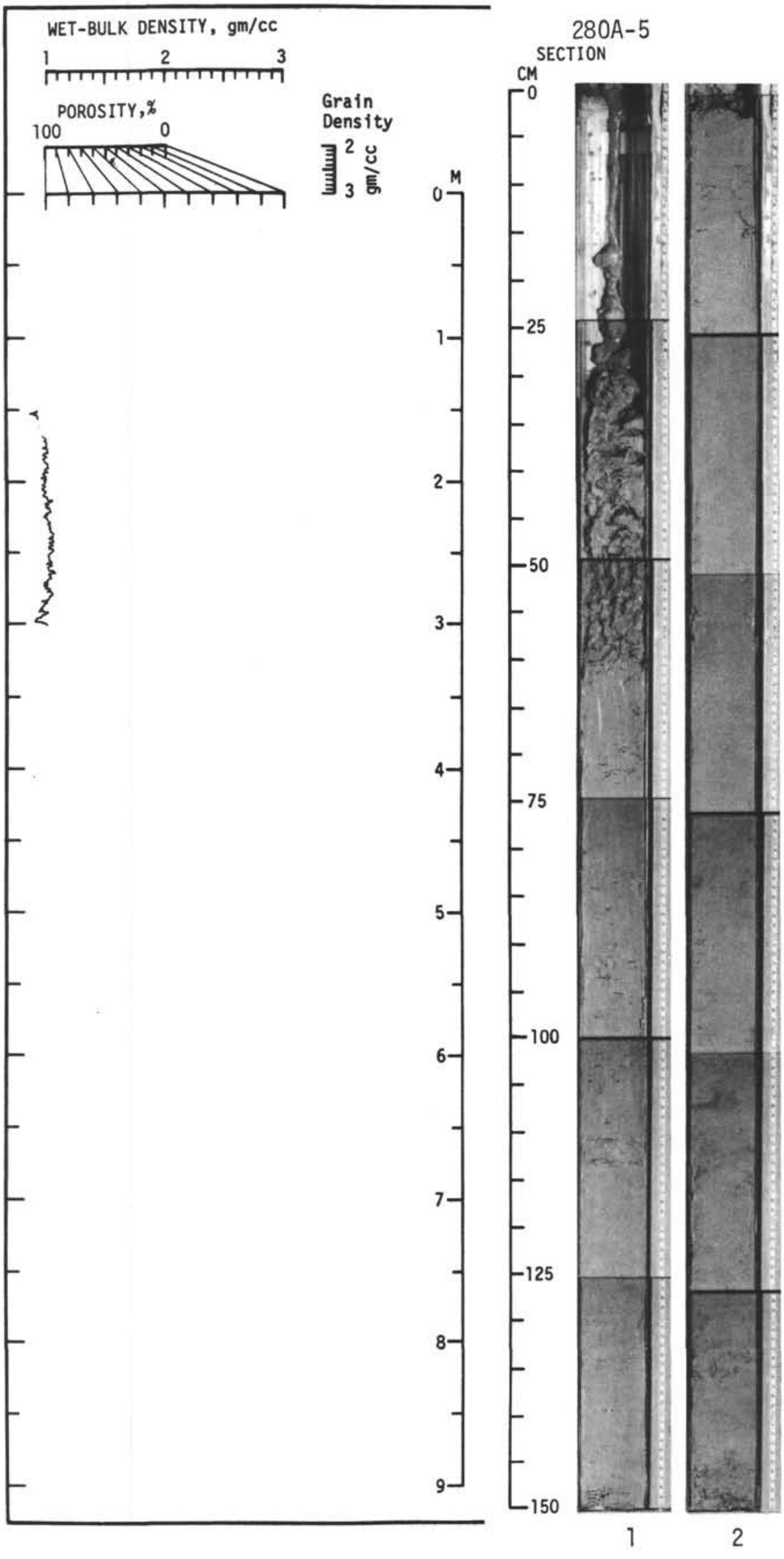
25
50
75
100
125
150
1
2
3
4
5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gm/cc
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1
2
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SECTION
CM
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50
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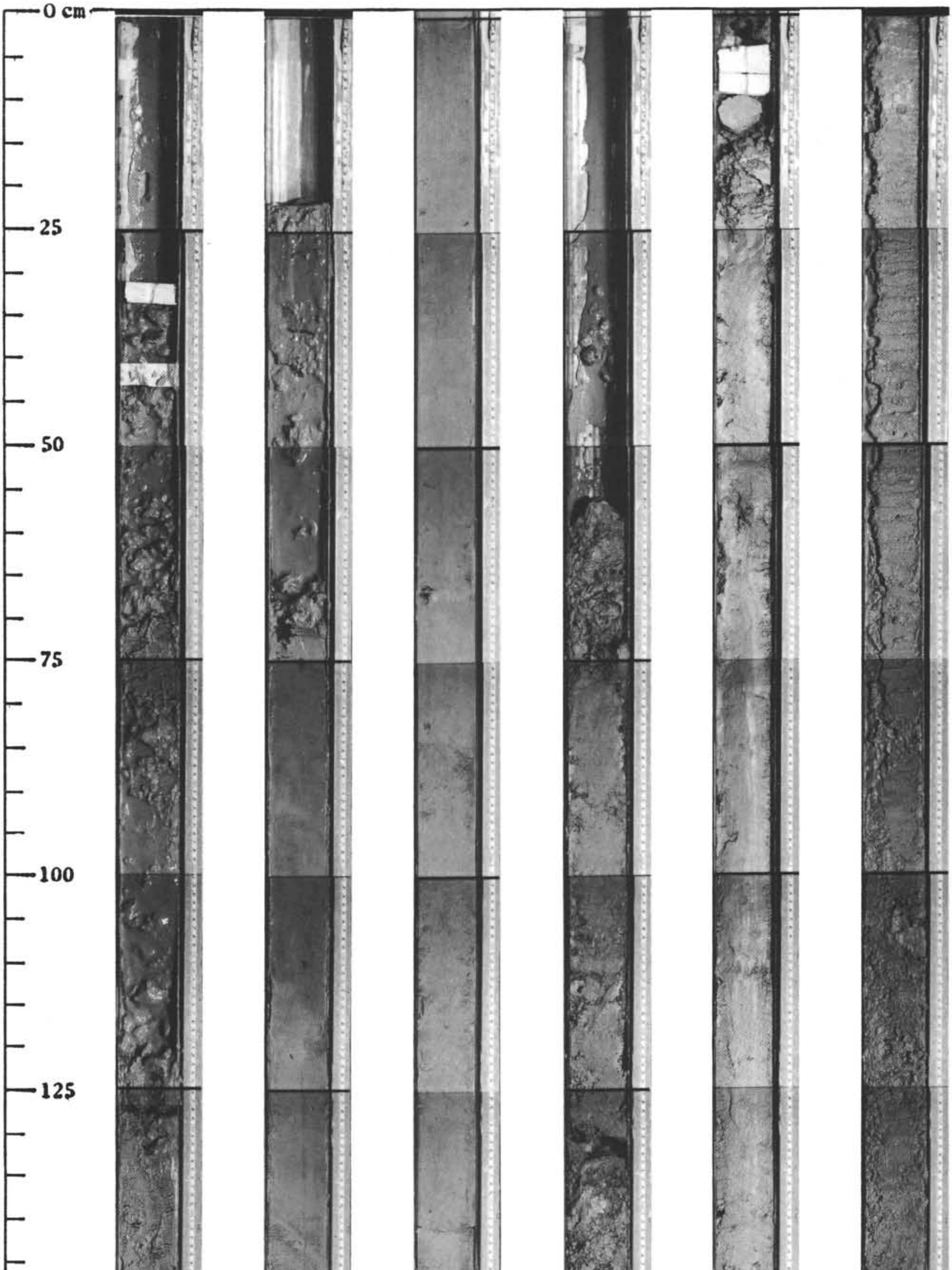
1
2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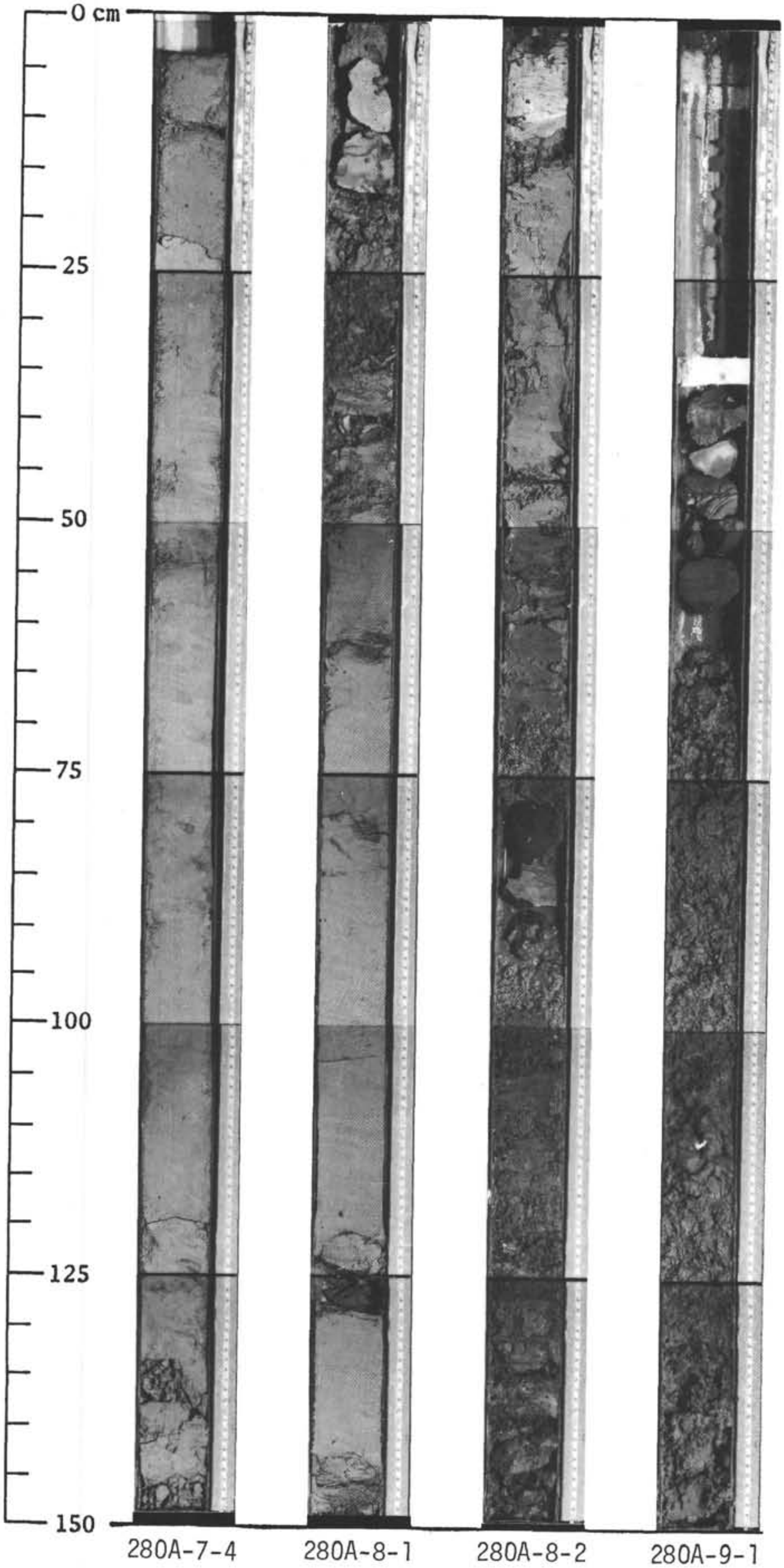
280A-7-3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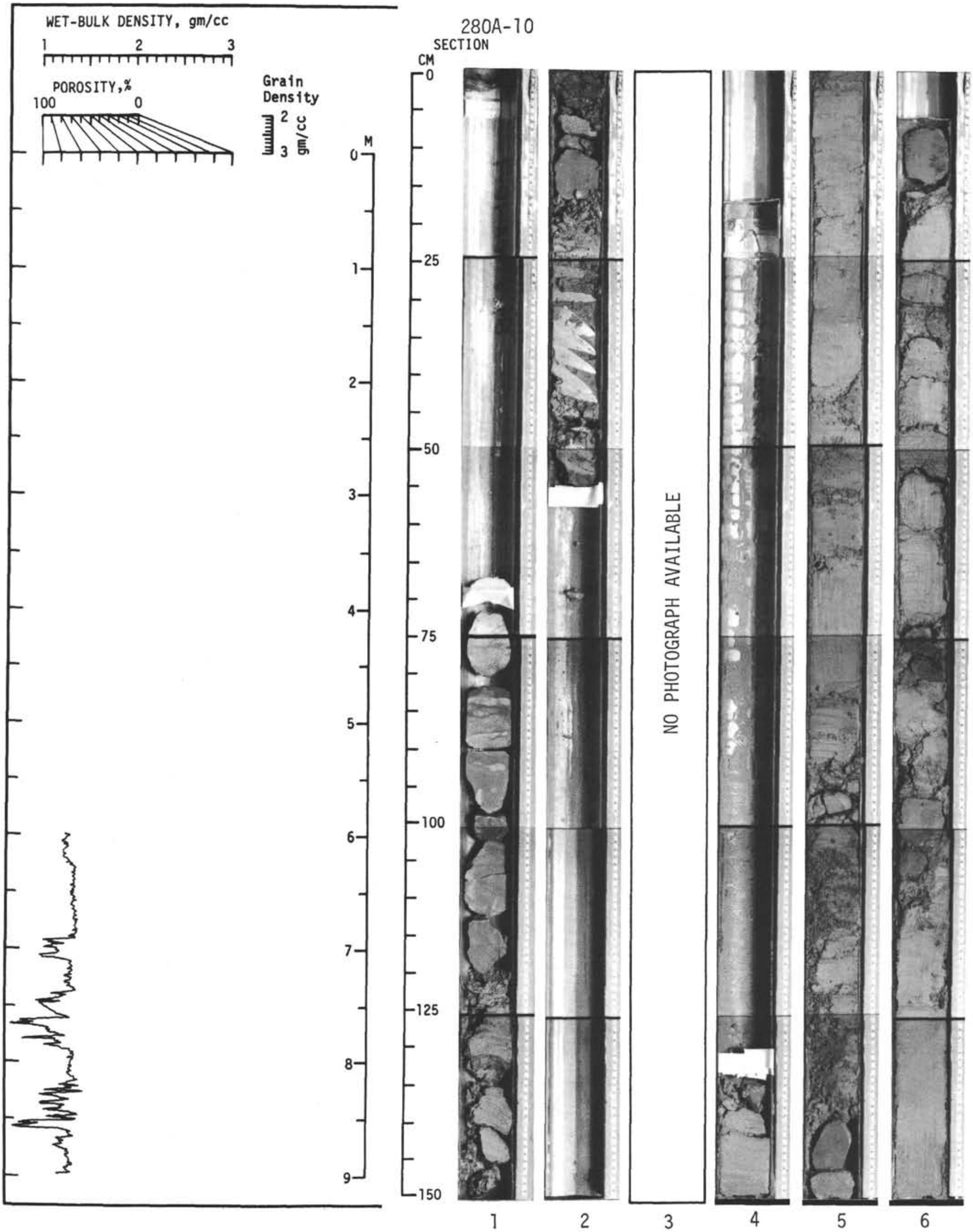
280A-8-1
280A-8-2
280A-9-1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POROSITY,%
Grain Density
gm/cc
M
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CM
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4
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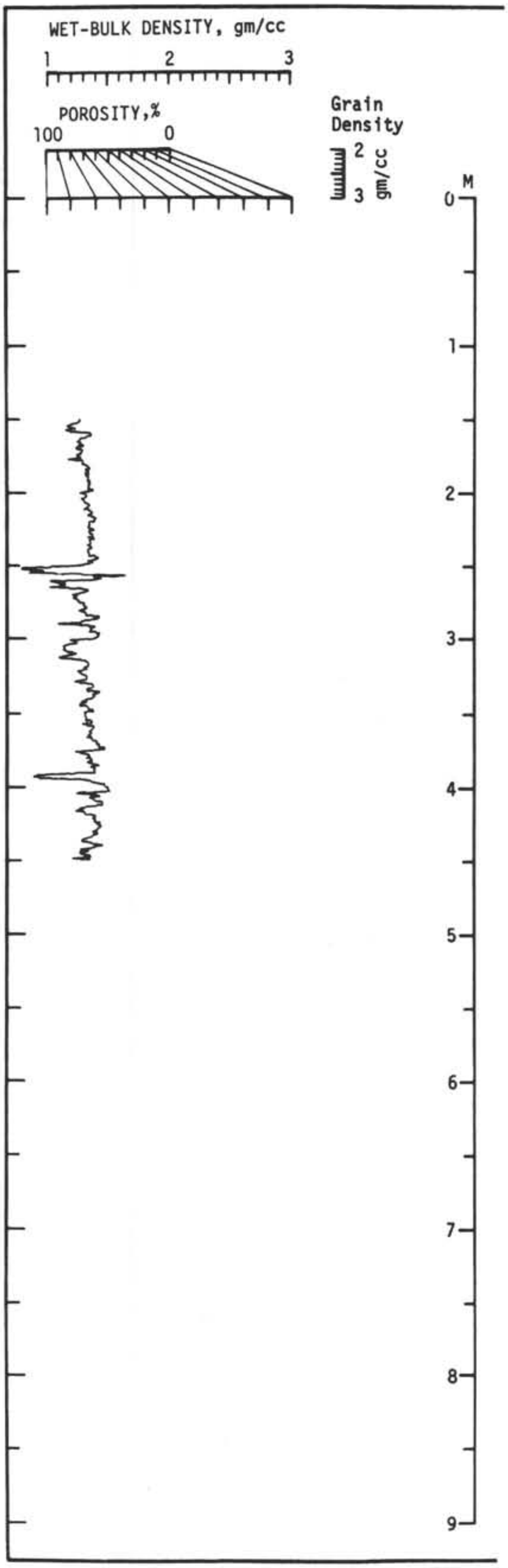
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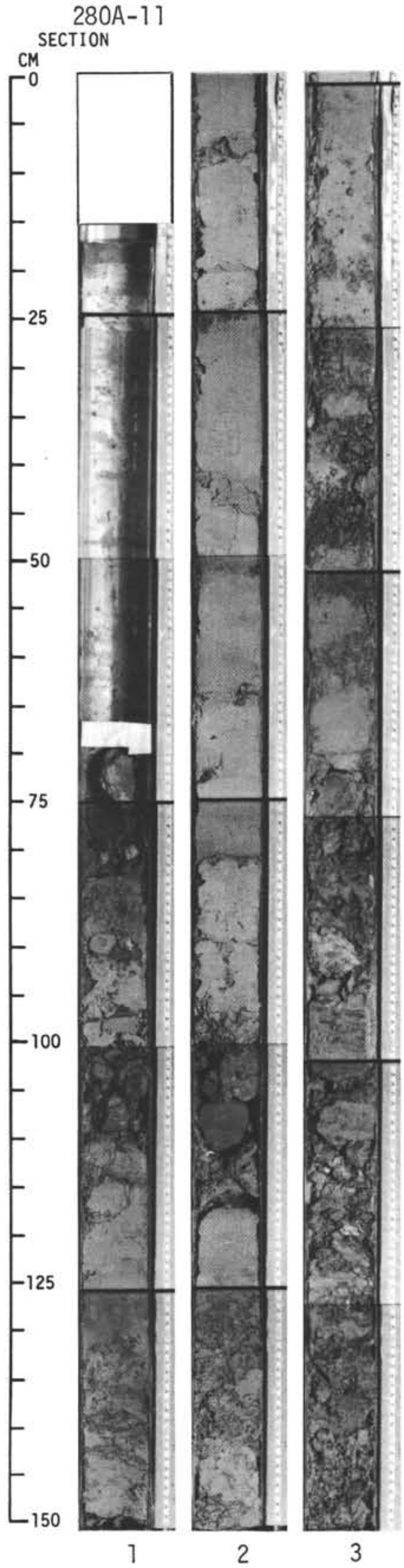
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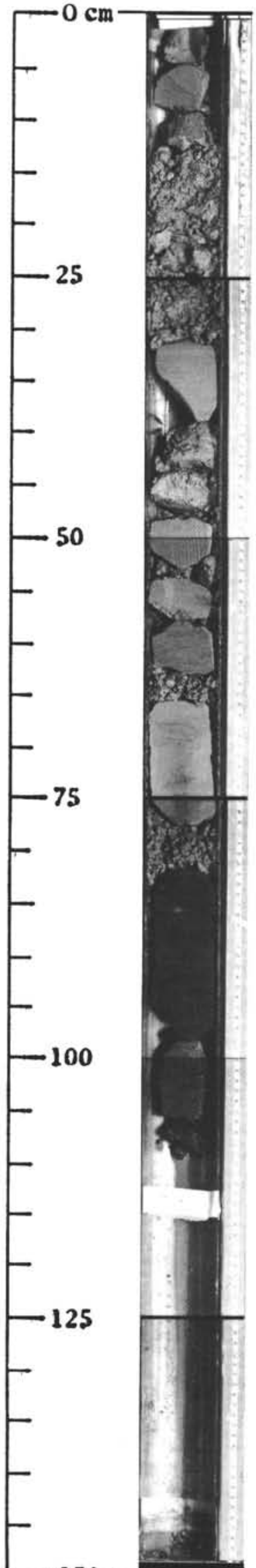

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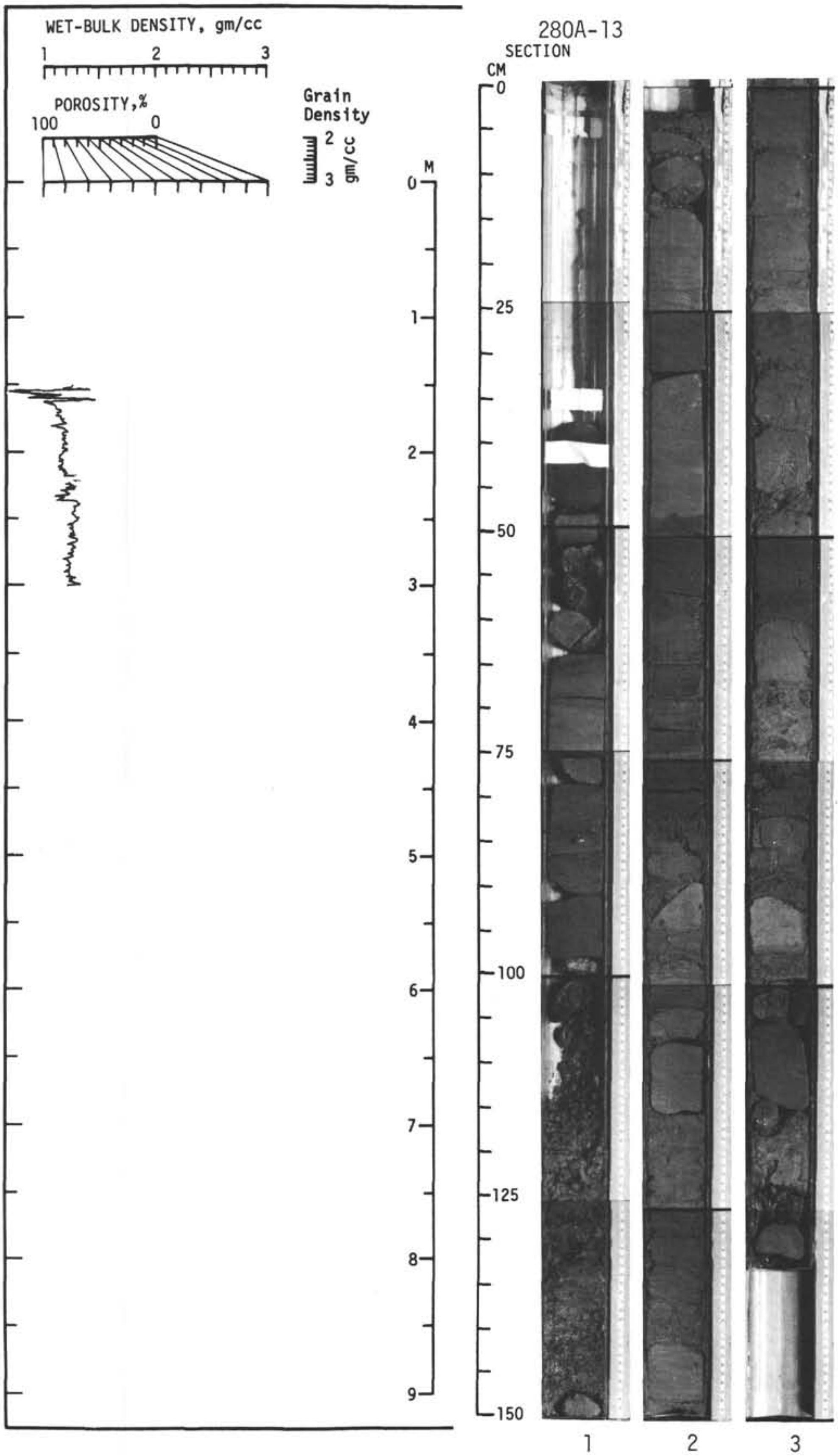
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Grain Density
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gm/cc
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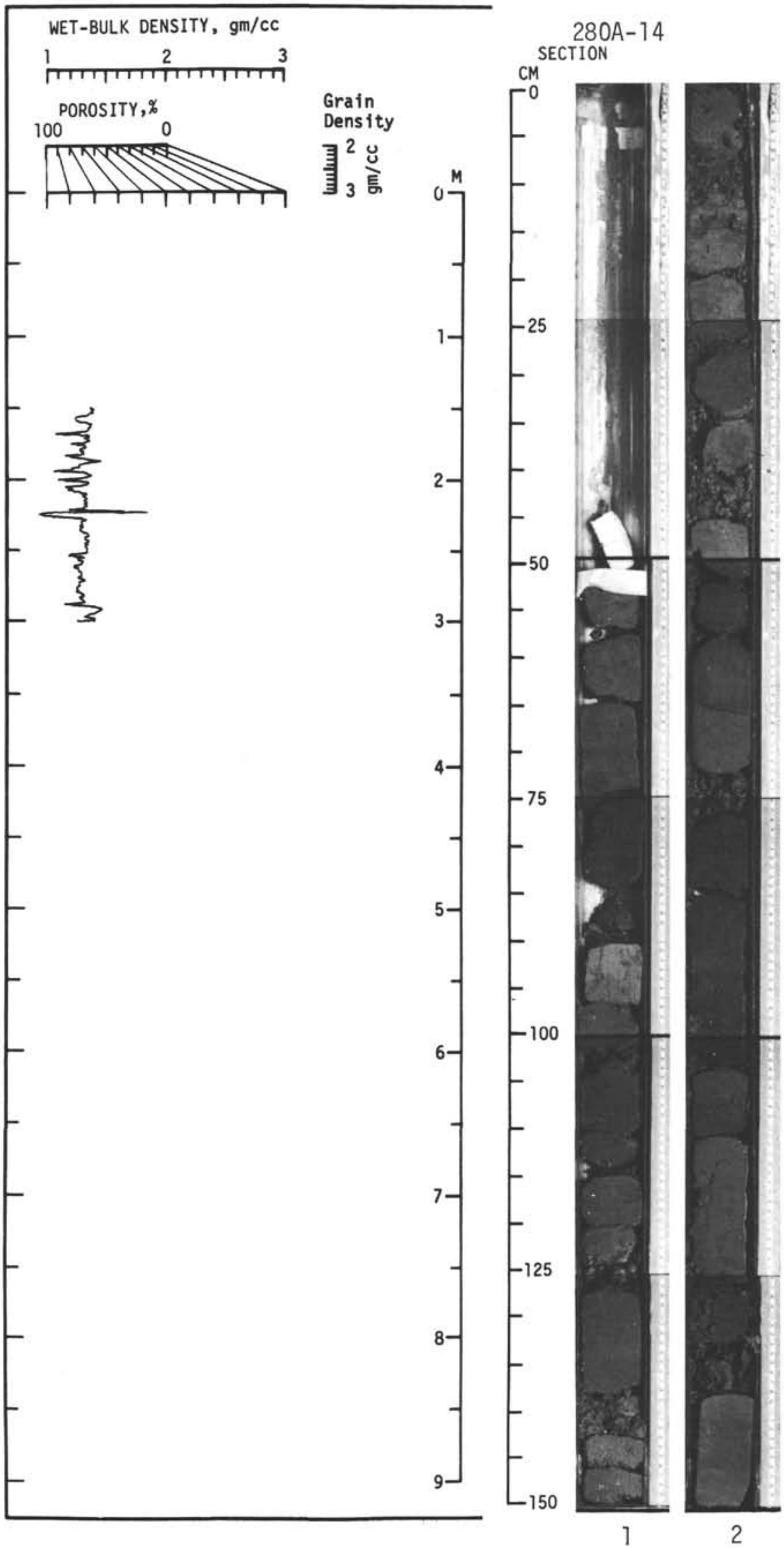
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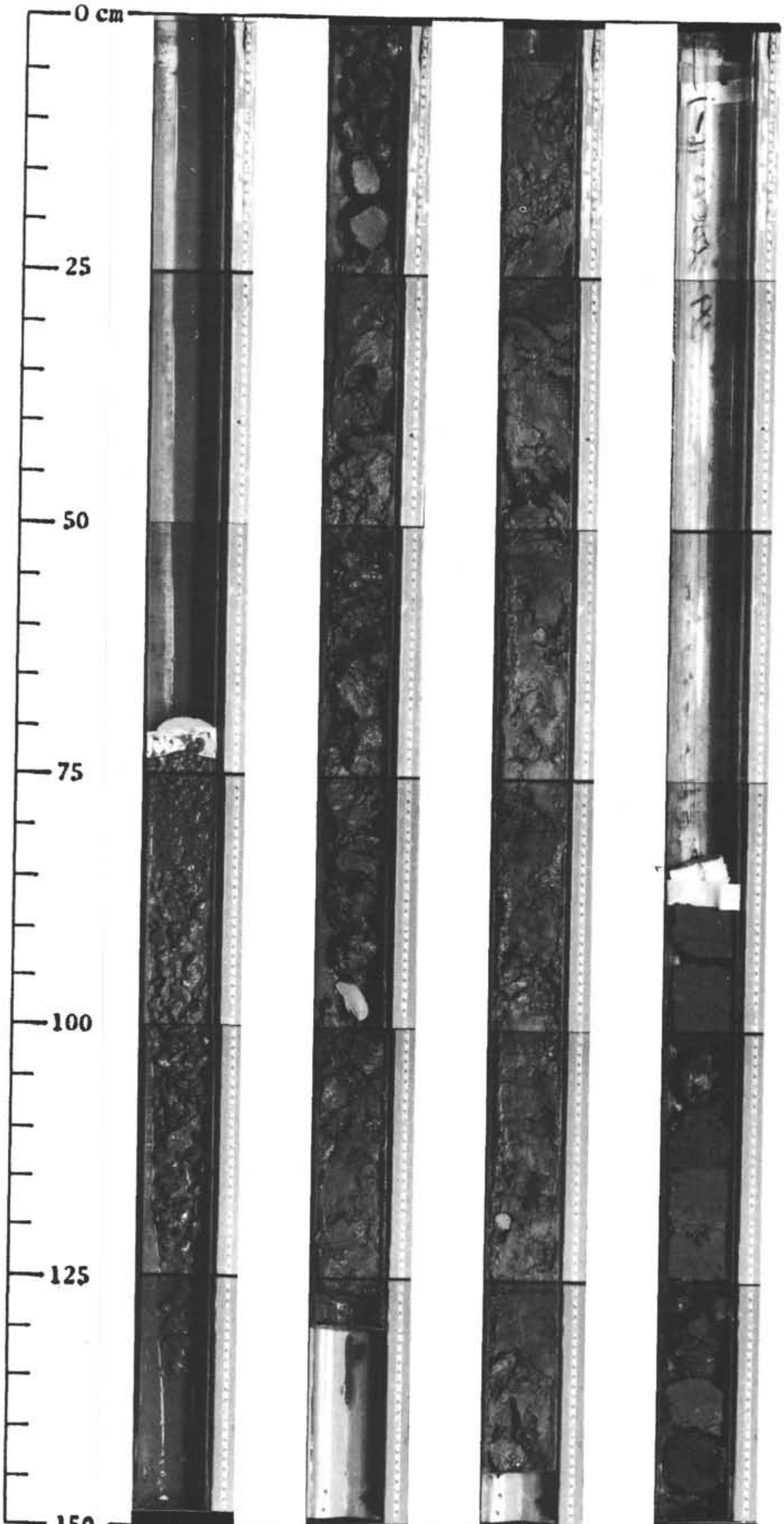
1 2



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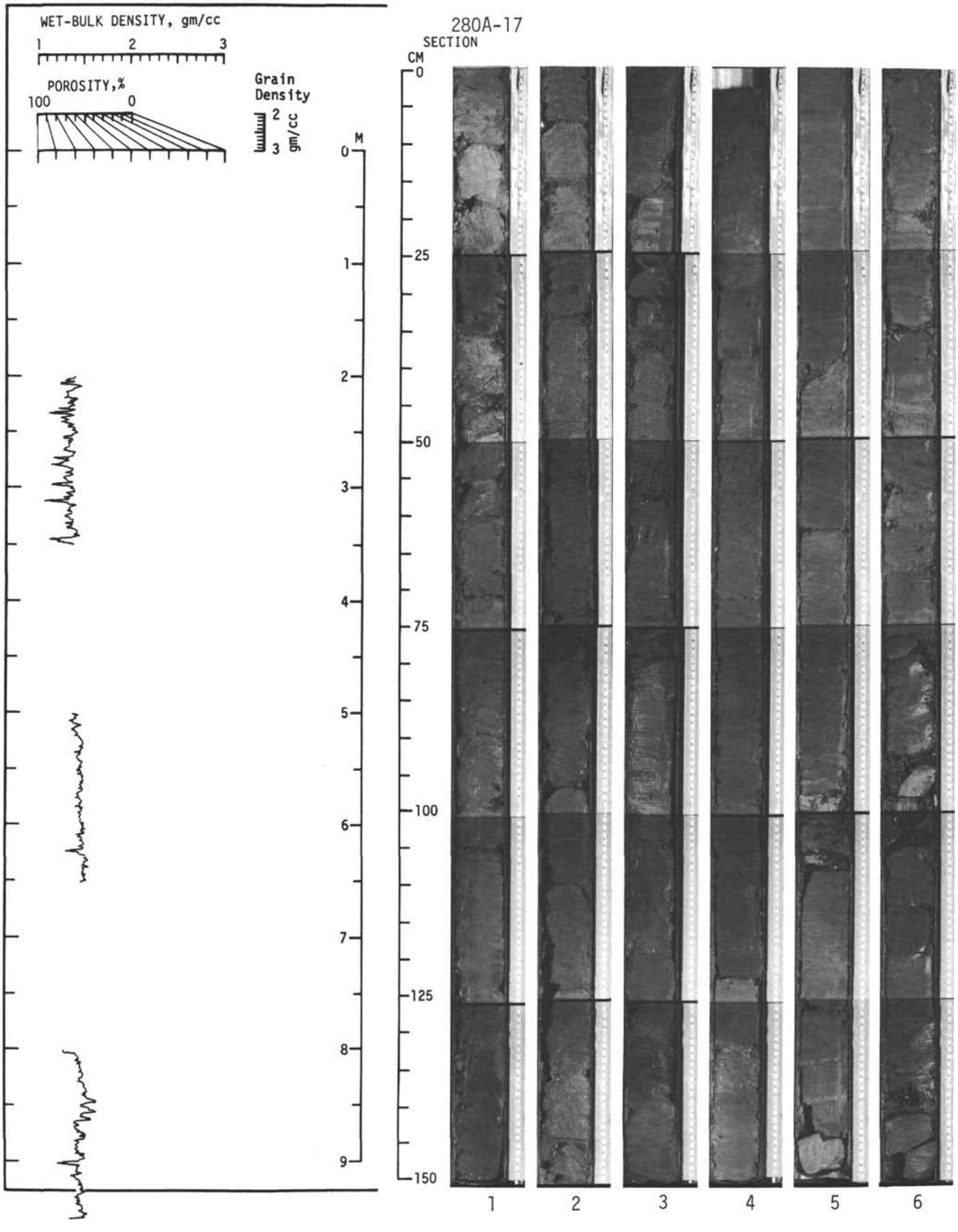
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2
3
gm/cc
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3
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5
6
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CM
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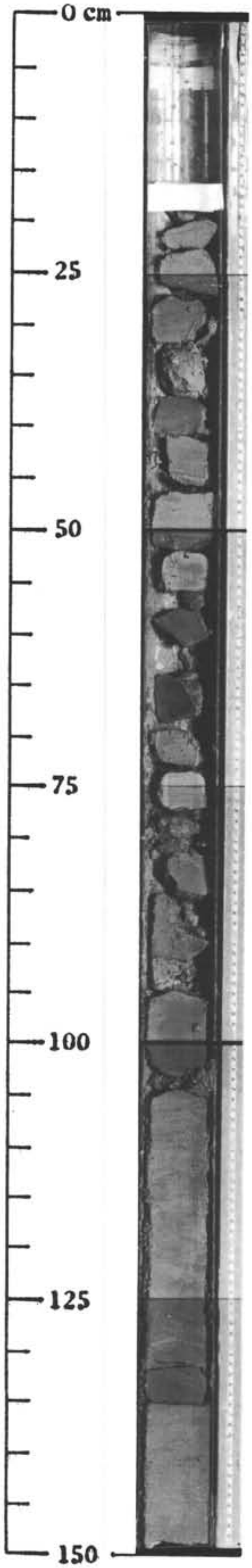
6



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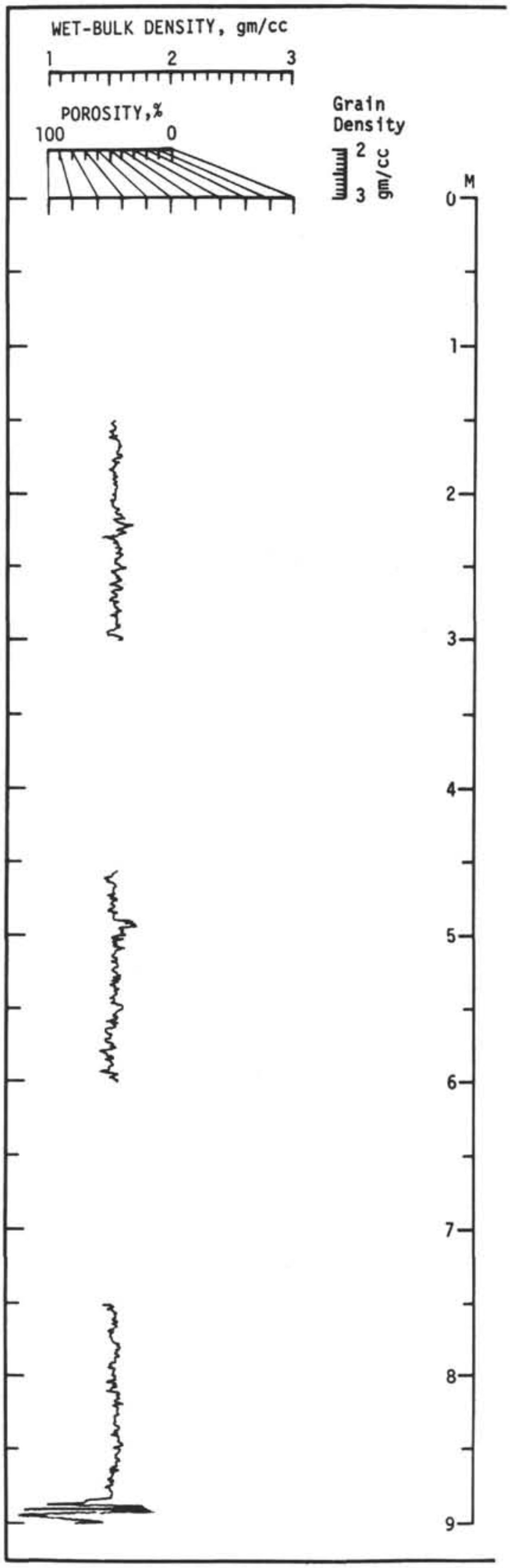
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Grain Density
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3
gm/cc
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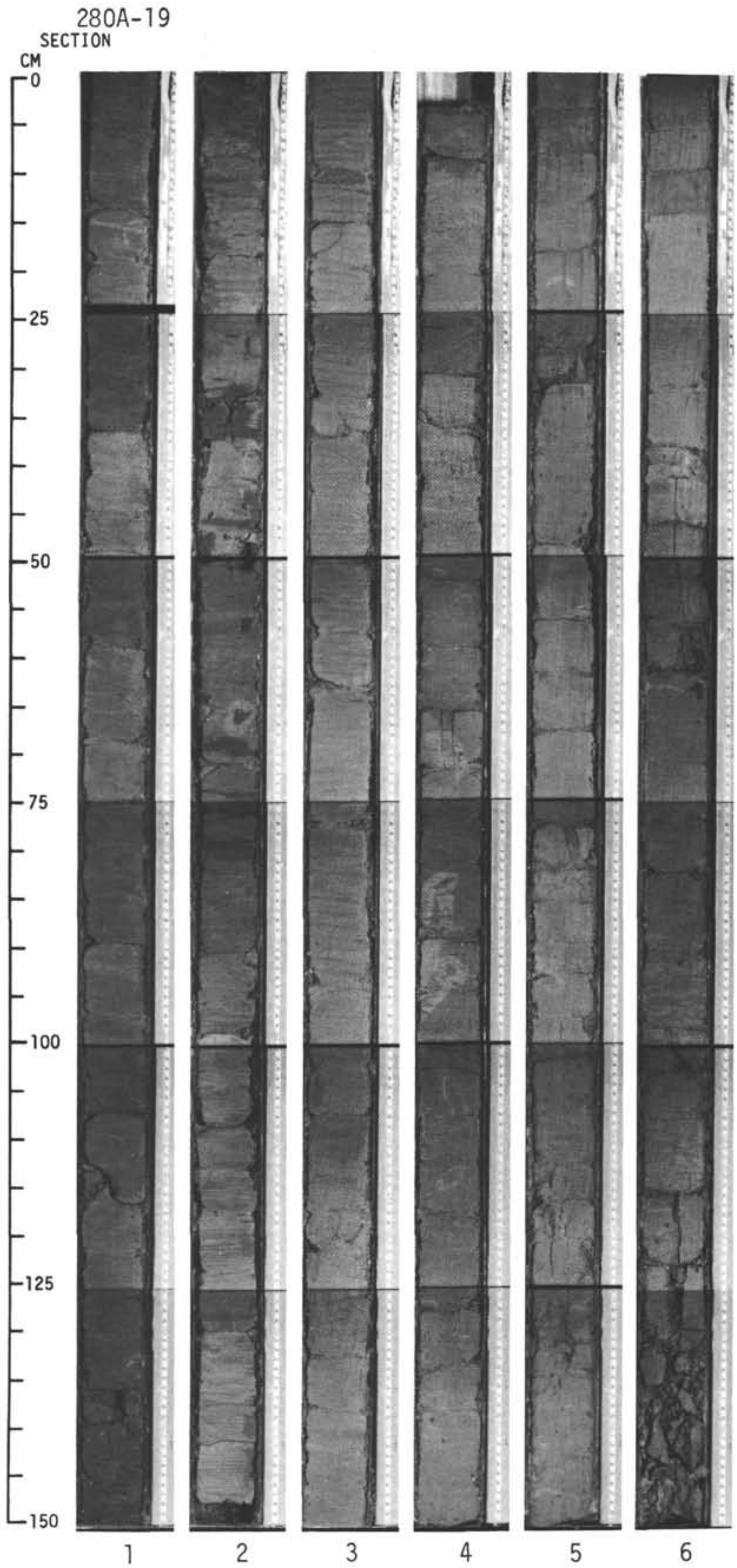
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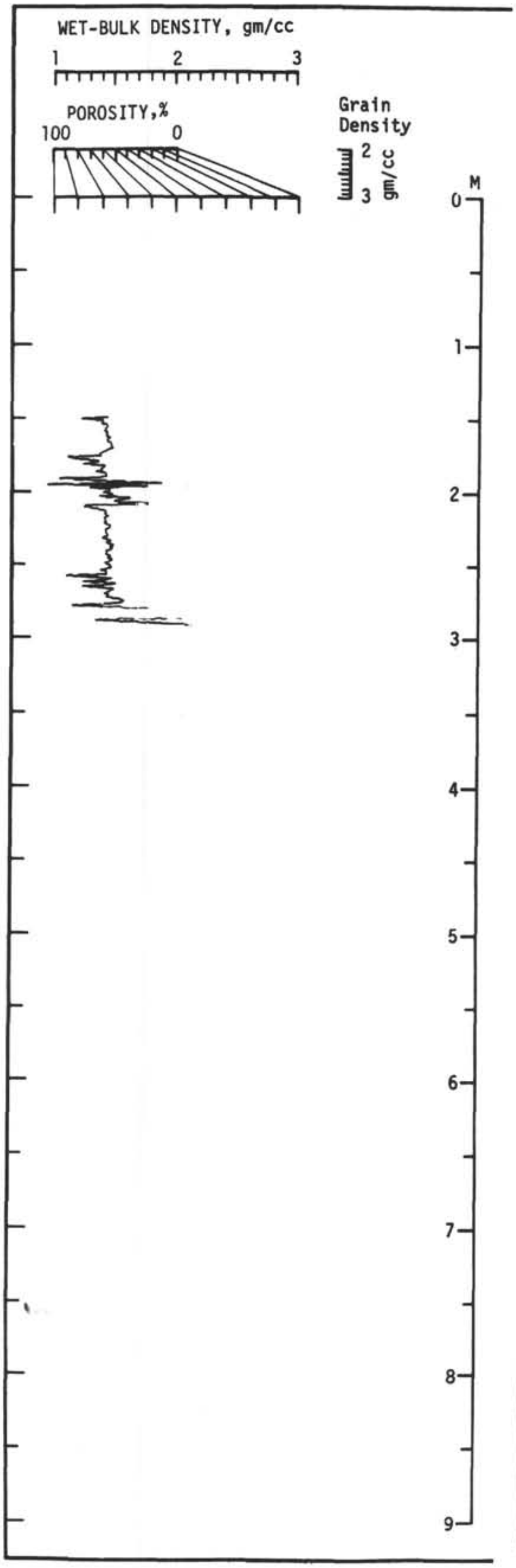
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Grain Density
2 3 gm/cc
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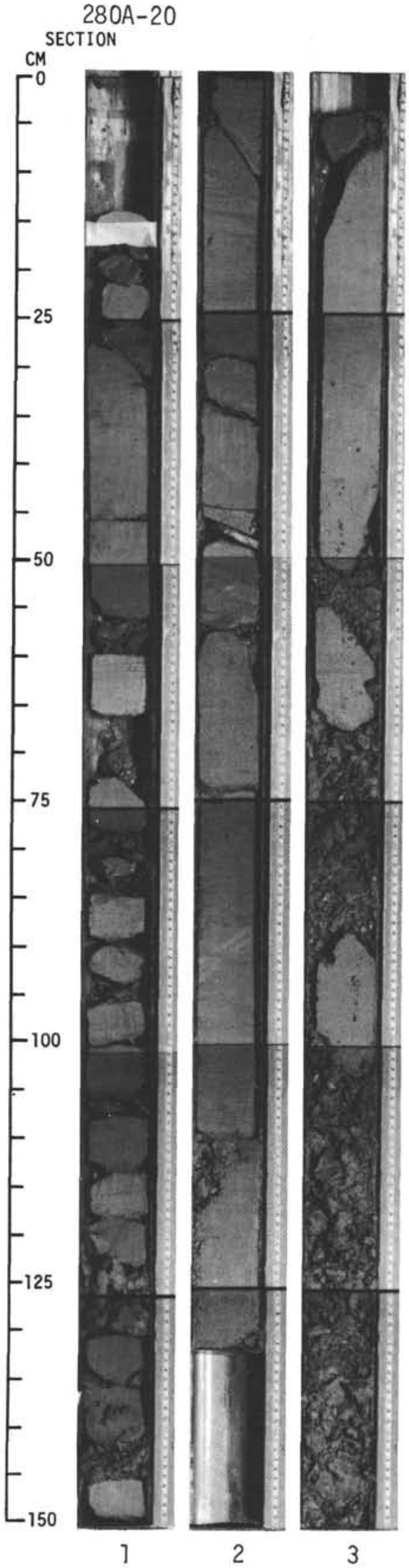
8
9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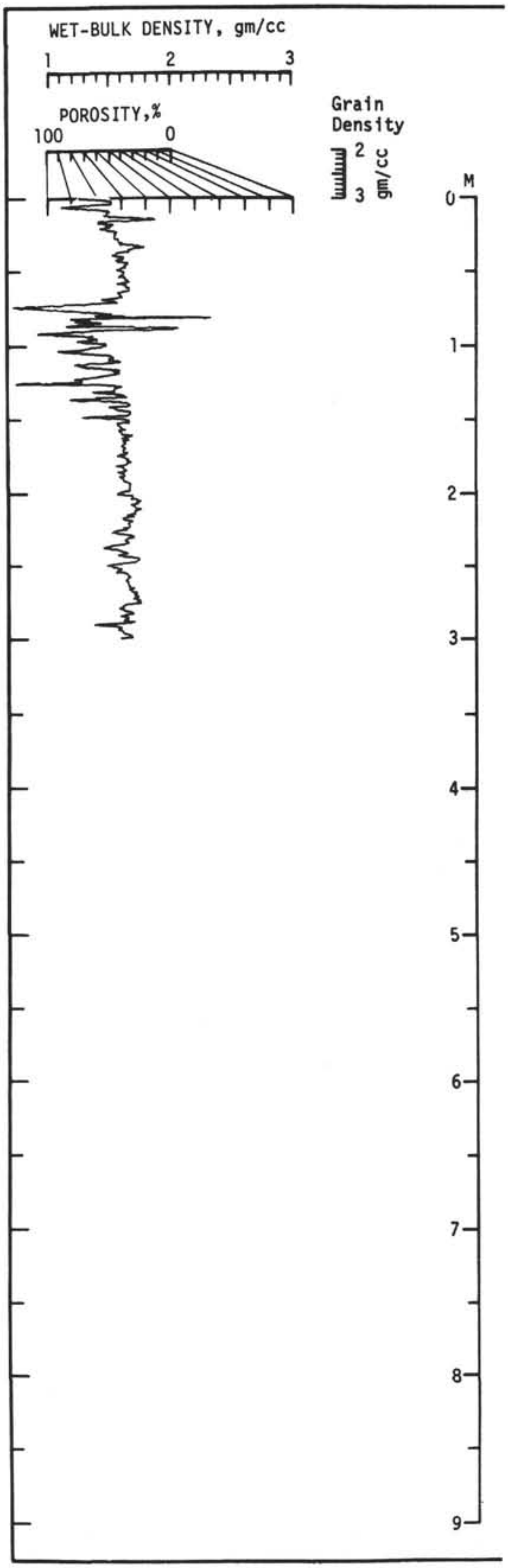
150
1 2 3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Grain Density
2
3
gm/cc
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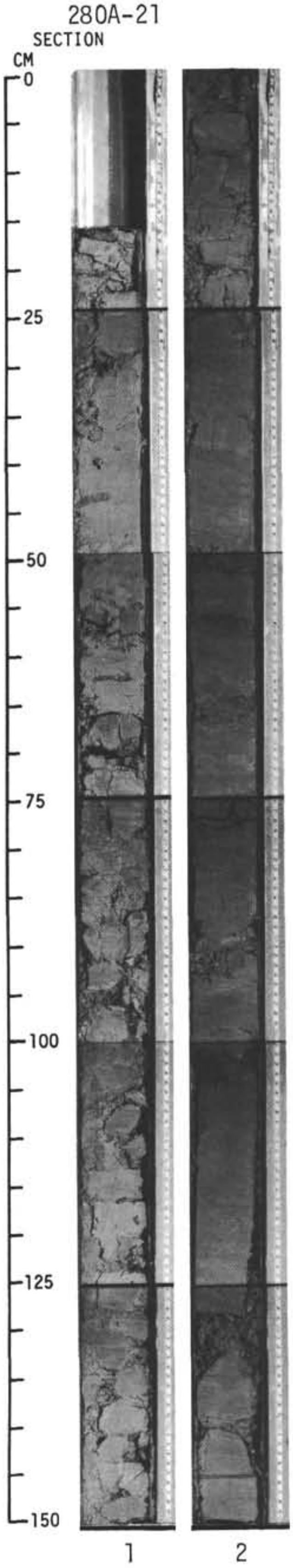
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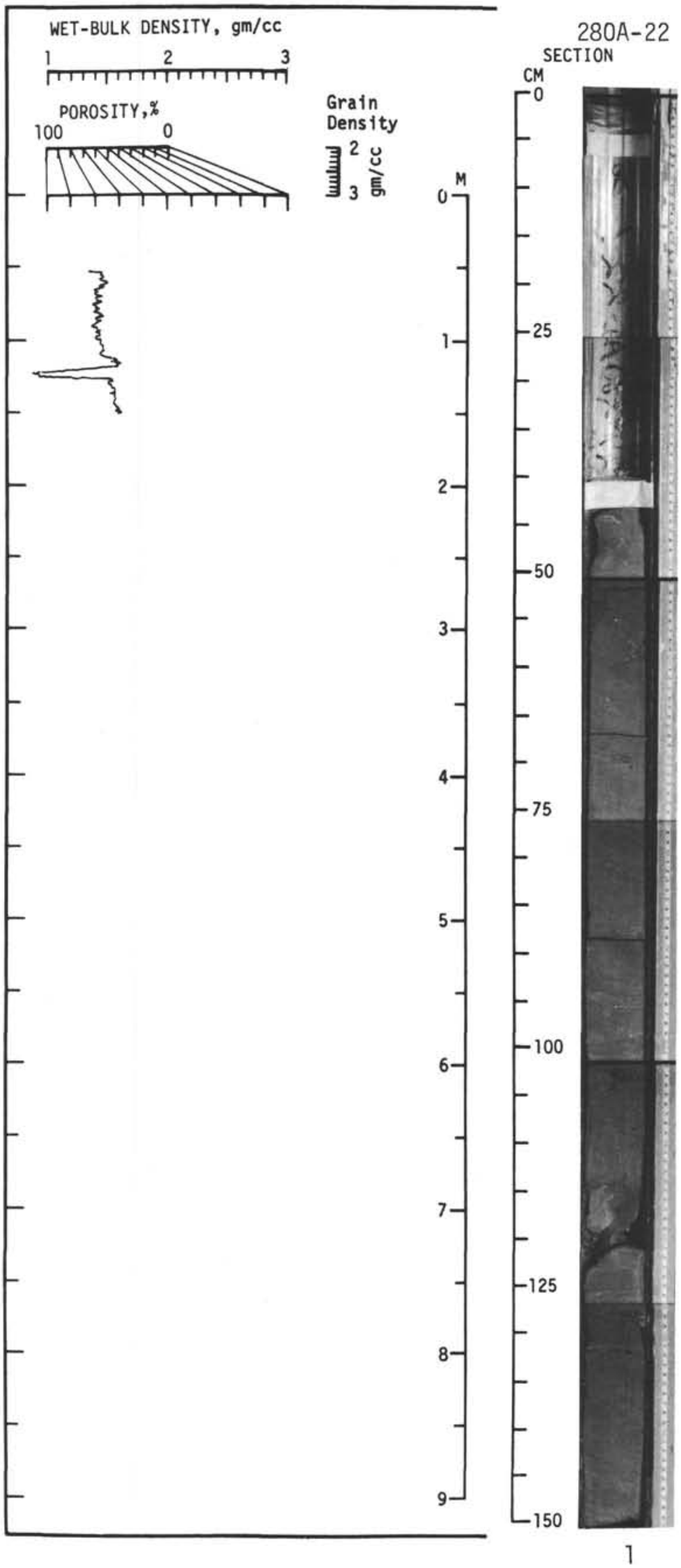
2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POROSITY,%
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Grain Density
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gm/cc
M
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1
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9
280A-22
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CM
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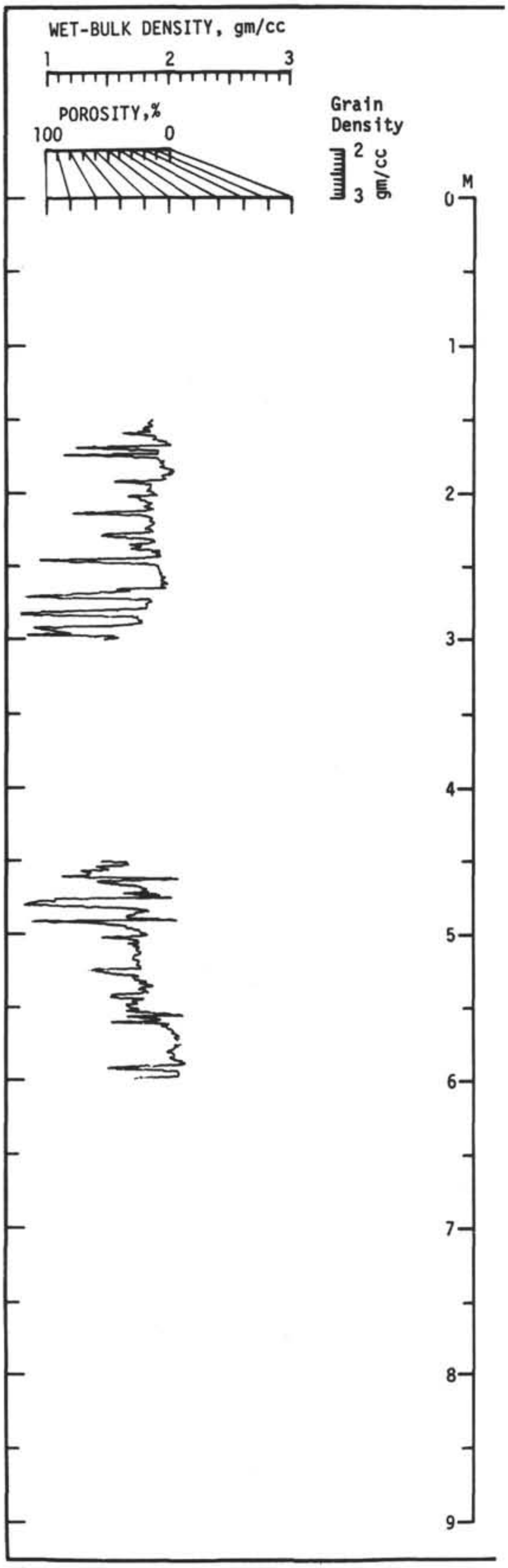
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Grain Density
2
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gm/cc
M
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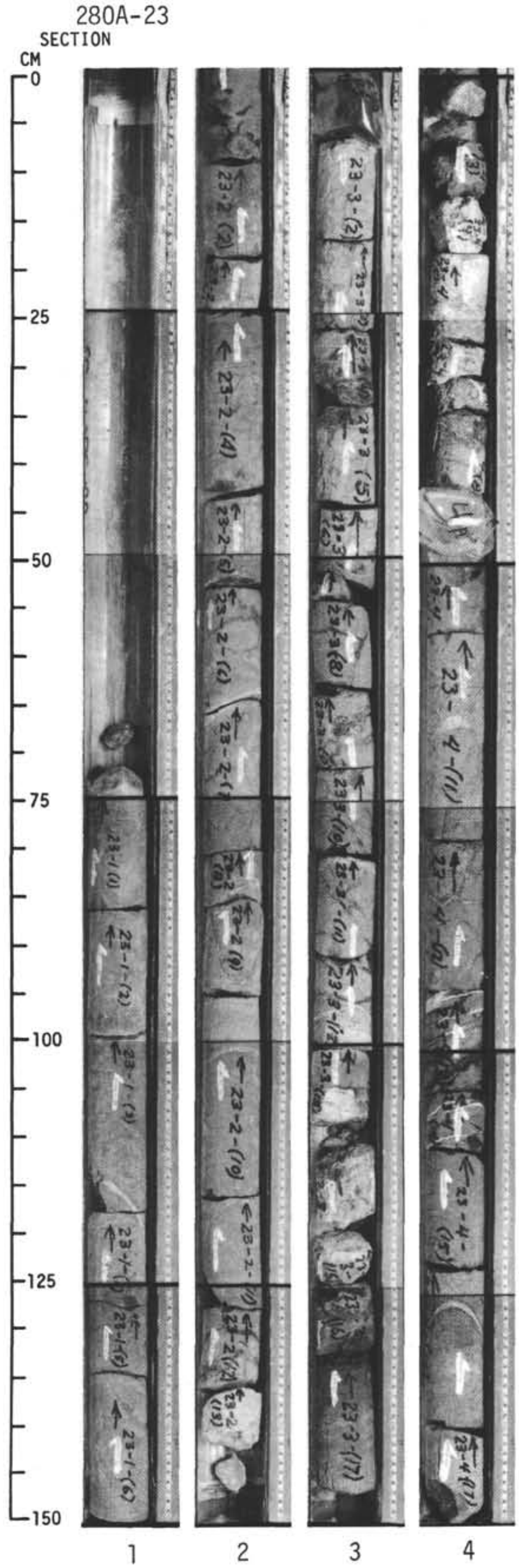
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150
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