8. SITE 237

The Shipboard Scientific Party[1]

SITE DATA

Date Occupied: 5 June 1972

Date Departed: 9 June 1972

Time on Site: 93 hours, 30 minutes

Position:
Latitude: 07°04.99'S
Longitude: 58°07.48'E

Water Depth: 1623 corrected meters (echo sounding)

Bottom Felt At: 1640 meters (drill pipe)

Penetration: 693.5 meters

Holes Drilled: 1

Number of Cores: 67

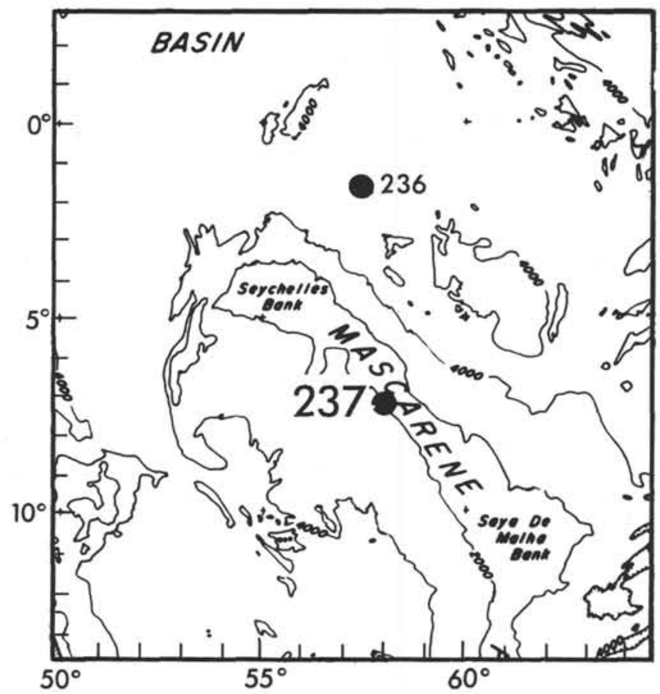
Total Length of Cored Section: 627 meters

Total Core Recovered: 312.1 meters

Acoustic Basement: Not reached

Age of Oldest Sediment: Lower Paleocene

Principal Results: This site is located on the Mascarene Plateau in a saddle between the Seychelles and Saya de Malha Bank. It was cored continuously to 373.5 meters, then drilled one joint. Thereafter, it was cored to 582.5 meters. From 582.5 meters to the bottom of the hole at 693.5 meters, the hole was alternately drilled and cored. One hole was drilled at this site. The sediment section consists of 225 meters of foram-rich nanno ooze overlain by 85.5 meters of nanno ooze. The remainder of the section consists of 91.5 meters of partly lithified and silicified nanno chalk with chert stringers, 19 meters of glauconitic foram-bearing nanno chalk, and 272.5 meters of foram-bearing nanno chalk. The complete section ranges from Pleistocene to lower Paleocene: Pleistocene 0-25.5 meters; Pliocene 25.5-82.5 meters; Miocene 82.5-187 meters; Oligocene 187-209 meters; Eocene 209-348 meters; and Paleocene 348 meters to base of sediment.



BACKGROUND AND OBJECTIVES

Pre-Cambrian granites, criss-crossed or laced by early Tertiary mafic dikes, form Seychelles Bank proper, but the extent of silicic material southeast toward Saya de Malha, or perhaps south into the northern portion of Mascarene Basin, remains a matter of controversy. From seismic refraction evidence (Shor and Pollard, 1963), Saya de Malha, and perhaps the extensive shoals reaching to basaltic Mauritius, are composed of basaltic volcanic rock capped by corals. A first-priority and perhaps very time-consuming hole should be sited in the intermediate depth saddle between Seychelles Bank and Saya de Malha in a fault-bounded region of nondescript magnetics (Fisher et al., 1967). Such a project, carried to basement, would solve the questions of foundation age and the petrologic affinity of Mascarene Plateau northwest of the segment extending south-southwest from Saya de Malha. The latter structure may be attributable to north-to-south volcanism on the trace of an early Tertiary transform fault of major proportions (Fisher et al., 1971). Furthermore, the lithologic and biostratigraphic data would establish the rate and continuity of subsidence of what is almost certainly a very thick shallow-water calcareous assemblage on a massive igneous base.

A 1964 profile by R/V *Chain* (Bunce et al., 1966) indicated that flat-lying reflectors, perhaps coralline

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material, capped the broad saddle near 7°S. That region was explored by R/V *Melville* early in 1971 on the ANTIPODE Expedition. A detailed site survey in a smooth crestal region of nondescript magnetics (except where obviously associated with dikes or border faulting) gave good seismic records with apparent penetration to a particularly strong reflector (at 0.2 to 0.9 sec) with moderate surface relief and evidence of faulting. Locally, in areas where the strong reflector is deep, a fairly discrete reflector lies above this zone, and faint reflectors, that do not appear to be multiples, occur below it. Shallow reflectors tend to be contorted, compacted, and subdued. At the site proposed (24-8), the first marked reflector comes to 0.25 sec with deeper faint reflectors at 0.52 and 0.7 sec. Figure 1, based primarily on *Melville's* 1971 exploration,[2] shows that the west side of the ridge is steep, trending northwest with a volcanic (?) rampart adjacent to the fault scarp. This rampart has high magnetic relief, too (see also Bunce et al., 1966). However, a dredge haul at 7°20.0′S, 57°56.3′E, at a depth of 2430→2265 meters, yielded solely cavernous and porous reef limestones coated with a thick carapace of manganese oxides. This occurrence suggests that the ancient reef area and its foundation may have been considerably more extensive, and may have been jostled and slivered by faulting, and intruded by large dikes. With subsidence, such dikes or peaks were then lapped by calcareous sediments and debris displaying faint layering on the profiles. A few miles northwest of the scarp, near proposed site 24-8, magnetic relief is low, and the basement—either volcanic or granitic (?)—may be more uniform.

To summarize, then, the aims of drilling this hole were:

1) To drill entirely through what probably is a subsided reef complex and some distance into the foundation (to whatever extent bit wear would allow). To establish whether this portion of Mascarene Plateau is granitic microcontinent (like the Seychelles block) or "oceanic basalt" (like the three Mascarene Islands and presumably the reef-capped banks to the south).

2) Ultimately to determine—paleontologically or radiochemically—a minimum age for the basement.

3) To sample the coralline (with lenses of chert or glauconite?) section in detail in order to elucidate rates and continuity of subsidence of an extensive reef complex on a very massive foundation, and the overall loading effect through time.

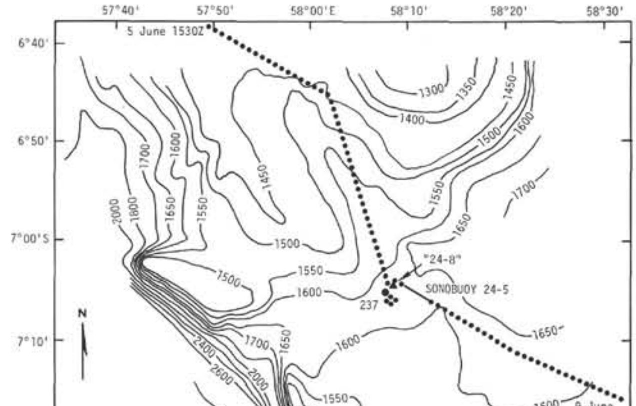

Figure 1. *Location of Site 237 and proposed site 24-8. Bathymetry based primarily on* Melville *1971 survey. Dotted line is track of* Glomar Challenger. *Contours in Matthews-corrected meters.*

OPERATIONS

Near-Site Activities

Following a direct run from Port Victoria, Mahé, *Glomar Challenger* approached Site 237 on a south-southeasterly course designed to split *Melville's* 1971 traverses, to cross completely a down-dropped basement block found in that earlier work, and to locate the basement high selected as a promising drilling site. No additional survey was required. Nearing proposed site 24-8, the vessel slowed to 6 and then 4 knots and both beacon and a lighted spar buoy were dropped. Still on the same south-southeasterly course, the seismic streamers and magnetometer were retrieved. Reversing course, *Glomar Challenger* homed on the beacon, which lay in a water depth of 1623 meters (corrected). This point is 1.1 nmi southwest of 24-8 (Figure 1, Figure 2).

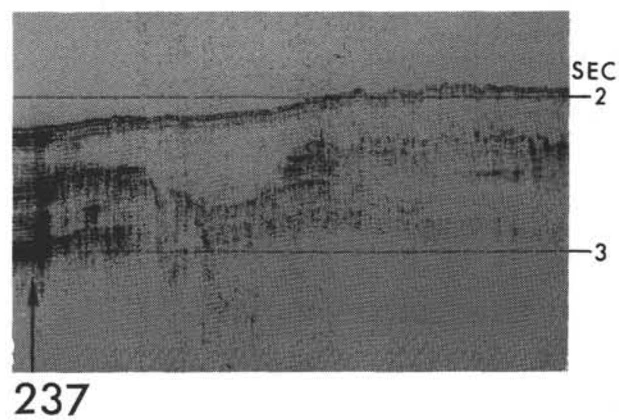

Figure 2. *On-site profile, Site 237. Site location indicated by arrow.*

At the conclusion of drilling activities, *Glomar Challenger* ran northeast at 4 knots, streaming and testing gear, then came to a southeasterly course paralleling topographic grain of the basement. A sonobuoy (24-4) was dropped and found defective. A second sonobuoy (24-5) was dropped and the oblique reflection run continued for 43 minutes. *Glomar Challenger* then struck out east-southeast in a series of very open zig-zags across the Central Indian Ridge to Site 238.

Drilling Program

Drill pipe depth was established at 1640 meters. The hole was continuously cored from the mudline to 2013

[2]It has been modified to include *Glomar Challenger*'s 1972 lines.

meters. The soft chalk was cored with no pump and very slow rotation of the drill string, and recovery was excellent throughout this section. Chert was encountered at 1922 meters. Recovery is always a problem in chert since the chert will not core as other formations. The roller bit seems to shatter the chert material, and only small pieces will actually get above the core catchers. These chips will then wedge in the core catcher, thus blocking the softer formations from entering.

The ship had some trouble staying over the beacon. The box thrusters would not turn enough RPMs to head the ship into the swells and against the wind. Taking the swells on the beam resulted in a constant roll of 4° to 8°. The ship's roll will affect the quality and quantity of the core recovered, but even more of a problem is the effect of the fluctuating weight on the bit. It can more or less pound itself into destruction while drilling such chert sections. From 2273.5 meters to total depth of 2333.5 meters, only every other 9.5 meters were cored. This improved core recovery as well as hole conditions. The bottom of Core 67 was at 2333.5 meters. At this point we were unable to retrieve the core barrel and the bit showed evidence of locking. When the drill pipe was pulled, our suspicions were confirmed. The bit had a locked cone that had caused the drill pipe to torque. The core barrel latch would not release because a bolt had vibrated loose in the latch and the latch catches could not be released. It was found later that one of the four bumper subs was damaged beyond repair and would have broken shortly if drilling had not been terminated. This damage can be attributed to the roll of the ship.

Total penetration was 693.5 meters: 66.5 meters was drilled, 627 meters was cored and 312.1 meters was recovered for a 49.8 percent overall recovery (Table 1).

TABLE 1
Coring Summary – Site 237

Core	Date (June 1972)	Time	Depth Below Sea Floor (m)	Depth From Drill Floor (m)	Cored (m)	Recovered (m)	Recovered (%)
1	6	0612	0-6.5	1640.0-1646.5	6.5	4.4	69
2	6	0655	6.5-16.0	1646.5-1656.0	9.5	3.0	31
3	6	0734	16.0-25.5	1656.0-1665.5	9.5	0.0	0
4	6	0811	25.5-35.0	1665.5-1675.0	9.5	9.2	97
5	6	0850	35.0-44.5	1675.0-1684.5	9.5	9.3	98
6	6	0924	44.5-54.0	1684.5-1694.0	9.5	9.5	100
7	6	1002	54.0-63.5	1694.0-1703.5	9.5	9.5	100
8	6	1035	63.5-73.0	1703.5-1713.0	9.5	9.2	97
9	6	1112	73.0-82.5	1713.0-1722.5	9.5	9.4	99
10	6	1153	82.5-92.0	1722.5-1732.0	9.5	9.4	99
11	6	1230	92.0-101.5	1732.0-1741.5	9.5	9.4	99
12	6	1305	101.5-111.0	1741.5-1751.0	9.5	9.4	99
13	6	1343	111.0-120.5	1751.0-1760.5	9.5	9.3	98
14	6	1416	120.5-130.0	1760.5-1770.0	9.5	9.0	95
15	6	1449	130.0-139.5	1770.0-1779.5	9.5	3.7	39
16	6	1522	139.5-149.0	1779.5-1789.0	9.5	9.3+	98
17	6	1600	149.0-158.5	1789.0-1798.5	9.5	9.3	98
18	6	1638	158.5-168.0	1798.5-1808.0	9.5	9.3	98
19	6	1713	168.0-177.5	1808.0-1817.0	9.5	9.0	94
20	6	1801	177.5-187.0	1817.5-1827.0	9.5	9.2	97
21	6	1836	187.0-196.5	1827.0-1836.5	9.5	9.5	100
22	6	1917	196.5-206.0	1836.5-1846.0	9.5	4.2	44
23	6	1957	206.0-215.5	1846.0-1855.5	9.5	9.4	99
24	6	2043	215.5-225.0	1855.5-1865.0	9 5	8.8	93
25	6	2133	225.0-234.5	1865.0-1874.5	9.5	9.5	100
26	6	2221	234.5-244.0	1874.5-1884.0	9.5	5.2	55
27	6	2304	244.0-253.5	1884.0-1893.5	9.5	9.4+	99
28	6	2351	253.5-263.0	1893.5-1903.0	9.5	9.5	100
29	7	0040	263.0-272.5	1903.0-1912.5	9.5	9.0	95
30	7	0131	272.5-282.0	1912.5-1922.0	9.5	9.5	100
31	7	0227	282.0-291.5	1922.0-1931.5	9.5	1.5	16
32	7	0317	291.5-301.0	1931.5-1941.0	9.5	3.3	35
33	7	0414	301.0-310.5	1941.0-1950.5	9.5	0	0
34	7	0523	310.5-320.0	1950.5-1960.0	9.5	0.8	8
35	7	0634	320.0-329.5	1960.0-1969.5	9.5	0.6+	6
36	7	0750	329.5-339.0	1969.5-1979.0	9.5	1.3+	14
37	7	0931	339.0-345.0	1979.0-1985.0	6.0	1.9	32
38	7	1105	345.0-354.5	1985.0-1994.5	9.5	1.5	16
39	7	1238	354.5-364.0	1994.5-2004.0	9.5		
40	7	1320	364.0-373.5	2004.0-2013.5	9.5		
Drilled, not cored			373.5-383.0	2013.5-2023.0	9.5		
41	7	1540	383.0-392.5	2023.0-2032.5	9.5	2.2	23
42	7	1701	392.5-402.0	2032.5-2042.0	9.5	1.3	14

TABLE 1 – *Continued*

Core	Date (June 1972)	Time	Depth Below Sea Floor (m)	Depth From Drill Floor (m)	Cored (m)	Recovered (m)	Recovered (%)
43	7	1825	402.0-411.5	2042.0-2051.5	9.5	4.3	45
44	7	2017	411.5-421.0	2051.5-2061.0	9.5	4.3	45
45	7	2212	421.0-430.5	2061.0-2070.5	9.5	3.0	32
46	7	2309	430.5-440.0	2070.5-2080.0	9.5	2.0+	21
47	8	0022	440.0-449.5	2080.0-2089.5	9.5	2.10	22
48	8	0125	449.5-459.0	2089.5-2099.0	9.5	1.5	16
49	8	0230	459.0-468.5	2099.0-2108.5	9.5	3.0	32
50	8	0341	468.5-478.0	2108.5-2118.0	9.5	1.5	16
51	8	0520	478.0-487.5	2118.0-2127.5	9.5	1.8	19
52	8	0653	487.5-497.0	2127.5-2137.0	9.5	1.3	14
53	8	0819	497.0-506.5	2137.0-2146.5	9.5	1.7	18
54	8	0958	506.5-516.0	2146.5-2156.0	9.5	0.6	6
55	8	1107	516.0-525.5	2156.0-2165.5	9.5	0.3	3
56	8	1233	525.5-535.0	2165.5-2175.0	9.5	1.5	16
57	8	1347	535.0-544.5	2175.0-2184.5	9.5	0.4	4
58	8	1504	544.5-544.0	2184.5-2194.0	9.5	1.1	1
59	8	1617	554.0-563.5	2194.0-2203.5	9.5	0.5	5
60	8	1712	563.5-573.0	2203.5-2213	9.5	0	.0
61	8	1826	573.0-582.5	2213.0-2222.5	9.5	1.0	11
Drilled one joint (2222.5-2232.0)							
62	8	2034	592.0-601.5	2232.0-2241.5	9.5	2.5	27
Drilled one joint (2241.5-2251)							
63	8	2153	611.0-620.5	2251.0-2260.3	9.5	2.4	26
Drilled one joint (2260.5-2270.0)							
64	8	2356	630.0-639.5	2270.0-2279.5	9.5	2.2	23
Drilled one joint (2279.5-2289.0)							
65	9	0240	649.0-658.5	2289.0-2298.5	9.5	3.8	40
Drilled one joint (2298.5-2308.0)							
66	9	0516	668.0-677.5	2308.0-2317.5	9.5	4.5	47.5
Drilled one joint (2317.5-2327.0)							
67	9	1535	687.0-696.5	2327.0-2336.5	9.5	6.6	69.0

LITHOLOGIC SUMMARY

Hole 237 was penetrated to a total subbottom depth of 693.5 meters. The site was continuously cored from the surface to a depth of 582.5 meters, except for the interval 373.5-383 meters (Cores 1-61). Between 582.5 and 693.5 meters, alternating 9.5-meter joints were cored (Cores 62-67). The sedimentary sequence can be divided into five units as shown in Table 2.

TABLE 2
Lithologic Units – Site 237

Subbottom Depth (m)	Unit	Lithology	Thickness (m)	Cores
	1	Foram-rich nanno ooze	225.0	1-24
225.0				
	2	Nanno ooze	85.5	25-33
310.5				
	3	Partly silicified nanno chalk with chert	91.5	34-42
402.0				
	4	Partly silicified glauconitic foram-bearing nanno chalk with chert	19.0	43-44
421.0				
	5	Partly silicified foram-bearing nanno chalk with chert	272.5	45-67
693.5				

Unit 1 (0.0-225.0 m; Cores 1-24)

This unit consists of foraminifer-rich and foraminifer-bearing nanno oozes. Calcareous nannofossils form 45-90 percent of this unit; planktonic foraminifera, 5-40 percent; and Radiolaria, 5-10 percent. Minor and trace components include quartz, dolomite rhombs, fish remains, volcanic ash, diatoms, and sponge spicules. Sediment color is predominantly white and bluish white, with some intervals being very pale orange, light gray, or light bluish gray. Texture is largely a function of composition, being typically 30-40 percent sand, 20-30 percent silt, and 30-50 percent clay in foraminifer-rich sediments, compared with 5-10 percent sand, 10-20 percent silt and 80 percent clay in the calcareous nannofossil-rich/foraminifer-poor sediments. Few sedimentary structures are preserved in the cores, rather extensive disturbance being the rule. With the exception of one thin hard layer at 188.5 meters (Core 21), no significant consolidation was observable in this unit. Calcareous fossils are well preserved throughout the unit, but the Radiolaria show poor preservation at many levels. Traces of chert, fragmented by the drilling, occur at 216 meters (Core 24).

Unit 2 (225.0-310.5 m; Cores 25-33)

This unit is a nanno ooze. Minor and trace components include foraminifera (1-5%), Radiolaria (0-10%), diatoms (0-5%), sponge spicules (3-7%), volcanic ash, quartz, fish remains, Fe-oxides, and palagonite. Sediment color is predominantly white to bluish white with some intervals being very pale orange, medium gray or greenish gray. Textural composition is 5-15 percent sand, 10-20 percent silt, and 60-80 percent clay. The sediments are soft and generally badly disturbed by coring. Calcareous nannofossils are mostly corroded and poorly preserved.

Unit 3 (310.5-402.0 m; Cores 34-42)

This unit consists of partially silicified nanno chalk with occasional layers and stringers of chert. The sediment is composed dominantly of calcareous nannofossils (>80%) and contains minor amounts of foraminifera (<10%) and volcanic ash (2-5%), together with trace amounts of Fe oxides, diatoms, and fish remains. Sediment color is predominantly grayish yellow green and light greenish gray. The calcareous nannofossils and foraminifera are poorly preserved and often partly recrystallized. Calcite cementation and initial infilling of foraminiferal chambers was followed by partial silicification and a further infilling of voids by chalcedony. Very few opaline skeletal grains appear to remain, nearly all having been dissolved and the silica precipitated as more stable phases.

Unit 4 (402.0-421.0 m; Cores 43-44)

This unit consists of partly silicified glauconitic foram-bearing nanno chalk, with thin chert layers. Calcareous nannofossils dominate the sediment (>80-%) and foraminifers are fairly abundant (5-15%). Minor and trace components include glauconite (2-5%), quartz, and plagioclase feldspar. Sediment colors are pale olive, greenish gray, dark greenish gray, and light bluish gray; one thin black layer of volcanic ash (50% clay minerals, 30-40% volcanic glass, and 5% calcareous nannofossils) occurs in Section 2 of Core 44. Calcareous fossils are poorly preserved and partly recrystallized; some voids are filled with sediment, others with calcite and yet others with chalcedony. A few badly corroded siliceous fossils are present.

Unit 5 (421.0-693.5 m; Cores 45-67)

This unit consists of partly silicified foram-bearing nanno chalk with thin chert horizons. Calcareous nannofossils are thought to make up the bulk of these very fine grained rocks, but the degree of diagenetic alteration and recrystallization makes this indentification tentative. Foraminifera, although similarly recrystallized, are nevertheless identifiable as planktonic species, and they comprise 5-15 percent of the sediment. Minor and trace components include Radiolaria, diatoms, sponge spicules. Fe-oxides, quartz, volcanic ash, glauconite, and fish remains. Carbonate fossils are generally poorly preserved, and infilling of voids and pervasive silicification are common. In many samples no opaline skeletal materials remain.

At four horizons, materials of shallow-water reef association occur:

452.2-452.4 meters (48-2, 120-140 cm) –
Discocyclina, a large benthic shallow-water foraminifer, occurs embedded in a (planktonic) foraminiferal nanno chalk.

517.3-517.4 meters (55-1, 130-140 cm) –
545.3-545.5 meters (58-1, 80-100 cm)
573.6-573.8 meters (61-1, 60-80 cm)
Coralline algal fragments embedded in (planktonic) foraminiferal nanno chalk.

Conclusions

1. The presence of small amounts of basic volcanic ash at many horizons gives evidence of volcanic activity in this area since the lower Paleocene.

2. The chert is of Eocene and Paleocene age. Most opaline skeletons are replaced by carbonate. The silica from opaline skeletons in part replaces calcareous fossils but is most common as a void filling.

3. This location has been the site of pelagic carbonate sedimentation since at least the lower Paleocene. There are, however, several aspects of the older sediments (Eocene and Paleocene) which are suggestive of shallower water conditions that those of today such as: (a) presence of glauconite, (b) sedimentary structures lensing and lamination, and (c) reef debris. The site almost certainly never had a water depth shallower than 200 meters and probably not shallower than 500 meters. The reef associated debris forms a very minor fraction of the sediments and is probably slide or slump material derived from the north and northwest where the escarpment of the Seychelles Bank rises steeply.

4. Present day water depth at Site 237 is close to 1650 meters and the base of the cored section lies at nearly 2350 meters. If the basal sediments of Unit 5, which are of Paleocene age, were deposited in a water depth of only a few hundred meters, then this area has subsided about 2 km over the past 60 m.y.

BIOSTRATIGRAPHIC SUMMARY

Introduction

The sedimentary sequence recovered at Site 237 ranges in age from early Paleocene to Quaternary, with condensed series in the late Eocene, Oligocene, and early Miocene. The Paleocene through middle Eocene section includes a considerable stratigraphic thickness (500 meters). Throughout the section the sediments consist mainly of nanno oozes and chalk which are strongly lithified in the lower part of the sequence. The sediment facies are pelagic throughout the section and rich in calcareous plankton.

Nannofossils, common throughout the sequence, are very well preserved in the Quaternary and Pliocene (upper 82.5 m; Cores 1 to 9) and moderately preserved below; secondary overgrowth increases toward the bottom of the section in the early Paleocene. Planktonic foraminifera are abundant, diverse, and well preserved in upper Neogene sediments (upper 120.5 m; Cores 1 to 13) and are common and poorly to moderately preserved in the lower Neogene, Oligocene, and upper and middle Eocene (120.5 to 291.5 m; Cores 14 to 31). In lower Eocene and Paleocene sediments (291.5 to 696.5 m; Cores 32 to 67), planktonic foraminifera are often recrystallized and silicified particularly in the lower part of the section. Radiolarians are abundant to absent and well to poorly preserved at various levels. They are especially abundant and well preserved in the middle Eocene.

Fossil zonations and chronostratigraphy are summarized on the site summary form at the end of this chapter. The Pleistocene/Pliocene boundary cannot be determined with certainty because sediments representing the interval between 9.5 and 25.5 meters (lower Core 2 and Core 3) were not recovered. The boundary, however, is placed at

25.5 meters below the unrecovered interval (in Core 3, CC) because the lowest occurrence of *Globorotalia truncatulinoides* is present in this sample. Downhole mixing cannot be excluded, however, and the boundary may occur higher in the unrecovered interval. The Oligocene/Miocene boundary is arbitrarily placed at 187 meters, between Cores 20 and 21, on the basis of nannofossil data; the foraminiferal zonation, however, indicates that the boundary should be placed somewhat higher (between Cores 19 and 20). The early/late Paleocene boundary was set at 546 meters, between Cores 58 and 59, on the basis of foraminiferal zonation at the lowest occurrence of *Morozovella angulata*. The hole was terminated in sediments of early Paleocene age (approximately 62.5 m.y.B.P.).

Calcareous Nannoplankton

Core 1 recovered an assemblage with many small placoliths, probably *Emiliania huxleyi* and *Gephyrocapsa oceanica*. It probably belongs to the *Emiliania huxleyi* Zone, but electron microscope studies would be necessary to confirm this result. Core 2 belongs to the *Gephyrocapsa oceanica* Zone with *Gephyrocapsa oceanica* and *G. caribbeanica*. The lower part of the Quaternary and the uppermost part of the Pliocene were not found, and Cores 4 and 5 belong to the *Discoaster tamalis* Zone with assemblages including *Discoaster tamalis, D. pentaradiatus* and *D. surculus*. The *Reticulofenestra pseudoumbilica* Zone with *Reticulofenestra pseudoumbilica* and *Sphenolithus abies* was recovered in Cores 6 through 8. Core 9 belongs to the *Ceratolithus rugosus* Zone characterized by the joint occurrence of *Ceratolithus rugosus, C. tricorniculatus*, and *C. primus*. The lowermost Pliocene and the uppermost Miocene zones were not found. The Miocene/Pliocene boundary, based on nannofossils, lies between Cores 9 and 10. Cores 10 through 12 are assigned to the *Ceratolithus primus* Zone based on assemblages including *Ceratolithus primus, Discoaster quinqueramus*, and *D. berggrenii*. Core 13 belongs to the *Discoaster neohamatus* Zone and contains *Discoaster* sp. cf. *D. neorectus, D. neohamatus*, and *D. bellus*. Core 14 recovered the *Discoaster bellus* Zone with *Discoaster neohamatus* and *D. bellus*. The upper part of the middle Miocene was not found. Core 15 yields assemblages typical of the *Discoaster kugleri* Zone with *Discoaster kugleri, D. exilis, D. divaricatus*, and *Coccolithus eopelagicus*. The *Discoaster exilis* Zone is present in Core 16 with assemblages including *Discoaster exilis, D. divaricatus*, and *Coccolithus eopelagicus*. Core 17 recovered the *Sphenolithus heteromorphus* Zone with *Sphenolithus heteromorphus* and *Discoaster exilis*. Cores 18 and 19 yielded assemblages typical of the *Helicopontosphaera ampliaperta* Zone with *Sphenolithus heteromorphus, Discoaster deflandrei*, and *Coronocyclus serratus*. The next lower zone recovered was the *Discoaster druggii* Zone in Core 20 with *Triquetrorhabdulus carinatus* and *Discoaster druggii*. The lowermost Miocene and the uppermost Oligocene Zone were not found, but the Oligocene/Miocene boundary lies somewhere between Cores 20 and 21. Cores 21 and 22 belong to the *Sphenolithus ciperoensis* Zone with *Triquetrorhabdulus carinatus, Sphenolithus ciperoensis*, and *Reticulofenestra bisecta*. The lower part of the upper Oligocene was not observed. Core 23 was assigned to the *Helicopontosphaera reticulata* Zone based on an assemblage including *Reticulofenestra umbilica, Ericsonia subdisticha, Sphenolithus predistentus*, and *Braarudosphaera bigelowii*. The upper Eocene was not found and Core 24 belongs to the middle Eocene *Chiasmolithus grandis* Zone with *Chiasmolithus grandis, Discoaster barbadiensis, D. saipanensis*, and *Reticulofenestra reticulata*. Cores 25 and 26 recovered the *Chiasmolithus solitus* Zone with *Chiasmolithus grandis, C. solitus, Reticulofenestra umbilica*, and *Thoracosphaera prolata*. Cores 27 through 32 contain rich assemblages belonging to the *Chiasmolithus gigas* Zone with *Chiasmolithus gigas, C. grandis, C. solitus, Nannotetrina fulgens, N. cristata*, and *Thoracosphaera prolata*. Core 36 recovered the *Discoaster sublodoensis* Zone with *Discoaster sublodoensis, Micrantholithus flos, Braarudosphaera bigelowii*, and *Sphenolithus furcatolithoides*. Core 37 belongs to the lower Eocene *Tribrachiatus orthostylus* Zone with *Tribrachiatus orthostylus, Discoaster diastypus, Micrantholithus flos*, and some down mixed middle Eocene forms like *Sphenolithus furcatolithoides*. Core 38 recovered the *Discoaster diastypus* Zone with *Discoaster diastypus, Chiasmolithus consuetus*, and *Braarudosphaera bigelowii*. Cores 39 and 40 had no recovery. Core 41 belongs to the late Paleocene *Discoaster multiradiatus* Zone with *Discoaster multiradiatus, D. mohleri*, and *Fasciculithus tympaniformis*. Cores 43 and 44 recovered the *Heliolithus kleinpellii* Zone with *Heliolithus kleinpellii, Fasciculithus tympaniformis, Chiasmolithus consuetus, Ellipsolithus macellus, Micrantholithus flos* and *Braarudosphaera bigelowii*. Cores 45 through 51 are assigned to the *Fasciculithus tympaniformis* Zone based on the assemblages which include *Fasciculithus tympaniformis, F. pileatus, F.* sp. cf. *F. ullii, Chiasmolithus consuetus, C. danicus, Neochiastozygus concinnus, Prinsius bisulcus*, and *Zygodicus plectopons*. Cores 52 through 54 and, according to Bukry (this volume), Cores 64 through 67 belong to the *Cruciplacolithus tenuis* Zone with poor assemblages including *Chiasmolithus danicus, Cruciplacolithus tenuis, Zygodiscus plectopons*, and *Biantholithus sparsus*.

Preservation: Quaternary and Pliocene assemblages are very well preserved or show slight overgrowth. Slight etching and slight overgrowth prevail in the upper part of the upper Miocene. The lower part of the upper Miocene, the middle and lower Miocene, the Oligocene, Eocene and Paleocene show slight etching and moderate overgrowth, which becomes more and more pronounced in the lower Paleocene.

Foraminifera

Abundance and Preservation

In Cores 1 to 24 (lithologic Unit 1) the coarse sediment fraction ($>63\mu$) is composed almost entirely of planktonic foraminifera. These are well preserved in Cores 1 to 13 but show signs of solution and extensive fragmentation in Cores 14 to 24. In Cores 25 to 31 (lithologic Unit 2), foraminifera are rare; siliceous components are the main constituents. Below Core 31 (lithologic Units 3, 4, and 5) the sediments are lithified and often hard to disaggregate, and thin sections from indurated horizons were analyzed. Softer horizons yielded debris of recrystallized limestone, chert debris, and common planktonic foraminifera. These are poorly to moderately well preserved; recrystallization and silicification become particularly strong below Core 59.

Planktonic Foraminiferal Zonation

Core 1 and the upper part of Core 2 belong to the Quaternary Zones N.23-N.22, as indicated by the presence of *Globorotalia truncatulinoides.* Core 1 contains a diverse tropical planktonic assemblage which includes common pink-colored *Globigerinoides ruber.* The pink variety of this species was not found in other cores at this site. The lower part of Core 2 and much of Core 3 were not recovered. Core 3, CC contained both *Globorotalia truncatulinoides* and *Globorotalia tosaensis* and the zonal limit N.22/N.21 (Pleistocene/Pliocene boundary) is placed at this level. It is possible, however, that Sample 3, CC includes elements of downhole mixing and that the occurrence of *G. truncatulinoides* here does not represent the first evolutionary appearance of the species. The N.21/N.20-N.19 boundary lies between Cores 4 and 5 at the base of *G. tosaensis.* The upper appearance of *Globoquadrina altispira altispira* and *Sphaeroidinellopsis* is higher than this level but with rare occurrences; these two species occur commonly in Core 5 and below. The N.19/N.18 zonal boundary is placed below Core 6, Section 5, at the lowest occurrence of *Sphaeroidinella dehiscens,* a level well above the highest occurrence of *Globorotalia tumida plesiotumida* in Core 8, Section 5. The N.18/N.17 limit, which represents the Miocene/Pliocene boundary, is marked by the base of *Globorotalia tumida tumida* between Cores 9 and 10.

Core 15, Section 3 to Core 17, Section 5 is assigned to the lower part of Zone N.13, based on the cooccurrence of *Globorotalia praemenardii, Globorotalia fohsi, Turborotalia mayeri,* and *Sphaeroidinellopsis subdehiscens.* Core 18, Section 8 and Core 19, Section 5 is placed in the interval of N.4 to N.6 inclusive. These zones were not separated because species known to have evolved in N.6 (*Sphaeroidinellopsis seminulina, Globigerinoides quadrilobatus sacculifer*) occur here with others which become extinct within, or at the top, of N.4 (*Turborotalia kugleri, Turborotalia pseudokugleri*). The Oligocene/Miocene boundary (N.4/P.22) appears to lie between Cores 19 and 20, at the lowest occurrence of *Globigerinoides* spp.

Cores 20 to 23 represent Oligocene Zones P.22 to P.19, and contain a fauna dominated by *Globoquadrina tripartita.* Upper Eocene assemblages were recovered only in 23, CC. This sample, which contains *Globigerinatheca mexicana* and *Turborotalia centralis*, was assigned to P.15. The highest occurrence of *Truncorotaloides rohri* in Core 24, Section 2 marks the late/middle Eocene boundary. Core 26, Section 2 to Core 36 could not be conclusively zoned because of the mixing of lower and middle Eocene species in this interval. The middle/early Eocene boundary was not defined. It appears, however, that Zone P.9, recognized here by the presence of *Morozovella caucasica* probably extends as high as Core 32. The Paleocene/Eocene boundary lies between Cores 38 and 41, based on the highest occurrence of *Morozovella velascoensis.* Samples from Cores 40 to 49 commonly contain *M. velascoensis* and *Morozovella aequa,* an association indicative of Zones P.4 and P.5. Below Core 49, foraminifera are poorly preserved; the high degree of recrystallization precluded sufficient species determination for age assignment. The base of P.3 appears to lie in Core 58 near the lowest occurrence of *Morozovella angulata.* In no samples below Core 58 were anguloconical tests observed; planktonic foraminifera are very small and could be identified as globigerinids and round-edged globorotaloids. The occurrence of these forms suggests a zonal assignment of early Paleocene (P.2-P.1) for the lower sediments and an approximate age of 63 m.y.

Benthic Foraminifera and Paleobathymetry

In the Neogene sequence, benthic foraminifera are never abundant and constitute no more than 1 percent of the foraminiferal population. Most of the species are deepwater modern forms with long Neogene ranges, and the assemblages are indicative of lower bathyal environment (approximately 600 to 2500 m) similar to the present-day conditions at this site.

In the Paleogene, the ratio of planktonic to benthic foraminifera was evaluated in thin section as well as in washed residue, and the high percentage of planktonic species reflects, as in the Neogene, a pelagic environment below shelf depth. Benthic species do not exceed 1 percent of the foraminiferal fauna except in some Paleocene horizons. Lower Eocene and Paleocene benthic faunas frequently contain deep water assemblages which include *Nuttallides truempyi* and *Pleurostomella* aff. *paleocenica.* This association is somewhat similar to the *Pleurostomella-Nuttallides* fauna described by Bandy (1970) in lower Eocene-Paleocene sediments from Central America, which he interpreted as indicative of abyssal depths. Associated with deep water indices, the Paleocene benthic assemblages commonly include such shallower species as *Bolivina midwayensis* and *Melonis* cf. *planatus*, among others, indicative of neritic (shallower than 200 m) or upper bathyal (200-600 m) environments. In a number of Paleocene horizons (Cores 50 to 53; Sample 58-1, 70; Core 67), the planktonic/benthic ratio is reduced. Benthic species comprise 10 to 50 percent of the foraminiferal population, and they are associated with glauconite, mollusc and echinoderm debris, and ostracods, an association suggestive of a shallower environment. At several levels (Samples 48-1, 120; 55-1, 130-140; 58-1, 80-100; 61-1, 60-80), fragments of limestone of shallow shelf or reef origin were recovered. These contain calcareous algae (*Archaeolithotamnium*) and larger foraminifera (*Discocyclina* and *Rzehakina*). The thick lower Eocene and Paleocene section recovered at Site 237 was deposited in a bathyal environment into which slumping of shallow-water material occurred.

The high degree of fragmentation of planktonic foraminifera in the middle to upper Eocene and Oligocene section may indicate that during this time interval the site of deposition was near calcium carbonate compensation depth, a suggestion supported by the high proportion of radiolarians to planktonic foraminifera in the middle Eocene.

It thus appears that the location of Site 237 has been a site of relatively deep water pelagic carbonate sedimentation since Paleocene time.

Radiolarians

Radiolarians in samples from Core 1, Section 1 through Core 12, Section 1 are rare to abundant, moderately to well preserved. From Core 25, Section 1 through Core 32, Section 2 they are abundant, and moderately to well preserved. From Core 36, Section 1 through Core 42, Section 1 they are few to common, moderately to well preserved. In the interval from Core 13, Section 1 through Core 24, Section 1, and from Core 43, Section 2 through Core 54, Section 1, radiolarians are insufficient for stratigraphic interpretation and their occurrences in Site 237 are as follows: 13-1, 49-52 cm (F, M); 14-1, 49-51 cm (C, M); 15-1, 129-132 cm (None); 16-1, 50-52 cm (None); 17-1, 49-51 cm (None); 18-1, 48-51 cm (None); 18-1, 133-135 cm (None); 19-1, 48-51 cm (R, P); 20-1, 48-50 cm (R, P); 21-1, 50-52 cm (R, M); 22-1, 100-102 cm (R, P); 23-1, 48-51 cm (R, P); 24-1, 39-43 cm (R, P); 43-2, at approximately 105 cm (R, M); 44-1, at approximatedly 85 cm (F, M); 45-1, at approximately 68 cm (R, M); 46-2, at approximately 75-77 cm (F, P); 47-2, at approximately 66 cm (F, P); 48-1, at approximately 98 cm (F, P); 49-2, at approximately 90 cm (F, P); 50-1, at approximately 70 cm (F, P); 52-1, at approximately 105 cm (R, M); 53-2, at approximately 82 cm (R, P); 54-1, at approximately 120 cm (C, P).

Assemblages in Core 1, Section 1 and Core 2, Section 1 are Quaternary, the *Pterocanium prismatium* Zone may be present though unrecognizable in Core 4, Section 1 and Core 5, Section 1; the *Spongaster pentas* and *Stichocorys peregrina* Zones apparently occur in Core 6, Section 1 through Core 11, Section 1; and Core 12, Section 1 is in the *Ommatartus penultimus* Zone.

Assemblages in Core 25, Section 1 and Core 26, Section 1 are in the *Podocyrtis mitra* Zone; those in Core 27, Section 1 and, probably, Core 28, Section 1 are in the *Podocyrtis ampla* Zone; those in Core 29, Section 1 (probably) and Core 30, Section 1 are in the *Thyrsocyrtis triancantha* Zone; and that in Core 32, Section 2 is in the *Theocampe mongolfieri* Zone.

Assemblages in Core 36, Section 1 and Core 37, Section 1 are probably in the *Buryella clinata* Zone (the transition from *Phormocyrtis striata exquisita* to *P. striata striata*, used to define the base of the *P. striata striata* Zone, seems overshadowed by other evidence indicating the *Buryella clinata* Zone), and those in Core 38, Section 1 through Core 42, Section 1 are in the *Bekoma bidarfensis* Zone.

SEDIMENT ACCUMULATION RATES

Sedimentation rates were tabulated as follows:

Series	Thickness (m)	Average Sedimentation Rate (m.y.)
Pleistocene	25.5	14.2
Upper Pliocene	9.5	7.9
Lower Pliocene	47.5	23.8
Upper Miocene	42.0	7.0
Middle Miocene	34.0	11.3
Lower Miocene	28.5	3.4
Oligocene	22.0	1.5
Upper Eocene	6.5	1.2
Middle Eocene	76.0	12.7
Lower Eocene	56.5	12.6
Upper Paleocene	198.0	30.5
Lower Paleocene	150.5	60.2

In the Neogene, sediments consists of nanno oozes whose rates of accumulation are comparable to those found at Site 236. The average accumulation rate for the late Neogene (middle Miocene through Pleistocene) is 11.3 m/m.y., a value identical to the average rate at Site 236 for the same interval. The lower Miocene rate of 3.4 m/m.y. is also comparable to the lower Miocene rate of 2.2 m/m.y. at Site 236.

The much reduced rate of accumulation of 1.5 m/m.y. for the Oligocene nanno ooze is lower than the equivalent value of 5.0 m/m.y. found at Site 236, but the reduced rate of 1.2 m/m.y. for the late Eocene is comparable to the equivalent value at Site 236.

During the middle and early Eocene and Paleocene, sediment accumulated at considerably higher rates than during the succeeding time intervals. A high average rate of 60.2 $m/10^6$ yrs was determined for the lower Paleocene, decreasing to 30.5 in the upper Paleocene and 13.9 in the middle-lower Eocene. These sediments are pelagic carbonate oozes. The sedimentation rates are to be compared with an early Eocene rate of 12.6 m/m.y. and a late Paleocene rate of 5.3 meters/m.y. found at Site 236.

A considerable fraction of the Paleocene and lower Eocene sediments is very fine-grained calcite, recrystallized to varying degrees, the origin of which is uncertain. It is probable that much shallow-water fine-grained carbonate debris was carried downslope into this area, where it accumulated together with the skeletons of pelagic organisms such as nannofossils and foraminifera. The source of this transported fine material probably lay to the northwest, where the escarpment of the Seychelles Bank today rises steeply, almost to sea leavel. The shallow-water grains would have been dominantly aragonite and magnesium calcite; these have since recrystallized and are now individually unrecognizable, forming merely the micrite of the sediments. Only the foraminifera are presently a recognizable skeletal grain type. This influx of fine-grained carbonate material was accompanied, however, on a few occasions by coarser grains, which were recognized as coralline algal and benthonic shallow-water foraminiferal debris.

PHYSICAL PROPERTIES

Bulk Density and Porosity

The bulk density and porosity of the foram-rich nanno ooze in lithologic Unit 1 (0 to 225 m) increases from 1.66 to 1.90 g/cm^3 and decreases from 62.3 to 48.0 percent, respectively, from near 50 meters to 223 meters below the sediment/water interface (Figure 3). No bulk density or porosity values were obtained for the upper 50 meters of sediment due to their highly disturbed condition. In fact, all reported values should be considered with some reservation. Most of the sections of Cores 1 through 33 were very "soupy", and the sediment had in many cases exhibited a very thixotropic behavior. Hard " consolidated" chunks of the nanno ooze were obtained in cores from 150 to 310 meters depth, and it is impossible to estimate the thickness of such hard layers in situ. The high degree of disturbance of the retrieved cores limits the reported density and porosity values to minimum and maximum values.

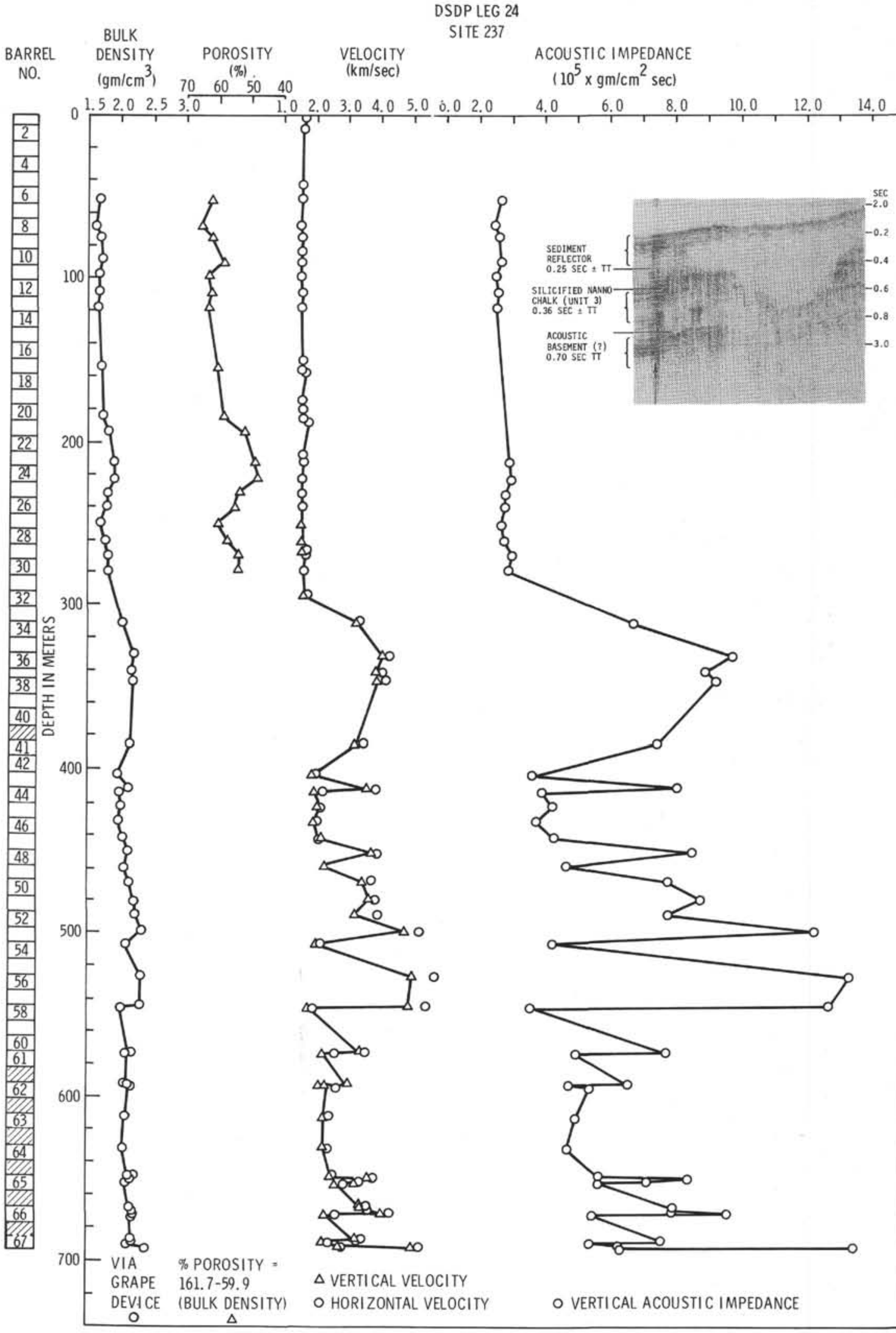

Figure 3. *Physical properties, Site 237. Inset shows correlation of physical properties and seismic reflections. Arrow denotes site; bracketing indicates artifacts caused by slowing ship, with consequent change in array and source depths and geometry.*

Bulk densities of the partly silicified nanno chalk and foram nanno limestones from lithologic Units 3, 4, and 5 were obtained by the GRAPE device on block samples approximately 1.5 × 1.5 cm × 2.5 cm. Bulk densities measured in the vertical direction (long axis) range from 1.93 to 2.70 g/cm^3 and those measured in the horizontal direction range from 1.92 to 2.70 g/cm^3 (Table 3).

Sonic Velocity

The foraminifer-rich nanno ooze and nanno ooze in lithologic Units 1 and 2 (0 to 310 m) are characterized by a rather uniform 1.55 km/sec average velocity (Figure 3). Velocity increases to 1.63 and 1.72 km/sec are observed at approximately 158 to 190 meters, respectively. These velocities were obtained through hard "consolidated" chunks of the nanno ooze found within fairly "soupy" core sections. It is reasonable to suggest that a considerable thickness of the hard "consolidated" nanno ooze (chalk ?) may exist in situ, and drilling disturbance has caused the "soupy" appearance of the sediment.

Since a density increase is suggested over the interval from 190 to 225 meters (Figure 3), and the velocity increase is apparent at 190 meters, it is suggested that a reflection boundary may exist at ±190 meters. Assuming an average velocity of 1.55 km/sec over this interval, a one-way travel time of 0.123 seconds is obtained for seismic energy propagation from the sediment/water interface to this potential reflector. This travel time corresponds well with the 0.25 seconds two-way travel time for the first apparent reflector observed on the seismic reflection profiles (Figure 3).

Another major reflector is detected on the seismic reflection profile at approximately 0.36 seconds two-way travel time, although badly obscured by the artificial pulse resulting from ship speed change (Figure 3). This reflector would appear to correlate with the high velocity (±3.5 km/sec), partly silicified nanno chalk layer of lithologic Unit 3 at 310 meters. A time correlation is obtained only if an average velocity of 2.0 km/sec is assumed for the sediment between 190 and 310 meters. The author believes

TABLE 3
Bulk Density of Limestones – Site 237

Sample[a]	Bulk Density (g/cm^3) Vertical	Horizontal	Velocity (km/sec) Vertical	Horizontal	Rock Description
34-1(13)	2.08	2.02	3.24	3.31	Nanno ooze limestone
36-1(12)	2.40	2.39	4.03	4.22	Foram nanno limestone
37-2(15)	2.32	2.32	3.82	3.98	Foram nanno limestone
38-1(13)	2.37	2.39	3.86	4.06	Foram nanno limestone
41-2(13)	2.29	2.30	3.20	3.41	Foram nanno limestone
43-2(1)	1.93	1.93	1.86	1.90	Foram nanno limestone
44-1(12)	2.24	2.28	3.54	3.79	Foram nanno limestone
44-2(2)	1.99	1.98	1.96	2.16	Nanno limestone with forams
45-2(6)	2.01	2.00	2.10	2.16	Foram nanno ooze/limestone
46-2(6)	1.96	1.92	1.91	1.95	Foram rich nanno limestone
47-2(2)	2.09	2.07	2.05	2.09	Foram rich nanno limestone
48-1(4)	2.27	2.25	3.76	3.84	Foram nanno limestone
49-2(2)	2.10	2.10	2.20	2.19	Foram nanno limestone
50-1(13)	2.25	2.29	3.41	3.63	Foram nanno limestone
51-2(10)	2.42	2.40	3.64	3.74	Foram nanno limestone
52-1(13)	2.42	2.45	3.18	3.81	Foram nanno limestone
53-2(9)	2.61	2.63	4.66	5.11	Recrystallized foram limestone
54-1(6)	2.14	2.10	1.98	2.14	Foram nanno limestone
56-1(5)	2.65	2.70	4.96	5.61	Recrystallized foram nanno limestone
58-1(6)	2.62	2.63	4.83	5.38	Foram nanno limestone (part. recryst.)
58-1(20)	2.01	1.98	1.78	1.85	Foram micrite
61-1(5)	2.26	2.29	3.36	3.47	Foram nanno limestone
61-1(13)	2.21	2.22	2.24	2.55	Foram nanno limestone
62-1(1)	2.23	2.23	2.93	3.00	Foram nanno limestone
62-1(6)	2.17	2.20	2.17	2.30	Glauconitic foram nanno limestone
62-2(5)	2.27	2.29	2.36	2.60	Micritic limestone
63-2(7)	2.16	2.19	2.26	2.35	Foram limestone (part. recryst.)
64-2(7)	2.09	2.09	2.23	2.29	Micritic limestone foram rich
65-1(8)	2.27	2.28	2.48	2.58	Micritic limestone
65-2(1)	2.33	2.35	3.57	3.14	Foram nanno limestone (part. recryst.)
65-2(12)	2.25	2.31	3.12	3.30	Foram micritic limestone
65-3(5)	2.19	2.17	2.61	2.82	Micritic limestone (recrystallized)
66-1(11)	2.33	2.33	3.40	3.55	Foram nanno limestone
66-2(14)	2.35	2.37	3.36	3.56	Foram nanno limestone (recrystallized)
66-3(17)	2.41	2.41	3.96	4.09	Micritic limestone
66-3(21)	2.33	2.34	2.33	2.59	Micritic limestone
67-1(2)	2.34	2.37	3.21	3.42	Micritic limestone
67-2(4)	2.30	2.36	2.31	2.44	Micritic limestone
67-3(7)	2.22	2.28	2.77	3.20	Micritic limestone
67-4(1)	2.36	2.37	2.65	2.74	Micritic limestone
67-5(9)	2.70	2.69	4.96	5.11	Micritic limestone

[a]Numbers in parentheses are the sequence of rock samples in this section.

that this interval is a hard (2.0 km/sec) "consolidated" nanno chalk in situ, that the low velocities measured in the laboratory were on highly disturbed core sections, and this correlation is a reasonable interpretation.

The velocities of the various limestones in lithologic Units 3, 4, and 5 range from 1.78 to 4.96 km/sec in the vertical direction and 1.85 to 5.38 km/sec in the horizontal direction (see Figure 3 and Table 3). The acoustic basement observed at approximately 0.7 sec two-way travel time on the seismic reflection profile cannot be correlated with any degree of accuracy to the physical property data. The author, however, believes that the hole was bottomed less than 100 meters from the acoustic basement of still unknown material.

Although the velocity measurements are numerous (41) for the 383 meters of various limestones from 310.5 to 693.5 meters, they are not sufficient to determine an accurate seismic energy propagation time to the acoustic basement. The obvious reason is the low recovery rate of the core limestones. One cannot state with assurance what percentage of each limestone makes up the total 383 meters in situ from 310.5 to 693.5 meters.

An interesting correlation is defined (Figure 4 and Table 4) between the acoustical and mineralogical properties of the various limestones. When thin sections of each of the limestones were examined and all samples were found to contain from 0 to 15 percent forams, the mineralogy of the fill contained in the forams was examined and defined. Figure 4 shows vertical velocity for each sample plotted versus the velocity anisotropism index and with fill mineralogy indicated. Section B in Figure 4 shows that all samples having a high velocity anisotropism (>1.09) have foraminifera filled with calcite regardless of their vertical velocity anisotropism (<1.09), the following observations are made: (1) in limestones having vertical velocities less than 2.8 km/sec, the foraminifera are filled with calcite or sediment, whereas (2) in limestones having vertical velocities of greater than 2.8 km/sec, the foraminifera are mainly filled with chert, chalcedony, or coarse calcite.

The relationship of bulk density to velocity for the 41 various limestone samples from lithologic Units 3, 4, and 5 is presented in Figure 5. The data suggest a linear relationship and least square analysis defines bulk density as:

$$\text{Bulk Density } (\text{g/cm}^3) = 1.737 \text{ g/cm}^3 + \left(0.171 \frac{\text{g} \cdot \text{sec}}{\text{cm}^3 \cdot \text{km}}\right) \sim (\text{Velocity (km/sec)}).$$

Acoustic Impedance

The acoustic impedance varies betwen 2.43 and 2.95 × 10^5 g/cm^2 sec in lithologic Units 1 and 2 (the nanno oozes) in the upper 310 meters. The various limestones from lithologic Units 3, 4, and 5 have acoustic impedance values ranging from 3.58 to 13.39 × 10^5 g/cm^2 sec. Other than the speculations on reflection surfaces mentioned earlier, no important aspects of the acoustic impedances can be defined because of the uncertainty as to the actual thicknesses of the various limestones.

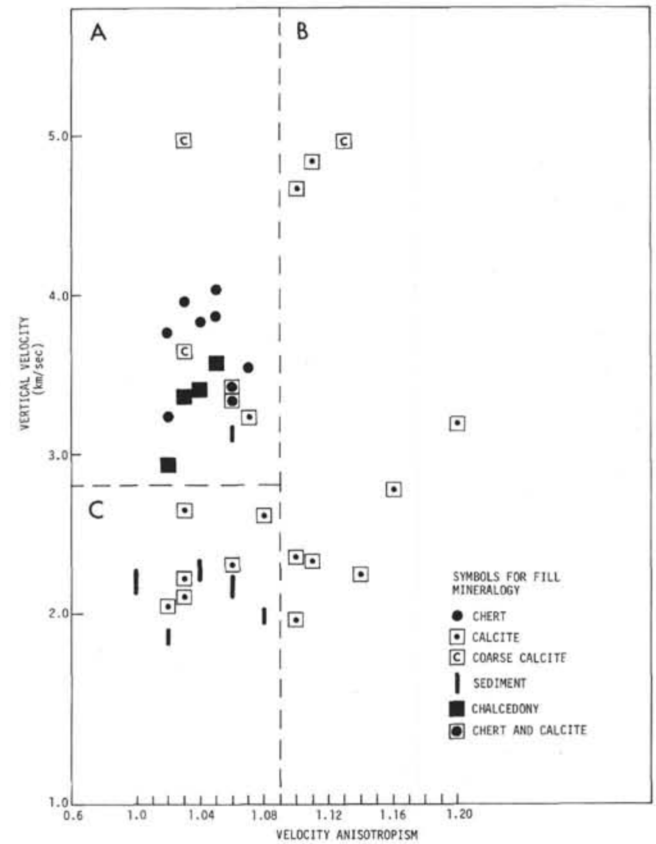

Figure 4. *Correlation between acoustical and mineralogic properties of limestone, Site 237.*

INTERSTITIAL WATER CHEMISTRY

Salinity, *p*H, and alkalinity data for pore waters squeezed from cored sediment samples at Site 237 are presented in Table 5 and Figure 6. Water content data are given in Table 6.

Salinity: Surface seawater salinity at Site 237 is 35.2‰, compared with a bottom water value of 34.8‰ (Wyrtki, 1971). Pore water salinities range 35.5-36.6‰. These values are generally more than 1‰ higher than bottom water salinities and suggest minimal loss of $SO_4^=$ but some additions of alkalinity and cations.

***p*H and Alkalinity:** Pore water *p*H values average 7.5 ± 0.3, except for one value; punch-in *p*H measurements consistently give values somewhat lower than the flow-through electrode values. Alkalinities are remarkably constant down to 300 meters in contrast to the usual trend of very high alkalinities at shallow depths, decreasing to rather low values below several hundred meters. The alkalinity at 385 meters is similar to most deep values in being rather less than the seawater value.

Water Content: Values decrease fairly steadily with depth, from 45-50 percent at the top of the cored section to 40 percent at about 180 meters; below 180 meters values are rather variable, in the range 30-40 percent.

CORRELATION OF REFLECTION PROFILES AND LITHOLOGIES

The seismic reflection records over the actual site do not resolve the sediment reflectors as clearly as those taken over

TABLE 4
Correlation Between Acoustic and Mineralogic Properties of Limestone – Site 237

Sample[a]	Vertical Velocity (ϕ) (km/sec)	Horizontal Velocity (ϕ) (km/sec)	Velocity Anisotropism θ/ϕ	Rock Classification	Forams (%)	Foram Chambers Filled (Yes or No)	Mineralogy of Fill
34-1(13)	3.24	3.31	1.02	Nanno ooze limestone	<10	Yes	Chert
36-1(12)	4.03	4.22	1.05	Foram nanno limestone	<10	Yes	Chert
37-2(15)	3.82	3.98	1.04	Foram nanno limestone	<10	Yes	Chert
38-1(13)	3.86	4.06	1.05	Foram nanno limestone	<10	Yes	Chert
41-2(19)	3.20	3.41	1.07	Foram nanno limestone	<10	Yes	Chert
43-2(1)	1.86	1.90	1.02	Foram nanno limestone	5 to 15	Yes	Sediment
44-1(12)	3.54	3.79	1.07	Foram nanno limestone	5 to 15	Yes	Chert
44-2(2)	1.96	2.16	1.10	Nanno limestone w. forams	5 to 15	Yes	Calcite
45-2(6)	2.10	2.16	1.03	Forma nanno ooze/limestone	5 to 15	Yes (very little)	Calcite
46-1(6)	1.91	1.95	1.02	Foram-rich nanno limestone	5 to 15	Yes	
47-2(2)	2.05	2.09	1.02	Foram-rich nanno limestone	5 to 15	Yes (very little)	Calcite
48-1(4)	3.76	3.84	1.02	Foram nanno limestone	5 to 15	Yes	Chert
49-2(2)	2.20	2.19	1.00	Foram nanno limestone	5 to 15	Yes (very little)	Sediment & calcite
50-1(19)	3.41	3.63	1.06	Foram nanno limestone	5 to 15	Yes	Calcite & chert
51-2(10)	3.64	3.74	1.03	Foram nanno limestone	5 to 15	Yes	Coarse calcite
52-1(13)	3.18	3.81	1.20	Foram nanno limestone	5 to 15	Yes	Calcite
53-2(9)	4.66	5.11	1.10	Recrystallized foram limestone	5 to 15	Yes	Calcite
54-1(6)	1.98	2.14	1.08	Foram nanno limestone	5 to 15	Yes	Sediment
56-1(5)	4.96	5.61	1.13	Recrystal. foram nanno limestone	5 to 15	Yes	Coarse calcite
58-1(6)	4.83	5.38	1.11	Foram nanno limestone (part. recryst.)	5 to 15	Yes	Calcite
58-1(20)	1.78	1.85	1.04	Foram micrite	5 to 15	No	
61-1(5)	3.36	3.47	1.03	Foram nanno limestone	5 to 15	Yes	Chalcedony
61-1(13)	2.24	2.55	1.14	Foram nanno limestone	5 to 15	Yes	Calcite
62-1(1)	2.93	3.00	1.02	Foram nanno limestone	5 to 15	Yes (some)	Chalcedony
62-1(6)	2.17	2.30	1.06	Glauconitic foram nanno limestone	5 to 15	Yes (some)	Sediment & calcite
62-2(5)	2.36	2.60	1.10	Micritic limestone	5 to 15	Yes	Calcite
63-2(7)	2.26	2.35	1.04	Foram limestone (part. recrystal.)	5 to 15	Yes	Sediment & calcite
64-2(7)	2.23	2.29	1.03	Micritic limestone Foram-rich	5 to 15	Yes	Calcite
65-1(8)	2.48	2.58	1.04	Micritic limestone	5 to 15	?	?
65-2(1)	3.57	3.74	1.05	Foram nanno limestone (part. recryst.)	5 to 15	Yes	Chalcedony
65-2(12)	3.12	3.30	1.06	Foram micritic limestone	5 to 15	Yes	Sediment
65-3(5)	2.61	2.82	1.08	Micritic limestone (recrystallized)	5 to 15	Yes	Calcite
66-1(11)	3.40	3.55	1.04	Foram nanno limestone	5 to 15	Yes	Chalcedony
66-2(14)	3.36	3.56	1.06	Foram nanno limestone (part. recrystal.)	5 to 15	Yes	Chert & calcite
66-3(17)	3.96	4.09	1.03	Micritic limestone	5 to 15	Yes	Chert
66-3(21)	2.33	2.59	1.11	Foram nanno limestone (recrystal.)	5 to 15	Yes	Calcite
67-1(2)	3.21	3.42	1.07	Micritic limestone	5 to 15	Yes	Calcite
67-2(4)	2.31	2.44	1.06	Micritic limestone	5 to 15	Yes	Calcite
67-3(7)	2.77	3.20	1.16	Micritic limestone	5 to 15	Yes	Calcite
67-4(1)	2.65	2.74	1.03	Micritic limestone	5 to 15	Yes	Calcite
67-5(9)	4.96	5.11	1.03	Micritic limestone	5 to 15	Yes	Coarse calcite

[a]Numbers in parentheses are the sequence of rock samples in the section.

exactly the same type structure one hour earlier, nor as is done by the site survey record from R/V *Melville.* This is largely due to the change in source-array geometry as the ship's speed is slowed to drop the beacon.

At the base of the transparent layer lies a reflection sequence complicated by the speed-induced artifacts, but appearing to comprise two units; the upper flat and the lower dipping slightly (Figure 7, 1 and 2). Between this pair and acoustic basement (*B,* same figure) are occasional reverberant sequences that may indicate another reflector.

Seismic-lithologic correlation rests as well on the physical properties: the upper transparent layer is taken to be the nanno ooze of lithologic Unit 1; the reflector at its base to be another ooze (lithologic Unit 2), but with some question, and the stronger sloping reflector (2, Figure 7) to be the top of the chalk-chert (Units 3, 4, 5). It is not unreasonable to suppose that the changes in the velocity-acoustic impedance profiles of Figure 3 are the agents of the observed reverberant arrivals and thus the changes in lithology reflected in these reflections. Acoustic basement,

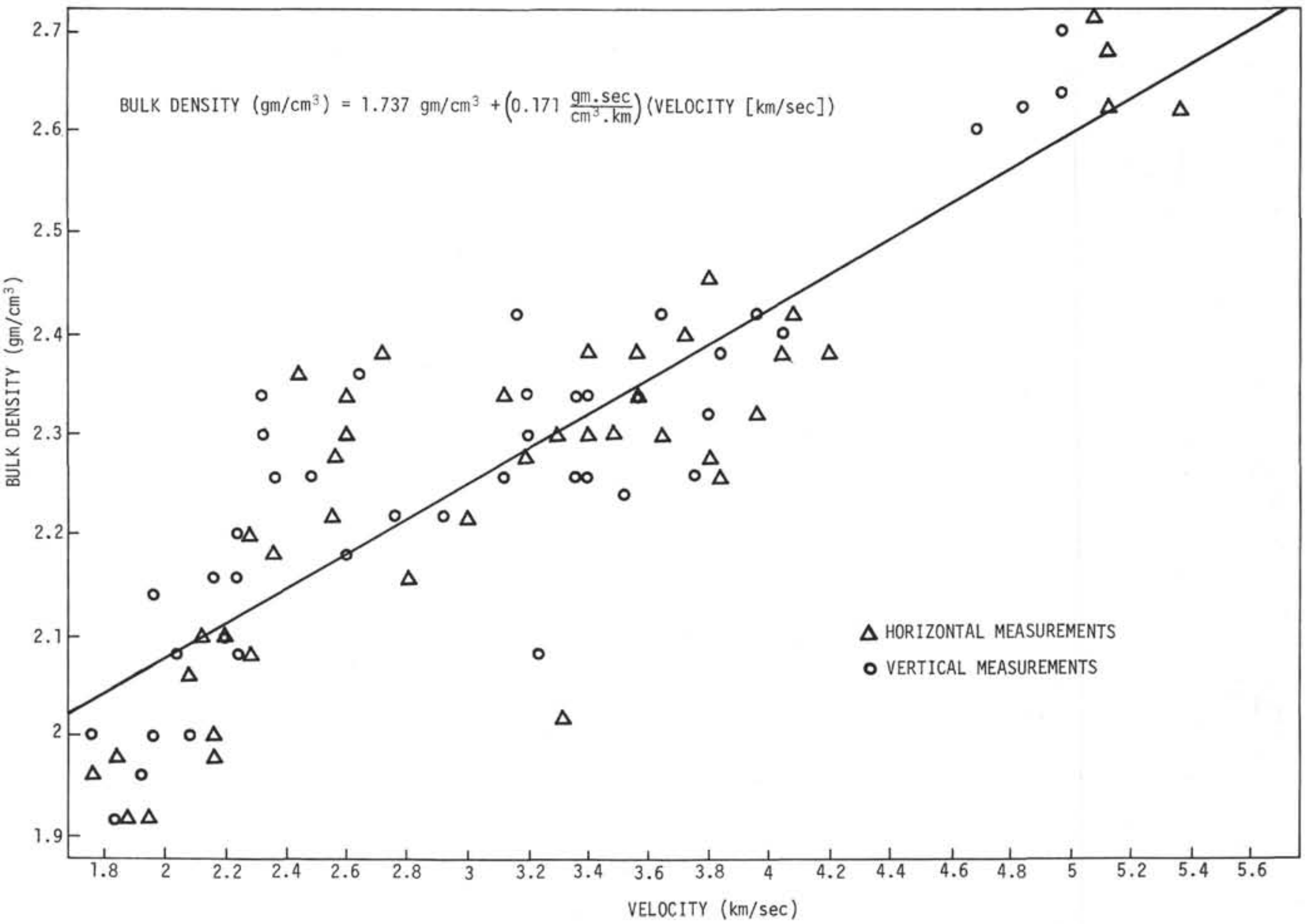

Figure 5. *Relationship of bulk density to velocity for limestone samples from lithologic Units 3, 4, 5.*

TABLE 5
Interstitial Water Chemistry – Site 237

Depth Below Sea Floor (m)	Salinity (°/°°)	pH[a]		Alkalinity (meg/kg)
Surface seawater	35.2	8.21		2.39
32	36.3		(7.37)	2.71
62	36.0		(7.22)	2.99
91	36.3	7.38	(7.15)	2.92
119	36.0	7.43	(7.17)	2.83
154	36.3	7.28	(7.16)	2.88
183	36.0	7.55	(7.20)	2.95
211	35.8	7.44	(7.12)	3.02
252	35.5	7.70	(7.25)	2.51
295	36.0	7.57		3.01
385	35.8	7.08		0.49
412	36.6	–		–

[a]pH values in parentheses are corrected (see explanatory notes, Chapter 1).

if its lithology differs from the material in which the hole bottomed, was not reached.

SUMMARY, CONCLUSIONS, AND SPECULATIONS

Site 237 (7°05.0'S, 58°07.5'E) was drilled in the saddle of intermediate depth joining Seychelles Bank to Saya de Malha and the shoal areas to the southwest. Water depth at the site was 1623 meters (corrected). The hole, a single penetration, was drilled to a depth of 693.5 meters below the sea floor where chert-induced bit wear and failure in core barrel recovery forced termination of drilling. The first 582.5 meters was cored continuously; from that depth to 693.5 meters, every alternate joint was cored. The total length of cored section was 627 meters, with recovery of 312.1 meters. Site 237 did not reach basement but bottomed in chert-bearing nanno chalk, of early Paleocene age, perhaps 60-65 m.y.

Five lithologic units were distinguished; these indicate that this locality was the site of pelagic carbonate sedi-

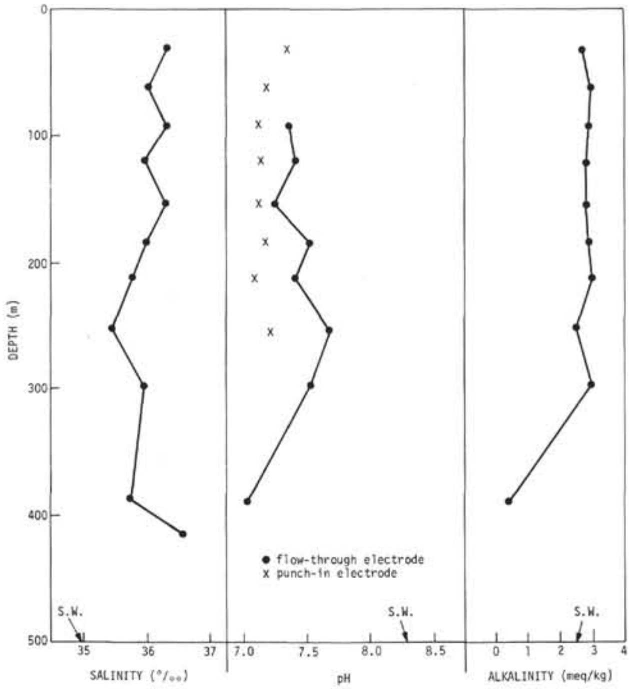

Figure 6. *Interstitial pore water, salinity,* pH, *and alkalinity, Site 237.*

mentation since at least early Paleocene time. All but Unit 4 are of considerable thickness; Unit 4 is characterized by glauconite, taken as indicative of shallow-water conditions. No igneous rocks, save minor volcanic glass, were noted. Overall, the section consists of nanno ooze back to early Eocene time (310.5 m in the section), with foraminifera common to abundant from late Eocene (225 m) to present. The nanno ooze overlies 110 meters of partly silicified nanno chalk with chert and glauconite. The lowest part of the section, from 421 to 693.5 meters, is very fine-grained, altered and recrystallized nanno chalk, with some recrystallized foraminifers and thin cherty horizons. At four levels in the lowest unit, materials of shallow-water, reef association occur embedded in planktonic foraminiferal nanno chalk. Small amounts of basic volcanic glass throughout the section evidence some explosive volcanic activity since the lower Paleocene. Chert is common in the Paleocene and lower Eocene sediments. Although pelagic sediments dominate the entire section, evidences of shallower water in Paleocene and Eocene time are found in the presence of glauconite, lensing and lamination of sediments, and by reef debris probably brought to this locality by slides or slumping from nearby banks or shoals. No prima facie shallow-reef biota, such as the corals that had been dredged nearby, were found at this site, though it was expected by some that such would be present at 2200 to 2400 meters below sea level. Lastly, if the basal sediments were deposited in depths of as little as 600 meters, the site has sunken, relative to sea level, about 2 km in 60 m.y. The actual rate of subsidence, stillstands, or even intermittent uplift are not established.

The sediment section recovered at Site 237 represents primarily a nanno chalk/ooze sequence from early Paleocene to Recent. It contains common to abundant calcareous plankton, with strong recrystallization in the lower part of the section (below middle Eocene). Radiolarians are especially abundant and well preserved in the upper and middle Eocene. The column ends in foram Zone P.1-P.2, which is about 60-65 m.y. old. Benthic foraminifera, here rarely making up more than a few percent of the foraminiferal population, do give some clues as to depth of water in past times. Assemblages indicate these sediments probably were deposited in a bathyal environment into which some slumped or shallower water skeletons were introduced during Paleocene and Eocene time. Apparent sedimentation rates through time differ widely in this locality. From middle Miocene to present, with the sediments being foraminiferal nanno ooze, the average rate has been 11.3 m/m.y., similar to that found at deep water Site 236. In late Eocene through early Miocene time, the nanno oozes accumulated at an average rate of 2.0 m/m.y.,

TABLE 6
Water Content of Sediments – Site 237

Core, Section Top of Interval (cm)	Water (%)
1-2, 104	46.56
2-2, 105	50.26
4-6, 100	57.06
5-6, 130	46.98
5-6, 140	44.35
6-4, 88	41.48
6-5, 102	41.15
8-2, 115	46.78
8-3, 82	46.79
9-2, 12	43.80
10-2, 68	44.58
10-5, 58	39.33
10-5, 80	40.76
11-3, 49	43.96
11-3, 102	44.84
11-5, 133	44.39
11-6, 137	40.09
12-3, 112	41.14
12-5, 90	41.71
13-3, 90	45.02
13-5, 105	44.66
17-2, 40	41.62
17-5, 115	42.44
17-6, 68	39.20
19-5, 75	37.86
20-2, 98	44.38
20-6, 39	40.67
21-2, 16	35.28
23-3, 56	32.99
23-5, 130	33.15
24-5, 80	31.47
24-6, 70	33.33
25-2, 16	37.64
25-5, 40	36.31
25-6, 78	37.89
26-2, 100	32.61
26-4, 66	35.69
27-4, 56	38.58
27-4, 84	36.35
27-5, 61	38.30
28-3, 68	35.50
28-3, 87	37.66
28-5, 138	35.68
29-3, 73	38.32
29-5, 115	35.92
30-3, 72	38.79
30-5, 132	35.72
32-2, 93	34.16

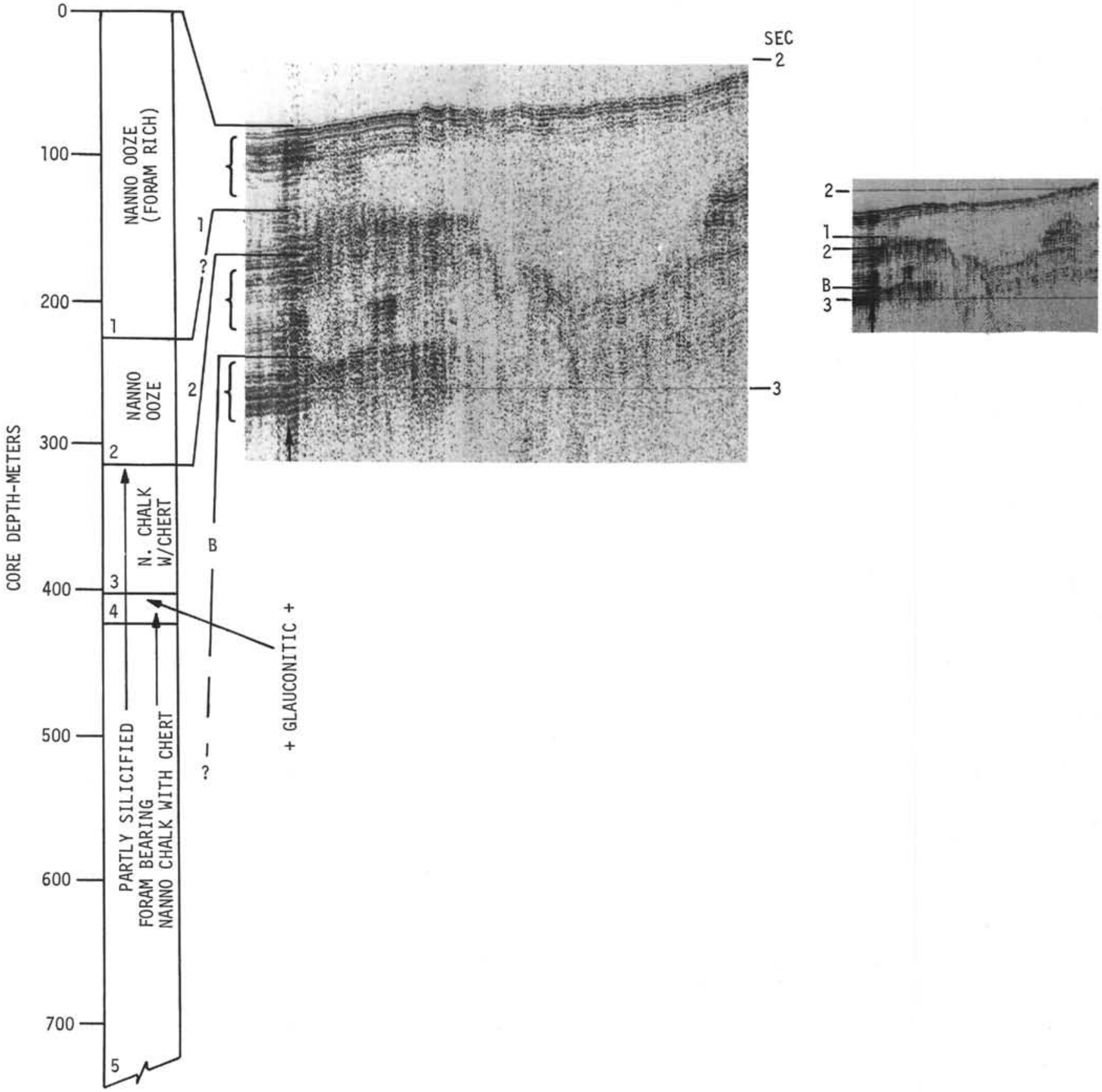

Figure 7. *Lithology and seismic reflections, Site 237. Brackets same as Figure 3;* 1, 2, *reflectors correlated with lithologic Units 2 and 3, respectively;* B, *acoustic basement, not sampled.*

slightly less than at Site 236. Rates for the lower-middle Eocene and Paleocene intervals, when sediments being deposited were in part pelagic carbonate oozes (now badly recrystallized), are much higher, 13.9 and 38.7 m/m.y., respectively. One possible cause for the latter high rate is that during Paleocene time, large quantities of cryptic, fine-grained carbonates, as well as coarser algal and benthonic foraminiferal debris, were carried to this locality by slumping. Finally, the extreme thickness at this site of Eocene and Paleocene deposits, 200 meters and 300 meters, respectively, is striking.

Bulk density and porosity measurements of nanno oozes were made only in the range 50-280 meters in this cored section; even these should be viewed with reservation because of the soupy nature and thixotropic behavior of the sediments. Sonic velocities (P_V) for the upper 310 meters of foram-nanno and nanno ooze are rather uniform at 1.55 km/sec. Velocity increases within these layers are apparent at 158 to 190 meters; the latter may mark the "first reflector" on some seismic reflection profiles. Velocity does increase to ±3.5 km/sec in the nanno chalk with chert layer below 310 meters. Velocities of the various limestones below 310 meters range from 1.8 to 5.4 km/sec, depending on degree of lithification and on the direction of propagation. Hence, good overall average velocity to "basement," or its depth, could not be determined.

The abundance and variety of these limestones afforded an opportunity to make preliminary observations on vertical and horizontal velocity anisotropy as a function of the mineralogy and degree of filling of foraminifera that make up 0 to 15 percent of the specimen. Very tentatively, all samples displaying high velocity anisotropy have foraminifera filled with calcite; those showing small velocity anisotropy have foraminifera filled with calcite (again), chert, chalcedony, or coarse calcite. Acoustic impedance measurements on these sediments were not definitive.

Detailed study of reflection records taken across Site 237 on this and previous occasions reveal five reflecting horizons, with inferred bed thicknesses of 0.25, 0.1, 0.1, 0.06, and 0.2 sec (two-way time). The deepest reflector is acoustic basement of unknown composition, this hole having been terminated before that level was reached. Above the basement, however, the nanno chalk may form the acoustically transparent section, and the majority of the column, silicified nanno chalk with significant quantities of chert, may be the upper reflecting beds.

Although a wealth of subsidiary information came out of this hole, of the three principal aims, the drilled column missed determining the age and the nature of the basement between the 600 m.y. old granitic Seychelles Bank and Tertiary (?) basaltic (?) Saya de Malha, but it did collect an excellent pelagic carbonate-limestone sequence representing Tertiary time.

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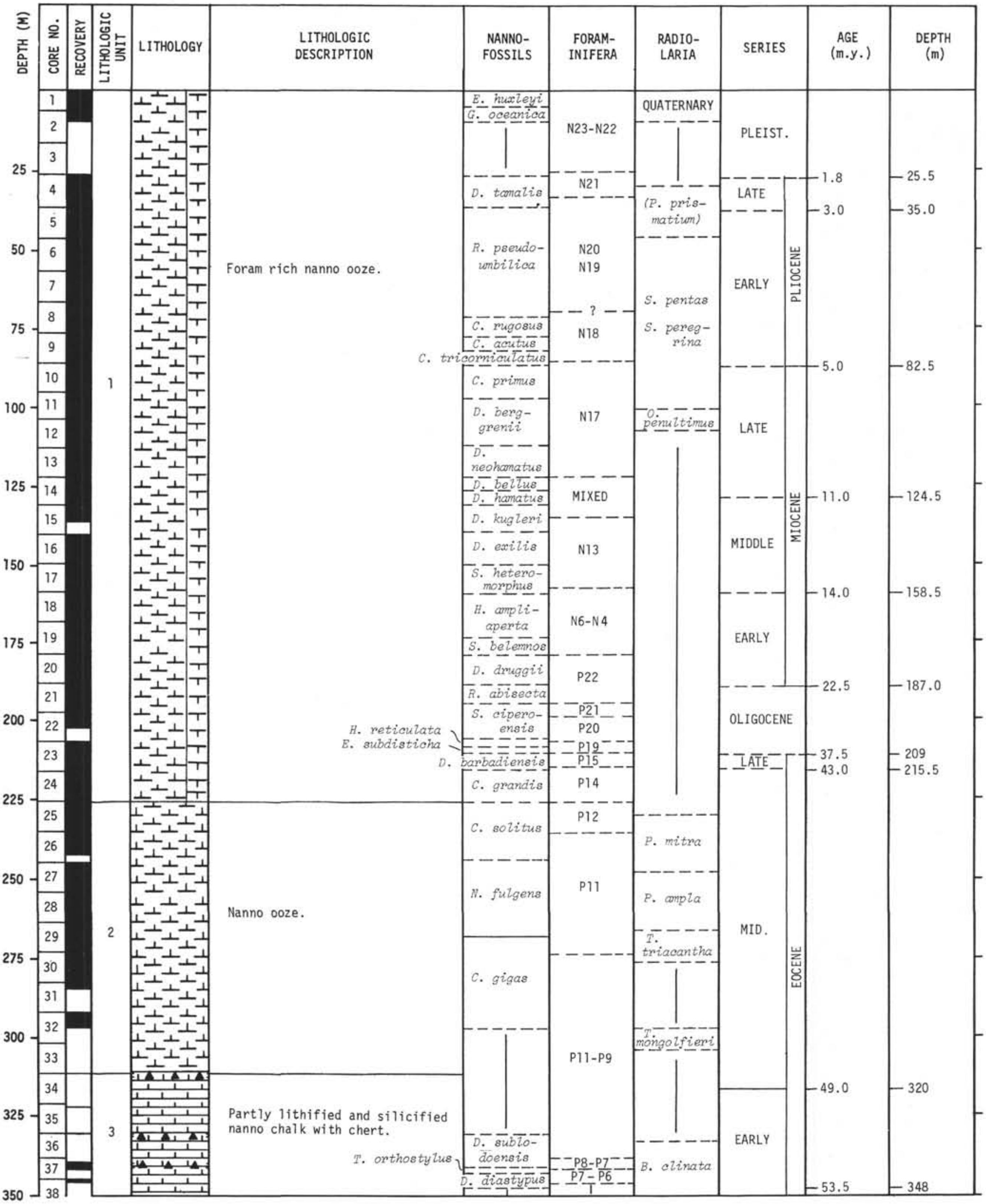
DEPTH (M)
CORE NO.
RECOVERY
LITHOLOGIC UNIT
LITHOLOGY
LITHOLOGIC DESCRIPTION
NANNO-FOSSILS
FORAM-INIFERA
RADIO-LARIA
SERIES
AGE (m.y.)
DEPTH (m)
25
50
75
100
125
150
175
200
225
250
275
300
325
350
1
2
3
Foram rich nanno ooze.
Nanno ooze.
Partly lithified and silicified nanno chalk with chert.
E. huxleyi
G. oceanica
D. tamalis
R. pseudo-umbilica
C. rugosus
C. acutus
C. tricorniculatus
C. primus
D. berg-grenii
D. neohamatus
D. bellus
D. hamatus
D. kugleri
D. exilis
S. hetero-morphus
H. ampli-aperta
S. belemnos
D. druggii
R. abisecta
S. cipero-ensis
H. reticulata
E. subdisticha
D. barbadiensis
C. grandis
C. solitus
N. fulgens
C. gigas
D. sublo-doensis
T. orthostylus
D. diastypus
N23-N22
N21
N20
N19
?
N18
N17
MIXED
N13
N6-N4
P22
P21
P20
P19
P15
P14
P12
P11
P11-P9
P8-P7
P7-P6
QUATERNARY
(P. pris-matium)
S. pentas
S. pereg-rina
O. penultimus
P. mitra
P. ampla
T. triacantha
T. mongolfieri
B. clinata
PLEIST.
LATE
EARLY
PLIOCENE
LATE
MIOCENE
MIDDLE
EARLY
OLIGOCENE
LATE
MID.
EOCENE
EARLY
1.8
3.0
5.0
11.0
14.0
22.5
37.5
43.0
49.0
53.5
25.5
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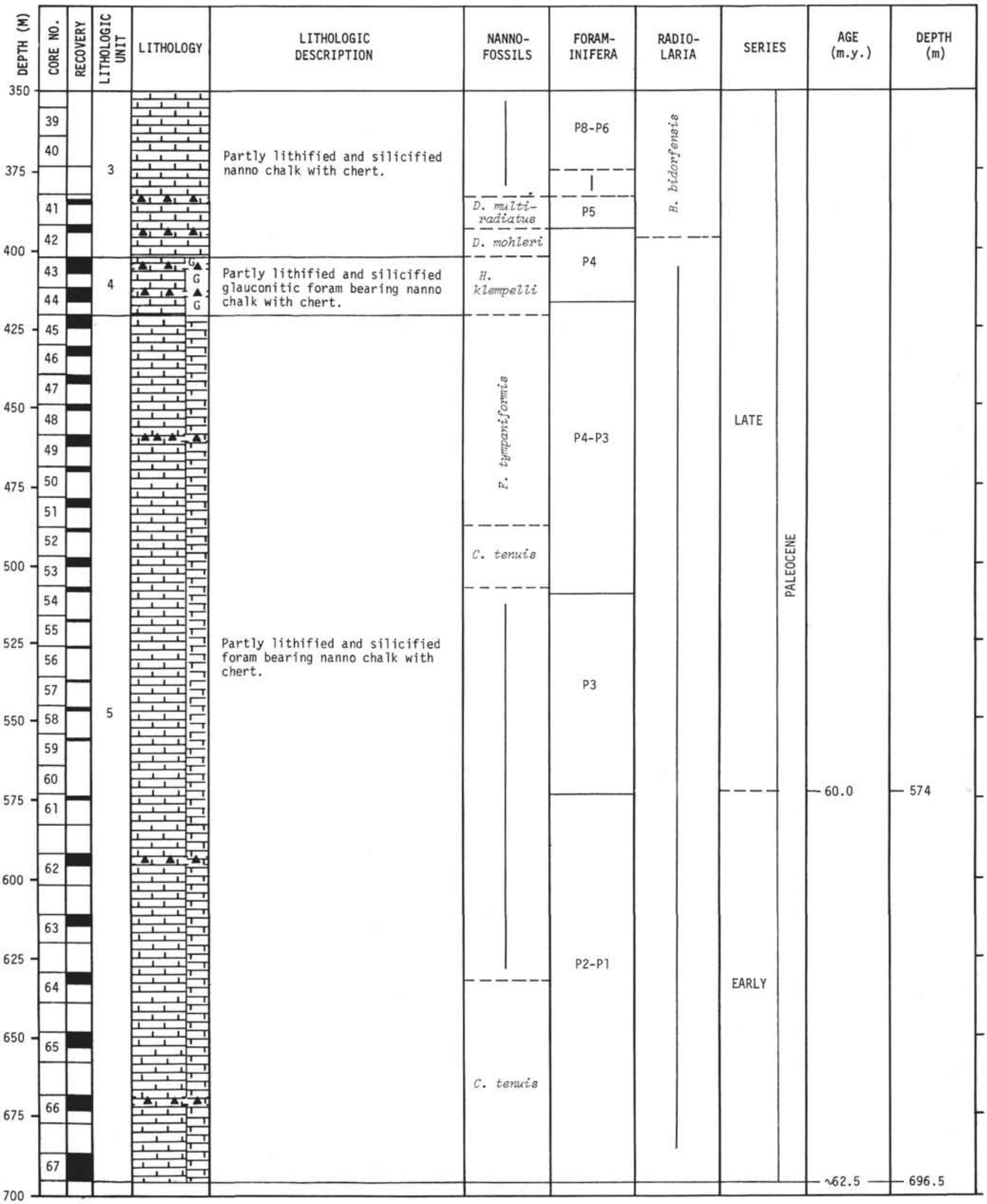
209
215.5
320
348


DEPTH (M)
CORE NO.
RECOVERY
LITHOLOGIC UNIT
LITHOLOGY
LITHOLOGIC DESCRIPTION
NANNO-FOSSILS
FORAM-INIFERA
RADIO-LARIA
SERIES
AGE (m.y.)
DEPTH (m)
350
375
400
425
450
475
500
525
550
575
600
625
650
675
700
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
3
4
5
G
Partly lithified and silicified nanno chalk with chert.
Partly lithified and silicified glauconitic foram bearing nanno chalk with chert.
Partly lithified and silicified foram bearing nanno chalk with chert.
D. multi-radiatus
D. mohleri
H. klempelli
F. tympaniformis
C. tenuis
C. tenuis
P8-P6
P5
P4
P4-P3
P3
P2-P1
B. bidorfensis
LATE
PALEOCENE
EARLY
60.0
~62.5
574
696.5

Site 237 Hole Core 1 Cored Interval: 0.0-6.5 m

AGE	ZONE	FOSSIL CHARACTER: NANNOS	FORAMS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	Emiliania huxleyi N23-N22	A/G	A/G	R/M	1	0.5, 1.0			—	FORAM NANNO OOZE Very pale orange (10YR8/2). Soupy sediment. Smear 1-1-80 Sand 20% Nannos 50% Quartz 1- 2% Silt 30% Forams 30-40% Dolo. Rhombs <1% Clay 50% Rads 5%
			A/M		2					
			A/M		3					Dark mottles at 1-3-70.
			A/M		4					
			A/M		Core Catcher					

Site 237 Hole Core 2 Cored Interval: 6.5-16.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	Gephyrocapsa oceanica N23-N22	A/G	A/G	R/M	1	0.5, 1.0			GZ	FORAM NANNO OOZE Very pale orange (10YR8/2). Grain Size Sand 83% Silt 9% Clay 7% Pumice fragment at 2-2-70.
			A/G		2				—	Smear 2-2-80 Sand 20-30% Nannos 40-50% Silt 30% Forams 30-40% Clay 40-50% Rads 5-10% Fish Debris 1- 2% Sponge Spic. <1%
			A/G		Core Catcher					

Explanatory notes in chapter 1

Site 237 Hole Core 3 Cored Interval: 16.0-25.5 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	N23-N22				Core Catcher					NO RECOVERY

Site 237 Hole Core 4 Cored Interval: 25.5-35.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	Discoaster tamalis N21	A/G	A/M	R/M	1	0.5, 1.0			—	NANNO OOZE White (N9). Soupy sediment. Smear 4-1-80 Sand 5-10% Nannos 60-70% Quartz <1% Silt 20-30% Forams 20-25% Clay 60-75% Rads 5%
			A/M		2					
			A/G		3					
			A/G		4					
			A/G		5					
			A/G		6					
			A/G		Core Catcher					

Explanatory notes in chapter 1

Site 237 Hole Core 5 Cored Interval: 35.0-44.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	Discoaster tamalis; N20-N19	A/G	A/M	F/M	1	0.5, 1.0				FORAM NANNO OOZE Bluish white (5B9/1). Soupy sediment. Smear 5-1-80 Sand 40% Forams 40-45% Quartz 1% Silt 30% Nannos 40-45% Volc. Glass <1% Clay 30% Rads 5-10%FP Diatoms <1% Sponge Spic. <1%
			A/M		2					Smear 5-2-5 (dark streak) Sand 10% Nannos 50-60% Quartz 1% Silt 20% Forams 30% Heavy Min. <1% Clay 70% Rads 5-10%FP Palagonite <1% Sponge Spic. 1% Fish Debris <1% Black streak at 5-2-100
			A/G		3					
			A/G		4					
			A/G		5					Darker patch at 5-5-35 to 40. Dark streaks at 5-5-65.
			A/G		6					
			A/G		Core Catcher					

Explanatory notes in chapter 1

Site 237 Hole Core 6 Cored Interval: 44.5-54.0 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	Reticulofenestra pseudoumbilica; N20-N19	A/G	A/M	C/M	1	0.5, 1.0				FORAM NANNO OOZE Bluish white (5B9/1). Dark mottles at 6-2-40 to 45.
			A/M		2					Smear 6-2-80 Sand 10-15% Nannos 70% Quartz <1% Silt 10% Forams 20-25% Clay 75-80% Rads 5% Fish Debris 1%
			A/G		3					Color grading to very light gray (N8).
			A/G		4					Smear 6-5-5 Sand 20% Nannos 60% Quartz <1% Silt 20% Forams 30% Pyrite <1% Clay 60% Rads 5- 7% Sponge Spic. 1% Fish Debris 1%
			A/G		5					Dark mottles at 6-5-60. Bluish white (5B9/1) horizon at 6-5-115.
			A/G		6					Bluish white (5B9/1) horizon at 6-6-0 to 105. Dark streaks at 6-6-50.
			A/M		Core Catcher					

Explanatory notes in chapter 1

Site 237 Hole Core 7 Cored Interval: 54.0-63.5 m

AGE | ZONE | FOSSIL CHARACTER (FORAMS, NANNOS, RADS) | SECTION | METERS | LITHOLOGY | DEFORMATION | LITHO. SAMPLE | LITHOLOGIC DESCRIPTION

Zone: Reticulofenestra pseudoumbilica; N20-N17

Section	Forams	Nannos
1		A/G
2	A/G	A/G
3		A/G
4		A/G
5		A/M
6		A/M
Core Catcher		A/G

FORAM RICH NANNO OOZE
Bluish white (N9). Soupy sediment.

Smear 7-1-80

Sand	10-20%	Nannos	70-80%	Quartz	<1%
Silt	20%	Forams	20%	Palagonite	<1%
Clay	60-70%	Rads	5%FP		
		Sponge Spic.	<1%		
		Fish Debris	<1%		

Smear 7-CC

Sand	20%	Nannos	60%	Quartz	<1%
Silt	20%	Forams	20-30%	Mica	<1%
Clay	60%	Rads	5%		
		Sponge Spic.	1- 2%		
		Fish Debris	<1%		

Explanatory notes in chapter 1

Site 237 Hole Core 8 Cored Interval: 63.5-73.0 m

AGE | ZONE | FOSSIL CHARACTER (FORAMS, NANNOS, RADS) | SECTION | METERS | LITHOLOGY | DEFORMATION | LITHO. SAMPLE | LITHOLOGIC DESCRIPTION

Zones: R. pseudoumbilica; N20-N19; ? ; Ceratolithus rugosus; N18

Section	Forams	Nannos	Rads
1	A/G	A/G	A/G
2		A/G	
3		A/M	
4		A/G	
5		A/M	
6		A/M	
Core Catcher		A/M	

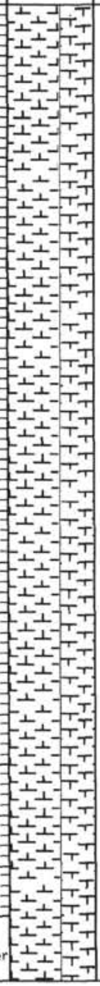
FORAM NANNO OOZE
Bluish white (5B9/1) with light bluish gray (5B7/1) horizons at 8-2-100, 8-2-125, 8-3-15, 8-3-35, 8-3-50, 8-3-105, 8-4-85, 8-4-105, 8-4-140, 8-5-100, 8-5-135, 8-6-50. Dark streaks at 8-1-50.

Smear 8-2-80

Sand	20%	Nannos	60%	Quartz	<1%
Silt	20%	Forams	30%		
Clay	60%	Rads	5- 7%		
		Diatoms	1%		
		Fish Debris	1%		
		Sponge Spic.	<1%		
		Silicoflag.	<1%		

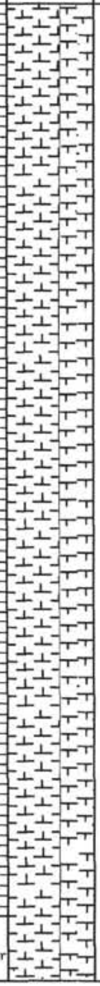
Explanatory notes in chapter 1

Site 237 Hole Core 9 Cored Interval: 73.0-82.5 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	C. rugosus N18	A/G	A/G	C/G	1	0.5, 1.0			—	FORAM NANNO OOZE Bluish white (5B9/1). Light bluish gray (5B7/1) horizon at 9-1-100 to 150. Smear 9-1-120 Sand 10% Nannos 70% Quartz <1% Silt 20% Forams 20-25% Clay 70% Rads 5% Sponge Spic. 1% Fish Debris <1%
			A/G		2					
			A/G		3					
			A/G		4					
			A/G		5					Darker (5B9/1 to 5B7/1) band at 9-5-140.
			A/G		6					Slightly darker bands at 9-6-25, 9-6-80 and 9-6-100. Smear 9-CC Sand 15% Nannos 60% Quartz <1% Silt 25% Forams 30% Clay 60% Rads 10%FP Sponge Spic. 1% Fish Debris <1%
			A/G		Core Catcher					

Explanatory notes in chapter 1

Site 237 Hole Core 10 Cored Interval: 82.5-92.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	C. primus N17	A/G	A/G	A/G	1	0.5, 1.0			—	FORAM RICH NANNO OOZE Bluish white (5B9/1) to white (N9) with darker bands at 10-1-103, 10-4-15, 10-4-80. Smear 10-1-80 Sand 30% Nannos 50-60% Quartz 1% Silt 20% Forams 20-30% Clay 50% Rads 10% Diatoms 1% Sponge Spic. 1% Fish Debris <1%
			A/G		2					Soupy sediment.
			A/G		3					
			A/G		4					
			A/M		5				—	Smear 10-5-120 Sand 30% Nannos 60% Quartz 1% Silt 20% Forams 25% Clay 50% Rads 10%FP Sponge Spic. 1% Diatoms <1% Fish Debris <1%
			A/M		6				—	Smear 10-CC Sand 5-10% Nannos 70% Silt 15-20% Forams 20% Clay 20-80% Rads 5% Sponge Spic. 3- 5%
					Core Catcher					

Explanatory notes in chapter 1

Site 237 Hole Core 11 Cored Interval: 92.0-101.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	C. primus N17	A/G	A/M	A/G	1	0.5, 1.0				FORAM NANNO OOZE Bluish white (5B9/1) with light bluish gray (5B7/1) horizons at 11-1-75, 11-3-60
			A/M		2					
			A/M		3				—	Smear 11-3-52 Sand 30% Silt 30% Clay 40% Nannos 50%, Forams 30%, Rads 5-10%, Diatoms 1- 2%, Sponge Spic. 1% Quartz <1%, Mica <1%
			A/M		4					
			A/G		5					
			A/G		6					
			A/M		Core Catcher				—	Smear 11-CC Sand 5% Silt 20% Clay 75% Nannos 80%, Forams 10-15%, Diatoms 5%, Sponge Spic. 1%, Silicoflag. <1%, Fish Debris <1% Quartz <1%

Explanatory notes in chapter 1

Site 237 Hole Core 12 Cored Interval: 101.5-111.0 m

AGE	ZONE	NANNOS	FORAMS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	C. primus N17	A/M	A/M	C/M	1	0.5, 1.0				FORAM RICH NANNO OOZE Bluish white (5B9/1) with light bluish gray (5B7/1) horizons at 12-1-5, 12-1-120, 12-5-80, 12-6-140.
			A/M		2					Slightly darker bands at 12-2-30 and 12-2-40.
			A/M		3					
			A/M		4					Few dark mottles.
			A/M		5					
			A/M		6		VOID			
			A/G		Core Catcher				—	Smear 12-CC Sand 10-15% Silt 20% Clay 70-75% Nannos 60-70%, Forams 10-15%, Rads 5%, Diatoms 1%, Sponge Spic. 1%, Fish Debris <1% Quartz 1%, Heavy Min. <1%, Palagonite <1%

Explanatory notes in chapter 1

Site 237 Hole Core 13 Cored Interval: 111.0-120.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	Discoaster neohamatus; N17	A/M	A/G		1	0.5, 1.0				FORAM RICH NANNO OOZE White (N9)
			A/G		2					
			A/G		3				—	Smear 13-3-100 Sand 30% Silt 20% Clay 50% Nannos 50-60% Forams 20-25% Rads 5- 7% Diatoms 1- 2% Sponge Spic. 1- 2% Fish Debris 1% Quartz <1% Mica <1% Heavy Min. <1%
			A/G		4					
			A/G		5					
	---- ?		A/M		6					Smear 13-CC Sand 20% Silt 20% Clay 60% Nannos 70% Forams 20% Rads 5-10% Diatoms 1- 2% Sponge Spic. <1% Fish Debris <1% Palagonite 1% Quartz <1%
			A/M		Core Catcher				—	

Explanatory notes in chapter 1

Site 237 Hole Core 14 Cored Interval: 120.5-130.0 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	D. bellus; ?	A/M	A/M		1	0.5, 1.0				FORAM RICH NANNO OOZE Bluish white (5B9/1)
			A/M		2					
			A/M		3					
			A/M		4					
			A/G		5					
			A/G		6					
			A/G		Core Catcher					

Explanatory notes in chapter 1

Site 237 Hole Core 15 Cored Interval: 130.0-139.5 m

AGE	ZONE	FOSSIL CHARACTER FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	D. kugleri N13	A/M			1	0.5 1.0	VOID			FORAM RICH NANNO OOZE Bluish white (5B9/1) Smear 15-1-80 Sand 10% Nannos 70-80% Quartz 1- 2% Silt 30% Forams 10-15% Volc. Glass <1% Clay 60% Rads 3- 5%
			A/M		2					
			A/M		3					
			A/M							

Explanatory notes in chapter 1

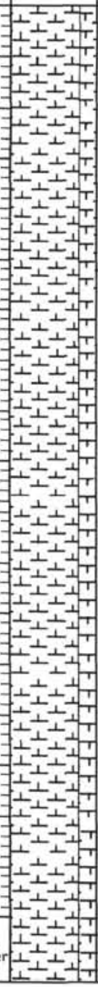
Site 237 Hole Core 16 Cored Interval: 139.5-149.0 m

AGE	ZONE	FOSSIL CHARACTER FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	D. exilis N13	A/M	A/G		1	0.5 1.0				FORAM RICH NANNO OOZE Bluish white (5B9/1) Smear 16-1-80 Sand 10% Nannos 70-80% Quartz <1% Silt 20% Forams 10-15% Clay 70% Rads 3- 5% Diatoms <1% Fish Debris<1%
			A/G		2					White (N9) horizon at 16-2-0 to 45.
			A/G		3					
			A/G		4					
			A/G		5					
			A/G		6					Smear 16-CC Sand 10-15% Nannos 70-80% Quartz <1% Silt 15% Forams 10-15% Heavy Min. <1% Clay 60% Rads 5% Palagonite <1% Diatoms 1% Fish Debris <1%
			A/G		Core Catcher					

Explanatory notes in chapter 1

Site 237 | Hole | Core 17 | Cored Interval: 149.0-158.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	Sphenolithus heteromorphus; N13; ?	A/M	A/M, A/M, A/M, A/M, A/M, A/M, A/G		1, 2, 3, 4, 5, 6, Core Catcher	0.5, 1.0				see below



FORAM RICH NANNO OOZE
White (N9)

Smear 17-1-80

Sand 10%	Nannos	80%	Quartz	<1%
Silt 10-15%	Forams	15%	Heavy Min.	<1%
Clay 75-80%	Rads	2- 3%FP		
	Diatoms	<1%		
	Sponge Spic.	<1%		
	Fish Debris	<1%		

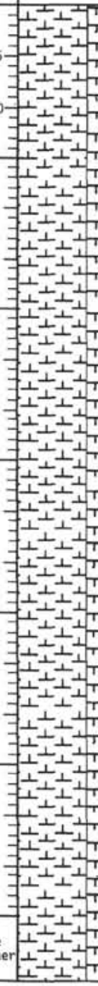
Smear 17-CC

Sand 10-15%	Nannos	70-80%	Quartz	1- 2%
Silt 15%	Forams	10-15%	Palagonite	<1%
Clay 60%	Rads	5%		
	Diatoms	1- 2%		
	Sponge Spic.	<1%		
	Fish Debris	<1%		

Explanatory notes in chapter 1

Site 237 | Hole | Core 18 | Cored Interval: 158.5-168.0 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	Helicopentosphaera ampliaperta; ?; N6-N4	A/M	A/G, A/M, A/M, A/M, A/M, A/G, A/G		1, 2, 3, 4, 5, 6, Core Catcher	0.5, 1.0				see below



FORAM RICH NANNO OOZE to FORAM NANNO OOZE
White (N9)

Smear 18-2-68

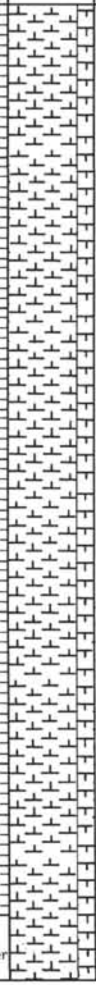
Sand 10-15%	Nannos	75-80%	Volc. Glass	<1%
Silt 15%	Forams	20-25%		
Clay 60%	Rads	1%		
	Diatoms	<1%		
	Sponge Spic.	<1%		

Smear 18-CC

Sand 1- 2%	Nannos	60-70%	Quartz	<1%
Silt 20-25%	Forams	15-20%	Heavy Min.	<1%
Clay 65-70%	Rads	3%FP	Palagonite	<1%
	Diatoms	<1%		
	Sponge Spic.	<1%		

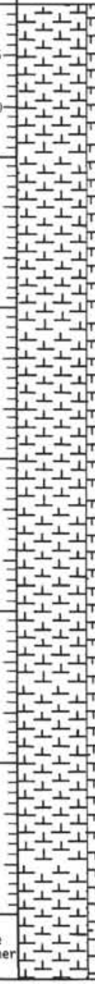
Explanatory notes in chapter 1

Site 237 Hole Core 19 Cored Interval: 168.0-177.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	S. belemnos; N6-N4; P22		A/G	A/M	1	0.5, 1.0				FORAM RICH NANNO OOZE White (N9)
			A/G		2					
			A/G		3					
			A/G		4					
			A/G		5					
			A/G		6					Smear 19-CC: Sand <5%, Silt 10%, Clay 85%; Nannos 80-90%, Forams 10-15%, Rads 1%, Diatoms <1%, Sponge Spic. <1%, Fish Debris <1%
			A/G		Core Catcher				—	

Explanatory notes in chapter 1

Site 237 Hole Core 20 Cored Interval: 177.5-187.0 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	Discoaster druggi; P22	A/M	A/G		1	0.5, 1.0				FORAM RICH NANNO OOZE White (N9)
			A/G		2					
			A/G		3					Few dusky patches.
			A/G		4					
			A/G		5					
			A/G		6					Smear 20-CC: Sand <5%, Silt 10%, Clay 85%; Nannos 80-90%, Forams 10%, Rads 1- 2%, Diatoms <1%; Palagonite <1%
			A/G		Core Catcher				—	

Explanatory notes in chapter 1

Site 237 Hole Core 21 Cored Interval: 187.0-196.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P22	A/M	A/G		1	0.5, 1.0				FORAM RICH NANNO OOZE White (N9) grading to very pale orange (10YR8/2). Smear 21-2-16 (thin hard layer) Sand 2- 3% Nannos 80% Volc. Glass 1- 2% Silt 20% Forams 5% Quartz <1% Clay 80% Fish Debris <1%
			A/G		2					
	?		A/G		3					Color grading to white (N9). Some dusky patches.
			A/G		4					
	P21		A/G		5					Very pale orange (10YR8/2) horizon at 21-5-35 to 42.
			A/G		6					Some dusky patches. Smear 21-CC Sand 10-15% Nannos 75-80% Silt 10% Forams 20% Clay 75-80% Rads 1- 2% Sponge Spic. 1%
			A/M		Core Catcher					

Explanatory notes in chapter 1

Site 237 Hole Core 22 Cored Interval: 196.5-206.0 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P20	A/M	A/M		1	0.5, 1.0	VOID			FORAM RICH NANNO OOZE White (N9) Smear 22-1-20 Sand 5-10% Nannos 85% Quartz <1% Silt 15% Forams 10% Heavy Min. <1% Clay 75-80% Sponge Spic. 2- 3% Volc. Glass <1% Rads 1% Palagonite <1%
			A/M		2					
			A/M		3					Smear 22-CC Sand 15% Nannos 80% Volc. Glass 1% Silt 10% Forams 15% Clay 75% Rads 2% Diatoms <1% Sponge Spic. <1%
			A/P		Core Catcher					

Explanatory notes in chapter 1

Site 237 Hole Core 23 Cored Interval: 206.0-215.0 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P19	A/M	C/M		1	0.5, 1.0			—	FORAM RICH NANNO OOZE White (N9) Smear 23-1-10 Sand 10% Nannos 85% Quartz <1% Silt 5% Forams 10% Volc. Glass <1% Clay 85% Diatoms 1% Rads 1% Sponge Spic. <1%
			C/P		2					Some dusky streaks and mottles throughout.
			C/M		3					
			C/M		4					
			C/P		5					
			C/M		6					Very pale orange (10YR8/2) horizon at 23-6-145 to 150. Smear 23-CC Sand 2- 3% Nannos 90% Quartz 1% Silt 20% Forams <5% Palagonite <1% Clay 80% Diatoms 1% Sponge Spic. 1% Rads <1% Fish Debris <1%
	P15		C/P		Core Catcher				—	

Explanatory notes in chapter 1

Site 237 Hole Core 24 Cored Interval: 215.5-225.0 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	?	C/M	C/M		1	0.5, 1.0			—	FORAM RICH NANNO OOZE White (N9). With small chert fragments and patches of yellowish gray (5Y8/1). Smear 24-1-10 Sand 5% Nannos 80-90% Quartz 1% Silt 20% Forams 5-10% Clay 75% Rads 1% Fish Debris 1% Sponge Spic. <1%
			C/P		2					Color grading to very pale orange (10YR8/2).
	P14		C/M		3					
			C/M		4					
			C/P		5					
			C/M		6					Smear 24-CC Sand 10% Nannos 85% Quartz <1% Silt 10% Forams 10-15% Clay 80% Diatoms <1% Rads <1% Sponge Spic. <1% Fish Debris <1%
			C/M		Core Catcher				—	

Explanatory notes in chapter 1

Site 237 Hole Core 25 Cored Interval: 225.0-234.5 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P12	C/M	R/M	A/G	1	0.5, 1.0				NANNO OOZE Very pale orange (10YR8/2). Smear 25-1-5 Sand 15% Nannos 90% Quartz <1% Silt 15% Rads 5% Clay 70% Diatoms 3- 5% Sponge Spic. 3% Fish Debris 1%
			R/M		2					Few dusky mottles at 25-1-100 to 120.
			R/M		3					
			R/M		4					
			R/M		5					
			R/M		6					Few bands at 25-6-100 to 150. Smear 25-CC Sand <5% Nannos 90% Volc. Glass <1% Silt 10% Rads 2- 3% Palagonite <1% Clay 85% Diatoms 1- 2% Sponge Spic. 1- 2% Fish Debris <1%
			R/M		Core Catcher					

Explanatory notes in chapter 1

Site 237 Hole Core 26 Cored Interval: 234.5-244.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P11	C/M	R/M	A/G	1	0.5, 1.0	VOID			NANNO OOZE White (N9). Very pale orange (10YR8/2) horizon at 26-2-70. Smear 26-1-85 Sand 10% Nannos 90% Palagonite <1% Silt 10% Rads 5% Clay 80% Sponge Spic. 5% Diatoms <1% Fish Debris <1%
			A/M		2					
			C/M		3					
			C/M		4					Smear 26-CC Sand 5% Nannos 90% Palagonite <1% Silt 15% Rads 5% Clay 80% Diatoms 3% Forams <1% Sponge Spic. <1%
			C/M		Core Catcher					

Explanatory notes in chapter 1

Site 237 Hole Core 27 Cored Interval: 244.0-253.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P11	C/M	C/M	A/G	1	0.5, 1.0				
			C/M		2					
			C/M		3					
			C/M		4					
			C/M		5					
			C/M		6					
			C/M		Core Catcher					

NANNO OOZE
Bluish white (5B9/1) to white (N9).

Smear 27-1-5

Sand 10-15%	Nannos	85-90%	Volc. Glass	<1%
Silt 15%	Rads	7-10%	Palagonite	<1%
Clay 60%	Sponge Spic.	5%		
	Diatoms	1- 2%		
	Forams	1%		

Smear 27-CC

Sand 15%	Nannos	85%	Palagonite	1%
Silt 15%	Rads	5-10%		
Clay 70%	Sponge Spic.	5- 5%		
	Forams	2- 3%		
	Fish Debris	1%		

Explanatory notes in chapter 1

Site 237 Hole Core 28 Cored Interval: 253.5-263.0 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P11	C/M	C/M	A/G	1	0.5, 1.0				
			C/M		2					
			C/M		3					
			C/M		4					
			C/M		5					
			C/M		6					
			C/M		Core Catcher					

NANNO OOZE
Bluish white (N9)

Smear 28-1-10

Sand 2- 3%	Nannos	80-85%	Volc. Glass	<1%
Silt 20%	Sponge Spic.	5- 7%		
Clay 75%	Forams	5%		
	Diatoms	3- 5%		
	Rads	3- 5%		
	Fish Debris	1- 2%		

Dusky patches
Color changing to very light gray to medium gray (N8 to N7) with a medium gray (N5) horizon at 28-3-15 and 28-4-10.

White (N9) changing to light gray (N7).

Bluish white (5B9/1) to white (N9).

Smear 28-3-15

Sand 10-15%	Nannos	80-85%	Fe-oxides	2- 3%
Silt 15-20%	Diatoms	3- 5%	Volc. Glass	1- 2%
Clay 60%	Rads	3- 5%	Palagonite	1- 2%
	Sponge Spic.	3- 5%		
	Fish Debris	1- 2%		
	Forams	<1%		

Smear 28-CC

Sand 10-15%	Nannos	80%
Silt 15%	Rads	5%
Clay 60%	Sponge Spic.	5%
	Forams	3- 5%
	Diatoms	3%
	Fish Debris	1- 2%

Explanatory notes in chapter 1

Site 237 | Hole | Core 29 | Cored Interval: 263.0-272.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P11	C/M	C/M, C/M, C/M, C/M, C/M, C/M, C/M	A/G	1, 2, 3, 4, 5, 6, Core Catcher	0.5, 1.0				

NANNO OOZE
Bluish white (5B9/1) to white (N9).
Smear 29-1-2

Sand	<5%	Nannos	80%	Volc. Glass	<1%
Silt	15-20%	Forams	5%	Palagonite	<1%
Clay	75-80%	Diatoms	3- 5%		
		Rads	3- 5%		
		Sponge Spic.	3%		
		Fish Debris	1%		

Few chert fragments at 29-1-65.
Smear 29-2-97 (thin medium dark gray [N4] horizon)

Sand	10%	Nannos	80%	Palagonite	5- 7%
Silt	20%	Rads	5%	Volc. Glass	1%
Clay	70%	Sponge Spic.	5%		
		Forams	1%		
		Diatoms	1%		
		Fish Debris	1%		

Light gray (N7) horizons at 29-2-125, 29-3-80.

Few grayish mottles.

Smear 29-CC

Sand	10%	Nannos	80%	Palagonite	<1%
Silt	20%	Forams	5%		
Clay	70%	Diatoms	5%		
		Rads	5%		
		Sponge Spic.	5%		

Explanatory notes in chapter 1

Site 237 | Hole | Core 30 | Cored Interval: 272.5-282.0 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P10-P9	C/M	C/M, C/M, C/M, C/M, C/M, C/M, C/M	A/G	1, 2, 3, 4, 5, 6, Core Catcher	0.5, 1.0				

NANNO OOZE
White greenish gray (5G6/1) changing to white (N9).

Smear 30-1-4

Sand	<5%	Nannos	90%
Silt	15%	Rads	3%
Clay	80%	Diatoms	2%
		Sponge Spic.	2%
		Forams	1- 2%

Dusky mottles throughout.

Smear 30-CC

Sand	15%	Nannos	80%	Palagonite	<1%
Silt	15%	Forams	5%		
Clay	70%	Rads	5%		
		Sponge Spic.	5%		
		Diatoms	3%		
		Fish Debris	1%		

Explanatory notes in chapter 1

Site 237 Hole Core 31 Cored Interval: 282.0-291.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P10-P9	C/M	C/P; C/M	A/G	1; Core Catcher	0.5; 1.0			–	NANNO OOZE White (N9)

Smear 31-CC

Sand 20%	Nannos	75-80%	Palagonite	<1%
Silt 20%	Rads	5-10%		
Clay 60%	Forams	5%		
	Sponge Spic.	5%		
	Diatoms	3- 5%		

Site 237 Hole Core 32 Cored Interval: 291.5-301.0 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P10-P9	C/M	C/P; A/M; A/M	A/M	1; 2; 3; Core Catcher	0.5; 1.0			–	NANNO OOZE White (N9). Chert fragment at 32-1-130.

Smear 32-CC

Sand 10%	Nannos	85%	Volc. Glass	<1%
Silt 20%	Forams	10%	Palagonite	<1%
Clay 70%	Diatoms	2- 3%		
	Sponge Spic.	<1%		
	Fish Debris	<1%		

Site 237 Hole Core 33 Cored Interval: 301.0-310.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P10-P9				Core Catcher					NO RECOVERY

Explanatory notes in chapter 1

Site 237 Hole Core 34 Cored Interval: 310.5-320.0 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P10-P9				1	0.5; 1.0	VOID			Fragments of silicified LIMESTONE. Grayish yellow green (5GY7/2) with chert stringers.

Site 237 Hole Core 35 Cored Interval: 320.0-329.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P10-P9		A/P		1	0.5; 1.0	VOID		–	Silicified LIMESTONE Grayish yellow green (5GY7/2) with chert stringers.

Smear 35-CC

Sand 1%	Nannos	95%	Fe-oxide	1%
Silt 15-20%	Forams	2- 3%	Volc. Glass	<1%
Clay 80%	Diatoms	1- 2%		

Site 237 Hole Core 36 Cored Interval: 329.5-339.0 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P10-P9	C/M	A/P; A/P		1; Core Catcher	0.5; 1.0	VOID		–	Silicified LIMESTONE and NANNO CHALK Grayish yellow green (5GY7/2)

Smear 36-CC

Sand 2- 3%	Nannos	90-95%	Fe-oxide	<1%
Silt 15%	Forams	2- 3%	Volc. Glass	<1%
Clay 80%	Diatoms	1%	Palagonite	<1%

Explanatory notes in chapter 1

Site 237 Hole Core 37 Cored Interval: 339.0-345.0 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P8-P6	C/P	A/P	C/M	1	0.5, 1.0	VOID			Silicified LIMESTONE and NANNO CHALK Grayish yellow green (5GY7/2) with chert veins.
			A/P		2				–	Smear 37-2-105 Sand <5% Nannos 90-95% Silt 20% Forams 2- 3% Clay 75% Fish Debris 1%

Site 237 Hole Core 38 Cored Interval: 345.0-354.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P8-P6	C/P	C/P	C/M	1	0.5, 1.0				Silicified LIMESTONE and NANNO CHALK Grayish yellow green (5GY7/2) to light greenish gray (5GY8/1).

Site 237 Hole Core * Cored Interval:

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					Core Catcher					*Core 39 354.5-364.0 m 40 364.0-373.5 m NO RECOVERY

Explanatory notes in chapter 1

Site 237 Hole Core 41 Cored Interval: 383.0-392.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P5	C/P	A/P	C/M	1	0.5, 1.0	VOID			CHERT fragments NANNO CHALK and LIMESTONE, partially silicified Grayish yellow green (5GY7/2).
			A/P		2					CHERT

Site 237 Hole Core 42 Cored Interval: 392.5-402.0 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P4		A/P A/P	F/M	1	0.5, 1.0				LIMESTONE partially silicified Grayish yellow green (5GY7/2)

Site 237 Hole Core 43 Cored Interval: 402.0-411.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P4		C/P		1	0.5, 1.0	VOID			Glauconitic LIMESTONE Pale olive (10Y6/2), partly silicified, with cherty layers.
		C/P	A/P		2					
			A/P		3					Dark layer.

Explanatory notes in chapter 1

Site 237 Hole Core 44 Cored Interval: 411.5-421.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P4	C/P	C/P, C/P, C/P		1, 2, 3	0.5, 1.0	VOID, VOID			

FORAM RICH NANNO LIMESTONE
Light bluish gray (5B7/1) to greenish gray (5GY6/1). Glauconitic.

Dark greenish gray (5G4/1).

Smear 44-2-100

Sand 20-30%	Nannos 80%	Volc. Glass	1- 2%
Silt 20%	Forams 15%	Feldspar	<1%
Clay 50-60%	Rads <1%	Heavy Min.	<1%
	Fish Debris <1%	Fe-oxide	<1%
		Palagonite	<1%

VOLCANIC ASH Thin black (N1) layer at 44-2-125
Smear 44-2-125

Sand <5%	Nannos <5%	Clay Min.	50%
Silt 45%		Volc. Glass	30-40%
Clay 50%		Fe-oxide	2- 3%
		Feldspar	2%
		Quartz	1%
		Mica	<1%
		Glauconite	<1%
		Zeolite	<1%

Color changing to greenish gray (5GY6/1) in 44-3.

Site 237 Hole Core 45 Cored Interval: 421.0-430.5 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P4	C/M	C/P, C/P, B		1, 2, Core Catcher	0.5, 1.0				

FORAM RICH NANNO CHALK to LIMESTONE
Pale olive (10Y6/2).

Smear 45-2-5

Sand 20%	Nannos 80%	Glauconite	1%
Silt 20%	Forams 5-10%	Heavy Min.	1%
Clay 60%	Rads 2- 3%	Volc. Glass	<1%
	Fish Debris 1%	Palagonite	<1%
	Diatoms <1%		

Explanatory notes in chapter 1

Site 237 Hole Core 46 Cored Interval: 430.5-440.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P4, ?	C/P	A/P, A/P, B		1, 2, Core Catcher	0.5, 1.0	VOID			

NANNO CHALK to LIMESTONE
Pale olive (10Y6/2)

Smear 46-1-100

Sand 10-15%	Nannos	90%	Volc. Glass	1- 2%
Silt 20%	Forams	5%	Fe-oxide	1%
Clay 65-70%	Diatoms	1%	Glauconite	1%
	Rads	1%	Feldspar	<1%
			Mica	<1%
			Heavy Min.	<1%

Patchy silicification

Smear 46-CC

Sand 20%	Nannos	80%	Fe-oxide	1%
Silt 20%	Forams	5-10%	Feldspar	<1%
Clay 60%	Rads	2- 3%	Heavy Min.	<1%
	Diatoms	1%	Palagonite	<1%
	Fish Debris	<1%	Glauconite	<1%

Site 237 Hole Core 47 Cored Interval: 440.0-449.5 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		C/P	A/P, A/P		1, 2	0.5, 1.0	VOID			

NANNO CHALK to LIMESTONE
Pale olive (10Y6/2)

Dusky yellow (5GY5/2) and grayish olive (10Y4/2) horizon at 47-2-0 to 50.

Site 237 Hole Core 48 Cored Interval: 449.5-459.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		C/P	B, C/P		1, Core Catcher	0.5, 1.0				

NANNO CHALK to LIMESTONE
Grayish olive (10Y4/2)

Smear 48-1-80

Sand <5%	Nannos	80-85%	Volc. Glass	3- 5%
Silt 20%	Forams	3- 5%	Pyrite	3%
Clay 75%	Rads	1%	Fe-oxide	1%
	Diatoms	1%	Glauconite	<1%
	Fish Debris	1%		

Explanatory notes in chapter 1

Site 237 Hole Core 49 Cored Interval: 459.0-468.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
			C/P		1	0.5, 1.0			—	NANNO CHALK to LIMESTONE Pale olive (10Y6/2) to grayish olive (10Y4/2). Smear 49-1-80 Sand 5% Silt 20% Clay 75% Nannos 85%, Forams <5%, Diatoms 1%, Rads 1%, FishDebris1% Volc. Glass 2- 3%, Pyrite 1- 3%, Fe-oxide <1%, Zeolite <1%
		C/P	C/P		2					

Site 237 Hole Core 50 Cored Interval: 468.5-478.0 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P3	C/P	C/P		1	0.5, 1.0				NANNO CHALK to LIMESTONE Predominantly pale olive (10Y6/2) with partially silicified layers.

Site 237 Hole Core 51 Cored Interval: 478.0-487.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					1	0.5, 1.0	VOID			
	P3	C/P	C/P		2				—	NANNO CHALK to LIMESTONE Grayish olive (10Y4/2) with a dark greenish gray (5G6/1) layer at 51-1-135. In 51-2 grayish yellow green (5GY7/2), dusky yellow green (5GY5/2) and pale olive (10Y6/2) hues, becoming grayish olive green (5GY3/2) at base. Smear 51-2-100 Sand 1% Silt 30% Clay 60% Nannos 90%, Forams 3%, Diatoms 1%, Rads <1% Volc. Glass 5- 7%, Pyrite 1- 2%, Quartz <1%, Feldspar <1%, Mica <1%, Fe-oxide <1%, Glauconite <1%
			C/P		Core Catcher					

Explanatory notes in chapter 1

Site 237 Hole Core 52 Cored Interval: 487.5-497.0 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P3	C/P	C/P		1	0.5, 1.0	VOID		—	NANNO CHALK to LIMESTONE Grayish yellow green (5GY7/2) with dusky yellow green (5GY5/2) layers at 52-1-15 to 35, 52-1-80 to 85, 52-1-105 to 115. Smear 52-1-85 Sand 1% Silt 20% Clay 80% Nannos 85-90%, Forams 5% Volc. Glass 3- 5%, Pyrite 2%, Feldspar <1%, Mica <1%, Palagonite <1%, Glauconite <1%
					Core Catcher					

Site 237 Hole Core 53 Cored Interval: 497.0-506.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					1	0.5, 1.0	VOID			
	P3	R/P	C/P		2				—	NANNO CHALK to LIMESTONE Dusky yellow green (5GY5/2) to grayish yellow green (5GY7/2). Smear 53-2-80 Sand 10% Silt 20% Clay 70% Nannos 80-84%, Forams 10-15% Volc. Glass 5%, Pyrite 2- 3%, Mica <1%, Fe-oxide <1%, Palagonite <1%, Glauconite <1%

Site 237 Hole Core 54 Cored Interval: 506.5-516.0 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P3	F/P	C/P		1	0.5, 1.0	VOID		—	NANNO CHALK to LIMESTONE Grayish yellow green (5GY7/2) to dusky yellow green (5GY5/2). Smear 54-1-100 Sand 10% Silt 20% Clay 70% Nannos 85%, Forams 10%, Diatoms <1%, Rads <1%, Fish Debris <1% Pyrite 2- 3%, Volc. Glass 1- 2%, Palagonite <1%

Explanatory notes in chapter 1

Site 237 Hole Core 55 Cored Interval: 516.0-525.5 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	FOSSIL CHARACTER: NANNOS	FOSSIL CHARACTER: RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P3				1	0.5 1.0	VOID			BIOMICRITE Pale olive (10Y6/2) with white (N9) coralline algae fragments. Smear 55-1-125 Micrite 95% Quartz <1% Nannos 1- 2% Glauconite <1% Fish Debris 1% Pyrite <1% Sponge Spic. <1%

Site 237 Hole Core 56 Cored Interval: 525.5-535.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	FOSSIL CHARACTER: NANNOS	FOSSIL CHARACTER: RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P3		R/P		1	0.5 1.0	VOID			MICRITE Pale olive (10Y6/2) with grayish olive (10Y4/2) layers at 56-1-115 and 56-1-135. Black layer (N9) at 56-1-5. Smear 56-1-135 Micrite 95% Volc. Glass 1% Sponge Spic. <1% Palagonite <1% Pyrite <1%

Site 237 Hole Core 57 Cored Interval: 535.0-544.4 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	FOSSIL CHARACTER: NANNOS	FOSSIL CHARACTER: RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P3				1 Core Catcher	0.5 1.0	VOID			MICRITE Pale olive (10Y6/2) with a grayish olive (10Y4/2) layer at 57-1-115.

Explanatory notes in chapter 1

Site 237 Hole Core 58 Cored Interval: 544.1-554.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	FOSSIL CHARACTER: NANNOS	FOSSIL CHARACTER: RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P3	R/P			1	0.5 1.0	VOID			MICRITE Pale olive (10Y6/2) to olive gray (5Y3/2). White (N1) coralline algae fragments at 58-1-90. CHERT layers at 58-1-110 and 58-1-140. Black (N9).

Site 237 Hole Core 59 Cored Interval: 554.0-563.5 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	FOSSIL CHARACTER: NANNOS	FOSSIL CHARACTER: RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					1	0.5 1.0	VOID			MICRITE Pale olive (10Y6/2) to grayish olive (10Y4/2). Chert layer at 59-1-135 and 59-1-145. Smear 59-1-130 Micrite 80% Fe-oxide 10% Nannos 1- 2% Dolo. Rhombs 5- 7% Volc. Glass 3- 5% Quartz <1% Feldspar <1%

Site 237 Hole Core 60 Cored Interval: 563.5-573.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	FOSSIL CHARACTER: NANNOS	FOSSIL CHARACTER: RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
										NO RECOVERY

Site 237 Hole Core 61 Cored Interval: 573.0-582.5 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	FOSSIL CHARACTER: NANNOS	FOSSIL CHARACTER: RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					1	0.5 1.0	VOID			MICRITE with CHERT Pale olive (10Y6/2) with white (N9) coralline fragments at 61-1-50 and grayish olive (10Y4/2) coralline fragments at 61-1-70. Black (N1) chert fragment at 61-1-45.

Explanatory notes in chapter 1

Site 237 Hole Core 62 Cored Interval: 592.0-601.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
			R/P		1	0.5, 1.0	VOID			MICRITE Pale olive (10Y6/2). Light olive gray (5Y5/2) horizon at 62-1-95 to 135 with many subhorizontal burrows. Darker streaks and mottles at 62-1-80.
					2					

Smear 62-1-50

Forams	1%FP	Micrite	90%
		Dolo. Rhombs	1- 2%
		Chert	1%
		Volc. Glass	<1%
		Glauconite	<1%

Smear 62-2-5

Sand	30%	Micrite	90%
Silt	30%	Glauconite	3%
Clay	40%	Pyrite	2- 3%
		Volc. Glass	2%
		Dolo. Rhombs	<1%

Site 237 Hole Core 63 Cored Interval: 611.0-620.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
			R/P		1	0.5, 1.0	VOID			MICRITE with CHERT Pale olive (10Y6/2). Black (N1) chert at 63-2-20. Silicified limestone fragments at 62-2-25.
					2					

Explanatory notes in chapter 1

Site 237 Hole Core 64 Cored Interval: 630.0-639.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P2-P1		R/P		1	0.5, 1.0	VOID			MICRITE with CHERT Pale olive (10Y6/2) with dark layers at 64-1-100, 64-1-135.
					2					Black (N1) chert at 64-2-150.

Smear 64-2-80

Forams	1%FP	Micrite	90%
Nannos	1%	Volc. Glass	5%
		Pyrite	1%
		Dolo. Rhombs	1%
		Glauconite	<1%

Site 237 Hole Core 65 Cored Interval: 649.0-658.5 m

AGE	ZONE	FORAMS	NANNOS	RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P2-P1				1	0.5, 1.0	VOID			MICRITE Grayish yellow green (5GY7/2) with grayish olive (10Y4/2) layers at 65-1-80 to 105, 65-1-140, 65-2-55 to 70, 65-2-140 to 150, 65-3-10 to 30, 65-3-95.
					2					
			R/P		3					

Explanatory notes in chapter 1

Site 237 Hole Core 66 Cored Interval: 668.0-677.5 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	FOSSIL CHARACTER: NANNOS	FOSSIL CHARACTER: RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P2-P1		R/P		1, 2, 3	0.5, 1.0				MICRITE and CHERT

MICRITE and CHERT
Grayish yellow green (5GY7/2) with grayish olive horizons at 66-1-75 to 105, 66-2-60 to 85, 66-2-140, 66-3-20, 66-3-65 to 75, 66-3-135.
Black (N1) chert at 66-1-130.

Smear 66-1-100

Nannos	3%	Micrite	90%
Fish Debris	<1%	Volc. Glass	2- 3%
		Feldspar	1%
		Pyrite	1%
		Dolo. Rhombs	1%

Explanatory notes in chapter 1

Site 237 Hole Core 67 Cored Interval: 687.0-696.5 m

AGE	ZONE	FOSSIL CHARACTER: FORAMS	FOSSIL CHARACTER: NANNOS	FOSSIL CHARACTER: RADS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
	P2-P1		R/P (Section 2), R/P (Section 5)		1, 2, 3, 4, 5	0.5, 1.0	VOID			MICRITE

MICRITE
Medium gray (N5)

Smear 67-1-85

Silt 30-40%	Nannos <1%	Micrite	95%
Clay 60-70%		Pyrite	1%
		Dolo. Rhombs	1%
		Palagonite	<1%

Smear 67-2-80

Sand 10%	Forams 1%FP	Micrite	90%
Silt 30%		Dolo. Rhombs	5%
Clay 60%		Volc. Glass	2%
		Pyrite	1- 2%
		Palagonite	<1%

Color change to light olive gray (5Y6/1)

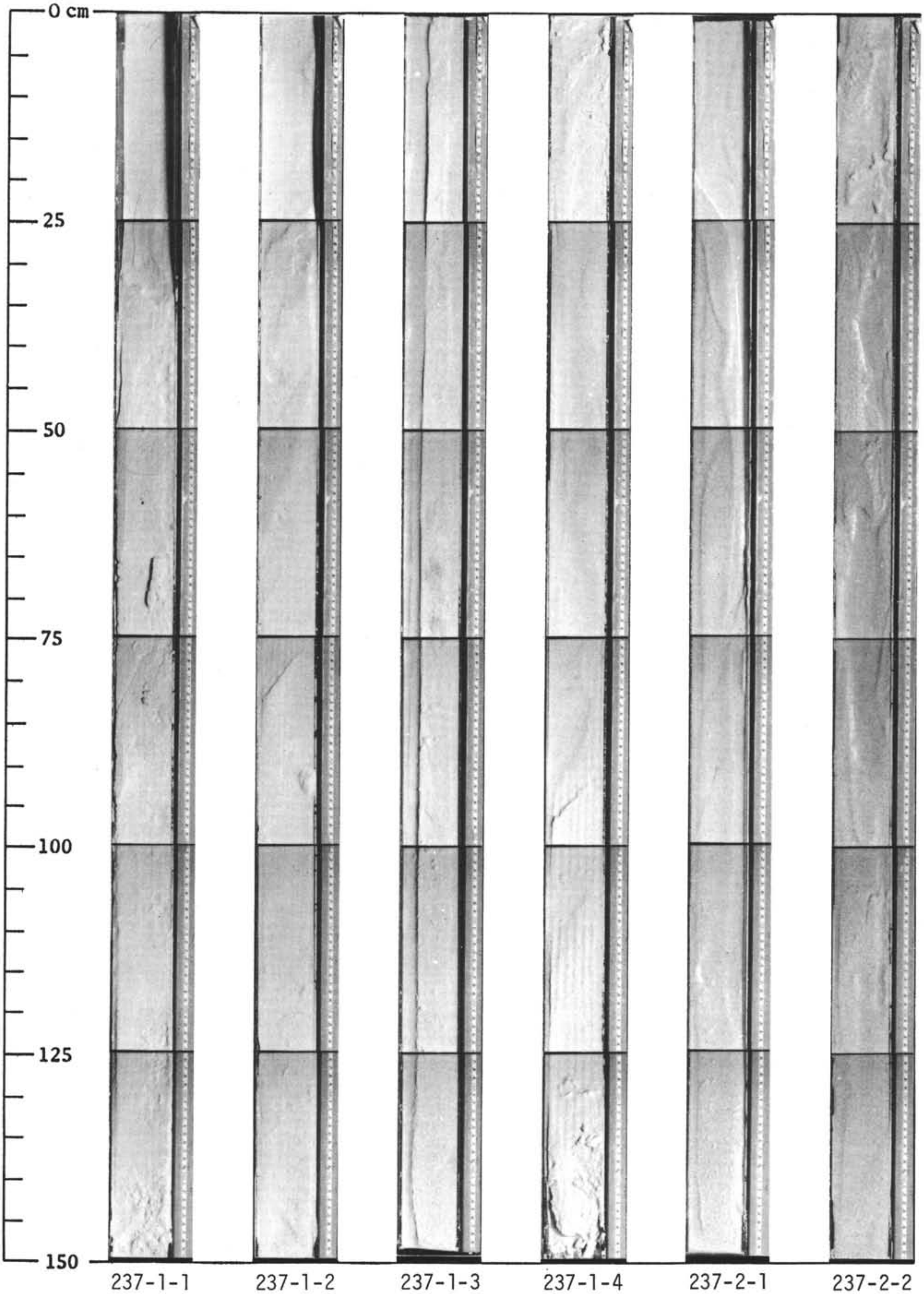
Smear 67-5-65

Sand 10%	Rads 1%FP	Micrite	85%
Silt 20%	Fish Debris 1%	Dolo. Rhombs	10%
Clay 70%		Pyrite	2%
		Volc. Glass	<1%

Smear 67-5-145

Sand <5%	Micrite	95%
Silt 20%	Fe-oxide	1- 3%
Clay 75-80%	Volc. Glass	1%
	Palagonite	<1%

Explanatory notes in chapter 1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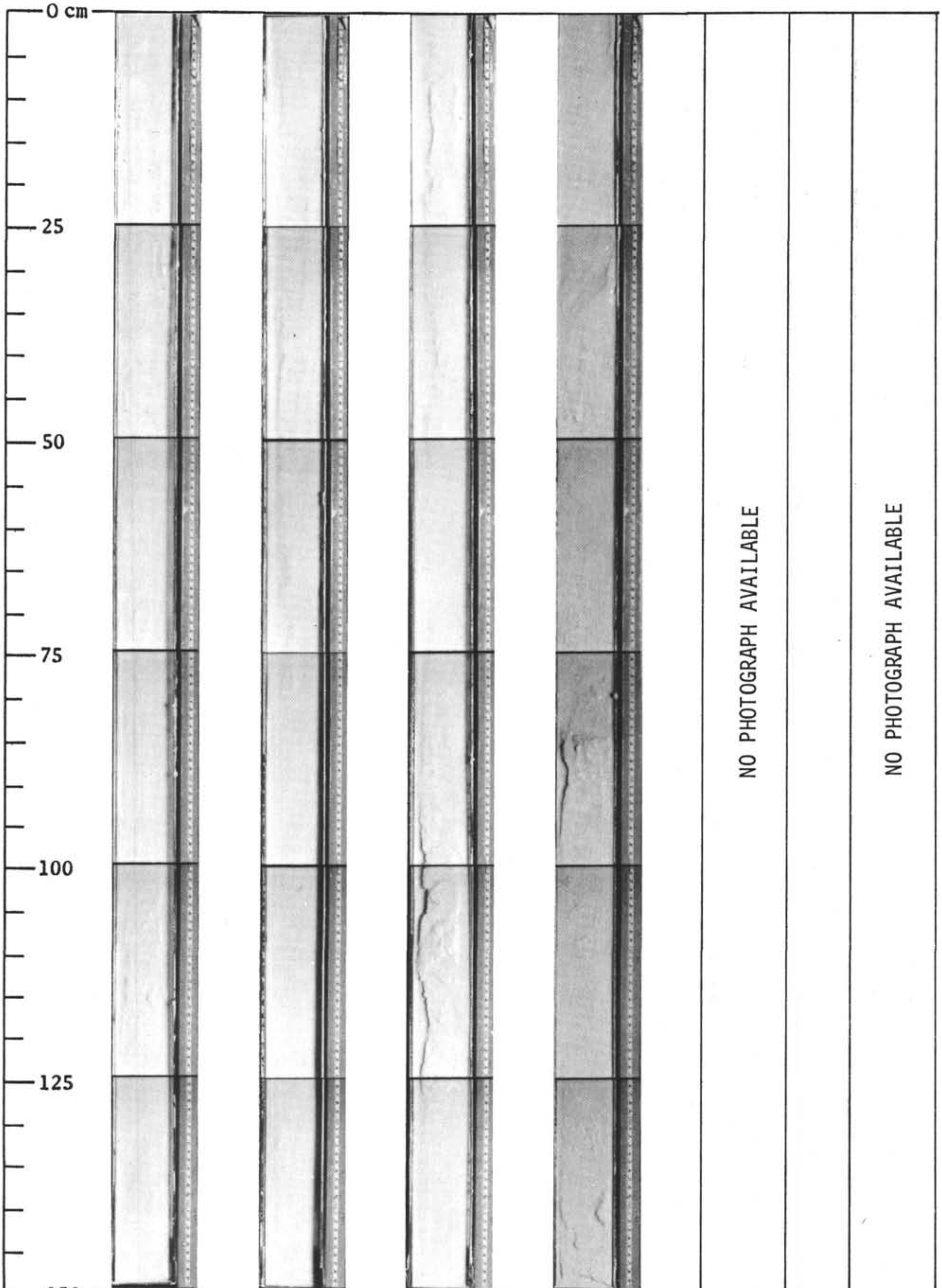

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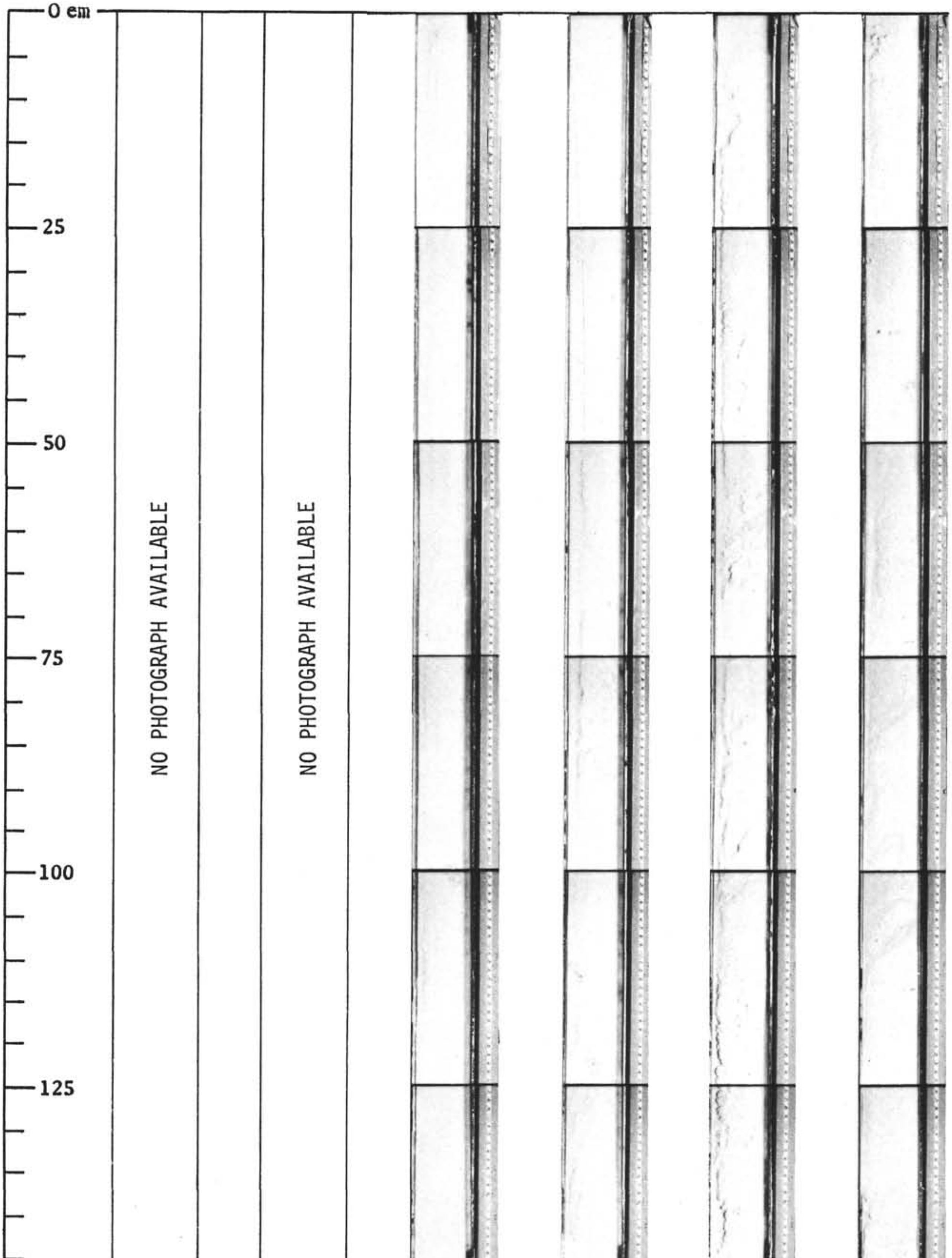
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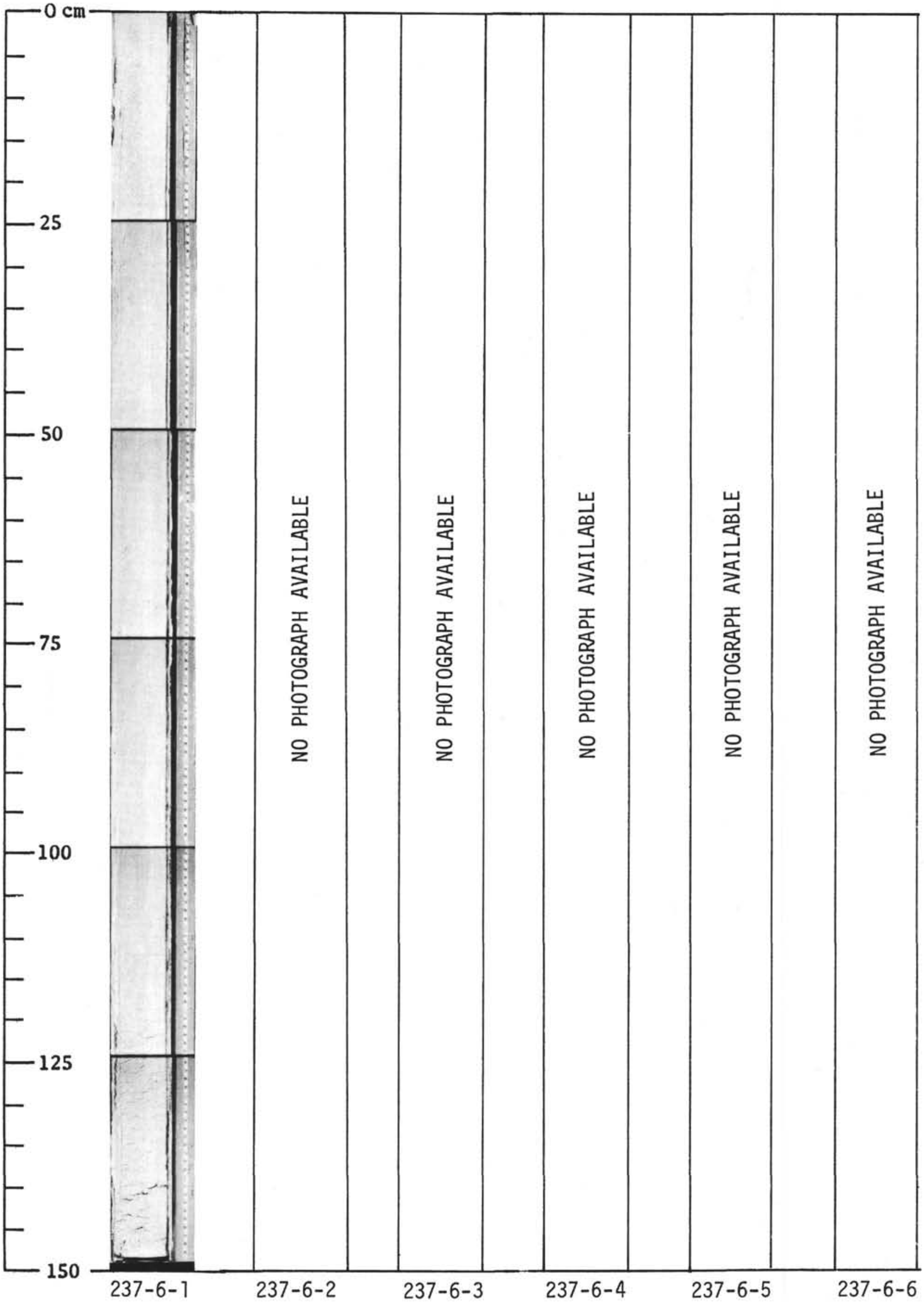
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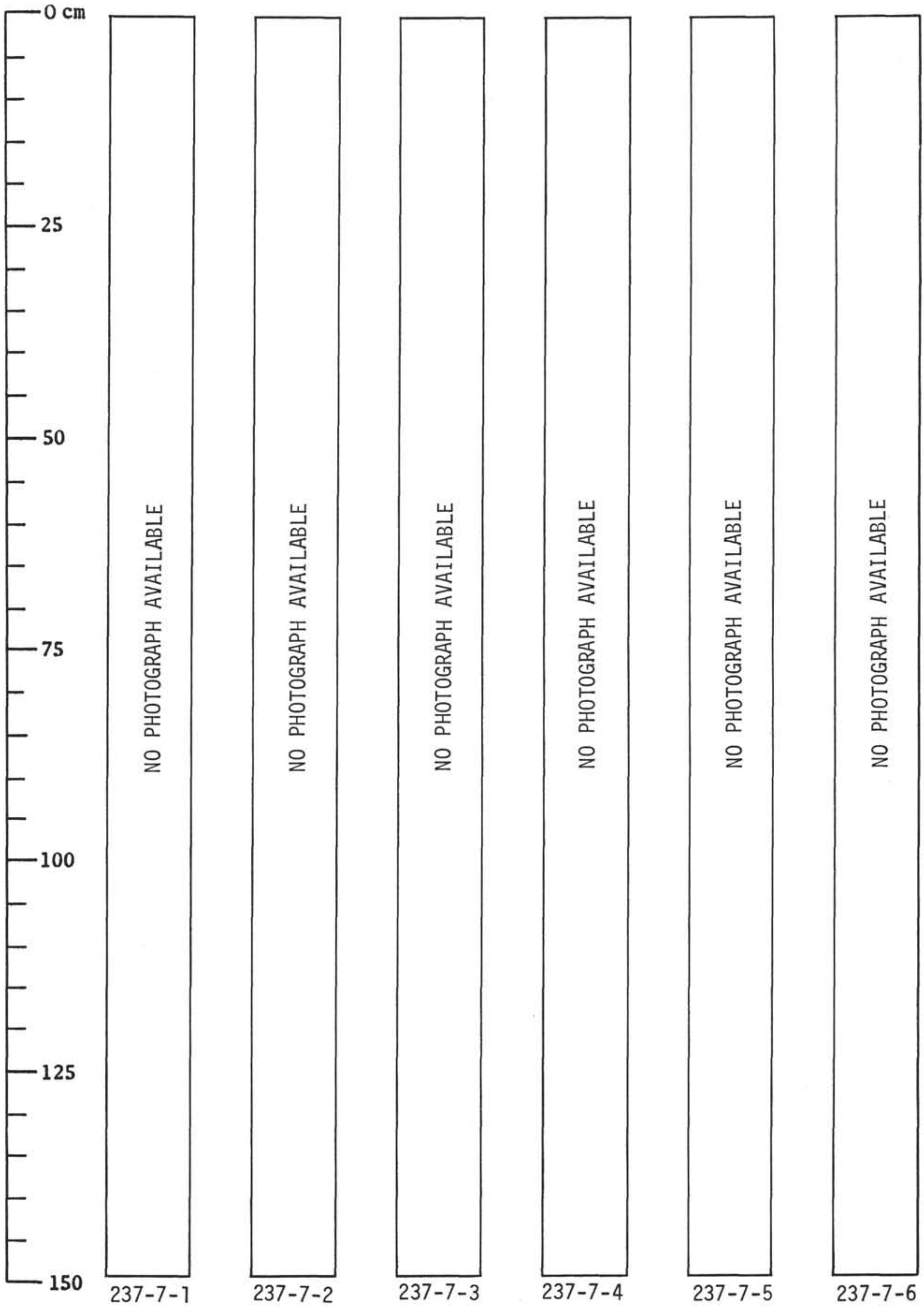
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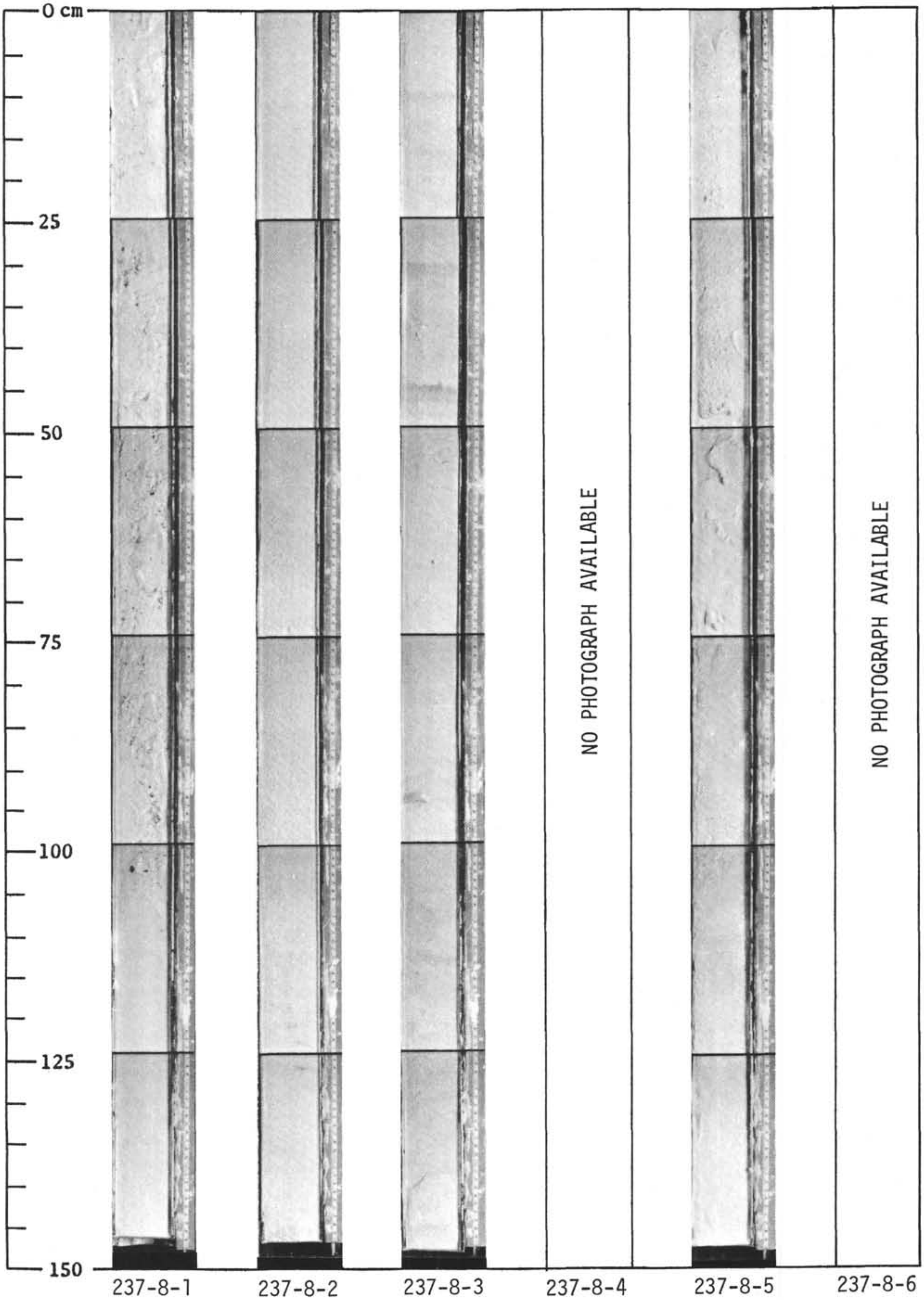
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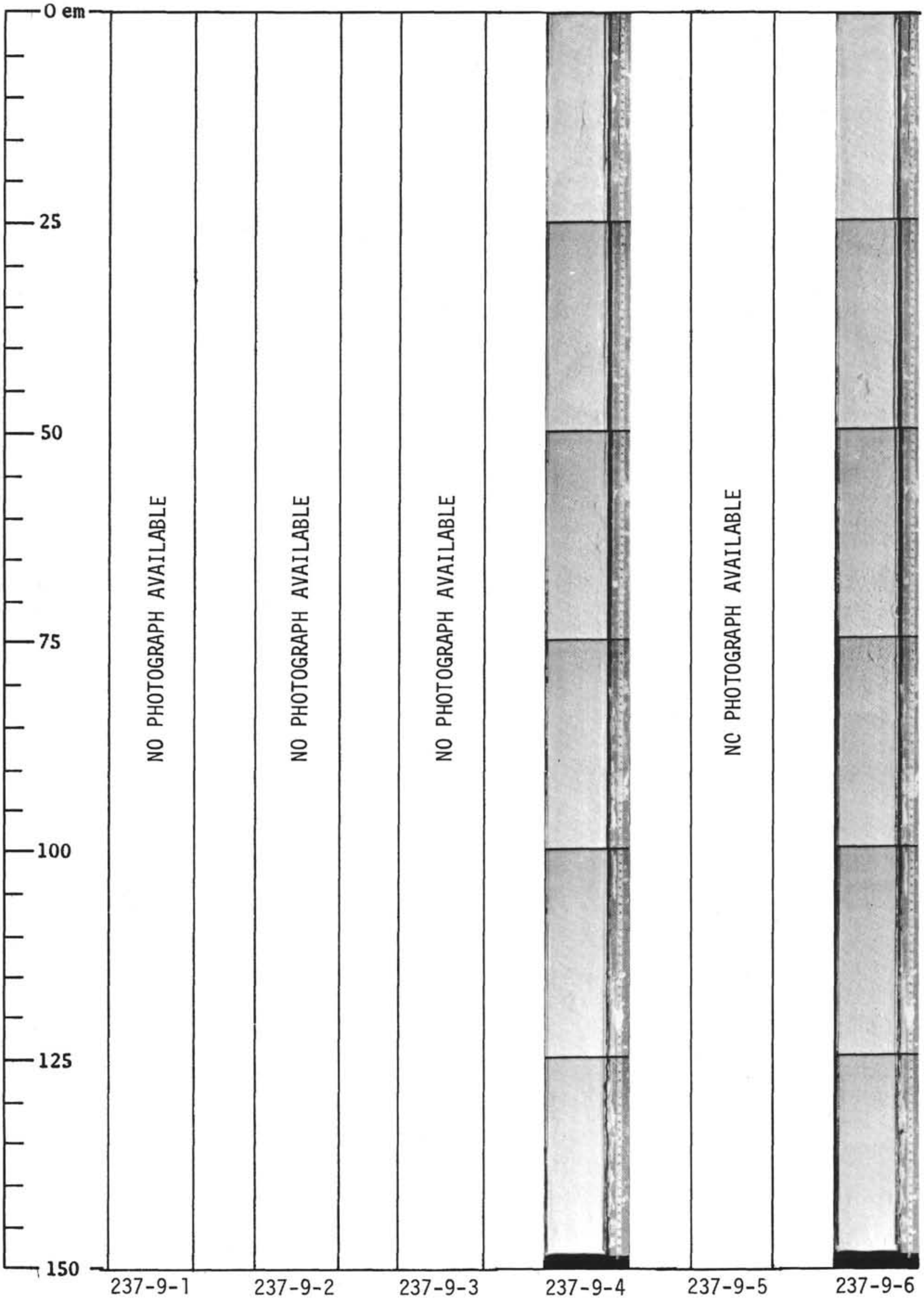
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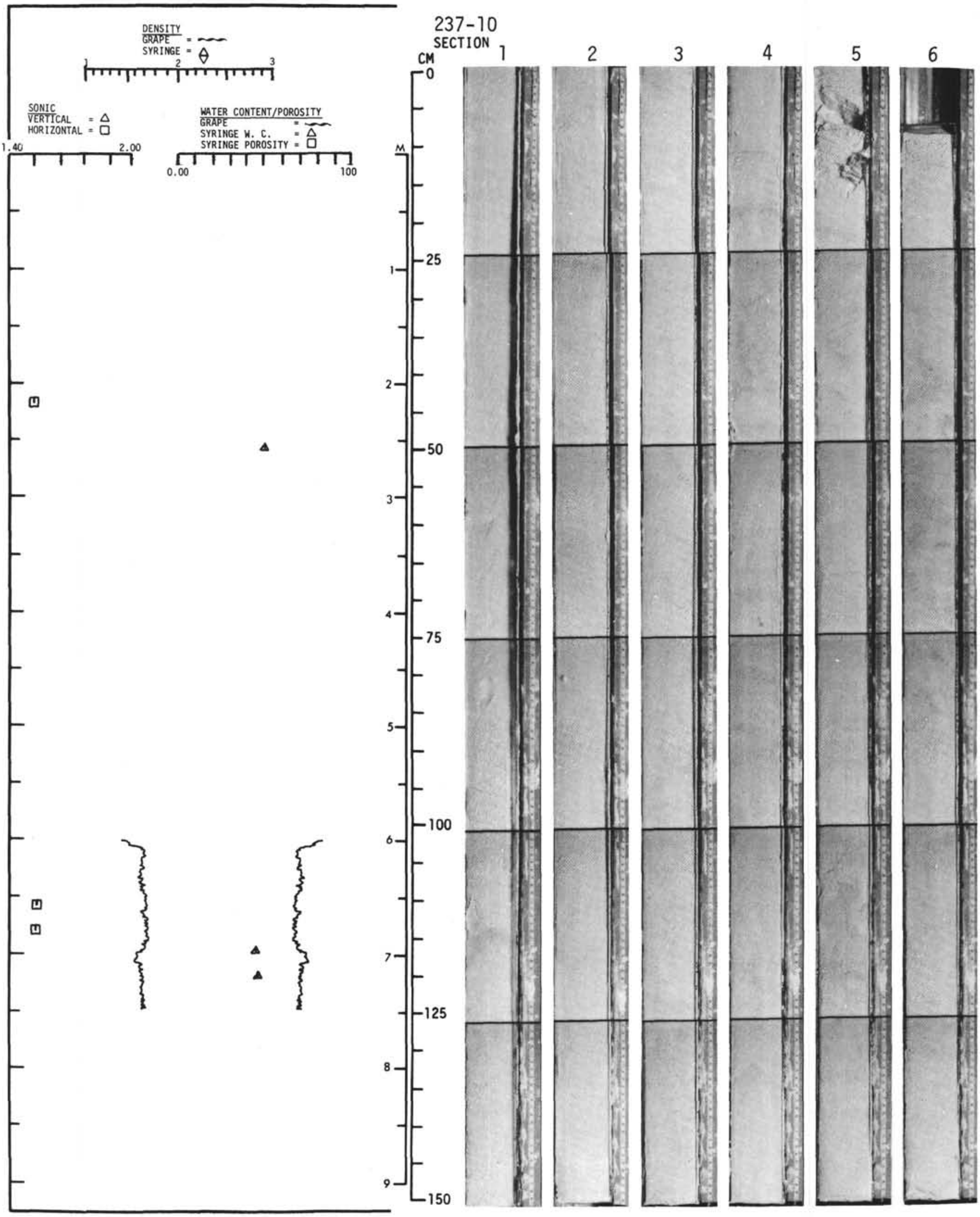
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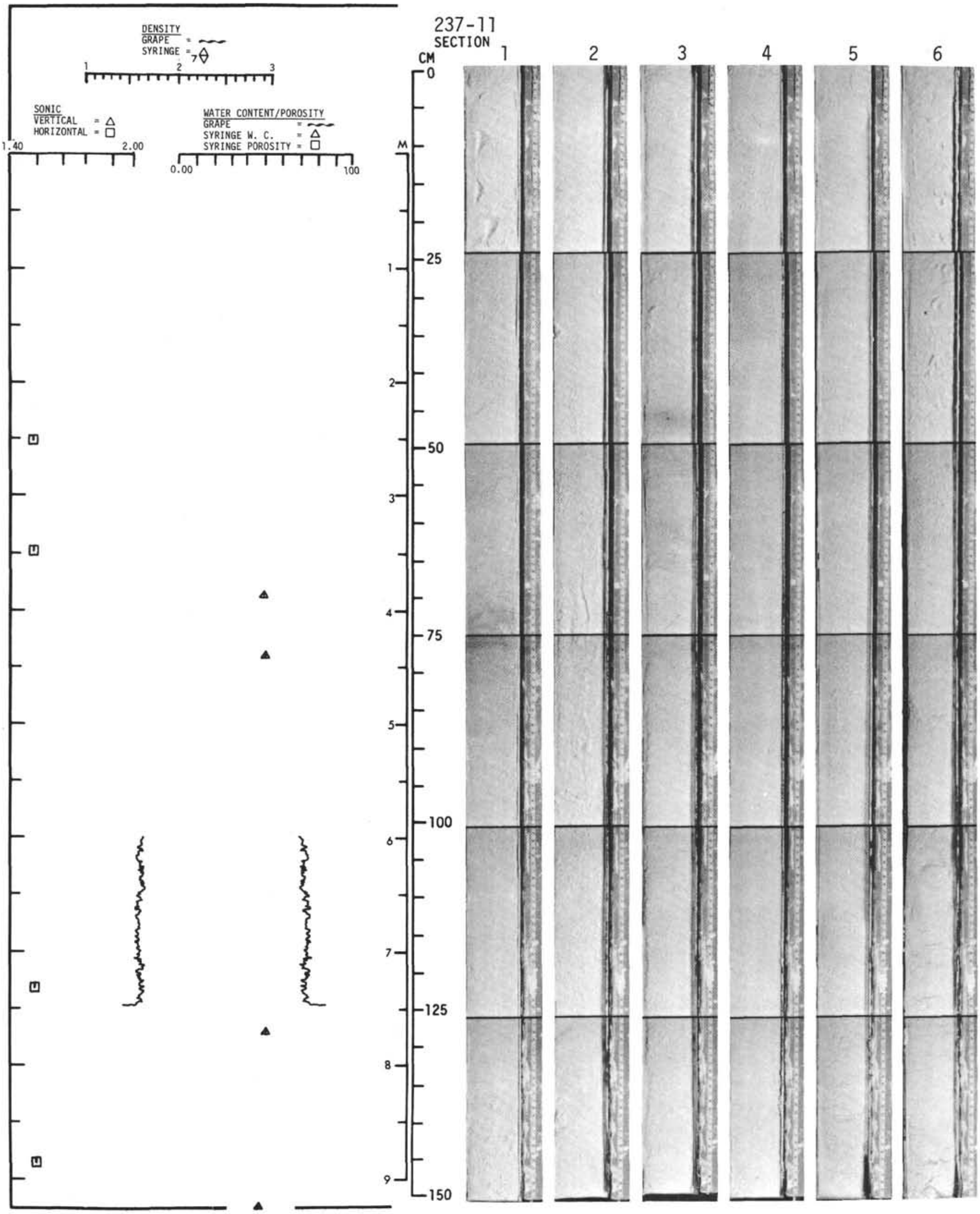
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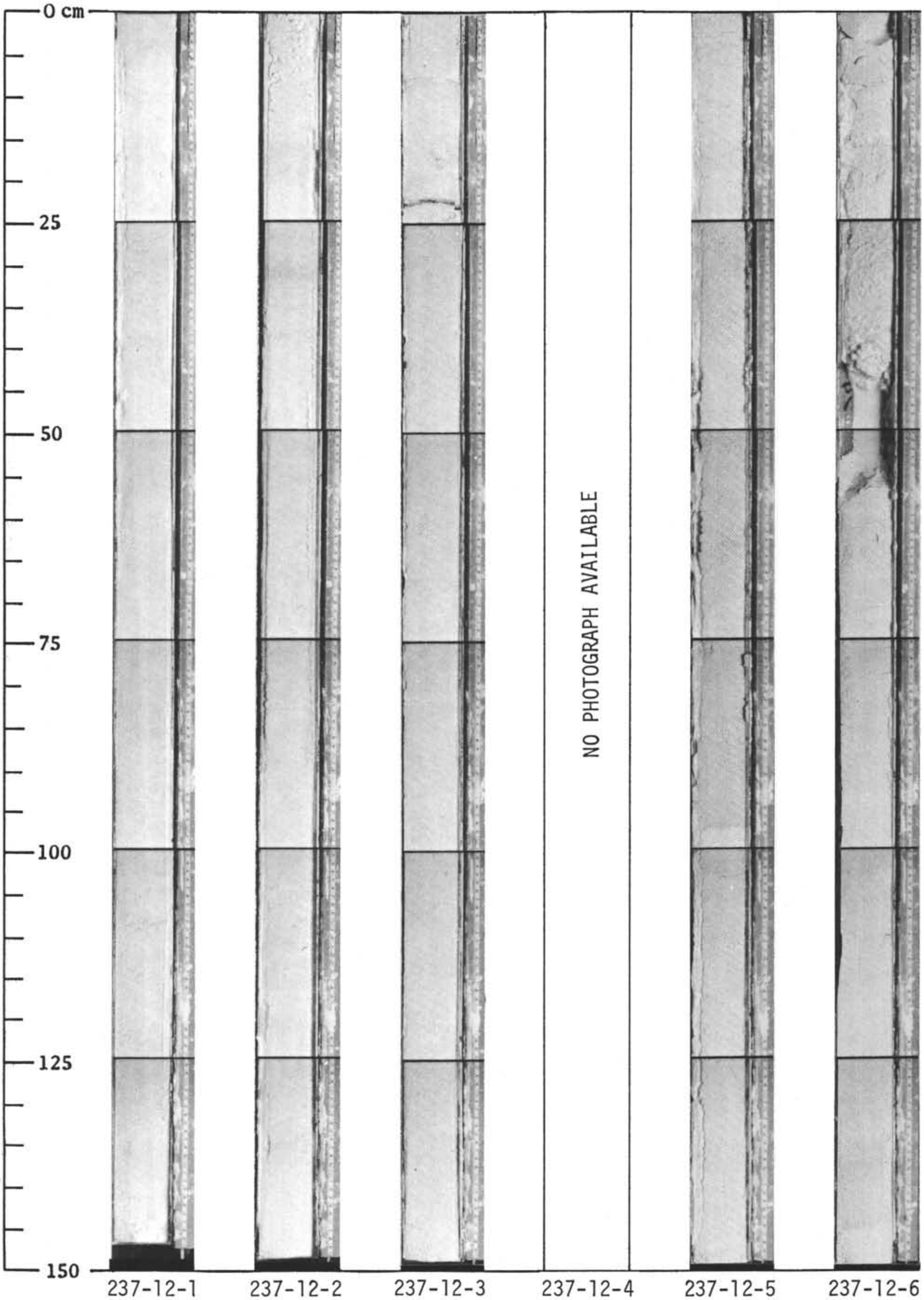
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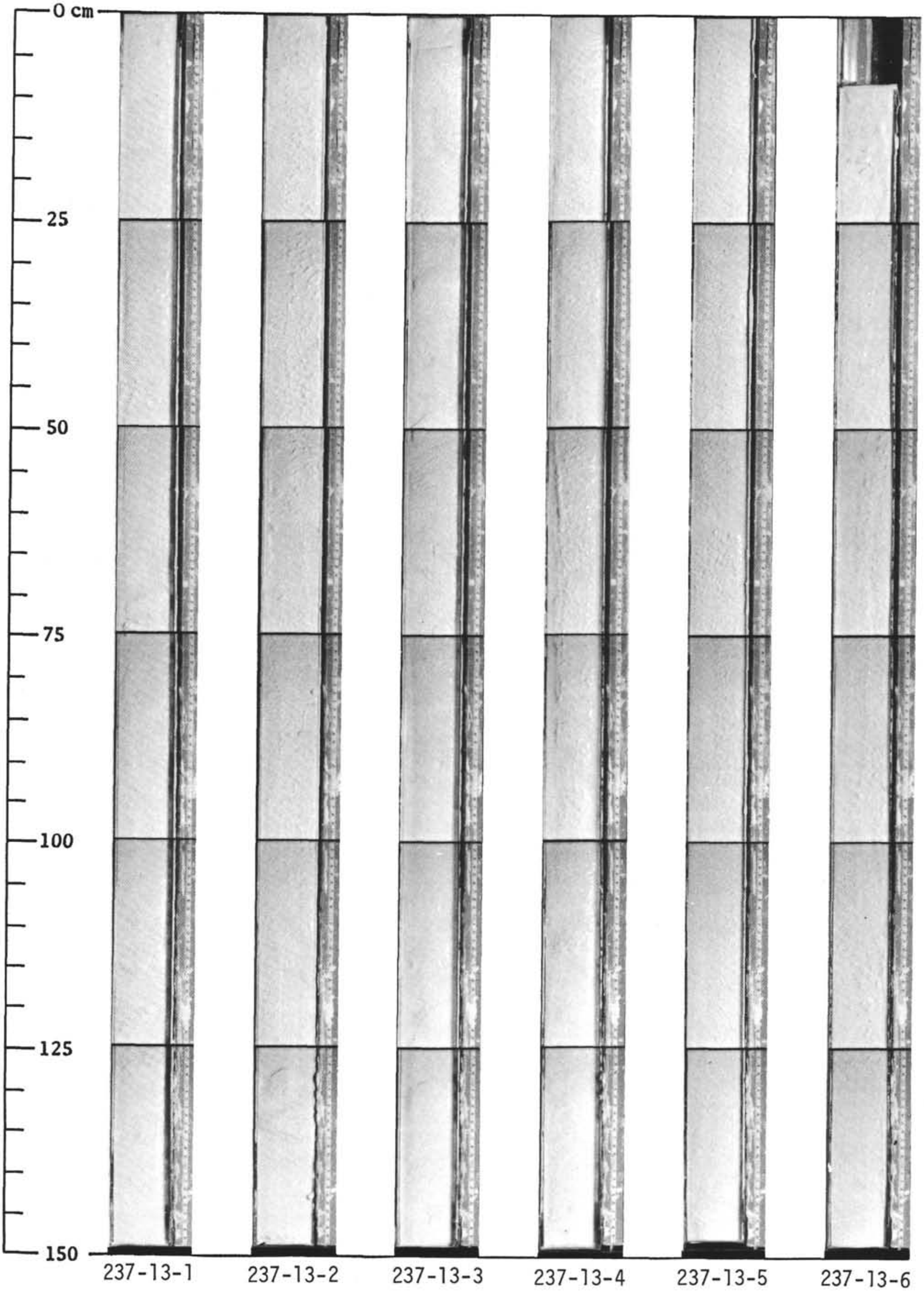
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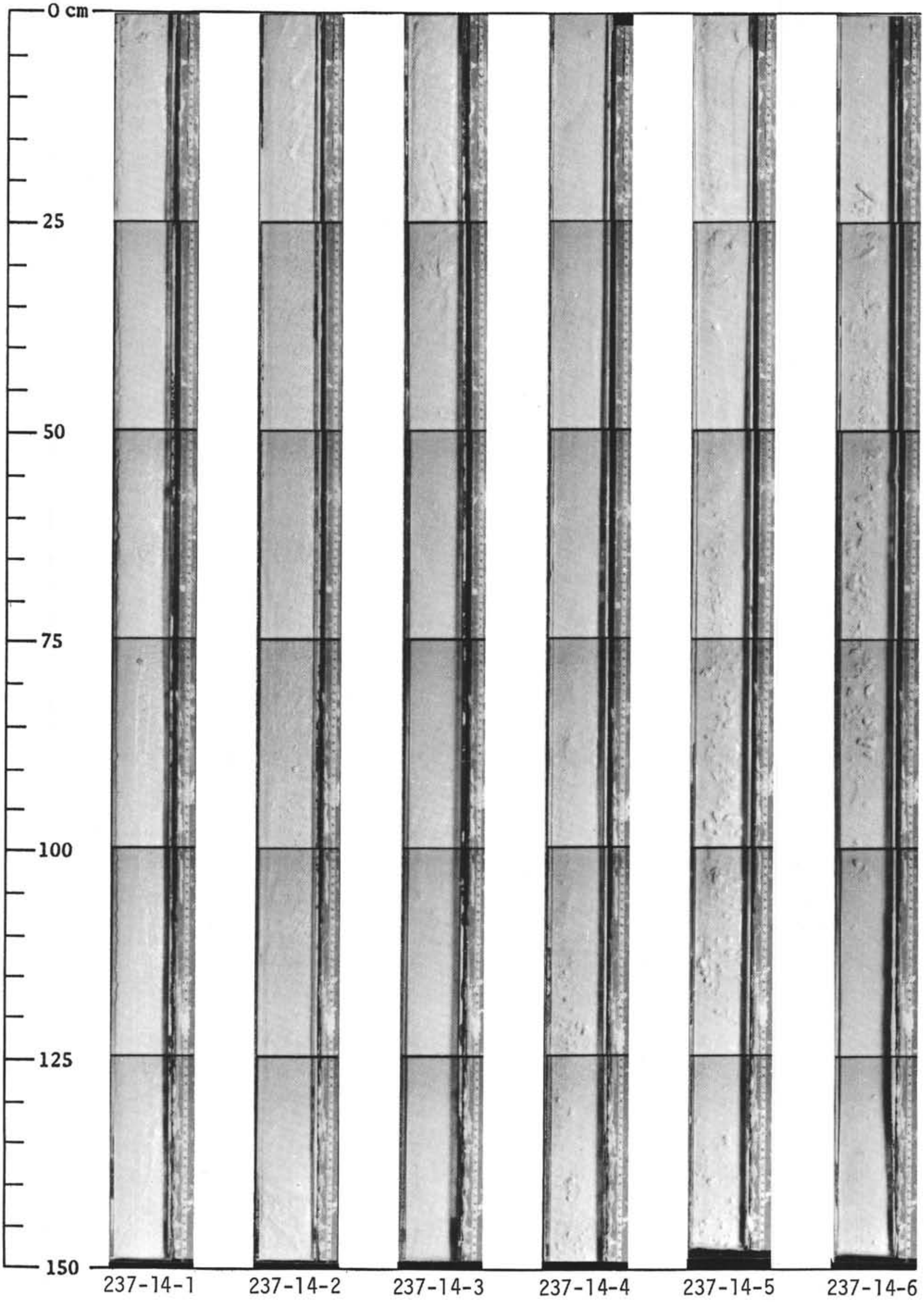
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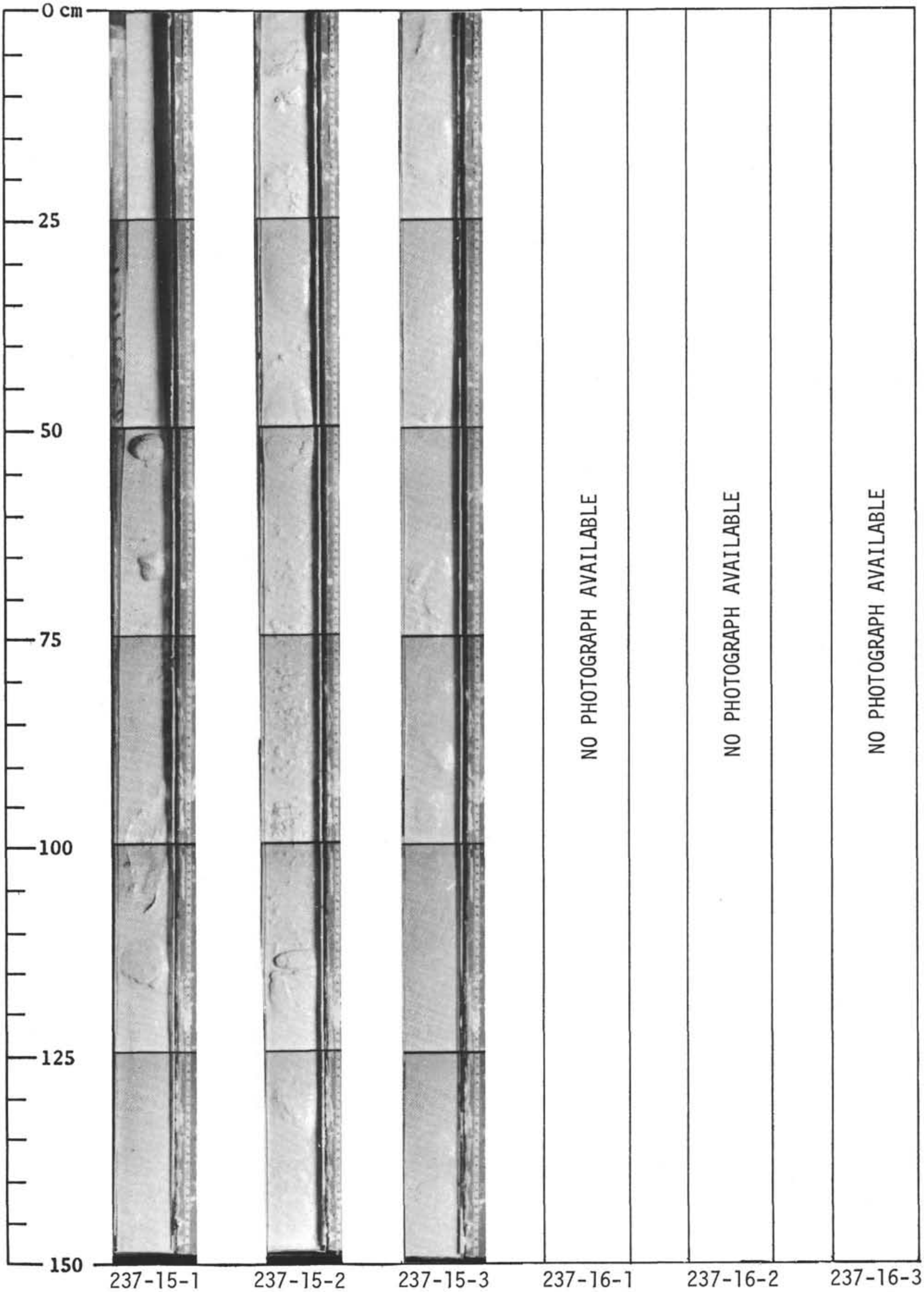
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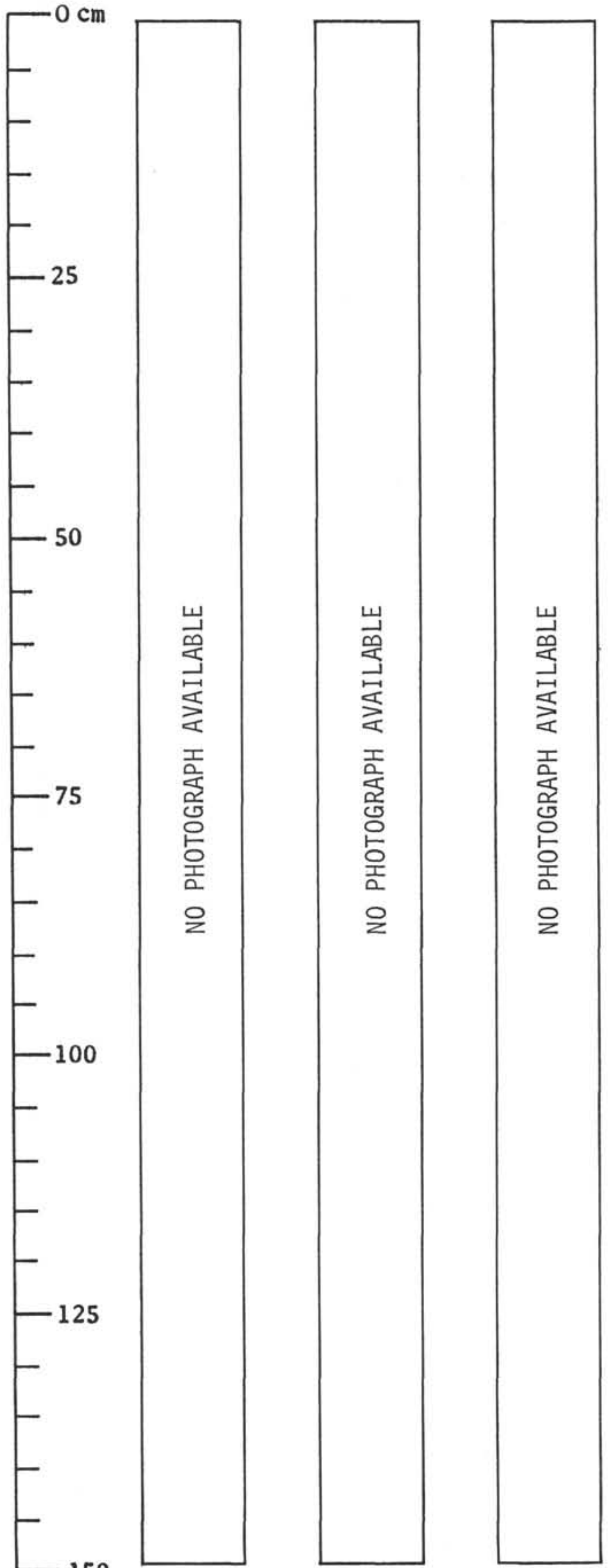

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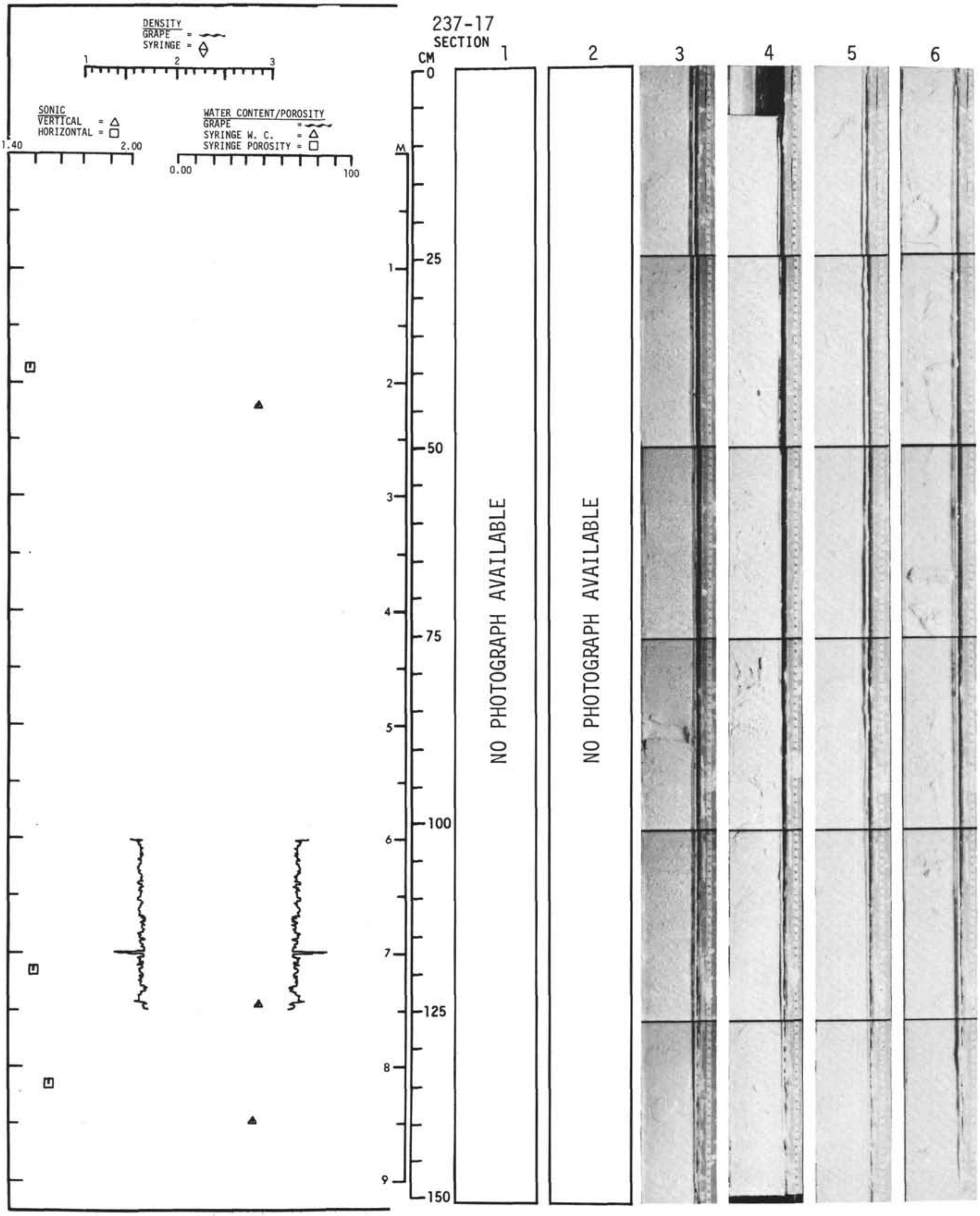
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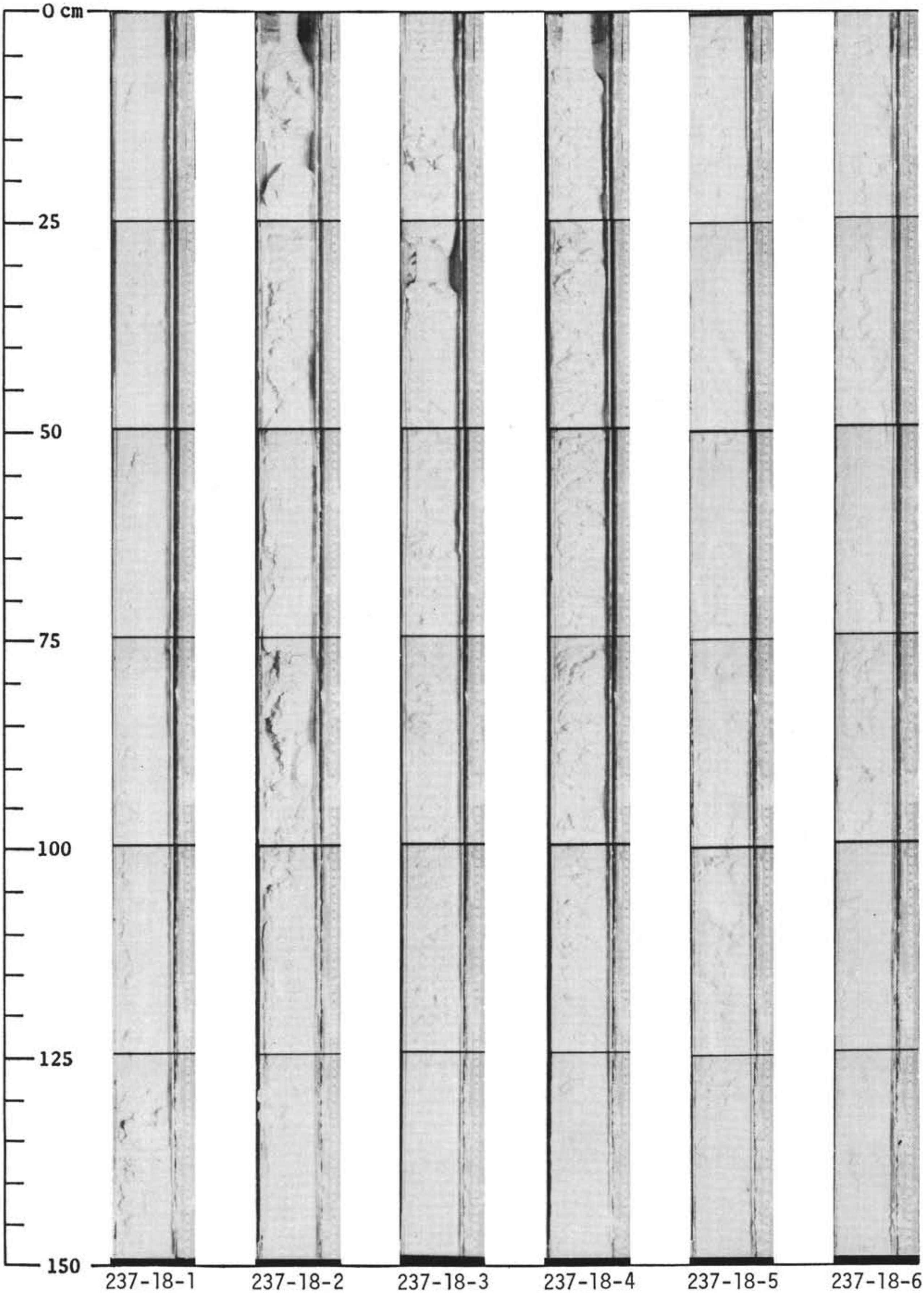
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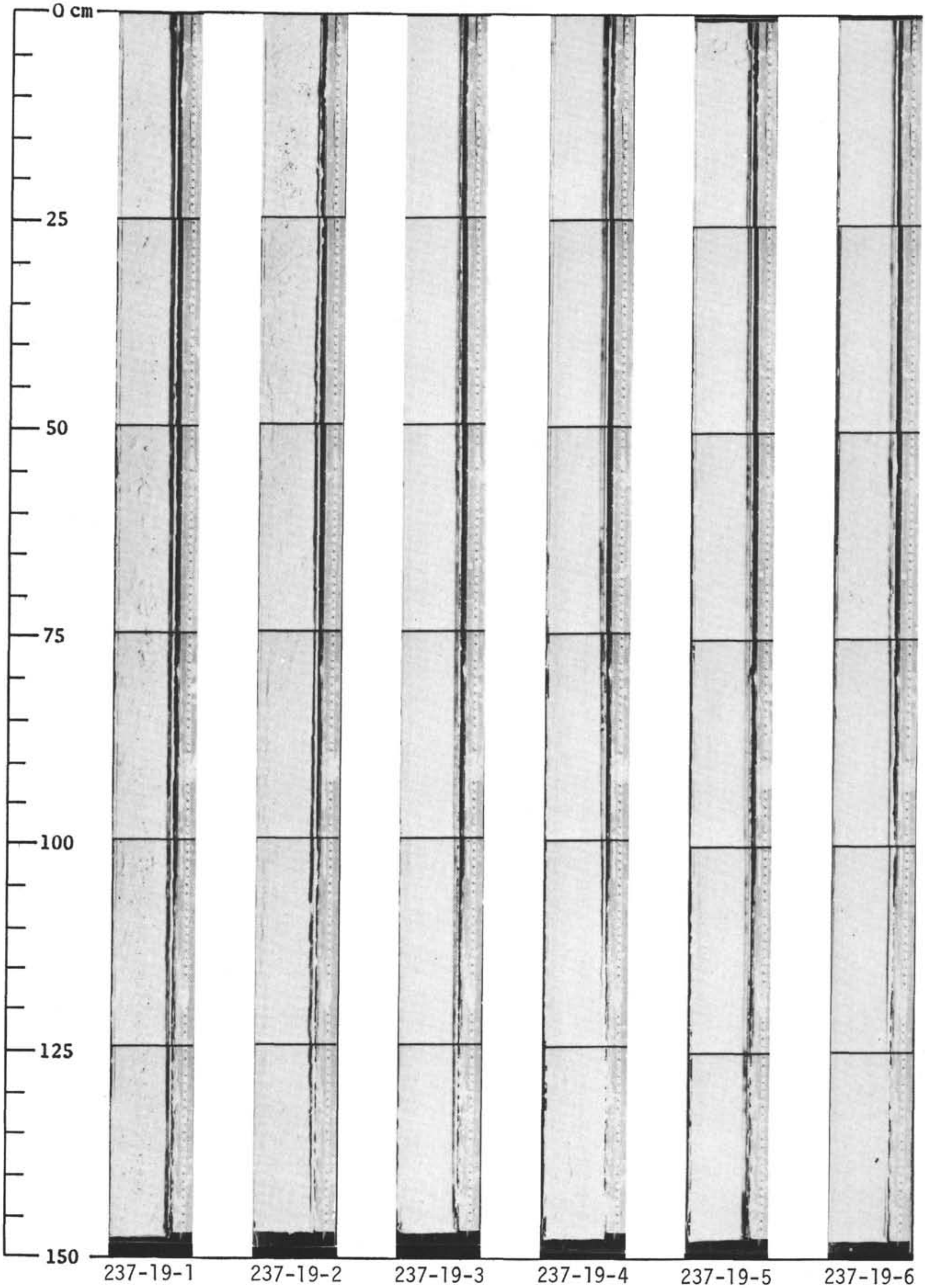
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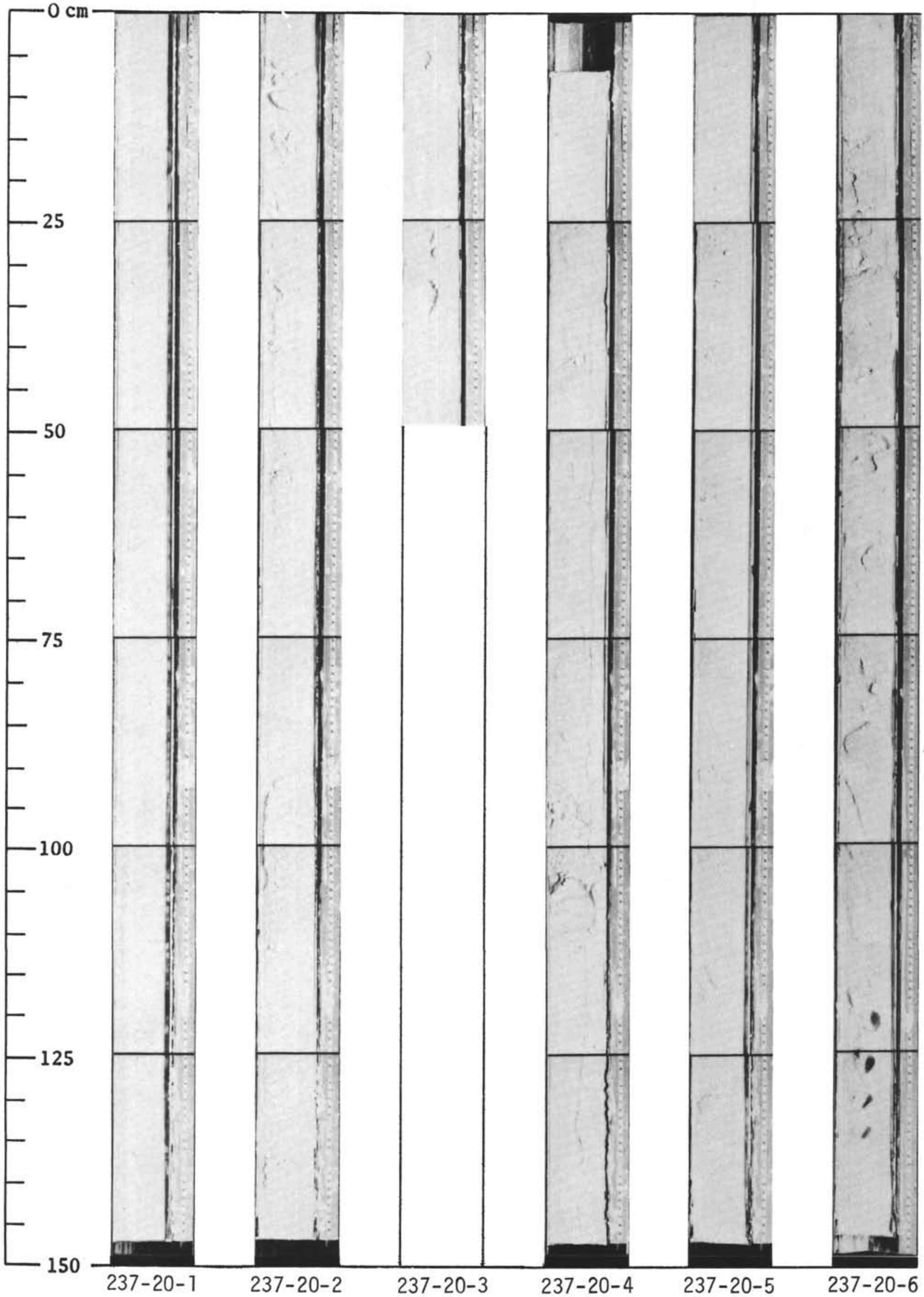
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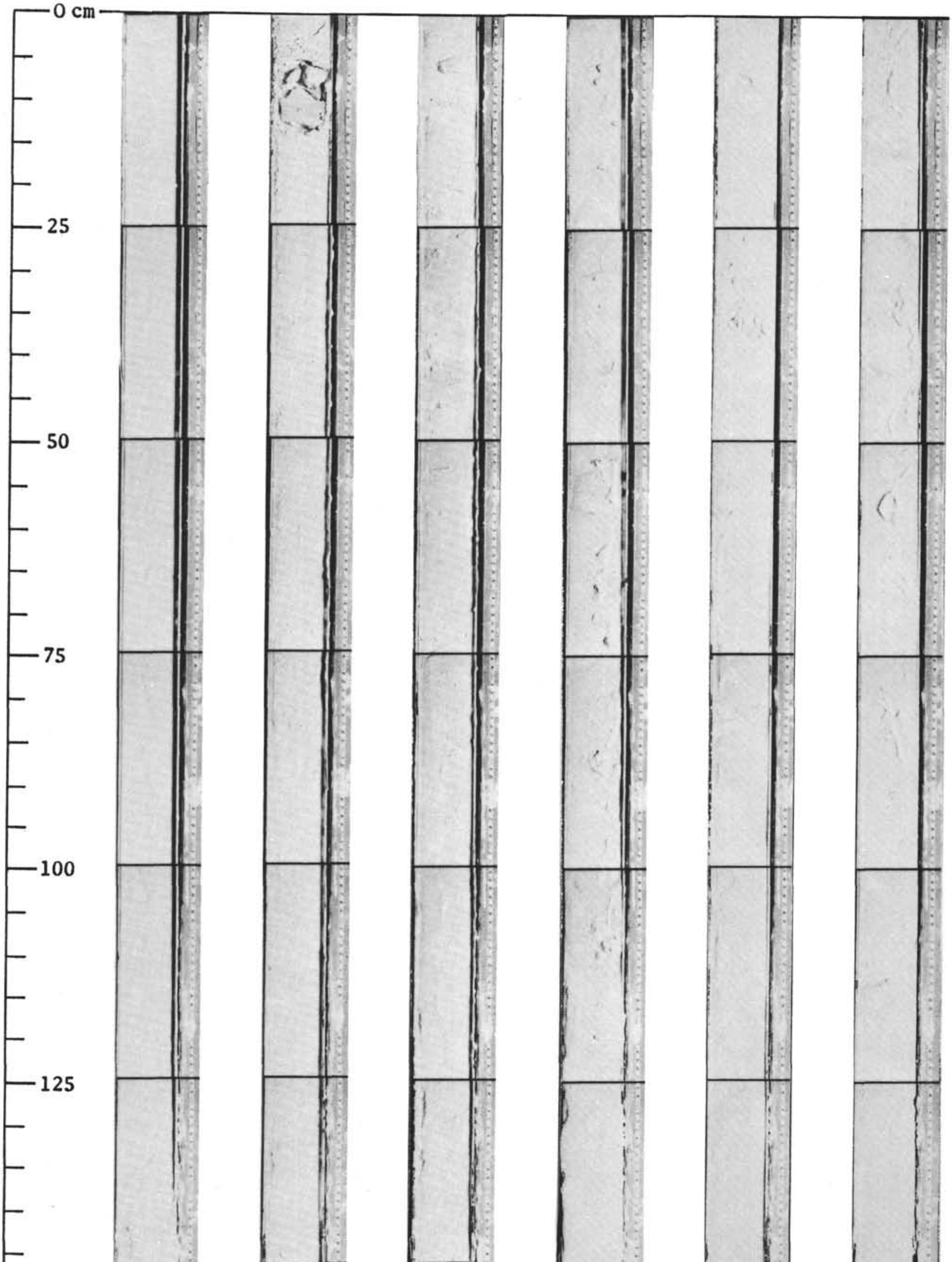
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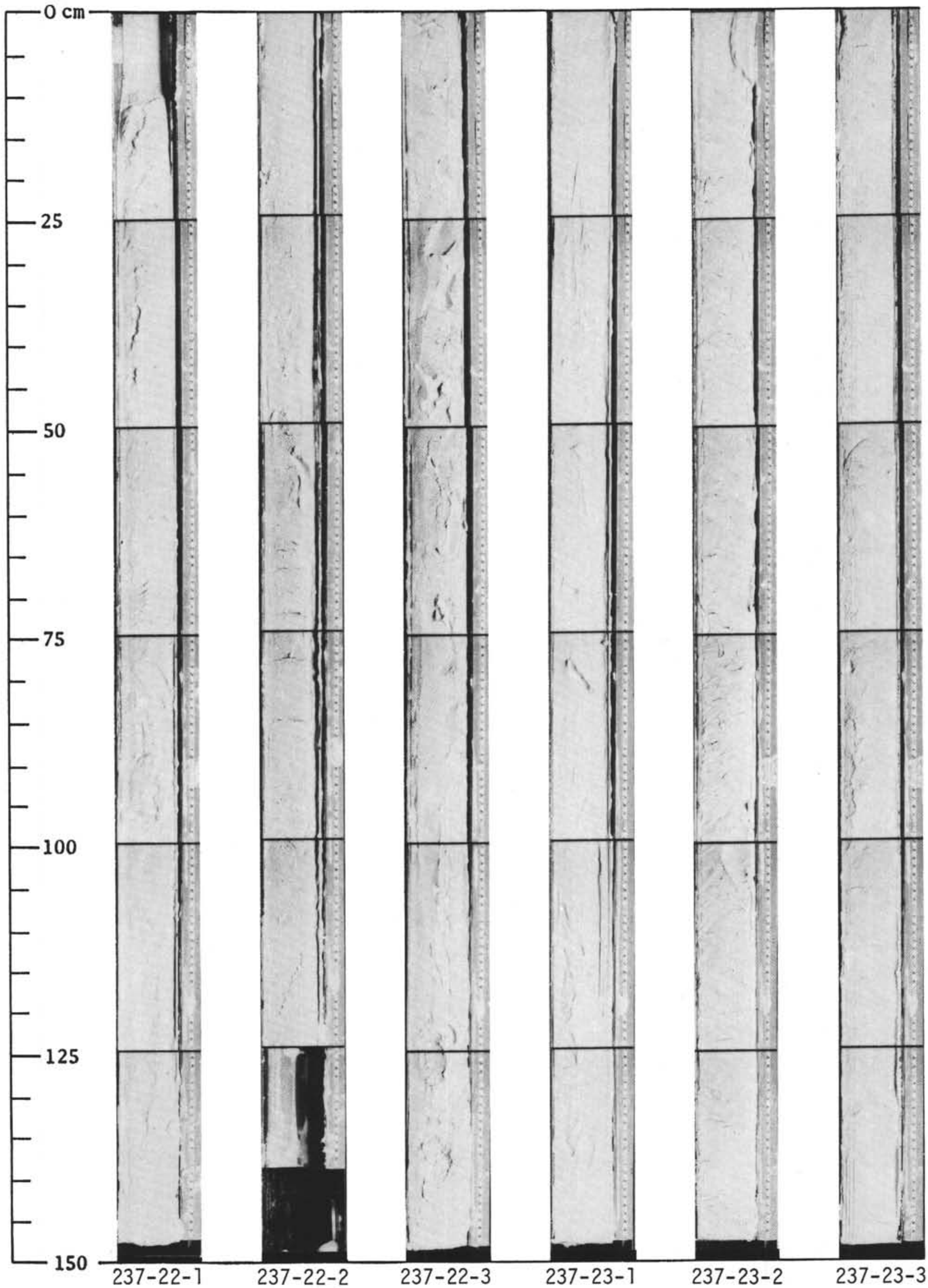
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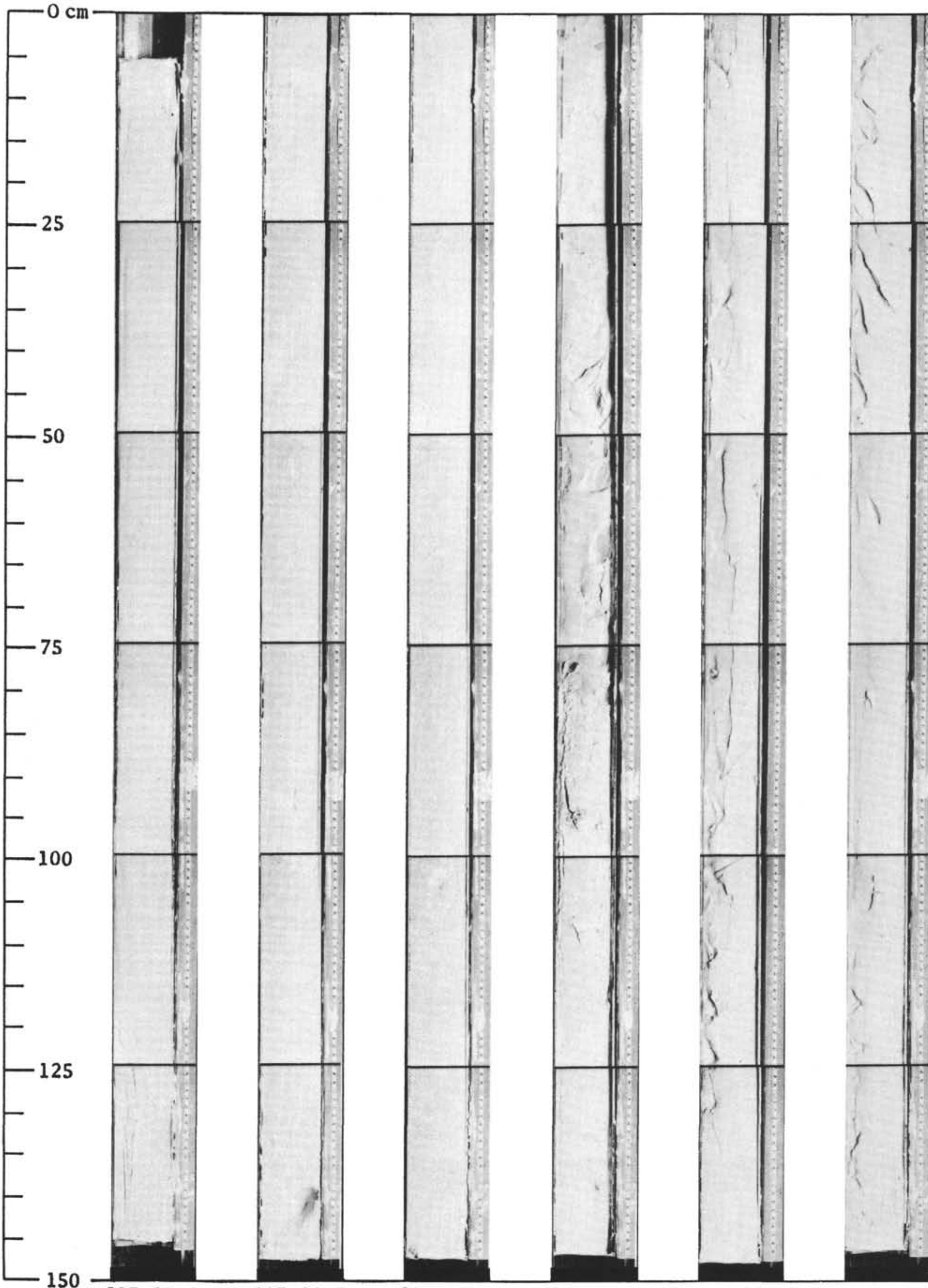
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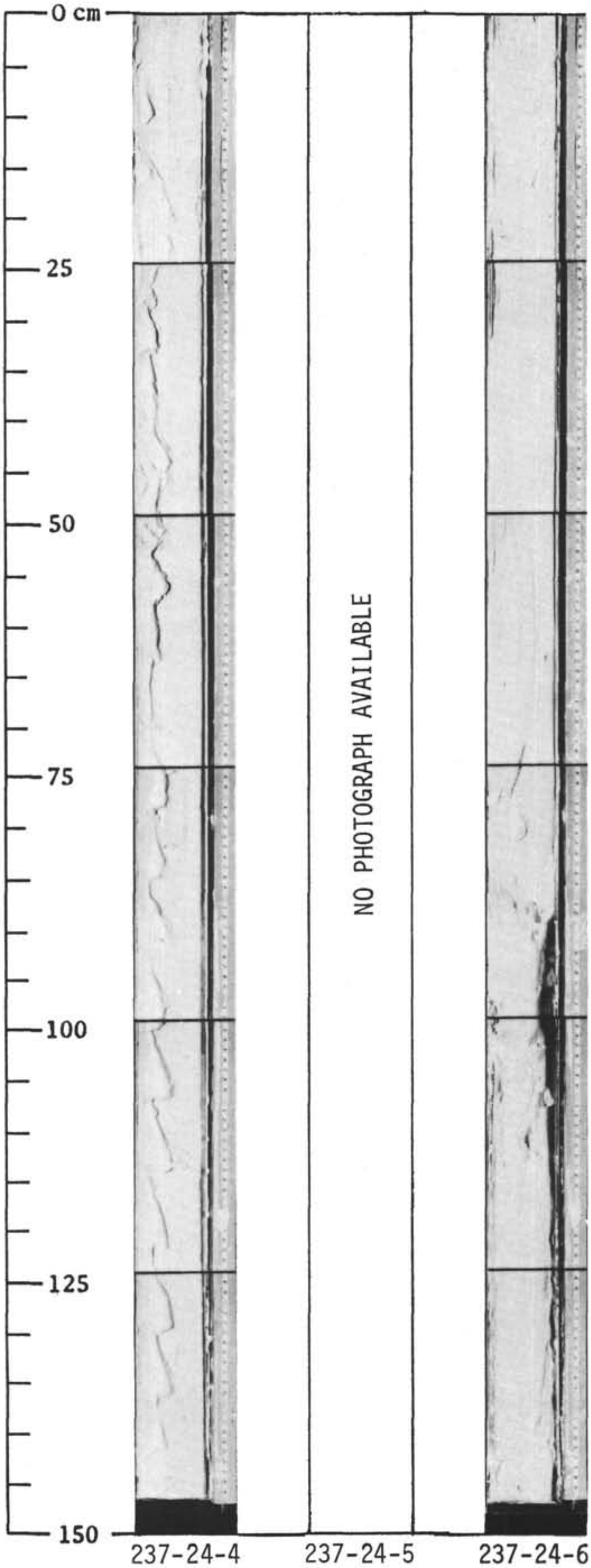
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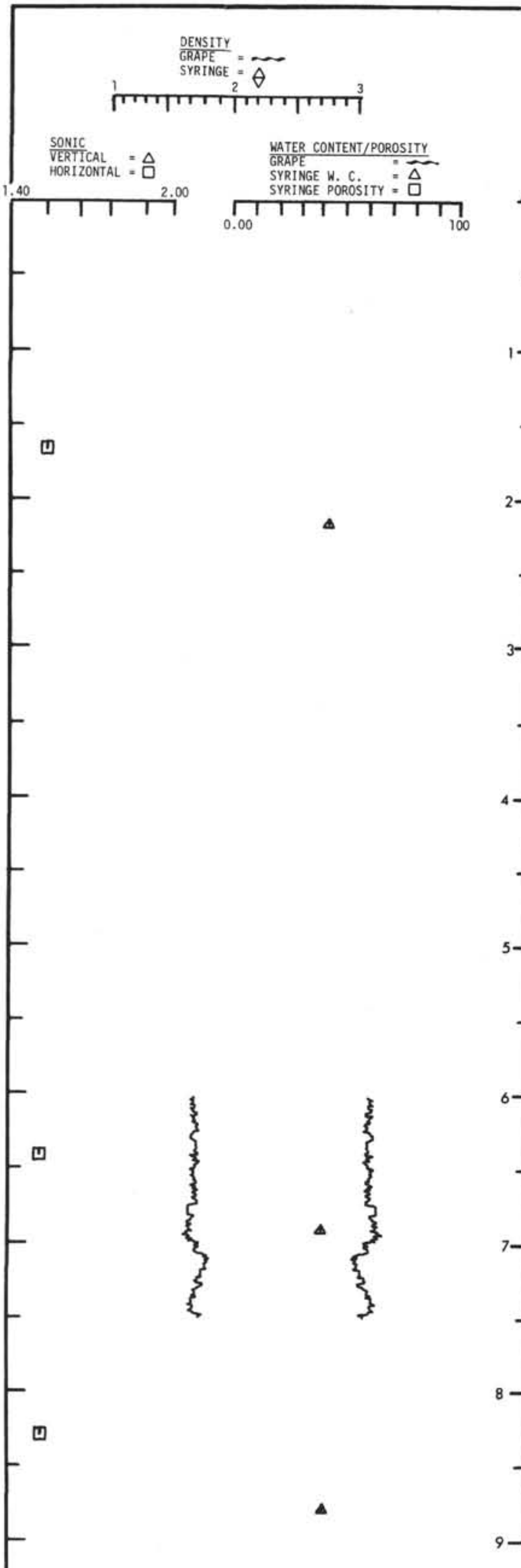
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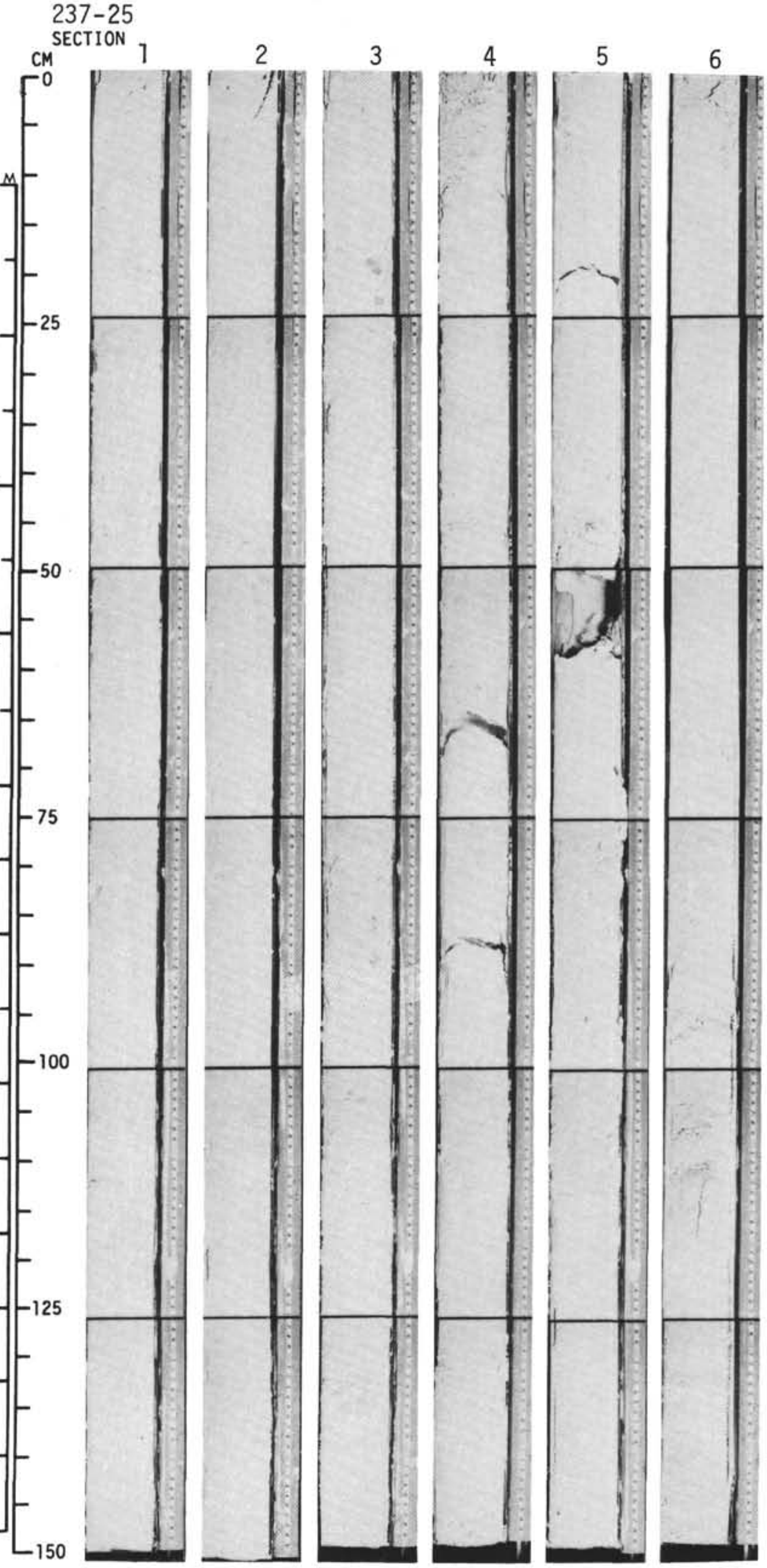
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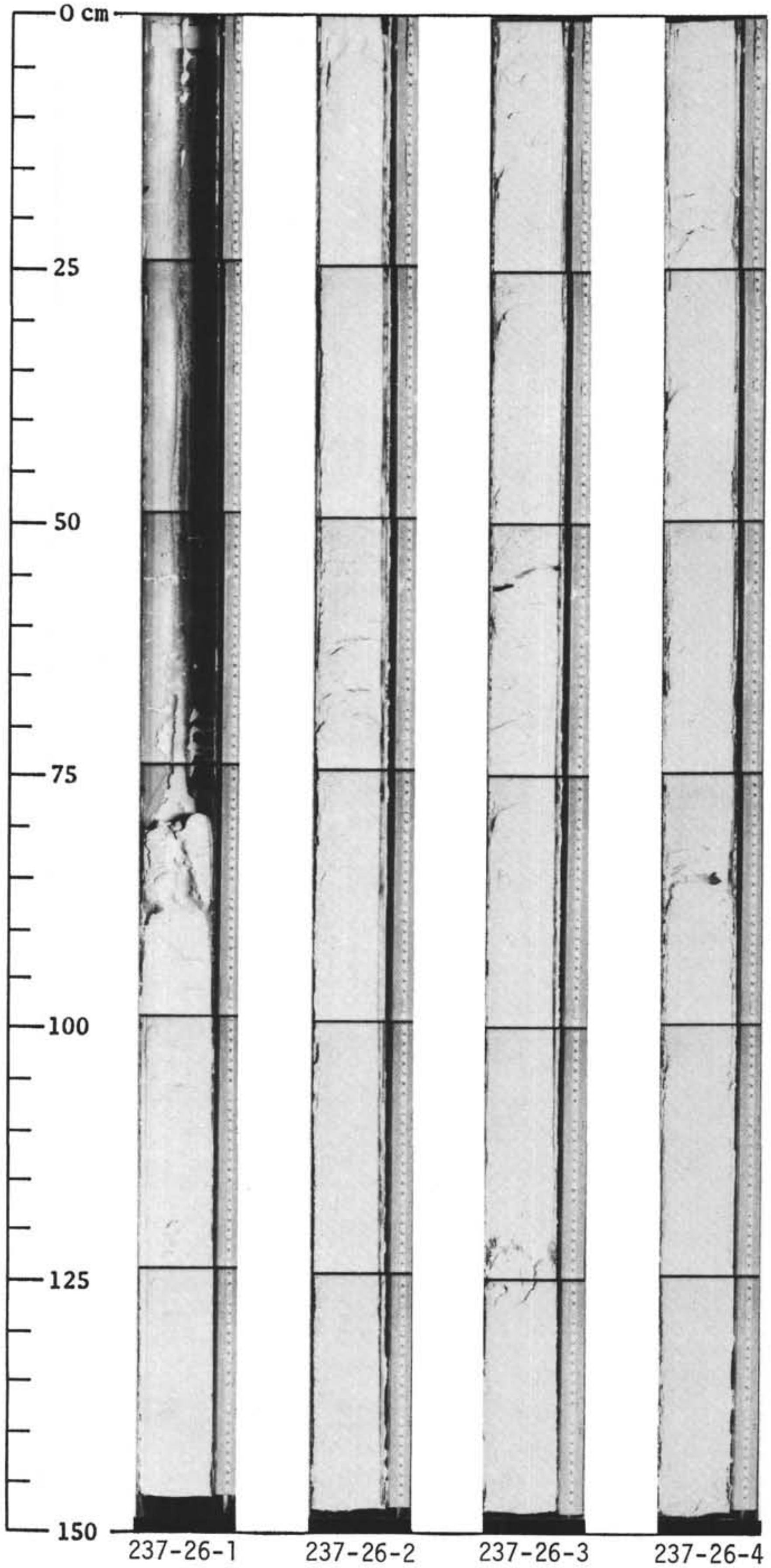
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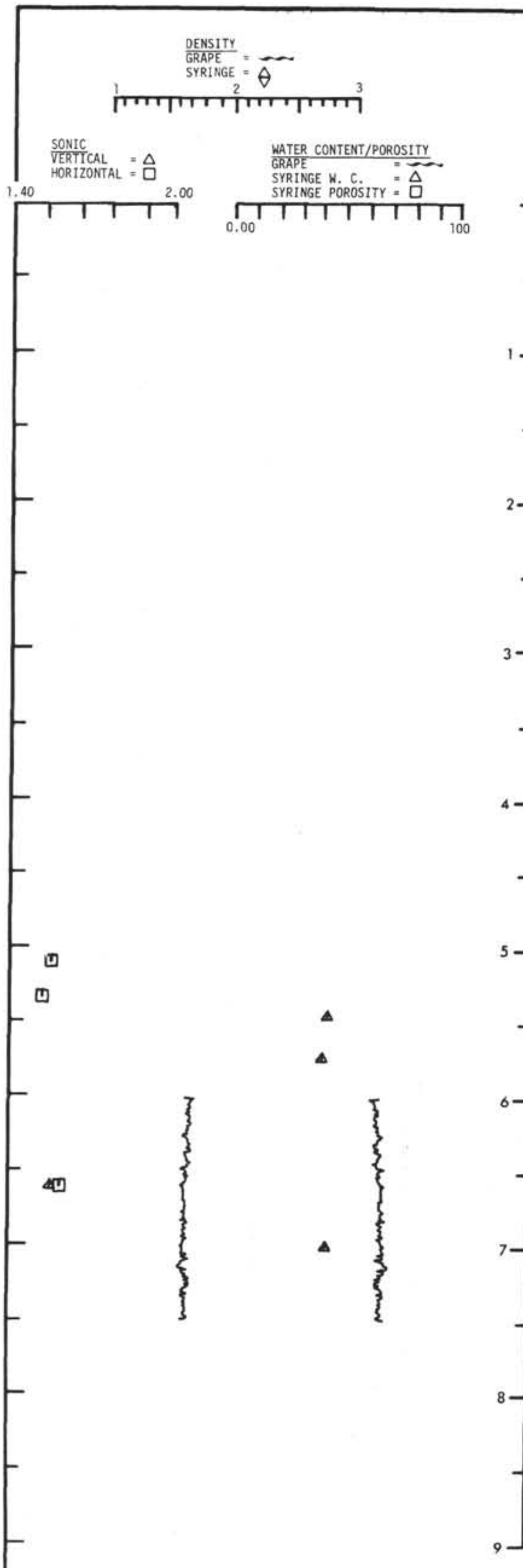
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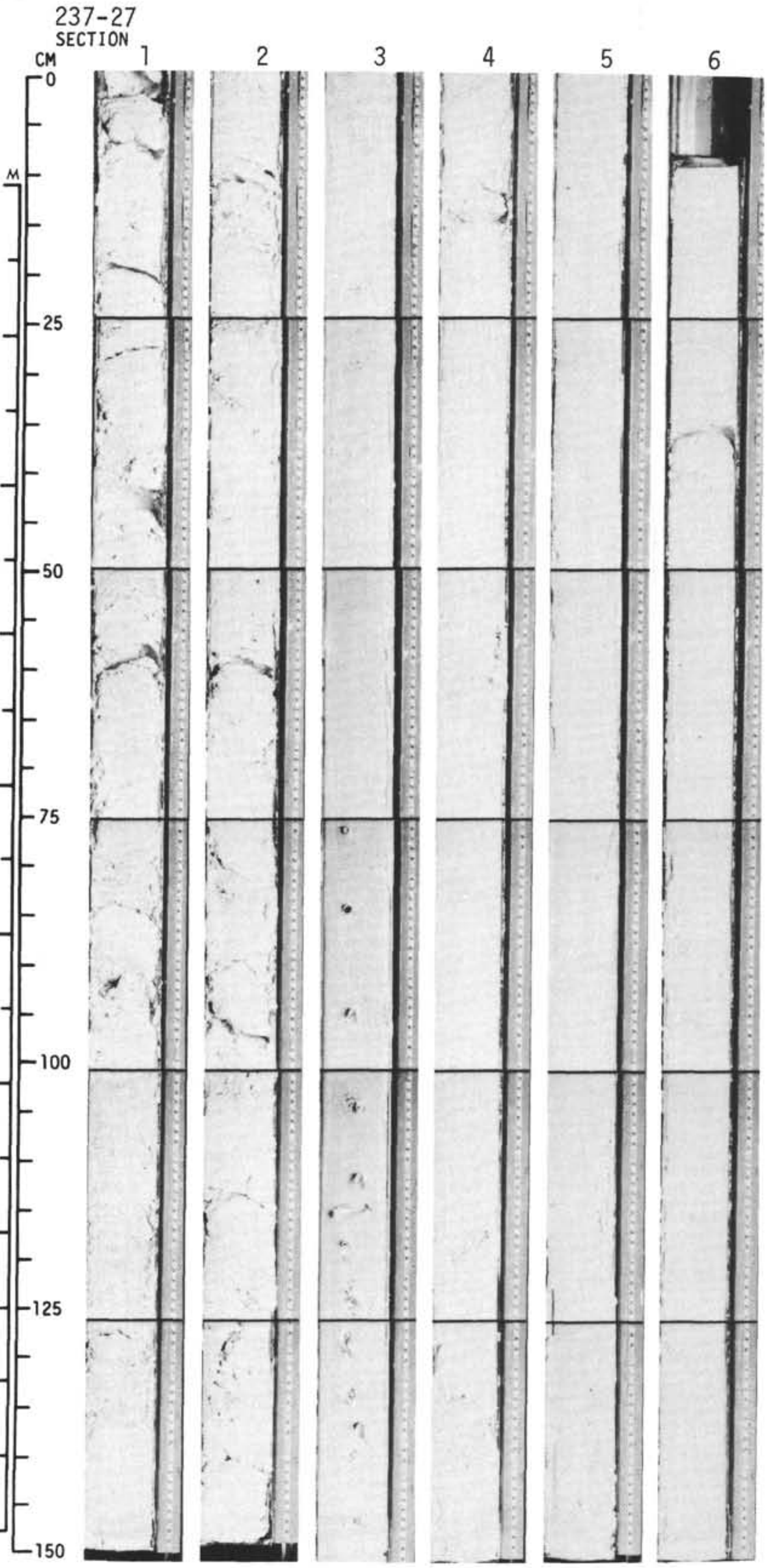
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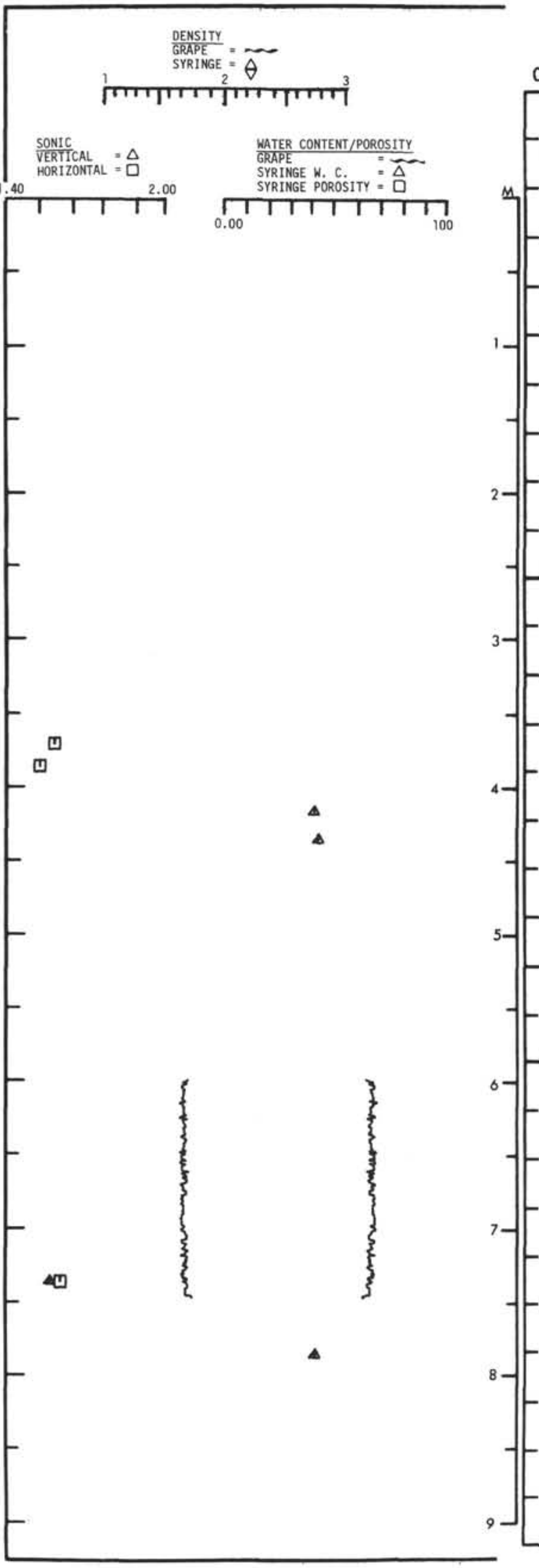
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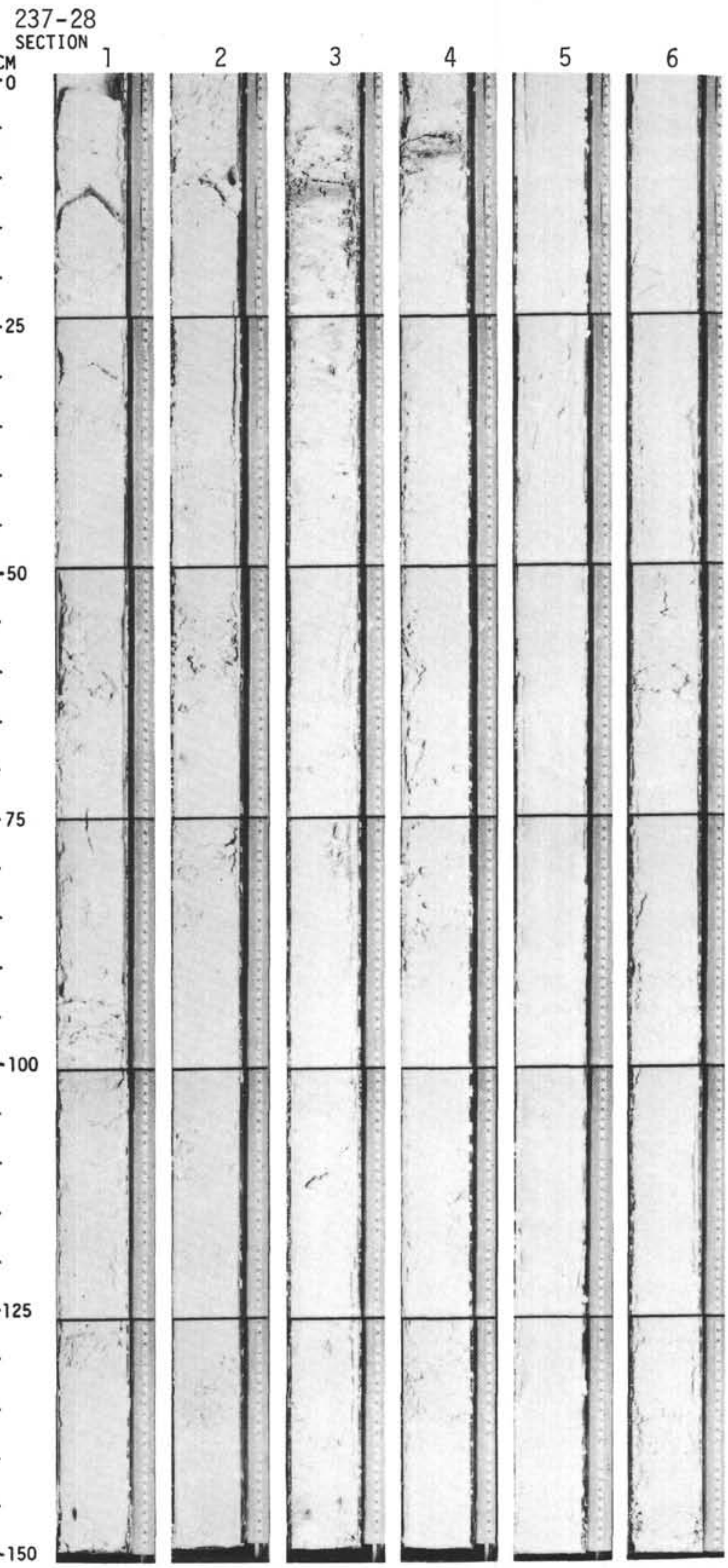
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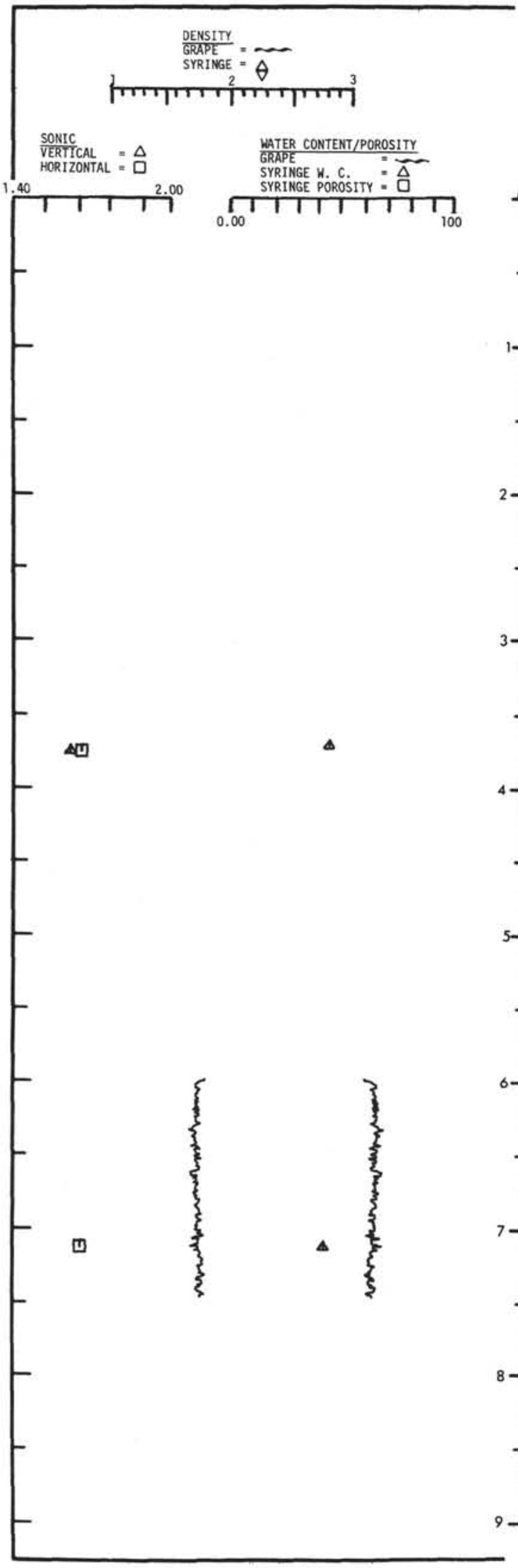
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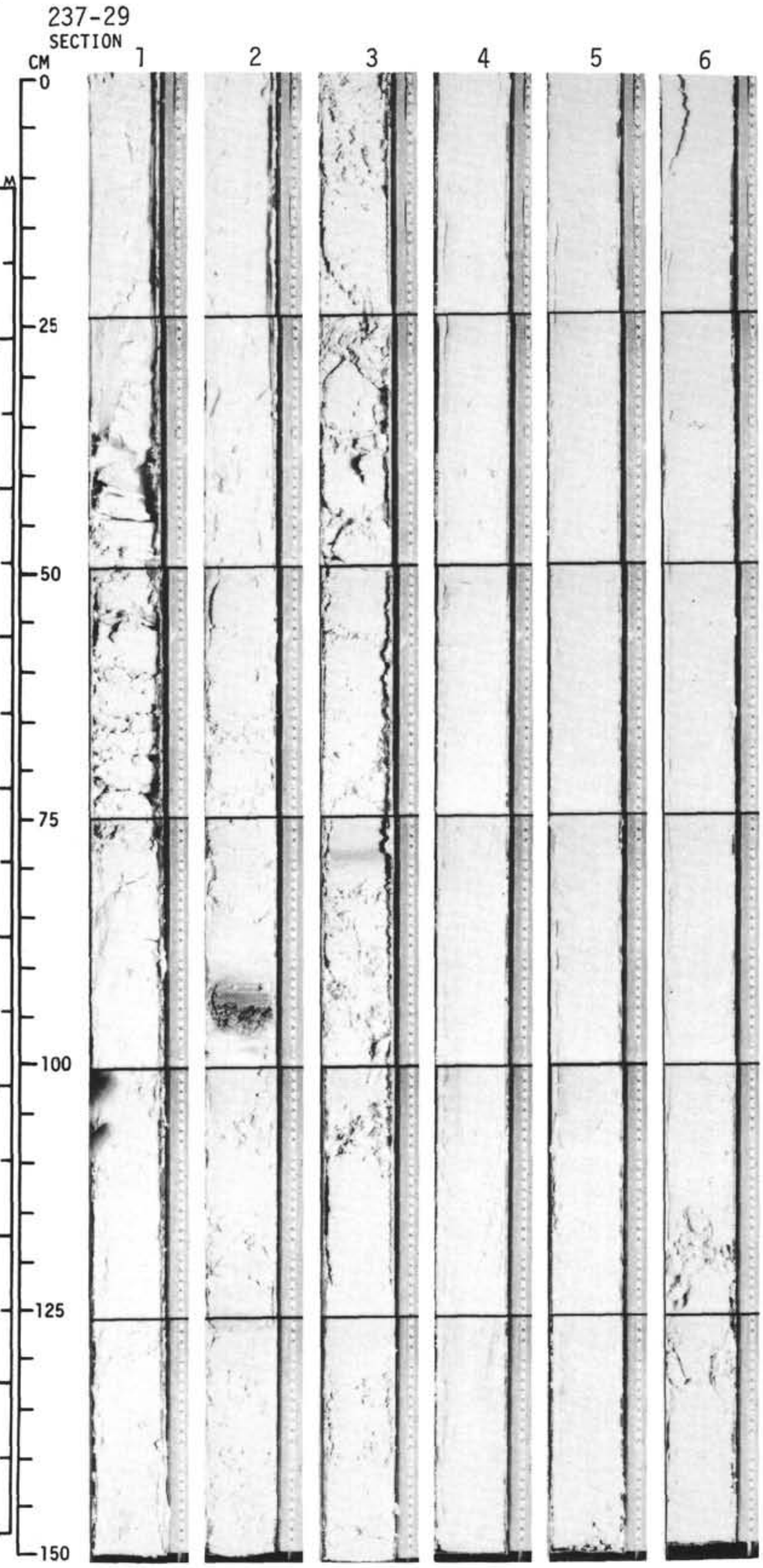
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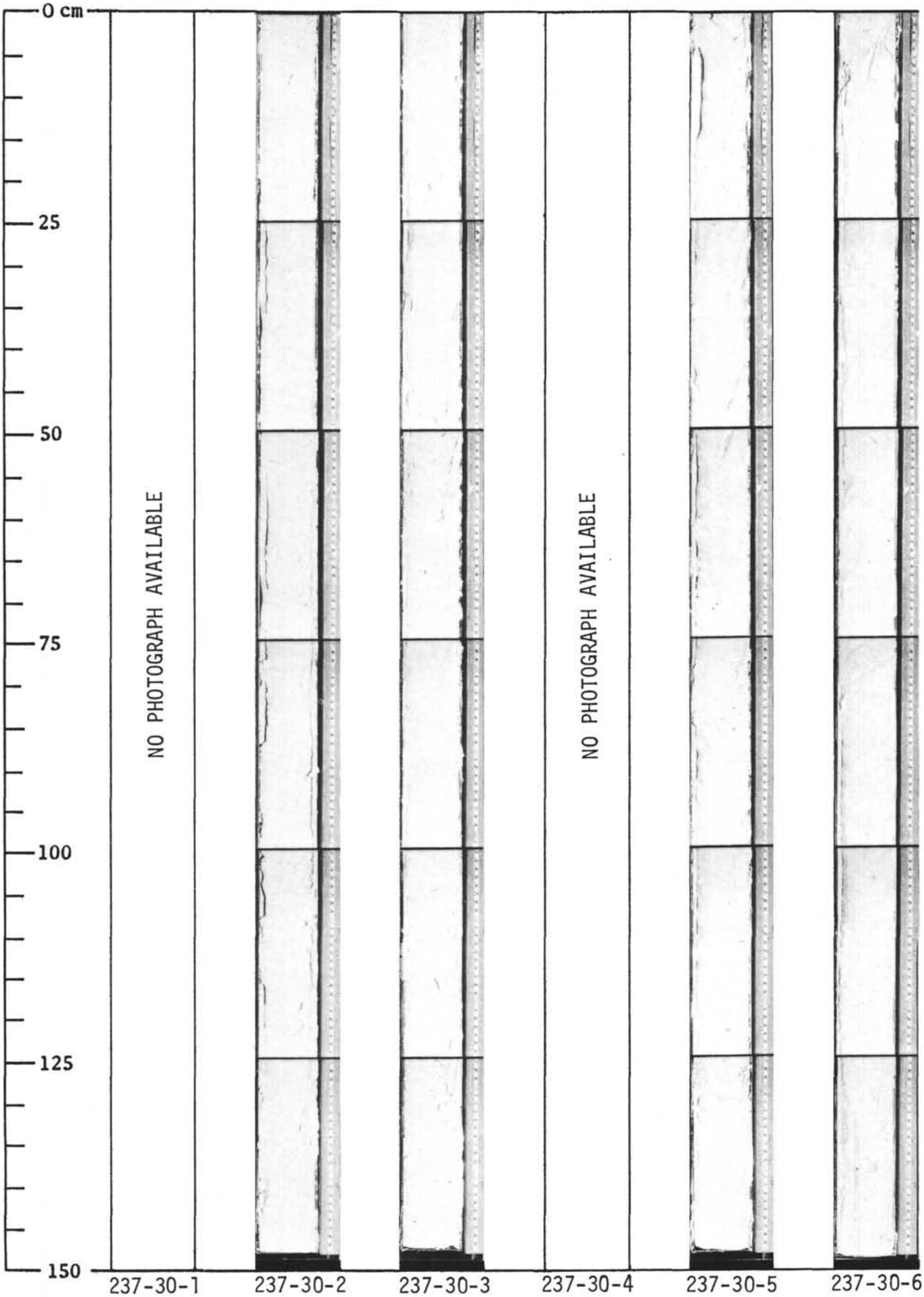
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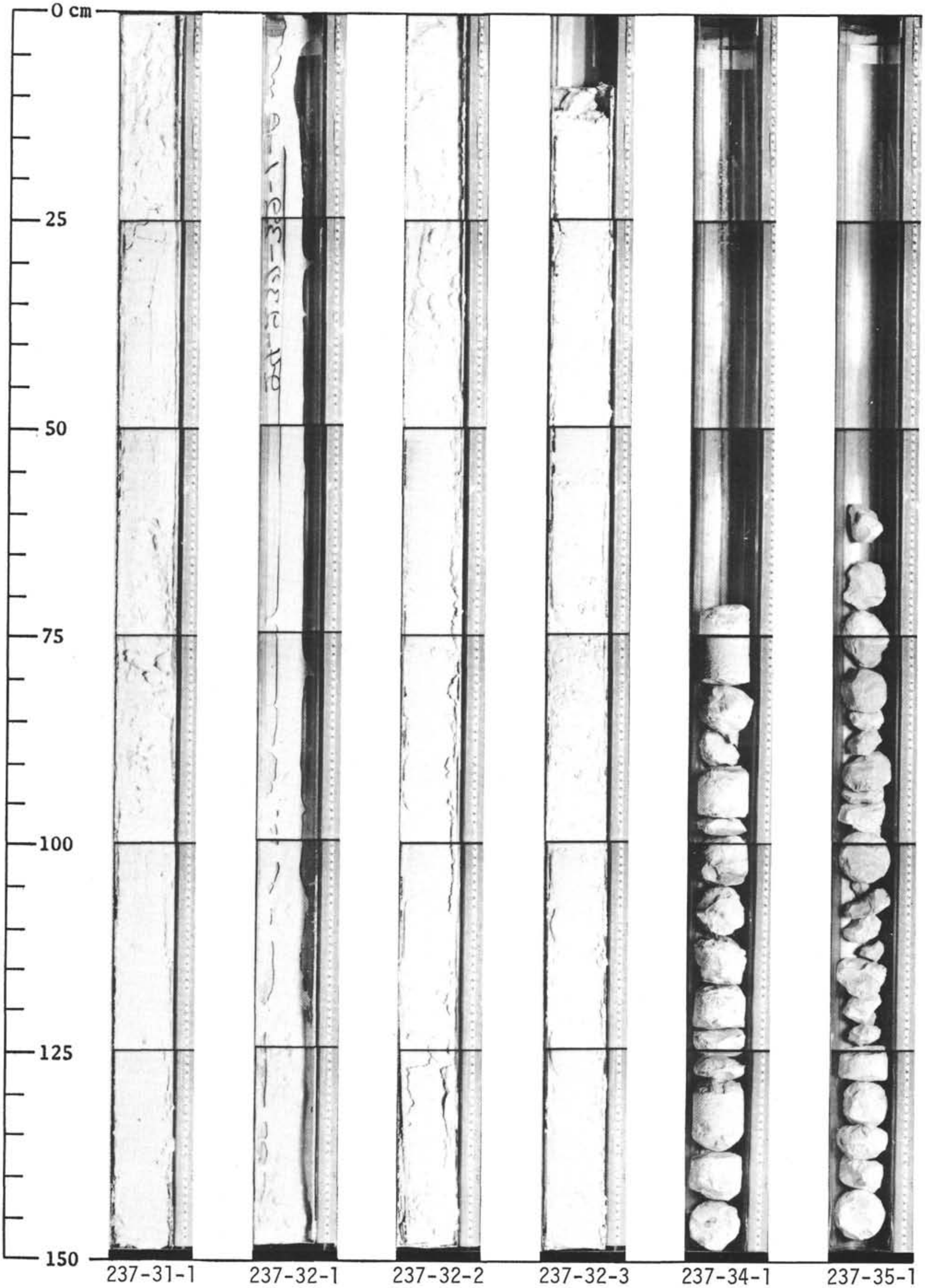
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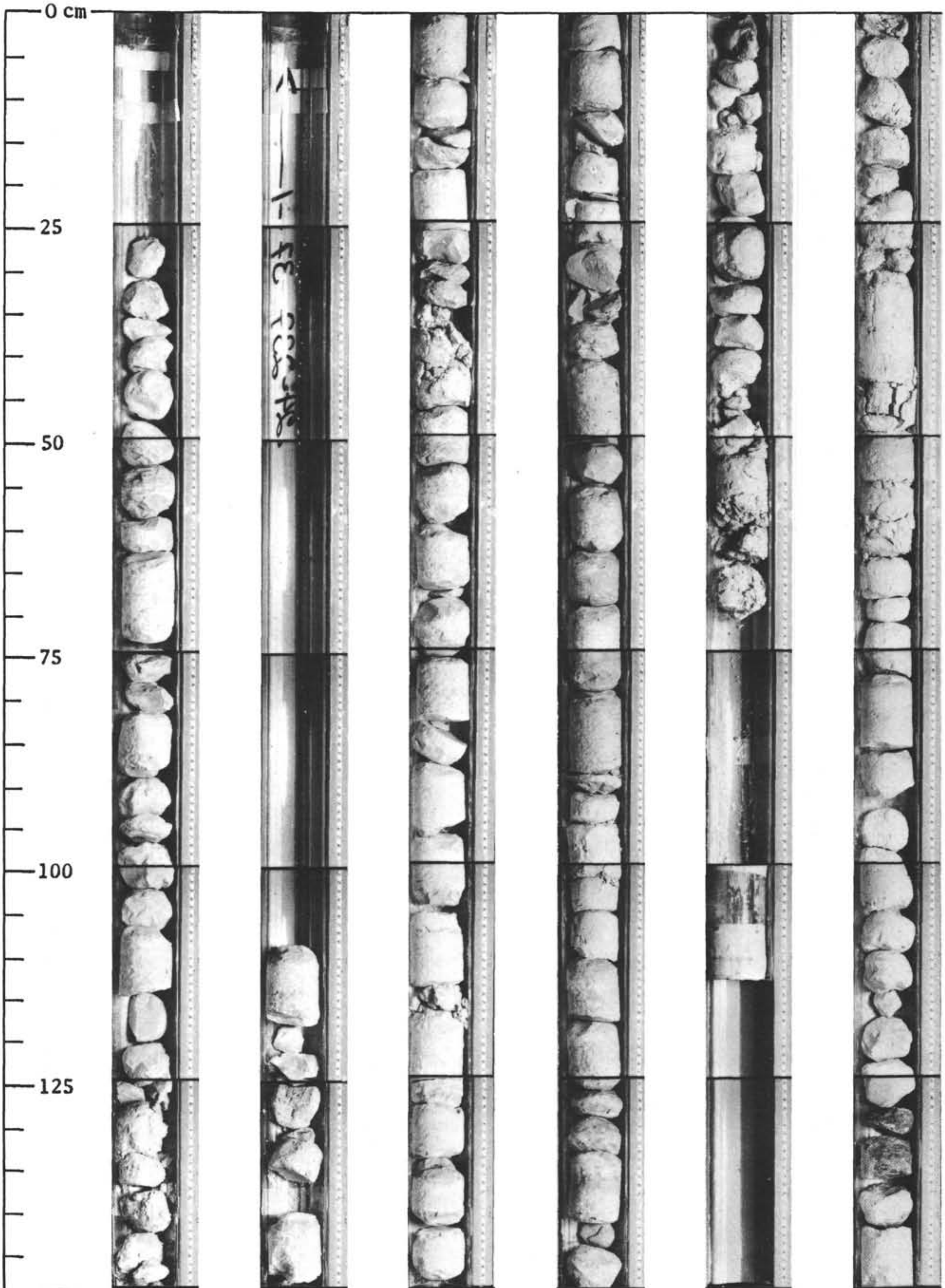
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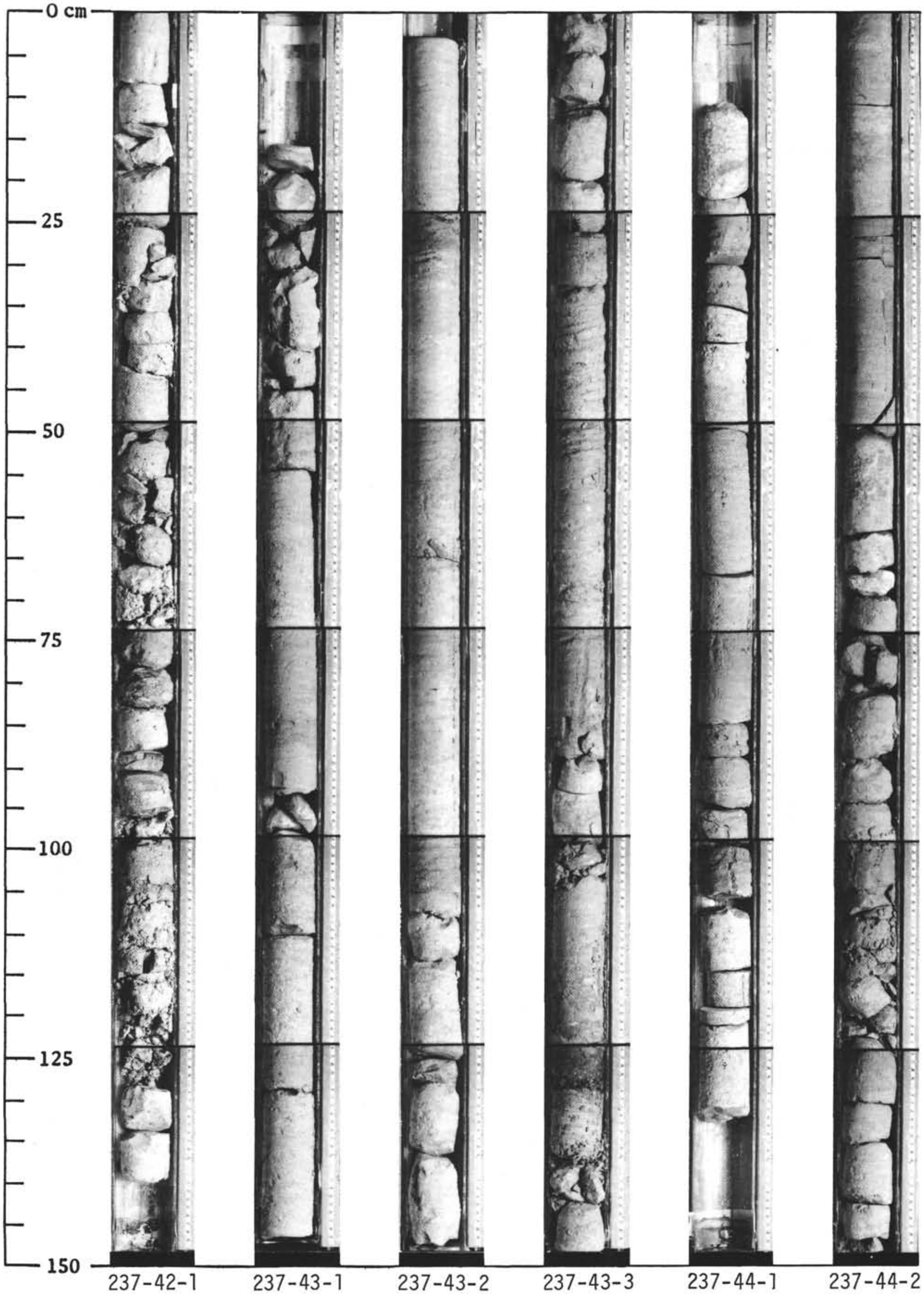
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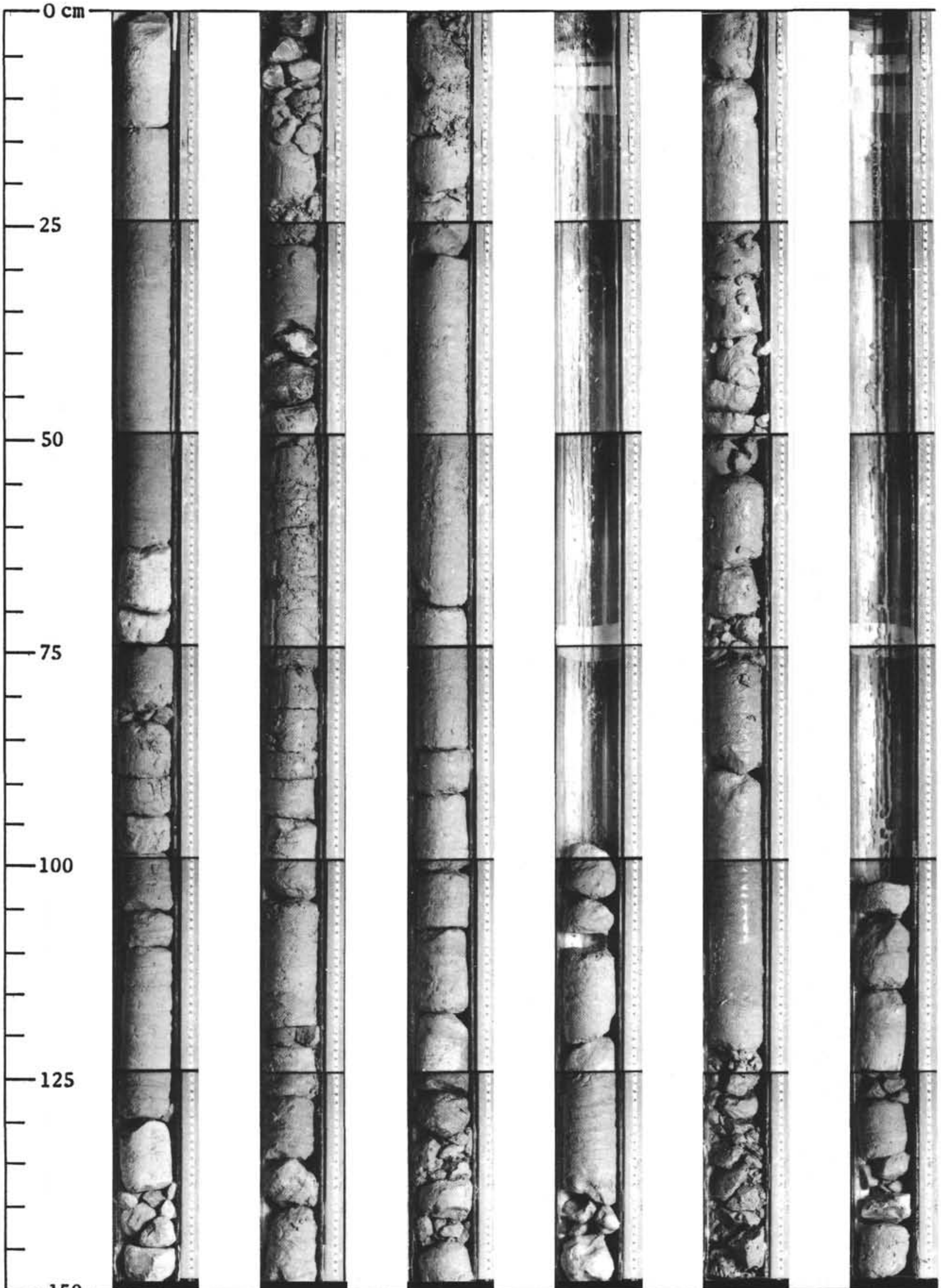
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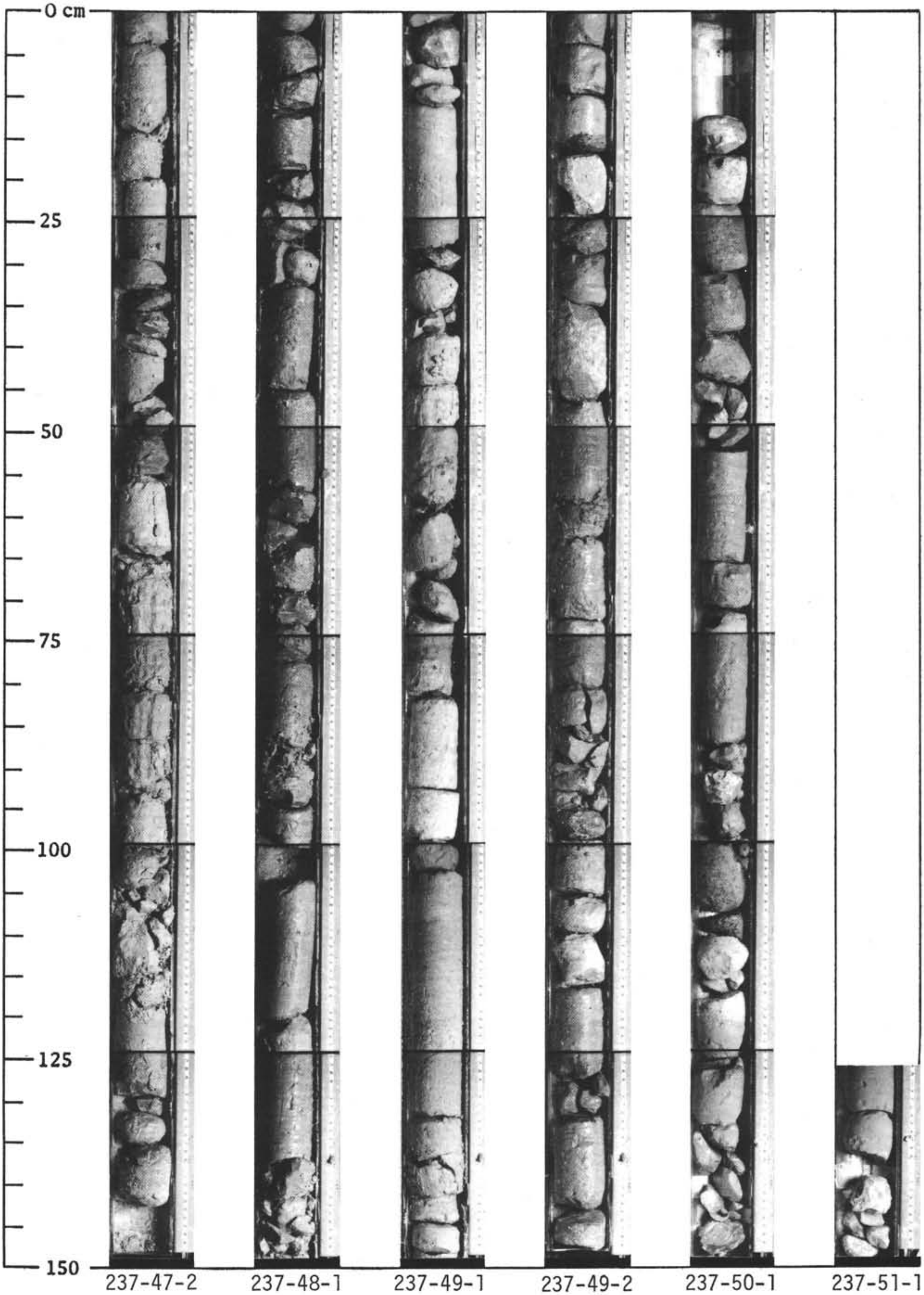
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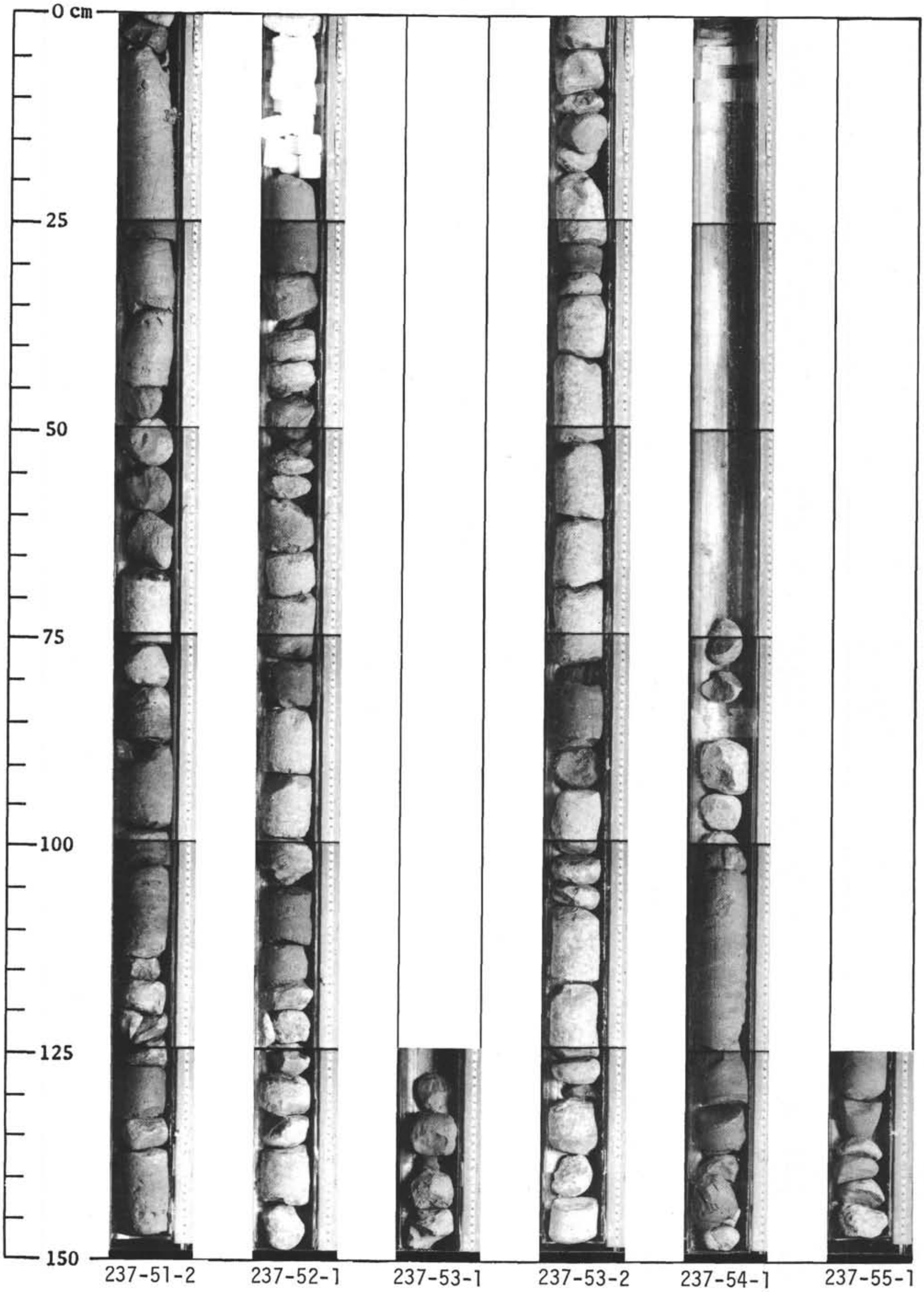
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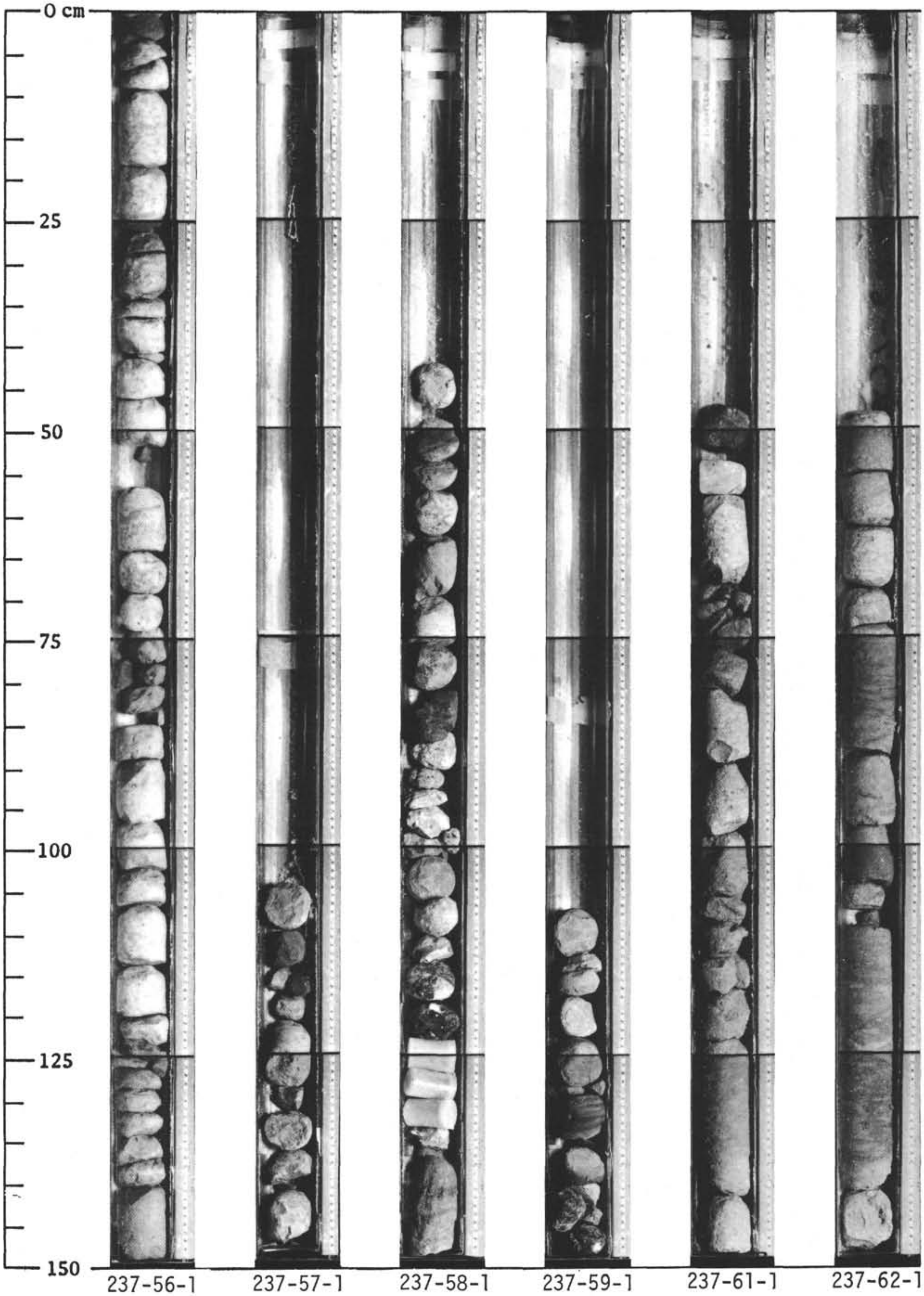
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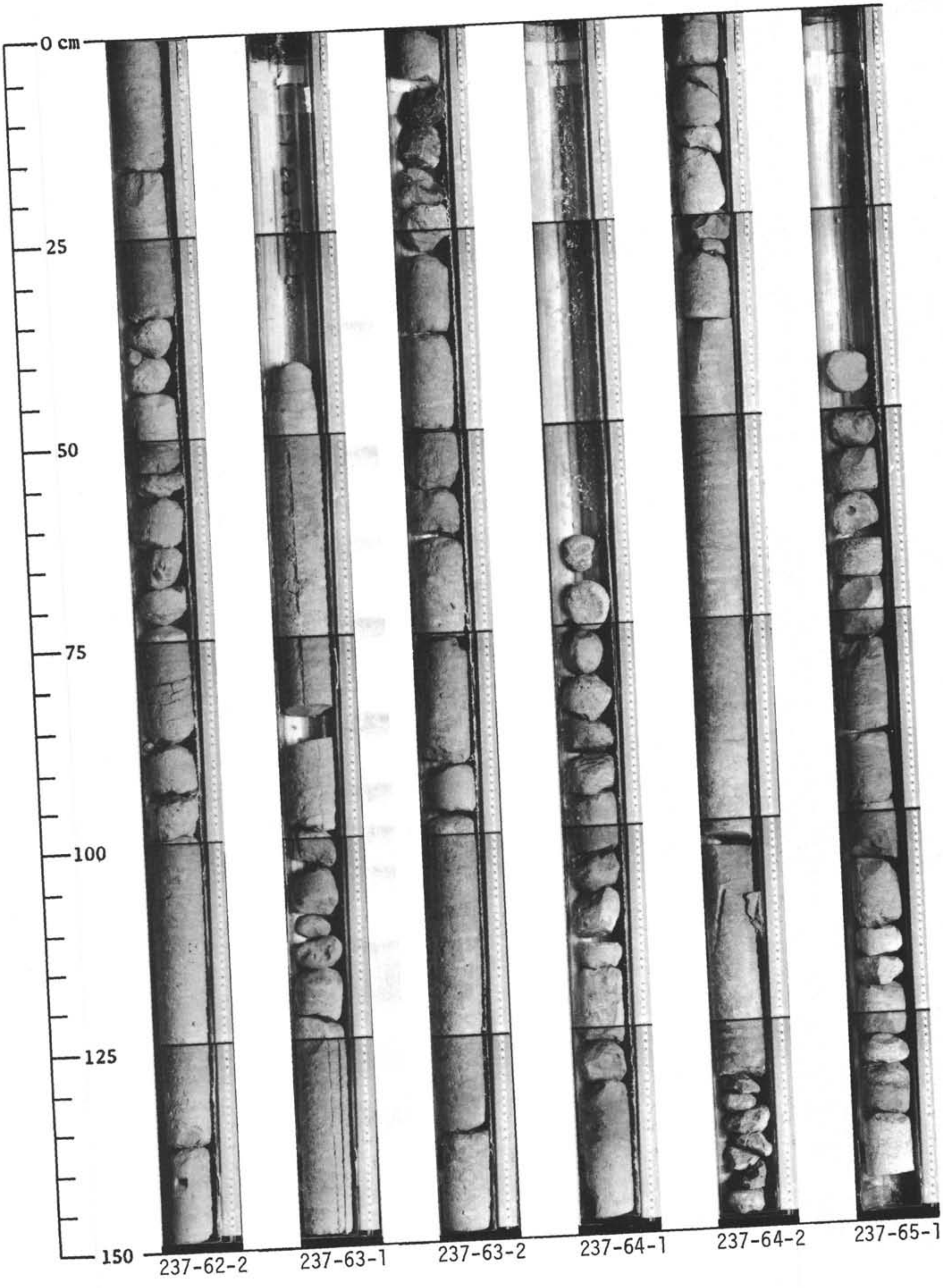
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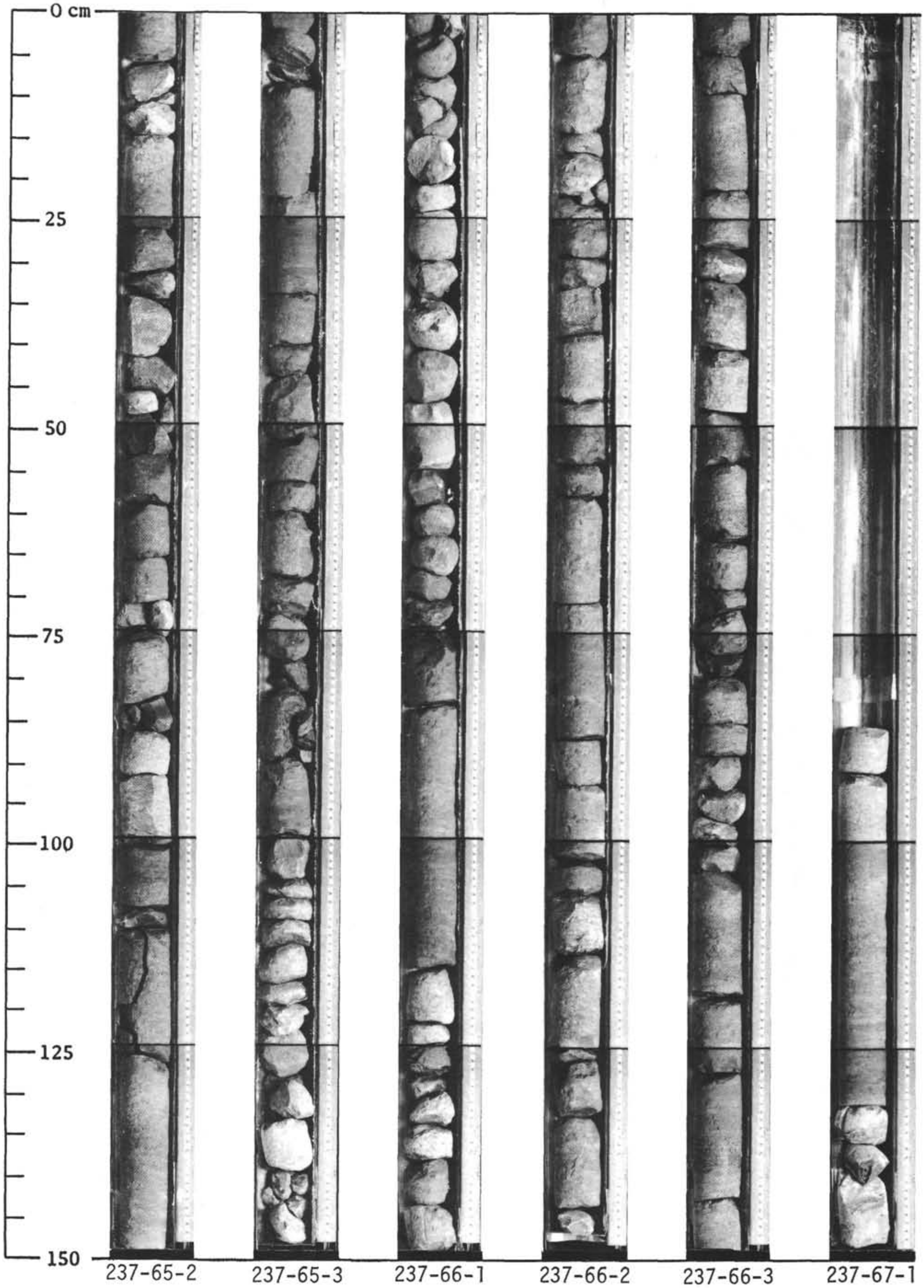
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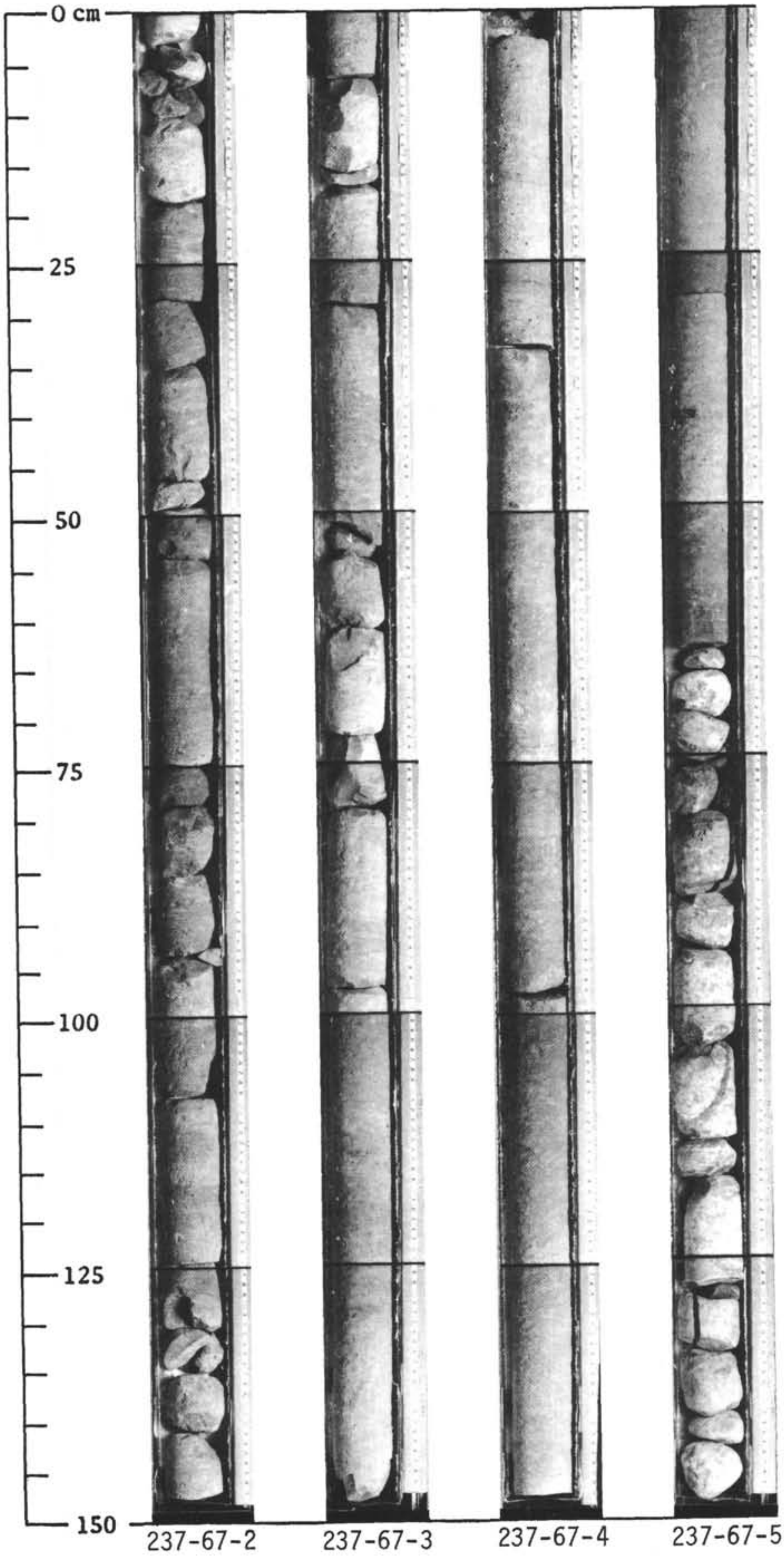
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