4. SITE 251

The Shipboard Scientific Party[1]

SITE DATA

Locality: North flank of Southwest Indian Ridge

Position:
lat 36°30.26'S
long 49°29.08'E

Dates Occupied: 17-21 September 1972

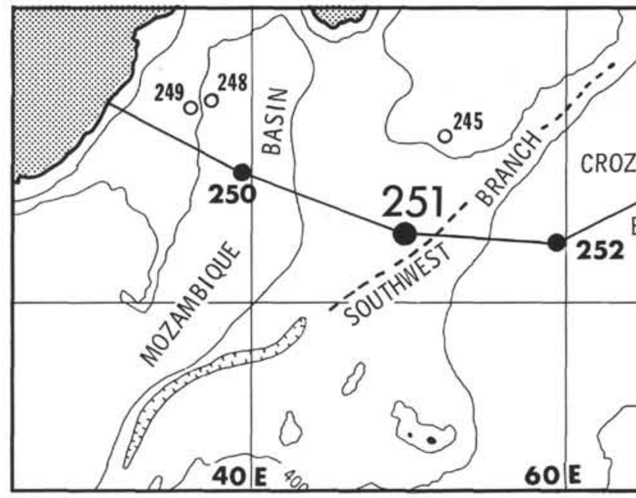
Water Depth: 3489 meters

Penetration: 499 meters

Number of Cores: 41

Oldest Datable Sediment Cored:
Depth (subbottom): 486 meters (Hole 251A, Core 29)
Nature: Nanno chalk
Age: Lower Miocene

Basement:
Depth encountered (subbottom): 487 meters
Nature: Glassy olivine basalt
Penetration: 12.5 meters



Principal Results: The basalt is overlain conformably by 18 meters of garnet-rich calcite chalk and 15 meters of brown nannofossil chalk of lower Miocene age. Above these sediments is a continuous lower Miocene to Recent section, 453 meters thick, of nannofossil ooze and chalk.

BACKGROUND AND OBJECTIVES

Site 251 is located about 180 km north of the Southwest Branch of the Indian Ocean Ridge in 3500 meters of water (Figure 1). The Southwest Branch is believed to be a presently spreading oceanic ridge, based on evidence from earthquake epicenters (Baranzangi and Dorman, 1969), sediment distribution (Ewing et al., 1969), and topography (Heezen and Tharp, 1965). The ridge structure trends northeast and is offset in the left lateral sense by several major north-northeast-trending fracture zones such as the Mozambique, Prince Edward, and Malagasy fractures (Heezen and Tharp, 1965; Schlich and Patriat, 1968, 1971).

The spreading rate and the age of the Southwest Branch are not known. Schlich and Patriat (1971), Berg (1971), and McKenzie and Sclater (1971) have calculated rates from identification of magnetic anomalies of 0.6-1.0 cm/yr in a northerly direction. However, the magnetic data over the ridge are extremely noisy and these calculations are therefore much in doubt. Further, McKenzie and Sclater (1971) have suggested that the Southwest Branch began actively spreading between 20 and 35 m.y. ago. If this is true then the tectonic history of the western Indian Ocean becomes considerably more complicated because the latest episode of spreading on the Carlsberg and Central Indian ridges began 36 m.y. ago (op. cit. and results of Hole 238, Leg 24). Part of the objectives of Site 251, then, were to determine the average spreading rate on the Southwest Branch over a significant time interval and to extrapolate this rate to the edge of the ridge flank in order to estimate the maximum age for the structure.

A second problem addressed at Site 251 is biostratigraphy. The site is located above the carbonate compensation depth throughout much of the record and should yield adequately preserved specimens from south of the tropical faunal zone of the Indian Ocean. Good faunal sections for the planktonic foraminifera of the subtropical to temperate zones in the Indian Ocean were not previously available. The biostratigraphic data from Site 251 fill this gap and, in addition, allow comparison with DSDP data from southern Melanesia and with other data from New Zealand.

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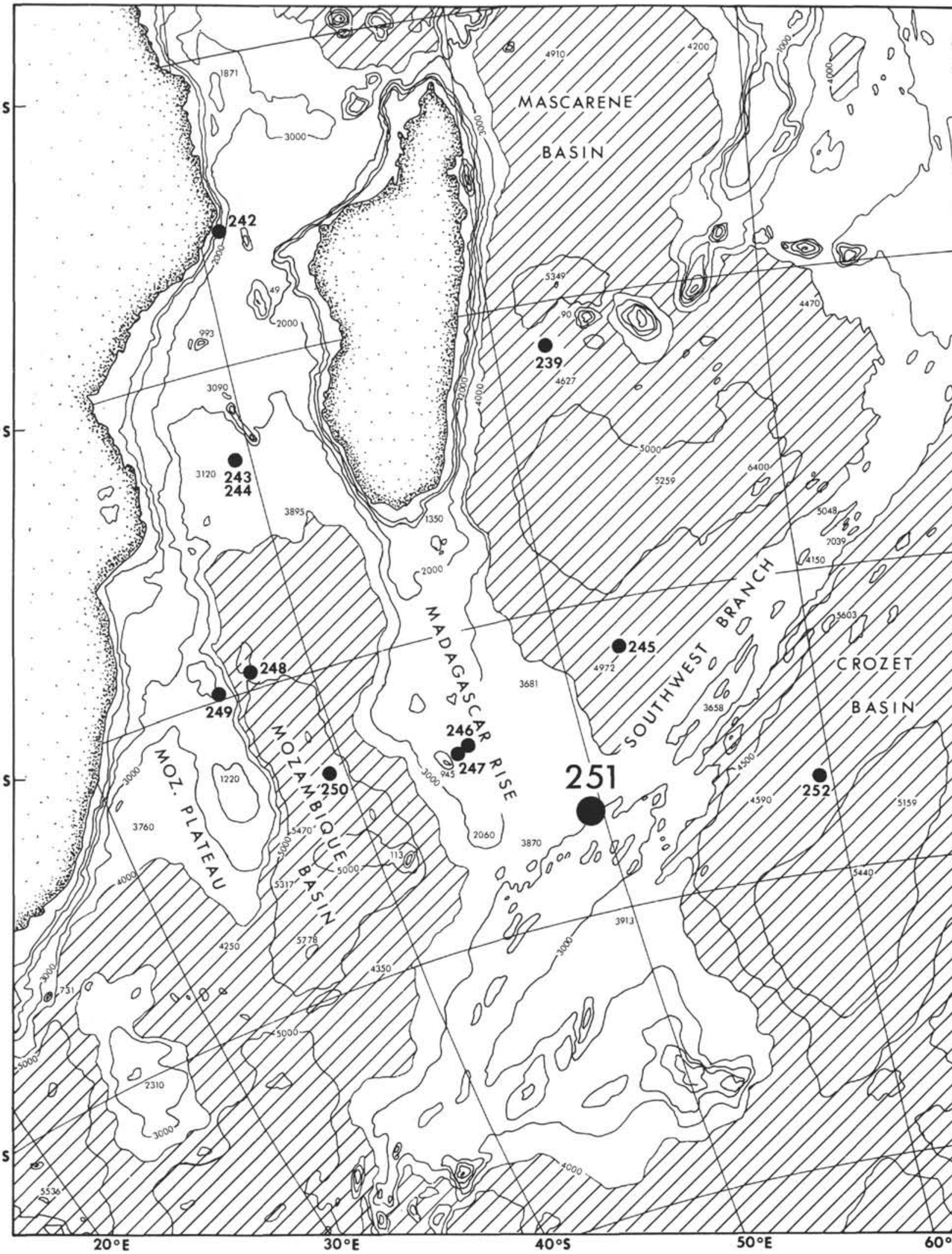

Figure 1. *Base chart and locality of Site 251. Other sites from DSDP Legs 24 and 25 are also shown. (Adapted from the Russian bathymetric chart of the Indian Ocean.)*

Because we had decided to drill this site (proposed Site 25-8) after our departure from Durban, no seismic profiler records were aboard to aid in site selection. We proceeded to the coordinates given on the Leg 25 prospectus, planning to spend slightly less than 4 hr surveying the general vicinity. The survey pattern (Figure 2) consisted of two east-west lines (one run postsite), two north-south lines, and one northeast-southwest line. This pattern showed that the regional structure strikes northeast-southwest and that the drill site is located in an intermontane basin about 5 n.mi. (9.3 km) wide with about 0.2-0.5 sec DT of sediment (Figure 3). No internal reflectors are obvious in an acoustically transparent section. At the site about 0.495 sec DT of sediment overlies the acoustic basement surface which is smooth and dips (apparent) slightly to the north. Mountain peaks are at depths between 4.0 and 4.5 sec DT with a relief above basement in the sedimentary basin of near 1.0 sec DT.

OPERATIONS

The beacon was dropped while underway in 3489 meters of water at 1233, 17 September and the first core was recovered at 2249. Vital statistics for all of the cores recovered from Site 251 are given in Table 1. Operations, including one run of the downhole heat-flow probe, continued uneventfully through the night in moderate weather conditions (moderate swells from the southwest and winds 15-20 knots from the west-northwest) until a complete power failure occurred at approximately 0900, 18 September resulting in loss of position and an excursion of possibly as much as 1000 ft.

It was decided to pull out of the hole to check that the bottom hole assembly had not been damaged while attempts were made to locate the cause of the power failure, and the positioning computer was reprogrammed. Several more power failures occurred as a result of tests aimed at locating the defective circuits before it was decided to return to the configuration of power assignments used prior to the modifications carried out at the Durban port call. Problems were also encountered when the positioning computer refused to accept the new program. However, this was traced to a blown fuse, and by early afternoon the ship was once more fully operational. Hole 251A was spudded and the first core was onboard at 1630.

Drilling and coring at Hole 251A continued uneventfully and there was no recurrence of the power failure, although some inexplicable power surges were noted. The downhole heat-flow probe was run successfully on one occasion at Hole 251A, although steadily deteriorating weather conditions (winds up to 40 mph from a northerly direction over strong swells from the southwest) made manhandling the core barrel with the probe on deck very difficult. Basement was reached at a subbottom depth of 489 meters in Core 30, after which one further core was cut before abandoning the site.

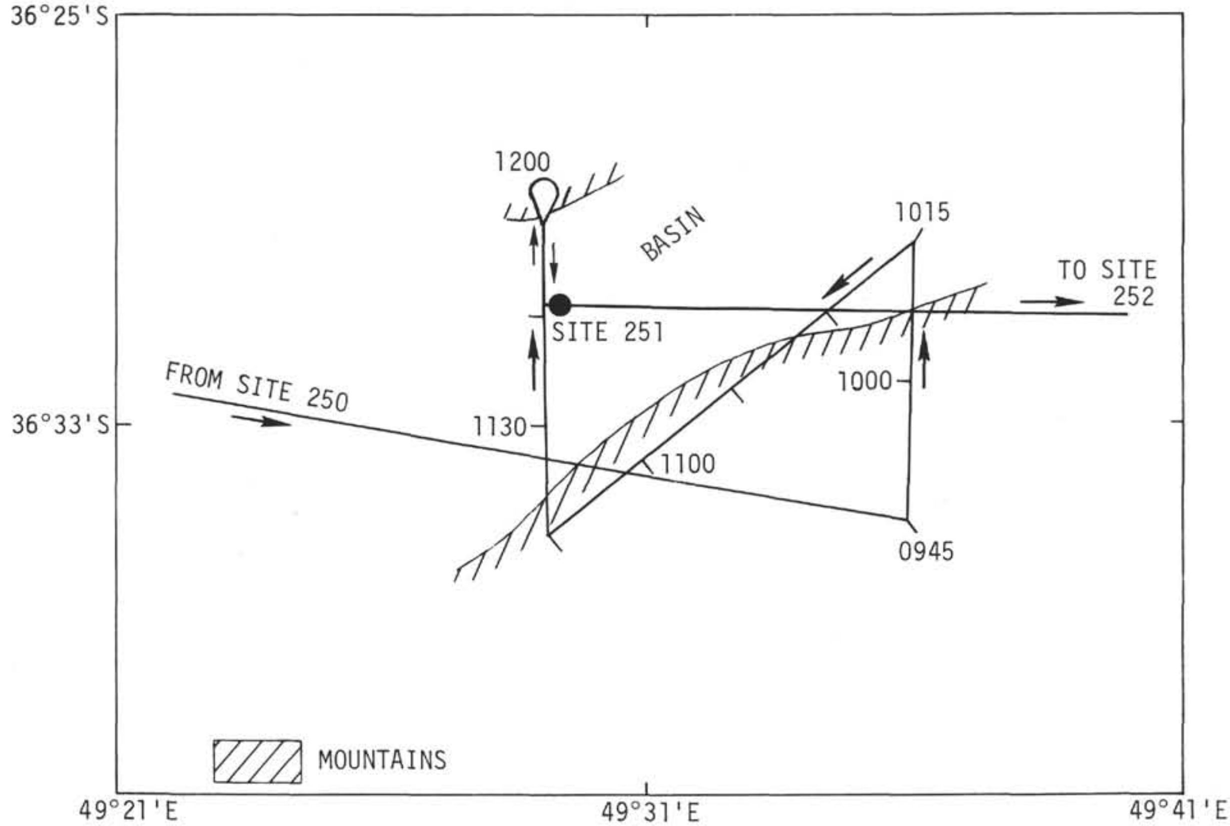

Figure 2. *Track chart of presite survey by D/V* Glomar Challenger, *Site 251.*

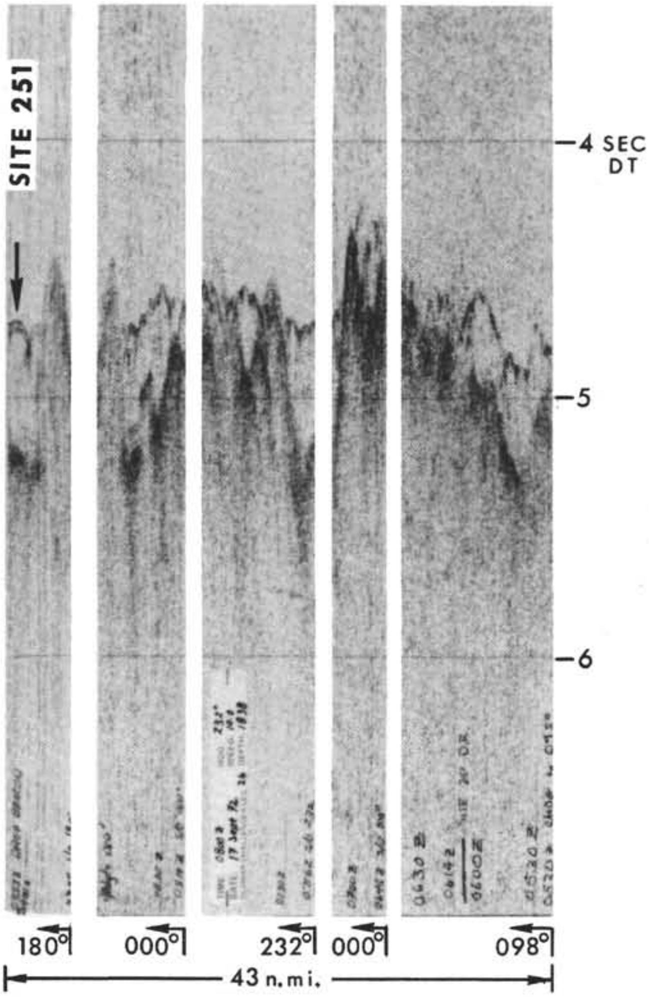

Figure 3. *Seismic reflection profile approaching Site 251 (see Figure 2), taken from D/V* Glomar Challenger.

The drill pipe was secured and we got underway for Site 252 at 0252, 21 September. Throughout operations at Hole 251A, following the power failure which terminated Hole 251, positioning was excellent despite weather conditions which made operations only marginally possible for much of the time.

LITHOLOGY

The sediments at Holes 251 and 251A, the latter beginning where the first had to be discontinued, can be divided into five gradational units, of which one is divided into two distinguishable subunits (Table 2). The basalt forming the basement represents a sixth unit.

Unit 1

The lithologic unit comprising the uppermost 11.5 meters of sediment at Site 251 is a soft, pale orange foraminiferal nannoplankton ooze, distinguished from the underlying unit, into which it grades, by its color and its relatively high content of foraminifera. In addition, radiolarians are common in trace amounts, and the sediment contains a few diatoms and sponge spicules. Microcrystalline pyrite, which characterizes the sediments at this site as a whole, is rare. Mottling is very localized and slight, in gray, yellow, and orange shades. Detrital material, mainly clay, quartz, and mica, is most abundant in this unit but constitutes less than 5% of the sediment on the average.

Unit 2

The first major lithologic unit, 228.5 meters thick, is a soft nannoplankton ooze conveniently described as two subunits distinguished from each other by a subtle difference in inorganic content and an attendant slight color contrast. Subunit 2a, gradational both with Unit 1 at 11.5 meters and with Subunit 2b at 106.5 meters, is a white nannoplankton ooze. Foraminifera are common but only in trace amounts, associated with traces of radiolarians and with a very few diatoms and discoasters. Trace amounts of finely disseminated pyrite are common throughout the unit, in several dark gray spots, streaks, and bands per meter of core length. Greenish, yellowish, purplish, and gray mottling, although localized and slight, becomes more apparent than in Unit 1. Pyritized burrows 0.5-1 cm in diameter and up to 5 cm long, some of them hollow, thorny, or with blunt projections, recur sporadically, several generally occurring in approximately every other core. The few percent of silt-sized detrital material is largely quartz and mica. Traces of authigenic calcite and siderite were noted.

Subunit 2b is a soft to stiff bluish-white nannoplankton ooze. The color change from that of Subunit 2a appears to result from a suffusion of the sediment by traces of microscopic pyrite. Larger trace amounts of fine pyrite are also found in gray streaks, bands, and mottles, as in Subunit 2a. Locally, black spots contain silt-sized framboids of radiating microcrystalline pyrite and gypsum as well as finely disseminated pyrite (see discussion by Criddle, this volume, Chapter 26). Pyritized burrows occur with the same degree of frequency and general size as in Subunit 2a. The frequency of radiolarian occurrence is decreased markedly from that of the overlying subunit; in other respects the microfossil content is similar, except that sponge spicules again occur as rare traces. The number of discrete yellowish burrows increases downward through the subunit, some of the burrows exhibiting "thorns" or projections similar to those of the pyritized burrows. The degree of mottling, slight at the top of the subunit, increases downward and is locally intense near the base. Authigenic calcite is a common trace constituent, but the proportions of detrital material remain much the same as in Subunit 2a, although they contain in addition sporadic traces of volcanic glass and heavy minerals. Subunit 2b becomes stiff toward its base and passes downward gradationally into Unit 3.

Unit 3

The main difference between the bluish-white nannoplankton chalk and the ooze of Subunit 2b is its semilithified nature; the boundary between these units is placed arbitrarily midway down the uncored interval separating the last cored stiff ooze (Core 12) and the first

TABLE 1
Cores Cut at Site 251

Core	Date (Sept. 1972)	Time	Depth from Drill Floor (m)	Depth Below Sea Floor (m)	Length Cored (m)	Length Recovered (m)	Recovery (%)
Hole 251							
1	17	2249	3499.0-3501.0	0-2.0	2.0	2.0	100
2	18	0014	3501.0-3510.5	2.0-11.5	9.5	9.0	95
3	18	0137	3510.5-3520.0	11.5-21.0	9.5	4.5	47
4	18	0243	3520.0-3529.5	21.0-30.5	9.5	9.4	99
5	18	0353	3529.5-3539.0	30.5-40.0	9.5	8.3	87
6	18	0457	3539.0-3548.5	40.0-49.5	9.5	9.2	97
7	18	0558	3548.5-3558.0	49.5-59.0	9.5	9.2	98
8	18	0659	3558.0-3567.5	59.0-68.5	9.5	9.1	96
9	18	0800	3567.5-3577.0	68.5-78.0	9.5	0.0	0
10	18	0901	3577.0-3586.5	78.0-87.5	9.5	6.4	67
Total					87.5	67.1	77
Hole 251A							
1	18	1630	3577.0-3586.5	78.0-87.5	9.5	9.5	100
2	18	1820	3586.5-3594.5	87.5-95.5	8.0	7.2	90
3	18	1950	3596.0-3605.5	97.0-106.5	9.5	0.0	0
4	18	2105	3605.5-3615.0	106.5-116.0	9.5	7.7	81
5	18	2207	3615.0-3624.5	116.0-125.5	9.5	9.0	94
6	18	2310	3624.5-3634.0	125.5-135.0	9.5	9.5	97
7	19	0020	3634.0-3643.5	135.0-144.5	9.5	9.5	100
8	19	0135	3643.5-3653.0	144.5-154.0	9.5	0.0	0
9	19	0255	3653.0-3662.5	154.0-163.5	9.5	9.5	100
10	19	0405	3662.5-3672.0	163.5-173.0	9.5	9.1	96
Drilled			3672.0-3691.0				
11	19	0533	3691.0-3700.5	192.0-201.5	9.5	4.6	48
Drilled			3700.5-3719.5				
12	19	0705	3719.5-3729.0	220.5-230.0	9.5	9.1	96
Drilled			3729.0-3748.0				
13	19	0845	3748.0-3757.5	249.0-258.5	9.5	7.0	74
Drilled			3757.5-3776.5				
14	19	1055	3776.5-3782.5	277.5-283.5	6.0	0.5	8
Drilled			3782.5-3805.0				
15	19	1249	3805.0-3814.5	306.0-315.5	9.5	3.5	37
Drilled			3814.5-3833.5				
16	19	1435	3833.5-3843.0	334.5-344.0	9.5	7.8	82
Drilled			3843.0-3862.0				
17	19	1624	3862.0-3865.0	363.0-366.0	3.0	1.8	60
Drilled			3865.0-3871.5				
18	19	1754	3871.5-3881.0	372.5-282.0	9.5	1.2	13
19	19	1907	3881.0-3890.5	382.0-391.5	9.5	0.38	4
20	19	2050	3890.5-3900.0	391.5-401.0	9.5	9.5	100
21	19	2246	3900.0-3909.5	401.0-410.5	9.5	5.4	57
22	20	0020	3909.5-3919.0	410.5-420.0	9.5	4.1	43
23	20	0150	3919.0-3928.5	420.0-429.5	9.5	1.9	20
24	20	0325	3928.5-3938.0	429.5-439.0	9.5	6.0	63
25	20	0456	3938.0-3947.5	439.0-448.5	9.5	6.3	66
26	20	0635	3947.5-3957.0	448.5-458.0	9.5	5.9	62
27	20	0845	3957.0-3966.5	458.0-467.5	9.5	2.1	22
28	20	1045	3966.5-3976.0	467.5-477.0	9.5	1.5	16
29	20	1211	3976.0-3985.5	477.0-486.5	9.5	2.6	27
30	20	1354	3985.5-3988.0	486.5-489.5	3.0	0.3	10
31	21	1810	3988.5-3998.0	489.5-499.0	9.5	6.2	65
Total					276.5	158.68	57

Note: Echo-sounding depth (to drill floor): 3499 meters; Drill-pipe length to bottom: 3522 meters (adjusted to match PDR depth).

TABLE 2
Lithologic Summary, Site 251

Unit/ Subunit	Hole/ Core	Depth Below Sea Floor (m)	Thickness (m)	Description
1	251/ 1, 2	0-11.5	11.5	Orange foraminiferal nannoplankton ooze
2a	251/2-9; 251A/1-4	11.5-106.5	95.0	White nannoplankton ooze with fewer forams and with streaks rich in fine pyrite, and pyritized burrows
2b	251A/4-12	106.5-240.0	133.5	Bluish-white nannoplankton ooze with disseminated fine pyrite and pyritized burrows and a slightly greater proportion of detrital material
3	251A/13-26	240.0-453.8	213.8	Bluish-white nannoplankton chalk with disseminated fine pyrite, rare pyritized burrows, moderately to intensely mottled near the base
4	251A/26-28	453.8-468.2	14.4	Yellowish-brown nannoplankton chalk with finely disseminated limonite and limonitized burrows and mottles
5	251A/28, 29	468.2-486.5	18.3	Pale yellowish-brown calcite (micarb) chalk with faint limonitized mottling
6	251A/30, 31	486.5-499.2TD[a]	12.5	Basalt, glassy to diabasic, subophitic

[a]TD = total depth.

appearance of semilithified chalk (Core 13). Foraminifera are the only biogenous components other than the coccoliths, and sedimentary structures become more prominent. The faint mottling of the upper units gives way to more discrete greenish and yellowish mottles, in which the microcrystalline pyrite tends to be concentrated. The yellow mottles become more pronounced than the green or gray, and towards the base of the unit limonitic colors dominate, especially in burrows, which are more common at this level than higher up. Pyrite-gypsum framboids occur more frequently than in Unit 2, forming up to 50% of several black spots 1-3 cm long in each section, but pyritized burrows have practically disappeared. The detrital components are predominantly quartz and mica, with some volcanic glass and rare heavy minerals such as zircon. Some authigenic calcite occurs.

Unit 4

Unit 3 grades into the yellow to reddish-brown nannoplankton chalk of Unit 4, which differs from Unit 3 only in the color produced by oxidation of the finely disseminated pyrite to limonite and related hydrated iron oxides. As in Unit 3, mottles, burrows, traces of foraminifera, and traces of detrital constituents (quartz, mica, volcanic glass, and heavy minerals) are found. Unit 4 is separated from underlying Unit 5 by an 8-cm layer of purplish-gray clay brecciated by drilling.

Unit 5

The lowermost sedimentary layer, about 18 meters thick, is a very pale yellowish-brown to white calcite (micarb) chalk. It consists of silt-sized recrystallized calcite rhombs with approximately 20% grains of authigenic garnet ($\sim 2\mu$ across) and traces of iron oxides. Unit 5 is locally and faintly mottled, randomly veined, and its fractures are stained with pink and yellow iron oxides, indicating some iron enrichment (see Fleet and Kempe, this volume, Chapter 21). The garnets probably reflect metasomatic transfer from the underlying basalt. They are discussed in more detail by Kempe (this volume, Chapter 25).

Unit 6

Unit 6 consists of basalt, upon which the overlying sediments are deposited normally. Three loose cobbles of basalt were encountered in Core 29, while the previous core contained grit-sized fragments adhering to the chalk. Solid basalt was cored at a depth of 486.5 meters and is a gray-brown weathered rock, highly vesicular, and glassy at the top. It becomes coarse to very coarse grained (diabasic), with fresh unweathered areas, towards the bottom of Core 31. Four thin sections were cut—one from a glassy cobble (Core 29) and three from the solid basalt core—from a weathered sample near the top and from two fresh areas towards the base.

The three cobbles of glassy olivine basalt are very fresh on the inside and are rimmed by mantles of basalt glass. They appear to have been knobs or projections knocked off by the drill bit. The glass is highly altered only near the surface, with macroperlitic cracks and, possibly, slight brecciation; fragments of chalk adhere to the weathered surface. The outer glass is pale reddish-brown (n=1.602), seen under the microscope to be partially divitrified into a mosaic of subvariolitic patches, containing minute olivine crystals.

The basalt glass is a darker red-brown, devitrified to a greater extent and having paler, roughly circular patches. It contains innumerable incipient acicular microlites of, apparently, olivine, disposed in a slightly spherulitic texture, with an average length of 0.2 mm. Scattered throughout the rock are small, very fresh microphenocrysts of olivine, euhedral in shape, and having an average length of 0.4 mm. The total (phenocrysts and microlites) modal proportion of olivine is about 10%. One large glomeroporphyritic cluster of labradorite crystals (6 mm across) is present in this section.

Olivine basalt occurs at the top of the main core, gray-brown in color and highly weathered and fractured. Veins and fracture films of calcite occur here and throughout the whole of the core where weathering is present. At the top, the basalt is highly vesicular, the vesicles (ca 1.0 mm across) being filled mainly with calcite.

In thin section, the rock has an intersertal texture and consists mainly of plagioclase and pyroxene. A very few indistinct and totally altered crystals of olivine (ca 0.5 mm) are present, pseudomorphed by bowlingite-iddingsite aggregate. The plagioclase laths are zoned labradorite, ranging from 0.1 to 1.3 mm in length: the larger ones are thus phenocrystic. Neutral-colored augitic pyroxene ($2V\gamma$ ca 45°) is the second main mineral, occurring in prisms reaching 0.6 mm in length, bunches of smaller prisms, and smaller grains. Small granules of iron oxide, largely concentrated in the very dark brown interstitial glassy mesostatic areas, form the only accessory mineral; microlites in the mesostasis are also probably incipient iron oxides.

Gray coarse- to very coarse-grained (diabasic) tholeiitic olivine basalt forms the bulk of the core and is locally fresh and unweathered at several levels.

The lower of the two rocks sectioned is considerably coarser than the higher sample; neither olivine nor quartz were observed in it, but in other respects it is essentially similar. Plagioclase and neutral-colored augitic pyroxene form the bulk of the rocks, which have an intersertal to subophitic texture, but a very few indistinct olivine crystals (ca 0.3 mm), totally altered to bowlingite-iddinsite, were noted in the first rock. The feldspar laths reach 2.5 mm in length in the first and 3.0 mm in the second; they are zoned and in the lower of the two samples are notably well twinned and in some cases slightly more sodic in composition (An_{49}). The pyroxene prisms, bunches of prisms and grains, up to 1.0 and 1.5 mm in length, respectively, have a $2V\gamma$ of about 45°; no pigeonite, hypersthene, or exsolution lamellae have been observed. Skeletal iron ore crystals, probably ilmenite, reach 0.2 and 0.7 mm, respectively, and the second rock contains traces of apatite; both contain veins and small patches of green chlorite. Interstitial mesostasis completes the rock and is notably well crystallized. The main interstitial minerals are chlorite, feldspar (including, possibly, alkali feldspar), and iron oxide, but quartz was noted in the higher of the two rocks.

SHIPBOARD GEOCHEMICAL MEASUREMENTS

Routine analyses for salinity, pH, and alkalinity were conducted on interstitial water samples squeezed from nine sediment samples taken at depths in the hole from 11.5 to 479 meters below the sea floor. In addition, pH was measured on the uppermost four samples of unsqueezed sediment by the punch-in method before the core recovery became too stiff for the electrodes. The sampling and analytical techniques are described in the report on Site 250, and the results are summarized in Table 4 and presented in graphical form in Figure 4.

Results

Salinity

Salinity at this site was maximal (35.2‰) in the uppermost sample, taken 11.5 meters below the sea floor. From this level the salinities fluctuated irregularly down the hole in the narrow range between 34.1‰ and 34.9‰ with no obviously meaningful trends.

TABLE 3
Modes of the Basalt, Site 251

	Glassy Olivine Basalt (29-1, 40 cm)	Olivine Basalt (31-2, 14 cm)	Coarse Olivine Tholeiitic Basalt (31-4, 5 cm)	Very Coarse (Diabasic) Olivine Basalt (31-5, 17 cm)
Plagioclase	2	38	45	46
Pyroxene		37	37	39
Olivine	10	0.5	0.25	nil
Iron oxide		9.5	8.75	9
Glass or mesostasis	88	15	8	5
Apatite				tr
Quartz			tr	
Chlorite			1	1

TABLE 4
Summary of Shipboard Geochemical Measurements, Site 251

Sample (Interval in cm)	Depth Below Sea Floor (m)	Lab Temp (°C)	pH Punch-in/ Flow-through	Alkalinity (meq/kg)	Salinity (°/oo)
(Reference seawater)	–	–	8.19/8.23	2.35	35.8
Hole 251					
2-6, 145-150	11.45-11.50	22.3	7.28/7.26	3.81	35.2
7-6, 145-150	58.95-59.00	22.5	7.08/7.11	5.18	34.9
Hole 251A					
4-5, 144-150	113.94-114.00	22.2	7.07/7.06	6.06	34.4
9-4, 145-150	159.95-160.00	22.0	7.03/7.09	5.87	34.6
15-1, 143-150	307.43-307.50	22.2	/7.48[a]	2.57	34.1
17-2, 143-150	365.93-366.00	22.2	/7.61[a]	2.39	34.6
20-6, 143-150	400.43-400.50	22.3	/8.15[a]	0.782	34.1
25-4, 143-150	445.93-446.00	22.3	/7.66[a]	1.57	34.6
29-2, 143-150	478.93-479.00	22.3	/7.67[a]	2.83	34.9

[a]Too stiff to measure punch-in.

pH

Punch-in and flow-through *p*H measurements at this site agree remarkably well, the values in individual samples differing by no more than 0.06 *p*H unit, with three of the punch-in and two of the flow-through values being higher. This agreement is too close for punch-in and flow-through values to be plotted as discrete points on the scale of Figure 4, in which only the flow-through values are depicted. The interstitial waters were extracted easily with relatively low squeeze-out pressures and short extraction times, and the belief that the *p*H of interstitial waters is reduced by the loss of carbon dioxide during extraction appears borne out. Unlike at Site 250, significant quantities of detrital clay were not present in the nannoplankton oozes of Site 251. It is possible that the availability of detrital clay particles for adsorbing the water may make extraction more difficult, and in future holes the deviance between punch-in and flow-through values will be compared with detrital clay content to test this possibility.

Flow-through *p*H values display a general inverse relationship with alkalinity (Figure 4). Values decrease down the hole from 7.26 in the sample taken 11.5 meters below the sea floor to a minimum of 7.06 and 7.09 at 114 and 160 meters, respectively, the levels of the alkalinity maximum. From this depth, *p*H increases smoothly down the hole to 7.67 at a depth of 479 meters, with the exception of a single, unexplained aberrant value of 8.15

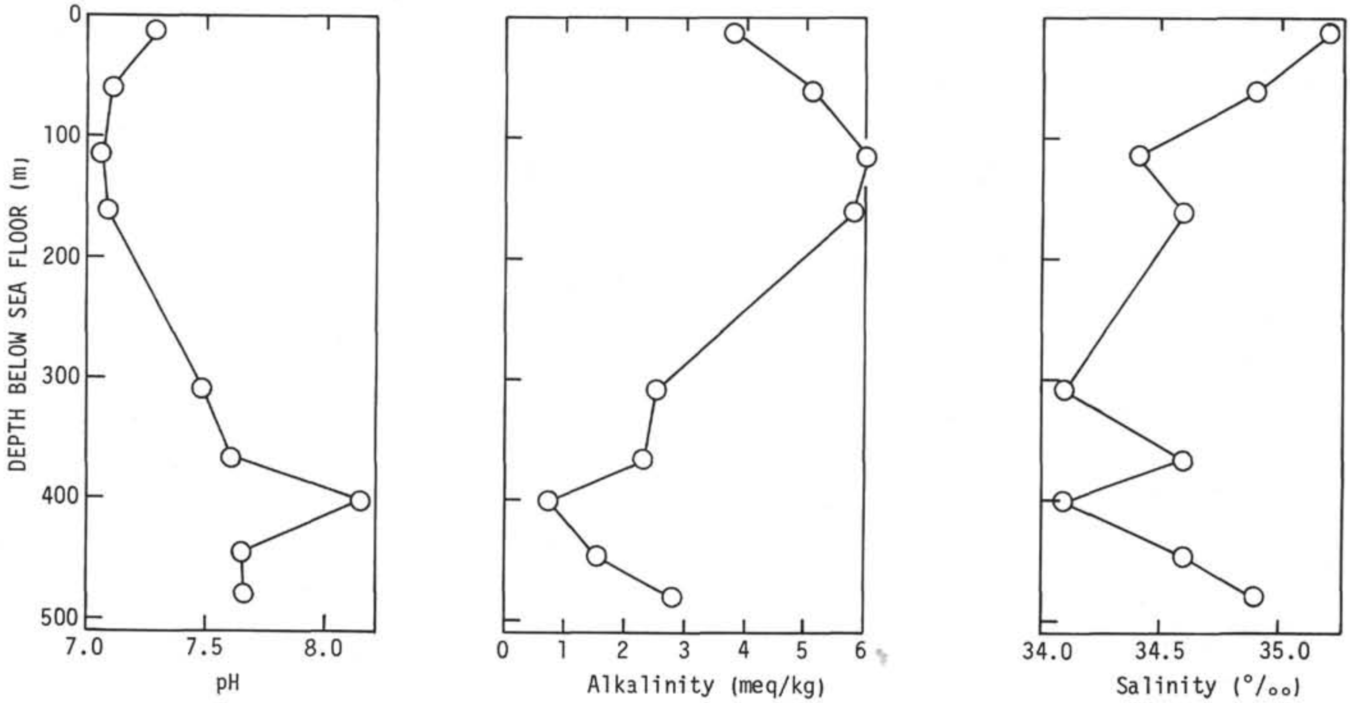

Figure 4. *Graphic summary of geochemical measurements taken at Site 251.*

which occurs at 400.5 meters depth. Only this single value is high enough to fall within the normal *p*H range (7.8-8.2) of seawater. This value is matched by an alkalinity minimum at the same level.

Alkalinity

In the uppermost sediments analyzed, the alkalinity was 2.35 meq/kg. From this level, alkalinity increased smoothly with depth to a well-defined maximum of 6.06 meq/kg 114 meters below the sea floor. Values decrease with greater depths to a minimum of 0.782 meq/kg at 400.5 meters, before increasing again with depth to a secondary maximum of 2.83 meq/kg at a depth of 479 meters, or 6 meters above the first basalt recovery.

As at Site 250, the alkalinity maximum 114 meters below the sea floor may be attributed to the decomposition of organic matter by sulfate-reducing bacteria after burial, this organic process releasing free sulfide ions and carbon dioxide. The widespread finely disseminated pyrite and common pyritized burrows of Lithologic Unit 2 at Site 251 constitute the obvious sink for the sulfide ions, which combine with available iron oxides and the iron in minerals.

A relationship between the magnitude of the alkalinity maximum and depositional rates noted during previous DSDP cruises (e.g., cf. Gieskis, unpublished Shipboard Report Leg 25, Sites 241 and 242) appears reaffirmed by data gathered thus far on Leg 26. Whereas at Site 250 the Pleistocene and Pliocene depositional rates were 45-55 and 43 m/m.y. respectively, and showed an alkalinity maximum of 21.91 meq/kg, the alkalinity maximum was only 6.06 meq/kg at Site 251, where depositional rates range only between 30 and 37 m/m.y.

PHYSICAL PROPERTIES

Physical properties measured at Site 251 were bulk density, porosity, acoustic velocity, and thermal conductivity. The methods are described in the Explanatory Notes (Chapter 2). The results are shown in the hole summary diagram.

Density, Porosity, and Water Content

The densities determined by the GRAPE and syringe methods are consistently higher than those from the section weight. The GRAPE values generally are slightly higher than the syringe values. Densities increase slowly and nearly linearly with depth from 1.65 g/cc near the surface to 1.85 g/cc near the basalt basement, reflecting consolidation of the rather uniform composition oozes.

Acoustic Velocities and Acoustic Impedance

Acoustic velocities are very uniform in the oozes throughout the upper 300 meters at this site averaging 1.55 km/sec, increasing in the brown chalk of the bottom 100 meters to 1.75 km/sec. The mean basalt velocity from six measurements on three samples was 5.56 km/sec. The acoustic impedance is also very constant, increasing only very slightly with depth to the basalt basement where there is a contrast of a factor of three. No reflectors in the sedimentary column are suggested by the acoustic impedance profile, and none are seen in the seismic profile record.

CORRELATION OF SEISMIC REFLECTION PROFILE WITH DRILLING RESULTS

The acoustic section at the site consists of a transparent section above a strong basement reflector at 0.5 sec DT. The basement has an apparent dip to the north. Based on measured acoustic velocities, it was expected to sample basement at about 380 meters subbottom (average velocity 1.56 km/sec). Instead the basement was reached at 489 meters (average velocity 1.96 km/sec). The cause of this discrepancy of about 20% is not immediately known.

Possible sources of error include drift of the drill hole, inaccurate acoustic velocity measurements, and mistaking a side-echo for the true basement arrival. The drill hole was surveyed and found to be 4° off vertical near its base and 8° at about 100 meters. This could not account for the discrepancy. The acoustic velocities were measured against a calibrated standard and found to be accurate. It could be that the cores were disturbed and yielded lower velocities, but if so, the measured results are surprisingly consistent. The apparent dip of the basement is about 2½° which is too small an angle to introduce slope error and consequently an error in basement depth. The best explanation may be that the acoustic basement has many side echoes so that the basement return from directly beneath the ship does not appear as a first basement arrival and is therefore masked.

PALEONTOLOGY

Biostratigraphic Summary

Site 251 is of particular biostratigraphic interest, since it has revealed an almost complete and uninterrupted mid-latitudinal Neogene sequence of uniform lithology ranging in age from the upper part of the lower Miocene to Recent. Only the lowermost part of the section shows a change in lithology which is accompanied by sparse poorly preserved microfossils. Unfortunately, the value of the site as a standard section is considerably restricted by strong and selective dissolution effects shown in the foraminiferal assemblages, especially in the Miocene part of the section.

The well-known foraminiferal zonation established in tropical areas cannot be applied directly to the mid-latitude succession of this site. The occurrence of some tropical forms, however, permits a limited correlation with the tropical zonation.

The nannoplankton, on the other hand, can be well correlated with published zonations from other areas.

The preservation of the microfossils suggests a deepening of the lysocline through the Neogene, if an increase in water depth with time is assumed.

Foraminifera

From the paleontological point of view, Site 251 is very interesting and valuable, as it has yielded a complete and presumably uninterrupted mid-latitudinal Neogene sequence. Unfortunately, however, because of the great water depth, the fauna has been affected by solution, insignificantly in Quaternary deposits, but considerably in the Miocene, especially the lower

Miocene part of the site. In several Miocene samples the foraminiferal assemblages consist of only two or four of the most resistant species. There are samples in the lower Miocene which contain nothing except very small-sized, practically unidentifiable specimens. These facts considerably diminish the value of the site as a possible standard section.

In all the assemblages down to the middle and lower Pliocene *Globorotalia inflata s.l.* predominates. It is always accompanied by *G. crassaformis*, which in the Pliocene sediments is not as abundant as the former species. Only in the upper Miocene does *G. crassaformis* become more abundant than *G. inflata*. In a part of the upper and middle Miocene section the predominant species is *Globorotalia miozea conoidea*. *Globigerina pachyderma* (dex.), *G. bulloides*, *Globorotalia truncatulinoides/tosaensis*, *Globigerinella aequilateralis*, *Orbulina universa*, *Globigerinoides ruber*, and *G. trilobus s.l.* are other species which compose the Quaternary and Pliocene assemblages. The whole fauna is typical of the temperate zone. Such a characteristic warm-water species as *Globorotalia menardii s.l.* is found sporadically and as isolated specimens only.

The changes in the relationship between warm-water and cold-water faunas suggest some climatic fluctuations. However, these fluctuations were relatively insignificant and not well pronounced.

The thickness of the Quaternary deposits is 37 meters. It was not possible to divide them into Recent and Pleistocene.

The Quaternary/Pliocene boundary was located by using the change in the *Globorotalia truncatulinoides: G. tosaensis* ratio. In addition, this boundary is characterized by a temperature change which is indicated by some increase of cold-water elements and decrease of warm-water elements in the Quaternary section as compared with those of the Pliocene section. The thickness of the Pliocene deposits is 93 meters.

It was possible to recognize upper Pliocene (Zone N21) sediments; however, no paleontological evidence was found to separate middle Pliocene (Zone N20) from the lower Pliocene (Zone N19) sediments. The base of the upper Pliocene was traced with the first appearance of *Globoquadrina humerosa*. Simultaneously *Globorotalia margaritae* and, somewhat lower in the section, *G. acostaensis* became extinct.

The Pliocene/Miocene boundary was located by using the frequency of *Globorotalia inflata s.l.* It is rare to very rare in the upper Miocene but becomes frequent in the Pliocene. Other species do not show any important changes in their vertical distribution across this boundary. *Globorotalia crassaformis* is frequent in the Pliocene and uppermost Miocene sediments. Its first appearance is a little lower in the section than *Globorotalia inflata*.

Morphological changes which take place in *Globorotalia inflata s.l.*, are of interest and of importance for stratigraphical purposes. They can be observed at other sites too, but are especially evident at Site 251.

In the Pliocene sequence at this location, especially in the upper Pliocene, *Globorotalia inflata s.l.* is represented by typical specimens, identical to those found in the Recent oceans. In the upper Miocene, however, it is very difficult to separate *Globorotalia inflata s.l.* from *G. crassaformis*. Both species are connected by transitional forms. *Globorotalia inflata s.l.* at that time had four or even five chambers in the final whorl, less vaulted umbilical side, a flat or almost flat spiral side, and its outline was subquadrangular. On the other hand during the same epoch, many transitional forms between *Globorotalia inflata s.l.* and *G. miozea conoidea* also existed and their separation sometimes is very difficult. This problem is discussed in detail in Chapter 6.

The whole thickness of Miocene deposits drilled at Site 251 is more than 350 meters. By using foraminifera as indicators, the sequence was divided into three parts: upper Miocene (150 m), middle Miocene (165 m), and lower Miocene (42 m). It was not possible to subdivide the sequence into zones.

In the upper part of the upper Miocene *Globorotalia crassaformis* was the dominant species, but in the lower part of the upper Miocene, as well as in the middle and lower Miocene, *G. miozea conoidea* predominated.

The following criteria were used for the subdivision of the Miocene sequence. The appearance of *Globorotalia limbata* and *G. acostaensis* marks the middle/upper Miocene boundary. *Globorotalia peripheroronda* is used as an indicator of the lower/middle Miocene boundary.

The unsatisfactory state of preservation of the foraminifera at Site 251 prevents any paleoclimatological or ecological conclusions.

Calcareous Nannoplankton

Stratigraphy: The thickness and the correlation of the nannoplankton zones with the foraminiferal zones are shown on the biostratigraphic and lithologic summary diagram included in the site report. A difference of 10 meters in thickness appeared when tracing the Pliocene/Quaternary boundary by means of nannoplankton and foraminifera. The core catcher of Core 7 (Hole 251) contains the lowermost-occurring *Gephyrocapsa* sp., but in each of the four samples from this core, rare *Discoaster brouweri* have been found, the samples have therefore been attributed to the Pliocene. In a few scattered samples reworked Paleogene nannofossils (*Reticulofenestra umbilica*, *Dictyococcites dictyodus*) have been encountered.

Preservation: The nannofossils within the upper 420 meters (Hole 251, Cores 1-10; Hole 251A, Cores 1-32) are abundant and well preserved to slightly etched. The samples at a depth of 420-470 meters contained common, moderately preserved assemblages with evidence of overgrowth in the lowermost 15 meters (Cores 27, 28). One sample from Core 29 (251A-29-2, 100 cm) showed some heavily overgrown discoasters among thick, rounded calcite particles; the other two samples from this core are barren. A pocket of nannoplankton ooze in the vesicular basalt of Core 31 contained common, moderately overgrown nannofossils.

Paleoecology: The preservation of the nannofossils at this site suggests a consistent depositional depth around the lysocline since the middle Miocene. Site 251 is considered to be situated on the flank of a slowly spreading ridge and therefore has been deepening since the formation of the crust beneath it (Sclater et al., 1971). The preservation of the nannofossils therefore suggests a continuous deepening of the lysocline through the Neogene. Transitional paleotemperatures throughout the Neogene are documented by the scarcity of *Sphenolithus abies* and of discoasters.

SEDIMENTATION RATE

The sedimentation rate for the whole sequence at this site is remarkably uniform ranging from a minimum value of 29 m/m.y. in the upper Miocene to a maximum of 32 m/m.y. in the late Pliocene-Pleistocene. The only exception is in the early Pliocene where the rate drops to about 13 m/m.y.

SUMMARY AND CONCLUSIONS

Summary of Results

Site 251 is located about 180 km north of the Southwest Branch of the Indian Ocean Ridge in 3489 meters of water. The geologic setting of the site is northeast-southwest-trending ridges with 0.2-0.7 sec DT of sediments in intermontane basins. On site we drilled 499 meters through 489 meters of sediments and 10 meters of basalt, coring 276.5 meters and recovering 158.38 meters.

Sediments at the site consist of nannoplankton ooze and chalk plus calcite (micarb) chalk, all divided into six units and subunits. Unit 1 consists of 11.5 meters of soft pale orange foraminiferal nannoplankton ooze of Quaternary age. This unit is distinguished from the underlying Unit 2 by its foram content, color, and lack of microcrystalline pyrite. Unit 2 is 228.5 meters of soft nannoplankton ooze divided into two subunits. Subunit 2a, including the Quaternary through lower Pliocene section, is white in color, contains pyritized burrows and finely disseminated pyrite, plus traces of Radiolaria, as does Unit 1. Subunit 2b is bluish-white, contains more pyrite than Subunit 2a, and fewer Radiolaria. It includes the lower Pliocene and part of the upper Miocene. Unit 3 is 213.8 meters of bluish-white nannoplankton chalk, of upper Miocene through uppermost lower Miocene age, containing disseminated pyrite and moderate to intense burrowing plus zeolites near its base. Unit 4, including the uppermost lower Miocene section, is a 14.4-meter-thick yellow to reddish-brown nannoplankton chalk. In this unit pyrite has been oxidized to limonite. Unit 5, the lowermost unit, includes 18.3 meters of lower Miocene section and is a yellowish-brown calcite (micarb) chalk with traces of iron oxides and abundant authigenic garnet. As near as can be determined, Unit 5 lies conformably on Unit 6, the latter being 12.5 meters of gray-brown basalt. Unit 6 is glassy and highly vesicular at the top and becomes coarse to very coarse grained downwards. A pocket of nannofossil ooze found in the basalt gives an age between 17 and 18 m.y. for the top of this unit.

Site 251 is of biostratigraphic interest because an almost complete uninterrupted mid-latitudinal Neogene sequence, from lower Miocene to Recent, was recovered. However, strong dissolution effects are evident in the Miocene section with concomitant decrease in less robust planktonic foraminifera and an increase in benthonic foraminifera content. A good correspondence is found between zonations by foraminifera and nannoplankton. The nannoplankton can be correlated with published zonations in other areas, but the foraminifera zonation established in tropical areas, cannot be directly applied to the mid-latitude succession at this site.

Sedimentation rates at the site are fairly uniform ranging between 29 and 32 m/m.y. An apparent abrupt decrease in this rate to about 13 m/m.y. was measured in the early Pliocene.

Preliminary Conclusions

The sedimentary section at Site 251 represents a fairly uniform deposition of carbonate sediments since the creation of this area of sea floor on the axis of the Southwest Branch 17-18 m.y. ago. Selective dissolution effects on calcareous microfossils, steadily decreasing in strength up to about the lower Pliocene, suggest that either the site was initially below the now deeper lysocline and steadily shoaled or that the lysocline was at first shallower than the site and then deepened below deposition level. We favor the latter interpretation based on the observation that the floor of the world's ocean deepens with age (Sclater et al., 1971). Evidently, the lysocline was as shoal as 2500 meters in the lower Miocene and has been deeper than the deposition depth ($\sim$3000 m) only since the lower Pliocene.

The age of the basement obtained at Site 251 helps in the solution of several tectonic problems of the Southwest Branch. The spreading rate determined from this age is 0.93 cm/yr averaged over 17 m.y. and measured in a north-northeast direction, or parallel to the fracture zones mapped in this region.

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APPENDIX A
Grain-Size Determinations for Site 251

Core, Section Top of Interval (cm)	Subbottom Depth (m)	Sand (%)	Silt (%)	Clay (%)	Classification
Hole 251					
1-2, 90	2.4	14.5	33.9	51.6	Silty clay
4-1, 90	2.9	10.2	33.9	56.0	Silty clay
2-2, 90	4.4	1.8	14.9	83.2	Clay
2-4, 90	7.4	0.7	10.3	89.0	Clay
2-6, 90	10.4	1.2	13.0	85.8	Clay
3-1, 90	12.4	1.6	19.1	79.3	Clay
3-3, 90	15.4	6.1	27.1	66.7	Silty clay
4-1, 91	21.9	1.3	20.4	78.4	Clay
4-3, 90	24.9	1.5	21.3	77.2	Clay
4-5, 90	27.9	1.4	21.2	77.4	Clay
5-2, 90	32.9	8.0	27.9	64.1	Silty clay
5-4, 90	35.9	1.6	26.8	71.6	Silty clay
5-6, 90	38.9	2.5	27.7	69.8	Silty clay
6-1, 90	40.9	2.6	25.8	71.5	Silty clay
6-5, 90	46.9	1.4	24.0	74.6	Silty clay
7-2, 90	51.9	2.2	17.5	80.3	Clay
7-6, 90	57.9	1.1	26.2	72.6	Silty clay
8-2, 90	61.4	1.5	23.0	75.4	Clay
8-4, 90	64.4	1.9	25.1	73.0	Silty clay
8-6, 90	67.4	.5	25.0	74.6	Silty clay
10-2, 90	80.4	.7	28.5	70.8	Silty clay
10-4, 90	83.4	.5	30.1	69.4	Silty clay
Hole 251A					
1-2, 90	80.4	0.3	27.5	72.1	Silty clay
1-4, 90	83.4	0.2	32.1	67.7	Silty clay
1-6, 99	86.5	0.5	28.2	71.2	Silty clay
2-2, 90	89.9	0.3	28.4	71.3	Silty clay
2-4, 90	92.9	0.5	32.5	67.0	Silty clay
4-2, 90	108.9	0.5	22.6	76.9	Clay
4-4, 90	111.9	0.2	22.9	77.0	Clay
4-6, 90	114.9	1.0	26.9	72.2	Silty clay
5-2, 90	118.4	0.4	32.4	67.3	Silty clay
5-4, 90	121.4	0.8	31.7	67.4	Silty clay
5-6, 90	124.4	0.5	31.0	68.5	Silty clay
6-2, 90	127.9	0.4	24.4	75.2	Clay
6-3, 90	129.4	2.4	29.5	68.1	Silty clay
6-4, 90	130.9	0.1	26.0	73.9	Silty clay
6-6, 90	133.9	0.4	25.2	74.4	Silty clay
7-2, 90	137.4	0.3	30.7	69.0	Silty clay
7-4, 90	140.4	0.5	22.3	77.2	Clay
7-6, 90	143.4	0.2	30.4	69.4	Silty clay
9-2, 90	156.4	0.5	23.5	76.0	Clay
9-4, 90	159.4	0.3	23.6	76.1	Clay
9-6, 90	162.4	0.6	25.8	73.6	Silty clay
10-2, 90	165.9	0.9	25.2	73.9	Silty clay
10-4, 90	168.9	0.4	24.7	74.8	Silty clay
10-6, 90	171.9	0.6	22.2	77.2	Clay
11-1, 90	192.9	0.8	24.9	74.2	Silty clay
11-3, 81	195.8	0.4	23.4	76.2	Clay
12-2, 90	222.9	0.2	22.7	77.1	Clay
12-4, 90	225.9	0.1	21.6	78.3	Clay
12-6, 90	228.9	0.2	26.9	72.9	Silty clay
13-2, 90	251.4	0.5	29.7	69.7	Silty clay
13-4, 90	254.4	0.9	32.7	66.5	Silty clay
15-3, 91	309.9	0.5	43.1	56.4	Silty clay
16-2, 90	336.9	0.4	38.0	61.5	Silty clay
16-4, 90	339.9	0.1	45.4	54.5	Silty clay
17-2, 85	365.4	0.4	45.8	53.8	Silty clay
18-1, 93	373.4	0.4	40.5	59.0	Silty clay
20-2, 90	393.9	0.5	26.8	72.7	Silty clay
20-4, 90	396.9	0.4	28.1	71.5	Silty clay
20-6, 90	399.9	0.3	32.6	67.1	Silty clay

APPENDIX A – *Continued*

Core, Section Top of Interval (cm)	Subbottom Depth (m)	Sand (%)	Silt (%)	Clay (%)	Classification
Hole 251A – *Continued*					
21-2, 90	403.4	0.5	27.8	71.6	Silty clay
21-4, 91	406.4	0.3	32.5	67.2	Silty clay
22-1, 90	411.4	0.8	39.1	60.2	Silty clay
22-3, 90	414.4	0.6	46.4	53.1	Silty clay
23-2, 90	422.4	0.4	38.2	61.4	Silty clay
24-2, 90	431.9	1.1	36.5	62.4	Silty clay
24-4, 90	434.9	0.9	37.4	61.7	Silty clay
25-2, 90	441.4	0.6	31.9	67.5	Silty clay
25-4, 90	444.4	0.9	34.4	64.7	Silty clay
26-2, 90	450.9	0.2	27.2	72.6	Silty clay
26-4, 90	453.9	0.3	25.8	73.9	Silty clay
27-2, 90	460.4	0.5	35.1	64.3	Silty clay
28-1, 90	468.4	0.2	92.1	7.7	Silt
29-2, 90	479.4	0.2	88.1	11.8	Silt

APPENDIX B
Carbon-Carbonate Determinations for Site 251

Core, Section, Top of Interval (cm)	Sub-bottom Depth (m)	Total Carbon (%)	Organic Carbon (%)	$CaCO_3$ (%)
Hole 251				
1-2, 88.0	2.38	10.5	2.5	67
2-1, 88.0	2.88	11.2	2.0	77
2-2, 88.0	4.38	11.2	0.3	91
2-4, 88.0	7.38	11.2	2.4	73
2-6, 88.0	10.38	12.1	0.3	99
3-1, 88.0	12.38	10.9	1.6	78
3-3, 88.0	15.38	10.4	0.2	84
4-1, 88.0	21.88	10.8	0.8	83
4-3, 88.0	24.88	11.0	0.2	90
4-5, 88.0	27.88	11.1	0.3	90
5-2, 88.0	32.88	10.6	0.1	87
5-4, 88.0	35.88	4.7	0.1	38
5-6, 88.0	38.88	4.4	1.0	28
6-1, 88.0	40.88	10.3	2.1	69
6-3, 88.0	43.88	10.6	2.0	71
6-5, 88.0	46.88	10.5	0.2	86
7-2, 88.0	51.88	11.1	0.2	90
7-4, 88.0	54.88	10.9	0.2	89
7-6, 88.0	57.88	10.2	0.3	82
8-2, 88.0	61.38	11.0	0.1	91
8-4, 88.0	64.38	11.2	0.6	88
8-6, 88.0	67.38	10.8	0.1	89
10-2, 88.0	80.38	10.8	0.1	89
10-4, 88.0	83.38	10.2	0.1	84
Hole 251A				
1-2, 88.0	80.38	10.8	0.1	89
1-4, 88.0	83.38	9.9	0.1	82
1-6, 84.0	86.34	10.6	0.1	88
2-2, 88.0	89.88	10.5	0.1	87
2-4, 88.0	92.88	10.5	0.1	87
4-2, 38.0	108.38	10.8	0.1	89
4-4, 88.0	111.88	10.5	0.1	86
4-6, 88.0	114.88	10.9	0.1	90
5-2, 88.0	118.38	10.9	0.1	90

APPENDIX B – *Continued*

Core, Section, Top of Interval (cm)	Sub-bottom Depth (m)	Total Carbon (%)	Organic Carbon (%)	$CaCO_3$ (%)
Hole 251A – *Continued*				
5-4, 88.0	121.38	10.4	0.1	86
5-6, 88.0	124.38	10.8	0.1	89
6-2, 88.0	127.88	10.3	0.1	85
6-4, 88.0	130.88	10.5	0.1	87
6-6, 88.0	133.88	10.7	0.1	88
7-2, 88.0	137.38	10.6	0.1	88
7-4, 88.0	140.38	10.1	0.1	83
7-6, 88.0	143.38	10.2	0.1	84
9-2, 88.0	156.38	10.6	0.1	88
9-4, 88.0	159.38	5.3	0.1	43
9-6, 88.0	162.38	10.5	0.1	87
10-2, 88.0	165.88	10.5	0.1	86
10-4, 88.0	168.88	10.6	0.1	88
10-6, 88.0	171.88	10.6	0.1	87
11-1, 88.0	192.88	9.7	0.1	80
11-3, 88.0	195.88	10.6	0.1	88
12-2, 88.0	222.88	10.7	0.1	89
12-4, 88.0	225.88	10.6	0.1	88
12-6, 88.0	228.88	10.9	0.1	91
13-2, 88.0	251.38	10.2	0.1	84
13-4, 88.0	254.38	9.8	0.1	81
15-3, 88.0	309.88	9.8	0.1	81

APPENDIX B – *Continued*

Core, Section, Top of Interval (cm)	Sub-bottom Depth (m)	Total (Carbon) (%)	Organic Carbon (%)	$CaCO_3$ (%)
Hole 251A – *Continued*				
16-2, 88.0	336.88	10.6	0.1	87
16-4, 88.0	339.88	10.5	0.1	87
16-6, 88.0	342.88	10.6	0.1	88
17-2, 81.0	365.31	10.7	0.1	89
18-1, 88.0	373.38	10.4	0.1	86
20-2, 88.0	393.88	10.0	0.1	83
20-4, 88.0	396.88	10.3	0.1	85
20-6, 88.0	399.88	10.0	0.1	83
21-2, 88.0	403.38	10.2	0.1	85
21-4, 88.0	406.38	9.4	0.1	77
22-1, 88.0	411.38	10.7	0.1	89
22-3, 88.0	414.38	10.7	0.1	89
23-2, 88.0	422.38	10.4	0.1	85
24-2, 88.0	431.88	9.8	0.1	81
24-4, 88.0	434.88	10.4	0.1	86
25-2, 88.0	441.38	10.2	0.1	84
25-4, 95.0	444.45	10.0	0.1	82
26-2, 88.0	450.88	9.4	0.1	78
26-4, 89.0	453.89	9.2	0.1	76
27-2, 88.0	460.38	10.0	0.1	83
28-1, 88.0	468.38	8.7	0.1	72
29-2, 38.0	478.88	8.6	0.1	71

APPENDIX C
X-Ray Analyses for Hole 251

Core	Cored Interval Below Sea Floor (m)	Sample Depth Below Sea Floor (m)	Diff.	Amor.	Calc.	Quar.	K-Fe.	Plag.	Kaol.	Mica	Chlo.	Mont.
Bulk Samples												
1	0.0-2.0	0.9	54.1	28.2	95.8	1.7	–	1.1	–	1.4	–	–
3	11.5-21.0	12.8	51.5	24.3	99.6	0.4	–	–	–	–	–	–
		14.8	57.1	33.0	96.8	1.8	–	–	–	1.4	–	–
5	30.5-40.0	37.2	51.2	23.8	98.4	0.5	–	–	–	1.1	–	–
7	49.5-59.0	57.5	52.2	25.3	98.7	1.3	–	–	–	–	–	–
10	78.0-87.5	84.2	62.9	42.0	98.2	1.8	–	–	–	–	–	–
2-20μ Fraction												
1	0.0-2.0	0.9	68.8	51.3	–	33.8	11.0	25.9	–	25.4	3.9	–
3	11.5-21.0	12.8	72.0	56.3	–	46.9	10.0	22.0	–	19.2	1.9	–
		14.8	75.4	61.6	–	48.3	8.4	25.8	2.9	13.1	1.4	–
5	30.5-40.0	37.2	77.6	65.0	–	44.0	9.1	23.8	–	20.6	2.5	–
7	49.5-59.0	57.5	77.8	65.4	–	42.5	10.1	26.0	–	19.6	1.8	–
10	78.0-87.5	84.2	71.8	55.9	–	42.8	9.8	25.5	–	20.0	1.9	–
<2μ Fraction												
1	0.0-2.0	0.9	95.2	92.5	–	19.1	–	14.7	10.1	21.2	–	34.9
3	11.5-21.0	12.8	88.5	82.0	–	9.9	3.7	4.4	7.5	10.3	–	64.3
		14.8	92.9	88.9	–	22.2	–	11.0	8.0	15.7	–	43.1
5	30.5-40.0	37.2	94.5	91.5	–	13.1	–	11.8	10.5	25.3	–	39.3
7	49.5-59.0	57.5	88.2	81.6	–	16.6	–	8.3	8.3	15.0	–	51.8
10	78.0-87.5	84.2	93.7	90.1	–	23.5	5.3	12.2	9.8	23.5	–	25.6

APPENDIX D
X-Ray Analyses for Hole 251A

Core	Cored Interval Below Sea Floor (m)	Sample Depth Below Sea Floor (m)	Diff.	Amor.	Calc.	U–9[a]	Quar.	K-Fe.	Plag.	Kaol.	Mica	Chlo.	Mont.	Paly.	Pyri.	Augi.
Bulk Samples																
1	78.0-87.5	85.8	50.7	22.9	99.1	–	0.9	–	–	–	–	–	–	–	–	–
4	106.5-116.0	114.2	49.9	21.7	99.0	–	1.0	–	–	–	–	–	–	–	–	–
6	125.5-135.0	133.2	53.8	27.8	99.4	–	0.6	–	–	–	–	–	–	–	–	–
9	154.0-163.5	158.7	52.9	26.4	99.0	–	1.0	–	–	–	–	–	–	–	–	–
12	220.5-230.0	228.2	51.2	23.7	98.9	–	1.1	–	–	–	–	–	–	–	–	–
15	306.0-315.5	309.3	51.2	23.8	99.0	–	1.0	–	–	–	–	–	–	–	–	–
18	372.5-382.0	373.1	49.8	21.6	97.1	–	1.0	–	–	–	1.9	–	–	–	–	–
20	391.5-401.0	399.3	56.6	32.2	92.9	–	2.1	–	–	–	2.9	2.1	–	–	–	–
22	410.5-420.0	414.5	54.0	28.1	98.8	–	1.2	–	–	–	–	–	–	–	–	–
24	429.5-439.0	435.3	61.3	39.6	88.8	–	4.2	1.2	1.5	–	4.2	–	–	–	–	–
26	448.5-458.0	453.0	54.2	28.4	95.6	–	2.0	–	–	–	2.4	–	–	–	–	–
		454.2	56.3	31.8	93.2	–	3.3	–	–	–	3.5	–	–	–	–	–
29	477.0-486.5	478.7	47.4	17.8	82.9	13.2	–	–	–	–	–	–	–	–	–	3.9
2-20μ Fraction																
1	78.0-87.5	85.8	61.9	40.4	–	–	35.6	9.2	26.4	–	25.2	3.5	–	–	–	–
4	106.5-116.0	114.2	75.3	61.5	–	–	43.8	9.1	23.7	–	21.3	2.1	–	–	–	–
6	125.5-135.0	133.2	77.9	65.5	–	–	39.4	11.2	21.2	–	19.2	1.7	7.3	–	–	–
9	154.0-163.5	158.7	72.5	57.0	–	–	35.0	13.5	25.5	–	22.8	2.1	–	–	1.2	–
12	220.5-230.0	228.2	76.9	63.9	–	–	39.2	10.1	21.3	1.8	25.4	1.1	–	–	1.2	–
15	306.0-315.5	309.3	77.8	65.2	–	–	35.3	7.8	33.8	4.0	19.2	–	–	–	–	–
18	372-5-382.0	373.1	59.2	36.2	–	–	45.0	14.9	15.2	4.1	20.8	–	–	–	–	–
20	391.5-401.0	399.3	70.6	54.1	–	–	42.1	13.4	14.4	–	23.0	1.3	5.7	–	–	–
22	410.5-420.0	414.5	66.8	48.1	–	–	47.6	9.4	18.5	–	22.4	2.0	–	–	–	–
24	429.5-439.0	435.3	72.4	56.8	–	–	42.1	12.3	19.2	0.3	24.2	1.9	–	–	–	–
26	448.5-458.0	453.0	66.8	48.2	–	–	40.1	12.7	19.3	–	25.6	2.3	–	–	–	–
		454.2	64.2	44.0	–	–	46.2	12.7	20.0	–	19.9	1.2	–	–	–	–
29	477.0-486.5	478.7	51.0	23.4	–	93.0	–	–	–	–	–	–	–	–	–	7.0
<2μ Fraction																
1	78.0-87.5	85.8	91.3	86.4	–	–	22.0	10.5	5.4	11.9	25.5	–	24.7	–	–	–
4	106.5-116.0	114.2	90.6	85.3	–	–	12.1	–	9.8	–	36.8	–	41.3	–	–	–
6	125.5-135.0	133.2	90.9	85.8	–	–	11.7	3.3	6.8	7.9	26.3	–	44.0	–	–	–
9	154.0-163.5	158.7	93.9	90.4	–	–	18.3	7.7	8.5	11.5	24.8	–	29.3	–	–	–
12	220.5-230.0	228.2	93.0	89.1	–	–	14.8	10.5	5.8	8.8	27.0	–	33.1	–	–	–
15	306.0-315.5	309.3	87.0	79.8	–	–	9.0	5.5	4.2	5.3	19.2	–	56.9	–	–	–
18	372.5-382.0	373.1	93.4	89.7	–	–	12.1	–	5.7	8.3	29.5	–	44.3	–	–	–
20	391.5-401.0	399.3	91.6	86.8	–	–	12.4	6.4	2.5	5.0	27.5	–	46.2	–	–	–
22	410.5-420.0	414.5	93.0	89.0	–	–	14.9	–	4.2	7.2	29.5	–	44.2	–	–	–
24	429.5-439.0	435.3	89.2	83.2	–	–	13.5	2.1	4.9	6.4	28.3	–	44.7	–	–	–
26	448.5-458.0	453.0	90.8	85.6	–	–	12.9	–	3.0	4.6	9.8	–	30.2	39.6	–	–
		454.2	91.5	86.8	–	–	21.4	9.7	3.9	7.0	39.4	–	18.7	–	–	–
29	477.0-486.5	478.7	63.6	43.1	–	5.8	0.8	–	–	–	–	–	15.8	–	–	77.6

[a]This mineral has been identified to be a garnet close in composition to grossularite. Diffraction peaks at 2.67A, 2.98A, and 1.59A, among others. An intensity factor of 2.49 was determined from the (420) peak of grossularite.

Site 251 Hole Core 1 Cored Interval: 0.0-2.0 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	
QUATERNARY	N22-N23 Globorotalia truncatulinoides	NN20	AG	0			1	0.5	VOID			
								1.0			XM *	10YR 7/3
					AG						MY	10YR 7/2
			AG	0			2				*	
					AG						* CC,GZ*	
						CG					*	10YR 7/1
			AG	0	AG	CG	Core Catcher				*	5Y 7/1

LITHOLOGIC DESCRIPTION

Disturbed mixture, mainly of very pale orange to pale orange FORAMINIFERAL NANNOPLANKTON OOZE, with lesser pale orange NANNOPLANKTON OOZE and NANNOPLANKTON FORAMINIFERAL OOZE.

TEXTURE: Sand 14%
Silt 34%
Clay 52%

MINOR CONSTITUENTS: Quartz in trace amounts present throughout; rare trace of mica; traces of radiolarians commòn, diatoms and sponge spicules rare. Traces of microcrystalline pyrite rare.

Total Carbon: 10.5%
Organic Carbon: 2.5%
Calcium Carbonate: 67%

CONSOLIDATION: Soft.

Explanatory notes in chapter 2

Site 251 Hole Core 2 Cored Interval: 2.0-11.5 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	
PLEISTOCENE	N22-N23 Globorotalia truncatulinoides	NN20					1				* KE	10YR 7/3 10YR 6/3 slight mottling of 10YR 5/3
			AG	1		CG		0.5			LE	
					AG			1.0			CC,GZ MY	10YR 8/2
											*	mottling
											*	5Y 8/0 5Y 7/1
			AG	1			2				LE	
											XM *	2.5Y 8/0 minor obscure streaks,
					AG						CC GZ MY	patches N4 (pyritiferous)
									VOID			
			AG	1			3					very minor N4 laminae & mottling
					AG						*	
			AG	1			4				*	
											CC GZ	10YR 8/1 very minor N4 laminae and mottling
			AG	1		FP	5				*	2.5Y 8/0
											*	very minor N4 streaks
									VOID			
			AG	1			6				CC GZ *	
											KE	
			AM	1-2	AG	CG	Core Catcher				*	2.5Y 8/0

LITHOLOGIC DESCRIPTION

NANNOPLANKTON OOZE. Through Sections 1 through 4, various very pale orange and white shades with very slight gray, yellow or orange casts; from 30 cm in Section 5 down, white.

TEXTURE: Sand 0.7-10%
Silt 10-34%
Clay 56-89%

MINOR CONSTITUENTS: Foraminifera are ubiquitous, from traces to 5%. Quartz is also present throughout in traces, but 1 smear slide contained 4%. Radiolaria are common in trace amounts, sponge spicules are less common. Traces of microcrystalline pyrite occur throughout the core, concentrated in very minor streaks, laminae and obscure mottles colored gray.

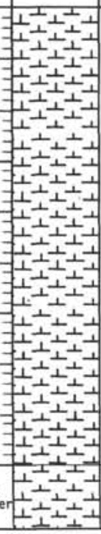
Total Carbon: 11.2-12.1%
Organic Carbon: 0.3-2.4%
Calcium Carbonate: 73-99%

CONSOLIDATION: Soft, but slightly more consolidated than Core 1.

Explanatory notes in chapter 2

Site 251 Hole Core 3 Cored Interval: 11.5-21.0 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
QUATERNARY	N22-N23 *Globorotalia truncatulinoides*	NN19	AM	2		CG	1	0.5, 1.0			*, *, CC, GZ, XM
					AG		2				*, *, *, *
			AM	2			3				XM, *, CC, GZ, *, KE
			AM	2	AG	CG	Core Catcher				*



2.5Y 8/0
faint N6 bands
1 cm N6 band
faint N6 mottling
1 cm N4 band
2.5Y 7/0
N6 and 5G 7/1 streaks
N6 streak
N6 streak
Greenish (5G 7/1) streaks
2.5Y 8/0

LITHOLOGIC DESCRIPTION

White NANNOPLANKTON OOZE with faint and narrow (up to 1 cm) bands and streaks colored dark gray or obscurely green by trace admixtures of finely disseminated microcrystalline pyrite. Rare and slight mottling.

TEXTURE: Sand 2-6%
Silt 19-27%
Clay 67-79%

MINOR CONSTITUENTS: Foraminifera are ubiquitous, in amounts varying from traces to 10%. Quartz is also present throughout, from traces to 2%. Radiolarians are present in amounts varying from traces to 2%. Traces of recrystallized calcite were observed in 1 smear slide.

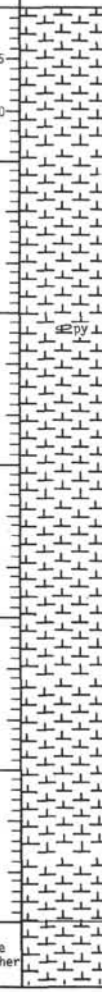
Total Carbon: 10.4-10.9%
Organic Carbon: 0.2-1.6%
Calcium Carbonate: 78-84%

CONSOLIDATION: Soft.

Explanatory notes in chapter 2

Site 251 Hole Core 4 Cored Interval: 21.0-30.5 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
QUATERNARY	N22-N23 *Globorotalia truncatulinoides*	NN19	AM	2			1	0.5, 1.0			*, *, CC,GZ, XM
			AM	2	AGE	CM	2				*, *, XM
			AM	2			3		py		*, CC, GZ
			AM	2			4				*, *
			AM	2	AGE	CM	5				KE, *, CC, GZ
			AM	2			6				*
			AM	2	AGE	CG	Core Catcher				*



2.5Y 8/0 throughout
obscure 5Y 8/1 and N6 streaks
obscure N6 streaks
pronounced N6 and 5Y 8/1 streaks
Pyritized burrow, thorny, 0.7 x 6 cm
diffuse N6 band
diffuse 5Y 8/1, 5G 7/1 and 5YR 7/1 bands
2.5Y 8/0

LITHOLOGIC DESCRIPTION

White NANNOPLANKTON OOZE with faint dark gray and lesser greenish, yellowish and purplish streaks and patches colored by traces of finely disseminated microcrystalline pyrite; one pyrite nodule (pyritized burrow) at 20 cm, Section 3.

TEXTURE: Sand 1-2%
Silt 20-21%
Clay 77-78%

MINOR CONSTITUENTS: Trace amounts of quartz are common. Foraminifera are present throughout in amounts of 1-2%; radiolarians are present in similar abundances.

Total Carbon: 10.8-11.1%
Organic Carbon: 0.2-0.8%
Calcium Carbonate: 83-90%

CONSOLIDATION: Soft.

Explanatory notes in chapter 2

Site 251 Hole Core 5 Cored Interval: 30.5-40.0 m

AGE: QUARTERNARY; U. PLIOCENE-QUATERNARY
FORAMS ZONE: Globorotalia truncatulinoides; N22-N23; N21
NANNOS ZONE: NN19

SECTION	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.
2	AG	1	AG	FM
4	AG	1		
5	AG	1	AG	
6	AG	1		
Core Catcher	AG	1	AG	CM

METERS: 0.5, 1.0

LITHOLOGY: VOID

LITHO. SAMPLE / remarks:

- 2.5Y 8/0
- CC GZ — obscure 5Y 8/1 streaks
- -do-
- -do-
- N6 patch
- 5G 7/1 patch w/1.2 cm N6 base
- same 2.5Y 8/0 with obscure, very minor N6 streaks
- CC GZ
- obscure, v. minor N6, 5G 7/1, 5Y 8/1 streaks
- 2.5Y 8/0, but with very faint greenish cast
- XM — 0.3 cm N6 band over 5YR 7/1
- KE CC GZ — diffuse N6 streaks and bands
- -do-
- 2.5Y 8/0

LITHOLOGIC DESCRIPTION

White NANNOFOSSIL OOZE with dark gray and very minor greenish, yellowish and purplish streaks, bands and patches colored by traces of finely disseminated microcrystalline pyrite. These colors are scattered infrequently throughout.

TEXTURE: Sand 2-8%
Silt 27-28%
Clay 64-72%

MINOR CONSTITUENTS: Foraminifera are present throughout, in amounts varying between 1 and 10%. Radiolarians are also ubiquitous, varying from traces to 4%.

Total Carbon: 4.4-10.6%
Organic Carbon: 0.1-1.0%
Calcium Carbonate: 28-87%

CONSOLIDATION: Soft.

Explanatory notes in chapter 2

Site 251 Hole Core 6 Cored Interval: 40.0-49.5 m

AGE: UPPER PLIOCENE-QUATERNARY
FORAMS ZONE: N21
NANNOS ZONE: NN19; NN18

SECTION	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.
1	AM	2		
2	AM	2	AGE	
3	AM	2	AGE	
4	AM	2	AGE	
5	AM	2	AGE	
6	AM	2	AGE	
Core Catcher	AM	2	AG	CG

METERS: 0.5, 1.0

LITHOLOGY: py

LITHO. SAMPLE / remarks:

- 2.5Y 8/0 throughout deformed
- N4.5 band
- CC,GZ — 1 cm N4.5 band
- N5, 5G 7/1 and 5YR 7/1 banding
- N5 bands
- diffuse N5 and 5YR 7/1 bands
- hollow pyritized burrow, 0.6 x 5 cm, in N5 streaks
- CC GZ — 0.5 cm N5 band
- diffuse N5 streaks
- diffuse N5, 5G 7/1 and 5YR 7/1 bands
- pyritized burrow, 1 x 4.5 cm, thorny
- diffuse 2.5Y 7/0 area
- diffuse N5 streaks
- XM CC GZ KE — -do-
- pyritized burrow, 0.5 x 4.5 cm
- diffuse N5, fewer 5Y 8/1 and 2.5Y 7/0 bands
- 2.5Y 8/0

LITHOLOGIC DESCRIPTION

White NANNOPLANKTON OOZE, with very minor pyritiferous gray, purple, yellow and green bands and patches, increasing in frequency down the core. Three pyritized burrows 0.5 to 1.0 x 4.5 cm, one hollow, others thorny, as indicated.

TEXTURE: Sand 1-3%
Silt 24-26%
Clay 72-75%

MINOR CONSTITUENTS: Foraminifera ubiquitous (1-3%); radiolarians also present throughout (1-2%); rare diatom traces; rare biotite and quartz traces.

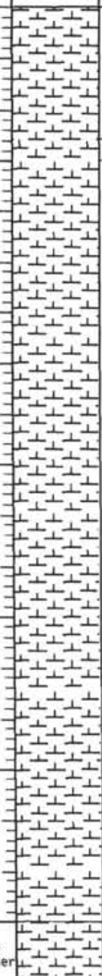
Total Carbon: 10.3-10.6%
Organic Carbon: 0.2-2.1%
Calcium Carbonate: 69-86%

CONSOLIDATION: Soft.

Explanatory notes in chapter 2

Site 251 Hole Core 7 Cored Interval: 49.5-59.0 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS. ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PLIOCENE	N21	NN18	AM	2	AGE		1	0.5 1.0			* *	2.5Y 8/0 predominant; diffuse N5 and lesser 5Y 8/1 streaks; same; 5Y 8/1 bands about 1 cm thick
			AM	2	AGE		2				* CC GZ	diffuse N5 streaks; diffuse N5 and 5Y 8/1 streaks
			AM	2	AGE		3				* *	diffuse N5, 5G 7/1, 5Y 8/1 and 5YR 7/1 streaks and bands
			AM	2	AGE		4				* * CC GZ	diffuse N4 and 5Y 8/1 streaks; same; also 5YR 7/1 more intense; bands 1 cm apart; -do-; diffuse streaks
			AM	2		CG	5					2.5Y 8/0 with diffuse streaks; more intense where indicated
			AM	2	AGE		6				KE XM CC GZ *	
			AM	2	AGE	CM	Core Catcher				*	2.5Y 8/0



White NANNOPLANKTON OOZE, with minor pyritiferous gray, purple, yellow and green bands and streaks, probably representing deformed mottles and burrows, as in higher cores.

TEXTURE: Sand 0.5-2.0%
Silt 18-22%
Clay 77-80%

MINOR CONSTITUENTS: Foraminifera throughout make up 1 to 2% of the sediment; radiolarians are also ubiquitous, mostly in trace amounts but as abundant as 1 or 2% locally. Traces of quartz are common.

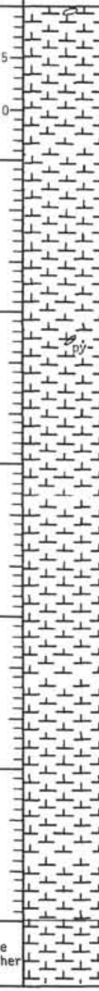
Total Carbon: 10.2-11.1%
Organic Carbon: 0.2-0.3%
Calcium Carbonate: 82-90%

CONSOLIDATION: Soft.

Explanatory notes in chapter 2

Site 251 Hole Core 8 Cored Interval: 59.0-68.5 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS. ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PLIOCENE	N21	NN18	AM	1-2			1	0.5 1.0			*	pyritized burrow, 1.5 x 7 cm; 2.5Y 8/0 throughout
			AM	1-2	AG	CG	2				* CC GZ	diffuse N6, 5Y 8/1 and 5G 7/1 streaks
			AM	1-2			3		py		*	very diffuse N5 and 5Y 8/1 streaks; Pyritized burrow, 1 x 4 cm, surfaced with small tubular ornamentations (fecal pellets?)
			AM	1-2			4				* CC GZ *	very diffuse N5 and 5G 7/2 streaks; 5 cm N5 patch; 2 cm 5Y 7/2 band; v. diffuse N5 and 5Y 7/2; 5B 7/1 patch; 1 cm N6 streak
			AM	1-2	AG	CG	5				*	2 cm N6 streak; diffuse N6 streaks; 1 cm N5 streak
			AM	1-2			6				KE * CC GZ XM	diffuse N5 streaks; 5B 7/1 patch; N5 streaks; N5 patch; diffuse N5 streaks
			AM	1-2	AG	CG	Core Catcher				*	2.5Y 8/0



White NANNOPLANKTON OOZE, with minor gray, purple, yellow and green bands and streaks colored by finely disseminated traces of microcrystalline pyrite, probably representing deformed mottles and burrows. As indicated, 2 pyritized burrows 1.5 x 7 and 1 x 4 cm.

TEXTURE: Sand 0.5-2%
Silt 23-25%
Clay 73-75%

MINOR CONSTITUENTS: Foraminifera 2% throughout; radiolarians 1% throughout. Rare traces of quartz and hematite. Trace of discoasters at Sec. 3.

Total Carbon: 10.8-11.2%
Organic Carbon: 0.1-0.6%
Calcium Carbonate: 88-91%

CONSOLIDATION: Soft.

Explanatory notes in chapter 2

Core 9 Cored Interval: 68.5 - 78.0 NO RECOVERY

Site 251 Hole Core 10 Cored Interval: 78.0-87.5 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	
UPPER PLIOCENE	N21 Globorotalia tosaensis	NN16					1	0.5, 1.0	VOID		*	2.5Y 8/0 throughout; ←N5 streak
			AM	2		FM	2				* CC,GZ *	←3 cm 5B 7/1 patch; ←5 cm 5B 7/1 patch
			AM	2	AG		3				*	N5 streaks
			AM	2		FM	4				CC,GZ *	---- [FORAMS DETERIORATING] ←1.5 x 5 cm pyritized burrow with 1 cm projection
			AM	2			5				XM * KE	2.5YR 6/0 patch; diffuse N5 area
			AM	2	AG	FM	Core Catcher				*	2.5Y 8/0

LITHOLOGIC DESCRIPTION

White NANNOPLANKTON OOZE with faint dark gray streaks and very minor patches with a very faint bluish cast, colored by traces of very finely disseminated microcrystalline pyrite.

TEXTURE: Sand 0.5-0.7%
Silt 28-30%
Clay 69-71%

MINOR CONSTITUENTS: 1-2% forams; Radiolaria mostly in trace amounts, but as abundant as 1 or 2%. Traces of silt-sized detrital quartz common; traces of siderite rare.

Total Carbon: 10.2-10.8%
Organic Carbon: 0.1%
Calcium Carbonate: 84-89%

CONSOLIDATION: Soft.

N.B.: Foraminifera appear to diminish from this core downwards.

Explanatory notes in chapter 2

Site 251 Hole A Core 1 Cored Interval: 78.0-87.5 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	
UPPER PLIOCENE	N21	NN16	AM	2			1	0.5, 1.0			* *	diffuse N4 and 5Y 8/1 streaks; 2.5Y 8/0 throughout; N4 and 5Y 8/1 streaks; ←5 cm N4 patch; stretched patch of 7.5YR 8/0
			AM	2	AG	FM	2		VOID		* CC GZ	N5 streaks; -do-
			AM	2			3				*	
			AM	2			4				CC * GZ	
			AM	2		FM	5				* *	←N5 streak; ←-do-; ←-do-; N5 streaks
			AM	2	AG		6		py		XM * * CC GZ KE	Pyrite, 0.5 x 2 cm; faint diffuse N5 streaks
			AM	2-3	AG	FM	Core Catcher				*	2.5Y 8/0

LITHOLOGIC DESCRIPTION

White NANNOPLANKTON OOZE with very minor dark gray and yellow streaks and rare purplish patches colored by finely disseminated traces of pyrite. Pyritized burrow in Section 6.

TEXTURE: Sand 0.2-0.5%
Silt 28-32%
Clay 68-72%

MINOR CONSTITUENTS: Forams less abundant than in Hole 251 cores (trace to 1%); radiolarians as abundant. Discoasters present to frequent. Detrital silt-sized quartz ubiquitous (traces to 1%); mica traces rarer; one occurrence of authigenic siderite.

Total Carbon: 9.9-10.8%
Organic Carbon: 0.1%
Calcium Carbonate: 82-89%

CONSOLIDATION: Soft.

Explanatory notes in chapter 2

Site 251 Hole A Core 2 Cored Interval: 87.5-95.5 m

AGE	FORAMS ZONE	NANNOS ZONE	FOSSIL CHARACTER: FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS. ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PLIOCENE	N21	NN16	AM	2-3			1	0.5, 1.0	VOID		*	2.5Y 8/0 with diffuse long deformed N5 streaks
					AG		2				* CC GZ	
			AM	2-3			3				*	
			AM	2-3			4				* CC GZ	5B 7/1
			AM	2-3	AG		5				* KE *	5B 9/1
			AM	2-3	AGE	RM	Core Catcher				*	2.5Y 8/0

White NANNOPLANKTON OOZE, gaining bluish cast toward bottom of core; containing minor diffuse deformed dark gray streaks colored by traces of finely disseminated pyrite.

TEXTURE: Sand 0.3-0.5%
Silt 28-32%
Clay 67-71%

MINOR CONSTITUENTS: Forams ubiquitous (traces to 1%); traces of radiolarians present throughout; traces of detrital silt-sized quartz common, mica rare.

Total Carbon: 10.5%
Organic Carbon: 0.1%
Calcium Carbonate: 87%

CONSOLIDATION: Soft.

Explanatory notes in chapter 2

Core 3 Cored Interval: 97.0 - 106.5 NO RECOVERY

Site 251 Hole A Core 4 Cored Interval: 106.5-116.0 m

AGE	FORAMS ZONE	NANNOS ZONE	FOSSIL CHARACTER: FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS. ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PLIOCENE	N21	NN15					1	0.5, 1.0	VOID; py		*	2 pyrite nodules, 0.5 x 1 and 0.5 x 2 cm; 5B 9/1 with diffuse N5 and 5Y 8/1 streaks
			AM	2-3	AGE		2				* CC GZ *	
			AM	2-3			3				*	
			AM	2-3			4				* CC GZ	
			AM	2-3	AGE		5		VOID		* *	
			AM	2-3			6				XM * CC GZ KE	[diffuse N5 bands] 5B 7/1; N5 and 5Y 8/1 0.5 cm layers; 5 cm 5Y 8/1 band; 3 cm N5 layer; 2 cm 5Y 8/1 band
	N19-N20	NN14	AM	2-3	AGE	FM	Core Catcher					2.5Y 8/0

NANNOPLANKTON OOZE, mostly bluish white, becoming light bluish gray in Section 6; diffuse gray and yellow 0.5 to 5 cm layers (mottles?) seen where less disturbed; 2 pyritized burrows at top of core.

TEXTURE: Sand 0.2-1.0%
Silt 23-27%
Clay 72-77%

MINOR CONSTITUENTS: Forams ubiquitous in trace amounts to 1%; radiolarians less common. Microscopic pyrite present throughout in trace amounts, also detrital silt-sized quartz. Mica traces common.

Total Carbon: 10.5-10.8%
Organic Carbon: 0.1%
Calcium Carbonate: 86-90%

CONSOLIDATION: Soft.

Explanatory notes in chapter 2

Site 251 Hole A Core 5 Cored Interval: 116.0-125.5 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	
LOWER AND MIDDLE PLIOCENE	N19-N20	NN13	AM	2-3			1	0.5, 1.0			*	1 cm N5 band; 2.5Y 8/0; 5B 9/1; 3 cm N5 band
			AM	2-3								
			AM	2-3			2				* CC GZ	Pyrite nodule 1.3 x 4 cm
			AM	2-3	AG				VOID			
			AM	2-3			3				*	
			AM	2-3								
			AM	2-3			4				* CC GZ	
			AM	2-3								
			AM	2-3			5				*	N5 layer; N4 streaks
			AM	2-3	AG							
			AM	2-3			6				KE; CC GZ	attenuated N5 streak
			AM	2-3								1 cm 5Y 8/1 band
			AM	2-3	AG	RM	Core Catcher				*	2.5Y 8/0

LITHOLOGIC DESCRIPTION

NANNOPLANKTON OOZE, bluish white except for top 80 cm which is white; occasional gray bands and streaks and rare yellow burrows (?) colored by trace amounts of finely disseminated pyrite; one pyritized burrow in Section 2.

TEXTURE: Sand 0.4-1.0%
Silt 32%
Clay 67-68%

MINOR CONSTITUENTS: Forams present in traces to 1%; NO RADIOLARIANS (which begin to disappear from this interval downwards); traces of detrital silt-sized quartz and mica common; single occurrences in trace amounts of volcanic glass, authigenic calcite, and sponge spicules.

Total Carbon: 10.3-10.7%
Organic Carbon: 0.1%
Calcium Carbonate: 85-88%

CONSOLIDATION: Soft.

Explanatory notes in chapter 2

Site 251 Hole A Core 6 Cored Interval: 125.5-135.0 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	
LOWER AND MIDDLE PLIOCENE	N18-N20		AM	2-3			1	0.5, 1.0			*	5B 9/1 throughout, with deformed obscure N5, 5G 7/1 and (rarer) 5Y 8/1 streaks
			AM	2-3					VOID			5G 7/1 streak
			AM	2-3			2				*	
			AM	2-3	AG						* CC GZ	
			AM	2-3			3				*	
UPPER MIOCENE	N16-N18	NN13	AM	2-3								
			AM	2-3			4				* CC GZ	
			AM	2-3							*	
			AM	2-3			5				*	
			AM	2-3	AG							
			AM	2-3			6				XM; * CC GZ	
			AM	2-3							KE	
			AM	2-3	AGE	RM	Core Catcher				*	2.5Y 8/0

LITHOLOGIC DESCRIPTION

Bluish white NANNOPLANKTON OOZE with faint gray and lesser greenish and yellowish mottles(?) deformed by drilling.

TEXTURE: Sand 0.1-2.4%
Silt 24-30%
Clay 68-75%

MINOR CONSTITUENTS: Finely disseminated pyrite, in addition to being responsible for the very minor color changes, is ubiquitous in trace amounts as microscopic grains. In addition, pyrite is present in one very dark gray band (148 cm, Section 4) as silt-sized round framboids. Detrital clay increases slightly at the base of the core (core catcher), and persists in slightly greater trace abundances down to Core 20.

Detrital silt-sized quartz in trace amounts is ubiquitous, mica is less common, and traces of volcanic glass are rare. Radiolarians, diatoms and sponge spicules are also rare.

Total Carbon: 10.3-10.7%
Organic Carbon: 0.1%
Calcium Carbonate: 85-88%

CONSOLIDATION: Soft.

Explanatory notes in chapter 2

Site 251 Hole A Core 7 Cored Interval: 135.0-144.5 m

AGE: UPPER MIOCENE

ZONE: FORAMS N18 / N16; NANNOS NN13 / NN12

FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.
FM	2-3		
FM	2-3		
FM	2-3	AG	
FM	2-3		
FM	2-3		
FM	2-3		
FM	2-3		
FM	2-3		
FM	2-3	AG	
FM	2-3		
FM	2-3		
FM (Core Catcher)	2-3	AGE	RM

SECTION: 1, 2, 3, 4, 5, 6, Core Catcher. METERS: 0.5, 1.0

LITHO. SAMPLE: *, * CC GZ, *, XM, CC GZ, *, *, CC GZ *, KE, *

LITHOLOGIC DESCRIPTION

2.5Y 8/0

5 cm N6 layer

faint 5G 7/1 streak

5B 7/1

slight N6 mottling

2 cm N6 band

slight 5Y 8/1 mottles

minor N6 bands

minor N6 bands

slight N6 mottling

1 cm 2.5Y 6/0 bands

diffuse 1 cm N6 band

[1 cm 2.5Y 6/0 band]

slight 5G 7/1 mottling

5B 9/1

NANNOPLANKTON OOZE, white at top grading down into bluish gray in Section 3 and light bluish gray in Section 4, with minor gray streaks and localized slight gray, yellowish and greenish mottling. Traces of microscopic pyrite are the coloring component; microscopic pyrite is also present throughout in trace amounts.

TEXTURE: Sand 0.1-0.3%
Silt 27-31%
Clay 69-73%

MINOR CONSTITUENTS: Traces of detrital silt-sized quartz are ubiquitous; mica is less common; traces of apatite and volcanic glass are rare. The detrital clay component, still in trace abundances, is more abundant than in Core 6, particularly from Section 3 down.

Total Carbon: 10.1-10.6%
Organic Carbon: 0.1%
Calcium Carbonate: 83-88%

CONSOLIDATION: Soft, but becoming distinctly stiffer in Section 3.

Explanatory notes in chapter 2

Core 8 Cored Interval: 144.5 - 154 NO RECOVERY

Site 251 Hole A Core 9 Cored Interval: 154.0-163.5 m

AGE: UPPER MIOCENE

ZONE: FORAMS N16-N18; NANNOS NN12

FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.
AM	2-3		
AM	2-3		
		AGE	
AM	2-3		
AM	2-3		
AM	2-3		
		AGE	
AM	2-3		
AM (Core Catcher)	2-3	AGE	RM

SECTION: 1, 2, 3, 4, 5, 6, Core Catcher. METERS: 0.5, 1.0

LITHOLOGY: VOID, PY, VOID, VOID, PY, VOID, PY

LITHO. SAMPLE: *, CC GZ, *, *, XM, * CC GZ, *, CC GZ *, KE

LITHOLOGIC DESCRIPTION

2.5Y 8/0 throughout with minor N5 streaks

pyrite nodule, 1 x 5 cm

pyrite nodule, 1 x 2 cm

pyrite nodule, 0.5 x 3.5 cm

1-2 cm N5 bands

4 cm 2.5Y 7/0 patch

5B 9/1

White NANNOPLANKTON OOZE with very minor deformed dark gray streaks colored by finely disseminated pyrite, which is also present in traces throughout the sediment. Three pyritized burrows were observed in the core.

TEXTURE: Sand 0.3-0.6%
Silt 24-26%
Clay 74-76%

MINOR CONSTITUENTS: Traces of detrital clay and quartz are present throughout; traces of volcanic glass are common; authigenic carbonate is rare. Traces of forams are common; radiolarians and sponge spicules are rare.

Total Carbon: 5.3-10.6%
Organic Carbon: 0.1%
Calcium Carbonate: 43-88%

CONSOLIDATION: Soft to soupy where deformed; stiff where less disturbed.

Explanatory notes in chapter 2

Site 251 Hole A Core 10 Cored Interval: 163.5-173.0 m

AGE	ZONE: FORAMS	ZONE: NANNOS	FOSSIL CHARACTER: FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER MIOCENE	N17-N18	NN12	AM	2-3			1	*	5B 9/1 throughout, with few N6 streaks (VOID)
			AM	2-3	AGE		2	CC GZ *	(VOID)
			AM	2-3			3	*	1 cm wide burrow, 2.5Y 8/0; 1 cm wide burrow, 2.5Y 8/0
			AM	2-3			4	CC GZ *	slight 2.5Y 8/0 mottling
			AM	2-3	AGE		5	* KE	
			AM	2-3			6	* CC GZ XM *	5Y 8/1 mottling; 5G 7/1 band (mottle?)
		NN11	AM	2-3	AGE	FM	Core Catcher	*	2.5Y 8/0

Bluish white NANNOPLANKTON OOZE, with very few pyritiferous dark gray streaks and occasional yellowish and greenish mottling.

TEXTURE: Sand 0.4-1.0%
Silt 22-25%
Clay 74-77%

MINOR CONSTITUENTS: Detrital clay and quartz traces ubiquitous; mica common; volcanic glass rare. Trace amounts of foraminifera present; radiolarians and sponge spicules rare.

Total Carbon: 10.5-10.6%
Organic Carbon: 0.1%
Calcium Carbonate: 86-88%

CONSOLIDATION: Stiff.

Explanatory notes in chapter 2

Site 251 Hole A Core 11 Cored Interval: 192.0-201.5 m

AGE	ZONE: FORAMS	ZONE: NANNOS	FOSSIL CHARACTER: FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER MIOCENE	N16-N18	NN11	AM	2-3	AGE		1	CC GZ * *	5B 9/1 overall; slight 5G 7/1, 5Y 8/1 and N5 mottling; N4 patch with pyrite framboids
							2	* *	disturbed 5Y 8/1, 5G 7/1 and N5 mottles
			AM	2-3	AGE		3	* XM CC GZ KE	closely spaced alternations (1-5 cm) of 5G 7/1, N6 and 5YR 7/1 bands - mottling and burrows; 1 cm N5 layer
			AM	2-3	AGE	FM	Core Catcher	*	5B 9/1

Bluish white NANNOPLANKTON OOZE with localized slight to intense yellowish, greenish, purplish and gray mottling colored by trace amounts of finely disseminated pyrite, with one black 5 cm patch containing 50% pyrite framboids.

TEXTURE: Sand 0.4-0.8%
Silt 23-25%
Clay 74-76%

MINOR CONSTITUENTS: Detrital clay and silt-sized quartz traces ubiquitous; traces of volcanic glass common; one occurrence of a trace of mica; forams common in trace abundances.

Total Carbon: 9.7-10.6%
Organic Carbon: 0.1%
Calcium Carbonate: 80-88%

CONSOLIDATION: Stiff where less deformed by drilling.

Explanatory notes in chapter 2

Site 251 Hole A Core 12 Cored Interval: 220.5-230.0 m

AGE: UPPER MIOCENE

ZONE: FORAMS N16-N18; NANNOS NN11

FOSSIL CHARACTER: FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION
AM	2-3	AG		1
AM	2-3	AG		3
AM	2-3			4
AM	2-3			5
AM	2-3			6
AM	2-3	AG	RM	Core Catcher

LITHOLOGY: VOID (Section 1, below 1.0 m)

LITHO. SAMPLE: CC GZ (Section 2); CC GZ (Section 4); XM (Section 6); CC GZ (Section 6); KE (Section 6)

LITHOLOGIC DESCRIPTION

5B 9/1

5 pyrite nodules, 0.5-1 x 1-2 cm

N1 bands 1 x 3 cm, with pyrite framboids

2 pyrite nodules, 0.5 x 1.0 cm

slight mottling

2.5Y 8/0

yellow burrow with "thorns", 4 mm wide

disturbed 5Y 8/1 burrows

5B 9/1, minor 2.5Y 8/0

5G 7/1 mottle

5Y 8/1 mottle

5Y 8/1 mottles

5B 9/1

Bluish white NANNOPLANKTON OOZE with traces of finely disseminated pyrite throughout, locally more concentrated in occasional greenish and yellowish mottles; also 2 1 cm thick zones containing up to 50% pyrite framboids. Section 2 contains 7 pyritized burrows.

TEXTURE: Sand 0.1-0.2%
Silt 22-27%
Clay 73-78%

MINOR CONSTITUENTS: Ubiquitous traces of detrital clay and silt-sized quartz; rare traces of mica and zircon; traces of forams in lower part of core; 1 rare sponge spicule occurrence.

Total Carbon: 10.6-10.9%
Organic Carbon: 0.1%
Calcium Carbonate: 88-91%

CONSOLIDATION: Stiff to semi-lithified where less disturbed by drilling.

Explanatory notes in chapter 2

Site 251 Hole A Core 13 Cored Interval: 249.0-258.5 m

AGE: UPPER MIOCENE

ZONE: FORAMS N16-N18; NANNOS NN11, NN10

FOSSIL CHARACTER: FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION
AM	2-3			1
AM	2-3	AG		2
AM	2-3			3
AM	2-3			4
AM	2-3	AG		5
AM	2-3	AG	RP	Core Catcher

LITHOLOGY: VOID (Section 1, top)

LITHO. SAMPLE: CC GZ (Section 2); CC,GZ XM (Section 4); KE (Section 5)

LITHOLOGIC DESCRIPTION

5B 9/1 throughout

crossed 5Y 8/1 burrows

black-ringed mottle w/framboids

-1.5 cm 5G 7/1 mottle

5Y 8/1 mottle

N5 bands

faint mottling

5B 9/1

Bluish white NANNOPLANKTON CHALK with traces of finely disseminated pyrite throughout, locally more enriched in fine pyrite as gray bands and yellow mottles; 1 black smear containing finely disseminated pyrite and silt-sized pyrite framboids.

TEXTURE: Sand 0.5-1.0%
Silt 30-33%
Clay 66-70%

MINOR CONSTITUENTS: Detrital clay and silt-sized quartz traces ubiquitous; mica and volcanic glass common; authigenic siderite rare. One rare trace of forams.

Total Carbon: 9.8-10.2%
Organic Carbon: 0.1%
Calcium Carbonate: 81-84%

CONSOLIDATION: Semi-lithified where less disturbed.

Explanatory notes in chapter 2

Site 251 Hole A Core 14 Cored Interval: 277.5-283.5 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS. ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE		LITHOLOGIC DESCRIPTION
UPPER MIOCENE	N16-N18	NN10	AM	2-3	AG		1	0.5, 1.0	VOID			5B 9/1; 2.5Y 8/0; N5 layers	NANNOPLANKTON CHALK, bluish white at top grading down to white; traces of microscopic pyrite throughout; few dark gray layers several millimeters thick at the bottom of the core. TEXTURE: Sand and silt 0-1% Clay 99-100% (Smear slide) MINOR CONSTITUENTS: Ubiquitous traces of detrital clay and silt-sized quartz and mica; rare traces of forams. CONSOLIDATION: Stiff to semi-lithified.
		NN9	AM	2-3	AG	—	Core Catcher				*	5B 9/1	

Explanatory notes in chapter 2

Site 251 Hole A Core 15 Cored Interval: 306.0-315.5 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS. ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE		LITHOLOGIC DESCRIPTION
MIDDLE MIOCENE	N9-N15	NN9	AM	2-3			1	0.5, 1.0	VOID			2.5Y 8/0; 4 mm 5Y 8/1 burrow; 5B 9/1	NANNOPLANKTON CHALK, top section white, rest bluish white; traces of finely disseminated pyrite throughout; one 2 cm black smear with 50% silt-sized pyrite framboids; infrequent 4-8 mm yellowish burrows and mottles as indicated. TEXTURE: Sand 0.5% Silt 43% Clay 56% MINOR CONSTITUENTS: Traces of detrital clay ubiquitous; traces of quartz, volcanic glass and forams common. Total Carbon: 9.8% Organic Carbon: 0.1% Calcium Carbonate: 81% CONSOLIDATION: Semi-lithified
			AM	2-3	AG		2				*	4 mm 5Y 8/1 burrow; 5Y 8/1 mottles; N1 1 cm spot with pyrite framboids	
			AM	2-3			3				XM; CC,GZ; *; KE	5Y 8/1 8 mm burrow; mottled area 2.5Y 6/6	
			AM	2-3	AG	RP	Core Catcher				*	5B 9/1	

Explanatory notes in chapter 2

Site 251 Hole A Core 16 Cored Interval: 334.5-344.0 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS. ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE		LITHOLOGIC DESCRIPTION
MIDDLE MIOCENE	N9-N15	NN9					1	0.5, 1.0	VOID		*	5B 9/1	NANNOPLANKTON CHALK, bluish white and white, occasional gray and yellowish burrows as indicated; 1-2 cm layers colored dark gray with finely disseminated pyrite, which is also present in lesser traces throughout. TEXTURE: Sand 0.1-0.4% Silt 38-45% Clay 54-62% MINOR CONSTITUENTS: Ubiquitous traces of detrital clay and silt-sized quartz; volcanic glass and foram traces common. Total Carbon: 10.5-10.6% Organic Carbon: 0.1% Calcium Carbonate: 87-88% CONSOLIDATION: Stiff to semi-lithified.
			CP	3	AG		2				CC GZ; *	2.5Y 8/0 w/occ. N5 streaks; 5Y 8/1 5 mm burrow	
			CP	3			3				*	2 cm N5 band; 5Y 8/1 burrow; N6 and 5Y 8/1 burrows; 5B 9/1	
			CP	3	AGE		4				CC GZ; *	2.5Y 8/0; N5 bands, 1 cm thick	
			CP	3			5				*	5B 9/1	
		NN8	CP	3			6				CC GZ; *; KE	N7 mottles	
			CP	3	AGE	—	Core Catcher					5B 9/1	

Explanatory notes in chapter 2

Site 251 Hole A Core 17 Cored Interval: 363.0-366.0 m

AGE	ZONE: FORAMS	ZONE: NANNOS	FOSSIL CHARACTER: FORAMS	FOSSIL CHARACTER: DISSOL. EFFECTS	FOSSIL CHARACTER: NANNOS	FOSSIL CHARACTER: SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MIDDLE MIOCENE	N9-N15	NN8	AM	3	AG		1	0.5, 1.0	VOID			
							2				CC, GZ, *, KE	2.5Y 8/0 throughout; 5GY 6/1 mottles; N5 streak
		NN7	AM	3	AGE		Core Catcher				*	5B 9/1

White NANNOPLANKTON CHALK with minor greenish mottles and dark gray streaks colored by finely disseminated pyrite.

TEXTURE: Sand 0.4%
Silt 46%
Clay 54%

MINOR CONSTITUENTS: Ubiquitous traces of detrital clay, silt-sized quartz, volcanic glass and forams.

Total Carbon: 10.7%
Organic Carbon: 0.1%
Calcium Carbonate: 89%

CONSOLIDATION: Semi-lithified where less deformed.

Explanatory notes in chapter 2

Site 251 Hole A Core 18 Cored Interval: 372.0-382.0 m

AGE	ZONE: FORAMS	ZONE: NANNOS	FOSSIL CHARACTER: FORAMS	FOSSIL CHARACTER: DISSOL. EFFECTS	FOSSIL CHARACTER: NANNOS	FOSSIL CHARACTER: SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MIDDLE MIOCENE	N9-N15	NN7	CP	3	AG		1	0.5, 1.0	VOID		*, *, CC,GZ, KE, *, *	5 mm N5 band; 5Y 8/1 mottles w/ N5 layer; 2 cm N5 band; 5Y 8/1 mottles; 2.5Y 8/0 throughout
			CP	3	AGE		Core Catcher				*	5B 9/1

White NANNOPLANKTON CHALK, locally foram bearing; rare yellow mottles and dark gray bands colored by finely disseminated pyrite, in part framboidal.

TEXTURE: Sand 0.4%
Silt 41%
Clay 59%

MINOR CONSTITUENTS: Ubiquitous traces of detrital clay and silt-sized quartz; forams present throughout in amounts varying from traces to 10%.

Total Carbon: 10.4%
Organic Carbon: 0.1%
Calcium Carbonate: 86%

CONSOLIDATION: Semi-lithified.

Explanatory notes in chapter 2

Site 251 Hole A Core 19 Cored Interval: 382.0-391.5 m

AGE	ZONE: FORAMS	ZONE: NANNOS	FOSSIL CHARACTER: FORAMS	FOSSIL CHARACTER: DISSOL. EFFECTS	FOSSIL CHARACTER: NANNOS	FOSSIL CHARACTER: SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MIDDLE MIOCENE	N9-N15	NN7	FM	3	AGE		1	0.5, 1.0	VOID; Py		*	Pyrite nodule 0.2 x 0.3 cm 5B 8/1
			RP	3	AGE		Core Catcher				*	2.5Y 8/0

Light bluish gray NANNOPLANKTON CHALK containing traces of finely disseminated pyrite and 1 pyritized burrow.

TEXTURE: Clay 100%
(Smear slide)

MINOR CONSTITUENTS: Traces of detrital silt-sized quartz.

CONSOLIDATION: Stiff.

Explanatory notes in chapter 2

Site 251 Hole A Core 20 Cored Interval: 391.5-401.0 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS. ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MIDDLE MIOCENE	N9-N15	NN6	AM	3			1	0.5, 1.0	VOID		*	5B 9/1 throughout
			AM	3	AGE		2				CC GZ *	
			AM	3			3		VOID			
			AM	3	AGE		4		VOID		* CC GZ	N5 mottles
			AM	3			5		VOID		*	1 cm N4 band
			AM	3			6		VOID		XM CC GZ KE	0.5 cm N4 band; 4 cm N4 band; 2 cm N4 band
			AM	3	AGE		Core Catcher				*	N7

Bluish white NANNOPLANKTON CHALK containing ubiquitous traces of finely disseminated pyrite, also with infrequent dark gray bands colored by larger traces of pyrite; locally mottled.

TEXTURE: Sand 0.3-0.5%
Silt 27-33%
Clay 67-73%

MINOR CONSTITUENTS: Ubiquitous traces of detrital silt-sized quartz; detrital clay in trace amounts still present throughout, but distinctly less than in cores higher up the section. Rare traces of forams.

Total Carbon: 10.0-10.3%
Organic Carbon: 0.1%
Calcium Carbonate: 83-85%

CONSOLIDATION: Stiff to semi-lithified where less disturbed by drilling.

Explanatory notes in chapter 2

Site 251 Hole A Core 21 Cored Interval: 401.0-410.5 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS. ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MIDDLE MIOCENE	N9-N15	NN6			AGE		1	0.5, 1.0	VOID		*	5B 8/1
			AM	3			2				CC GZ *	5B 8/1; very slight mottling; -do-; -do-; -do-
			AM	3	AGE		3				*	N4 streak; very faint mottles
			AM	3			4				XM CC GZ KE *	2 cm N4 band; 3 cm N4 band; 5B 9/1; 10 5Y 8/1 subhorizontal burrows 2-12 cm apart, each 4 mm wide
			AM	3	AGE		Core Catcher				*	5B 9/1

Light bluish gray and bluish white NANNOPLANKTON CHALK containing ubiquitous traces of finely disseminated pyrite which in larger trace amounts colors 2-3 cm dark gray layers. Ten yellow burrows spaced 2-12 cm apart occur at the base of the core.

TEXTURE: Sand 0.3-0.5%
Silt 28-32%
Clay 67-72%

MINOR CONSTITUENTS: Ubiquitous traces of detrital silt-sized quartz; mica and forams rare.

Total Carbon: 9.4-10.2%
Organic Carbon: 0.1%
Calcium Carbonate: 77-85%

CONSOLIDATION: Stiff to semi-lithified.

Explanatory notes in chapter 2

Site 251 Hole A Core 22 Cored Interval: 410.5-420.0 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS.,ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MIDDLE MIOCENE	N9-N15	NN6	AM	3	AGE		1	0.5, 1.0	VOID		CC GZ *	5B 9/1 throughout; 1 cm 5YR 7/1 band
			AM	3			2				*	slight mottling; mottling; mottling
			AM	3	AGE		3				CC GZ XM * KE	5Y 8/1 mottling; faint N4 mottling; 2.5Y 8/0 mottling; 5GY 9/1 mottling
			AM	3	AGE		Core Catcher				*	2.5Y 8/0

Bluish white NANNOPLANKTON CHALK with traces of finely disseminated pyrite throughout; gray, yellowish and greenish mottling, also colored by larger traces of pyrite, increases downwards from slight in Section 2 to moderate in Section 3.

TEXTURE: Sand 0.6-0.8%
Silt 39-46%
Clay 53-60%

MINOR CONSTITUENTS: Traces of detrital quartz are common; detrital clay and mica traces are rare.

Total Carbon: 10.7%
Organic Carbon: 0.1%
Calcium Carbonate: 89%

CONSOLIDATION: Stiff.

Explanatory notes in chapter 2

Site 251 Hole A Core 23 Cored Interval: 420.0-429.5 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS.,ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MIDDLE MIOCENE	N9-N15	NN6					1	0.5, 1.0	VOID		*	5B 8/1 throughout
			CP	3	CM		2				CC GZ * KE	slight, faint mottling N5
			CP	3	CM		Core Catcher				*	5B 9/1

Light bluish gray to bluish white NANNOPLANKTON CHALK with traces of finely disseminated pyrite throughout, faintly mottled at the base of the core.

TEXTURE: Sand 0.4%
Silt 38%
Clay 61%

MINOR CONSTITUENTS: Ubiquitous traces of detrital clay and silt-sized quartz; traces of volcanic glass are rare.

Total Carbon: 10.4%
Organic Carbon: 0.1%
Calcium Carbonate: 85%

CONSOLIDATION: Stiff.

Explanatory notes in chapter 2

Site 251 Hole A Core 24 Cored Interval: 429.5-439.0 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	SILICEOUS FOSS.,ETC.	NANNOS	DISSOL. EFFECTS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MIDDLE MIOCENE	N9-N15	NN6	AP	3	CM		1	0.5, 1.0			*	5B 8/1; faint mottling; N7
			AP	3			2				CC GZ *	1 cm N1 spot
			AP	3	CM		3				*	N7.5; N7; Intense mottling and burrowing; N7.5
							4				CC GZ	N1 spot; Intense N7 mottling
			AP	3	CM		Core Catcher				XM KE *	5Y 7/1

Light bluish gray and light gray NANNOPLANKTON CHALK, in part intensely burrowed and mottled.

TEXTURE: Sand 0.1%
Silt 36-37%
Clay 62%

MINOR CONSTITUENTS: Authigenic calcite 1%; ubiquitous traces of detrital clay and quartz; common traces of forams; rare mica.

Total Carbon: 9.8-10.4%
Organic Carbon: 0.1%
Calcium Carbonate: 81-86%

CONSOLIDATION: Stiff to semi-lithified.

Explanatory notes in chapter 2

Site 251 Hole A Core 25 Cored Interval: 439.0-448.5 m

AGE	FORAMS ZONE	NANNOS ZONE	FOSSIL CHARACTER: FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
MIDDLE MIOCENE	N9-N15	NN6	AP	3	CM		1	0.5, 1.0	VOID		
			AP	3	CM		2				*, CC GZ, *
			AP	3			3				*
					CM		4		VOID		XM, *, CC GZ, * KE
							5				*
LOWER MIOCENE	N4-N8	NN5	AP	3	CM		Core Catcher				*

Lithology annotations (top to bottom):

N8

Intense mottling of N7 and 5GY 6/1

4 mm 5Y 8/1 burrows

0.5 cm N1 spot with framboidal pyrite

moderate 5GY 6/1 mottling

-do-

4 mm 5Y 8/1 burrow

1 and 2 cm N1 spots

7 4 mm burrows

N7.5

slight mottling

Intense mottling grading to moderate

N1 2 cm spot

5Y 8/1

LITHOLOGIC DESCRIPTION

Light gray NANNOPLANKTON CHALK, largely mottled slightly to intensely and containing discrete yellow burrows. In addition to the finely disseminated pyrite which occurs in trace amounts throughout, several black 1-2 cm spots contain as much as 50% silt-sized pyrite framboids.

TEXTURE: Sand 0.6-0.9%
Silt 32-34%
Clay 65-68%

MINOR CONSTITUENTS: Ubiquitous traces of detrital silt-sized quartz, common traces of volcanic glass; rare mica; common traces of authigenic calcite; ubiquitous forams (traces to 2%).

Total Carbon: 10.0-10.2%
Organic Carbon: 0.1%
Calcium Carbonate: 82-84%

CONSOLIDATION: Semi-lithified where less disturbed by drilling.

Explanatory notes in chapter 2

Site 251 Hole A Core 26 Cored Interval: 448.5-458.0 m

AGE	FORAMS ZONE	NANNOS ZONE	FOSSIL CHARACTER: FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
LOWER MIOCENE	N4-N8	NN5	AP	3			1	0.5, 1.0	VOID		*
			AP	3	CM		2				CC GZ * * * *
			AP	3			3				*, XM
			AP	3	CM		4				CC GZ XM KE
			AP	3							
			AP	3	CM		Core Catcher				*

Lithology annotations (top to bottom):

N7 and N8

moderate mottling

2 cm N1 spot

N8

burrows

burrows

moderate mottling

1 cm N1 spot

moderate mottling grading intense

sandy burrow

moderate mottling

5Y 6/1 mottles, moderate

-do-

intense 2.5Y 5/2 mottles

2.5Y 6/2

5Y 6/1

5YR 8/4 mottle

moderately mottled

moderately mottled

5Y 6/1 burrows

10YR 8/4

5Y 6/1 burrows

10YR 7/8

burrows in 10YR 7/3

10YR 6/3 nanno ooze

7.5YR 5.5/4

LITHOLOGIC DESCRIPTION

NANNOPLANKTON CHALK, grayish white to light gray with traces of finely disseminated pyrite in the upper part of the core, grading downward to become predominantly pale yellow brown and pale grayish orange in Section 4. Intensely to moderately mottled. In the upper part of the core the mottles are grayish and greenish and contain up to 1% fine pyrite. The mottles grade downward to become grayish brown in Section 3. Mottles in the lowermost yellow-brown part of the core contain traces of limonite and are yellow. The very base of the core is light brownish gray and is ZEOLITE BEARING NANNOPLANKTON CHALK.

TEXTURE: Sand 0.2-0.3%
Silt 26-27%
Clay 73-74%

MINOR CONSTITUENTS: Ubiquitous traces of quartz and detrital clay, rare mica. Common volcanic glass in trace amounts. Traces of authigenic carbonate and foram tests and fragments are common.

Total Carbon: 9.2-9.4%
Organic Carbon: 0.1%
Calcium Carbonate: 76-78%

CONSOLIDATION: Semi-lithified.

Explanatory notes in chapter 2

Site 251 Hole A Core 27 Cored Interval: 458.0-467.5 m

AGE	FORAMS ZONE	NANNOS ZONE	FOSSIL CHARACTER: FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
LOWER MIOCENE	N4-N8	NN5			CMO		1	0.5, 1.0	VOID		*, KE
			CM	3	CMO		2				CC GZ, *, XM
			CM	3	CMO		Core Catcher				*

Lithology annotations (top to bottom):

5YR 7/6 moderate mottling of 5YR 5/6

10YR 7/4 with 10YR 7/8 burrows

moderate mottling of 10YR 6/4

-do-

-do-

-do-

5YR 6.5/4

LITHOLOGIC DESCRIPTION

NANNOPLANKTON CHALK, grading down from reddish yellow to yellow brown, moderately mottled yellowish red, yellow, and light yellow-brown; traces of finely divided limonite ubiquitous.

TEXTURE: Sand 0.5%
Silt 35%
Clay 64%

MINOR CONSTITUENTS: Traces to 5% volcanic glass; traces of heavy minerals (rutile, pyroxene); traces of foraminifera.

Total Carbon: 10.0%
Organic Carbon: 0.1%
Calcium Carbonate: 83%

CONSOLIDATION: Semi-lithified.

Explanatory notes in chapter 2

Site 251 Hole A Core 28 Cored Interval: 467.5-477.0 m

AGE	ZONE: FORAMS	ZONE: NANNOS	FOSSIL CHARACTER: FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
LOWER MIOCENE	N4-N8	NN5	CP	3	CMO CMO		1	0.5 1.0			* * XM CC GZ XM * KE
			RP	3	B		Core Catcher				*

LITHOLOGIC DESCRIPTION

intensely mottled

burrows

10YR 5/1 "pebbles"

10YR 7/3

2.5Y 7.5/2

Top 60 cm: Yellow brown NANNOPLANKTON CHALK containing traces of iron oxides throughout; in part intensely burrowed and mottled; containing traces of volcanic glass.

Bottom (72-150 cm) part: Very pale brown CALCITE (MICARB) CHALK, silt-sized calcite rhombs, with traces of iron oxides. (Sand 0.2%, Silt 92%, Clay 8%).

Total Carbon: 8.7%
Organic Carbon: 0.1%
Calcium Carbonate: 72%

CONSOLIDATION: Lithified.

NOTE: Approximately 30% of the core catcher sediment is 2-micron grains of authigenic garnet.

Explanatory notes in chapter 2

Site 251 Hole A Core 29 Cored Interval: 477.0-486.5 m

AGE	ZONE: FORAMS	ZONE: NANNOS	FOSSIL CHARACTER: FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
LOWER MIOCENE	N4-N8		RP	3	B B		1	0.5 1.0	VOID		TS * * * * XM
			RP	3	B		2				CC GZ * KE
			RP	3	B		Core Catcher				*

LITHOLOGIC DESCRIPTION

3 cobble-sized fragments of basalt 5Y 8/1

mottling and pink veining

5Y 7/4 veins faint mottling

Mixed 5Y 8/1 and 5Y 8/2

5Y 7/4 stain

0.5 mm fine N1 dots in lines

2.5Y 6/4

Top 7 cm of core: Three loose, rounded, weathered, partly 2-5 cm fragments of GLASSY OLIVINE BASALT and BASALT GLASS.

Rest of core: Yellowish-white silt-sized GARNET-RICH CALCITE (MICARB) CHALK, locally faintly mottled, fractured and veined pink at 110 cm, fractured and veined yellow at 130 cm. (Sand 0.2%, Silt 88%, Clay 12%).

NOTE: Approximately 30% of the sediment is 2-micron grains of authigenic garnet.

Total Carbon: 8.6%
Organic Carbon: 0.1%
Calcium Carbonate: 71%

CONSOLIDATION: Semi-lithified.

Explanatory notes in chapter 2

Site 251 Hole A Core 30 Cored Interval: 486.5-489.5 m

AGE	ZONE: FORAMS	ZONE: NANNOS	FOSSIL CHARACTER: FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
LOWER MIOCENE	No data	NN4-NN5			CMO		1	0.5 1.0	VOID		
							Core Catcher				

LITHOLOGIC DESCRIPTION

Sequence of:

1. 5 cm
2. 3 cm
3. small pebbles
4. 7 cm

Highly weathered VESICULAR BASALT.

Explanatory notes in chapter 2

Site 251 Hole A Core 31 Cored Interval: 489.5-499.0 m

AGE	ZONE: FORAMS	ZONE: NANNOS	FOSSIL CHARACTER: FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
							1	0.5 1.0	VOID		* TS
							2				
							3				
							4				* TS
							5				* TS
							Core Catcher				

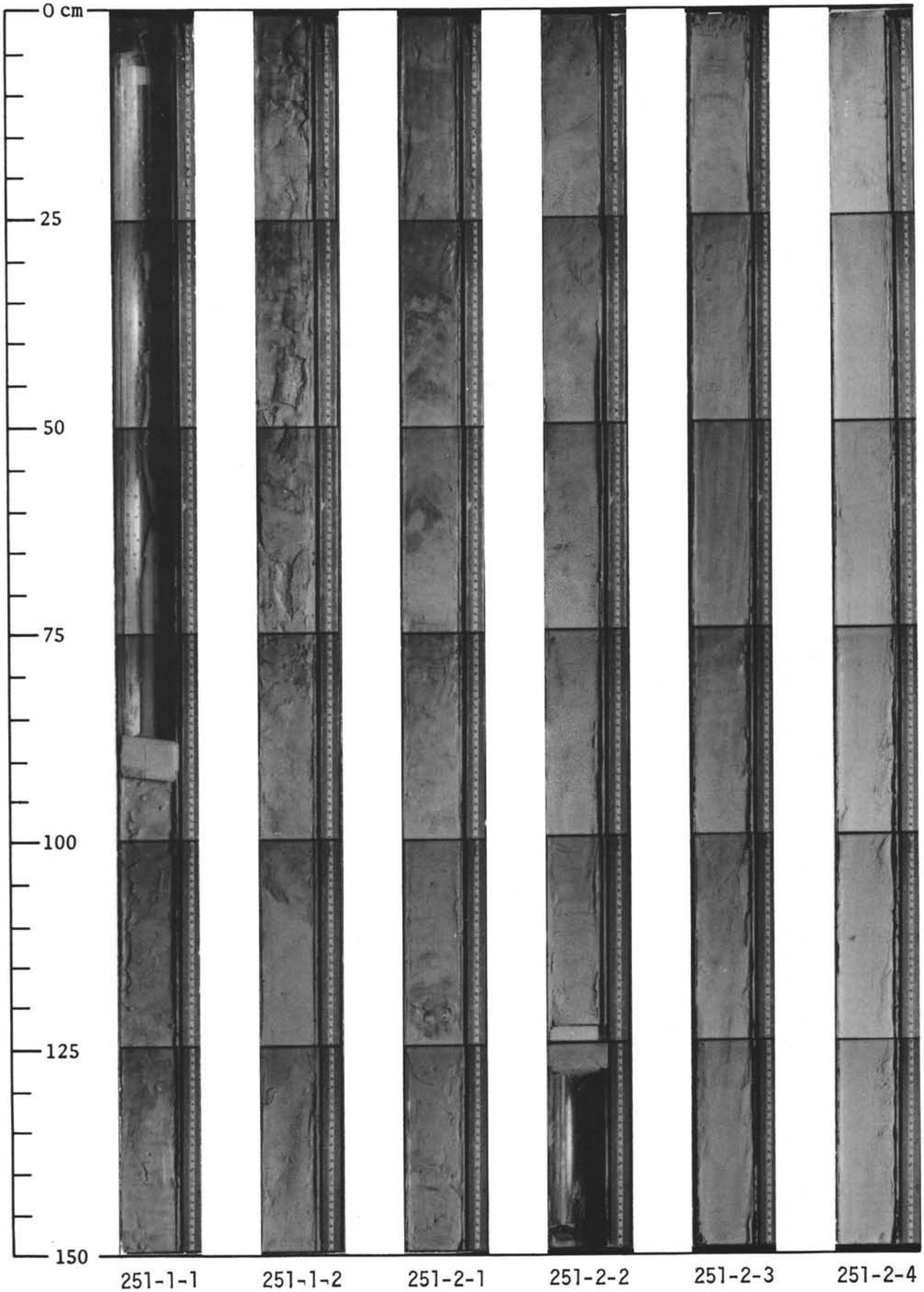
LITHOLOGIC DESCRIPTION

Section 1: Highly weathered gray-brown fractured VESICULAR BASALT.

Rest of core: Highly weathered gray-brown fractured BASALT.

calcite veining
-do-
highly vesicular
calcite veining
-do-
vesicles
calcite veins and films
fresh gray area
fresh, but weathered at fractures
coarse grained from this interval downward
fresh gray
fresh
calcite vein
calcite film
fresh gray
calcite film
calcite film

Explanatory notes in chapter 2



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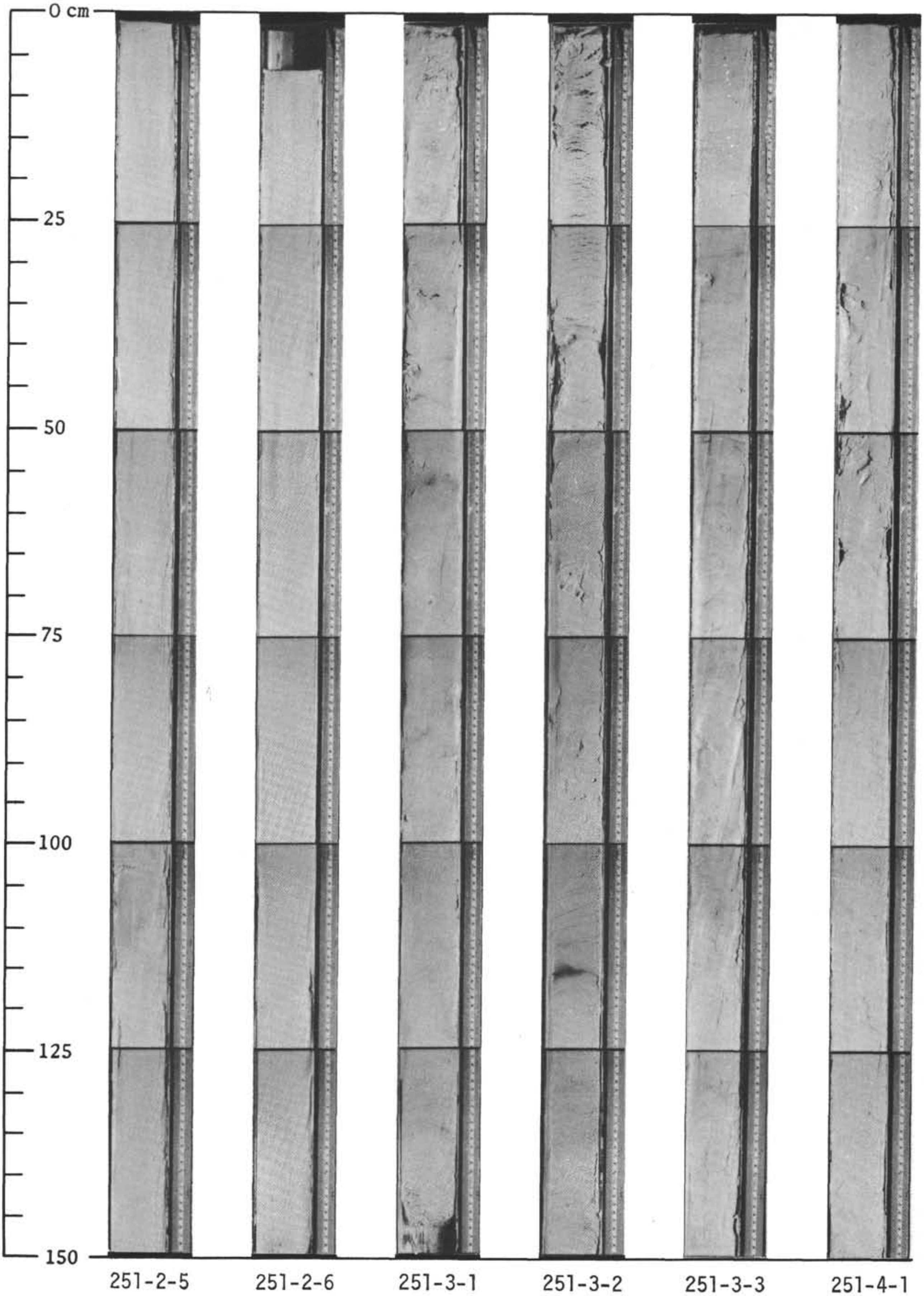
251-2-4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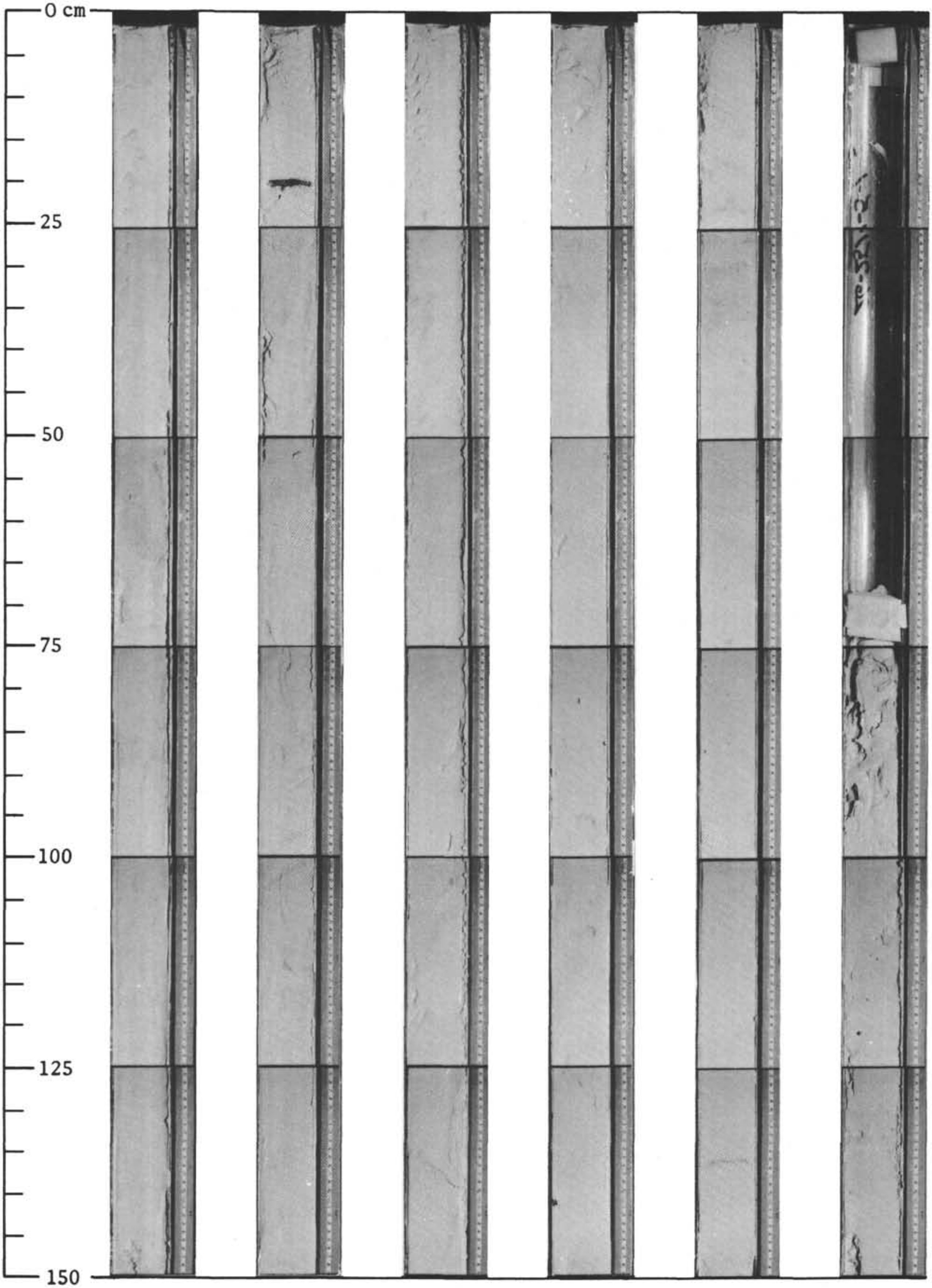
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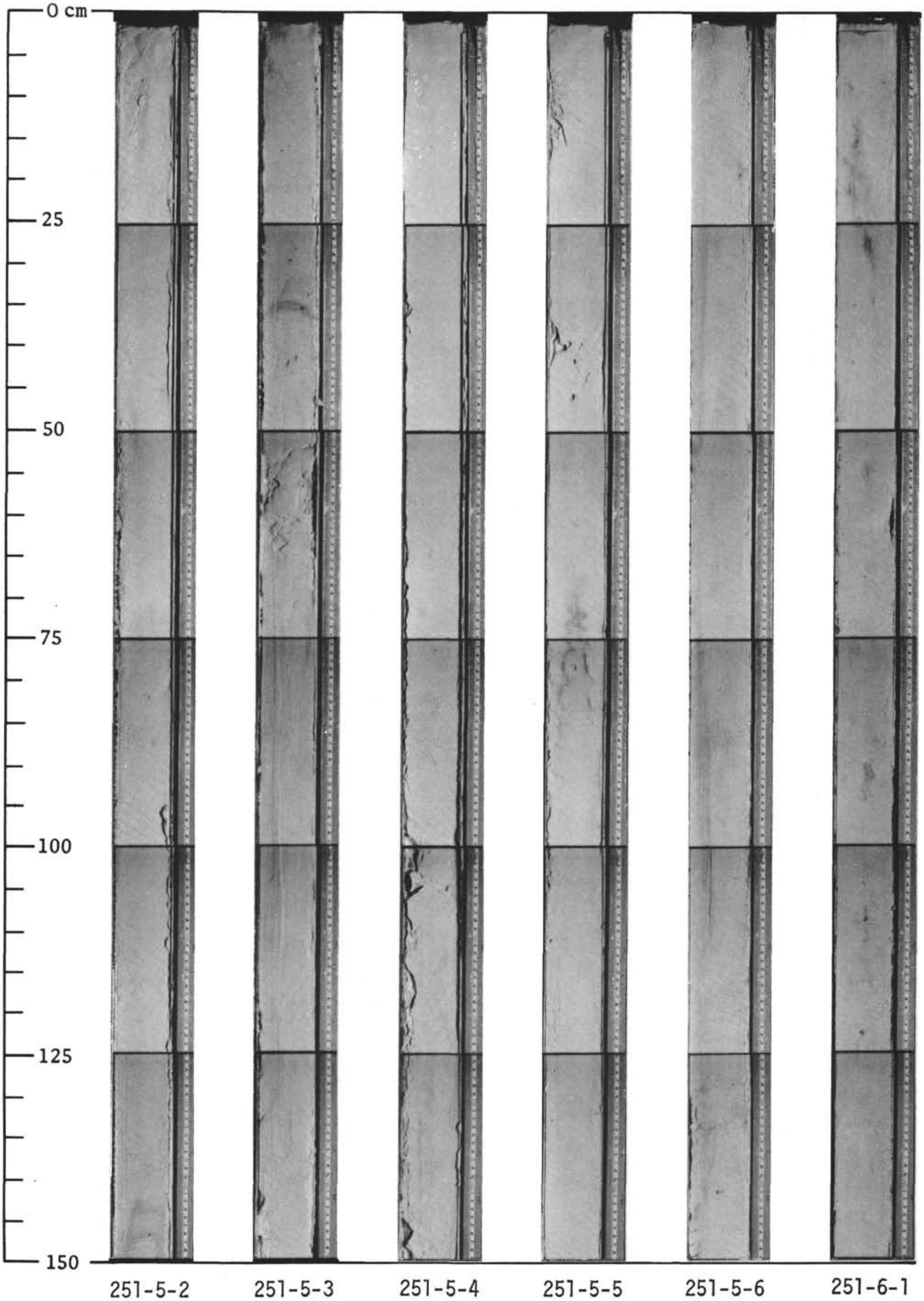
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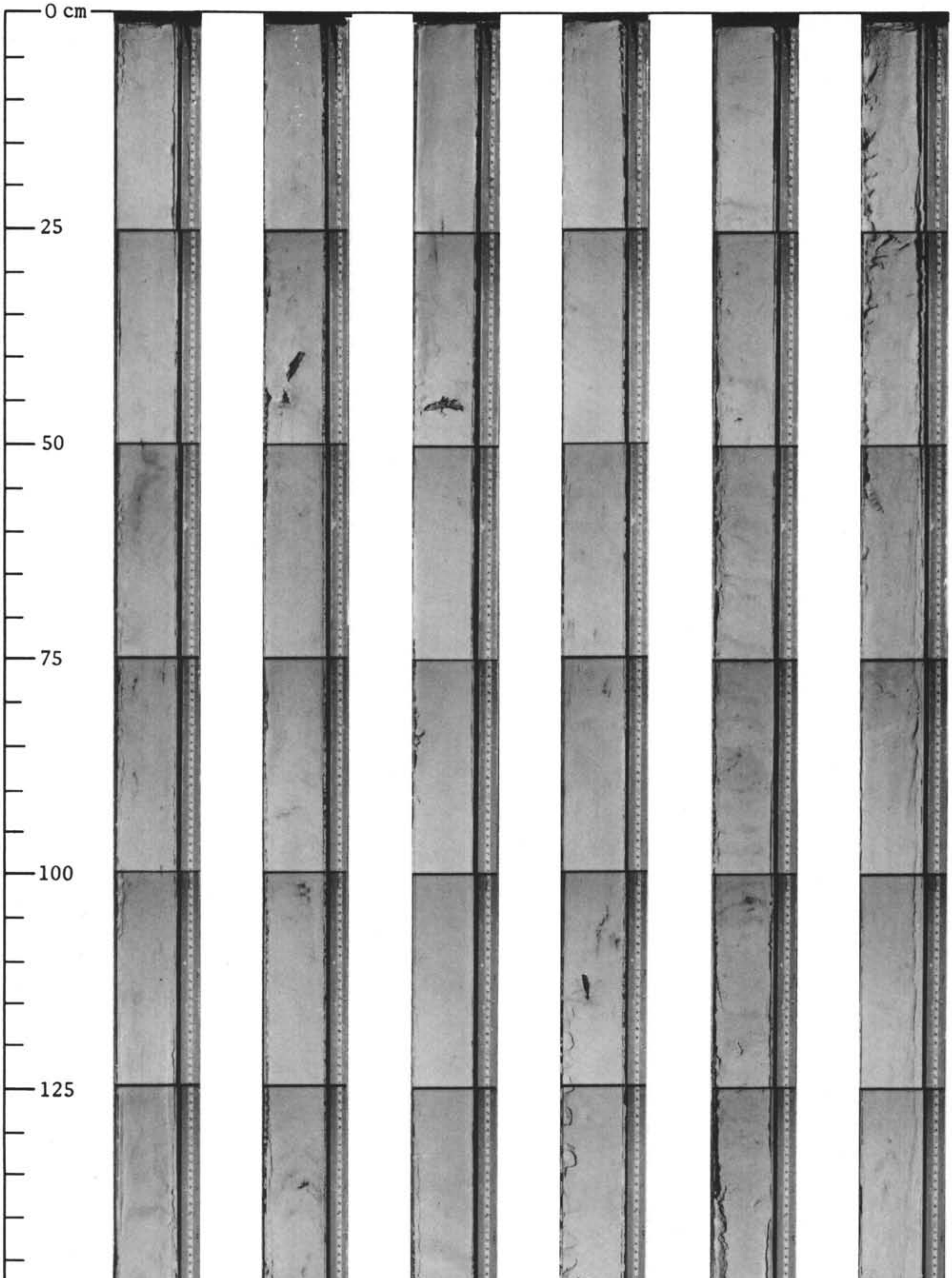
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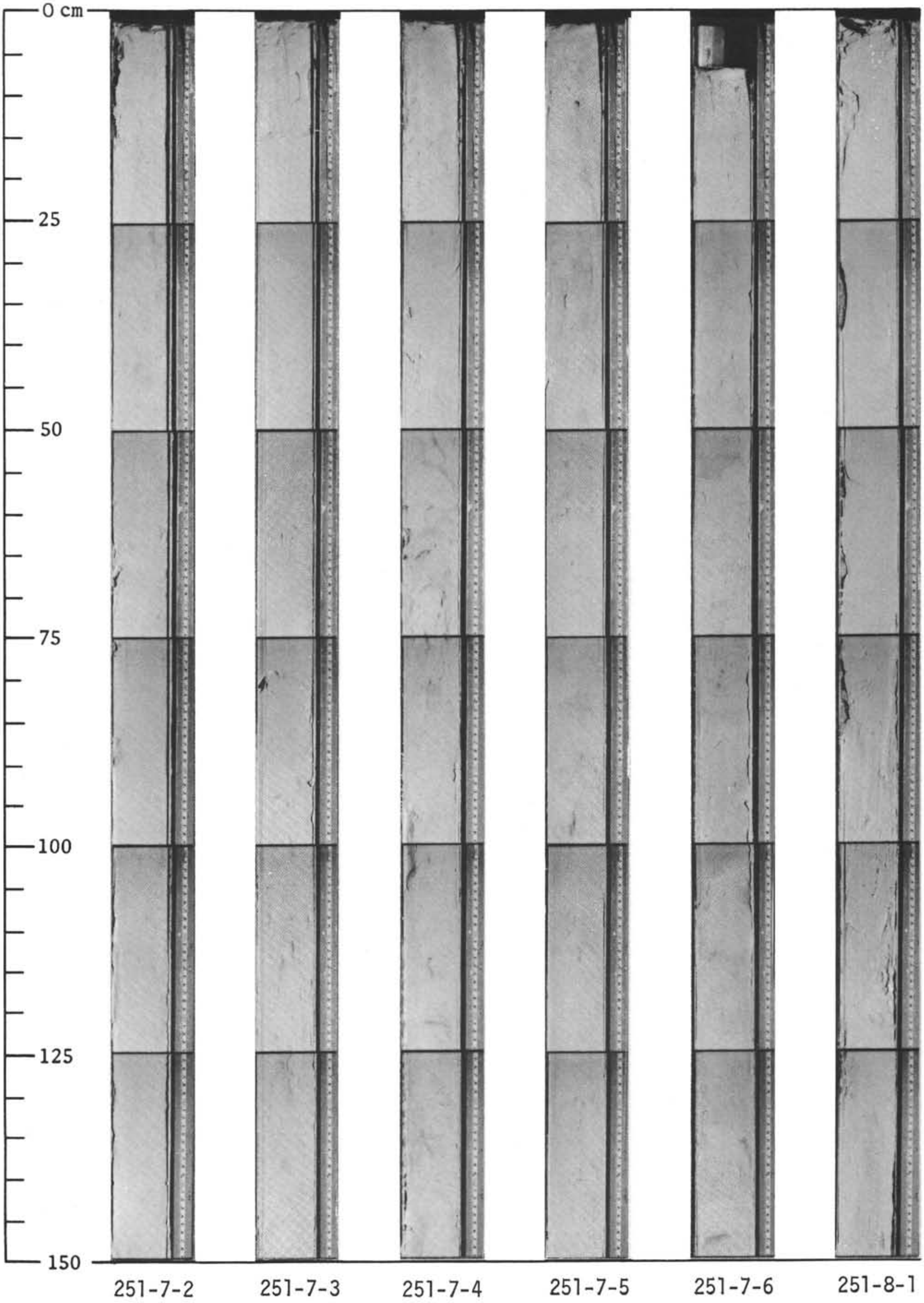
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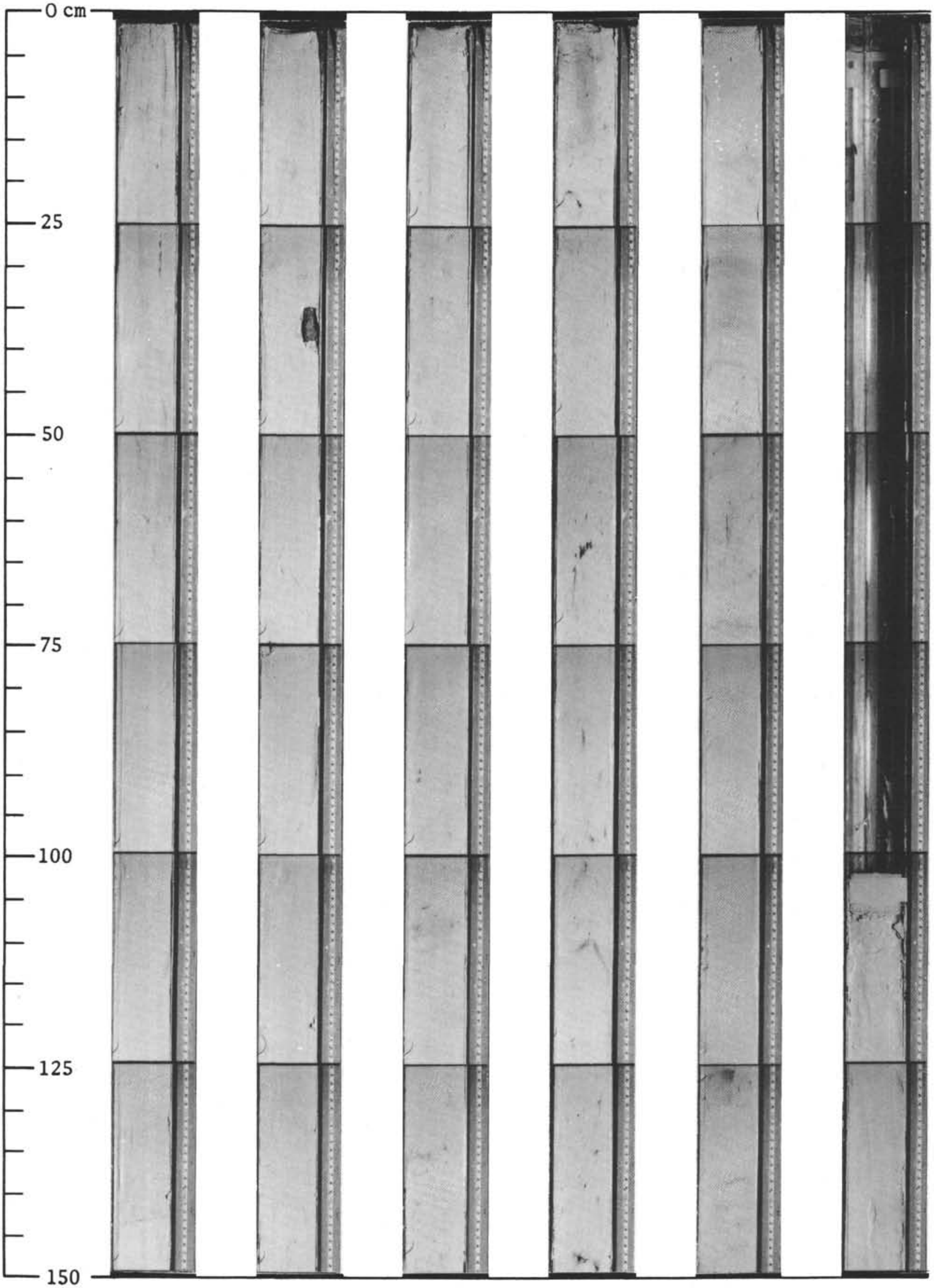
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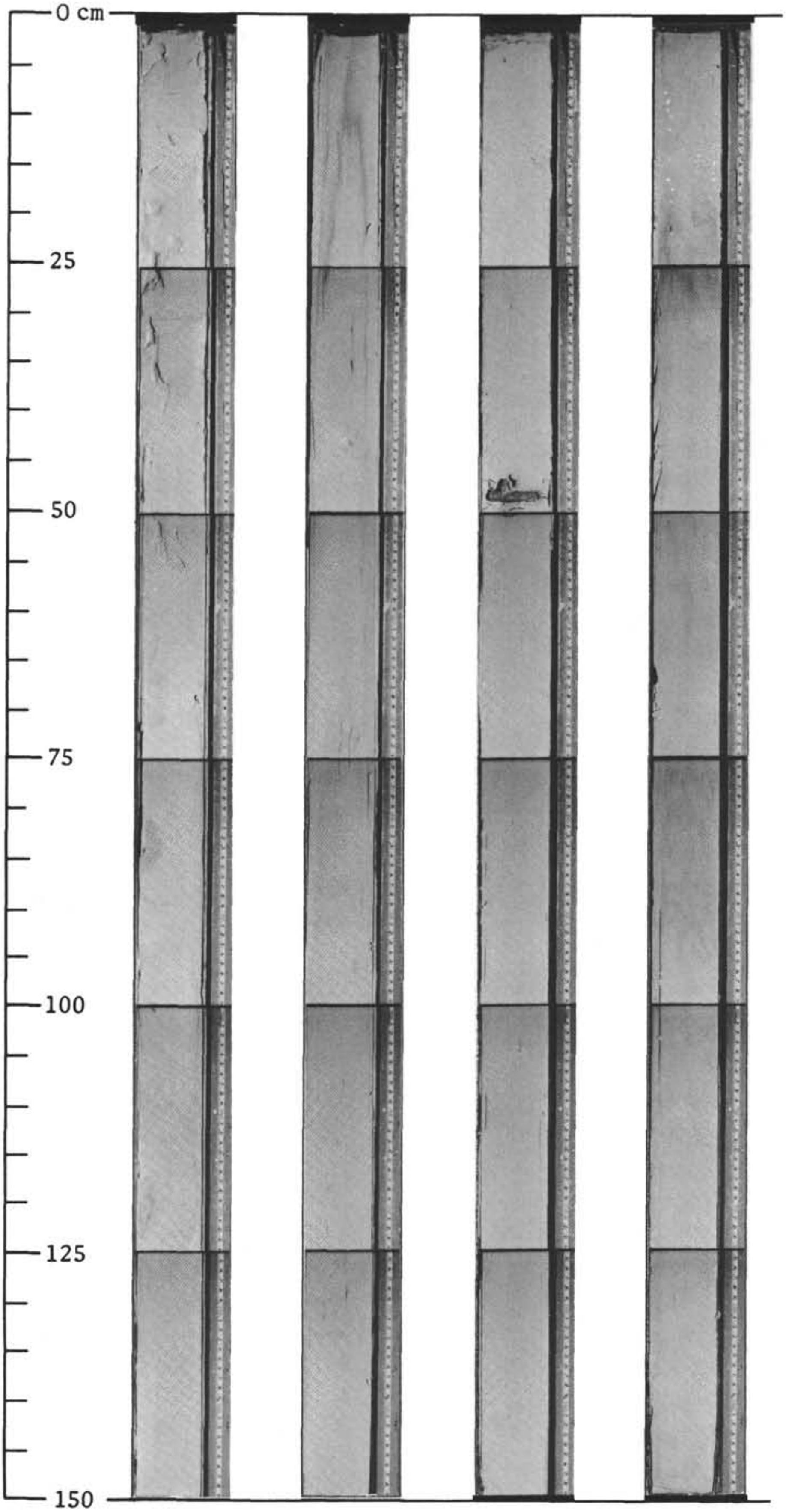
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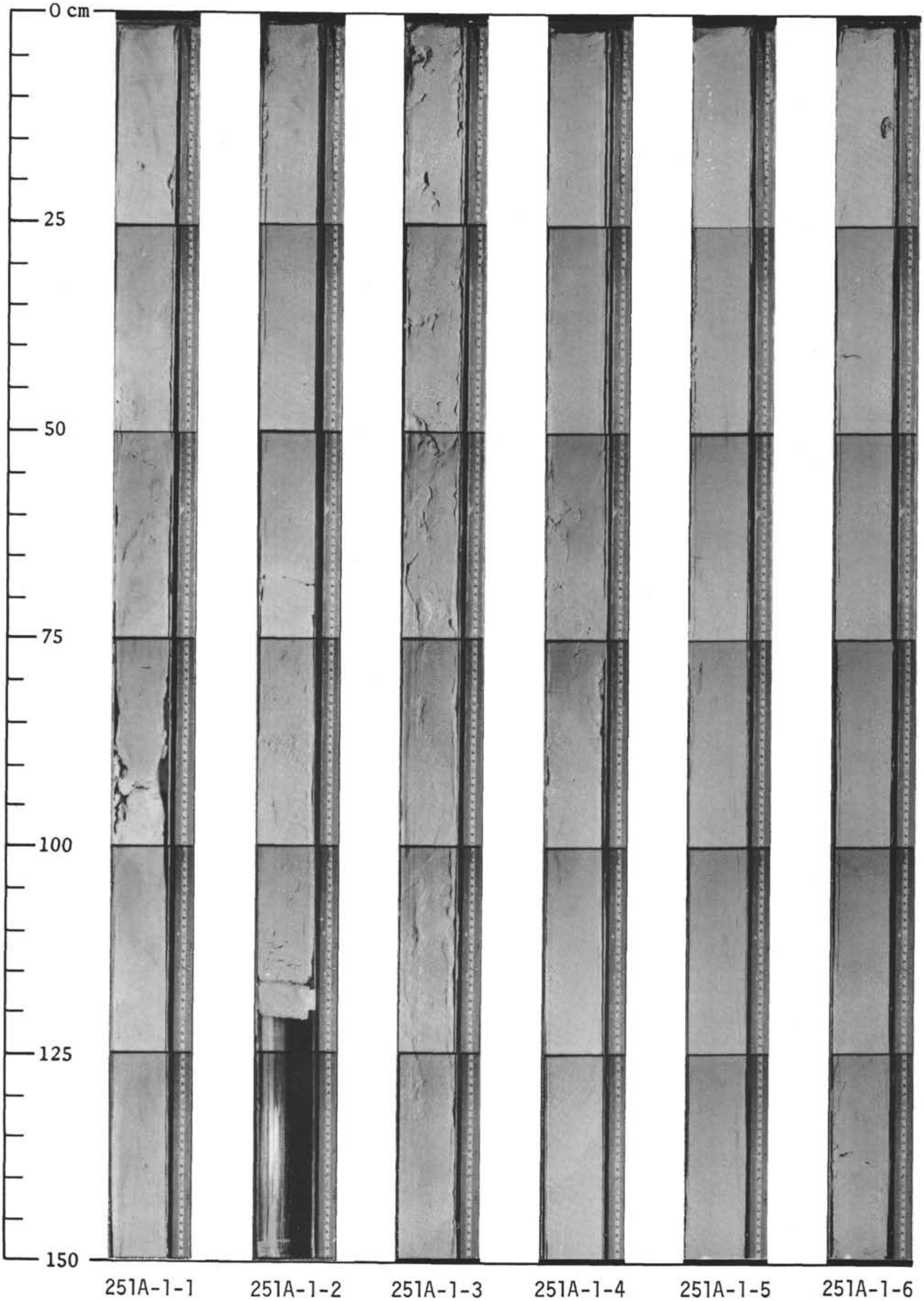
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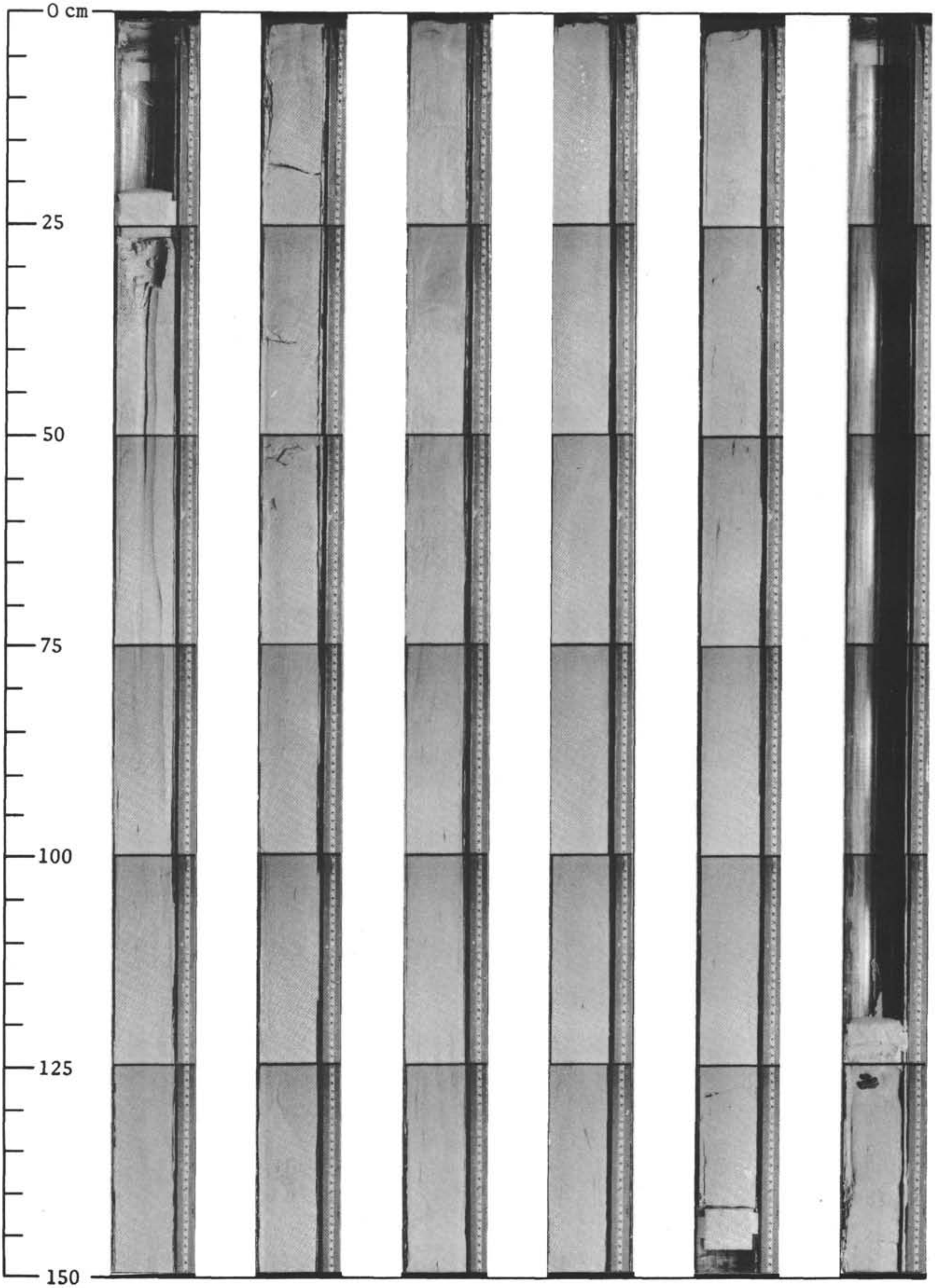
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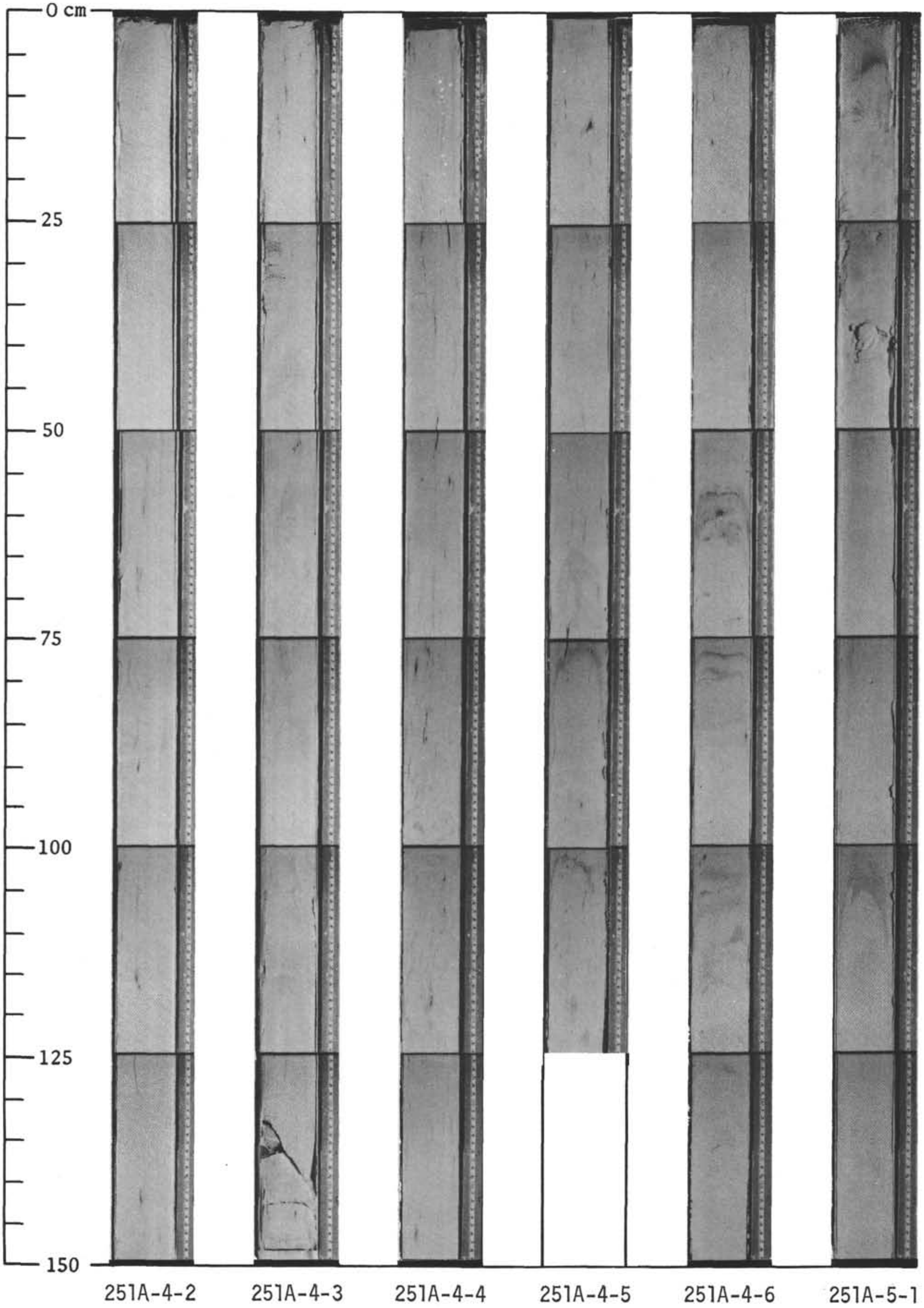
251A-4-1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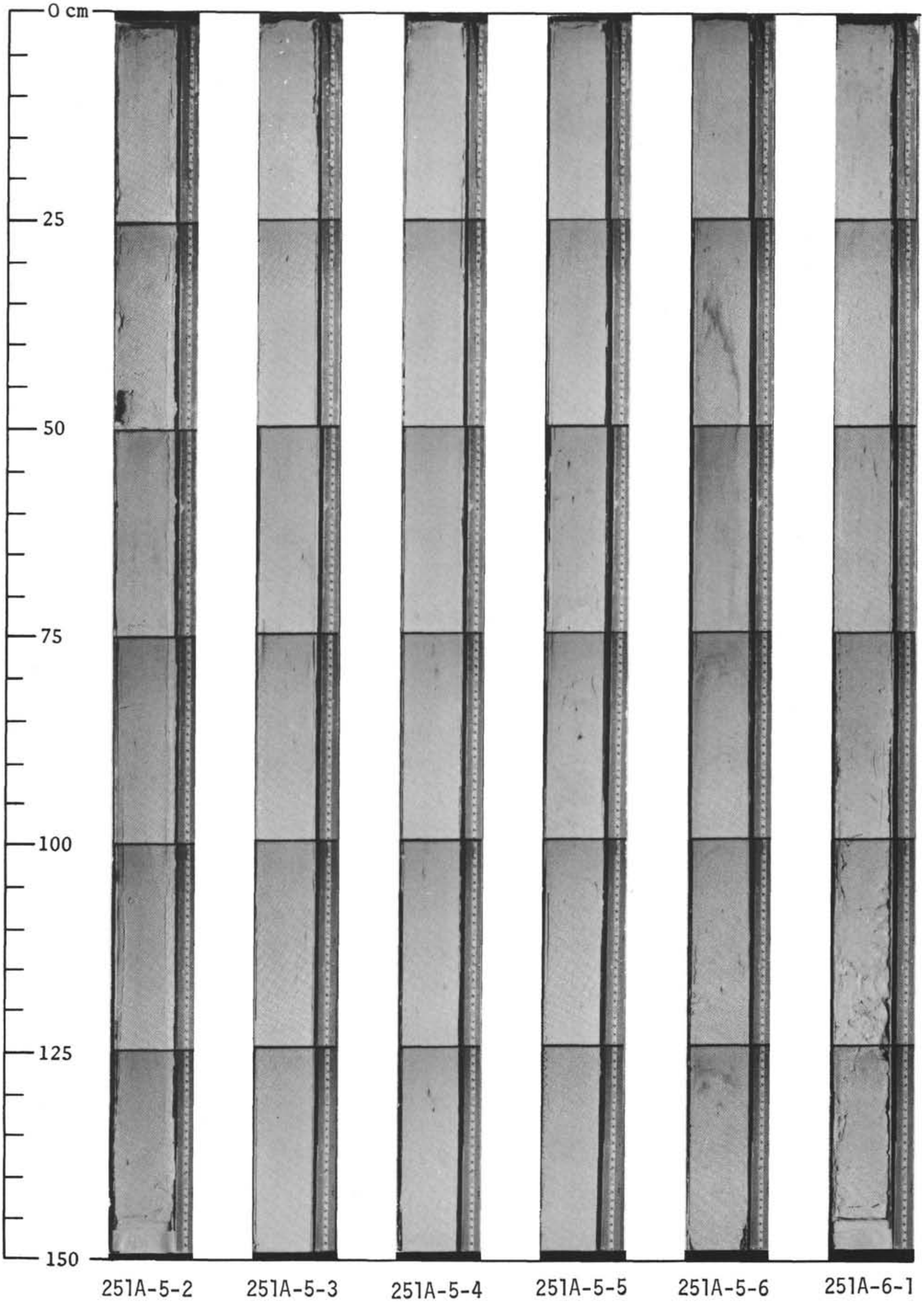
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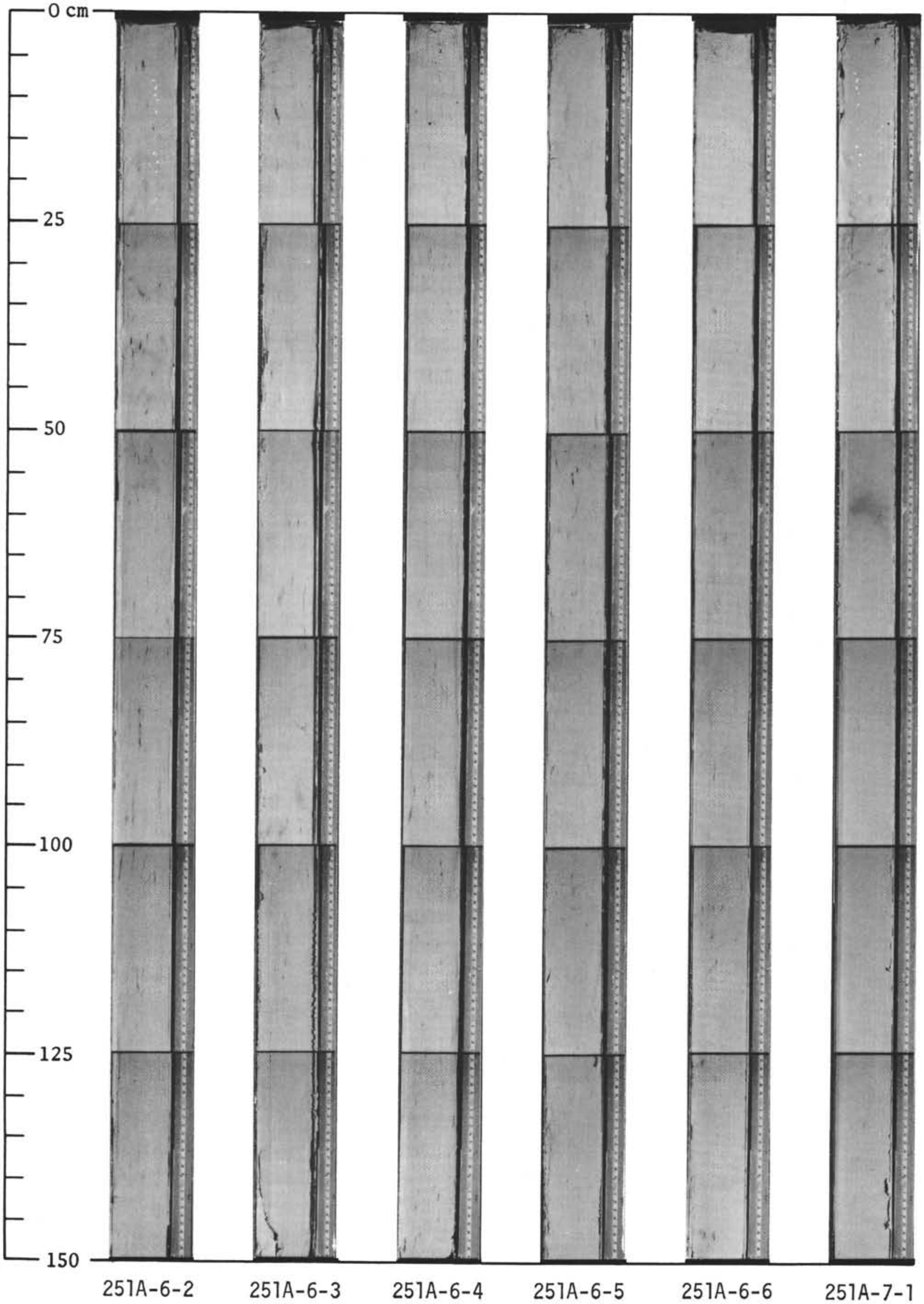
251A-6-1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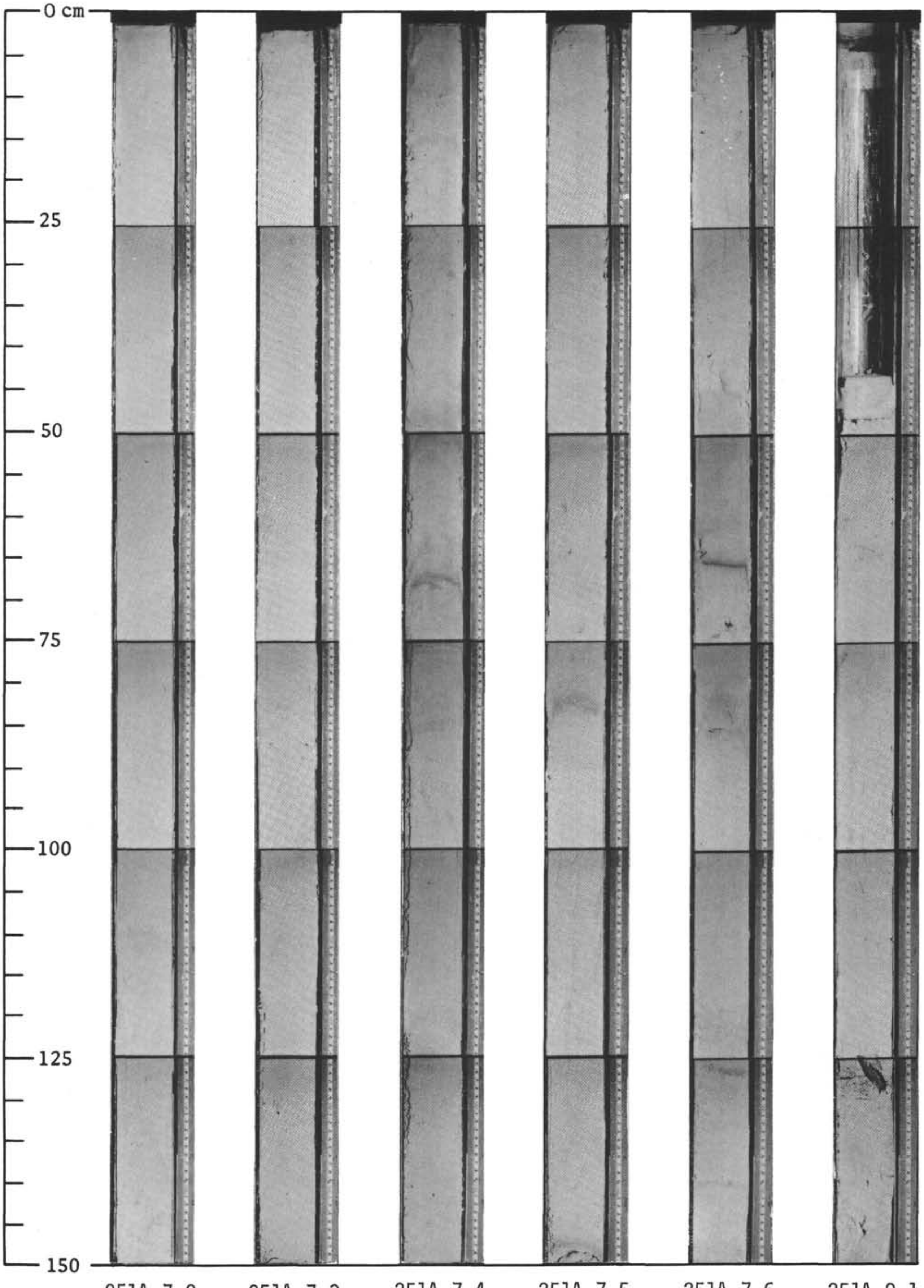
251A-6-4
251A-6-5
251A-6-6
251A-7-1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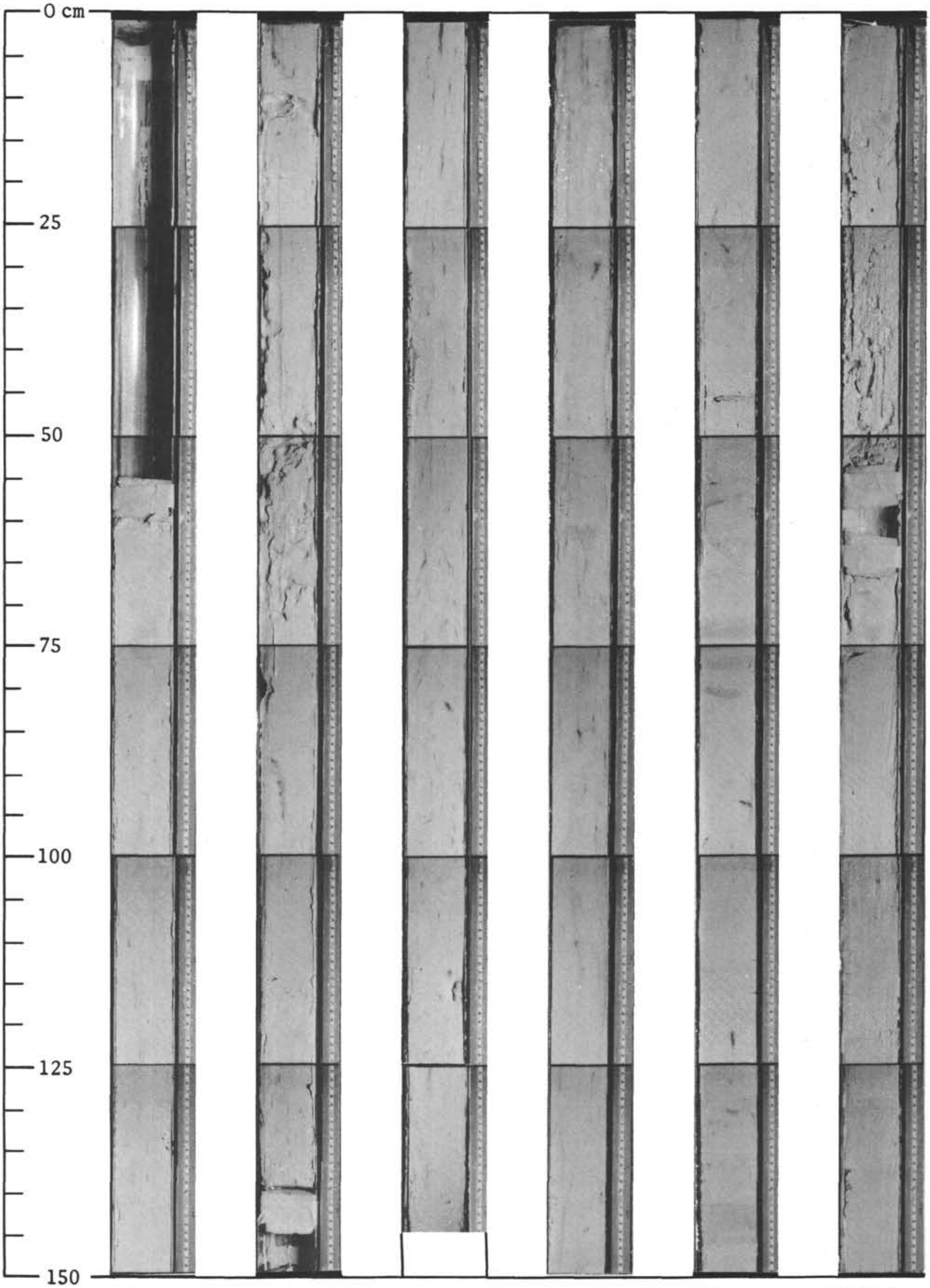

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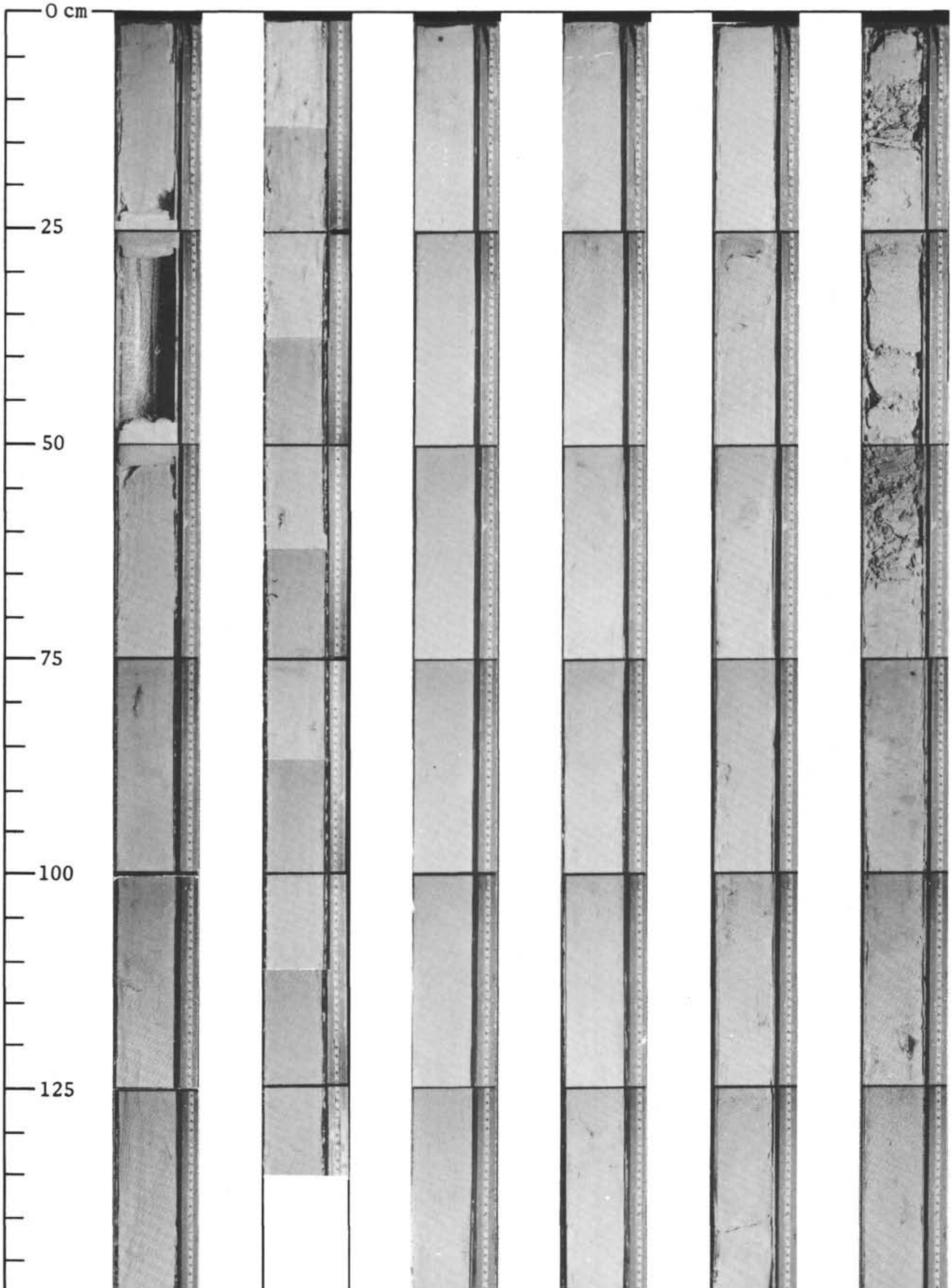
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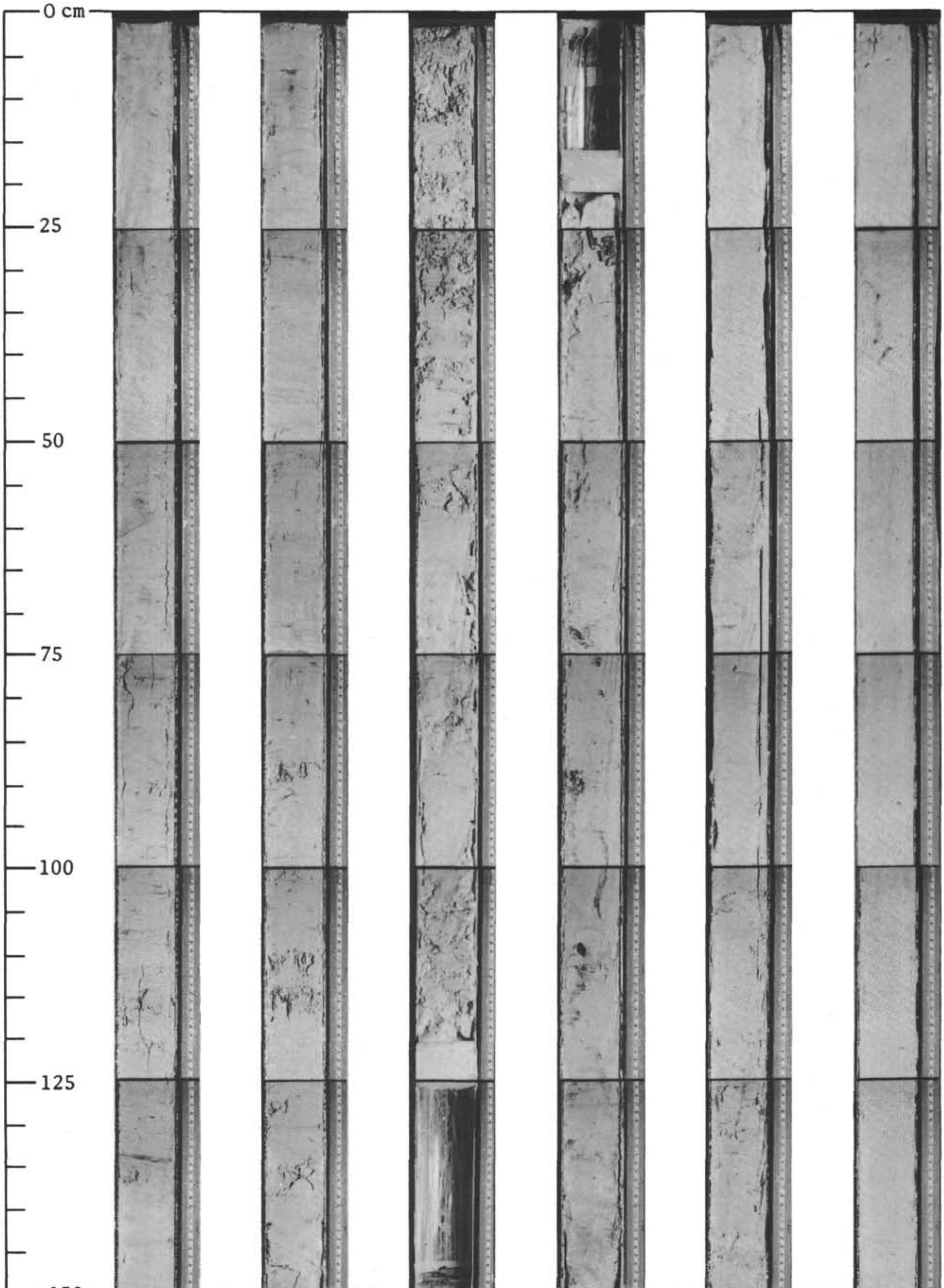
251A-11-1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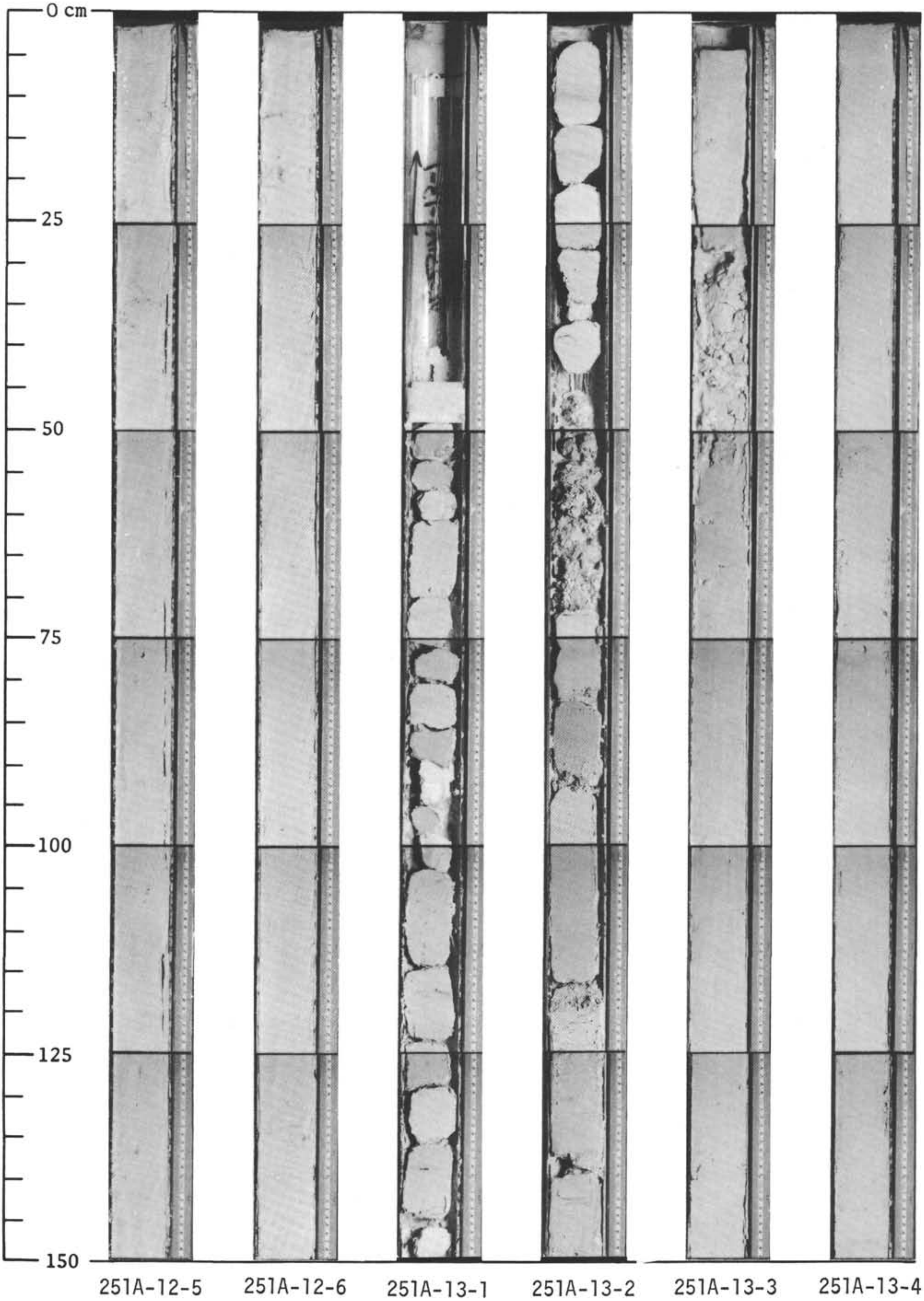
251A-12-3
251A-12-4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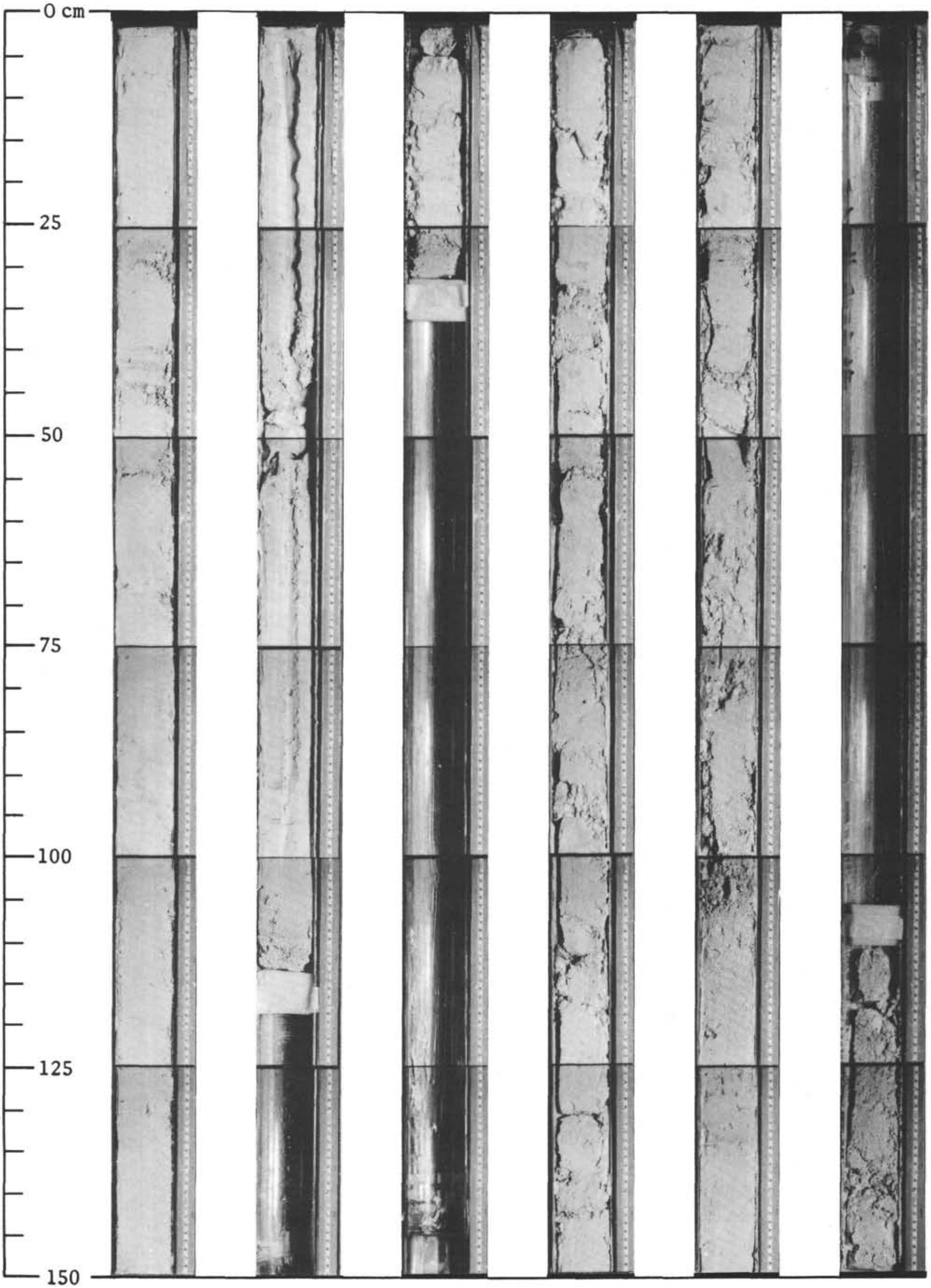
251A-13-4



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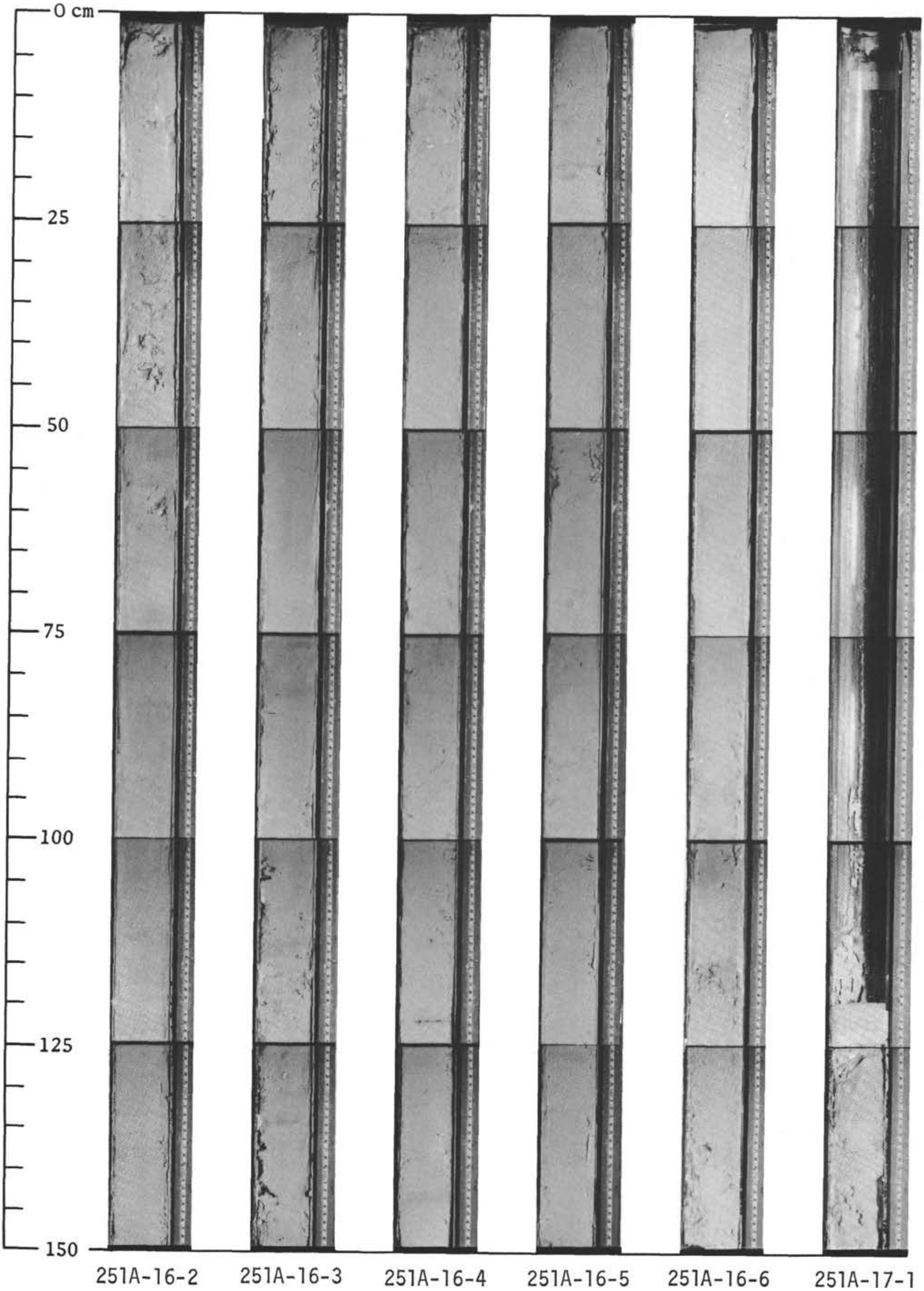
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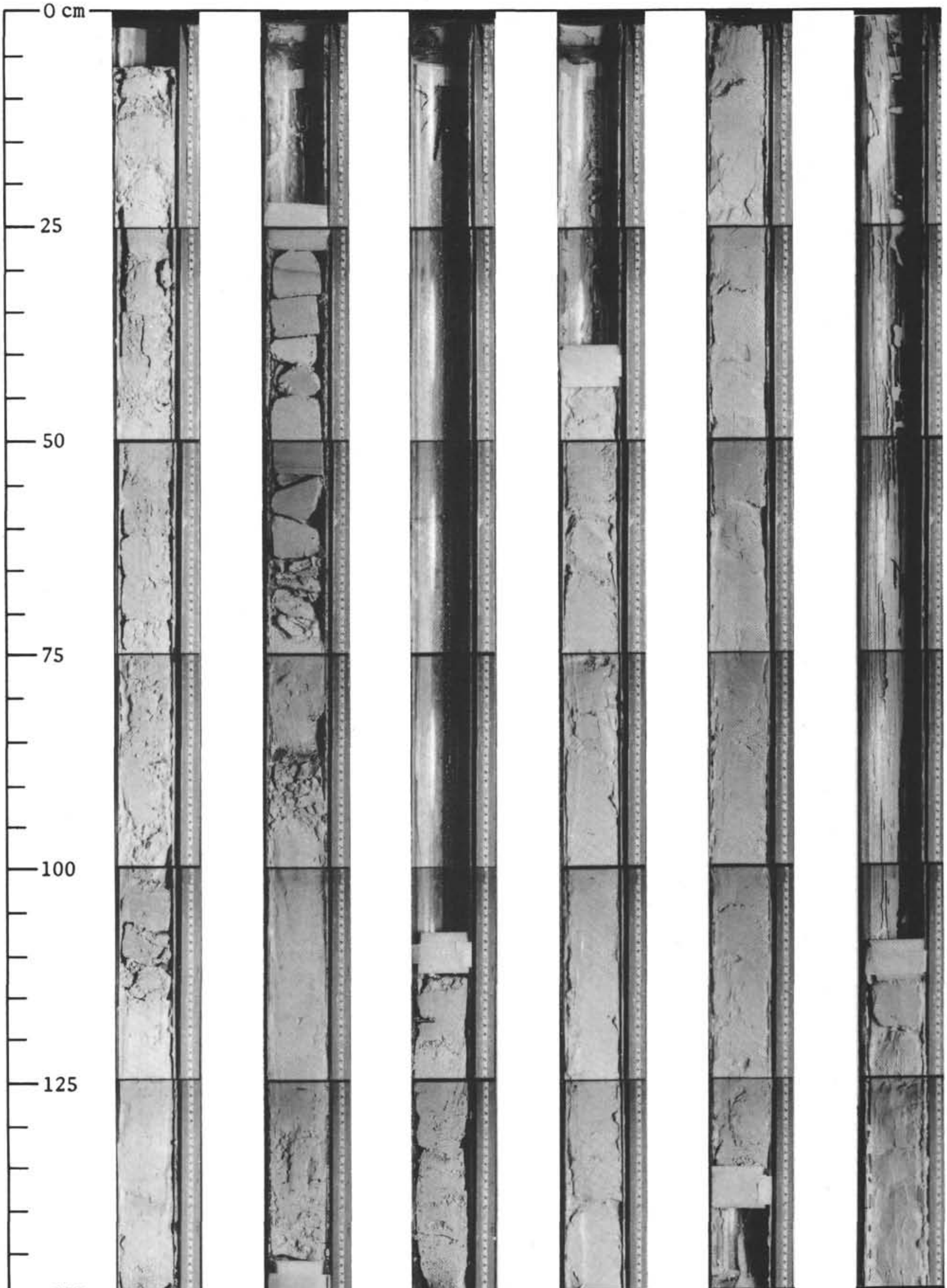
251A-16-6
251A-17-1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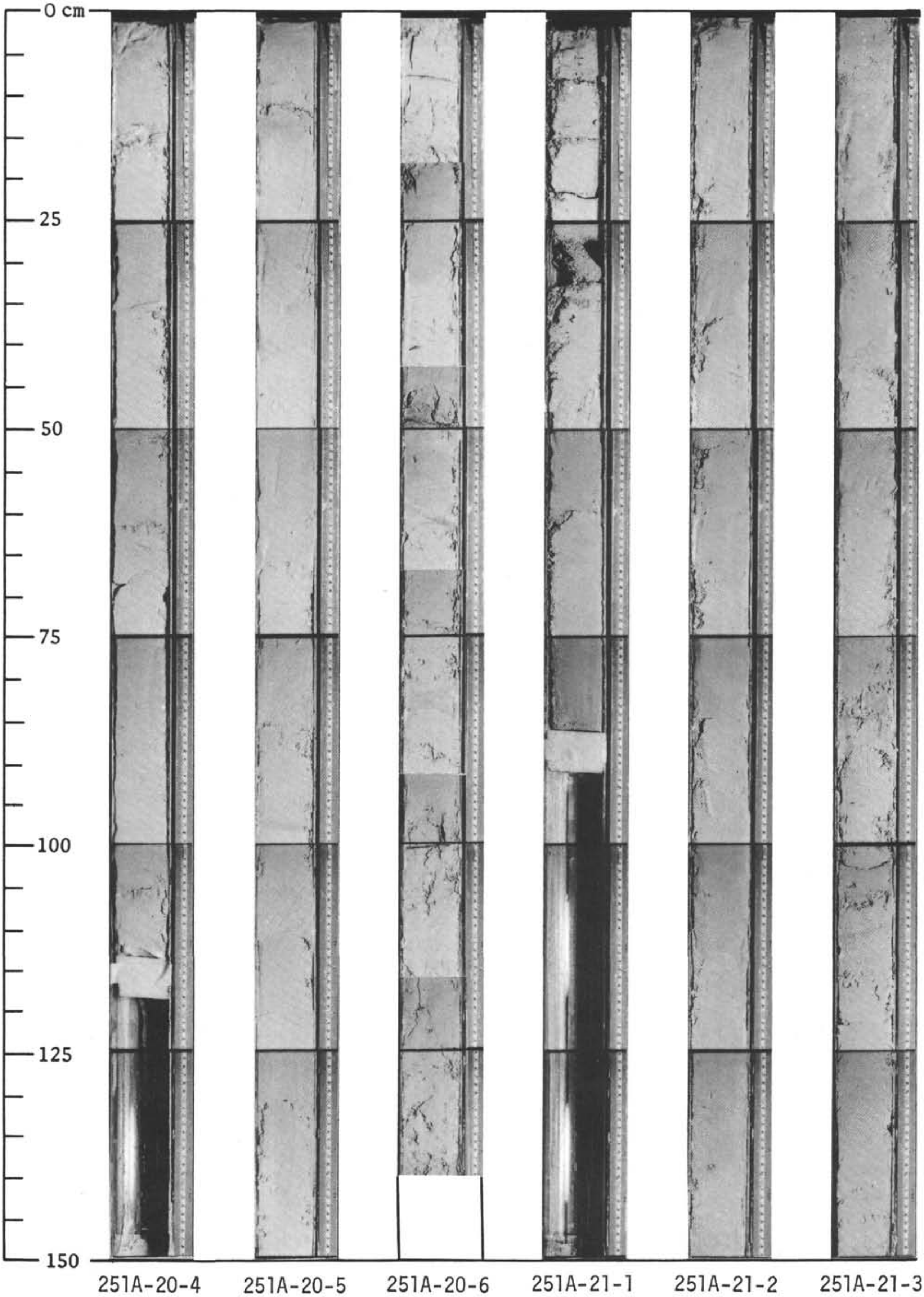
251A-20-1
251A-20-2
251A-20-3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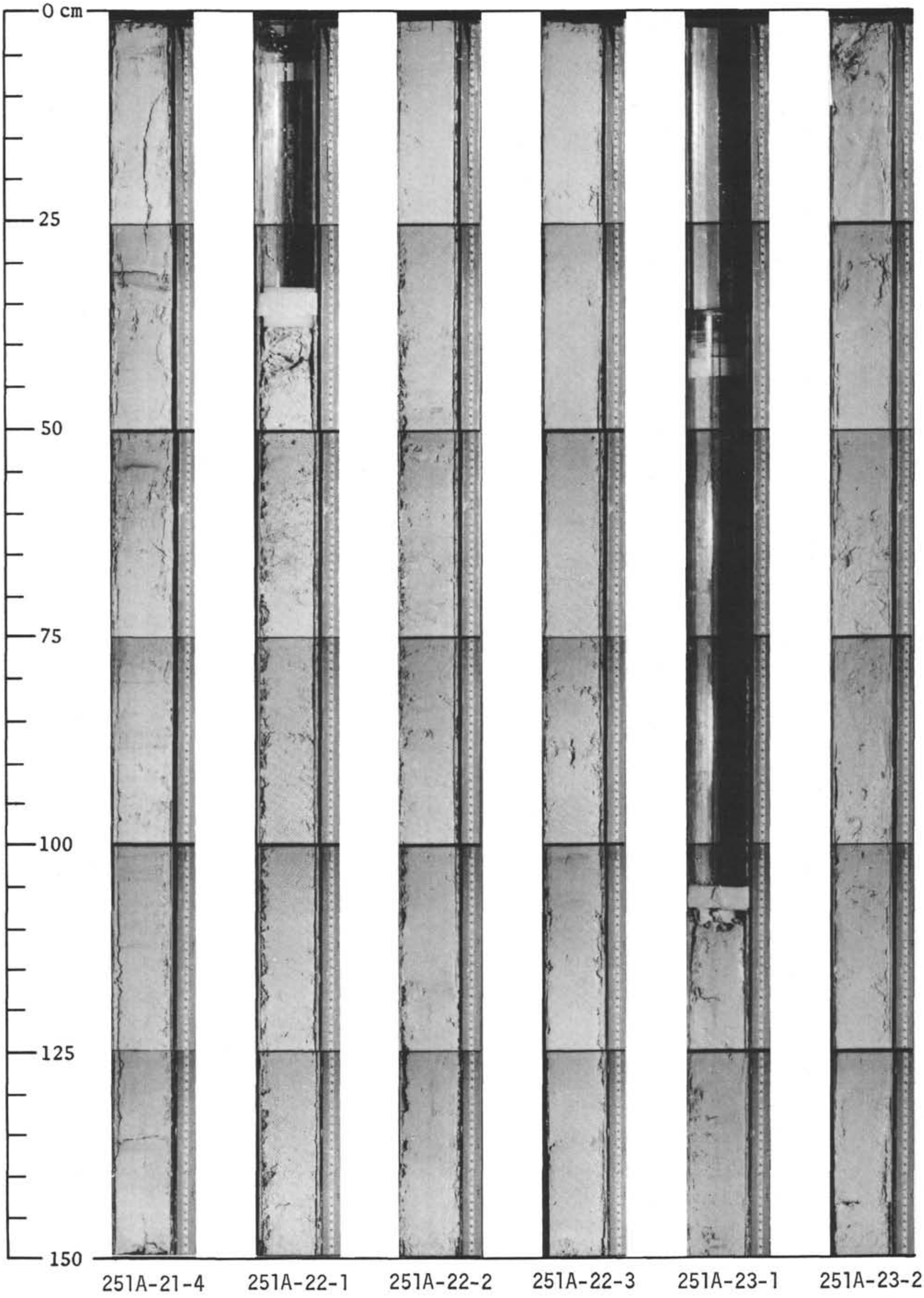
251A-21-1
251A-21-2
251A-21-3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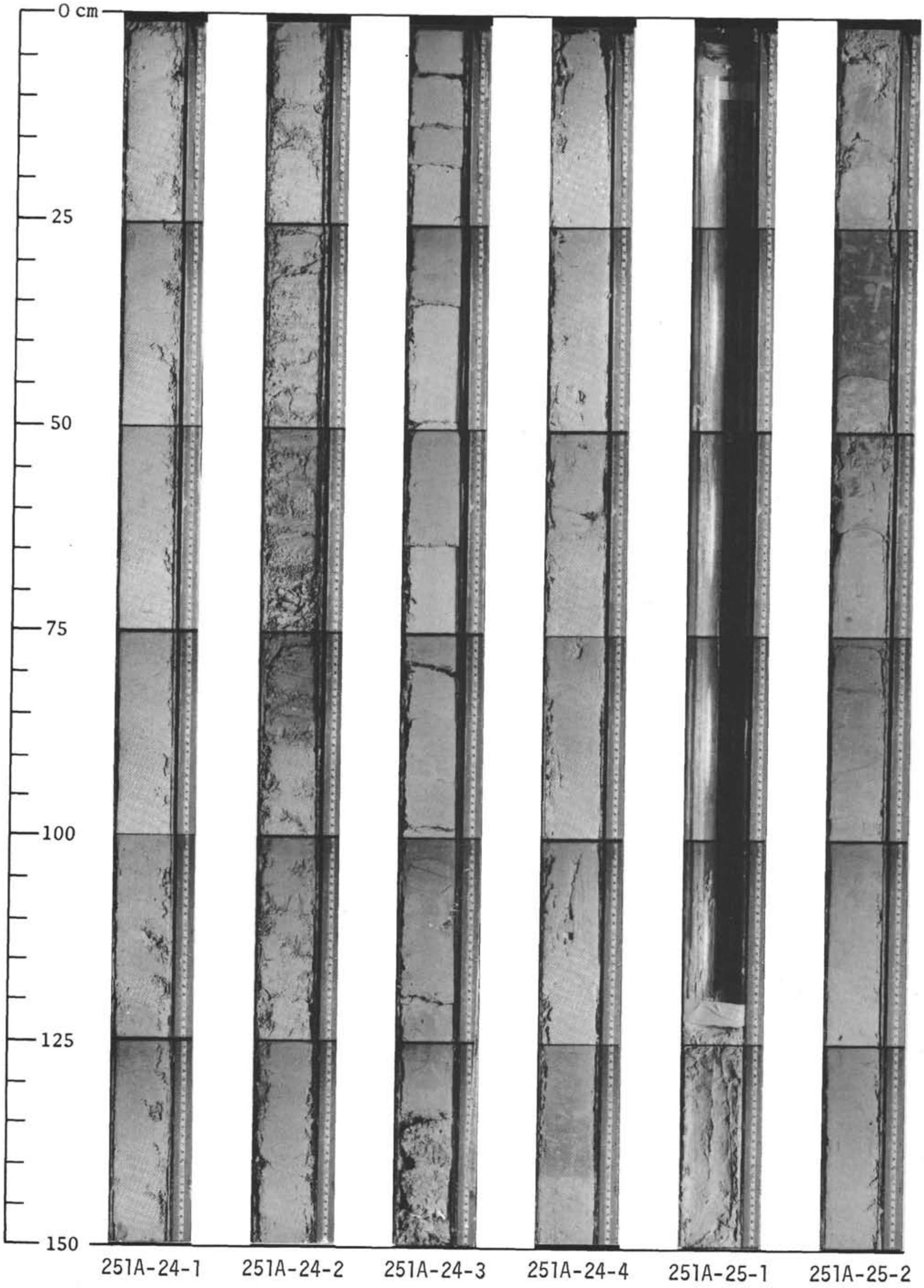
251A-21-4
251A-22-1
251A-22-2
251A-22-3
251A-23-1
251A-23-2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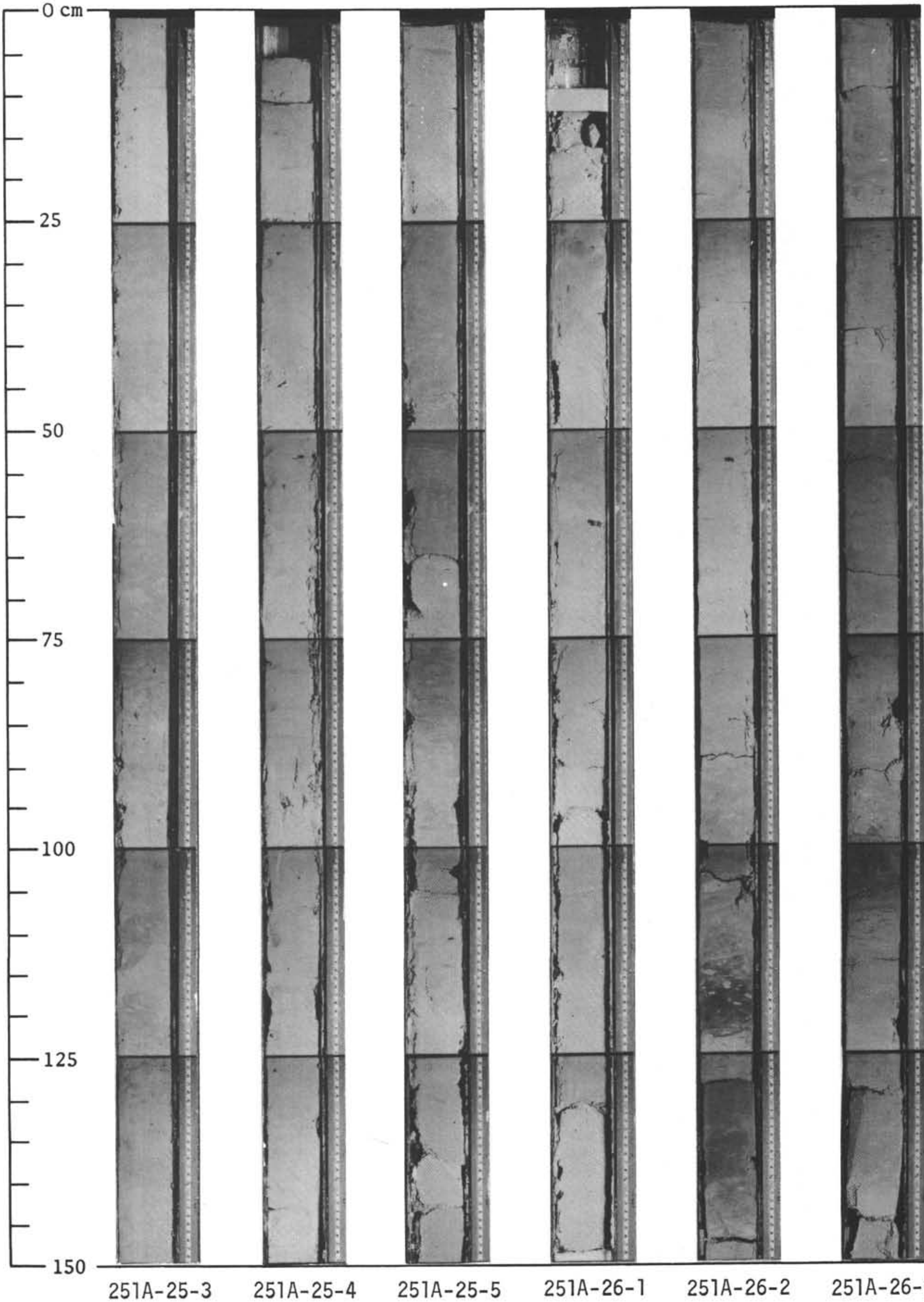
251A-24-3
251A-24-4
251A-25-1
251A-25-2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75
100
125
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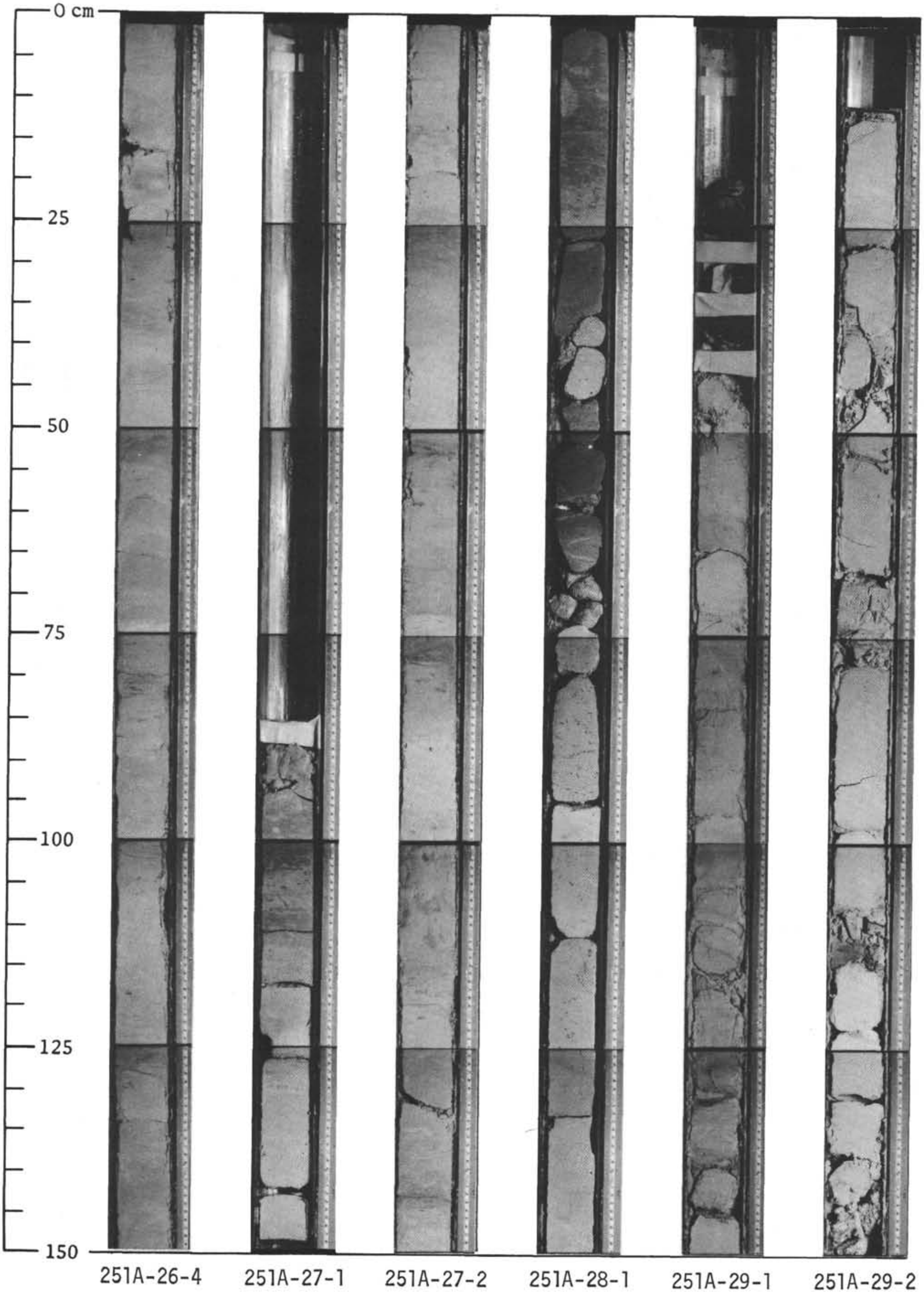
251A-25-3
251A-25-4
251A-25-5
251A-26-1
251A-26-2
251A-26-3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100
125
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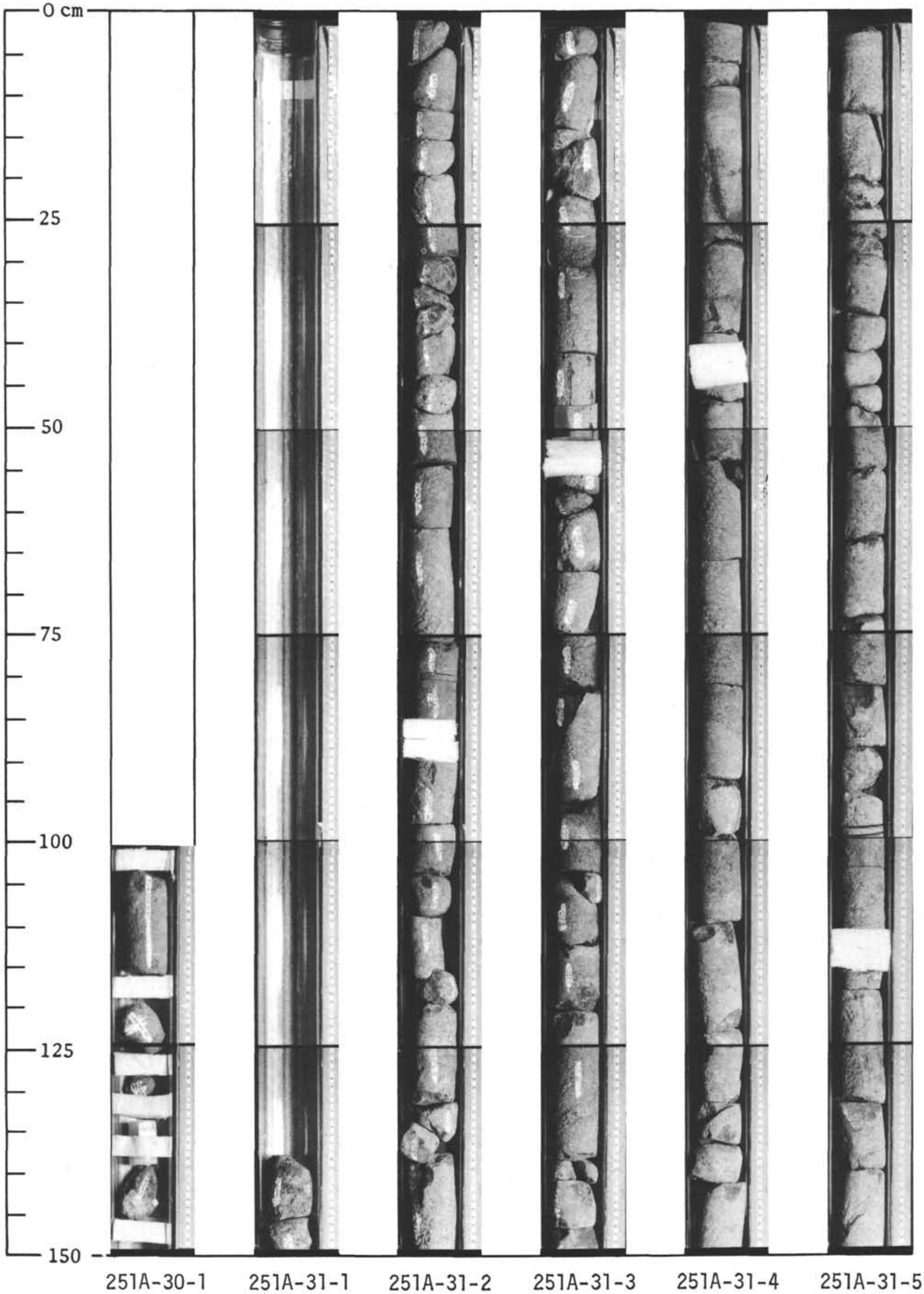
251A-27-1
251A-27-2
251A-28-1
251A-29-1
251A-29-2


0 cm
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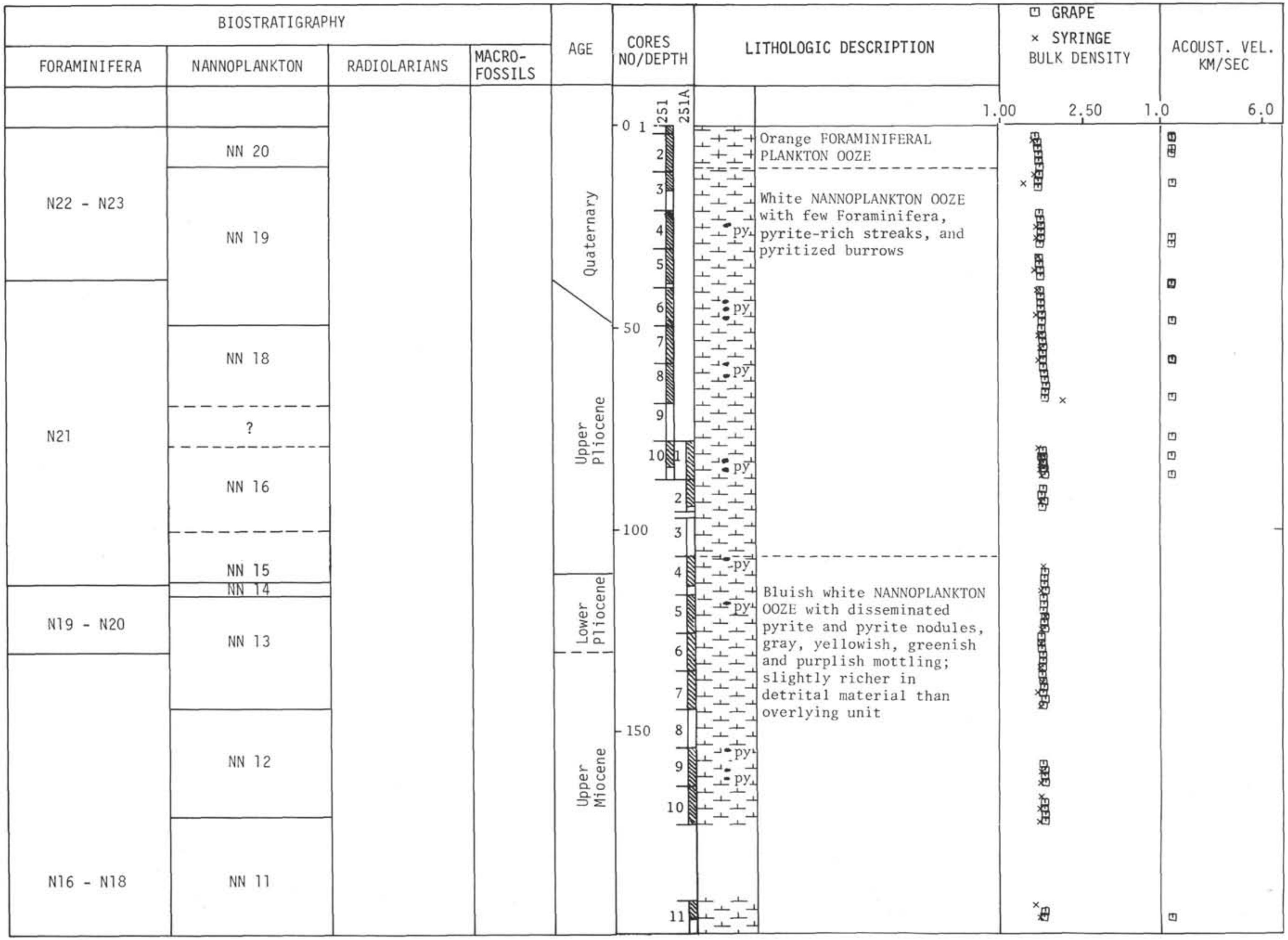
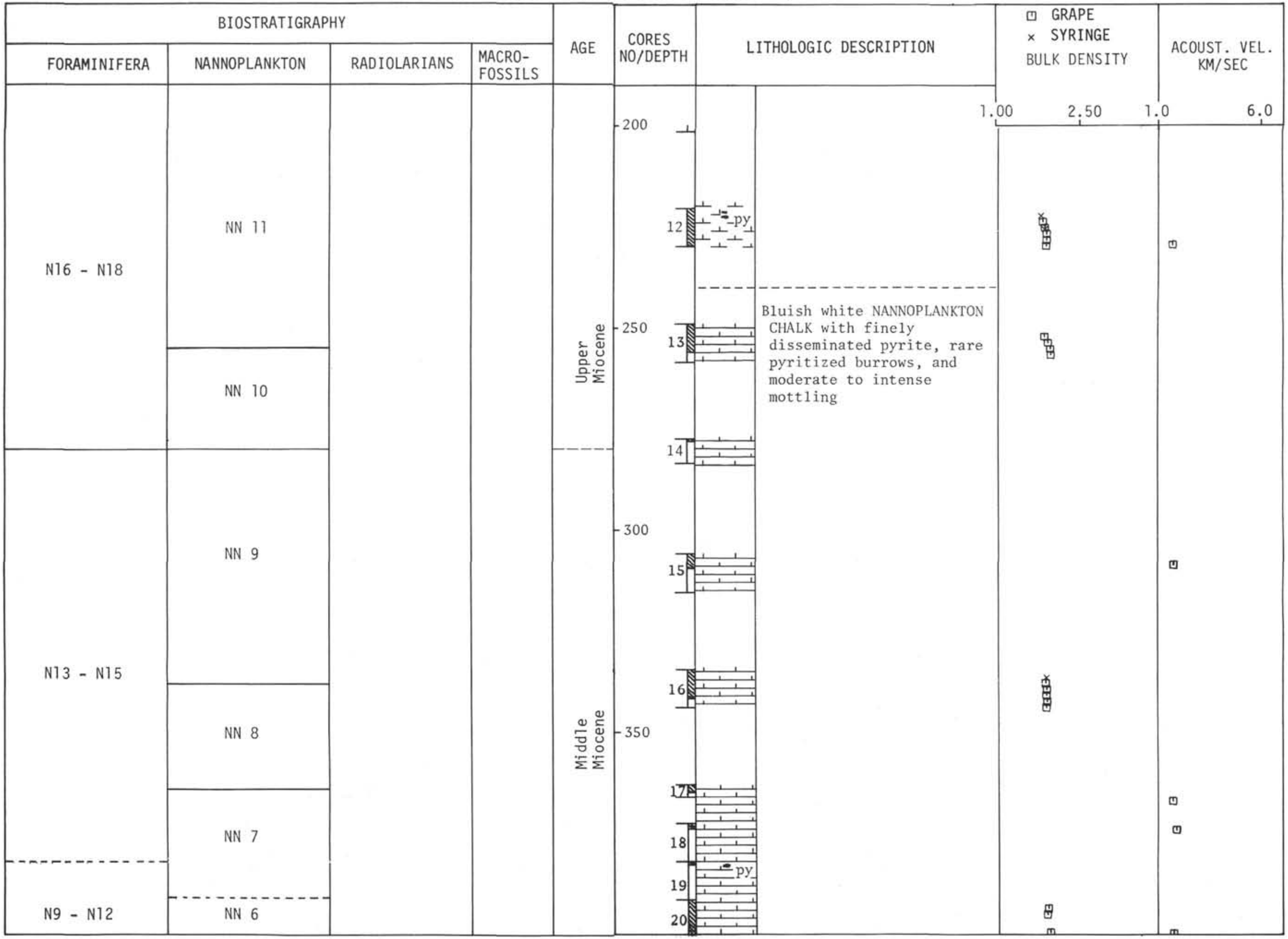
50
75
100
125
150
251A-30-1
251A-31-1
251A-31-2
251A-31-3
251A-31-4
251A-31-5

SUMMARY OF DRILLING RESULTS: SITE 251/0 - 200 m



SUMMARY OF DRILLING RESULTS: SITE 251/200 - 400 m



SUMMARY OF DRILLING RESULTS: SITE 251/400 - 600 m