5. SITE 267

The Shipboard Scientific Party[1]

SITE DATA, HOLES 267 AND 267A

Date Occupied: 6 Jan 1973

Date Departed: 7 Jan 1973

Position: 59°15.74'S; 104°29.30'E

Water Depth: 4522 corrected meters (echo sounding)

Water Depth (adopted): 4564 meters (drill pipe from rig floor)

Total Penetration: 290 meters

Number of Cores: 10

Total Section Cored: 86.5 meters

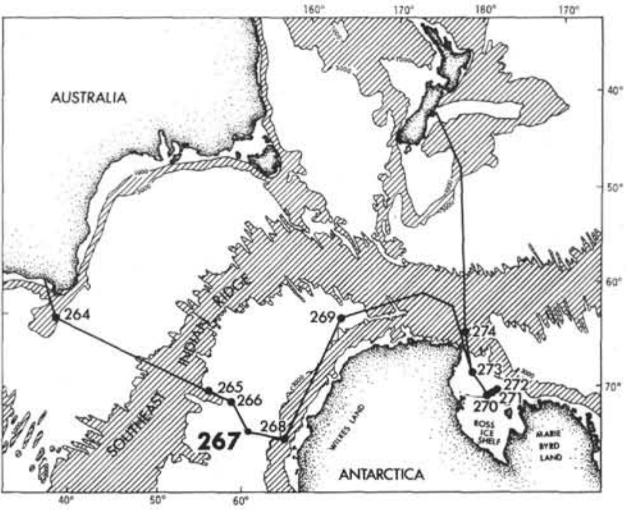
Total Section Recovered: 38.5 meters

Percent Recovery: 45%

Oldest Sediment Cored:
Depth below sea floor: 205 meters
Lithology: Foram-nanno limestone
Age: Mid Oligocene

Basement:
Depth below sea floor: 0.22 sec (reflection time)
Depth below sea floor: 205 meters (drilled)
Average velocity to basement: 1.87 km/sec
Lithology: Basalt

Principal Results: The section penetrated in these two holes consists of about 100 meters of Quaternary and Pliocene silty clays overlying lower Oligocene to lower Miocene nanno oozes and chalks. The contact between these units occurs somewhere in the unsampled interval between 99 and 127.5 meters subbottom. Glassy basaltic rock was encountered at 205 meters and about 16 meters were cored. The lower Oligocene age of basal sediment, though not well determined, does not conform precisely with the upper Eocene age suggested by magnetic anomalies. This discrepancy suggests the possibility of a basal unconformity or that the basalt represents a sill. A major climatic change is suggested by the appearance in the clay of ice-rafted grains, after an interval of carbonate deposition. This inferred climatic change probably took place in the middle or late Miocene, but it is not clear whether the initiation of ice rafting preceded, coincided with, or followed this major change in the nature of sedimentation. Thus, it is still uncertain whether the change from carbonate to clay deposition reflects the birth of the Antarctic Convergence, passage of the sea floor below the carbonate compensation depth (CCD), or a sharp rise of the CCD.



SITE DATA, HOLE 267B

Date Occupied: 7 Jan 1973

Date Departed: 8 Jan 1973

Position: 59°14.55'S; 104°29.94'E

Water Depth: 4495 corrected meters (echo sounding)

Water Depth (adopted): 4539 meters (drill pipe from rig floor)

Total Penetration: 323 meters

Number of Cores: 10

Total Section Cored: 95.0 meters

Total Section Recovered: 53.5 meters

Percent Recovery: 56%

Oldest Sediment Cored:
Depth below sea floor: 314 meters
Lithology: Foram nanno chalk
Age: uppermost Eocene or lowermost Oligocene

Basement:
Depth below sea floor: 0.35 sec (reflection time)
Depth below sea floor: 314 meters (drilled)
Average velocity to basement: 1.78 km/sec
Lithology: Basalt

Principal Results: The stratigraphic section in Hole 267B contrasts markedly with that in the first two holes at this site. Here, about 300 meters of Neogene silty clays predominate

---

[1] Dennis E. Hayes, Lamont-Doherty Geological Observatory, Palisades, New York (Co-chief scientist); Lawrence A. Frakes, Florida State University, Tallahassee, Florida (Present address: Monash University, Clayton, Victoria, Australia) (Co-chief scientist); Peter J. Barrett, Victoria University of Wellington, Wellington, New Zealand; Derek A. Burns, New Zealand Oceanographic Institute, Wellington, New Zealand; Pei-Hsin Chen, Lamont-Doherty Geological Observatory, Palisades, New York; Arthur B. Ford, U.S. Geological Survey, Menlo Park, California; Ansis G. Kaneps, Scripps Institution of Oceanography, La Jolla, California; Elizabeth M. Kemp, Florida State University, Tallahassee, Florida (Present address: Bureau of Mineral Resources, Canberra City, Australia); David W. McCollum, Florida State University, Tallahassee, Florida (University of South Carolina, Beufort, South Carolina); David J.W. Piper, Dalhousie University, Halifax, Nova Scotia; Robert E. Wall, National Science Foundation, Washington, D.C.; Peter N. Webb, New Zealand Geological Survey, Lower Hutt, New Zealand (Present address: Northern Illinois University, de Kalb, Illinois).

through almost the entire section with uppermost Eocene or lowermost Oligocene calcareous chalk being only poorly developed at the base (maximum thickness, 21 m). An unconformity may be present at or near the base of the clay sequence, below which the Oligocene and parts of the Miocene are missing. The erosion to produce such an unconformity, unless extremely localized, could not have begun before the middle Oligocene as evidenced at Hole 267 and must have terminated during or before the early Miocene.

The age of middle upper Eocene chalk is in precise agreement with the age suggested by magnetic anomalies. Although Holes 267 and 267A are only 2 km from Hole 267B, their respective sections are remarkably different, including total thickness.

BACKGROUND

Site 267 (Figure 1) is located in the deep basin south of the Southeast Indian Ridge and about 600 km north of the Wilkes Land continental shelf in a water depth of about 4450 meters. Magnetic anomalies indicate that the age of the oceanic crust here is 40-45 m.y. (Eocene) (Figure 2). The site lies just north and west of the distal portion of the vast South Indian Abyssal Plain in an area of low topographic relief which is apparently devoid of major turbidite sedimentation. The sediments are acoustically transparent and about 0.3-0.4 sec thick (250-350 m), overlying a relatively low relief surface of oceanic basement (layer 2). The upper one-third of the section appears to be stratified, and the structural relief on these strata reflects the small-scale relief of the bottom topography (Figure 3).

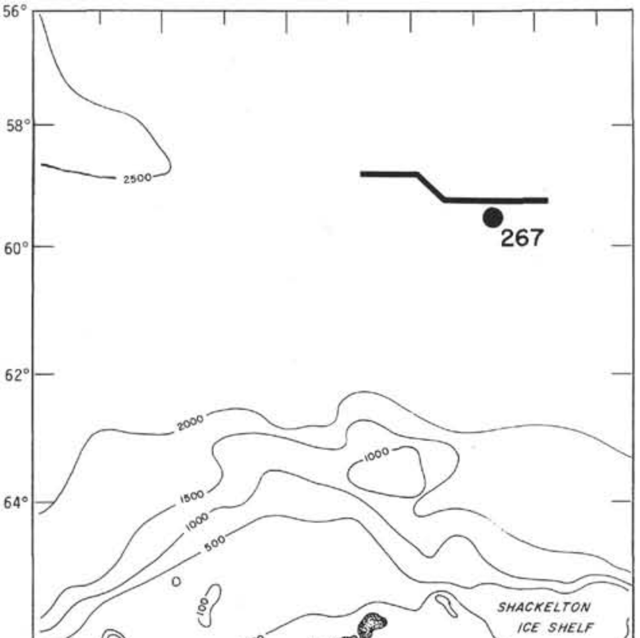


Figure 1. *Location of Site 267 and bathymetry. Contours in fathoms (corrected). Solid line is track line for the* Eltanin *49 seismic profile shown in Figure 3.*

Site 267 represents one of the most southerly sites (and therefore the oldest) where the total sediment cover is thin and penetration to basement is feasible. This site, Site 266, and Site 268, were chosen to provide a composite rise-basin-ridge reconnaissance profile for comparison with similar profiles anticipated adjacent to other sectors of Antarctica.

OPERATIONS

The approach to and selection of Site 267 were carried out in the same manner as for previous sites. After hauling gear and reversing course to get back over the site selected, the beacon was dropped in 4522 meters (corrected PDR) of water at 2005 on 5 January 1973.

The profiler records, while quite noisy, indicated a variable sediment thickness of 0.2 to 0.5 sec (two-way travel time) in the vicinity of the site. A sonobuoy record taken while on station indicated 0.22 sec of transparent sediment over acoustic basement.

Hole 267 was spudded in at 0845 on 6 January. Because the presence of numerous drifting icebergs made it likely that there would be a limited amount of in-hole time, minimal coring was done in the sedimentary section in an effort to reach basement. Total penetration was 219.5 meters below the sea floor, with the last 16 meters being in basalt.

The bottom-hole assembly and drill string were withdrawn and a new hole, 267A, was spudded in at 0000 on 7 January with the objective of acquiring additional cores from the sedimentary section. Three cores (one with no recovery and the deepest penetrating to 70.5 subbottom) were taken in this hole before an approaching iceberg made it necessary to pull out.

The bottom-hole assembly was cleared of the bottom at 0315 and the ship maneuvered to a new position for drilling, which put her clear of the iceberg drift. The new position was offset 8000 ft to the north and 1600 ft to the east of the beacon. A new beacon was dropped in 4495 meters of water (PDR corrected) at 1034 on 7 January to insure reliable signal at offset position and Hole 267B was spudded in at 1215. A second sonobuoy record was obtained showing 0.35 sec (two-way travel time) of sediment over acoustic basement.

Drilling with intermittent coring was carried out in this hole to a depth of 323 meters subbottom. A total of 10 cores was taken to fill in sampling of the sedimentary section at this site.

The drill string and bottom-hole assembly were recovered and the rig floor secured at 1530 on 8 January. The ship got underway on course 012° at 1543 hr and the geophysical gear was streamed. Following a Williamson turn, profiler, bathymetric, and magnetic data were acquired along an azimuth of 192° which passed the ship over both beacons.

LITHOLOGY

At Site 267, a thick sequence of clay sediments overlies nanno ooze and basalt. The thicknesses of the

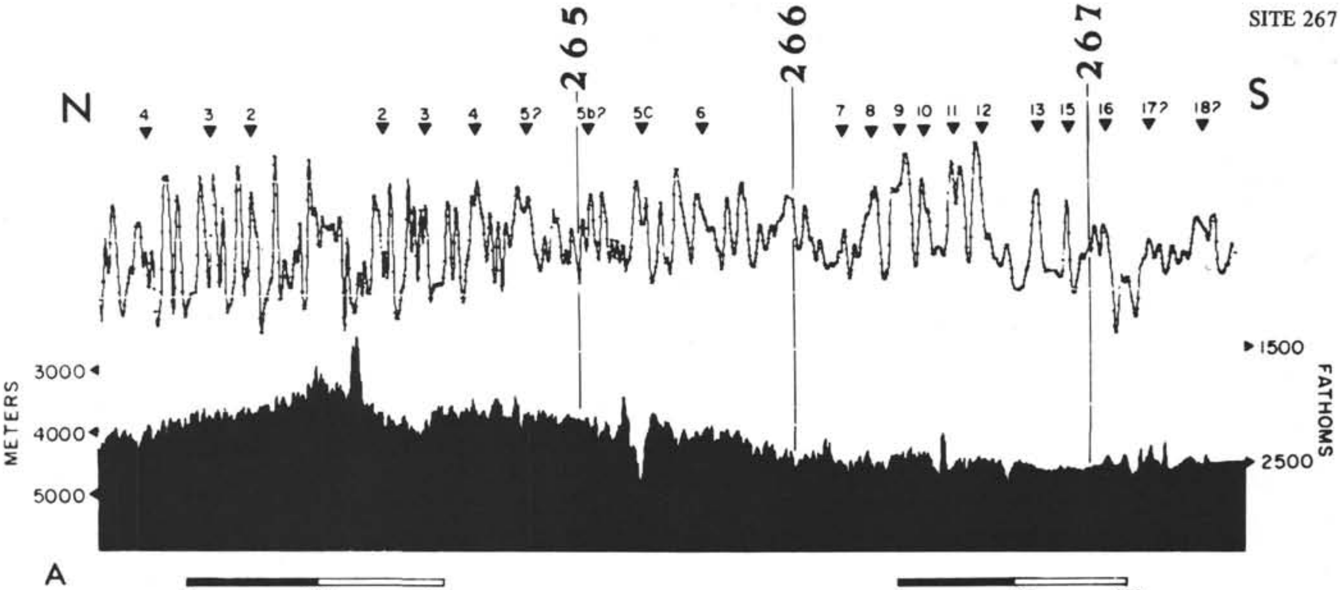


Figure 2. *Topographic and magnetic anomaly profiles between Sites 265 and 267.*

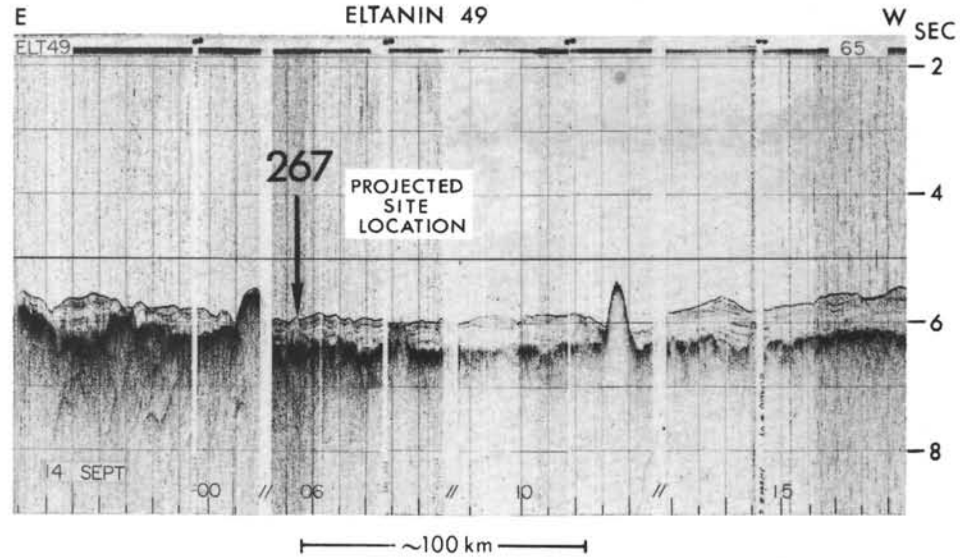


Figure 3. Eltanin *49 acoustic reflection profile in vicinity of Site 267. Vertical scale in seconds of two-way reflection time. Location of profile shown in Figure 1.*

different lithologies in Holes 267 and 267A, which were drilled at the same location, are very different from those in Hole 267B, drilled 2.6 km away (Tables 2 and 3).

Unit 1

Unit 1 is made up of a range of lithologies from clay with a trace of diatoms, through clay diatom ooze, to almost pure diatom ooze. Identifiable biogenic material is mostly diatomaceous, but radiolarians are also widespread in trace amounts. Nannofossils were found in trace amounts in a bed of carbonate-rich clay in Core 3, Section 5. Table 4 summarizes some important lithologic characteristics of Unit 1.

There appears to be no lithologic basis for a correlation within Unit 1 between Hole 267B and the two other holes.

Pebbles and granules, presumed to be ice rafted, are abundant in Cores 1 and 1A. Trace amounts of sand, which may also be ice rafted, have been found throughout Holes 267 and 267A.

Much of Unit 1 is intensely mottled. This mottling is believed to be due mainly to bioturbation, although some could be diagenetic.

X-ray diffraction analysis (Appendix III) shows the sediments are similar to those of Unit 1 at Site 266, except in having higher amphibole and mica contents, reflecting proximity to the continent. In Core 4B, and to a lesser degree in 3B and 5B, the sediment contains up to 10% of fine silt-sized rhodochrosite (identified by X-ray diffraction, Appendix III). The origin of this mineral has been discussed by Berger and von Rad (1972, p. 817).

At 1A-6, 10-13 there is a bed of manganese oxide coated pebbles (2-3 cm) and adherent granules. This is interpreted as representing a period of no deposition. The bed does not mark any pronounced lithologic changes, but interpretation is difficult because the immediately overlying 10 cm of sediment was removed for

TABLE 1
Coring Summary, Site 267

Core	Date (Jan. 1973)	Time	Depth From Drill Floor (m)	Depth Below Sea Floor (m)	Length Cored (m)	Length Recovered (m)	Recovery (%)
Hole 267							
1	6	1022	4574.0-4578.0	0.0-4.0	4.0	3.6	90
2	6	1137	4616.0-4625.5	42.0-51.5	9.5	cc	–
3	6	1310	4663.5-4673.0	89.5-99.0	9.5	6.3	66
4	6	1447	4701.5-4711.0	127.5-137.0	9.5	9.5	100
5	6	1644	4739.5-4749.0	165.5-175.0	9.5	4.0	42
6	6	1916	4777.5-4784.0	203.5-210.0	6.5	1.0	15
7	6	2201	4784.0-4793.5	210.0-219.5	9.5	1.5	16
Total					58.0	25.9	45
Hole 267A							
1	7	0101	4578.0-4587.5	4.0-13.5	9.5	8.9	94
2	7	0235	4606.5-4616.0	32.5-42.0	9.5	0.0	–
3	7	0900	4635.0-4644.5	61.0-70.5	9.5	2.7	28
Total					28.5	11.6	41
Hole 267B							
1	7	1442	4654.0-4663.5	105.0-114.5	9.5	1.5	16
2	7	1605	4682.5-4692.0	133.5-143.0	9.5	0.5	5
3	7	1740	4692.0-4701.5	143.0-152.5	9.5	1.1	12
4	7	1915	4711.0-4720.5	162.0-171.5	9.5	3.3	35
5	7	2027	4730.0-4739.5	181.0-190.5	9.5	9.5	100
6	7	2154	4749.0-4758.5	209.5-219.0	9.5	8.5	89
7	7	2350	4777.5-4787.0	238.0-247.5	9.5	9.5	100
8	8	0201	4806.0-4815.5	266.5-276.0	9.5	9.5	100
9	8	0400	4834.5-4844.0	295.0-304.5	9.5	9.5	100
10	8	0610	4863.0-4872.5	313.5-323.0	9.5	0.6	6
Total					95.0	53.5	56

TABLE 2
Lithologic Units, Holes 267 and 267A

Unit	Lithology	Subbottom Depth (m)	Unit Thickness (m)	Age
1	Clay, clay diatom ooze, and intermediate mixed clay diatom sediments	0-~110	~110	Early Miocene to Plio-Pleistocene (Matuyama)
2	Nanno ooze and chalk; micritic limestone	~110-~207	~97	Middle Oligocene to late Oligocene
3	Basalt	~207- ?	–	

TABLE 3
Lithologic Units, Hole 267B

Unit	Lithology	Subbottom Depth (m)	Unit Thickness (m)	Age
1	Clay, diatom ooze, and mixed clay diatom sediments	0-~310	~310	Middle or lower Miocene to early Pliocene
2	Nanno chalk	~310-~320	~ 10	Middle to early Oligocene
3	Basalt	~320- ?	–	

TABLE 4
Lithologic Summary of Unit 1

Core	Color Type [a]	Ice-Rafted Sediment (Abundance[b])	Bedding (Sharp Boundaries)	Mottling Intensity	Diatoms (%)
1	2	H	Present	L	2-15
1A	2	M	Present	L-M	30-70
2	2	?L	n.d.	n.d.	15
3A	1C	N	Absent	M	20-60
3	1B	L	Absent	H	tr-1
1B	1A	L	Absent	M	20
2B	1	L	Absent	M	30-60
3B	4	?L	Present	L	40-60
4B	1	?L	Absent	M	65-70
5B	1	N	Present	L-M	20-80
6B	1A	N	Absent		40-70
7B	1A	N	Absent	M-H?	15-40
8B	1A	N	Absent	M-H	10-40
8B-base		N	Present	L-M	90
9B	3	N	Absent	L-H	tr-10

[a] Color: Cores can be grouped into the following types solely on the basis of color. (1) Close association, with much mottling, of light olive-gray (5Y5/2) and pale brown (5YR5/2); (1A) As 1, but the light olive-gray is dominant. Usually a few grayish-green (5G5/2) mottles also; (1B) As 1 but the pale brown dominant, (1C) As 1, but with light olive-gray replaced by pale yellow-brown (10YR6/2), and pale brown replaced by light brown (5YR6/4). Interpreted as becoming type 1 with further compaction; (2) Moderate yellowish-brown (10YR5/4); (3) Light brown (5YR6/4) and dark yellowish-brown (10YR4/2) interbedded and mottled; (4) Shades of gray (N5 to N7)

[b] N = None; L = Low; M = Medium; H = High; n.d. = no data.

geochemical sampling. The manganese oxide geochemistry is discussed in Chapter 25.

Ice rafted sediment: The abundance of ice-rafted material is estimated from the number of pebbles, granules, and coarse sand grains found while scraping the split core surface. A low abundance is indicated where coarse sand grains could only be detected in coarse residues after sieving.

Bedding: Beds with sharp, little-disturbed bedding planes are recorded.

Intensity of mottling: This is estimated from the length of core over which color boundaries are spread by mottling; low: 0-5 cm; medium: 5-20 cm; high: >20 cm.

Percent diatoms: Estimated from smear slides.

Unit 2

This unit consists of nanno oozes and chalks, with minor amounts of forams, diatoms, Radiolaria, and clay. Ooze was recovered from Cores 267-4 and 5; it is intensely mottled and ranges in color from grayish-orange-pink to light brown. No correlation between lithology and color could be distinguished. *Zoophycos* burrows are found in Core 5, Section 2.

Nanno chalk was found in Cores 267-5 and 6, and 267B-10. In the latter, there are flattened burrows about 1 cm diameter, with 1-2 mm wide white rims.

In Core 267-6, there is a micritic limestone with occasional forams. No sparry calcite was observed in thin section. The limestone has rare fine elongate mottles interpreted as burrows. Similar to these, but much more abundant, are thin (1 mm) sinuous tubes dissolved out of the limestone, with concentrations of an opaque mineral along their margins. Their origin is not known. The limestone occurs immediately above basalt in Core 6. Although the comparatively high degree of lithification suggests contact metamorphism by the underlying basalt, no evidence of recrystallization is visible in thin section. Neither is there any evidence, however, that the limestone is in sedimentary contact with the basalt.

Unit 3

Basalt was encountered in Hole 267 at a subbottom depth of 205 meters and was drilled to a depth of 219.5 meters. A total of about 2.3 meters of basalt was recovered in Cores 6 and 7, in addition to that in core catchers. Basalt was not reached in Hole 267A, but about 25 cm was recovered in Core 10 in Hole 267B at a subbottom depth of 323 meters.

In hand specimen, the basalt appears nearly uniform in all three cores. It is medium dark to dark gray (N_3 to N_4), becoming lighter gray where altered. Alteration is particularly obvious in Core 7 where veinlets up to about 0.5 cm wide and vesicles are filled with secondary carbonate minerals. Selvages of fresh, black glass up to 2 cm thick occur on several basalt fragments in Core 7. Plagioclase phenocrysts are only rarely visible. Brownish spherulitic masses several centimeters or less in diameter locally give the rock a mottled appearance.

In thin section, the basalt is seen to consist chiefly of unidentifiable brownish devitrification products in closely packed radial growth patterns. The spherulites are interspersed with up to about 10% of euhedral to subhedral, lath-shaped to blocky, microphenocrysts of plagioclase. Plagioclase also forms abundant, small and anhedral quench crystals. Microphenocrysts of clinopyroxene, probably augite, are less abundant, and olivine was not observed. The absence of olivine and its pseudomorphs contrasts with its general presence in the basalts of Hole 265 and suggests that major chemical differences exist between the basalts of these two areas. The abundance of glass, now devitrified, and of quench crystals suggests that the basalt is more likely extrusive than intrusive.

Interpretation

This site resembles Sites 266 and 265 in having siliceous pelagic sediments overlying calcareous diatomaceous sediments, but has a higher clay content. This may reflect increased sediment supply from the continent (clay mineralogy is similar to 266, but 265 has more montmorillonite), or less dilution by biogenic material. There has been some contribution of ice-rafted sediment since at least the late Miocene. The bed of manganese oxide-coated pebbles indicates winnowing by bottom currents. The variation in thickness of Miocene sediments between Holes 267/267A and 267B is most easily explained by a local erosional unconformity in Hole 267 of approximately ?middle/late Oligocene age. The variation in thickness of Unit 2 between the two sites probably has a similar origin. Basement is 80 meters deeper at Hole 267B, yet its basal carbonate section is much thinner, so infilling of basins in basement appears unimportant at this locality.

PHYSICAL PROPERTIES

Wet bulk-density determinations were obtained on nearly all cores using both syringe samples and the GRAPE technique. The syringe samples also provided porosity measurements. These data, together with sonic-velocity observations, have been plotted for the combined Holes 267 and 267A and for Hole 267B, respectively (Figure 7).

Aside from the usual trend of decreasing porosity and increasing bulk density with depth of burial, the following observations were noted. First, in contrast to the previous two sites where a relatively abrupt change in physical properties was found across a lithologic boundary between diatom ooze above and nanno ooze below, the changes observed with depth at Site 267 are gradual. The single exception to this is in Core 6, Sections 2, 3, and 5, all of which show anomalously and inexplicably low GRAPE wet bulk densities.

Second, a comparison of the wet bulk-density variation with depth for the combined Holes 267 and 267A with that for Hole 267B suggests that, while they show similar trends, there is a systematic displacement between them. Thus, for any given depth of burial down to 175 meters subbottom, sediment from Holes 267 or 267A is 0.1 to 0.2 g/cc more dense than sediment from the same depth subbottom in Hole 267B.

Finally, several of the core sections on which closely spaced sonic-velocity measurements were obtained show a rather clear inverse relationship between velocity and wet bulk density. This correlation for Section 267A-1-5 (top 100 cm), illustrated in Figure 4, shows changes of about 25 m/sec in sonic velocity for changes in wet bulk density of 0.10 g/cc.

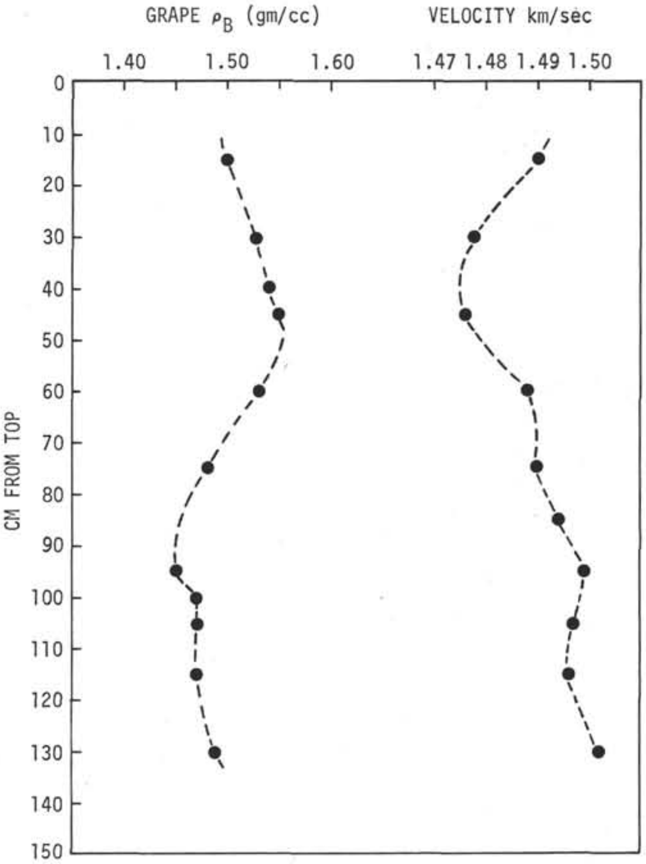


Figure 4. *Relationship between wet bulk density (G.R.A.P.E.) and sonic velocity in Section 5 of Core 1, Hole 267A.*

Several velocity measurements were obtained on hard-rock samples from Cores 267-6, 267-7, and 267B-10. Values for basalt fragments ranged from 5.16 to 5.78 km/sec.

Alkalinity, *p*H, and salinity data are summarized in Figure 5. There are no distinctive trends or correlations with lithology, and values recorded are within the expected ranges from other sites. In the section of overlap between Holes 267 and 267A, there is good to fair correspondence of the measurements.

BIOSTRATIGRAPHIC SUMMARY

Foraminifera, diatoms, Radiolaria, and ostracodes are well represented in various parts of Holes 267, 267A, and 267B. Siliceous microfossils are best developed in the Miocene-Pliocene sediments with foraminifera and nannofossils dominant in the late Eocene-early Miocene sediments.

Remarks in the biostratigraphic summary of Site 266 on the usefulness of the various microfossil groups also apply to this site. Established low-latitude Neogene calcareous microfossil zonation is of little or no use in dating these sediments. Radiolaria and diatoms are clearly more useful. Siliceous microfossils are present in abundance, exhibit high diversity, and are generally well

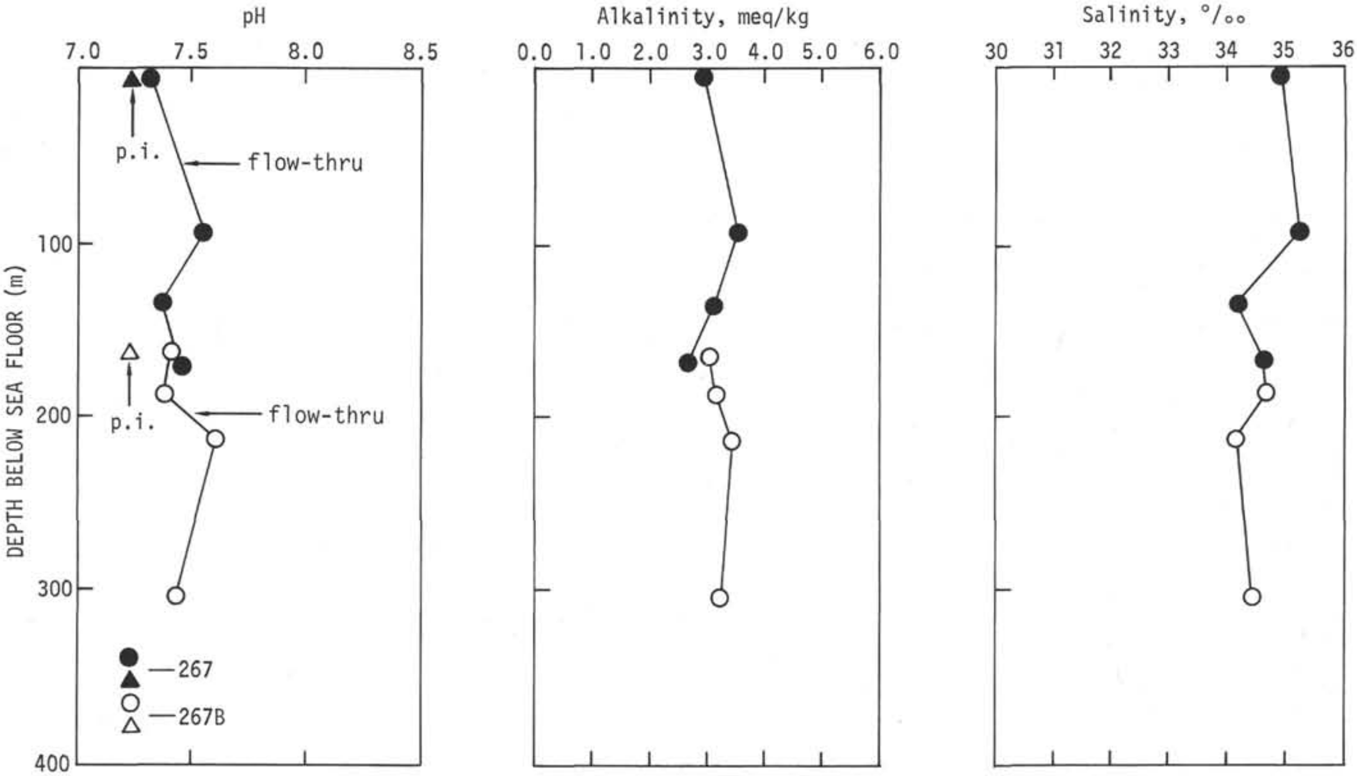


Figure 5. *Shipboard measurements of* pH, *alkalinity, and salinity of sediment pore waters at Site 267.*

preserved. The absence of agglutinated and calcareous benthonic foraminifera possibly results from a combination of a shallow lysocline and a high clastic sedimentation rate, the latter resulting in high turbidity at the sediment-water interface. The presence or absence of agglutinated taxa may also be related to the availability of cementing materials. Echols (1971) noted that in the Recent sediments of the Scotia Sea, agglutinated taxa incorporate either calcareous or siliceous cement. Agglutinated taxa with calcareous cement do not occur below the lysocline.

Echols also noted that taxa with siliceous cement (particularly the Ataxophragmiidae) occur most abundantly where there is a high diatom population and rarely or not at all in sediments with only a few diatoms. This suggests that diatoms contribute to the dissolved silica in interstitial waters. The absence of significant agglutinated benthonic taxa in the diatom-rich Neogene sediments at Site 267 (and at earlier sites) can probably be explained by the fact that the terrigenous component was high enough to cause a high level of turbidity at the sediment-water interface. According to Stainforth (1952) and other authors, the development of agglutinated forms is severely checked in the presence of turbid conditions.

The late Eocene lysocline for foraminifera and nannofossils at Site 267 was considerably lower than that prevailing during the Neogene, with the result that calcareous microfossils are abundant. In both New Zealand and Australia, the late Eocene was a period of widespread transgression with deposition of thick carbonate successions upon clastic sediments. In many places these clastic successions included coal measures and carbonaceous sediments. The occurrence of cosmopolitan calcareous assemblages in the late Eocene of Site 267 allows ready correlation with the biostratigraphic schemes of these more northerly areas. It seems likely that the southern Australian basins and the offshore Antarctic basins had a common circulation at that time. Late Eocene faunas at Site 267 indicate temperate conditions and contrast sharply with the cool faunas present in the overlying Neogene sediments. These paleotemperature trends are reflected in the species diversities of the various microfossil groups. Foraminifera are most diverse in the late Eocene where there are about 40 species present, 11 of them planktonics. By the Oligocene this number had declined to about 15 species, with only 3 species of planktonic foraminifera. No foraminifera were extracted from Miocene-Pliocene sediments, but closer sampling might yet produce a small fauna. Nannoplankton diversity figures are as follows: 6 species in the late Eocene, 12 in the mid Oligocene, 6 species in the late Oligocene, 4 to 6 in the early Miocene, after which the group disappears from the record. Radiolaria are abundant from the Miocene to Pliocene, the diversity in the Pliocene being about 10 times that of the Miocene. Conversely, Miocene diatoms are about three times more diverse than those of the Pliocene although Pliocene diatoms occur in greater abundance.

Foraminifera

Holes 267/267A

Planktonic foraminifera are very limited at this site, both stratigraphically and in abundance. They occur only in Cores 5 and 6 and comprise a fauna dominated by *Globigerina angiporoides* and *Catapsydrax unicavus*. The assemblage in Core 6 is slightly more diverse and includes several specimens of *Globigerina linaperta*.

The closest age determination for the basal portion of Holes 267 and 267A is late Eocene/early Oligocene. Although the presence of *G. linaperta* in Core 6 indicates a late Eocene age according to the New Zealand zonation, the fauna lacks other typically Eocene species such as *Globigerapsis index*, and so is more likely of early Oligocene age. This, however, may require revision on the basis of additional Antarctic data.

Hole 267B

Abundant and well-preserved foraminifera occur in Core 10B with the richest fauna being extracted from 10B-1, 90-92 cm. The fauna from this interval comprises 12 planktonic and at least 30 benthonic taxa. Planktonics constitute at least 95% of the fauna. Agglutinated taxa constitute a minor proportion of the benthonic taxa. Calcareous benthonics are mostly small and fragile. The larger benthonics (e.g., *Lenticulina*) are usually broken. Large ostracodes are present in moderate numbers.

The following taxa were recorded: (planktonic foraminifera) *Chiloguembelina cubensis* (Palmer), *Chiloguembelina martini* (Pijpers), *Catapsydrax echinatus* Bolli, *Hantkenina* sp. (single broken specimen), *Globigerina* (*Subbotina*) *linaperta* Finlay, *G.* (*S.*) *angiporoides* Hornibrook, *Globorotalia* (*Turborotalia*) spp., ?*Globigerapsis index* (Finlay); (benthonic foraminifera) *Siphotextularia*, *Dorothia*, *Lenticulina*, *Astacolus*, *Dentalina*, *Nodosaria*, *Lagena*, *Entosolenia*, *Nodosarella*, *Ellipsopolymorphina*, *Pleurostomella*, *Pullenia*, *Globocassidulina*, *Fursenkoina*, *Bulimina*, *Alabamina*, *Gyroidinoides*, and *Cibicides*.

This fauna has much in common with Eocene faunas of southern Australia (i.e., Eucla, St. Vincent, Murray and Otway basins, and Naturaliste Plateau) and New Zealand. The fauna in Hole 267B is a deep open marine assemblage, certainly deeper than its Australian and New Zealand counterparts. Temperatures were neither tropical nor cold, and it is thus very unlikelly that continental glacial conditions existed in the upper Eocene in nearby East Antarctica.

Ludbrook and Lindsay (1969) show that in South Australia *Globigerina linaperta* ranges through the middle and upper Eocene, terminating at the Eocene-Oligocene boundary. A similar range is known from New Zealand (Jenkins, 1971). The absence of the ubiquitous taxon *Pseudogloboquadrina primitiva* (Finlay) from 267B is significant. In both South Australia and New Zealand this species terminates at the middle-upper Eocene boundary and so its absence in 267B suggests, perhaps, that the fauna is late Eocene. An exhaustive search produced a single broken test of *Hantkenina* (perhaps *H. alabamensis compressa* Parr), a taxon with a very restriccted range in South Australia. Ludbrook and Lindsay (1969) show it as being confined to the middle upper Eocene and McGowran et al. (1971) suggest a correlation with the boundary between P15 and P16. It is noteworthy that the common Eocene taxon *Globigerapsis index* is absent from 267B (a few dubious specimens were recovered but they are probably not *index*). In New Zealand, *G. index* ranges up to the Eocene-Oligocene boundary. In South Australia it terminates within the lower part of the upper Eocene and a similar range in the area of Site 267B may explain its absence from this middle upper Eocene fauna. There is one other alternative explanation, already advanced—that *G. index* is confined to marginal glauconitic marls and absent or poorly represented in deeper-water pelagic sediments. Such a facies preference would explain its absence from 267B.

This fauna is correlated with the *Turborotalia aculeata* Zone of South Australia; the *Globigerina linaperta* Zone and Kaiatan-Runangan Stages of New Zealand; and P15-P16 of the Blow zonation.

Nannofossils

Holes 267/267A

In Hole 267 a Recent to lower Oligocene section was cored. The uppermost part of the section (Cores 1 to 3) consisted of siliceous oozes with no nannofossils. In the lower section however, Cores 4 to 6 contained significant nannofossil assemblages, although these had a low diversity. There is a marked change in the assemblages within the brown chalk section directly above the limestone/basalt contact in Core 6. The assemblages in this section are more diverse. The assemblages in Cores 4 to 6 at the site include the species: *Cyclicargolithus floridanus*, *Dictyococcites scrippsae*, *Coccolithus pelagicus*, *Chiastomolithus altus* (rims), *C. altus*, *Discoaster deflandrei*, *Dictyococcites abisectus*, *Sphenolithus moriformis* (small type), *Discoaster nodifer*, *Reticulofenestra hillae*, *Coccolithus eopelagicus*, *Reticulofenestra* cf. *gartneri*, *R. umbilica*, *Dictyococcites bisectus*, *Sphenolithus moriformis*, *Chiastomolithus oamaruensis*, *C. expansus*, and *Ericsonia subdisticha*.

Occasional specimens of reworked *Isthmolithus recurvus* are also present in Core 4.

The calcareous sediments of Cores 4 to 6 can be biostratigraphically subdivided as follows. Upper Oligocene: Sample 4-1, 115 cm to Sample 4-6, 122 cm; middle Oligocene: Sample 5-1, 90 cm to Sample 5-3, 123 cm; lower Oligocene: Core 6-1.

No nannofossils were found in the three cores taken in Hole 267A.

Hole 267B

In the thicker section of sediments sampled at Hole 267B, Cores 1 to 9 contained either siliceous oozes or muds with no nannofossils. Only the short section of brown worm-burrowed chalk (Core 10) in contact with the basalt contained common well-preserved nannofossils.

In this short calcareous section the assemblages contain the following species: *Coccolithus pelagicus*, *Reticulofenestra hillae*, *Coccolithus eopelagicus*, *Reticulofenestra umbilica*, *Zygrabdolithus bijugatus*, *Dictyococcites bisectus*, *Isthmolithus recurvus*, *Cyclococcolithina formosa*, *Sphenolithus moriformis*, *Chiastomolithus altus*, and *C. oamaruensis*.

The distribution of these nannofossil species gives a lower Oligocene to latest Eocene age for these sediments.

Radiolaria

Holes 267/267A

Holes 267 and 267A consist of about 100 meters of Quaternary and Pliocene silty clay overlying early Miocene to middle Oligocene nanno ooze and chalk. Radiolaria are present in all of the samples studied. Neogene sediments contain common, moderately to well preserved Radiolaria, whereas Paleogene sediments contain few, moderately to poorly preserved Radiolaria.

Radiolarian zones represented in these two holes are: Sections 1-1 to 1-3, the *Saturnalis circularis* Zone; Samples 1, CC to 1A, CC the *Helotholus vema* Zone; Core 2, the *Theocalyptra bicornis spongothorax* Zone; and Core 3A, the *Antarctissa conradae* Zone. Core 3 is of early Miocene age, probably in the *Cyrtocapsella tetrapera* Zone. Cores 4 and 5 are believed to be of late and middle Oligocene age, respectively, on the basis of the correlation of radiolarian assemblages with Sites 277 and 278 of Leg 29. The Miocene/Pliocene boundary is located at the coring gap between Cores 1A and 2. The Oligocene/Miocene boundary lies between Cores 4 and 5.

The *Antarctissa denticulata* Zone, *Stylatractus universus* Zone, and *Eucyrtidium calvertense* Zone are not encountered at the top of these two holes. The *Actinomma tanyacantha* Zone may be present in the coring gap between Cores 3A and 3. No reworked older Radiolaria are found in any samples examined in these two holes.

Hole 267B

Hole 267B is offset about 2 km from Holes 267 and 267A. About 300 meters of Neogene diatomaceous silty clays overlie middle to early Oligocene chalk. Thus an unconformity is present near the base of the clay sequence, between which parts of the Miocene and Oligocene are missing. Radiolaria are common and well preserved in the post-Miocene sediments, and few to common and moderately preserved in the Miocene sediments. Oligocene sediments are barren of Radiolaria.

Radiolarian zones represented are: Cores 1-3, the *Helotholus vema* Zone; Core 4 to Core 6, Section 3, the *Theocalyptra bicornis spongothorax* Zone; Sections 6-4 to 7-3, the *Antarctissa conradae* Zone; and Sections 7-4 to 8-3, the *Actinomma tanyacantha* Zone. Section 8-4 to Sample 9, CC is of middle to early Miocene age. No reworked older Radiolaria are observed in the samples studied in this hole.

Diatoms

Holes 267/267A

Samples from this site contained diatoms in low abundance in a fair preservational condition. Only three cores could be zoned on the basis of diatoms. Sample 1, CC contained a portion of the *Rhizosolenia barboi/Nitzschia kerguelensis* Zone. Sample 2, CC contained a portion of the *Denticula hustedtii* Zone. The remainder of the cores were barren. From Hole 267A only 1A, CC contained a portion of the *Rhizosolenia barboi/Nitzschia kerguelensis* Zone. The remainder of the cores were barren.

Hole 267B

Diatom abundance and preservation at this site is generally poor, but portions of three diatom zones could be recognized. Core 1 is unzoned and can only be described as having diatoms characteristic of Miocene aged sediment. Cores 2, 3, and 4 contained a portion of the *Denticula hustedtii* Zone. Core 5 contained a portion of the *Denticula hustedtii/Denticula lauta* Zone. Cores 6 through 8 contained a portion of the *Denticula lauta/Denticula antarctica* Zone. Below Core 8 this hole is barren of diatoms.

Silicoflagellates

Holes 267/267A

Silicoflagellates are generally rare to few in all cores at Hole 267, with the exception of Core 1 where silicoflagellates are abundant. Of the three cores taken at Hole 267A, only Core 1 contains significant amounts of silicoflagellates.

At 9.5 meters (Sample 1, CC) the assemblage present is indicative of the *Distephanus speculum* Zone A. From 42 to 99 meters (Cores 2 and 3) a lack of floral diversity prevents an age designation. The section from 130.5 to 137 meters (between 4-3 and 4-6) contains a portion of the late Oligocene *Naviculopsis biapiculata* Zone. An enigmatic assemblage of silicoflagellates with no known correlative is found at 166 to 170 meters (between Sections 5-1 and 5-3).

At Hole 267A, only Core 1 could be zoned on the basis of silicoflagellates. The sampled interval of Core 1 at 7.5 to 13.5 meters (between 1-6, 2 and 1, CC) is assigned to the *Distephanus speculum* Zone A, however this age is questionable because of difficulties with reworked material of a slightly older age.

Hole 267B

Silicoflagellates occur abundantly or commonly in Cores 1 and 3, while the remainder of the cores contain rare amounts or are barren altogether. Preservation of silicoflagellates present in Cores 1 through 3 is good; however, only spine fragments and a few whole specimens remain in Cores 4 through 10.

Core 1 contains a portion of the *Dictyocha pseudofibula* Zone which is confined to the interval between Gilbert magnetic events "A" (3.7 m.y.) and "B" (3.92 m.y.). The sediment interval between Samples 2, CC and 3-1, 130-132 cm is assigned to the upper *Mesocena diodon* Zone (~Gilbert magnetic event "B"—Epoch 5). Sample 3, CC is thought to contain the lower *Mesocena diodon* Zone (Epoch 5, 5 m.y.). The Pliocene/Miocene boundary is placed between Samples 3-1, 130-132 cm, and 3, CC, even though a lower boundary in the coring gap between 3, CC and 4-1 is possible (for further discussion, see Silicoflagellate Biostratigraphic chapter). Sample 4, CC contains one specimen of *Mesocena cir-*

culus which, if not reworked, indicates an upper Miocene age. With the exception of Core 6, the remainder of the cores in Hole 267B are of such low diversity that no sediment age determination is possible. Core 6 yielded only one specimen of the middle Miocene species *Dictyocha octacanthus*.

SUMMARY AND CONCLUSIONS

Site 267 is located on the northern extremity of the deep basin south of the Southeast Indian Ridge and about 600 km north of the Wilkes Land continental shelf, in a water depth of 4550 meters. Three holes were drilled at this locality, the third or "B" hole being offset about 2 km north-northeast in order to avoid converging icebergs. Perhaps one of the most significant results of drilling at Site 267 is the demonstration of marked stratigraphic differences between closely spaced holes.

Correspondence of lithology and biostratigraphy is good between interspaced cores in the first two holes, as is usual at DSDP sites. The composite section from these two sets of data differs however from the sequence in the B hole in three significant respects:

1) the Pliocene-Recent sequence is greatly attenuated as compared with Hole 267B;

2) the Oligocene is well developed while possibly lacking altogether in Hole 267B; and

3) sedimentation rates are uniformly low, whereas they are extremely irregular in Hole 267B.

Although there is a great influence of terrigenous sedimentation at Site 267 much more marked than at Sites 265 and 266, the upward transition from deposits of calcareous nannofossils to diatomaceous strata can still be seen. The lithologic change takes place more abruptly and apparently considerably earlier at Site 267 (late Oligocene to early Miocene) than at Site 266 (middle to late Miocene), once again demonstrating a diachronous facies boundary separating sediments rich in calcareous nannofossils below from diatomaceous ones above. The terrigenous component is most abundant in early Miocene and younger strata, these being dominantly clays and silty clays associated with varying concentrations of diatoms, including oozes, while earlier sediments, dominantly nannofossil oozes and chalks, contain little clay and silt. It seems likely that this section of the Southern Ocean was cut off from an abundant supply of clastic material from Antarctica before the early Miocene, probably because the site occupied a position relatively high on the ridge flank and hence well above the pathways traversed by most bottom currents. Since the early Miocene, however, Site 267 has been located in water depths exceeding about 4300 meters, based on the age-depth curve in Kemp, Frakes, and Hayes (this volume), and at these depths it was subject to bottom transport processes, probably in the form of nepheloid layers but including a few turbidity currents.

Ice-rafted erratics up to pebble size are found in sediments of middle Miocene age and younger; their occurrence at levels back to early Miocene (Core 3) is possibly the result of fall-ins during drilling. In either situation, ice rafting commenced earlier at Site 267 than at Site 266, another case of a diachronous facies boundary younging towards the north. The existence of a northward-decreasing gradient in rafting intensity is demonstrated by relative abundances of sand grains at Sites 266 and 267 (Piper, this volume).

One unconformity was sighted visually at this site, and two others are postulated on stratigraphic evidence. In Core 1A-6 a thin bed of ferromanganese-coated pebbles suggests a period of reduced sedimentation, and any missing interval is thought to be short since Gilbert A overlies Gilbert B.

A second unconformity may exist within Core 1 in view of the fact that the core catcher is dated as middle Matuyama and the sedimentation rate for the entire 4 meter core is therefore less than 2 m/m.y.

The third unconformity probably occurs below the oldest sediments in the first two holes (Core 6) but above the oldest ones in Hole 267B (Core 10B); that is, between the middle Oligocene and lowermost Oligocene/latest Eocene. In this interpretation the nannofossil deposits of Hole 267B represent a thin remnant on basement of a formerly thicker, but probably varied, sequence continuing upward into the Oligocene and Miocene, the great majority of which (?latest Eocene to middle Miocene) has been stripped by submarine erosion. Erosion affected the locality 2 km away as well, but the missing section there includes only the Eocene to middle Oligocene strata. A buttressing effect due to channeling of currents through the site of Hole 267B is indicated; bottom relief would have approximated 200 meters judging from relative elevations of the basal middle Miocene sediments. Following erosion, the depression filled more rapidly than surrounding higher ground, probably by means of bottom transport by currents and beginning in the middle Miocene. However, filling has continued until comparatively recently, and that this has been most effective in post-Miocene time is indicated by the fact that Hole 267B deposits of this age are six times as thick as those in the first locality (150 m versus 25 m).

Sedimentation rates at Site 267 (Figure 6) are best reckoned from rates outside Hole 267B, where two intervals of relatively rapid sedimentation (middle Miocene, up to 70 m/m.y.; and post Miocene, up to 30 m/m.y.) alternate with slower rates. Normal rates for the region as suggested by more stable conditions in Hole 267A average to about 5.5 m/m.y., for accumulation of dominating clays since the middle Oligocene.

The oldest sediments at Site 267 began to accumulate shortly after formation of oceanic basement. Basal nannofossil chalks in Hole 267B are late Eocene-earliest Oligocene (35-38 m.y.) in age while the basement age is considered to be about 41 m.y. (late Eocene) on the basis of the site being positioned between sea-floor anomalies 15 and 16 (Weissel and Hayes, 1972). The abundance of glass, now devitrified, and of quench crystals in the basalt suggests that the rock is more likely extrusive than intrusive.

REFERENCES

Berger, W. H. and von Rad, U., 1972. Cretaceous and Cenozoic sediments from the Atlantic Ocean. *In* Hayes, D. E., Pimm, A. C., et al., Initial Reports of the Deep Sea Drilling Project, Volume 14: Washington (U.S. Government Printing Office), p. 787.

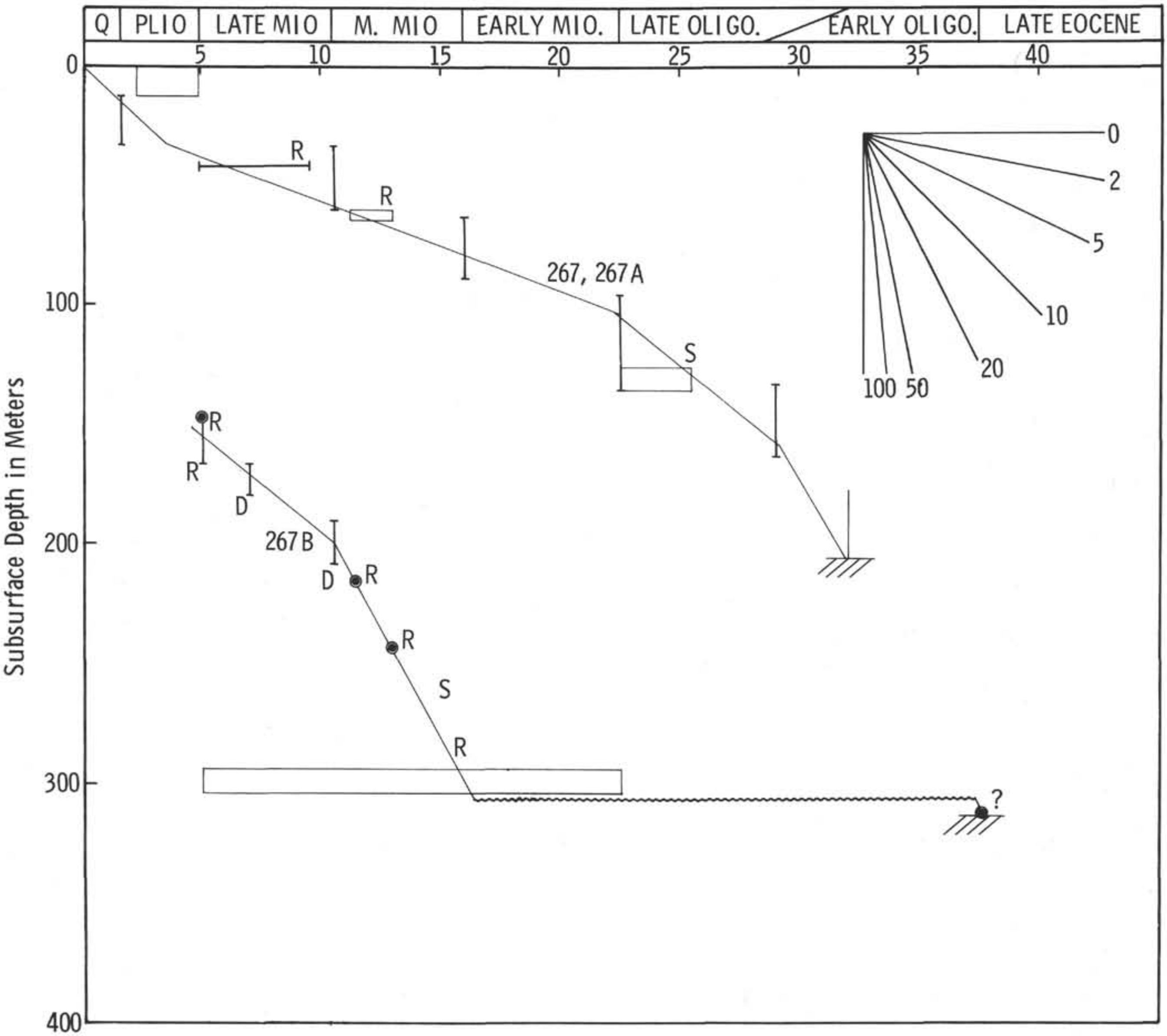


Figure 6. *Comparison of accumulation rates between Holes 267-267A and Hole 267B.*

Echols, R. J., 1971. Distribution of foraminifera in sediments of the Scotia Sea area, Antarctic waters. *In* Reid, J. L., (Ed.), (Am. Geophys. Union) Antarctic Oceanology I, Antarctic Res. Ser., v. 15: Washington, p. 93-168.

Jenkins, D. G., 1971. New Zealand Cenozoic planktonic foraminifera: New Zealand Geol. Surv., Paleontol. Bull. 42.

Ludbrook, N. H. and Lindsay, J. M., 1969. Tertiary foraminiferal zones in South Australia: Internatl. Conf. Plankt. Microfossils Proc. 1st, v. 1:, Leiden (E. J. Brill), p. 366-374.

McGowran, B., Lindsay, J. M., and Harris, W. K., 1971. Attempted reconciliation of Tertiary biostratigraphic systems; Spec. Bull. (Otway Basin) Geol. Surv. South Australia and Victoria, p. 273-281.

Stainforth, J. M., 1952. Ecology of arenaceous foraminifera: Micropaleontologist, v. 2, p. 42-44.

Weissel, J. K. and Hayes, D. E., 1972. Magnetic anomalies in the southeast Indian Ocean. Antarctic Research Series, 19, 234-249.

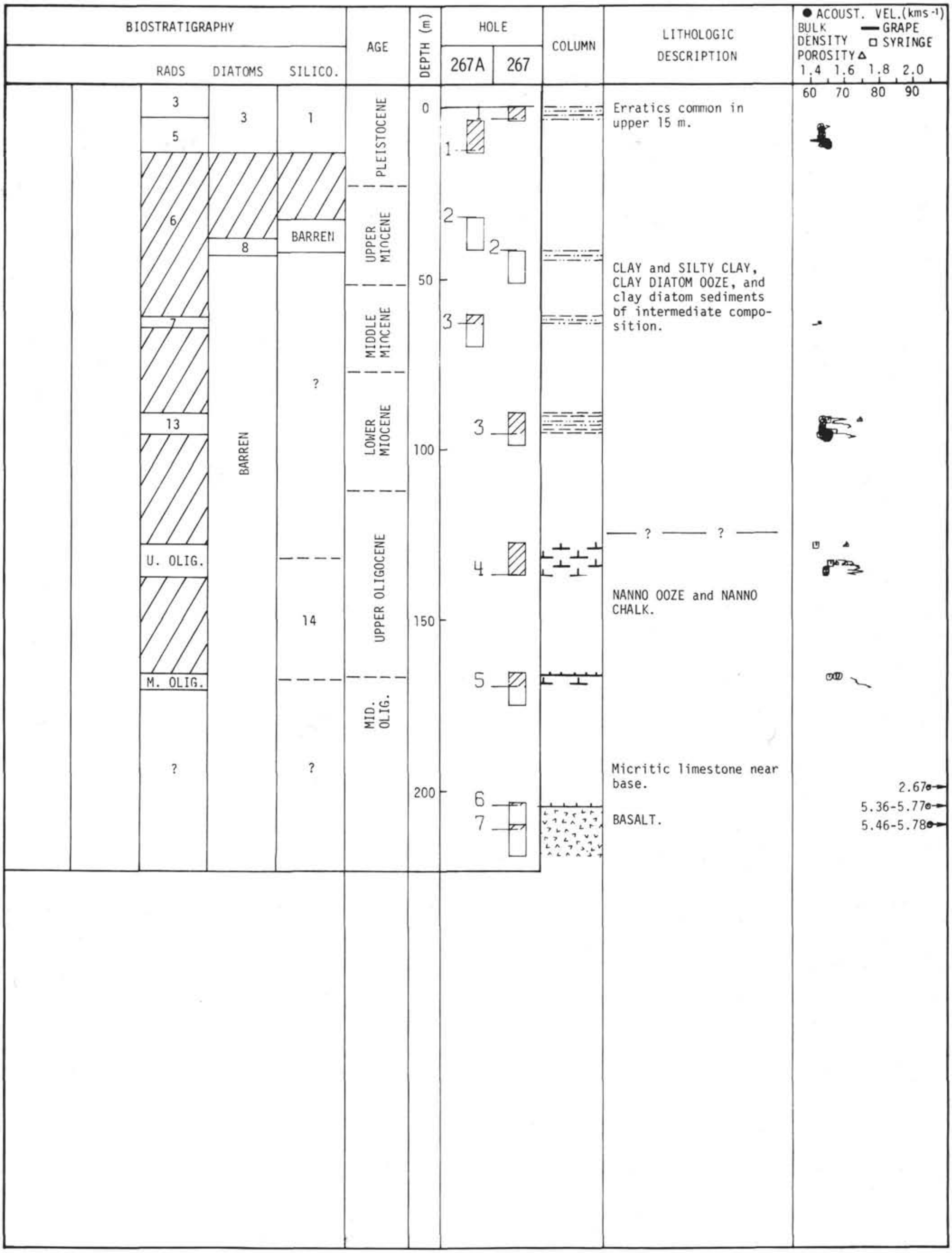


Figure 7a. *Graphic hole summary, Holes 267, 267A.*

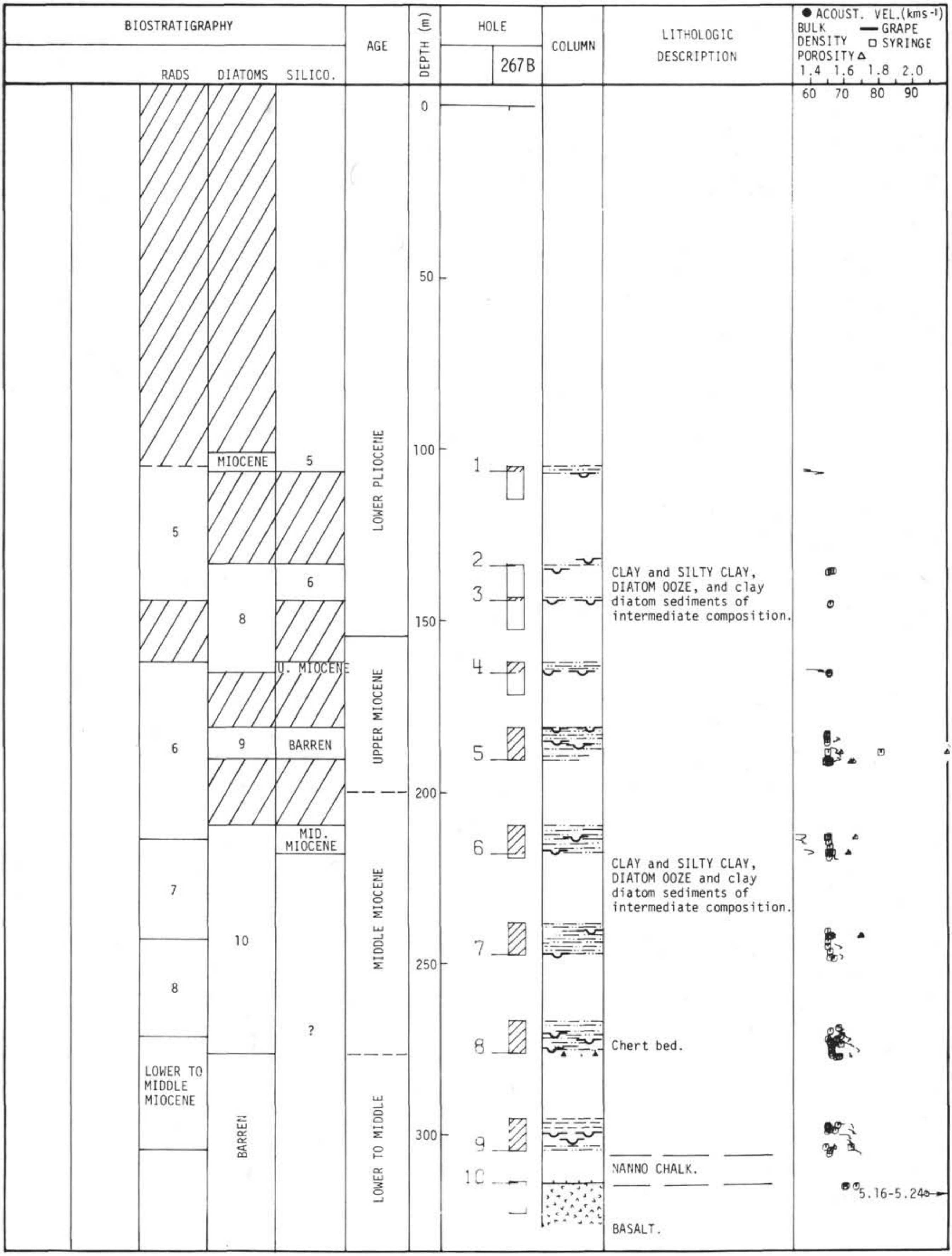
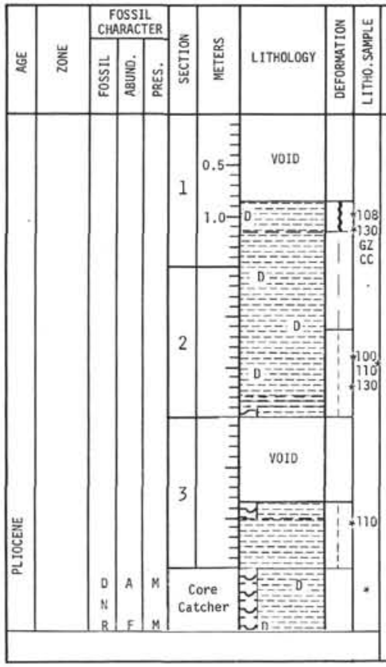


Figure 7b. *Graphic hole summary, Hole 267B.*

Site 267 Hole Core 1 Cored Interval: 0-4 m



LITHOLOGIC DESCRIPTION

Moderate yellowish brown (10YR 5/4) diatom-bearing CLAY. 1-20 cm beds with varying amounts of diatoms (range 2-15%). Scattered erratic granules and pebbles.

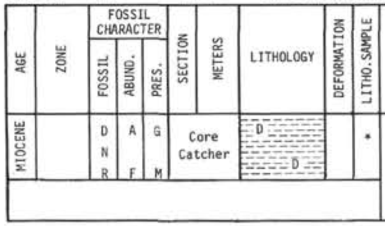
87-117 cm light olive gray (5Y 5/2)

Sec. 2 (100 cm, typical smear slide):
95% terrigenous (90% clay, 10% silt)
5% diatoms

2 beds diatom-rich clay

bed of diatom-rich clay

Site 267 Hole Core 2 Cored Interval: 42-51.5 m

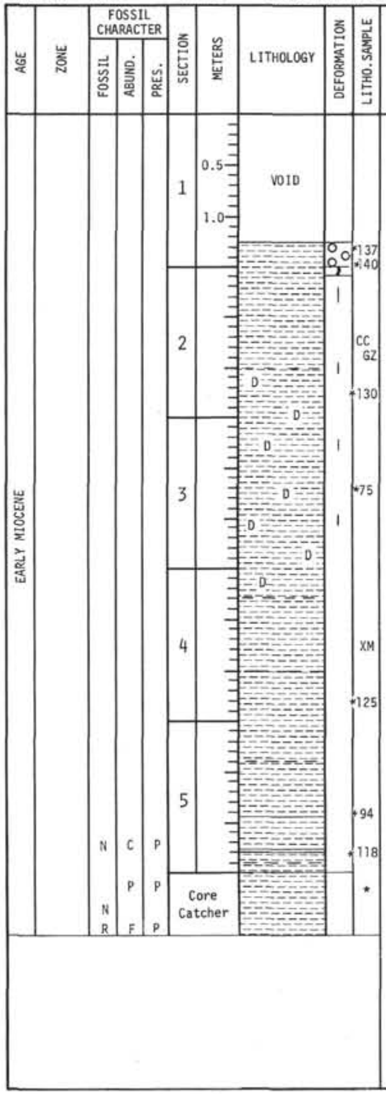


LITHOLOGIC DESCRIPTION

Moderate yellowish brown (10YR 5/4) DIATOM BEARING CLAY.

Sec. CC:
85% terrigenous (93% clay, 7% silt)
15% diatoms

Site 267 Hole Core 3 Cored Interval: 89.5-99 m



LITHOLOGIC DESCRIPTION

Light brown (5YR 6/4) CLAY.

In lower part of section, other lithologies noted below.

Sec. 2 (100 cm) to Sec. 4 (30 cm), slightly higher diatom content (? ~2%).

Sec. 4 (125 cm, typical smear slide):
95% clay
5% silt
TR diatoms

Mottled pale yellowish brown CLAY, 10YR 6/2.

Thin bed (1.5 cm) 5YR 7/2 carbonate-rich CLAY.

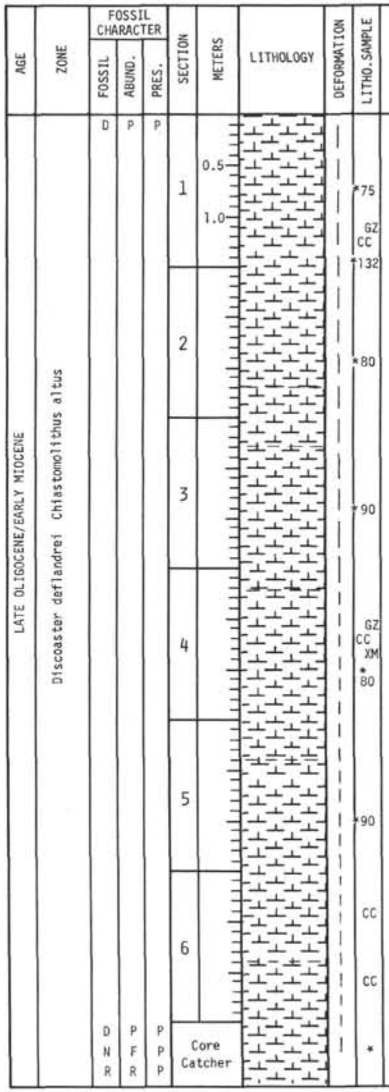
Mottled (10YR 6/2) CLAY.

Bulk X-ray (94.8 m):

Amorph.	- 59.8%
Ident.	- 40.2%
Quar.	- 30.8%
K-Fe.	- 8.9%
Plag.	- 17.1%
Mica	- 32.9%
Chlo.	- 2.1%
Mont.	- 7.3%
Amph.	- 0.9%

Explanatory notes in Chapter 1

Site 267 Hole Core 4 Cored Interval: 127.5-137 m



LITHOLOGIC DESCRIPTION

Grayish orange pink (5YR 7/2) NANNO OOZE; some darker-colored sediment, as indicated.

Intense mottling, a few traces of bedding. No detectable lithological changes with color.

Sec. 2 (130 cm) to Sec. 3 (30 cm), light brown (5YR 6/3).

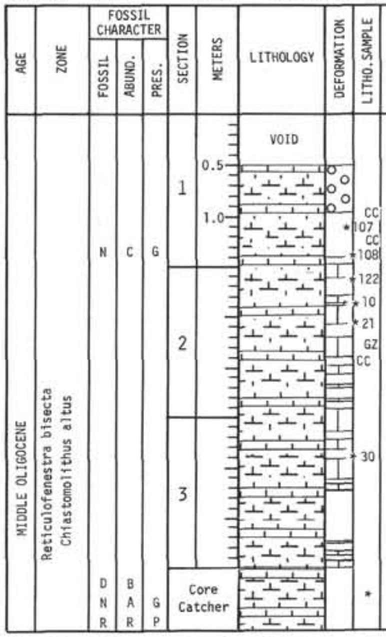
Sec. 3 (90 cm, typical smear slide):
93% calc. nannofossils
1% diatoms
1% radiolarians
5% clay

Sec. 4 (25 cm) to Sec. 5 (40 cm), light brown (5YR 6/4).

Bulk X-ray (132.8 m):
Amorph. - 37.5%
Ident. - 62.5%
Calc. - 68.1%
Quar. - 12.4%
K-Fe. - 3.2%
Plag. - 5.3%
Mica - 10.3%
Chlo. - 0.8%

Below Sec. 6 (90 cm), light brown (5YR 6/4).

Site 267 Hole Core 5 Cored Interval: 165.5-175 m

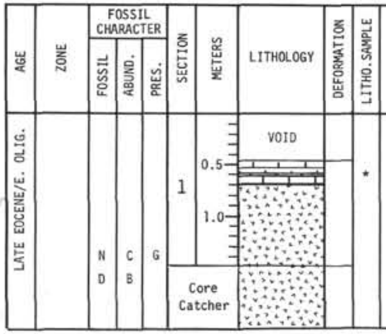


LITHOLOGIC DESCRIPTION

Moderate yellowish brown (10YR 5/4) NANNO OOZE and NANNO CHALK; chalk intervals undeformed, ooze intervals moderately deformed; considerable mottling in places; some beds and mottles of colors 10YR 4/4 and 10YR 7/2.

Sec. 2 (21 cm, typical smear slide):
95% calc. nannofossils
2% carbonate
3% clay

Site 267 Hole Core 6 Cored Interval: 203.5-210 m

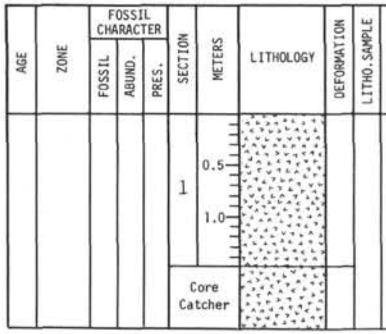


LITHOLOGIC DESCRIPTION

Very pale orange (10YR 8/2) NANNOFOSSIL CHALK overlying very light gray (N8) LIMESTONE (foraminifer-bearing micrite); overlying BASALT, partly altered, amygdaloidal, with irregular calcite veinlets.

Smear Slide (nanno chalk):
95% calc. nannofossils
5% clay

Site 267 Hole Core 7 Cored Interval: 210-219.5 m



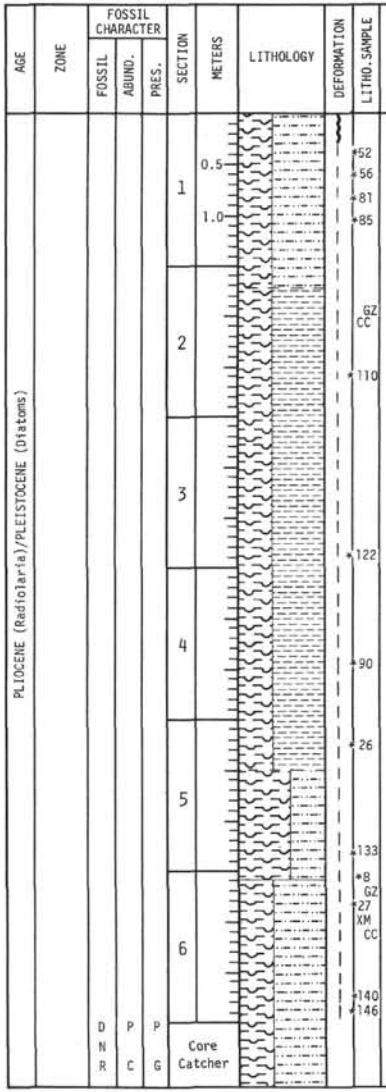
LITHOLOGIC DESCRIPTION

Glass at 15 cm and 30 cm.

BASLAT, altered, slightly porphyritic, with irregular calcite veinlets.

Explanatory notes in Chapter 1

Site 267 Hole A Core 1 Cored Interval: 4-13.5 m



LITHOLOGIC DESCRIPTION

Color down to Sec. 6 (13 cm): moderate yellowish brown (10YR 5/4).

Diatom detrital silty CLAY.

Around 25 cm of Sec. 2, grades down into diatom detrital CLAY.

Sec. 2 (110 cm, typical smear slide):
50% diatoms
50% terrigenous (80% clay, 20% silt)

Bulk X-ray (11.8 m):

Amorph.	- 76.4%
Ident.	- 23.6%
Quar.	- 29.5%
K-Fe.	- 14.8%
Plag.	- 16.5%
Mica	- 32.3%
Chlo.	- 0.5%
Mont.	- 4.3%
Amph.	- 2.2%

Around 55 cm of Sec. 5, grades down into Silty Clay DIATOM OOZE.

At Sec. 6 (13 cm): Bed of manganese coated pebbles.

At Sec. 6 (13-60 cm): 5YR 5/6.

DIATOM DETRITAL SILTY CLAY

Sec. 6 (60-100 cm): Mottled gradational color change.

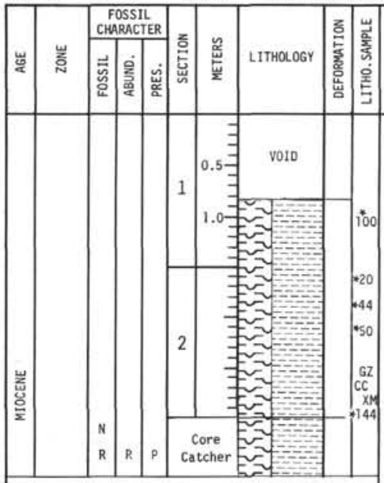
Sec. 6 (100-144 cm): 10YR 5/4.

Sec. 6 (144-150 cm): 5YR 5/6.

Sec. 6 (140 cm, typical smear slide):
30% diatoms
70% terrigenous (70% clay, 30% silt)

CC: 10YR 5/4.

Site 267 Hole A Core 3 Cored Interval: 61-70.5 m



LITHOLOGIC DESCRIPTION

Intensely mottled, pale yellowish brown (10YR 6/2) and light brown (5YR 6/4) DIATOM DETRITAL SILTY CLAY and DIATOM DETRITAL CLAY.

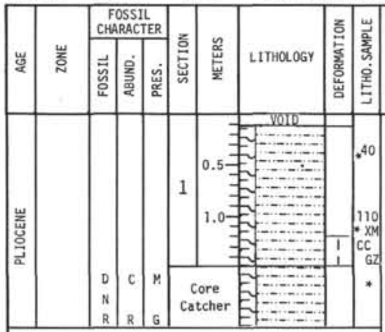
Sec. 2 (50 cm, typical smear slide):
40% diatoms
60% terrigenous (85% clay, 15% silt)

Diatoms vary from 20-60%; silt percent of terrigenous varies from 15 to 30%.

Bulk X-ray (63.5 m):

Amorph.	- 59.4%
Ident.	- 40.6%
Quar.	- 37.6%
Plag.	- 17.1%
Kaol.	- 3.3%
Mica	- 42.0%

Site 267 Hole B Core 1 Cored Interval: 105-114.5 m



LITHOLOGIC DESCRIPTION

12-42 cm: Some 10YR 5/4 mottles.

Soft, light olive gray (5Y 5/2) DIATOM-RICH SILTY CLAY; very rare erratic granules.

Sec. 1 (110 cm, typical smear slide):
20% diatoms
80% terrigenous (70% clay, 28% silt, 2% sand)

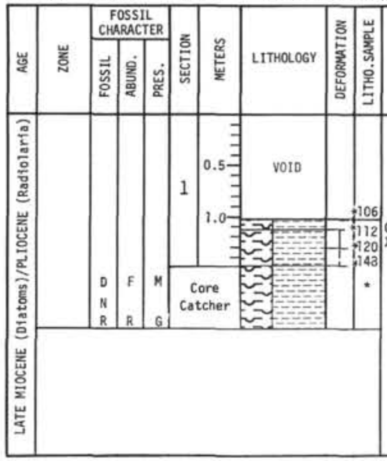
From Sec. 1 (145 cm) downward, sediment is medium light gray (N6).

Bulk X-ray (106.1 m):

Amorph.	- 71.1%
Ident.	- 28.9%
Quar.	- 22.8%
K-Fe.	- 15.2%
Plag.	- 18.1%
Kaol.	- 1.2%
Mica	- 34.5%
Chlo.	- 0.6%
Mont.	- 5.4%
Amph.	- 2.2%

Explanatory notes in Chapter 1

Site 267 Hole B Core 2 Cored Interval: 133.5-143 m



LITHOLOGIC DESCRIPTION

At top of core: two blocks, ?no preserved contacts.

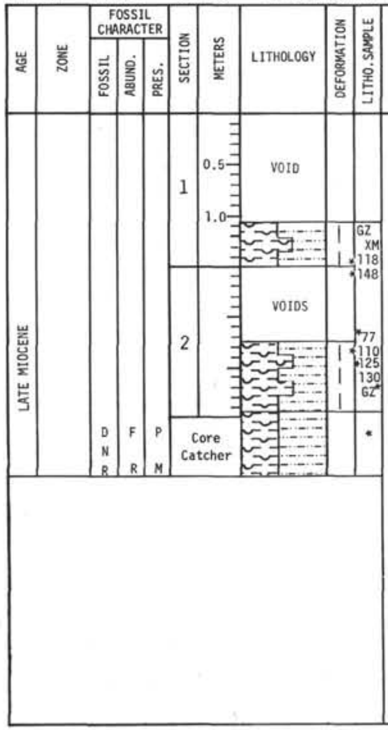
Sec. 1, 103-111 cm, 5GY 4/1 stiff diatom detrital clay; Sec. 1, 111-114 cm, 5Y 4/2 stiff diatom detrital clay; otherwise, soft, mottled pale brown (5YR 5/2) and grayish olive (10Y 4/2), soft, CLAY DIATOM OOZE; diatom content very variable.

Below 142 cm: only 10Y 4/2.

Sec. 1 (112 cm):
40% diatoms
60% terrigenous (80% clay, 20% silt)

Sec. 1 (148 cm):
60% diatoms
40% terrigenous (75% clay, 25% silt)

Site 267 Hole B Core 3 Cored Interval: 143-152.5 m



LITHOLOGIC DESCRIPTION

Soft, light gray (N7) SILTY CLAY DIATOM OOZE, and medium gray (N5) DIATOM DETRITAL SILTY CLAY in alternating beds 1-20 cm thick.

Variation shown in lithology column schematic.

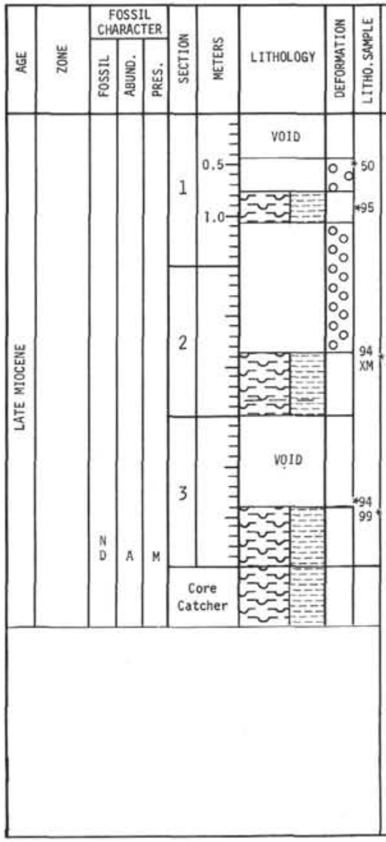
Sec. 2 (125 cm, smear slide of N7 silty clay diatom ooze):
60% diatoms
40% terrigenous (65% clay, 35% silt)
Contains 2% high relief, high birefringence fine silt size mineral.

Sec. 2 (110 cm, smear slide of N5 diatom detrital silty clay):
60% terrigenous (70% clay, 30% silt)
40% diatoms
TR calc. nannofossils
Contains 1% high relief mineral as in Sec. 2 (125 cm).

Bulk X-ray (146.0 m):

Amorph.	- 71.3%
Ident.	- 28.7%
Quar.	- 26.5%
K-Fe.	- 12.2%
Plag.	- 17.1%
Kaol.	- 2.1%
Mica	- 32.4%
Chlo.	- 1.5%
Mont.	- 6.6%
Amph.	- 1.6%

Site 267 Hole B Core 4 Cored Interval: 162-171.5 m



LITHOLOGIC DESCRIPTION

Block of 5G 5/2 diatom rich clay.

Soft, light olive gray (5Y 5/2) CLAY DIATOM OOZE.

Sec. 1 (95 cm, typical smear slide):
70% diatoms
30% terrigenous (80% clay, 20% silt)

Sec. 2: Pale brown (5YR 5/2) SILTY CLAY DIATOM OOZE with mottles of 5Y 5/2 clay diatom ooze; mottles increasingly abundant downwards.

Sec. 2 (94 cm, smear slide of 5YR 5/2 silty clay diatom ooze):
70% diatoms
30% terrigenous (67% clay, 33% silt), including 10% high relief mineral.

Core has a remarkable concentration (highest in Sec. 2, 94 cm) of fine silt size high relief, high birefringence mineral.

Sec. 3: With 30% mottles light brown (5YR 6/4).

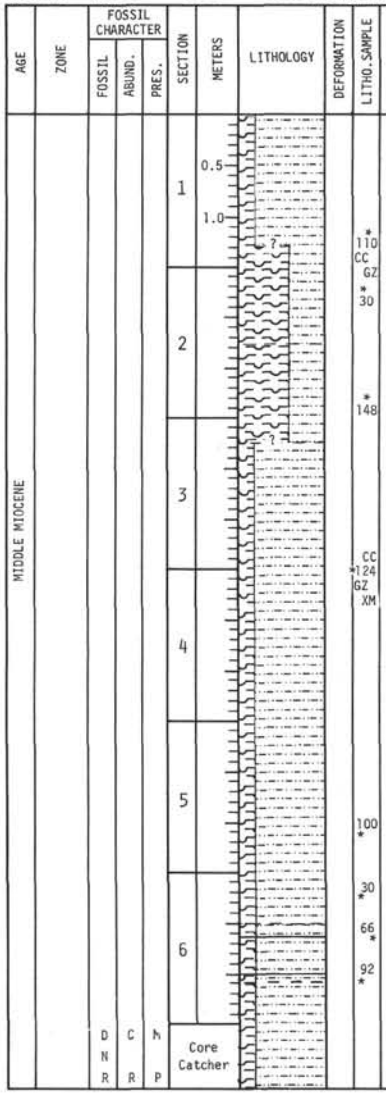
No core catcher sample.

Bulk X-ray (164.5 m):

Amorph.	- 70.5%
Ident.	- 29.5%
Rhod.	- 12.1%
Quar.	- 23.6%
K-Fe.	- 9.3%
Plag.	- 12.5%
Kaol.	- 1.5%
Mica	- 33.2%
Chlo.	- 2.1%
Mont.	- 1.1%
Clin.	- 3.6%
Amph.	- 1.0%

Explanatory notes in Chapter 1

Site 267 Hole B Core 5 Cored Interval: 181-190.5 m



LITHOLOGIC DESCRIPTION

Core stiff throughout.

Pale brown (5YR 5/2) DIATOM RICH SILTY CLAY.

pale brown (5YR 5/2)

CLAY DIATOM OOZE; diatom content ranges from 50% to 80%; some silty clay near base of core.

mottled pale brown (5YR 5/2) and light olive gray (5Y 5/2)

Sec. 3 (124 cm, typical smear slide):
50% diatoms
50% terrigenous (80% clay, 20% silt)

light olive gray (5Y 5/2)

Bulk X-ray (217.4 m):

Amorph.	- 66.9%
Ident.	- 33.1%
Quar.	- 29.7%
K-Fe.	- 9.8%
Plag.	- 16.1%
Kaol.	- 2.7%
Mica	- 33.1%
Chlo.	- 2.2%
Mont.	- 5.3%
Amph.	- 1.0%

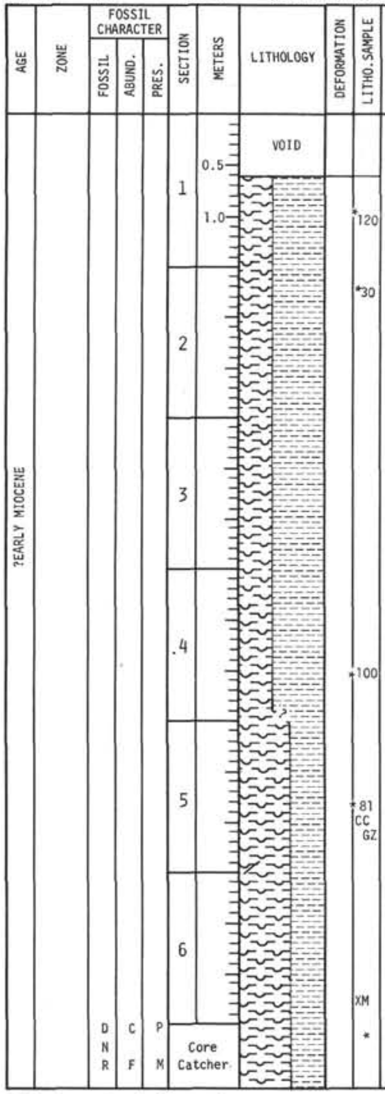
Pale brown (5YR 5/2) gradual color change at top sharp base.

Light olive gray (5Y 5/2), mottled.

Pale brown (5YR 5/2) sharp top, gradual base, both mottled.

light olive gray (5Y 5/2)

Site 267 Hole B Core 6 Cored Interval: 209.5-219



LITHOLOGIC DESCRIPTION

Core stiff throughout.

Light olive gray (5Y 5/2) DIATOM DETRITAL CLAY; very rare 5G 6/1 mottles.

Typical smear slide:
50% diatoms
50% terrigenous (80% clay, 20% silt)

Bulk X-ray (302.1 m):

Amorph.	- 58.2%
Ident.	- 41.8%
Quar.	- 34.5%
K-Fe.	- 11.4%
Plag.	- 17.1%
Mica	- 30.4%
Chlo.	- 1.6%
Mont.	- 3.7%
Amph.	- 1.4%

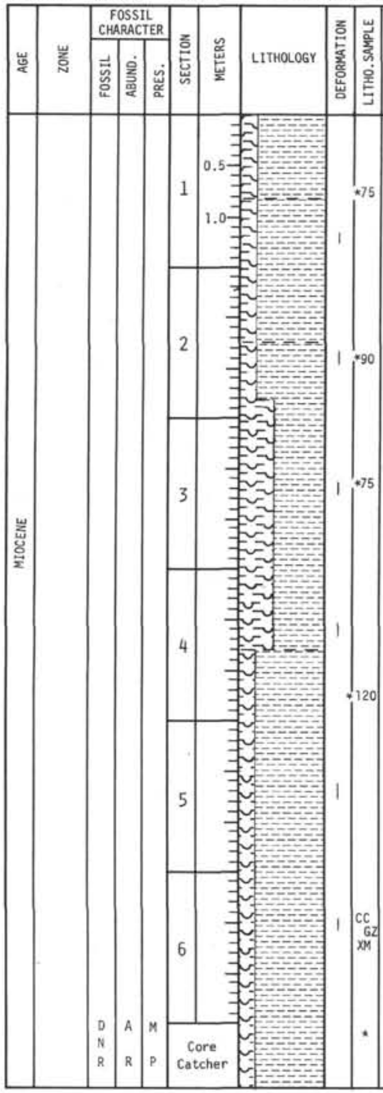
Position of boundary uncertain, presumed to be gradational.

Light olive gray (5Y 5/2). CLAY DIATOM OOZE.

Sec. 5 (81 cm, typical smear slide):
70% diatoms
30% terriyenous

Explanatory notes in Chapter 1

Site 267 Hole B Core 7 Cored Interval: 238-247.5 m



LITHOLOGIC DESCRIPTION

Core stiff throughout.

Light olive gray (5Y 5/2) DIATOM RICH CLAY.

rare 5GY 5/2 mottles

5YR 5/2 mottles make up 10-30% of sediment, decrease in abundance downwards

Sec. 2 (90 cm):
85% terrigenous (80% clay, 20% silt)
15% diatoms

no visible mottling

Position of boundary uncertain, presumed to be gradational.

very rare 5YR 5/2 mottles

Grayish olive (10Y 4/2) DIATOM DETRITAL CLAY; some diatom detrital silty clay.

Sec. 3 (75 cm):
60% terrigenous (65% clay, 35% silt)
40% diatoms

a few 5G 5/2 mottles

Gradual change.

a few 5YR 5/2 mottles

Sec. 4 (120 cm):
80% terrigenous (80% clay, 20% silt)
20% diatoms

5G 5/2 mottles make up 5% of sediment

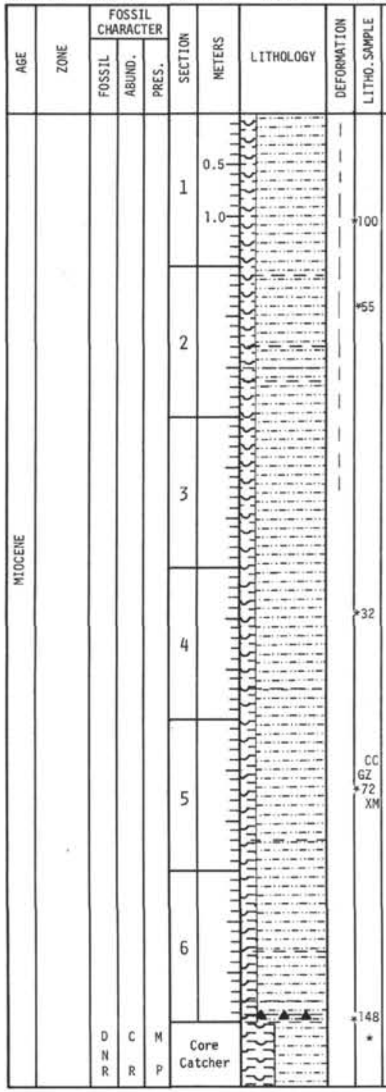
Light olive gray (5Y 5/2) DIATOM RICH CLAY.

Bulk X-ray (246.1 m):

Amorph.	- 63.0%
Ident.	- 37.0%
Quar.	- 31.1%
K-Fe.	- 10.6%
Plag.	- 16.6%
Kaol.	- 1.4%
Mica	- 33.5%
Chlo.	- 1.2%
Mont.	- 5.5%

In Sec. 6, a few semi-lithified intervals.
Sec. 6 (128-131 cm):
a few 5YR 5/2 mottles.

Site 267 Hole B Core 8 Cored Interval: 266.5-276 m



LITHOLOGIC DESCRIPTION

Core stiff throughout. About 15% is semi-lithified, in 5-20 cm long segments.

light olive gray (5Y 5/2)

DIATOM RICH SILTY CLAY. Diatom content varies between 10% and 40%. All color boundaries mottled and gradational.

pale brown (5YR 5/2)

Sec. 2 (55 cm):
90% terrigenous (73% clay, 27% silt)
10% diatoms

5Y 5/2
5YR 5/2

light olive gray (5Y 5/2)

Bulk X-ray (273.3 m):

Amorph.	- 59.5%
Ident.	- 40.5%
Quar.	- 33.1%
K-Fe.	- 10.8%
Plag.	- 16.9%
Mica	- 31.8%
Chlo.	- 1.6%
Mont.	- 4.7%
Amph.	- 1.0%

5YR 5/2

Position of boundary uncertain, presumed to be gradational.

pale brown (5YR 5/2)

Sec. 5 (72 cm):
80% terrigenous (90% clay, 10% silt)
20% diatoms

DIATOM RICH CLAY

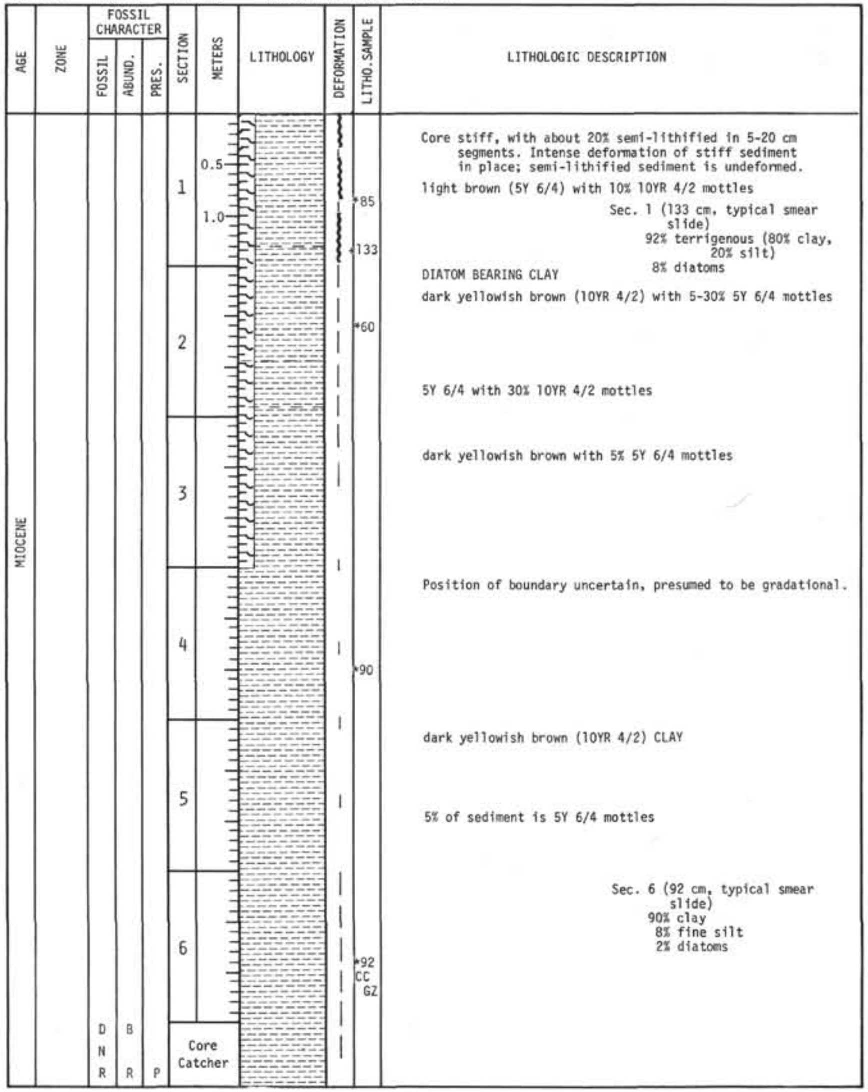
gradual mottled contact between 5YR 5/2 and 5Y 5/2

light olive gray (5Y 5/2)

Sec. 6 (130-146): grayish olive (10Y 5/2)
Sec. 6 (146-147): olive gray (5Y 3/2) CHERT
Sec. 6 (148-150): pale olive (10Y 7/2) DIATOM OOZE
CC: DIATOM DETRITAL CLAY

Explanatory notes in Chapter 1

Site 267 Hole B Core 9 Cored Interval: 295-304.5 m



Core stiff, with about 20% semi-lithified in 5-20 cm segments. Intense deformation of stiff sediment in place; semi-lithified sediment is undeformed.

light brown (5Y 6/4) with 10% 10YR 4/2 mottles

Sec. 1 (133 cm, typical smear slide)
92% terrigenous (80% clay, 20% silt)
8% diatoms

DIATOM BEARING CLAY

dark yellowish brown (10YR 4/2) with 5-30% 5Y 6/4 mottles

5Y 6/4 with 30% 10YR 4/2 mottles

dark yellowish brown with 5% 5Y 6/4 mottles

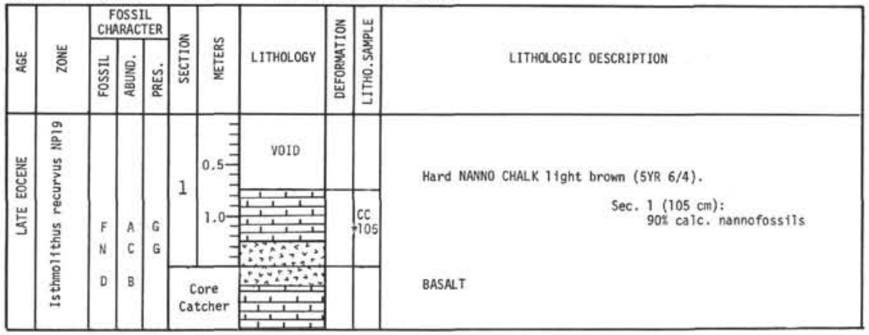
Position of boundary uncertain, presumed to be gradational.

dark yellowish brown (10YR 4/2) CLAY

5% of sediment is 5Y 6/4 mottles

Sec. 6 (92 cm, typical smear slide)
90% clay
8% fine silt
2% diatoms

Site 267 Hole B Core 10 Cored Interval: 313.5-323 m

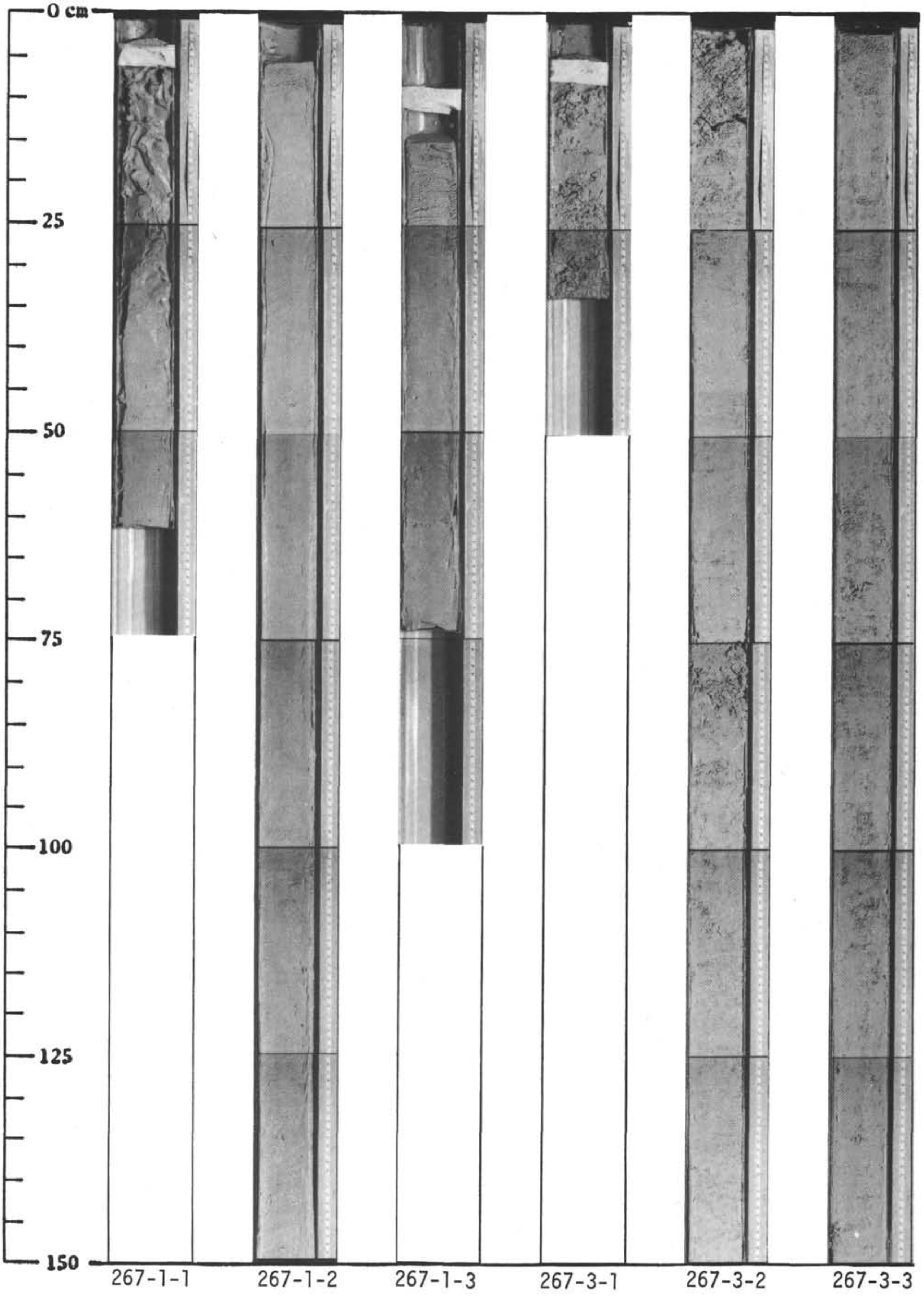


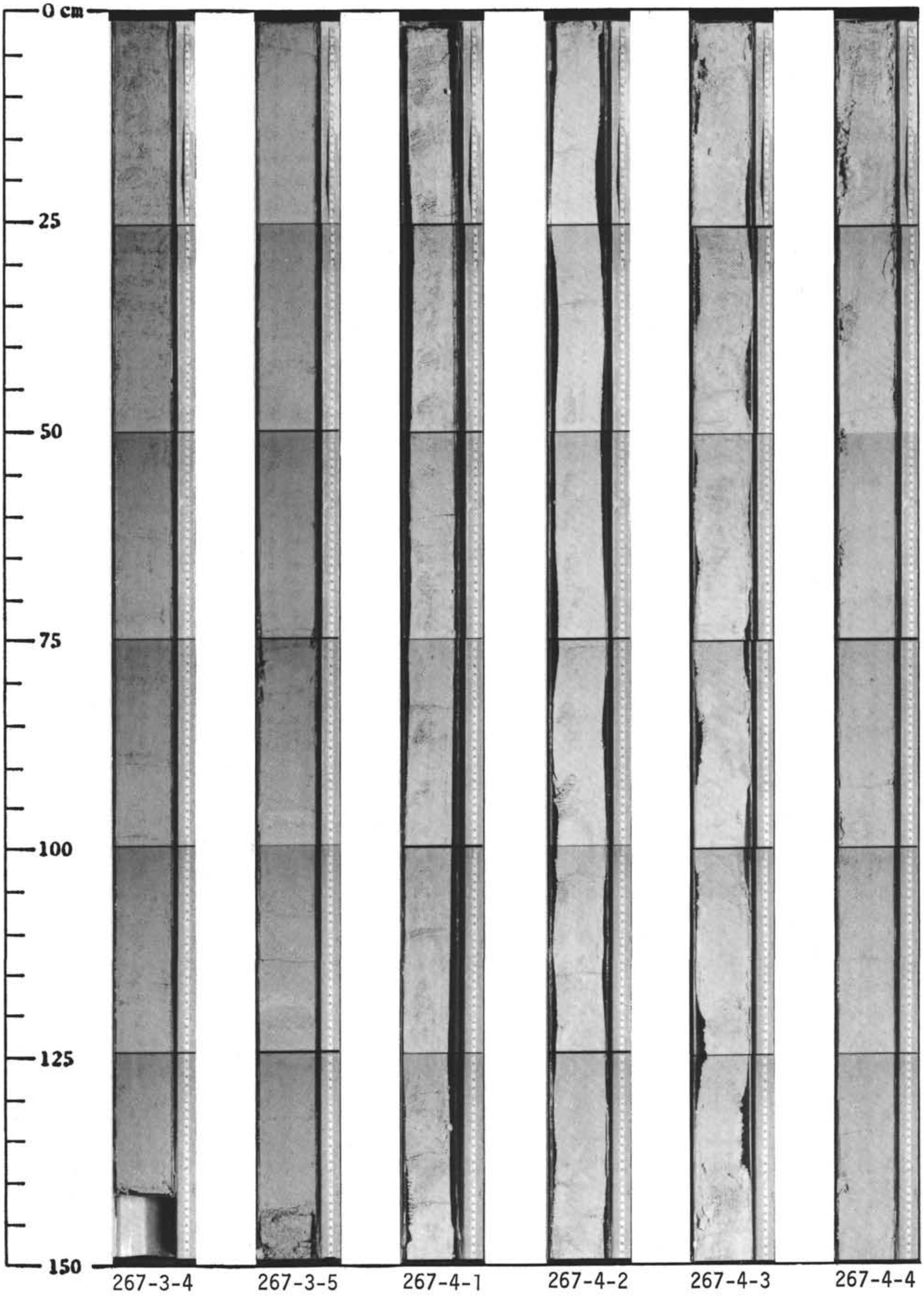
Hard NANNO CHALK light brown (5YR 6/4).

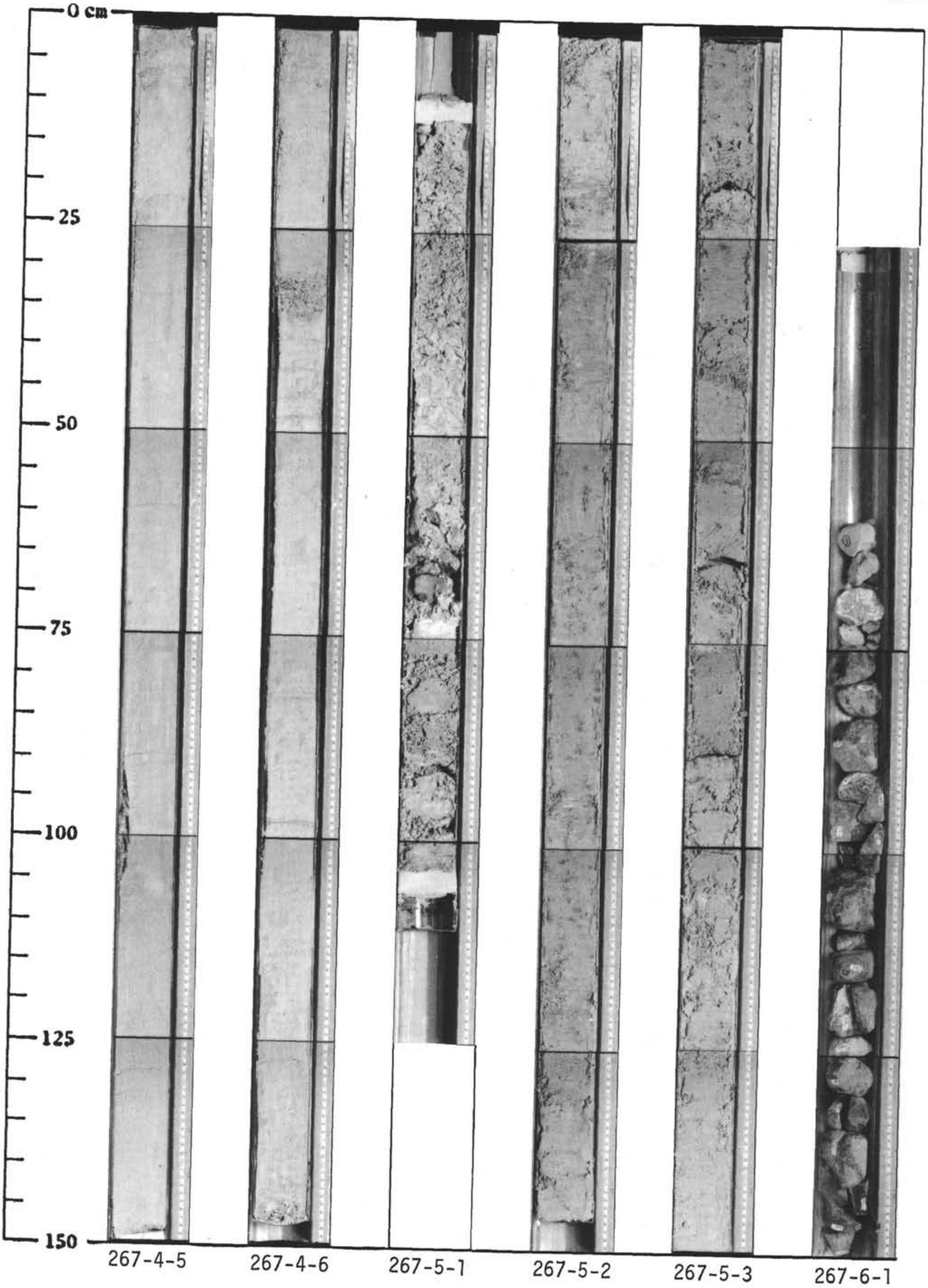
Sec. 1 (105 cm):
90% calc. nannofossils

BASALT

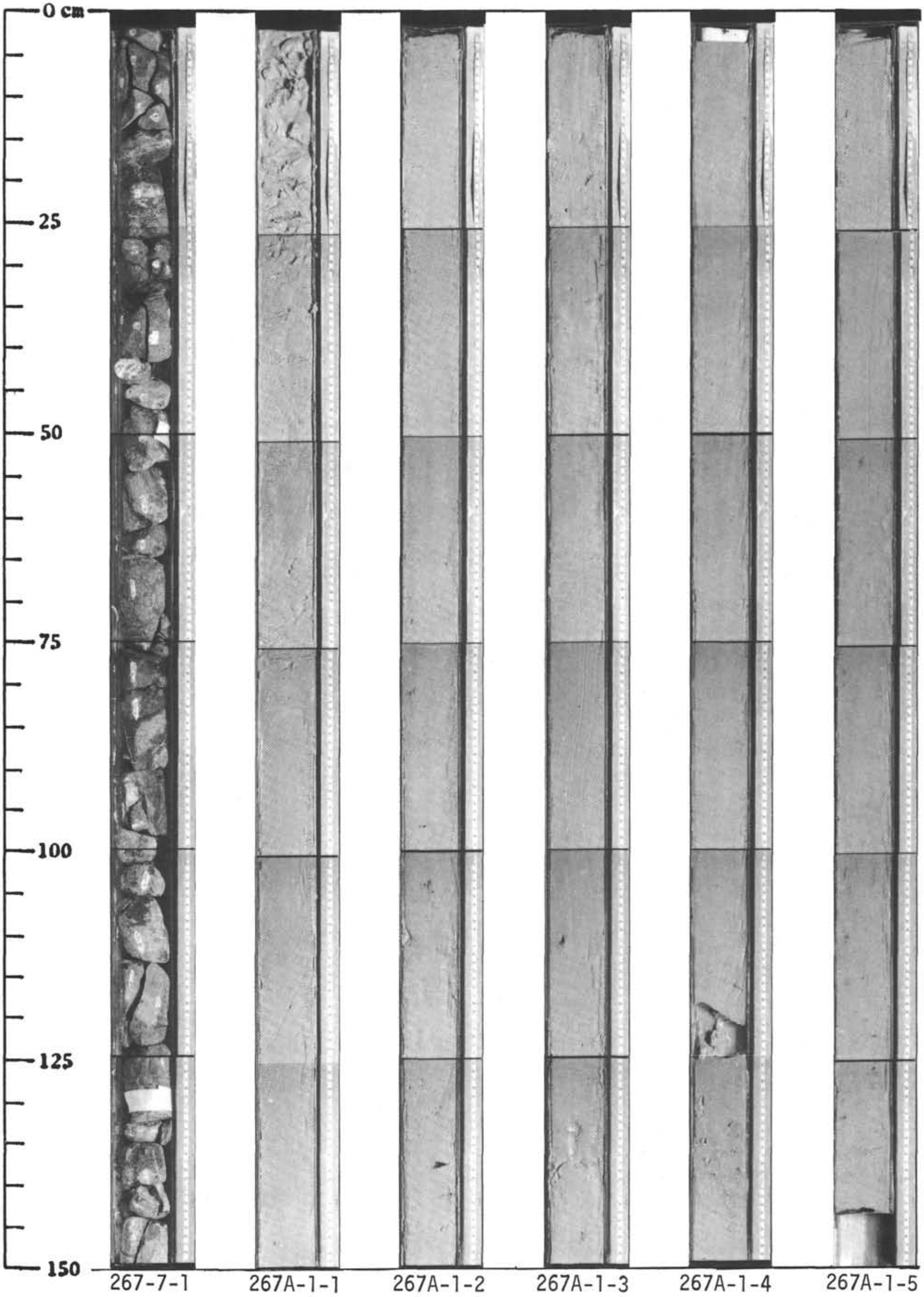
Explanatory notes in Chapter 1

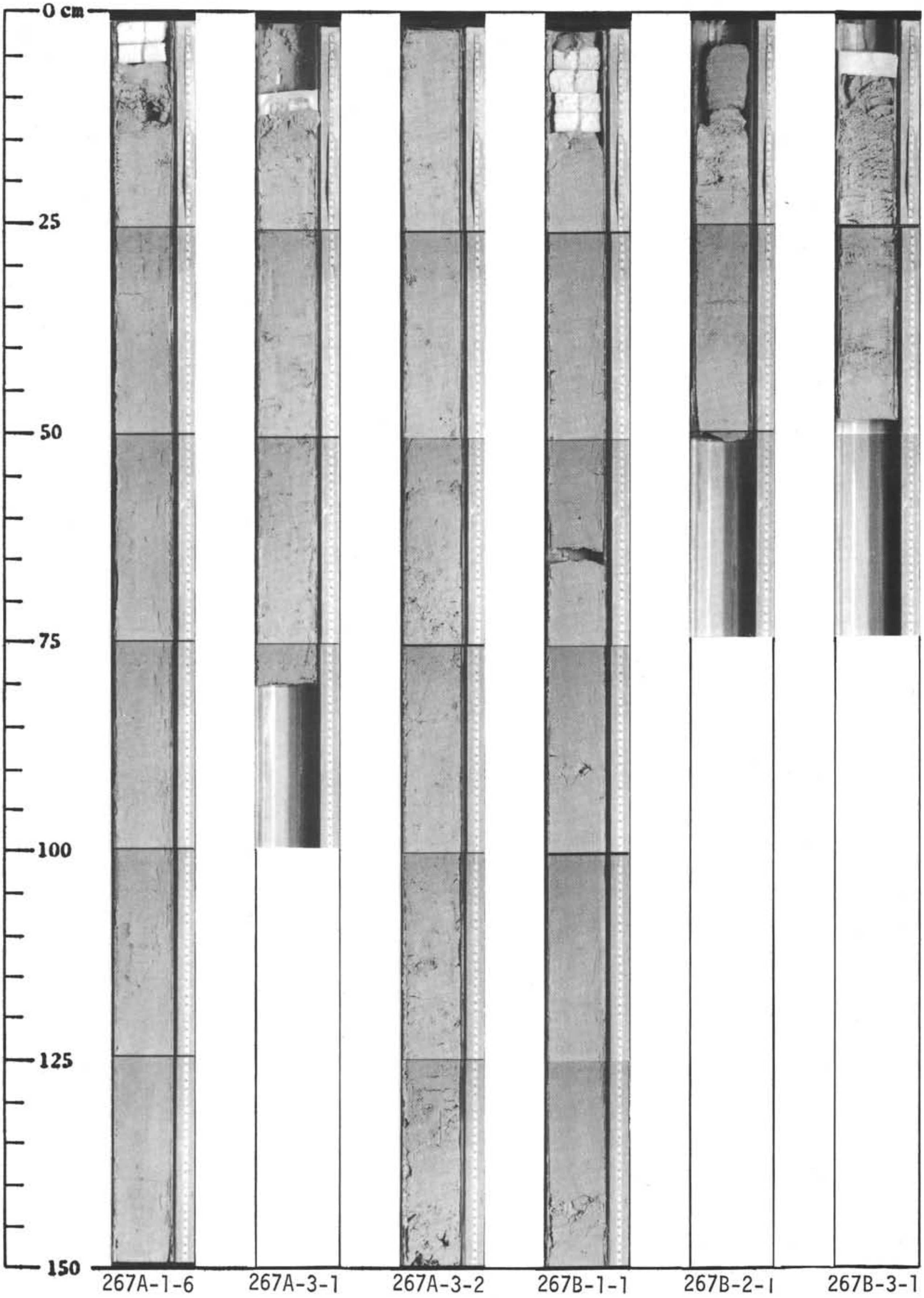

0 cm
25
50
75
100
125
150
267-1-1
267-1-2
267-1-3
267-3-1
267-3-2
267-3-3

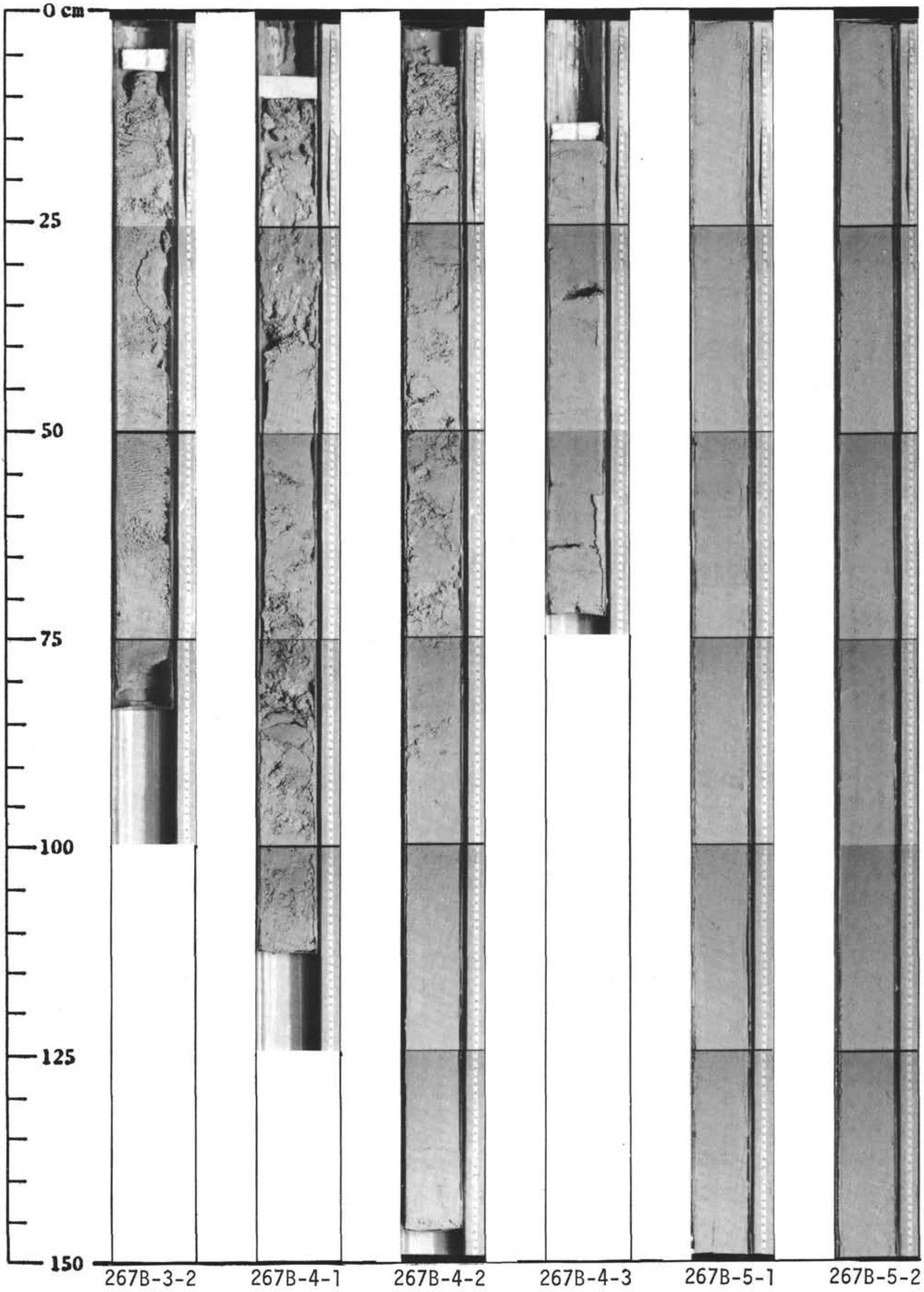

0 cm
25
50
75
100
125
150
267-3-4
267-3-5
267-4-1
267-4-2
267-4-3
267-4-4

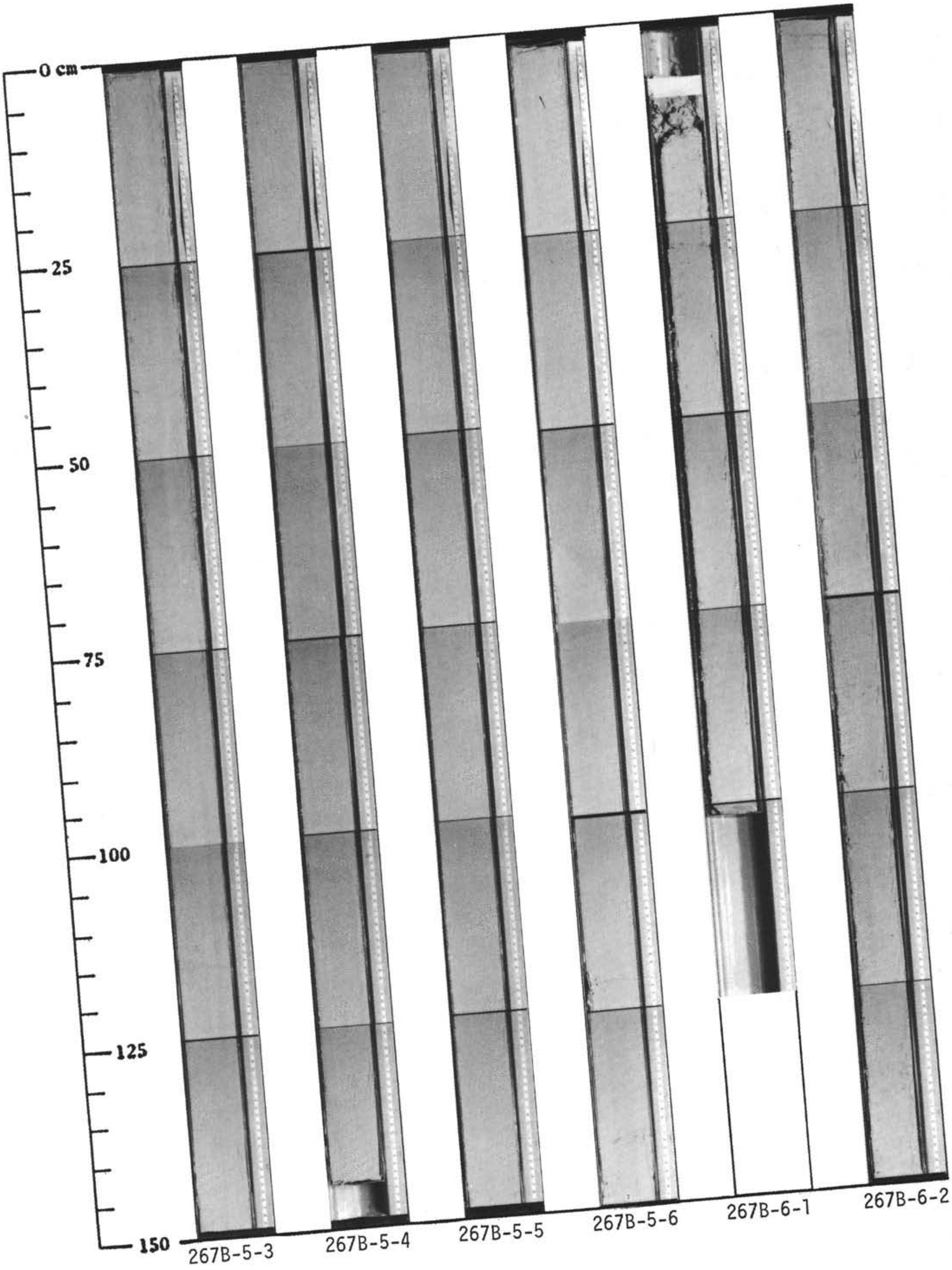


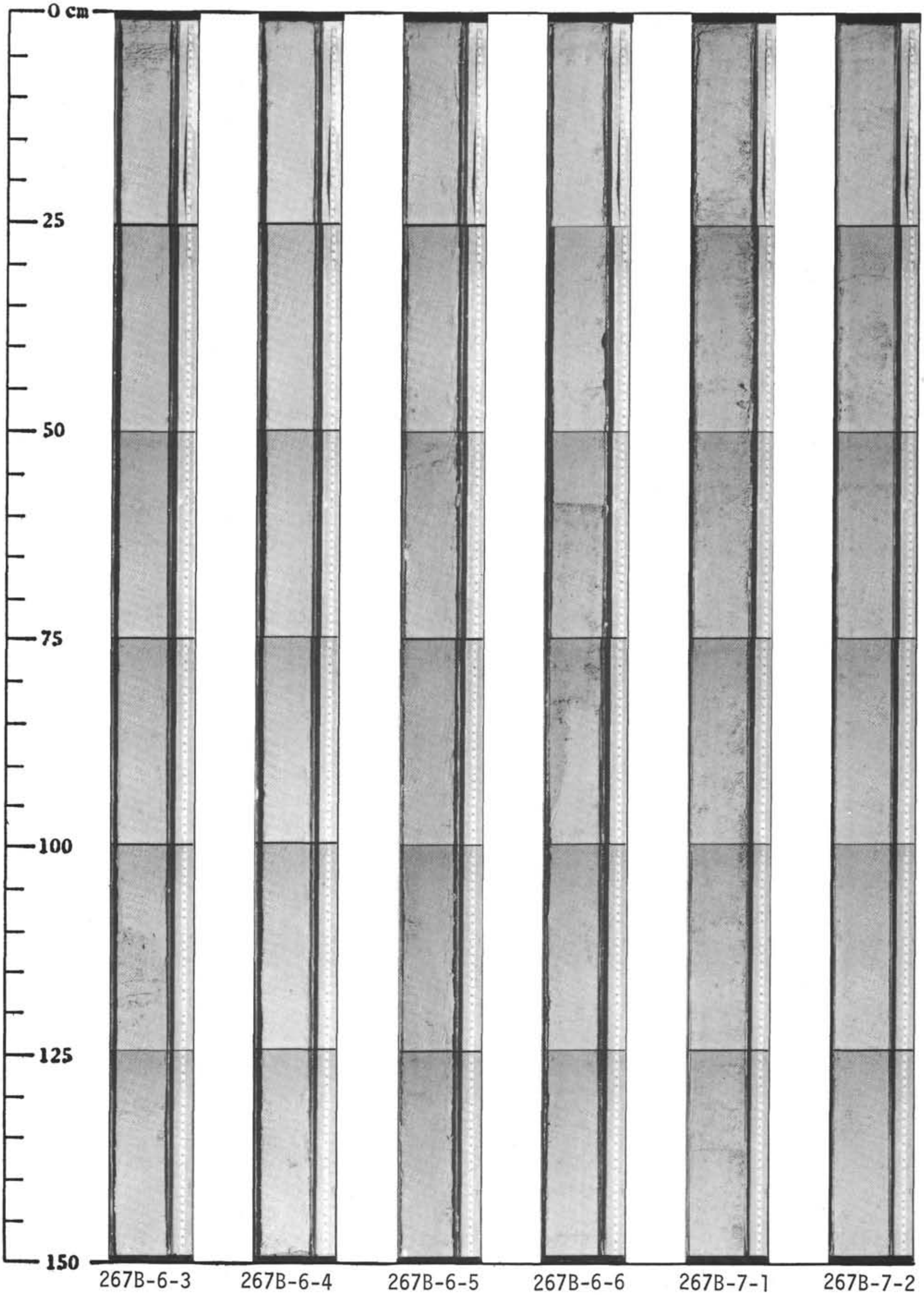
0 cm
25
50
75
100
125
150
267-4-5
267-4-6
267-5-1
267-5-2
267-5-3
267-6-1

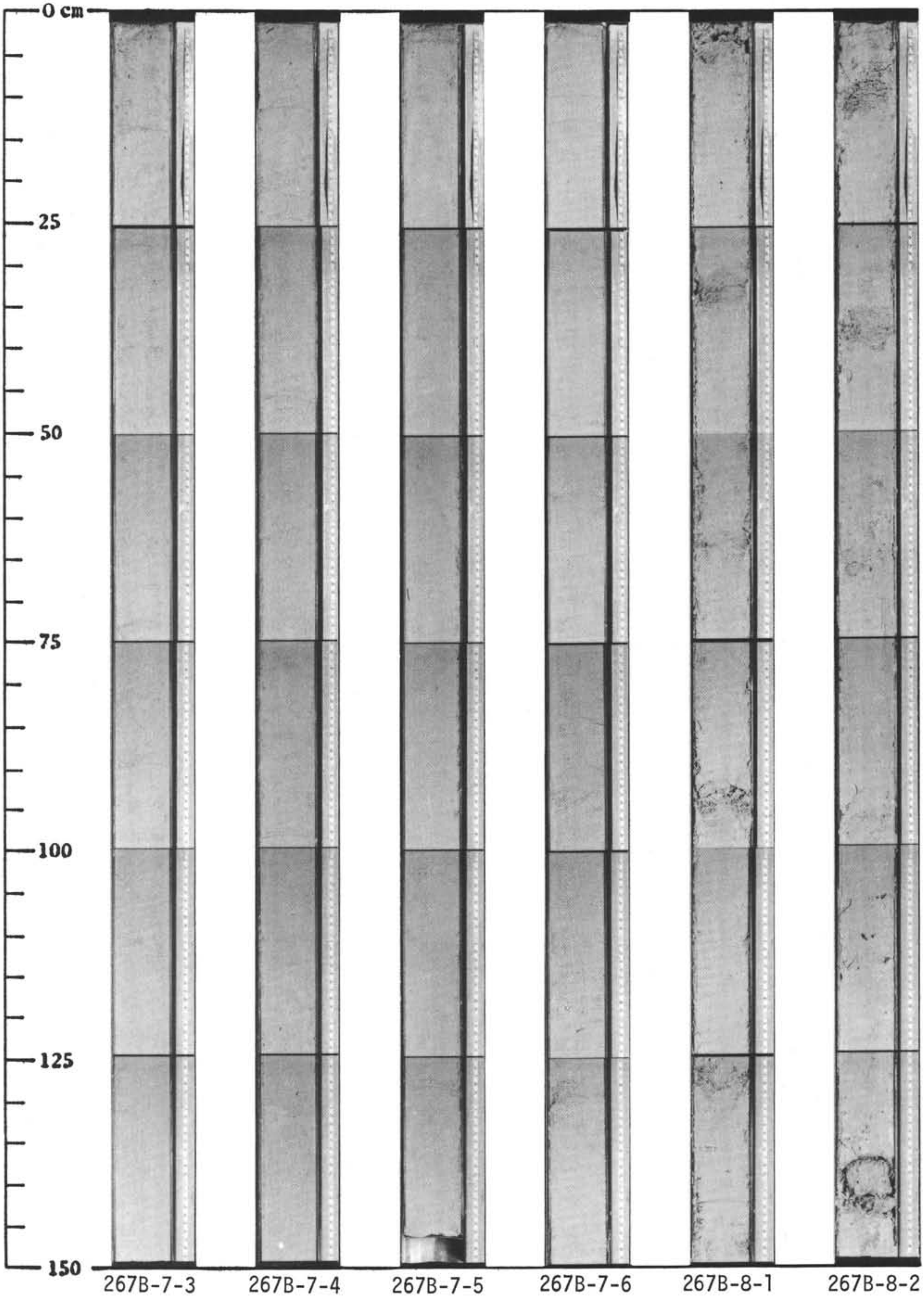

0 cm
25
50
75
100
125
150
267-7-1
267A-1-1
267A-1-2
267A-1-3
267A-1-4
267A-1-5

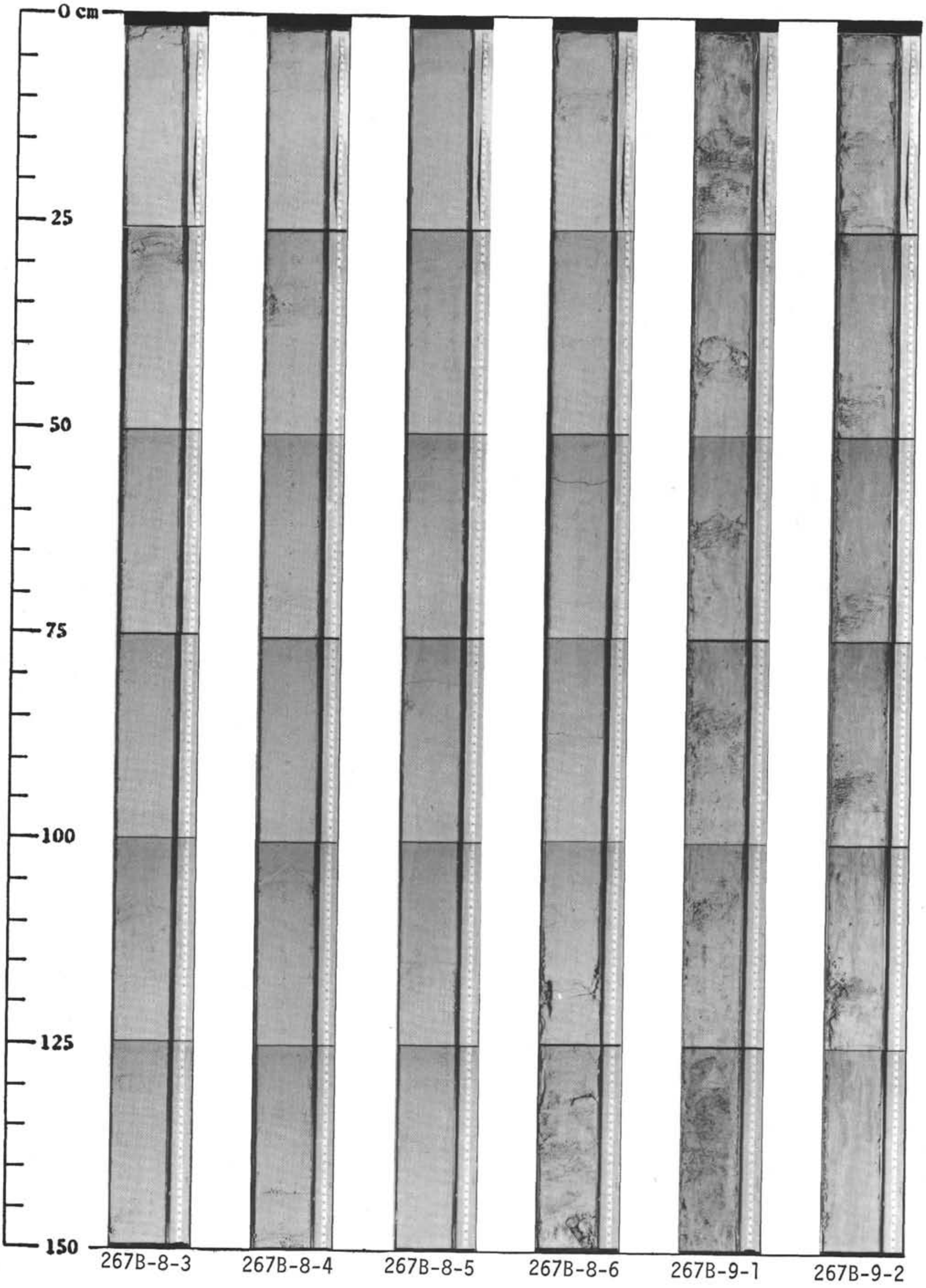

0 cm
25
50
75
100
125
150
267A-1-6
267A-3-1
267A-3-2
267B-1-1
267B-2-1
267B-3-1

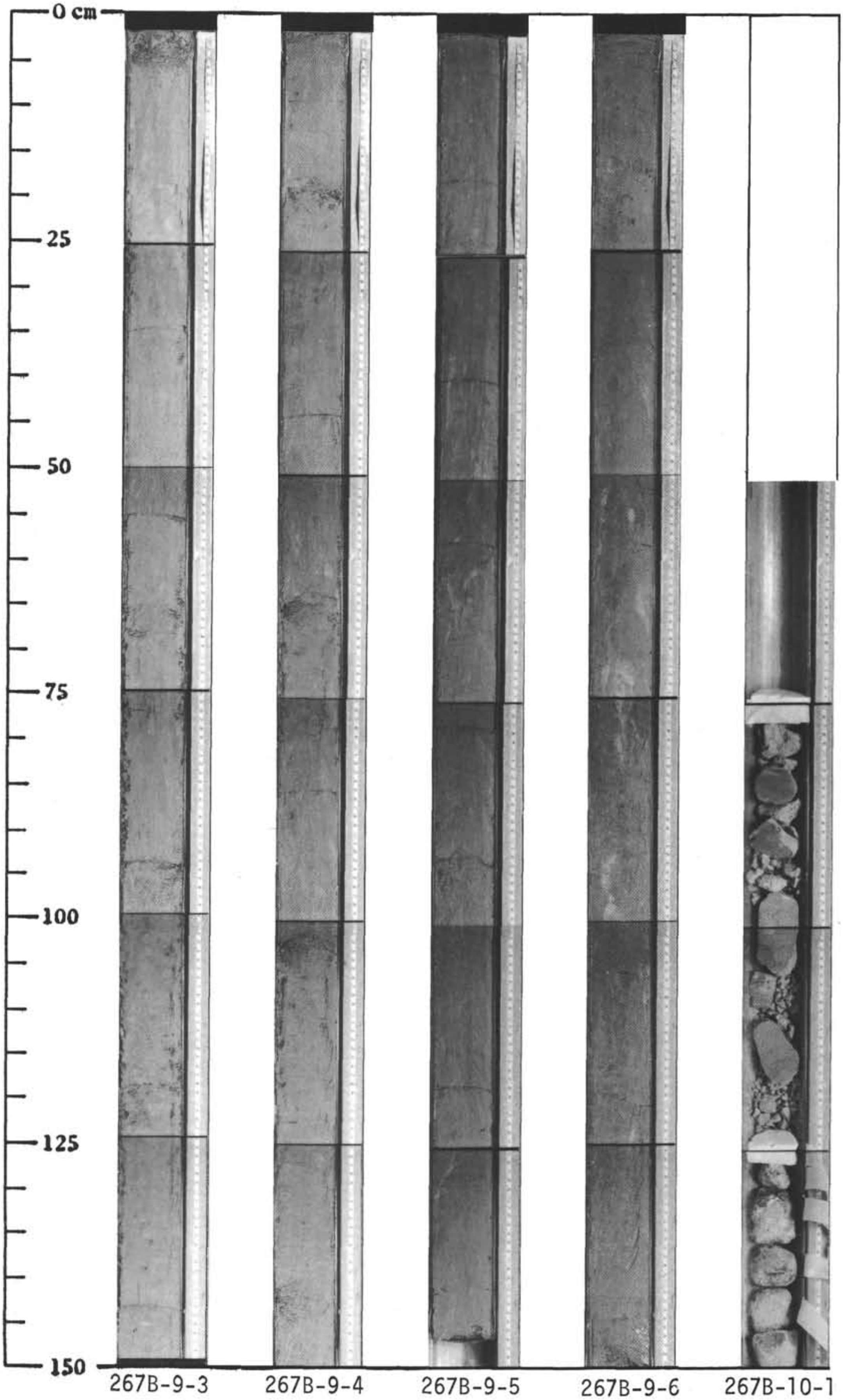

0 cm
25
50
75
100
125
150
267B-3-2
267B-4-1
267B-4-2
267B-4-3
267B-5-1
267B-5-2


0 cm
25
50
75
100
125
150
267B-5-3
267B-5-4
267B-5-5
267B-5-6
267B-6-1
267B-6-2


0 cm
25
50
75
100
125
150
267B-6-3
267B-6-4
267B-6-5
267B-6-6
267B-7-1
267B-7-2


0 cm
25
50
75
100
125
150
267B-7-3
267B-7-4
267B-7-5
267B-7-6
267B-8-1
267B-8-2


0 cm
25
50
75
100
125
150
267B-8-3
267B-8-4
267B-8-5
267B-8-6
267B-9-1
267B-9-2


0 cm
25
50
75
100
125
150
267B-9-3
267B-9-4
267B-9-5
267B-9-6
267B-10-1