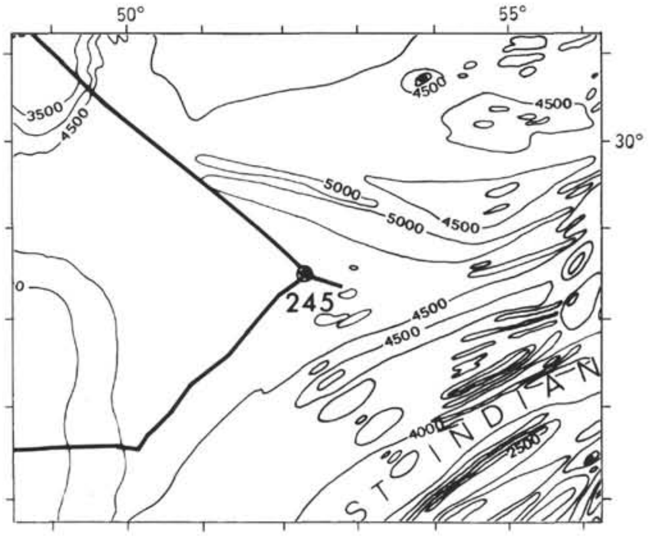
7. SITE 245

The Shipboard Scientific Party[1]

SITE DATA



Location: Southern Madagascar Basin

Position: 31°32.02′S, 52°18.11′E

Water Depth: 4857 meters

Total Penetration: 396.5 meters (245) and 149 meters (245A)

Cores: 26 cores (213.5 m cut, 129.5 m recovered)

Deepest Unit Recovered: Basalt

BACKGROUND AND OBJECTIVES

South of 20°S latitude, the Central Indian Ridge divides into two distinct branches which, respectively, separate the Antarctic continent from Australia and from Africa. The east branch (Southeast Indian Ridge) extends from near the Mascarene Islands through Amsterdam and St. Paul islands and joins the Pacific Antarctic Ridge south of Australia. The west branch (Southwest Indian Ridge) extends south of the Mascarene Islands and Madagascar past Marion and Prince Edward islands and is joined by the southern limit of the Mid-Atlantic Ridge west of Bouvet Island. Between these two ridges and the bordering continents are several plateaus: towards Africa, the Madagascar Ridge, the Mozambique Ridge, and the Agulhas Plateau; towards Antarctica, the Crozet and Kerguelen-Heard plateaus which have been considered by several authors to be microcontinents. Between the seismically active mid-ocean ridge system and these plateaus are several deep oceanic basins: east of Madagascar, the Mascarene Basin: to the west, limited by the Mozambique and Madagascar ridges, the Mozambique Basin: to the southeast of Madagascar, the Madagascar Basin: in the central part of the south Indian Ocean, limited by the Southwest and Southeast Indian ridges, the Crozet Basin.

The Southwest Indian Ridge is a nearly north-south-spreading ridge offset by several fracture zones running almost north-south. The spreading rate (half rate) along this ridge is about 0.6-0.9 cm per year, and it is assumed that spreading along this structure did not occur before about 40 million years ago (Schlich and Patriat, 1971a; McKenzie and Sclater, 1971; Bergh, 1971). The Southeast Indian Ridge has been a northeast-southwest-spreading ridge, at least for the last 45 million years (anomalies 1 to 18). Beyond anomaly 18, the magnetic pattern can still be identified, but the direction of spreading appears to be more or less north-northeast-south-southwest. The central anomaly of this ridge has been clearly identified and is offset in the vicinity of Amsterdam and St. Paul islands by several fracture zones running in a northeast-southwest direction. The present spreading rate (half rate) is found to be 3.4 cm/yr, but several changes have been observed at about 10, 24, and 50 million years (Schlich and Patriat, 1967; 1971b). Anomaly 17 has been recognized on both sides of Kerguelen-Heard Plateau (Le Pichon and Heirtzler, 1968; Schlich and Patriat, 1971b). Magnetic profiles run in the Crozet Basin and in the Madagascar Basin show very characteristic anomalies which can be correlated in a west northwest-east southeast direction. The large-scale right-lateral offset of these anomaly patterns on each side of the Southwest Indian Ridge (in the Madagascar and Crozet basins) is about 1000 km. According to the geomagnetic time scale proposed by Heirtzler et al. (1968), these anomalies can be identified with anomalies 23-28 (Schlich et al., 1971).

Site 245, provisionally located in position 31°36′S, 52°27′E at a water depth of about 4900 meters, is situated in the southern part of the Madagascar Basin about 200 miles northwest of the Southwest Indian Ridge axis and about 300 miles east of the Madagascar Ridge crest (Figure 1). This site was selected from seismic reflection data obtained by *Conrad* Cruise 11 in 1967 and a detailed site survey by *Conrad* Cruise 14 in 1971.

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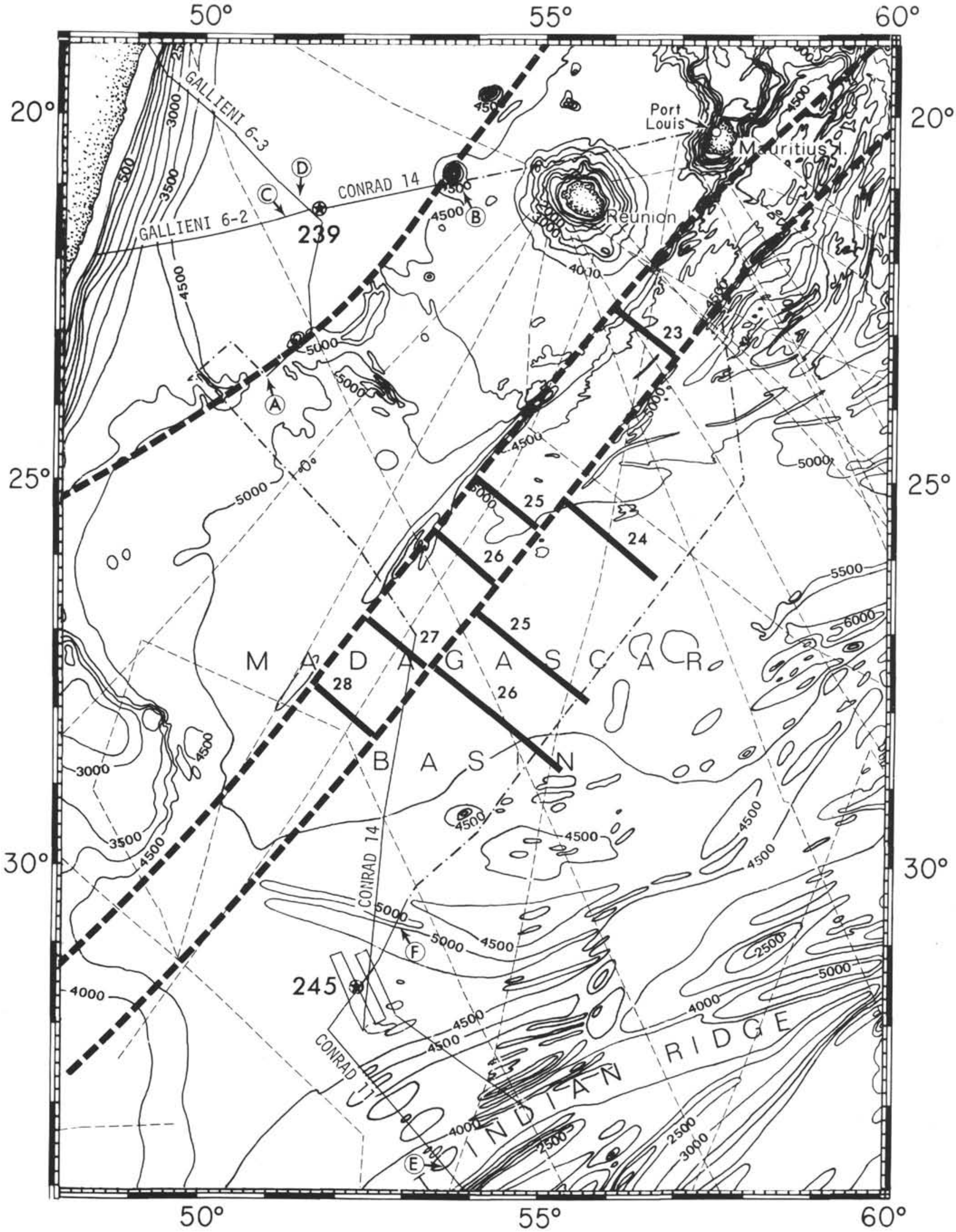

Figure 1. *Location map for Site 245. Isobaths in meters The letters refer to the seismic reflection profile given in Figure 2. Magnetic lineations in the Madagascar Basin are from Schlich et al. (1972).*

The *Conrad* 11 seismic reflection profile (Figure 2) shows, in the vicinity of the site, a smooth basement topography upon which rests clearly stratified sediments, 0.4 to 0.5 sec DT (double way time). Three small basement highs pierce the sediment sequence just north of the proposed drilling site; some discontinuities in the reflectors suggest small-scale faulting also.

The *Conrad* 14 seismic reflection profiles (Figure 3) consist of four 60-mile traverses run at 10-mile intervals, oriented north-northwest-south-southeast perpendicular to the dominant morphological trends in this area, and a fifth traverse directed northward through the proposed site (Figure 4). The basement appears locally smooth to the west in the surveyed area. Faulting is clearly evident to the east and to the north where the basement becomes progressively more rough. The sediment section, thickest to the southwest of the surveyed area in down-faulted pockets (0.4 sec DT), is highly stratified with several prominent reflectors. The seismic profiles show large- and small-scale basement faulting in the sediment section to the north.

The magnetic data obtained by *Gallieni*, Cruise 1 to Cruise 6 (1967 to 1972), (Schlich and Patriat, 1971c; Schlich et al., 1972) lead to the inference that Site 245 should be situated on anomaly 28/29, that is, the basement could be as old as 68/69 million years according to the geomagnetic time scale proposed by Heirtzler et al. (1968).

The objectives of drilling this hole were to establish the age of the basement and to check, in conjunction with a site located south of the Southwest Indian Ridge in the Crozet Basin, the proposed magnetic anomaly pattern. In addition, a second objective was to recover as complete as possible a sedimentary record for comparison between the north and south flanks of the Southwest Indian Ridge.

SURVEY DATA AND OPERATIONS

Glomar Challenger departed from Site 244 at 1817 hours LT (local time) (1517 GMT) on 29 July 1972 and after 3 days and 23 hours of steaming across the southeastern Mozambique Channel, the northern tip of the Madagascar Ridge, and the Madagascar Basin, reached the area surveyed by *Conrad* in 1967 (Cruise 11) and 1971 (Cruise 14). The location proposed for Site 245 at 31°36′S, 52°27′E was crossed along a course of 116° at about 1700 LT (1400 GMT) on 2 August 1971. The airgun reflection profile was continued in the same direction at a speed of 8.7 knots for about 13 miles. At 1900 LT (1600 GMT), the course was reversed to 286° and speed reduced to about 7 knots to enhance the clarity of the seismic reflection profile. The main structural features were identified on the airgun records and correlated with the *Conrad* data. A suitable location was found about 8 miles to the west-northwest of the proposed site and about 5 miles to the northwest of a small fault running nearly parallel to the *Conrad* 11 track. Two satellite fixes (1730, 1800 GMT) obtained during the presite survey allowed excellent positioning of the vessel. At 2156 LT (1856 GMT) the course was changed and Site 245 was approached along a course of 000°. At 2230 LT (1930 GMT) the 16-kHz beacon was dropped under way above the selected site. Immediately after retrieval of the airguns, hydrophones, and magnetometer, the ship reversed course at 2253 LT (1953 GMT) to take up station at 2340 LT (2040 GMT). The geographic coordinates of Site 245 are: 31°32.02′S, 52°18.11′E (Figure 4).

The *Glomar Challenger* airgun reflection profile obtained in the near-site area has the same characteristics as the *Conrad* profiles. The sediment section shows several prominent reflectors, and at Site 245, the seismic acoustic basement is at a depth of 0.41 sec DT (Figure 5).

The major site objective was to sample, date, and identify the basement and also to establish the stratigraphic sequence. The observed seismic acoustic basement was expected at a depth of about 340 meters; consequently, a program of intermittent coring was planned between 0 and 290 meters and continuous coring from 290 meters to basement. Since the measured velocity of the sediments appeared to be rather higher than the predicted values, it was decided to start continuous coring from 311 meters below the sea floor. The basement was reached at 390 meters, and due to poor recovery conditions, only 1.5 meters of basalt was recovered between 395 and 396.5 meters subbottom depth.

Rough sea conditions at the time of spud-in prevented adequate sampling of the sedimentary sequence above 120 meters depth, and it was therefore decided to drill a second hole (245A) at the same location with nearly continuous coring between 20 and 150 meters to provide complementary samples.

Drilling and coring at this site started at 1318 (LT) on 3 August 1972 and ended at 1500 (LT) on 6 August 1972. The first hole was completed and the drill pipe pulled above the mud line at 0400 (LT) on 6 August 1972. Nineteen cores were taken from Hole 245 and seven cores from Hole 245A. The total cored section is 213.5 meters and the total core recovery, 129.5 meters (Tables 1 and 2). The total time spent on the site was 4 days and 3 hours. The operations were somewhat delayed while replacing the brake bands on the drawworks and the shut-off valve about the swivel (5 hours). On Core 15, downhole inclinometer measurements indicated that the hole was 4.5° off the vertical. The average drilling rate was 76.7 m/hr for Hole 245 and 137 m/hr for Hole 245A. The average coring rate was 8.5 m/hr for Hole 245 and 52.5 m/hr for Hole 245A. After completion of drilling and coring at both holes, the four-cone bit appeared to be in only fair condition: 19 teeth were missing or chipped.

At 1900 (LT) on 3 August 1972, unreliable signals from the 16-kHz beacon made it necessary to drop a 13.5-kHz beacon, which landed at a distance of 600 feet south of the original 16-kHz beacon. Operations were continued satisfactorily with this offset. During drilling and coring, a sonobuoy for wide-angle reflection and refraction was launched, but because of contrary wind and current conditions, the drift of the sonobuoy was insufficient to provide complete data and after three hours of recording the signal was lost.

Glomar Challenger departed from Hole 245A at 0130 LT (2230 GMT) on 7 August 1972 in a northerly direction while the airguns, hydrophones, and magnetometer were streamed. At a distance of about 2 miles from the beacon, the vessel reversed course (225°) to pass over the beacon. At 0214 LT (2314 GMT) the beacon was passed at a distance of about 0.5 miles to starboard and the ship steamed southwest towards Site 246.

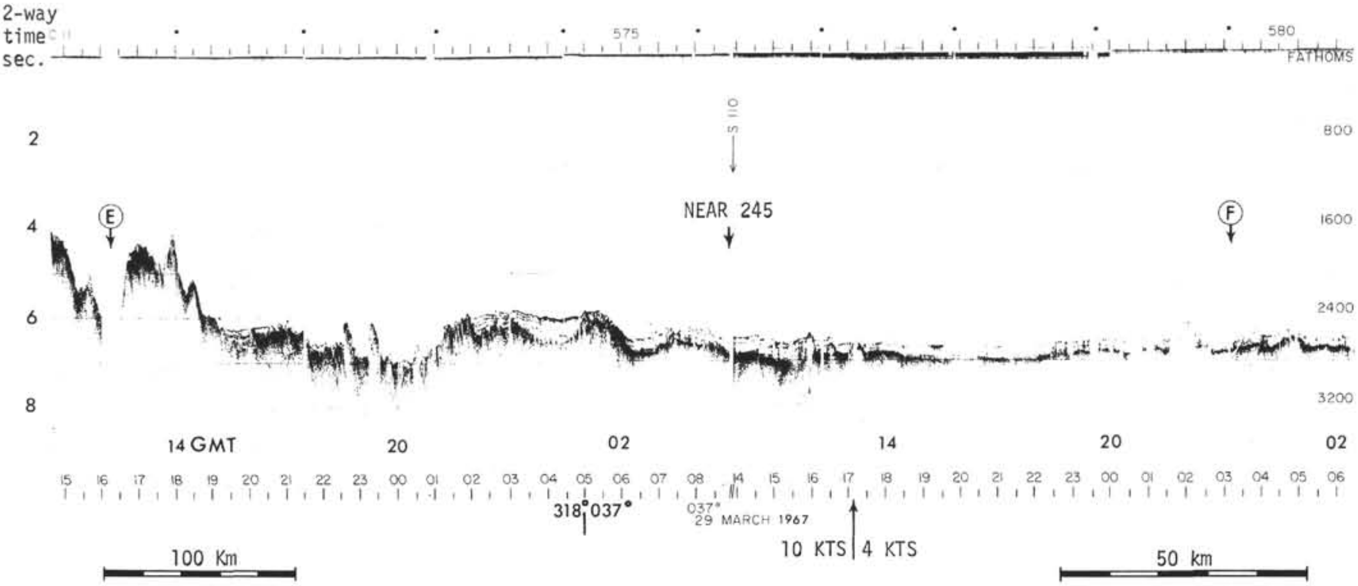

Figure 2. Conrad *11 seismic reflection profile in the vicinity of Site 245. The location of this profile is given in Figure 1 (solid lines).* Conrad *11 records are from unpublished Lamont-Doherty Geological Observatory data.*

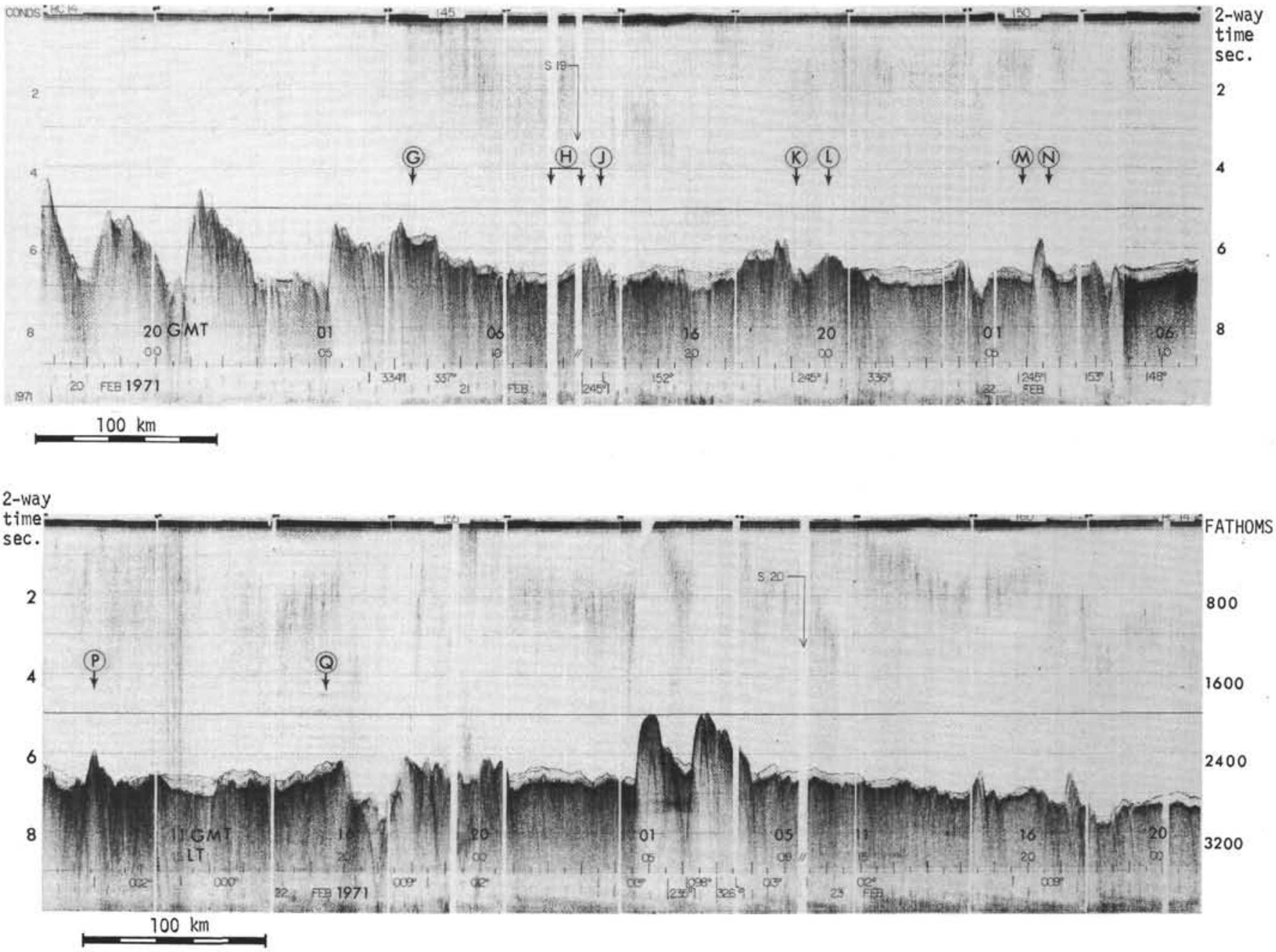

Figure 3. Conrad *14 seismic reflection profiles in the vicinity of Site 245. The locations of these profiles are given in Figures 1 and 4 (solid lines in Figure 1).* Conrad *14 records are from unpublished Lamont-Doherty Geological Observatory data.*

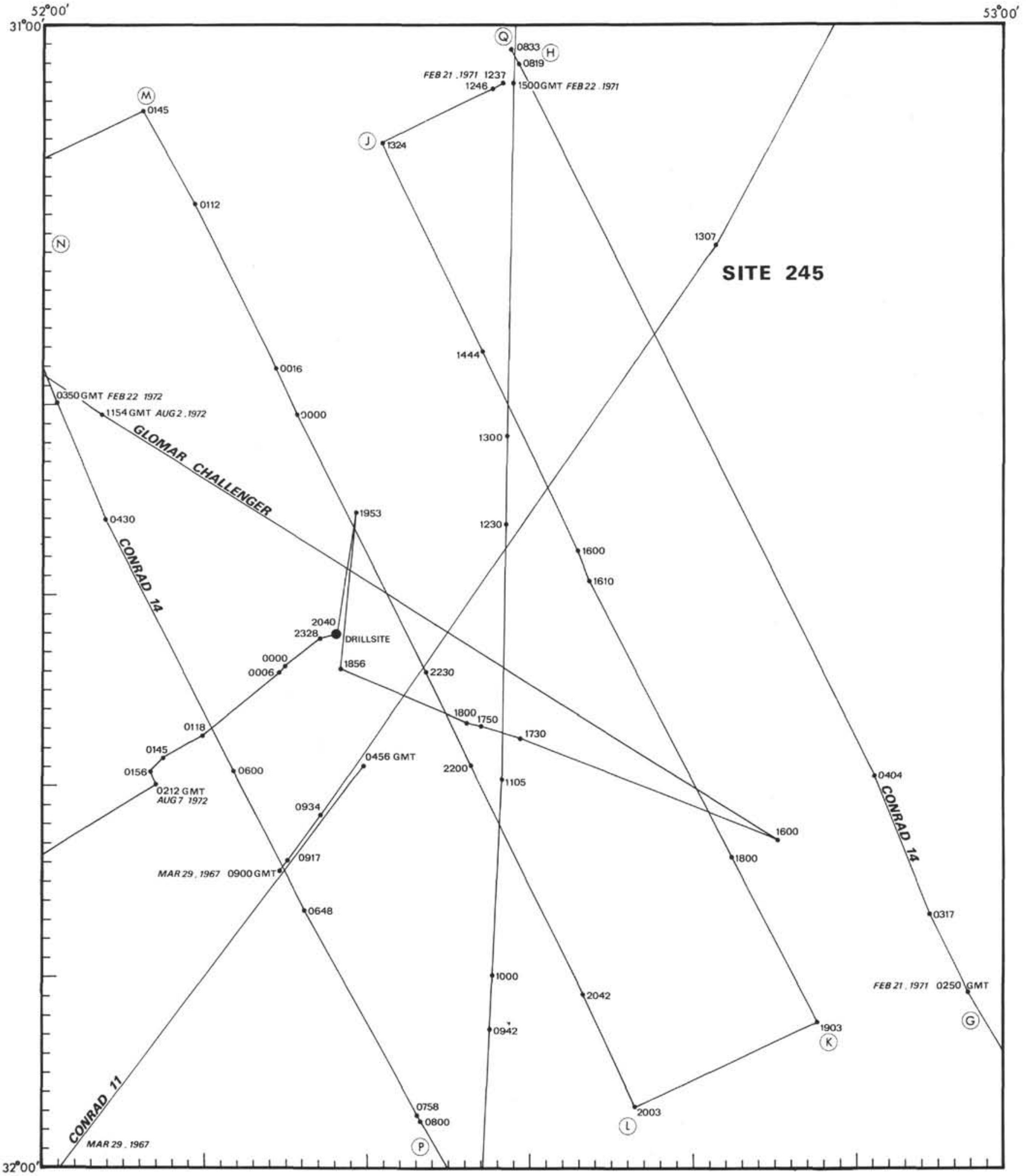

Figure 4. Conrad *14 Site Survey and details of the* Glomar Challenger *site approach. The letters shown refer to the seismic reflection profile given in Figure 3.*

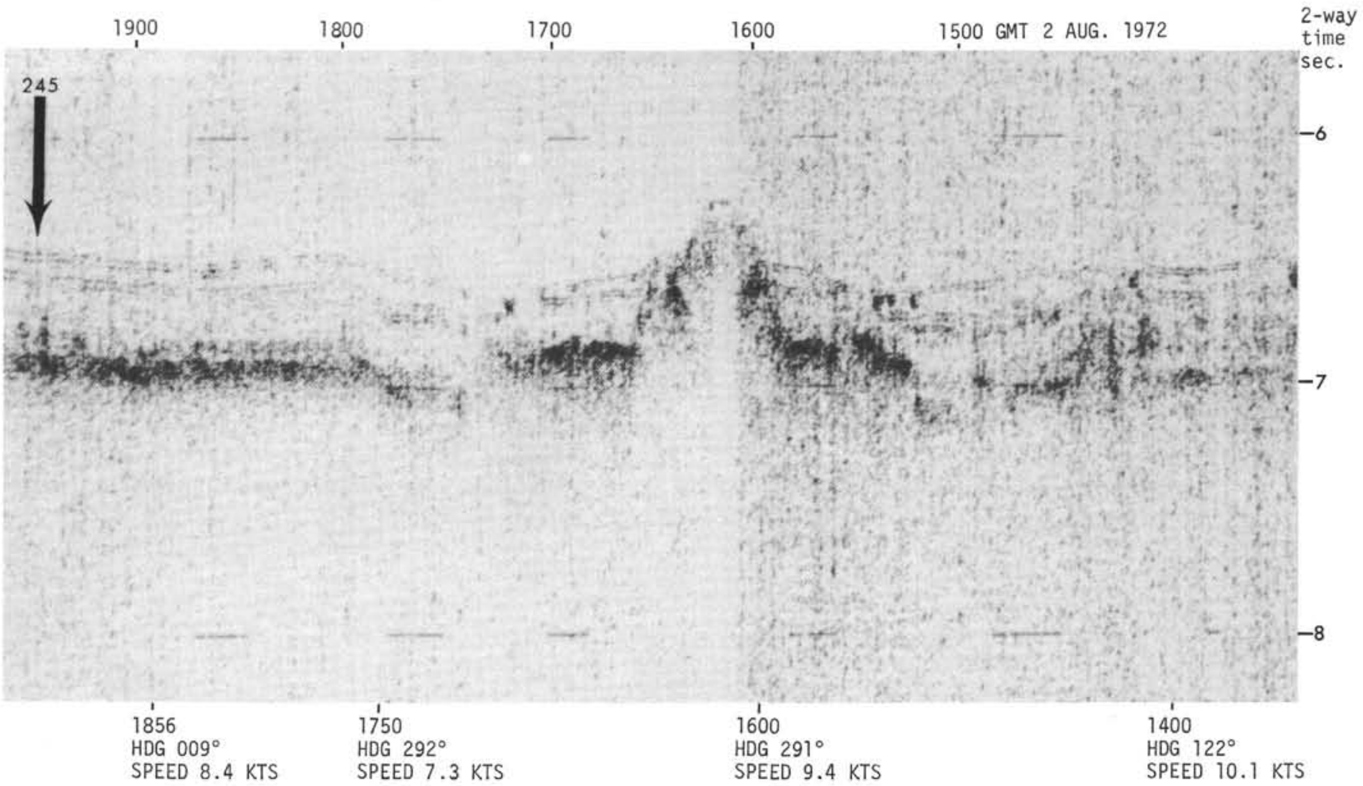

Figure 5. Glomar Challenger *seismic reflection profile on approach to Site 245.*

TABLE 1
Coring Summary, Hole 245

Core	Depth Below Sea Floor (m)	Cored (m)	Recovered (m)	Recovery (%)
1	7-16	9	8.8	98
2	61-70	9	0.3	3
3	121-130	9	4.4	49
4	159-168	9	8.3	92
5	207-216	9	7.5	83
6	245-254	9	2.1	23
7	254-263	9	2.4	27
8	283-292	9	2.8	31
9	311-320	9	3.7	41
10	320-329	9	4.5	50
11	329-338	9	7.5	83
12	338-347	9	6.3	70
13	350-359	9	7.8	87
14	359-368	9	8.3	92
15	368-376	8	4.5	56
16	380-389	9	1.4	16
17	389-393	4	CC	0
18	393-395	2	CC	0
19	395-396.5	1.5	1.5	100
Total		150.5	82.1	54.6

Note: Echo sounding depth (to drill floor) = 4867 meters; drill pipe length to bottom = 4873 meters.

TABLE 2
Coring Summary, Hole 245A

Core	Depth Below Sea Floor (m)	Cored (m)	Recovered (m)	Recovery (%)
1	26-35	9	9.3	100
2	54-63	9	9.0	100
3	63-72	9	2.6	29
4	72-81	9	7.7	86
5	91-100	9	5.4	60
6	100-109	9	4.4	49
7	140-149	9	9.0	100
Total		63	47.4	75.2

Note: Echo sounding depth (to drill floor) = 4867 meters; drill pipe length to bottom = 4873 meters.

LITHOLOGY

Introduction

At Site 245, two holes were drilled, 245 and 245A. Hole 245 penetrated a sedimentary sequence 389 meters thick which extends back in time to early Paleocene. Below the sediment, basement was reached and cored and 1.62 meters of basalt were recovered between 389 and 396.5 meters. In order to obtain a more complete stratigraphic record, a side hole, 245A, was drilled to a depth of 149 meters, providing seven cores from the upper part of the sedimentary column.

Examination of the cores reveals five major lithostratigraphic units including the basaltic basement. Three of the units have clear internal lithologic changes which warrant subunit assignments (Table 3).

Figure 6 summarizes the lithology and establishes a stratigraphic column for the site.

Description of Lithologic Units

Unit I: Brown Clay

Unit I consists of a 63-meter-thick brown, silt-rich clay which grades downwards into a brown silty clay. This sediment is very soft and generally is greatly deformed by drilling. The color is moderate yellowish brown to dusky yellowish brown and the average composition is about 70-80 percent clay and 20-30 percent silt. The silt fraction is composed mainly of quartz and feldspar (70%), micas (10%), and other minerals (chlorite, biotite, and hematite). Numerous prismatic minerals (clinoptilolite?) are present in the sediment.

The brown clay displays many black streaks, spots, and patches which are believed to contain iron-manganese oxides. Some micronodules were observed throughout the cores in Unit I. In Core 2, Section 6 of Hole 245A, one small nodule is 1 cm in diameter.

The sediment is practically devoid of fossils except in some micronodules where a surprisingly large amount (25%) of poorly preserved nannofossils were observed. Coarse sieve fractions contained abundant fish teeth and bones. However, some nannofossil-rich layers are interbedded in the brown clay; one or two may be redeposited sediment. In the core catcher of Core 1 (Hole 245), a clayey nanno ooze was recovered (65% nannos) which provided a middle Miocene age, while in the core catcher of Core 2 (Hole 245A) a brown silt/nanno-rich clay is late Eocene in age. Moreover, at about 60.5 meters below the sea floor in Hole 245A, a 30-cm-thick bed of orange-pink clay-bearing nanno-ooze (90% nannos) interlayered in the brown clay is late Eocene in age.

The lower boundary of Unit I is relatively well defined. In effect, below 63 meters, in Unit II, the amount of well preserved nannofossils is never less than 2-5 percent throughout the cores, whereas nannofossils in trace amount are etched in the overlying Unit I.

Unit II: Variegated Interbedded Clays and Oozes

This 63-meter-thick unit, which consists mainly of brown to light brown nanno-bearing clay, is soft to moderately stiff and contains interlayered brown silty clay, brown silt-bearing clay, and pink and brown clay-rich nanno ooze beds. Extreme deformation of the recovered material obscures the depositional relationships among these diverse sediments. The lower boundary is located at a depth of 126 meters where a sharp contact occurs between the upper light brown nanno-bearing silty clay and the lower pale orange nanno ooze. The brown silt-bearing clays and silty clays seem to be similar to the brown clay in Unit I, except that they contain a noticeable amount (2%-5%) of nannofossils.

Silty and clayey sediments in Unit II contain specks and streaks of a dark or dusky yellowish brown material which is possibly rich in Fe/Mn oxides. These interlayered silty clays also contain some heavy minerals which include hematite, epidote, chlorite, and rutile.

Unit II is mostly middle Eocene in age; the uppermost part was deposited during the beginning of the late Eocene.

Unit III: Clay-rich Nanno Ooze

This 83-meter-thick unit is clearly differentiated from the overlying unit by the fact that it consists only of a nearly pure nanno ooze (nanno content is 80%-85%). The degree of consolidation ranges between soft near the top to very stiff near the lower boundary at a depth of 209 meters.

Two subunits (A and B) are recognized based on color and differing percentages of foraminifera and silt-sized or clay-sized carbonate fragments.

Subunit IIIA: The upper part of Unit III, is a pale orange clay-bearing to clay-rich nanno ooze containing foraminifera and iron oxides. Some manganese micronodules form specks in the sediment. Clinoptilolite, a subhedral to euhedral zeolite, is present in noticeable amounts (1%-2%).

Subunit IIIB: This consists mostly of a pinkish gray clay-rich nanno ooze interlayered with pale brown zeolite-bearing nanno ooze. This sediment contains a large quantity (10%-15%) of silt-sized to clay-sized carbonate fragments (micarb), which may result from the disaggregation and partial recrystallization of the nannofossils and foraminiferal test fragments.

In Core 4 (Section 4 and core catcher), a few fragments of brown chert occur together with some scattered thin (5-10 cm) semi-indurated chalk layers. This change, at 209 meters, marks the lower boundary of Unit III. Unit III is mainly early Eocene in age.

Unit IV: Clay-rich Nanno Chalk

This 181-meter-thick unit constitutes almost half of the entire sedimentary sequence. The sediment is a semilithified to lithified nanno ooze with interlayered cherts, silicified chalk, and devitrified volcanic ash.

Three subunits (A, B, C) are recognized, based on the nature of the minor constituents.

Subunit IVA: This subunit is represented by a pinkish-gray to white clay-rich nanno chalk, with silicified interbeds and brown to grayish orange-pink beds of chert (3-30 cm thick). Throughout the core, and particularly within the silicified levels, dark patches and irregular laminations within the core section indicate an intensely burrowed and bioturbated sediment. The silt- and clay-sized carbonate particles which compose a large amount of the chalk (5%-30%) are believed to originate partly by nannofossil fragmentation and partly by recrystallization. Clay and foraminifera content is noticeable. Approximately at 213 meters (Core 5), just below a bed of chert, a pinkish-gray foram-bearing nanno ooze is present which contains 5 percent foraminifera and 5 percent clay. Only one devitrified volcanic ash layer, consisting of nearly 90 percent pure clay (mostly montmorillonite), is present in this subunit (Core 5). A more detailed discussion and

TABLE 3
Lithologic Units and Subunits, Holes 245 and 245A

Depth (m)	Lithologic Units	Subunits	Thickness (m)
	(I) Brown clay (silt-rich		63
63			
	(II) Variegated clays and oozes		63
126			
	(III) Clay-rich nanno ooze	A) Pale orange nanno ooze	83
		B) Pinkish-gray nanno ooze	
209			
	(IV) Clay-rich nanno chalk	A) Nanno chalk; silicified nanno chalk and chert	
		B) Gray clay-rich nanno chalk devitrified volcanic ash	181
		C) Black ferromanganoan clayey nanno chalk	
389			
	(V) Basalt	A) Dark green glassy basalt	7
		B) Dark green diabasic basalt	
396.5			

petrographic summary of the chert and silicified chalk is presented below.

Subunit IVB: This subunit is a gray clay-rich chalk containing 22 separate interbeds of green, olive-gray to reddish-orange devitrified volcanic ash which range in thickness from about 0.5 cm to 10 cm. Outlines of partly dissolved volcanic glass fragments and feldspars are observed within this sediment, which is composed of almost pure clay (montmorillonite). A significant increase in the abundance of clay content in the chalk (15%-20%) and the devitrified volcanic ash layers occurs simultaneously. In some portions of the unit, the sediment is more appropriately named a nanno claystone.

The entire subunit displays a great deal of burrow mottling, especially close to and/or within devitrified volcanic ash layers. A comparatively higher percentage of foraminiferal fragments (5%) was revealed in some of the burrows. Towards the base of the unit, the darker gray chalk is intensively speckled with black spots and streaks of ferromanganoan oxides.

In Cores 10 and 12, natural breaks which have slickenside-appearing surfaces are inclined 30°-45° to the long axis of the core, suggesting high angle faulting.

Subunit IVC: This is the lower part of the nanno chalk sequence from 368 meters to its contact on the basement at 389 meters (Cores 15-17). Compared to the overlying chalk of subunit B, the clay content increases considerably (30%-40%), resulting in a clayey nanno chalk. The most outstanding feature characterizing this subunit is the occurrence of a high content of ferromanganoan oxides giving a brownish to olive black color to the chalk. The composition of this chalk can be summarized as follows: nannofossils, 40%; clay, 30%; carbonate particles, 15%; Mn/Fe oxide, 10%; and foraminifera, 5%.

The nanno chalks of Unit IV are mainly Paleocene in age, the upper 77 meters being early Eocene in age.

Unit V: Basalt

Basalt was encountered at about 389 meters below the sea floor. Core catchers of Cores 17 (389-394 m) and 18 (393-395 m) contained small fragments, each about 6 cm in length, as the only recovery in those cored intervals. In Core 19 (395-396.5 m), the full 1.5 meters were recovered.

In Core 17, the basalt was glassy and greenish black while medium-grained dark gray diabasic basalt was recovered in Cores 18 and 19. Inclusions of the diabasic

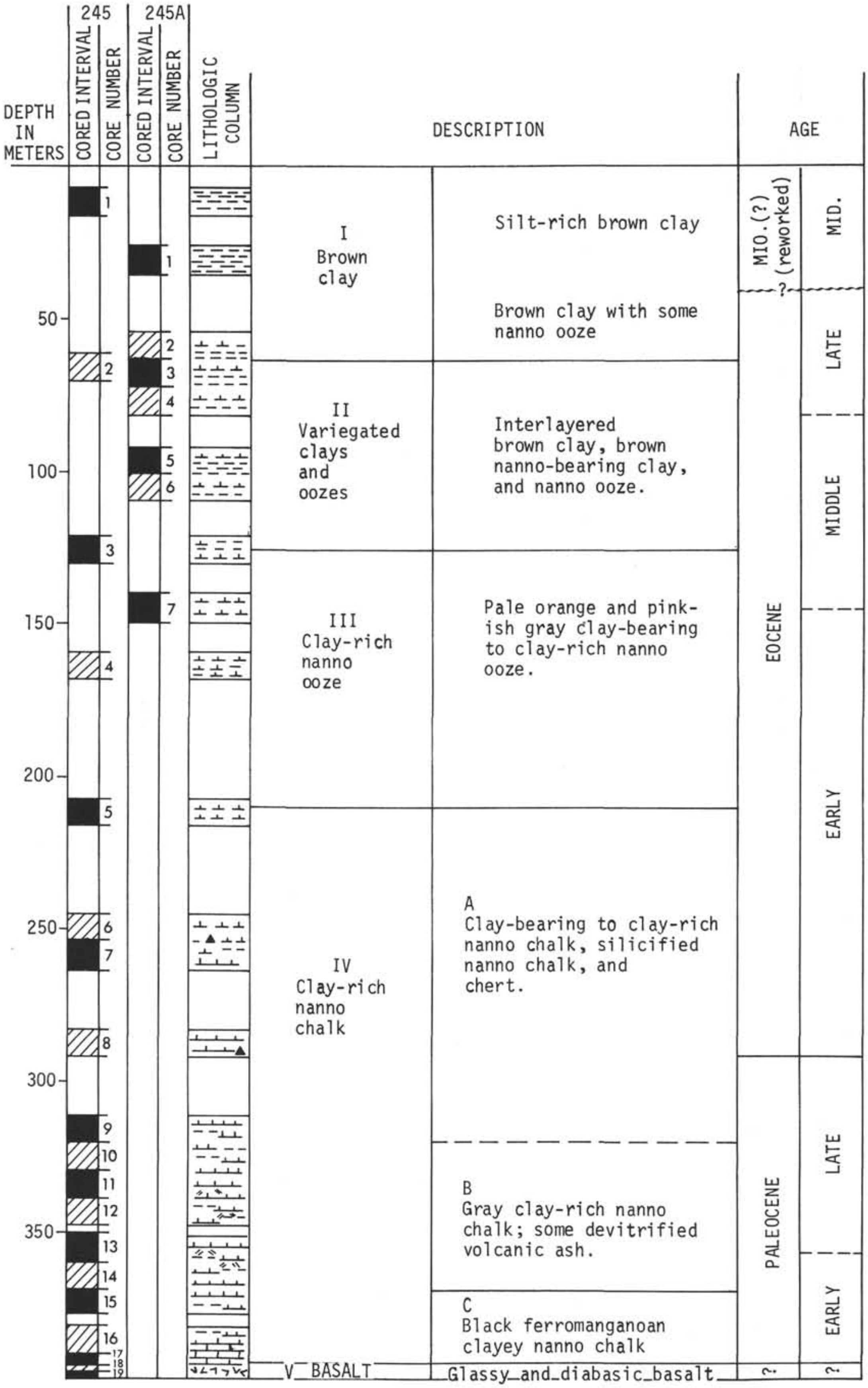

Figure 6. *Stratigraphic column, Holes 245 and 245A. Dashed lines indicate uncertain boundaries. The wavy line indicates a hiatus.*

basalt were found in the glassy basalt from Core 17. Unfortunately, the contact between the two basalt types was not recovered. However, the contacts between a large (3 cm × 2 cm) diabasic basalt inclusion and the glassy host is sharp, although smaller inclusions have irregular gradational boundaries due to partial assimilation. Veins that occur throughout the cores are filled with calcite and chlorite. Younger fractures which in some places cut across the veins, are marked by reddish-brown iron stains. Calcite-bearing veins are generally wider (4 mm) than those containing chlorite (1 mm).

The glassy basalt in Core 17 has a porphyritic texture with microphenocrysts of plagioclase, augite, and altered olivine set in a variolitic groundmass of plagioclase, magnetite, and sideromelane; chlorite, calcite, and smectites occur as alteration products. Vesicles up to 1 mm in diameter are filled with chlorite. Diabasic inclusions have textures and modal compositions similar to the underlying diabasic basalt in Cores 18 and 19. An average mode for the glassy microporphyritic basalt is plagioclase phenocrysts, 8%; augite phenocrysts, 5%; olivine phenocrysts, 3%; groundmass, 84%.

The diabasic basalt in Core 19 is fresh, except in narrow altered zones near fractures, medium-grained, and nonporphyritic. It is composed of subophitic intergrowth of plagioclase and augite with subordinate amounts of interstitial magnetite, glass, chlorite, smectites, and calcite.

Modal variation is slight, the contents of plagioclase and augite varying from 50-58 percent and 30-36 percent, respectively, with variable amounts of magnetite, glass, chlorite, smectites, and calcite forming the remaining 6-20 percent.

The major and trace element analysis indicates that the diabasic basalt is similar in composition to the low K tholeiites recovered from the mid-ocean ridges.

Cherts and Silicified Chalk

Fourteen chert-bearing horizons were encountered in Hole 245. They occur mostly in Cores 5 through 9 (see above subunit IVA) and consist either of individual brown chert fragments or of thin (5-10 cm) silicified nanno chalk layers. Individual fragments exhibit irregular angular shape, porcellaneous appearance, and conchoidal fracture and probably represent a drilling breccia rather than single nodules. The thin, hard, silicified chalk beds generally occur within those sections of the nanno ooze and chalk levels which contain a higher percentage (1-5) of foraminifera as compared to the foraminifera content where silicified chalk is absent. The chert clearly replaces the chalk, as demonstrated by silicified foraminifera tests and the preservation of burrow mottling.

Thin sections made both from selected chert fragments and from silicified chalk beds reveal the complete lack of siliceous fossils. Silicification occurs as spherulitic cristobalite fillings of foraminiferal test chambers, as partial or complete replacement of foram tests, and as microcrystalline chalcedony mosaic throughout the matrix. The remaining matrix (approximately 30%) consists of fine silt- and clay-sized, irregularly shaped carbonate particles which are notably more abundant than in nonsilicified intervals. Calcareous nannofossils are rare in the matrix but are present in a few sheltered foram chambers. Where found, nannofossils are composed of carbonate. Clay minerals are apparently absent from silicified zones, although they are common in nonsilicified zones.

Lithologic Interpretations

A sequence of geologic events at Site 245 is tentatively interpreted from the preceding lithologic descriptions, progressing through the lithologies from bottom to top of the section.

1) The basalt and diabasic basalt could be older than the sediment. According to the paleontological data, the last sampled deposits overlying the basement are about 63 million years old.

2) The oldest chalk deposit resting on the basement contains an abnormally high amount of Fe/Mn oxides. This sediment seems to be more or less similar to the "mixed amorphous iron-manganese oxide-detrital facies" previously described on Pacific legs (von der Borch et al., 1971) and not so much different from the strongly Fe/Mn-enriched deposits overlying mid-oceanic active ridges (Bostrom et al., 1969). Both high ferromanganoan oxide and high clay contents suggest volcanic inputs. Metallic components might originate by the precipitation from seawater of metallic ions yielded by hydrothermal exhalations and/or by halmyrolysis of basalts and basaltic glass. Very likely, clay (mostly montmorillonite) results from volcanic glass devitrification and thus comes indirectly from volcanic activity.

3) In the overlying deposits (subunit IVA), the decrease in clay content occurs simultaneously with the appearance of silicified levels in the chalk. Considering the complete lack of siliceous fossils throughout the whole sedimentary sequence, occurrence of the silicified layers might be related to dissolution of clay from devitrified volcanic ash layers or, more likely, from dissolution of dispersed clay in the chalk and the subsequent concentration of some silica as microcrystalline chalcedony comprising most of the matrix of chert zones. The alteration of a clay mineral (montmorillonite, for instance) with silica removal may represent one stage of the progressive silicification of the sediment.

The cherts in Hole 245 bear a strong resemblance to those encountered in the western Pacific Ocean during Leg 7 (Moberly and Heath, 1971). Although the secondary nature of silica in calcareous sediments at Site 245 is obvious, direct evidence of its source is lacking.

4) Extremely heavy bioturbation throughout the chalk section (subunits IVA and IVB) indicates intense biologic activity on the sea floor during late Paleocene and part of early Eocene. It is obvious that environmental conditions were particularly favorable for the development of a flourishing benthonic fauna. Although the reason why ash layers (in particular) display such intense bioturbation is still not clear, high nutrient contents of interstitial water, special physical properties of the sediment (porosity), and moderately deep water can be inferred.

5) More than half of the thick (264 m) nannofossil deposits are early Eocene in age. Consequently, a fairly high rate of sedimentation of about 33 m/m.y. is calculated. This fact strongly suggests that (a) the sediments were

deposited well above the calcium carbonate compensation depth zone; and (b) there was a fairly high productivity in the sea euphotic zone.

6) At the beginning of the middle Eocene (Unit II), a relatively sudden appearance of silt occurs simultaneously with a sharp lowering of the sedimentation rate (about 9 m/m.y.). Nannofossil deposits and silty clay are interfingered or mixed. In some places, fossils are poorly preserved. This fact suggests (a) increased sediment supply from a terrigenous source; and/or, (b) reduced biogenic productivity; and/or, (c) deepening of the sea floor close to the calcium carbonate compensation depth zone.

7) The last sequence (Unit I) at the top of the sedimentary column indicates the disappearance of calcareous fossils starting approximately in late Eocene and continuing until the Holocene. During this time interval, only detrital and volcanic materials were deposited. Very sparse, thin fossiliferous levels (at 10.5 m, for instance) or partly preserved nannofossils inside manganese nodules indicate that the brown clay was deposited well below the calcium carbonate compensation depth. The ensuing rate of sedimentation is low, 1-2 m/m.y., but slightly higher than commonly occurs in red clays. This fact may be related to terrigenous supplies, either wind-transported or brought by nepheloid layers from not too distant land masses. Nevertheless, this type of sediment can be considered as a pelagic deposit.

PHYSICAL PROPERTIES

The sonic velocity data in general defines a fairly smooth curve from the sediment-water boundary through unit III (209 m).

Between 60 and 100 meters depth, this smooth curve shows a positive "bulge." From about 100 meters to the top part of Unit IV, and at about 213 meters, there is an increase of velocity with depth. Possible anomalies occur at about 160 and 168 meters where velocities of 1.67 km/sec and 1.60 km/sec, respectively, were measured in thin chalks in Core 4. This core is essentially nanno ooze which has other measured velocities of 1.53, 1.53, and 1.54 km/sec. Unit IV extends from approximately 209 meters to basement at 389 meters. This unit is a nanno chalk with interbedded chert, silicified chalk, and devitrified volcanic ash. In this unit, the gradient of velocity versus depth is essentially constant to basement. The data are more scattered and have several anomalous values associated with the interbedding. The large positive anomalies with their approximate depths are:

1) 3.95 km/sec in a chert in Core 5 at 213 meters;

2) 1.99 km/sec in a limestone in Core 5 at 214 meters;

3) 3.03 and 3.63 km/sec in chert in Core 6 at 248 meters;

4) 2.65 km/sec in silicified chalk and 3.12 km/sec in chert in Core 7 at 257 meters; and

5) 2.72 km/sec in silicified chalk in Core 8 at 284 meters.

A negative anomaly of 1.75 km/sec occurs at about 354 meters in intensely burrowed devitrified volcanic ash. Table 4 contains a summary of sonic velocities related to lithology.

TABLE 4
Sonic Velocity Versus Lithology

Lithology	No. of Tests	ν	σ	Limits	
Brown clay	7	1.50	±0.018	1.46	1.52
Nanno ooze	9	1.54	±0.011	1.52	1.55
Nanno chalk	74	(1.87)	–	1.58	2.12
Burrowed clay-rich nanno chalk	2	2.03	–	2.03	2.03
Silicified chalk	3	2.67	–	2.49	2.81
Devitrified volcanic ash	1	1.99	–	–	–
Intensely burrowed volcanic clay	1	1.75	–	–	–
Chert	7	(3.35)	–	2.93	3.95
Diabasic basalt	9	(5.22)	–	4.87	5.48
Sample (1)*	2	4.90	–	4.87	4.93
¶	1	5.08	–		
Sample (2)*	2	5.20	–	5.09	5.31
¶	2	5.37	–	5.30	5.37

Notations used:

ν = average sonic velocity
σ = standard deviation (used where meaningful)
* = perpendicular to bedding plane or vertical
¶ = parallel to bedding plane or horizontal

The bulk densities increase from about 1.25 to 1.40 g/cm^3 between 25 to 35 meters. From there to about 215 meters (top of Unit IV), the average values increase smoothly with depth. At 77 meters, there is a 16 percent reduction in a syringe bulk density measurement which is reflected by a reduction in porosity and is also near a lower value of thermal conductivity (79 m). No definite correlation with lithology is seen, although it is about 50 cm above the boundary between a light brown nanno-rich clay and a brown silty clay. At about 213 meters, there is a high syringe bulk density value of 2.37 g/cm^3. The same sample shows an increase in porosity to 69.3 percent. The lithology log indicates this is a nanno chalk-chert boundary. The GRAPE value of the chert is about 2.06 g/cm^3. The high density and high porosity for the syringe sample seem incompatible and are unexplained at the present.

At the approximate depths of 330, 332, and 356 meters, low density values ranging from 1.35 to 1.54 g/cm^3 were measured in thin layers of devitrified volcanic ash. At about 354 meters, a clay-rich nanno chalk was measured at 1.36 g/cm^3. Excluding these values, the average bulk density from 205 meters to basement is 1.99 g/cm^3 with a standard deviation of less than 3 percent.

The acoustic impedance increases between 15-75 meters. The clay-rich nanno chalk at about 354 meters has a negative anomaly due to the lower bulk density. There is a general increase of acoustic impedance from 75 meters to basement with individual positive anomalies reflecting those of the sonic velocity.

The water content and porosity data are highly variable. Some of this must be due to the disturbed condition of the cores—especially those from Hole 245A. Generally, both properties decrease with depth to about 73 meters where the water content is 34.4 percent. From there to about 76 meters, the water content sharply increases to 40.9 percent and then varies about a mean of 41 percent to 104 meters. At about 77 meters, the porosity has an apparently anomalously low value of 56.7 percent which is probably related to the negative bulk density anomaly at 77 meters and the lower thermal conductivity value at about 79 meters. At about 125 meters, water content decreases sharply to approximately 30 percent. From there to basement, the decrease in percent water is essentially linear, with the exception of several positive anomalies. The clay-rich nanno chalk is known to have thin layers of devitrified volcanic ash. These are definitely related to two of the higher water content values below 300 meters, and, along with gradation or variation in minor lithology of the chalk, might explain other scattered values.

Thermal conductivity increases with depth from 0 to about 60-65 meters. There is an anomalously low value of 2.14 mcal/cm sec °C at 79 meters. There is no clearly defined trend below about 125 meters, where large variations occur. These are considered to be due to the interbedding. At about 284 meters, two tests were made 65 cm apart. One was in the nanno chalk and had a value of 3.54 mcal/cm sec °C and the other, in silicified chalk, was 2.78 mcal/cm sec °C.

BIOSTRATIGRAPHY

Calcareous Nannoplankton, Hole 245

Core 245-1 is without calcareous nannoplankton. Only in the core catcher an assemblage of middle Miocene age occurs, but this sample probably is not autochthonous. Also in one other sample of this core, an assemblage of Paleocene age was observed (Figure 7).

The core catcher of Core 2 is very rich in well-preserved calcareous nannoplankton, indicating a late Eocene age, probably the *Isthmolithus recurvus* Zone (NP19) with *Reticulofenestra umbilica, Cyclococcolithus formosus, Isthmolithus recurvus, Discoaster tani nodifer, Discoaster barbadiensis,* and *Dictyococcites dictyodus.* The upper part of Core 3 contains relatively few nannoplankton without typical species. Samples 3-3, 107 cm to 3-4, 30 cm probably belong to the *Discoaster saipanensis* Zone (NP17) with *Discoaster saipanensis,* and *Discoaster barbadiensis.* Coccoliths in these samples are partly dissolved. In the lower part of Core 3, the *Chiphragmalithus alatus* Zone (NP15) was identified along with *Chiphragmalithus alatus, Chiphragmalithus cristatus,* and *Chiasmolithus grandis.*

Samples 4-1, 40 cm to 4-3, 140 cm probably belong to the *Discoaster sublodoensis* Zone (NP14).

The *Discoaster lodoensis* Zone (NP13) was observed in Samples 4-5, 50 cm to 6-2, 14 cm with *Discoaster lodoensis,* which becomes very frequent, *Chiasmolithus grandis,* and *Cyclococcolithus formosus. Marthasterites tribrachiatus* was found only rarely. In Sample 6-2, 97 cm, this species becomes more abundant. In the interval from the core catcher of Core 6 to level 8-1, 145 cm, the *Discoaster binodosus* Zone (NP11) was identified with *Marthasterites tribrachiatus* but without *Discoaster multiradiatus* and *Marthasterites contortus.*

The *Marthasterites contortus* Zone (NP10) was observed in Samples 8-2, 50 cm and 8-2, 110 cm with *Marthasterites contortus, Discoaster multiradiatus,* and *Marthasterites tribrachiatus.* Preservation of the nannoplankton in the Eocene sediments is not good; the species are calcified.

The interval between the core catcher of Core 8 and level 9-3, 100 cm belongs to the *Discoaster multiradiatus* Zone (NP9) of the late Paleocene. The samples have abundant well-preserved nannoplankton with the typical species *Discoaster multiradiatus, Discoaster gemmeus, Chiasmolithus bidens,* and *Fasciculithus tympaniformis.* The *Heliolithus riedeli* Zone (NP8) occurs in the interval between 9, CC and 10-2, 34 cm.

The *Discoaster gemmeus* Zone (NP7) with *Discoaster gemmeus, Fasciculithus tympaniformis, Chiasmolithus bidens, Ellipsolithus macellus, Ellipsolithus distichus, Cruciplacolithus tenuis,* and *Zygodiscus sigmoides* was determined in Sample 10-2, 100 cm.

The *Heliolithus kleinpelli* Zone (NP6) was observed in Samples 10-3, 50 cm to 11-4, 110 cm. *Heliolithus kleinpelli* becomes very frequent in some samples.

The *Fasciculithus tympaniformis* Zone (NP5) was recognized in the interval of 11-5, 100 cm to 13-4, 50 cm. It was not possible to identify the *Ellipsolithus macellus* Zone (NP4).

The interval between 13-5, 100 cm and 6, CC belongs to the *Chiasmolithus danicus* Zone (NP3) with *Chiasmolithus*

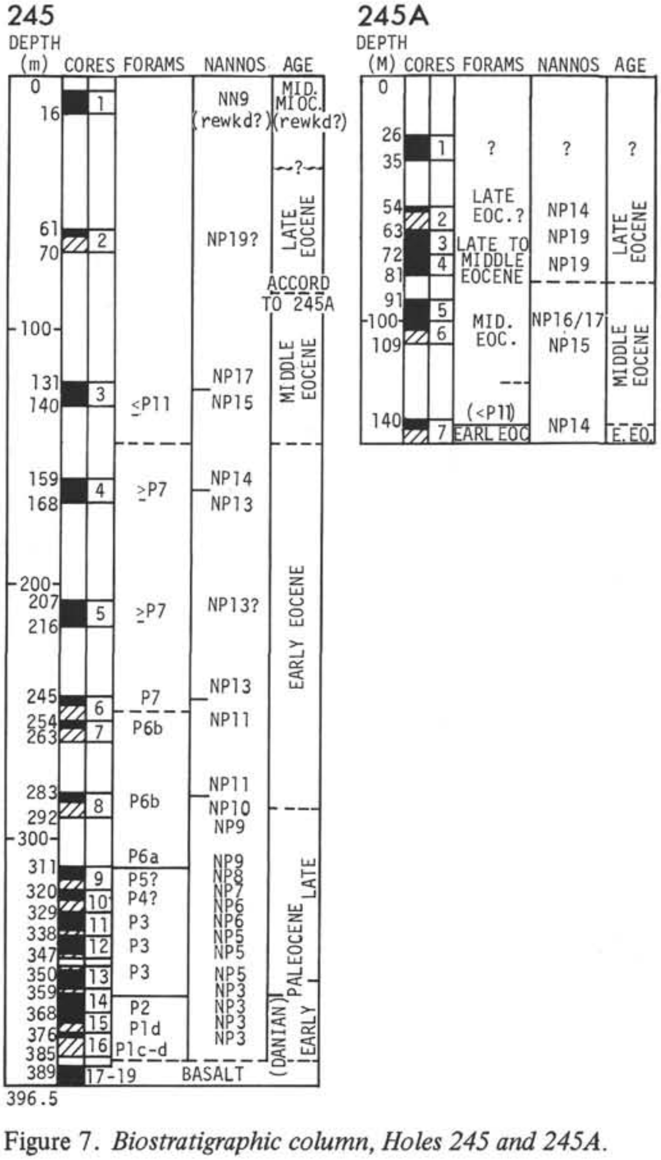

Figure 7. *Biostratigraphic column, Holes 245 and 245A.*

danicus, Cruciplacolithus tenuis, Zygodiscus sigmoides, Cyclococcolithus inversus, and *Coccolithus cavus*. Some of the samples are rich in nannoplankton.

Calcareous Nannoplankton, Hole 245A

Core 1 is without nannoplankton. Cores 2 to 4 belong to the *Isthmolithus recurvus* Zone (NP19). In Core 245A-2, nannoplankton are found only in the micronodules. In all the other samples of this core, the nannoplankton are dissolved. *Sphenolithus pseudoradians* was not observed, but *Sphenolithus* cf. *predistentus* becomes abundant in some samples. Other species of these cores are: *Discoaster barbadiensis, Discoaster saipanensis* (only a few), *Discoaster tani nodifer, Reticulofenestra umbilica, Isthmolithus recurvus, Cyclococcolithus formosus,* and *Helicopontosphaera compacta*. These samples are very rich in calcareous nannoplankton.

Core 5 contains only a few nannoplankton; an age determination is not possible. Core 6 is not rich in nannoplankton, and the coccoliths are slightly dissolved. Samples belong to the *Discoaster saipanensis* Zone (NP17)/*Discoaster tani nodifer* Zone (NP16). The core catcher of Core 6 seems to correspond with the *Chiphragmalithus alatus* Zone (NP15), but this species occurred infrequently.

Core 245A-7 contains an assemblage of the *Discoaster sublodoensis* Zone (NP14) with *Discoaster sublodoensis, Discoaster lodoensis, Discoaster barbadiensis, Chiasmolithus grandis, Zygolithus dubius, Chiphragmalithus acanthodes, Chiphragmalithus cristatus. Cyclococcolithus formosus,* and *Sphenolithus radians*. The nannoplankton of this core are heavily calcified; therefore, exact identification is sometimes difficult.

Paleogene Foraminifera

These two holes, drilled on the same site in order to complement one another, cut through a Paleogene sequence extending from the Danian to the late Eocene. The oldest level corresponds to the middle Danian, which is separated from the basalt by only a few uncored meters. Approximately 35 meters of sediments separate the late Eocene from the middle Miocene in Core 245-1. It will be noted that in this section, descriptions proceed from older to younger faunas.

Comments on the Materials Available

The Paleocene (including the Danian) was cored in a subcontinuous manner so that a fairly accurate zonation could be made. The cores in the early Eocene are sparser, and they have been somewhat satisfactorily fitted into the zonal scale. Coring in the middle Eocene is again more sequential (thanks to auxiliary Hole 245A), but depositional conditions in part of the sequence were not favorable for the accumulation of foraminifers that could be used for chronostratigraphy. The late Eocene, which is mainly dated on the basis of the nannoplankton, did not reveal any truly characteristic forms.

The cores have a good percentage of recovery, except for those at the bottom of the early Eocene and those in the late Eocene. When pelagic assemblages are present, the microfauna is generally rich and diversified, sometimes in an excellent state of preservation. However, in the early and middle Eocene, the shells are often recrystallized. Beginning at a given level in Core 245-3, there is a change in sedimentary characteristics accompanied by an important change in the microfauna. A benthonic assemblage is dominant, or is even the only one present, while pelagic assemblages thin out or disappear, apparently by dissolution.

Generally, the residue on the 177-micron sieve is not very abundant, but is often made up almost exclusively of the remains of organisms (mainly foraminifers, with both ostracods and radiolarians being scarce). In the upper part of the middle Eocene and in the late Eocene, there is almost no residue.

Comments on the Composition of Planktonic Assemblages

Generally, when the foraminiferal microfauna is well represented, planktonic assemblages are highly diversified with several species abundant.

From a quantitative standpoint, no obstacle appears to exist in the way of a chronostratigraphic diagnosis; from a qualitative standpoint, on the other hand, we are handicapped by the specific faunal composition, especially beginning with the late Paleocene. Several species which are normally used for determining conventional zone scales or for correlating to these scales are missing or are represented by relatively untypical specimens. For example, this is the case for species such as those of the *trinidadensis-uncinata* group as well as the group of *pusilla, velascoensis, wilcoxensis, formosa, palmerae, spinulosa, lehneri, topilensis, Pseudohastigerinas,* and the *Hantkeninas* from the middle Eocene. This, of course, is caused by the present geographic position of this site which is very far south of the sedimentary series which are normally used to work out such scales. Likewise, it is probable that its geographic position in the Paleocene and Eocene was also quite different from the equatorial or tropical zones normally examined, either because of the latitude itself or due to isolation in relation to conventional regions such as the Caribbean, the Mediterranean Sea, or New Zealand.

An obvious result is either that a link with conventional zone scales established in such regions cannot be made without considerable difficulty or it becomes entirely impossible. On the other hand, it should also be noted that these paleogeographic particularities have as a corollary the existence or preferential development of new species or ones not normally taken into consideration. Hence, they will assist in setting up a local zone scale as soon as the material can be analyzed in sufficient detail.

In general, planktonic species dominate along the profile. In the residue on the 177-micron sieve they generally represent more than 80 percent of the fauna, and sometimes even 90 to nearly 100 percent; on the 60-micron sieve the benthonic part may sometimes be slightly greater than on the other sieve. However, there are two exceptions: (1) in the Paleocene where benthonic forms are relatively more abundant at the level of Core 245-13, (they also reach the point of dominating at the level of Cores 245-12, 11 and 10); (2) beginning at level 245-3-4, 58 cm where, as will be noted later, different sedimentary conditions occur with a special benthonic assemblage, and where planktonic species disappear, probably by dissolution.

Main Outline of Chronostratigraphic Conclusions

Upon completion of the preliminary analysis, it is possible to propose the following subdivisions which involve either planktonic or benthonic foraminiferal assemblages.

Paleocene 1

This subdivision covers the levels older than level 245-14-1, 100-102 cm with *Globorotalia (Morozovella) angulata* and *G. (M.) conicotruncata.* This corresponds to what some authors refer to as the Danian. A subdivision of Paleocene 1 can be considered, which is based on the disappearance of *Eoglobigerinae* and *Globigerina (Globoconusa) daubjergensis.* Below this (245-15-1, 130-132 cm and deeper), we are in Blow's Zone P.1; above this (beginning with 245-15-1, 104-106 cm), we should have the equivalent of Zone P.2 (for lack of being able to characterize it by its marker species).

The species most frequently encountered are as follows:

Eoglobigerina edita (Subbotina, 1953)
Eoglobigerina taurica Morozova, 1961
Eoglobigerina cf. *polycamera* (Khalilov, 1956)
Globoconusa daubjergensis (Brönnimann, 1952)
Globoconusa conusa Khalilov, 1956
Globigerina (Subbotina) triloculinoides Plummer, 1926
Globigerina (Subbotina) trivialis Subbotina, 1953
Globigerina subquadrata Morozova, 1961
Globorotalia (Turborotalia) pseudobulloides (Plummer, 1926)
Globorotalia (Turborotalia) cf. *varianta* Subbotina, 1953
Globorotalia (Turborotalia) compressa (Plummer, 1926)
Globorotalia (Turborotalia) cf. *haunsbergensis* Gohrbandt, 1963
Globorotalia (Turborotalia) trinidadensis Bolli, 1957
Globorotalia (Turborotalia) cf. *inconstans* (Subbotina, 1953)
Globorotalia (Turborotalia) cf. *quadrata* (White, 1928).

In the upper part, an evolution can be seen toward species such as *Globigerina velascoensis* Cushman, 1927 (perhaps *G. quadritriloculinoides* Khalilov, 1956) and *Globorotalia (Turborotalia) ehrenbergi* Bolli, 1957, as well as toward forms with a subsymmetric tendency (as is found later with the group of *G. (T.) chapmanni* Parr, 1938). In addition, we also find *G. (T.)* cf. *spiralis* Bolli, 1957.

Samples examined:

16, CC
16-1, 120-122 cm
16-1, 90-92 cm
16-1, 44-45 cm
15, CC
15-3, 125-127 cm
15-3, 75-77 cm
15-3, 25-27 cm
15-2, 100-102 cm
15-2, 50-52 cm
15-1, 130-132 cm
15-1, 104-106 cm
15-1, 50-52 cm
14, CC
14-6, 122-124 cm
14-6, 100-102 cm
14-6, 50-52 cm
14-5, 100-102 cm
14-5, 50-52 cm
14-4, 100-102 cm
14-4, 40-42 cm
14-3, 115-117 cm
14-3, 40-42 cm
14-2, 100-102 cm
14-2, 50-52 cm

Paleocene 2

This subdivision covers the next levels, older than level 245-9-1, 77-79 cm with *Globorotalia (Morozovella)* of the *rex-subbotinae* group. It corresponds to almost the entire remaining Paleocene, i.e., Blow's Zones P.3-P.5. Most of this interval is dominated by benthonic assemblages. In addition, one of the common species in these levels, *Globorotalia (Planorotalites) pseudomenardii*, is still present (245-9-3, 50-52 cm) just below the guide forms of the next level. This suggests that either its distribution here is different from the normal distribution or Zone P.5 is of reduced thickness.

The most common species (in addition to several ones already mentioned) are the following:

Globorotalia (Morozovella) angulata (White, 1928)
Globorotalia (Morozovella) conicotruncata (Subbotina, 1953)
Globorotalia (Morozovella) kubanensis Shutzkaja, 1956

These are found at the bottom of Paleocene 2 (upper part of Core 14) and are clearly different, with their "truncated-cone-shaped *Globorotalia*", from the underlying Danian levels. In Core 13, immediately above, we find in addition: *Globorotalia (Morozovella) velascoensis* (Cushman, 1925); *Globorotalia (Turborotalia) ehrenbergi* Bolli, 1957; a group of variants, which are probably organized around *Globorotalia faragi* el Naggar, 1966; and various forms corresponding to the group of *Globorotalia tadjikistanensis* Bykova, 1953.

We have seen that an episode with a benthonic dominance then occurs (upper part of Core 13 and Cores 12, 11 and 10); the planktonic species take on a very secondary role, the benthonic dominance coincides with a volcanic ash deposit. This may explain why some species, which are expected to begin at a certain time (e.g., *Globorotalia (Morozovella) aequa*), only appear higher up (Core 9 for instance). Planktonic species make a small reappearance in Core 10, and we find:

Globorotalia (Acarinina) mckannai (White, 1928)
Globorotalia (Acarinina) whitei Weiss, 1928
Globorotalia (Morozovella) occlusa Loebl. and Tappan, 1957
Globorotalia (Morozovella) velascoensis (Cushman, 1925)
Globorotalia (Acarinina) acarinata Subbotina, 1953.
Globorotalia (Acarinina) acquiensis Loebl. and Tappan, 1957.

Globorotalia (Planorotalites) pseudomenardii Bolli, 1957 appears to exist solely in the upper part of Paleocene 2 (i.e., at the bottom of Core 9), whereas there are hardly more than a few meters in the same core between them and the level where the group *Globorotalia (Morozovella) subbotinae* appears. As has been noted previously, very little space remains for the *G. (M) velascoensis* Zone (P.5), which in principle does not contain *G. (P.) pseudomenardii.* This problem requires a more detailed investigation as well as more thorough analysis of the nomenclature of the species present.

Samples examined:

14-1, 100-102 cm
13-6, 100-102 cm
13-6, 50-52 cm
13-5, 50-52 cm
13-4, 100-102 cm
13-4, 50-52 cm
13-3, 100-102 cm
11-4, 110-112 cm
11-4, 30-32 cm
11-3, 100-102 cm
11-3, 50-52 cm
11-2, 100-102 cm
11-2, 50-52 cm
11-1, 100-102 cm

13-3, 50-52 cm
13-2, 100-102 cm
13-2, 50-52 cm
13-1, 140-142 cm
12, CC
12-5, 100-102 cm
12-5, 50-52 cm
12-4, 100-102 cm
12-4, 50-52 cm
12-3, 100-102 cm
12-3, 50-52 cm
12-2, 100-102 cm
12-2, 50-52 cm
12-1, 140-142 cm
11, CC
11-5, 110-112 cm
11-5, 50-52 cm
11-1, 50-52 cm
10, CC
10-3, 110-112 cm
10-3, 50-52 cm
10-2, 100-102 cm
10-2, 35-37 cm
10-1, 120-122 cm
10-1, 30-32 cm
9, CC
9-3, 100-102 cm
9-3, 50-52 cm
9-3, 28-30 cm
9-2, 130-132 cm
9-2, 110-112 cm
9-2, 30-32 cm
9-1, 140-142 cm
9-1, 110-112 cm

Early Eocene 1

This subdivision covers the next levels, older than level 245-6-2, 100-102 cm, with *Globorotalia (Morozovella) aragonensis*. This level corresponds, through a considerable thickness, to Blow's Zone P.6. The scarcity of *G. (M.) wilcoxensis*, as well as the difficulty in spotting the appearance of *Pseudohastigerinas* (which seem to be quite late because *P. wilcoxensis* was observed in level 245-7-1, 100-102 cm), are such that the subdivision usually assumed to exist between a Paleocene Subzone P.6a, and an early Eocene Subzone P.6b cannot be positively identified. However, the top of Core 245-9 most certainly belongs to P.6a. It contains:

Globorotalia (Acarinina) mckannai (White, 1928)
Globorotalia (Acarinina) soldadoensis (Brönnimann, 1952)
Globorotalia (Acarinina) whitei Weiss, 1928
Globorotalia (Morozovella) aequa Cushman and Renz, 1942
Globorotalia (Morozovella) rex Martin, 1943
Globorotalia (Morozovella) subbotinae Morozova, 1939
Globorotalia (Morozovella) velascoensis (Cushman, 1925)
Globigerina (G.) velascoensis Cushman, 1925
Pseudogloboquadrina primitiva (Finlay, 1947).

In Cores 8 and 7, the most common species are the following; they belong to Zone P.6b:

Globorotalia (Acarinina) cf. *angulosa* (Bolli, 1957)
Globorotalia (Acarinina) convexa Subbotina, 1953
Globorotalia (Acarinina) esnaensis (Le Roy, 1953)
Globorotalia (Acarinina) pseudotopilensis Subbotina, 1953
Globorotalia (Acarinina) soldadoensis (Brönnimann, 1952)
Globorotalia (Acarinina) cf. *triplex* Subbotina, 1953
Globorotalia (Morozovella) aequa Cushman and Renz, 1942
Globorotalia (Morozovella) dolabrata Jenkins, 1965
Globorotalia (Morozovella) marginodentata Subbotina, 1953
Globorotalia (Morozovella) subbotinae Morozova, 1939
Globorotalia (Morozovella) wilcoxensis Cushman and Ponton, 1932
Globorotalia (Turborotalia) pseudoscitula group Glaessner, 1937
Globorotalia (Turborotalia) traubi Gohrbandt, 1967
Globorotalia (Turborotalia) salisburgensis Gohrbandt, 1967
Globorotalia (Turborotalia) cf. *perclara* Loebl. and Tappan, 1957
Globigerina (?Globoconusa) chascanona Loebl. and Tappan, 1957
Pseudogloboquadrina primitiva (Finlay, 1947)

Samples examined:

9-1, 77-79 cm
8, CC
8-2, 110-112 cm
8-2, 50-52 cm
8-1, 145-147 cm
8-1, 15-17 cm
7, CC
7-2, 110-112 cm
7-2, 35-37 cm
7-1, 100-102 cm

Early Eocene 2

This subdivision covers the next two levels, up to the disappearance of *Globorotalia (Morozovella) crater* (level 245A-7-2, 110-112 cm). This interval more or less includes the remainder of the early Eocene. However, since *Hantkenina aragonensis* was not found, the upper boundary cannot be precisely located according to the standard scale. A usable boundary, at least for the time being (this is why the boundary is marked in the tables with a question mark), appeared to coincide with the disappearance of *G. (M.) crater*, while *G. (M.) aragonensis* continues with forms less typical than the ones previously found. We have not yet attempted to subdivide this early Eocene 2 and, in particular, to delimite standard Zones P.7 to P.9. A suitable subdivision can be proposed with the appearance of *G. (M.) crater* (level 245-5-4, 57-59 cm). In Core 245-4 and even beginning with the top of Core 245-5, there are some rare *Globorotalia (G.)* cf. *spinulosa* and *Globigerina (G.) boweri*, all of which have already been mentioned as existing in the upper zone of the early Eocene.

The main species encountered are the following (the boundaries given here are still approximate):

Globorotalia (Acarinina) acarinata Subbotina, 1953 (Cores 245-6 and 5)
Globorotalia (Acarinina) angulosa (Bolli, 1957)
Globorotalia (Acarinina) rotundimarginata Subbotina, 1953 (beginning with Core 245-5)
Globorotalia (Acarinina) spinuloinflata (Bandy, 1949)
Globorotalia (? Acarinina) gr. *broedermanni* Cushman and Bermúdez, 1949
Globorotalia (Acarinina) triplex Subbotina, 1953
Globorotalia (Morozovella) aragonensis Nuttall, 1930 (with dextral forms in Cores 245-4 and 245A-7)
Globorotalia (Morozovella) gr. *bullbrocki* Bolli, 1957 (beginning with Core 245-4)
Globorotalia (Morozovella) crater Finlay, 1939 (beginning with level 245-5-4, 57-59 cm)
Globorotalia (Morozovella) subbotinae Morozova, 1939 (Core 6)
Globorotalia (Globorotalia) cf. *spinulosa* (Cushman, 1927) (beginning with level 245-5-2, 58-60 cm)
Globigerina (Globigerina) cf. *boweri* Bolli, 1957 (beginning with level 245-5-2, 58-60 cm)

Globigerina (Globigerina) pseudoeocaena Subbotina, 1953 (beginning with Core 245-5)
Globigerina cf. *"Globigerinoides" higginsi* Bolli, 1957
? Globigerina senni (Beckmann, 1954) (beginning with Core 245-5)
Pseudoglobiquadrina primitiva (Finlay, 1947)
Globigerinita sp. (beginning with Core 4).

It is quite probable that Core 245-6 belongs to Blow's Zone P.7 and that at least part of Core 5 belongs to Zones P.8-P.9, especially when *G. (M.) crater* is present. More specific data on a possible subdivision of early Eocene 2 and on its boundary with the middle Eocene can probably be obtained from a thorough analysis of the systematics of various other species such as *Globorotalia (Acarinina) pentacamerata, G. (A.) interposita, G. (A.)* of the *broedermanni-mattseensis* group and various apparently new species, as well as *Chiloguembelina* and *Guembelitria* (mainly localized on certain levels).

Samples examined from Hole 245:

6-2, 97-99 cm
6-2, 14-16 cm
6-1, 110-112 cm
5, CC
5-6, 100-102 cm
5-5, 50-52 cm
5-4, 115-117 cm
5-4, 57-59 cm
5-3, 110-112 cm
5-3, 60-62 cm
5-2, 118-120 cm
5-2, 58-60 cm
5-2, 50-52 cm
5-1, 118-120 cm
5-1, 36-38 cm
4, CC
4-6, 110-112 cm
4-6, 50-52 cm
4-5, 140-142 cm
4-5, 100-102 cm
4-5, 50-52 cm
4-4, 42-44 cm
4-3, 140-142 cm
4-2, 146-148 cm
4-2, 100-102 cm
4-2, 50-52 cm
4-1, 93-95 cm

Samples examined from Hole 245A:

7, CC
7-6, 120-122 cm
7-6, 70-72 cm
7-6, 30-32 cm
7-5, 110-112 cm
7-5, 80-82 cm
7-5, 32-34 cm
7-4, 110-112 cm
7-4, 70-72 cm
7-4, 20-22 cm
7-3, 140-142 cm
7-3, 60-62 cm
7-2, 110-112 cm

Middle Eocene

This subdivision covers the next levels up to the interval between Cores 245A-5 and 245A-4 (as well as by horizontal correlation between 245-3 and 245-2). Actually, this upper boundary is mainly determined by the nannoplankton. As we said in the preceding paragraph, the lower boundary is arbitrarily located at the disappearance of *Globorotalia (Morozovella) crater*.

In Hole 245, as has been stated previously, a subdivision can be located in the middle of Core 3 (between levels 245-3-4, 103-105 cm and 58-60 cm), where a sedimentary change is associated with a change in the foraminiferal assemblage, which becomes almost exclusively benthonic and new, while planktonic species persist very sparsely or are absent. These same features are also found in Hole 245A beginning with Core 6. The core catcher for this core is an "anomaly" because some specimens of *G. (M.) aragonensis*, and especially of *G. (M.) crater*, are present. This presence is difficult to explain other than by reworking because of the difference in depth between this core and the preceding Core 245A-7, which contains *G. (M.) crater* (while the "intercalated" Core 245-4 is devoid of *G. (M.) crater)*

The most common species are:
Globorotalia (Morozovella) bullbrocki Bolli, 1957
Globigerina (Globigerina) boweri Bolli, 1957
Globigerina (Globigerina) pseudoeocaena Subbotina, 1953
? Globigerina senni (Beckmann, 1954)
Pseudogloboquadrina primitiva (Finlay, 1947)
Globigerinita sp.

The presence of an individual which can be compared with *Globorotalia spinulosa* in the core catcher of Core 245A-5 suggests that we are effectively still in the middle Eocene, or at the most toward its upper part.

Samples examined from Hole 245:

3, CC
3-6, 140-142 cm
3-6, 75-77 cm
3-5, 120-122 cm
3-5, 68-70 cm
3-4, 140-142 cm
3-4, 103-105 cm
3-4, 58-60 cm
3-4, 30-32 cm
3-3, 107-110 cm
3-1, 130-135 cm
3-1, 60-62 cm

Samples examined from Hole 245A:

7-1, 110-112 cm
6, CC
6-3, 142-144 cm
6-3, 120-122 cm
6-3, 80-82 cm
6-3, 30-32 cm
6-2, 120-122 cm
6-2, 80-82 cm
6-2, 25-27 cm
6-1, 110-112 cm
6-1, 48-50 cm
5, CC
5-4, 130-132 cm
5-4, 80-82 cm
5-4, 30-32 cm
5-3, 125-127 cm
5-3, 90-92 cm
5-3, 50-52 cm
5-2, 115-117 cm
5-1, 120-122 cm
5-1, 80-82 cm

Late Eocene

This subdivision was actually determined by nannoplankton associations, provided that we exclude a specimen close to *Globigerina (Subbotina) angiporoides* Hornibrook, 1965 (245A-4, CC), a unique specimen close to *Globigerinita martini* Blow and Banner, 1962 (245A-2-4, 28-30 cm), and several representatives of *Spiroplectammina* which should be compared with *foliacea* (Grzybowski, 1898) and *tejonensis* Mallory, 1959 (245A-2-4, 28-30 cm).

Samples examined from Hole 245A:

4, CC
4-6, 100-102 cm
4-6, 50-52 cm
4-5, 110-112 cm
4-5, 40-42 cm
4-4, 85-87 cm
4-3, 110-112 cm
4-3, 60-62 cm
4-2, 130-132 cm
4-2, 95-97 cm
4-2, 30-32 cm
4-1, 126-128 cm
3, CC
3-3, 140-142 cm
3-2, 115-117 cm
3-2, 50-52 cm
3-2, 13-15 cm
3-1, 104-106 cm
2, CC
2-6, 110-112 cm
2-6, 30-32 cm
2-5, 114-116 cm
2-5, 70-72 cm
2-4, 120-122 cm
2-4, 70-72 cm
2-4, 28-30 cm
2-3, 100-102 cm
2-3, 50-52 cm
2-2, 130-132 cm
2-2, 90-92 cm
2-2, 50-52 cm
2-1, 100-102 cm
2-1, 20-22 cm

Benthonic Foraminifera Assemblages

A partial inventory of benthonic foraminifers served two purposes: (1) identifying several species having definite chronostratigraphic value which could be used if other markers were lacking (the range of these species is approximately the space of a stage or subsystem), and (2) revealing successive assemblages (B1, B2, and B3) apparently possessing a chronostratigraphic value, at least those (B1 and B2) in the Paleocene and early Eocene, i.e., older than the sedimentary facies change already mentioned within Core 245-3.

Benthonic assemblage B1 is the one richest in species. It is found beginning at the bottom. It gives way to a second assemblage (B2) at the level where the group *Globorotalia (Morozovella) rex-subbotinae* appears. Hence, it corresponds to the Paleocene. It can be characterized by the presence of:

Robulus velascoensis (White, 1928)
Neoflabellina semireticulata (Cushman and Jarvis, 1928)
Bulimina arkadelphiana var. *midwayensis* Cushman and Park., 1936
Aragonia ouezzanensis (Rey, 1955)
Pullenia coryelli White, 1929
Asterigerina cf. *"Eponides" broennimanni* Cushman and Renz, 1946
"Gyroidina" caucasica Subbotina, 1947
Anomalina welleri var. *laevis* Vasilenko, 1954

It can probably be subdivided, at the level of Zone P.3 or toward the boundary with Zone P.4, when the following two small species appear: *Tappannina* cf. *selmensis* (Cushman, 1933) and *Bulimina thanetensis* Cushman and Parker, 1947.

Benthonic assemblage B2 corresponds to the early Eocene and the part of the middle Eocene which precedes the facies change in Core 245-3. It includes

Aragonia cf. *semi-reticulata* Le Roy, 1953
Nuttallides gr. *truempyi* (Nuttall, 1930)–*carinotruempyi* Finlay, 1937
Alabamina spp.
Oridorsalis spp.

In the upper part, the succession of these *Aragonia* by *Aragonia capdevilensis* (Cushman and Bermúdez, 1937) might be used to establish a subdivision.

Benthonic assemblage B3 accompanies the characteristic sediment found in the upper cores, beginning with level 245-3-4, 58-60 cm.

Various genera are represented by species which are difficult to determine, at least on the basis of this preliminary inventory. In reality, they make up an apparently mixed assemblage of forms from medium shelf depths which were displaced into a bathyal environment. Species from the following genera are examples: *Glomospira, Ammodiscus, Haplophragmoides, Spiroplectammina, Gaudryina, Siphonodosaria, Aragonia, Pullenia, Pleurostomella, Nodosarella, Cassidulina, Gyroidina, Cibicides* (especially *C. tholus* Finlay, 1959) *Eponides, Oridorsalis,* and *Nuttallides* (especially *N. truempyi* [Nuttall, 1930]).

Biostratigraphic Summary

In the first core of Site 245, rare nannoplankton fossils indicate a middle Miocene age. From middle Miocene to late Eocene, the rate of sedimentation is very small. The small number of cores, as well as a lack of fossils in the few sediment samples obtained, make it impossible to distinguish whether or not the sedimentation rate is small.

Sediments certainly are missing between the middle Miocene and Recent because a sedimentation rate of 0.8 m/m.y. is most unlikely, even if the location of the site in a deep-sea environment below the CCD is taken into consideration.

Within Core 2A, nannoplankton found in some of the micronodules indicate a late Eocene age. Beginning with a given level in the middle Eocene, a detailed stratigraphic zonation cannot be given upwards because there are only benthonic species present. They have been partly transported from shelf depth into bathyal associations. Planktonic species nearly disappear, probably by dissolution. Age indications for this part are mainly based on nannoplankton, which also become less abundant within this sequence.

The tight coring schedule in the Paleocene, and the relatively intensive one in the early Eocene, enabled an acceptable chronostratigraphic scale to be worked out. The rate of sedimentation throughout the Paleogene section is between 10 to 19 m/m.y. Nearly all nannoplankton zones of the early Eocene and Paleocene were recognized. The sediments are very rich in well preserved calcareous nannoplankton in the Paleocene; they are overgrown in the early Eocene.

Planktonic, as well as benthonic foraminifera, allow a local zonation, which can be more or less reliably correlated with the conventional planktonic scale. The lowermost part of the Paleocene, above the basalt, seems to be missing.

At this site, the main handicap concerning the planktonic foraminifera was caused by the absence of many species which are normally present (some of which act as guide-forms) in the Mesogean realm. It is possible that these absences are caused by cold "austral" influences which would explain how "warmer" species were eliminated. The consequences of this relative impoverishment, correlative with the presence of numerous new variants or species, are important and are particularly appreciable in the early and middle Eocene. They can partially account for some discrepancies between ages determined by foraminifera and by nannoplankton, with regard to the boundaries between stages or zones.

CORRELATION OF REFLECTION PROFILES AND LITHOLOGIES

Characteristics of the airgun reflection profile run by *Glomar Challenger* in the near-site area are quite comparable to the data obtained by *Conrad* in 1967 (Cruise 11) and 1971 (Cruise 14). The basement locally appears smooth but large- and small-scale basement faulting is evident to the east and to the north of the selected site. At Site 245, the seismic acoustic basement is at a depth of

0.41 sec DT. In the overlying stratified sediments, two reflectors can be identified on the airgun seismic profile. The first appears very clearly at 0.10 sec DT, the second, much less distinct and of variable density, is at about 0.32 sec DT (Figure 5).

At Site 245, basaltic basement was encountered at a depth of 389 meters below the sea floor. The lithologic description shows that the whole sedimentary section can be broadly subdivided, according to composition and texture, into four distinct units: (1) brown clay (0 to about 63 m), (2) variegated clay and ooze (63 to about 126 m), (3) pale orange and pinkish gray nanno ooze (126 to about 209 m), and (4) nanno chalk with silicified nanno chalk, chert, gray clay-rich nanno chalk, devitrified volcanic ash and, just above basement, black manganiferous clayey nanno ooze.

It is possible to correlate the first reflector at 0.10 sec DT with the lithologic change observed in Cores 245-2 and 245A-3 at a subbottom depth of 61-72 meters. According to the physical properties, this reflector should be located at about 70-75 meters subbottom depth. A slight change in sonic velocity is observed between Core 245A-2 (54-63 m) and Core 245A-4 (72-81 m); moreover, the acoustic impedance increases very sharply and reaches a maximum value of about 75 meters; at the same depth a strong reduction of the syringe bulk density, reflected by a similar reduction of porosity and thermal conductivity, is observed.

The lithologic boundaries at about 126 meters (transition between the variegated clay and oozes and the nanno ooze) and 209 meters (transition between the nanno ooze and the nanno chalk) cannot be correlated on the airgun reflection profile with any clear reflector.

The second, less distinct reflector at about 0.32 sec DT, can be correlated with the appearance of chert layers which are present in Core 4 (159 to 168 m), Core 5 (207-216 m), Core 6 (245-254 m), Core 7 (254-263 m), and Core 8 (283-292 m) of Hole 245. In Cores 4, 5, and 7, the chert layers are sporadic and thin, and represent less than 4 percent in each of these cores. In Cores 6 and 8, the chert layers are quantitatively much more important and represent as much as 15 percent of the whole cored interval in Core 8. Therefore, the ill-defined reflector at 0.32 sec DT might be correlated with the increase in frequency and thickness of the chert layers observed between 283 and 292 meters.

If the above correlations are valid, then the interval velocity between the sea floor and the reflector at 0.10 sec DT (0 to 70/75 m) is 1.45 ±0.05 km/sec. The average measured velocity for this section is about 1.49 km/sec (Cores 245-1 and 245A-2). The interval velocity between the reflector at 0.10 sec DT and the ill-defined reflector at 0.32 sec DT (70/75 to 283/292 m) is 1.95 ±0.06 km/sec. The weighted average measured velocity for this section (Cores 245-3 to -8 and Cores 245A-4 to -7), taking the chert layers and the silicified chalk into account, is about 1.75 km/sec. The interval velocity between the reflector at 0.32 sec DT and the acoustic basement at 0.41 sec DT (283/292 to 389 m) is 2.25 ±0.1 km/sec. The average measured velocity for this last sedimentary layer is about 2.0 km/sec (Cores 245-9 to 16).

The overall interval velocity for the sedimentary sequence from the sea floor down to the basement reflector at 0.41 sec DT is 1.9 km/sec, while the average measured velocity for the same interval is about 1.75 km/sec. These systematic differences between shipboard measurements and the velocities calculated by reflection time and measured drill distance are probably related to the fact that coring was not continuous and that, consequently, the correct percentage of high velocity material cannot be determined.

Figure 8 shows the correlation which can be established between the reflection profiler record and lithology.

SUMMARY AND CONCLUSIONS

Site 245 is located in the southern Madagascar Basin in a water depth of 4857 meters, about 300 miles east of the Madagascar Ridge crest and about 200 miles northeast of the Southwest Indian Ridge axis, but beyond the apparent limit of oceanic crust formed by spreading from the latter ridge. According to the magnetic data obtained by *Gallieni* Cruises 1 to 6, 1967 (Schlich et al., 1971, 1972), it should be situated on anomaly 28/29, representing oceanic crust formed about 68/69 million years ago and moved to its present position by spreading from the Central Indian Ridge. Selection of the final site was greatly facilitated by the results of a detailed site survey by *Conrad* Cruise 14 in 1971. The principal objectives were (a) to sample, identify, and date the seismic acoustic basement in order to check (in conjunction with a complementary site located south of the Southwest Indian Ridge) the proposed magnetic anomaly age pattern and (b) to establish the biostratigraphic sequence for comparison between the Madagascar and Crozet basins close to the north and south flanks, respectively, of the Southwest Indian Ridge.

The *Glomar Challenger* airgun reflection profile at Site 245 shows a strong locally smooth acoustic basement reflector at 0.41 seconds DT overlain by weakly stratified sediments divided into three acoustic layers by a clear reflector at about 0.10 seconds DT and a second less distinct reflector of variable density at 0.32 seconds DT.

Hole 245 was drilled and intermittently cored to a depth of 310 meters followed by continuous coring to 396.5 meters, which included 7.5 meters penetration into basaltic basement. Rough sea conditions during spud-in prevented adequate sampling of the uppermost 120 meters, and a second complementary hole (245A) was therefore drilled at the same location, with nearly continuous coring between 20 and 150 meters. The scientific results are summarized in Figure 9.

For the 389-meter sediment section, four lithologic units are proposed. The uppermost is 63 meters thick and consists of brown silt-rich clay grading downwards into brown silty clay; the silt fraction (about 20% of the whole) being composed mainly of quartz, subordinate mica, and accessory chlorite, biotite, and hematite. The unit is almost devoid of fossils due to calcite dissolution, but a sample from 1, CC at a depth of 16 meters, yielded nannofossils of middle Miocene age and poorly preserved nannofossils in some manganese micronodules (Core 245A-2 at 54-63 m) indicate a late Eocene age. Younger sediments, if present, are confined to the uppermost 7 meters which were not

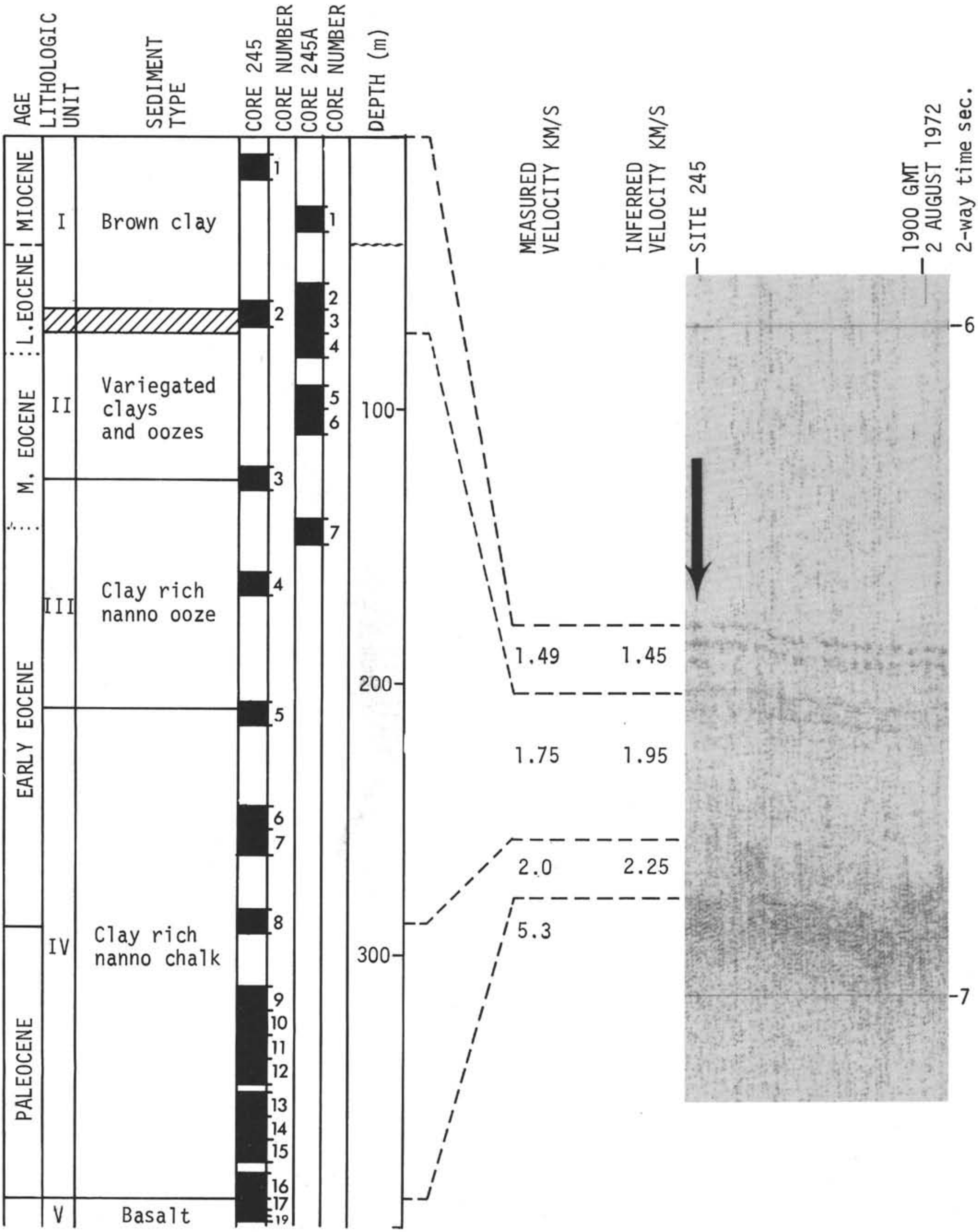

Figure 8. *Correlation of seismic profile and lithology. The wavy line in the depth column indicates a hiatus.*

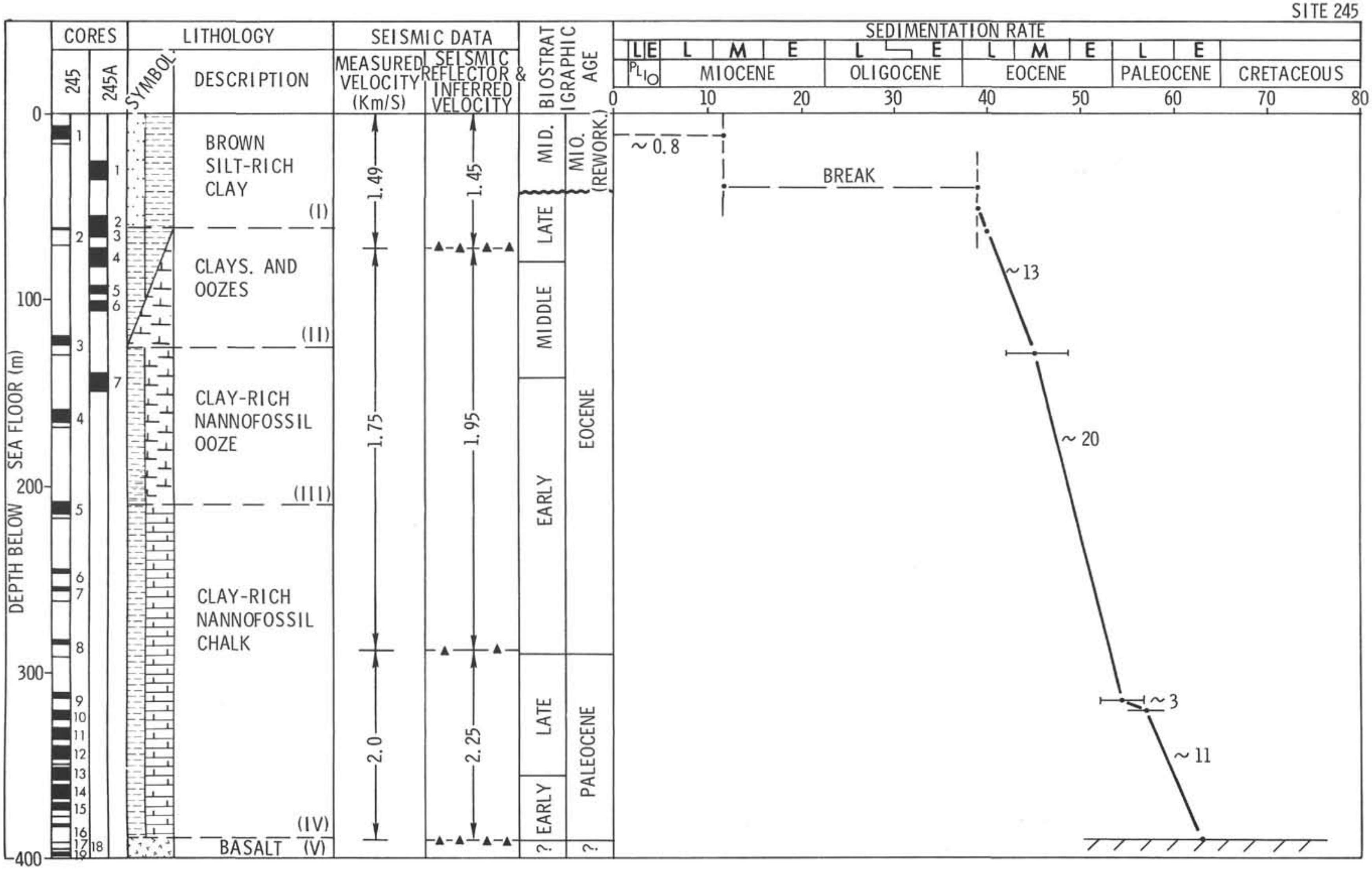

Figure 9. *Summary Diagram, Site 245.*

sampled. An unconformity (represented by absence of Oligocene to middle Miocene) may occur as deep as the lower boundary of Unit 1, which also correlates very well with the clear acoustic reflector at about 0.10 seconds DT, giving an inferred interval velocity of 1.45 km/sec (measured value = 1.49 km/sec).

The lower Units II-IV provide a 326-meter-thick, richly fossiliferous and almost complete lower Paleogene succession. Unit II comprises 63 meters of middle and upper Eocene variegated brown nanno-bearing clay with interbedded layers of brown nanno ooze and unfossiliferous brown silty clay which is essentially similar to the brown clay of Unit I. At 126 meters depth, Unit II is in sharp contact with the underlying pale orange to pinkish gray nanno ooze of Unit III, which is 83 meters thick and mainly of late early Eocene age. The lower boundary of Unit III is marked, at 209 meters, by the transition from stiff nanno ooze to nanno chalk and by the first appearance of thin chert beds. The Paleocene/early Eocene Unit IV is 181 meters thick, constituting almost half of the sedimentary section, and is essentially pinkish gray to white nanno chalk, intensely burrowed and bioturbated, with always some foraminifera and an increasing clay content with depth. Interbedded chert and silicified nanno chalk beds are common in the upper half of Unit IV, and the somewhat diffuse acoustic reflector at about 0.32 seconds DT almost certainly corresponds with a zone of particularly prominent chert bands near 290 meters depth. In the lower part of Unit IV, chert bands are not developed but numerous interbeds (0.5 to 10 cm thick) of green, olive-gray, and orange devitrified volcanic ash are present. The lowest 20 meters of Unit IV is clay-rich (20%-30%), and brown to olive black in color due to the relatively high content (about 10%) of manganese oxides.

Dark glassy basalt containing inclusions of a subjacent gray medium-grained tholeiitic basalt underlies the sediments at a depth of 389 meters, and 1.5 meters of apparently unaltered rock was recovered. The lowest sediments cored were confidently dated as early Paleocene (Danian), with an age of approximately 62/63 million years. The unlikely possibility that the lowermost 7 1/2 meters were not sampled due to low recovery (1.4 out of 9 m cored) in Core 16, places the above age in error but not more than about one million years according to the sedimentation rate. The minimum age determination of about 63-64 m.y. is about 5 m.y. less than the value predicted from the magnetic anomaly pattern according to the geomagnetic time scale proposed by Heirtzler et al. (1968).

Preliminary estimates of sedimentation rates indicate the following: middle Eocene, 9.5 m/m.y.; early Eocene, 33 m/m.y. at least; late Paleocene, 10 m/m.y.; early Paleocene, 9 m/m.y. at least.

The lower two-thirds of the succession consists almost entirely of biogenic sediments. At the beginning of the middle Eocene, detrital silt layers appear and increase in amount through the upper Eocene (in which shelf or slope benthonic foraminifera are also present) with concomitant decrease in fossil content. The Oligocene, all of the Neogene (except some poorly identified middle Miocene sediments), and the Quaternary are absent. It appears that progressive deepening of the sea floor was not only accompanied by increased sediment supply from a terrigenous source but also by a significant decrease in the abnormally high sedimentation rate which characterized the early Eocene, due to carbonate dissolution.

The evidence is consistent with the following model in terms of the sea-floor spreading hypothesis:

1) Formation of Site 245 oceanic basaltic crust at the Central Indian Ocean ridge crest during early Paleocene or possibly Late Cretaceous. Commencement of pelagic sedimentation with lateral spreading, accompanied by hydrothermal and volcanic activity giving rise to interbedded volcanic ash layers and Mn/Fe impregnation of sediments at least during the early late Paleocene.

2) Progressive lateral drift and subsidence accompanied by greatly increased biological productivity (possibly in the equatorial belt) during early Eocene, producing a thick nanno ooze succession devoid of siliceous fossils. Compaction of lower oozes to form chalk with concomitant chert formation and silicification of chalk beds as a result of release of silica during dissolution of dispersed clay or volcanic ash layers.

3) Sea floor approaches CCD as lateral drift progresses, with resulting drop in sedimentation rate during middle Eocene. Influx of terrigenous sediment at this time suggests epeirogenic uplift of the nearest continental block.

4) Sea floor below CCD and rapid reduction of terrigenous sediment supply during late Eocene. Resumption of detrital and volcanic sediment accumulation only during middle Miocene to produce brown clays at an average rate of 1-2 m/m.y.

5) Apparently little or no clastic sedimentation took place during the Pliocene and Holocene, while the sea floor continued to move laterally to its present location, remaining deeper than the compensation depth.

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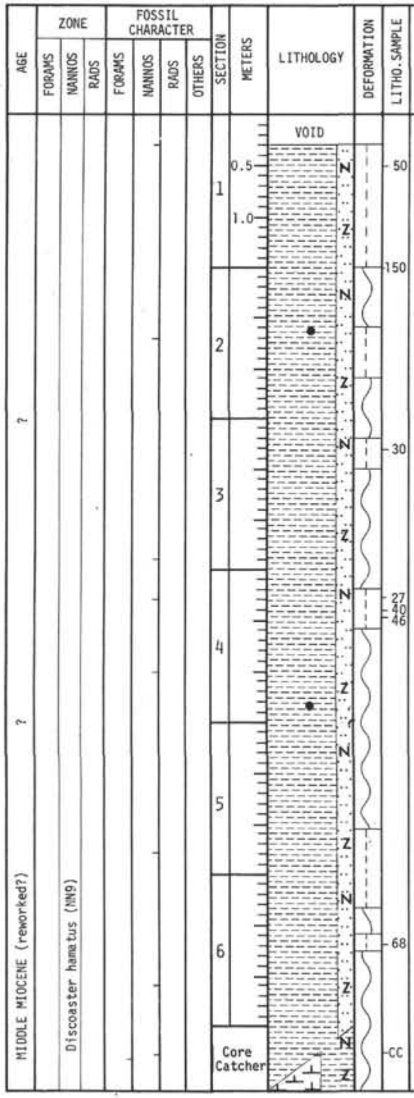
Site 245 Hole Core 1 Cored Interval: 7-16 m



LITHOLOGIC DESCRIPTION

Core is soft and deformed by drilling, in places soupy. Color is moderate brown (5YR4/4 - 5YR3/4).

BROWN CLAY (SILT-RICH)
Smears 1-150, 3-30---6-68

Texture	Composition	
0-15-85	clay min.	87%
	qtz. & feld.	9%
	mica	2%
	opaques	2%
	forams	Tr.
	calc. nannos	Tr.
	zeolites(?)	Tr.

Micas are mostly chlorite. Opaques presumably are Fe and Mn oxides. Micronodules of MnO_2 remain on coarser sieves with fish teeth and bones.

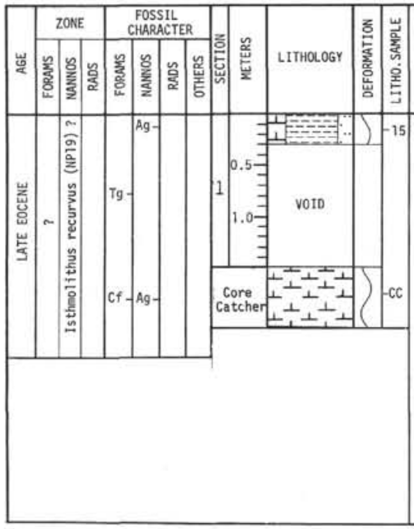
Minor lithology in core catcher is clayey nanno ooze with 65% calc. nannos and 35% clay.

Grain Size
2-100 (0-30-70) silty clay
4-29 (0-24-76) clay

Carbon-Carbonate
1-59 (0.2-0.2-0)

X-ray 1-119	
qtz.	P
plag.	P
k-feld.	P
mica	P
mont.	P
kaol.	P
gibb.	P

Site 245 Hole Core 2 Cored Interval: 61-70 m



LITHOLOGIC DESCRIPTION

Core is soft and greatly deformed. Color is dark yellow brown (10YR4/2); moderate orange pink (5YR8/4) in core catcher.

BROWN SILT/NANNO-RICH CLAY
Smear 1-15

Texture	Composition	
0-20-80	clay min.	70%
	calc. nannos	15%
	qtz. & feld.	13%
	opaques	2%

CLAY-RICH NANNO OOZE
Smear CC

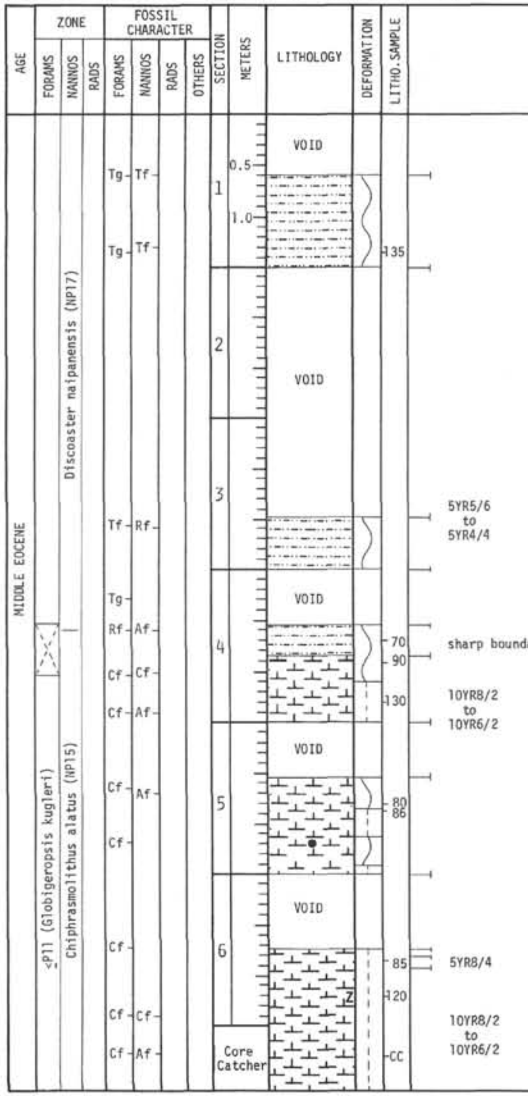
Composition			
calc. nannos	70%	clay min.	20%
qtz. & feld.	2%	mica	1%
opaques	1%	heavies	Tr.
		forams	Tr.

A sharp break occurs in this core between the brown clay and nanno ooze.

Carbon-Carbonate
1-15 (1.2-0.1-9)
CC (7.9-0.1-65)

Explanatory notes in chapter 1

Site 245 Hole Core 3 Cored Interval: 121-130 m



LITHOLOGIC DESCRIPTION

Core is greatly disturbed, soft to moderately stiff in places. Colors are light to moderate brown (5YR5/6 to 5YR4/4) and very pale or (10YR8/2) to pale yellow brown (10YR6/2).

NANNO-BEARING SILTY CLAY
Smear 1-135, 4-70

Texture	Composition	
0-30-70	clay	65%
	qtz.	20%
	mica	5%
	opaques	5%
	calc. nannos	5%

Qtz. grains frequently overgrown with carbonate (dolomite?).

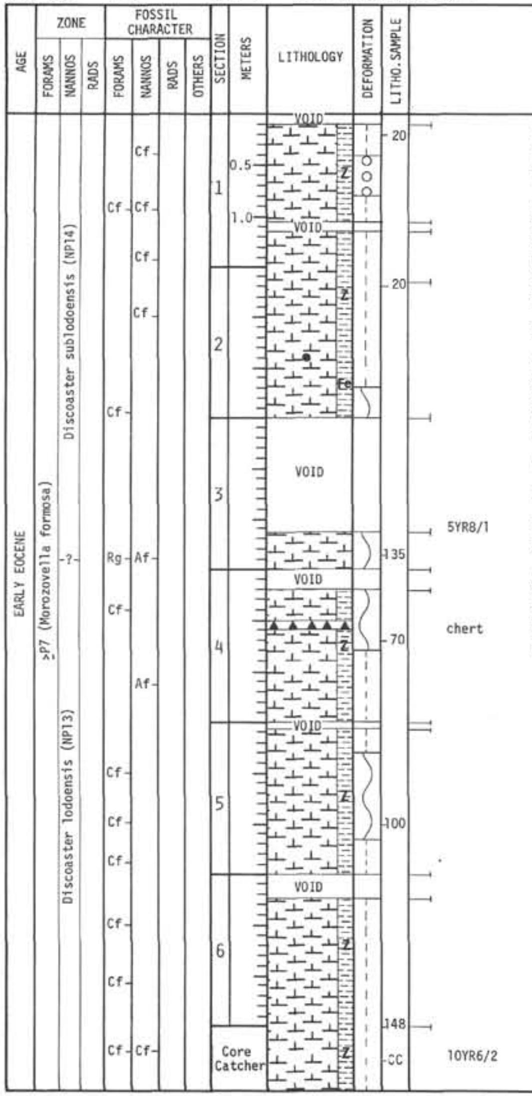
CLAY-BEARING NANNO OOZE
Smears 5-80, 6-85

Composition	
calc. nannos	90%
clay	9%
forams	1%
opaques	Tr.

Minor lithology - small black streaks and patches rich in Mn-Fe oxides; rare Mn micronodules. Zeolites may be present (phillipsite?).

Carbon-Carbonate
4-51 (7.2-0.1-60)
5-90 (10.0-0.1-83)

Site 245 Hole Core 4 Cored Interval: 159-168 m



LITHOLOGIC DESCRIPTION

Core is soft to moderately stiff with some deformation. Color is mostly pinkish gray (5YR8/1) and core catcher is pale yellow brown (10YR6/2).

CLAY-RICH NANNO OOZE
Smears 1-20, 2-20,----CC

Composition		
calc. nannos	85%	Prismatic mineral is
micarb	2%	probably a zeolite
zeolites	Tr.	R.I. <caedex. X-ray
opaques	Tr.	shows presence of
clay	13%	clinoptilolite.

Some very stiff beds are nearly chalk.

Minor lithology in core catcher is a ZEOLITE-BEARING NANNO OOZE

Composition	
calc. nannos	80%
clay	5%
zeolite (clinop?)	5%
micarb.	10%

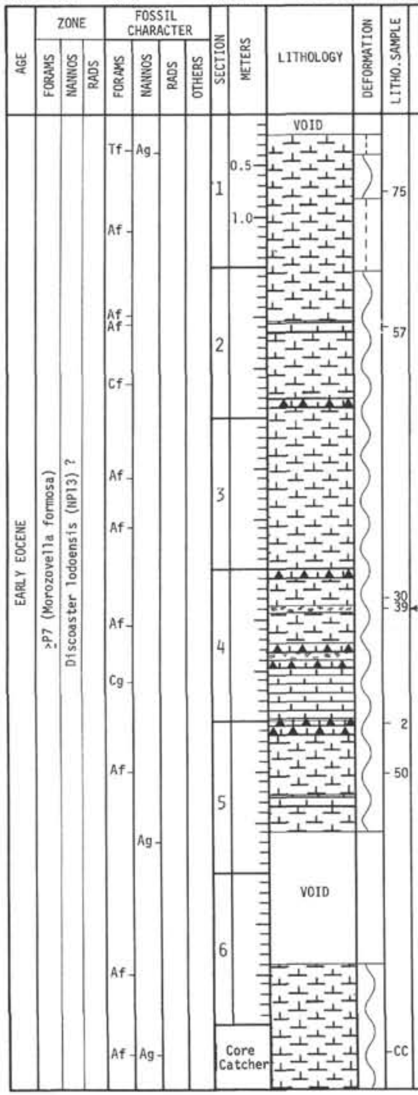
Brown chert fragments occur in Section 4.

$CaCO_3$ Content	
1-115	86%
CC	77%

X-ray 5-89	
calc.	M
qtz.	T
mica	T
paly.	T
clin.	T

Explanatory notes in chapter 1

Site 245 Hole Core 5 Cored Interval: 207-216 m



silicified chalk

devitrified volcanic ash

LITHOLOGIC DESCRIPTION

Core is very stiff to semilithified, greatly deformed by drilling. Some sections are partly soupy. Color is dominantly pinkish gray (5YR8/1) with minor pale yellow brown, light olive gray, and white.

NANNO OOZE AND NANNO CHALK
Smears 1-75, 4-30

Composition	
calc. nannos	90%
micarb.	5%
clay	5%

Minor lithology: FORAM-BEARING NANNO OOZE

Composition	
calc. nannos	85%
forams	5%
micarb.	5%
clay	5%

DEVITRIFIED VOLCANIC ASH (minor lithology)
Smear 4-39 (also X-ray sample)

Composition	
clay	90%
feld.	5%
calc. nannos	3%
opaques	2%

SILICIFIED NANNO CHALK (minor lithology)
Smear 5-2

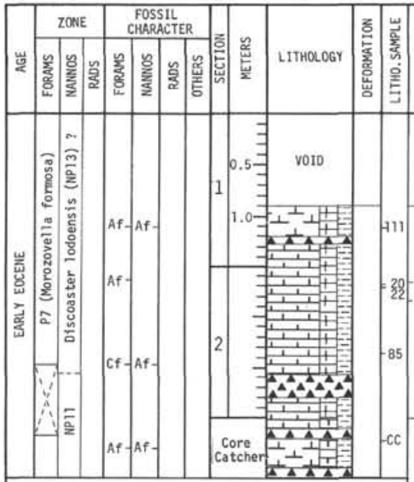
Composition	
calc. nannos	70%
isotropic SiO_2	30%

Carbon-Carbonate
3-139 (10.2-0.1-85)

$CaCO_3$ Content	
1-15	90%
4-12	86%
5-15	75%
CC	89%

X-ray 4-41 (devitrified volcanic ash)	
mont.	A
calc.	P
plag.	P
k-feld.	P
qtz.	T

Site 245 Hole Core 6 Cored Interval: 245-254 m



5YR8/1
10YR5/4
5YR8/1
10YR8/2

LITHOLOGIC DESCRIPTION

Sediment in core is semilithified, somewhat fragmented by the drilling process. Sedimentary structures are not deformed. Large amount of biodisturbance; sediment intensely burrowed and mottled throughout. Dominant color is pinkish gray (5YR8/1); very pale orange (10YR8/2) in core catcher and cherts are gray orange pink (5YR7/2).

CLAY/CARBONATE-RICH NANNO CHALK
Smears 1-111, 2-20, 2-22, 2-85

Composition	
calc. nannos	70%
micarb.	15%
clay	15%
zeolites(?)	Tr.

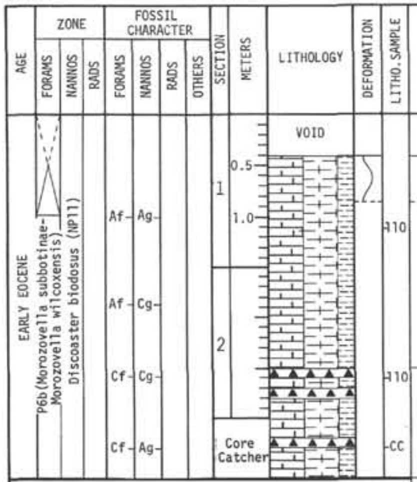
CLAY/FORAM-RICH NANNO CHALK
Smear CC

Composition	
calc. nannos	65%
forams	15%
clay	20%

CHERT thin sections display silicified foraminifera and nanno ghosts but no diatoms or radiolarians.

Carbon-Carbonate
1-125 (9.8-0.1-81)

Site 245 Hole Core 7 Cored Interval: 254-263 m



5YR8/1
N9 white
10YR8/2
CHERT-10YR4/2
5YR8/1

LITHOLOGIC DESCRIPTION

The top of Section 1 is soupy, otherwise core is not deformed except fragmentation by drilling process (fragments range from 3 to 15 cm in length). Dominant color is white, with some pink (5YR8/1) and orange (10YR8/2). Moderate burrow mottling throughout.

CLAY-RICH CARBONATE NANNO CHALK
Smears 1-110, 2-110

Composition	
calc. nannos	55%
micarb.	35%
clay	10%

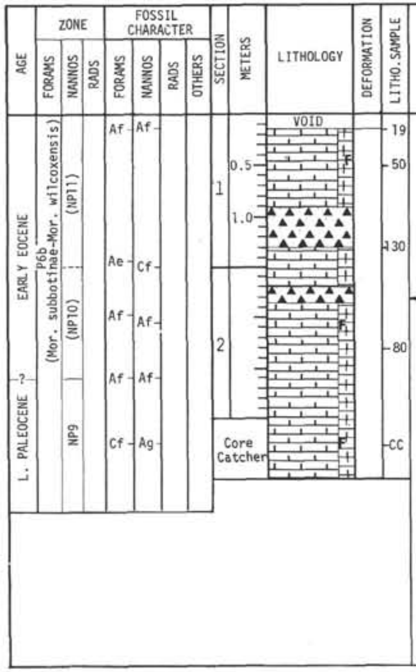
Silicification of chalk increases from Section 2, 100 cm to Section 2, 120 cm, where it is chert. Burrow mottling is common.

CHERT

Thin sections from the core catcher chert display abundant remains of calcium carbonate grains, ghosts of nannos, and abundant foraminifera filled with chalcedony and opal(?).

Explanatory notes in chapter 1

Site 245 Hole Core 8 Cored Interval: 283-292 m



LITHOLOGIC DESCRIPTION

5YR8/1

white

Sediment semilithified; cut by band saw; fragmented by drilling process - burrow mottling (even in chert) is common throughout the core.

Dark yellowish brown (10YR5/4) beds of chert included in variegated silicified chalk with lumps and burrow mottling.

light olive gray
CHERT

FORAM/CLAY-BEARING CARBONATE-RICH NANNO CHALK
Smears 1-50, 2-80, CC

Composition

nannos.	65%	forams	5%
micarb.	20%	clay	10%

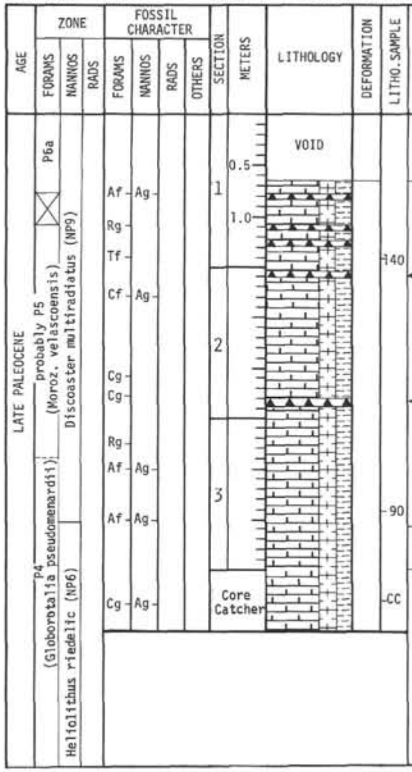
CHERT and SILICIFIED NANNO CHALK - (minor lithologies).

Note: Carbonate particles which compose a large amount of this chalk are believed to originate from nannos fragmentation.

Carbon-Carbonate
1-83 (10.8-0-90)
2-68 (10.4-0.1-86)

$CaCO_3$ Content
CC 85%

Site 245 Hole Core 9 Cored Interval: 311-320 m



LITHOLOGIC DESCRIPTION

Core is semilithified, fragmented somewhat by drilling and cutting processes. Irregular bedding and burrowing throughout. Dominant color is green gray (5GY6/1).

CLAY/CARBONATE-RICH NANNO CHALK
Smear 3-90

Composition

calc. nannos	65%	forams	Tr.
micarb.	15%	chlor.	Tr.
clay	20%		

CHERT

5GY6/1

SILICIFIED NANNO CHALK AND CHERT (minor lithologies) Silicified nanno chalk beds are dark green gray (5GY4/1). Cherts are brown gray (5YR4/1) to dark green gray (5GY4/1).

CHERT

Micarb (carbonate fragments) are believed to be mostly nanno fragments.

Carbon-Carbonate
1-100 (9.2-0.1-76)

X-ray 1-101

calc.	M	trid.	T
cris.	P	mont.	T

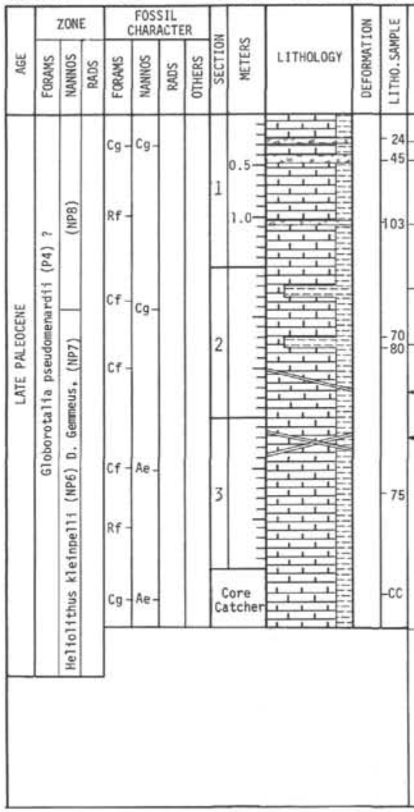
5YR6/1 zone of extensive burrowing

5GY6/1

$CaCO_3$ Content
CC 76%

Explanatory notes in chapter 1

Site 245 Hole Core 10 Cored Interval: 320-329 m



LITHOLOGIC DESCRIPTION

5GY5/2
5GY5/2
5GY5/1
5GY5/2 heavily burrowed
5GY5/2 heavily burrowed
natural break
natural breaks
5GY6/1

Semilithified sediment.
Mottled throughout by small burrows.
Dominant color is mostly greenish gray (5GY6/1) - but, Section 2 is N7-N8, light to very light gray.

CARBONATE-BEARING CLAY-RICH NANNO CHALK
Smears 2-70, 3-75, CC
Composition

calc. nannos	75%
micarb.	10%
clay	15%

Natural breaks have slickenside-like surfaces.

Minor lithologies include:
1) NANNO-RICH CLAYSTONE (5GY5/2)
2) DEVITRIFIED VOLCANIC ASH

Smears 1-24, 1-103
Composition

clay	99%
nannos	1%

-good shard outlines
-some pieces of volcanic glass
-greenish gray color (5GY5/2)

3) CLAY-RICH NANNO CHALK
Smears 3-75, CC
Same sediment as above but clay content is higher.

Carbon-Carbonate
1-24 (5.9-0.1-49) devitrified volcanic ash
1-46 (4.1-0.1-33) devitrified volcanic ash

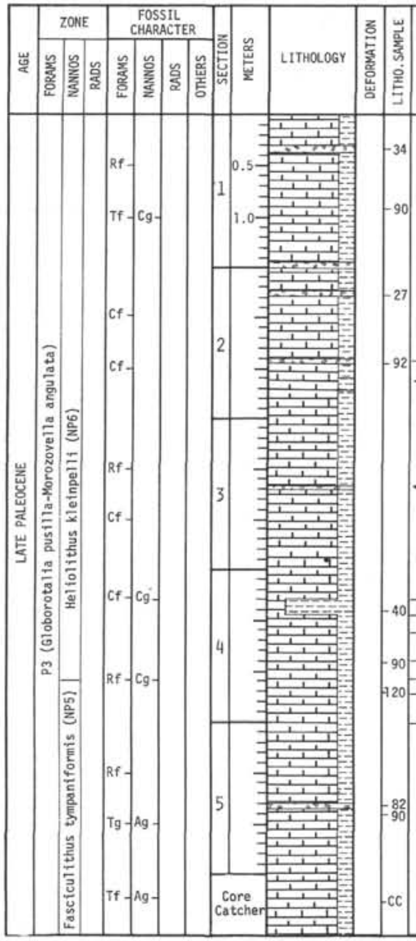
X-ray 1-45 (devitrified volcanic ash)

calc.	A	qtz.	P
paly.	P	mica	P
mont.	P	k-feld.	T

$CaCO_3$ Content

3-20	75%
CC	82%

Site 245 Hole Core 11 Cored Interval: 329-338 m



LITHOLOGIC DESCRIPTION

N7

Sediment is semilithified and fractured by the drilling and cutting processes. Dominant color is light olive gray (5Y6/1) and pink gray (5YR8/1) is minor. In Section 4, grays (5YR6/1) and browns (10YR4/2 and 10YR6/2) alternate.

Burrow mottling throughout with a probable fedding track in Section 2.

CLAY-RICH NANNO CHALK
Smear 1-90
Composition

calc. nannos	80%
clay	15%
micarb.	5%

3 lines of concentric marks. Feeding trail?

5GY6/1
5GY4/1

DEVITRIFIED VOLCANIC ASH
Smears 2-27, 2-92, 5-82
Composition

*clay	95%
nannos	5%
shards	Tr.

*Clay probably is an iron-rich montmorillonite.

Carbon-Carbonate
4-66 (6.3-0.1-52)

10YR4/2
5YR6/1
10YR5/4
5YR6/1
10YR5/4
10YR6/2

$CaCO_3$ Content

5-67	75%
CC	79%

X-ray 1-34 (ash)

mont.	M
calc.	P
plag.	T

X-ray 2-91 (ash)

mont.	A
calc.	M
plag.	P
qtz.	T

5YR8/1

Explanatory notes in chapter 1

Site 245 Hole Core 12 Cored Interval: 338-347 m

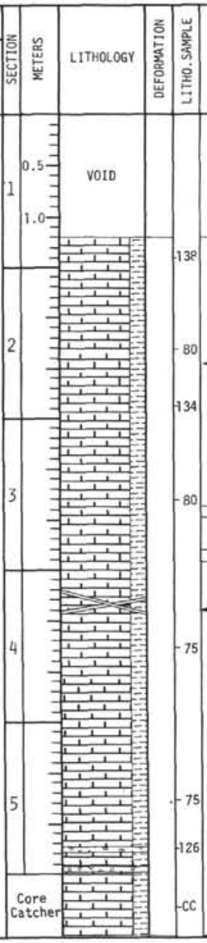
AGE: LATE PALEOCENE

ZONE — FORAMS: P3 (Globorotalia pusilla-Morozovella angulata)

ZONE — NANNOS: Tasciculithus tympaniformis (NP5)

FOSSIL CHARACTER (FORAMS, NANNOS):

Cf - Cg
Rf
Tg
Cf
Tg
Rf
Rg
Rg
Rg
Rg - Ag



LITHOLOGIC DESCRIPTION

Semilithified sediment cut by band saw; fragmented (slightly) by drilling process. Dominant color is pinkish gray (5YR8/1). Patches displaying intensely burrow mottling are 5YR7/2 and 5YR4/1 stained.

CLAY-RICH NANNO CHALK
Smears - all except 5-126
<u>Composition</u>

micarb.	85%
calc. nannos	
clay	15%

(minor lith) DEVITRIFIED VOLCANIC ASH
Smear 5-126
<u>Composition</u>

clay	95%
calc. nannos	5%
vol. gls.	Tr.

<u>Carbon-Carbonate</u>
3-2 (10.1-0.1-84)
4-35 (10.3-0.0-86)

<u>CaCO$_3$ Content</u>

2-31	62%
4-22	85%

<u>X-ray 2-134</u>

calc.	M
mont.	T

5YR8/1
burrows

unusual
lamina

5YR7/2

heavily
burrowed
5YR7/2
heavily
burrowed

Two intersecting fractures with slickensides on surfaces.

Site 245 Hole Core 13 Cored Interval: 350-359 m

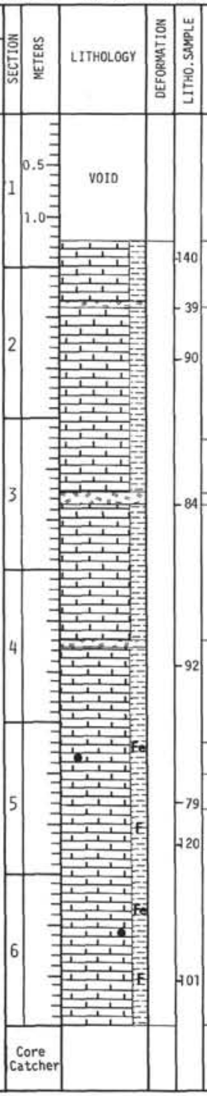
AGE: LATE PALEOCENE; EARLY/LATE PALEOCENE (?)

ZONE — FORAMS: P3 (Globorotalia pusilla-Morozovella angulata)

ZONE — NANNOS: Fasciculithus tympaniformis (NP5); Chiasmolithus danicus (NP3)

FOSSIL CHARACTER (FORAMS, NANNOS):

Tg
Rg
Cg
Ag
Tg
Af - Cg
Tg
Af - Cg
Cg
Af
Af
Cf - Cg



LITHOLOGIC DESCRIPTION

Semilithified sediment, not deformed except fragmentation (slight) by drilling process. Mostly grayish orange pink 5YR7/2 with numerous 5Y8/1: yellowish gray, 5YR6/1 light olive gray, 5YR7/4 patches. Core intensely burrowed, mainly in the volcanic ash and near the bottom.

CARBONATE/CLAY-RICH NANNO CHALK
most smears
<u>Composition</u>

calc. nannos	60%	opaques	Tr. to 1%
clay	20%	feld.	Tr.
micarb.	20%		

CLAYEY NANNO CHALK
Smear 2-90
<u>Composition</u>

calc. nannos	50%	clay	40%
micarb.	10%		

DEVITRIFIED VOLCANIC ASH
Smears 2-39, 3-84
<u>Composition</u>

clays	98%
*opaques	2%

*Note: the whole chalk, especially down to the bottom is speckled by dark opaque materials which look like Fe-Mn oxides. See Smear 5-120.

<u>Carbon-Carbonate</u>
4-108 (9.3-0.0-77)
5-99 (9.6-0.0-80)
6-105 (9.5-0.0-79)

<u>CaCO$_3$ Content</u>

3-38	83%

<u>X-ray 2-35</u>		<u>X-ray 3-81</u>		<u>X-ray 4-72</u>	
mont.	A	mont.	M	mont.	M
plag.	A	plag.	P	qtz.	T
qtz.	T				
paly.	T				

5YR7/2

5GY6/1
intensely
burrowed

5Y8/1 to
5Y6/1

5YR4/1
intensely
burrowed

5YR7/2

5YR6/1

10YR7/4

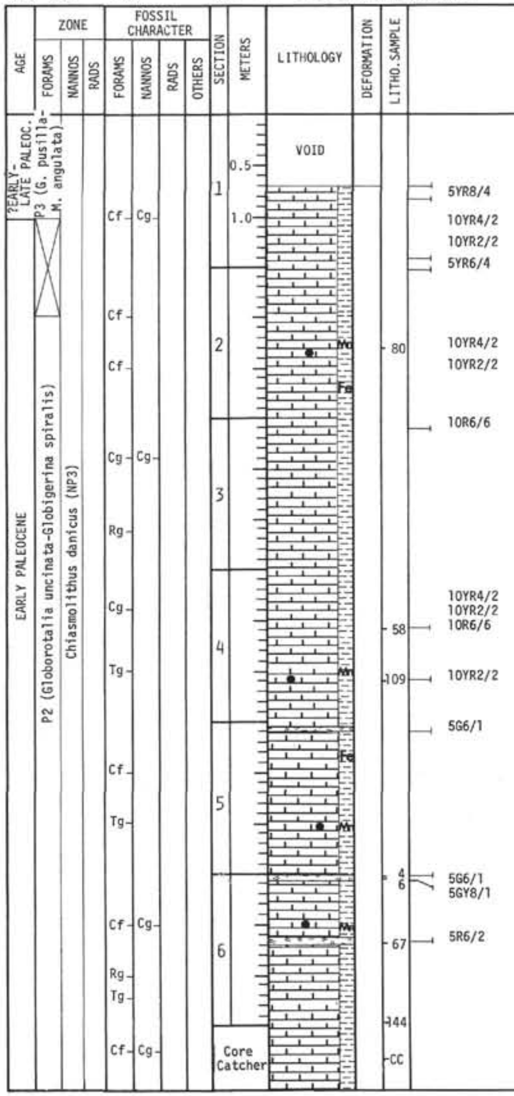
10YR7/4
5Y6/1
intensely burrowed

10YR7/4
intensely burrowed
↓
10YR4/2 dark yellowish brown
Intense burrow mottling with 5YR7/4 and 5YR6/1

5YR5/6

Explanatory notes in chapter 1

Site 245 Hole Core 14 Cored Interval: 359-368 m



LITHOLOGIC DESCRIPTION

Semilithified sediment; undeformed. Variegated colors are related to burrow mottling. Colors range from light yellow brown (5YR5/6) to dark yellow brown (10YR2/2) and moderate red orange (10R6/6).

CLAY-RICH NANNO CHALK
Smear 2-80
Composition

calc. nannos	70%	carb. rhombs	Tr.
micarb.	10%	qtz.	Tr.
clay	20%	opaques	Tr. to 1%

Opaques are Fe-Mn oxides.

DEVITRIFIED VOLCANIC ASH
Smears 6-4, 6-6
Composition

clay	70%
opaques	20% (Fe-Mn oxides)
calc. nannos	10%

The Fe-Mn oxides speckle the sediment throughout the core.

Grain Size
5-7 (4-55-41) clayey silt

Carbon-Carbonate
2-53 (9.2-0.0-76)
3-37 (8.5-0.0-71)

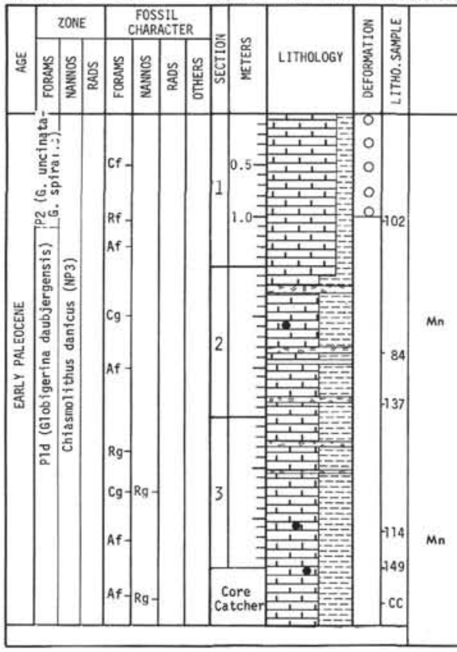
$CaCO_3$ Content

3-38	78%
CC	74%

X-ray 6-64

mont.	M
qtz.	T

Site 245 Hole Core 15 Cored Interval: 368-376 m



LITHOLOGIC DESCRIPTION

Sediment semilithified, cut by band saw; not deformed.
Color dominantly moderate yellow brown to dusky yellow brown (10YR2/2) grading downwards into brown black (5YR2/1) or olive black (5Y2/1).

CLAYEY NANNO CHALK
Smears 3-114, CC
Composition

calc. nannos	50%	forams	5%
clay	30%	micarb.	5%
Mn Fe oxides	10%		

MINOR LITHOLOGIES
1) VARIEGATED CLAY RICH NANNO CHALK
(top of core)
see Core 14 = same lithology

2) DEVITRIFIED VOLCANIC ASH
Orange to moderate pink = 5YR8/1 - 5R7/1
Smear 2-84
Composition

clay	90%	micarb.	1%
forams	3%	carb. rhombs	1%
calc. nannos	5%		

Carbon-Carbonate
2-71 (7.6-0.0-63)
3-149 (7.0-0.0-58)

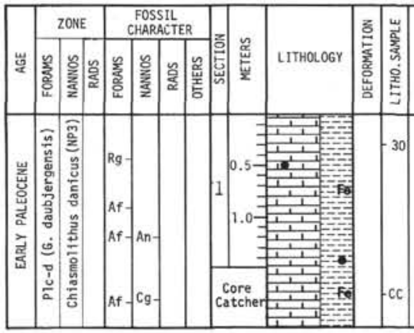
$CaCO_3$ Content

CC	42%

X-ray 2-83

calc.	A
mont.	M
qtz.	T

Site 245 Hole Core 16 Cored Interval: 380-389 m



LITHOLOGIC DESCRIPTION

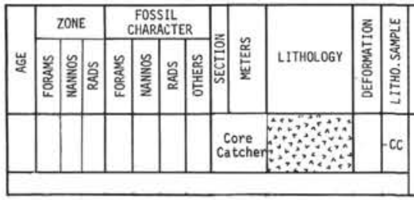
Sediment semilithified; cut by band saw; and not deformed.
Color is uniformly inbetween brownish black (5YR2/1) and olive black (5Y2/1).

CLAYEY NANNO CHALK
Smears 1-30, CC
Composition

calc. nannos	45%	Mn-Fe oxides	10%
clay	30%	forams	5%
micarb.	15%	chlor.	Tr.

Carbon-Carbonate
1-59 (5.7-0.0-47)

Site 245 Hole Core 17 Cored Interval: 389-390 m

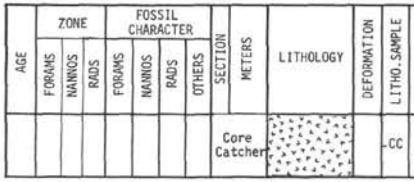


LITHOLOGIC DESCRIPTION

A piece (6 cm long) of gray to dark green GLASSY BASALT. Diabase inclusions, one 2 x 3 cm in two dimensions. Some vesicles and phenocrysts. Fractures filled with calcite.

Explanatory notes in chapter 1

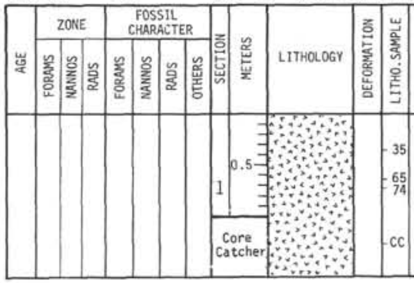
Site 245 Hole Core 18 Cored Interval: 393-395 m



LITHOLOGIC DESCRIPTION

A 6 cm long piece of dark greenish gray DIABASIC BASALT.

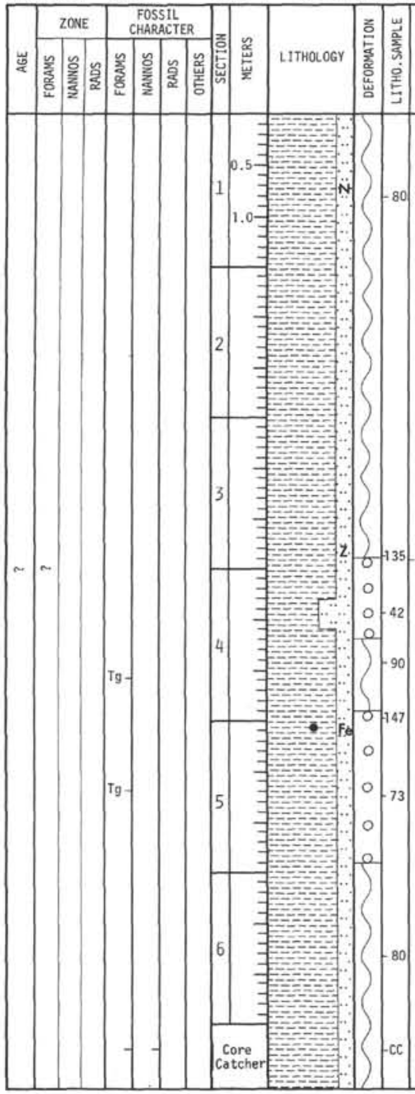
Site 245 Hole Core 19 Cored Interval: 395-396.5 m



LITHOLOGIC DESCRIPTION

DIABASIC BASALT, medium grained, color 5G2/1; greenish black on fresh surfaces. Veins of chlorite/calcite in all fragments except between 60 and 90 cm. Small hairline fractures, slightly altered.

Site 245 A Hole Core 1 Cored Interval: 26-35 m



LITHOLOGIC DESCRIPTION

Very soft to soft sediment disturbed by drilling; some stiff levels are present.

Color is dominantly moderate brown (5YR4/4 and 5YR3/4) at the top and dusky brown (10YR4/2 and 10YR5/4) towards the base.

Dom. 5YR4/4 to 5YR3/4

BROWN CLAY (SILT-RICH)
Smears 4-90, 6-80

Texture	Composition	
(0-20-80)	clay	70-80%
	qtz. & feld.	10-15%
	micas	5%
	heavies	1%
	opaques	1%
	calc. nannos	Tr.
	zeolites(?)	Tr.

FORAM/NANNO-BEARING SILTY CLAY
Smear 4-42

Composition	
clay	65%
qtz. & feld.	15%
micas	5%
opaques	5%
forams	5%
nannos	3%
micarb	1%
carb. rhombs	1%

From sieve remain investigations: fish teeth abundant, with bones and 1 rad.

Dom. 10YR5/4 to 10YR4/2

Carbon-Carbonate
3-142 (0.1-0.1-0)

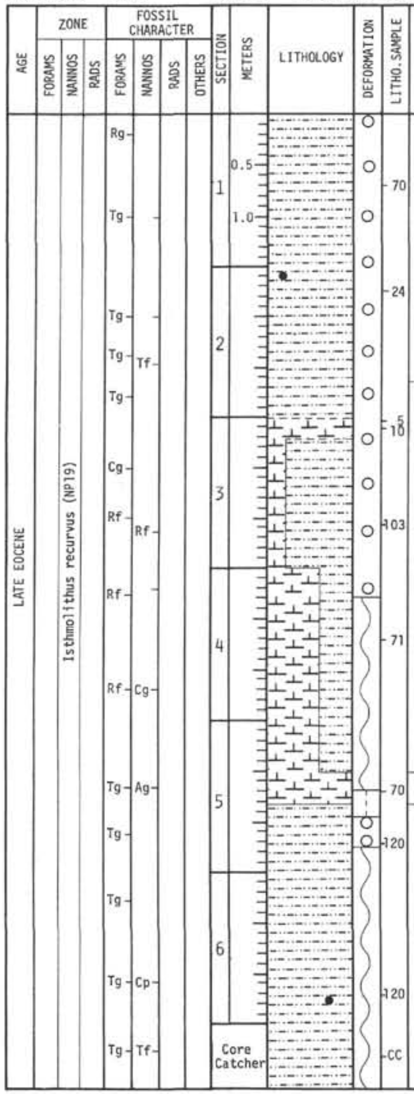
X-ray 1-79

paly.	A	mont.	P
qtz.	P	kaol.	P
plag.	P	k-feld.	T
mica	P	gibb.	T

streaks of 10YR5/4

Explanatory notes in chapter 1

Site 245 A Hole Core 2 Cored Interval: 54-63 m



LITHOLOGIC DESCRIPTION

Core is greatly disturbed by drilling; sediments are soft with some stiff zones. Colors are dominantly yellow brown (10YR4/2) with light brown (5YR5/6) and moderate orange pink (5YR8/4) patches. Black streaks throughout the core.

10YR4/2
and
10YR2/2

BROWN SILTY CLAY
Smears 1-70, 5-120, 6-120

Texture	Composition	
(0-30-70)	clay	70%
	qtz. & feld.	23%
	micas	5%
	opaques	2%

Black streaks probably Fe-Mn oxides; some micronodules occur.

10YR4/2
and
10YR5/4

CLAY-BEARING NANNO OOZE
Smear 5-70

Composition	
calc. nannos	90%
clay	10%
qtz.	Tr.

Drilling breccia now but originally interlayered silty clay and nanno ooze beds.

Grain Size
5-120 (0-23-77) clay

Carbon-Carbonate
4-129 (6.2-0.1-50)

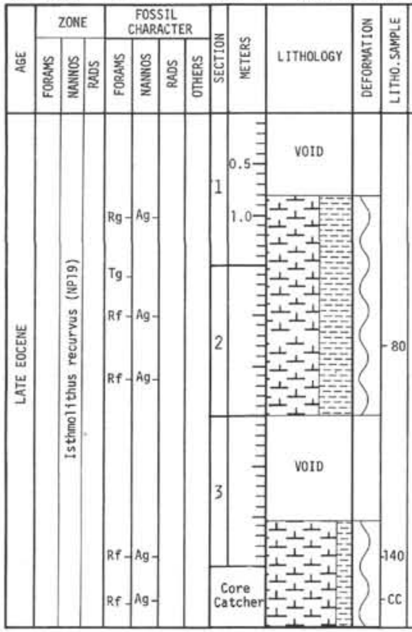
Abundant
black specks

X-ray 2-32	
calc.	M
qtz.	P
mica	P
k-feld.	T
plag.	T
kaol.	T
paly.	T

5YR8/4

10YR4/2
and
10YR5/4

Site 245 A Hole Core 3 Cored Interval: 63-72 m



LITHOLOGIC DESCRIPTION

Core intensely deformed; sediment is very soft.
Dominant color is moderate orange pink (5YR8/4) to light yellow brown (5YR6/4); some dark yellow brown streaks and patches (10YR4/2).

CLAYEY NANNO OOZE
Smear 2-80

Composition	
clay	20%
calc. nannos	70%
qtz. & feld.	7%
micas	3%

CLAY-RICH NANNO OOZE
Smear CC

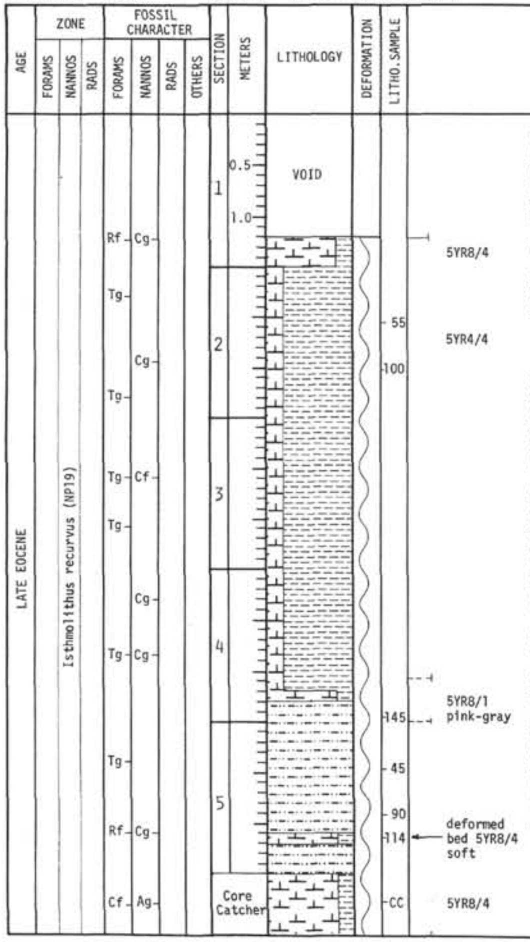
Composition	
calc. nannos	70%
clay	25%
qtz. & feld.	3%
opaques	2%
micas	Tr.

This ooze appears mixed with the brown one in the core (disturbed interbedding) but constitutes the main part of the core catcher and of the Section 3.

Carbon-Carbonate
1-103 (7.1-0.1-59)

Explanatory notes in chapter 1

Site 245 A Hole Core 4 Cored Interval: 72-81 m



LITHOLOGIC DESCRIPTION

Sediment extremely mixed-up; slurry and drilling breccia consisting of light to moderate yellowish brown (5YR4/4-5/6), dark yellowish brown (10YR4/2), and moderate orange pink (5YR8/4); cannot be accurately separated into distinct areas of the core.

Few spots and dark streaks of Mn oxide(?).

NANNO-RICH CLAY
Smear 2-55

Texture	Composition	
(0-20-80)	clay	80%
	calc. nannos	15%
	qtz. & feld.	5%

CLAY-RICH NANNO OOZE
Smears 5-114, CC

Composition	
calc. nannos	70%
micarb.	5%
clay	15%
qtz. & feld.	10%

BROWN SILTY CLAY (minor lith)
Smears 5-45, 5-90

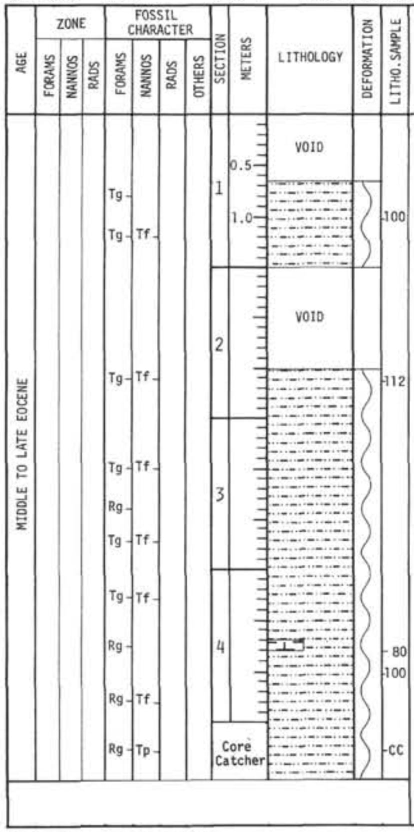
Composition	
clay	60%
qtz. & feld.	30%
opaques	3%
Fe-oxides	1%
micas	5%
forams	Tr.

Grain Size
2-134 (0-26-74) (silty clay)

Carbon-Carbonate
3-65 (1.6-0.1-12)

X-ray 5-15	
calc.	M
qtz.	P
mica	P
paly.	T
k-feld.	T
plag.	T
chlor.	T

Site 245 A Hole Core 5 Cored Interval: 91-100 m



Explanatory notes in chapter 1

LITHOLOGIC DESCRIPTION

Core is stiff and intensely deformed throughout. Mixture of moderate yellowish browns (5YR4/4 and 5YR3/4); mostly 5YR3/4.

BROWN SILTY CLAY
Smears 1-100, 2-112, 4-100, CC

Texture	Composition	
(0-35-65)	clay	60%
	qtz.	25%
	micas	5%
	feld.	3%
	Fe-oxides	4%
	heavies	1%
	calc. nannos	2%

Heavies: hematite, epidote, chlorite and rutile.

BROWN NANNO CLAY (SILT-RICH) (minor lith)
Smear 4-80

Texture	Composition	
(0-20-80)	clay	45%
	calc. nannos	40%
	qtz. & feld.	10%
	micas	1%
	opaques	4%
	micarb.	Tr.

Opaques are presumably Fe-Mn oxides.

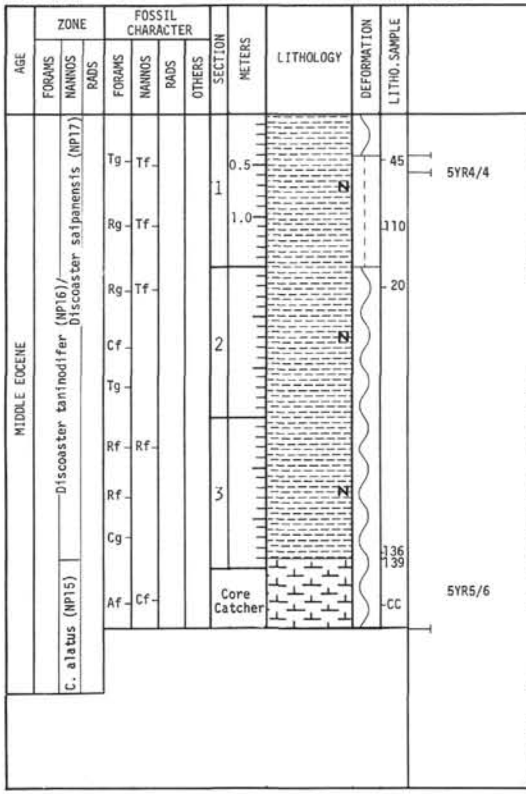
This minor lithology appears in spots, specks and casts which might come from deformed beds.

Grain Size
1-89 (0-15-85) clay
4-129 (0-17-83) clay

Carbon-Carbonate
1-86 (0.1-0.2-0)

X-ray 4-99	
paly.	A
qtz.	P
k-feld.	P
mica	P
mont.	P
plag.	P
chlor.	T

Site 245 A Hole Core 6 Cored Interval: 100-109 m



LITHOLOGIC DESCRIPTION

Core greatly deformed - slurry and drilling breccia.
Dominate color is dark yellowish brown (10YR4/2); one thick bed and mottles of moderate brown (5YR4/4). A third color inbetween these two; and results presumably from mixing.

BROWN NANNO-BEARING CLAY
Smears 1-110, 3-136

Texture	Composition	
(0-10-90)	clay	90%
	calc. nannos	5%
	qtz. & feld.	3%
	opaques	2%
	chlor.	Tr.

BROWN CLAY (*SILT-BEARING*)
Smear 2-20 (minor lith)

Composition	
clay	95%
qtz.	3%
opaques	2%

BROWN NANNO OOZE
Smears 3-139, CC

Composition	
calc. nannos	80%
micarb.	15%
clay	5%
heavies	Tr.
forams	Tr.

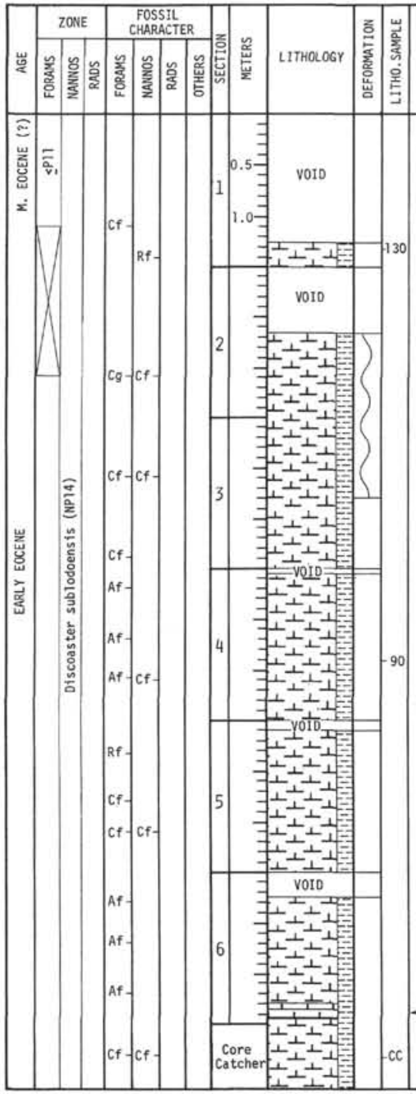
Note: The nanno content increases down to the bottom of the core. Close to the core catcher there is a nanno rich clay (see smear 3-136).

Carbon-Carbonate
1-45 (0.1-0.2-0)

X-ray 2-29

paly.	A	plag.	T
qtz.	P	mont.	T
k-feld.	P	chlor.	T
mica	P	kaol.	T

Site 245 A Hole Core 7 Cored Interval: 140-149 m



not deformed
moderately stiff

← chalk

LITHOLOGIC DESCRIPTION

Soft to stiff sediment. Becomes very stiff down to the bottom of the core.
Color is uniformly pinkish gray (5YR8/1).

CLAY-RICH NANNO OOZE
Smears 1-130, 4-90, CC

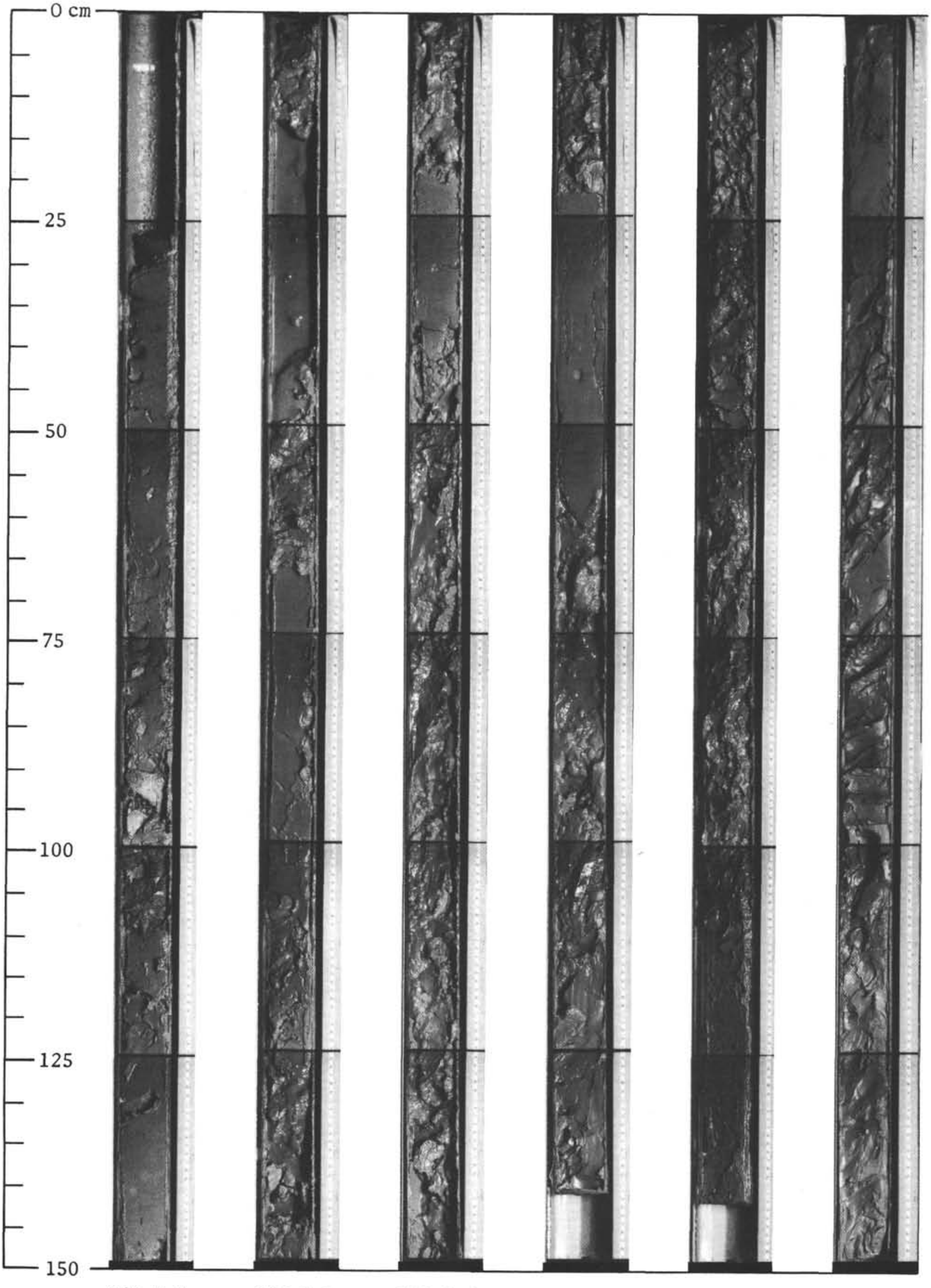
Composition	
calc. nannos	80%
clay	15%
zeolites?	Tr.

Small beds of NANNO CHALK.

Note: Purple euhedral to subhedral minerals abundant in some places: zeolites?. See smear 1-130; probably clinoptilolite.

Carbon-Carbonate
3-89 (9.6-0.1-79)

Explanatory notes in chapter 1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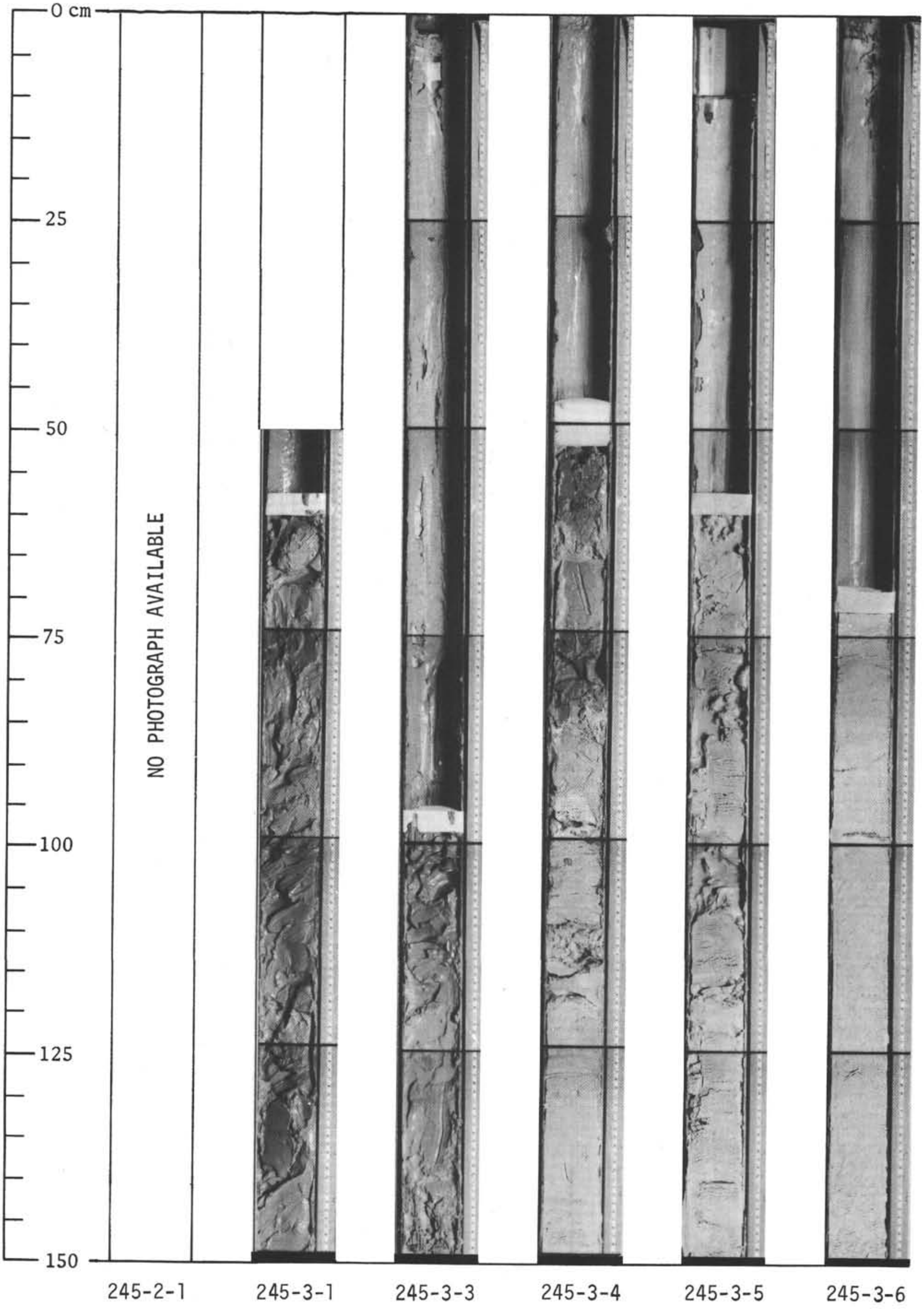
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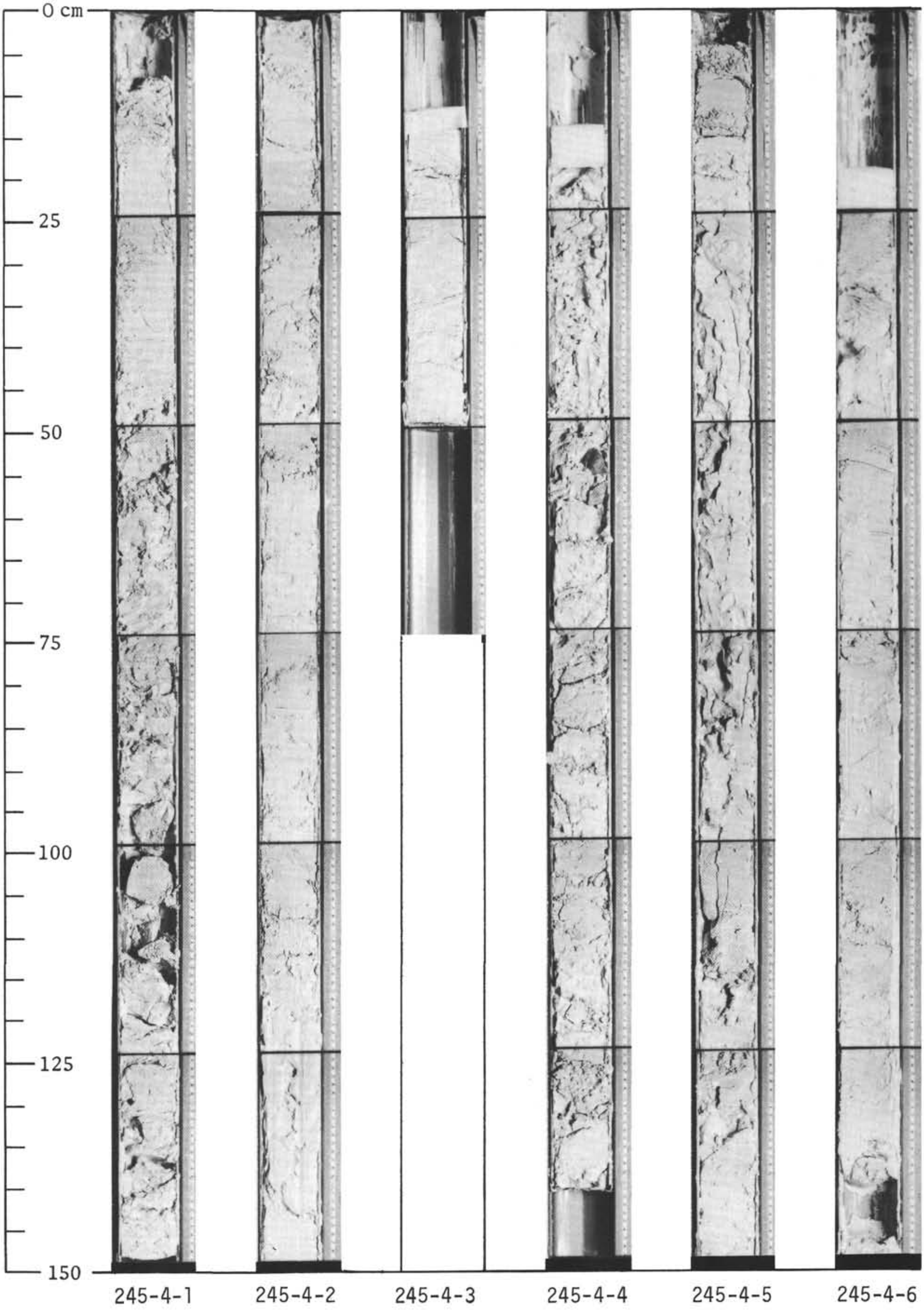
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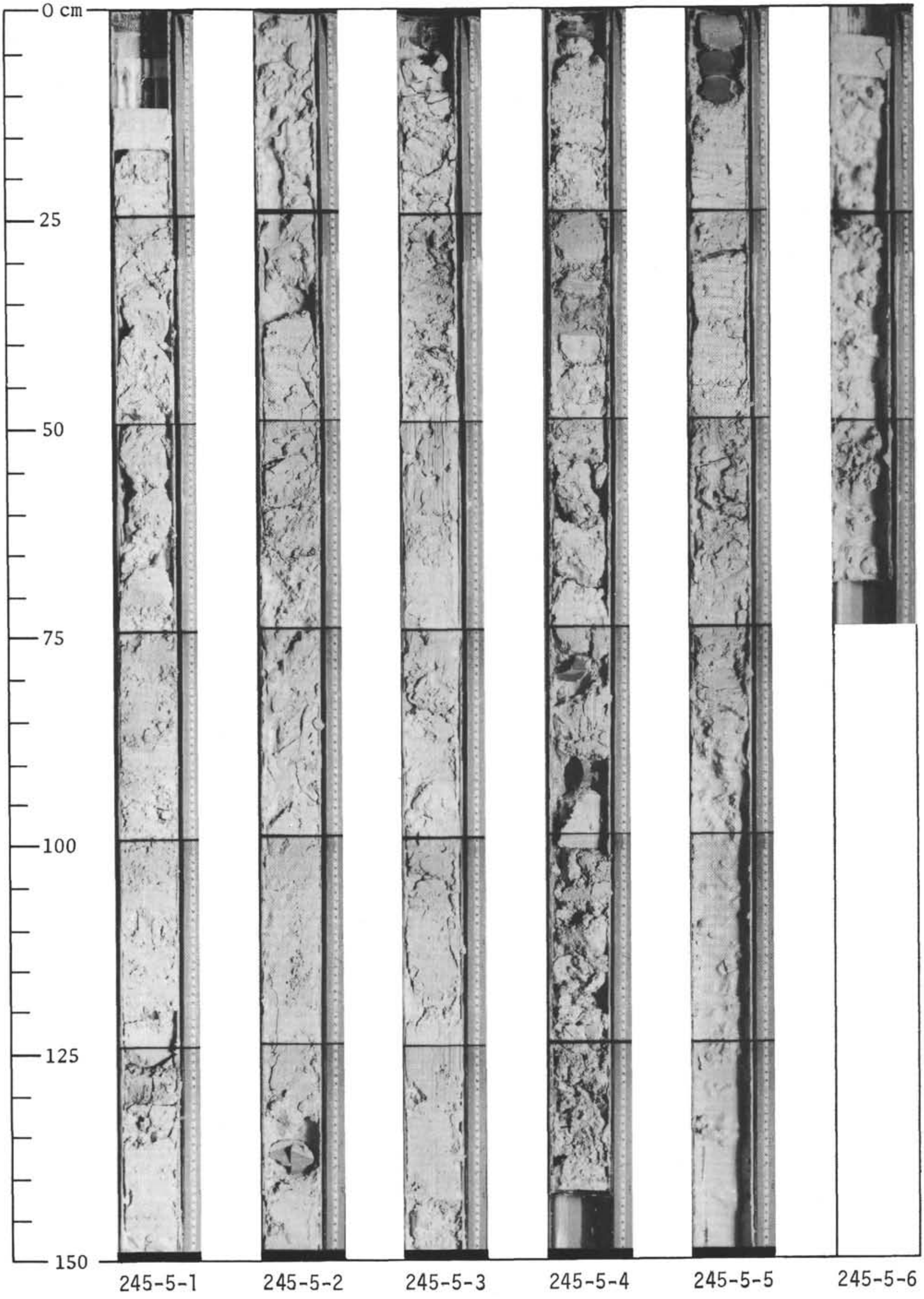
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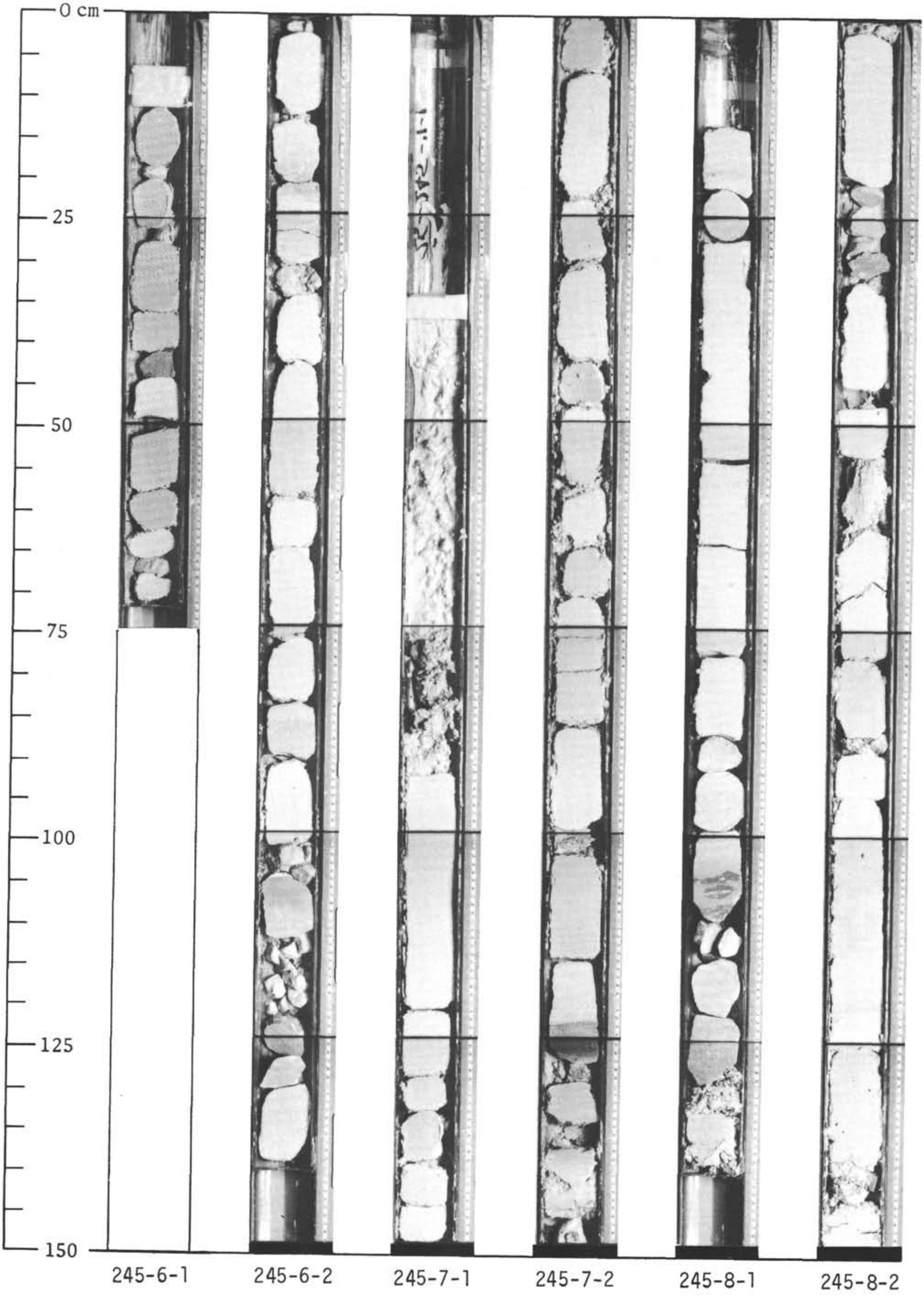
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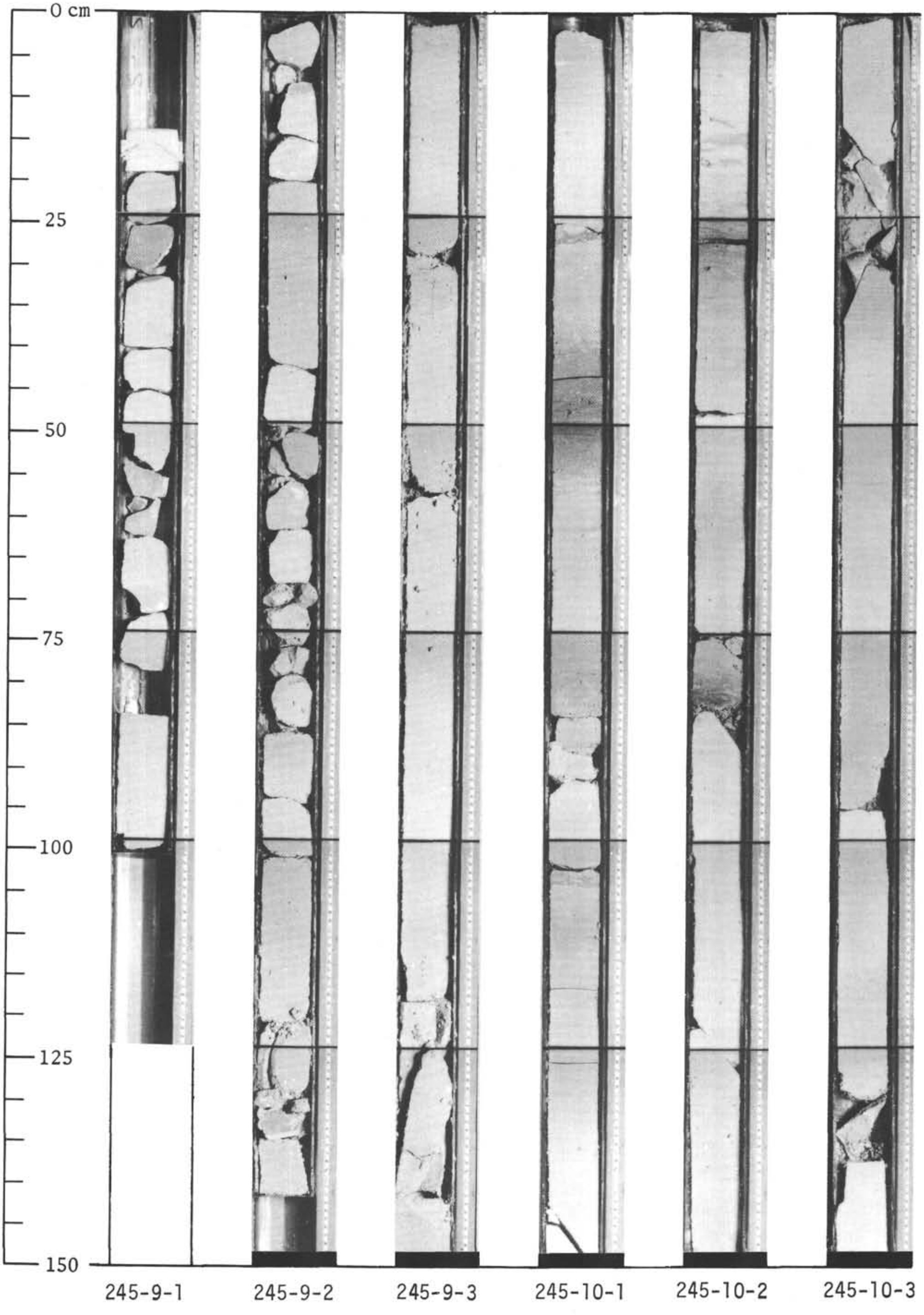
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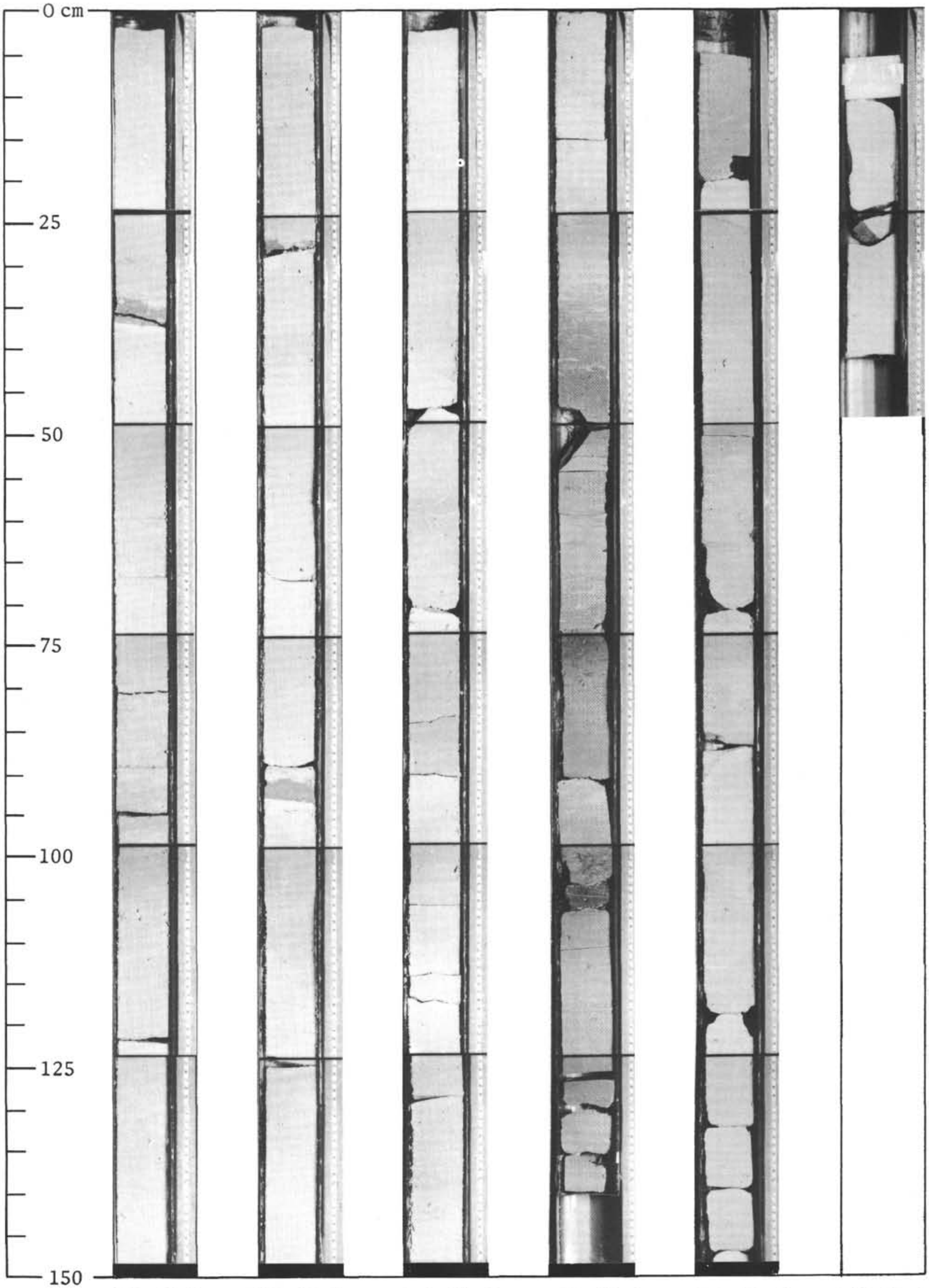
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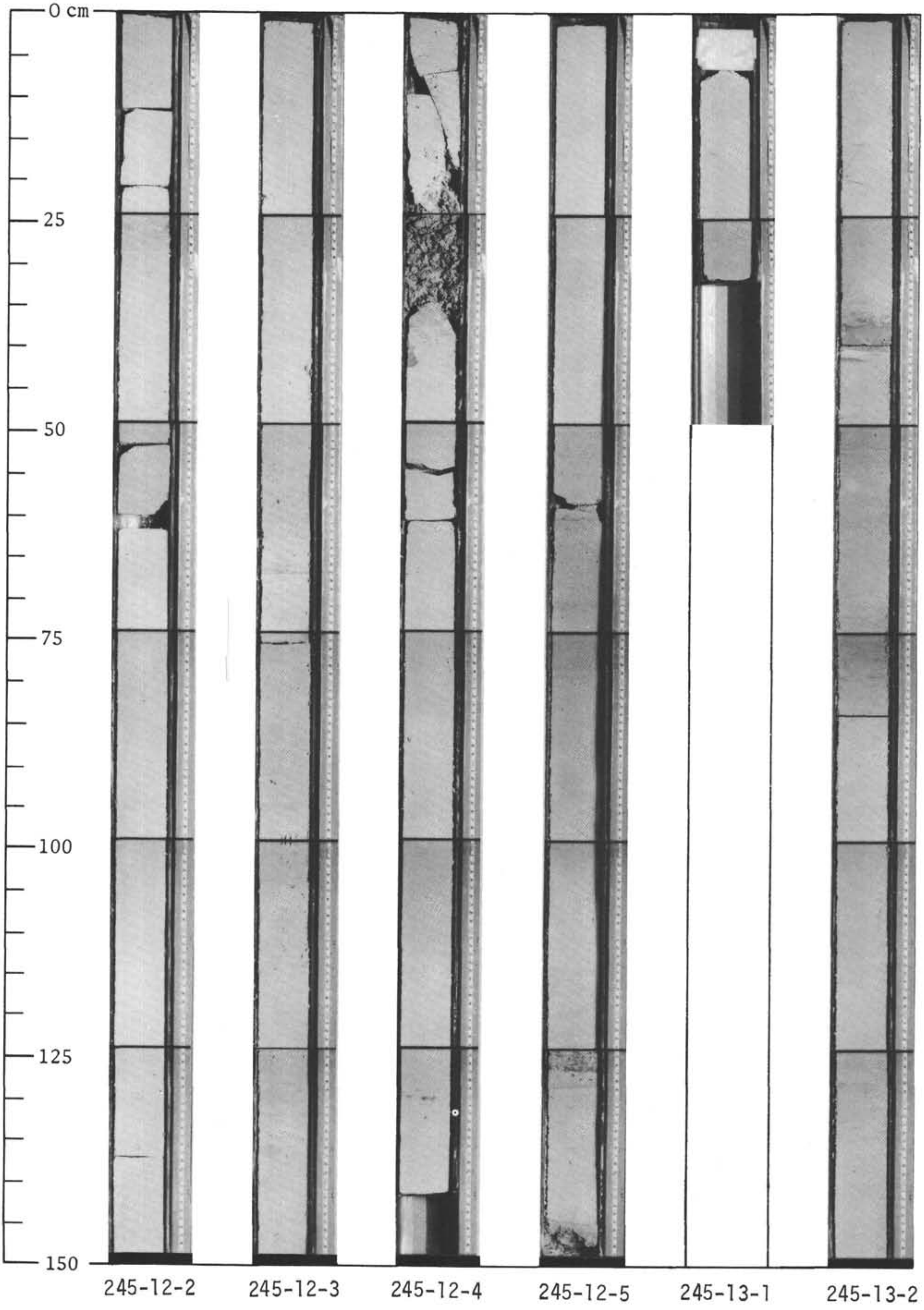
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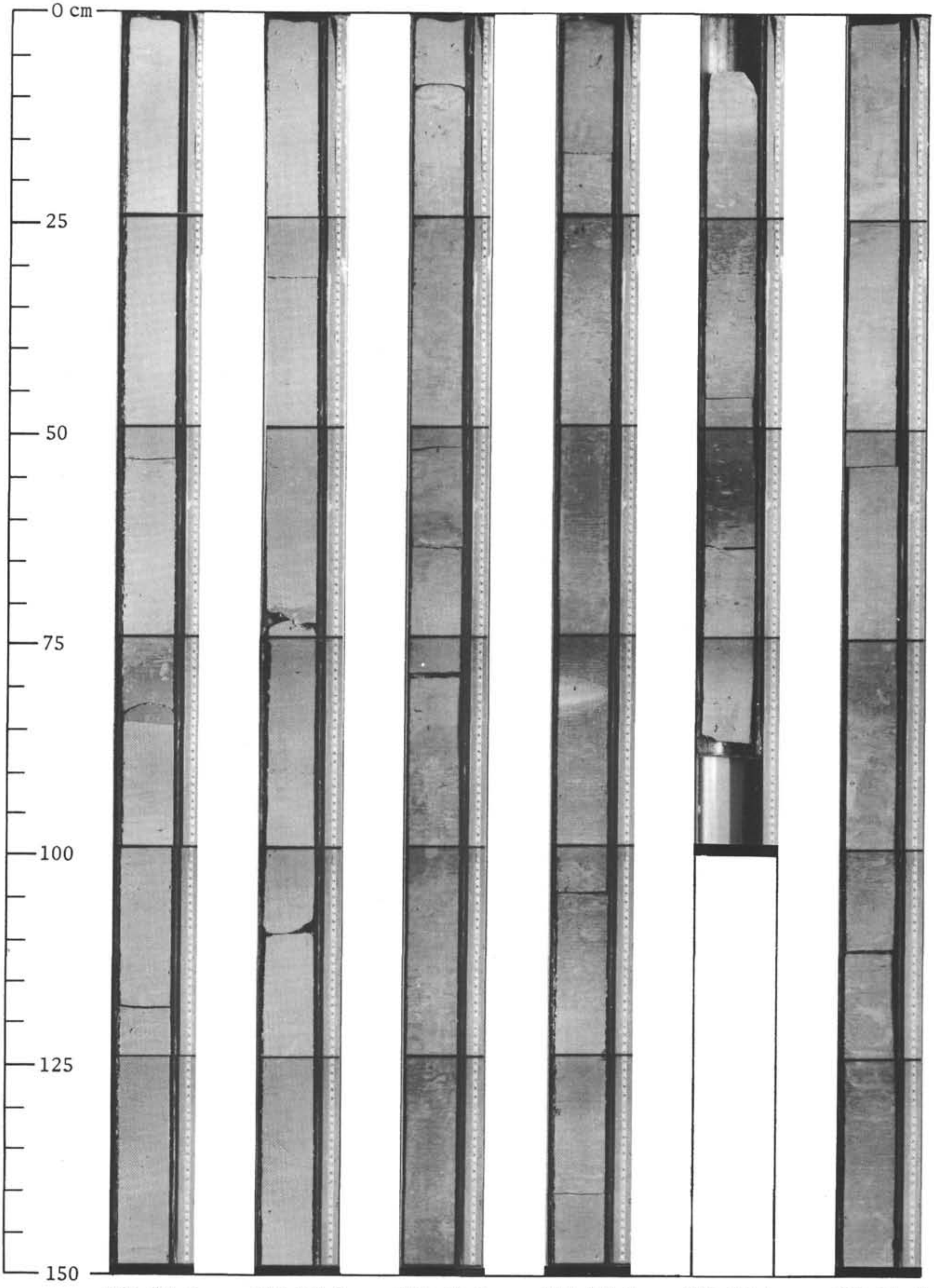
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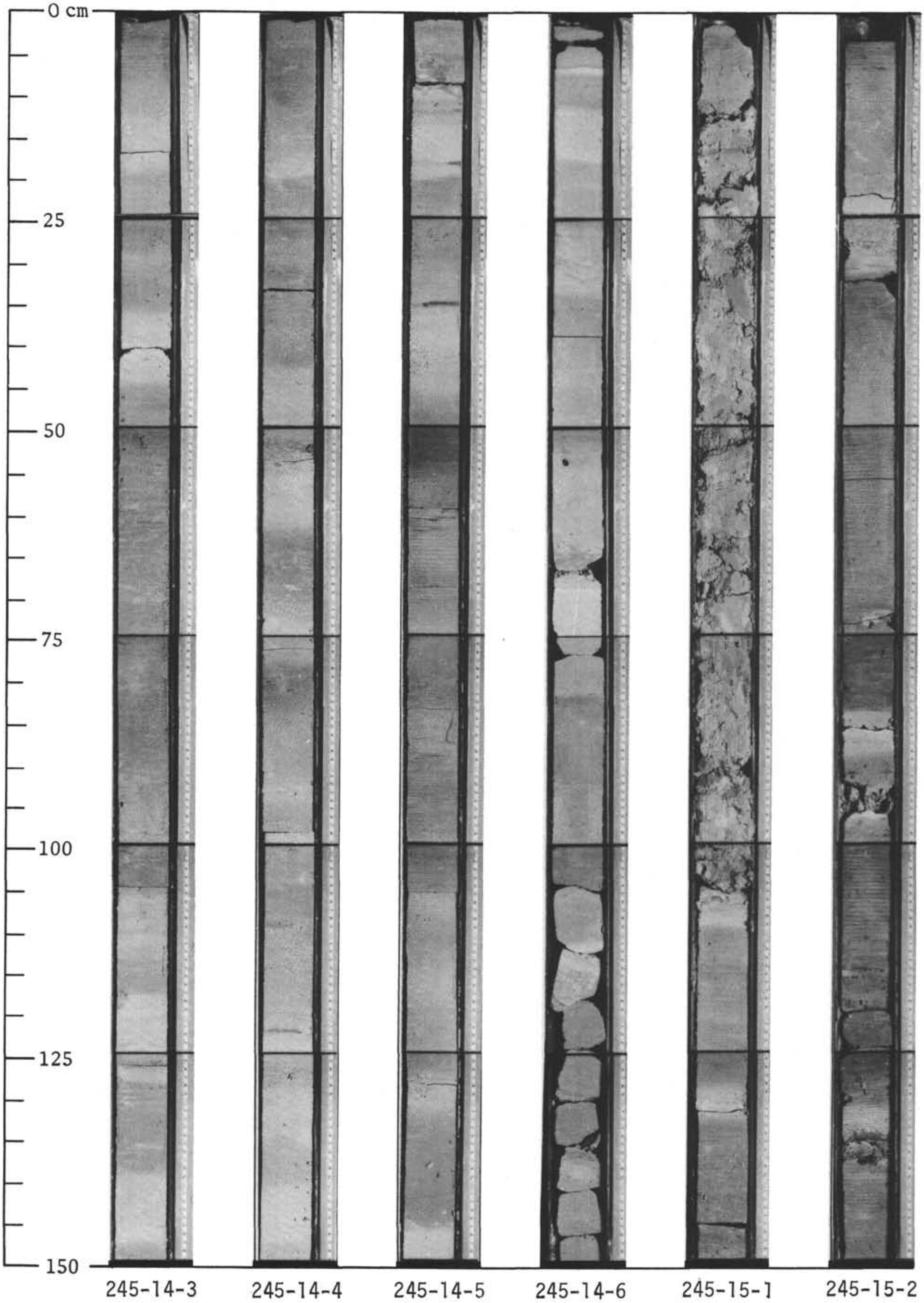
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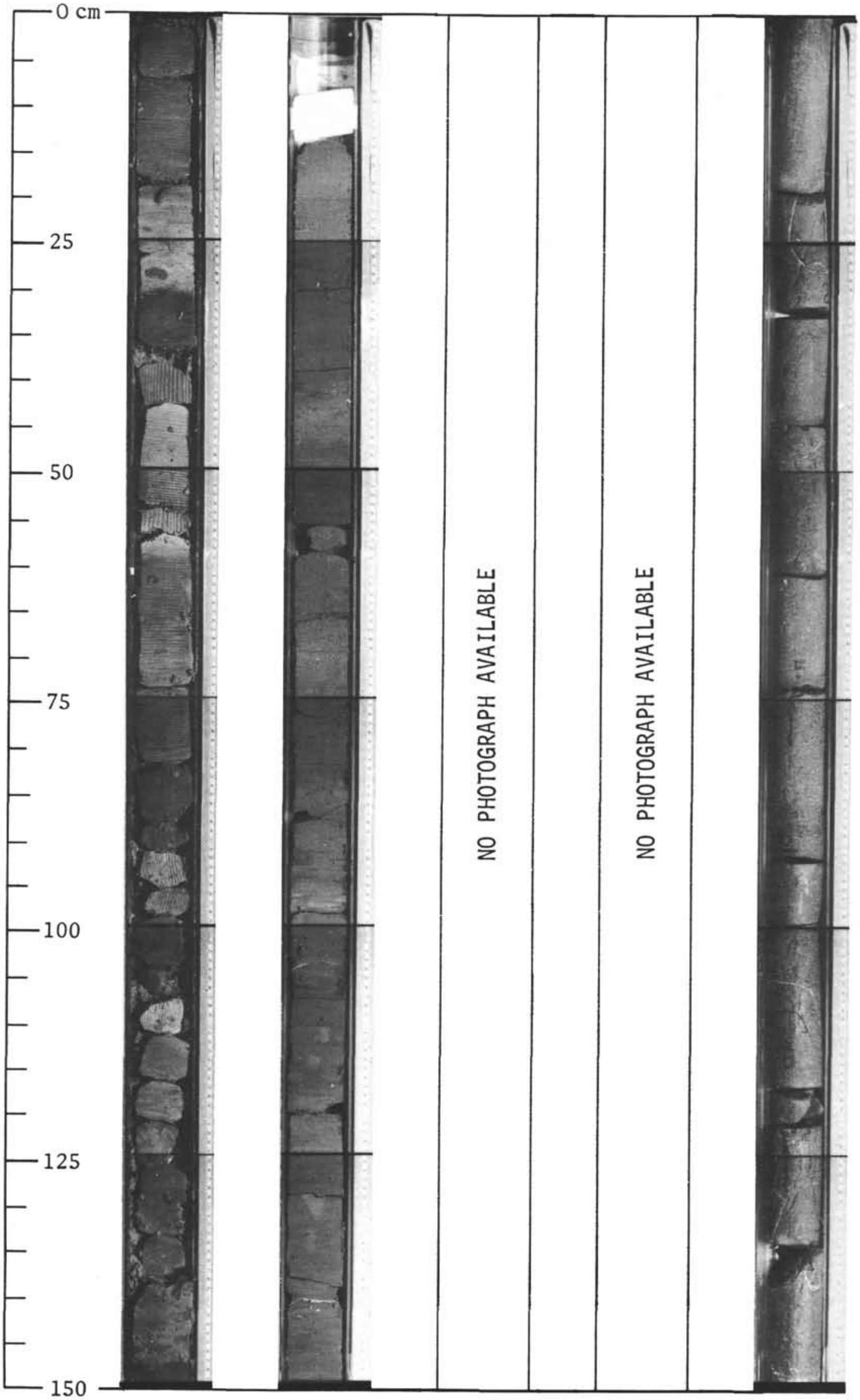
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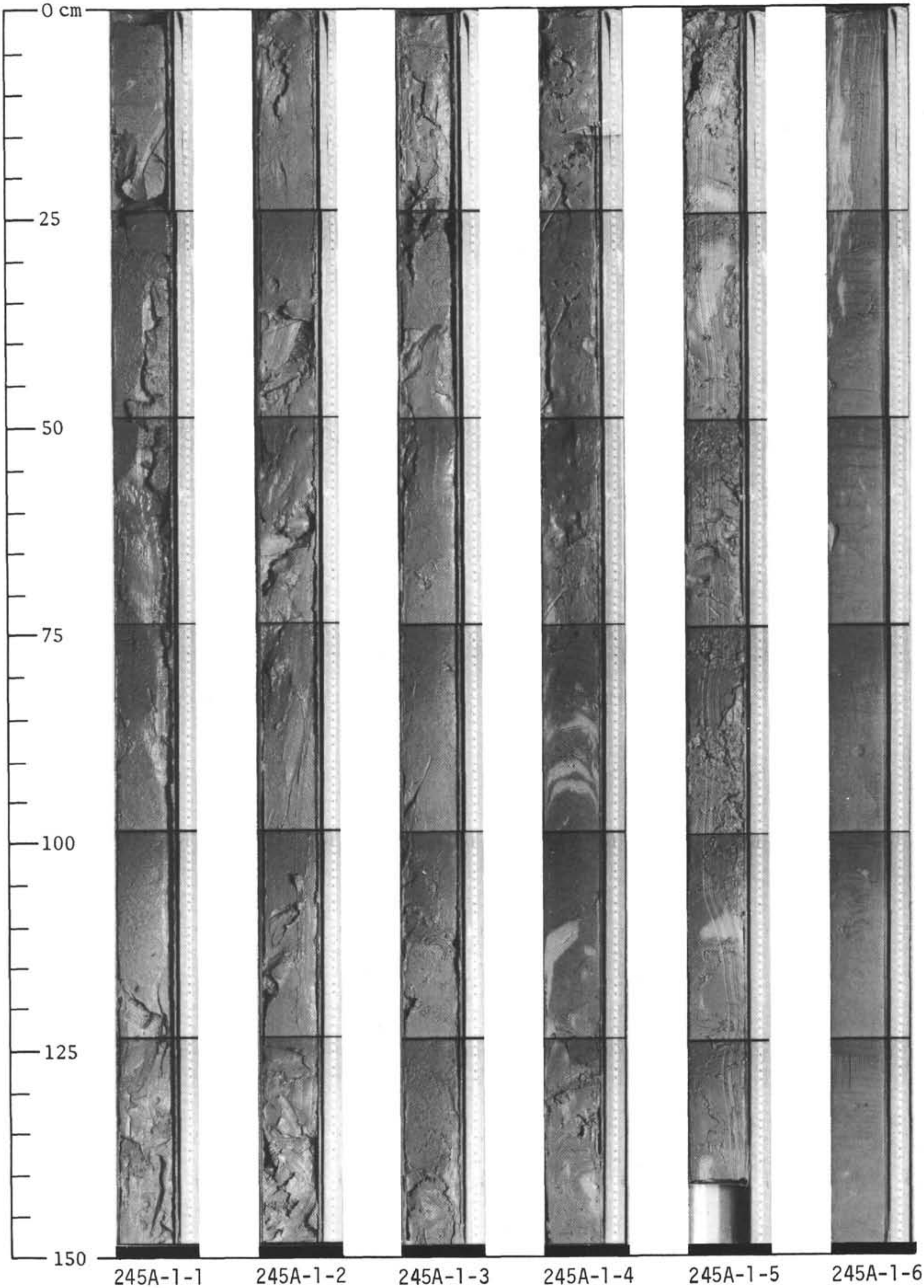
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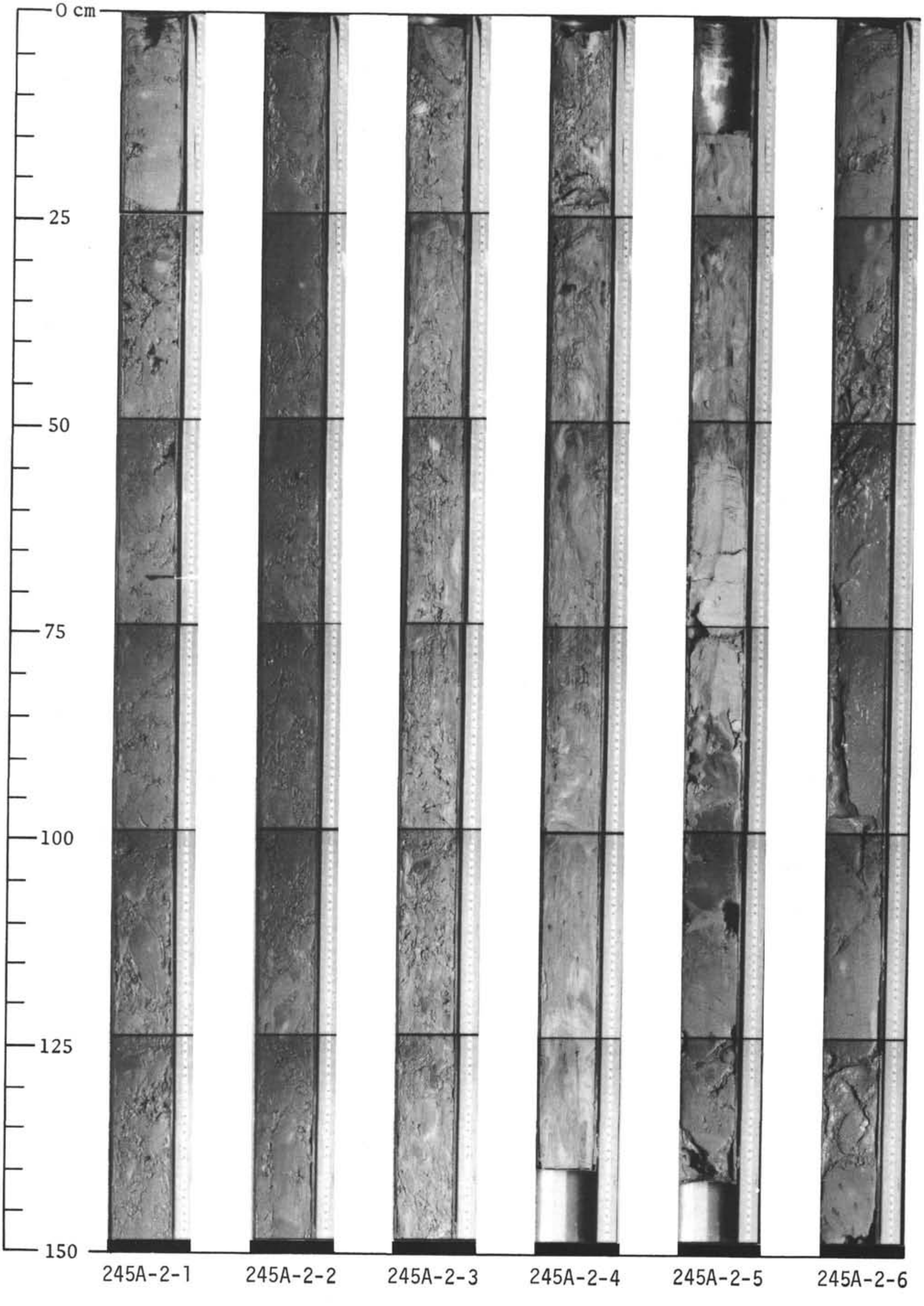
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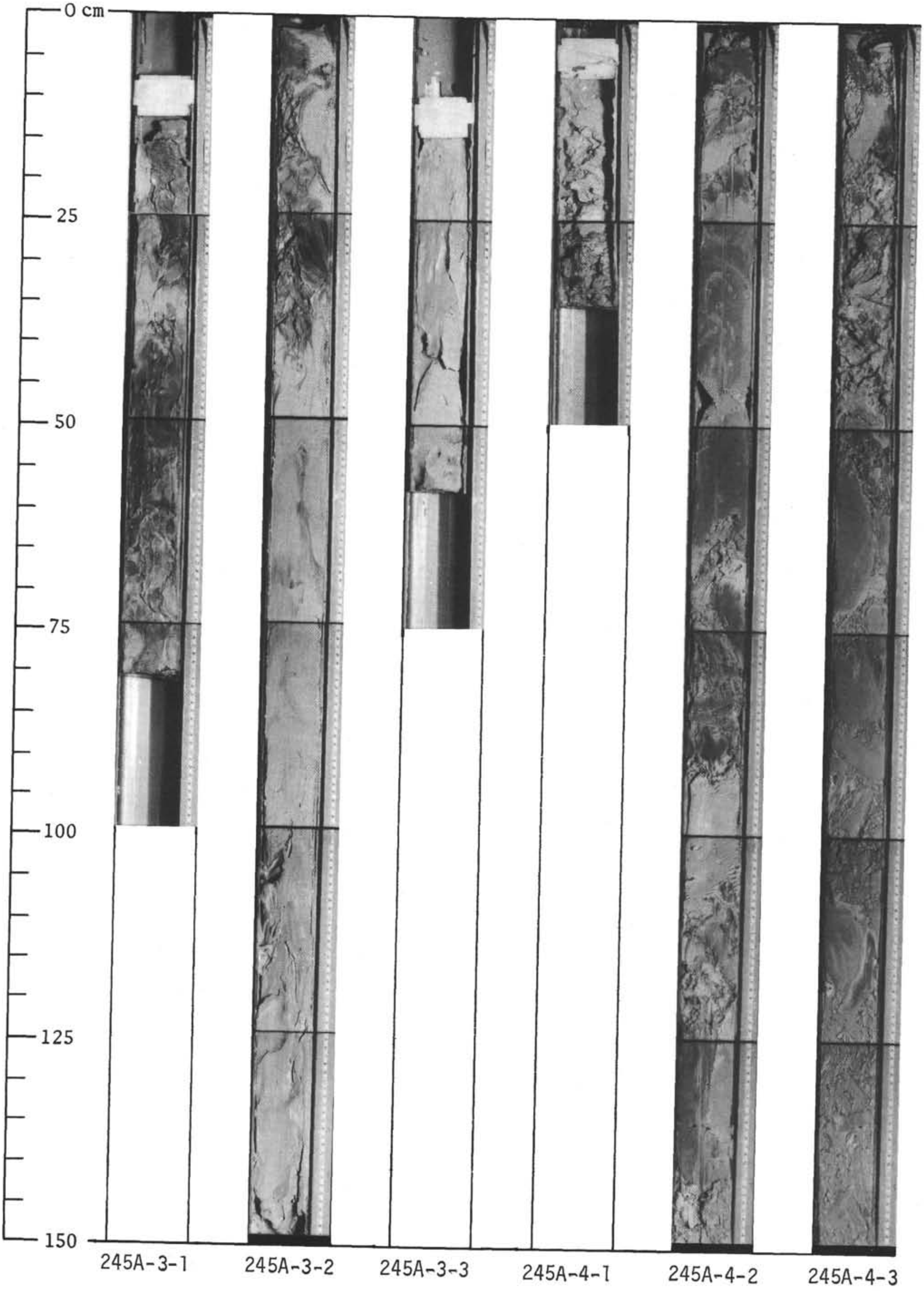
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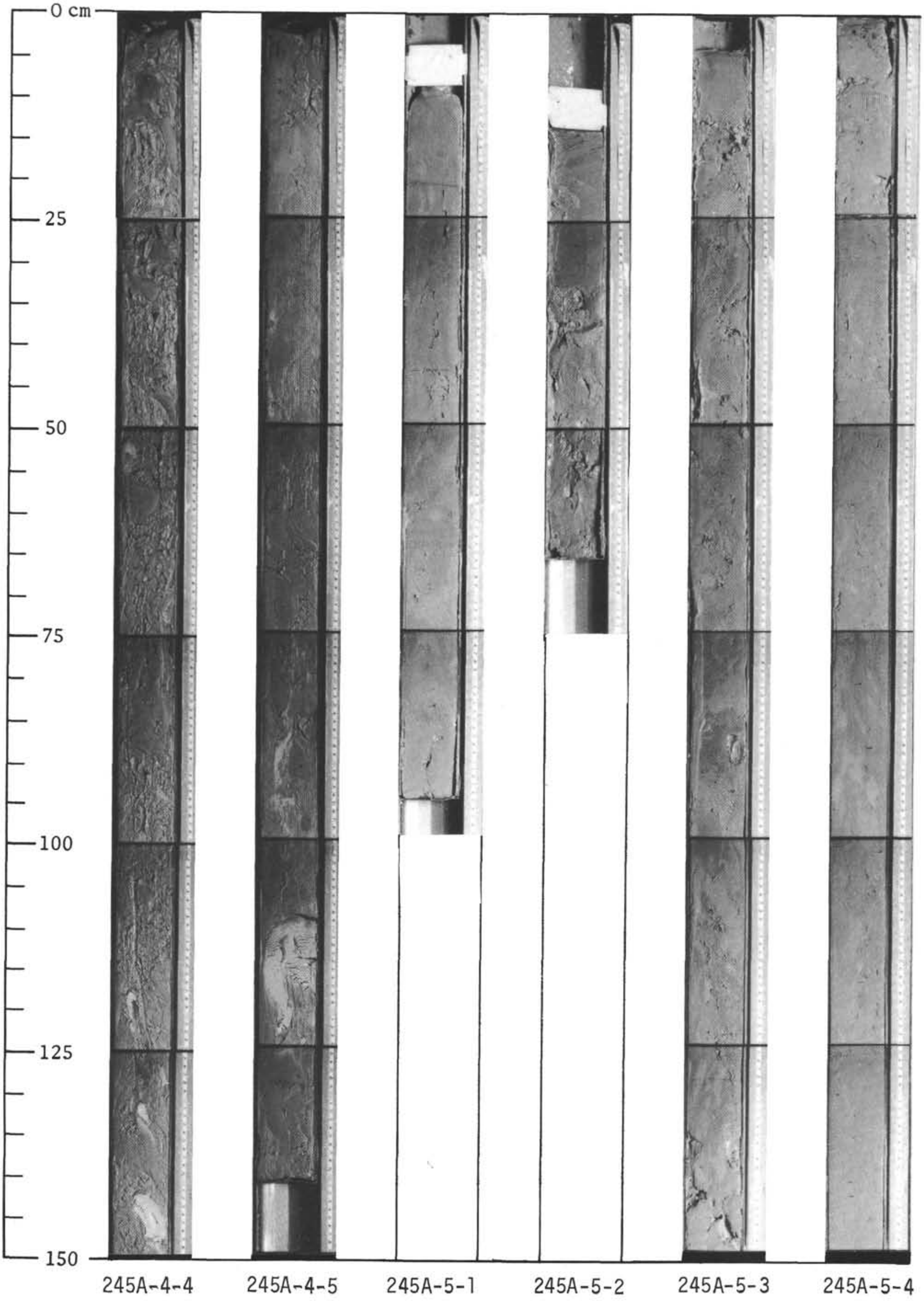
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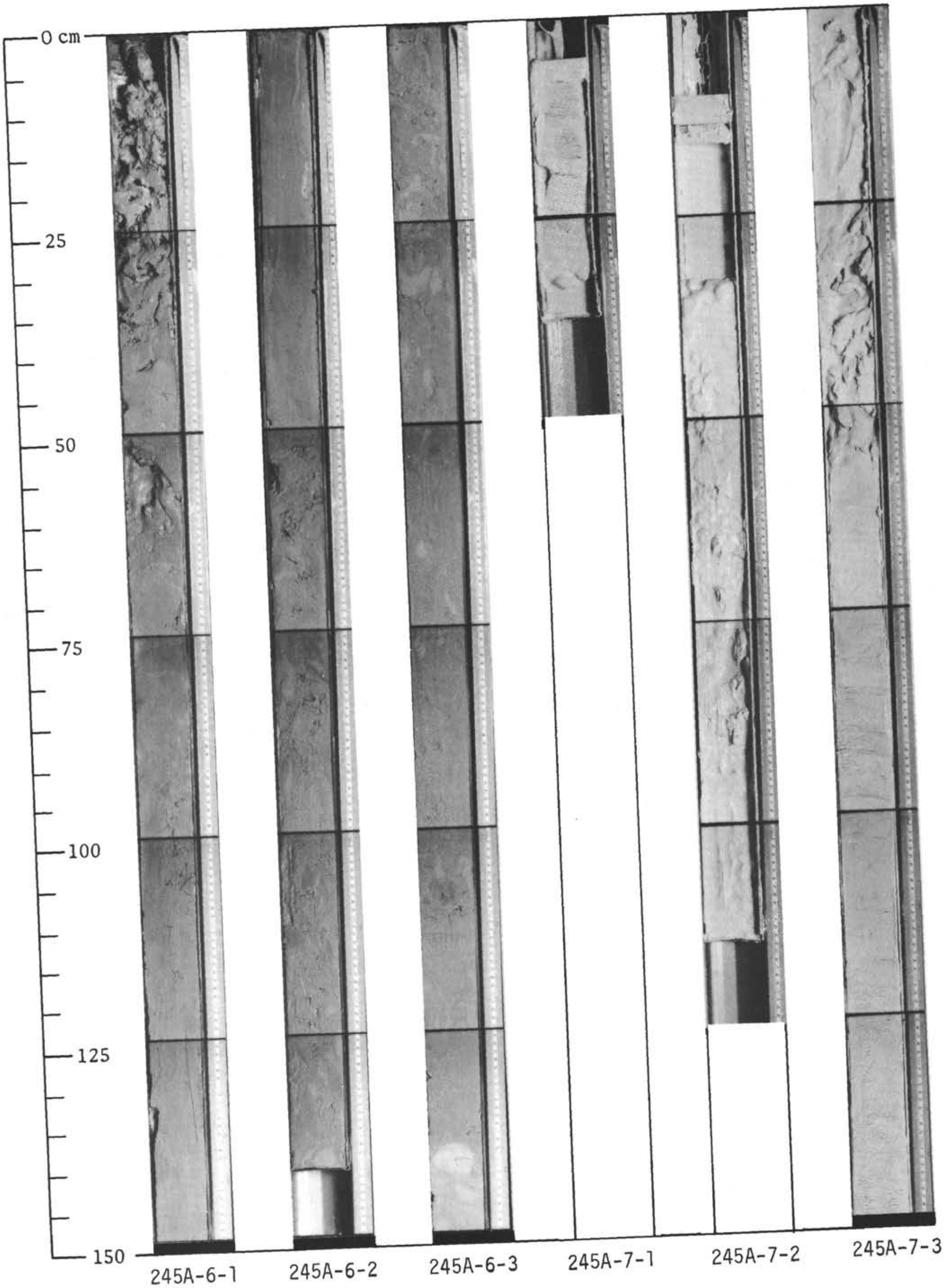
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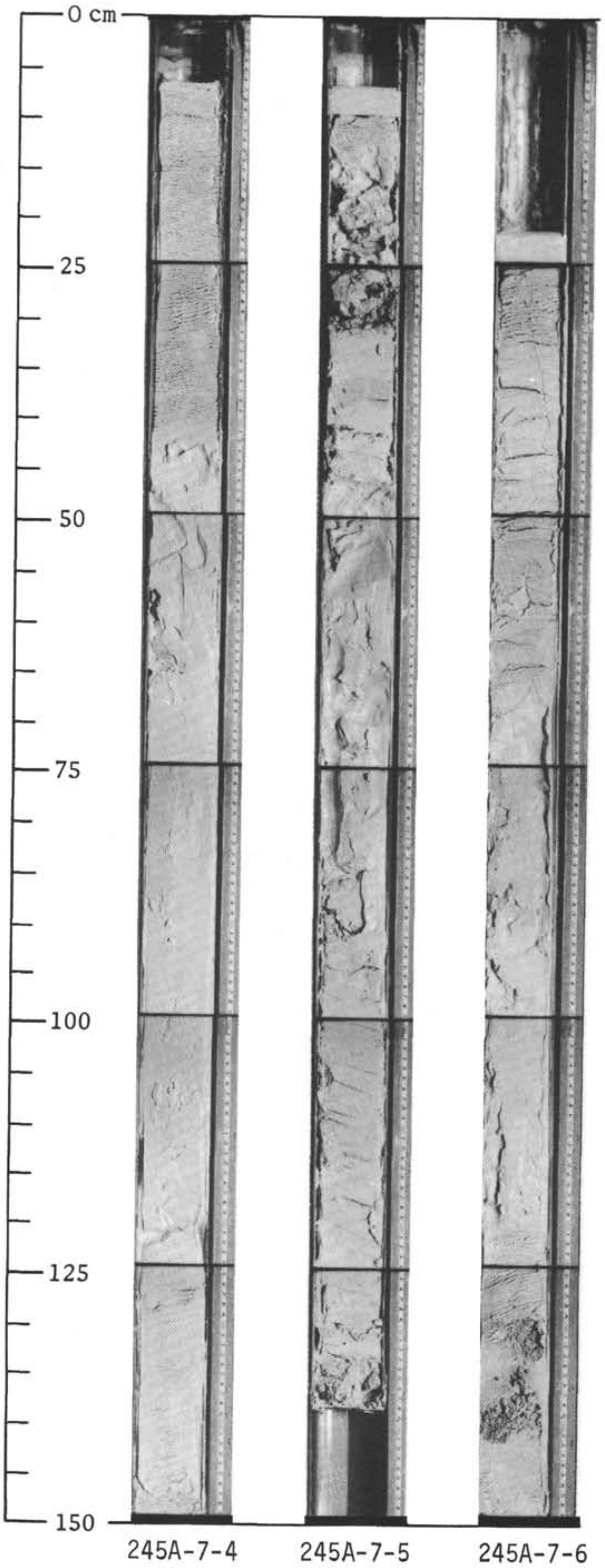
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