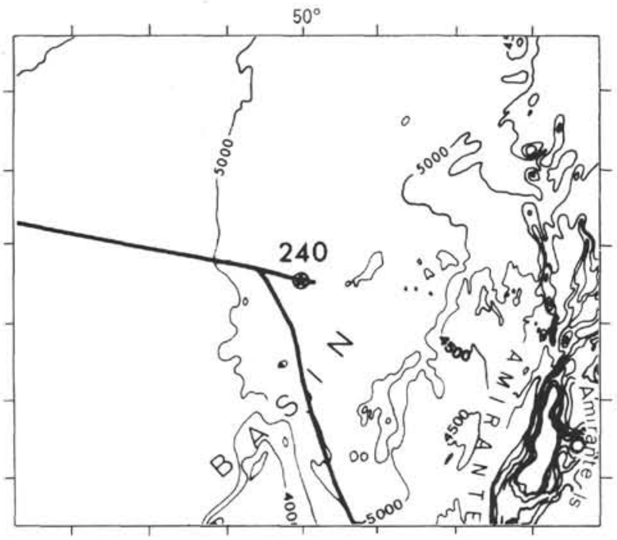
3. SITE 240

The Shipboard Scientific Party[1]

SITE DATA



Location: Somali Basin

Position: 03°29.28′S, 50°03.42′E

Water Depth: 5082 meters

Total Penetration: 195 meters (240) and 202 meters (240A)

Cores: 12 cores (87 m cut, 28.3 m recovered)

Deepest Unit Recovered: Basalt

BACKGROUND AND OBJECTIVES

The Somali Basin, in the northwestern part of the Indian Indian Ocean, is limited on the west and northwest by the coast of Africa, on the east and northeast by the Carlsberg Ridge, and on the south by an irregular boundary passing through the Comores Islands, the northern end of Madagascar, thence northeast to the Seychelles Islands and along the northeastern border of the Mascarene Plateau to the Central Indian Ridge. The Somali Basin is divided into eastern and western parts by a nearly north-south line extending from Chain Ridge down to Madagascar. Site 240 is located in the deep central abyssal plain in the western part of the southern Somali Basin, 350 miles to the west of Seychelles Islands and about 500-600 miles from Africa (Figure 1).

From geological studies of the islands on the Seychelles Bank (Baker, 1963; Baker and Miller, 1963) and from seismic refraction and gravity measurements made on the bank itself (Matthews and Davies, 1966), it has been established that the crust under the flat-topped Seychelles Bank is of continental type. It has also been shown that the 30-km-thick crust under the central part of the bank extends as far as the edge of the bank and that the Mohorovicic Discontinuity slopes upward very steeply under the peripheral cliff (Matthews and Davies, 1966).

The presence of a large block of Precambrian granite surrounded by deep ocean is of great interest in connection with plate tectonics. Baker and Miller (1963) suggested that "the eastern part of the continent of Africa once extended as far as the line of the Mascarene Ridge." Francis et al. (1966) later proved the existence of oceanic crust, using the data from the seven seismic refraction profiles shot in a south southwest-north northeast direction by *Discovery* and *Owen* (September-October 1963) between Lamu on the Kenya coast and the Seychelles Bank (Figure 1).

The proposed Site 240 was located very close to refraction station 5 of Francis et al. (1966). After interpretation of the data, Francis et al. proposed an uppermost layer of soft sediments formed probably during the Tertiary (thickness: 0.1 km, velocity: 1.91 km/sec), a second layer of consolidated sediments of Jurassic and Cretaceous age (thickness: 0.6 km, suggested velocity: 2.5 km/sec), and a third layer corresponding, probably, to volcanic material (thickness: 2.5-3.5 km, velocity 4.20 km/sec).

Seismic reflection data obtained during August 1963 by *Vema* and during April 1964 by *Chain* in the western part of the Somali Basin led to the conclusion that the northern and southern parts of the western Somali Basin are very different. An abrupt change in depth to basement at about 3°30′N has been shown by Bunce et al. (1967). In the southern section of the basin, the sediment cover appears to be relatively thin, 1.0-0.5 sec DT (double way time) and even less over small abyssal hills (Figures 1 and 2). The sediment sequence of the abyssal plain is not well defined, but since refraction station 5 of Francis et al. (1966) is very close to the *Vema* reflection profile, it is possible to combine the two sets of data. The uppermost transparent layer observed on both refraction and reflection profiles is about 0.1 km thick and has a sonic velocity of 1.91 km/sec. Below this transparent layer, there are indistinct reflections, suggestive of stratified sediment sequences to a depth of about 0.5 sec DT, which should correspond to the 2.5 km/sec layer of Francis et al. (1966).

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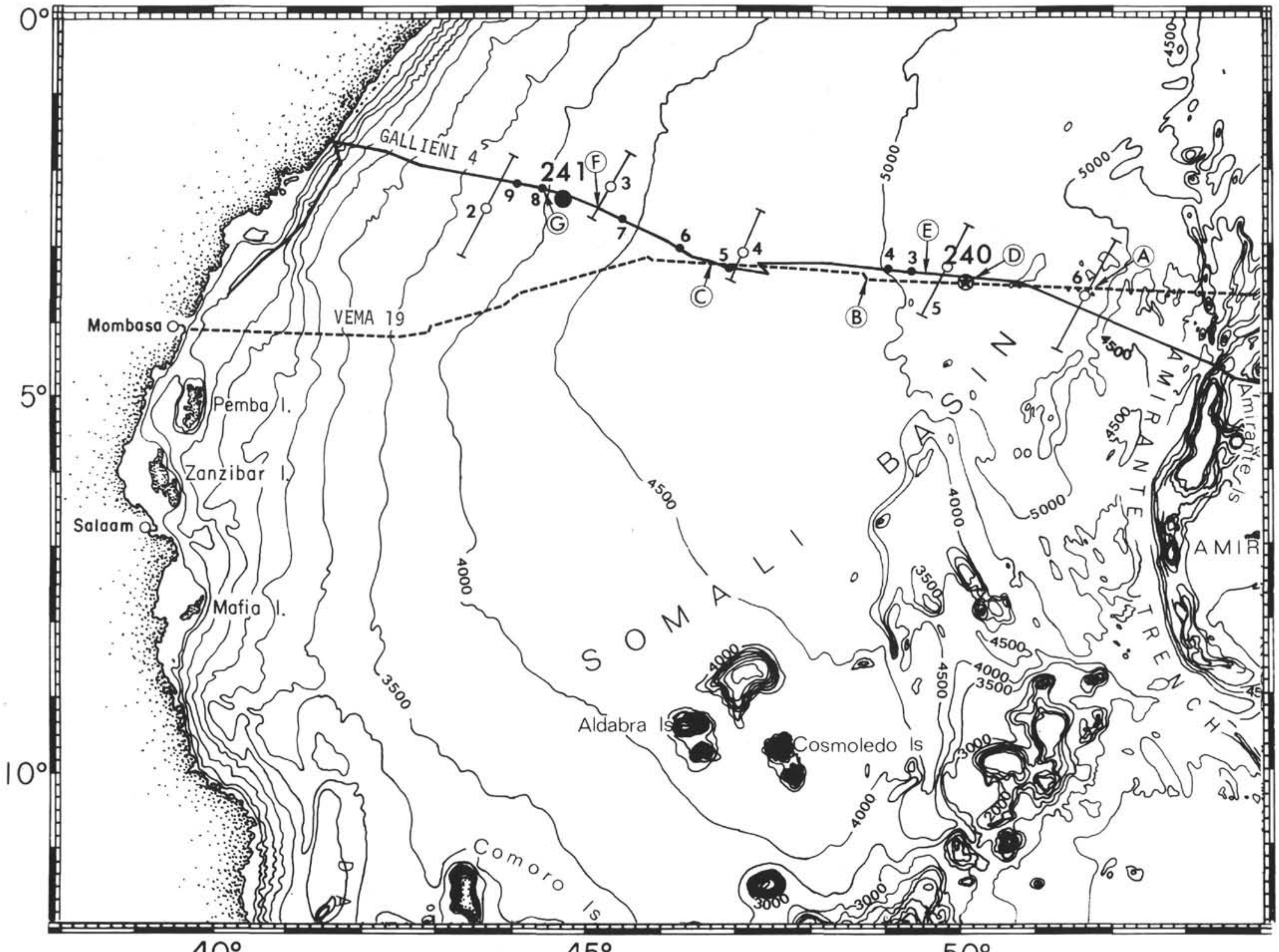

Figure 1. *Location map for Site 240. Isobaths in meters. The letters shown refer to the seismic reflection profiles given in Figures 2 and 3. The open circles indicate the refraction profile of Francis et al. (1966); the dots are used to denote the sonobuoy stations of Schlich et al. (1972).*

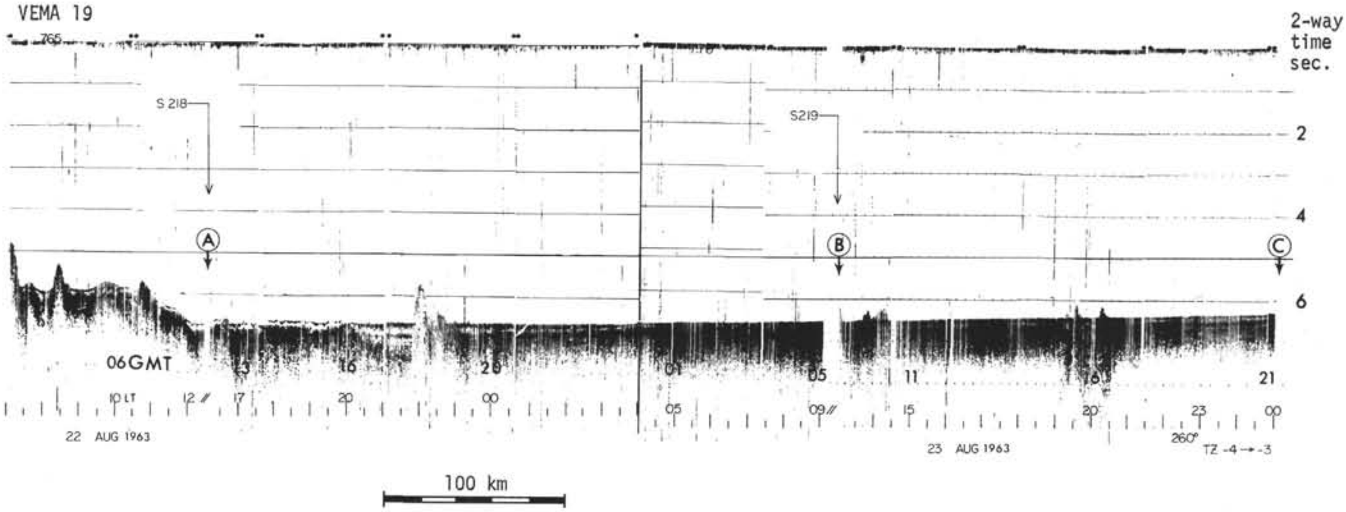

Figure 2. Vema *19 seismic reflection profile in the vicinity of Site 240. The location of this profile is given in Figure 1.* Vema *19 records are by courtesy of Lamont-Doherty Geological Observatory.*

Seismic reflection data (flexotir) were also obtained by *Gallieni* 4 in 1970 along a profile almost due west from Seychelles Bank to Mombasa and crossing the proposed Site 240 (Figures 1 and 3). The data obtained east of 49°E show a very rough basement topography of oceanic type covered by an extremely variable thickness of sediments (0.8 ± 0.4 sec DT). An upper relatively transparent layer of about 0.2 sec DT overlies a series of well-stratified layers lying upon the rough basement. Wide-angle reflection and refraction sonobuoy data obtained very close to the proposed site suggest a mean velocity of 2.0 km/sec for the sedimentary layers (stations 2 and 3) and a velocity of 5.3 km/sec for the basement.

Site 240 was provisionally located in position 03°31′S and 49°45′E; taking the more recent *Gallieni* data into account, three alternative sites were also proposed. The objectives of drilling this hole were (a) to clarify the interpretation of seismic data by Francis et al. (1966); (b) to determine the stratigraphic succession with particular reference to seismic layer identification, composition, and age; and (c) to establish a basement age in an area where no magnetic anomaly pattern has been recognized.

SURVEY DATA AND OPERATIONS

Glomar Challenger departed from Site 239 at 1600 LT (local time) (1200 GMT) on 3 July 1972, and Site 240 was approached along a course of 327° after 5 days 7 hours steaming across the Mascarene Basin and the southern part of the western Somali Basin. At 2300 LT (1900 GMT) on 8 July, about 8 miles before reaching the proposed site, speed was reduced to 6 knots in order to improve the quality of the airgun records. At 0019 LT (2019 GMT) on 9 July the first proposed site at 03°27′S, 49°34′E was reached, but the basement reflection, expected at a depth of about 0.35 sec DT, could not be recognized on the airgun records. The reconnaissance profile was continued on a course of 310° for about 10 miles. At 0148 LT (2148 GMT) it was decided to traverse the two alternative sites located 30 miles to the east at roughly 03°30′S, 50°00′E. At 0700 LT (0300 GMT) the proposed site was reached, but again basement could not be resolved and a systematic site survey was commenced. During the first part of the survey, a lapse in satellite navigation fixes and a strong northward flowing current prevented accurate positioning. At 0944 LT (0544 GMT) a satellite fix established the correct location of the ship, and it was possible to return to the vicinity of the second proposed site. The site was approached along a course of 270° and an apparently suitable location (03°29.28′S, 50°03.42′E) was reached. At 1248 LT (0848 GMT) the 16-kHz beacon was dropped under way above the identified site. The site was recrossed at 1327 LT (0927 GMT) to check the positioning of the beacon. The airguns, hydrophones, and magnetometer were then brought onboard and the site was occupied at about 1350 LT (0950 GMT); see Figure 4.

As explained above, the basement was not clearly identified on the airgun records (Figure 5). The records show a thin transparent sediment layer overlying a stratified layer of ill-defined thickness, and because of the poor quality of this record it was decided to refer to the *Gallieni* 4 flexotir data in spite of their slight inaccuracy in location (1 or 2 miles). These data led us to believe that basement could be as deep as 400 meters (first arrow from the right on Figure 3).

Because the major site objective was to sample, date, and identify the basement, it was decided to cut only a few cores in the sedimentary sequence and to start continuous coring at a depth of about 300 meters.

Basement was unexpectedly encountered at about 190 meters (Core 6) and since no core was recovered for this section, it is not possible to establish the precise depth of basement. Only basalt was recovered in Core 7 (192-193 m) and in Core 8 (193-195 m) when the drilling rate was very considerably reduced, and only a core catcher sample of hard basalt was recovered. In order to recover the sediments immediately above basement, it was decided to drill a second hole (240A) at the same location with continuous coring from 168 meters to basement. Basement

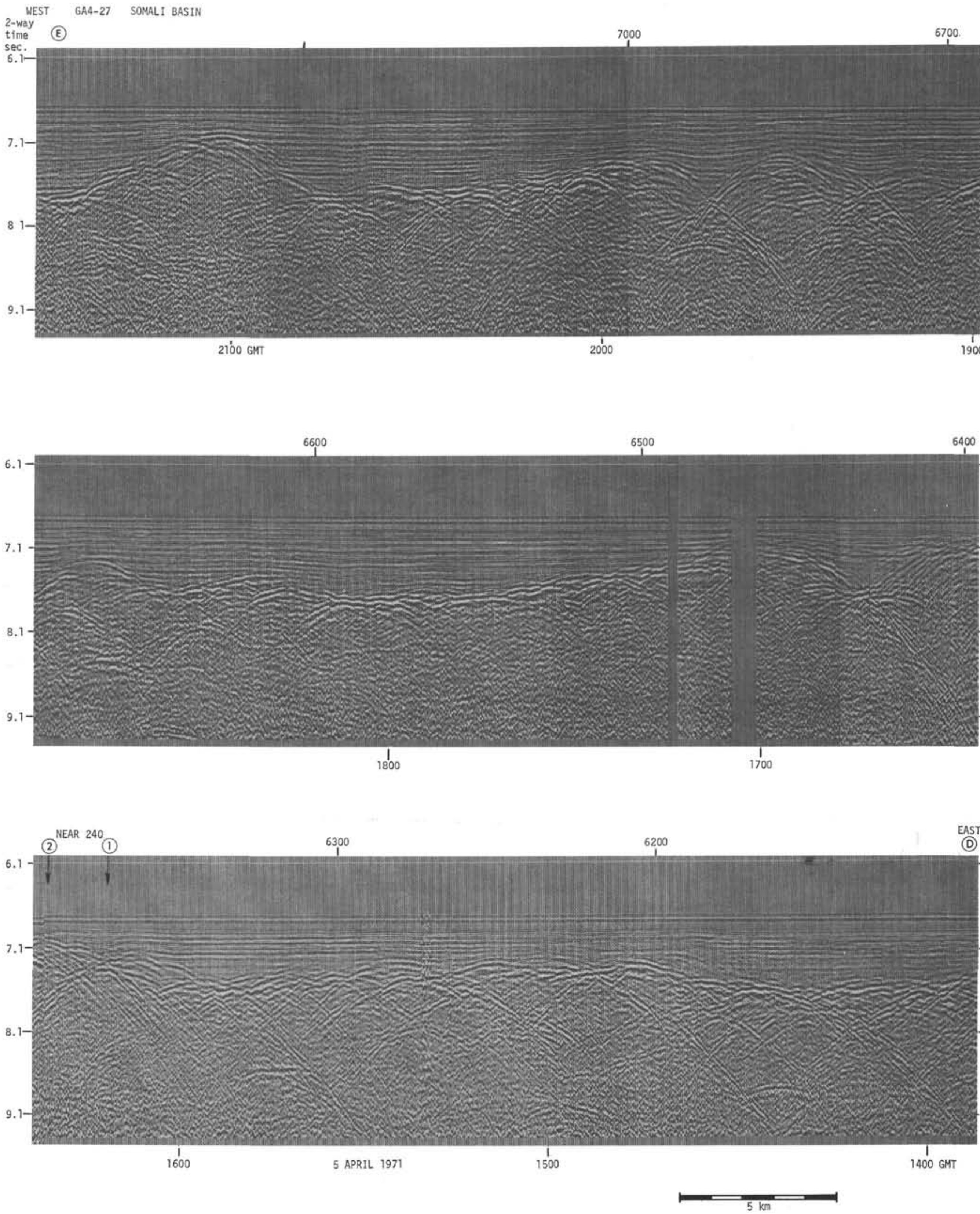

Figure 3. Gallieni *4 seismic reflection profile (flexotir sound source and variable area recording) in the vicinity of Site 240. The location of this profile is given in Figure 1.* Gallieni *4 records are from Schlich et al. (1972) courtesy of Institut de Physique du Globe de Paris and Comité d'Études Pétrolières Marines.*

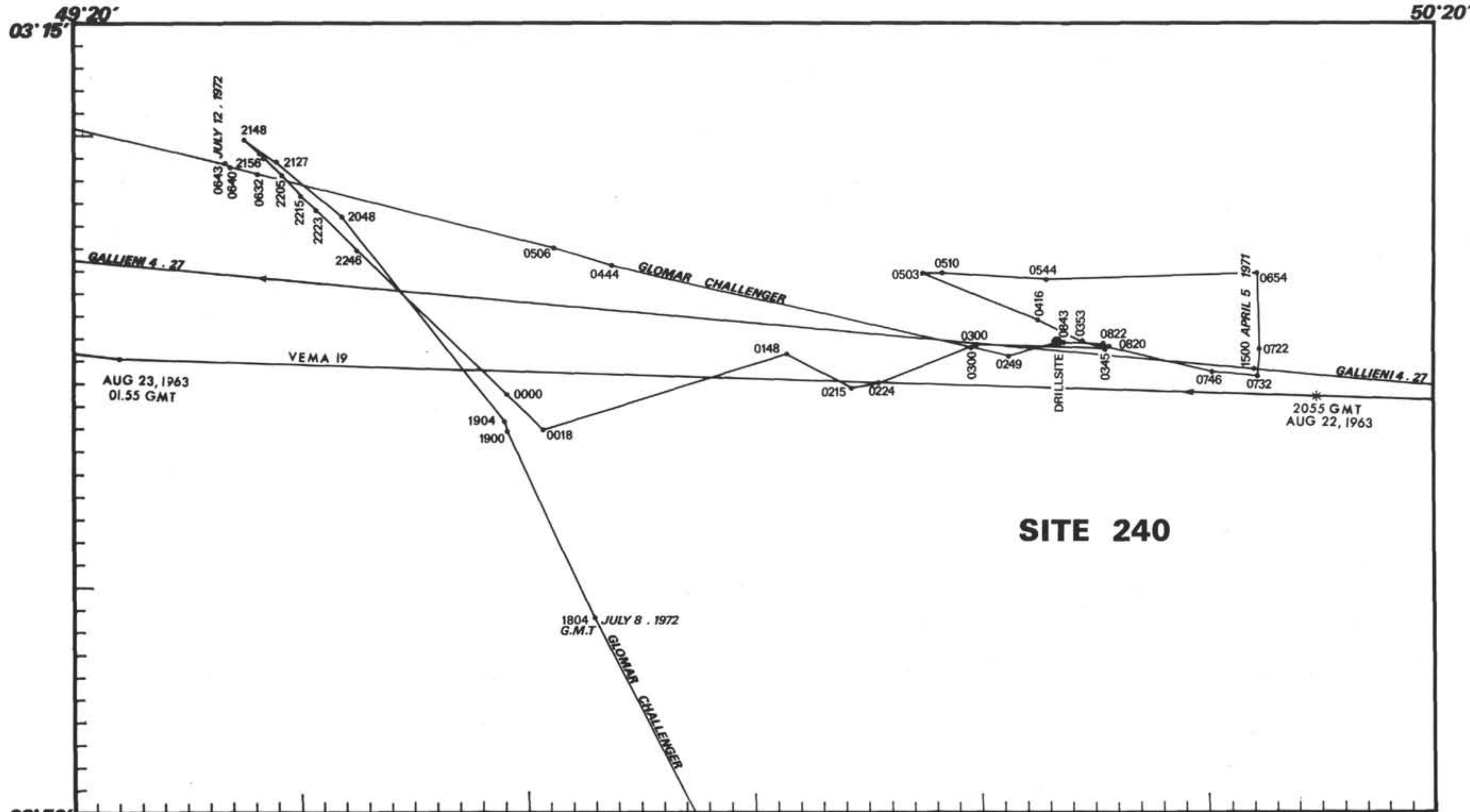

Figure 4. *Details of the* Glomar Challenger *site approach.*

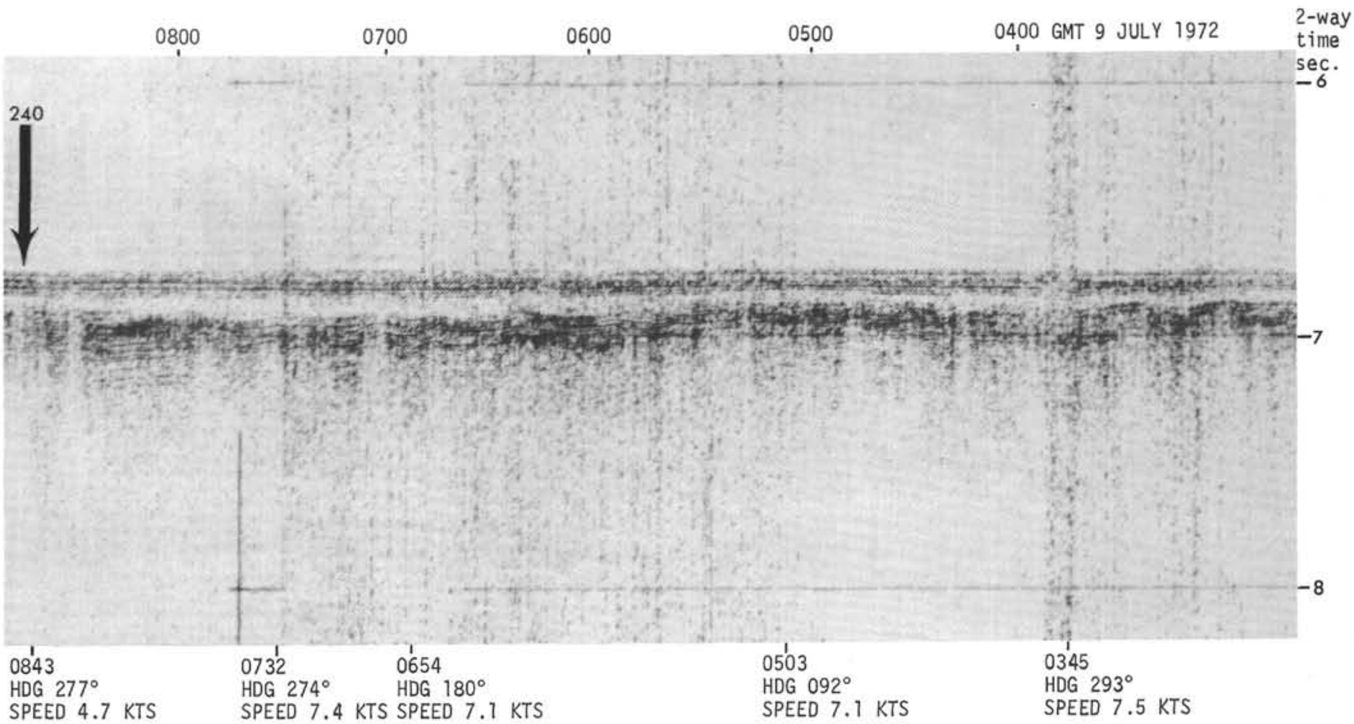

Figure 5. Glomar Challenger *seismic reflection profiles on approach to Site 240.*

was encountered at 200 meters. For a cored interval of 34 meters, only 3.2 meters of highly disturbed sediments were recovered in Cores 1 to 3 (168-195 m), and the last core, Core 4 (195-202 m), in this second hole was completely empty.

At this site, drilling and coring started at 0100 (LT) on 10 July 1972 and ended at 1332 on 11 July. Eight cores were taken from Hole 240 and four cores from Hole 240A. The total cored section is 87 meters and the total core recovery, 28.3 meters (Tables 1 and 2). The total time spent on the site was 2 days and 16.5 hours including delays caused by (a) measurement of the drill pipe on the way in, (b) replacement of burst flexible water feed pipe to power sub, and (c) testing of Schlumberger hoist, collar locator, and dummy severing charge. Inspection of the bit after completion of drilling and coring in the two holes showed it to be in very poor condition with all three cones missing and the water courses partially plugged. This may explain the small percentage of recovery in Hole 240A, which was drilled and cored after the drilling in basalt in Hole 240 for a period in excess of 5 hours.

Glomar Challenger departed from Site 240 at 0530 LT (0130 GMT) on 12 July 1972 in an easterly direction at 5 knots while the airguns, hydrophones, and magnetometer were streamed. At a distance of about 2 miles from the beacon the ship reversed course so as to pass over the beacon with all geophysical systems in operation. The beacon was passed at 0622 LT (0222 GMT), and after 38 minutes steaming at 5 knots the speed was increased to about 10 knots and the ship steamed in the direction of Site 241.

TABLE 1
Coring Summary, Hole 240

Core	Depth Below Sea Floor (m)	Cored (m)	Recovered (m)	Recovery (%)
1	0-6	6	9.0	150
2	6-14	8	0.0	0
3	73-82	9	7.2	80
4	148-157	9	1.8	20
5	157-166	9	5.9	66
6	183-192	9	0.0	0
7	192-193	1	1.2	100
8	193-195	2	CC	0
Total		53	25.1	47

Note: Echo sounding depth (to drill floor) = 5092 meters; drill pipe length to bottom = 5092 meters.

LITHOLOGY

Introduction

Two holes were drilled at Site 240; Hole 240 to a depth of 195 meters and Hole 240A to a depth of 202 meters.

TABLE 2
Coring Summary, Hole 240A

Core	Depth Below Sea Floor (m)	Cored (m)	Recovered (m)	Recovery (%)
1	168-177	9	1.3	14
2	177-186	9	1.4	16
3	186-195	9	0.5	6
4	195-202	7	0.0	0
Total		34	3.2	9

Note: Echo sounding depth (to drill floor) = 5092 meters; drill pipe length to bottom = 5092 meters.

Sediment recovery was poor in both holes. In Hole 240, 25.1 meters was recovered (47%) and in Hole 240A, 3.2 meters was recovered (9%). From Hole 240, basalt recovery totaled 1.2 meters. Ages of sediment range from Eocene to Quaternary.

Interpretations of the sediment column are somewhat tenuous because of the disturbed nature of the cores and poor recoveries. The problems can be listed as follows:

1) Extreme deformation occurred in all cores; some of the coarser sand/silt beds were "soupy."

2) Infiltration of lithologies from overlying beds into the cores was common and especially noticeable in the "soupy" coarse sand of Unit II.

3) Displaced flora and fauna occurred in most cores, which could be either the result of infiltration and mixing or a primary characteristic of the sediments.

4) Poor recovery occurred in both holes; at Hole 240A, poor recovery is attributed mostly to a badly worn bit and, possibly in part, to the coarse sands. In Hole 240, lithologic characteristics may have been the prime cause for low recovery.

5) Depths to tops and bases of the designated units do not correspond in Holes 240 and 240A. Units in Hole 240A are from 10 to 20 meters deeper. This discrepancy might be caused by a change in basement relief.

6) Finally, the coring intervals in the two holes were different, thereby making precise unit correlations somewhat questionable.

Bearing these problems in mind, the cored section at Site 240 was divided into three lithologic units (Table 3). A stratigraphic column is given in Figure 6.

Description of Lithologic Units

Unit I Nanno/Rad Ooze and Silty Clay

Major lithologies in Unit I are silt-bearing and silt-rich nanno/rad ooze, nanno/rad-bearing silty clay and clayey silt, and silty clay. Colors are dominantly dark greenish grays, greenish grays, and olive grays.

TABLE 3
Lithologic Units, Site 240

Depth (m)[1]		Lithologic Units	Thickness (m)[1]	
240	240A		240	240A
		I Green gray and olive silt/clay/ nanno-rich rad ooze; nanno-rich and nanno-bearing clayey silt and silty clay.	157	177
157	177			
		II Moderate dark yellow brown and dusky yellow nanno ooze, silty clay, sandy silt, and sand	33	23
190[2]	200			
		III Dark gray fine- and medium-grained basalt	5	2
195	202			

[1]Depths and thicknesses somewhat uncertain because of drilling problems.

[2]Basalt possibly encountered at 183 m.

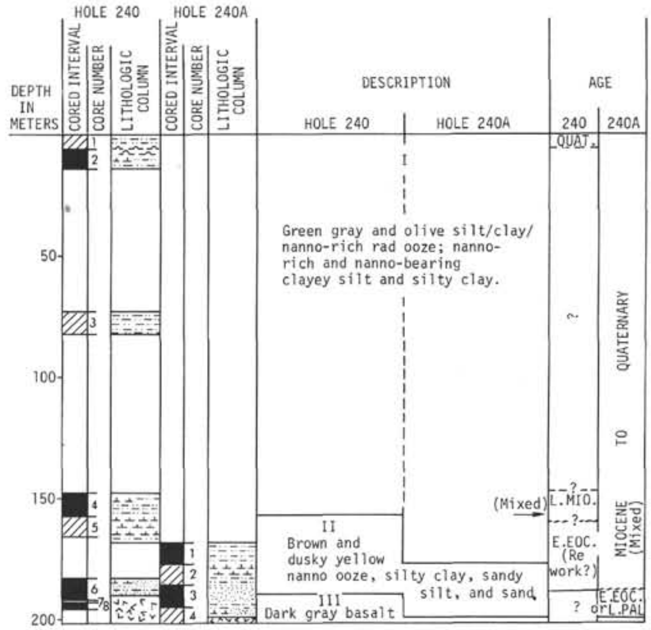

Figure 6. *Stratigraphic columns, Holes 240 and 240A. Dashed lines indicate uncertain positions; wavy line indicates a hiatus.*

Although bedding characteristics are mostly destroyed, there are indications that the oozes and/or clays are interbedded with the coarse silt beds. Faint traces of graded bedding were observed in some silt beds, and there is an apparent repetition of lithologies that can be seen even in the disturbed cores.

Clays are quite homogeneous in the samples studied with kaolinite, mica (illite), montmorillonite, and palygorskite occurring in about the same relative ratios in the X-ray samples. Montmorillonite is the dominant clay mineral.

Coarser grained components in the detrital terrigenous samples include quartz, feldspar, micarb, fragmented fossils (reworked?), and heavy minerals. Heavy mineral studies of Hole 240 indicate that orthopyroxene is dominant, followed by amphibole and clinopyroxene with minor amounts of epidote, garnet, olivine, and zircon also present. Traces of glauconite also occur in the samples. In Hole 240A, heavy mineral studies show orthopyroxene>garnet>amphibole with olivine, epidote, and apatite also present.

Grain-size analyses of sand in Cores 3 and 4 of Hole 240 indicate that the bulk of the coarser grained samples are in the sand-size range (coarse to very fine sand).

Major differences between Unit I of Hole 240 and Unit I of Hole 240A include the following:

1) The base of the unit is 20 meters lower in Hole 240A.

2) Sediment age seems to be a little older for the base of Unit I in Hole 240A (early Miocene versus late Miocene in Hole 240).

3) Nanno-bearing, silt-rich clays are dominant in Hole 240A and there is an absence of nanno/rad oozes.

Unit II: Nanno Ooze, Silty Clay, Silt, and Sand

Unit II is distinct from Unit I in lithology and color. Major lithologies are silt/foram-bearing nanno ooze, silty clay, silty sand, and sand. Colors are moderate yellow brown, dark yellow brown, medium olive brown, minor greenish gray, and olive gray. Because of drilling difficulties and, possibly, of changes in basement relief, tops and bases of Unit II are different in Holes 240 and 240A (see Table 3).

The equivalency of Unit II in the two holes is based mostly on similarities of sediment, even though only 2 meters were recovered in Hole 240A. However, the characteristic lithologies (nanno oozes and coarse sands), diagnostic colors, and basaltic basement directly below the unit in both holes, apparently makes the interpretation valid.

The coarse sand units have the following characteristics:

1) A wide range in grain sizes from very fine sand (0.062 mm) to very coarse sand (1.0 mm) with most falling in the very fine (0.062-0.125 mm) to medium (0.5-1.0 mm) grain sizes.

2) The presence of displaced fauna, by age and by habitat.

3) Moderate to well-rounded grains.

4) Large proportions of quartz and potash feldspar in the light mineral fractions.

5) A distinctive heavy mineral assemblage of amphiboles, epidote, garnet, pyroxene, and tourmaline.

The age of Unit II is most probably early Eocene. However, in Core 3, Hole 240A, late Paleocene nannofossils were recovered from the core catcher sample.

Unit III: Basalt

Basalt was encountered 190 meters below the sea floor at Site 240. About 1.2 meters were recovered in Core 7 between 192 and 193 meters, and the core catcher of Core 8 (193-195m) contained a small fragment.

The basalt is dark gray and very fine grained. Several glassy zones occur; the most apparent is at 33 cm in Section 1 of Core 7 where concentric layers partly surround a glassy basalt fragment. The entire core is highly fractured, and calcite fills some fractures to a width of 1 cm. Several druses (crystal-lined cavities) occur in the basalt where calcite crystals project inward from the cavity borders. Chalk fragments enclosed within the basalt are baked and occur in Section 1 at 33-36 cm and 86-90 cm in Core 7. Although altered, the chalk fragments contain recognizable early Eocene microfossils. The basalt was either extruded onto, or intruded into, limey sediment near the surface. The thick glassy zones with concentric layering favors an extrusive origin as they may mark the outer parts of pillows or the outer part of an irregular flow.

Microscopic examination revealed the basalt to vary from holohyaline to variolitic hypohyaline with a few microphenocrysts of plagioclase and olivine (replaced by chlorite, serpentine, and carbonate). Microvesicles (0.5-1 mm) are filled with calcite, chlorite, and quartz. Chalk inclusions are recrystallized to a medium-grained marble near the contact with the basalt. In the lower part of the core the basalt has a pilotaxitic texture suggesting slight movement during the final consolidation of the rock. Major components are glass (35%-40%), plagioclase (30%-50%), and augite (25%-30%), with minor amounts of calcite, chlorite, smectites, magnetite, goethite, and serpentine (pseudomorphs after olivine). Because of the glassy and/or altered nature of the samples, no detailed modes have been attempted.

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

Lithologic Interpretations

Because of technical problems encountered at the site, lithologic interpretations must be kept very general. However, some preliminary conclusions can be drawn.

1) The basalt cooled rapidly at or near the surface of the sea floor. Thick glassy zones favor an extrusive origin as they may mark the outer parts of pillows or the margins of an irregular flow. Altered chalk fragments, however, indicate baking, leaving open the possibility that the basalt is a shallow intrusive.

2) The coarse sands in Unit II represent proximal turbidite deposits, probably eroded from Madagascar or possibly the Seychelles. Landmasses apparently were closer during the early Eocene than during later parts of the Tertiary.

3) The sequence in both Units I and II consists of alternating beds of pelagic oozes and detrital beds, which suggests that conditions changed often during sedimentation, probably reflecting changes in landmass uplift and erosion rather than great changes in ocean floor relief or movement.

4) The site has been above the CCD throughout most of the sediment accumulation.

PHYSICAL PROPERTIES

Only 25.1 meters of core was recovered at Site 240, and much of this was greatly disturbed by drilling. The average of GRAPE bulk densities for Core 1 (1.16 g/cm^3) was 19 percent less than the average syringe density value of 1.44 g/cm^3. There is a peak GRAPE value of 1.35 g/cm^3 at a depth of 5 meters which apparently is not associated with lithology, but might easily represent a less-disturbed portion of the core since it is within 6 percent of the syringe density values.

Core 3 has only a 2 percent difference between the averages of the two bulk density arrays; the average GRAPE bulk density is 1.55 g/cm^3 and the syringe bulk density is 1.52 g/cm^3. The third method of measuring bulk density, i.e., weighing a complete core section to obtain an average density for that section, was applied twice. These resulted in bulk density values for Samples 240-3-2 and 240-3-3 of 1.54 g/cm^3 and 1.55 g/cm^3, respectively. These correspond closely to the other bulk density values for Core 3. In Section 2 of Core 4, a surprisingly high value of the GRAPE bulk density (2.50 g/cm^3) is accompanied by a very low water content (23.1%). From the lithology, it appears that these anomalies may be related to a bed of coarse quartz sand. It should be realized, however, that it is difficult to obtain reliable water contents from sandy beds.

The second hole (240A) yielded very little usable core. Worthy of note, perhaps, is the GRAPE record for

240A-1-1. A basalt fragment in a sandy bed at 135 cm produced a bulk density value of 2.34 g/cm^3. The sand bed has a GRAPE density of 2.20 g/cm^3. The fragment (which may have been displaced) filled approximately two-thirds of the cross-section of the core liner.

There is very little variation of sonic velocity within a given core section. A small (3%) increase at 162 meters is registered, but is probably not significant. These velocities of core measured in the liner with values below 2.74 km/sec may be biased higher by the velocity of the liner unless there is excess water to counter this effect. The acoustic impedance shows a slight but definite increase from the top of Sample 240-3-2 to the bottom of 240-3-5. Furthermore, the vertical sonic velocity on a basalt sample from 240-7-1 was 6 percent higher (in average) than the horizontal value of 5.21 km/sec. This difference may be related to oriented structure of the rock.

Correlations of physical properties with lithologic units at specific depths is not possible at this site. Changes are obvious in these properties between the clays, sands, and basalt, but the sediments are generally so disturbed that individual values of bulk density cannot be taken as true values, with the exception of those of Core 240-3. The close correlation for the three methods is convincing, at least for field data. The large discrepancy between GRAPE densities and syringe densities in Core 240-1 is explained by the fact that one can be selective when sampling with a syringe, whereas the GRAPE must take the average of the cross-section being measured. The syringe values here are considered more accurate. Many cores have some disturbance at their outer boundary at least and may have excess water there. This would tend to reduce the GRAPE density value. The large difference in bulk density in Core 240-1 indicates great disturbance; this is born out by visual inspection of the core.

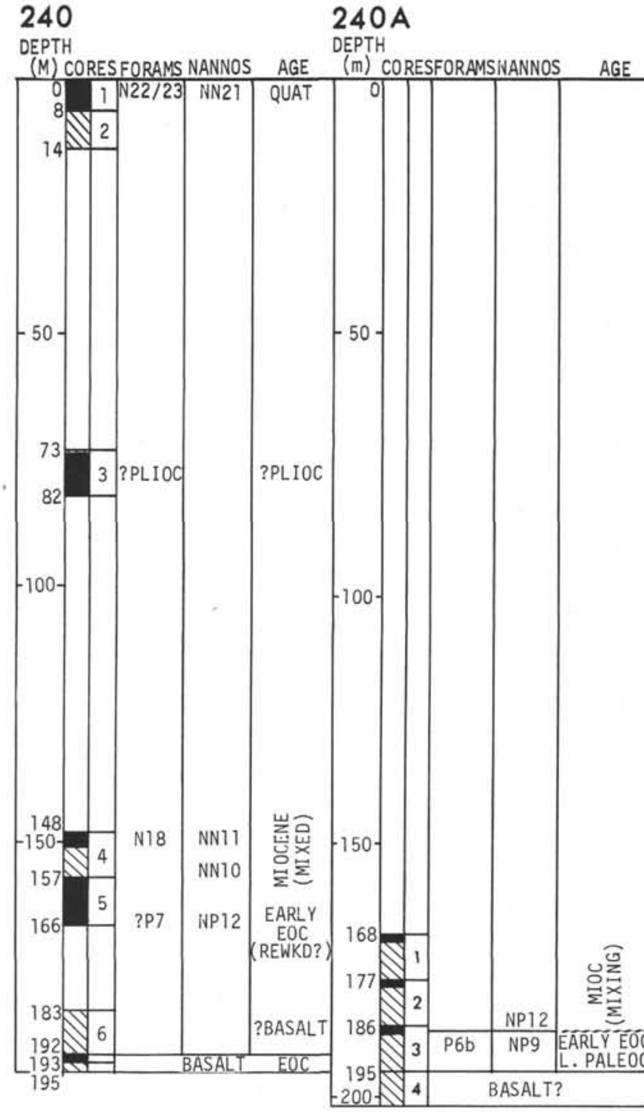

Figure 7. *Biostratigraphic column for Holes 240 and 240A.*

BIOSTRATIGRAPHY

Calcareous Nannoplankton, Hole 240

Quaternary

Calcareous nannoplankton are very abundant in Core 1 as are Radiolaria, diatoms, and some silicoflagellates. These belong to the Pleistocene, *Emiliania huxleyi* Zone (NN21) and include *Emiliania huxleyi, Gephyrocapsa oceanica, Helicopontosphaera kamptneri, Cyclococcolithus leptoporus,* and *Syracosphaera pulchra* (Figure 7). Some reworked species of the Pliocene and Miocene are observed. Core 3 is without nannoplankton.

Neogene

Core 4 contains only few nannoplankton. The species belong to the assemblage of the *Discoaster quinqueramus* Zone (NN11) of the late Miocene. The core catcher of Core 4 seems to be the *Discoaster calcaris* Zone (NN10).

Paleogene

The boundary between Paleogene and Neogene lies most probably within Core 5. In Samples 240-5-1, 88 cm and 240-5-2, 32 cm, are some species of Miocene age. However, an exact determination of a zone is not possible.

The early Eocene, *Marthasterites tribrachiatus* Zone (NP12) was determined in two samples of Core 5, Section 6 with *Marthasterites tribrachiatus, Discoaster lodoensis, Discoaster barbadiensis,* and *Chiasmolithus grandis.*

Calcareous Nannoplankton, Hole 240A

Neogene

Only a few samples in Core 2 contain nannoplankton, which are not abundant and not well preserved. The species observed indicate a probable late Miocene age (NN10?).

Paleogene

Sample 240A-3-1, 106 cm belongs to the early Eocene, *Marthasterites tribrachiatus* Zone (NP12) with *Marthasterites tribrachiatus* and *Discoaster lodoensis.* The sediments are rich in calcareous nannoplankton and the preservation is good.

The *Discoaster multiradiatus* Zone (NP9) of the latest Paleocene was determined for Sample 240A-3-1, 127 cm and the core catcher sample, with a very rich nannoplankton assemblage. The most frequent species are: *Discoaster multiradiatus, Thoracosphaera* sp., *Ellipsolithus macellus, Ellipsolithus distichus, Zygodiscus sigmoides,* and *Fasciculithus tympaniformis.*

Foraminifera

Quaternary and Neogene

Cores at Hole 240 were taken between thick uncored intervals. Only the uppermost core contains good foraminiferal associations, although some signs of dissolution are observed even at the top of Core 1 (theoretically at the sea floor). Dissolution increases with depth in the core. The upper and lower part of the core seem to be composed of mixed material from deep and shallow water. The age of Core 1 is Pleistocene throughout, probably mixed with Holocene (*Pulleniatina obliquiloculata finalis*) in the core catcher. Material from Section 1 and Section 6 contain shallow- and shelf-water foraminifera such as *Astrononion stelligerum, Florilus boueanus, Ammonia beccarii, Hanzawaia concentrica,* and *Cibicides praecinctus* together with such deep-water forms as *Eggerella bradyi, Eggerella nitida, Epistominella exigua, Cibicides wuellerstorfi, Pullenia bulloides, Melonis pompilioides,* and *Oridorsalis tenera.* The amount of specimens in the grain-size fraction >160μ between Section 2 and the lowermost Section 6 is very small with only the most resistant specimens (against dissolution) remaining.

Core 3, 70 meters below Core 1, is nearly free of calcareous material. Only two out of six samples contained rare planktonic foraminifera. Section 1, 110 cm should be at least of Pliocene age according to the presence of one *Pulleniatina primalis;* the core catcher has one *Pulleniatina obliquiloculata,* which could mean Pleistocene. There are no other indications as to the age; possibly, late Pliocene is most accurate.

In Core 4, at 150 meters, the grain-size fraction >160μ is composed chiefly of quartz with few well-preserved foraminifera. All foraminifera fit a late Miocene age (*Globigerina apertura, G. bulloides, G. nepenthes, G. venezuelana, Globigerinoides obliquus extremus, G. trilobus immaturus, G. t. trilobus, G. t. sacculifer, Globorotalia acostaensis acostaensis, G. a. humerosa, G. a. tegillata, G. menardii, G. multicamerata, G. scitula, Globoquadrina altispira altispira, G. a. globosa, G. dehiscens, Orbulina universa universa, O. u. suturalis, Sphaeroidinellopsis grimsdalei,* and *Sph. subdehiscens subdehiscens*). The benthonic foraminifera are predominantly from the inner shelf (*Ammonia* spp. and *Elphidium* spp.) with some from the outer shelf (*Cibicides* spp., *Brizalina* spp., *Bolivinita quadrilatera, Bulimina marginata,* and *Globobulimina* sp.). Corroded *Amphistegina* and *Asterigerina* might even point to a source in a reef environment.

Nearly no fossils, and no age indicators at all, were observed in samples from Core 5, Sections 1 and 2. Samples from Core 5, Sections 3, 4, and 6 contain planktonic foraminifera which range in age from early middle Miocene to early Pliocene (*Sphaeroidinellopsis seminulina, S. subdehiscens, Orbulina universa. Praeorbulina glomerosa, Globoquadrina altispira, G.* cf. *dehiscens, Globigerinoides obliquus, G. obliquus extremus, G. trilobus, G. conglobatus, G. ruber, G. sicanus, Globigerina apertura, G. nepenthes*), or even Quaternary (*Globigerina bulloides calida*). The benthonic foraminifera are mostly from shelf and nearshore environments. Especially interesting is Sample 5-6, 126-129 cm. In this sample, part of the accompanying benthonic foraminifera, which are typical for reef environment, are very abraded—often fossil casts only (*Amphistegina* sp., *Heterostegina* spp. et al.); the older typically middle to early Miocene planktonic foraminifera also are worn. Species from the inner shelf and nearshore nonreefal environment are remarkably fresh (*Florilus boueanus, Ammonia* aff. *A. beccarii,* and *Cibicides* sp.); there are no adequately fresh planktonic foraminifera.

The appearance of these sandy samples with reworked Miocene planktonic foraminifera associated with a large amount of reworked benthonic foraminifera from a reef environment leads to the conclusion that these are reworked Miocene sediments that were originally deposited nearer the shoreline. In the coarse fraction of Sample 5-3, 129-132 cm there are many fish teeth.

The samples from Hole 240A are of about the same composition as those of Hole 240. A recapitulation of the species compositions of the core catchers and samples from the cores is of no value. A further evidence for the extremely nearshore origin of the material is the presence of *Balanus*-residues in the core catcher of Core 2. Sample 240A-1-1, 101-103 cm shows good correspondence in character with Sample 240-5-6, 126-129 cm. Both are from about the same depth below the sea floor.

Paleogene

The Paleogene was penetrated with certainty only in the second of these two holes (240A), and then only through a small thickness, i.e., the bottom of Core 3. Assemblages of the same age are found also in the upper part of this core (even including two fragments of a *Racemiguembelina fruticosa* from the Maestrichtian) as well as less abundantly in the overlying core and in Core 5 from Site 240. Their relative dispersal among Neogene microfossils, along with the entirely different sandy nature of the wash residue, suggest that these are reworked forms.

The faunas are extremely rich and exhibit good preservation after cleaning with Calgon. They represent an assemblage from the lower part of the early Eocene, or the P.6b Zone on the Blow scale (or Bolli's *Globorotalia rex* Zone). However, one of the guide-species, *Globorotalia (Morozovella) wilcoxensis,* is extremely rare. At the approximate same level there also appears the first, but not very typical, representatives of the *G. (M.) aragonensis* group.

The benthonic part is very poor and shows little diversification. Major species include:

Eponides cf. *Oridorsalis ecuadorensis* (Galloway and Morrey, 1929)

? Asterigerina bronnimanni (Cushman and Renz, 1946)

Cassidulina sp.

Pleurostomella sp.

Anomalina sp.

It perhaps represents an impoverished bathyal assemblage. Shell preservation of the benthonics is good, as is that of planktonic species, although the planktonics in places show the beginnings of dissolution. The most frequent planktonic species are the following:

Globorotalia (Acarinina) esnaensis (Le Roy, 1953)
Globorotalia (Acarinina) gravelli (Brönnimann, 1952)
Globorotalia (Acarinina) mckannai (White, 1928)
Globorotalia (Acarinina) soldadoensis (Brönnimann, 1952)
Globorotalia (Acarinina) triplex Subbotina, 1953
Globorotalia (Acarinina) wartsteinensis Gohrbandt, 1957
Globorotalia (Acarinina) whitei (Weiss, 1928)
Globorotalia (Morozovella) aequa Cushman and Renz, 1942 (or *loeblichi* el Naggar, 1966).
Globorotalia (Morozovella) aragonensis var. *twisselmanni* Mallory, 1959
Globorotalia (Morozovella) formosa Bolli, 1957
Globorotalia (Morozovella) gracilis Bolli, 1957
Globorotalia (Morozovella) marginodentata Subbotina, 1953
Globorotalia (Morozovella) quetra Bolli, 1957
Globorotalia (Morozovella) rex Martin, 1943
Globorotalia (Morozovella) subbotinae Morozova, 1939
Globorotalia (Morozovella) gr. *trichotrocha* (Loebl. and Tappan, 1957)
Globorotalia (Morozovella) cf. *wilcoxensis* Cushman and Ponton, 1932
Pseudogloboquadrina primitiva (Finlay, 1947)
Chilogümbelina cf. *crinita* (Glaessner, 1937)
Chilogümbelina cf. *wilcoxensis* (Cushman and Ponton, 1932)

In Core 240-7, basalt encloses or is in contact with limestone fragments in which a few planktonic forms are found, most probably of early Eocene age at least.

Core 240-5 has two samples (core catcher and level 240-5-6, 149-150 cm) which apparently can be differentiated from the others for two reasons. First, although the washed residue for both is sandy, the foraminiferal content is different from that of the other samples in the same core. This difference is both quantitative, because the content is relatively more abundant, and qualitative because forms are present which are not (or very rarely) found higher in the section. These forms include:

Globorotalia (Morozovella) aragonensis (Nuttall. 1930)
Globorotalia (Morozovella) of the *G. aragonensis* group
Globorotalia (Morozovella) cf. *dolabrata* Jenkins, 1965
Globorotalia (Morozovella) sp. (with truncated cone-shaped test).

At the same time, the specimens are often poorly preserved or incomplete, and they may have even been displaced. Second, this assemblage is also different from the assemblage of the same early Eocene age in Core 240A-3. The difference is quantitative because of its poverty, and qualitative through the absence of several species such as those belonging to group *G. (M.) aequa-G. (M.) subbotinae-G. (M.) marginodentata* or various Globigerininae and Acarininae. The presence of a few individuals relatively close to *G. (M.) aragonensis* may suggest that they are slightly younger, perhaps already from Zone P.7, which had been displaced as indicated above.

Samples examined were:
240-7, thin section
240-5, CC
240-5-6, 149-150 cm
240A-3, CC
240A-3-1, 126-127 cm
240A-3-1, 120-122 cm

An extremely large hiatus separates the early Eocene from the Miocene. At Hole 240, it is located at the bottom of Core 5. Perhaps the bottom of this core itself is even Miocene, with some displaced Eocene. At Hole 240A, Core 2 is Miocene. As noted previously, the fact that the residue becomes extremely sandy beginning with Sample 240A-3-1, 112-114 cm indicates that the Neogene is already present here, with some displaced Eocene. This could also be attributed to technical contamination which occurred during drilling.

Biostratigraphic Summary

The study of the cored sequence was made difficult because of the technical mixing of sediments and faunas. However, some conclusions can be made with regard to the biostratigraphy.

Upper Miocene to Recent sediments are mainly detrital material. They overlie early Eocene sediment; thus, the gap is very large, more than 40 m.y. The overall sedimentation rate for the upper Miocene to Recent section is about 25 m/m.y.

Eocene is observed only in part of Core 3, Hole 240A. There is an uncertainty about the exact age. Is it earliest Eocene (foraminifera)? or latest Paleocene (nannofossils)? The benthonic assemblage corresponds most probably to an impoverished bathyal environment; planktonics are abundant and show some dissolution. In the remaining part of this core, as well as at the base of Core 240-5, it cannot be decided if the recovered faunas are in situ or displaced. The displaced hypothesis is supported by a drastic change in the lithologic nature of the washed residues and the presence of both Maestrichtian and Paleocene specimens. A rate of sedimentation cannot be calculated because of the shortness of the section.

By horizontal correlation between these quite close sister holes, a conclusion can be reached that the basalt underlies the lowermost Eocene or uppermost Paleocene sediments. Within the basalt, a chalk inclusion, with baked contacts, contains Eocene species.

CORRELATION OF REFLECTION PROFILES AND LITHOLOGIES

The sedimentary section in the vicinity of the site consists mainly of a relatively thin transparent layer of about 0.2 sec DT thickness, that overlies a stratified sediment sequence of variable thickness ranging from 0 to 0.6 sec DT, which in turn is resting upon a rough basement (see Figure 2, *Vema* 19 seismic data and Figure 3 *Gallieni* 4 flexotir profile).

As explained previously, it was not possible during the presite survey to resolve the basement reflection from the *Glomar Challenger* airgun records at the first surveyed location (03°27'S, 49°34'E), nor from those at the alternative location (approximately 03°30'S, 50°00'E). The beacon finally was dropped at a location where an uplift of the stratified sediment sequence could be seen on the airgun records that could correspond to a basement rise.

At the site, the observed sedimentary sequence on the airgun record consists of an apparent acoustically transparent layer of about 0.13 sec DT overlying a stratified layer of poorly defined thickness (Figure 5). According to the *Gallieni* 4 flexotir record, basement at this site could be expected at about 0.3 to 0.4 sec DT (Figure 3). Of course, the comparison of both records is subject to positioning errors since the *Gallieni* data were located only by celestial fixes and dead reckoning. Using a sonic velocity of about 1.9 km/sec for the first layer, and 2.5 km/sec for the second layer (Francis et al., 1966), or a mean velocity of 2.0 km/sec (Schlich et al., 1972), it was concluded that basement was at least 350 meters deep.

The first reflector at 0.13 sec DT, which separates the relatively transparent layer and the stratified layer, corresponds, according to the mean sonic velocity of 1.51 km/sec obtained from Core 3 (73-82 m), to a depth of about 98 meters. Even though coring intervals are varied, no change in lithology seems to correspond to this depth. At Hole 240, a lithological change is observed between Core 4 (148-157 m) and Core 5 (157-166 m), and at Hole 240A, the same lithological change occurs between Core 1 (168-177 m) and Core 2 (177-186 m). Because there is a displacement of about 20 meters for the stratigraphic sequences in both holes (deeper in Hole 240A), it is anticipated that the first lithological change occurs at a depth of about 157 meters (Hole 240) to 177 meters (Hole 240A). From the physical properties, a very slight change in sonic velocities can be observed between Cores 3 and 5 of Hole 240 and between Cores 1 and 2 of Hole 240A, which may correspond to this stratigraphic limit.

Considering the *Gallieni* flexotir data (Figure 3), it is worthwhile to note that the first reflector, which corresponds to the top of the stratified layer, lies at a consistent depth of 0.20 sec DT (about 151 m assuming a velocity of 1.51 km/sec). This may correspond to the interface of the first (green silty clay, clayey silt, silt- or clay-bearing nanno ooze) and second (moderate dark yellow brown and dusky yellow nanno ooze, sandy silt, silty clay and sand) units.

The second very poorly defined reflector, which, as has been shown by drilling corresponds to basement, was encountered at 190 meters at Hole 240 and 200 meters at Hole 240A. The airgun record made while leaving the site, and while again passing over the beacon with much smoother sea conditions, shows a possible basement reflection at about 0.23 sec DT. This leads to an inferred velocity to basement of 1.65 km/sec (Hole 240) and 1.74 km/sec (Hole 240A), which is in excess of the average measured velocity by about 10 percent. On the flexotir record, this basement depth of 0.23 sec DT could correspond to the second arrow from the right on Figure 3. As shown in Figure 8, only a poor correlation of seismic reflection profiles with lithologies can be established.

SUMMARY AND CONCLUSIONS

Site 240 is located in the central abyssal plain of the western part of the Somali Basin, 500 miles from the African coast and 350 miles west of the Seychelles Islands.

Unfortunately, operations at this site were beset by technical difficulties starting with a poor seismic reflection record during the presite survey and ending with a prematurely wornout drilling bit, which precluded complete success in the achievement of the objectives.

The scientific results are summarized in Figure 9. The first hole, 240, was cored at widely spaced intervals and penetrated 190 meters of Quaternary and Tertiary sediments and 5 meters into the underlying basalt. A second hole, 240A, was drilled at the same site in order to sample more thoroughly the sediments immediately overlying basalt (which was reached after 200 m penetration), but a completely damaged bit precluded significant core recovery.

Seismic reflection data by *Vema* and *Gallieni* in the vicinity of the site indicate that the sedimentary section consists mainly of a relatively thin transparent layer of about 0.2 sec DT thickness overlying stratified sediments of variable (0-0.6 sec DT) thickness which are resting upon rough basement. The presite airgun survey indicated an acoustically transparent layer about 0.13 sec DT thick, resting on stratified sediments of unresolved thickness. The underlying basement reflection was determined at about 0.23 sec DT only under the smoother sea conditions that existed while leaving the site. Using the measured sonic velocities of 1.51 km/sec from Core 3 (73-82 m) and 1.56 km/sec from Core 5 (157-166 m), only a poor correlation between the reflection profile and lithology was obtained. It should also be noted that the velocity of 1.9 km/sec derived from Francis et al. (1966) refraction data for the first layer is significantly higher than the measured value and that the 2.5 km/sec layer of these authors was not encountered at this site. This can perhaps be explained by the fact that the holes were located on a basement high where the deeper layer could not be expected.

The sediments recovered from both holes show extreme drilling deformation and mixing, which is confirmed by the occurrence of displaced fauna in nearly every core. The upper, relatively transparent layer is about 157 meters thick in Hole 240 (about 20 m thicker in Hole 240A) and is distinguished from the lower stratified layer (23-26 m thick) mainly on the basis of color, the former ranging from dark greenish gray to olive gray, whereas the latter is dominantly yellow brown to olive brown.

The upper lithologic unit comprises silt-bearing to silt-rich nannofossil and/or radiolarian ooze, nannofossil- and/or radiolarian-bearing silty clay and clayey silt, and silty clay or clayey silt of Holocene to late Miocene age. Graded bedding is faintly recognizable in the silt units. Detrital minerals (characteristic of a terrigenous origin) include quartz, heavy minerals, (pyroxene, garnet, amphibole, olivine, and epidote, and apatite), feldspar, mica, and clay minerals (of which montmorillonite is dominant). In addition to planktonic foraminifera, the sands and silts of this upper unit contain many displaced and/or reworked benthonic foraminifera characteristic of a shallow nearshore shelf and reef environment.

The lower, brown to yellow lithologic unit comprises silt/foram-bearing nanno ooze, silty sand and clay, sandy silt, and medium to coarse sand (containing microcline, garnet, amphibole, pyroxene, epidote, tourmaline, and abundant quartz grains). Only planktonic foraminifera are present, and these, together with the nannofossils, indicate an early Eocene age. The uppermost part is middle Miocene, and the Oligocene is entirely unrepresented so that a hiatus of about 40 m.y. may be located within this unit.

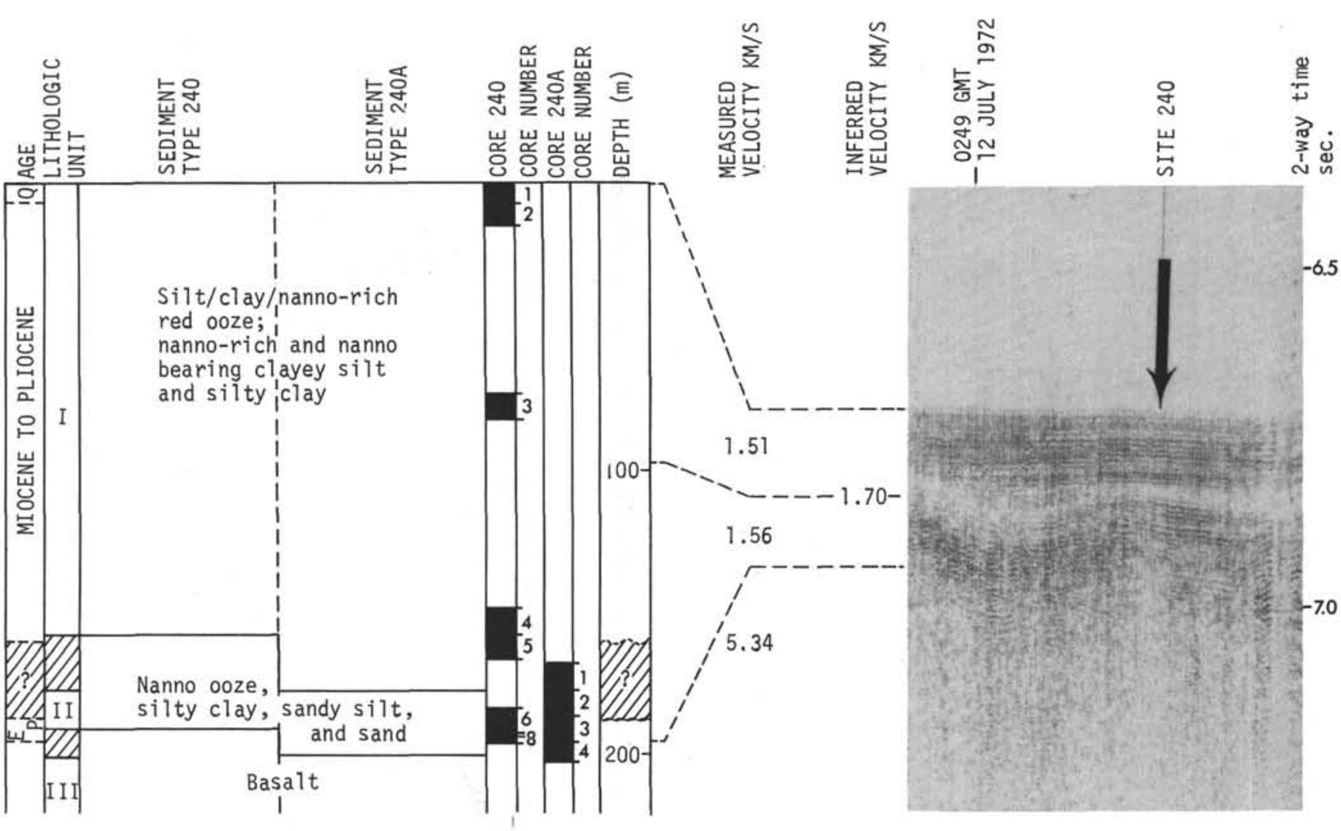

Figure 8. *Correlation of seismic reflection profile with lithology. Wavy lines in the depth column indicate hiatuses.*

Both sedimentary units have lithologies typical of pelagic-biogenic sediments which are interbedded with the distal zones of turbidites. The turbidites were derived from a continental granitic/metamorphic provenance area, probably East Africa, which is 500 miles distant. Tentative sedimentation rates are 3.5 m/10^6 years for the complete stratigraphic section represented (early Eocene to Holocene), and 15.7 m/10^6 years for the upper lithologic unit (late Miocene to Holocene).

At Hole 240, the drilling rate decreased at 183 meters depth, and no recovery was made from Core 6 (183-192 m) owing to the stripping of dogs from the core catcher. Core 7 (192-193 m) recovered basalt, which is presumed to have been reached at a depth of about 190 meters. The tholeiitic basalt is a dark gray, fine-grained, partly glassy rock with numerous fractures, calcite veins up to 1 cm wide, and calcite-filled druses. The basalt contains accessory calcite, and inclusions of pale brown chalk are indurated or recrystallized, one of them containing nannofossils of early Eocene age. The basalt is presumed to have been extruded as thin flows or pillows over lower Eocene sediments or, possibly, to have been intruded beneath a thin cover of sediment, causing induration of the overlying 7 meters. This is evidenced by the reduction in drilling rate at 183 meters depth. In either case, the basalt is probably of early Eocene age, but the material cored (at a very slow penetration rate of 1 m per hour) does not constitute the basement upon which the earliest sedimentation took place, which must be at least as old as early Eocene. The evidence for basement age on either side of the Chain Ridge (Leg 24, Sites 234 and 235) in the northern Somali Basin is negative in each case. Therefore, the basement-age objective of all three sites was not realized. This is unfortunate since no linear magnetic anomalies have been recognized in the western Somali Basin, and deep-sea drilling has failed to establish a basement baseline date for such magnetic anomaly patterns that may be determined in the future.

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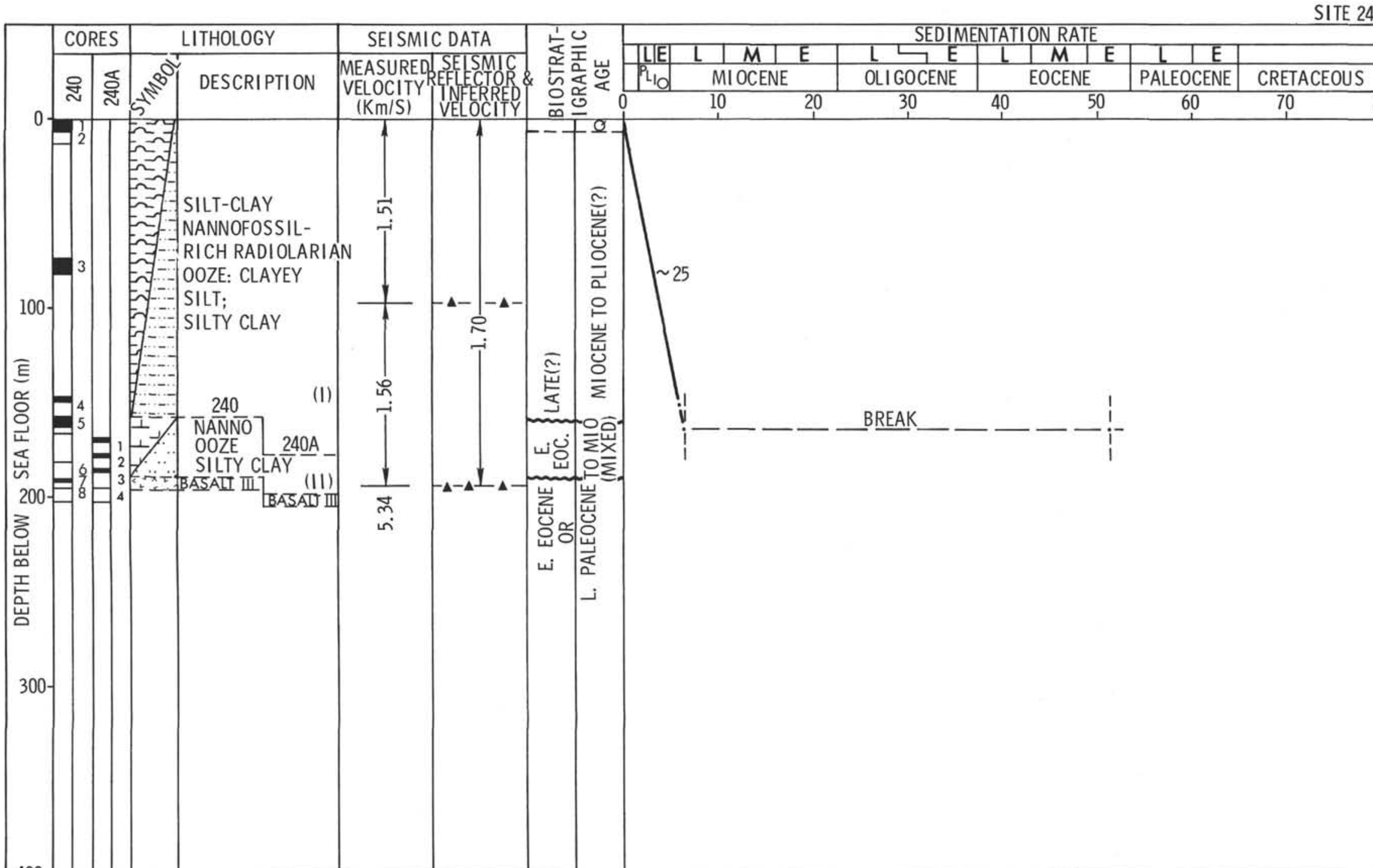
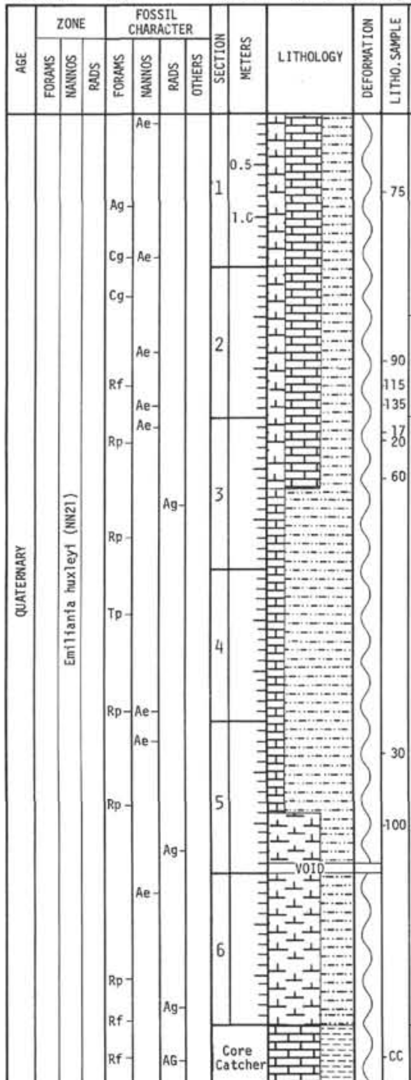


Figure 9. *Summary diagram, Holes 240 and 240A.*

Site 240 Hole Core 1 Cored Interval: 0-6 m



5GY6/1

5G6/1 & 10Y4/2

5GY4/1 with 5Y5/2

5GY4/1

LITHOLOGIC DESCRIPTION

Core is deformed, being soft to soupy except in Section 2 which is stiff. Colors mainly dark green gray (5GY6/1) with alternations of olive colors (10Y4/2, 5Y5/2 and 5Y4/1).

SILT/CLAY/NANNO-RICH RADIOLARIAN OOZE
Smears 1-75, 2-90, 2-115, 2-135, 3-17, 3-20, 5-100

Composition

rads	50%	forams	3%
det. clay	20%	diatoms	1%
calc. nannos	15%	heavies	1%
qtz. & feld.	10%	mica	Tr.

DIATOM-BEARING RAD-RICH DETRITAL SILTY CLAY
Smears 3-60, 5-30, CC

Texture	Composition	
(3-32-65)	det. clay	55%
	rads	20%
	qtz. & feld.	13%
	diatoms	10%
	heavies	2%

Deformed core has caused considerable variations in lithology; distinct lithologic boundaries are vague. Other lithologies within this core include foram/rad-rich nanno ooze, nanno-bearing silt-rich radiolarian ooze and silt-bearing rad nanno ooze.

Grain Size
1-74 (9-29-62) silty clay
2-129 (4-51-45) clayey silt
3-15 (5-86-9) silt
4-49 (5-75-20) silt

Carbon-Carbonate
1-50 (3.5-0.6-24)
5-39 (3.8-0.4-28)

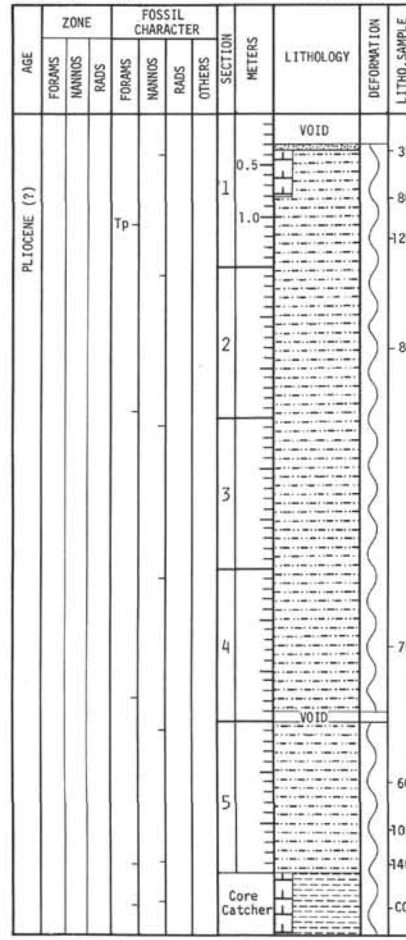
X-ray 3-60

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

Foraminifera are of mixed ages.
Radiolaria are of Quaternary age.

Core 2 Cored Interval: 6-14 m NO RECOVERY

Site 240 Hole Core 3 Cored Interval: 73-82 m



5GY4/1 & 5Y4/1

5GY4/1

5GY4/1 & 5Y4/1

N4 & 5GY4/1

LITHOLOGIC DESCRIPTION

Core is moderately deformed, in general soft to soupy with stiff areas in Sections 1-3. Color mainly dark green gray (5GY4/1) with some green gray (5Y4/1).

DETRITAL SILTY CLAY
Smears 1-120, 2-80, 4-75, 5-60, 5-105, 5-140

Texture	Composition	
(5-30-65)	det. clay	65%
	qtz. & feld.	25%
	others	8%
	heavies	2%

NANNO-RICH DETRITAL CLAY
Smears 1-35, 1-80, CC

Texture	Composition	
(0-20-80)	det. clay	65%
	calc. nannos	15%
	forams	10%
	qtz. & feld.	8%
	rads	2%

Sand at top of Section 1. Vague grading in Section 5 as well as black pyritic streaks. Clayey silts in Section 5.

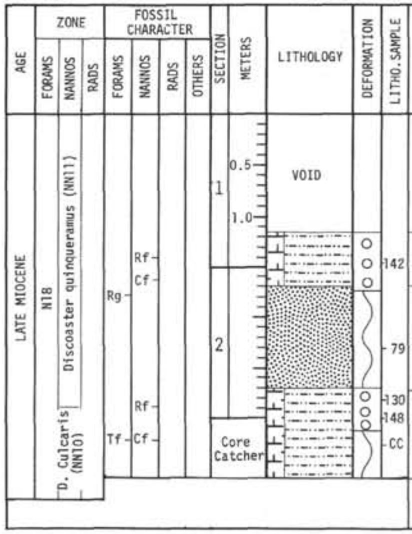
Grain Size
1-27 (66-19-15) sand

Carbon-Carbonate
5-40 (0.2-0.2-0)

X-ray 1-130		X-ray 2-120		X-ray 5-50	
mont.	A	mont.	A	mont.	A
qtz.	P	qtz.	P	k-feld.	P
k-feld.	P	k-feld.	P	plag.	P
plag.	P	plag.	P	kaol.	P
kaol.	P	kaol.	P	mica	P
mica	P	mica	P	paly.	P

Explanatory notes in chapter 1

Site 240 Hole Core 4 Cored Interval: 148-157 m



LITHOLOGIC DESCRIPTION

Core is soft and soupy with some drilling breccia. Colors are dark green gray (5GY4/1 and 5G4/1) and gray (N4-N5).

5GY4/1

DETRITAL QUARTZ SAND
Smears 2-79, 2-130

Texture	Composition	
(95-3-2)	qtz.	75%
	feld. & rock frag.	10%
	clay	10%
	opaques	3%
	heavies	2%

N4 & N5

NANNO-BEARING DETRITAL SILTY CLAY
Smears 1-142, 2-148, CC

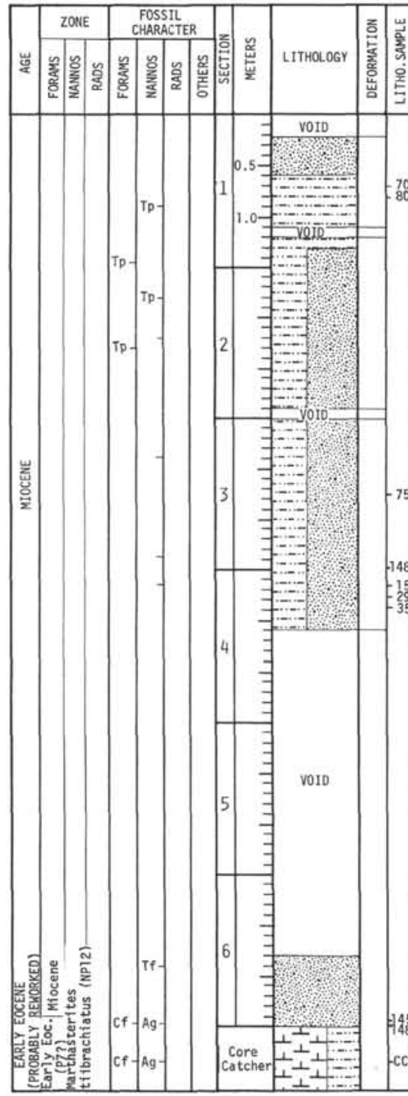
Texture	Composition	
(5-20-75)	det. clay	80%
	calc. nannos	10%
	qtz. & feld.	10%

5G6/1 & 5G4/1

Some sand may have been lost during coring and core retrieval. Sands are partly rounded, coarse-grained; may be some grading.

Grain Size
2-149 (66-20-14) sand
2-150 (96-1-3) sand
2-150.5 (97-1-2) sand

Site 240 Hole Core 5 Cored Interval: 157-166 m



LITHOLOGIC DESCRIPTION

Core is greatly deformed resulting in lithologic mixtures and extreme color variation. Colors include a dominance of moderate yellow brown (10YR5/4) with dark yellow brown (10YR4/2), gray (N5), and green gray (5G6/1).

10YR5/4, 10YR4/2, 5G6/1 & 5Y4/4

DETRITAL SILTY CLAY
Smears 1-80, 3-75, 4-15, 4-35, 6-145

Texture	Composition	
(0-30-70)	det. clay	80%
	qtz. & feld.	15%
	opaques & heavies	5%

10Y4/2 with N5

DETRITAL SILTY SAND
Smears 1-70, 3-148, 4-29

Texture	Composition	
(65-25-10)	qtz. & feld.	85%
	det. clay	10%
	mica	3%
	opaques	1%
	heavies	1%

5YR4/4

CLAY/CARBONATE-RICH NANNO OOZE
Smears 6-148, CC

Composition	
calc. nannos	50%
det. clay	30%
micarb.	20%

5G6/1

Grain Size
2-111 (93-1-6) sand
6-165.3 (85-7-8) sand
6-165.4 (83-10-7) sand

Carbon-Carbonate
3-109 (0.1-0.1-0)

X-ray 3-78

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

5G6/1 with N5, 10YR4/2 & 5Y5/2

Explanatory notes in chapter 1

Core 6 Cored Interval: 183-192 m Drillers report that the drilling interval may have been basalt.

Site 240 Hole Core 7 Cored Interval: 192-193 m

AGE	ZONE: FORAMS	ZONE: NANNOS	ZONE: RADS	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	OTHERS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
								1	0.5, 1.0	VOID		35, 88, 120
								Core Catcher				CC

LITHOLOGIC DESCRIPTION

BASALT and BASALT BRECCIA
Holohyaline to variolitic hypohyaline basalts contain microphenocrysts of plagioclase and replaced (chlorite, calcite, and serpentine) olivines.

E. Eocene foraminifera occur in chalk inclusions at 33-36 cm and 86-90 cm intervals.

Site 240 Hole Core 8 Cored Interval: 193-195 m

AGE	ZONE: FORAMS	ZONE: NANNOS	ZONE: RADS	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	OTHERS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
								Core Catcher				CC

LITHOLOGIC DESCRIPTION

Entire core void except for basalt fragment in CC. Fragment was 5 cm x 6 cm in size.

BASALT
Dense, crystalline, medium grained with chlorite-rimmed fractures. Dark to greenish gray.

Site 240 A Hole Core 1 Cored Interval: 168-177 m

AGE	ZONE: FORAMS	ZONE: NANNOS	ZONE: RADS	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	OTHERS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
LATE MIOCENE TO EARLY PLIOCENE / MOSTLY LATE MIOCENE	~N16-N19			Rp, Tp				1	0.5, 1.0	VOID; VOID		45, 55, 95, 145
								Core Catcher				CC

LITHOLOGIC DESCRIPTION

Core is greatly deformed being soft in upper meter and soupy in lower part and in the core catcher. Bit worn out and recovery poor. Color mainly dark green gray (5GY4/1) with some gray olive (10Y4/2).

DETRITAL SILTY CLAY
Smears 1-45, 1-55, 1-145, CC

Texture	Composition	
(0-25-75)	det. clay	75%
	qtz. & feld.	23%
	opaques	1%
	heavies	1%

DETRITAL CLAY (SILT-RICH)
Smear 1-95

Texture	Composition	
(5-15-80)	det. clay	80%
	qtz. & feld.	17%
	opaques	2%
	heavies	1%

Heavies include sphene, rutile, garnet, and hypersthene.

Grain Size
1-94 (13-11-76) clay

Carbon-Carbonate
1-144 (0.2-0.2-0)

X-ray 1-50

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

Site 240 A Hole Core 2 Cored Interval: 177-186 m

AGE	ZONE: FORAMS	ZONE: NANNOS	ZONE: RADS	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	OTHERS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
E. MIOC.-E. PLIOC. ? E.-L. MIOCENE				Tp, Tp, Tp, Tp	Tp, Tf, Rf			1	0.5, 1.0			142
								Core Catcher				CC

LITHOLOGIC DESCRIPTION

Core is very soupy. Colors are green gray (5GY6/1), gray olive (10Y4/2) and moderate brown (5YR4/4).

DETRITAL SAND
Smear CC

Texture	Composition	
(90-5-5)	qtz. & feld.	90%
	det. clay	5%
	forams	2%
	shell frag.	2%
	heavies	1%

DETRITAL CLAY (SILT-BEARING)
Smears 1-142, CC

Texture	Composition	
(0-10-90)	det. clay	90%
	qtz. & feld.	6%
	forams	3%
	heavies	1%

Sand contains some granule-sized fragments of quartz, shells, and coral.

Grain Size
1-99 (97-0-3) sand

Site 240 A Hole Core 3 Cored Interval: 186-195 m

AGE	ZONE: FORAMS	ZONE: NANNOS	ZONE: RADS	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	OTHERS	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
MIOCENE; LATE PALEOCENE / EARLY EOCENE	PROBABLY Mioc. (Eoc. reworked); (M. subbotinae-M. wilcoxensis) P6b	M. tribrachiatus (NP12); D. multiradiatus (NP9)		Ce, Ce, Ae, Ae, Ae	Af, Cg, Cg, Ag			1	0.5, 1.0	VOID		110, 127
								Core Catcher				CC

LITHOLOGIC DESCRIPTION

Core is soft with yellow (5Y6/1), yellow brown (10YR5/4), and dark yellow orange (10YR6/6) colors.

NANNO OOZE
Smears 1-110, CC

Composition	
calc. nannos	90%
det. clay	5%
micarb.	3%
qtz. & feld.	2%

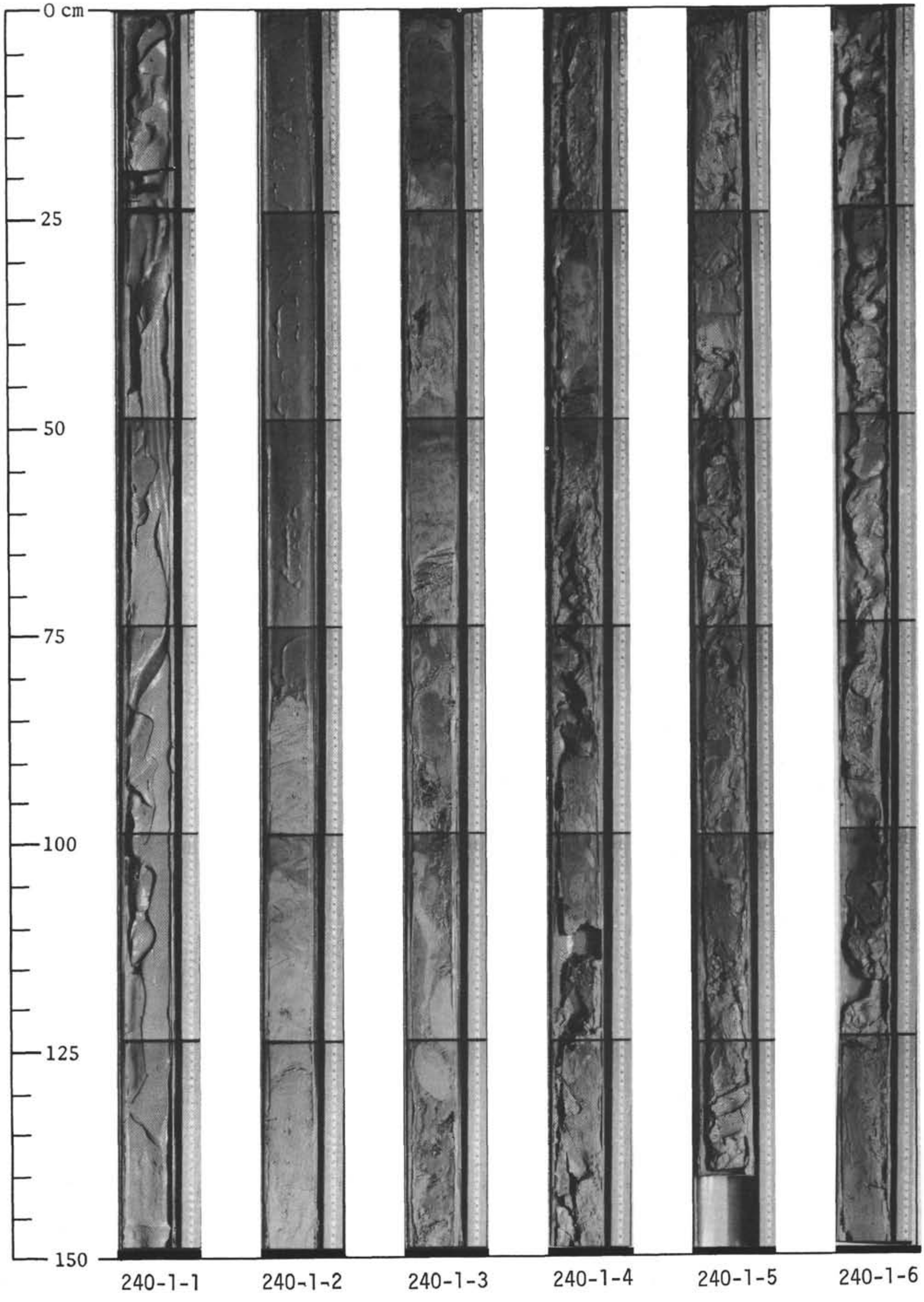
FORAM/SILT-BEARING NANNO OOZE
Smear 1-127

Composition	
calc. nannos	90%
qtz. & feld.	5%
forams	5%

Sand unit at 130-150 cm is similar to sand in Core 2 and may be contamination from caving. Fossil assemblage (mostly Early Eocene) also has Maestrichtian and Miocene forams.

Explanatory notes in chapter 1

Core 4 Cored Interval: 195-202 m Drillers report that the drilling interval may have been basalt.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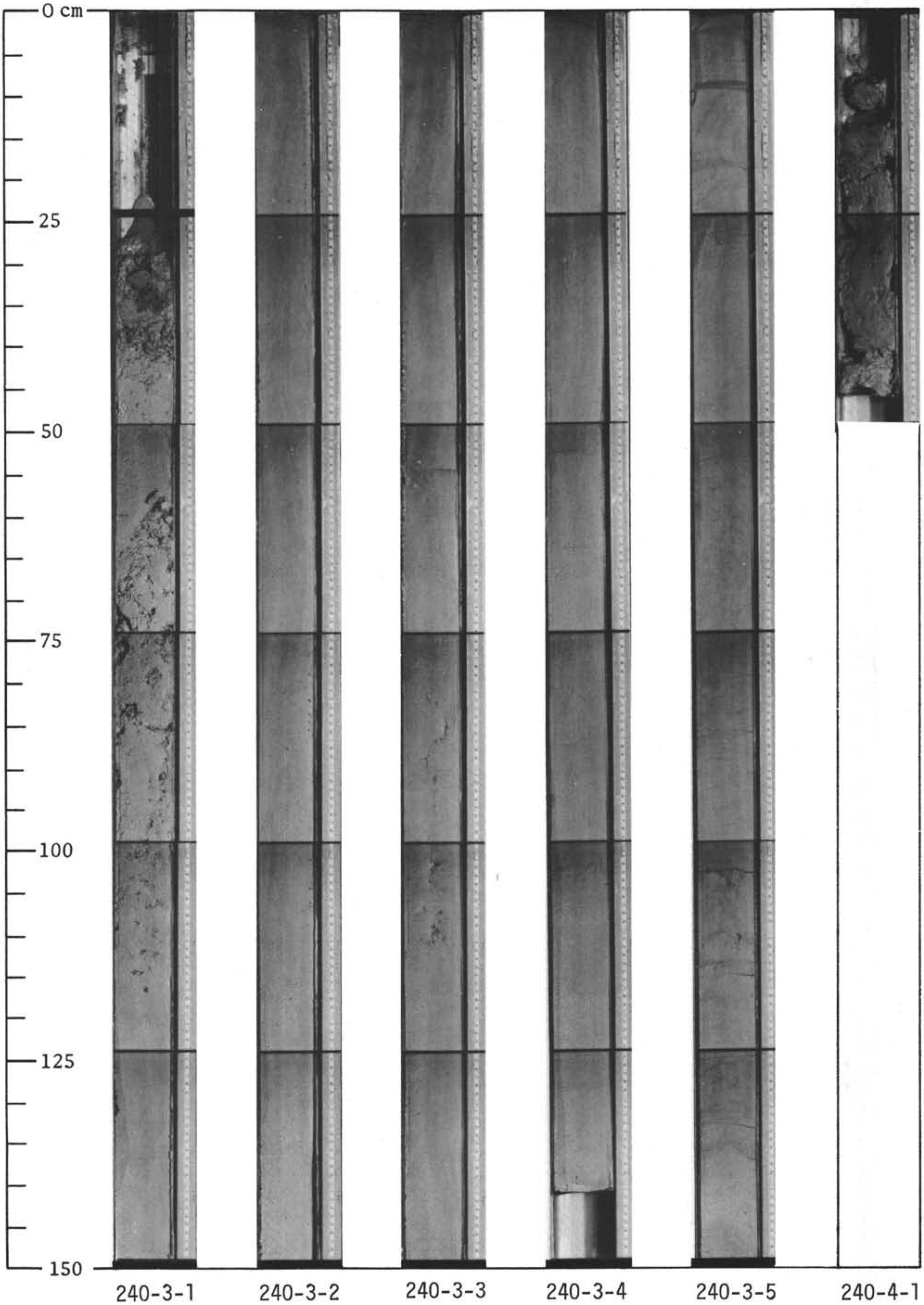
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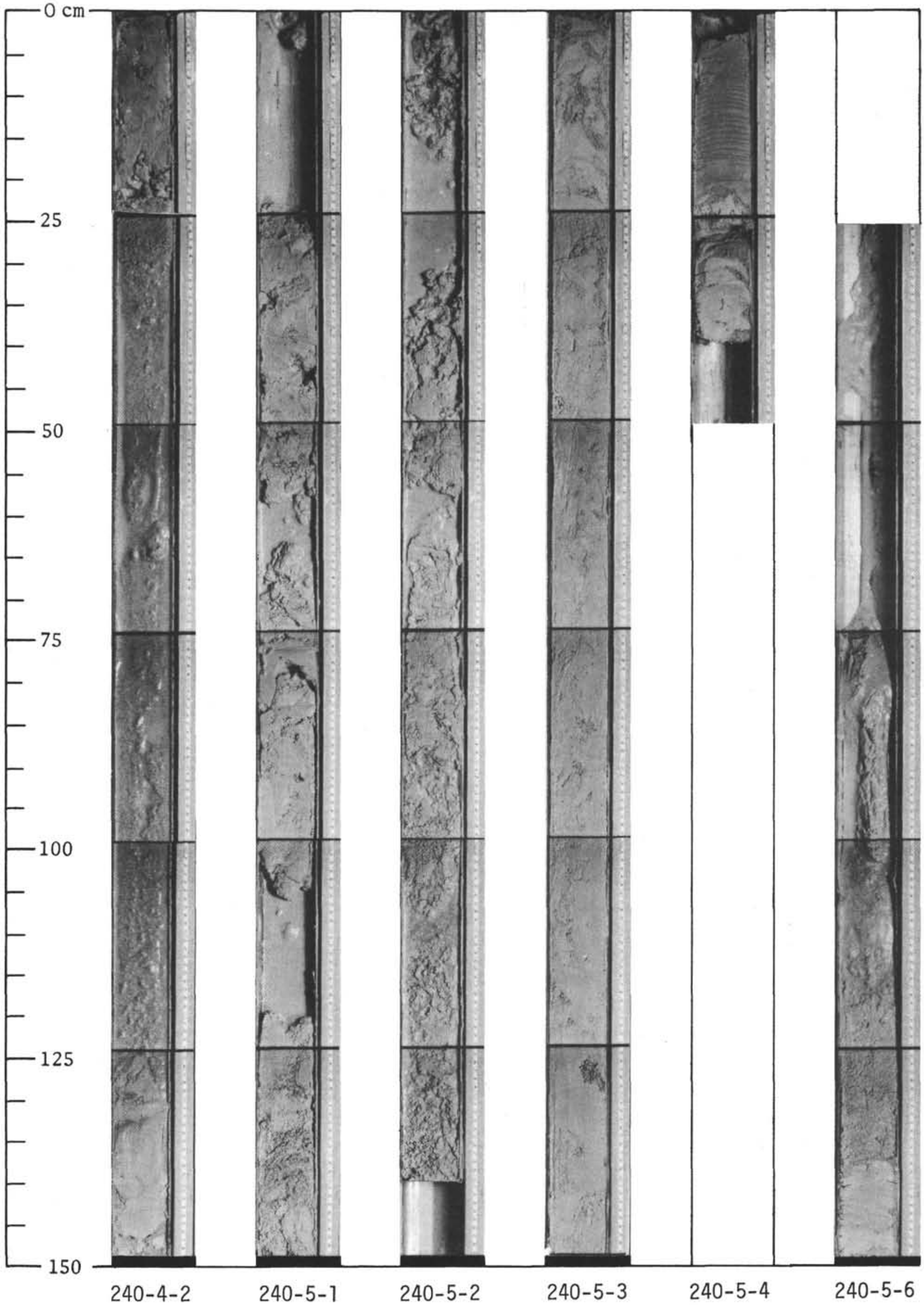
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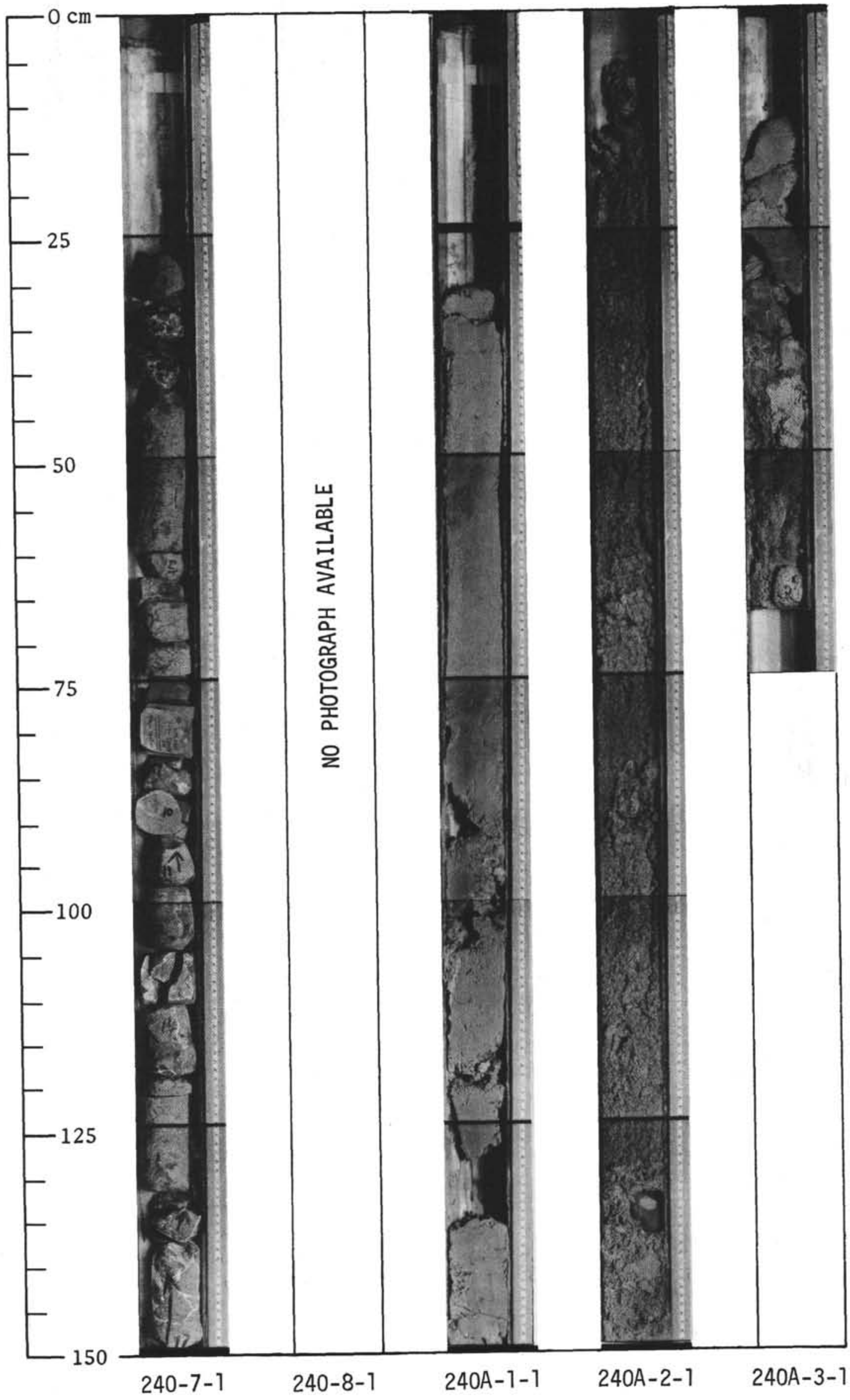
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