12. SEDIMENT COARSE FRACTIONS FROM THE WESTERN INDIAN OCEAN AND THE GULF OF ADEN (DEEP SEA DRILLING PROJECT LEG 24)

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ABSTRACT

Hemipelagic sediments in the Gulf of Aden, pelagic deep-water deposits in the Somali Basin and pelagic shallow-water sequences in the central Indian Ocean were penetrated and recovered during Leg 24 of the Deep Sea Drilling Project. The coarse fractions from these sediments have been studied. They have provided evidence that the Gulf of Aden has existed at least since middle Miocene as an ocean basin with typical hemipelagic sediments (high total sedimentation rates, high terrigenous input, high contents of organic carbon, high sedimentation rates of calcareous nannoplankton and planktonic foraminifera, high proportion of benthic fossils, abundant fish remains) suggesting its water masses to have been very fertile. The region had an arid climate during Miocene and Pleistocene times, while it seems to have been less dry during Pliocene (plant debris). An elevated ridge crest not accessible to coarse sediment components from both sides of the gulf had already been developed in the Miocene. The region now occupied by the >5000-meter-deep Alula-Fartak Trench which offsets Sheba Ridge seems to have been passable for sediment transport from the Arabian side of the gulf to the southeast during Pliocene. Upper Cretaceous deposits above the Somali Basin basement east of Chain Ridge are already true pelagic sediments. The preservation of calcareous sediment components of both deep Somali Basin sites suggests that a large portion has been replaced from areas of shallower water depths. Pliocene sediments east of Chain Ridge contain shallow-water-derived components which may have come either from the Gulf of Aden or from an area northeast of Carlsberg Ridge. The central Indian Ocean sites contain early Tertiary to Quaternary pelagic oozes and chalks. The sediments of all three sites are pertinent to the equatorial high production belt thus precluding major geographic readjustments of that piece of oceanic crust in a north-south direction since early Tertiary. The degree of fragmentation of planktonic foraminifera offers a useful tool for determining paleodepth although these sites were nearly always well above the calcium carbonate compensation depth. This is important for the interpretation of vertical sea-floor movements in connection with shifts of the spreading centers. The pattern of preservation of planktonic foraminifera also shows that a high proportion of the recovered sediments are displaced. This is substantiated by the joint occurrence of well-preserved planktonic foraminifera and true shallow-water-derived components in coarse-grained horizons in a matrix of poorly preserved calcareous oozes.

INTRODUCTION

During Leg 24 of D/V *Glomar Challenger* in the northwest Indian Ocean and Gulf of Aden, holes were drilled at eight sites covering the following major physiographic provinces (Figure 1 and Table 1):

1) Site 231—Gulf of Aden, close to the continental margin of Somalia;

2) Sites 232 and 233—Gulf of Aden, on either side of the Alula-Fartak Trench, an apparent transform fault;

3) Sites 234 and 235—Somali Basin on either side of Chain Ridge, a supposed continuation of Owen Fracture Zone;

4) Site 236—north of the Seychelles Bank, one of the Indian Ocean microcontinents;

5) Site 237—on the saddle of the Mascarene Plateau between Seychelles Bank and Saya de Malha; and

6) Site 238—east of the Central Indian Ridge, within the filled eastern end of the Argo Fracture Zone.

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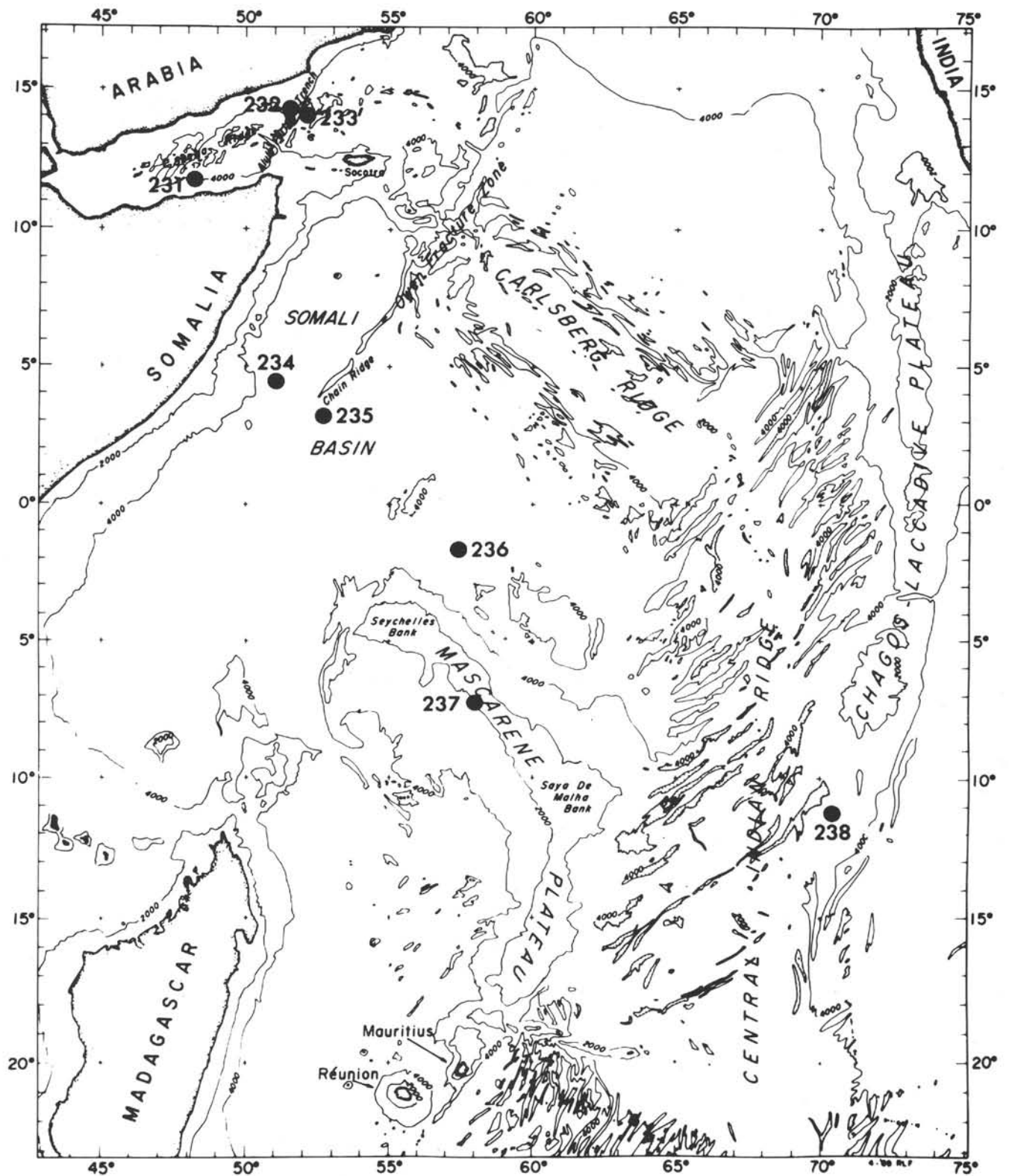
Figure 1. *Location of DSDP Leg 24 drill sites in the Western Indian Ocean and Gulf of Aden.*

TABLE 1
Station List of Samples Used in this Report

Hole	Latitude	Longitude	Water Depth (m)	Penetration (m)
DSDP Sites				
231	11°53.41'N	48°14.71'E	2161	584
232	14°28.93'N	51°54.87'E	1758	434
232A				
233	14°19.68'N	52°08.11'E	1860	271
233A				
234	04°28.96'N	51°13.48'E	4738	247
234A				
235	03°14.06'N	52°41.64'E	5146	684
236	01°40.62'S	57°38.85'E	4504	328
237	07°04.99'S	58°07.48'E	1640	694
238	11°09.21'S	70°31.56'E	2844	587
ANTIPODE Cores				
ANTP 120P	11°08.4'S	70°31.4'E	2827	close to DSDP 238
ANTP 142P	10°16.5'S	58°58.0'E	2763	close to DSDP 237
ANTP 146P	7°02.4'S	58°09.9'E	1638	close to DSDP 237
ANTP 150P	1°39.6'S	57°35.3'E	4482	close to DSDP 236
CHAIN Cores (Cruise 100, Leg 4)				
CHN 30P	04°27.7'N	51°08'E	5049	close to DSDP 234
CHN 32P	03°14.2'N	52°41'E	5123	close to DSDP 235

Geographically the sites span an area of 25° of latitude and 22° of longitude and were drilled in water depths ranging from 1640 to 5146 meters. The sediments recovered from these eight sites range, stratigraphically, from upper Cretaceous to Pleistocene. Oceanic basaltic basement was reached and penetrated at four sites (231, 235, 236, 238, Fisher et al., 1972). The most striking feature of these sediments is their apparent homogeneity (Figure 2). In the majority of cores they consist of fine-grained calcareous nannofossil ooze and do not show the rich diversity of sedimentary facies known from drill sites in other oceans. However, the lithologic changes are great enough at each site to distinguish several lithologic units, although often on the basis of variations in calcium carbonate content alone. Gross lithology, stratigraphy, and the correlation of the sedimentary sections of Sites 231-238 are shown in Figures 2 and 3.

This study describes the coarse fraction of the sediments of these eight sites. Special emphasis has been given to the preservation of calcareous particles, mainly pteropod and planktonic foraminifera tests.

The study will deal with:

1) Distribution of components at each site;

2) Overall regional sedimentation patterns of single components and groups of components;

3) Discussion of regional aspects including summaries for the Gulf of Aden, the Somali Basin, and pelagic sites in the central Indian Ocean; and

4) General regional aspects.

Although this study is based mainly on coarse fraction analyses (for a detailed description of this method see Sarnthein, 1971), shipboard smear slide data (Appendix B) and the data provided by the Deep Sea Drilling Project (grain size, organic and total carbon content, and X-ray diffraction analysis) were also used.

METHODS

All samples for the coarse fraction analysis of Leg 24 sediments were taken onboard *Glomar Challenger* (except CHAIN 100 and ANTIPODE samples) using the standard sampling procedure of the Deep Sea Drilling Project. The original volume of the samples was usually 10-20 cc and, in a number of |core-catcher samples, somewhat more. The following laboratory procedure was used: drying at about 60°C, determination of dry weight of total sample, wet sieving using a 63μ standard sieve, drying at 60°C, and determination of dry weight of the sand fraction (> 63μ is here synonymous with coarse fraction). A number of core-catcher samples were sieved through a 163μ standard sieve. These samples are noted in Appendix A. The data are scanty in parts of some sites because the sediments could not be prepared by this method (in particular sediments at Sites 232, 233, and 237).

An average of about 300 grains per sample were counted using a stereomicroscope with incident light. This is sufficient to obtain a gross picture of the component distribution (ca. 25-30 components differentiated), because the diversity of particles contributing to the coarse fraction is usually rather small.

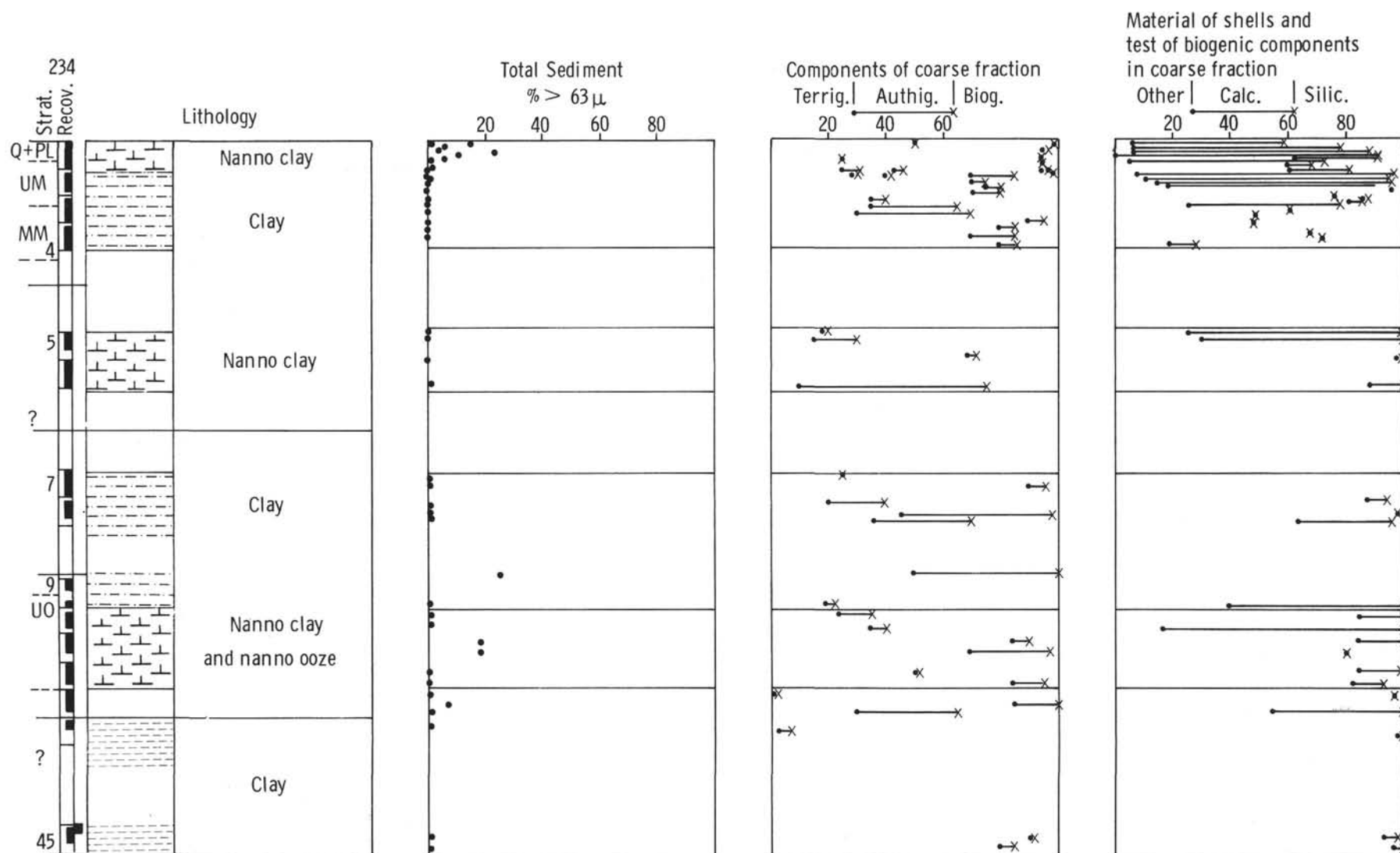The various components distinguished in this study are shown in Table 2.

Figure 2. *Basic lithology and stratigraphy of DSDP Leg 24 drill sites in the western Indian Ocean and Gulf of Aden. The zonation follows Berggren (1972).*
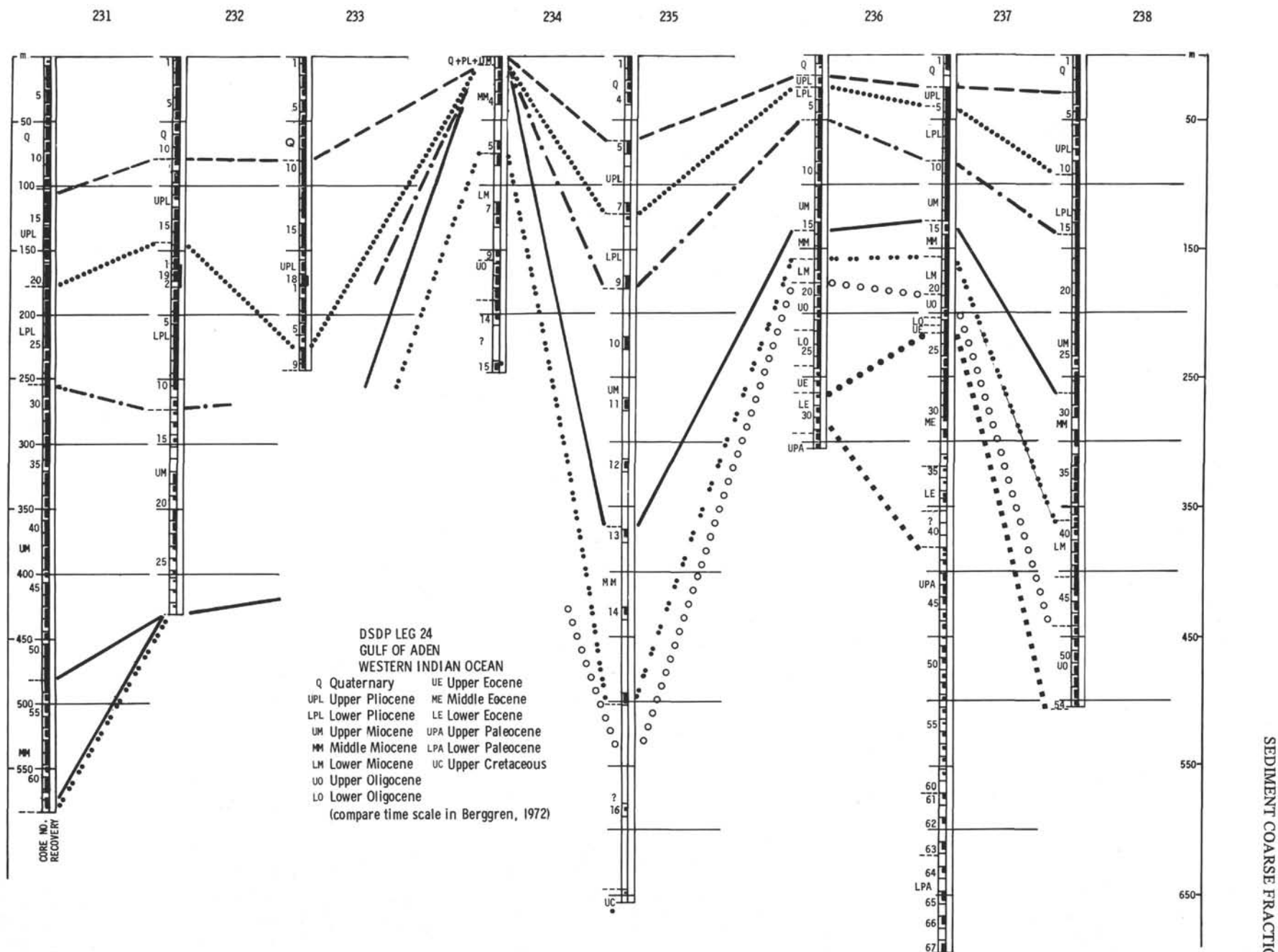
Figure 3. *Correlation chart for DSDP Leg 24 drill sites in the western Indian Ocean and Gulf of Aden.*

SEDIMENT COARSE FRACTIONS

TABLE 2
Occurrence of Various Terrigenous, Authigenic,
and Biogenic Components Distinguished in This Study

Terrigenous Components (= Clastic Grain)	Authigenic Components	Biogenic Calcareous Components (Plankton and Mero-plankton)	Biogenic Calcareous Components (Benthos)	Biogenic Siliceous Components	Miscellaneous Biogenic Components
Quartz	Pyrite	**Planktonic:**	Algae	Diatoms	Plants (other)
Mica	Quartz	Foraminifera	Foraminifera	Radiolaria	Hystrichosphaerids
Feldspar	Glauconite	(whole	Bivalves	Sponges	Arenaceous
Heavy	Zeolite	tests)	Gastropods		foraminifera
minerals	Gypsum	Foraminifera	Bryozoa		Fish
Dolomite		(fragments)	Corals		
rhombs		Pteropods	Ostracods		
Rock		Ostracods	Echinoids		
fragments		**Meroplank-**			
Resedimented		**tonic:**			
fossiliferous		Larvae of			
material		bivalves and			
		gastropods			

In most samples, only the following components are significant: plant debris, diatoms, Radiolaria, planktonic foraminifera, benthic foraminifera, sponge spicules, pteropods, echinoderms, and fish debris. Only in layers with a high proportion of shallow-water-derived material debris from molluscs, corals, and bryozoans was frequently found. The hemipelagic sediments of the Gulf of Aden and the clays of the Somali Basin contain higher proportions of terrigenous grains (mainly quartz and mica). Authigenic minerals are usually of minor importance in the size fraction studied.

If the coarse fraction of a sample was dominated by one or two components, as is usual in the case of pelagic sediments, their abundance was often estimated with only the minor elements being counted. Detailed studies of foraminifera, ostracods, Radiolaria, and diatoms can be found in specific chapters in this volume.

The following results of these coarse fraction analyses are given in Appendix A:

1) Percentage of sand fraction ($> 63\mu$) of the total sediment;

2) Proportion of terrigenous, authigenic, and biogenic components in the coarse fractions;

3) Proportion (in the biogenic component group) of tests and shells consisting of the following materials: calcareous, siliceous, and unidentified;

4) Proportion of single components in the total biogenic group; and

5) The following calculated ratios:

a) planktonic foraminifera (whole tests and fragments):
   Radiolaria

b) planktonic foraminifera (whole tests):
   fragments of planktonic foraminifera

c) planktonic foraminifera (whole tests):
   calcareous benthic foraminifera

The smear slide analyses made by the shipboard scientists have been included in Appendix B.

Thin sections from a number of ooze and chalk sediments were prepared. This was done by freeze drying and impregnating the samples (F. Werner, Geological Institute, University of Kiel, Germany).

The proportion of coarse fraction (> 0.063 mm) in all investigated samples of the Leg 24 sediments from the western Indian Ocean and the Gulf of Aden is shown in Figure 4. The textural homogeneity of these sediments is quite striking. In only a few cases did the sediments from the different sites show lithological differences based on textural changes. Based on these observations, three different lithofacies can be defined: (1) Fine-grained sediment with small sand fractions and no sand layers (represented at Sites 231, 232, 233, 234, 235, 237); (2) Fine-grained sediments with small sand fractions, but with isolated sand layers (represented at Sites 231, 232, 233, 234, 235, 236, 238); (3) Coarse sandy sediments in great thickness (not as isolated horizons), represented at Sites 237 and 238. Both, the homogeneous fine-grained and the coarse-grained facies need a sedimentation mechanism continuing unchanged for a certain time, while the fine-grained sediment with intercalated sand horizons require frequent and, because of their sharp boundaries, sudden changes of the sedimentation models, as will be substantiated in the forthcoming pages.

GULF OF ADEN SITES

Coarse Fractions, Site 231

Site 231 is located in the inner Gulf of Aden, south of Sheba Ridge (the continuation of the seismically active mid-ocean Carlsberg Ridge into the Gulf of Aden) close to the Somalia continental margin. The area has been mapped in great detail (for example, Laughton et al., 1970). It was known from seismic studies that above a rather smooth basement two sedimentary sequences occurred: the lower one was acoustically transparent, resulting in speculations about a possible evaporite sequence; the upper one was stratified.

The site finally chosen is located about 70 km north of Somalia, just beyond "magnetic anomaly 5" in 2152 meters of water. It is situated on the southwest portion of a small transform fault which offsets Sheba Ridge. Basaltic basement was reached after penetrating and continuously coring
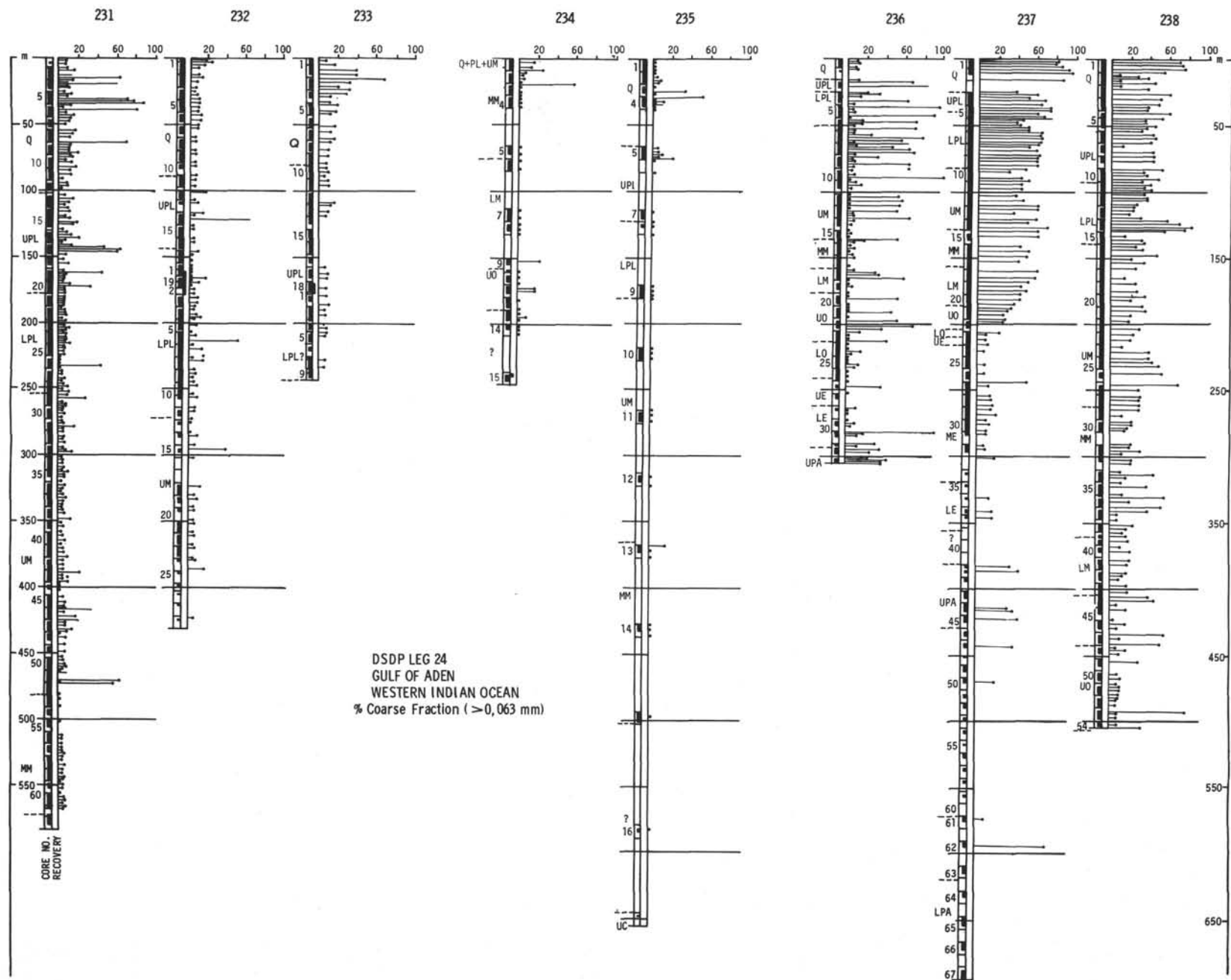
Figure 4. *Distribution of coarse fractions (in percent of total sediment).*

a 567-meter-thick sedimentary sequence. Correlation between lithology and seismic records was rather good. The transparent deposits consisted of very homogeneous nanno-fossil oozes (Plate 1), while the sediment above contained numerous sand layers (appearing as stratification in the seismic records). The whole section of hemipelagic sediments ranges stratigraphically from middle Miocene to Pleistocene, giving a minimum age for the basaltic basement.

Five sedimentary units, which become increasingly lithified with depth have been defined. A sixth unit is comprised of basaltic rocks, which contain inclusions of recrystallized nanno chalk, about 13 m.y. old (compare Figures 5A and B).

The colors of the sediments are grayish-olive, olive-gray, and light olive-gray. The deposits are texturally silty sandy clays or clayey sandy silt. Only a few horizons in upper Miocene to Pleistocene sediments are sands (Figure 6a), from determinations based on smear slide and grain size analyses.

The calcium carbonate content of these sediments ranged from 30% to 60%, the organic carbon from 0.3% to 0.9%. H_2S was found nearly throughout the section. X-ray mineralogy determinations showed the presence of calcite, aragonite, dolomite, quartz, K-feldspar, plagioclase, kaolinite, mica, chlorite, montmorillonite, palygorskite, pyrite, and amphibole.

Sedimentary structures are present in zones indicated in Figure 7. They consist either of a combination of texture and color variations (mainly in the upper part of the sedimentary sequence) or only slight changes of hues. Burrowing and mottling were found rather frequently in two zones (Figure 7 and Plate 2) and are otherwise almost absent. Changes of the intensity of burrow mottling in the otherwise homogeneous sediments might be indicative of oxygen content variations in the bottom water. If this is true, then sedimentary structures indicate poorly oxygenated bottom water in this area, particularly during upper Miocene, lower Pliocene, and Pleistocene time.

The coarse-fraction content is rather uniform throughout the sedimentary sequence. Only isolated horizons contain more than 10%-15% of >0.063 mm material. These horizons occur more frequently in the upper Pliocene and Pleistocene portion of the section. They are clearly not restricted to the Pleistocene sediment. A purely paleoclimatic (explaining this occurrence as related to Pleistocene eustatic sea-level oscillations) interpretation for the occurrence of shallow-water-derived material in these sand horizons seems therefore insufficient (Figure 8, and Site Report 231). Some of the sandy horizons are volcanic ash (at 170, 179, 203 m), especially in Pliocene sediments.

Biogenic and clastic terrigenous components are dominant throughout the entire sedimentary sequence (Figure 6b), while authigenic particles occur mainly in middle and upper Miocene deposits. The proportions of both groups of components are extremely variable (see Appendix A), and no sharp major boundary was found, but, in general, it can be said that biogenic components become more important in the younger sediments of this site, while terrigenous components form the larger portion of the older part of the section.
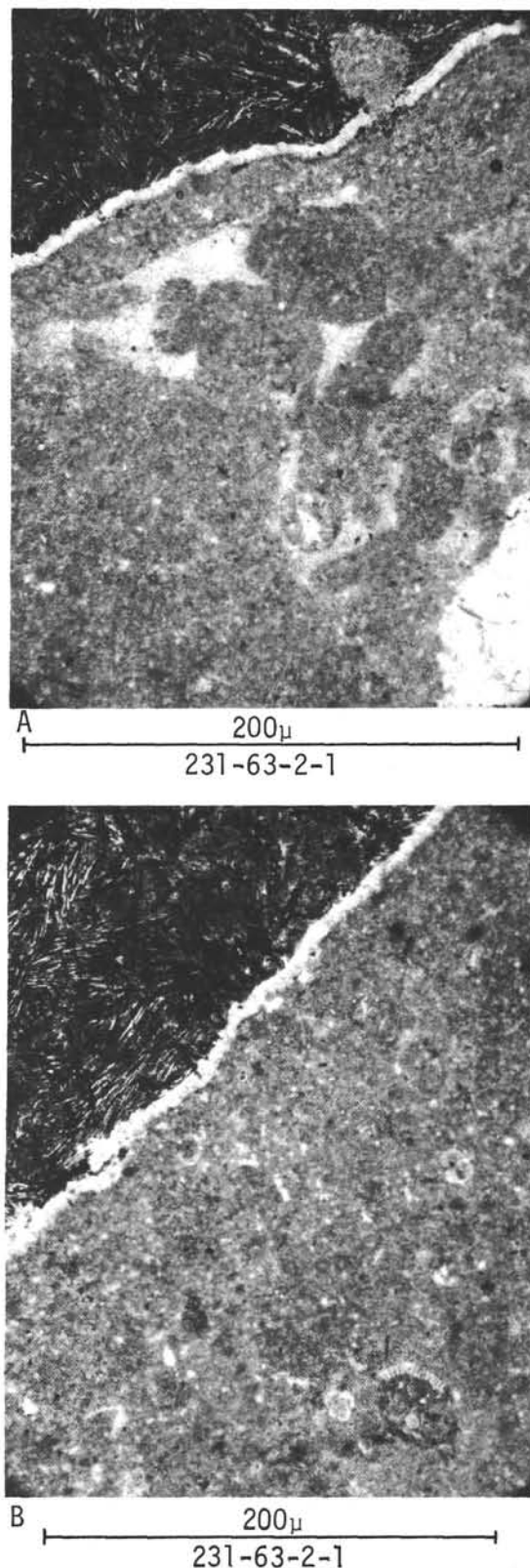
Figure 5 (A and B). *Sediments directly above basaltic basement at 24-231-63-2-1 (shipboard thin section). The nanno chalks are partly recrystallized, but their biogenic origin is visible due to the presence of recognizable remains of fossils. The origin of the pellet-like structure in (A) is not clear.*
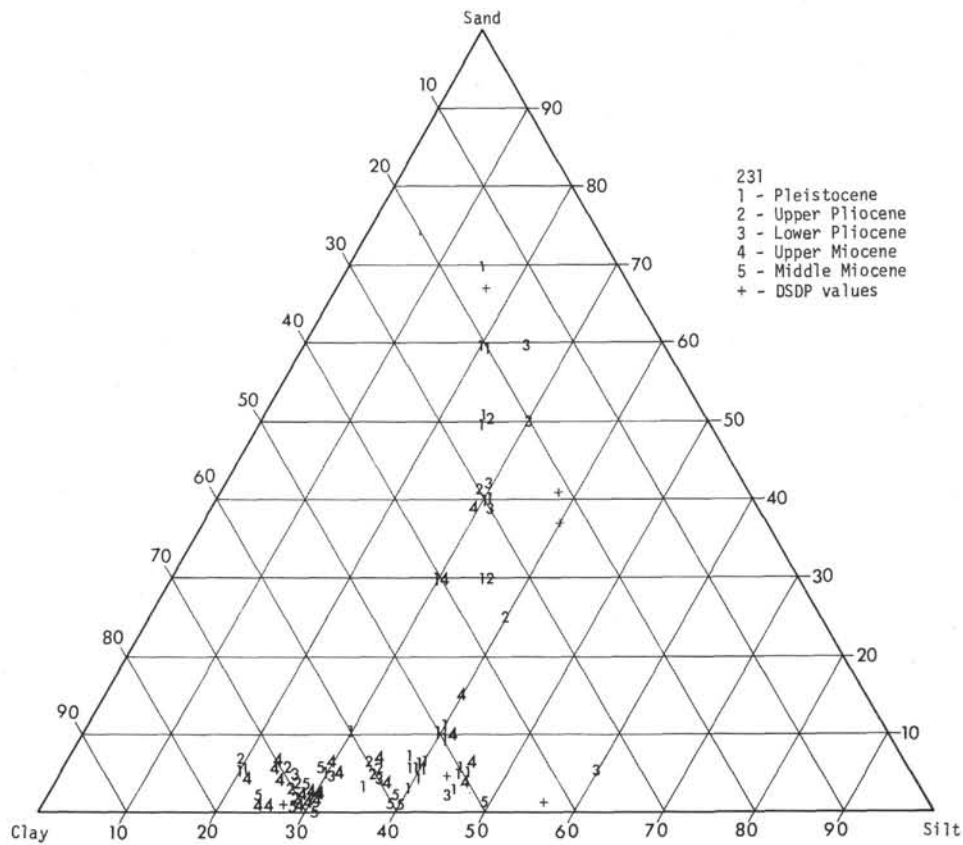
Figure 6a. *Clay-silt-sand triangle diagram of Site 231 sediments, based on smear slide analyses. Numbers indicate age of sample.*
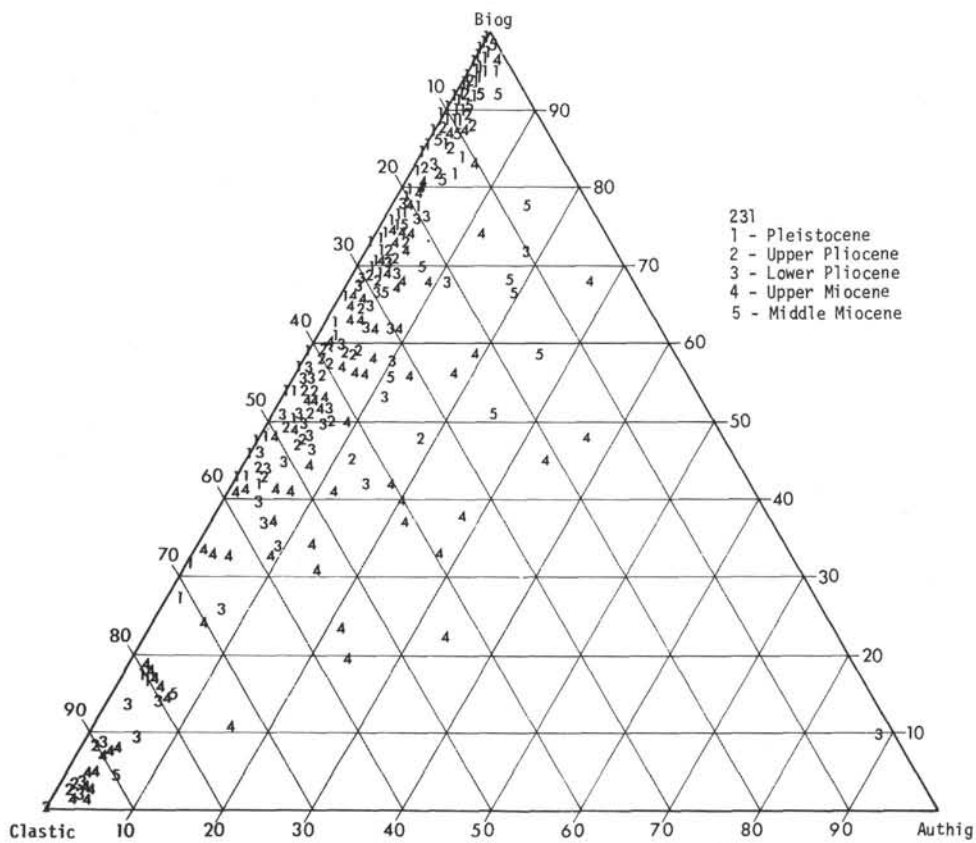
Figure 6b. *Biogenic-clastic-authigenic triangle diagram of Site 231 sediments, based on coarse fraction analyses.*
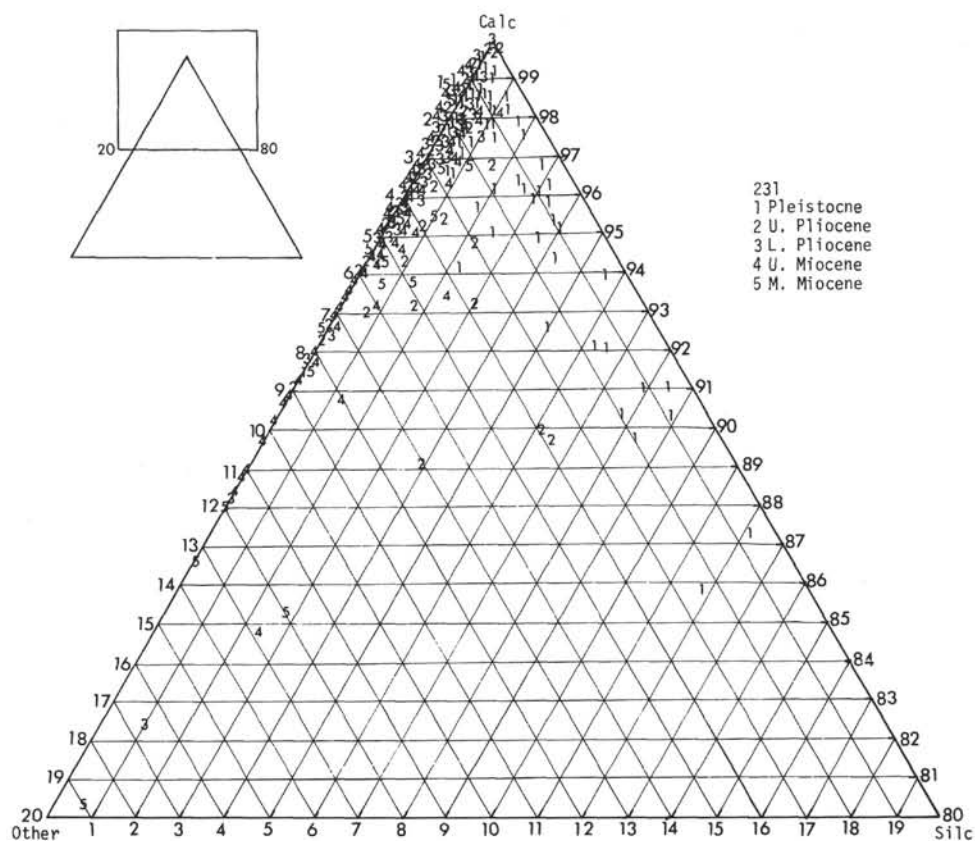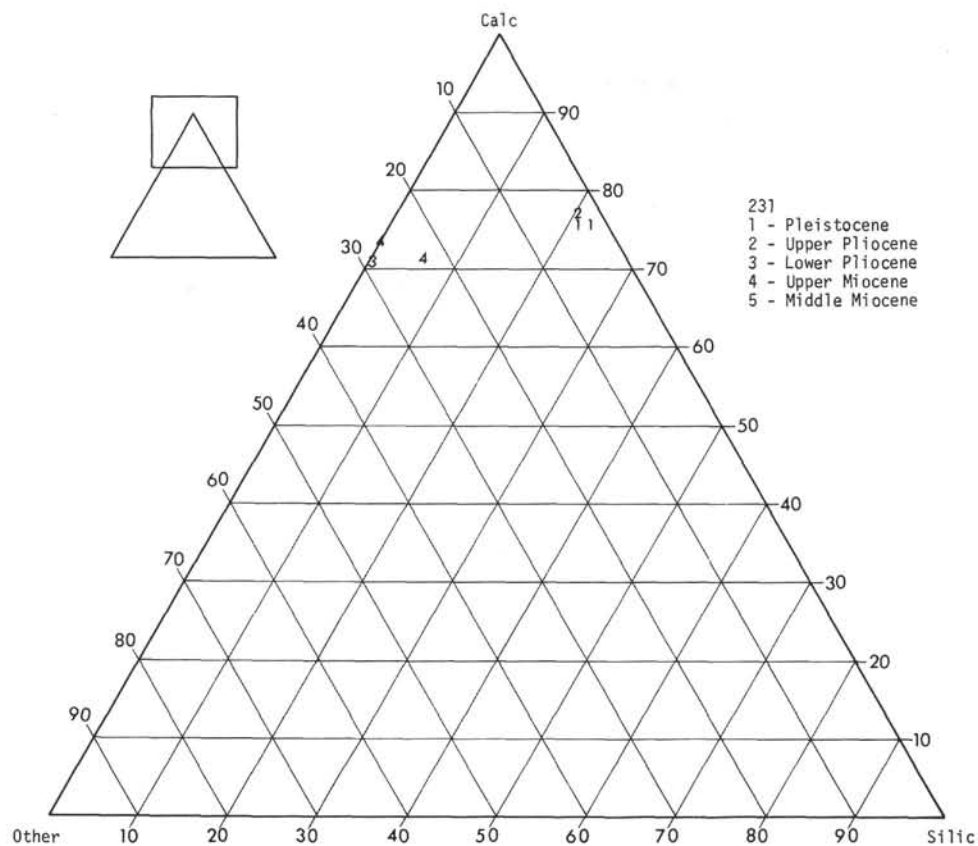
Figure 6c. *Calcareous-siliceous-other shell materiel of fossil tests and skeletons of Site 231 sediments, based on coarse fraction analysis.*
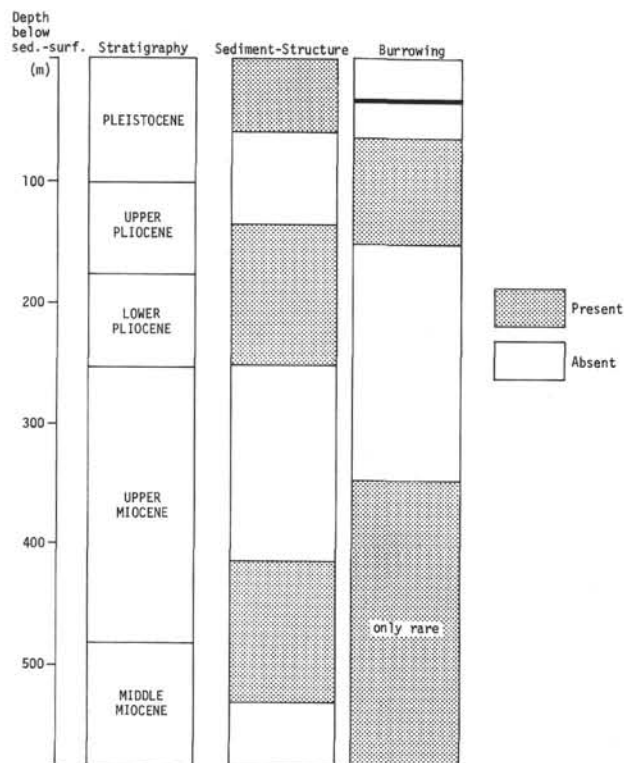
Figure 7. *Gross distribution of sedimentary structures and biogenic burrow mottling in Site 231 sediments.*

231-43-1

Figure 8. *Sediments in the Gulf of Aden. Types of burrowing in upper Miocene sediments of Site 231. Beside the types described on Plate 2 another very thin tube-like type is recognized (24-231-43-1 (128-149).*

Terrigenous Components

The distribution of terrigenous clastic coarse-fraction components is given in Table 3. Two different assemblages can be distinguished in the samples at this site.

The first assemblage occurs mainly in the very homogeneous clayey silty nanno oozes and is composed predominantly of quartz, mica, and dolomite rhombs (Figure 9). It is very fine grained (almost entirely in the lowermost size range of the sand fractions) and is usually characterized by small quartz/mica ratios (Figure 10). The quartz grains are mostly angular; however, well-rounded ones are also found. Of special interest are the idiomorph dolomite rhombs which are found rather frequently. Maximum size of these rhombs is about 100μ, and they almost always possess a well-defined milky core inside a clear cover.

The other assemblage occurs mainly in sandy horizons and also contains the above-mentioned three minerals, although the quartz is rounded and polished with diameters up to 1 mm in size. It also contains additional heavy minerals, rock fragments, fossil detritus, and is characterized by high quartz/mica ratios (see Figures 10 and 11).

The rock fragments consist of the following types:

1) Fossiliferous sandstone and limestone with Recent and fossil larger foraminifera, reworked fossil gastropods, bivalves, bryozoans, glauconite, and dark gray, well-rounded quartzite;

2) Quartzitic fine- and coarse-grained sandstone; and

3) Fine-grained limestone.

They occur frequently in the upper Pliocene and Pleistocene sandy horizons (Table 4 and Figure 11), but were

found not to be restricted to these deposits, as they were also detected in the homogeneous upper Miocene to lower Pliocene sediments (they were not found in middle Miocene

TABLE 3
Terrigenous Clastic and Authigenic Components in
Site 231 Coarse Fractions[a]

Stratigraphy	Terrigenous Components	Authigenic Components	Quartz/Mica Ratio
Pleistocene	Quartz, mica, feldspar, heavy minerals, dolo rhombs, rock fragments, reworked fossils, volcanic glass	Pyrite, glauconite (quartz)	Compare Figure 10
Upper Pliocene	Quartz, mica, feldspar, dolo rhombs, rock fragments, volcanic glass	Pyrite, glauconite	
Lower Pliocene	Quartz, mica, dolo rhombs, heavy minerals, rock fragments, volcanic glass	Pyrite, glauconite	
Upper Miocene	Quartz, mica, feldspar, dolo rhombs, rock fragments, volcanic glass	Pyrite, glauconite, quartz, (gypsum?)	
Middle Miocene	Quartz, mica, dolo rhombs, heavy minerals, volcanic glass	Pyrite, glauconite	

[a]Underlined components occur frequently to commonly.
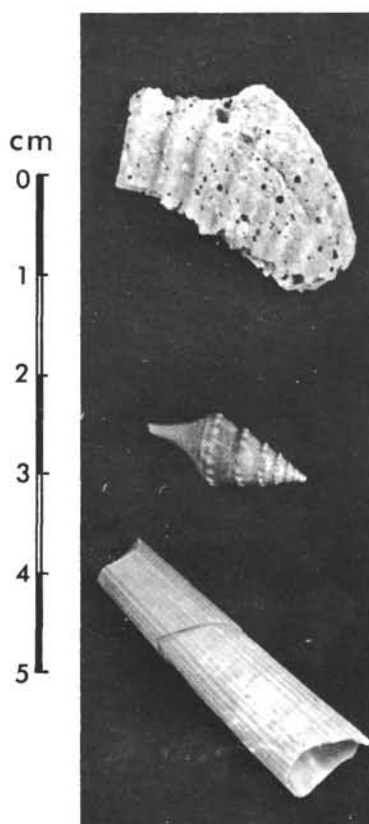
Figure 9. *Large fossils found in Pleistocene sediments of Site 231.*

sediments). The preservation of small (diameter ca 1-3 mm) dark gray, rounded, soft clay pebbles in light gray nannofossil ooze in Sample 24-231-43-1, 74 cm should be

mentioned here. The occurrence of shallow-water-derived fossils and fossil fragments in these horizons suggests that the bulk of the sedimentary components was slumped from shallow-water areas on or close to the shelf.

Feldspar and volcanic glass occur throughout the sequence and, although feldspar was expected to occur commonly in these sediments, only a few grains could be identified. Volcanic glass shards were found throughout the entire sequence but occur as a well-defined ash horizon only in Sample 24-231-20-2, 30 cm.

The quartz/mica ratio is highly variable in these sediments (Figure 10). In the stratified part of the sedimentary sequence, where this ratio is always higher in the coarse layers than in the fine-grained nanno ooze, it is indicative of shallow-water-derived material. However, in the older more homogeneous part of this site the quartz/mica ratio was found to be rather variable. It is higher in the older sediments and decreases slowly as sediments become younger. This might indicate broadening of the Gulf of Aden, which was a narrow oceanic appendage in middle Miocene, to an open gulf.

Authigenic Components

Pyrite and glauconite are the main authigenic components of the Site 231 coarse fraction. Although pyrite is the most common authigenic material, its abundance exceeds 10% of the total coarse fraction (Figure 6b) only in middle to lower Pliocene deposits. In a number of samples it was found as a replacement mineral of siliceous fossils.

Glauconite usually occurs only as single grains. It is found more frequently in the coarse horizons than in the fine-grained nannofossil oozes. The particles are either globular or of undefined morphology, but in many cases they are still identifiable as fillings of foraminiferal chambers, although none of the foraminiferal carbonate is preserved. Rather fresh-looking benthic and planktonic
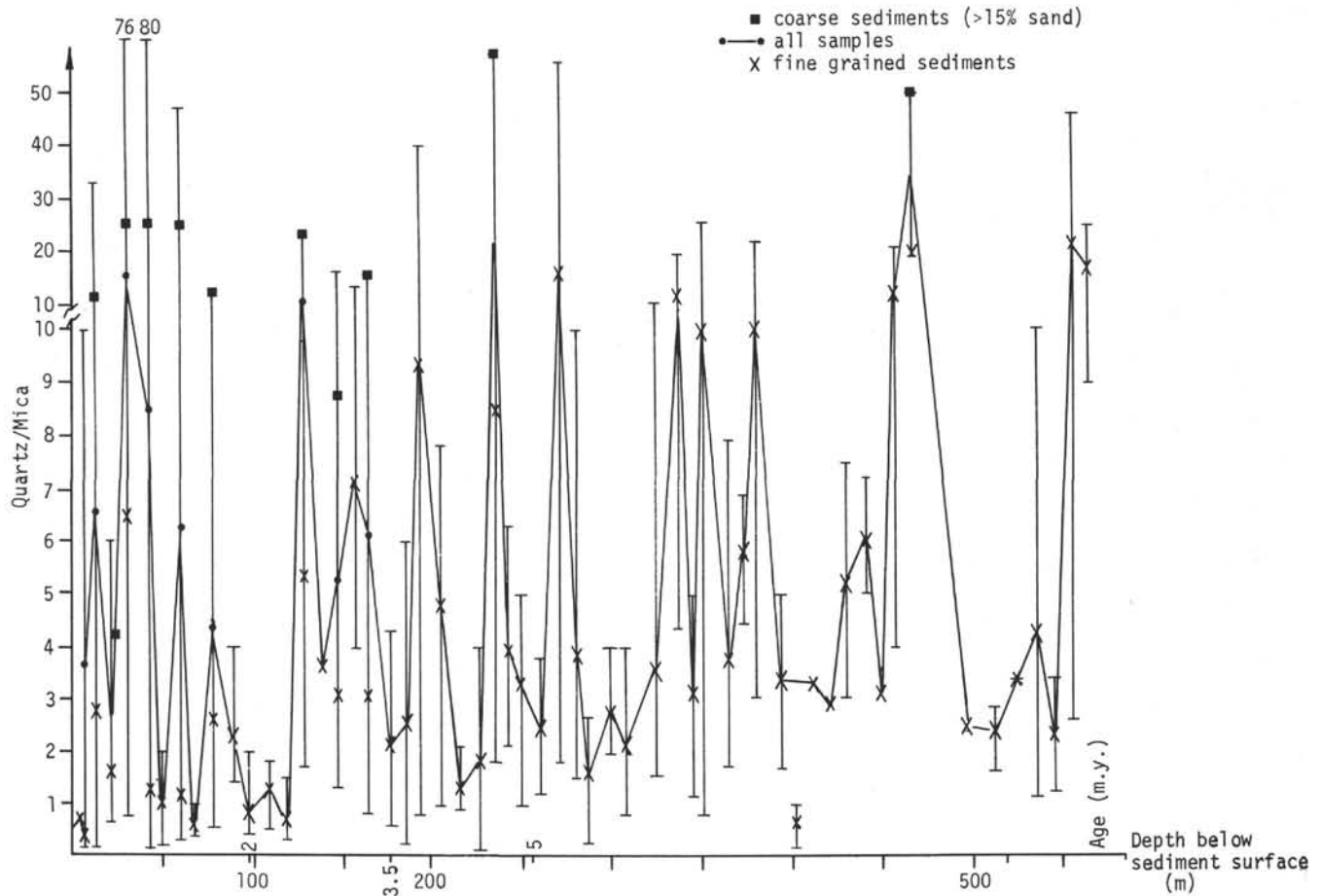
Figure 10. *Quartz/mica ratio in Site 231 coarse fractions. Where available, coarse and fine grained sediments were differentiated by signatures. Average values per core.*
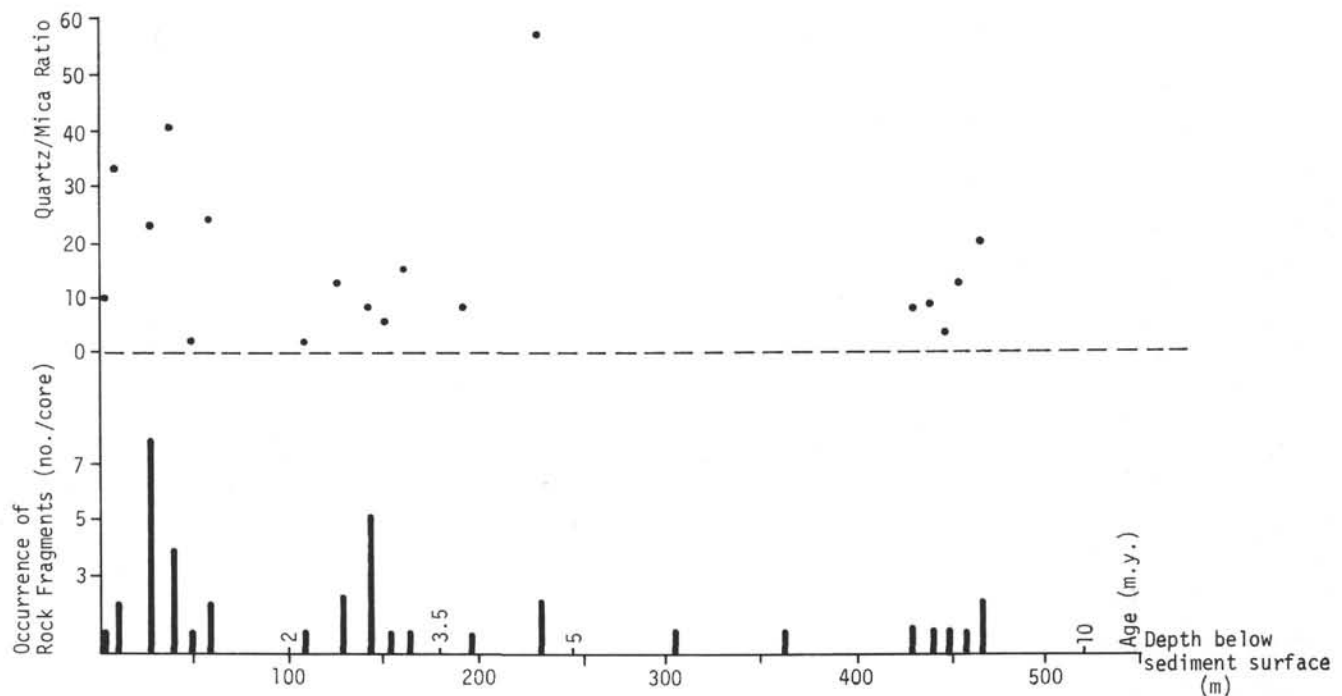
Figure 11. *Occurrence of rock fragments in Site 231 coarse fractions (as number of samples with rock fragments/core) and quartz/mica ratios of the same samples.*

TABLE 4
Occurrence of Rock Fragments
in Site 231 Sediments

Epoch	Sample	Abundance
Pleistocene	2-1, 33	Frequent
	3-4, 105	
	3-4, 129	
	5-3, 26	
	5-3, 56	
	5-3, 84	
	5-3, 88	
	5-3, 122	
	5-6, 65	
	5-6, 69	
	5, CC	
	6-1, 73	
	6-1, 118	
	6-2, 73	
	6-2, 107	
	7-2, 72	
	7, CC	
	8-5, 37	
	8-5, 127	
Upper Pliocene	13-5, 72	
	15-2, 74	
	15-3, 72	
	17-2, 56	
	17-2, 75	
	17-3, 15	
	17-3, 71	
	17, CC	
	18, CC	
	19-2, 43	
Lower Pliocene	22, CC	Rare
	26-4, 74	
	26, CC	
	34, CC	
Upper Miocene	40, CC	
	47, CC	
	48, CC	
	49, CC	
	50-2, 30	
	51-6, 1	
	51, CC	
Middle Miocene		

foraminifera, whose chambers are filled, suggest that the formation of glauconite has continued into Pleistocene times and that the source of it is not exclusively limited to glauconite-bearing Tertiary or Mesozoic strata. Gypsum also occurs in a very few samples. It is suspected to be the result of secondary alteration during sample treatment. This sometimes occurs if the samples are very rich in fine-grained pyrite. Idiomorph quartz crystals are also rare, and it is not clear whether or not they are reworked.

Biogenic Components

The biogenic components from the coarse fraction at this site are dominantly calcareous. Only six of the investigated samples contain less than 80% calcareous particles (Figure 6c). The distribution of the major fossil group (Figure 6c) shows clearly the siliceous components are almost absent in middle Miocene to lower Pleistocene sediments. Essentially they do not appear before the upper Pliocene and reach maximal proportions (never more than 12% of the biogenic components) in Pleistocene deposits. Components of other than siliceous or calcareous composition occur most frequently during the Miocene, while their

proportion diminishes in younger sediments in favor of calcareous particles.

Calcareous plankton found in these sediments consists of planktonic foraminifera, pteropods, gastropod and bivalve larvae, and ostracods. The fragmented shells of pteropods occur frequently in Pleistocene sediments, but are otherwise virtually absent (except in a very few samples younger than middle Miocene). Although they have been found mostly in sandy horizons, they exist also in the intercalated fine-grained nanno oozes; their presence suggests a better calcium carbonate preservation than in pre-Pleistocene sediments. The planktonic foram and pterpod data are summarized in Figures 12 and 13, respectively. The gastropod and bivalve larvae are rare to common in Pleistocene coarse sediments, but are not found in most of the fine-grained nanno oozes.

Benthic calcareous components consist of algal crusts, foraminifera, bivalves and gastropods, coral and bryozoan fragments, ostracods, and echinoid debris. Benthic foram and echinoderm data are tabulated in Figures 14 and 15. Algal crusts are found in upper Pliocene and Pleistocene coarse horizons. Bivalves (mostly fragmented) and more seldom gastropods are components belonging to the suite of shallow-water-derived material. Their scarcity in middle Miocene sediments and their increasing abundance in the younger deposits illustrate the greater input of shallow-water-derived material. Fragments of corals and bryozoans are confined to middle Miocene and Pleistocene samples. Ostracods occur in almost all cores.

Siliceous components consisting of diatoms, Radiolaria, and sponge spicules are tabulated in Figures 16, 17, and 18 respectively.

Hystrichosphaerids and plant debris also occur here. The plant debris reaches a peak of abundance in upper Miocene to Pleistocene sediments.

Arenaceous benthic foraminifera are rare to common in the sediments. The latter is surprising since they usually are not preserved in marine sediments.

Fish remains (both teeth and fragments of bones) occur most frequently in middle Miocene sediments, slowly decreasing in abundance to a minimum in Pleistocene deposits.

Coarse Fractions, Sites 232 and 233

Sites 232 and 233 are situated to either side of the 5000-meter-deep Alula-Fartak Trench (Laughton et al., 1970) at the mouth of the Gulf of Aden. The Alula-Fartak Trench is a northeast-southwest-trending transform fault offsetting the western continuation of Sheba Ridge toward the southwest. Despite the small distance between these sites, Site 232 supposedly was located over basement older than 10 m.y., while northeast of the crest of Sheba Ridge, Site 233 was located above basement close to "magnetic anomaly 3" (= 5 m.y.). This geologic difference (see Figure 19) was expected to be displayed by differences in the nature of the basement and by the nature of the overlying sediments.

Site 232

The holes drilled at Site 232 on the northwest flank of the Alula-Fartak Trench underlie 1743 (Hole 232) and 1726 (Hole 232A) meters of water, respectively. After
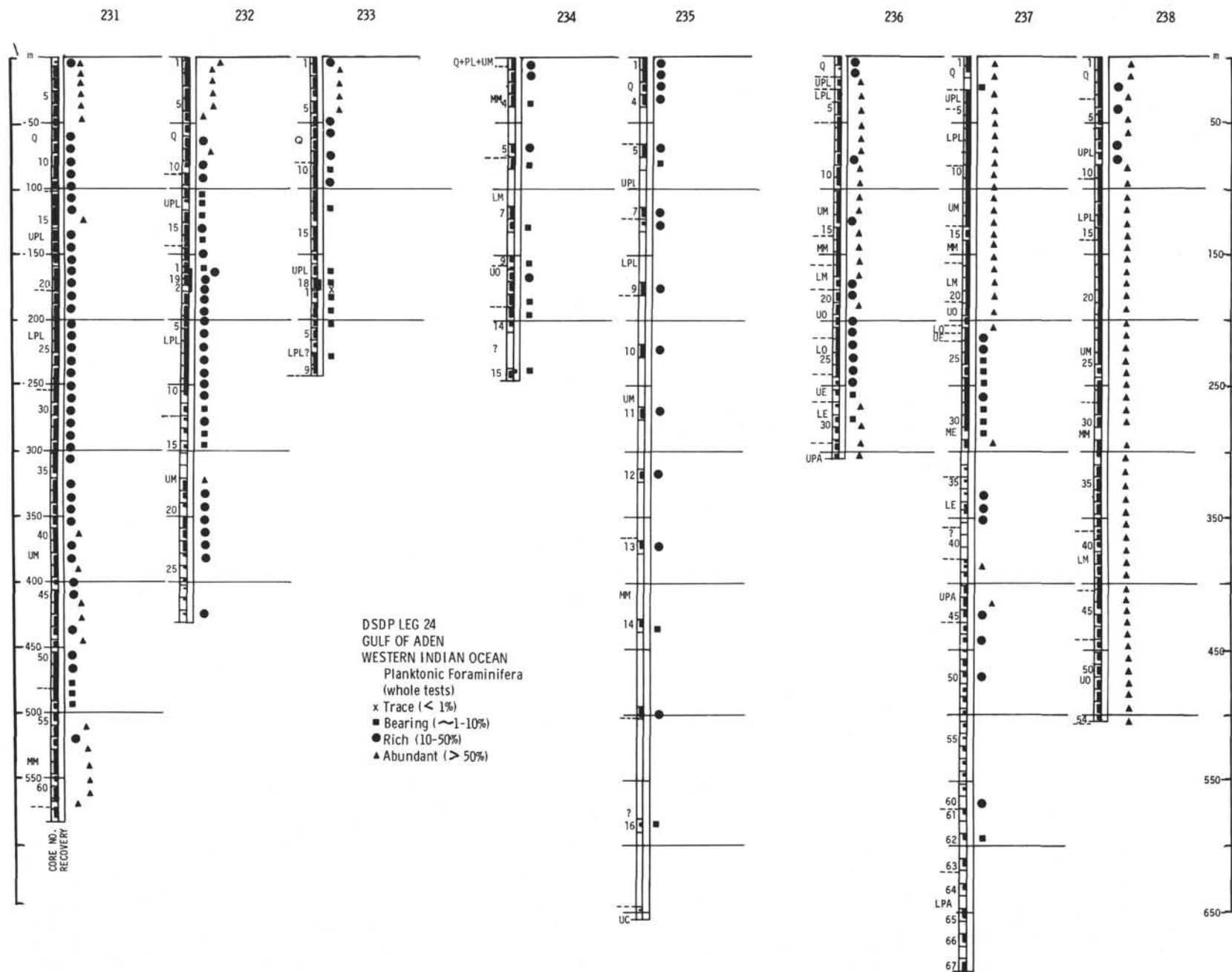
Figure 12. *Distribution of planktonic foraminifera (whole tests), based on percentages of biogenic components of coarse fractions. Only maximal value of each core is given (compare with Appendix).*
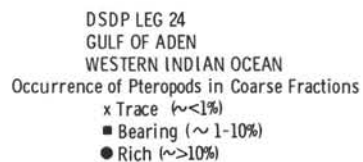
Figure 13. *Occurrence of pteropods in Leg 24 coarse fractions (in percent of biogenic coarse fraction components).*

Figure 14. *Occurrence of calcareous benthic foraminifera in Leg 24 coarse fractions (only highest value in each core is given), based on percentages of biogenic components.*

SEDIMENT COARSE FRACTIONS
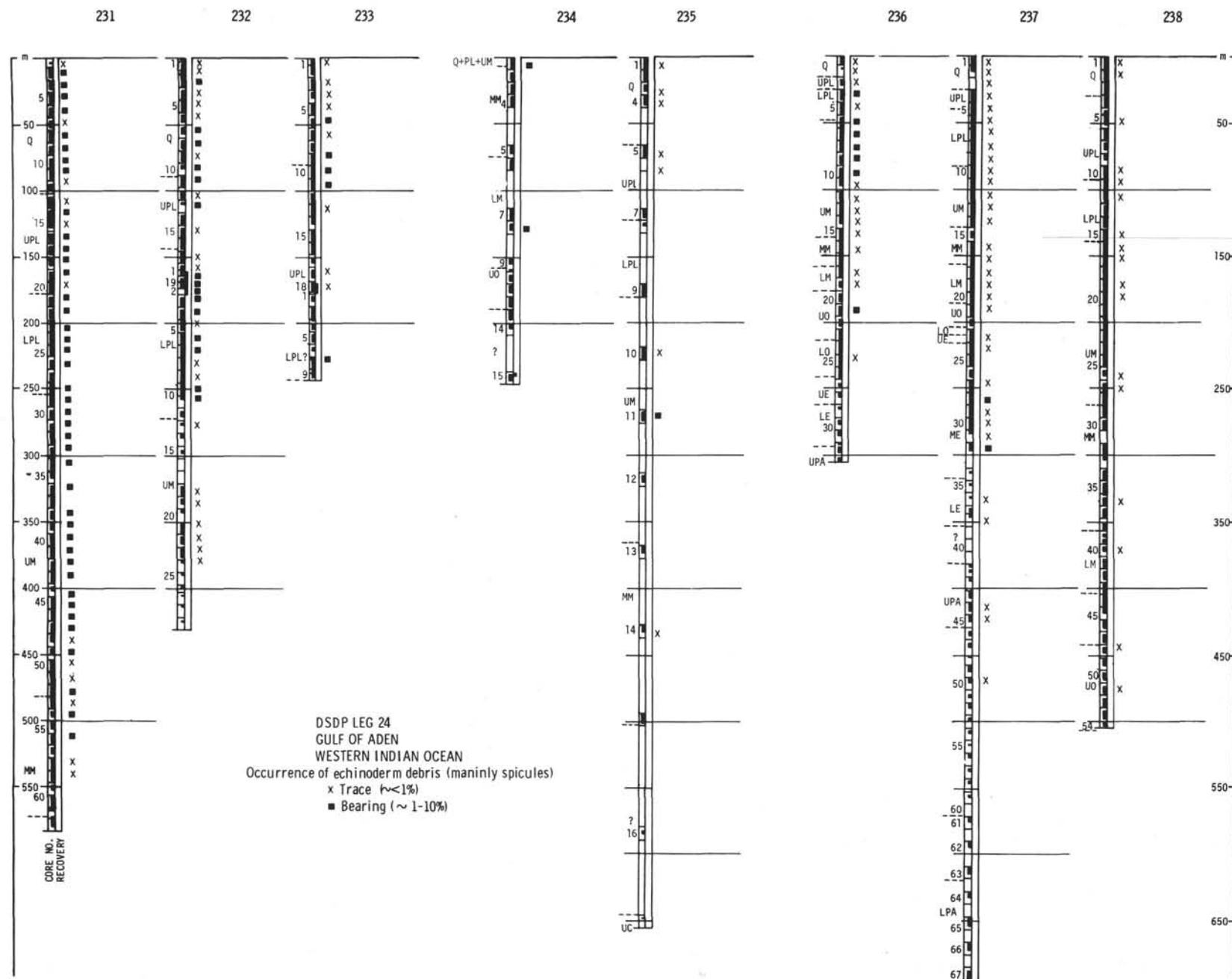
Figure 15. *Occurrence of echinoid debris (mostly spicules) of Leg 24 coarse fractions (only highest value is given for each core), based on percentages of biogenic components.*
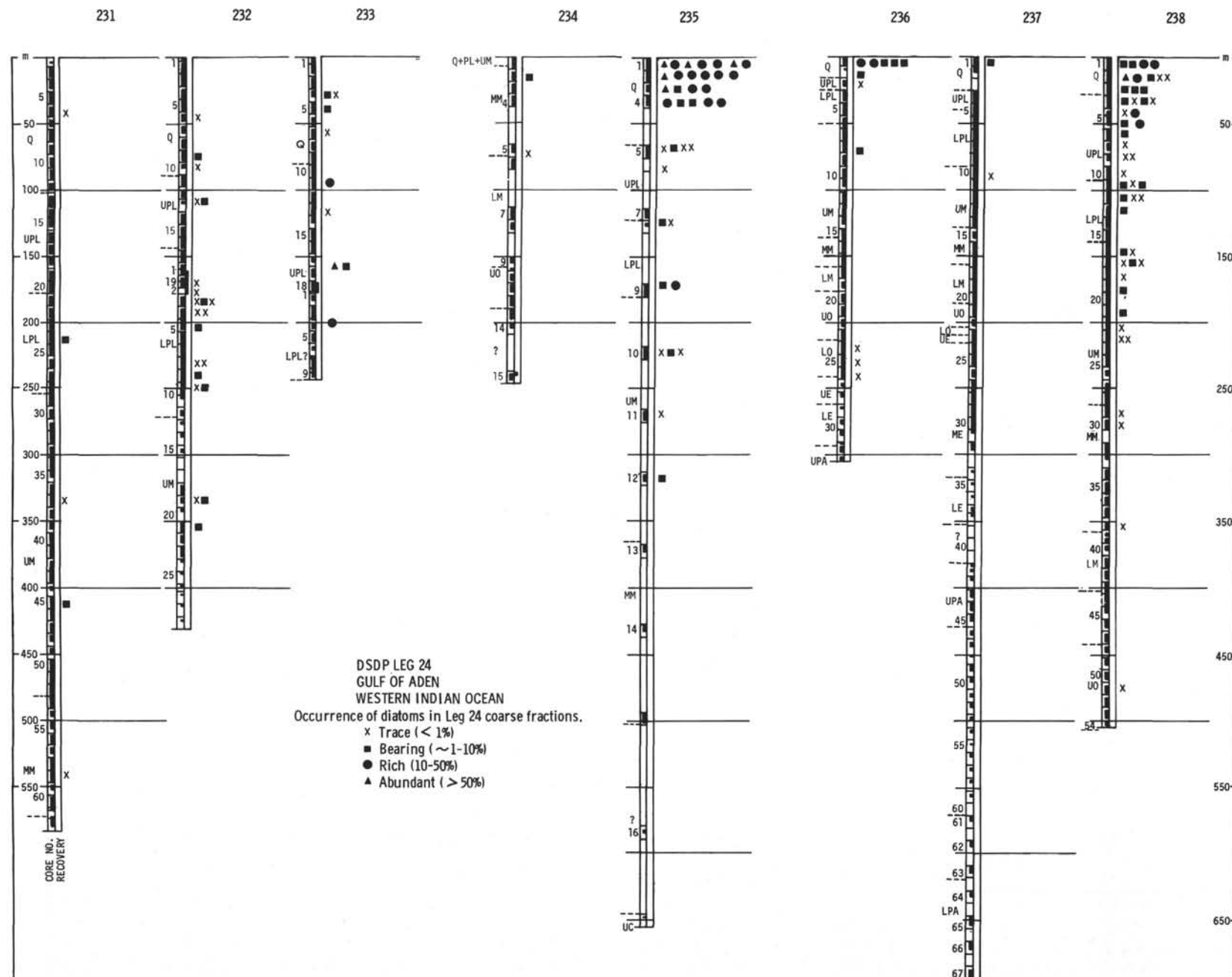
Figure 16. *Occurrence of diatoms in Leg 24 biogenic components of coarse fractions (each point indicates abundance in one sample, samples with no diatoms have been omitted).*
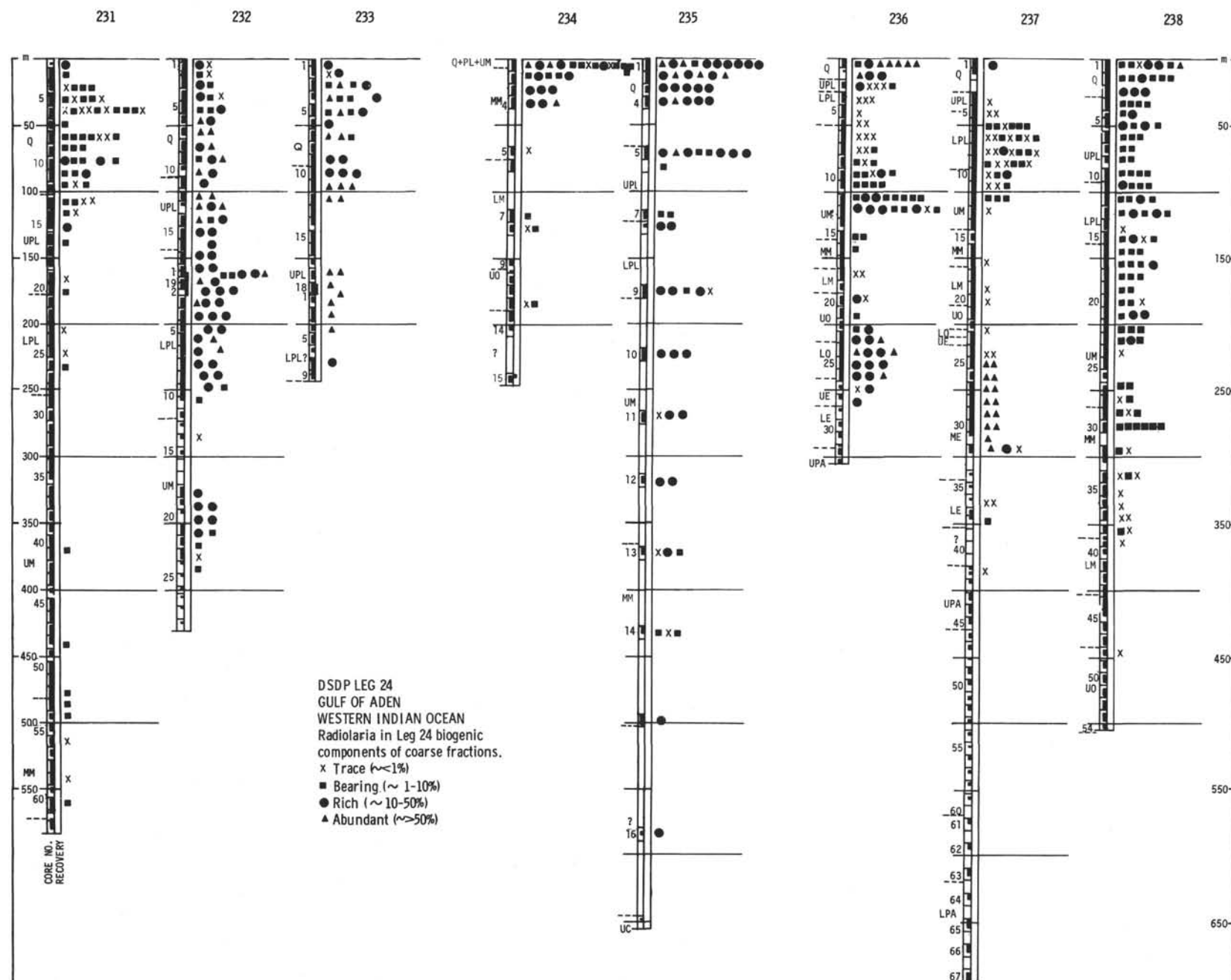
Figure 17. *Occurrence of radiolarian skeletons in Leg 24 biogenic components of coarse fractions (each signature represents one sample; samples without radiolaria have been omitted).*
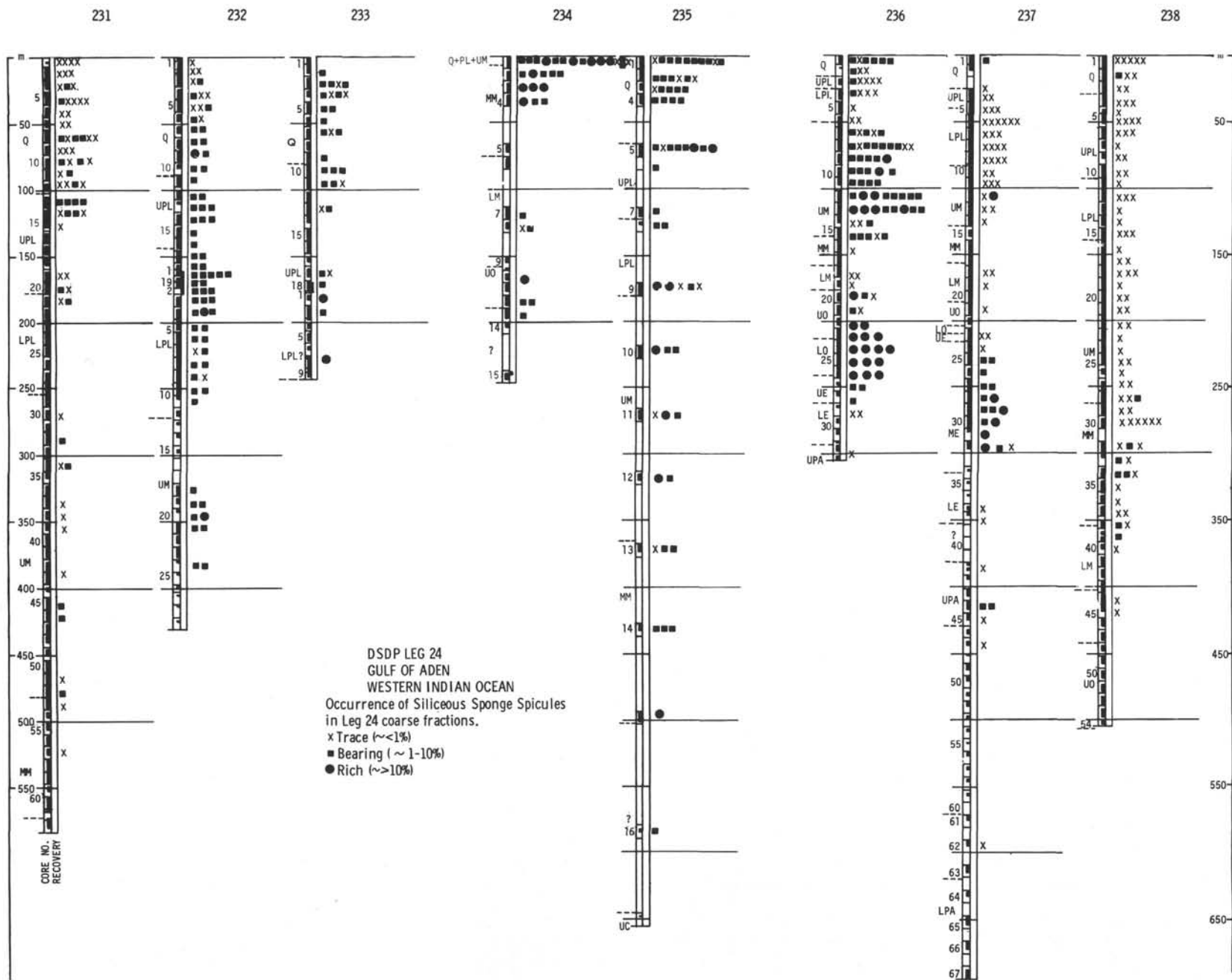
Figure 18. *Occurrence of siliceous sponge spicules in Leg 24 coarse fractions (proportions of biogenic components; each signature represents one sample; samples without sponge spicules have been omitted).*

SEDIMENT COARSE FRACTIONS
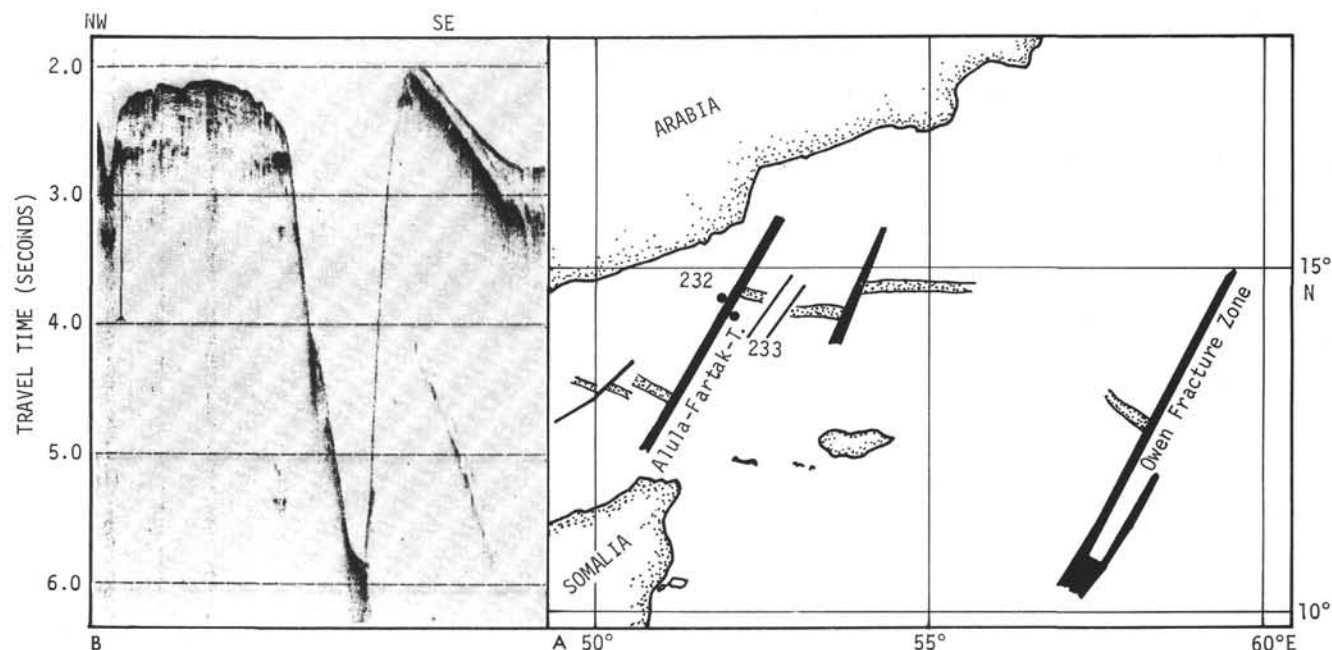
Figure 19. *Geological setting of Sites 232 and 233.* (A) *Sketch map delineating Sheba Ridge and Alula-Fartak Trench (from Laughton et al., 1970);* (B) *Seismic reflection record (airgun) of* Glomar Challenger *across the Alula-Fartak Trench close to DSDP sites.*

penetration of the sedimentary sequence, "acoustic basement" was reached at a depth of 396.5 meters. The lithology of this horizon is lithified quartzose sandstone > 20 meters thick of apparent upper Miocene age (Plate 3, Figure 2). The overlying sequence ranges from upper Miocene to Pleistocene in age. The sediments were divided into six different lithologic units based mainly on different proportions of clastic terrigenous components. Of 434 meters of material penetrated, 392 meters consist of nannofossil oozes. The input of clastic terrigenous material reaches a maximum during deposition of silt and sandstone during upper Miocene.

The recovered sediments range texturally from silty clays to sands (Figure 20a), consisting of a diverse assemblage of dominantly terrigenous components (based on X-ray determinations: dolomite, quartz, K-feldspar, plagioclase, kaolinite, mica, chlorite, montmorillonite, palygorskite, amphibole, and calcite). The calcite consists of either biogenic remains or micarb (fine-grained calcareous matter of uncertain origin). Organic carbon contents range from 0.2% to 1.3%, while calcium carbonate ranges from 5% to over 60% in the Quaternary sediments. All the sediments gave off strong odors of H_2S.

The dusky yellow-green nanno oozes are fairly uniform in color. The silt and sandstone layers are medium to dark gray. As at Site 231, sedimentary structures and burrow mottling are very unevenly distributed. Sedimentary structures are common throughout the whole section except in a few upper Miocene and lower Pliocene cores (Figures 21A to C, Figure 22). Burrows commonly were found only in uppermost Pliocene and Pleistocene deposits, while they are scarce elsewhere in these sediments (Figure 22).

The proportion of coarse fraction is rather small in most samples, reaching higher values only in individual layers. The dominant components are clastic terrigenous grains,

particularly in upper Miocene and Pliocene sediments (Figure 20b, Plate 3). With decreasing age, biogenic components become more important and are virtually the only constituents in Pleistocene sediments. Authigenic minerals were found rarely in sediments younger than upper Miocene, where in one sample they reach a maximum of 50%. Pore-water salinities measured onboard and the frequent occurrence of gypsum in the lowermost part of Site 232 may indicate the presence of evaporite-bearing older sediments below the layers sampled.

Site 233

At Site 233 (1839 m water depth) on the southeastern flank of the Alula-Fartak Trench "acoustic basement" was reached after penetrating 237 meters of sediment. After penetrating a diabase body drilling rates increased, suggesting that this was a sill underlain by sediments. No samples were recovered from below the diabase due to a blocked drill bit. The deposits ranged from upper Pliocene to Pleistocene. Eight lithologic units, based mainly on variations of the micarb proportions, were distinguished.

The recovered sediments are very fine grained (Figure 23a) and belong texturally (based on smear slide analysis) almost exclusively to clays. However, shore-lab grain size determinations have shown that they contain much more silt than determined onboard ship. Organic carbon content ranges from 0.8% to 2.8% and the calcium carbonate content between 40% and 70%. X-ray diffraction determinations show a mineral assemblage similar to that at Site 232. Sedimentary structures are scarce in pre-Pleistocene sediments, but common in Pleistocene deposits (Figure 24). Burrowing and mottling was almost absent except in the uppermost Pliocene and Pleistocene sediments (Figure 22).

To illustrate the nature of the sediments of both Alula-Fartak-Trench sites, micrographs of the smear slides

Figure 20a. *Clay-silt-sand triangle diagram of Site 232, based on smear side analyses.*

232 and 232A
1 Pleistocene
2 Upper Miocene
3 Lower Pliocene
4 Upper Miocene
+ DSDP values

Figure 20b. *Distribution of biogenic-clastic-authigenic components in Site 232 sediments, based on coarse grain analyses.*

232 and 232A
1 Pleistocene
2 Upper Pliocene
3 Lower Pliocene
4 Upper Miocene

Figure 20c. *Composition of tests and skeletons in Site 232 sediments (calcareous, siliceous and other material), based on coarse grain analyses.*

of this site are shown in Plates 4 and 5. The smear slide results (see Appendix B of this chapter and Sediment Summary chapter, this volume) as well as the coarse grain analysis showed clearly the decreasing proportion of terrigenous components in the sediments with decreasing age (Figure 23b) in favor of biogenic components. There seems to be an almost complete change from terrigenous upper Pliocene coarse-fraction assemblages to entirely biogenic Pleistocene ones. Authigenic minerals are rare.

Terrigenous Components, Sites 232 and 233

The terrigenous components of coarse fractions from Sites 232 and 233 are so similar to the coarse-fraction assemblages from Site 231 that very few additional remarks are needed. The occurring particle types are summarized in Table 5. Quartz/mica ratios are highly variable in sediments of both sites despite their apparent homogeneity (Figure 25).

Authigenic Components, Sites 232 and 233

As at Site 231, pyrite and glauconite are the main authigenic components of these coarse fractions (Table 5). Pyrite is more frequent in the basal part of both sites, but its proportion decreases in the Pleistocene sediments in favor of glauconite. Pyrite is found as a pseudomorph of siliceous fossils in the upper Miocene and lower Pliocene sediments of 232. Gypsum was found rarely in the coarse fractions of both sites presumably being a result of the laboratory processing. However, it occurs more frequently

in Miocene sediments at Site 232 than would be expected due to this treatment.

Biogenic Components, Sites 232 and 233

The biogenic components of both sites, like the terrigenous components, are almost identical. The data are plotted in Figures 20c and 23c and tabulated in Table 5. Calcareous fossils are dominant at both sites in pre-upper Pliocene and Pleistocene samples. Siliceous fossils formed the major biogenic constituent during upper Pliocene and reach higher proportions in Site 233 than in Site 232 sediments.

Planktonic foraminifera occur abundantly in the sediments of both sites (except in the sandstones of Site 232). Pteropods are confined to upper Miocene and Pleistocene of Site 232 only. Presumably shallow-water-derived biogenic components (bivalves, gastropods) were found dispersed in the sediments of Site 232 (in upper Miocene, lower Pliocene, and uppermost Pleistocene samples). At Site 233, however, they were restricted to upper Pliocene deposits, suggesting a possible source in the northwest or north now being separated off by the Alula-Fartak Trench.

Plant debris is very abundant in uppermost Miocene sediments of Site 232.

SOMALI BASIN SITES

Coarse Fraction, Site 234 (Western Somali Basin)

Holes drilled at Site 234 (west of Chain Ridge in the Somali Basin, 4721 m of water) penetrated sediments from
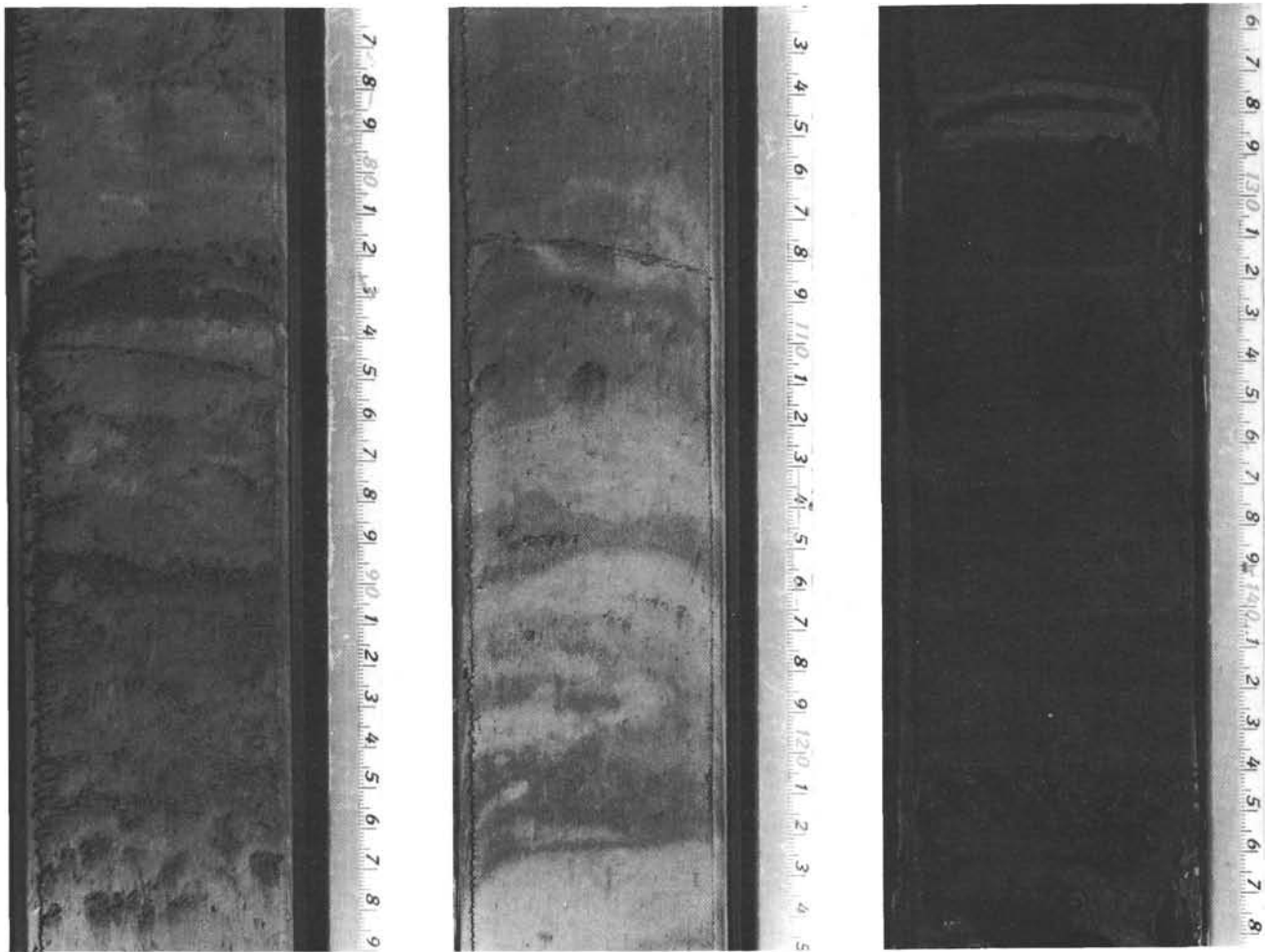
Figure 21. *Sedimentary structures at Site 232; (A) 24-232-4-6(102-125), Pleistocene nanno ooze with slight color changes, which indicate bedding planes. Some burrows are filled by coarse material; (B) 24-232-7-4(76-99), Pleistocene nanno ooze with distinct layers; (C) 24-232- A-14-1(125-148), upper Miocene silty clay to sandy silt with intercalated quartz sand layers; the main sedimentary components are terrigenous, while plant debris is dominant with the biogenic fraction of the sediment (compare data of coarse fraction analysis).*

lower Oligocene to Plio/Pleistocene in age (although major parts of this section could not be dated due to the lack of suitable fossils). The sediments consist dominantly of very fine clays, nanno clays, and oozes which yield only very small coarse fractions except for some horizons in the Plio/Pleistocene and the Oligocene part of the section (Figures 4, 26, 27). The sediments are very homogeneous and sedimentary structures are rare. The few visible ones are mainly due to color changes (Figure 28) and, to a lesser degree, to textural changes. The colors of the sediments are mostly pale green to greenish-gray, olive-gray, and other greenish and bluish hues. Burrows are not abundant but are found in nearly all cores. Often they are visible only because of very fine-grained pyrite coatings.

Organic carbon ranges from 0.2% to 0.3%; the calcium carbonate content ranges from 0.0% to 45.0%. X-ray diffraction analyses show the presence of the following minerals: amphibole, calcite, chlorite, dolomite, quartz, K-feldspar, plagioclase, kaolinite, mica, montmorillonite, palygorskite, and pyrite. Montmorillonite reaches a maximum in the deepest sediments at this site. This is presumably the reason for finally forcing abandonment of both holes without reaching basement. Texturally most of the analyzed sediments were clays (Figure 26a).

The recovered cores are divided into six different lithological units as indicated in the site report. These units are predominantly divided on the basis of calcium carbonate content. Although the sediments of this site appear homogeneous, the coarse fractions show a wide variety of components (Figures 26b, 26c, 27). In nearly all samples terrigenous grains are more predominant than at other sites of the open Indian Ocean. Horizons with coarse fractions, which are nearly all terrigenous material, are found at all depths (Figure 26b). Miocene and upper Oligocene sedi-
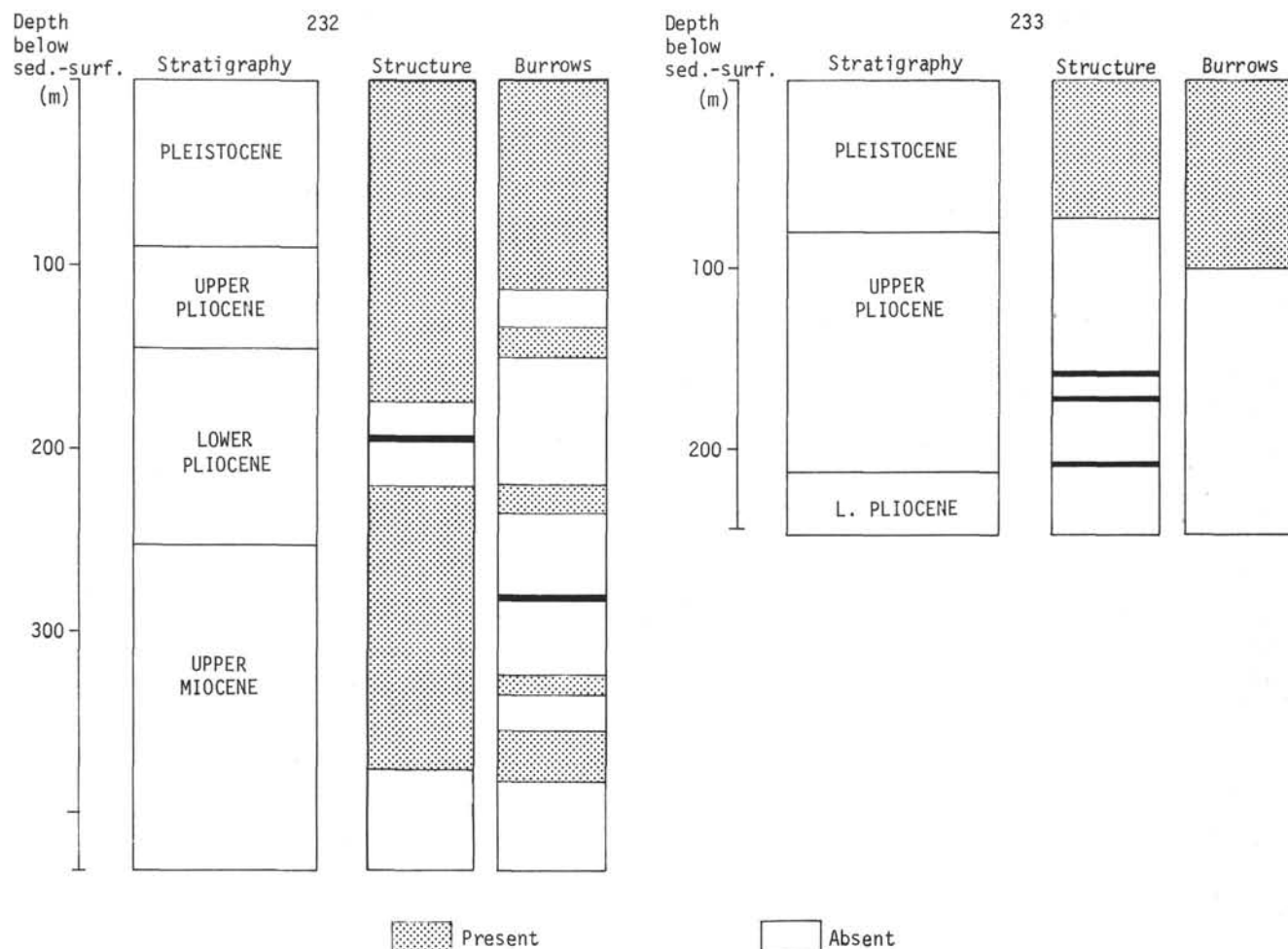
Figure 22. *Gross distribution of sedimentary structures and burrowing/mottling in sediments of Sites 232 and 233.*

ments seem to be richer in authigenic components than the Plio/Pleistocene parts of the section. Only rarely does the major part of the coarse fraction consist of biogenic remains (Figure 29A and B).

Terrigenous Components

The composition of the main terrigenous grain assemblages is indicated in Table 6. Most of these grains are confined to the 0.063-0.150 mm size fraction. The following minerals are found: quartz, feldspar, mica, heavy minerals, dolomite rhombs, volcanic glass, and ash fragments. Quartz is the dominant terrigenous component; the grains are always small and mostly angular. Mica is the second most important clastic component, but is always rarer than quartz. The quartz/mica ratios are always > 1 (maximal values 40 to 100 or more, see Figure 30). The heavy minerals presumably come from the same source as quartz and mica. Most questionable is the origin of the dolomite rhombs, but they characteristically accompany the fine-grained clastic mineral assemblages.

Volcanic glass shards are common constituents of these coarse fractions.

Authigenic Components

Five different authigenic components occur in the sediments of this site and often reach high proportions. The results are plotted in Figure 26b and tabulated in Table 6. Pyrite is found either in irregular forms, or as molds of fossils (in particular as chamber fillings of planktonic foraminifera). Pyrite pseudomorphs of siliceous fossils, particularly Radiolaria, diatoms, and sponge spicules, are frequently found in Oligocene and middle and upper Miocene sediments. Pyrite does not occur in the same sample as manganese nodule or crests.

Sand-sized, idiomorph, very light zeolite crystals occur frequently as accessory minerals in Oligocene to upper Miocene sediments. In a few cores they occur as distinct sand layers, particularly in Oligocene sediments, which also contain high proportions of montmorillonite. Zeolites seem to be more abundant in zones where virtually all calcium carbonate has been dissolved rather than in calcareous horizons.

Idiomorph quartz crystals occur in Oligocene or middle Miocene sediments, either isolated as single crystals or attached to siliceous fossils, particularly radiolarian skeletons. This indicates a diagenetic origin for these crystals.
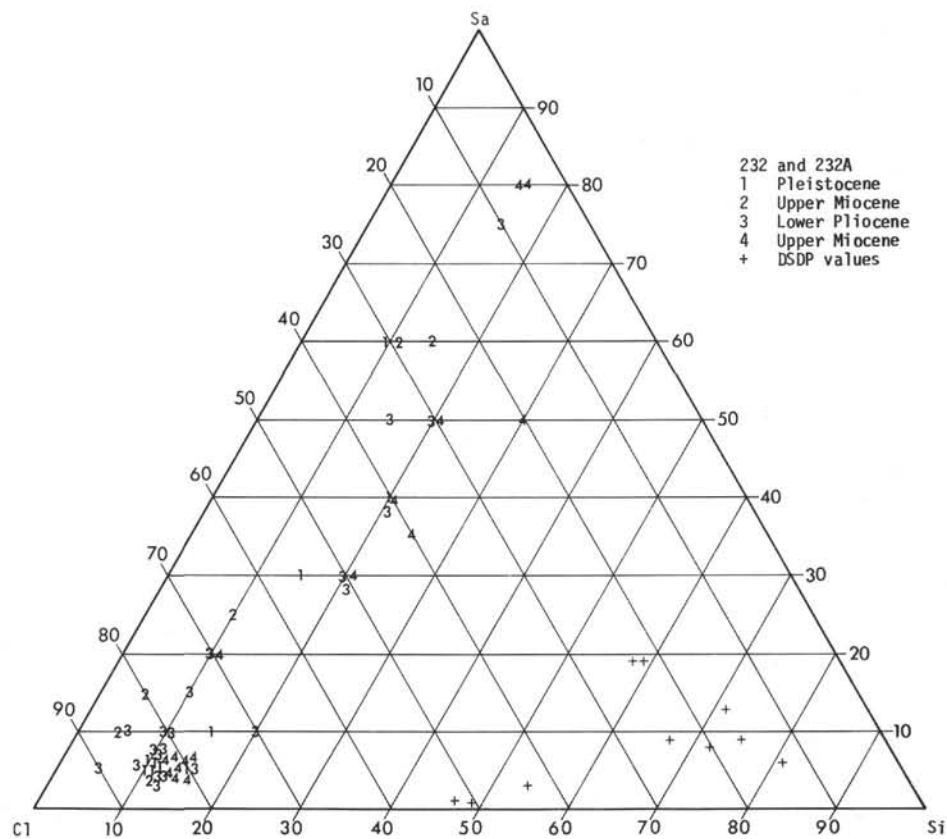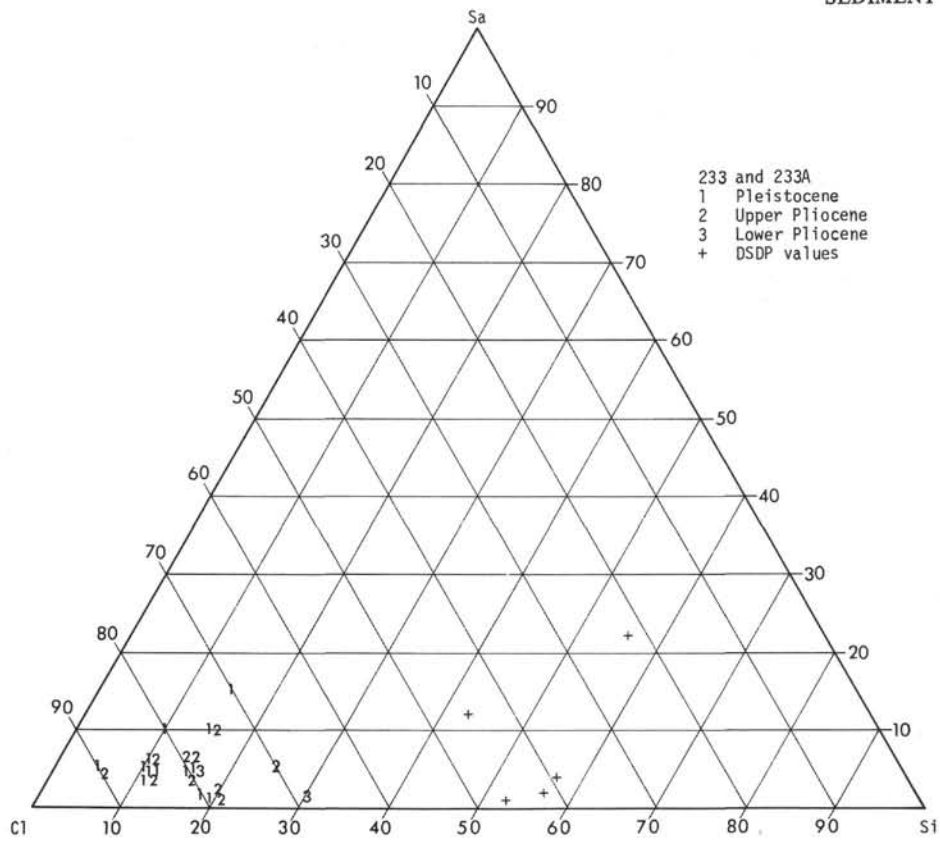
Figure 23a. *Clay-silt-sand triangle diagram of Site 233, based on smear slide analyses.*
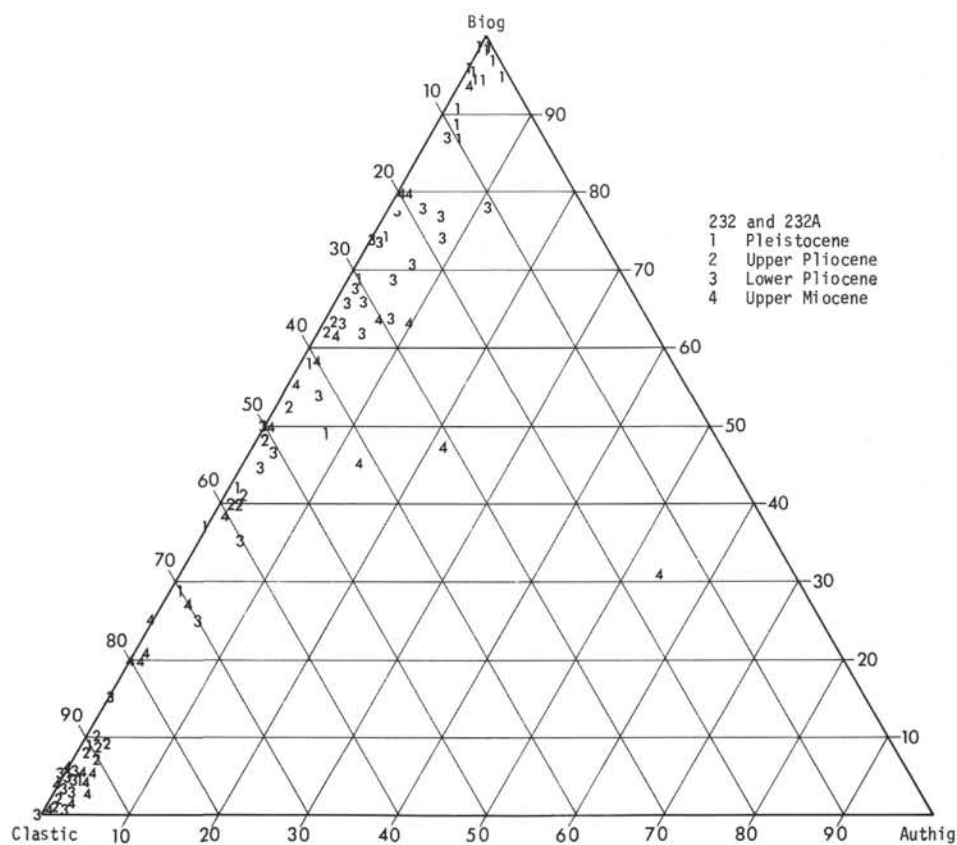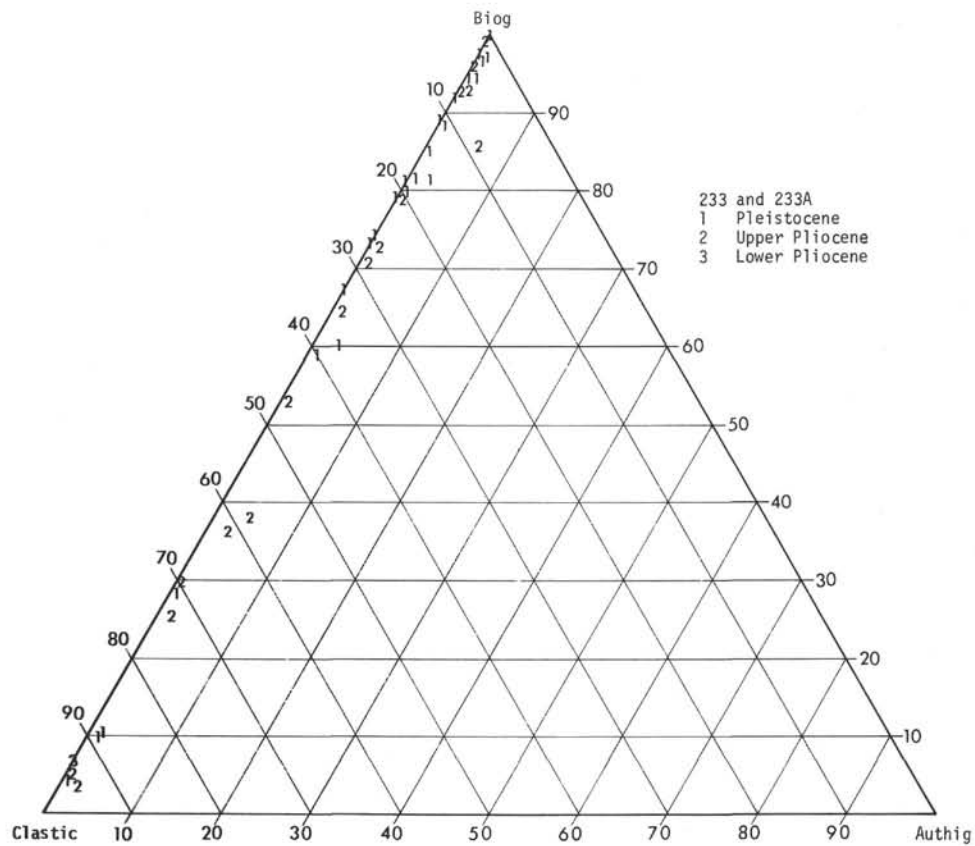

Figure 23b. *Distribution of biogenic-clastic-authigenic components in Site 233 sediments, based on coarse grain analyses.*
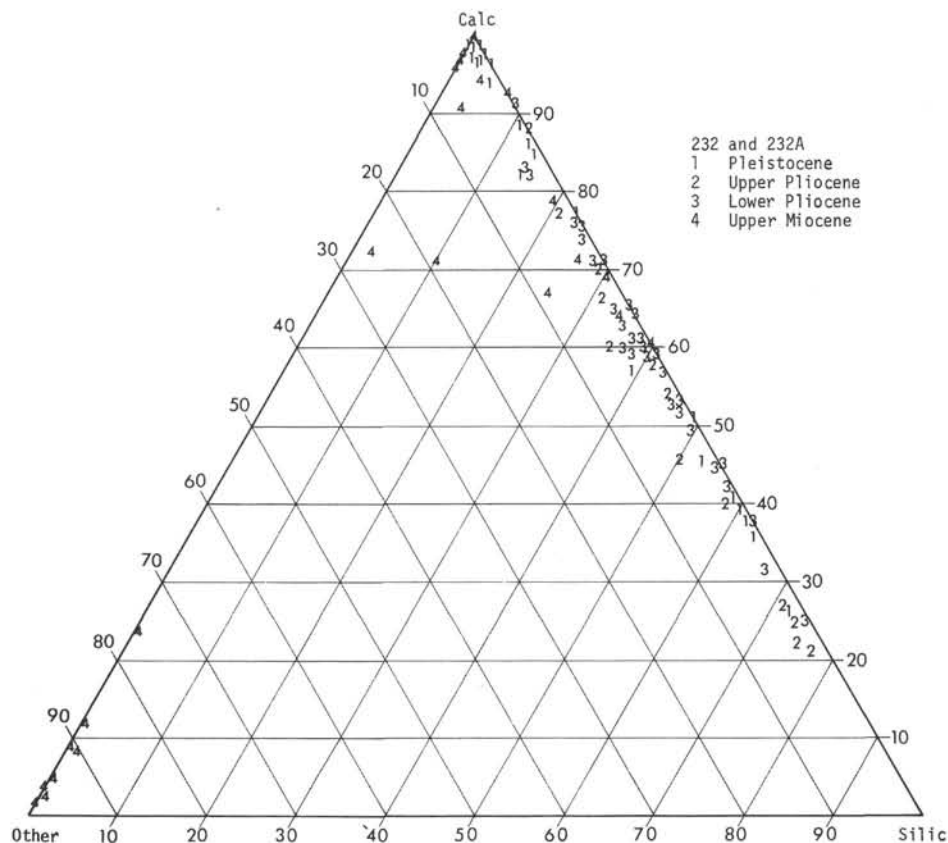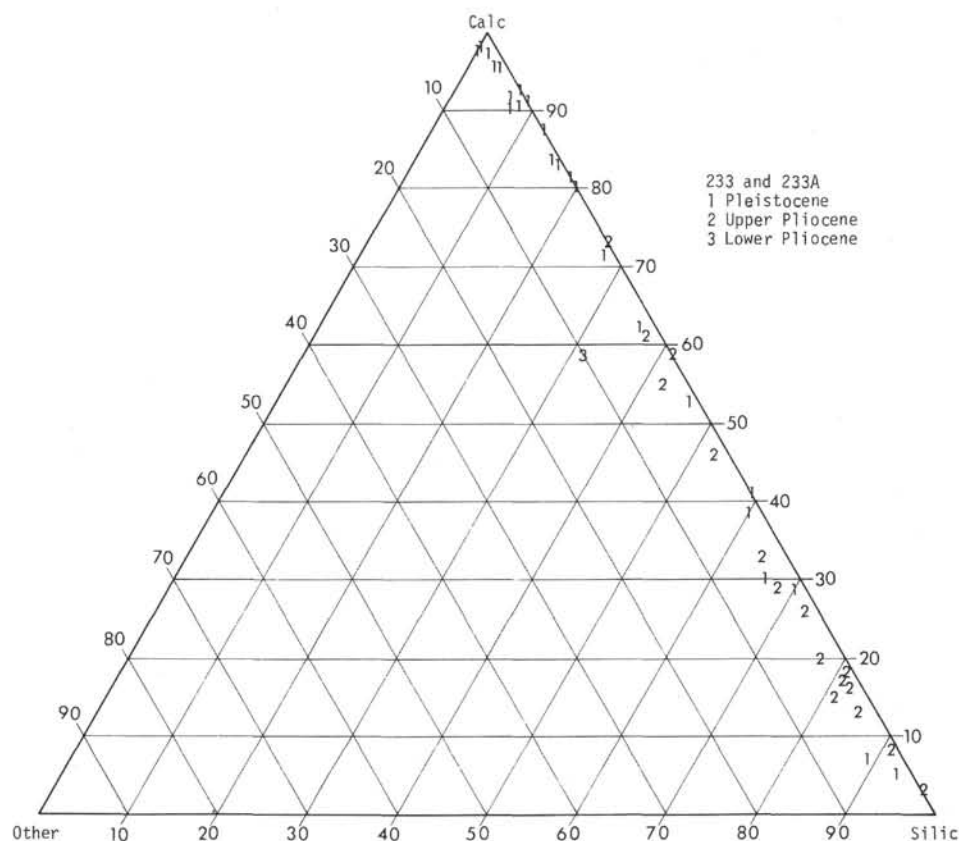
Figure 23c. *Composition of tests and skeletons in Site 233 sediments, based on coarse grain analyses.*

Biogenic Components

Biogenic components at this site contain a high proportion of noncalcareous and nonsiliceous fossils (Figures 26c, 27). Except for a few horizons in the Oligocene, Miocene, and the Plio/Pleistocene, calcareous fossils are dissolved. Pyrite pseudomorphs of siliceous fossils are abundant.

Biogenic components rare to abundant in the coarse fractions are calcareous and arenaceous, benthic, and planktonic forams, echinoids, Radiolaria, diatoms, sponge spicules, fish debris, hystrichosphaerids, and plant debris.

Fish debris is abundant at this site, possibly due to dissolution of diluting components, particularly siliceous and calcareous fossils. This is indicated by a high degree of fragmentation of planktonic foraminiferal tests (Figure 29B), a rather small foraminiferal plankton/benthos ratio and pyritization of many siliceous fragments.

Coarse Fractions, Site 235 (Eastern Somali Basin)

Site 235 is the second site in the Somali Basin. It is situated in about 5100 meters of water, east of Chain Ridge. The objectives at this site were to obtain sediments for comparison with Site 234 sediments, to date the sediments by means of their fossil content, and to attempt to establish a minimum age for the oceanic basaltic basement, which was reached almost 5800 meters below the water surface. Sediments ranging from Upper Creta-

ceous to Pleistocene were spot cored and recovered. The sediments consist of dark greenish to yellow-gray nanno oozes and nanno clays.

Sedimentary structures were detected because of slight color changes. Textural changes are visible only in Pleistocene cores. Burrows are very rare (Figure 31). Texturally the investigated samples are clays or silty clays (Figure 32). The organic carbon content ranges from 0.2% to 0.7% and the calcium carbonate content from 2% to 80%. X-ray analyses show the presence of the following minerals: calcite, dolomite, aragonite, quartz, K-feldspar, plagioclase, kaolinite, mica, montmorillonite, palygorskite, pyrite, phillipsite, and chlorite. This mineral assemblage is very similar to that at Site 234. The high montmorillonite content of the sediments caused difficulty in drilling (particularly in Pleistocene/Pliocene sediments at about 70-140 m below the sea floor).

Sediments recovered at this site can be divided into three lithologic units as indicated in the site report. Basis for these distinctions were color changes and, like Site 234, changes in the calcium carbonate content. The small amount of coarse fraction found in these fine-grained sediments (Figure 32a and Plate 6) is mostly biogenic in origin (Figure 32b). Clastic and authigenic components are of minor importance in the bulk of the samples. Pliocene and upper Miocene samples seem to be somewhat richer in authigenic components and middle Miocene sediments somewhat richer in terrigenous components.
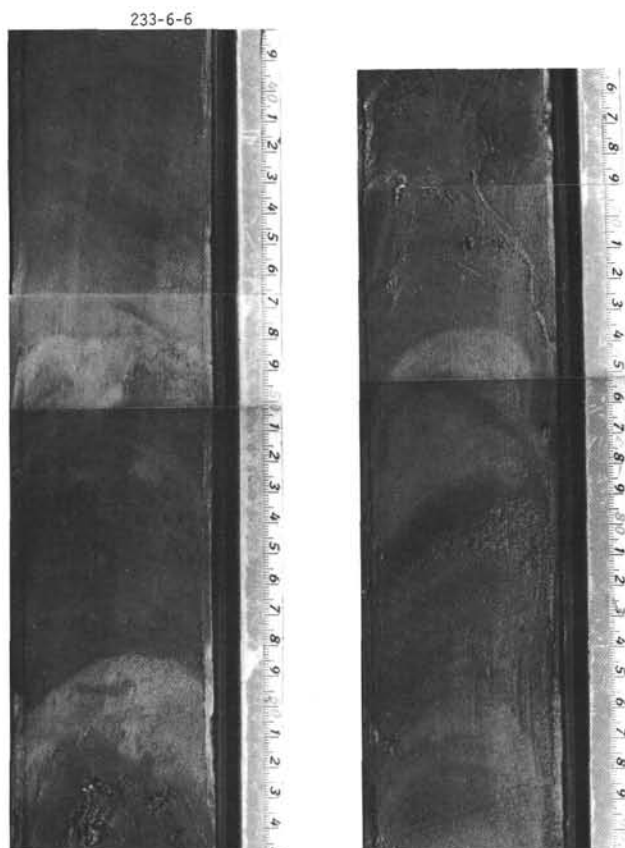
Figure 24. *24-233-6-6, Sedimentary structures in the very homogenous Pleistocene sediments consist mostly of simple color changes, similar to those at Site 232 (compare Figure 21A).*

Terrigenous Components

The terrigenous coarse fractions are found mainly in Miocene sediments. Pliocene deposits contain still fewer clastic grains and Pleistocene sediments almost none. The mineral assemblage is similar to that at Site 234 and consists mainly of mica and quartz. Heavy minerals, dolomite rhombs, and volcanic glass are minor components (Table 7). The quartz/mica ratio is smaller than 1 in surface samples and increases with increasing depth and age to values around 20 in the basal sediments. This is considerably different from the Site 234 sediments where the ratios are much higher (Figure 30). All other terrigenous grains are of minor importance and are scattered throughout the samples. Only colorless volcanic glass was found as a minor constituent in many samples, as at Site 234, indicating a constant but limited volcanic input to these basin sediments.

Authigenic Components

The authigenic components in the coarse fractions are similar to those at Site 234. They include pyrite, quartz,

zeolites, and glauconite and reach highest proportions in Pliocene and middle Miocene sediments (Figure 32b). Manganese nodules and crusts are not found here. Pyrite is the most important authigenic mineral found frequently in nearly all cores, and in many samples is a pseudomorph of siliceous tests, spicules, or fragments. Quartz rarely occurs as isomorph crystals, indicating an authigenic origin for this mineral.

Zeolites and glauconite only occur in the coarse fraction of undated, lowermost Core 16, which is low in calcium carbonate.

Biogenic Components

Test and shell materials of Site 235 coarse fractions are shown in Figure 32c. The bulk of the samples contains predominantly siliceous and calcareous fossils. Only a few Pliocene, upper, and middle Miocene samples contain high proportions of other shell material.

The following components contribute to the biogenic assemblages in the coarse fractions: calcareous and arenaceous benthic planktonic foraminifera, rare pteropod fragments, and rare ostracods, echinoid spicules, bivalve debris (occurring in same samples as pteropods), diatoms (mainly in Pliocene and Pleistocene sediment), abundant Radiolaria, sponge spicules, plant debris (most abundant in upper Miocene to lower Pliocene cores) and hystrichosphaerids.

Fish remains are present throughout the whole sedimentary column, reaching highest proportions in Cores 6, 8, 9, 10, 11, 12, 13, 14, 15, and 16 (base of hole to Pliocene).

CENTRAL INDIAN OCEAN SITES

Coarse Fractions, Site 236

This site is situated several hundred kilometers north of Seychelles Bank in 4487 meters of water in the outermost foothills of the Carlsberg Ridge. After penetration of 306 meters of nannofossil oozes, clays, cherts, and chalks (Pleistocene to upper Paleocene in age) basaltic oceanic basement was reached. The possible early Tertiary age of the sea floor based on magnetic anomalies (Fisher et al., 1968) was thus verified. Basement and surface topography roughly follow the strike of Carlsberg Ridge. The sediments encountered were divided into six lithologic units based on changes in calcium carbonate content. The underlying basalts (litho unit 7) also contain inclusions of recrystallized nanno chalks.

The usually rather fine-grained nanno oozes, chalks, and clays, which are yellow-gray to orange and, at the base, dusky brown, contain a great number of coarse-grained horizons suggesting a high proportion of reworked material (Figures 4, 33a). This theory is supported by the frequent occurrence of reworked Eocene, Oligocene, and Miocene micro- and nannofossils in younger sediments.

Primary sedimentary structures occur frequently throughout the whole section (Figure 34), but are often heavily disturbed by drilling and coring. Burrow mottling is very scarce. The calcium carbonate content varies between 0% and 95%; the organic carbon content ranges between 0.1% and 0.2%. X-ray diffraction shows the presence of the

TABLE 5
Occurrence of Terrigenous and Authigenic Components in
Coarse Fractions at Sites 232 and 233[a]

	Site 232		Site 233		
Stratigraphy	Terrigenous	Authigenic	Terrigenous	Authigenic	Quartz/Mica Ratios
Pleistocene	Quartz, mica, feldspar, heavy minerals, rock fragments dolo rhombs, volcanic glass	Glauconite, pyrite	Quartz, mica, feldspar, heavy minerals, dolo rhombs volcanic glass	Glauconite, pyrite, (gypsum?)	Compare Figures 1 and 2
Upper Pliocene	Quartz, mica, heavy minerals, dolo rhombs, rock fragments	Pyrite, glauconite	Quartz, mica, feldspar, dolo rhombs, heavy minerals	Pyrite, glauconite (gypsum?)	
Lower Pliocene	Quartz, mica, heavy minerals, dolo rhombs, volcanic glass	Pyrite, glauconite, zeolite			
Upper Miocene	Quartz, mica feldspar, heavy minerals, dolo rhombs	Pyrite, glauconite, zeolite, gypsum, (quartz)			

[a]Underlined components occur frequently, others only rarely.
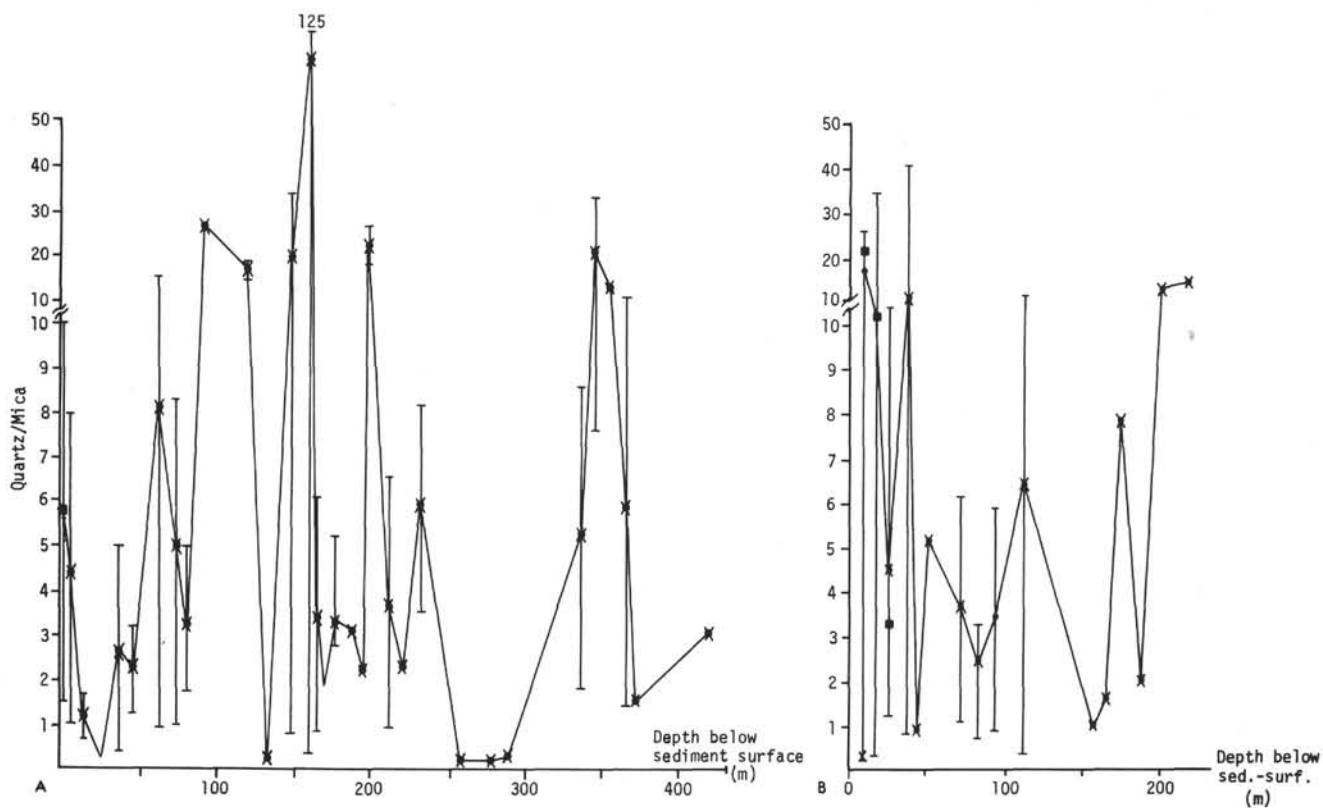
Figure 25. (A) *Quartz/mica ratios in Site 232 coarse fractions;* (B) *Quartz/mica ratios in Site 233 coarse fractions.*
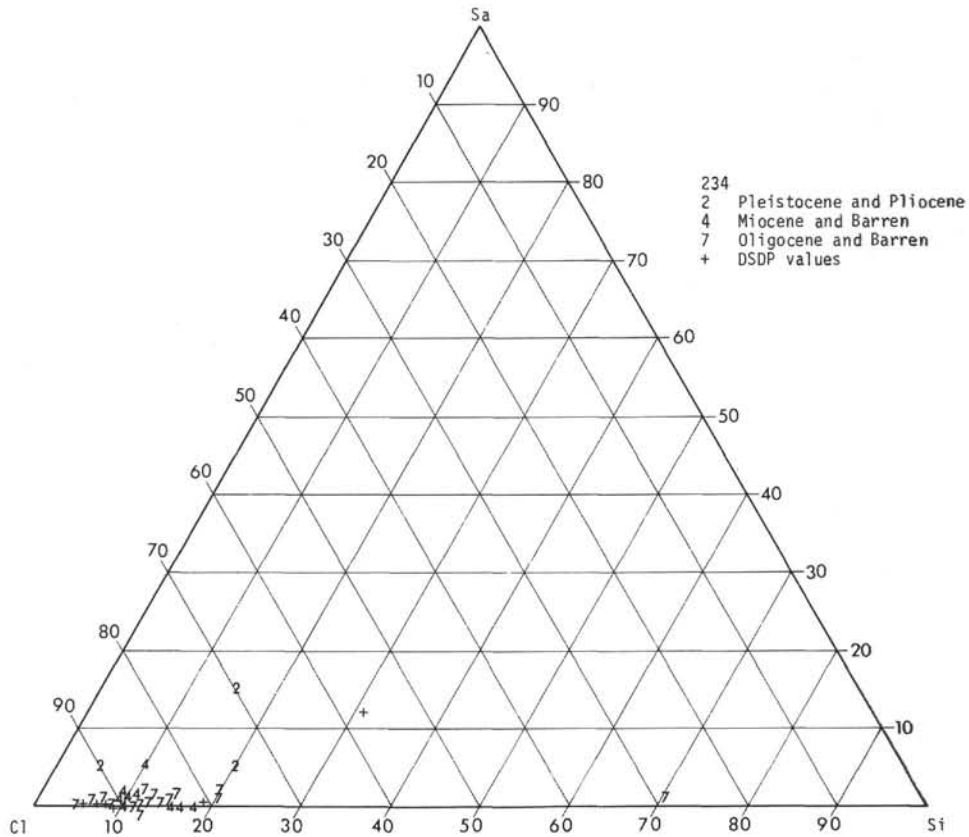
Figure 26a. *Clay-silt-sand triangle diagram of Site 234, based on smear slide analyses.*
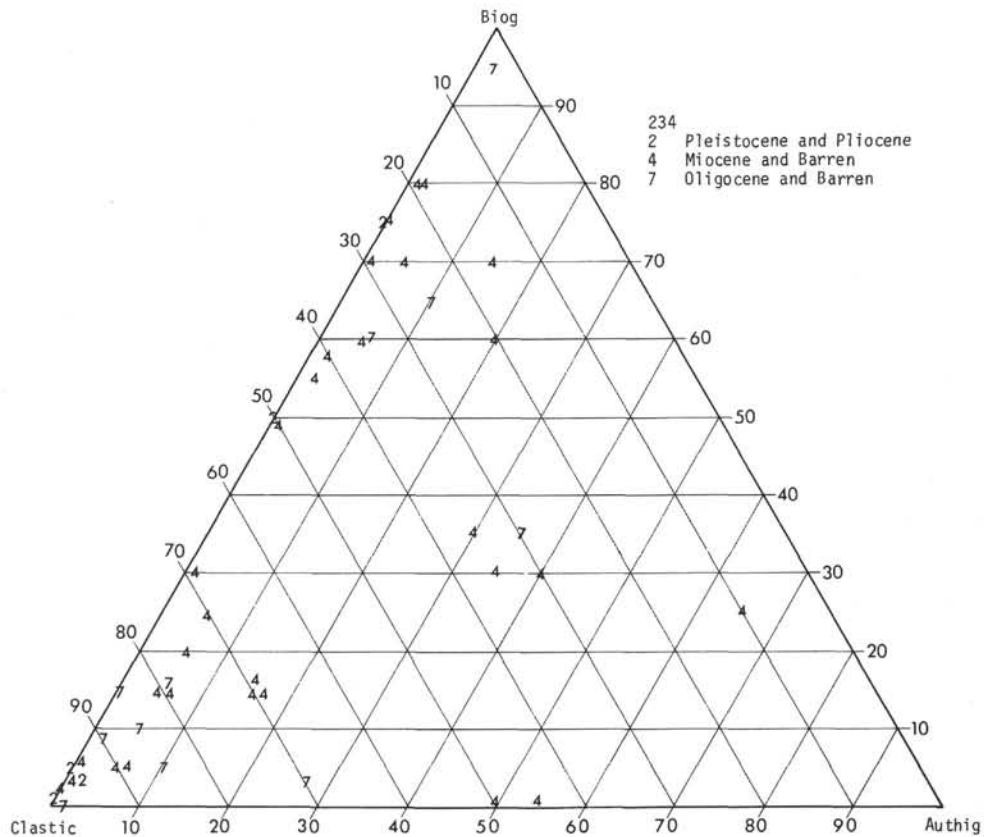
Figure 26b. *Distribution of biogenic-clastic-authigenic components in Site 234 sediments, based on coarse grain analyses.*
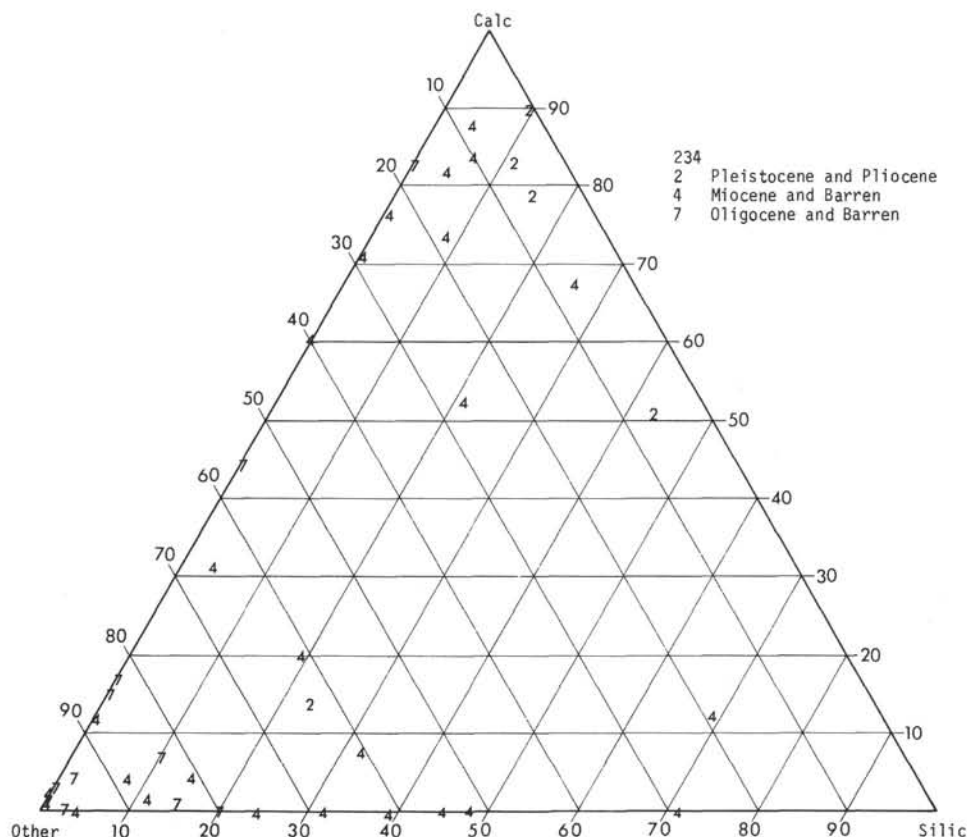
Figure 26c. *Composition of tests and skeletons of Site 234 sediments (calcareous, siliceous and other material), based on coarse grain analyses.*

following minerals aside from calcite: dolomite, aragonite, K-feldspar, plagioclase, kaolinite, mica, montmorillonite, palygorskite, clinoptilolite, phillipsite analcite, pyrite, barite (gypsum and halite).

The coarse fractions are almost entirely biogenic, with the exception of Miocene sediments.

Terrigenous Components

The proportion of terrigenous clastic components is small (Figure 33b), and, in the bulk of the samples, less than 1%. Only a few Miocene and Oligocene horizons contained a sizable clastic fraction.

Clastic components are tabulated in Table 8. Quartz is rare and the majority of the grains are small and angular, but in samples with rock fragments somewhat bigger grains are found. Mica is a rare constituent and together with dolomite rhombs and fine-grained quartz might be an eolian contribution to the sediment. Not enough grains were found for a determination of the quartz/mica ratio.

Rock fragments were found in upper Miocene and Pliocene sediments. They are limited to sandy horizons (see Table 9 and Appendix A) and occur together with shallow-water benthic foraminifera. The rock fragments consist of limestone fragments and crystalline, granite-like rocks. The source for these components, all three foreign to a pelagic deep-water environment, may be somewhere very close to Seychelles Bank because there (if no speculation about unknown microcontinents is made) would be the nearest outcrop of continental crust with similar rocks. This

would provide an explanation for the limestone fragments and also for the occurrence of shallow-water benthic foraminifera.

Volcanic glass is found mainly in Oligocene and Miocene sediments and usually consists of very light glass particles. Volcanic ashes are indicated in Table 9.

Authigenic Components

Glauconite, zeolite, and pyrite occur rarely as single grains as indicated in Table 8. The Miocene and Pliocene glauconite was found mainly in the sandy horizons and might therefore, at least in part, be redeposited.

Biogenic Components

Calcareous biogenic grains predominate throughout the recovered section (Figure 33c). They consist of forams (benthic and planktonic), rare pteropods, echinoids, algal crusts, fragments of corals, bryozoans, and bivalves (the last four indicative of a shallow-water source. Table 10). Siliceous fossils consist of diatoms (occurring in single horizons in the upper Miocene and lower Oligocene), Radiolaria (frequent only in upper Miocene and upper Eocene to upper Oligocene samples), and sponge spicules whose frequency is correlative with that of the Radiolaria (Figure 35).

Rare plant debris and arenaceous benthic foraminifera also occur along with fish debris, a common component of these sediments. They occur in almost all post-upper Oligocene samples but are rare before. The peak of
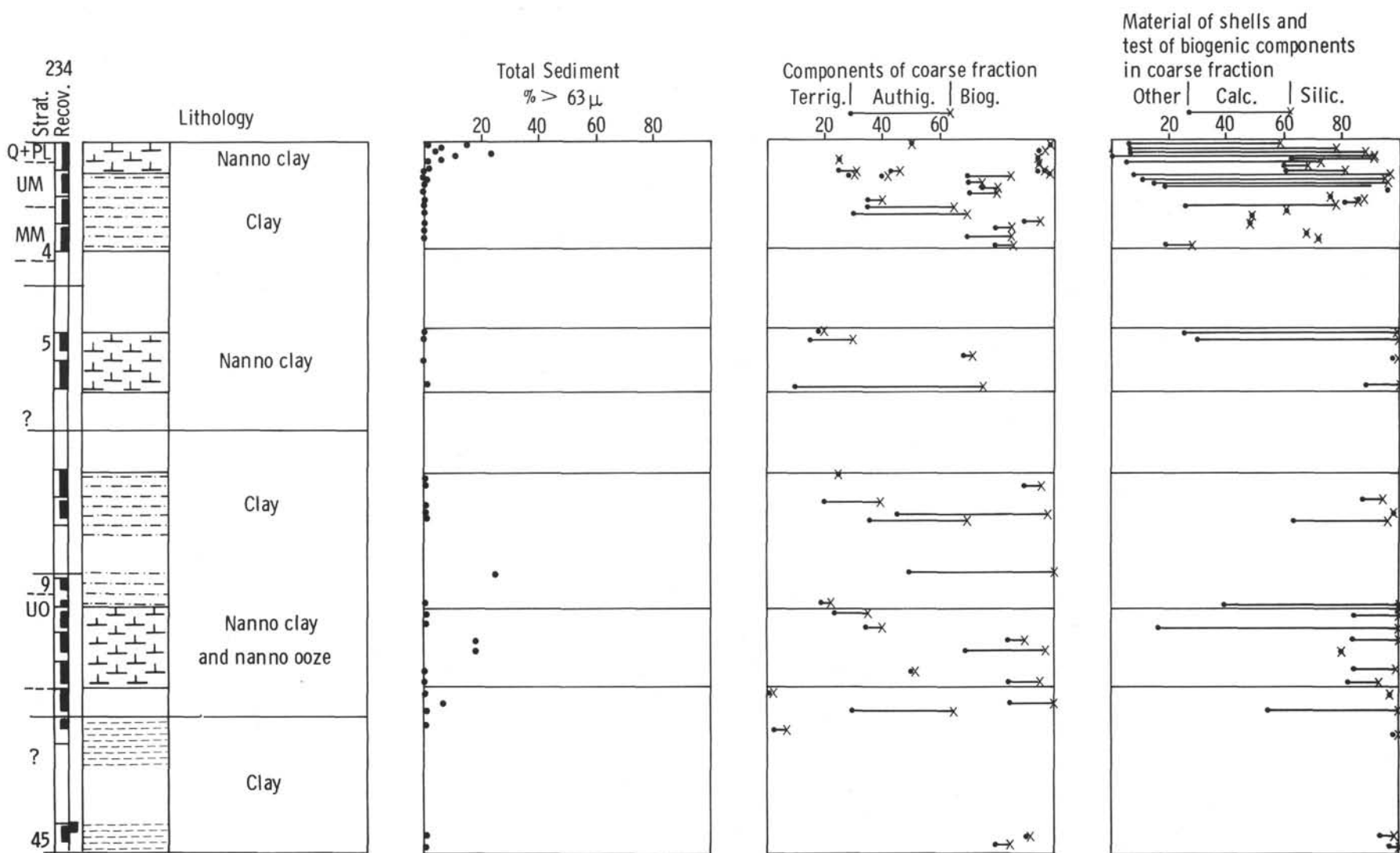
Figure 27. *Lithology of Site 234 sediments: gross lithology, percentage of sand fraction in total sediment, main components of coarse fraction, material of shells, and tests of biogenic components.*
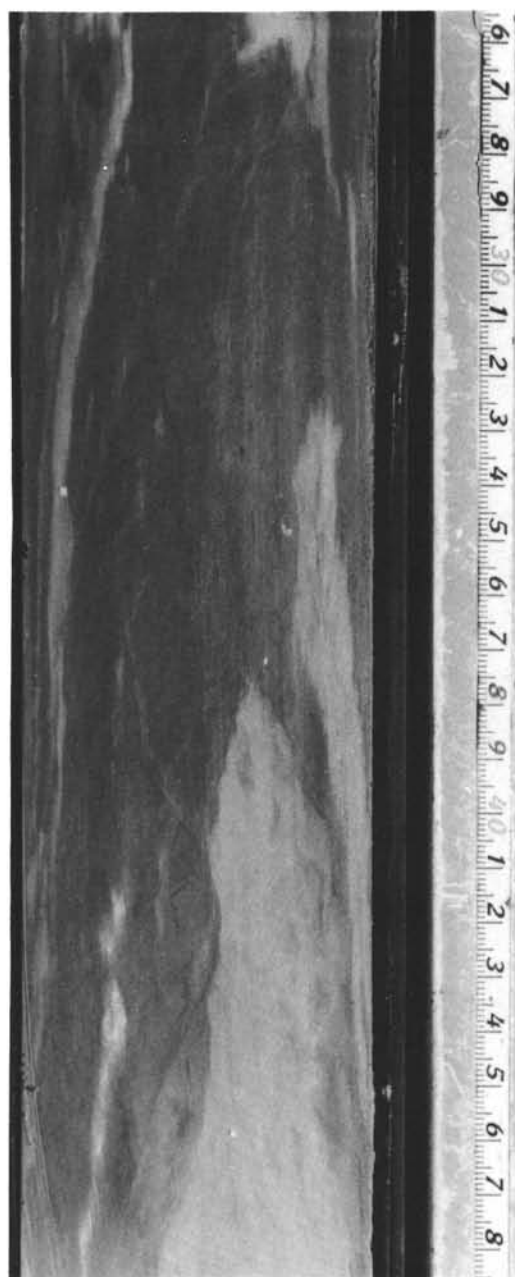
234-5-3

Figure 28. *24-234-5-3(25-48). Lithologic changes in very fine grained middle Miocene. Bedding is disturbed due to drilling/coring process.*

abundance of fish debris is during upper to middle Miocene where diluting components are dissolved.

Coarse Fractions, Site 237

Site 237 is located in 1622 meters of water on the saddle between the Seychelles (granitic basement) and Saya de Malha Bank (basaltic basement according to Shor and Pollard, 1963) in a fault-bounded region of nondescript magnetics (Fisher et al., 1967). Several flat-lying reflectors are visible on available seismic records over the acoustic basement (Bunce et al., 1966).
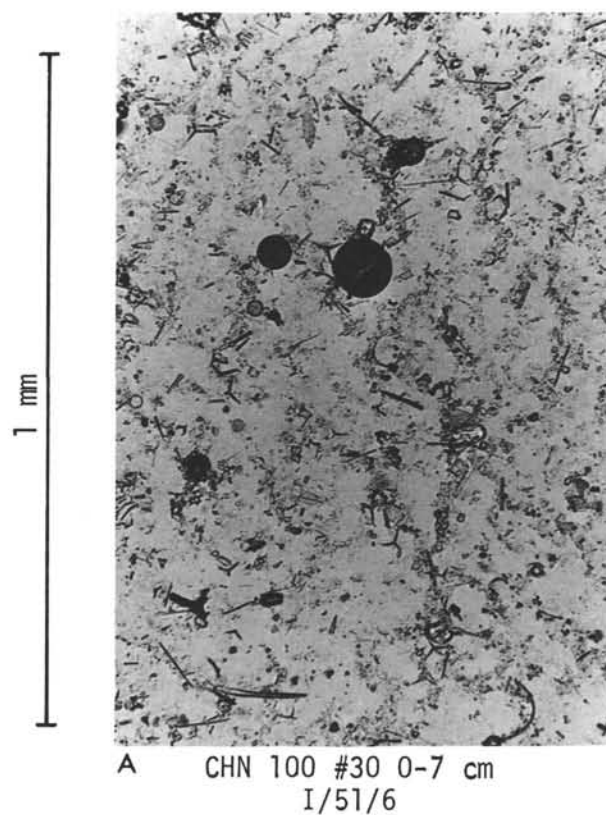
A   CHN 100 #30 0-7 cm
I/51/6
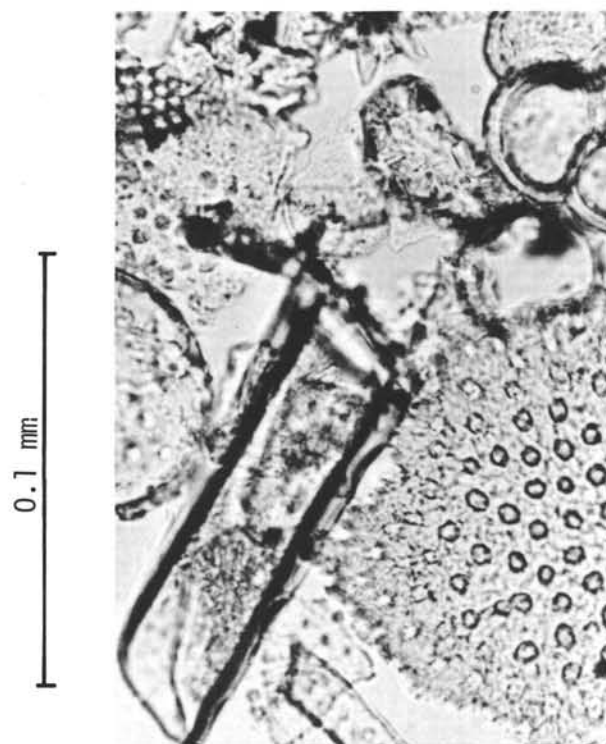
B   CHN 100 #30 110 cm
I/51/18

Figure 29. *Sediments of CHAIN 100/30 (smear slides): (A) surface (0-7 cm) sediments, mainly consisting of siliceous organic remains; (B) subsurface (110 cm) sediments with tests and fragments of planktonic foraminifera, radiolaria and a few mineral grains.*

TABLE 6
Composition of Authigenic and Terrigenous Grains
of Coarse Fractions at Site 234[a]

Stratigraphy	Terrigenous Grains	Authigenic Grains	Quartz/Mica Ratio[b]
Plio/Pleistocene	Quartz, feldspar, mica, heavy minerals, volcanic glass, dolo rhombs	Manganese nodules glauconite (only exceptional)	>1
Upper Miocene	Quartz, feldspar, mica, heavy minerals, volcanic glass and dolo rhombs	Manganese crusts (only in uppermost part), pyrite, zeolite (mostly in lower part of section)	>1
Middle Miocene	Quartz, feldspar, mica, volcanic glass, dolo rhombs	Pyrite, zeolite, quartz	>1
Oligocene	Quartz, feldspar, mica, heavy minerals, dolo rhombs, volcanic glass	Pyrite, zeolite, quartz	>1

[a]Most frequent mineral grains have been underlined. Others appear in samples only
as accessoric components.

[b]Maximum values 40 to 100.
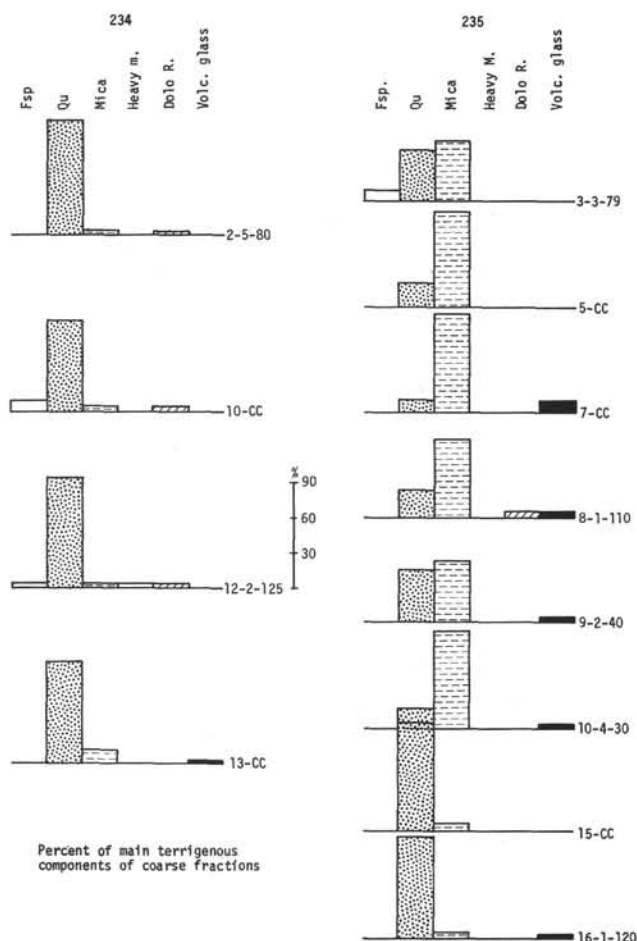
Figure 30. *Characteristic terrigenous component assemblages of Site 234 and 235 sediments. Remark systematic differences of quartz and mica proportions.*

The almost entirely calcareous sequence ranging from Paleocene to Recent was penetrated to a depth of 693.5 meters. Basement was not reached, but some of the recorded reflectors could be ascribed to chalk and chert layers in the nanno oozes. Cherts intercalated into nanno chalks were found mainly in Paleocene and lower Eocene sediments. The remaining sediments consist almost entirely of nanno to foram-rich nanno oozes (see Plate 7).

All samples investigated were texturally sands or sandy silts in post-lower Oligocene sediments, but sediments below were much more fine grained containing a higher proportion of coarse fraction only at the Paleocene base and in distinct horizons (Figure 4). Sedimentary structures, (Plate 7) usually consisting of layering indicated by slight color changes (in post-lower Eocene and in Paleocene sediments) or by textural changes (mainly basal sediments of site and lower Eocene deposits) are unevenly distributed throughout the section, as shown in Figure 36. Burrows were found only very occasionally and are either not present or not visible or preserved in the rather homogeneous sediments.

Terrigenous Components

Terrigenous components in the coarse fraction are rare (Figure 37b) and, except for volcanic glass, almost restricted to Paleocene sediments (Table 11), where heavily recrystallized calcareous rock fragments of unknown origin and, occasionally, quartz and dolomite rhombs are found. Brown and colorless volcanic glass was found in lower and middle Eocene sediments.

Authigenic Components

Glauconite (mostly as a filling of foraminiferal chambers) and chert fragments were the only authigenic components found in the coarse fractions of this site (Table

685
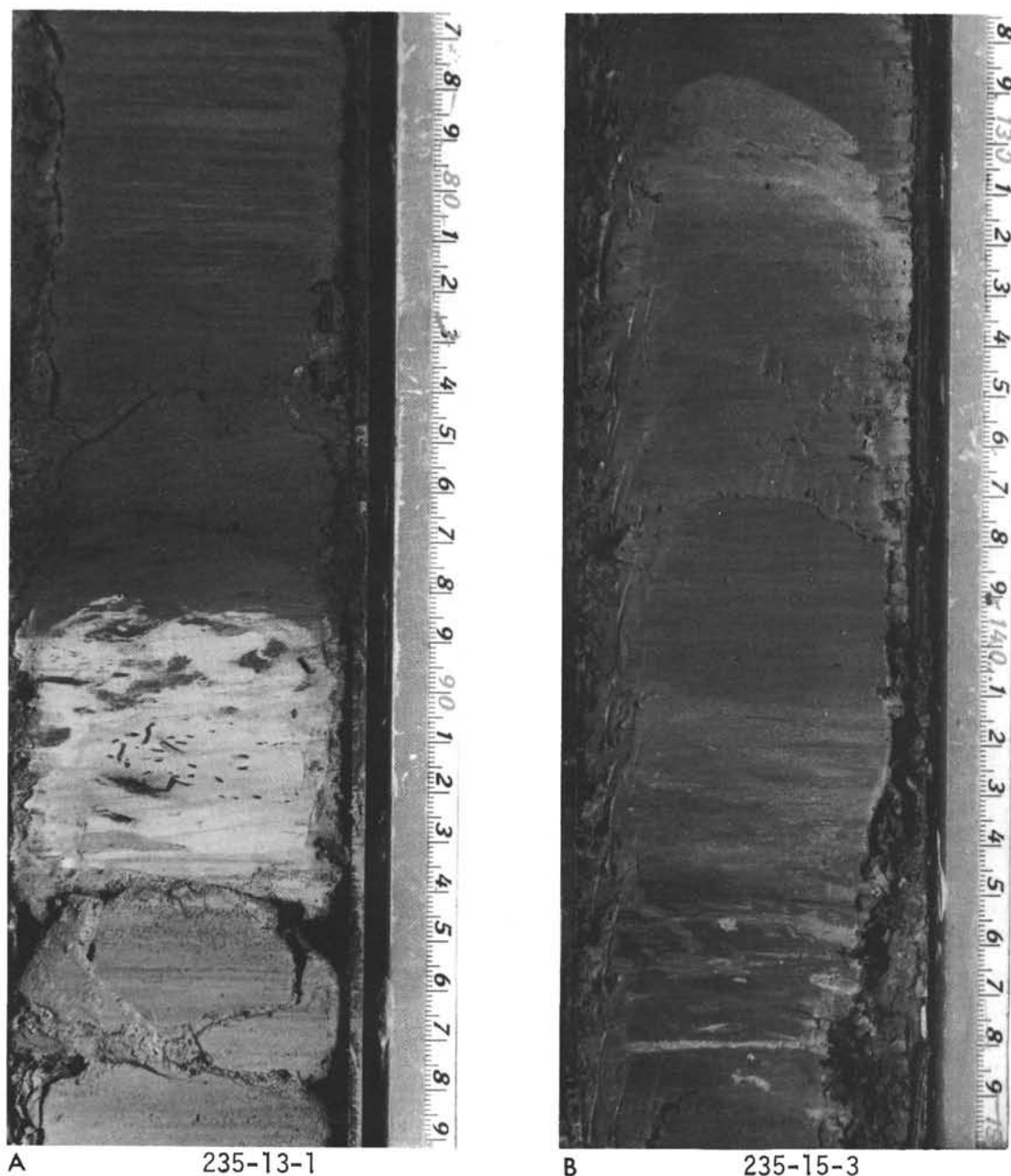
Figure 31. *Structures and burrows in Site 235 middle Miocene nannofossil ooze:* (A) *24-235-13-1 (76-99);* (B) *24-235-15-3(128-150).*

11). Both are rare (Figure 37b) and are restricted to lower Eocene and Paleocene sediments.

Biogenic Components

The biogenic components of these coarse fractions are dominantly calcareous throughout the section with the exception of a part of the Eocene deposits which contain almost only siliceous coarse-fraction components (Figure 37c).

Calcareous fossils consist of forams (benthic and planktonic), occasional pteropods, echinoid spicules, and rare ostracods.

Algal crusts and shallow-water larger benthic foraminifera were found in a number of horizons in the Paleocene sediments (Figure 38). These shallow-water biogenic components indicate that at least part of the sediment came from a shallow region. The sedimentary structures (frequent bedding and lensing in parts of the older sediments, see Plate 7) and the occurrence of glauconite in these sediments might be connected to this downslope transport of sediment.

Siliceous fossils consist of rare diatoms (only in one sample), Radiolaria, and sponge spicules. The latter two occur frequently in upper Miocene to upper Pliocene and dominantly in upper Eocene to upper Oligocene cores.

Figure 32a. *Clay-silt-sand triangle diagram of Site 235, based on smear slide analyses.*

Figure 32b. *Distribution of biogenic-clastic-authigenic components of Site 235 sediments, based on coarse grain analyses.*

Figure 32c. *Composition of tests and skeletons of Site 235 sediments (calcareous, siliceous and other material), based on coarse grain analyses.*
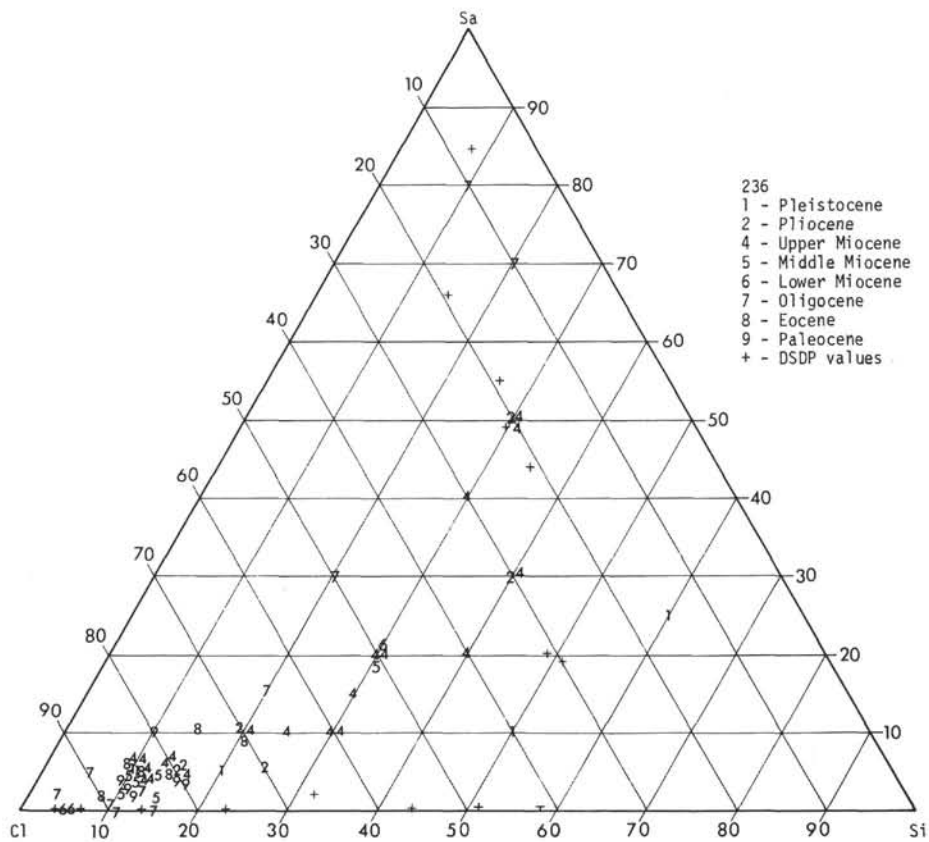
Figure 33a. *Clay-silt-sand triangle diagram of Site 236, based on smear slide analyses.*
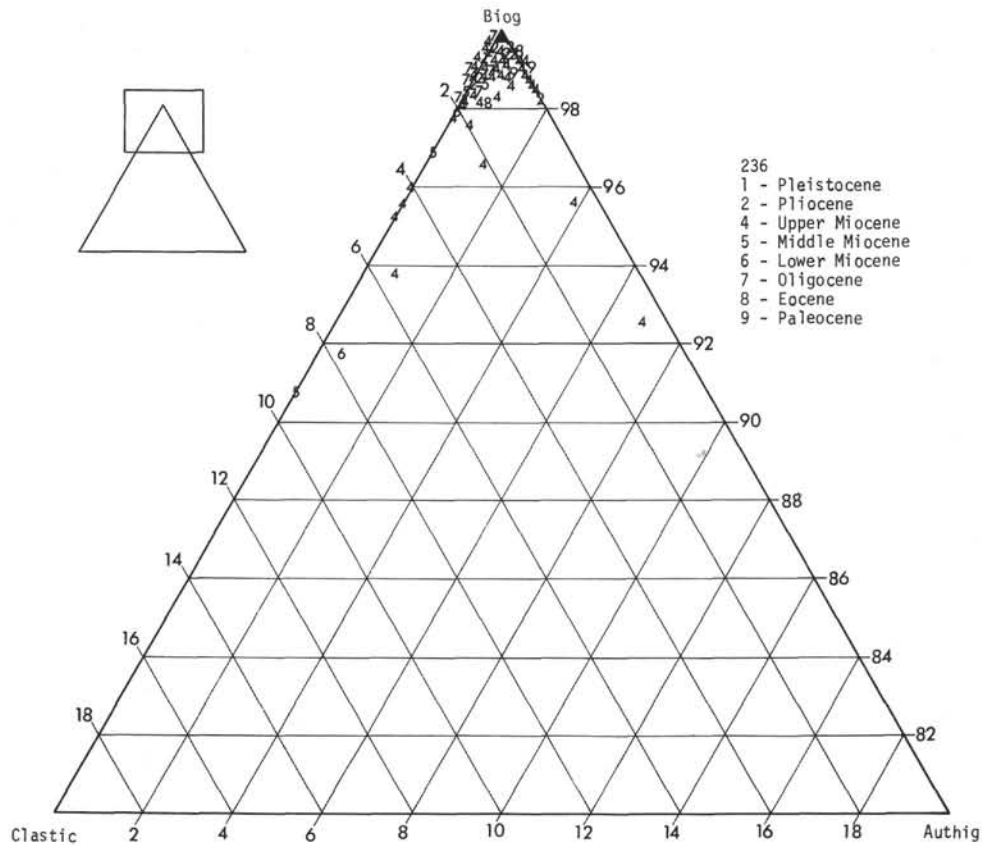
Figure 33b. *Distribution of biogenic clastic-authigenic components in Site 236 sediments, based on coarse grain analyses. Only samples with < 100% biogenic components have been drawn up. Samples outsite field see small diagram.*

236
1 - Pleistocene
2 - Pliocene
4 - Upper Miocene
5 - Middle Miocene
6 - Lower Miocene
7 - Oligocene
8 - Eocene
9 - Paleocene

Figure 33c. *Composition of tests and skeletons of Site 236 sediments (calcareous, siliceous and other material), based on coarse grain analyses. Only samples with < 98% calcareous fossils have been drawn up.*

236
1 - Pleistocene
2 - Pliocene
4 - Upper Miocene
5 - Middle Miocene
6 - Lower Miocene
7 - Oligocene
8 - Eocene
9 - Paleocene

TABLE 7
Terrigenous and Authigenic Coarse Fraction Components at Site 235[a]

Stratigraphy	Terrigenous Components	Authigenic Components	Quartz/Mica Ratio (min/max value)
Pleistocene	<u>Mica</u>, quartz, volcanic glass	<u>Pyrite</u>, quartz	0.3-1.0
Upper Pliocene	<u>Quartz</u>, volcanic glass, <u>Mica</u>, quartz	<u>Pyrite</u>, quartz	0.1-1.3
Lower Pliocene	<u>Mica</u>, quartz, volcanic glass, dolo rhombs, heavy minerals	Pyrite, quartz	0.3-2.2
Upper Miocene	<u>Mica</u>, quartz, volcanic glass	<u>Pyrite</u>, quartz (pyrite is many times pseudomorphus after siliceous biogenic components	0.2-14
Middle Miocene	<u>Quartz</u>, mica, heavy minerals	Pyrite, (also one pyrite nodule about 2 cm)	2-14
Undated Core 16	Quartz, mica, volcanic glass	Zeolite, pyrite, glauconite, quartz	23

[a]Common to abundant components are underlined. All others occur only rarely.

Hystrichosphaerids and arenaceous benthic foraminifera are very scarce. Fish remains are rare to common.

Coarse Fractions, Site 238

Site 238 is situated in about 2800 meters of water close to the northwestern end of Argo Fracture Zone, near the junction of the Chagos-Laccadive Ridge and the Central Indian Ridge, an area extensively mapped and investigated by R. L. Fisher and his associates (Fisher, 1964; Fisher et al., 1971). Although missing the objective to sample the basement of the southern end of Chagos-Laccadive Ridge, oceanic basaltic basement was reached after penetrating a sedimentary section over 500 meters thick, ranging from lower Oligocene to Pleistocene in age. The sediments consist almost entirely of very light, purely pelagic, calcareous nannofossil oozes and chalks. They have been divided into three different sedimentary units based on slight changes in the proportions of the major components (almost entirely biogenic). A fourth unit consists of the basaltic cores with their sediment inclusions (Plate 9). The dominant color of the sediment is white, becoming pale orange to brownish due to a higher content of Fe-oxides in the lower part of the section. The basal sediments of the section (belonging to unit 3) are more vividly colored due to their greater petrographic variations (volcanic ashes, zeolite sands, concentration of Fe-oxides, see Figure 39). The sediments are so homogeneous that sedimentary structures are distinguished by slight color changes. However, thin sections of unconsolidated sediments of this site (Plate 8, Figures 1-3) show indications of current activity sorting the fine matrix of the sediments from the foraminiferal shells. Burrows have been detected only in Core 9.

From 0 to 250 meters, the bulk of the sediments belongs texturally to silty clays and silty sands. Below they are mostly clayey silts (see Figure 32a and Figure 4). As at Site 237, the sediments are generally fine grained in the older parts of the sections, although at Site 238 a slow but continuous decrease in grain size with increasing depth below sediment surface was found (Figure 4).

The calcium carbonate content is, in most of the investigated samples, very high (more than 85%). Organic carbon content usually ranges from 0.0% to 0.1% with one occurrence of 0.4% at Sample 39-5, 98 cm. The X-ray diffraction analyses show, aside from calcite: dolomite, quartz, K-feldspar, plagioclase, mica, kaolinite, chlorite, montmorillonite, clinoptilolite, phillipsite, gypsum, and halite.

The coarse fractions consist almost entirely of biogenic components (Figure 40b). Only a very few Oligocene samples directly above basement contained a higher proportion of clastic and authigenic minerals (see Table 12).

Terrigenous Components

With the exception of the upper Oligocene and the lowermost lower Miocene sediments, terrigenous grains were too rare in the coarse fractions to be meaningful. They consist commonly of isolated grains of quartz and volcanic glass fragments. Only in the lowermost part of this sedimentary section do terrigenous components make up a larger proportion of the sediments: light and dark volcanic glass, quartz, heavy minerals, and calcareous rock fragments of unknown origin. A volcanic ash layer occurs at Sample 24-238-53-2, 53 cm. With the exception of the calcareous rock fragments, all these minerals are assumed to be related to volcanic activity whose influence and input into the sediments decrease as this site (and its sediments) were removed from the active rift zone. The calcareous rock fragments are very fine grained and recrystallized and might be indurated calcareous ooze. However, they are surprisingly angular. Their coincidence with the volcanic material may, therefore, not be accidental. They may come from the same source and were affected by the volcanism.

Authigenic Components

The distribution of authigenic components shows a close correlation to terrigenous material. Pyrite is scarce in the upper part of the section. In the lower part micronodules of Fe-oxides, pyrite, and zeolite occur in the metalliferous basal sediments.
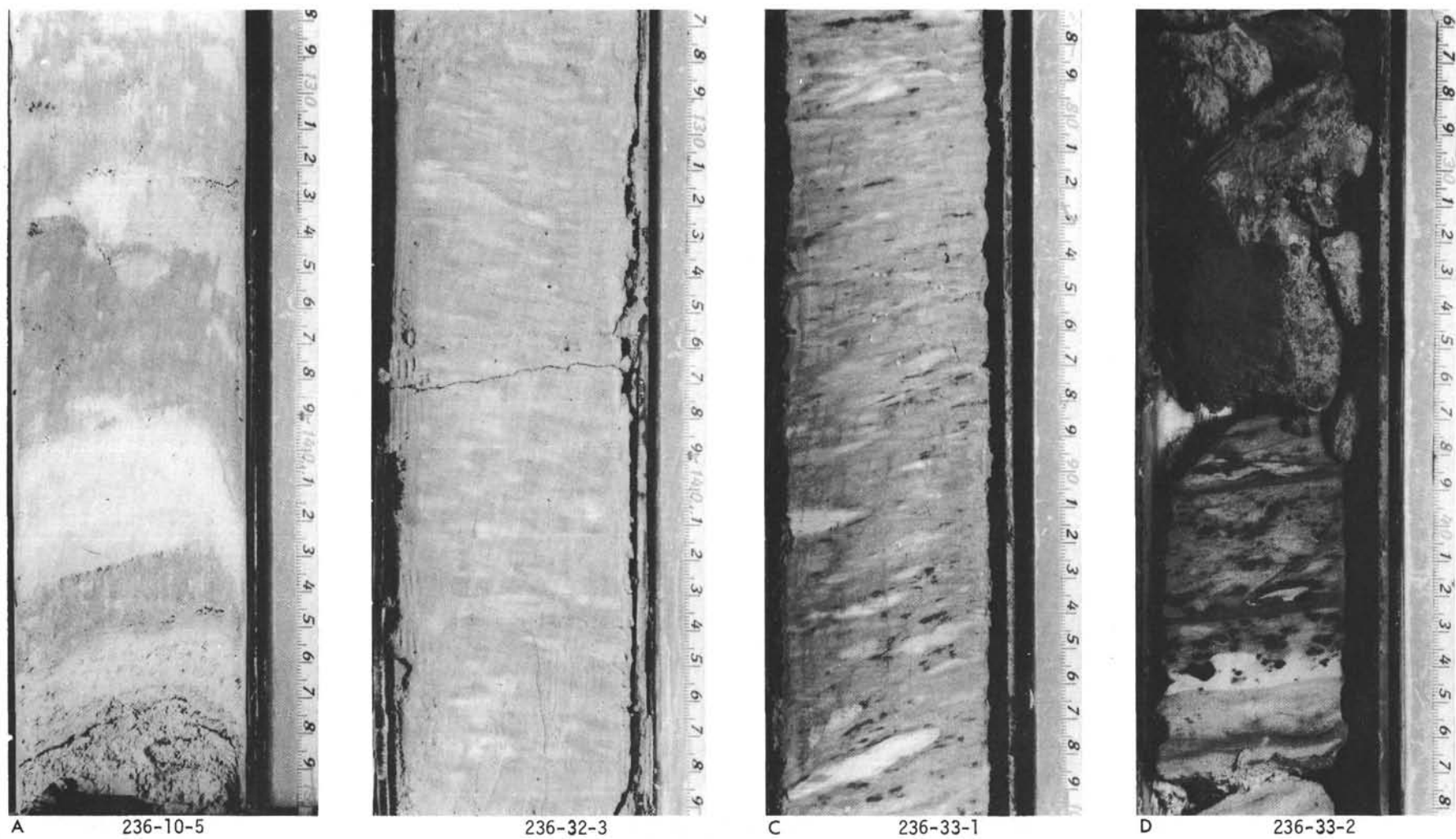
Figure 34. *Sedimentary structures in Site 236 sediments:* (A) *24-236-10-5 (128-150), upper Miocene nanno ooze;* (B) *24-236-32-3 (128-150), upper Paleocene/ lower Eocene nanno chalk;* (C and D) *24-236-33-1 (77-100) and 24-236-33-2 (25-49), upper Paleocene nanno chalk.*

A   236-23-5 (27-30)
.05 mm

B   236-24-6 (94-98)
.05 mm

C   236-24-6 (94-98)
.05 mm
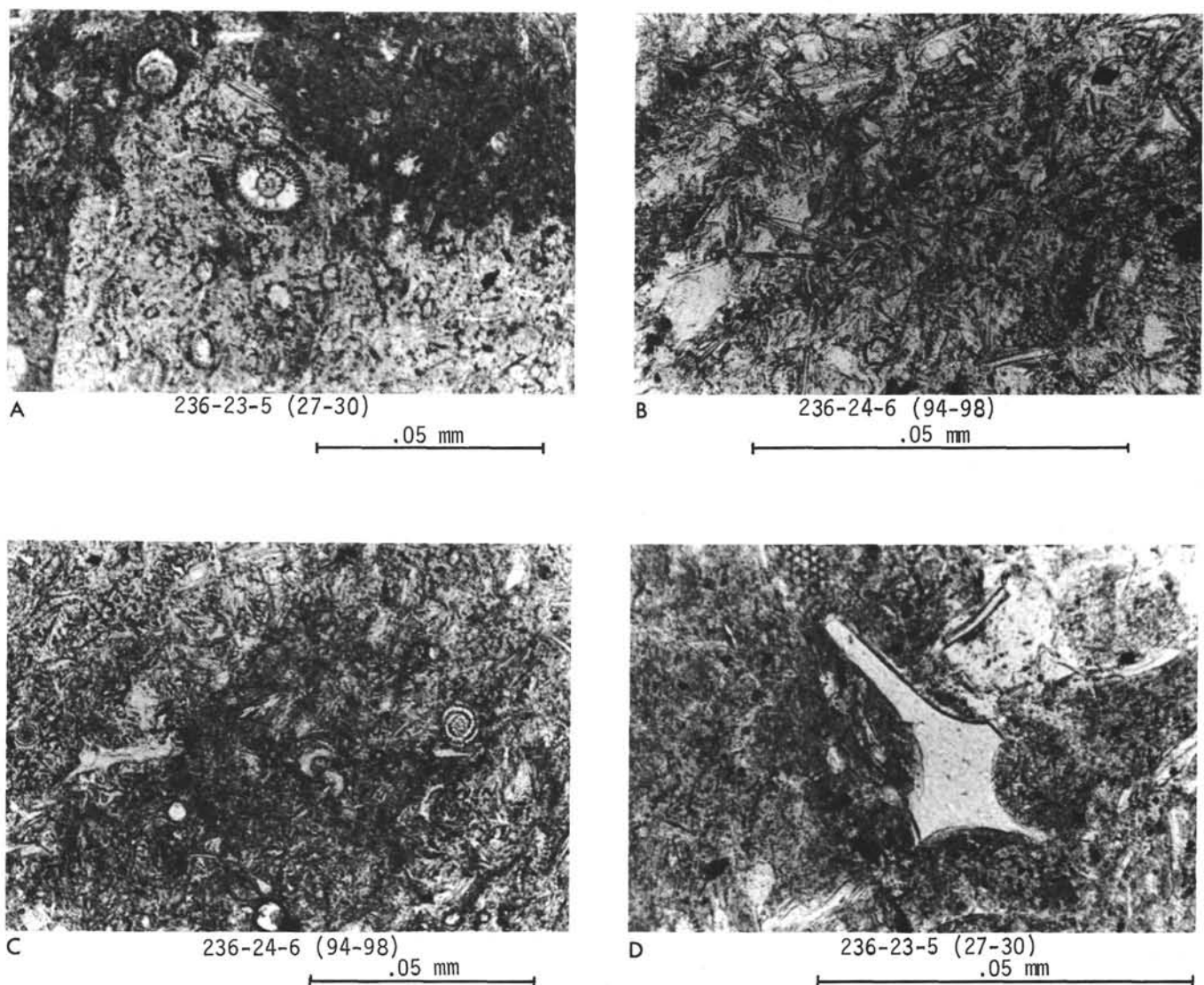
D   236-23-5 (27-30)
.05 mm

Figure 35. *Oligocene nanno oozes and chalk (very rich in well preserved siliceous components; especially radiolaria, sponge spicules and volcanic glass shards) of Site 236 (thin sections). (A) 24-236-23-5(27-30); (B and C) 24-236-24-6(94-98); and (D) 24-236-23-5(27-30).*

Biogenic Components

The biogenic component of this coarse fraction consists almost entirely of calcareous shells and planktonic foraminifera. Only a few Pleistocene and upper Miocene samples contain a considerable amount of siliceous tests and skeletons (Figure 40c). Although the dominance of the calcareous tests is so overwhelming, there is nearly almost always a small contribution of siliceous material.

Calcareous biogenic components consist predominantly of benthic and planktonic foraminifera, but they also include rare pteropod fragments (lower Miocene and upper Oligocene), rare ostracods, and rare echinoid spicules. Planktonic foraminifera contribute the dominant portion of these coarse fractions except a few horizons, mainly in Pleistocene cores, where siliceous components prevail.

Siliceous biogenic components consist of diatoms, Radiolaria, and sponge spicules. Diatoms are very rare in

sediments older than upper Miocene, but they become increasingly more abundant in younger sediments and are the dominant component in a number of Pleistocene samples (Figure 16). Radiolaria were found frequently in middle Miocene to Pleistocene sediments, but are almost absent in the older deposits (lower Miocene to upper Oligocene). Sponge spicules are a common to frequent component in almost all samples. Only in middle Miocene sediments do they seem to be somewhat enriched.

Fish debris, arenaceous foraminifera, and hystrichosphaerids occur rarely.

REGIONAL DISTRIBUTION OF COMPONENTS

A regional distribution of single coarse-fraction components is shown in Figures 12-18 and 41-46.
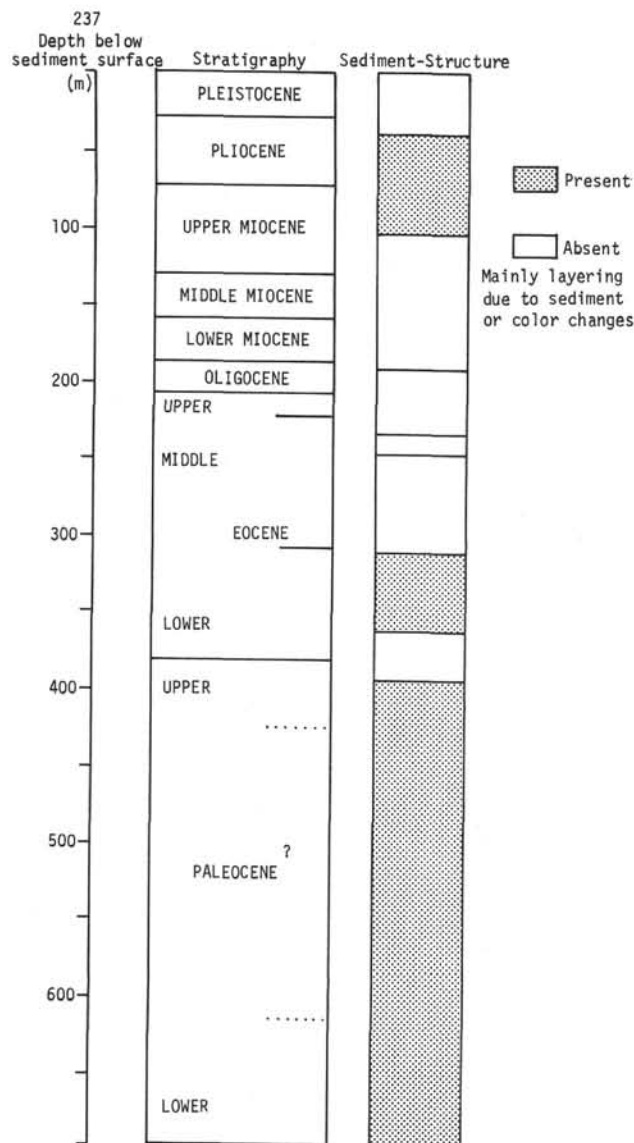
Figure 36. *Distribution of primary sedimentary structures in Site 237 sediments.*

TABLE 8
Terrigenous and Authigenic Components at Site 236

Stratigraphy	Terrigenous Components	Authigenic Components
Pleistocene		
Pliocene	Quartz, dolo rhombs, rock fragments[a]	Glauconite
Upper Miocene	Quartz, mica,[a] rock fragments, dolo rhombs volcanic glass	Glauconite, pyrite, zeolite
Middle Miocene	Quartz, mica,[a] heavy minerals, dolo rhombs, volcanic glass	
Lower Miocene	Quartz, dolo rhombs, volcanic glass	Pyrite, zeolite
Oligocene	Quartz, mica,[a] dolo rhombs, volcanic glass	
Eocene	Quartz	Zeolite, quartz(?)
Upper Paleocene	Quartz	Glauconite, pyrite

[a]Too few grains to determine quartz/mica ratio.

TABLE 9
Occurrence of Rock Fragments and Volcanic Ashes in Sediments at Site 236

Rock Fragments	
3-2, 55 } 3-2, 78 }	Pliocene
5-1, 93 5-3, 89 5-4, 62 6-4, 68 } 7-5, 98 8-4, 43 9-4, 84	Upper Miocene

Volcanic Ashes	
18, CC	Lower Miocene
22-1, 130 } 23-6, 76 } 23, CC	Oligocene

TABLE 10
Shallow-Water-Derived Fossils at Site 236

3-2, 66 cm	Coral	Upper Pliocene
5-1, 93 cm	Bryozoan	
5-3, 89 cm	Algae, bryozoan }	
5-6, 80 cm	Bryozoan }	Upper Miocene
6-3, 134 cm	Bryozoan }	
12-6, 46 cm	Bivalve (?)	

Terrigenous Components

Coarse fraction analysis is probably not a definitive method for studying terrigenous material in an area where the bulk of these components presumably is eolian in origin; in such a region terrigenous material is not contained in the sand fraction, but rather in the silt and clay fraction (Füchtbauer and Müller, 1970). A definite trend, high clastic terrigenous input to the Gulf of Aden, decreasing in the Somali Basin and almost disappearing in the central Indian Ocean sites, was found. Not only does the proportion of clastic terrigenous components decrease, but so does the grain size. The compositions of the mineral assemblages also change in a characteristic way. Quartz/mica ratios decrease with increasing distance from land.

The wind-transported material in the Gulf of Aden came presumably from the surrounding desert areas. Because of the generally similar land geology on both sides of the Gulf of Aden (Beydoun, 1970), it seems difficult to indicate the source area more precisely in this preliminary study. The rock fragments and rounded quartz grains found in several horizons in the sediments at Sites 231 and 232 together with shallow-water fossils must have been water transported and can come only from either side of the gulf.

The terrigenous components in the Somali Basin are distinct on either side of Chain Ridge, suggesting different sources for these sediments. The composition of the terrigenous coarse-fraction components at Site 234 is so similar to the Gulf of Aden distribution that it seems

693
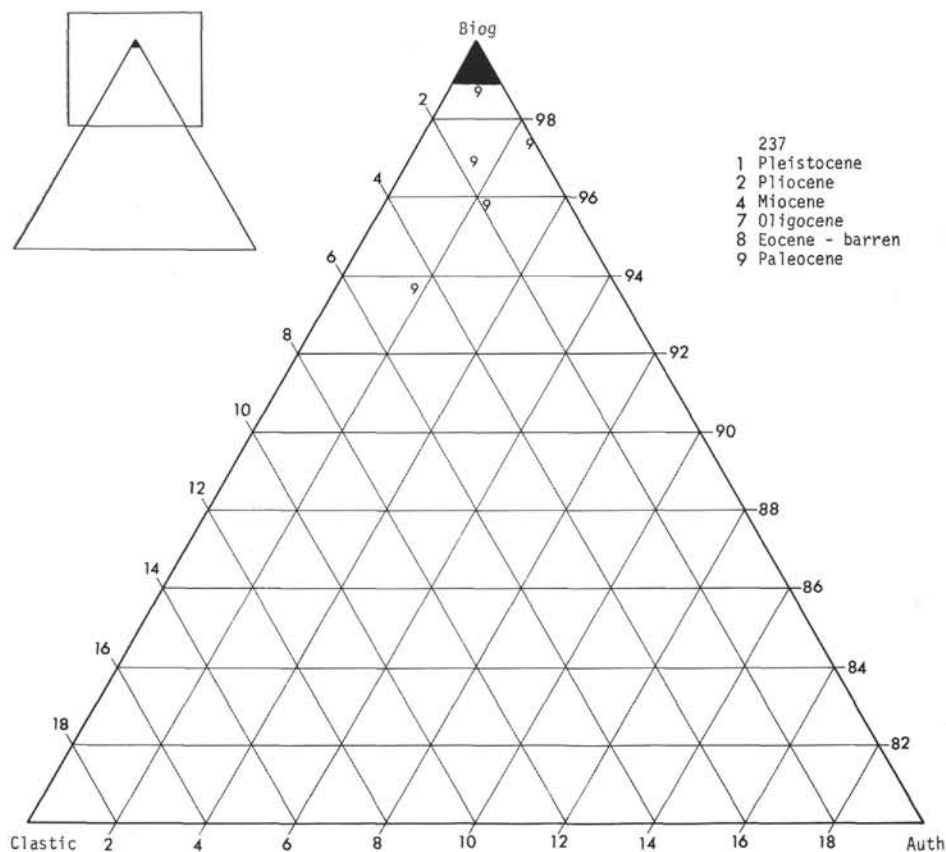
Figure 37a. *Clay-silt-sand triangle diagram of Site 237, based on smear slide analyses.*

237
1 Pleistocene
2 Pliocene
4 Miocene
7 Oligocene
8 Eocene - barren
9 Paleocene

237
1 Pleistocene
2 Pliocene
4 Miocene
7 Oligocene
8 Eocene + barren
9 Paleocene
+ DSDP - values
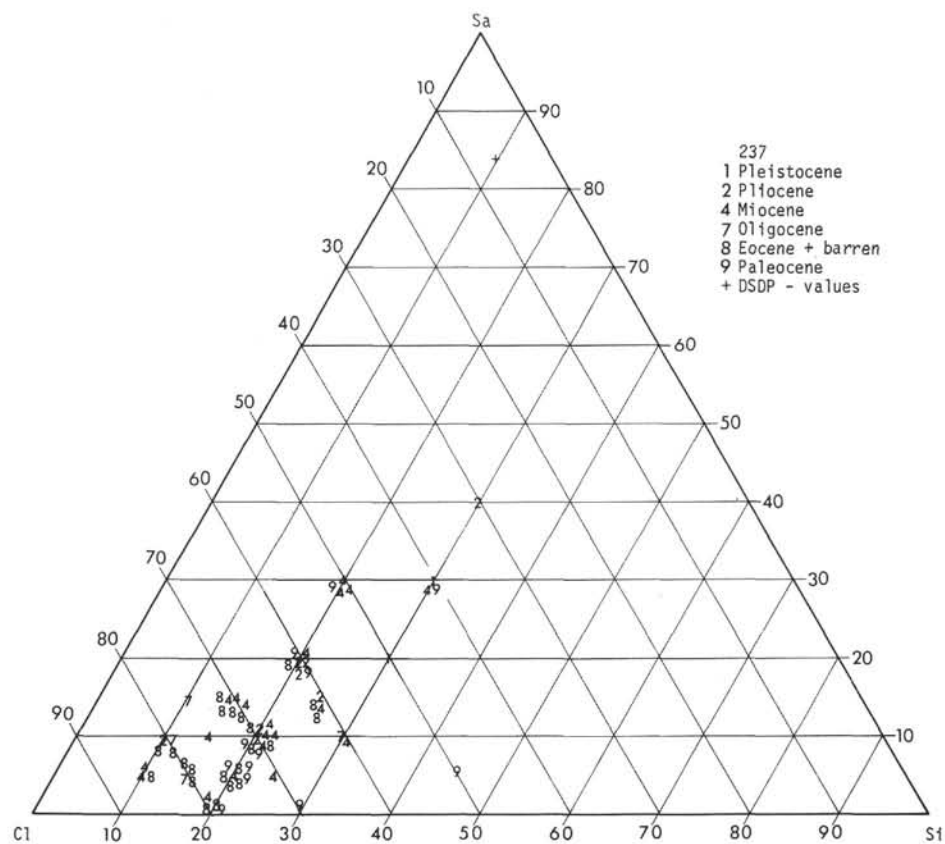
Figure 37b. *Distribution of biogenic-clastic-authigenic components of Site 237 sediments, based on coarse grain analyses. Only samples with < 99% biogenic components have been drawn up.*
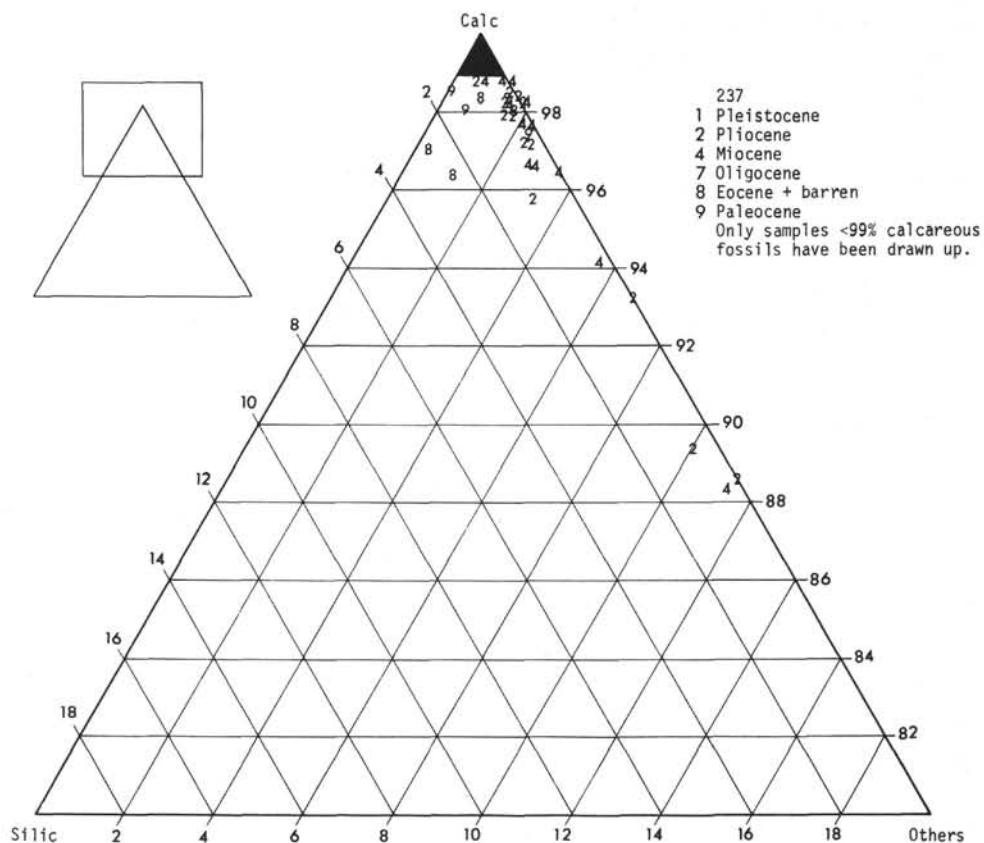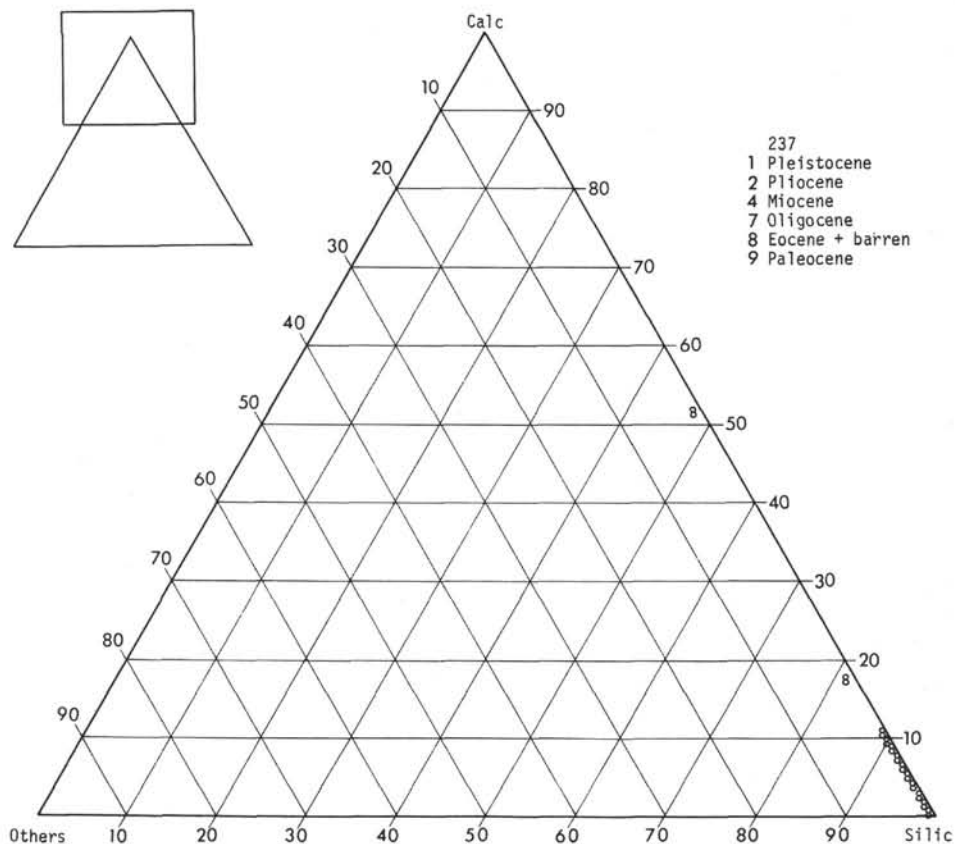
Figure 37c. *Composition of tests and skeletons of Site 237 sediments (calcareous, siliceous and other material), based on coarse grain analyses. Only samples with < 99% calcareous fossils have been drawn up.*

TABLE 11
Terrigenous and Authigenic Components at Site 237

Stratigraphy	Terrigenous Components	Authigenic Components
Oligocene to Pleistocene		
Middle Eocene	Volcanic glass (brown and light)	
Lower Eocene	Volcanic glass	Glauconite, chert fragments
Paleocene	Quartz, dolo rhombs, rock fragments (heavy heavily recrystallized calcareous rocks, in Sample 3-90, 47-120 cm)	Glauconite (mostly fillings of foram chambers), chert fragments

237-41-7-140

43mm
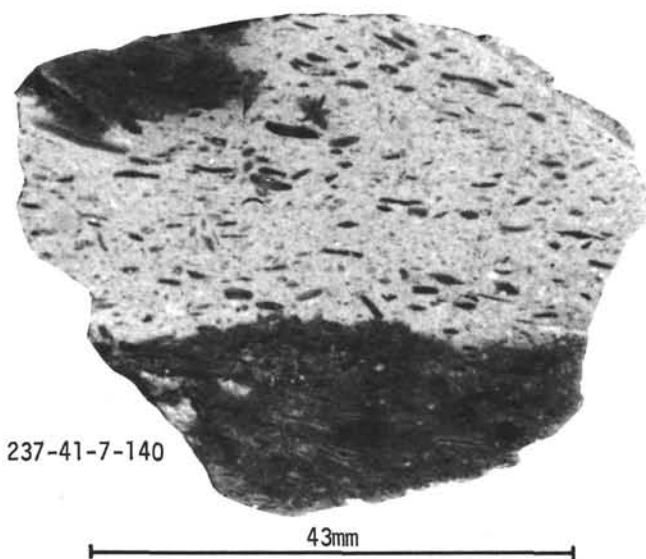
Figure 38. *24-237-41-2 ,140 polished section. Horizon of silicified shallow water benthic foraminifera (Discocyclina) in upper Paleocene chalks. Upper and lower boundary of this horizon are both sharp. Compare for details, Chapter 19, this volume.*

TABLE 12
Terrigenous and Authigenic Components at Site 238

Stratigraphy	Terrigenous Components	Authigenic Components
Pleistocene		Pyrite
Pliocene		
Upper Miocene	Volcanic glass	Pyrite
Middle Miocene		
Lower Miocene	Volcanic glass, quartz, rock fragments (calcareous, heavily recrystallized)	Pyrite
Upper Oligocene	Volcanic glass (light and dark), dolo rhombs, calcareous rock fragments, quartz, heavy minerals. Volcanic ash at Sample 53-2, 53 cm	Pyrite, quartz, micronodules, zeolite

difficult not to accept an African/Arabian source area. Goldberg and Griffin (1970) described very similar silt-sized mineral assemblages caught in the southwest monsoon. The monsoon is capable of carrying a heavier dust load than the other winds of the area.

The almost complete absence of clastic terrigenous coarse-fraction components in the central Indian Ocean does not allow any obvious regional conclusion to be drawn. However, granitic rock fragments at Site 236, north of the Seychelles, must have their origin in the weathering continental basement of this area.

Volcanic ashes composed of almost colorless glass are found in a number of sites. Their common occurrence in pelagic sediments might be correlated to differentiation of dissolved gas phases from extruding lavas during volcanic activity along the rift.

Authigenic Components

Distributions of authigenic components are discussed for individual sites in the preceding section.

Biogenic Components

Tests and fragments of planktonic foraminifera are the more ubiquitous components of the coarse fractions in all eight drill sites from the northwestern Indian Ocean and the Gulf of Aden. Fragments and whole tests have been counted separately, but in Figure 12 only the distribution of the maximal occurrence of the whole tests in each core is given. They are common to abundant at all holes although the water depths of the eight sites range from over 5000 meters in the Somali Basin to less than 2000 meters both for a Mascarene Plateau site in the central Indian Ocean sites and the two Alula-Fartak sites in the Gulf of Aden. This suggests that, at least for the Somali Basin localities, there is a considerable amount of redeposited material. It is expected that those sites lying either beneath or very close to the calcium carbonate compensation depth should have fragmented planktonic foraminifera (Thiede, 1973a) which may eventually be dissolved (Berger and von Rad, 1972).

The shallow central Indian Ocean sites are much more homogeneous than the Gulf of Aden sites, suggesting that planktonic foraminifera are less common and less well preserved in the hemipelagic sediment than in the open ocean. The effect is well known from other areas of the world ocean (Berger, 1971), although the normal pattern of calcium carbonate preservation on continental margins (Thiede, 1973a) is expected to vary in this area due to the extremely well-developed oxygen minimum of the upper water masses in the northern Indian Ocean (Wyrtki, 1971; von Stackelberg, 1972).

The aragonitic shells of pteropods are much more susceptible to dissolution, therefore they were rarely found (Figure 13). As they usually are not preserved in water depth greater than about 2500 meters, they are good indicators for sediments which are displaced (for example, Sites 235 and 236). They occur commonly in the Pleistocene deposits at Site 231 combined with other displaced components from shallower water depths (Herman, 1971; Stubbings, 1939). Larvae of gastropods and bivalves rarely are found in the Gulf of Aden sediments. These delicate shells also occur only in displaced material from the continental margin.

238-54-1

Figure 39. *Basal lower Oligocene sediments of Site 238 (24-238-54-1, 75-110) consisting of grayish orange nanno fossil oozes with intercalated thin zeolitic sand layers and volcanic ashes consisting of colorless glass.*

Ostracods occur rarely, but are widely distributed at all sites. Limited knowledge about their distribution pattern in oceanic sediments (Puri, 1971) precludes further discussion.

Calcareous Benthos

Aside from a number of shallow-water-derived components, which will be discussed later, calcareous foraminifera and echinoids are the dominant contributors of calcareous tests or fragments of benthic origin in deep-sea sediments. Foraminifera are the most abundant shell-bearing benthic calcareous deep-sea organisms which are usually deposited at very constant sedimentation rates (Thiede, 1973b). However, regional quantitative differences between the highly fertile upwelling areas off Somalia and Arabia and the central water masses of the Indian Ocean are clearly expressed (Figure 14). The proportion of the biogenic coarse fraction which consists dominantly of benthic foraminifera is also higher in samples which have undergone considerable dissolution (Berger, 1970), for example, at Sites 234, 235, and 236. Because of the presence of displaced sediments from shallower water depths, it seems important to study the pattern of calcium carbonate deposition and preservation in greater detail.

After foraminifera, echinoids are the next most important benthic producer of calcareous particles in the deep sea (Figure 15). They occur, as other benthos does, more frequently in the more fertile areas of upwelling of Somalia and Arabia (Kudrass, 1973). In other respects echinoid spicules are as homogeneously distributed in the deep-sea sediments as benthic foraminifera, suggesting that this distribution is generally very characteristic for deep-sea benthos.

Siliceous Fossils

The siliceous biogenic assemblage of these coarse fractions consists of diatoms, Radiolarians, and sponge spicules (Figures 16, 17, and 18). The fragile skeletons of diatoms are not a usual component of deep-sea coarse fractions due to their susceptibility to dissolution either while still in the water column or, after deposition, in the sediments (Schrader, 1971a and b). Except in single horizons at Sites 232 and 233 and very isolated occurrences at 231, they were not found in the Gulf of Aden (Figure 16). They are almost absent in the sediments from the Somali Basin west of Chain Ridge (Site 234), but they constitute an important component in the Pleistocene sediments at Site 235 east of Chain Ridge, decreasing rapidly in abundance with increasing age during the Tertiary and missing from the lowermost part of the section. Diatoms are almost absent from Site 237, but occur in lower Oligocene and Pleistocene sediments at Site 236 and appear still more frequently in the deposits of 238, decreasing in abundance downwards over the whole length of the cored section.

Radiolarian skeletons and siliceous sponge spicules (Figures 17 and 18) correlate almost perfectly with one another with respect to their abundance in the coarse fraction. They occur in the deposits of all sites, and in many samples they are the dominant biogenic component. Their abundance clearly changes vertically at Sites 231, 234, 235, 236, 237, and 238, but they occur in almost
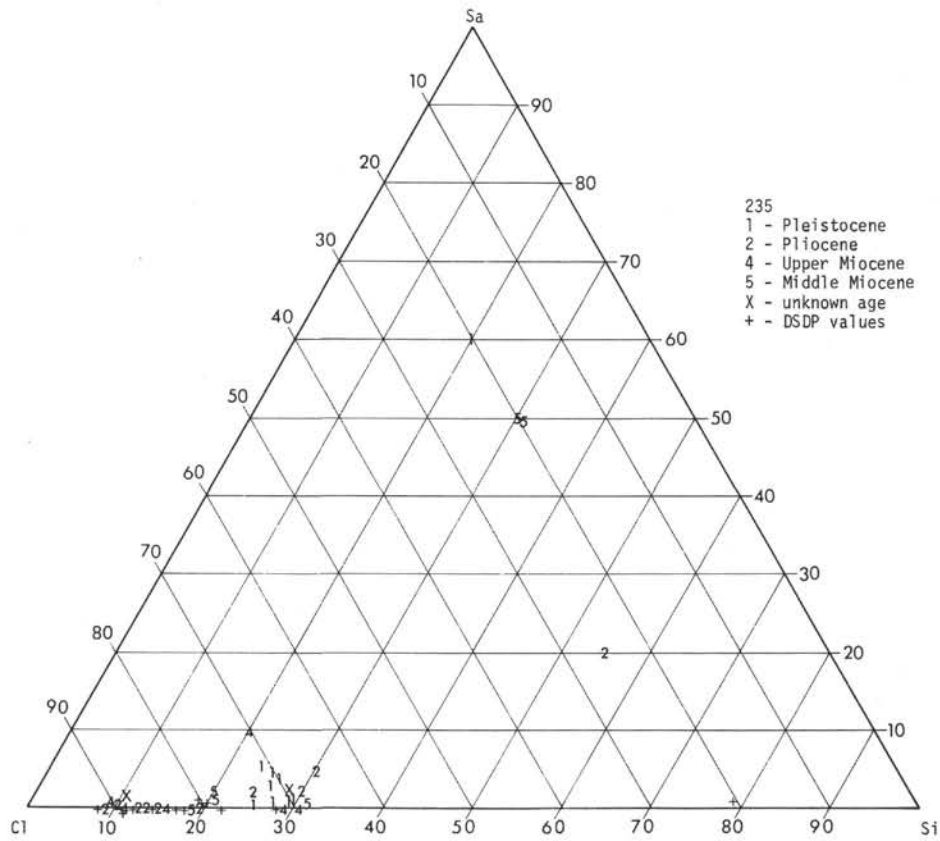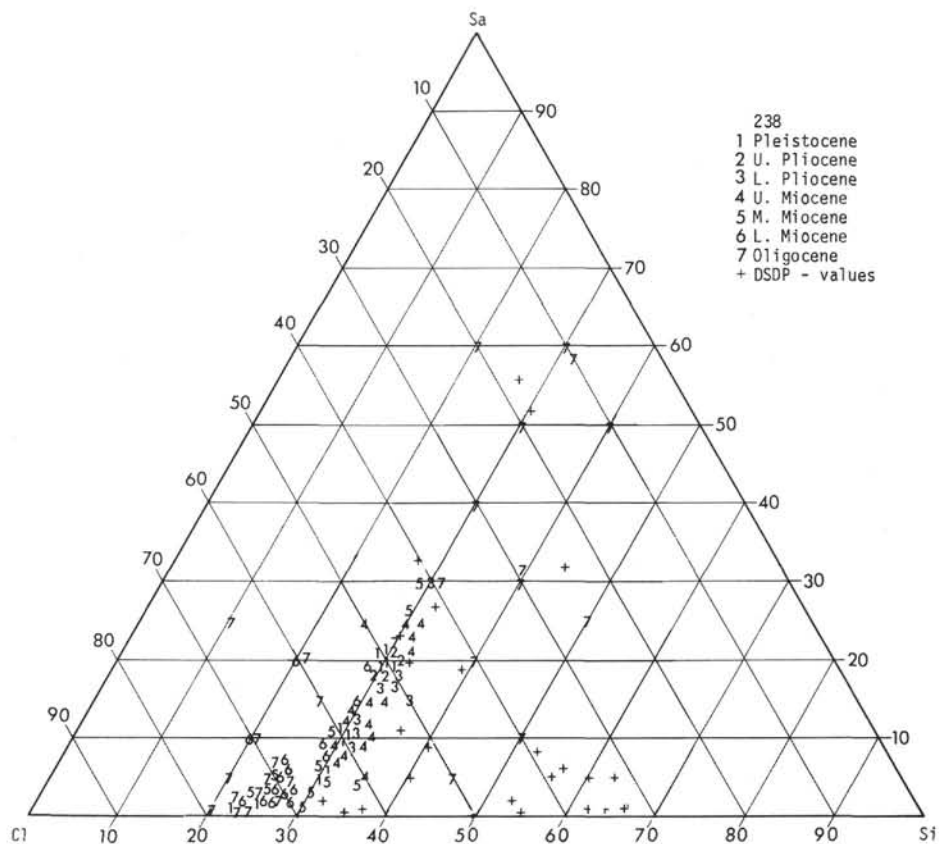
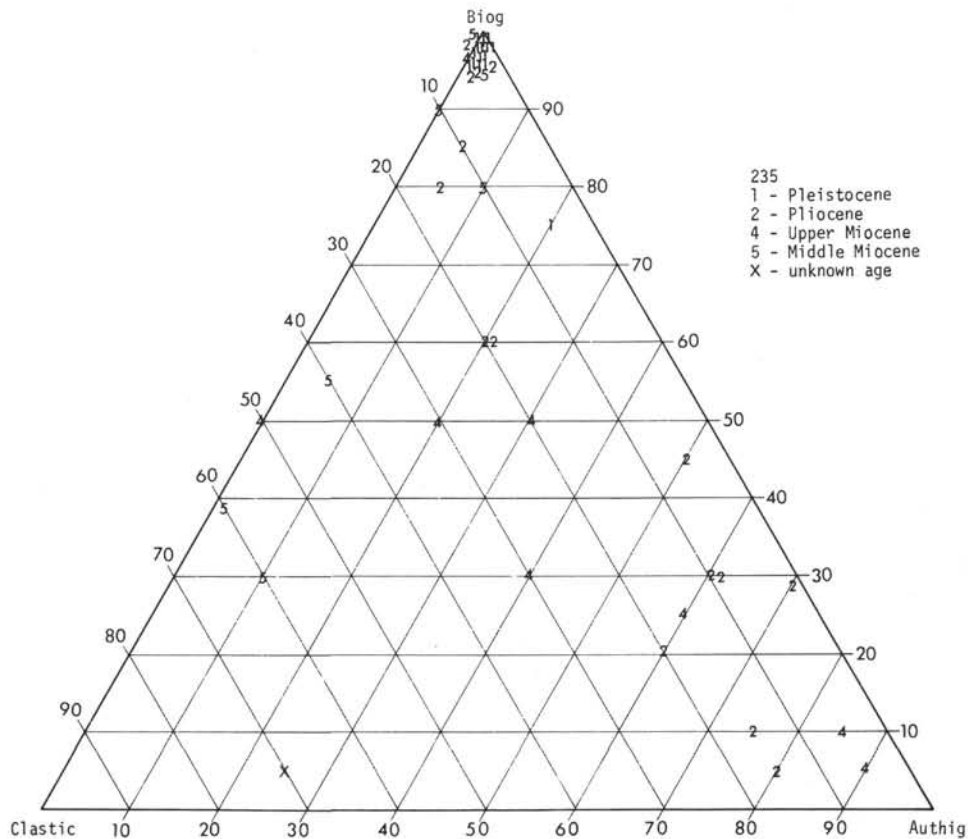Figure 40a. *Clay-silt-sand triangle diagram of Site 238, based on smear slide analyses.*
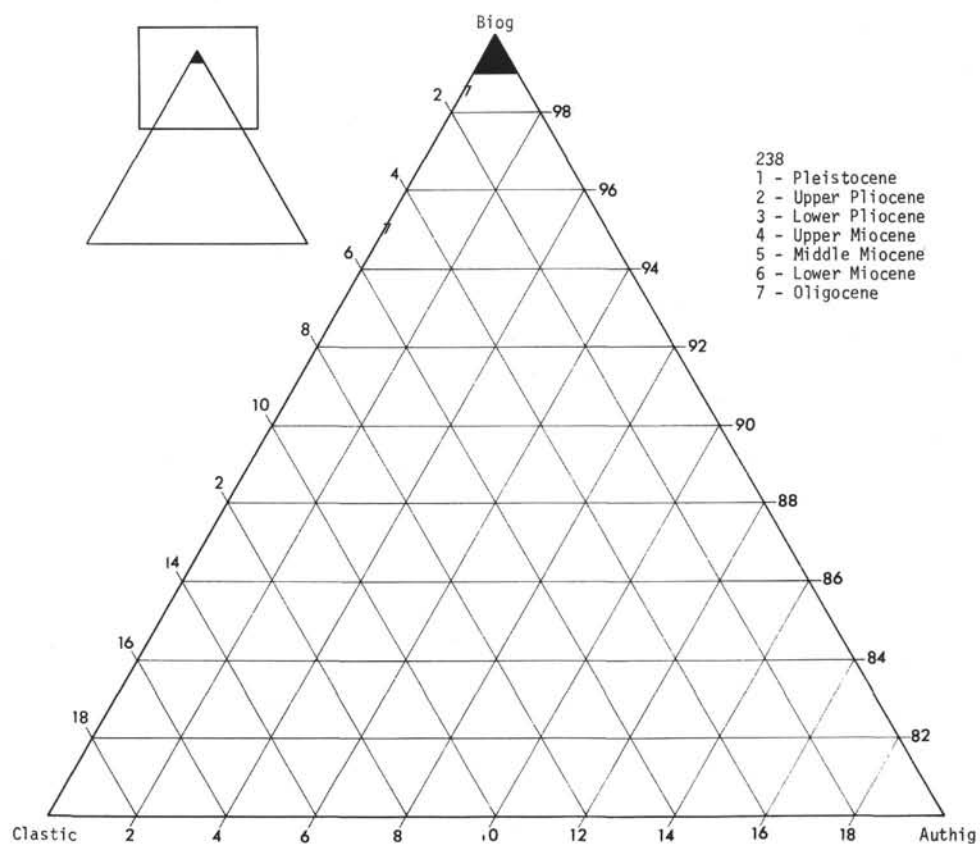
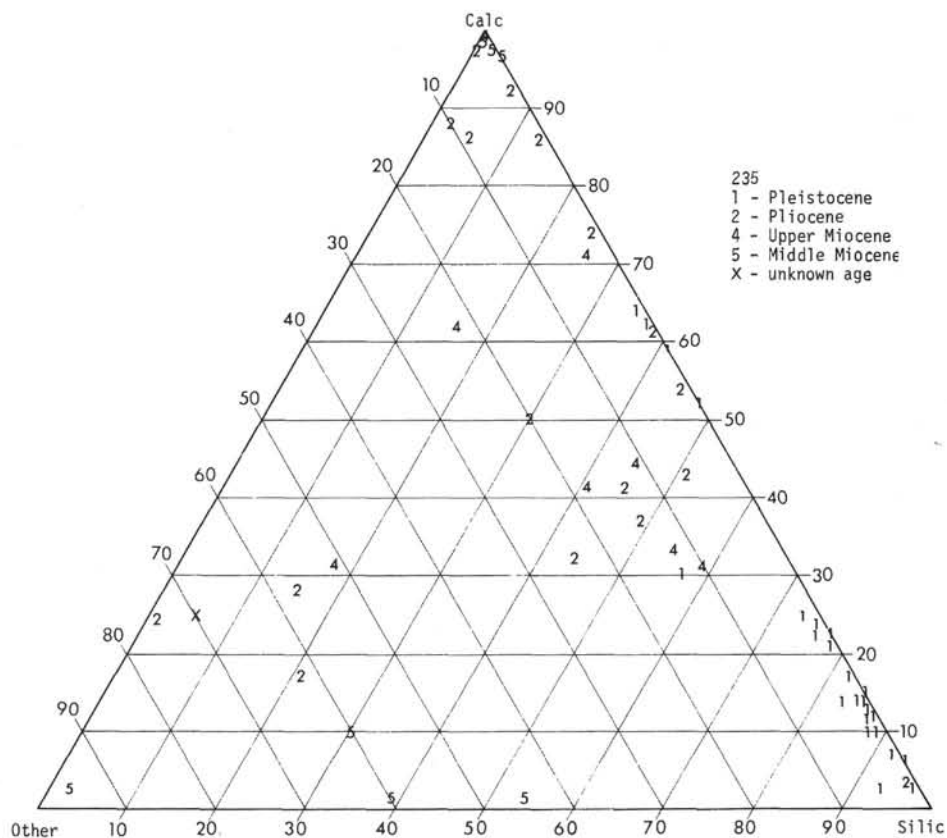Figure 40b. *Distribution of biogenic-clastic-authigenic components in Site 238 sediments, based on coarse grain analyses. Only samples with < 99% biogenic components have been drawn up.*
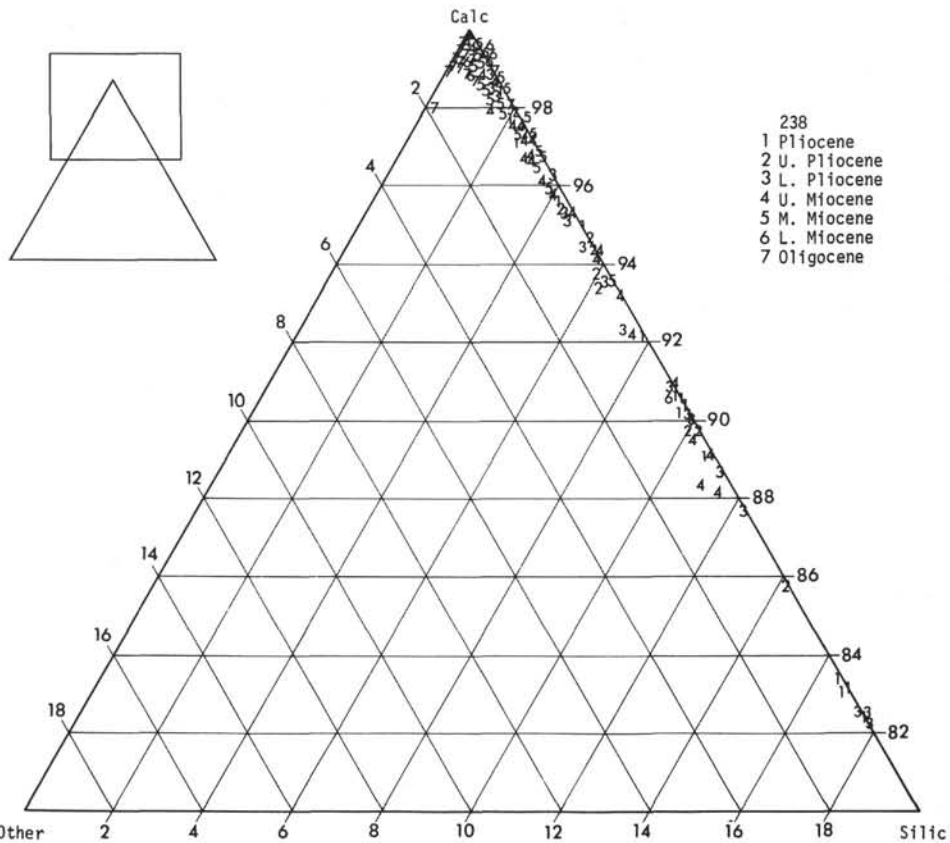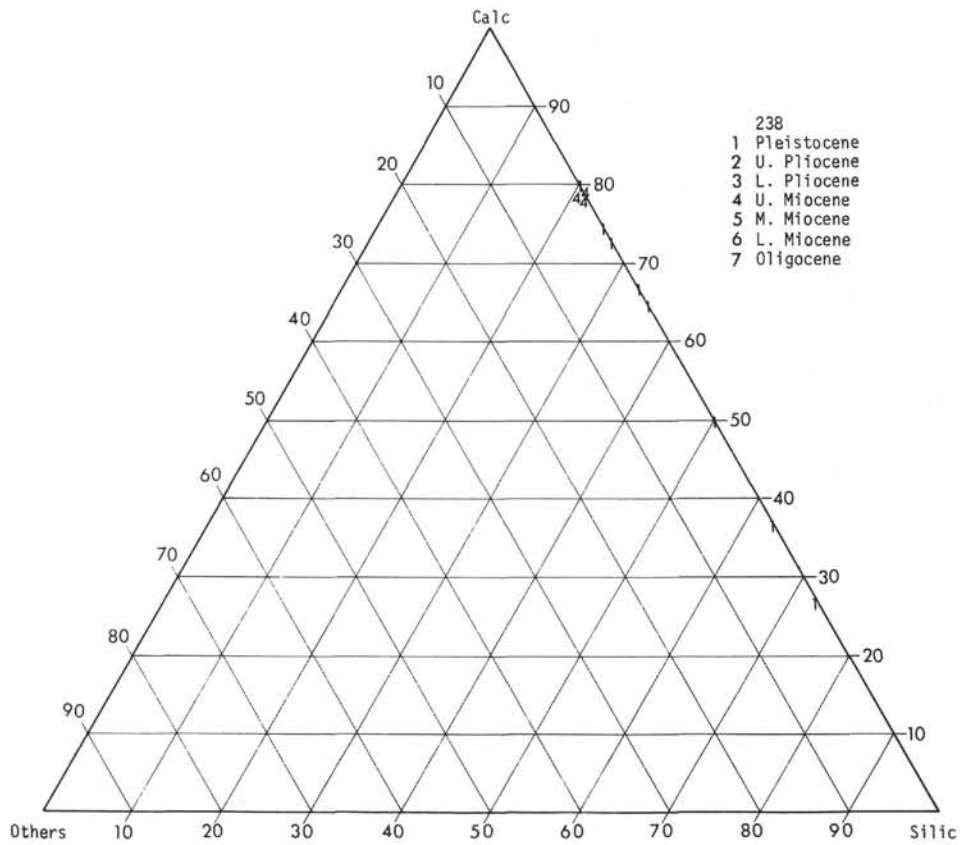
Figure 40c. *Composition of tests and skeletons of Site 238 sediments (calcareous, siliceous and other material); based on coarse grain analyses. Only samples with < 99.8% calcareous material have been drawn up.*
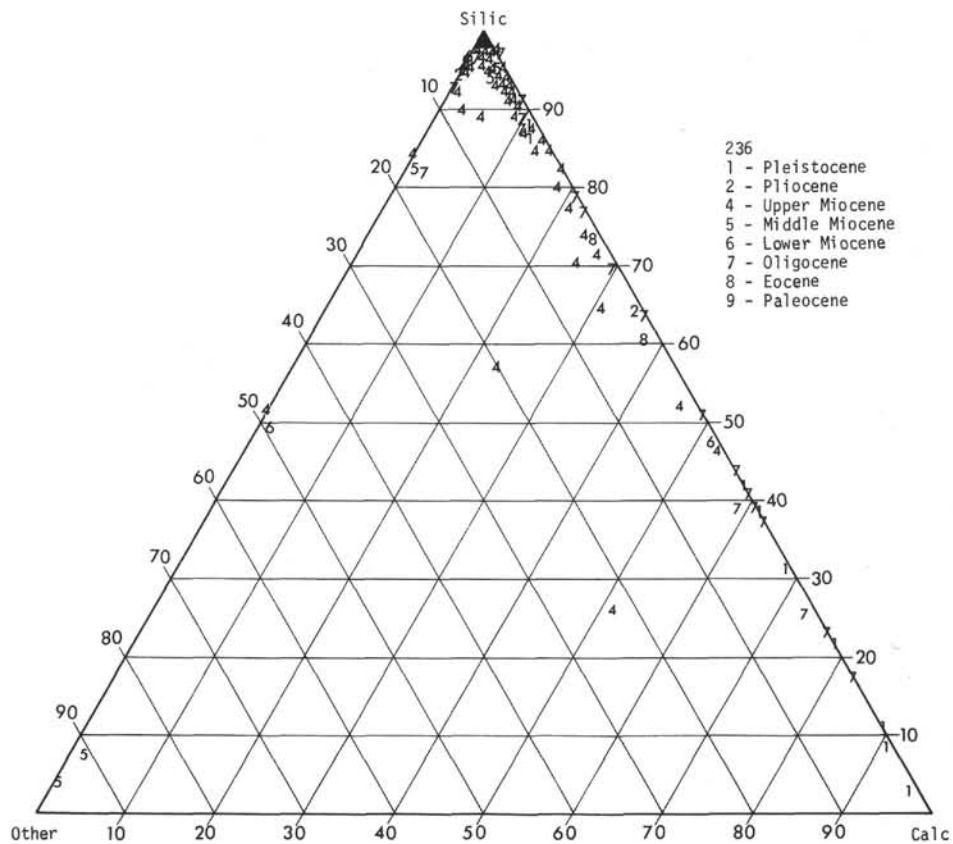
699

constant quantities in the sediments from Sites 232 and 233. The correlation between sites with relation to these benthic and planktonic components is not well understood. However, if all the siliceous components at one site are compared, the coincidence of the occurrence of these components is striking. Sites 236 and 238 have been chosen as examples (Figure 41). The occurrence of siliceous sponge spicules and radiolaria is almost parallel while diatoms always can be correlated to the maximum abundance of both other components. Radiolaria always exceed the range of the diatoms, sponge spicules always that of Radiolaria. This strongly suggests that the siliceous components in these coarse fractions are subject to selective solution. Diatoms are dissolved before Radiolaria and Radiolaria before sponge spicules. A similar sequence of SiO_2 solution has been described, although on a smaller scale, by Schrader (1972a and b) from Quaternary sediments of the north Atlantic Ocean.

It is therefore rather questionable how much paleoclimatic evidence can be drawn from these components which should be indicators of the high production belt close to the tropical divergence (Casey, 1971; Kozlova, 1971; Lisitzin, 1971). The production of these skeletons decreases, at least in the Pacific, north and south of this belt which seems to have been rather stable throughout the Tertiary (Riedel, 1971). However, it seems clear that the sediments were situated close to or under this belt if the preserved siliceous fossils are as dominant since Miocene as at Site 238, and as at 236 in Oligocene, upper Miocene, and Plio/Pleistocene sediments.

One might express this dominance of siliceous fossils, in particular Radiolaria, by calculating a ratio

$$R = \frac{\text{planktonic foraminifera (whole tests and fragments)}}{\text{Radiolaria}}$$

for all sites (Figure 42). The dominance of the siliceous fossils in the horizons cited seems to offer good evidence for a former position under this tropical belt, if the present location of the site has been removed from this climatic zone because of movement of the oceanic crust (Berger, 1973). Radiolaria, however, also occur rather frequently in the northern part of the Indian Ocean (Petrushevskaya, 1971).

Fossils Consisting of Other Biogenic Material

The following fossils consisting of other biogenic material and not derived from shallow coastal waters must be mentioned.

Arenaceous benthic foraminifera were found at all sites (Figure 43). Following the trend of other benthos, they occur more frequently in the hemipelagic sediments at Sites 231 and 232 (but not 233). Their abundant occurrence in sediments at Sites 231 and 232 is striking in comparison to their scarcity at all other sites, even those of similar water depth (close to islands) of the open ocean. Although arenaceous foraminifera are also known as ubiquitous, but scarce deep-sea organisms, higher abundances of them in deep-sea sediments from temperate, subtropical, and tropical climatic zones might be indicative of a hemipelagic sedimentary environment close to the continental margin. However, their geological importance is expected to be
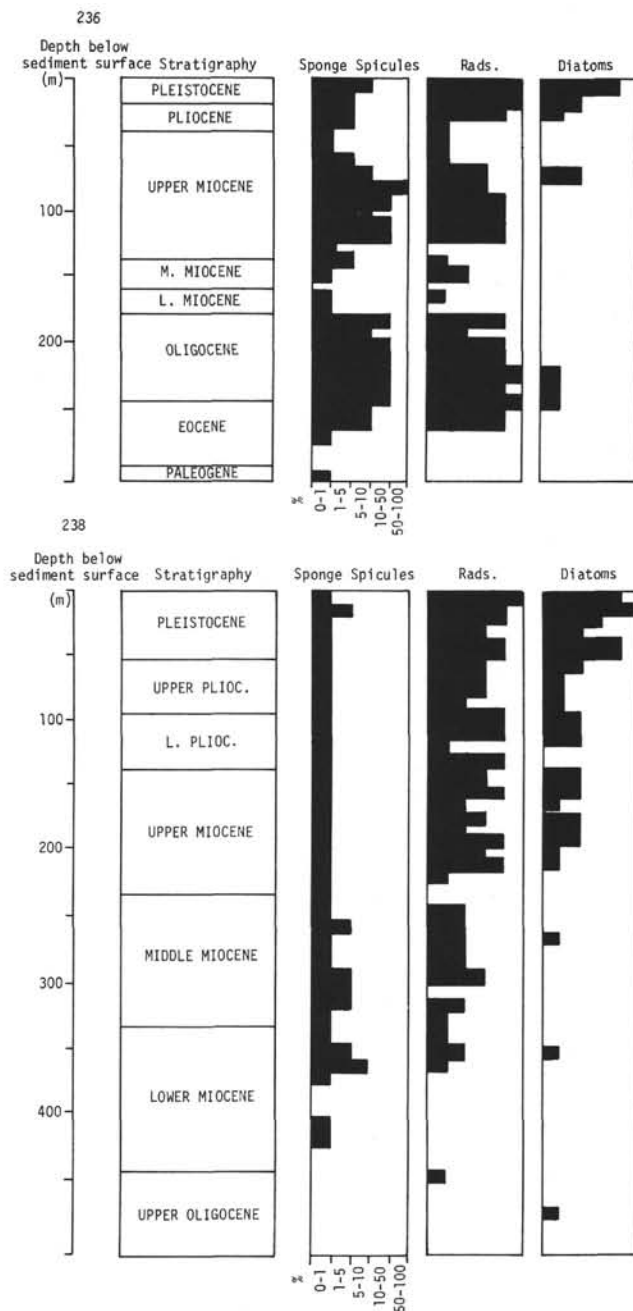
Figure 41. *Distribution of silicous components of coarse fraction of Sites 236 and 238. Values indicated are maximal percentages of the biogenic components per core.*

rather restricted, since they are rarely preserved in marine deposits, but they usually are subject to rapid diagenetic destruction due to dissolution of the cementing substance of their shells (Kudrass, 1973).

The other important biogenic component of non-siliceous and noncalcareous composition in oceanic coarse fractions are fish remains (Figure 44). If preserved, they are found as accessories in all types of sediment (Berger and von Rad, 1972). If the diluting components have been dissolved, the proportion of fish debris rises considerably. This is well documented in sediments from Sites 234, 235,
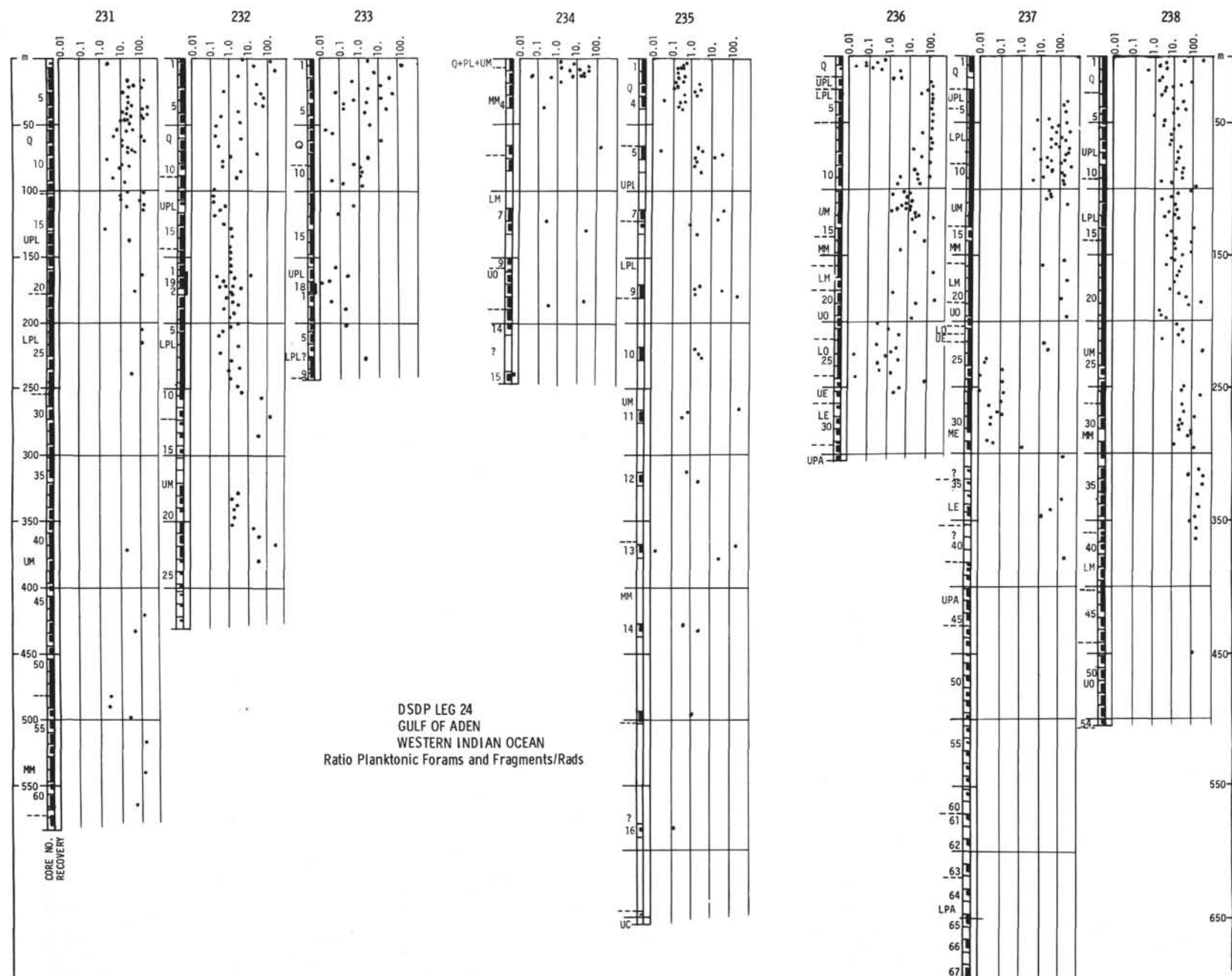
Figure 42. Ratio = $\dfrac{\text{Planktonic foraminifera (while tests and fragments)}}{\text{Radiolaria}}$ based on analyses of Leg 24 coarse fractions.
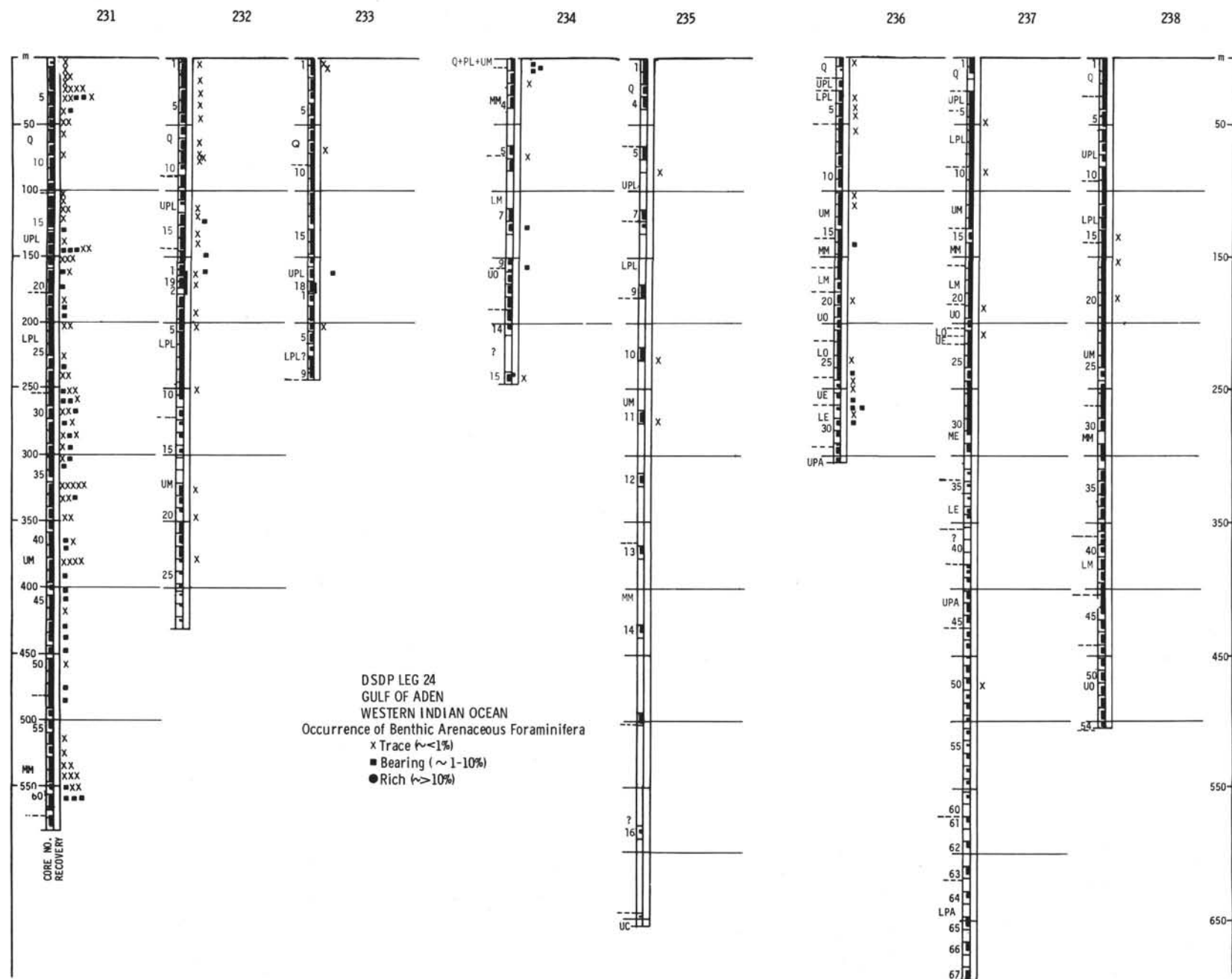
Figure 43. *Occurrence of benthic arenaceous foraminifera in Leg 24 coarse fractions (in percent of biogenic assemblage). Each sign indicates frequency in one sample. Samples without arenaceous benthic foraminifera are omitted.*

DSDP LEG 24
GULF OF ADEN
WESTERN INDIAN OCEAN
Distribution of fish debris in coarse fractions
(in percent of biogenic components).
Average values for each core.
Remark: different scale at 235, 236
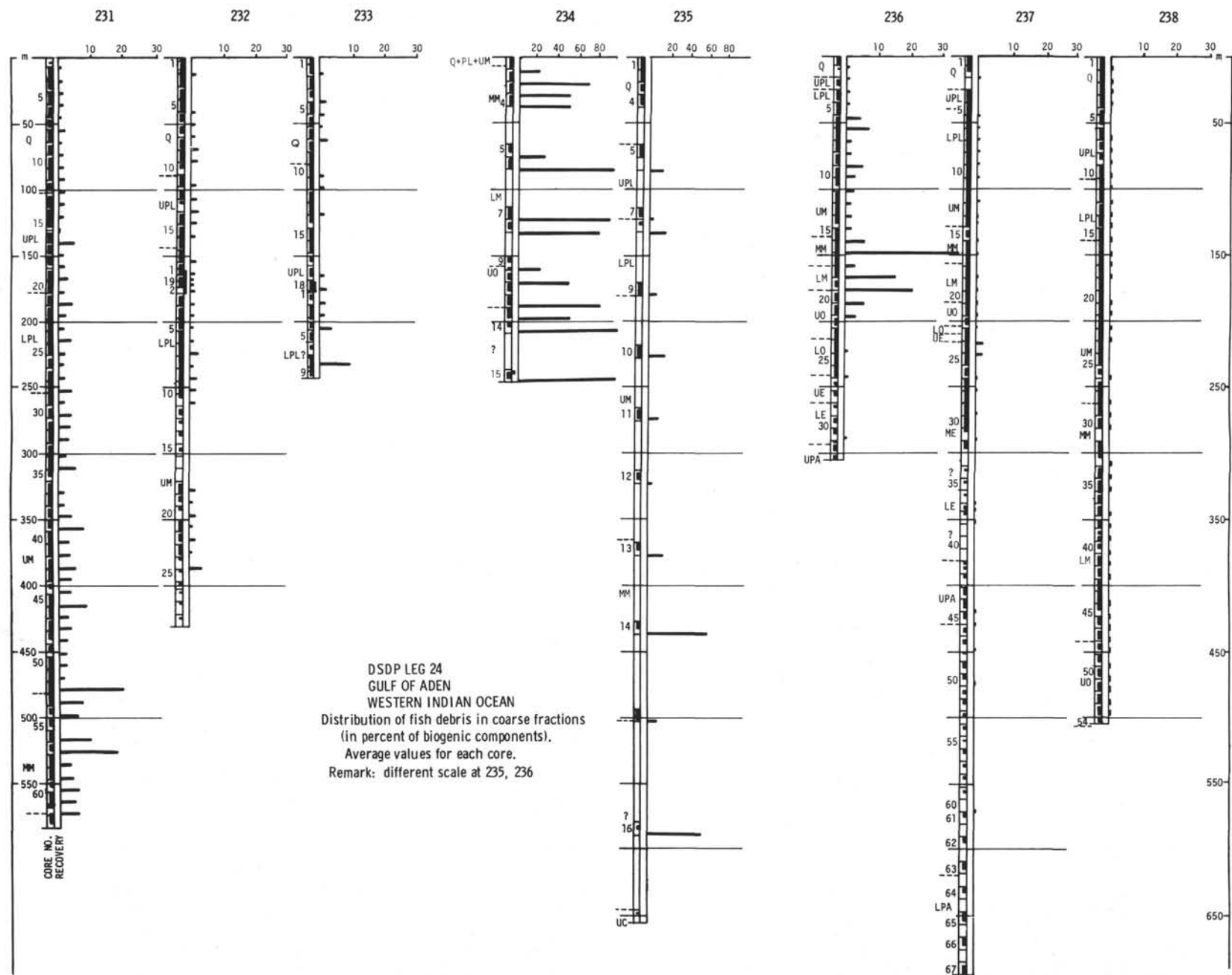
Figure 44. *Distribution of fish debris in coarse fractions of Leg 24 (in percent of biogenic components). High proportions of fish debris are in most cases coincident with bad preservation of calcareous components.*

and the upper Oligocene to middle Miocene sediments of 236. However, they also occur more frequently than usual at Sites 231, 232, and 233. The dissolution of other components is not as important here as the high organic production of this fertile area. A careful mapping of the actual sedimentation rate of fish debris would presumably depict areas of higher fertility in the ocean, especially areas of oceanic upwelling.

Shallow-Water Biogenic Components

Although consisting of a wide variety of chemical substances and being produced by very distinct organisms, these components have a common source area in rather shallow water (Figure 45). The result is not only that they are alien to the pelagic deep-water environment, but also that they are accompanied by an assemblage of normal oceanic biogenic components which are only distinct from the autochthonous components by their stage of preservation. Reworked sediments are more common in the deep sea than previously thought, and the determination of the proportion of reworked allochthonous and of autochthonous components in the sediments is of utmost importance. Primary indicators for the solution of this problem, at least in the area bordering continents and islands, are the following biogenic components (as used in this chapter).

Calcareous algal crusts are restricted to very shallow depths along the coast (especially in tropical arid areas) or to very shallow areas in the ocean such as islands or banks. They were found in horizons in Paleocene sediments at Site 237 and in horizons at Site 231 which contain a high portion of displaced material.

Plant remains presumably of continental origin have been frequently found in the Gulf of Aden sites and in the Somali Basin (but only east of Chain Ridge) and in upper Miocene sediments at Site 236. However, they are not very good indicators of shallow-water-derived material because when wet, they are easily suspendable in water, and this results in their widespread occurrence rather far from land. They are therefore not used here extensively. In the Gulf of Aden sediments they are scarce in pre-upper Miocene sediments, but increase in abundance through upper Miocene, Pliocene, and Pleistocene, becoming rare again in surface deposits. The peak in plant accumulation in sediments at Site 232 during the upper Miocene seems difficult to explain since usually plant debris requires fluvial transport to the sea (Sarnthein, 1971). This does not correlate with the occurrence of Miocene evaporites, which require highly arid conditions in the Red Sea. The rather high abundance of plant debris in the eastern and not the western part of the Somali Basin poses a serious problem which needs explanation.

A thin horizon of shallow-water *Discocylina* in the Paleocene of Site 237 should be especially noted. Fragments of bryozoans and corals have been found at Sites 231 and 236. Benthic molluscs (bivalves and gastropods) occur in sediments at Sites 231, 232, 233, 235, and 236.

The association of pteropods and mollusc larvae with the above-mentioned shallow-water-derived components is easily understood because of their susceptibility to dissolution in deeper waters. Stubbings (1939) mentions that the coastal sediments from 0 to 150 meters of water in the Gulf of Aden are virtually pteropod free, but their maximal occurrence lies below 150-400 meters. For benthic molluscs, maximum abundance at 200 to 400 meters of water suggests that the bulk of the shallow-water-derived material comes from these water depths. Certainly for algal crusts, and possibly for corals and bryozoans, a shallower source area is necessary.

The ratio of planktonic to benthic foraminiferal shells has been used many times for the determination of paleowater depths (Grimsdale and Morkhoven, 1955). This ratio has also been calculated for samples of the Leg 24 sites in a hope to gain some information about possibly displaced foraminiferal faunas (Figure 46). Only the abundance of whole tests of planktonic foraminifera and benthic calcareous foraminifera has been used for the calculation of this ratio. Fragments of planktonic foraminifera are excluded because of the difficult and uncertain estimation of whole tests from fragmented faunas. Arenaceous benthic foraminifera have not been taken into account for the ratio because of their erratic preservation pattern. This ratio has been shown to be highly variable at all sites with the exception of Site 238 where it increases very slowly downwards from about 100 in surface sediments to 200-500 in the lower Miocene/upper Oligocene sediments. Since the variations of this ratio are almost parallel to the degree of calcium carbonate dissolution, it is assumed that it is almost entirely controlled by the greater resistance of calcareous benthic foraminifera to calcium carbonate dissolution. The smallest value of this ratio occurs in the Somali Basin sediments, thus showing exactly the reverse result than that expected from former studies (Grimsdale and Morkhoven, 1955; and many others). This does not apply to horizons of shallow-water-derived material which usually contain more benthic foraminifera and thus smaller ratios than the autochthonous sediment.

PRESERVATION OF CALCAREOUS FOSSILS

It has already been stated that the study of preservation of calcareous material in deep-sea sediments is of utmost interest. The roughly horizontal pattern of the distribution of solution facies (Berger, 1968) is one of the few tools available in the open oceans to determine if sediments are displaced. Displacement is most easily established by the presence of shallow-water components. However, these components are scarce and do not have easy access to deeper basins of deposition. Preservation patterns of siliceous skeletons are not as clearly depth related as those of calcareous material.

In this study, the degree of fragmentation of the ubiquitously occurring planktonic foraminifera has been taken to determine the degree of preservation of calcareous material (Berger, 1968, 1971; Berger and von Rad, 1972). A ratio of unfragmented tests to fragmented ones was expected to be depth related and therefore to offer information concerning paleodepths. It was unlikely that this could be determined using other methods because the Leg 24 sites in the Indian Ocean were situated either well below or well above the calcium carbonate compensation depth, while the sediments of the Gulf of Aden were deposited close to or on the continental margin, which has
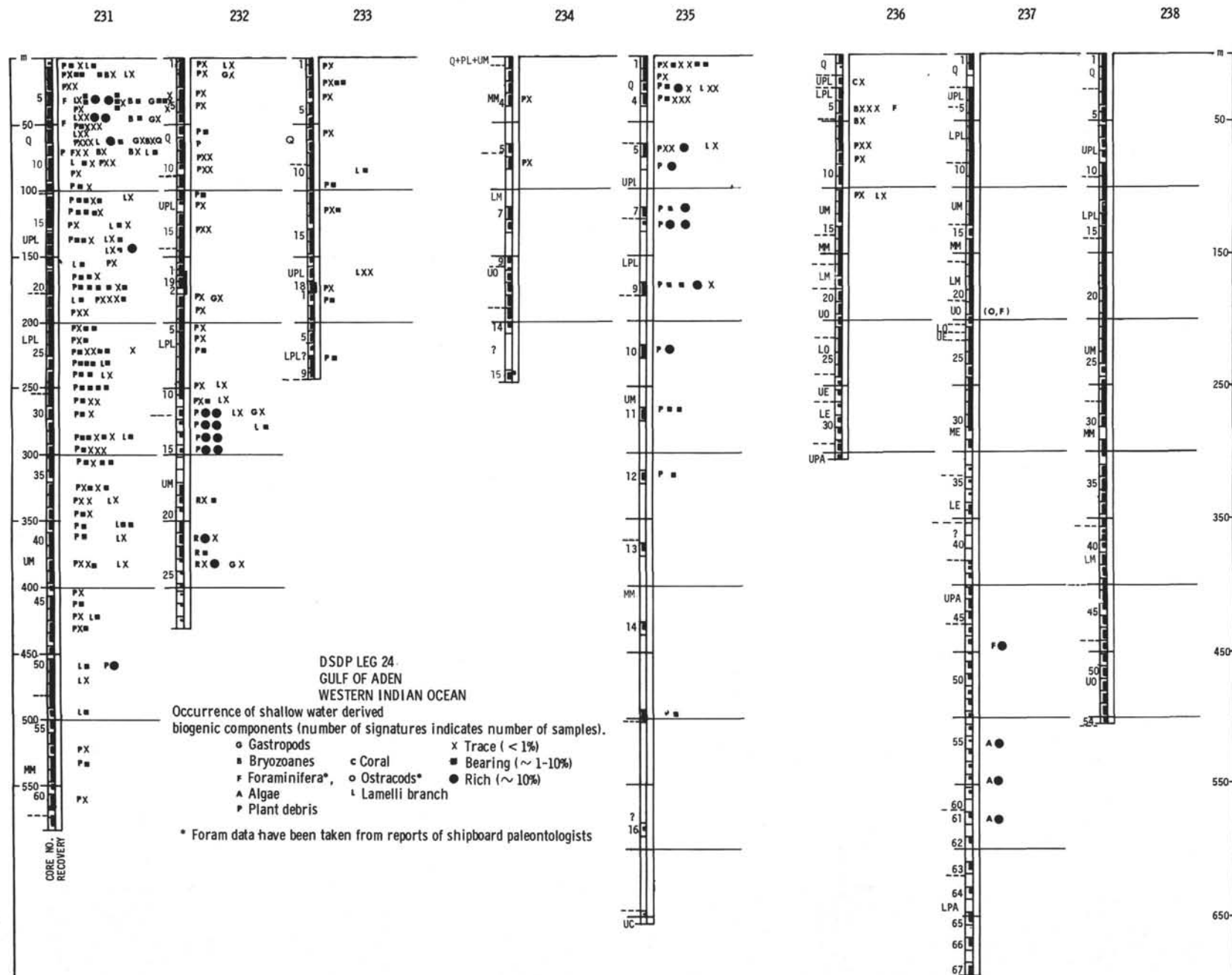
Figure 45. *Occurrence of shallow water derived biogenic components (each signature indicates one sample, samples without grains belonging to this group are omitted).*

SEDIMENT COARSE FRACTIONS

DSDP LEG 24
GULF OF ADEN
WESTERN INDIAN OCEAN
Ratio Planktonic/Calcareous Benthic Forams
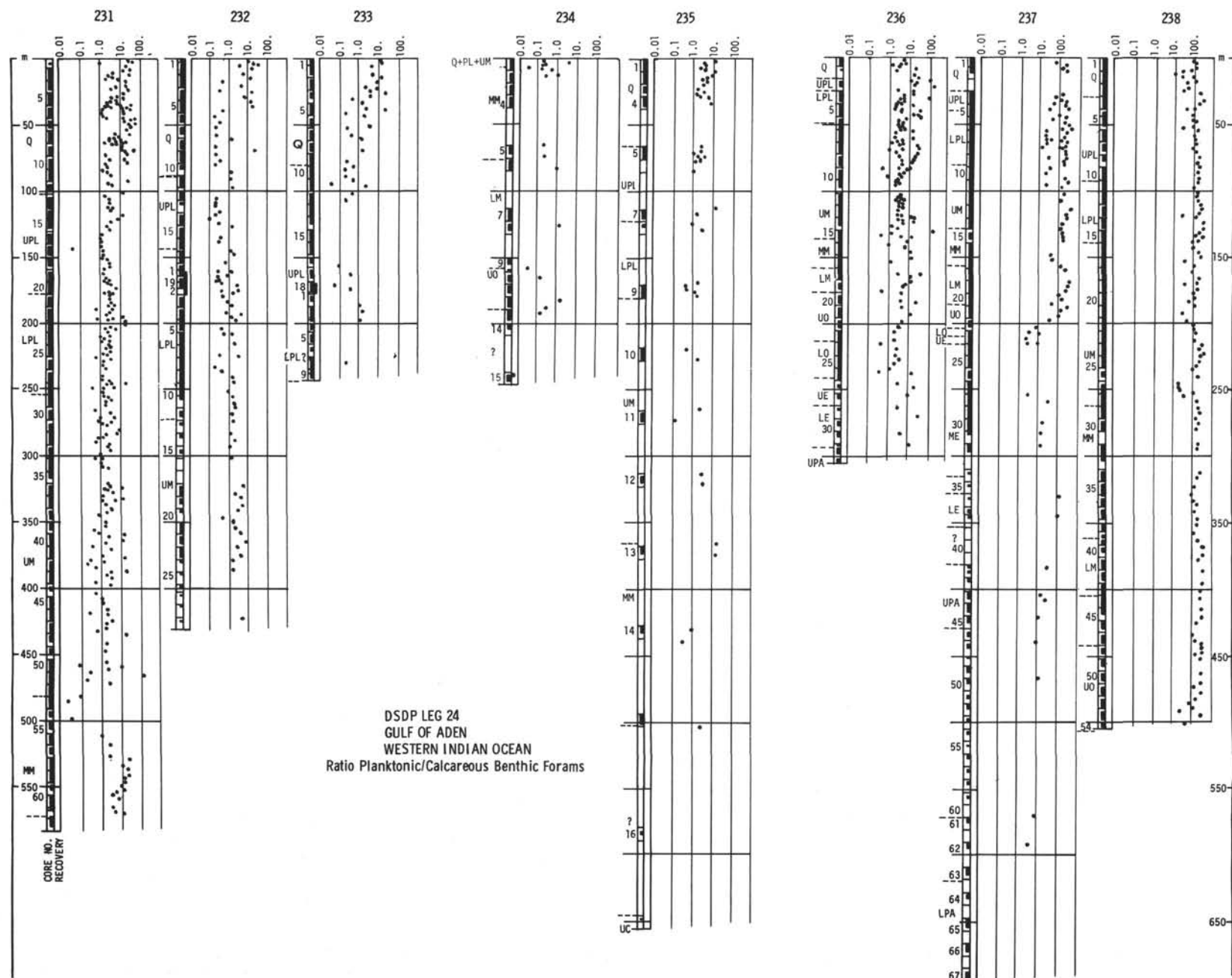
Figure 46. *Distribution of ratios* $R = \dfrac{Planktonic\ foraminifera\ (whole\ tests)}{Calcareous\ benthic\ foraminifera}$ *in Leg 24 coarse fractions.*

its own pattern of calcium carbonate preservation (von Stackelberg, 1972; Thiede, 1973a).

The ratio

$$R = \frac{\text{planktonic foraminifera (whole tests)}}{\text{fragments of planktonic foraminifera}}$$

is directly dependent on water depth, as shown in Figure 47. It thus offers a rough method for approximating depth of deposition of a calcareous pelagic deep-sea sediment. This method is valid only in the open ocean because calcareous material is less well preserved in hemipelagic deposits which have a high organic content. Because of this, the values from the three Gulf of Aden sites are considerably smaller than would be expected from this curve (Figure 47). This ratio was calculated for all samples investigated (Figure 48) and conclusions were drawn despite a considerable scatter in the values of the ratio. In the Gulf of Aden, the Pleistocene and Miocene sediments generally are better preserved than Pliocene sediments. Despite its greater water depth, Site 235 in the Somali Basin shows better preservation, according to the ratios, than Site 234. The considerable scatter of values at Site 236 obscures any clear trend. At Site 237, Paleocene/lower Eocene and upper Eocene/lower Oligocene faunas are more poorly preserved than sediments of other ages. In general, the ratios at Site 238 increase with increasing depth below the sea floor.

A primary problem is to determine the reasons for the large value scatter. In calculating average values for the cores (Figure 49), it was found that although the general trend at Site 238 was easily recognizable, a number of cores contained sediment from shallow-water depths which were characterized by better preservation of the calcareous sediment than was indicated by the water depth of deposition of the surrounding sediment. This conclusion is substantiated by the Site 236 samples, where a number of coarse horizons clearly contain a small proportion of shallow-water components. In Figure 49 at Site 236, the coarse-grained horizons have been excluded, but still the finer sediment showed similar inconsistencies. This phenomenon was observed at nearly all sites and we therefore have concluded that almost all deep-sea oozes and chalks obtained at these localities consist not only of autochthonous sediments, but also of great proportions of displaced sediment (Parker, 1971). Calculation of the depth of origin of the Site 236 coarse horizon shows an average water depth of 3000 meters despite the presence of shallow-water-derived material. Considerable mixing of sediments is therefore probable.

In Figure 50a-d, the preservation of the planktonic foraminiferal faunas at Sites 231, 232, 233, and 237 is shown. The Gulf of Aden sites, again show better preserved Pleistocene and Miocene than Pliocene sediments. Site 237, from about a similar water depth in the open Indian Ocean is considerably different.

Paleodepths can be calculated from these values for all sites which lie well below or well above the range of fluctuation of the calcium carbonate compensation depth. This has been done provisionally for all sites except the Gulf of Aden Localities (Figures 51a-e), without taking into account fluctuations of the calcium carbonate compensation depth. Using these figures, former water depths derived
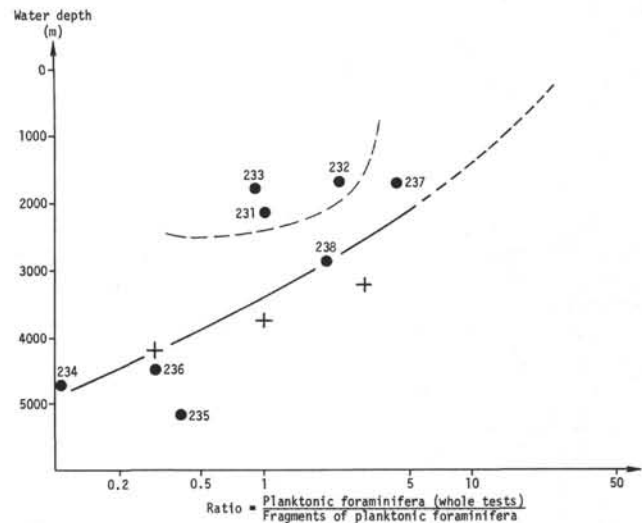
Figure 47. *Preservation of planktonic foraminiferal shells, illustrated by the*

$$Ratio = \frac{Planktonic\ foraminifera\ (whole\ tests)}{Fragments\ of\ planktonic\ foraminifera}.$$ *Values based on surface sediments of Leg 24 sites, crosses based on data taken from Belyaeva (1970).*

from the hypothesis of age/depth constancy (Sclater et al., 1971; Berger and von Rad, 1972) were calculated where basaltic basement had been reached and a reasonable age for the basement determined (Figures 52 and 53).

Sites 234 and 235 are both characterized by foraminiferal preservation which indicates water depths 1000-2000 meters shallower than at present. It must therefore be assumed that the proportion of displaced sediments is very great in the basin.

Site 236 clearly reveals two distinct zones. $CaCO_3$ preservation at the base of this site (Paleocene) is consistent with former water depths based on the age/depth constancy curve. However, the ratios drop considerably in Eocene sediments (between about 40 and 50 m.y.) and reach the level (or slightly above) of expected values at about lower Oligocene and then drop slowly to the present values. The computed former water depth is based on the preservation of foraminifera in individual horizons considerably above the age/depth constancy curve and is a measure of the input of displaced sediments. The parallel occurrence of very deep water computed for a time of reduction in spreading or possibly no spreading (Fisher et al., 1971) is probably not coincidental. The curve might really reflect a crustal oscillation.

Foraminiferal preservation in Site 237 sediments offers the reverse of what was expected: shallow water depth during the Paleocene and Eocene with sinking occurring afterwards. Foraminiferal preservation, however, does not agree with this. Computation tells us that the site was situated in deep water (about 4000 m) until lower Oligocene and was sequentially uplifted. The presence of the shallow-water-derived components can be explained as a result of slumping. However, foram evidence is more difficult to explain, because samples indicating deep water might be winnowed, resulting in a relative enrichment of foram fragments, and hence computation of a greater water depth (compare Vincent et al., this volume).
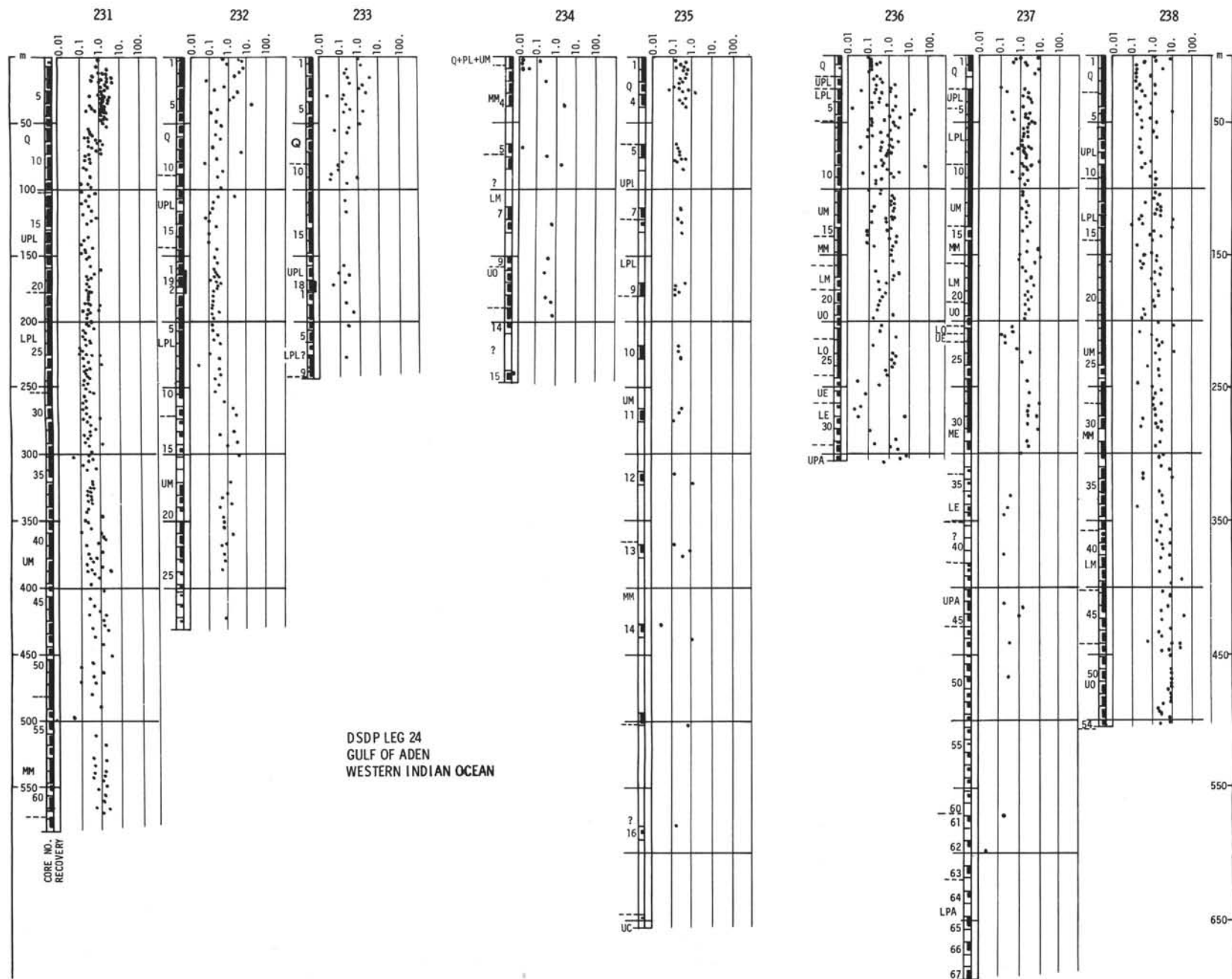
Figure 48. *Preservation of planktonic foraminiferal faunas in Leg 24 sites, expressed as* $Ratio = \dfrac{Planktonic\ foram\ (whole\ tests)}{Fragments\ of\ planktonic\ foram}$.
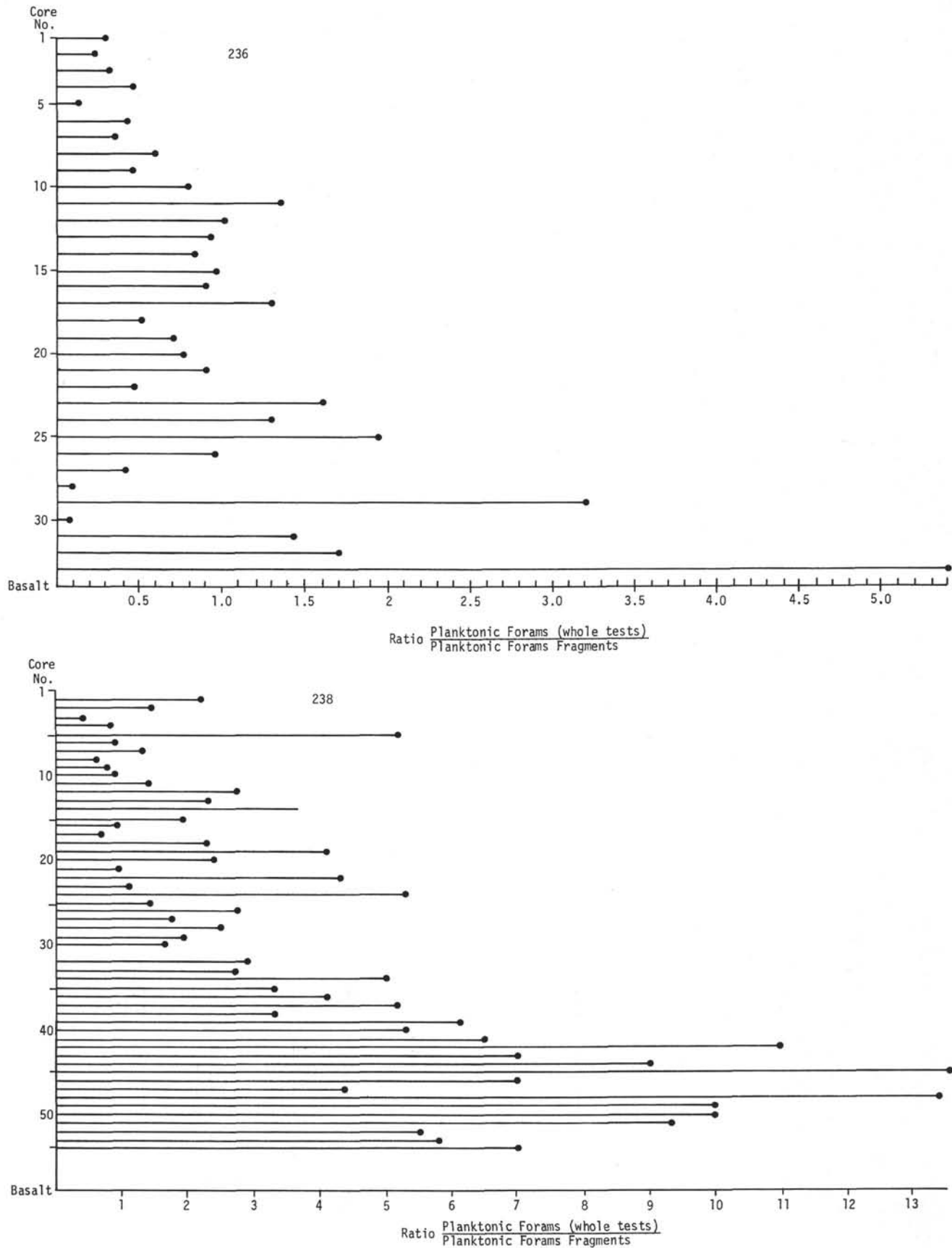
Figure 49. *Fragmentation of planktonic foraminiferal shells in Site 236 and 238 sediments. Average values for each core in Site 238, average values for fine grained sediments (< 15% sand sized material in Site 236).*

The best correlation between computed and expected water depth was found for Site 238, although the values are too high in the older part of the curve and too low in its younger part. It also means that, for this site, fewer fragments were found than expected close to the ridge (old sediments) and excess fragments were found far from the ridge (young sediments). This positive anomaly close to the ridge can be explained by the removal of fragments, the negative anomaly might, however, either be due to the contribution of fragments or to the removal of whole tests. It does not seem coincidental that the computed paleo-water depths for displaced sediments at Sites 234, 235, and 236 usually lie between 2000 and 3000 meters, exactly the range of this negative anomaly. Probably the source of displaced sediments in this area has to be sought in these water depths.

The determination of the position of the calcium carbonate compensation depth and the foraminiferal lysocline is of utmost importance. Site 236 alone was suitable for determining the position of the calcium carbonate compensation depth which was found to have been just below 4000 meters in lower Miocene times, somewhat deeper than indicated by Berger and von Rad, 1972. However, since paleodepths at this site are question-able, this problem will not be further discussed before data from all Indian Ocean sites and additional foraminiferal counts are available.

AGE/DEPTH CONSTANCY AND SEDIMENTATION RATES

In applying the age/depth constancy of basaltic oceanic basement (Sclater et al., 1971; Sclater and Detrick, 1973), to the Leg 24 drill sites, major inconsistencies are found (Figure 52). From eight sites, five reached an acoustic basement consisting of basic rocks. One of these five (Site 233) ended in a sill presumably underlain by sediments. The other four sites which penetrated the sediments down to the basaltic basement show a considerable scatter around the hypothetical curve (Figure 52).

Since these values are based on the age of the oldest sediment, it is possible to explain that a position below the age/depth constancy curve might be due to a stratigraphical gap between the basalt and the oldest sediment, the underlying basalt being considerably older (for example, Site 235). The position of a site considerably above the curve is much more difficult to explain.

Site 236 is situated on old oceanic crust which possibly was uplifted when spreading started after a period of no or
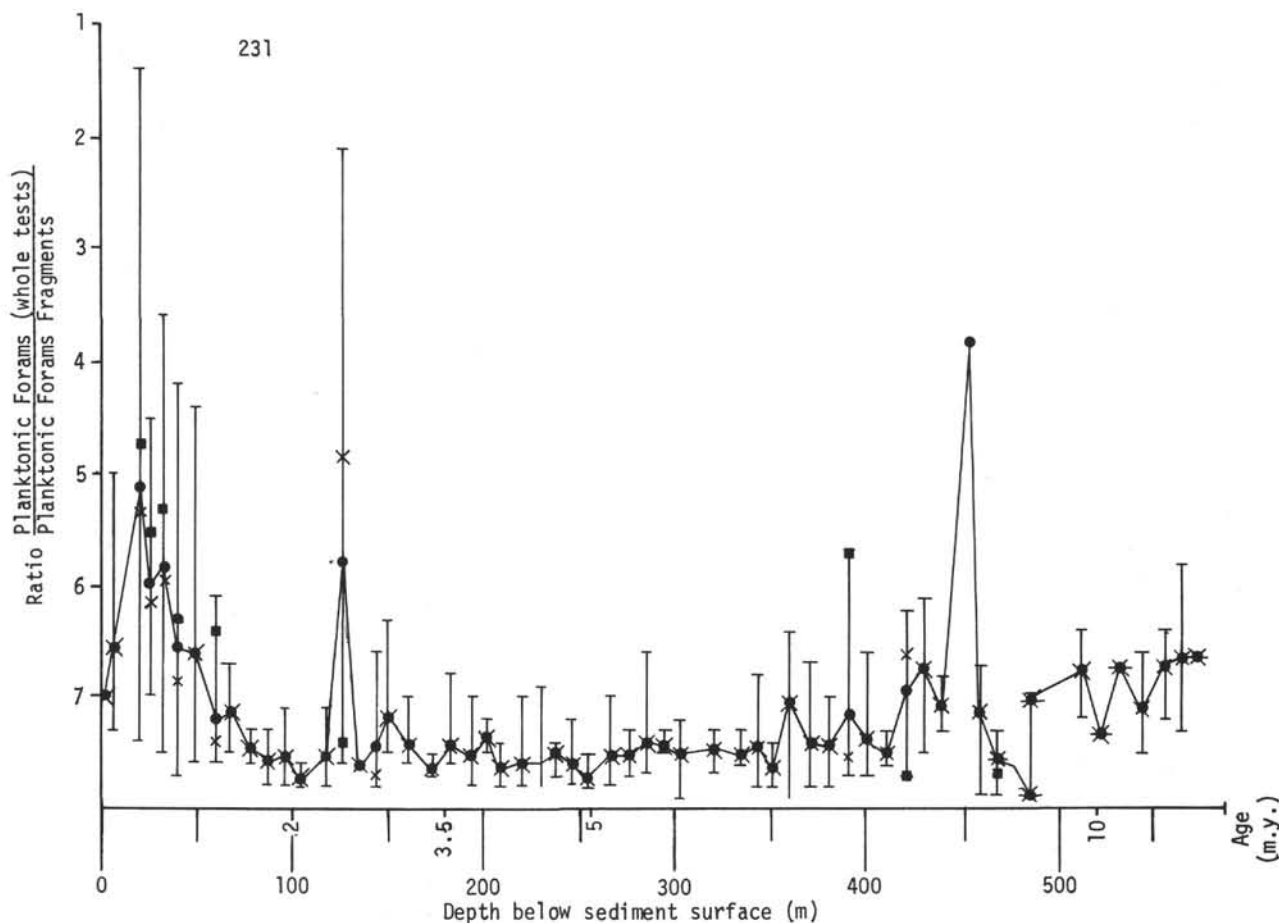
Figure 50a. *Preservation of planktonic foraminiferal faunas in Site 231. Minimum and maximum values are indicated:* ■ *average ratios in coarse layers per core (> 15% sand);* ● *average ratios of all samples per core; and* × *average ratios of fine sediments (< 15% sand) per core.*
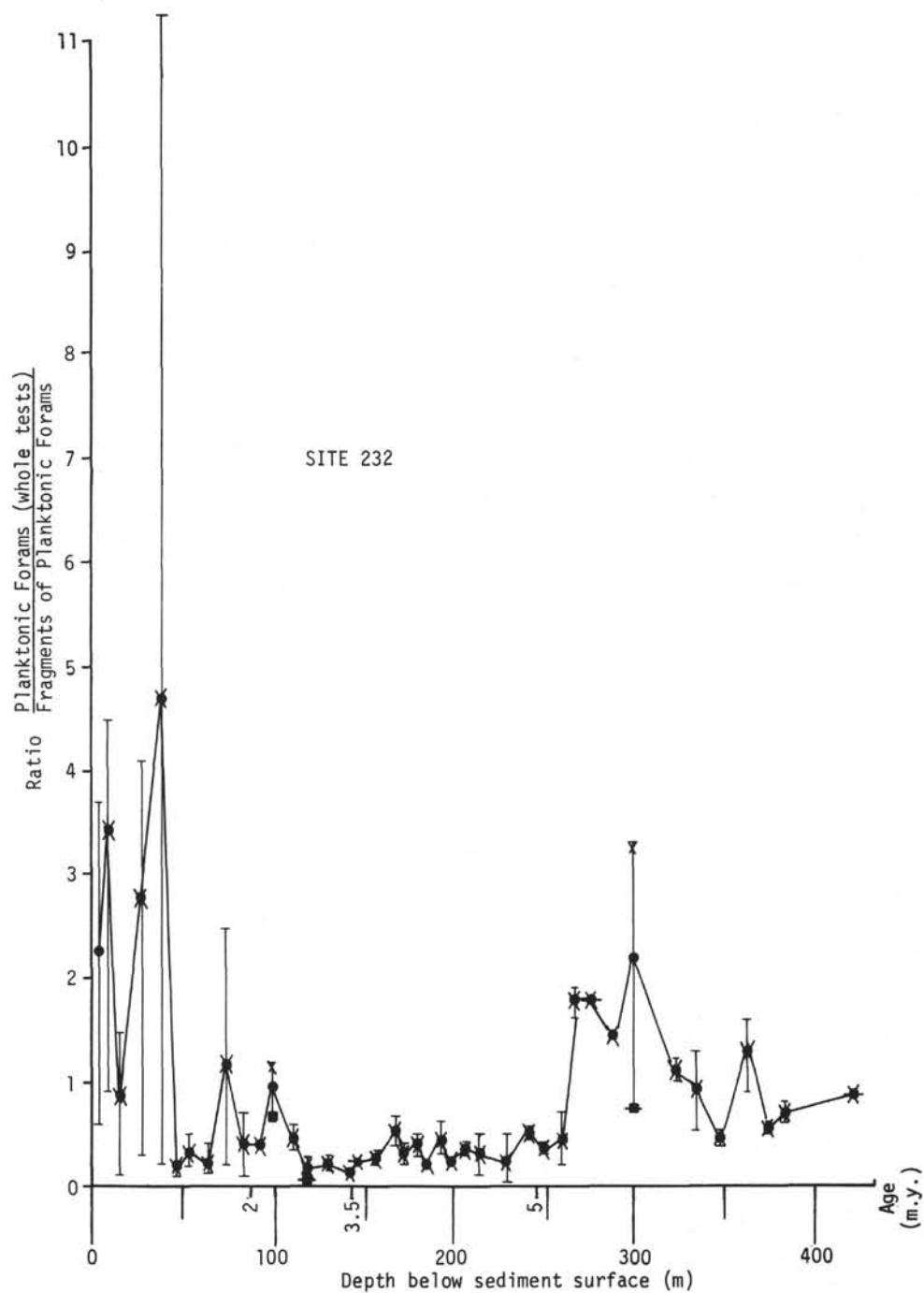
Figure 50b. *Preservation of planktonic foraminiferal faunas in Site 232. See caption (Figure 50a) for minimum and maximum values.*
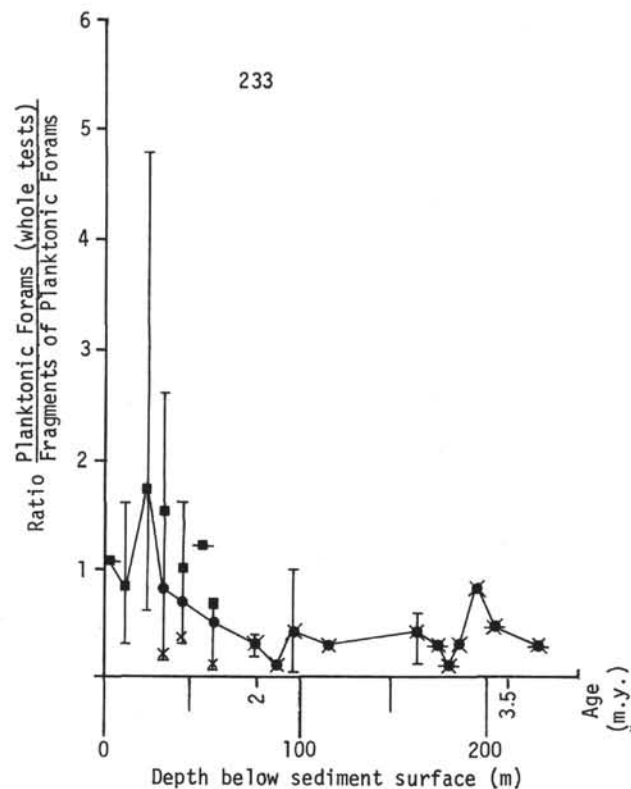
Figure 50c. *Preservation of planktonic foraminiferal faunas in Site 233. See caption (Figure 50a) for minimum and maximum values.*
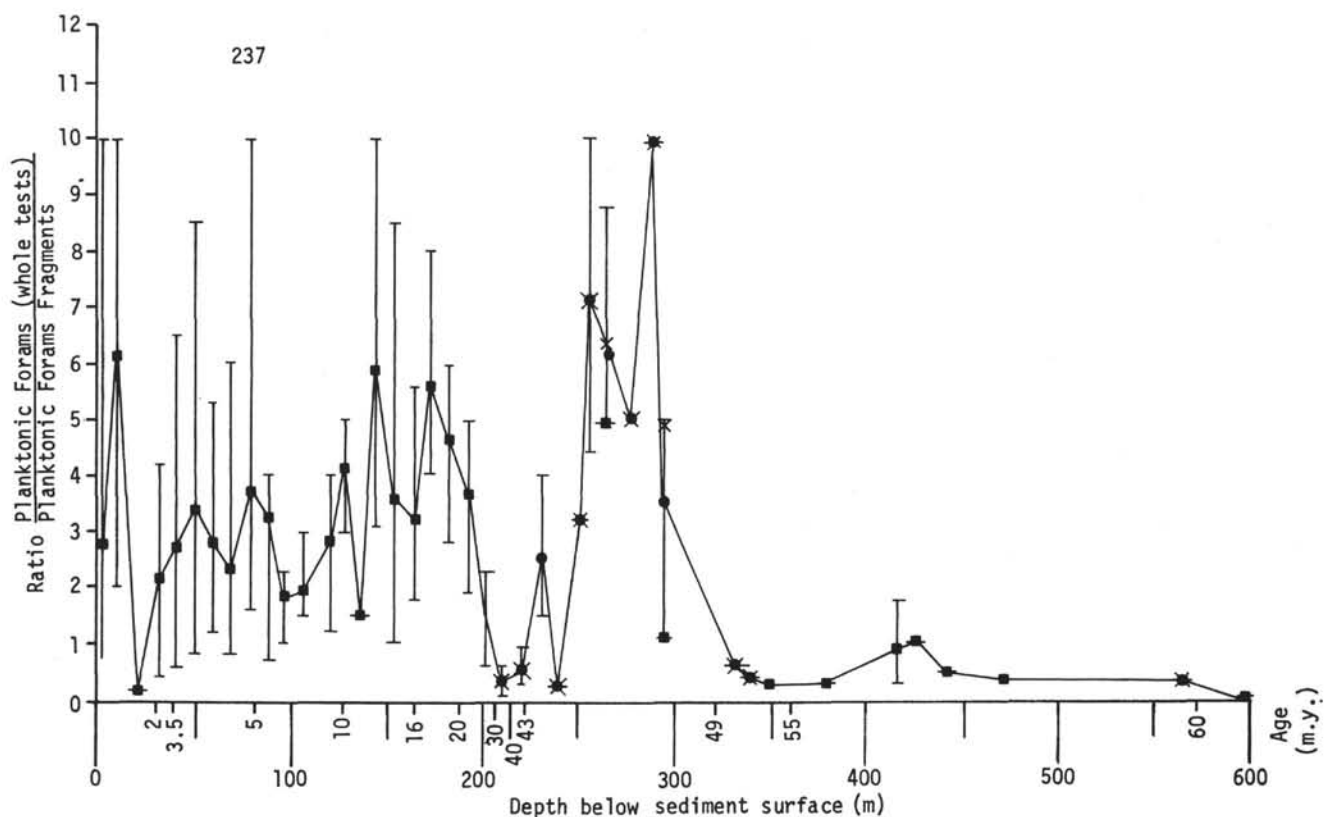
Figure 50d. *Preservation of planktonic foraminiferal faunas in Site 237. See caption (Figure 50a) for minimum and maximum values.*
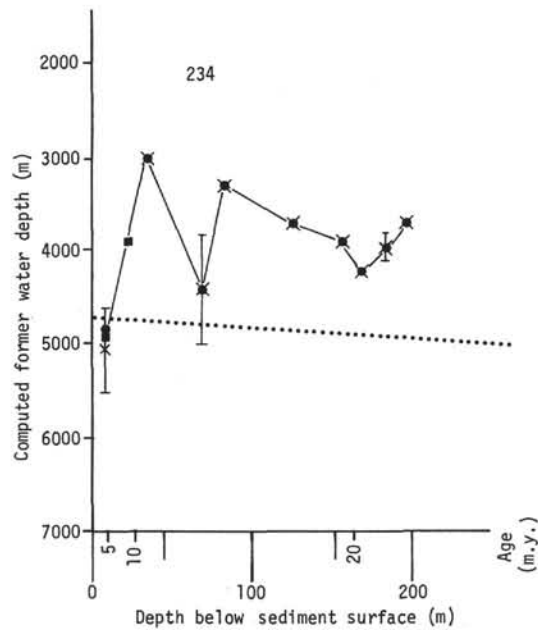
Figure 51a. *Computed former water depths, Site 234. Minimum and maximum values are indicated:* ■ *average of coarse sediments (> 15% sand) per core;* ● *average of all samples per core;* ✕ *average of fine sediments (< 15% sand) per core;* ..... *present depth below water surface;* ..... *paleodepths based on age/depth constancy.*
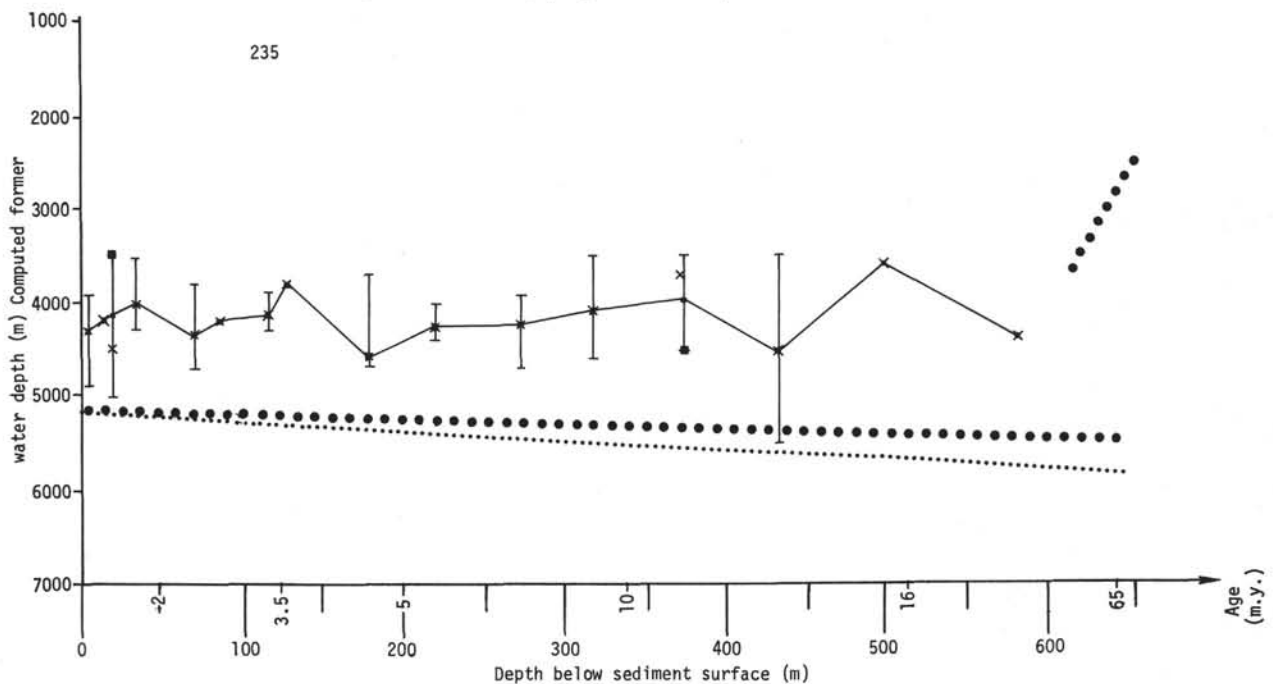
Figure 51b. *Computed former water depths, Site 235. See caption (Figure 51a) for minimum and maximum values.*

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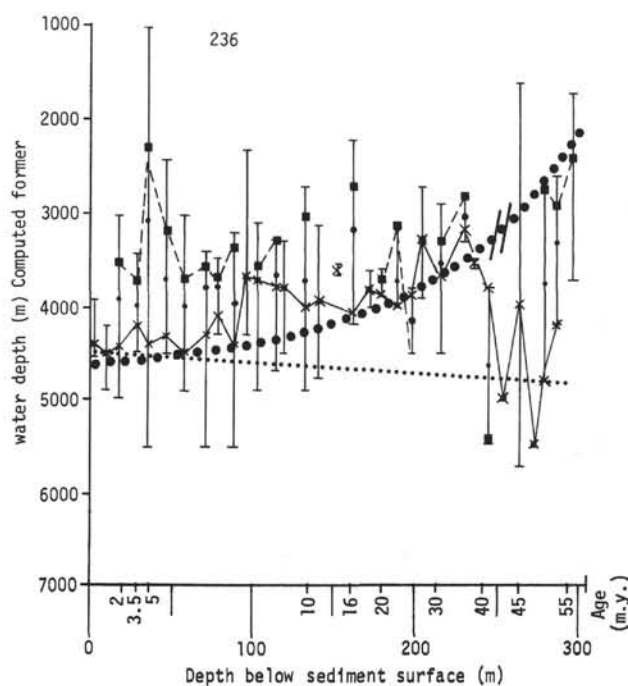
Figure 51c. *Computed former water depths, Site 236.*
See caption (Figure 51a) for minimum and maximum
values.
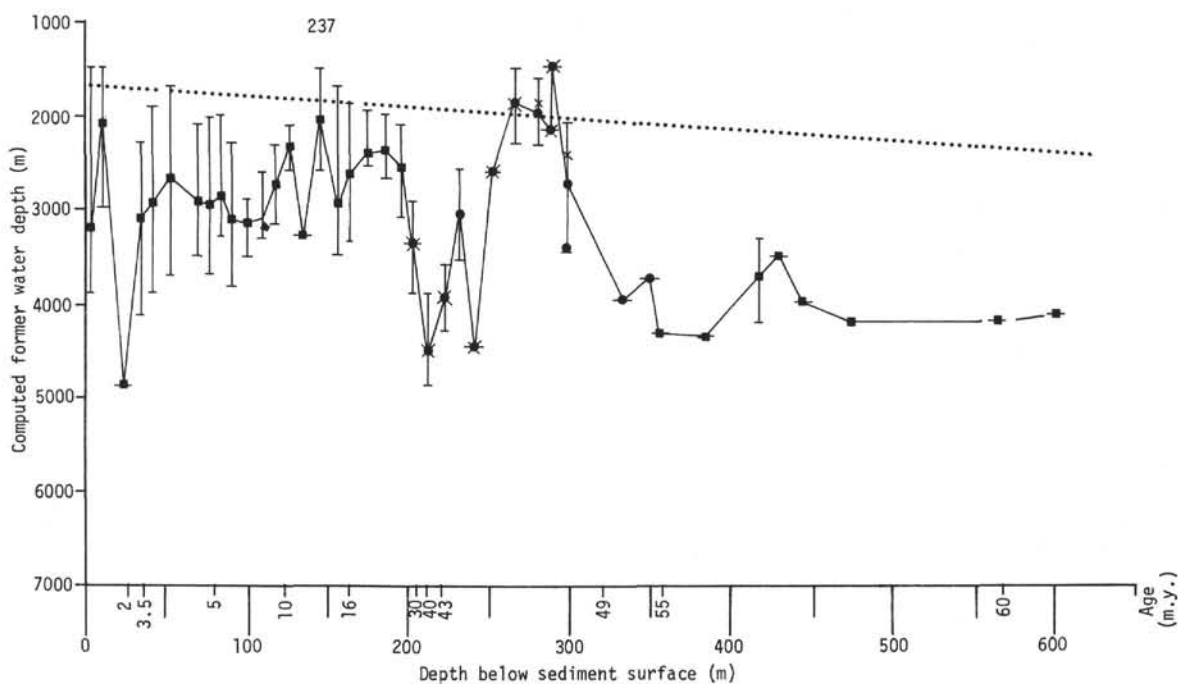
Figure 51d. *Computed former water depths, Site 237. See caption (Figure 51a) for minimum and maxi-*
mum values.
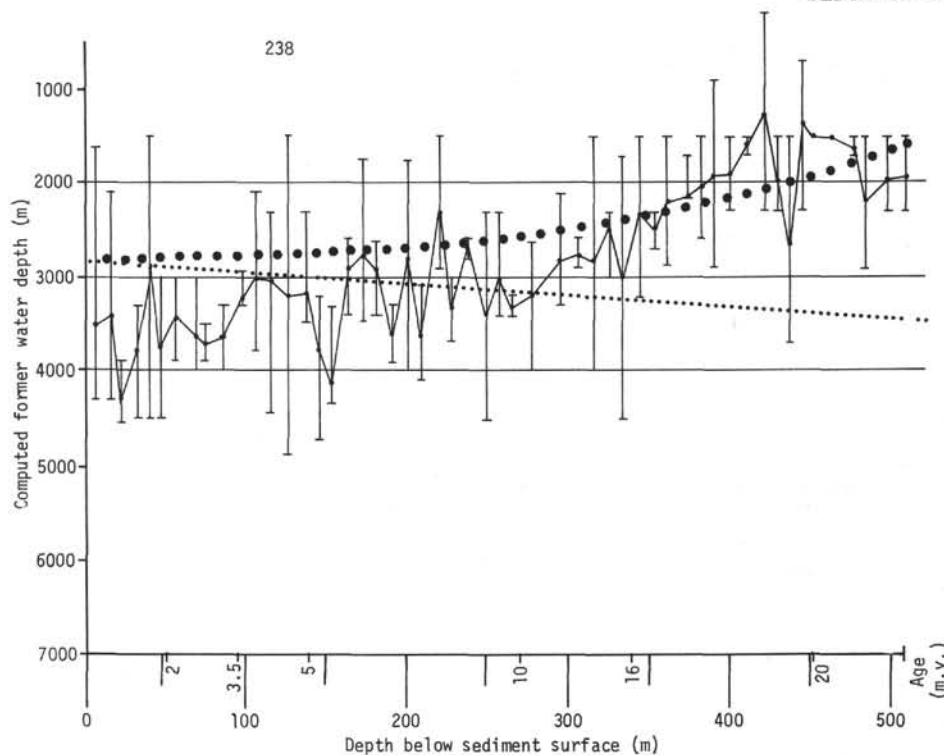
Figure 51e. *Computed former water depths, Site 238. See caption (Figure 51a) for minimum and maximum values.*

slow spreading (McKenzie and Sclater, 1971). The other two sites lie in the cleft of a transform fault (Site 238), or in an embryonic ocean basin (Site 231). This might possibly explain the elevated position of the basaltic basement. As these age/depth constancy curves are always based on smoothed topographic profiles, (for example, McKenzie and Sclater, 1971; and others) local highs of the basement would explain such an elevation of the curve although this would not be consistent with the character and presence of the sediments described here.

Figure 54 shows the reconstruction of former water depths. This has been tried for all Leg 24 sites, where true basaltic, oceanic basement was reached. Corrections for local topography and the sediment load have been taken into account (Berger, 1973; van Andel and Bukry, 1973). Oscillations of the oceanic crust due to shifts of the spreading axis are especially problematic for this kind of reconstruction. Except for Site 235, the figures are based on only one phase movement although this is presumably not correct (especially for Site 236).

The rate of subsidence also has an effect on the sedimentation rates (Figure 55a,b). In part a of this figure, sedimentation rates are calculated to be equivalent to the subsidence rate of a newly formed oceanic crust (effects of a sediment load have not been taken into account). The curve defined by these sedimentation rates is a boundary between two different sedimentary environments. If the actual sedimentation rates at a site are below this curve, only normal pelagic sediments and displaced material from the ridge can be expected; if the sedimentation rates are above, soon no material from the ridge can reach the site and the sediment pile can only be built up by normal pelagic sediments and displaced material from outside the ridge area, in many cases continental material. However,

these assumptions are only valid for the open ocean and cannot be applied to areas very close to the continental margin.

It is also important to consider only basement built up and affected by the same continuous spreading rift. Such a simple case has almost never been found in the complicated Indian Ocean, and only Sites 233 and 238 seem to follow this simple scheme. While Site 231 is situated on rather young oceanic basement very close to the continental margin, all other sites lie either on basement which has been affected several times by new spreading activity (Sites 235, 236) or above unknown basement (regarding its nature or its age or both: Sites 232, 234, 237).

The average total sedimentation rates of all Leg 24 Indian Ocean and Gulf of Aden sites are shown in Figure 56a-c. The holes always penetrated deeper into the sedimentary sequences shown in these diagrams, but only the parts with well-defined upper and lower stratigraphic boundaries were taken into account.

In general, several patterns of sedimentation rates are not well understood in terms of the preceding discussion. Shallow-water-derived (not from the ridge area) material occurs in the following Sites: 231, 232, 233, 235, 236 (indicated by a cross in the diagrams of Figure 56). This means that the greatest input of shallow-water material has occurred in the Indian Ocean and the Gulf of Aden since uppermost middle Miocene time (Figure 57a). The coincidence of shallow-water material in sites with rather young basement is poorly understood, but might be a regional pattern in the Indian Ocean and adjacent seas.

In correlating the first occurrence of shallow-water material (expressed in terms of age) with the sedimentation rates of deposits they have been found in, it is obvious (Figure 57a) that the sedimentation rates for the sites on
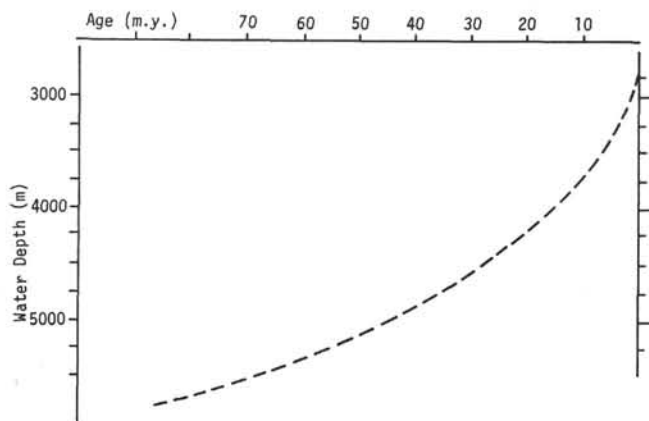
Figure 52. *Depth of present sea floor as a function of its age, taken from Berger (1972). This curve is only valid for "old" oceans, for open oceanic environment, for areas not affected by transform faults, guyots and ridges.*

| Basement reached. Sites, which did not reach basement, are positioned based on oldest sediment recovered.

Figure 53. *Positions of Leg 24 sites in the water depth/age of basement constancy diagram (compare Figure 52). Sites, which did not reach basement, have been placed on age of oldest recovered sediment.*

young basement are far from reaching the minimum sedimentation rates which should be expected following the curve of Figure 55b. The discrepancy between the estimated minimum sedimentation rates and the values actually found is greatest for the sites on the youngest basement decreasing systematically for older basement (Figure 57b). Only negative discrepancies are of critical importance because positive ones would allow an explanation for the presence of shallow-water-derived components.

Negative values, however, virtually prohibit a transport mechanism for these components as indicated in Figure 55b.

There are several possible reasons for these discrepancies:

1) Estimated age of basement is too young due to a stratigraphical gap between basalt and overlying basal sediments. This does not seem possible since the age of sediments directly above basement and the assumed ages (based on magnetic anomalies) for the basaltic basement agree rather well.

2) Because of compaction and possible changes of volume due to diagenetic processes, the present thickness of sediments does not necessarily represent the true thickness of sediments (which was probably greater). However, the discrepancies seem to be too large to be due only to compaction (see Physical Properties sections of Site Reports, this volume). Also, if this process has an important effect on sedimentation rates, it does not explain the age coincidence of this material in widely distant areas of the Indian Ocean.

3) An evident possibility to reach the present sites if sedimentation rates were insufficient to offer a transport path directly from the continental margin is indicated by the very young basement ages of Sites 231 and 233 in the embryonic oceanic basin of the Gulf of Aden. Allowing these components a way not only perpendicular to the spreading ridge, but also along the basin axis, the presence of these components may not pose such a serious problem any longer.
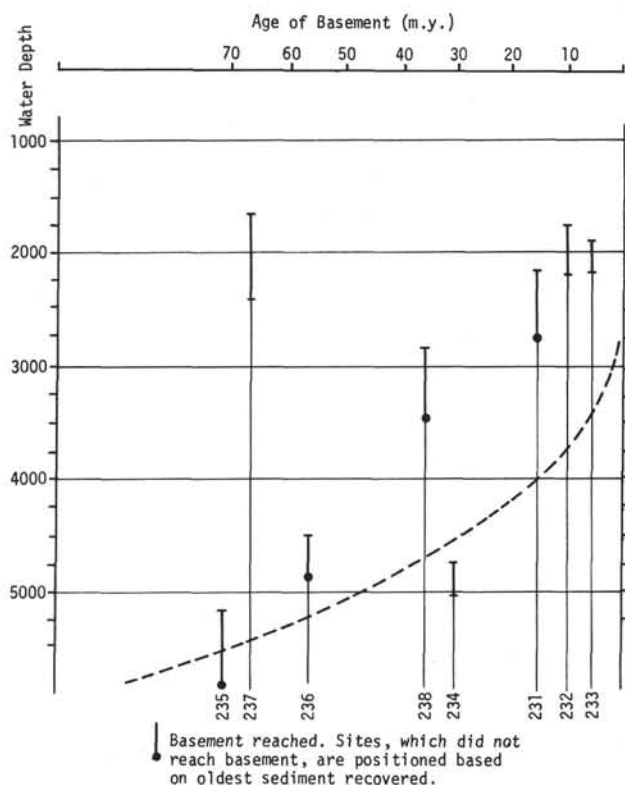
SUMMARY AND CONCLUSIONS

The conclusions presented here are based mainly on results of the coarse fraction analysis of the Leg 24 sites in the northwestern Indian Ocean and the Gulf of Aden. A number of pending questions, which could not be resolved due to their regional character, might deserve reconsideration as soon as data from DSDP Leg 23 (Whitmarsh et al., 1972) and Leg 25 (Simpson et al., 1972) have been released. Their drill sites cover physiographic provinces adjacent to those of Leg 24 (cf. Figure 57) and are expected to bear important evidence for the source areas of the redeposited Leg 24 sediments for example.

Gulf of Aden Sites

The three sites in the Gulf of Aden cover a wide variety of sediments which range from almost entirely pelagic oozes to shallow-water quartzose sandstone. However, the bulk of these sediments must be called hemipelagic although they are considered in the text and sediment descriptions to be mostly nanno oozes due to the overwhelming dominance of calcareous nannofossils.

The sediments of the Gulf of Aden sites (231, 232, 233) here are considered hemipelagic because:

1) They contain a high proportion and diversity of terrigenous components (wind and water transported).
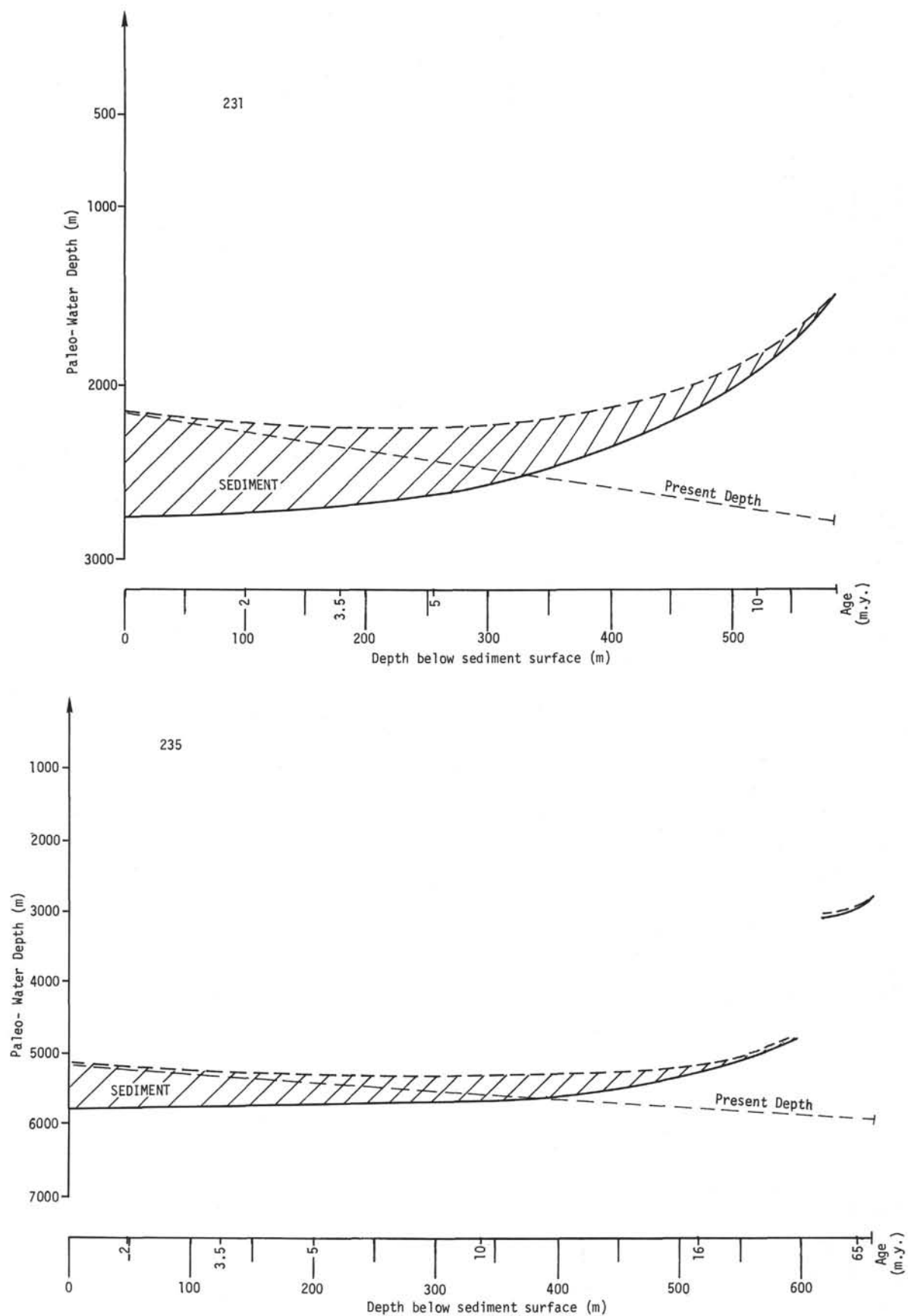
Figure 54. *Reconstruction of former water depth for the Site 231, 235, 236, and 238. Truck of basement is corrected for topographic effect and load of sediments (Berger, 1973, Sclater et al., 1971).*
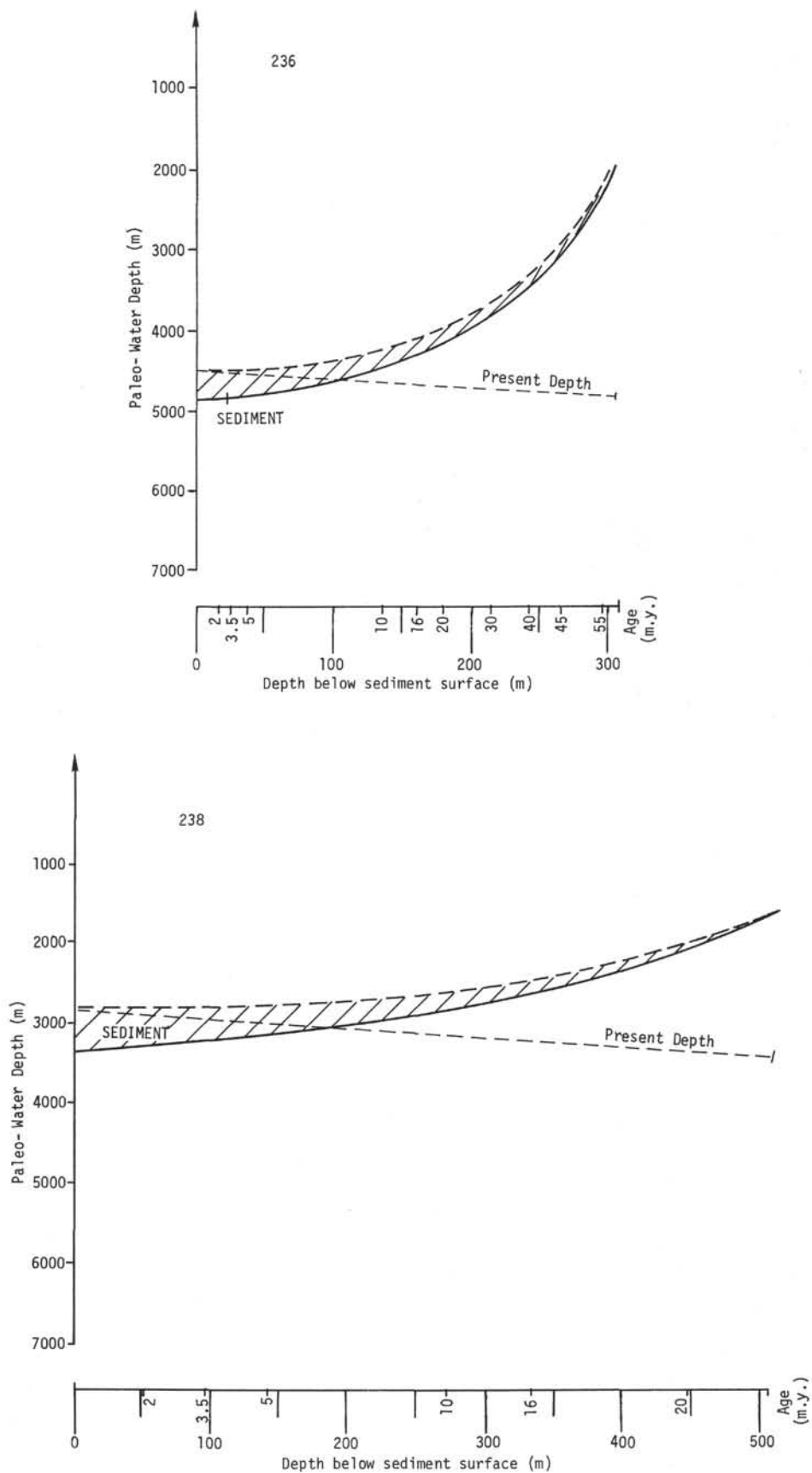
Figure 54. *(Continued)*.
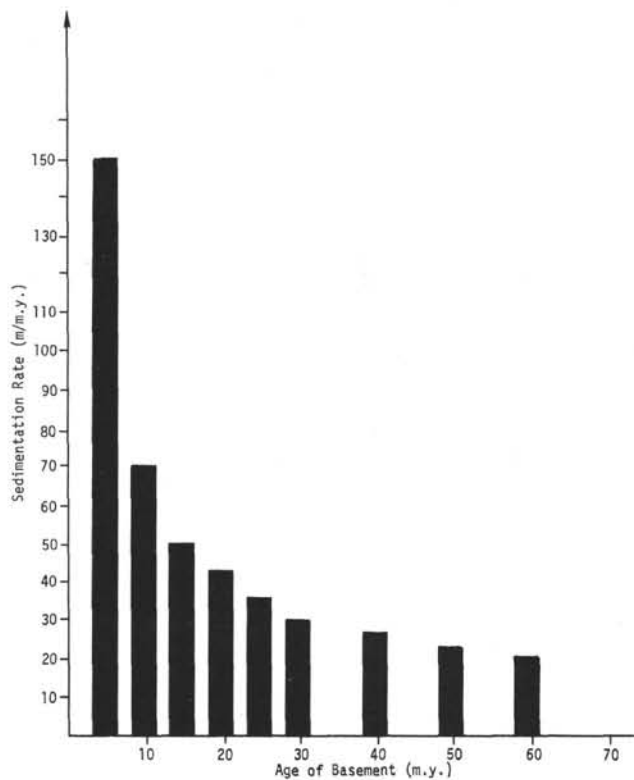
Figure 55a. *Minimum sedimentation rates for the maintenance of similar water depth through time (subsidence of crust = sediment accumulation).*
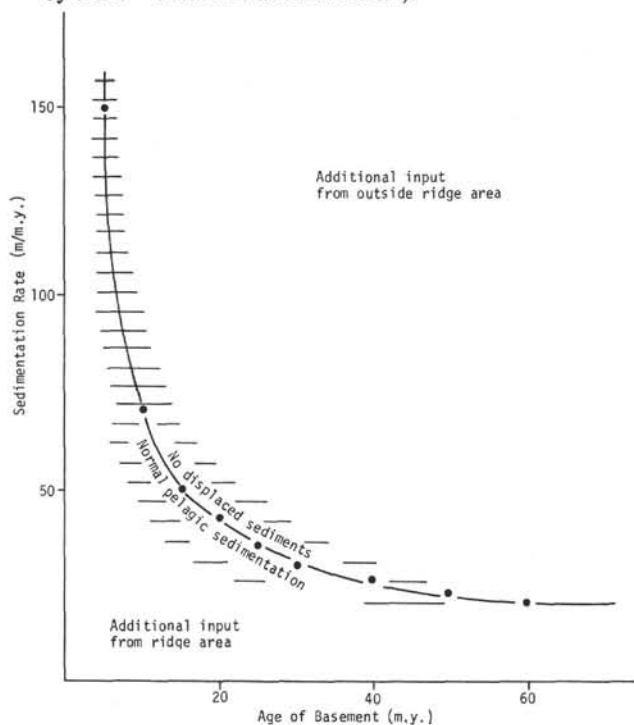
Figure 55b. *Presumable source areas for displaced material depending on subsidence of crust and sedimentation rates. Only valid for suspension following topography in the open ocean and above basement of same spreading cycle.*

2) There is a high organic carbon content, commonly a hydrogen sulfide odor, and patches of bitumen are present (Site 231).

3) They contain abundant authigenic minerals, especially pyrite.

4) There is a high content of shallow-water-derived material as well as pteropods and mollusc larvae in the same horizons.

5) They contain poorly preserved calcareous fossils (except in horizons with shallow-water-derived sediment), despite the fact that the water depth was not extremely great.

6) Although sedimentation rates do not change considerably (Einsele and Werner, 1968), burrows and primary sedimentary structures show inhomogeneity while the macroscopic appearance of the sediments is very homogeneous.

7) Benthic autochthonous fossils (foraminifera, echinoids) as well as remains of fishes are frequent to abundant throughout the whole sedimentary sequence which points to the high productivity of this area since the middle Miocene.

Beside these characteristics, the following features are common for all three sites:

1) The total sedimentation rates range between 40 and 90 m/m.y. (Figure 56). The bulk of the sediments of these three sites consists of calcareous nannofossil ooze.

2) The calcareous fossils are better preserved during Miocene (only Sites 231 and 232) and Quaternary than during Pliocene.

3) Siliceous remains of both benthic and planktonic organisms have revealed a similar distribution pattern (they are bonded to the fine-grained parts of the sedimentary column and thus are not redeposited), suggesting that this pattern is likely due to differential preservation.

4) Plant debris occurs ubiquitously at all sites, but is especially enriched in uppermost Miocene at Site 232. Otherwise, its abundance decreases generally from Sites 231 to 233.

5) The composition and preservation of the shallow-water-derived material are very unhomogeneous suggesting distinct source areas.

Almost 600 meters of middle Miocene to Recent sediments overlie oceanic basaltic basement at Site 231. The sediments directly above basaltic basement are truly hemipelagic without any shallow-water input suggesting that a small but well-developed oceanic basin with a centrally elevated ridge already existed in middle Miocene times (Figure 59).

A terrigenous, presumably airborne, fraction occurs in all samples. Its characteristic components are quartz, mica, dolomite rhombs, and few other mineral grains. Its grain size is in the lowermost range of the sand fraction. Since material $> 63\mu$ comprises only a few percent of the total, it seems reasonable to assume that the bulk of the wind-transported material has not been examined here due to its finer grain size (Füchtbauer and Müller, 1970).

Quartz/mica ratios may depend strongly on water and wind transport, since they are always much higher in coarse horizons with shallow-water-derived sediments. In general, quartz/mica ratios have decreased since upper Miocene

(Figure 10). This might be a good indicator for the increasing size of the Gulf of Aden (Figure 59).

The terrigenous components which occur together with shallow-water fossils consist of big (up to 0.5-1.0 mm) rounded and polished quartz grains, mica, rock fragments, and reworked older fossiliferous sediments. Coarse-grained layers with high proportions of shallow-water-derived components (rock fragments and reworked older fossiliferous sediments, benthic molluscs and their larval stages, pteropods all associated with higher quartz/mica ratios) are frequent in Pliocene and Pleistocene sediments. The occurrence of shallow-water-derived components in older and in more fine-grained sediments as well, precludes a purely paleoclimatic interpretation for this continuous detrital input from the shelf or upper continental slope (Figure 9). The composition and preservation of the shallow-water-derived material is inhomogeneous which suggests several source areas. Conversely, the bulk of the fine-grained terrigenous clastic grains is very homogeneous in composition.

The bulk of the sedimentary components are biogenic and pelagic in origin. Planktonic foraminifera are better preserved during upper Miocene and Pleistocene than during Pliocene suggesting, along with the preservation pattern of the siliceous fossils, that the reduced oxygen content in the northern Indian Ocean (Wyrtki, 1971) was subject to major fluctuations (Schott et al., 1970; Stackelberg, 1972). This might be correlated to the almost synchronous appearance or disappearance of burrowing/mottling in the sediments (Figure 7, see Olausson and Olsson, 1969).

The shallow-water-derived fossils indicate a source area between 150 and 400 meters (Stubbings, 1939). They appear earlier in the sediments than expected suggesting a transport along the basin as well as across. Benthic autochthonous fossils (foraminifera, echinoids, as well as remains of fishes) are frequent to abundant throughout the whole sedimentary sequence, which indicates high organic productivity since the middle Miocene.

The sedimentary sequences penetrated on either side of the Alula-Fartak Trench are similar to that at Site 231 in many respects. Therefore only the points which are considerably different from Site 231 will be mentioned.

The basal sediments of Site 232 consist of massive, fossiliferous, quartzose sandstone and nanno oozes at upper Miocene age. The oldest sediments at Site 233, where the drilling was terminated after having penetrated a diabase sill on the eastern flank of the trench, are lower Pliocene in age. This supports the results of Ramsay and Funnell, 1969, who dated sediments from the walls of the trench.

Shallow-water-derived fossils (except plant debris) occur throughout Site 232 but only in upper Pliocene sediments at Site 233, thus indicating that sediments could pass across
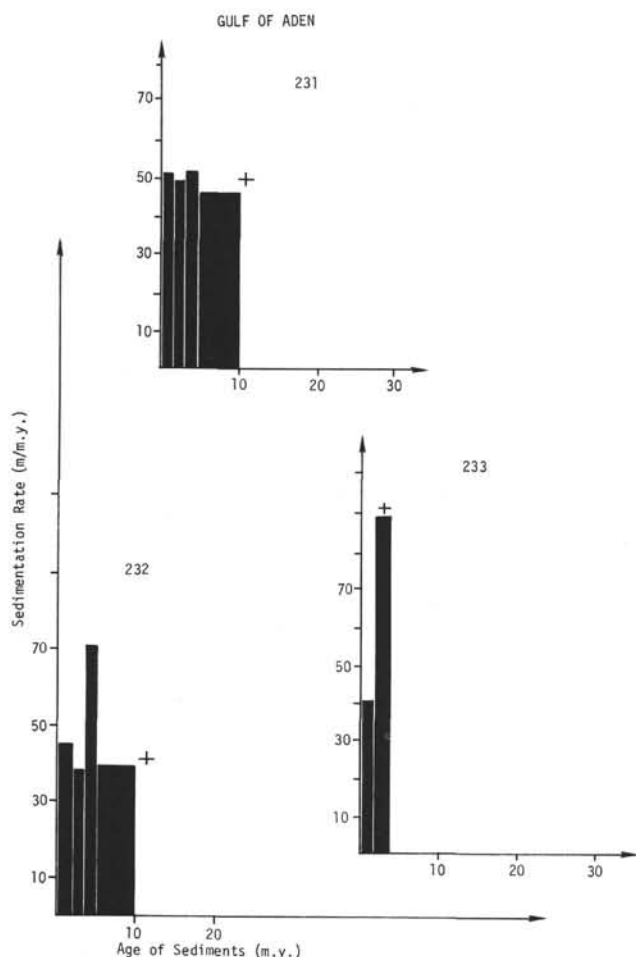
Figure 56. *Sedimentation rates in the Gulf of Aden, the Somali Basin, and the central Indian Ocean. Crosses indicate first occurrences of shallow derived fossils.*
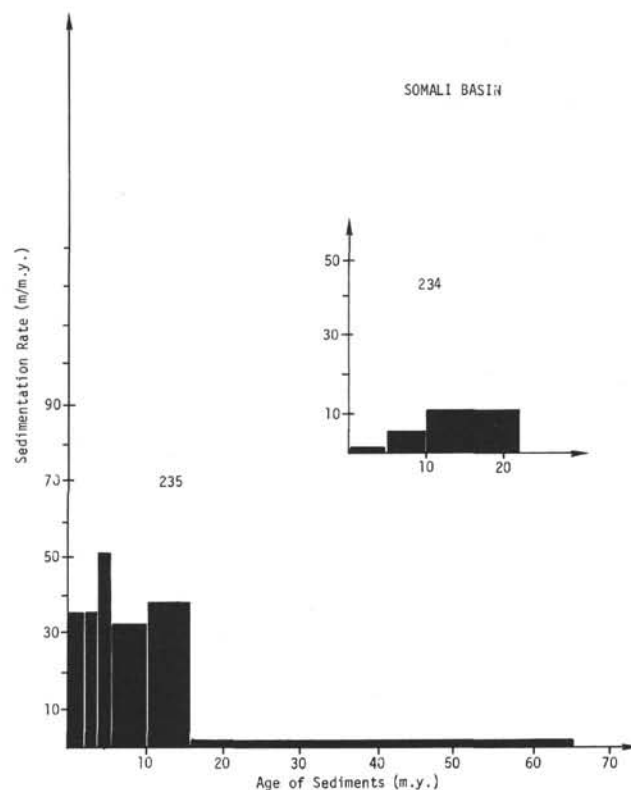
Figure 56. *(Continued).*
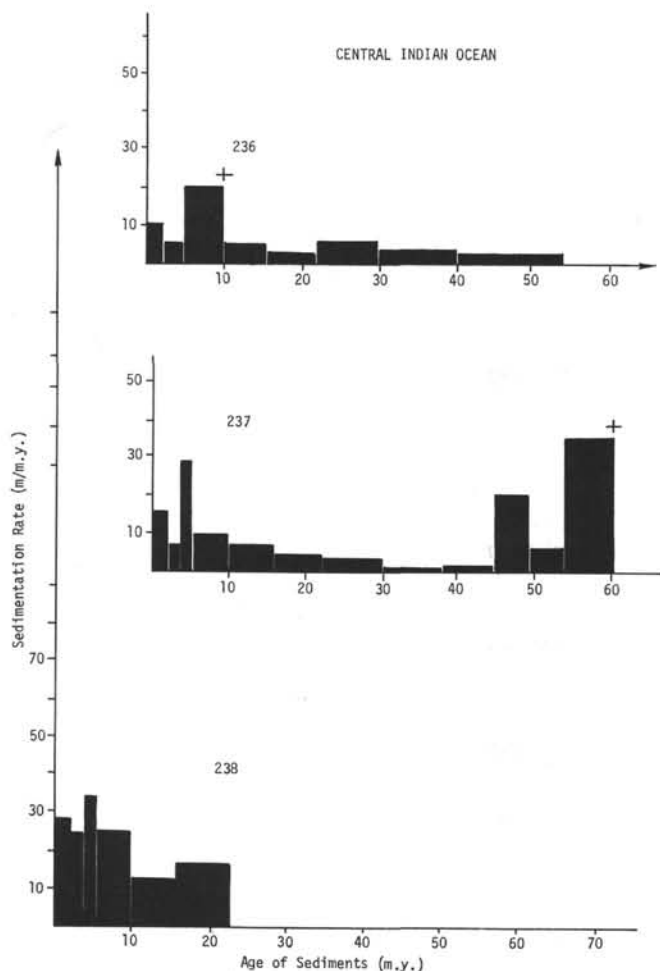
Figure 56. *(Continued).*

the region now occupied by the Alula-Fartak Trench at that time. Foraminifera, however, do not support this theory. Rock fragments are found in upper Pliocene and Pleistocene samples at Site 232. Volcanic ashes consisting of almost colorless glass similar to those at Site 231 occur in lower Pliocene sediments of all Gulf of Aden sites. However, their number decreases in an easterly direction.

High pore-water salinities and the occurrence of gypsum in the basal sediment at Site 232 suggest the presence of older evaporite-bearing formations below the section cored. Paleoclimatological evidence for arid conditions has been proven for Miocene (Azzaroli, 1968, Azzaroli and Fois, 1964) and Pleistocene times. Knowledge about Pliocene climate is much more scanty. The decrease in abundance of plankton (foraminifera) might be due to climatic fluctuations.

Somali Basin Sites

Somali Basin sediments were recovered at two sites: Site 234 west of Chain Ridge and Site 235 east of Chain Ridge. Reflection seismic records showed sequences of stratified sediments with an intermediate layer of seismically transparent deposits continuous over great distances (Bunce et al., 1966). The results at both sites revealed considerably distinct geological environments on either side of Chain

Ridge despite their regionality. Important differences between these sites have been tabulated in Table 13, thus this table needs only the addition of the following statements.

Terrigenous detritus from the coarse fractions at both sites differ mainly with respect to quartz/mica ratios (Figure 30), although these minerals are assumed to be mostly wind transported. Sorting and redeposition of these minerals by water cannot be excluded.

It seems remarkable that the oldest sediments at Site 235 are quite similar to those at Site 234 (although these are considerably younger). Although plant debris is almost missing in the lowermost part of 235 and in all of 234, it is found frequently in the post-middle Miocene sediment at Site 235. It might be interpreted that the sites were located in a continuous basin before this lithologic break at Site 235 or that both sites had similar and then later, different sources of redeposited sediments.

Manganese nodules and crusts are restricted to Site 234 Pliocene and upper Miocene sediments and have also been found in stratigraphically similar levels on the eastern flank of Chain Ridge (Pimm et al., 1972). They indicate a well-oxygenated environment of low sedimentation rate which is characteristic for the elevated Chain Ridge and the western part of the Somali Basin. Although these components are restricted to the uppermost cores of this site, pyrite and zeolites are the characteristic authigenic minerals found below the occurrence of the manganese nodules and crusts. Authigenic pyrite and zeolites are also characteristic at Site 235.

The higher calcium carbonate content at Site 235, in spite of its greater water depth, indicates that the better preservation of calcareous fossils is related to redeposition of this material from shallow areas by current (either from the direction of Chain Ridge or preferably, due to its greater bulk regionally, from or through Carlsberg Ridge). Siliceous fossils are better preserved at Site 235 than at Site 234 due to higher sedimentation rates (Schrader, 1972a).

Determining the source area of the displaced sediments is a problem. It seems clear from the lithological differences of the sediments on either side of Chain Ridge that the deposits could not have had the same source area, at least not since uppermost middle Miocene. The stratified upper sequence west of Chain Ridge thickens to the east and north but terminates abruptly at Chain Ridge (Bunce et al., 1967) requiring a northern source and the presence of Chain Ridge. The transparent sequence thickens toward the continent to the west and is more clearly stratified here and sloping upward at Chain Ridge which might indicate synsedimentary movements (Bunce et al., 1967).

In conclusion, a northwestern source can be accepted for these sediments. This suggestion can be substantiated by the occurrence of canyons on the Somalia continental margin (Ulrich, 1968) and the occurrence of fossil erosional features at the mouth of the Gulf of Aden and in Somalia (Laughton, 1966). The similarity of the terrigenous components to those of the Gulf of Aden has to be noted. This assumption may also apply to the pre-upper Miocene sediments at Site 235, but do not fit with the findings in the younger sediments of this site.

Although the sediments east and west of Chain Ridge appear to be rather uniform (Bunce et al., 1967), the

post-uppermost middle Miocene sediments at Site 235 are different. The different composition of the terrigenous coarse-fraction components associated with the occurrence of plant debris and the presence of bivalve fragments since upper Pliocene suggests a source area other than either Chain or Carlsberg ridges. The parallelity of the occurrence of shallow-water-derived material in upper Pliocene sediment at Site 232 might be an important clue for the solution of this problem. Thus, one has to seek a source area close to the mouth of the Gulf of Aden (Laughton, 1966) which seems to be supported by the occurrence of bivalve fragments. However, the suggestion of Ewing et al., 1963, of a passage of Indus and Ganges cone sediments through Carlsberg Ridge cannot be rejected. A detailed seismic reflection study is needed to solve this problem. The evolution of Owen Fracture Zone and Chain Ridge might bear this missing link (Matthews, 1966).

The type of pelagic basal Upper Cretaceous sediment at Site 235 also suggests that the Somalia Basin must have existed at that time as a wide ocean basin. This does not support the hypothesis of McElhinny (1970) that India and Madagascar maintained their proximity until Late Cretaceous.

Central Indian Ocean Sites

The three DSDP sites in the central Indian Ocean offer insight into problems of sedimentation in a tropical ocean. Two of these sites are situated west of Carlsberg-Central Indian Ridge (Sites 236 and 237) and one east of the Central Indian Ridge south of Chagos-Laccadive Ridge. They lie therefore on pieces of ocean floor belonging to different plates. Sites 236 and 238 are situated above magnetic anomalies in part recognizable as to age and strike (Site 236) as shown by Fisher et al., 1971. The basement below 237 on the saddle between Saya de Malha Bank and the Seychelles is unknown, but seems not to be normal oceanic basement because it lacks clear magnetic anomalies. For further structural details of the area covered by these three sites, see Fisher et al. (1967, 1968, and 1971).

Site 236 was supposed to penetrate sediment down to oceanic basement belonging to magnetic anomaly 27 (?) (early Paleocene). The oldest recovered sediment was upper Paleocene. The section penetrated consisted of nanno oozes/chalk and clays (in lower Miocene and upper Oligocene).

These clays do suggest that the site was situated at that time below the calcium carbonate compensation depth. There is a surprising time correlation of the preservation of calcareous fossils to the shifts of spreading rates and directions. Oscillation of the sea floor due to these shifts might also control the position of this site relative to the calcium carbonate compensation depth.

A certain portion of the terrigenous clastic components in the coarse fraction of the sediments seems to have been transported by wind, others come together with shallow-water fossils presumably from Seychelles Bank. Volcanic ashes were found mainly in Oligocene and Miocene sediments.

The occurrence of frequent, well-defined, coarse-grained horizons with well-preserved calcareous components in a fine-grained matrix of poorly preserved calcareous fossils indicates that a high portion of these sediments is redeposited. The source of these sediments must have been,

during pre-upper Miocene times, an area of purely pelagic sediments, and during upper Miocene and Pliocene, Seychelles Bank or a similar area, which is shallow enough to produce the registered fossils and which consists of continental crust. The appearance of shallow-water-derived components during upper Miocene is in striking time coincidence with similar findings at Site 235 and in the Gulf of Aden (Figure 59).

High proportions of well-preserved siliceous fossils (Figure 41) suggest that this site was situated, at least since Eocene, under or very near the high production belt of the equatorial divergences (Riedel, 1971). Major fluctuations in the presence of the siliceous fossils might be either due to differences of the preservation or to relative movements of this belt.

Site 237 is situated today in only 1640 meters of water between the Seychelles and Saya de Malha. The layered sediments (Bunce et al., 1966) were penetrated down to lower Paleocene and are pelagic throughout (despite a previously expected thick coralline and glauconite-rich sequence).

Shallow-water-derived fossils were found only in Paleocene and upper Oligocene sediments. However, these
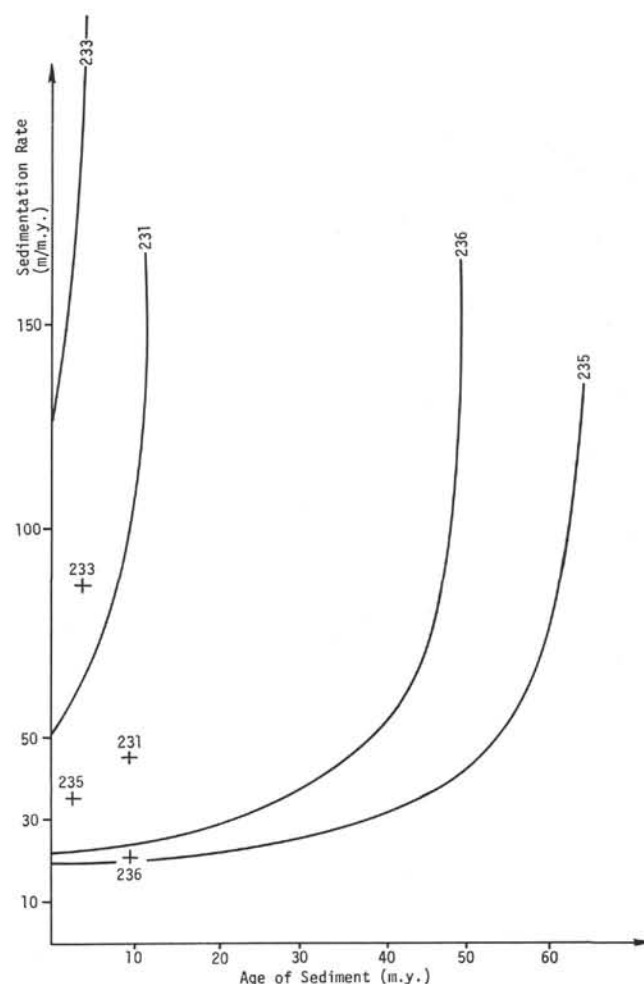
Figure 57a. *Correlation of the first occurrence of shallow water derived components and of sedimentation rates of "mother" sediments (curves are segments of Figure 55B).*

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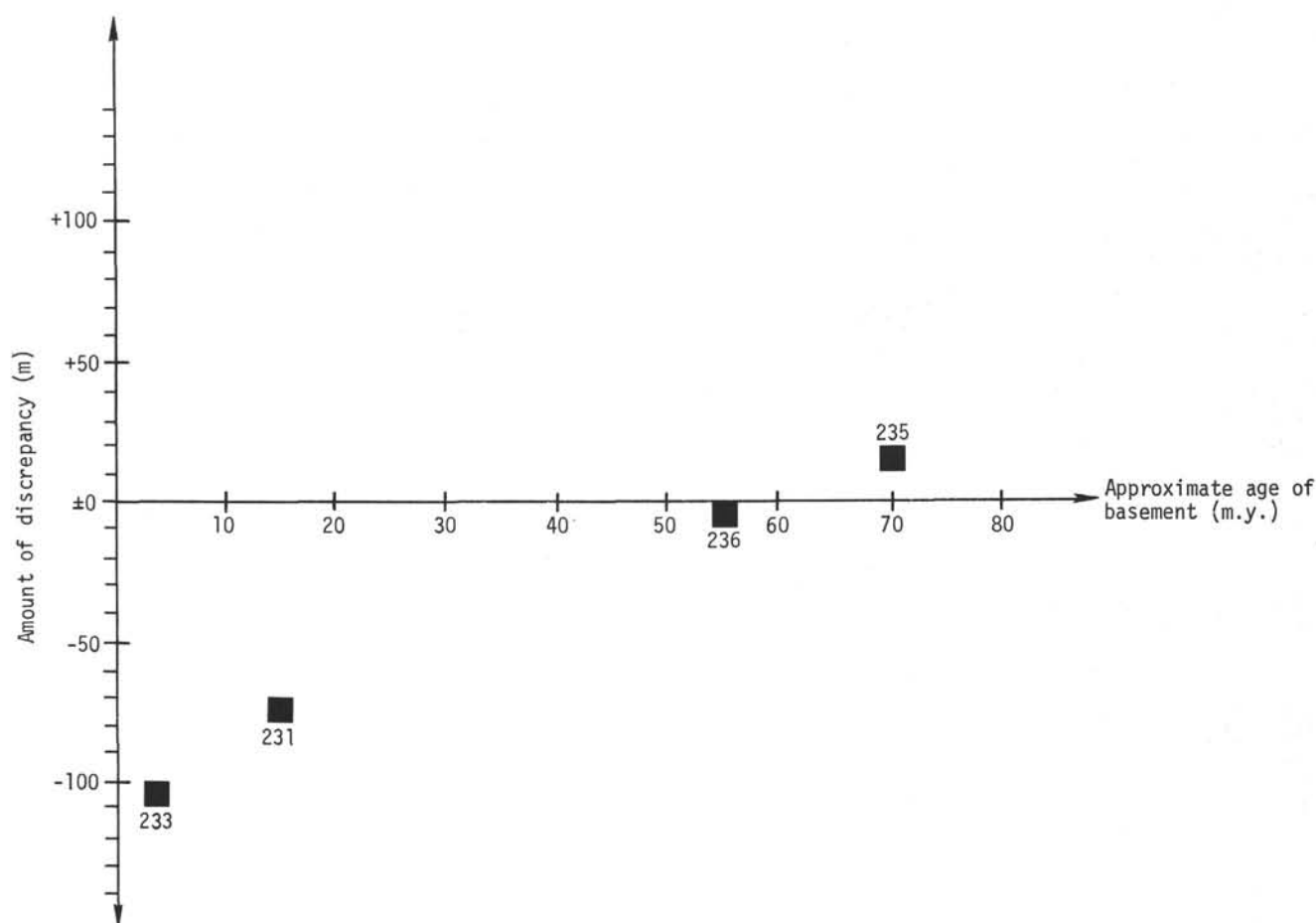
Figure 57b. *Discrepancy of expected minimum sedimentation rates and actually found values versus age of basement of sites.*

fossils (algal crusts, large benthic foraminifera) do not allow inferences concerning a specific shallow site to be made. Since they only occur in thin horizons intercalated in a recrystallized matrix of presumably nanno chalk, they do not offer any indication of the water depth into which these shallow-water fossils were redeposited, although it could not have been very shallow (at least several hundred meters; compare Vincent et al., this volume.

The preservation of planktonic foraminifera offers several possibilities for interpreting paleodepths. They indicate that the water depth has not changed considerably since lower/upper Oligocene (rather coarse-grained sediments: winnowed?). Their poor preservation in older (not winnowed?) sediments might be either due to very shallow water depths (would this be consistent with the finer grain sizes of these sediments?) or to water depths of about 4000 meters (Figure 51), still well above the calcium carbonate compensation depth. Critical times for these possible movements seem to be middle Eocene to lower Oligocene.

Siliceous fossils do not occur frequently before Eocene time. Fluctuations in their abundance are very similar to Site 236 and indicate either a similar pattern of SiO_2 preservation as found at Site 236 or rather simultaneous relative movements of both sites to the high production belt under the equatorial divergences (Riedel, 1971). The position of Sites 236 and 237 in the equatorial area is not consistent with India's supposed south-north movement in the Late Cretaceous – early Tertiary (McElhinny, 1970),

since the basal sediments of both sites also require an open-oceanic environment.

The upper Oligocene to Recent sediments of Site 238 on the margin of the Central Indian Ridge, within or very close to the Argo Fracture Zone, are entirely highly pelagic.

Since the site never was deeper than the calcium carbonate compensation depth, all calcareous components are well preserved. The consistency of this site through time with age/depth constancy is proven by the increasingly better preservation of calcareous particles with increasing age of sediments. The basement today is much higher than expected from subsidence curves, possibly due to the proximity to, or perhaps occurrence within the Argo Fracture Zone (see Engel and Fisher, 1969, figure 1).

The increasing abundance of siliceous components demonstrates (if this is not interpreted as a phenomenon of preservation) the relative movement of the crust below this site closer to the equatorial high production belt. Siliceous fossils occur frequently since uppermost lower Miocene.

The basal sediments are metalliferous and contain components of volcanic origin and authigenic minerals, a result of posteruptive volcanic activity along the transform fault while this site was still close to the rifting area. The volcanic input decreases in younger sediment, as the crust at this site moves away from the active rift.

It seems important to note that a high proportion of the sediments at all sites are displaced (Parker, 1971) in close agreement with the structural movement of the oceanic

TABLE 13
Differences Between Site 234 (West of Chain Ridge)
and Site 235 (East of Chain Ridge)

	Site 234	Site 235
Water depth (m)	4738	5146
Basin boundaries	Continental margin with canyons (Ulrich, 1968) west and north, Chain Ridge southeast, open to southwest	Chain Ridge northwest, Carlsberg Ridge northeast, open to the south
Basement	Unknown, not reached, oldest dated sediments Oligocene	Basaltic, Upper Cretaceous
Sediments	Clays and nanno clays, overlain by nanno ooze. Very fine-grained in the whole basin (Müller, 1967)	Nanno oozes and nanno clays
Sedimentation rates (m/m.y.)	Decreasing from > 10 m during lower and middle Miocene to < 2 m during Plio/Pleistocene	< 2m Upper Cretaceous to lower Miocene (hiatus?) 30-50 m since middle Miocene
Coarse fractions Terrigenous Components	Quartz >Mica (Upper Oligocene to Recent)	Quartz > Mica (Upper Cretaceous to Miocene) Quartz < Mica (Miocene-Recent)
Calcareous plankton	Poorly preserved	Moderately to well preserved
Siliceous fossils	Very poorly preserved	Moderately preserved
Fish remains	Very frequent	Common to seldom
Shallow-water-derived fossils	None	Fragments of bivalves in upper Pliocene and Pleistocene sediments, frequent plant debris since middle Miocene

crust and ruled by an equilibrium between subsidence of crust and total sedimentation rates (Figure 55). Shallow-water-derived components have been found surprisingly contemporaneous in a number of sites in late Tertiary sediments (Figure 57). The fragmentation of planktonic foraminifera appears to be a refined tool for the determination of paleodepths (Figure 47).

ACKNOWLEDGMENTS

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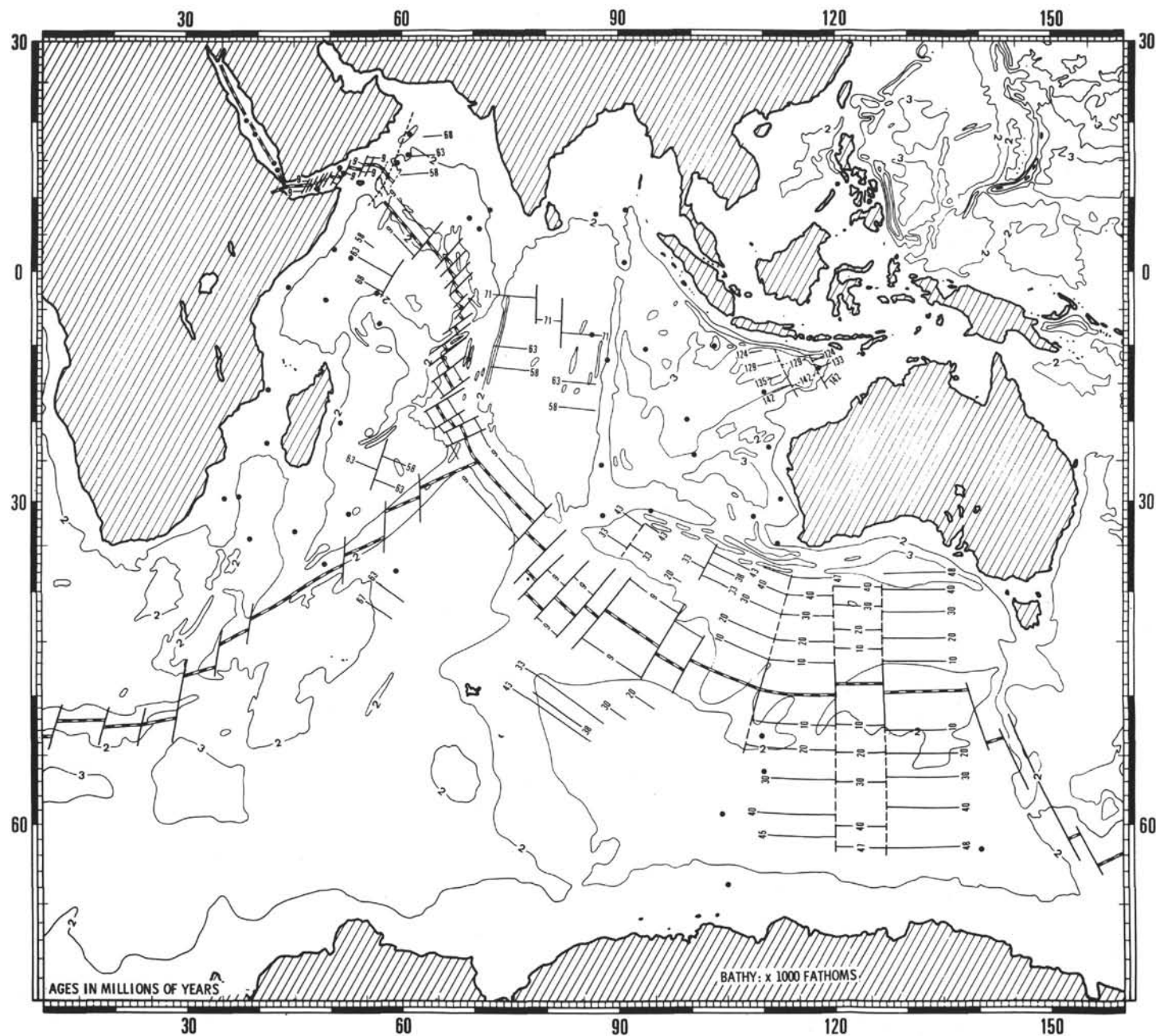
Figure 58. *Situation of all Indian Ocean Deep-Sea Drilling Project drill sites (G. Pautot, personal communication).*
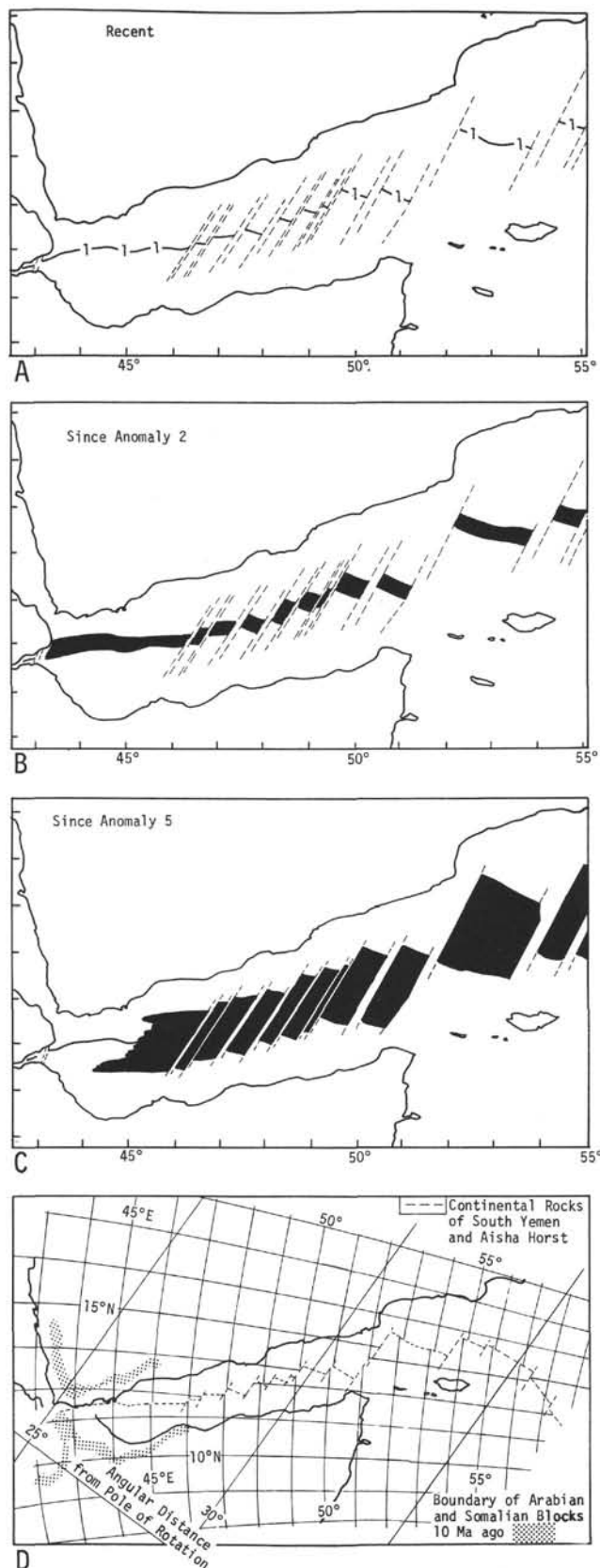
Figure 59. *Development of the Gulf of Aden since Middle Miocene (after Laughton et al., 1970) (A) Recent stage;*
(B) oceanic crust formed since anomaly 2 (in black);
(C) oceanic crust formed since anomaly 5 (in black);
(D) paleogragraphic situation about 10 Mio. yrs. age.

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PLATE 1

Sediments at Site 231 off Somalia (smear slides).

Figure 1   Sample 1-1, 115 cm. Quaternary sediment consists
                mainly of debris of biogenic skeletons (Radiolaria,
                diatoms, foraminifera) and terrigenous mineral grains.
                The matrix is dominated by coccoliths.

Figures 2, 3   Sample 3-2, 80 cm. Quaternary nannofossil ooze with
                debris and shells of foraminifera (mainly planktonic).

Figure 4   Sample 3-4, 120 cm. Quaternary nannofossil ooze
                with debris and shells of foraminifera. Remark big
                benthic foraminifera.

Figure 5   Sample 21-2, 108 cm. Lower Miocene, many hori-
                zons at Site 231 contain big terrigenous mineral
                grains, partly well rounded. Remark large dolomite
                rhomb. Matrix consists mainly of coccoliths.

Figure 6   Sample 35-5, 100 cm. Upper Miocene nannofossil
                ooze with high proportion of terrigenous compo-
                nents. Remark typical discoasters.

PLATE 1
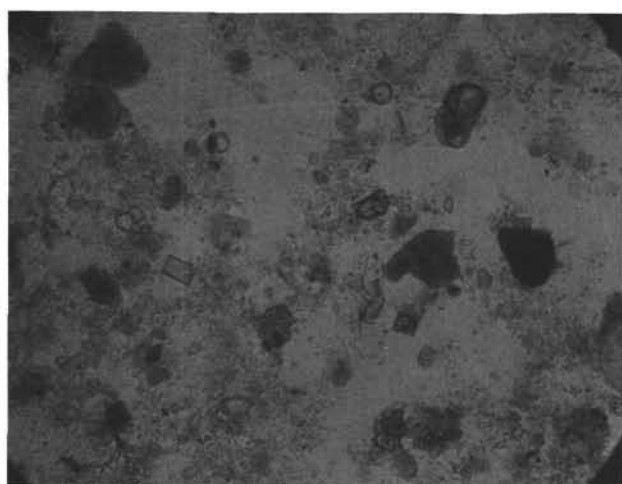
200µ   1
231-1-1-115
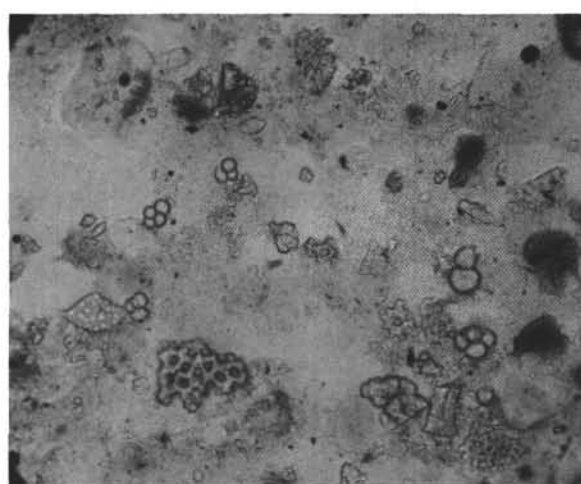
200µ   2
231-3-2-80
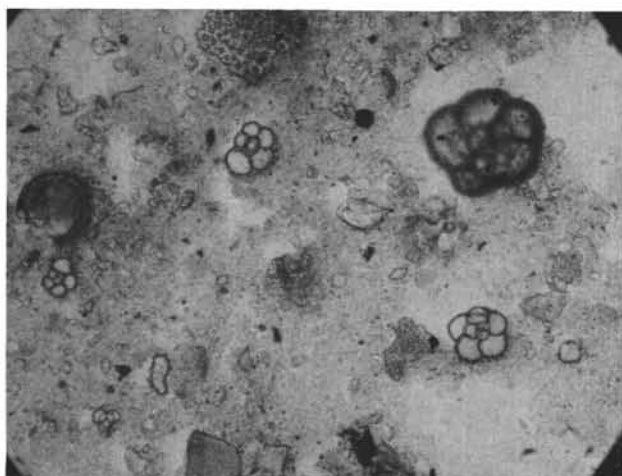
200µ   3
231-3-2-80
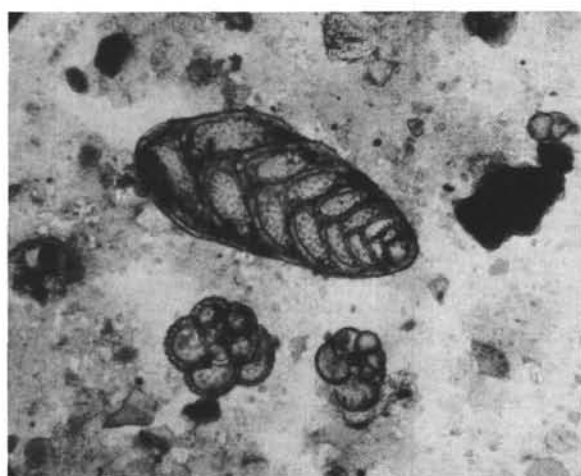
200µ   4
231-3-4-120
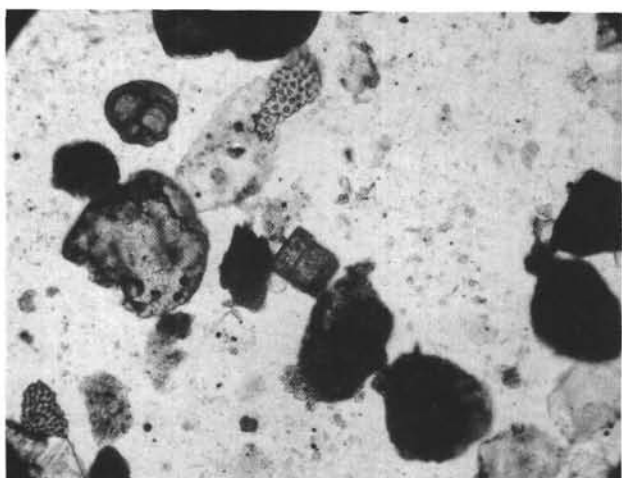
200µ   5
231-21-2-108
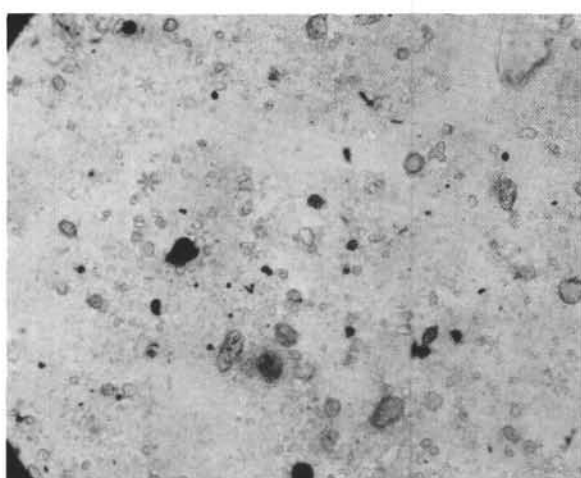
200µ   6
231-35-5-100

PLATE 2

Sediments at Site 231. Biogenic activity characterizes in some
horizons the otherwise apparently very homogeneous sediments
of the Gulf of Aden. Four types of burrows have been found.

Figure 1   Sample 44-1, 77-100 cm; a plane-like horizontal type,
rather undifferentiated, the planes of burrowing are
0.5-1.0 cm thick; tube-like burrows, 0.5-1.0 cm in
diameter, with homogeneous infilling, either of the
same sediment as surrounding (many times only to be
recognized because of pyrite coatings) or of sediment,
which is different from the surrounding sediment
either due to different texture or different color.

Figure 2   Sample 53-2, 77-100 cm; tube-like burrows 0.5-1.0 cm
in diameter, with typical internal structures.

Figure 3   Sample 53-6, 77-99 cm; small tube-like burrows
1-2mm in diameter, occurring in discrete horizons.
Burrowing can be of such an intensity that only
cloud-like structures are preserved.

Figure 4   Sample 58-6, 101-124 cm.

PLATE 2

231-44-1
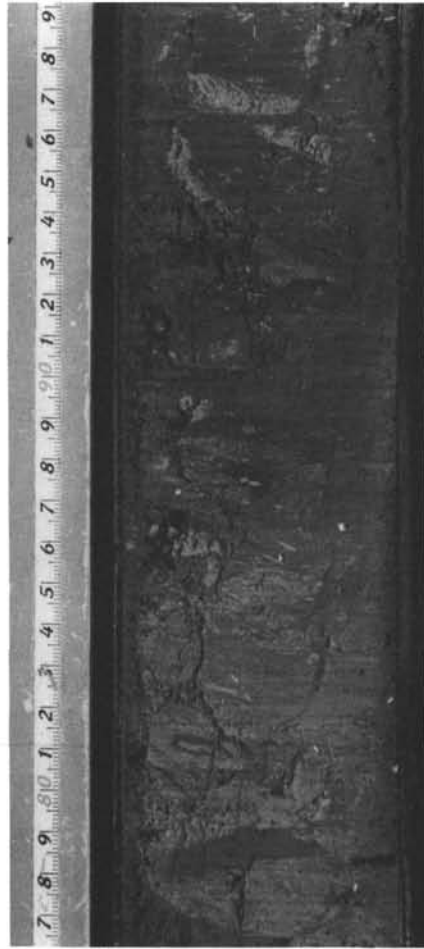
231-53-2

231-53-6
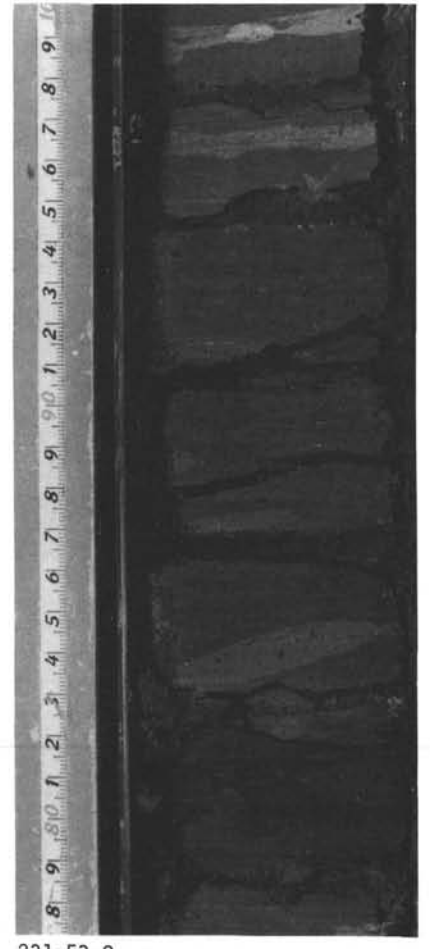
231-53-8

SEDIMENT COARSE FRACTIONS

PLATE 3

Basal sediments of Hole 232A.

Figure 1   Sample 15A-2, 55-59 cm. Thin section; upper Mio-
                 cene terrigenous sediments mainly composed of angu-
                 lar quartz fragments dispersed in a clayey pyritic
                 matrix.

Figures 2, 3   Sample 17A, CC. Shipboard thin section; upper Mio-
                 cene fine-grained quartzitic sandstone composed
                 mainly of angular to round quartz grains and a small
                 percentage of heavy minerals.

Figures 4-6   Sample 27A-100 cm. Shipboard thin section; upper
                 Miocene quartzitic sandstone, presumably represent-
                 ing the acoustic basements on the northwestern flank
                 of the Gulf of Aden. Remark diverse mineral compo-
                 sition of quartz, silicates, and carbonates.
                 4. Rounded basic volcanic fragments.
                 5. Fragments of fossils.
                 6. Foraminiferal shell.

PLATE 3
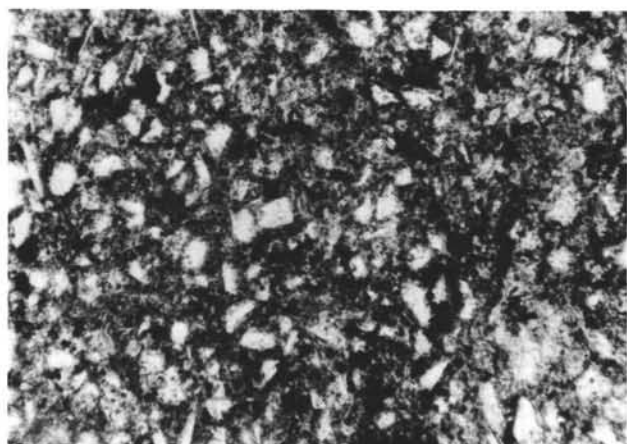
0.4 mm

232A-15-2 (55-59)

1
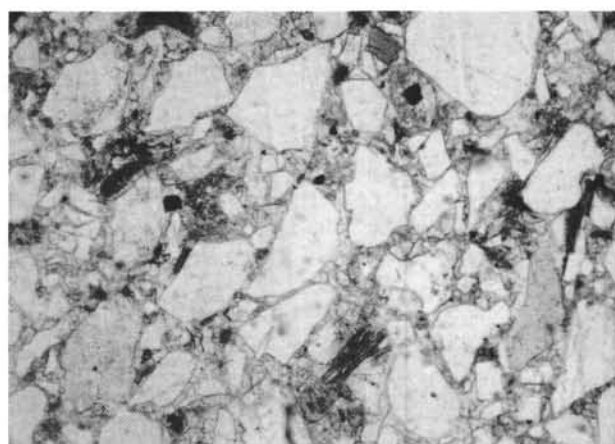
0.5 mm

232A-17-CC

2
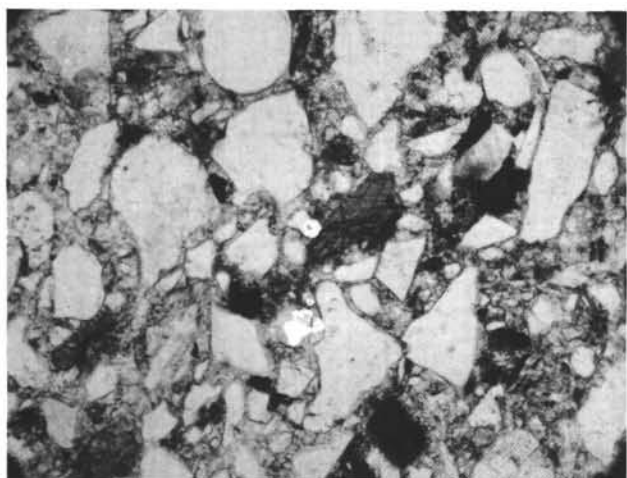
0.5 mm

232A-17-CC

3
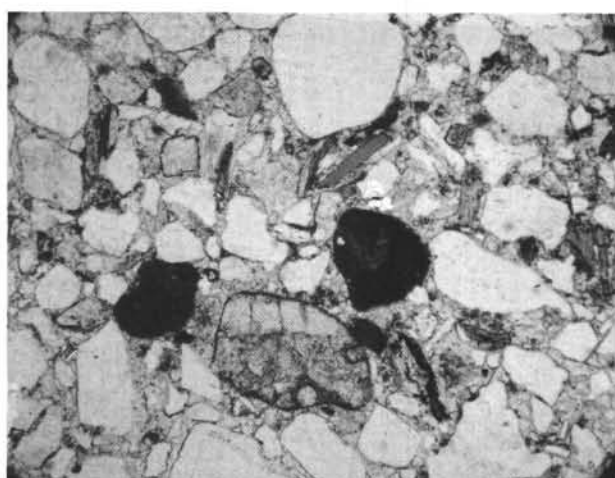
0.5 mm

232A-27-1

4
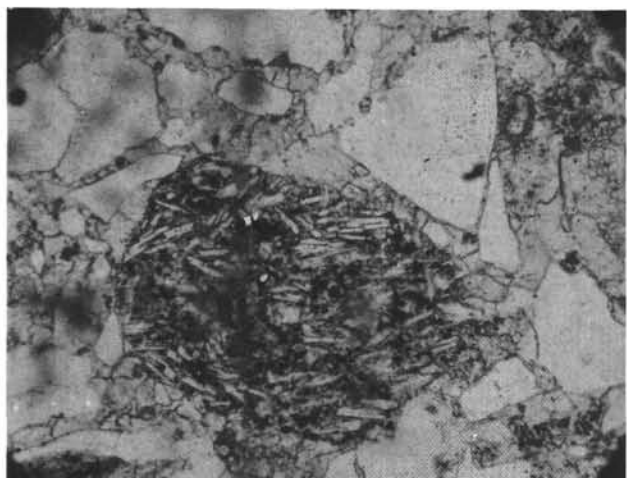
0.2 mm

232A-27-1

5
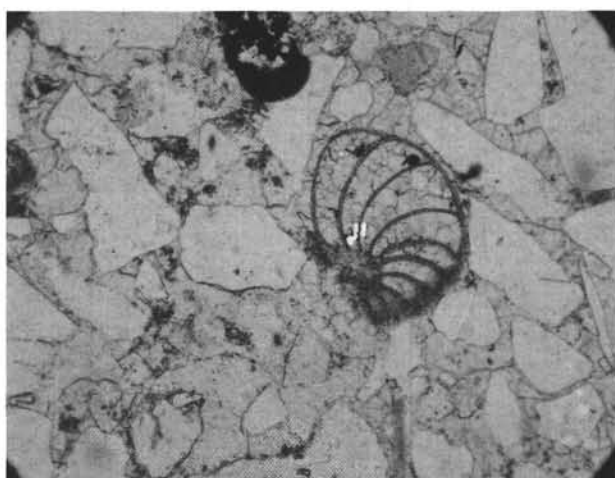
0.5 mm

232A-27-1

6

PLATE 4

Sediments at Site 233. Smear slides.

Figures 1, 2   Sample 1-3, 90 cm. Quaternary sandy nanno ooze. Matrix consists mainly of coccoliths. These sandy horizons contain a major portion of calcareous shells and terrigenous material.

Figure 3   Sample 1-4, 140 cm. Quaternary nanno ooze with major portion of siliceous tests and sponge spicules. Remark dolomite rhomb with core.

Figure 4   Sample 7-1, 80 cm. Quaternary nanno ooze with major portion of siliceous tests and sponge spicules.

Figure 5   Sample 8-2, 130 cm. Quaternary nanno ooze.

Figure 6   Sample 10-4, 80 cm. Homogeneous upper Pliocene nanno ooze.

PLATE 4

600µ   1

233-1-3-90

100µ   2

233-1-3-90

100µ   3

233-1-4-40

100µ   4

233-7-1-80

100µ   5

233-8-2-130

100µ   6
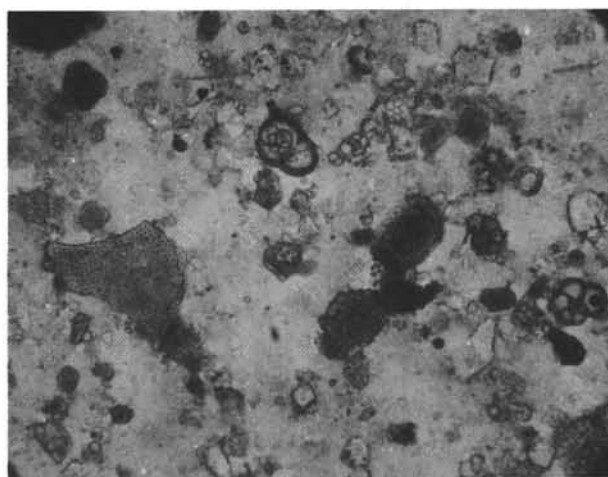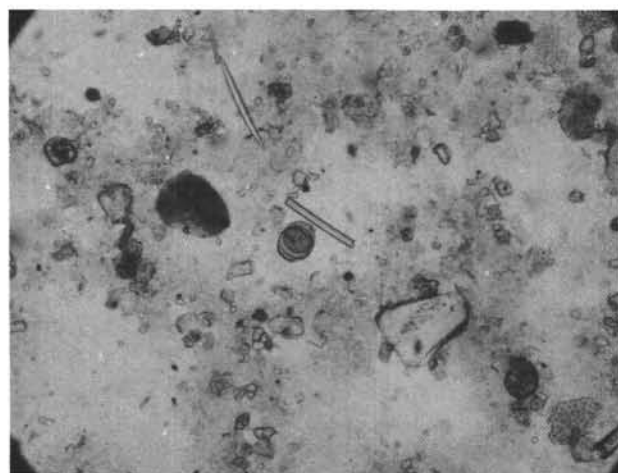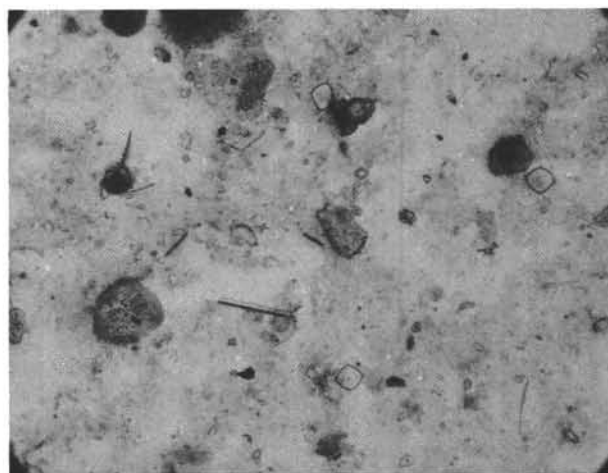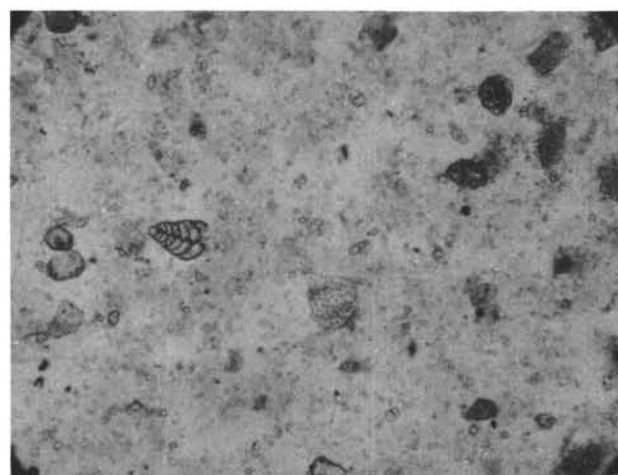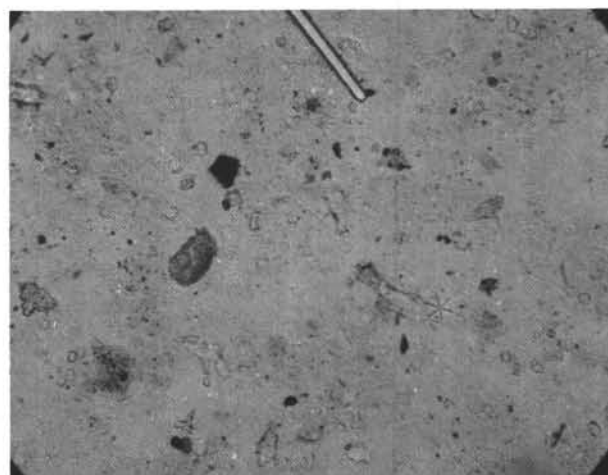
233-10-4-80

PLATE 5

Sediments at Site 233. Smear slides.

Figure 1   Sample 20-4, 80 cm. Upper Pliocene nanno ooze with siliceous components. Remark dolomite rhomb with typical core.

Figure 2   Sample 13-3, 80 cm. Upper Pliocene nanno ooze with discoasters, dolomite rhombs, and a certain fraction of terrigenous minerals.

Figure 3   Sample 15-4, 80 cm. Upper Pliocene nanno ooze with broken skeletons of siliceous organisms.

Figure 4   Sample 16-3, 80 cm. Upper Pliocene nanno ooze, rich in discoasters, with a certain portion of terrigenous material.

Figure 5   Sample 5A-3, 48 cm. Lowermost upper Pliocene nanno ooze (matrix) with big terrigenous grain of quartz and heavy minerals.

Figure 6   Sample 7A-5, 80 cm. Lower Pliocene silt nanno ooze.

PLATE 5
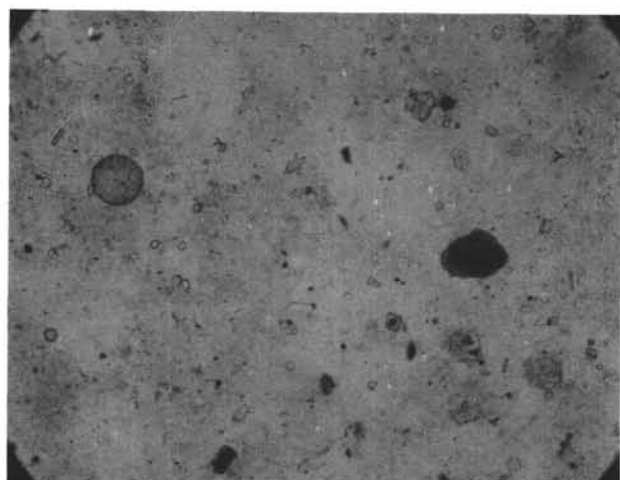
100μ
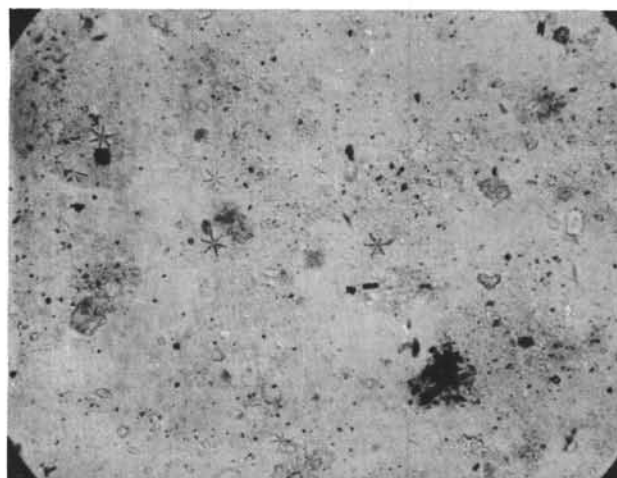
233-10-4-80   1

100μ

233-10-4-80   2

100μ

233-15-4-80   3

100μ

233-16-3-80   4

100μ

233A-5-3-48   5

100μ

233A-7-5-80

PLATE 6

1 mm

CHAIN 32 cm 3-8   1

0.1 mm

CHAIN 32 cm 3-8   2

1 mm

CHAIN 32 cm 450-452   3

0.1 mm   4

CHAIN 32 cm 800

1 mm   5

CHAIN 32 cm 800
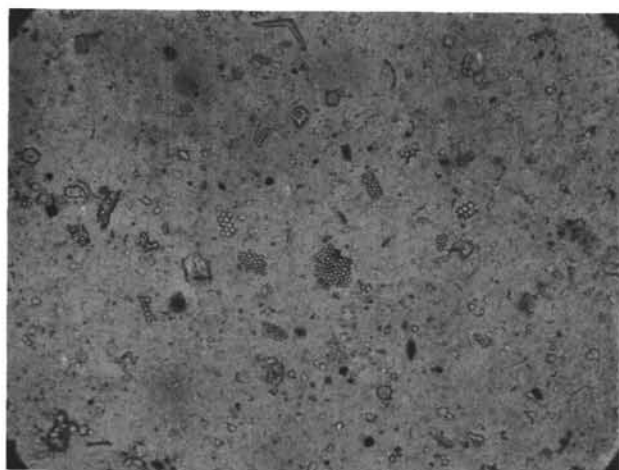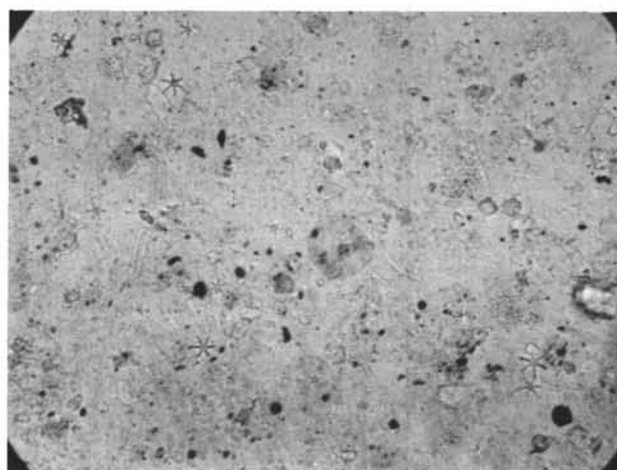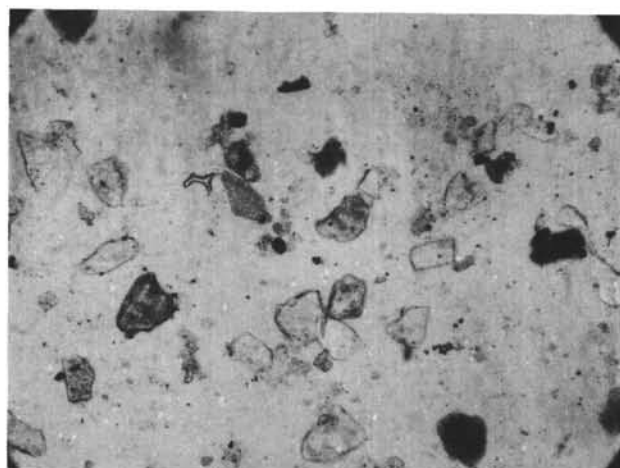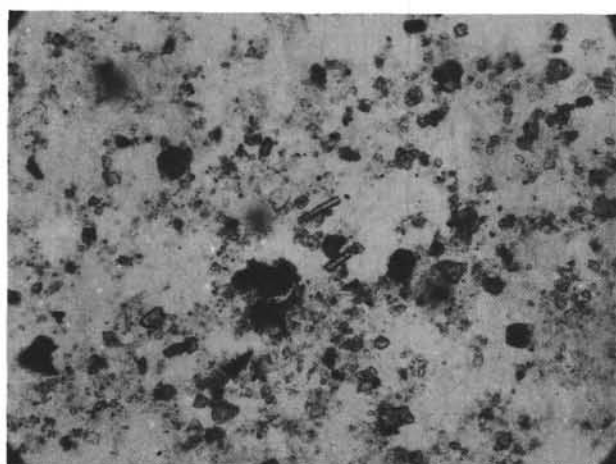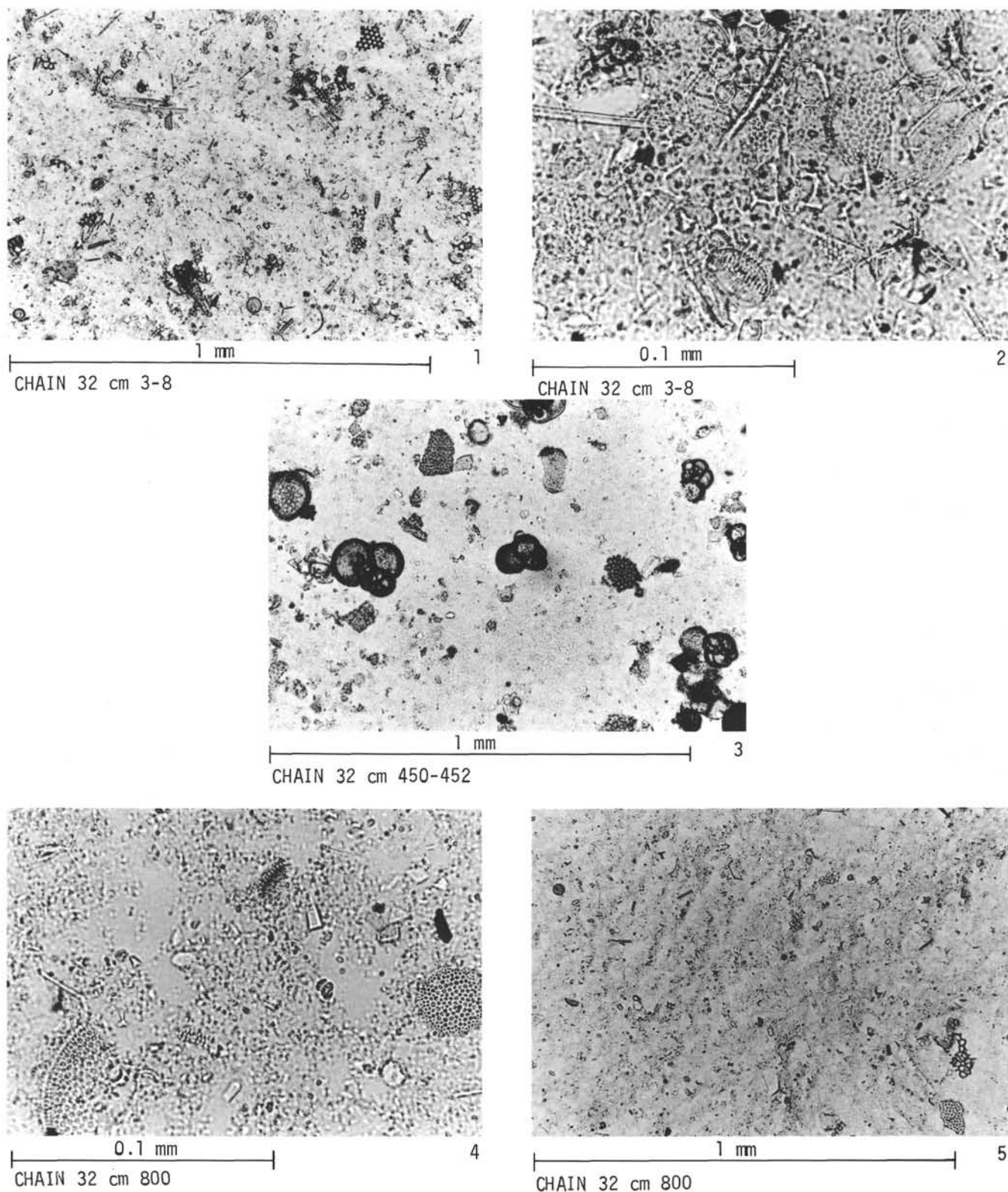
Surface and subsurface sediments at Site 235 (smear slides).

Figures 1, 2   Chain 100/32 P cm 3-8. Dominantly siliceous skeletons: diatoms, fragments of Radiolaria, sponge spicules.

Figure 3   Chain 100/32 P cm 400-452. Nanno ooze with planktonic foraminifera and fragments of Radiolaria.

Figures 4, 5   Chain 100/32 P cm 800. Nanno ooze with high proportion of siliceous skeletons.

PLATE 7

0.4 mm   1
237-48-1-53-60

0.4 mm   2
24-237-48-1-53-60

0.4 mm   3
237-63-1-140

0.4 mm   4
24-237-27-5-60-62

0.4 mm   5
237-63-1-140
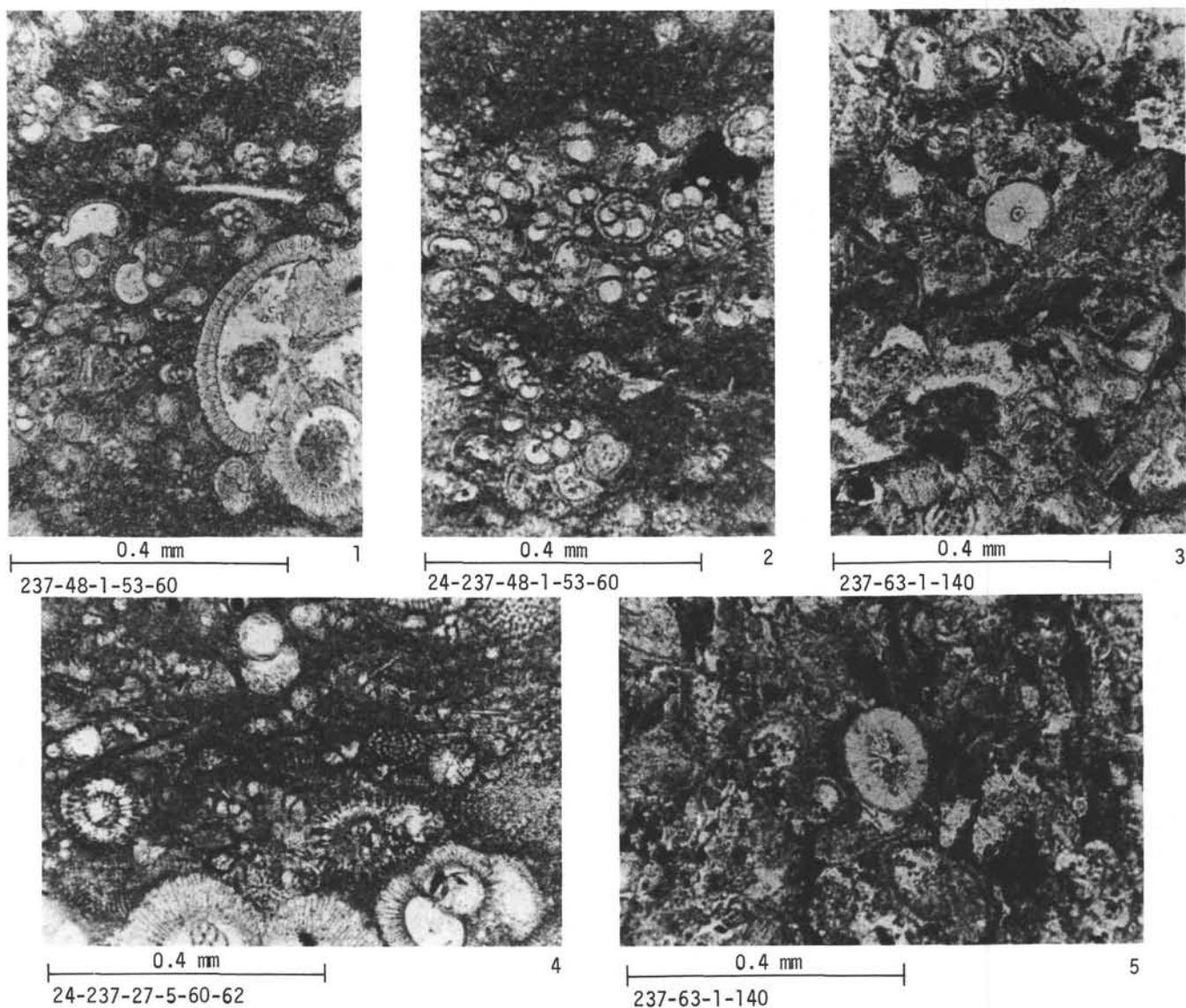
Sediments at Site 237 (all thin sections).

Figures 1, 2   Sample 48-1, 53-60 cm. Upper Paleocene foraminif-
eral nannofossil chalk. The planktonic foraminifera
are well preserved and are found enriched in thin lay-
ers wedging out to the site (resembling small lenses).

Figures 3, 5   Sample 63-1, 140 cm. Paleocene chalk with excellent
preserved Radiolaria.

Figure 4   Sample 27-5, 60-62 cm. Middle Eocene nannofossil
ooze very rich in thick-walled planktonic foraminifera
and well-preserved Radiolaria.

PLATE 8

Sediments of Site 238 (thin sections).

Figures 1-3   Sample 48-2, 40-44 cm. Lower Miocene/upper Oligo-
                   cene nannofossil chalk with many planktonic foram-
                   inifera, which are found in small lens-formed units.

Figure 4   Sample 50-3, 25-30 cm. Upper Oligocene nannofossil
                   chalk.

Figures 5, 6   Sediment inclusions in the basalt. Heavily recrystal-
                   lized nannofossil (?) chalk.
                   5. Sample 60-3, 1 cm.
                   6. Sample 64-1, 6 cm. Glassy rim of the basalt.

PLATE 8
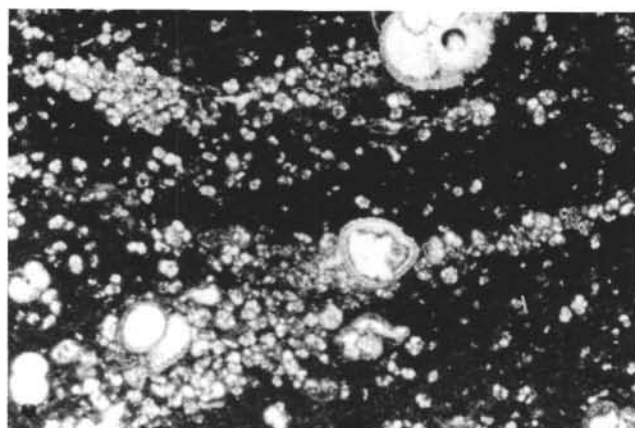
2 mm

238-48-2 (40-44) 1

238-48-2 (40-44) 2
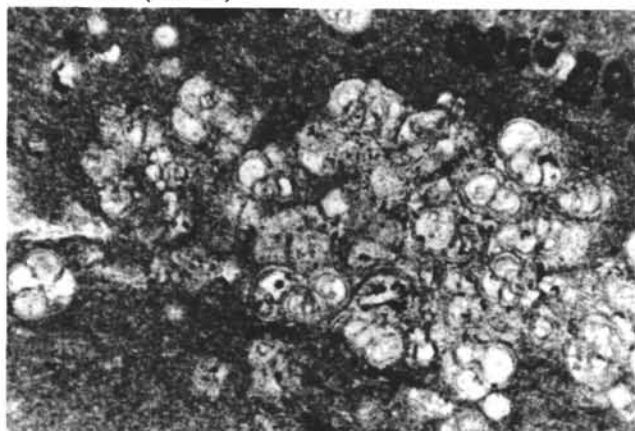
24-238-48-2 (40-44) 3
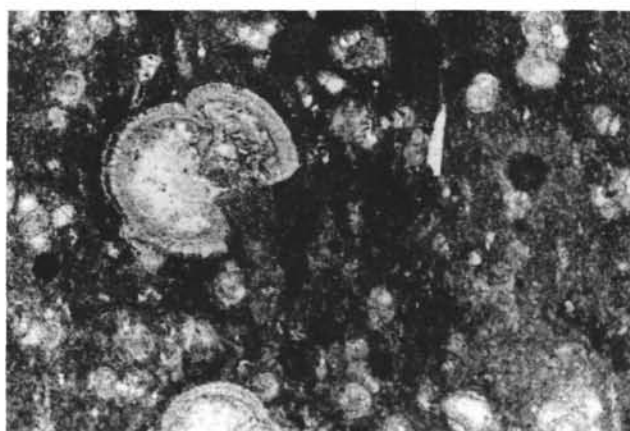
1 mm

24-238-50-3 (25-30)

0.5 mm 5

238-60-3-1

1 mm 6
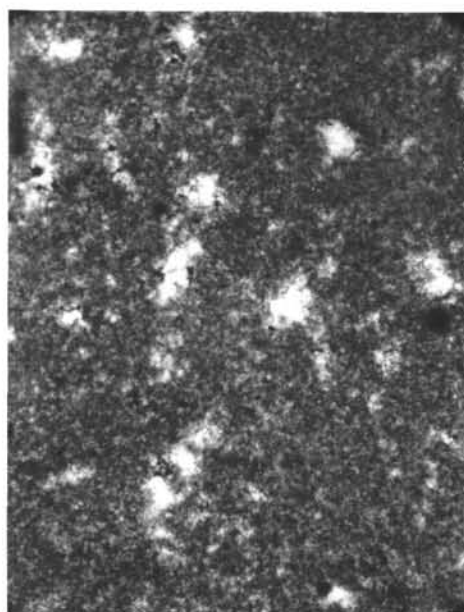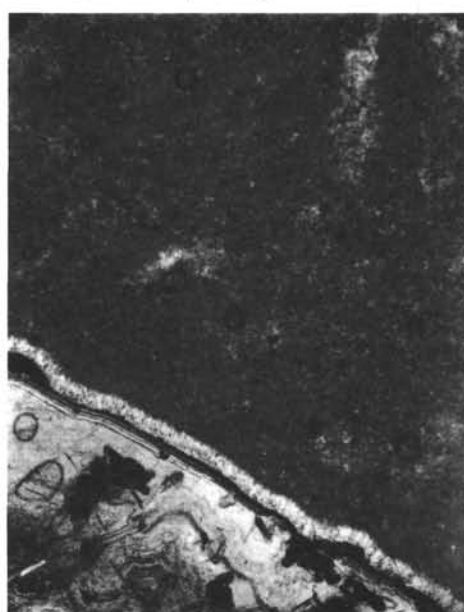
238-64-1-6

PLATE 9

Sediment inclusions in the basaltic basement of Site 238 (shipboard thin sections).

Figures 1-3   Lower Oligocene (?) heavily recrystallized nannofossil chalk with fragments and tests of foraminifera.
1. Sample 57-3, 6 cm.
2. Sample 57-2, 6 cm.
3. Sample 57-56.

Figures 4-6   Lower Oligocene (?) heavily recrystallized nannofossil chalk with few recognizable fossil fragments. Pellet-like structures are of unknown origin. Sample 58-4, 6 cm.
4. Glassy rim of the basalt.

PLATE 9
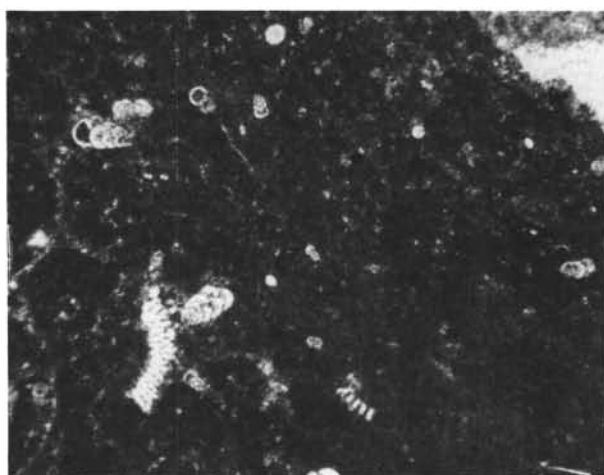
0.5 mm   1

238-57-3-6
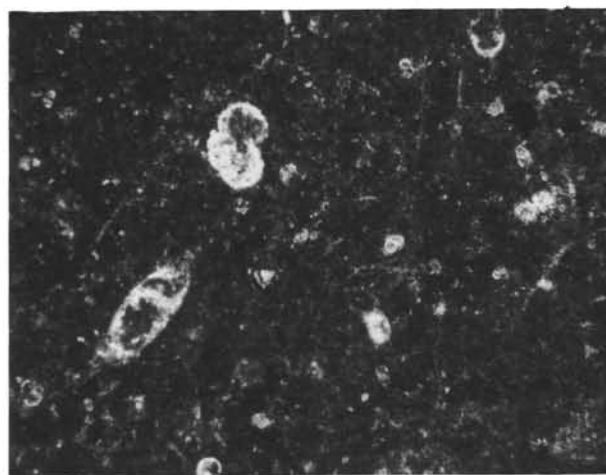
0.5 mm   2

238-57-2-6
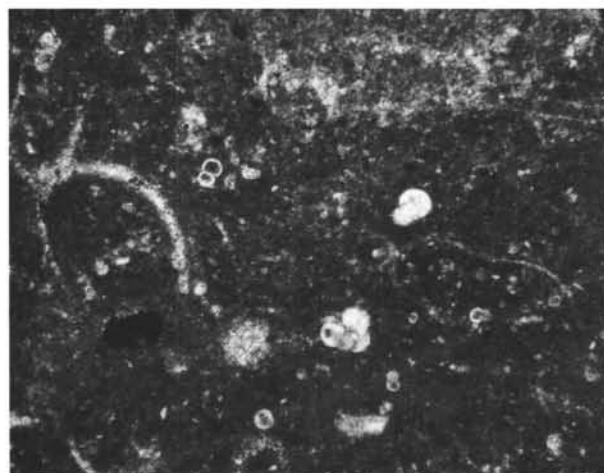
0.5 mm   3

238-57-56
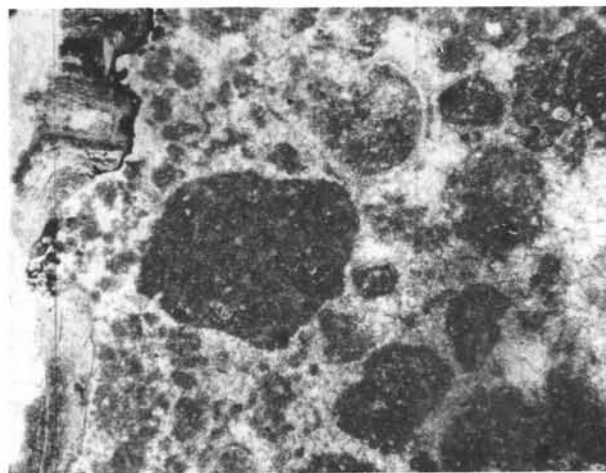
0.5 mm   4

238-58-4-6
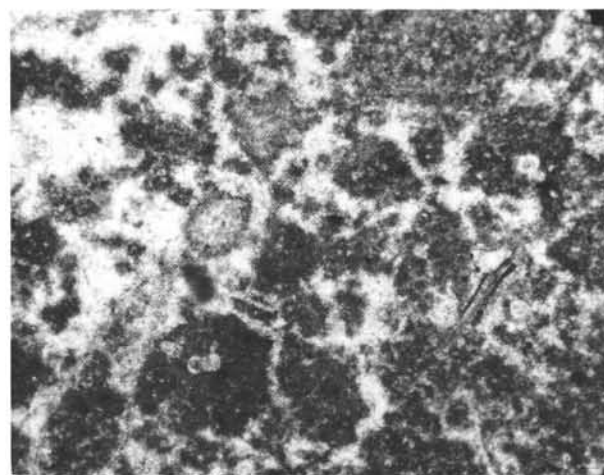
1 mm   5

238-58-4-6
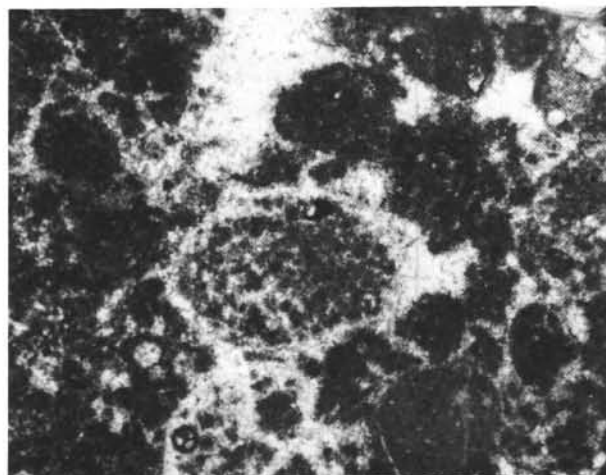
238-58-4-6

APPENDIX A
Data of Coarse Fraction Analysis

APPENDIX A$_1$
Data of Coarse Fraction Analysis of CHAIN and ANTIPODE Stations
Close to DSDP Leg 24 Drill Sites

Samples	% Sand-sized Mat. (> 0.063 mm)	% Clastic	% Authig.	% Biog.	% Indet.	% Other Shell Mat.	% Calc. Foss.	% Silic. Foss.	% Fish	% Aren. Benth. Foram	% Plant Debris	% Hystrichosph.	% Ostracod	% Pteropod	% Bivalve/Benth. Gastrop.	% Echin.	% Calc. Benth. Foram	% Plankt. Foram Frag.	% Plankt. Foram	% Sponge Spic.	% Rad.	% Diatom	Ratio: Plankt. Foram + Frag/Rad.	Ratio: Plankt. Foram/Frag.	Ratio: Plankt. Foram/Benth. Foram
ANTP 120, 0-50 cm				100			92	8						Tr			Tr	49	43	Tr	8		12.	.9	112.
ANTP 142, 0-30 cm				100		Tr	46	54	Tr								Tr	17	29	P	43	8	1.	1.7	58.
ANTP 146, 0-50 cm				100			100										Tr	34	65					1.9	68.
ANTP 150, 0-50 cm				100		Tr	94	6	Tr							Tr	P	68	22	P	5		18.	33.	11.
CHN 100-30, 0-7 cm	9	Tr		100			16	84						P			Tr	9	4	Tr	83		.2	.4	6.
CHN 100-30, 110 cm	87	Tr		99		Tr	85	14	Tr				Tr	18		Tr	6	25	35	3	11		5.5	1.4	6.5
CHN 100-30, 1108 cm	P	Tr		99		Tr	39	60	Tr								P	35	P	P	59		.6	.07	1.3
CHN 100-32, 3-8 cm	P			100			P	98									Tr	P	Tr	Tr	97		.02	.3	1.
CHN 100-32, 450-452 cm	42	P		98		Tr	67	33	Tr							Tr	P	30	35	P	31		2.1	1.2	18.
CHN 100-32, 800 cm	Tr	3	Tr	96	Tr	P	35	64	Tr		Tr						Tr	7	27	4	60		.6	4.	36.

Note: Tr = <1.1%. P = 1.1-2.9%.

APPENDIX A₂
Data of Coarse Fraction Analysis of DSDP Leg 24 Drill Sites

Core, Section Top of Interval (cm)	% Sand-sized Mat. (> 0.063 mm)	% Clastic	% Authig.	% Biog.	% Indet.	% Other Shell Mat.	% Calc. Foss.	% Silic. Foss.	% Fish	% Aren. Benth. Foram	% Plant Debris	% Hystrichosph.	% Coral (C); Bryoz. (B)	% Ostracod	% Pteropod	% Bivalve (B); Gastrop. (G)	% Larvae / Benth. Gastrop. (G)	% Echin.	% Calc. Benth. Foram	% Plankt. Foram Frag.	% Plankt. Foram	% Algae	% Sponge Spic.	% Rad.	% Diatom	Ratio: Plankt. Foram + Frag./Rad.	Ratio: Plankt. Foram/Frag.	Ratio: Plankt. Foram/Benth. Foram
Site 231																												
1-1, 132	5	P	Tr	96		P	76	21	Tr	Tr	P								P	37	38		Tr	21		3.6	1.	26.
2-1, 133		Tr		99		Tr	99		Tr	Tr					90	TrB		Tr	P	P	P						.9	.9
2-2, 61	7	5	Tr	94		Tr	99	Tr	Tr						Tr				P	24	72		Tr				3.	47.
2, CC	6	10		90		Tr	97	P							Tr				P	54	40		Tr	P		41.	.7	17.
3-1, 70	14	6	P	93		Tr	98	Tr	Tr					Tr	5	TrB	TrB	Tr	P	15	75		Tr	Tr		201.	5.1	42.
3-2, 72	11	5	Tr	95		Tr	98	P				Tr							3	44	51		Tr	P		89.	1.1	16.
3-3, 72	9	7		93		Tr	98	Tr	Tr						10			Tr	P	20	68		Tr				3.5	48.
3-4, 72		4		96		Tr	99		Tr				P						6	57	35						.6	5.8
3-4, 97	62	Tr		99		P	98		P	Tr					27	pB	pB/TrG	Tr	11	15	41						2.8	3.8
3-4, 105	65	P		98		Tr	99		Tr	Tr					9	pB	TrB/TrG	Tr	10	10	67						6.6	6.8
3-4, 129	75	19	Tr	80		P	98		P	Tr			TrB	Tr	23	17B		Tr	11	15	31						2.	2.8
3-4, 146	15	9		91		Tr	99		Tr						Tr			P	6	35	57						1.6	9.4
3, CC	12	5	Tr	94		P	98		P						7	pB	TrB		3	27	60						2.2	20.
4-1, 73	9	P	3	95		Tr	100		Tr									Tr	P	48	49						1.	22.
4-2, 48	24	11		89		P	99		Tr	Tr	Tr				22		TrB	Tr	7	15	53						3.5	7.8
4-2, 56	60	10		90		P	99		Tr	Tr					26	pB		P	8	27	39						1.4	4.6
4-2, 73	7	6	P	93		P	98	P	Tr	Tr				P				Tr	P	24	70					167.	3.	25.
4-2, 111	7	5	Tr	94		Tr	99	Tr	Tr						Tr			Tr	4	29	66		Tr				2.3	16.
4-3, 72	2	12		88		P	95	4	P								TrB	5	5	34	59		P	P		32.	1.8	12.
4, CC	3	10	Tr	89		P	92	7	Tr	Tr	Tr							Tr	6	42	44		Tr	6		15.	1.	7.2
5-1, 73	10	5	Tr	95		Tr	98	P	Tr						4		pB	P	12	25	53		P.				2.1	4.5
5-2, 73	5	25	Tr	75		P	96	P	Tr	Tr								Tr	8	58	28		Tr	P		37.	.5	3.4
5-2, 118	5	3		97		Tr	99		Tr						16	TrB		P	8	14	60						4.4	8.
5-3, 26	69	25	Tr	76		P	97	Tr	P	Tr					43	pB	4B	Tr	9	16	23			Tr		54.	1.5	2.5
5-3, 53	74	43		57		P	98						pB		13	20B		P	19	16	28						1.7	1.5
5-3, 84	71	57		43		P	99		P						26	13B/pG	pB	P	3	13	33						2.5	4.2
5-3, 88	84	71	Tr	29		8	92		5	P					10	8B/pG		23	10		40						4.	1.8
5-3, 97	7	3	Tr	96		P	97	P	Tr						Tr			P	P	24	70		P			67.	2.9	50.
5-3, 122	8	P	Tr	97		Tr	99	Tr	Tr	Tr					Tr	TrB/TrG		Tr	P	41	54		Tr				1.3	23.
5-4, 73	5	P	Tr	98		Tr	98	P	Tr						Tr			Tr	4	39	54		Tr	P		65.	1.4	13.
5-5, 65	11	3		97		Tr	99	Tr	Tr						Tr			Tr	P	31	65		Tr				2.1	35.
5-6, 65	63	11		89		P	99		P						18	5B/TrG		Tr	9	15	52						3.5	6.1
5-6, 69	68	13		87		P	99		P						34	4B/TrG		Tr	4	25	31						1.3	8.1
5, CC	21	10	P	89		Tr	99		Tr						Tr	pB		Tr	6	29	61			Tr		202.	2.1	11.
6-1, 73	12	9		91		Tr	99	Tr	Tr						P	TrB	TrB	Tr	P	43	49			Tr		198.	1.1	18.
6-1, 118	22	6		94		Tr	94	6			Tr				P	TrB/TrG		Tr	P	35	52			6		16.	1.5	19.
6-2, 73	78	68		32		P	98		P				pB		14	10B		P	18	35	18						.5	1.
6-2, 107	79	41		59		P	97	Tr							3	54B/TrG		P	9	15	14			Tr		33.	.9	1.6
6-3, 72	4	11	Tr	87		Tr	100		Tr									P	P	57	40						.7	15.
6-3, 115	7	48	P	50		P	97	Tr	Tr		P				Tr			Tr	7	67	21			Tr		131.	.3	2.8
6-4, 72	14	9		91		Tr	96	3	Tr									P	P	31	64		P	P	Tr	38.	2.1	43.
6-4, 110	16	15		85		Tr	99	Tr	Tr			Tr		Tr				Tr	Tr	20	76			Tr		206.	3.8	82.
6-5, 73	8	15		85		P	95	4	Tr		Tr							Tr	P	43	48			4		25.	1.1	16.
6-5, 80	8	21	Tr	78		Tr	95	4	Tr		Tr							Tr	Tr	45	49		Tr	Tr		34.	1.1	81.
6-6, 73	7	8	Tr	91		P	90	8	P		Tr							Tr	P	41	47		Tr	7		13.	1.2	37.
6, CC	9	10		90		P	98	Tr	P									P	P	30	67			Tr		184.	2.2	42.
7-1, 92	7	80		18		P	98		P			Tr							3	33	62						1.9	20.
7-2, 72	6	45	Tr	54		4	94	P	P	Tr								Tr	4	56	33		Tr	P		62.	.6	7.7
7-3, 72	8	9	Tr	90		P	99		P										P	21	76						3.6	36.
7, CC	13	53	P	47		P	97	Tr	P							TrB	TrB	6	6	65	25		Tr			.4	4.	4.
7, CC*	3	28	P	70		5	95		4	Tr						TrB		Tr	7	58	28						.5	3.9
8-0, 0		4	Tr	96		Tr	90	9	Tr		Tr			Tr					4	53	33			9		9.9	.6	8.9
8-1, 73	9	37	P	62		P	96	P	P										5	50	41		P	P		77.	.8	7.7
8-2, 72	9	46		54		Tr	96	3	Tr										4	65	28		Tr	P		37.	.4	7.3
8-3, 72	1	17	Tr	82			89	11											6	52	31		P	10		8.8	.6	5.7
8-4, 73	11	12	P	87		Tr	99	Tr	Tr									Tr	5	50	43			Tr		137.	.9	7.9
8-5, 37	68	27		73		P	99		Tr	Tr					7	11B		P	20	20	38						1.9	1.9
8-5, 73	Tr	21	Tr	77		P	98	P	Tr		Tr								P	53	43		P				.8	23.
8-5, 127	19	23	P	77		P	98	Tr	Tr		Tr							Tr	5	41	48	P	Tr	Tr		215.	1.2	12.
8-6, 72	14	26	P	72		Tr	91	8	Tr				TrB	Tr	Tr	pB/TrG		Tr		62	27		Tr	8		11.	.4	10.
9-1, 72	10	6		94		P	91	8	Tr		Tr						TrG			64	25			8		11.	.4	12.
9-2, 72	9	23	Tr	76		9	92	7	P										Tr	41	50		Tr	6		15.	1.2	61.
9-3, 73	9	9	2	89		Tr	95	4	Tr		Tr								P	62	30		Tr	4		26.	.5	17.
9-4, 72	8	6	P	92		P	98	Tr	P										P	51	44		Tr				.9	19.
9, CC	10	54	3	43		9	92		P		5		TrB	Tr		pB/TrG		P	19	29	37						1.3	2.
10-2, 72	8	20	P	79		Tr	87	12	Tr					Tr				Tr		55	29		P	11		8.	.5	18.
10-3, 73	12	51	Tr	49		Tr	96	3	Tr							pB			6	62	25		Tr	P		35.	.4	4.3
10-4, 73	10	28	P	71		P	96	P	P										P	55	39		P	P		87.	.7	24.
10-5, 72	7	53	P	45		P	76	22	Tr										8	47	21		Tr	22		3.2	.4	2.7
10, CC	16	33	Tr	67		P	96	P	P						P	TrB	TrB	P	11	46	35			P		44.	.7	3.1
11-2, 72	8	55	3	42		P	93	5	P									P	10	65	16			5		17.	.2	1.6
11-3, 72	11	54		46		P	90	8	Tr		Tr								6	58	26		Tr	7		11.	.4	4.7
11, CC*	6	13	5	82		P	86	12	P								Tr		5	51	29		P	10		7.7	.6	5.5

Core, Section Top of Interval (cm)	% Sand-sized Mat. (> 0.063 mm)	% Clastic	% Authig.	% Biog.	% Indet.	% Other Shell Mat.	% Calc. Foss.	% Silic. Foss.	% Fish	% Aren. Benth. Foram	% Plant Debris	% Hystrichosph.	% Coral (C); Bryoz. (B)	% Ostracod	% Pteropod	% Bivalve (B); Gastrop. (G)	% Larvae / Benth. Gastrop. (G); Bivalve (B)	% Echin.	% Calc. Benth. Foram	% Plankt. Foram Frag.	% Plankt. Foram	% Algae	% Sponge Spic.	% Rad.	% Diatom	Ratio: Plankt. Foram + Frag./Rad.	Ratio: Plankt. Foram/Frag.	Ratio: Plankt. Foram/Benth. Foram
Site 231																												
12-1, 72	7	26	P	72		Tr	99	Tr	Tr											66	33	Tr					.5	
12-2, 72	6	56	Tr	43	P		99		P										P	58	40						.7	27.
12-4, 72	7	36	Tr	63		6	90	4	3		P	P							5	69	16	Tr		3		28.	.2	3.
12, CC	6	19	3	78		P	96	P	P		Tr							Tr	P	78	15	P		Tr		195.	.2	6.4
12, CC*	P	11	6	84		P	95	P	P	Tr								Tr	3	49	42	Tr	P			47.	.9	12.
13-2, 72	4	37	4	59		4	90	6	P	Tr	P							Tr	7	71	11	P	5			16.	.2	1.5
13-4, 72	13	16	Tr	84		4	89	8	P	Tr	P						Tr^B		8	57	24	P	5			17.	.4	2.9
13-5, 72	7	41	3	55		4	93	3	3		Tr							Tr	5	69	18	P	Tr			115.	.3	3.4
13, CC	6	15	P	82		5	93	P	Tr		5								5	72	16	P	Tr			206.	.2	3.1
14-3, 72	8	26	P	73		P	97	Tr	Tr		P								5	61	32	Tr					.5	6.8
14-4, 56	6	29	P	69		7	89	4	P	Tr	P	5	Tr					P	5	52	31	P	P			30.	.6	6.2
14-5, 72	7	7	P	92		3	95	P			3		Tr					Tr	Tr	78	15	P		Tr		215.	.2	17.
14, CC	9	32	P	67		4	95	Tr	3		Tr							Tr	5	46	43	Tr					.9	9.
15-2, 74	16	39	P	60		P	99				Tr	Tr				pB		Tr	7	54	34						.6	4.7
15-3, 72	12	40	P	58			100								Tr	Tr^B		Tr	9	63	26						.4	3.1
15, CC*	Tr	8	4	89		P	77	20	Tr	P								Tr	13	9	55		Tr	19		3.3	5.9	4.3
16-2, 72	8	90	Tr	9		3	95	P	3									P	13	56	24		P			70.	.4	1.9
16, CC*	Tr	43	12	45		9	91		6	Tr	P					Tr^B		Tr	17	55	17						.3	1.
17-2, 56	46	11		89			100									pB			15	68	16						.2	1.
17-2, 75	61	12		88		6	94		P	4					P	Tr^B			31	26	35						1.4	1.1
17-3, 15	53	7		93			100									6^B		P	82	7	4						.6	.05
17-3, 23	47	10		90			100												80	rest resedimented biogenic detritus								
17-3, 71	9	45	4	52		P	97		P	Tr									10	70	18						.3	1.9
17-4, 73	6	48	5	47		5	95		P	Tr	Tr							P	12	62	20						.3	1.7
17, CC	7	32	3	65		6	94		4	Tr	Tr							Tr	7	78	9						.1	1.4
17, CC*	3	36	5	58		Tr	99				Tr								16	51	32						.6	2.1
18-2, 71	5	48	5	47		3	97		P	Tr		Tr							9	57	30	Tr					.5	3.5
18-3, 72	7	43	P	54		4	96		P	Tr	Tr								7	53	36						.7	4.9
18, CC	6	43	7	50		P	98		P	Tr					P	pB		P	26	26	41						1.6	1.5
19-2, 43	46	48	P	50		8	92		4	P	Tr							P	29	30	31	Tr					1.	1.1
19-2, 72	6	80	1	19		6	93	Tr	6					r				Tr	12	47	33						.7	2.7
19-3, 71	4	36	5	59		P	97		P		P								12	63	22						.4	1.8
19-4, 73	3	25	4	72		P	98	Tr	P		Tr								7	59	33			Tr		170.	.6	5.1
19, CC*	Tr	34	18	48		3	96	Tr	P										10	63	24	Tr					.4	2.5
20-3, 30	30	100							volcanic ash: colorless glass																			
20-2, 71	6	44	2	54		P	98		Tr		P							Tr	4	69	24						.3	5.5
20-3, 72	5	54	P	43		7	93		5	Tr	P		Tr						3	62	27						.4	8.7
20-4, 72	5	29	P	70		P	98		Tr		P								6	68	24						.4	4.1
20-5, 72	6	95	Tr	4		5	94	Tr	4		Tr								13	54	27	Tr					.5	2.
20-6, 72	5	12	3	85		Tr	100				Tr								6	61	33						.5	6.
20, CC	5	23	4	53		P	97	P			Tr								8	58	34	Tr		Tr		84.	.5	3.9
21-1, 72	3	22	5	73		P	99		P									P	6	63	29						.5	4.6
21-2, 71	.5	54	P	44		Tr	99		Tr							pB		Tr	6	61	29						.5	5.2
21-3, 72	6	20	3	77		P	98	Tr	Tr		Tr								4	63	31	Tr					.5	7.
21-4, 72	8	85	5	10		P	98	Tr	Tr	Tr	Tr							Tr	6	67	25	Tr					.4	4.3
21-6, 73	8	31	Tr	69		Tr	99				Tr							P	6	55	36						.7	5.7
21, CC	5	26	P	71		P	99		P									P	5	65	26						.4	5.6
21, CC*	Tr	P	90	8		29	71		26	P	P			P				P	30	18	21						1.2	.7
22-1, 72	6	31	P	68		P	97		P		Tr								14	51	32						.6	2.3
22-2, 73	6	60	5	35		P	99		P										P	81	16						.2	12.
22-3, 73	5	44	6	50		3	97		P		Tr							Tr	8	45	43						1.	5.3
22-4, 72	4	45	4	51			100												10	59	31						.5	3.
22-5, 72	6	46	4	51		5	95		5									Tr	P	66	26						.4	13.
22, CC*	Tr	35	12	53		P	98		P	P									25	55	20						.4	.8
23-2, 71	6	43	Tr	56		P	98		Tr		Tr								P	56	39						.7	14.
23-4, 72	8	42	P	56		4	96		P		P	Tr						P	10	56	29						.5	3.
23-5, 72	5	29	3	68		8	92		3	Tr	3	Tr							15	48	29						.6	1.9
23, CC	4	95	Tr	4		4	96	Tr	3		Tr		Tr					Tr	7	50	38			Tr		129.	.8	5.3
24-1, 72	5	47	6	42		P	97		P									Tr	8	71	17						.2	2.
24-2, 72	4	46	3	50		3	97		3									Tr	7	70	19						.3	2.9
24-3, 73	4	90	Tr	9		Tr	99		Tr										15	69	15						.2	1.
24-5, 73	4	57	9	35		4	96		4										8	70	18						.3	2.3
24-6, 72	5	80	5	15		P	97		P		Tr								9	56	32						.6	3.5
24, CC	17	48	Tr	51		17	83	Tr	16		Tr		Tr			Tr^B		Tr	18	38	24				Tr		.6	1.4
25-1, 72	6	23	P	75		P	97	Tr	Tr		P							Tr	9	59	28	Tr				177.	.5	3.
25-2, 72	5	15	P	83		P	98		P		Tr							Tr	3	83	11						.1	3.5
25-3, 72	3	39	P	59		3	97		P		Tr								7	75	16						.2	2.4
25-4, 72	3	42	6	51		8	92		5		4							Tr	7	57	27						.5	4.1
25-5, 72	3	53	P	46		P	98		P				Tr					Tr	10	70	17						.2	1.7
25, CC*	Tr	32	11	57		5	96		P	Tr	Tr					Tr^B		Tr	24	35	36						1.	1.5
25, CC	4	21	11	69		P	99		P										17	48	33						.7	1.9
26-2, 73	3	37	6	57		5	96		3		P							P	18	68	11						.2	.7
26-3, 74	5	42	P	57		5	95		4			Tr						Tr	8	59	27						.5	3.5
26-4, 74	44	43	15	42		P	98		Tr		Tr					pB		Tr	27	32	36	Tr					1.1	1.3
26-5, 73	P	29	P	68		3	97		P			Tr						Tr	13	64	19						.3	1.4

Core, Section Top of Interval (cm)	% Sand-sized Mat. (> 0.063 mm)	% Clastic	% Authig.	% Biog.	% Indet.	% Other Shell Mat.	% Calc. Foss.	% Silic. Foss.	% Fish	% Aren. Benth. Foram	% Plant Debris	% Hystrichosph.	% Coral (C); Bryoz. (B)	% Ostracod	% Pteropod	% Bivalve (B); Gastrop. (G)	% Larvae / Benth. Gastrop. (G)	% Echin.	% Calc. Benth. Foram	% Plankt. Foram Frag.	% Plankt. Foram	% Algae	% Sponge Spic.	% Rad.	% Diatom	Ratio: Plankt. Foram + Frag./Rad.	Ratio: Plankt. Foram/Frag.	Ratio: Plankt. Foram/Benth. Foram
Site 231																												
26-6, 73	3	19	5	76		P	97		P		P							Tr	10	73	20						.3	2.1
26, CC	3	31	4	65		4	95		P	Tr	Tr							P	9	70	15			Tr		86.	.2	1.7
27-2, 73	8	57	6	37		5	95		5										11	65	19						.3	1.7
27-4, 74	6	95	P	3		P	98		P									Tr	6	61	31						.5	4.8
27-5, 72	4	33	5	62		P	98			Tr	P					TrB			7	60	30						.5	4.1
27-6, 72	3	51	4	46		P	97		P			Tr							P	60	35						.6	21.
27, CC	3	26	5	70		5	95		3	Tr	Tr			Tr				Tr	5	61	28						.5	5.4
28-1, 72	4	21	Tr	78		P	98				P	Tr						Tr	4	67	27						.4	7.6
28-3, 72		67	7	27		7	92		6		P							P	19	60	12						.2	.6
28-4, 72	3	30	8	62		4	96		P		P							P	11	63	20						.3	1.8
28-6, 72	8	84	P	14		12	88		6	3	3								15	47	27						.6	1.8
28, CC		10	18	72		5	95		4	Tr				Tr				P	17	42	34						.8	2.
29-3, 72	4	32	6	62		4	96		P	Tr	P								6	68	22						.3	3.5
29-4, 72	6	50	P	49		4	96		3	P									5	62	28						.5	5.4
29-6, 72	3	57	P	41		4	96		P	P	Tr								8	67	21						.3	2.7
29, CC	4	90	P	8		P	98		Tr	Tr	Tr							Tr	7	74	17						.2	2.5
30-2, 72	3	32	4	64		P	98		Tr	Tr	Tr							Tr	17	66	14	Tr					.2	.8
30-3, 72	3	33	P	65		3	97		3										6	64	27						.4	4.5
30-4, 72	4	95	Tr	4		6	93	Tr	5	Tr								Tr	18	56	18		Tr				.3	1.
30-6, 72	3	26	3	71		4	96		3		Tr								5	59	33						.6	7.
30, CC*	Tr	39	28	33		9	91		8	Tr								4	32	28	28						1.	.9
31-2, 72	7	20	P	80		P	98		P									Tr	5	72	21						.3	4.4
31-4, 72	3	58	9	33		7	93		6	P								P	19	48	25						.5	1.3
31, CC	3	93	P	5		P	97		P	Tr								P	15	47	34						.7	2.3
32-1, 72	3	30	8	62		6	94		4		P							Tr	P	62	29						.5	9.8
32-2, 70	4	27	3	70		P	98		P		P							Tr	5	54	38						.7	8.1
32-3, 72	6	93	P	5		P	98		P	Tr									6	77	15						.2	2.5
32-4, 72	6	95	Tr	4		P	97		P		Tr							Tr	14	54	28						.5	1.9
32-5, 72	3	63	4	33		10	90		4	P	P	P						P	21	51	16						.3	.8
32, CC*	Tr	37	7	56		9	89	P	8	Tr	Tr					pB		Tr	40	19	27		P				1.4	.7
33-1, 72	3	24	3	73		5	95		P	Tr	3							Tr	8	58	28						.5	3.5
33-2, 72	5	37	7	56		3	97		P									Tr	12	49	35						.7	3.
33-4, 72	3	23	Tr	76		4	96		3		Tr							P	9	55	31						.6	3.5
33, CC	3	95	3	P		5	95		3	P	Tr								28	39	28						.7	1.
34-1, 72	4	65	Tr	35		11	89		10		P							P	8	74	6						.07	.7
34-2, 72	4	80	Tr	19		5	95	Tr	3	Tr	Tr							P	21	49	23		Tr				.5	1.1
34-4, 72	4	42	5	53		12	87	Tr	10	Tr	Tr							Tr	14	58	14		Tr				.2	1.
34-5, 72	3	43	6	51		4	96		P		P							Tr	10	65	20						.3	2.
34, CC	3	14	12	74		4	96		3	P									13	47	36						.8	2.9
36-2, 72	5	22	4	74		Tr	99		Tr	Tr								Tr	9	60	29						.5	3.1
36-3, 90	3	44	4	52		6	94		5	Tr	Tr								8	53	33						.6	4.4
36-4, 72	4	17	P	81		5	95		P	Tr	P	Tr							P	59	34						.6	12.
36-5, 72	3	47	12	42		P	97		P									P	10	63	23						.4	2.2
36-6, 92	3	38	5	57		P	98		Tr	Tr	Tr	Tr						P	7	69	20						.3	2.8
36, CC	3	32	Tr	67		P	98		Tr	Tr	P							P	5	64	28						.4	6.
37-2, 72	4	34	3	64		P	97		P		Tr								12	65	21						.3	1.8
37-3, 72	3	38	P	60		P	99		P										3	62	34						.6	11.
37-4, 72	3	7	3	90		4	96		3	Tr	Tr								5	56	33						.6	6.2
37-5, 72	P	34	8	58		P	97	Tr	P		Tr				Tr	TrB		Tr	15	59	22			Tr			.4	1.5
37, CC	3	95	P	3		P	96	Tr	Tr	P									12	49	34		Tr				.7	2.8
38-2, 72	5	27	P	70		7	93		3			3						Tr	5	65	23						.3	5.
38-5, 75	5	23	4	74		5	95		4		Tr							P	5	72	17						.2	3.3
38, CC*		5	27	68		5	95	Tr	4	Tr								P	37	23	33		Tr				1.5	.9
39-2, 72	4	33	4	63		4	95	Tr	4	Tr			Tr					P	11	66	16		Tr				.2	1.4
39-4, 72	6	58	Tr	41		9	91		7		P					pB		P	13	52	23						.4	1.8
39, CC	3	26	18	57		13	86	Tr	13						Tr	pB		Tr	31	33	19						.6	.6
40-2, 73	P	53	13	34		7	93		5	P	P							P	10	74	8						.1	.9
40-3, 73	3	19	Tr	80		P	99		P										4	46	48						1.	12.
40-5, 74	5	65	Tr	34		6	94		6										15	33	48						1.4	3.
40, CCW	7	Tr	3	96		P	98		P									Tr	5	36	57						1.6	12.
40, CCG	3	22	18	60		Tr	99				Tr					TrB		Tr	17	45	36						.8	2.1
41-2, 73	3	52	7	41		3	97		P	P								P	20	65	11						.2	.5
41-3, 73	4	54	15	31		4	94	P	4										13	35	46			P		37.	1.3	3.5
41, CC	3	56	7	37		6	94		6									P	16	59	18						.3	1.1
42-2, 75	3	18	P	81		P	98		P		Tr								P	56	40						.7	17.
42-3, 73	4	70	5	25		12	88		9	Tr	Tr	Tr						P	32	40	14						.4	.4
42-5, 74	3	80	5	15		4	96		4									P	18	52	25						.5	1.4
42-6, 73	3	27	6	67		6	94		4	Tr	Tr							Tr	34	59	9						.2	.3
42, CC	3	40	20	40		8	92		7	Tr						TrB		Tr	34	28	28						1.	.8
43-1, 74	21	15	37	47		P	98		P										5	28	65						2.3	14.
43-2, 74		26	6	69	Tr	P	97	Tr	Tr	Tr	Tr							Tr	8	59	30		Tr				.5	3.7
43-5, 73	4	43	4	54		8	92		8									Tr	7	63	21						.3	2.9
43-6, 74		31	13	56		5	95		5							Tr			8	52	34						.6	4.
43, CC*	P	21	33	46		6	94		P	4								P	39	28	26						.9	.7

Core, Section Top of Interval (cm)	% Sand-sized Mat. (> 0.063 mm)	% Clastic	% Authig.	% Biog.	% Indet.	% Other Shell Mat.	% Calc. Foss.	% Silic. Foss.	% Fish	% Aren. Benth. Foram	% Plant Debris	% Hystrichosph.	% Coral (C); Bryoz. (B)	% Ostracod	% Pteropod	% Bivalve (B); Gastrop. (G)	% Larvae [Bivalve (B); Benth. Gastrop. (G)]	% Echin.	% Calc. Benth. Foram	% Plankt. Foram Frag.	% Plankt. Foram	% Algae	% Sponge Spic.	% Rad.	% Diatom	Ratio: Plankt. Foram + Frag./Rad.	Ratio: Plankt. Foram/Frag.	Ratio: Plankt. Foram/Benth. Foram
Site 231																												
44-1, 99	Tr	56	24	9		11	89		too few particles																		.3	3.
44, CC*	Tr	41	22	37		7	93		6	P								P	39	21	30	P					1.4	.8
45-1, 74	5	54	5	41		16	82	P	14	Tr	Tr								13	48	21		Tr		Tr		.4	1.6
45-3, 75	4	90	P	8		4	96		4				P					P	18	44	32						.7	1.7
46-1, 72	3	80	Tr	19		P	98		P									Tr	11	44	42						1.	3.7
46-3, 74	20	95	P	3		8	91	P	8								pB	P	26	46	14		P				.3	.5
46-4, 74	5	90	P	8		P	98	Tr	Tr	Tr								Tr	15	30	54			Tr		127.	1.8	3.7
46, CC	3	9	P	89		P	98		P		Tr					P		Tr	7	38	51						1.4	7.5
47-3, 74	5	23	9	68		P	97		P		Tr								14	32	51						1.6	3.6
47-4, 73	4	80	5	15		P	99		Tr		Tr								8	60	31						.5	3.9
47, CC	Tr	34	28	39		10	90		8	Tr	Tr							P	36	18	34						1.9	.9
48-3, 73	6	12	Tr	87		P	98	P	P								pB	Tr	P	55	39		P			85.	.7	14.
48, CC*	4	40	18	42		5	95		4	P									17	35	43						1.2	2.5
49, CC	Tr	44	34	22		4	96		P	P								P	24	13	56						4.2	2.3
50-2, 30-70	4	48	8	43		P	98		P								pB	Tr	16	35	46						1.3	2.9
50-3, 73	7	23	P	74		P	98		P									Tr	P	60	35						.6	14.
50-4, 73	4	74	15	11		27	73		3		27								33	37	3						.1	.1
50, CC*	P	41	9	51		5	95		5	Tr								Tr	14	37	43						1.2	3.
51-6, 1	63	80	P	18		Tr	98	Tr	Tr								TrB	Tr	39	36	22		Tr				.6	.5
51-6, 49	55	47	P	50		P	98		P									Tr	22	68	7						.1	.3
51, CC*	1	10	7	83		P	99		P								TrB		12	50	36						.7	3.1
52, CC	Tr	55	21	24		22	72	6	21	P							pB	5	49	12	5		P	5		3.7	.4	.1
53, CC	Tr	90	5	5		12	85	P	7	5							TrB	Tr	79	P	P		Tr	P		2.7	1.	.03
54, CC	P	14	18	68		5	94	P	5				pB					4	48	38	P			P		33.	.06	.05
56-4, 134	3	33	11	56		13	86		13									P	16	39	30						.8	1.8
56, CC	P	15	4	82		6	94	Tr	5	Tr						Tr		P	10	32	51			Tr		147.	1.6	
57, CC*	3	14	19	17		19	80	Tr	18	Tr	Tr								7	46	28		Tr				.6	4.1
58-2, 130	4	7	Tr	92		P	98		P	Tr									P	33	63						1.9	42.
58-6, 51	3	23	7	69		P	99		P										P	62	35						.6	15.
58, CC	P	6	P	92		7	93		5	Tr	P							Tr	P	37	53						1.4	23.
59-2, 120	4	23	3	74		5	94	Tr	5										P	60	32			Tr	Tr	183.	.5	26.
59-4, 104	5	3	P	94		P	99		Tr	Tr								Tr	P	40	55						1.4	22.
59-6, 106	3	29	4	68		5	95		5	Tr								Tr	P	64	29						.5	19.
59, CC	P	P	10	89		P	97		P	Tr				Tr				4	42	50							1.2	11.
60-2, 117	P	24	25	50		8	92		7	Tr									4	34	54						1.6	13.
60-2, 120 (Bulk)	P	7	15	78		3	97		P	Tr									5	51	41						.8	8.
60, CC	Tr	15	26	59		7	93		7	Tr				Tr					13	38	57						1.5	4.4
61-4, 110	5	9	P	88		3	97		P	P									5	40	52						1.3	9.8
61-6, 110	P	80	5	15		12	88		11	Tr									8	46	34						.7	4.4
61, CC*	P	12	P	87		P	97	P	Tr	P	Tr								10	27	60			P		82.	2.2	5.9
62-1, 85	4	P	Tr	98		5	95		5										4	37	54						1.4	14.
Hole 232																												
1-1, 92	15	P	Tr	97		P	85	14	Tr		Tr		Tr						3	49	31		Tr	13		6.	.6	10.
1-2, 73	23	Tr	Tr	99		P	98	Tr	Tr		Tr		Tr			TrB		Tr	4	29	63			Tr		123.	2.2	15.
1, CC*	15	5		95		Tr	100		Tr		Tr				Tr			Tr	P	20	76						3.8	29.
2-2, 83	14	3	P	95		Tr	94	5	Tr		Tr							Tr	10	45	39		Tr	4		19.	.9	3.7
2-4, 83	9	P	P	97		Tr	100		Tr		Tr		14			TrG		Tr	4	13	59						4.5	16.
2, CC	8	P	P	97		P	97	P	Tr		Tr							Tr	9	25	62		Tr	Tr		201.	2.5	6.8
3-2, 83	13	4	Tr	96		Tr	99	Tr	Tr		Tr	Tr							5	38	55		Tr				1.5	11.
3-4, 83	8	70	Tr	29			77	23										Tr	10	62	5		P	20		3.3	.08	.5
3, CC*	4	9	P	89			96	4										Tr	9	44	42			4		19.	.9	4.5
4-2, 83	3	95	Tr	4			51	49										Tr	17	26	7		3	46		.7	.3	.4
4-4, 83	6	4	Tr	95		Tr	97	P		Tr	Tr							Tr	5	17	74		Tr	P		67.	4.1	14.
4, CC*	8	P		98			99	P										Tr	6	14	45		Tr			89.	3.3	7.5
5-2, 83	9	8	Tr	91		P	94	4	Tr	Tr	Tr							Tr	5	44	46		Tr	4		24.	1.1	10.
5-4, 83	8	Tr	Tr	99		Tr	98	P	Tr							Tr		Tr	6	7	85		Tr	P		55.	13.	15.
5, CC*	7	30	Tr	70		Tr	88	12	Tr									Tr	10	31	6		P	10		3.5	.2	.7
6-2, 83	11	10		90		Tr	38	61	Tr										11	24	P		P	59	Tr	.5	.1	.2
6, CC*	9	63		37		Tr	88	11	Tr									Tr	22	53	11		Tr	10		6.3	.2	.5
7-2, 83	7	90	Tr	9		Tr	42	57	Tr									Tr	23	12	6		3	54		.3	.5	.3
7, CC*	6	95	Tr	4		P	26	73	Tr		P							P	13	10	P		P	71		.2	.2	.2
8-3, 83	3	57	P	43		4	82	15	P	Tr								Tr	16	47	18		P	13		5.2	.4	1.1
8, CC*	4	24	P	75		Tr	36	63	Tr									Tr	9	23	P		4	59		.4	.1	.3
9-2, 83	P	Tr	5	94		Tr	96	3	Tr		Tr							Tr	5	26	65			3		27.	2.5	13.
9, CC	3	44	7	49		4	57	40	P		Tr	Tr						Tr	19	31	6		38	38	P	1.	.2	.3
9, CC*	3	41	Tr	58		P	45	54	Tr		Tr	Tr						Tr	16	21	8		P	51		.6	.4	.5
10-2, 80	P	10	P	87		Tr	39	61			Tr								7	29	P		4	56	Tr	.6	.08	.3
10, CC*	4	51	P	47		Tr	86	14			Tr							P	23	35	26		Tr	13		4.7	.7	1.1
11-3, 83	3	58	P	41		Tr	70	30	Tr									Tr	16	36	16		P	27		2.	.4	1.

Core, Section Top of Interval (cm)	% Sand-sized Mat. (> 0.063 mm)	% Clastic	% Authig.	% Biog.	% Indet.	% Other Shell Mat.	% Calc. Foss.	% Silic. Foss.	% Fish	% Aren. Benth. Foram	% Plant Debris	% Hystrichosph.	% Coral (C); Bryoz. (B)	% Ostracod	% Pteropod	% Bivalve (B); Gastrop. (G)	% Larvae / Bivalve (B); Benth. Gastrop. (G)	% Echin.	% Calc. Benth. Foram	% Plankt. Foram Frag.	% Plankt. Foram	% Algae	% Sponge Spic.	% Rad.	% Diatom	Ratio: Plankt. Foram + Frag./Rad.	Ratio: Plankt. Foram/Frag.	Ratio: Plankt. Foram/Benth. Foram
Hole 232																												
12-2, 83	15	90	Tr	9		P	21	77	P		P								5	10	6		4	72		.2	.6	1.2
12, CC*	4	90	Tr	9		P	25	73	P									Tr	8	14	P		5	68		.2	1.2	.3
13-1, 93	6	90	Tr	9		P	27	71	P		Tr							P	13	8	5		P	68	Tr	.2	.6	.3
13-1, 118	13	98	Tr	Tr		5	60	35	5									P	32	17	9		P	32	P	.8	.5	.3
13, CC*		90	Tr	9		P	41	58		Tr	Tr								16	18	7		4	54		.5	.4	.5
14-3, 83	3	51	P	48		4	22	74	P	Tr		Tr							10	10	P		4	71		.2	.2	.2
14-5, 66	62	98	Tr	Tr			89	11											43	43	P		6	6			.1	.1
14, CC*	P	57	P	41		4	46	51	Tr	P									14	26	5		4	47		.7	.2	.4
15-3, 83	P	59	Tr	40		Tr	59	41	Tr		Tr							Tr	9	39	11		3	38		1.3	.3	1.2
15, CC	P	37	Tr	63		3	66	31	P	Tr	Tr							Tr	11	48	7		Tr	30		1.8	.2	.6
16-3, 83	4	90	Tr	9		Tr	54	45		Tr									11	38	5		4	42		1.	.1	.5
17-3, 83	3	33	Tr	66		P	60	39	P									Tr	10	38	11		5	34		1.4	.3	1.1
17, CC	P	46	P	53		P	62	36	Tr	P								Tr	19	35	8		4	32		1.3	.2	2.3
18-3, 83	Tr	51	P	46		Tr	59	40	Tr									Tr	13	34	Tr		4	36		1.2	.3	.8
18, CC*	P	26		74		P	60	38	Tr	P								Tr	21	32	7		P	36		1.1	.2	.3
19-2, 83	Tr	42	4	54		Tr	25	74	Tr										9	12	5		7	67		.3	.4	.5
19, CC*	P	18	8	78		P	63	43	Tr	Tr				Tr				3	23	22	15		5	37	Tr	1.	.7	.6
Hole 232A																												
1-2, 80	4	21	P	78			90	10										Tr	13	61	16		P	7		11.	.3	1.
1-4, 44	16	95		5			71	30										Tr	16	40	15		P	P		2.	.4	.1
1-4, 90	P	94	Tr	5		P	50	49	Tr	Tr								P	20	23	6		9	40		.7	.3	.3
1-5, 26	7	98	Tr	Tr			71	29										4	20	40	7		P	27		1.8	.17	.3
1, CC	3	31	Tr	68		P	45	54	P									Tr	14	23	8		3	51		.6	.4	.6
2-2, 83	Tr	17	6	77	Tr	P	76	21	P										9	46	22		5	16		4.4	.5	2.5
2-4, 83	4	11	P	87		Tr	53	47	Tr									Tr	6	30	16		4	43		1.1	.5	2.8
2, CC	4	25	Tr	75			64	36											8	44	12		4	31	Tr	1.8	.3	1.4
3-2, 126	6	60	5	35		P	51	48	P							TrG		Tr	12	31	7		P	66	Tr	.9	.2	.6
3-4, 85	6	95	Tr	4		P	59	40	Tr		Tr							Tr	10	40	9		P	36	P	1.3	.2	.9
3, CC	3	26	5	69			75	25											10	54	11		P	23	Tr	2.8	.2	1.1
4-2, 76	6	95	Tr	4		Tr	42	57	Tr										10	24	8		10	48		.7	.3	.8
4-4, 87	11	95	Tr	4		P	60	39	P									Tr	4	35	20		13	25	Tr	2.2	.6	4.7
4, CC	4	18	4	78		P	57	42		Tr	Tr						Tr	P	9	36	11		P	39	Tr	1.2	.3	1.2
5-2, 83	7	53	P	45		Tr	75	24	Tr									Tr	7	51	16		P	18	4	3.7	.3	2.2
5, CC	P	23	6	71		P	65	33	Tr	Tr	Tr								16	43	7		4	29		1.7	.2	.5
6-2, 83	8	31	P	66			45	55										P	8	26	10		6	49		.7	.4	1.3
6-5, 72	52	100																										
6, CC	3	29	7	64		P	32	66	P		Tr							Tr	8	18	5		P	63	Tr	.4	.3	.7
7-2, 83	16	95	Tr	4		4	83	12	P		P								12	48	23		Tr	11		6.2	.5	1.9
7, CC	P	33	5	62		P	38	61	P									P	6	29	P		P	59		.5	.1	.5
8-2, 83	11	35	P	63			65	35										Tr	4	40	20		P	33	Tr	1.8	.5	4.6
8, CC	3	11	11	78		Tr	76	24	Tr									Tr	12	61	P		P	21	Tr	3.1	.04	.2
9-5, 32	5	50		50		Tr	53	47	Tr									Tr	16	23	12		8	36	4	1.	.5	.7
9-5, 114	3	70	5	25	Tr	P	60	38	P										11	30	18		Tr	37		1.3	.6	1.7
10-4, 58	8	85		15		Tr	74	25	Tr		Tr					TrB		Tr	9	49	15		5	20	Tr	3.1	.3	1.6
10, CC	3	60	Tr	39		3	82	15	P	Tr								P	20	44	17		5	8	23	8.1	.4	.9
11-1, 92	7	95	Tr	4		P	94	3	P		Tr							Tr	8	74	12		P	P		50.	.2	1.5
11, CC	4	14	54	32		4	96		Tr		3					TrB		P	16	46	32						.7	2.
12-2, 36	3	95	Tr	4		89	11				87					TrB			4	3	4						1.6	1.9
12, CC	Tr	95	Tr	4		91	9				91					TrG			P	4	P					109.	1.9	1.4
13-1, 96	Tr	20		80		99	Tr				99					TrB												
13, CC	Tr	75		25		76	24				76							Tr	7	6	11						1.8	1.5
14-1, 83	11	70	3	27		91	9	Tr			91								P	4	P			Tr		34.	.7	1.
14, CC	5	50		50	Tr	98	P				98								Tr	Tr	P						2.	2.5
15-2, 83	39	95		5		97	3				97								Tr	Tr	Tr						1.	1.
15, CC	3	80		20		95	5				95								P	Tr	P						3.3	1.2
18-2, 62	10	95	Tr	4		P	99		P										7	41	50						1.2	7.
18, CC	5	95	Tr	4	Tr	P	78	20	Tr	Tr							Tr	Tr	16	31	31		4	16		3.8	1.	1.9
19-1, 102	8	38	P	61		Tr	60	40			Tr							Tr	5	36	19		P	37	Tr	1.5	.5	3.6
19, CC	3	31	22	48		8	68	25	Tr	Tr	7							Tr	7	25	34		3	20	P	3.	1.3	4.9
20-1, 52	4	44	Tr	55		P	69	30	P										5	47	18		P	28		2.3	.4	3.8
20, CC	P	78	Tr	22		P	71	27	P	Tr									29	27	14		11	16		2.7	.5	.5
21-2, 54	3	79	Tr	20		P	64	34	P	Tr								Tr	17	26	20		P	31		1.5	.8	1.2
21, CC	P	27	10	63			93	7										Tr	16	42	34		P	3	P	24.	.8	2.
22-2, 83	5	42	13	46		22	75	P	P		20								9	27	40			P		40.	1.6	5.4
22, CC	P	30	6	65		P	98		P		Tr							Tr	5	48	44						.9	8.3
23-2, 68	4	40	Tr	59		Tr	100		Tr									Tr	11	59	29						.5	2.7
23, CC	P	5	Tr	95		P	99	Tr		Tr								Tr	8	56	34			Tr		253.	.6	4.5

Core, Section Top of Interval (cm)	% Sand-sized Mat. (>0.063 mm)	% Clastic	% Authig.	% Biog.	% Indet.	% Other Shell Mat.	% Calc. Foss.	% Silic. Foss.	% Fish	% Aren. Benth. Foram	% Plant Debris	% Hystrichosph.	% Coral (C): Bryoz. (B)	% Ostracod	% Pteropod	% Bivalve (B): Gastrop. (G)	% Larvae [Bivalve (B); Benth. Gastrop. (G)]	% Echin.	% Calc. Benth. Foram	% Plankt. Foram Frag.	% Plankt. Foram	% Algae	% Sponge Spic.	% Rad.	% Diatom	Ratio: Plankt. Foram + Frag./Rad.	Ratio: Plankt. Foram/Frag.	Ratio: Plankt. Foram/Benth. Foram
Hole 232A																												
24-1, 35	5	95	Tr	4		7	91	3	5	Tr	Tr					TrG		Tr	28	40	31		P	P		51.	.8	1.1
24, CC	15	98	Tr	Tr		27	71	P	Tr		26								15	36	20		22				.6	1.4
29, CC	3	19	P	80			100												9	47	44						.9	5.
Hole 233																												
1, CC	18			100		Tr	83	16		Tr	Tr							Tr	3	40	40			16		4.4	1.	12.
2-2, 83	37	21		79		Tr	99		Tr	Tr									4	36	58						1.6	13.
2-4, 10	37	26		74		Tr	98	Tr	P									P	4	68	25			Tr		154.	.4	6.
2, CC			3	97			88	12										Tr	3	65	20		P	11		7.7	.3	6.4
3-2, 30	67	4		97		Tr	100				Tr							Tr	5	16	77						4.8	14.
3-2, 98	29	18	Tr	82		P	92	6			P								3	57	32		Tr	5		17.	.6	9.3
3-3, 40-65		17	P	81		Tr	40	60	Tr									Tr	6	19	14		P	58		.6	.7	2.5
3-4, 81	19	5	Tr	95		Tr	91	8			Tr								5	35	51		Tr	8		11.	1.5	9.9
3, CC	23	8		92			81	19										Tr	6	37	38		P	17		4.4	1.1	6.5
4-2, 53		89	Tr	10		4	7	89	P			Tr							7	Tr			P	68		.08		
4-2, 109	29	11		89		Tr	96	P	Tr									Tr	4	26	67		Tr	P		46.	2.6	19.
4-3, 111	26	33		67		P	91	8	P										7	59	25			7		11.	.4	3.9
4-3, 121	10	70	Tr	29			41	60											4	34	P		P	55	P	.7	.08	.7
4, CC	9	P	Tr	97		Tr	73	27	Tr		Tr							Tr	6	56	9		Tr	26	Tr	2.5	.2	1.6
5-2, 30	18	27		73			90	10	Tr					Tr				Tr	10	57	22			10		9.2	.4	2.3
5-2, 39		37	P	60		P	29	70	P										16	8	5		5	66		.2	.6	.3
5-4, 33	15	12	Tr	7		Tr	96	3	Tr										P	35	58			3		29.	1.6	21.
5, CC	10	19		81		P	63	36	P										5	46	12		3	29	3	2.	.3	2.2
6, CC	15	2	Tr	97		Tr	84	15	Tr									P	9	34	40		Tr	14		5.1	1.2	4.6
7-2, 47		95	Tr	4		P	5	93	P		Tr							Tr	P	P	Tr		P	91		.02	.7	.3
7-3, 82	9	89	Tr	10		4	30	66	4									Tr	P	25	P		Tr	64	Tr	.4	.07	.6
7-5, 22	15	20	Tr	80			93	7										Tr	15	49	28		P	5		15.	.6	1.9
9-4, 70	8	40	Tr	59			80	20										P	11	40	19			20		3.4	.4	1.8
9, CC	7	14	Tr	85		Tr	53	46	Tr	Tr								P	16	31	5		P	43		.8	.2	.3
10-2, 82	7	28	Tr	71		P	55	42	P									P	9	39	6		P	41		1.1	.1	.7
10-4, 81	7	73	Tr	26			73	27									pB		26	40	6		P	26		1.8	.1	.2
10, CC	4	7	P	91			59	41						Tr				Tr	12	45	P		P	39		1.2	.04	.2
11-2, 81	7	5		95		Tr	8	91	Tr									Tr	P	P	P		P	66	23	.06	1.	.8
11-4, 82	8	70		30		P	26	71	P									Tr	14	11	Tr		P	69		.2	.07	.05
11, CC		6	P	93		P	61	36	Tr		P		Tr					Tr	6	40	14		Tr	36		1.5	.3	2.4
13-4, 81	6	47	Tr	52		P	46	52	P	Tr			Tr					Tr	11	26	8		Tr	51		.7	.3	.3
13, CC	4	14	6	80		P	17	81	Tr	P			Tr					Tr	8	7	P		4	76	Tr	.1	.3	.3
18-2, 81	5	95	Tr	4		P	16	83	P					Tr		TrB			8	5	Tr		3	80		.08	.1	.1
18-4, 93	8	Tr		99			P	97								TrB		Tr	Tr	Tr	Tr		Tr		97		.5	.3
18, CC	6	61	4	35		3	33	64	P	P									14	12	8			62	P	.3	.6	.6
19-4, 81	6	95	Tr	4		P	13	86				P						Tr	4	6	P		P	84		.09	.3	.6
Hole 233A																												
1-3, 81		35	Tr	65		3	20	77	P		Tr	Tr							8	11	Tr			77		.01	.06	.08
2, CC	9	63	3	34		3	29	68	P		P		P						6	17	6		10	58		.4	.3	1.
3-4, 102	4	27	Tr	73		P	18	82	Tr		Tr								4	8	7		P	79		.2	.8	1.9
4-4, 27	6	21		79		4	15	82	3	Tr									3	8	3		P	47	33	.2	.4	1.
7-4, 59	3	94	Tr	5	P	10	59	30	9		P		P					10	26	17	6		19	11		2.1	.3	.2
Site 234																												
1-0, 0-10	15	50		50		6	52	43	4	P								P	8	43			12	31		1.4		
1-1, 30	Tr	99		Tr		6	79	15	6										3	76			6	9		8.5		
1-1, 80	6	95	P	3		6	83	11	6									Tr	P	81	Tr		10	P		63.	.004	.3
1-2, 30	4	95		5		63	23	14	63									Tr	Tr	22			13	Tr		1.6		
1-2, 81	24	25		75		Tr	90	9	Tr									Tr	P	79	9		P	8		11.	.1	4.6
1-2, 130	11	95		5		7	67	27	6	P								Tr	7	57	P		15	11		5.3	.04	.4
1-3, 30	6	95	Tr	4		60	8	32	60									Tr	7				32					
1-3, 80	6	98		P	P	61	19	19	59	P	Tr							P	16				18	Tr		36.		
1-4, 80	Tr	25	5	70		8	89	4	8									Tr	12	74	P		Tr	3		22.	.04	.2
1-5, 80	Tr	43	P	55		10	85	6	10									P	12	71	Tr		P	3		21.	.01	.06
1-6, 10	P	29	Tr	70		14	82	4	14									P	16	60	4		P	P		31.	.07	.3
1, CC	Tr	40	P	58	Tr	18	74	8	19									P	15	45	12		Tr	7		8.2	.3	.8
2-2, 80	Tr	70	15	15		96		4	94														P	P				
2-3, 70	Tr	70	5	25		76		24	75		P												13	11				
2-4, 80		75	5	20		87	P	12	86		Tr								Tr	Tr			P	9		.05		
2-5, 80	Tr	70	10	20		81	4	15	81										P		P		9	4	P	.5		1.
2, CC	6	35	5	60		27	52	21	26	Tr									25	17	11		5	17		1.6	.6	.4
3-2, 80	Tr	35	30	35		61		39	60	P													12	28				
3-5, 80	Tr	30	40	30		48		53	48														16	37				
3, CC	Tr	90	5	5		45		55	45														11	44				

Core, Section Top of Interval (cm)	% Sand-sized Mat. (> 0.063 mm)	% Clastic	% Authig.	% Biog.	% Indet.	% Other Shell Mat.	% Calc. Foss.	% Silic. Foss.	% Fish	% Aren. Benth. Foram	% Plant Debris	% Hystrichosph.	% Coral (C); Bryoz. (B)	% Ostracod	% Pteropod	% Bivalve (B); Gastrop. (G)	% Larvae / Benth. Gastrop. (G)	% Echin.	% Calc. Benth. Foram	% Plankt. Foram Frag.	% Plankt. Foram	% Algae	% Sponge Spic.	% Rad.	% Diatom	Ratio: Plankt. Foram + Frag./Rad.	Ratio: Plankt. Foram/Frag.	Ratio: Plankt. Foram/Benth. Foram
Site 234																												
4-2, 80	Tr	80	5	15		68		32	67		Tr	Tr											12	20				
4-5, 80	Tr	70	15	15		71		29	71														4	24				
4, CC	Tr	80	5	15	3	19	9	70	19											3	6		3	67		.1	2.	
5-1, 77	Tr	19	Tr	80		23	77	Tr	23										6	69	P			Tr		141.	.02	.3
5, CC	Tr	15	15	70		30	70	Tr	29	Tr									41	16	12				Tr		.7	.3
6-3, 120	Tr	69	Tr	30		98	P		98		Tr									P								
6, CC	Tr	10	65	25		89	11		89										4	P	4						1.5	1.
7-3, 81	Tr	25		75																								
7, CC	Tr	90	5	5		88	5	8	88										3	P			3	5		.3		
8-2, 60	Tr	20	20	60		99		Tr	99														Tr	Tr				
8-3, 10	Tr	45	54	Tr																								
8, CC	Tr	35	35	30		65	31	4	63	P								6	6	10	9		P	P		13.	.7	1.5
9-1, 39	25	50	50																									
9, CC	Tr	19	Tr	80	Tr	40	60		38	4									52	4	P						.6	.05
10-3, 24	Tr	25	10	65		85	15		85										10	5	P						.3	.2
10, CC	Tr	35	5	60	Tr	17	82		17										Tr	25	42	15					.4	.6
11-2, 85	18	85	5	10		83	17		too few particles																			
11-3, 30	18	70	27	3		80		20	too few particles																			
12-2, 125	Tr	50	Tr	49		84	15	Tr	84											P	8	4		Tr		13.	.4	1.3
12, CC	Tr	85	10	5		82	10	8	82										Tr	5	P	P		7		.5	.7	.3
13-2, 100	Tr		Tr	99		97		P	97														P					
13-3, 78	6	85	15																									
13, CC	Tr	30	35	35		55	46		55										36	5	5						.9	.1
14, CC	Tr	3	P	95		99	P		99											P								
15-3, 105	Tr	90	Tr	9	Tr	94	4	P	94										Tr	P	P		P					
15, CC	Tr	80	5	15		98	P		98	Tr										P	Tr							
Site 235																												
1-1, 90	P	Tr	P	97		Tr	3	97	Tr											P	Tr		P	5	90	.6	.2	
1-2, 80	Tr		Tr	99		P	24	75	Tr		Tr						Tr		Tr	14	8		4	47	25	.5	.6	11.5
1-3, 70	Tr	Tr		99		P	10	87	Tr		P								Tr	7	P		P	29	57	.3	.4	5.
1-4, 80	Tr		Tr	99		Tr	21	78	Tr		Tr								Tr	18	P		6	36	36	.6	.1	6.
1-5, 80	Tr	Tr		99		Tr	10	89			Tr								Tr	6	3		10	30	49	.3	.5	3.5
1-6, 80	Tr	Tr		99		P	12	87			P								Tr	7	4		Tr	30	57	.4	.7	6.5
1, CC	Tr	P		99		P	14	84	Tr		P								Tr	9	4		P	49	33	.3	.5	11.
2-2, 80	P	Tr	Tr	98		Tr	12	88	Tr										Tr	6	5		4	31	53	.5	.8	10.
2-3, 80	P		Tr	99		Tr	14	86	Tr										Tr	8	5		6	56	24	.2	.7	7.
2-4, 80	5			100			23	78											Tr	18	4		P	43	33	.5	.2	4.5
2-5, 80	P	Tr	Tr	98		Tr	7	92			Tr								Tr	4	P		Tr	51	41	.1	.5	7.
2-6, 80	4			99			52	48											P	35	15		P	30	17	1.7	.4	5.4
2, CC	Tr		Tr	99			14	86											13	P			Tr	62	24	.2	.1	
3-2, 90	Tr	Tr	P	97		4	P	93	Tr		3								Tr	P	Tr		Tr	23	69	.1	.3	2.
3-3, 79	34	Tr		99	Tr	P	64	34	P		13				4	Tr[B]			5	29	25		P	30	P	1.8	.9	4.6
3-3, 120	Tr	5	20	75		13	30	57	Tr		Tr								P	26	P		10	28	19	1.	.1	2.
3-4, 80	P	P		98		P	22	76	P		Tr						Tr		P	14	6		4	25	15	.5	.4	3.8
3, CC	51	P		98			59	41						P		Tr[B]			3	26	27		P	45		1.2	1.1	8.2
4-1, 80	P	P		98		Tr	24	75			Tr							Tr	Tr	13	10		3	39	33	.6	.8	
4-2, 110	9	P		99		Tr	6	94										Tr	Tr	4				93	Tr	.05		
4-3, 12	9	Tr		99		Tr	17	82			Tr								Tr	13	4		P	71	8	.2	.3	9.
4-4, 69	Tr	Tr	Tr	98		Tr	12	87	Tr		Tr								Tr	7	4		6	46	36	.3	.6	
4, CC	P	Tr		99		Tr	14	86	Tr		Tr								8	6			6	41	38	.3	.7	
5-1, 63	3			100		Tr	62	37	Tr						Tr			Tr	P	49	9		P	35	Tr	1.7	.2	4.2
5-2, 24	4	3	Tr	96		P	3	96	P										P	Tr			Tr	45		.04	.2	
5-2, 132	3	P	P	96		Tr	73	26	P			Tr		Tr	Tr	Tr[B]		Tr	3	56	13		7	19		3.6	.2	4.
5-3, 60	5	Tr		99		P	92	7	P						Tr		Tr		13	58	18		6	P		47.	.3	1.4
5-3 (scrapings)	7	Tr		99		Tr	86	14	Tr										11	52	23		4	7	P	11.	.5	2.2
5-5, 82	7	Tr	70	29		P	54	45	Tr		Tr								3	27	20		12	33	Tr	1.4	.7	6.1
5-6, 45	19	Tr	Tr	98		Tr	61	39	Tr		Tr								P	52	7		P	37		1.6	.1	4.
5, CC	Tr	10	5	85		14	37	49	Tr		13								P	28	7		20	28	Tr	1.3	.2	2.8
6, CC	Tr	20	20	60		57	28	15	11	Tr	46					Tr		Tr	4	17	7		4	10	Tr	2.4	.4	1.7
7-3, 120	Tr	10	60	30		9	86	5	Tr		8								P	53	31		3	P		45.	.6	16.
7, CC*	Tr	15	5	80		75	24	Tr	6		69								P	18	4			Tr		21.	.2	2.
8-1, 110	Tr	20	60	20		63	17	20	25		39								5	7	5		3	15	P	.8	.8	1.
8, CC*	Tr	20	20	60	Tr	20	50	30	5		15								5	27	19		5	25	Tr	1.8	.7	4.1
9-2, 40	Tr	10	60	30		14	41	45	4		8	P							7	19	15		31	13	P	2.6	.8	2.3
9-2, 80	Tr	15	80	5		6	43	51	4			P							9	28	6		29	23		1.5	.2	.6
9-3, 80-120	Tr	5	50	45		10	88	P	8		P								16	62	11		Tr	P		61.	.2	.7
9-5, 85	Tr	15	75	10		24	32	44	8		16								4	22	6		7	22	15	1.3	.3	1.6
9, CC	Tr	4	Tr	95		P	77	Tr	P		Tr								5	83	13		Tr	Tr		139.	.2	2.6
10-2, 52	Tr	5	85	10		11	44	46	10			Tr								35	8		10	35	Tr	1.3	.2	
10-4, 30	Tr	30	20	50		51	31	17	17		34								7	19	6		5	11	P	2.3	.3	.8
10, CC	Tr	50		50	Tr	22	62	16	21	Tr								Tr	7	36	19		4	12	Tr	4.7	.5	2.8
11-2, 100	P	Tr	Tr	98		Tr	99		Tr		Tr								8	57	33		Tr	Tr		240.	.6	4.
11-4, 90	3	30	40	30		12	33	55	5		7								P	21	10		21	33		.9	.4	
11, CC	Tr	20	30	50		18	41	42	15	Tr	P								18	19	P		3	38	Tr	.6	.1	.1
12-3, 55	Tr	15	60	25		10	31	59	6		P	Tr							Tr	26	5		14	35	10	.9	.2	5.
12, CC	Tr	5	90	5		3	71	25	3										6	30	35		5	21		3.2	1.1	5.9
13-1, 142	18	Tr		99		Tr	98	P	Tr										Tr	81	16		Tr	Tr		226.	.2	19.
13-2, 30 (bulk)	Tr	10		90		44	Tr	55	44											Tr	Tr		9	45		.02	1.	
13, CC	Tr	10	10	80		Tr		96	4										P	57	38		P	P		41.	.7	20.
14-1, 60	Tr	40	5	55		95	P	P	95										P	Tr			Tr	P		.8		
14-2, 72	Tr	Tr		99		P	97	P	P		Tr								P	89	4		Tr	P		132.	.05	1.5
14, CC	Tr	60	10	30		85	11	4	85										5	P	3		P	P		3.8	1.1	.6

Core, Section Top of Interval (cm)	% Sand-sized Mat. (> 0.063 mm)	% Clastic	% Authig.	% Biog.	% Indet.	% Other Shell Mat.	% Calc. Foss.	% Silic. Foss.	% Fish	% Aren. Benth. Foram	% Plant Debris	% Hystrichosph.	% Coral (C); Bryoz. (B)	% Ostracod	% Pteropod	% Bivalve (B); Gastrop. (G)	% Larvae / Benth. Gastrop. (G)	% Echin.	% Calc. Benth. Foram	% Plankt. Foram Frag.	% Plankt. Foram	% Algae	% Sponge Spic.	% Rad.	% Diatom	Ratio: Plankt. Foram + Frag./Rad.	Ratio: Plankt. Foram/Frag.	Ratio: Plankt. Foram/Benth. Foram
Site 235																												
15, CC	Tr	60	Tr	39		13	47	40	11			P		Tr					4	22	21		8	32		1.3	1.	6.
16-1, 120	Tr	70	25	5		55	6	38	55											5	P		4	34		.2	.2	
Site 236																												
1-1, 104	6			100			42	59												38	4		Tr	43	15	1.	.1	
1-2, 10	9			100		Tr	31	68	Tr									Tr	Tr	26	5		P	53	14	.6	.2	6.
1-2, 75	7			100		Tr	9	91	Tr									Tr	Tr	5	3		P	85	5	.1	.6	7.
1-3, 39	6			100			10	90										Tr	Tr	6	3		5	80	5	.1	.5	5.
1-4, 6	5			100		Tr	3	96	Tr	Tr								Tr	Tr	P	P		P	91	4	.03	.2	1.
1, CC	4			100			21	79										Tr	Tr	17	P		P	77		.3	.2	4.
2-1, 70	7			100			38	62											Tr	32	6		3	54	4	.7	.2	19.
2-1, 148	9			100		P	87	12	P									Tr	P	78	6		Tr	11		7.8	.1	2.6
2, CC	9			100		Tr	89	11	Tr					Tr				Tr	P	62	25		Tr	10		8.5	.4	18.
3-1, 36	10			100		Tr	64	35	Tr									Tr	Tr	51	12		P	32	Tr	2.	.2	32.
3-1, 78				100			100											Tr	Tr	64	36						.6	94.
3-2, 55	66		P	98		Tr	99	Tr	Tr					Tr				Tr	4	56	38		Tr				.7	9.1
3-2, 66	81	Tr		100	Tr		99	Tr					TrC					Tr	P	32	63		Tr	Tr		226.	2.	21.
3-2, 78	81		P	99			100	Tr						Tr				Tr	P	44	52			Tr		264.	1.2	18.
3-2, 100				100		Tr	100											Tr		49	50						1.	120.
3-2, 118	11			100		P	98	Tr	P										P	91	6		Tr				.06	3.3
3-3, 11	15	Tr		100		Tr	100	P	Tr									Tr	P	73	23		Tr	Tr		125.	.3	15.
3, CC	11	Tr		100		Tr	98	P	Tr					Tr				Tr	P	66	29			P		78.	.4	12.
4-1, 65	30	Tr	Tr	99	Tr		97	P										P	6	53	37		P	Tr		210.	.7	6.2
4-2, 113	11	Tr		100		Tr	99	Tr	Tr					Tr				Tr	3	76	20		Tr				.3	6.
4-3, 33	57			100			100	Tr										Tr	Tr	43	56		Tr			1.3		94.
4-4, 70	33	Tr		100		Tr	100		Tr										7	62	30						.5	4.1
4-4, 113	P	Tr		100		P	98	Tr	P										4	64	30					252.	.5	7.3
4-5, 101	P	P		99		5	95		5										6	75	15						.2	4.1
4, CC	5			100		Tr	99	Tr	Tr	Tr								Tr	8	49	42			Tr		211.	.9	5.4
5-1, 93	89	4		96	Tr	Tr	99	Tr	Tr				TrB	Tr				Tr	5	18	74			Tr		183.	4.	16.
5-1, 125		Tr		99		5	95	Tr	5										7	74	14		Tr				.2	2.
5-2, 11	3	Tr		100		4	96		4					Tr				Tr	P	91	P						.03	1.5
5-3, 89	86	Tr		99		Tr	100				Tr		TrB	Tr	Tr			Tr	3	5	89	Tr					19.	27.
5-3, 118	Tr	5		95		16	84		16									P	P	68	9						.1	4.
5-4, 62	46	P		98		Tr	100		Tr									Tr	5	30	64						2.2	12.
5-6, 80		Tr		100	Tr	Tr	99		Tr				TrB	Tr				Tr	P	36	59						1.6	26.
5, CC		Tr		100		Tr	99		Tr	Tr								Tr	P	16	80						4.9	37.
6-1, 18	11			100		P	99	Tr	P									Tr	P	82	14			Tr		260.	.2	7.6
6-1, 106	68	Tr		100			100	Tr						Tr				P	14	45	39		Tr				.9	2.8
6-2, 38	13			100		Tr	99	Tr	Tr										P	83	14			Tr		213.	.2	6.
6-3, 74	3			100		48	52		48										P	43	7						.2	2.4
6-3, 134	62			100			100						TrB	Tr				P	11	38	49						1.3	4.7
6-4, 68	72		P	99	Tr	Tr	99		Tr					Tr				P	7	36	54						1.5	7.3
6-5, 40	78		Tr	99			100							Tr				Tr	6	21	73						3.5	12.
6, CC	4			100		P	98		P									Tr	21	36	41		Tr				1.1	1.9
7-1, 68	3	Tr	Tr	98		4	96	Tr	3	Tr								Tr	4	83	8			Tr		213.	.1	1.9
7-2, 70	22			100		Tr	99	P	Tr					Tr				Tr	P	62	33		P				.5	13.
7-3, 58	77		P	99		Tr	99	Tr	Tr									Tr	8	46	45		Tr			1.		5.7
7-4, 80	54	Tr	Tr	99		Tr	98	P	Tr									P	8	69	19		P				.3	2.4
7-5, 35	Tr	5	Tr	94		6	93	Tr	6										5	80	8			Tr		98.	.1	1.5
7-5, 98	62	Tr	Tr	99		Tr	99	Tr	Tr									Tr	9	42	47		Tr				1.1	5.
7-6, 39	58			100		Tr	97	P	Tr									P	P	29	64		P	Tr		238.	2.1	23.
7, CC	14			100		Tr	99		Tr									P	9	54	35						.7	3.9
8-1, 85	61			100		Tr	97	P	Tr									Tr	P	49	49		P				1.	30.
8-2, 114	20	Tr		100			100	Tr										Tr	8	53	38		Tr				.7	4.9
8-3, 22	45			100			95	5										Tr	8	39	46		5				1.2	5.6
8-3, 74	Tr	Tr	Tr	99		7	91	P	7										4	82	4		P				.05	.9
8-4, 43	50	Tr	Tr	99		Tr	98	P	Tr										17	38	41		P	Tr		216.	1.1	2.4
8-4, 106	59			100		Tr	97	P	Tr										P	41	53		P	Tr		223.	1.3	21.
8-5, 146	36			100		P	87	12	P			Tr						Tr	P	56	29		P	6	4	14.	.5	21.
8-6, 66	10			100		P	98	Tr	P			Tr						Tr	10	42	40		Tr				.9	3.8
8, CC	9	Tr	Tr	99		·	100	Tr										Tr	4	52	43		Tr				.8	12.
9-1, 118	6	Tr		100		Tr	97	P	Tr										6	57	34		P				.6	5.5
9-2, 121	42			100			97	3										Tr	11	54	35		3				.7	5.6
9-3, 124	62			100		Tr	94	5	Tr			Tr						Tr	7	50	36		4	Tr		83.	.7	5.4
9-4, 84	65		4	96		Tr	98	P	Tr					Tr				Tr	5	46	45		P	Tr		186.	1.	9.2
9-5, 30	3	P	P	97		22	26	52	22										9	13	4		43	9		.5	.3	.5
10-2, 113	3	Tr		100		Tr	92	7	Tr										6	45	41		5	3		29.	.9	7.3
10-3, 94	4			100		P	94	5	P					Tr					6	59	28		P	P		54.	.5	4.7
10-4, 7	100			100		Tr	98	P	Tr										7	44	47		P	Tr		167.	1.1	6.6
10-5, 77	Tr	Tr		100		5	70	25	5									P	4	62	3		14	12		5.6	.05	.8
10, CC			Tr	99		Tr	99	Tr	Tr	Tr									11	31	53		4	P		57.	1.7	5.
11-1, 65	3		Tr	100		Tr	92	7	Tr										10	48	33		6	P		68.	.7	3.2
11-1, 125	11		P	99		Tr	94	4	Tr										4	70	22		4				.3	5.6
11-2, 88	P	Tr	Tr	99		4	65	31	4										5	44	16		7	24		2.5	.4	3.5
11, CC	Tr		P	98		P	85	14	P										8	15	61		5	9		8.8	4.1	7.4

Core, Section Top of Interval (cm)	% Sand-sized Mat. (> 0.063 mm)	% Clastic	% Authig.	% Biog.	% Indet.	% Other Shell Mat.	% Calc. Foss.	% Silic. Foss.	% Fish	% Aren. Benth. Foram	% Plant Debris	% Hystrichosph.	% Coral (C); Bryoz. (B)	% Ostracod	% Pteropod	% Bivalve (B); Gastrop. (G)	% Larvae / Bivalve (B); Benth. Gastrop. (G)	% Echin.	% Calc. Benth. Foram	% Plankt. Foram Frag.	% Plankt. Foram	% Algae	% Sponge Spic.	% Rad.	% Diatom	Ratio: Plankt. Foram + Frag./Rad.	Ratio: Plankt. Foram/Frag.	Ratio: Plankt. Foram/Benth. Foram
Site 236																												
12-1, 70	52			100		Tr	90	9	Tr										5	57	29		P	7		12.	.5	6.4
12-2, 85	Tr		Tr	100		P	53	46	P	Tr								Tr	P	44	6		18	28		1.8	.1	2.7
12-3, 90	11			100			82	18											5	51	26		10	8		10.	.5	5.9
12-4, 92	55	Tr		100		Tr	95	5	Tr										8	40	47		4	Tr		233.	1.2	6.
12-5, 85	4	Tr		100			85	15											6	30	49		7	8		10.	1.6	8.4
12-6, 46	52			100	Tr	P	80	18	Tr			Tr				TrB		Tr	7	31	41		8	9		7.7	1.3	5.6
12-6, 104	3			100		P	89	9	P										6	29	54		4	6		15.	1.8	8.8
12, CC	7		Tr	100		Tr	86	13	Tr									Tr	7	38	41		6	7		11.	1.1	5.8
13-1, 105	P	P		98		P	71	28	Tr	Tr								Tr	5	52	14		10	17		3.8	.3	3.
13-2, 103	50	P	Tr	98		P	78	21	P										P	26	40		16	5		13.	1.5	3.5
13-2, 120	3			100		Tr	47	53	P										P	38	8		22	31		1.5	.2	6.
13-3, 30	3	Tr		100		Tr	88	11	Tr										4	34	50		9	2		36.	1.5	11.
13-4, 1	62			100			97	P											3	40	54		P	P		66.	1.4	16.
13-5, 98	P			100		P	74	24	P										8	36	31		23	P		52.	.9	4.1
13-6, 47	7			100		P	92	7	P										8	35	49		7	Tr		199.	1.4	5.8
13, CC	Tr	Tr		99		P	92	7	P										P	38	51		P	5		19.	1.3	18.
14-2, 62	4	Tr		99		Tr	99	Tr	Tr										6	52	46		Tr				.9	7.3
14-3, 70	P			100		Tr	99	Tr	Tr					Tr				Tr	11	75	13		Tr				.2	1.3
14, CC	Tr	Tr		100		P	95	4	P					Tr	Tr				12	34	48		4				1.4	3.3
15-2, 62	3	P		99		Tr	100		Tr										Tr	50	49						1.	11.
15-3, 92	Tr	P	Tr	98		6	88	6	6									Tr	5	73	10		6				.1	1.8
15-4, 106	Tr	4		96		19	57	6	19						Tr				11	57	6		5	P		34.	.1	.5
15-5, 145	50			100	Tr	Tr	95	4	Tr						Tr				8	24	63		4				2.7	7.9
15-6, 90	14	Tr		100		Tr	99	Tr	Tr										4	44	50		Tr				1.1	12.
15, CC	P			100		Tr	97	P	Tr										7	26	64		Tr	Tr		94.	2.5	9.6
16-1, 86	Tr	9		91		92	7	P	92										Tr	6	Tr		Tr	P		5.7	.1	1.
16-3, 119	5			100			100											Tr	7	34	59						1.8	8.8
16-5, 110	Tr	3		97		96	4		95	Tr										3	Tr						.3	
16, CC	3	Tr		99			100												5	39	56						1.4	12.
17-3, 114	5	Tr		100		Tr	100		Tr										4	44	52						1.2	14.
17, CC	Tr	P		99		5	95		5										28	28	40						1.4	1.4
18-2, 105	Tr	8	Tr	92		17	83	Tr	17										7	53	23			Tr		147.	.4	3.8
18-4, 100-150	30			100			100	Tr											P	18	80		Tr				4.4	64.
18-4, 120	27	Tr		100			100												6	26	68						2.6	11.
18-5, 83	56	Tr	Tr	99		Tr	98	Tr	Tr									Tr	6	30	62		Tr				2.1	11.
18, CC	Tr	25	Tr	75		50	50	Tr	50										P	29	18			Tr			.6	8.
19-2, 110	Tr			100		59	41		59											41								
19-3, 113	5			100		3	97		3									Tr	6	49	41						.9	6.8
19, CC	Tr	P		98			99	Tr					Tr						41	37	20		Tr				.5	.5
20-2, 110	P			100		Tr	48	52	Tr											25	23		26	26		1.8	.9	
20-4, 138	55	Tr		100			91	9			Tr								8	45	38		9				.8	4.8
20, CC	Tr	Tr		100		17	83	Tr	16	Tr									5	49	28		Tr	Tr		179.	.6	5.4
21-1, 77	P	Tr		100		P	88	11	P									P	P	57	29		8	P		32.	.5	27.
21-3, 58	Tr	P		99		7	93		7										6	56	32						.5	5.6
21-5, 116	43			100			100	Tr										Tr	4	34	61		Tr				1.8	14.
22-1, 130	51	99		Tr			volcanic ash																					
22-3, 125	37			100			80	21											P	62	15		16	4		18.	.2	7.
22, CC	11	33		67			23	77											P	23	9		22	43		.5	.7	5.
23-2, 80	P			100			44	56											5	24	15		22	34		1.1	.6	3.
23-3, 68	4			100			77	23											15	16	46		11	12		5.	2.8	3.
23, CC	Tr	10		90				100															22	78				
24-1, 107	Tr			100		P	26	73	P										5	17	3		14	59	Tr	.3	.2	.6
24-4, 143	15	P		98			64	36											8	22	34		19	17		3.4	1.5	4.2
24-6, 95	3			100			51	50											7	14	30		11	37		1.2	2.2	4.3
24, CC	Tr			100			P	98												P			24	74		.03		
25-2, 77	Tr	Tr		100			38	62										Tr	3	14	20		16	45	Tr	.8	1.4	6.6
25-6, 90	11			100		Tr	70	29	Tr										16	15	39		17	13		4.3	2.6	2.5
25, CC	7			100			18	82											6	4	8		41	37		.3	1.9	1.5
26-2, 39	Tr			100			39	64											18	11	10		28	34	Tr	.6	.9	.5
26-5, 40	Tr	Tr		99		P	40	58	P										Tr	20	19		24	34		1.1	1.	20.
26, CC	Tr			100		Tr	P	97	Tr										Tr		Tr		40	57		.02		
27-2, 144	35	Tr		99		Tr	90	9	Tr										Tr	84	5		8	Tr		96.	.05	5.
27, CC	Tr			100		Tr	74	25	Tr										Tr	42	31		10	15		5.	.7	34.
28, CC	8	P		99		P	61	38	P										Tr	55	5		6	31		1.9	.09	9.
29-1, 76	P	P	Tr	98		P	97	Tr	P										P	88	7		Tr				.07	2.8
29-1, 145	P			100		Tr	99		Tr											96	3						.03	
29, CC	Tr			100		Tr	98	Tr	Tr										P	9	87		Tr				9.5	52.
30-2, 130	6			100		Tr	99		Tr											94	5						.05	
31-2, 70	7			100		P	98		P										P	86	10						.1	6.
31, CC	28		Tr	99			100												Tr	27	72						2.7	120.
32-2, 70	8			100			100												P	72	26						.4	11.
32-3, 50	35			100			100												Tr	37	62						1.7	108.
32, CC	23			100			100													25	75							3.

Core, Section Top of Interval (cm)	% Sand-sized Mat. (> 0.063 mm)	% Clastic	% Authig.	% Biog.	% Indet.	% Other Shell Mat.	% Calc. Foss.	% Silic. Foss.	% Fish	% Aren. Benth. Foram	% Plant Debris	% Hystrichosph.	% Coral (C); Bryoz. (B)	% Ostracod	% Pteropod	% Bivalve (B); Gastrop. (G)	% Larvae; Bivalve (B); Benth. Gastrop. (G)	% Echin.	% Calc. Benth. Foram	% Plankt. Foram Frag.	% Plankt. Foram	% Algae	% Sponge Spic.	% Rad.	% Diatom	Ratio: Plankt. Foram + Frag./Rad.	Ratio: Plankt. Foram/Frag.	Ratio: Plankt. Foram/Benth. Foram
Site 236																												
33-2, 23	42	Tr		99			100												Tr	10	89		Tr				9.3	93.
33-3, 40	36		Tr	100			100	Tr											Tr	13	86		Tr				6.7	200.
33-3, 107	33		Tr	99			99		Tr						Tr				Tr	56	42						.8	54.
Site 237																												
1-1, 73	80			100			100												Tr	9	91						10.	
1-2, 85	78			100			100												Tr	50	50						1.	
1-3, 65	84			100			100												Tr	58	42						.7	
1-4, 85	79			100			100												Tr	62	38						.6	85.
1, CC	56			100			100							Tr				Tr	Tr	40	59						1.5	147.
2-1, 85	92			100			100											Tr	Tr	33	66						2.	153.
2-2, 85	94			100			100			Tr								Tr	Tr	9	90						10.	
2, CC	85			100			100		Tr									Tr	Tr	12	86						7.	259.
3, CC	39			100			100	Tr										Tr		91	9		Tr				.1	
4-1, 85	58			100			100											Tr		44	55						1.3	
4-2, 65	62			100			100			Tr								Tr	Tr	70	30						.4	150.
4-3, 85	58			100			100	Tr		Tr								Tr	Tr	31	67		Tr				2.1	81.
4-4, 85	51			100			100	Tr		Tr								Tr	Tr	38	61		Tr				1.6	187.
4-5, 85	63			100			100			Tr										33	67						2.	
4-6, 85	66			100			100	Tr										Tr	Tr	25	75			Tr		400.	3.	300.
4, CC	63			100			100						Tr	Tr				Tr	P	20	79						4.2	74.
5-1, 85	62			100		Tr	100		Tr									Tr		44	55		Tr				1.3	250.
5-2, 75	62			100			100	Tr										Tr		63	36		Tr				.6	51.
5-3, 85	66			99			99	Tr												13	86		Tr	Tr		241.	6.5	
5-5, 85	61			100			100							Tr				Tr	Tr	25	75						3.	300.
5, CC	75			100			99	Tr										Tr	Tr	32	66		Tr	Tr		293.	2.1	99.
6-1, 85	45			100			98	P											Tr	28	70		Tr	p		70.	2.5	250.
6-2, 85	40			100			89	10	Tr										Tr	50	39		Tr	9		9.4	.8	66.
6-3, 85	41			100		Tr	99	Tr	Tr	Tr									Tr	14	84		Tr	Tr		350.	6.	300.
6-4, 85	48			100		Tr	100		Tr										Tr	11	89						8.	400.
6-5, 85	49			100		Tr	98	P	Tr									Tr	Tr	21	76		Tr	Tr		101.	3.4	119.
6-6, 85	51			100			98	P											Tr	23	76		Tr	P		65.	3.3	500.
6, CC	49			100			99	P											P	44	53		Tr	Tr		96.	1.2	26.
7-1, 85	64			100		Tr	100	Tr	Tr										Tr	20	80			Tr		500.	4.	
7-2, 85	67			100			99	Tr											Tr	40	60			Tr		167.	1.5	300.
7-3, 85	67			100			98	P											5	43	51		Tr	P		71.	1.2	21.
7-4, 85	64			100		Tr	99	Tr	Tr										Tr	20	79			Tr		250.	4.	200.
7-5, 85	62			100		Tr	98	Tr	Tr									P		44	52			Tr		97.	1.2	26.
7-6, 85	62			100		Tr	99	P	Tr									Tr	Tr	41	57		Tr	Tr		111.	1.4	64.
7, CC	62			100		Tr	97	P	Tr										Tr	15	81		Tr	P		49.	5.3	123.
8-1, 85				100		Tr	100	Tr	Tr									Tr	Tr	25	74		Tr	Tr		400.	3.	300.
8-2, 85	61			100			99	Tr	Tr											33	66		Tr	Tr		450.	2.	
8-3, 85	49			100			89	11										Tr	Tr	45	42		Tr	11		8.	.9	50.
8-4, 85	65			100			99	Tr										Tr	Tr	14	85		Tr	Tr		350.	6.	300.
8-5, 85	52	Tr		100		Tr	96	3	Tr									Tr	4	41	50			3		29.	1.2	13.
8-6, 85	56			100			93	7											Tr	52	41		Tr	6		15.	.8	107.
8, CC	62			100		Tr	99	Tr	Tr						Tr				Tr	40	60			Tr		250.	1.5	150.
9-1, 85	55			100		Tr	98	P	Tr									Tr	Tr	33	65			P		75.	2.	200.
9-2, 85	60			100			99	Tr										Tr	Tr	30	70		Tr	Tr		150.	2.3	210.
9-3, 85	59			100			100	Tr								Tr		Tr	Tr	9	90					550.	10.	250.
9-4, 85	60			100			98	P								Tr		P		38	58		Tr	P		49.	1.5	37.
9-5, 85	63			100			100											Tr	Tr	14	85						6.	300.
9-6, 85	59			100			98	P								Tr				38	60		Tr	P		79.	1.6	
9, CC	61			100			99	P											Tr	26	72		Tr	Tr		137.	2.8	201.
10-2, 82	47			100		Tr	99	Tr	Tr	Tr						Tr		Tr	Tr	20	78			Tr		250.	4.	200.
10-5, 85	31			100		Tr	94	6	Tr										Tr	56	38		Tr	5		20.	.7	67.
10, CC	44			100		Tr	88	11	Tr										P	34	52		Tr	11	Tr	8.2	1.5	31.
11-2, 85	51			100		Tr	99	Tr	Tr									Tr	Tr	49	49		Tr	Tr		200.	1.	200.
11-5, 85	52			100		Tr	99	Tr										Tr	Tr	30	69		Tr	Tr		250.	2.3	350.
11, CC	41			100			97	P	Tr									Tr	P	33	61		Tr	P		40.	1.9	32.
12-2, 85	35			100		Tr	98	P	Tr									Tr	Tr	39	58		Tr	P		50.	1.5	150.
12-5, 85	43			100		Tr	97	P	Tr									Tr	Tr	39	58		Tr	P		50.	1.5	300.
12, CC	58			100			97	4										Tr	Tr	24	72			4		28.	3.	103.
13-2, 85	58			100			100	Tr										Tr	Tr	20	80		Tr				4.	400.
13-5, 85	36			100			99	Tr											Tr	44	55		Tr	Tr		250.	1.2	
13, CC	58			100		Tr	100		Tr										Tr	22	77						3.4	195.
14-2, 85	50			100			100	Tr										Tr	Tr	25	74		Tr				3.	300.
14-5, 85	70			100			100											Tr		17	84						5.	
14, CC	60			100			100												Tr	20	80						4.1	167.
15-2, 85	58			100		Tr	100		Tr											40	60						1.5	150.
16-2, 85	41			100		Tr	100		Tr									Tr	Tr	20	79						4.	200.
16-5, 85	50			100		Tr	100		Tr					Tr	Tr			Tr	Tr	9	90						10.	225.
16, CC	48			100			100											Tr	Tr	24	76						3.1	226.

Core, Section Top of Interval (cm)	% Sand-sized Mat. (> 0.063 mm)	% Clastic	% Authig.	% Biog.	% Indet.	% Other Shell Mat.	% Calc. Foss.	% Silic. Foss.	% Fish	% Aren. Benth. Foram	% Plant Debris	% Hystrichosph.	% Coral (C); Bryoz. (B)	% Ostracod	% Pteropod	% Bivalve (B); Gastrop. (G)	% Larvae [Bivalve (B); Benth. Gastrop. (G)]	% Echin.	% Calc. Benth. Foram	% Plankt. Foram Frag.	% Plankt. Foram	% Algae	% Sponge Spic.	% Rad.	% Diatom	Ratio: Plankt. Foram + Frag./Rad.	Ratio: Plankt. Foram/Frag.	Ratio: Plankt. Foram/Benth. Foram
Site 237																												
17-2, 85	39			100		Tr	100		Tr										Tr	49	50						1.	60.
17-5, 90				100		Tr	100												Tr	49	50						1.	61.
17, CC				100			100	Tr					Tr					Tr		10	89			Tr		26.	9.	
18-2, 85	60			100		Tr	99	Tr					Tr					Tr	Tr	35	64		Tr				1.8	144.
18-5, 85	57			100		Tr	100	Tr					Tr					Tr	Tr	30	69		Tr				2.3	350.
18, CC	50			100			100													15	85							5.6
19-2, 85	43			100		Tr	100		Tr									Tr	Tr	20	79						4.	400.
19-5, 85	51			100		Tr	99	Tr	Tr				Tr					Tr	Tr	11	87		Tr				8.	400.
19, CC	43			100		Tr	100	Tr	Tr									Tr		18	81			Tr		299.	4.5	299.
20-2, 85	42			100		Tr	100		Tr									Tr	Tr	26	73						2.8	105.
20-5, 85	36			100			100											Tr	Tr	14	85						6.	150.
20, CC	34			100		Tr	99	Tr	Tr										P	16	82			Tr		195.	5.1	65.
21-2, 85	29			100		Tr	99	Tr	Tr	Tr								Tr	Tr	20	80		Tr				4.	400.
21-5, 85	26			100		Tr	100		Tr									Tr	Tr	17	82						5.	167.
21, CC	27			100		Tr	100		Tr									Tr	Tr	34	65						1.9	131.
22-2, 85	25			100		Tr	100	Tr	Tr										Tr	30	69		Tr			350.	2.3	70.
22, CC	20			100		Tr	100		Tr				Tr						4	60	36						.6	9.
23-2, 85	6			100		Tr	99		Tr				Tr						7	58	35		Tr				.6	5.
23-5, 85	6			100		Tr	99	Tr	Tr	Tr			P						Tr	88	10		Tr				.1	17.
23, CC	9			100		P	97	Tr	P				Tr					Tr	3	80	13		Tr				.2	3.9
24-2, 85	5			100		P	96	P	P										4	73	19		Tr	Tr		24.	.3	4.7
24, CC				100		Tr	98	Tr	Tr				Tr					Tr	5	48	45			Tr		55.	1.	10.
25-5, 85	7			100			4	96												Tr	4		9	87		.04	4.	
25, CC				100	Tr		5	95											P		3		5	90		.03	1.5	
26-2, 85	5			100		Tr	12	88	Tr											10	P		8	80		.2	.2	
26, CC	48			100			P	99					Tr								Tr			99		.01		
27-2, 90	10			100			10	90												P	8		4	86		.1	3.2	
27, CC	12			100			P	98											Tr	P	Tr		P	97		.01		
28-2, 95	12			100		Tr	17	83	Tr				Tr						P	P	12		8	75		.2	4.4	6.7
28-5, 85	14			100			8	92					Tr							Tr	7		21	71		.1	10.	
29-2, 60	14			100			5	95												Tr	4		9	86		.06	5.	
29-2, 95	19	Tr		100		Tr	8	92	Tr										Tr	P	7		5	87		.09	5.	69.
29-5, 95	9			100			9	91												Tr	8		18	73		.1	8.8	
30-2, 75	12			100			5	95												Tr	4		9	86		.06	5.	
30-5, 110	9			100			5	95											Tr	Tr	4		16	79		.06	5.	25.
31-1, 80	10			100		Tr	5	95	Tr				Tr						Tr	Tr	4		19	76		.05	10.	20.
32-3, 40	7			100		Tr	6	94	Tr				Tr							Tr	5		19	75		.08	5.	
32-5, 65	6			100		Tr	53	46	Tr				Tr				Tr		P	9	41		8	38		1.3	4.7	15.
32, CC	16			100		Tr	99	Tr	Tr				Tr							46	53		Tr	Tr		315.	1.1	
36-1, 130	10			100		Tr	99	Tr	Tr									Tr	Tr	62	37			Tr		200.	.6	150.
37-1, 130	13			100			99	Tr	Tr											69	30		Tr	Tr		75.	.4	
38-1, 90	15	Tr		99		Tr	98	P	Tr									Tr	Tr	78	20		Tr	Tr		20.	.3	100.
41-1, 70	35			100			100	Tr											Tr	79	20		Tr	Tr		500.	.3	33.
44-2, 95			P	97		Tr	97	P	Tr									Tr	Tr	72	24		P				.3	25.
44-3, 90	35	P	P	96		Tr	99	P	Tr								Tr	Tr	P	39	58		P				1.5	38.
45-1, 70	41	Tr	Tr	99		Tr	100	Tr	Tr									Tr	4	48	47		Tr				1.	12.
47-2, 120	35	P	P	97		P	98	Tr	P										3	63	32		Tr				.5	10.
50-1, 75	18	Tr		100		P	99		Tr	Tr		Tr	Tr						P	71	25						.4	14.
60 (Decant)	10	5	P	94		Tr	100		Tr										P	73	24						.3	10.
62, CC (Decant)	70	Tr	Tr	99			100	Tr											Tr	96	4		Tr				.04	6.
Site 238																												
1-1, 75	69			100			100												Tr	80	20						.3	50.
1-2, 85	71			100		Tr	98	P	Tr									Tr	Tr	39	58		P			50.	1.5	150.
1-3, 85	71		Tr	99			100	Tr										Tr	Tr	10	90		Tr			450.	9.	225.
1-4, 90	51			100			79	21										Tr	Tr	30	49		Tr	20	Tr	4.	1.7	250.
1-5, 75	36			100			67	33												40	27		Tr	27	7	2.5	.7	
1-6, 85	7			100			73	28											Tr	54	18		Tr	9	18	8.	.3	100.
1, CC	24			100			37	63											Tr	28	9		Tr	52	11	.7	.3	25.
2-1, 90	35			100			P	99											Tr	Tr	Tr		9	89		.1	5.	10.
2-2, 85	39			100			49	51											Tr	39	10	P	10	39		5.	.3	25.
2-3, 90	7			100			65	35											Tr	32	32		32	3		2.	1.	100.
2-4, 105	74			100			99	P										Tr	Tr	74	25		Tr	Tr	Tr	100.	.3	
2-6, 75	47			100			92	8											Tr	71	21		Tr	7	Tr	13.	.3	150.
2, CC	40			100		Tr	90	10	Tr										Tr	34	56		Tr	9		10.	1.7	83.
3-1, 85				100		Tr	83	17	Tr										Tr	58	25		Tr	13	3	6.3	.4	75.
3-3, 85	35			100			83	17											Tr	66	17			13	3	6.3	.3	50.
3-5, 85	57			100			82	18											Tr	53	29		Tr	12	6	5.	.6	250.

Core, Section Top of Interval (cm)	% Sand-sized Mat. (> 0.063 mm)	% Clastic	% Authig.	% Biog.	% Indet.	% Other Shell Mat.	% Calc. Foss.	% Silic. Foss.	% Fish	% Aren. Benth. Foram	% Plant Debris	% Hystrichosph.	% Coral (C); Bryoz. (B)	% Ostracod	% Pteropod	% Bivalve (B); Gastrop. (G)	% Larvae (Bivalve B / Benth. Gastrop. G)	% Echin.	% Calc. Benth. Foram	% Plankt. Foram Frag.	% Plankt. Foram	% Algae	% Sponge Spic.	% Rad.	% Diatom	Ratio: Plankt. Foram + Frag/Rad.	Ratio: Plankt. Foram/Frag.	Ratio: Plankt. Foram/Benth. Foram
Site 238																												
4-1, 85	48			100		Tr	89	11	Tr										Tr	36	53			9	P	10.	1.5	300.
4-3, 108	47			100		Tr	96	4	Tr										Tr	57	38		Tr	4	Tr	25.	.7	200.
4-5, 84	38			100			91	9												76	15		Tr	8	P	12.	.3	
4, CC	36			100		Tr	97	P	Tr										Tr	48	48		Tr	P	Tr	50.	1.	125.
5-2, 78	58			100			90	10											Tr	63	27			9	Tr	10.	.4	75.
5-4, 23	48			100			27	73											Tr	P	24		Tr	24	48	1.1	10.	100.
6-1, 90	34			100			83	17											Tr	69	14		Tr	14	P	6.	.2	100.
6-2, 110	41			100			95	5											Tr	47	47		Tr	5		20.	1.	200.
6-4, 85	31			100			75	25											Tr	50	25		Tr	12	12	6.	.5	100.
6, CC	28	P		99			90	10									Tr		P	30	58		Tr	9		10.	2.	40.
7-3, 80	39			100			86	14											Tr	55	31		Tr	9	5	9.2	.6	200.
7-5, 120	42			100			90	10											Tr	40	50		Tr	10		9.	1.3	125.
7, CC	38			100		Tr	90	10	Tr										Tr	30	60		Tr	10		9.	2.	150.
8-2, 85	41			100			94	6											Tr	60	35		Tr	5	Tr	20.	.6	150.
8, CC	40			100		Tr	94	6	Tr										Tr	62	31			6		15.	.5	
9-1, 35	39			100			95	5											Tr	59	35		Tr	5	Tr	20.	.6	150.
9, CC	45			100		Tr	94	6	Tr										Tr	47	47		Tr	6	Tr	17.	1.	250.
10-1, 50	32			100			98	P					Tr						Tr	59	39			P		50.	.7	200.
10-3, 78	35			100		Tr	96	4	Tr											64	32			4		20.	.5	
10-5, 78	41			100			98	P											Tr	39	58		Tr	P	Tr	50.	1.5	300.
10, CC	28			100			98	P											Tr	49	48		Tr	P		50.	1.	250.
11-1, 69	37			100			82	18											Tr	33	49			16	P		1.5	300.
11-3, 84	33			100			90	10											Tr	36	54			9	Tr	10.	1.5	300.
11-5, 100	37			100		Tr	92	7												37	55			6	P	17.	1.5	
11, CC	32			100		Tr	99	P	Tr								Tr		Tr	29	69		Tr	Tr		100.	2.3	175.
12-1, 85	33			100		Tr	95	4	Tr				Tr						P	41	52		Tr	4		23.	1.3	25.
12-3, 85	33			100			88	12											Tr	52	35			9	4	10.	.7	200.
12-5, 80	22			100			82	18											Tr	16	66		Tr	16	Tr	5.	4.	400.
12, CC	24			100		Tr	95	5	Tr										Tr	16	79		Tr	5	Tr	20.	5.	500.
13-1, 50	20			100		Tr	95	5	Tr						Tr				Tr	32	63		Tr	4		23.	2.	300.
13-2, 85	20			100			90	10											Tr	20	70			10		9.	3.5	350.
13-3, 85	16			100		Tr	94	6												39	55			6		15.	1.4	
13-5, 85	28			100			82	18											P	57	24			16	P	5.	.4	15.
13, CC				100			96	P												19	79			P		25.	4.	
14-1, 85	54			100		Tr	100		Tr										Tr	75	25						.3	150.
14-2, 65	67			100			100	Tr												62	37		Tr				.6	
14-3, 85	79			100			100												Tr	9	91					10.		500
14-5, 85	73			100			100													91	9						.1	
14, CC	45			100			99	Tr											Tr	9	90			Tr		110.	10.	500.
15-1, 85	8			100			91	9											Tr	36	54			9		10.	1.5	300.
15-3, 85	27			100			89	11											Tr	44	44		Tr	11		8.	1.	200.
15-5, 90	25			100		Tr	99	Tr	Tr										Tr	20	79		Tr	Tr		17.	4.	400.
15, CC	29			100		Tr	99	P					Tr				Tr		Tr	49	49		Tr	Tr		100.	1.	250.
16-1, 85	23			100			91	9												76	15			8	P	12.	.2	
16-3, 20	28			100		Tr	92	8	Tr										Tr	46	46			7	Tr	13.	1.	100.
16-5, 85	42			100		Tr	100	Tr	Tr									Tr	Tr	60	40						.7	100.
16, CC				100		Tr	99	P	Tr										Tr	37	61		Tr	Tr		100.	1.7	25.
17-1, 85	17			100		Tr	97	P	Tr										Tr	39	58		Tr	P	Tr	50.	1.5	300.
17-3, 85				100		Tr	88	11	Tr	Tr									Tr	66	22			9	P	10.	.3	50.
17-5, 85	29			100			93	7											Tr	62	31			6	Tr	15.	.5	
17, CC	21			100	Tr	Tr	88	11	Tr										Tr	55	33		Tr	11		8.	.6	150.
18-2, 85				100			97	P					Tr						Tr	24	72		Tr	P		40.	3.	100.
18-5, 85	12			100		Tr	96	4	Tr										Tr	43	53		Tr	3		30.	1.3	250.
18, CC				100		Tr	96	4					Tr						Tr	26	69		Tr	4		28.	2.7	200.
19-2, 88	24			100			95	5											Tr	47	47			5		20.	1.	67.
19-5, 85	24			100			89	11												36	54		Tr	9	P	10.	1.5	
19, CC			Tr	100			100											Tr	Tr	9	90						10.	250.
20-2, 85	35			100			98	2	Tr	Tr									Tr	24	73			P		44.	3.	150.
20-5, 85	21			100		Tr	98	P	Tr										Tr	24	73		Tr	P		80.	3.	150.
20, CC	30			100		Tr	99	Tr	Tr									Tr	Tr	44	55		Tr	Tr		225.	1.3	83.
21-2, 85	34			100			99	P											Tr	39	59		Tr	Tr		100.	1.5	150.
21-5, 85	20			100		Tr	78	22	Tr											50	29		Tr	20	P	3.5	.6	
21, CC				100		Tr	80	20	Tr										Tr	45	34			20		4.	.8	40.
22-2, 95	18			100		Tr	90	10	Tr										Tr	59	30			10	Tr	9.	.5	75.
22-5, 85	28			100			94	6											Tr	28	66		Tr	6		17.	2.3	117.
22, CC				100		Tr	97	P	Tr				Tr						Tr	9	87		Tr	P		37.	10.	167.
23-2, 90	21			100			94	6												66	28			6	Tr	17.	.4	
23-5, 85	18			100		Tr	80	20	Tr										Tr	40	40		Tr	20	Tr	4.	1.	200.
23, CC			Tr	100		Tr	98	2	•Tr										Tr	36	62		Tr	P		55.	1.8	175.
24-2, 84	10			100			100	Tr											Tr	20	80		Tr				4.	400.
24-5, 85	38			100			100	Tr											Tr	30	70			Tr		500.	2.3	350.
24, CC			Tr	100			100												Tr	9	91						10.	500.

Core, Section Top of Interval (cm)	% Sand-sized Mat. (>0.063 mm)	% Clastic	% Authig.	% Biog.	% Indet.	% Other Shell Mat.	% Calc. Foss.	% Silic. Foss.	% Fish	% Aren. Benth. Foram	% Plant Debris	% Hystrichosph.	% Coral (C); Bryoz. (B)	% Ostracod	% Pteropod	% Bivalve (B); Gastrop. (G)	% Larvae Bivalve (B); Benth. Gastrop. (G)	% Echin.	% Calc. Benth. Foram	% Plankt. Foram Frag.	% Plankt. Foram	% Algae	% Sponge Spic.	% Rad.	% Diatom	Ratio: Plankt. Foram + Frag./Rad.	Ratio: Plankt. Foram/Frag.	Ratio: Plankt. Foram/Benth. Foram
Site 238																												
25-2, 85	39						100	Tr											Tr	40	60		Tr				1.5	300.
25-5, 85	42						100	Tr											Tr	33	66		Tr				2.	300.
25, CC	45			100	Tr		100	Tr										Tr	Tr	55	44		Tr				.8	200.
26-2, 85	49			100			100	Tr											Tr	28	71		Tr				2.5	125.
26, CC				100	Tr		100		Tr										Tr	25	75						3.	300.
27-2, 75	68			100			100											Tr	Tr	85	14						.2	25.
27-5, 80	26			100			98	P											P	48	48		Tr	P		56.	1.	25.
27, CC				100			98	P											P	19	77		Tr	P		50.	4.	40.
28-2, 85	28			100		Tr	99	Tr	Tr										Tr	40	59		Tr				1.5	150.
28-5, 85	28			100		Tr	99	Tr	Tr										Tr	44	55		Tr	Tr		225.	1.3	63.
28, CC	27			100		Tr	97	P	Tr										Tr	19	77		Tr	P		33.	4.	200.
29-2, 85	26			100		Tr	98	P	Tr										Tr	44	53			P	Tr	55.	1.2	300.
29-5, 85	10			100			99	P											Tr	41	58		Tr	Tr	Tr	150.	1.4	350.
29, CC				100			97	P												37	60		Tr	P		40.	1.7	
30-2, 42	19			100		Tr	97	P	Tr										Tr	58	39		Tr	P		50.	.7	200.
30-3, 85	19			100		Tr	96	4	Tr										Tr	26	70		Tr	4		28.	2.7	400.
30-4, 85	17			100		Tr	97	P	Tr										Tr	36	60		Tr	P		40.	1.7	250.
30-5, 85	14			100			99	P												66	33		Tr	Tr		100.	.5	
30-6, 85	16			100		Tr	99	P	Tr									Tr		30	69		Tr	Tr		100.	2.3	
30, CC				100		Tr	98	P	Tr											24	73		Tr	P		80.	3.	
32-2, 38	17			100		Tr	94	6	Tr										Tr	28	65		Tr	6		17.	2.3	350.
32-2, 60	29			100		Tr	98	P	Tr											41	57		P	Tr		150.	1.4	
32, CC				100		Tr	100	Tr												17	83		Tr				5.	
33-1, 110	20			100			99	Tr					Tr						Tr	30	69		Tr				2.3	350.
33, CC	20			100		Tr	99	Tr	Tr											25	74		Tr				3.	
34-2, 65	9			100		Tr	98	P	Tr										Tr	10	88		Tr	Tr		250.	9.	450.
34-2, 136	42			100		Tr	100		Tr										Tr	66	33						.5	200.
34-4, 74	13			100			97	3												65	32		P	P		90.	.5	
34, CC	9			100		Tr	99	P	Tr											9	90		Tr	Tr		550.	10.	
35-2, 85	38			100		Tr	100		Tr										Tr	33	66						2.	150.
35-5, 52				100		Tr	100		Tr										Tr	20	79						4.	100.
35-5, 75	8			100		Tr	99	Tr	Tr											20	79		Tr	Tr		500.	4.	
36-2, 75	53			100			100											Tr	Tr	83	17						.2	100.
36-5, 25	17			100			99	P											Tr	11	88		Tr	Tr		225.	8.	200.
37-2, 15	36			100		Tr	99	Tr	Tr										Tr	37	62			Tr		400.	1.7	125.
37-5, 85	6		Tr	100		Tr	100	Tr	Tr											20	80		Tr				4.	
37, CC	3		Tr	100		Tr	99	P	Tr										Tr	9	89		Tr	Tr		275.	10.	250.
38-2, 17	19			100		Tr	97	3	Tr										Tr	19	77		P	Tr	Tr	100.	4.	200.
38-5, 75	14			100		Tr	99	P	Tr											27	72		Tr	Tr		275.	2.7	
39-2, 85	13			100			91	9											Tr	27	63		9	Tr		250.	2.3	175.
39-5, 85	16	Tr		100		Tr	100		Tr										Tr	9	90						10.	250.
40-1, 100	8		Tr	100		Tr	99	Tr	Tr										Tr	20	79		Tr				4.	400.
40-2, 75	19			100		Tr	100		Tr										Tr	20	80						4.	
40, CC			Tr	100		Tr	100		Tr								Tr	Tr	Tr	11	88						8.	400.
41-2, 48	18			100		Tr	100		Tr											25	75						3.	
41-5, 90	16			100		Tr	100		Tr							Tr			Tr	9	90						100.	250.
42-2, 75	13			100		Tr	100		Tr											30	70						2.3	
42, CC	6	Tr	Tr	100		Tr	100		Tr										Tr	5	95						20.	500.
43-2, 85	13			100			100												Tr	9	91						10.	500.
43-5, 85	16			100			100												Tr	20	80						4.	400.
44-2, 85	37	Tr		100		Tr	100	Tr	Tr											9	91		Tr				10.	
44-5, 135	43	Tr		100		Tr	100		Tr										Tr	11	89						8.	400.
45-2, 38	13	Tr		100			100												Tr	20	80						4.	400.
45, CC	Tr	Tr	Tr	100		Tr	100	Tr	Tr										Tr	P	98		Tr				50.	400.
46-2, 26	12			100		Tr	100		Tr										Tr	20	79						4.	200.
46, CC	5			100		Tr	100		Tr										Tr	9	91						10.	
47-1, 124	56		Tr	100		Tr	100		Tr										Tr	30	69						2.3	175.
47-2, 35-60	8	P		98		Tr	100		Tr											20	80						4.	
47-3, 42	51	Tr		100			100												Tr	20	80						.8	200.
47, CC				100		Tr	100		Tr										Tr	20	80						10.	500.
48-1, 109	P			100			100												Tr	2	98						25.	500.
48-2, 99	13			100		Tr	100		Tr								Tr		Tr	20	80						25.	500.
48-3, 33	7			100		Tr	100		Tr								Tr			11	88						8.	
48, CC				100		Tr	99	Tr	Tr										Tr	20	79			Tr		167.	4.	200.
49-2, 110	28			100		Tr	100		Tr											9	90						10.	500.
49, CC				100		Tr	100		Tr							Tr				9	90						10.	
50-2, 59	5	Tr		99		Tr	100		Tr											9	91						10.	500.
50-4, 103	8			100		Tr	100		Tr							Tr			Tr	9	90						10.	500.
50, CC	4		Tr	99		Tr	100		Tr							Tr			Tr	9	90						10.	500.
51-2, 100	8			100		Tr	100		Tr											11	89						8.	
51-4, 29	7			100		Tr	100		Tr							Tr			Tr	9	90						10.	225.
51, CC	6	Tr		99			100	Tr								Tr	Tr		Tr	9	90				Tr		10.	500.

Core, Section Top of Interval (cm)	% Sand-sized Mat. (> 0.063 mm)	% Clastic	% Authig.	% Biog.	% Indet.	% Other Shell Mat.	% Calc. Foss.	% Silic. Foss.	% Fish	% Aren. Benth. Foram	% Plant Debris	% Hystrichosph.	% Coral (C); Bryoz. (B)	% Ostracod	% Pteropod	% Bivalve (B); Gastrop. (G)	% Larvae Bivalve (B); Benth. Gastrop. (G)	% Echin.	% Calc. Benth. Foram	% Plankt. Foram Frag.	% Plankt. Foram	% Algae	% Sponge Spic.	% Rad.	% Diatom	Ratio: Plankt. Foram + Frag./Rad.	Ratio: Plankt. Foram/Frag.	Ratio: Plankt. Foram/Benth. Foram
Site 238																												
52-2, 115	7	Tr	Tr	99		Tr	100		Tr										Tr	9	90					10.		225.
52-5, 90	5	Tr		100		Tr	100		Tr										Tr	20	79					4.		100.
52, CC	3	Tr	Tr	100		P	98		P										Tr	29	68					2.3		117.
53-2, 52	78	98		P										Tr					P	20	78					5.		
53-5, 143	5			100		Tr	100		Tr					Tr					P	20	78					4.		40.
53, CC	4	Tr		99		Tr	99		Tr			Tr		Tr					Tr	9	90					10.		500.
54-1, 92	26	70	20	10			100							Tr						20	79					10.		
54-1, 120	6	5		95		Tr	99									Tr			Tr	20	79					4.		80.

APPENDIX B
Smear Slide Data, Leg 24

Core, Section Top of Interval (cm)	% Sand	% Silt	% Clay	% Quartz	% Feldspar	% Mica	% Heavy Min.	% Clay Min.	% Volc. Glass	% Palagonite	% Glauconite	% Pyrite	% Micro Nod.	% Dolorhombs	% Zeolite	% Micarb	% F.chinod.	% Pteropods	% Other Molluscs	% Forams	% Nannos	% Sponge Spic.	% Rads	% Diatoms	% Silicoflag.	% Fish Debris	% Plant Debris	% Other Components
Site 231																												
1-1, 115	5	40	55	2	1		1		2					1		10				5	60	1	1	1		1		
2-2, 72	6	30	65	2	1	1	1					1				2				5	70	1	2	2		1		
2, 00	5	45	50	5	2		2		1			1		2				2		5	60	1	5	1			1	
3-2, 80	10	30	60	5		1	1				1	1		1		2				6	70		1					
3-4, 120	50	25	25	50	1	1						2		1		6	1	5		11	20	1	1			1		
3-4, 140	30	35	35	5	1	1	1					1				20		1		5	50	1	2					
4-2, 54	40	30	30	10		1	1					1		1		10		10		45	20	1	5					
1-2, 120	5	40	55	5		1	2													5	80		1					
5-1, 95	5	40	55	5		2	1		2			2				20				5	50							
5-2, 120	5	45	50	2								2		2		20		1		5	60		2	1				
5-2, 145	70	45	45	20	5	2	5									20		15		15	20	1	1					
5-3, 90	50	25	25	10	2		5							2		30				30	15	2	5					
5-5, 80	5	20	75	5			1							1						5	80		2					
6-1, 105	30	30	40	10		1	1					2				10				20	50	1	2					
6-2, 100	60	20	20	5	2		2							1		20		5	5	30	30	2						
6-2, 147	10	40	50	10			2					2		1						30	40	1	2			1		
6-4, 100	2	40	50	1		2						1		1				5		5	80	1	1					
7-3, 80	5	40	55	2		1	1					1		1				1		5	80	1						
7-3, 102	60	20	20	5								5				20		5	5	30	30							
8-1, 80	10	40	50	5	2	1	1					2				10				5	70	1						
8-2, 80	5	40	50	1								1		1		10				1	80							
8-3, 80	5	45	50	2	1	1	1					1						2			70		2	45		1		
8-4, 91	40	30	30	5	2		1					5		2		5		2		42	30					1		
8-5, 35	40	40	30	20	5		1					5					5			20	30		5			1		
9-2, 90	5	40	55	5	1							2		1						5	80	5	1					
9-5, 90	3	45	52	5	2	2						2		1						5	80	2	1					
10-1, 100	3	40	57	2										2				1		12	80	2	2					
10-4, 80	3	35	62	5	1							1		1						1	80	3	1			1		
11-3, 80	5	45	50	10	1	2						2		2				1		5	70	2	2	10				
12-2, 80	5	40	55	20	1		2		1			1		2				1		5	60	2	1			1		
12-4, 40	5	20	75	20				5	2			2		1						5	50	1	1					
13-3, 80	5	25	70	20	2									1						2	70	2	2					
14-2, 80	2	28	70	5			1					1		1						2	80	1	1					
14-4, 80	5	20	75	5								2		1		10				1	80	2	1					
15-1, 90	5	25	70	20	5		5		5			2		2		5				1	30	2	3					
15-3, 20	40	30	30	10	2		2												1	10	50	1	10					
14-4, 80	3	27	70	5		1			2			5		1							80	1	1					
17-1, 100	3	27	70	20	5		2					5		5						5	50	1	2					
17-2, 100	25	40	35	10			1							30						5	30	2	5					
18-2, 80	5	35	60	5			1					2		1							80		3					
19-2, 44	30	35	35	10	5		5					1		2						20	40	2	10					
19-3, 90	5	35	60	5		1	1					1		1						2	80	1	1					
20-2, 31	50	25	25	1	5		1		90											2	80		1					
20-3, 30	5	35	60	2	2		1					1		2						2	80		2					
21-2, 22	50	30	20	2	2		1		95												80		1					
21-2, 108	40	30	30	50	10		2					5		2		2				20	20		5					
21-4, 100	5	35	60	5	2	1			1			1		2						2	80		1					
22-1, 88	60	25	15	3	2		1		95												90	1	2					
22-5, 40	5	25	70	2	2				2					1							90	1	2					
23-5, 19	5	60	35	2	2			90													5							
24-2, 10	30	40	30	20	10		2					1		2						20	40	1	5					
24-4, 100	5	40	60	5	2		2					2		2						2	80							
25-4, 100	5	30	65	2	1							2		1						2	90		1					
26-4, 75	40	30	30	30	5							5		5						5	40	1	2					
28-4, 80	2	45	53	1	1							1	1		1					1	90		2					
29-4, 100	5	45	50	5	2		1					1	1	1						1	80				1			
30-3, 96	10	40	50	2	1	1	1		1			2	1	1						2	80		2					
31-4, 100	5	30	65	1	1	1	1					2		1						1	90							
32-4, 80	5	45	50	1	1	1						1		1							90	1						
33-5, 100	2	25	70	1		1	1					1		1	1					1	90		1					
34-4, 100	5	25	70	2			2		1					2	1					2	80							
35-2, 80	5	25	70	2	2		1		1			1		1	1						90		1					
36-2, 110	3	30	70				1							1						1	90		1					
37-3, 73	2	25	70	1	1		1		1			2		1	1					1	90		2					
38-3, 100	5	25	70	2			1		1			1		1						1	90		1					
39-3, 100	1	30	70	2		1	2		1			2		1							80	1	1					
40-2, 80	5	30	65	2	1		1					1		2						1	90		1					
41-3, 100	3	27	70	2	1		1					2		2						1	85		1					
42-5, 100	2	28	70	1			1					1		1						1	90		1					
43-5, 100	3	30	65	2		1						1		2						1	85		1					
44-1, 90	5	30	65	5	2		1		1	10		5		1						5	50	1						
45-3, 120	2	20	75		1		1							1						1	90	1	1					
46-6, 90	40	30	30	30	5		1					2		2		5				2	50		2					
47-3, 100	3	27	70	1			1					1		1						1	90	1	1					
48-3, 80	2	20	75	1		1						1								1	90		1					
50-1, 97	30	40	30	15	5	1	3					2								5	50		5					
50-3, 100	3	47	80	2	1				1					2	1					1	90							
51-6, 50	30	35	35	20	5	1	3					5		2	1					5	40	1	3					
52-3, 80	3	27	70	2			1		1			1		1	1					1	90		1					
53-3, 80	2	23	75	1			1		1			1		1	1						90	1						
54-2, 100	2	28	70	1			1					1		1							90	1						
55-2, 80	5	40	60	2			1		1			1		1							90		1					
56-3, 90	3	50	50			1	1					1		1						1	90		1					

Core, Section Top of Interval (cm)	% Sand	% Silt	% Clay	% Quartz	% Feldspar	% Mica	% Heavy Min.	% Clay Min.	% Volc. Glass	% Palagonite	% Glauconite	% Pyrite	% Micro Nod.	% Dolorhombs	% Zeolite	% Micarb	% Echinod.	% Pteropods	% Other Molluscs	% Forams	% Nannos	% Sponge Spic.	% Rads	% Diatoms	% Silicoflag.	% Fish Debris	% Plant Debris	% Other Components
Site 231																												
58-3, 80	3	40	60	2	1							1		1						1	90	1	1					
59-3, 120	5	30	65	1					1			1								1	90		2					
61-4, 80	3	27	70	2	2							5		1							80		1					
62-1, 60	1	25	75	1	1																95							
62-1, 89	2	30	70	1	1																95							
62-1, 130	2	30	70				1		1												95							
Hole 232																												
1-1, 100	5	10	85	2																15	75					2		
2-1, 110	5	15	80	5					1			1								10	75					1		
2-2, 116	5	10	85	2								30								5	55					2		
2-3, 80	5	10	85	5	11															5	80					2		
3-2, 80	5	10	85	2					1			20								5	85					1		
4-4, 74	10	15	75						5			20								20	50					1		
5-2, 80	5	10	85	2								1								10	90					1		
6-4, 76	40	20	40	40	10	5			5											5	40							
6-4, 105	60	10	30	60	5	2						5									30					2		
8-3, 80	55	10	35	5					1											5	85					1		
9-5, 80	30	15	55	40																	60					2		
11-2, 30	5	10	85	5					2					1						5	80		2			2		
12-2, 128	60	10	30	60	5		5													10	20					2		
13-1, 85	25	10	65	15				10												10	70					2		
14-2, 135	15	5	80	10			5														80		2					
14-5, 55	60	15	25	50			20														30							
16-3, 80	10	5	85	5																	80		2			2		
17-3, 80	10	5	85	2										1						5	90		5			3		
17-6, 150	20	10	70	20	5		2					3								5	70							
18-2, 80	10	5	85	5																5	90					2		
18-5, 80	5	10	85	5			2													15	80						2	
19-3, 80				2										1						5	90			2		2		
Hole 232A																												
1-2, 80	5	10	80	2																5	90					2		
1-4, 40	75	15	10	5					90												10					1		
1-5, 25	50	15	35	10			2		60											5	30							
2-3, 80	5	10	85	5										1							90		5					
3-3, 80	5	10	85									1			1						90		5	5				
4-2, 90	5	10	85	2								1								2	90		2	1		2		
4-3, 100	15	10	75	5								3								10	70		5	2				
5-3, 80	5	10	85	2								2								5	90			2				
6-2, 80	5	10	85	2																5	90					2		
6-4, 30	5	10	85	5																80			5	2				
6-5, 75	10	10	80	10			1													5	75		3					
7-1, 72	40	20	40	30		2	5														60					2		
7-5, 92	30	20	50	20			10													3	60					2		
8-5, 150	30	20	50	20			5													5	70							
9-5, 120	10	20	70	3					5			10									80		3			2		
9-6, 118	50	20	30	50			5						2							5	40		2			2		
10-5, 130	5	15	80	1								5								5	90					2		
11-1, 117	20	10	70	10			5					5									85					2		
12-2, 84	5	10	85	5								10								5	80					2		
13-1, 100	5	10	85	5			2					10								2	80							
14-1, 118	80	15	5	80	2	2	5							1						5	5							
15-2, 58	80	15	5	80	2		5													5	5					2		
18-2, 102	40	20	40	40			5								5					5	50					2		
18-3, 80	5	15	80	5								1		1						10	80					2		
19-2, 80	5	15	85	1																5	90		2			2		
20-1, 68	30	20	50	30	2		5													5	60							
21-3, 78	50	20	30	40		3	5					5		1						10	40					2		
21-6, 100	35	25	40	25	2		5		2			5								10	50					2		
22-1, 104	5	15	80	5		2						10									80					2		
22-3, 140	5	15	80	5								5								5	90					2		
23-1, 102	50	30	20	60	3		5					5								5	25							
23-3, 90	5	15	80	3			1													5	90		1					
29-1, 230	5	15	80	5								5									90					2		
Hole 233																												
1-3, 90	15	10	80	5								1								5	90	1	1					
1-4, 140	10	10	85	3																5	90			3				
3-3, 90	15	10	80	5								1								5	80		2	2				
4-3, 172	5	10	85	2					3(1)			1								3	90		2	2				
5-3, 80	5	10	90	2								2									90		2	2				
5-5, 115	15	15	70									2									80							
6-2, 80	5	10	85	2								2	2								90			2				
6-4, 80	5	15	80	5								3									90			2				
7-1, 80	5	25	75	5								1			10						80		2	2				
7-4, 130	5	10	85	5											20						70		2	2				
8-2, 130	5	20	80	5											30					2	70		2	2				

(1)Basalt fragm.

Core, Section Top of Interval (cm)	% Sand	% Silt	% Clay	% Quartz	% Feldspar	% Mica	% Heavy Min.	% Clay Min.	% Volc. Glass	% Palagonite	% Glauconite	% Pyrite	% Micro Nod.	% Dolorhombs	% Zeolite	% Micarb	% Echinod.	% Pteropods	% Other Molluscs	% Forams	% Nannos	% Sponge Spic.	% Rads	% Diatoms	% Silicoflag.	% Fish Debris	% Plant Debris	% Other Components
Hole 233																												
8-4, 130	5	20	80	3								2				20					80		2	2				
9-4, 80	5	10	85	5										2		10					90		2	2				
10-4, 80	5	10	85	3												15					80	1	2	2				
11-4, 80	5	5	90	2										2		10					80	2	2	2				
12-3, 80	2	20	80	3										2		30					70		2	2				
13-3, 80	10	15	80	10										2		40					60	2	2	2				
15-4, 80	5	15	80	2												10					80		10	2				
16-3, 80	5	15	80	2								2		2		10					90		2	2				
18-4, 90	5	25	70	5								2		2		50					60		5	2				
19-5, 70	5	10	85	2												10					90	2	2	2				
Hole 233A																												
1-2, 110	5	15	80	2												10					80	3	5	2				
5-2, 80	2	20	80	5								5		2		40					30	3	5	1				
5-3, 48	70	20	10	60								5		2		30				2	10		2					
7-5, 80	2	15	80	5								5				30					40	2	2					
7, CC	2	35	65									10				50					40							
Hole 234																												
1-1, 30	5	20	75	10				30	2					2							40					1		
1-2, 80	15	15	60	5		20	1									30					40	5	5	2		1		
1-4, 80	2	5	90	3					2					1							90		2					
2-3, 80	2	10	85	3			2	90	1			3												1				
3-2, 80		10	90	3	2			90	5			2																
3-4, 68	1	10	90	3	1	1	1	90	2			3														3		
4-3, 80	1	10	90	10			2	90				1														1		
5-2, 80	1	10	90	5		1	1	80				2		1							15	1				1		
6-2, 80	1	10	85	7		1	3	30						1							60							
7-3, 80		15	80	15		1	2	80			1	1																
8-2, 70	1	10	85	12		1	3	90				1														1		
9-1, 37	1	5	95	5				95	2																	1		
9-1, 82		10	85	10			2	80	1			1									10					1		
10-1, 130		5	95	5		1	1					1		1							95	1						
10-3, 90		7	90	5		1	1					1		1							90	5						
10-4, 100		10	90	10		1	1	80													10							
10, CC		10	90	5		1	1	40	1			1									50					1		
11-1, 100		5	95	5																	95	2						
11-2, 85	50	20	30	5				5	70			1									20							
11-3, 4		10	90	10		1	1	80													10							
11-3, 30	60	10	30	10		3	1	15	50												10							
11, CC		10	90	5	1	1	1	70	2			1									20	1						
12-1, 85		15	80	15		1	2	60	1			1									15							
12-4, 85		10	95	5		1	1	40	1			1									50	1						
13-1, 80		15	85	10		3	1	85																		2		
13-2, 58	1	10	90	5		3	1	90				1										1				1		
13-3, 78	1	70	30	3		2		25	70			2																
14-2, 80		10	90	9		1						1																
15-1, 88	2	15	80	5		1	2	70				2									20							
15-1, 132		10	90	7		2	1	90																		1		
15-3, 110	1	10	90	5		2	2	80				2									10					1		
Hole 234A																												
1-1, 29	1	15	80	15		1	2	80				1																
1-1, 110		15	85	10		1	2	85				2																
Site 235																												
1-1, 80	5	25	70	1			1		1											1	90	1	2	1	4			
1-4, 80	5	25	70	1					1					1							90	1	1	2	1			
2-1, 80	5	30	70						1												90	2	2	3				
2-3, 80	2	30	70				1		1											2	90	2		2	1			
2-5, 80	3	25	70						1											1	95	2	2	2	1			
2, CC	1	25	75	1					1											1	90	2	2	2	1			
3-2, 80	3	25	70	1			1		1					1						1	90	2	1	2	2			
3-3, 75	60	20	20	5					5					1						22	50	2	2	2	1			
4-2, 110	3	30	70	1			1		1												80	2	3	3	1			
5-2, 25	3	30	70	2				90													2	2	2	2	1			
5-2, 83	1	25	75	2																2	90	2	2	2	1			
5-3, 60	20	60	20	3	2		1					1		1		50				7	40	1	1	1	1			
5-6, 90	5	30	65	2				10	2												70	1	2	2	1	1		
7-2, 90		20	80	2			1	70	2												10							
7-4, 90		15	85	2			1							1							95							
8-1, 90	1	15	85				1		1					1					1	1	90			1				
9-2, 100		15	85			1	1													1	95							
9-4, 130	1	15	85	1		1	1		2	90		1								1	2							
9-6, 100		10	10						1			1		1							95			1				
10-2, 100	2	15	85		1		1		1			1								1	90			1				
10-5, 100	1	10	90					70	1			1		1							30							

Core, Section Top of Interval (cm)	% Sand	% Silt	% Clay	% Quartz	% Feldspar	% Mica	% Heavy Min.	% Clay Min.	% Volc. Glass	% Palagonite	% Glauconite	% Pyrite	% Micro Nod (Ni); Fe-ox. (F)	% Dolorhombs	% Zeolite	% Micarb	% Echinod.	% Pteropods	% Other Molluscs	% Forams	% Nannos	% Sponge Spic.	% Rads	% Diatoms	% Silicoflag.	% Fish Debris	% Plant Debris	% Other Components
Site 235																												
11-2, 135		10	90						1			1								1	95		1					
11-3, 40	10	20	70	1				95						1							5							
11-3, 50	2	30	70	1					3			1		2							90		1					
11-3, 55	1	30	70	1					2			1		2							95		1					
12-2, 105	1	20	80	5		1			1												95							
13-1, 140	50	30	20	2					2			5		1		30				25	30							
13-1, 102	50	30	20	2					1			5				30				30	30		2					
13-2, 80	1	30	70	2					1			1		2							95							
14-2, 70		20	80						1			1								1	95							
14, CC	1	20	80	2				90	1			1									5							
15-3, 100		20	80						1					1							95							
16-1, 140	1	10	90	1	1			95													1							
16-1, 143	3	30	70	5				90				2		1						1	1							
Site 236																												
1-2, 72	25	60	15	2																5	5		60	20		2		
1-3, 30	10	50	40	2						1										5	30		50	15		3		
1, CC	5	10	85	2	1															5	80		10	3		1		
2-1, 120	5	20	75									1								5	75		15			1		
2, CC	5	10	85	1						1										10	75		10	1		1		
3-1, 80	5	25	70																	8	90		2					
3-2, 77	30	40	30	1																40	50					2		
3-3, 133	10	20	70	1				40						3		10				10	30		2			2		
4-1, 90	5	15	80	1																5	90					1		
4-1, 145	5	15	80	2				35												10	50							
4-3, 78	50	30	20	2	1							1								60	30							
5-1, 95	50	30	20	1				5												60	30							
5-1, 145	20	40	40					20						2		5				40	30							
5-3, 100	10	25	65					40				3								10	40					1		
6-2, 80	5	10	85	1																5	90							
6-3, 90	5	10	85					25								2				5	60					2		
7-1, 80	5	10	80	2				10				2									80							
8-1, 28	5	10	85	2										1						5	90							
8-4, 35	30	40	30	2												10				40	45							
8-6, 15	50	30	20																	60	35		3					
9-2, 70	5	15	80	2					1											15	80							
9-4, 70	40	30	30											3		10				60	20		5			2		
10-5, 96	10	30	60	1																20	70		5			1		
10-5, 116	10	30	60									2								15	80		2					
11-1, 43	5	10	80									1				1				5	90		2					
12-1, 100	5	10	80									2								5	85		5					
12-3, 89	10	20	70																	12	80		5					
12-4, 90	20	30	50						1											25	65		10					
13-5, 100	20	30	50					3												15	70		10			1		
13-5, 140	15	30	55									10								15	60		10					
14-3, 92	5	10	85			1														5	90					1		
15-1, 90	5	10	85										1F							5	90					1		
15-5, 90	2	15	85						1											5	90		1					
15-6, 14	20	30	50						1											25	70		2			1		
15-6, 102	5	10	85	3				80					5F							5	5					2		
16-2, 80	2	10	88					80	1				2F							5	5					2		
16-3, 110	5	10	85	2				30					1F	1						10	50					1		
17-2, 80	5	10	82	1				20					3F							5	65					1		
18-4, 80	20	30	50										1F							25	70							
19-2, 90		5	95					85					3F		5						2					1		
20-3, 120	30	20	50						1											25	60		10					
20-5, 80		10	90										1F							3	95							
21-6, 140		15	85										2F							5	90							
22-1, 125	5	5	90						1											5	90		3			1		
22-1, 132	70	20	10						80	2			1F							5	10					1		
22-4, 80	2	3	95										1F							5	90							
23-6, 70	80	10	10	5	2				85	1											5							
24-3, 80		5	95																		95		5					
25-3, 90	3	12	85										1F								95		4					
26-5, 30		10	90																	2	95		3					
27-1, 48	15	20	65																	20	75		2					
27-2, 123	5	10	85					5												5	85		3					
28-1, 30	10	15	75																	10	80		5					
29-1, 103	5	10	85					20					1F							5	70							
30-2, 100	10	20	70					20												10	70							
31-1, 80	5	15	80					5												5	90							
32-2, 80	2	8	90											1						3	95		1					
32-2, 140	5	10	85										1F							10	85							
33-1, 100	5	10	85	1				20												15	60							
33-2, 43	5	10	85	1									5F							10	80							
32-2, 68	5	15	80					10					2F							5	80							
33-3, 67	5	15	80					30					10M							5	50							
33-3, 103	10	10	80										3F							10	85							

Core, Section Top of Interval (cm)	% Sand	% Silt	% Clay	% Quartz	% Feldspar	% Mica	% Heavy Min.	% Clay Min.	% Volc. Glass	% Palagonite	% Glauconite	% Pyrite	% Micro Nod (N); Feox. (F)	% Dolorhombs	% Zeolite	% Micarb	% Echinod.	% Pteropods	% Other Molluscs	% Forams	% Nannos	% Sponge Spic.	% Rads	% Diatoms	% Silicoflag.	% Fish Debris	% Plant Debris	% Other Components
Site 237																												
1-1, 80	20	30	50	2								1								40	50		5					
2-2, 80	25	30	45	2																40	50	1	10			2		
4-1, 80	10	25	70	1																25	70	1	10					
5-1, 80	40	30	30	1					1											45	45	1	10	1				
5-2, 5	10	20	70	1			1			1										30	60	1	10		*	1		
6-2, 80	15	10	80	1																25	70	1	5			1		
6-4, 5	20	20	60	1								1								30	60	1	7			1		
7-1, 80	20	20	65	1						1										20	80	1	5			1		
7, CC	20	20	60	1	1															30	60	2	5			1		
8-2, 80	20	20	60	1																30	60	7	1	1	1	1		
9-1, 120	10	20	70	1																25	70	1	5			1		
9, CC	15	25	60	1																30	60	1	10			1		
10-1, 80	30	20	50	1																30	60	1	10	1		1		
10-5, 120	30	20	50	1																25	60	1	10	1		1		
10, CC	10	20	75																	20	70	5	5					
11-3, 52	30	30	40	1	1															30	50	10	1	2				
11, CC	5	20	75																	15	80	1		5	1			
12, CC	10	20	75	1			1			1										15	70	1	5	1		1		
13-3, 100	30	20	50	1		1	1													25	60	1	7	2		1		
13, CC	20	20	60	1						1										20	70	1	10	2		1		
15-1, 80	10	30	60	2					1											15	80		5					
16-1, 80	10	20	70	1																15	80	5		1		1		
16, CC	15	15	60	1			1			1										15	80	5		1		1		
17-1, 80	10	15	80	1			1													15	80	1	3	1		1		
17, CC	15	15	60	2						1										15	80	1	5	2		1		
18-2, 68	15	15	60						1											25	80	1	1	1				
18, CC	2	25	70	1			1			1										20	70	1	3	1				
19, CC	5	10	85							1										15	90	1	1	1		1		
20, CC	5	10	85							1										10	90		2	1				
21-2, 16	3	20	80	1					2											5	90					1		
21, CC	5	10	80																	20	80	1	2					
22-1, 20	10	15	80	1			1		1	1										10	85	3	1					
22, CC	15	10	75						1											15	80	1	2	1				
23-1, 10	10	5	85	1					1											10	85	1	1	1				
23, CC	3	20	80	1						1										5	90	1	1	1		1		
24-1, 10	5	20	75	1																10	90	1	1			1		
24, CC	10	10	80	1																15	85	1	1	1		1		
25-1, 5	15	15	70	1																	90	3	5	5		1		
25, CC	5	10	85						1	1											90	2	3	2		1		
26-1, 85	10	10	85							1											90	5	5	1		1		
26, CC	5	15	80							1										1	90	1	5	3				
27-1, 5	15	15	60						1	1										1	90	5	10	2				
27, CC	15	15	60							1										3	85	5	10			1		
28-1, 100	3	20	75						1											5	85	7	5	5		2		
28-3, 25	15	20	60						2	2			3F							1	85	5	5	5		2		
28, CC	15	15	60																	5	80	5	5	3		2		
29-1, 2	5	20	80						1	1										5	80	3	5	5		1		
29-2, 97	10	20	70						1	7										1	80	5	5	1		1		
29, CC	10	20	70							1										5	80	5	5	5				
30-1, 9	5	15	80																	2	90	2	3	2				
30, CC	15	15	70							1										5	80	5	5	3		1		
31, CC	20	20	60							1										5	80	5	10	5				
32, CC	10	20	70						1	1										10	85	1		3		1		
35, CC	1	20	80						1				1F							3	95			2				
36, CC	3	15	80										1F							3	95			1				
37-2, 105	5	20	75																	3	95					1		
44-2, 100	30	20	55		1		1		1	1			1F							15	80			1		1		
44-2, 125	5	45	50	1	2	1		50	40		1		3F		1						5			3	1	1		
45-2, 5	20	20	60			1			1	1	1									10	80			3	1	1		
46-1, 100	45	20	70		1	1	1		2	1	1		1F							5	90			1	1			
46, CC	20	20	60		1		1			1	1		1F							10	80			3	1	1		
48-1, 80	5	20	75						5			1	1F							5	85			1		1		
49-1, 80	5	20	75						3			3	1F		1					5	85			1	1	1		
51-2, 100	1	30	60	1	1	1			7		1	2	1F							3	90			1	1			
52-2, 85	1	20	80			1	1		5	1	1	2								5	90							
53-2, 80	10	20	70				1		5	1	1	3	1F							15	84					1		
54-1, 100	10	20	70						2	1	3									10	85			1	1	1		
55-1, 125				1							1	1			90						2	1				1		
56-1, 135									1	1					95							1						
59-1, 130									5				10F	7	80						2							
62-1, 50				1					1					2	90					1								
62-2, 5	30	30	40						2		3	3		1	90					1	1							
64-2, 80									5		1	1		1	90					1	1							
66-1, 100				1					3					1	90						3					1		
67-1, 85		40	65							1		1		1	95						1							
67-2, 30	10	30	60						2	1		2		5	90					1								
67-5, 65	10	20	70						1			2		10	85									1		1		
67-5, 175	5	20	80						1	1			3M		95													

Core, Section Top of Interval (cm)	% Sand	% Silt	% Clay	% Quartz	% Feldspar	% Mica	% Heavy Min.	% Clay Min.	% Volc. Glass	% Palagonite	% Glauconite	% Pyrite	% Micro Nod (N); Fe-ox. (F)	% Dolorhombs	% Zeolite	% Micarb	% Echinod.	% Pteropods	% Other Molluscs	% Forams	% Nannos	% Sponge Spic.	% Rads	% Diatoms	% Silicoflag.	% Fish Debris	% Plant Debris	% Other Components
Site 238																												
1-2, 50	20	30	50																	20	80							
1-4, 50	20	30	50																	20	60		20					
2-1, 39	10	30	60																	10	85		2					
2-3, 100	20	30	50										1								20	70							
2-5, 100	20	30	50																	20	75		2	1				
3-3, 100	2	20	75														1				5	90	2	1		1			
4-4, 100	10	30	60																		10	90		1					
4, CC	5	30	65																		10	90		2					
5-3, 125	20	30	50																		10	80	2	2	2	3			
5, CC	5	30	65																		5	90		2	2				
6-3, 100	20	30	50		1																10	90	1	5	1				
7-3, 90	20	30	50																		10	85	1	5	2				
8-3, 100	20	30	50																		15	80	1	5	2				
9-2, 130	20	30	50																		15	80	1	2	1				
10-1, 100	20	30	50																		15	80	1	1	1				
11-3, 100	15	35	50							1											10	80	1	5	1				
11-3, 105	20	30	50																		15	80	1	3	1				
12-4, 100	10	30	60																		10	85	1	1	1	1			
13-3, 100	10	30	60																		10	85	1	2	1	1			
14-1, 50	20	30	50												1						20	80							
14-5, 30	30	30	40												1						30	70		1					
15-2, 118	20	30	50										1								20	80	1	1	1				
15-3, 100	20	30	50							1											10	85	1	2	2				
16-3, 82	10	30	60							1			1								5	90	1	3					
17-2, 84	5	30	65										1								2	90	1	1	2	1			
17-3, 100	10	30	60			1															5	90	1	2	2				
18-3, 100	20	30	50													1					20	75	1	1	1				
18-6, 120	20	30	50																		20	80	1	1					
19-3, 100	25	30	45				1														20	75	1	1	1	1			
20-3, 100	25	30	45																		25	70	1	1	1				
22-3, 22	25	25	50																		20	80	1	1					
22-3, 100	25	30	45																		25	70	1	1	1	1	1		
23-3, 100	20	30	50																		15	80	1	1	1	1			
24-3, 100	10	30	60		1																10	85	1	1					
25-3, 100	10	30	60																		10	90	1						
26-2, 100	5	30	65														5				5	90							
27-3, 10	10	30	60							1			2								5	90		2					
27-4, 100	10	30	60							1											10	85	1	1	1				
28-2, 100	10	30	60	1													5				10	85	1	1		1			
29-2, 100	25	30	45														5				20	75	1	1					
29, CC	30	30	40																		25	70	1	1	1				
30-2, 100	10	30	60																		10	85	1	1					
31, CC	5	30	65										1				5				3	90	1						
32-2, 100	3	25	70														5				3	90	1						
32, CC	5	35	60														5				5	90	1						
33, CC	3	25	70														5				2	90	1						
34-2, 100	2	25	75														5				2	90							
34, CC	3	30	65														5				2	90	1						
35-2, 100	5	30	65														5				3	90	1				1		
35, CC	3	30	70														5				3	90	1						
36-2, 100	5	25	70														5				5	90	1				1		
37-2, 100	3	27	70							1							5				3	90	1						
38-2, 100	2	25	73											1F			5				2	90	1						
39-2, 100	1	25	75							1				1F								95	1	1					
39-5, 100	15	30	55							1				1F			10				10	75	1						
40-2, 100	10	30	60											2F			5				10	75							
41-2, 69	10	30	60											2F		20	10				10	50							
41-2, 100	5	25	70													2					3	95							
41, CC	5	25	70											1F							2	95	1						
42-2, 100	5	25	70											2F		1						90							
43-2, 100	20	20	60													1	5				10	85							
43, CC	10	20	70													1	10				5	80	1						
44-2, 100	20	30	50							1				1F		1	10				10	80							
45-2, 100	3	27	70														5				2	90							
46-2, 100	4	26	70											1F			5				3	90							
47-2, 100	2	28	70													2	2				1	95							
47-3, 107	2	23	75												1	1	5				2	90							
48-2, 100	2	25	70							1						2	2				3	90							
49-2, 100	1	24	75											1F			2				1	95							
50-2, 100	1	20	80											1F		2	2				1	95							
51-2, 100	5	25	70											1F		2	5				1	95							
51-3, 90	15	25	60					30	2				10F		30	20					10			2				
52-2, 100	3	20	75											1F		5	20				1	70							
52-3, 5	20	30	50	5				10	30	10			10F	1		10					5		1					
52-4, 60	5	20	75	1					5				10F		2	5				5	70							
52-4, 90	40	30	30						50				5F			5				1	40							
52-5, 19	50	30	20						90													5						
52-5, 26(1)	25	10	65	3	3				65	20			5F							2	5							
52, CC	3	25	72											1F		1	5				2	90							
53-2, 49	30	40	30					10	40	3				5F							2	40							
53-2, 71	20	40	30					15	40					5F								30							

(1)Light green horizon

Core, Section Top of Interval (cm)	% Sand	% Silt	% Clay	% Quartz	% Feldspar	% Mica	% Heavy Min.	% Clay Min.	% Volc. Glass	% Palagonite	% Glauconite	% Pyrite	% Micro Nod (N); Fe-ox. (F)	% Dolorhombs	% Zeolite	% Micarb	% Echinod.	% Pteropods	% Other Molluscs	% Forams	% Nannos	% Sponge Spic.	% Rads	% Diatoms	% Silicoflag.	% Fish Debris	% Plant Debris	% Other Components
Site 238																												
53-2, 117	20	40	40					20	25	1			10F/5M							2	40							
53-3, 22	25	50	25	2				15	30	3			10F/5M							2	30							
53-3, 46	60	30	10						75				3F							1	15							
53-3, 74	60	20	20	3				5	60				2F							2	25							
53-3, 128	60	30	10						70				5F/3M								20							
53-3, 126[1]	2	23	75					80	5				5F/2M								5							
53-4, 59	5	45	50					15		2			10F/5M		3						60							
53-5, 80	10	50	40							2			3F							10	80							
53, CC	3	27	70						1				1F			3				2	95							
54-1, 48	10	20	70	1			2	5					3F							5	85							
54-1, 84	50	40	10	3	3		1	10		5			10F		50						10							
54-1, 98	30	30	40	2	3			30	40	3			10F							2	5							
54, CC	5	25	70					10	1				2F		5	40				1	50							
55-1, 15	20	20	60					10		2			10F							15	60		1					
60-3, 65						95														1								

[1] Light green horizon

Note: Analyses were made by shipboard sedimentologists D. J. Cronan, V. V. Damiani, D. J. J. Kinsman, and J. Thiede. Grain-size, carbon-carbonate, and X-ray mineralogy data can be found in Appendix I, II, and Chapter 18; this volume, respectively.