39. BIOSTRATIGRAPHIC SUMMARY, DEEP SEA DRILLING PROJECT LEG 63[1]

John A. Barron and Richard Z. Poore, U.S. Geological Survey, Menlo Park, California
and
Reinhard Wolfart, Bundesanstalt fur Geowissenschaften und Rohstoffe, Hannover, F.R. Germany

During Leg 63, eleven holes were drilled at seven sites off California and Mexico (Fig. 1). A primary objective of Leg 63 was to obtain a series of upper Cenozoic stratigraphic sections between southern California and southern Baja California. This north-to-south transect of sections has improved correlation of California microfossil assemblages with the low-latitude planktonic microfossil zones and provides a means for studying fluctuations in the cool-water California Current.

The most valuable sections are from offshore southern California (Sites 467 to 469), northern Baja California (Site 470), and southern Baja California (Site 472). The occurrences of coccoliths, radiolarians, diatoms, and planktonic foraminifers and the resulting biostratigraphic zonation of these sections are summarized in this chapter. For detailed reports, the reader is referred to the individual chapters by Bukry (coccoliths and silicoflagellates), Wolfart (radiolarians), Barron (diatoms), and Poore (planktonic foraminifers) in this volume. Similarly, the reader is referred to the individual site reports for discussion of the largely unfossiliferous hemipelagic sections recovered at Sites 471 and 473.

The biostratigraphic time scale adopted for Leg 63 is shown in Figure 2. This scale is modified slightly from that of Ryan and others (1974) and correlated to the paleomagnetic time scale of La Brecque et al. (1977), as updated by Mankinen and Dalrymple (1979). Middle-latitude coccolith zones are included in the Miocene after Bukry (this volume), and middle- to high-latitude radiolarian zones are added in the Pliocene and Quaternary after Kling (1973). Correlation of the diatom zones follows Barron (1980), except for minor modification (Barron, this volume). The Pliocene/Quaternary boundary is that of Haq et al. (1977), the Miocene/Pliocene boundary is from Cita (1975) and Van Couvering et al. (1976), and the middle/upper Miocene boundary is after Berggren and Van Couvering (1974) and Theyer and Hammond (1974).

This time scale represents an integration of low-latitude zonations (planktonic foraminifers, coccoliths, and radiolarians) with middle- to high-latitude zonations (diatoms, coccoliths, and radiolarians, in part) and serves as a model that can be tested by comparing the various microfossil biostratigraphies in the Leg 63 sections.

Coccoliths are the most consistently occurring planktonic microfossils in Leg 63 sediments and provide biostratigraphical information even where planktonic foraminifers, radiolarians, and diatoms were removed by diagenesis. Low-latitude coccolith zones (Bukry 1971a, 1973a, 1975a) are more easily distinguished in the southern sites, although they also allow fairly refined biostratigraphy in the lower middle and middle middle Miocene and upper Pliocene through Quaternary of the northern sites (Sites 467 to 469). Temperate zones (Bukry, 1973b), which span broader time intervals than do low-latitude zones, are used in the upper middle Miocene through lower Pliocene of Sites 467 and 468 with only minor modification. At Sites 467 to 469 low-diversity temperate assemblages containing sparse and sporadic low-latitude guide taxa are established in the middle Miocene *Discoaster exilis* Zone.

After coccoliths, radiolarians are the next most consistently occurring planktonic microfossil in Leg 63 sediments. Low-latitude zones after Riedel and Sanfilippo (1971, 1978), Moore (1971), and Dinkelman (1973) are integrated with middle- to high-latitude zones after Hays (1970), Kling (1973), and Foreman (1975) to construct the Leg 63 radiolarian zonation (Wolfart, this volume). Low latitude zones are used in the Miocene, whereas middle- to high-latitude zones are employed in the Pliocene and Quaternary. As with coccoliths, low-latitude zones are more easily identified at the southern sites (Sites 470 and 472) and within the middle Miocene than to the north or within the upper Miocene.

Diatoms generally occur in the same sediments as radiolarians but are more susceptible to dissolution. Abundant and diverse diatom assemblages typify the middle and upper Miocene at Sites 469, 470, and 472 and the middle Miocene at Site 468. The middle- to high-latitude North Pacific diatom zonation of Koizumi (1973) as modified by Barron (1980) is applicable, although the absence of the marker taxa *Denticulopsis kamtschatica* in the uppermost Miocene through lower Pliocene necessitates the use of a more local zonation for this interval (Barron, this volume). Warm-water diatom taxa increase in abundance to the south, where the Miocene assemblages of Sites 470 and 472 allow correlation with the low-latitude diatom biostratigraphy of Burckle (1972, 1978) (Barron, this volume).

The record of planktonic foraminifers in Leg 63 sediments is generally disappointing. Dissolution, diagenesis, masking by siliceous and terrigenous material, reworking, and a number of unconformities all contribute to the problem. Planktonic foraminifers are few to abundant in Pliocene and Quaternary sediments and essentially absent from pre-Pliocene sediments recovered

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[1] *Initial Reports of the Deep Sea Drilling Project*, Volume 63.

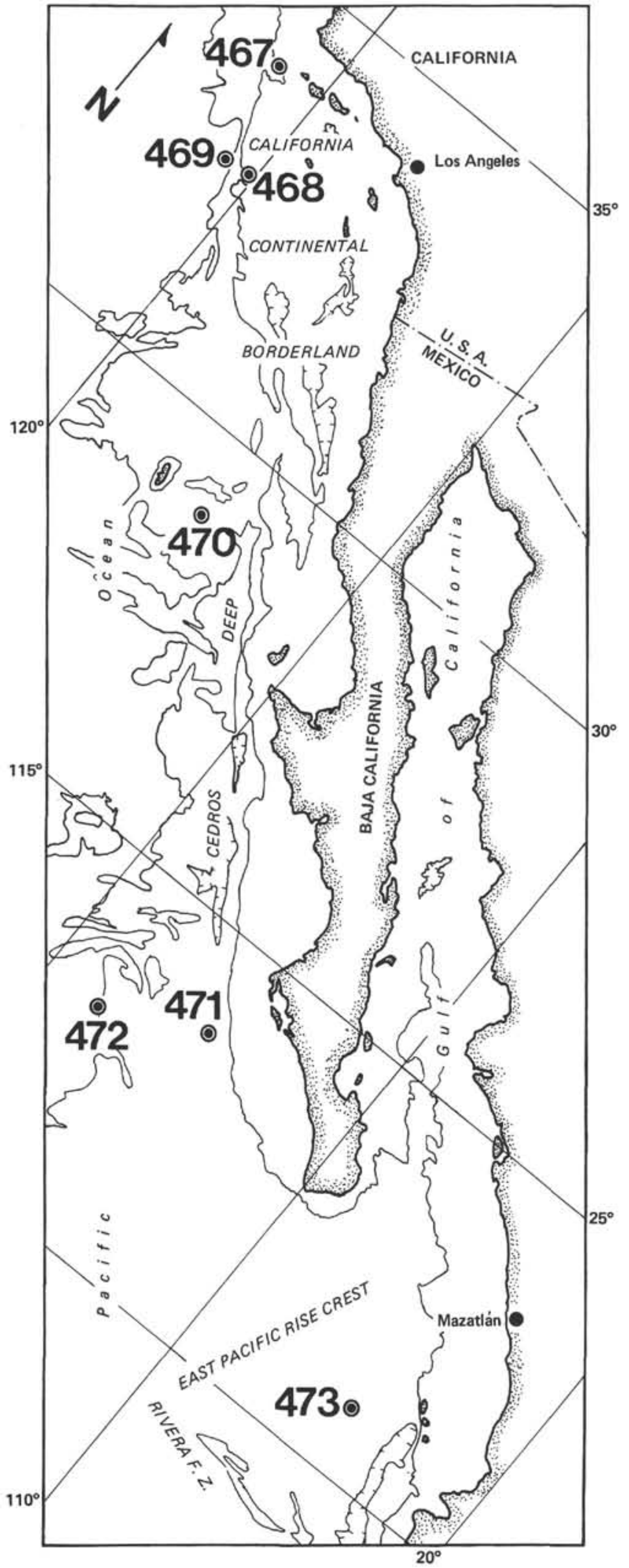


Figure 1. Location of the Leg 63 sites off southern California and Baja California.

from three sites (Sites 467 to 469) in the California Continental Borderland. Species of *Neogloboquadrina* and unkeeled *Globorotalia* are useful for zoning the extratropical Pliocene and Quaternary assemblages from these sites. Planktonic foraminifers are present but typically sparse throughout the middle Miocene through Quaternary sequence recovered at Site 470 near Guadalupe Island. Standard low-latitude zones (Blow, 1969) can be recognized in the subtropical middle Miocene assemblages of Hole 470, whereas extratropical zones must be used in the Pliocene and Quaternary. Upper Miocene assemblages are sparse and only contain long-ranging taxa.

SITE 467

A single hole was drilled at Site 467 (33°50.97′N, 120°45.47′W, 2128 m water depth) to provide a reference section for the San Miguel Gap area of the outer California Continental Borderland. The hole was continuously cored to a sub-bottom depth of 1042 meters, where lower middle Miocene sediment of the *Sphenolithus heteromorphus* Zone (coccolith) was encountered.

The planktonic microfossil zonation for Hole 467 is shown in Figure 3. It is apparent that the uppermost Miocene to Quaternary part of the section (above 500 m sub-bottom depth) can serve as a reference section for coccoliths, radiolarians, and diatoms. The older part of the section is zonable only by coccoliths.

Coccoliths are present in most of the 110 cores recovered at Site 467. Middle Miocene to lowest Pliocene coccoliths are generally few to common and are moderately to poorly preserved. Quaternary and Pliocene (Cores 1–36) coccoliths are abundant and moderately well preserved. Reworked coccoliths from the Eocene occur sparsely in Cores 1 to 9 and in Cores 32 and 42 but are essentially absent in Miocene Cores 47 to 110.

Only a few of the low-latitude coccolith zones and subzones could be specifically identified because of the paucity of low-latitude marker species in the low-diversity assemblages. Recognition of the low-latitude *Sphenolithus heteromorphus* Zone through *Discoaster kugleri* Subzone is possible in the lower part of Hole 467; but cooler, low-diversity assemblages, which occur from Section 1 of Core 90 through Core 56, are only assignable to the long, cool-water *Discoaster variabilis* Zone. Low-diversity uppermost Miocene and lower Pliocene assemblages are difficult to separate into individual zones, but selected samples in the upper Pliocene and Quaternary allow more definitive zonal assignment.

Radiolarian abundance is generally low in the Quaternary through uppermost Miocene sediments recovered at Site 467. Below Core 56, radiolarians are very rare and poorly preserved. The Quaternary and Pliocene radiolarian assemblages resemble those of the subarctic North Pacific, and the zonation of Kling (1973) is applicable. Equatorial taxa, such as *Stichocorys peregrina* and *Cyrtocapsella* ssp., in the uppermost Miocene sediment of Site 467, however, suggest an influence of equatorial waters during that time.

Diatoms are more abundant in the middle and upper Miocene than in the Pliocene and Quaternary sections. Silica diagenesis below a sub-bottom depth of 500 meters removes all except the most resistant and long-ranging diatoms. The middle Pliocene interval from Cores 23 to 36 contains only reworked, fairly resistant middle and upper Miocene diatoms, which usually constitute just a minor component of the diatom assemblage. Middle- to high-latitude diatom zones can be applied in the uppermost Miocene to lowermost Pliocene and in the upper Pliocene through Quaternary section. Diatoms suggest a short hiatus within the lower Quaternary (ca., 0.9–1.4 Ma) at the top or within the upper part of Core 8 (Barron, this volume).

Planktonic foraminifers are common to abundant in Cores 1 through 18 and common to sparse in Cores 19 through 33. Sediments recovered below Core 33 are essentially barren of planktonic foraminifers. Assemblages in Cores 27 through 33 are only diagnostic of bracketed upper Miocene to lower Pliocene Zones N17 through N19. More definitive age assignment, however, can be made in the upper Pliocene through Quaternary by recognition of middle- to high-latitude events in the genus *Neogloboquadrina* (Poore, this volume).

The various microfossil zonal assignments in Hole 467 show little or no discrepancy when compared to the time scale adopted for Leg 63 (Fig. 2).

SITE 468

Three holes were drilled at Site 468 on the Patton Escarpment (Hole 468—32°37.03′N, 120°07.07′W, 1849 m water depth and Holes 468A and 468B—32° 37.41′N, 120°06.55′W, 1737 m water depth) to investigate the tectonic history of the California Continental Borderland and to provide a middle Miocene reference section for the area. Hole 468 was cored continuously to 241 meters sub-bottom depth and was abandoned due to sloughing of middle Miocene volcaniclastic sand and breccia down the hole. Hole 468A was spudded 1.2 km upslope, where the post-Miocene section is thicker, and was continuously cored to 35 meters. Hole 468B at this site was cored to 416 meters sub-bottom depth.

Figures 4 and 5 show the microfossil zonation of Hole 468 and the composite section formed by Holes 468A and 468B. Cores 1 and 2 of Hole 468B overlap with Cores 3 and 4, respectively, of Hole 468A. In both sections, relatively thick middle Miocene intervals are overlain by condensed and partly fragmentary uppermost middle Miocene to Quaternary intervals. The clastic lower parts of both sections cannot be zoned by microfossils. The tectonic implications of these sections are discussed in the Site 468 Report (this volume).

The short Pliocene and Quaternary interval at Site 468 is characterized by warm-water coccoliths and is readily zonable. Most of the cores of the middle Miocene section are barren or contain *Sphenolithus heteromorphus* Zone or *Coccolithus miopelagicus* Subzone coccoliths. The coccoliths are moderately well preserved, and minor overgrowth of specimens occurs only in the middle Miocene.

Radiolarians are generally sparse to few, and preservation is poor to moderate. Quaternary and Pliocene assemblages resemble those described from the northeastern Pacific by Kling (1973); however, the presence of some warm-water species (*Amphirhopalum ypsilon* and *Theocorythium vetulum*) indicates that during the Quaternary it was warmer at Site 468 than at nearby Site 467. Sporadic warm-water radiolarians in the Miocene section permit the use of low-latitude zones and suggest that the upper Miocene is condensed and possibly incomplete.

Nearly equivalent middle Miocene diatomaceous sections ranging from Subzone a of the *Denticulopsis lauta* Zone to Subzone b of the *Denticulopsis hustedtii–D. lauta* Zone are present in Holes 468 and 468B. The top of the diatomaceous sequence is slightly younger in Hole 468B, where Section 4 of Core 3 contains lower upper Miocene diatoms. The relatively thin upper Miocene through Quaternary section contains only sparse diatoms reworked from the middle Miocene. In the diatomaceous section, diatoms are typically common to abundant and are poorly to moderately well preserved.

Planktonic foraminifers are sparse to abundant with moderate to poor preservation in the Pliocene and Quaternary of Holes 468, 468A, and 468B. The middle- to high-latitude stratigraphy for this interval has been developed by Poore (this volume). Miocene assemblages, where present, are typically meager and difficult to zone, an exception being the assemblages of Cores 5 through 9 of Hole 468, which are assigned to Zones N9 to N10.

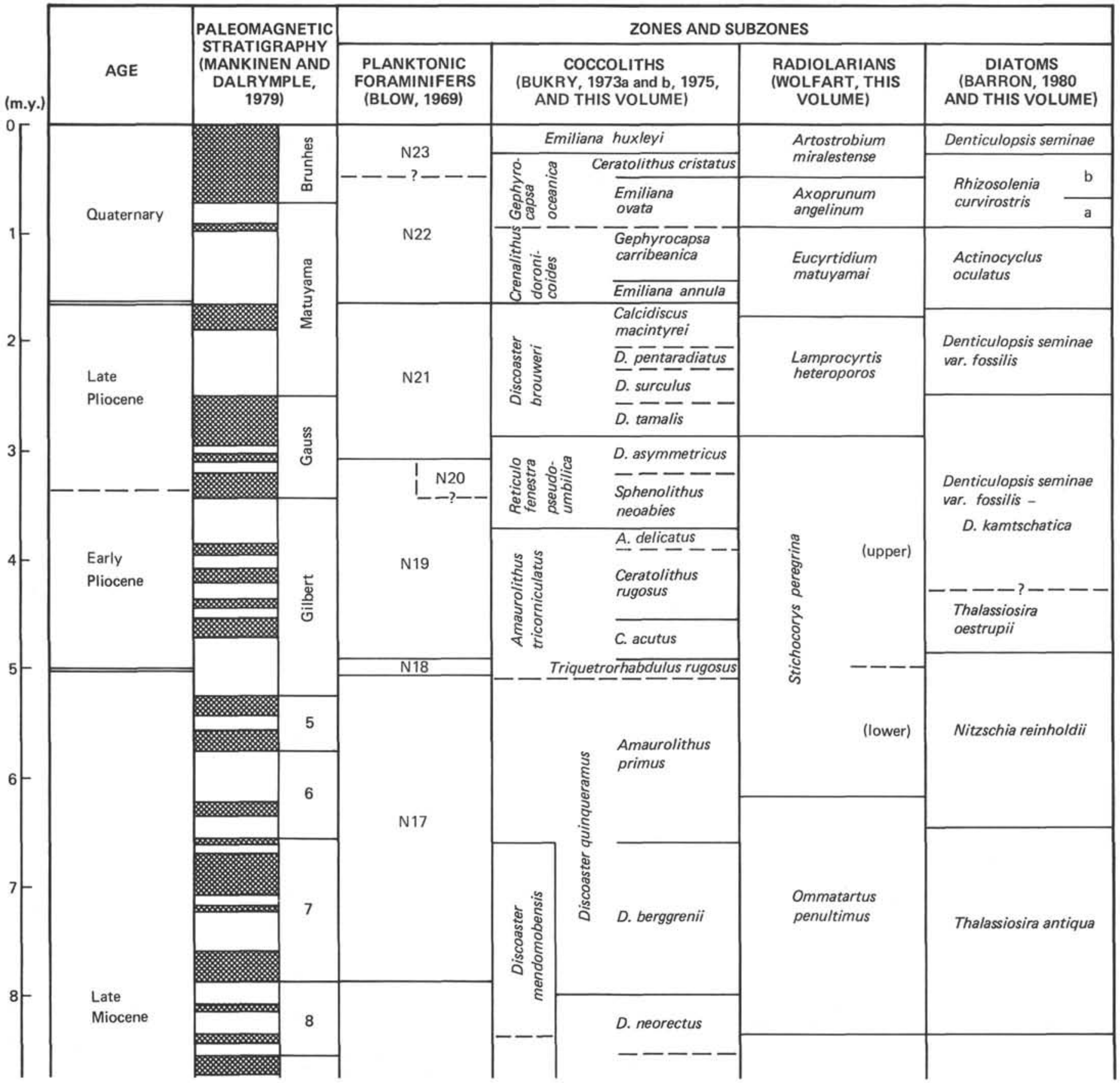
The only significant inconsistency in the microfossil zonal assignments at Site 468 occurs in the interval from Core 6 through Core 9 of Hole 468, where diatoms and planktonic foraminifers indicate a slightly older age than the coccoliths. The coccolith assignment may reflect diagenesis, which could have removed the marker taxon *Sphenolithus heteromorphus* from the assemblage.

SITE 469

A single hole was drilled at Site 469 (32°37.00′N, 120°32.90′W, 3790 m water depth) at the foot of the Patton Escarpment to provide a pelagic reference section for the California Continental Borderland. Hole 469 was continuously cored to 454 meters sub-bottom depth, the lower 60 meters in basement rocks.

The microfossil zonation in Hole 469 is shown in Figure 6. Coccoliths occur throughout the sedimentary section, whereas radiolarians, diatoms, and planktonic foraminifers are confined to successively younger (higher) parts of the section.

The lower Miocene to Quaternary coccolith assemblages at Site 469 are generally diverse, abundant, and moderately well preserved. In contrast to Site 467, warm-water discoasters occur in the lower upper Miocene of Site 469 and allow assignment to low-latitude zones. Upper lower Miocene coccoliths of the *Helicosphaera ampliaperta* Zone immediately above the basement date the time that the Farallon-Pacific ridge


(m.y.)
0
1
2
3
4
5
6
7
8
AGE
PALEOMAGNETIC STRATIGRAPHY (MANKINEN AND DALRYMPLE, 1979)
ZONES AND SUBZONES
PLANKTONIC FORAMINIFERS (BLOW, 1969)
COCCOLITHS (BUKRY, 1973a and b, 1975, AND THIS VOLUME)
RADIOLARIANS (WOLFART, THIS VOLUME)
DIATOMS (BARRON, 1980 AND THIS VOLUME)
Quaternary
Late Pliocene
Early Pliocene
Late Miocene
Brunhes
Matuyama
Gauss
Gilbert
5
6
7
8
N23
?
N22
N21
N20
?
N19
N18
N17
Emiliana huxleyi
Gephyrocapsa oceanica
Ceratolithus cristatus
Emiliana ovata
Crenalithus doronicoides
Gephyrocapsa carribeanica
Emiliana annula
Discoaster brouweri
Calcidiscus macintyrei
D. pentaradiatus
D. surculus
D. tamalis
Reticulofenestra pseudoumbilica
D. asymmetricus
Sphenolithus neoabies
Amaurolithus tricorniculatus
A. delicatus
Ceratolithus rugosus
C. acutus
Triquetrorhabdulus rugosus
Discoaster quinqueramus
Amaurolithus primus
Discoaster mendomobensis
D. berggrenii
D. neorectus
Artostrobium miralestense
Axoprunum angelinum
Eucyrtidium matuyamai
Lamprocyrtis heteroporos
Stichocorys peregrina
(upper)
(lower)
Ommatartus penultimus
Denticulopsis seminae
Rhizosolenia curvirostris
b
a
Actinocyclus oculatus
Denticulopsis seminae var. fossilis
Denticulopsis seminae var. fossilis – D. kamtschatica
?
Thalassiosira oestrupii
Nitzschia reinholdii
Thalassiosira antiqua

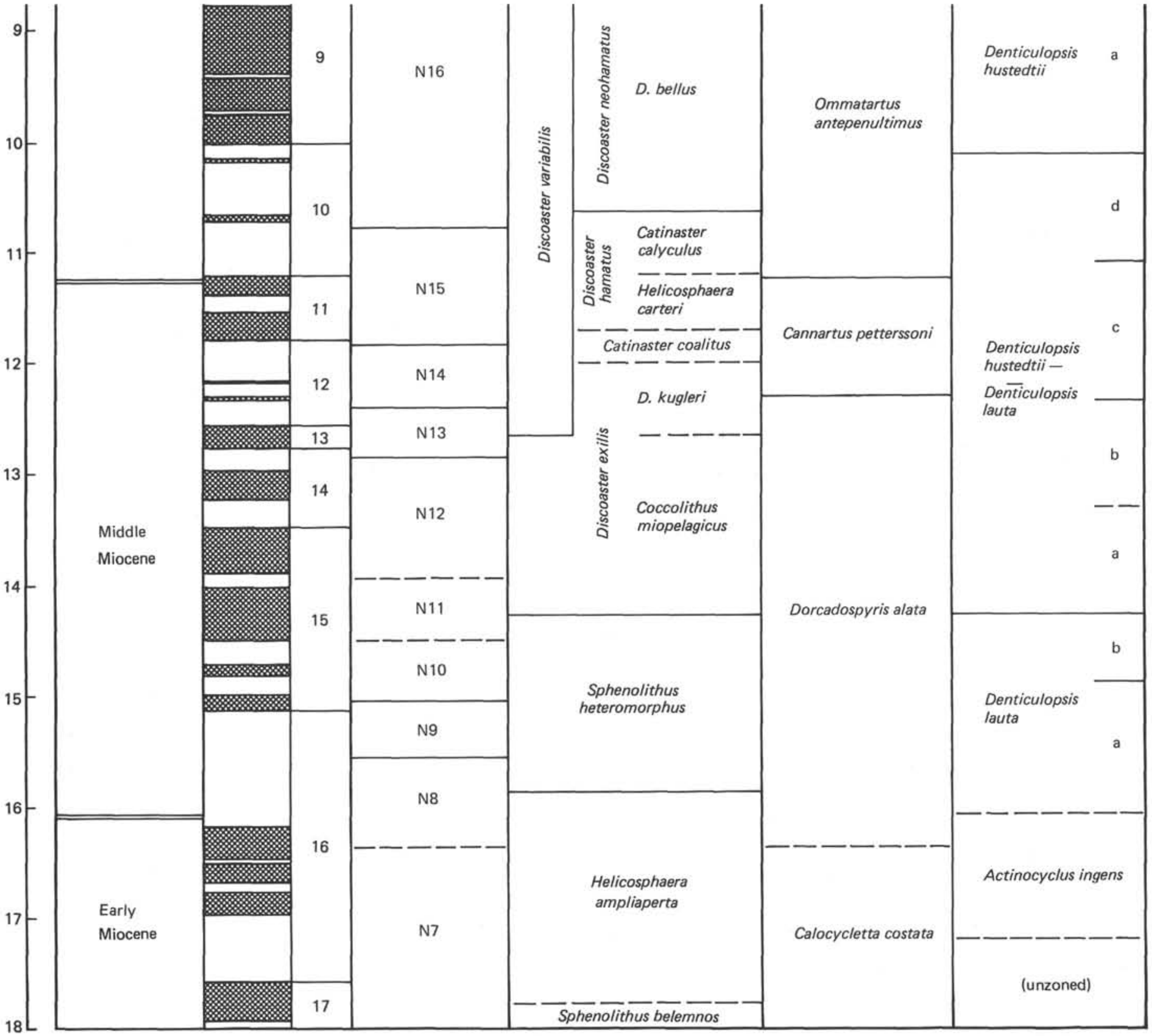
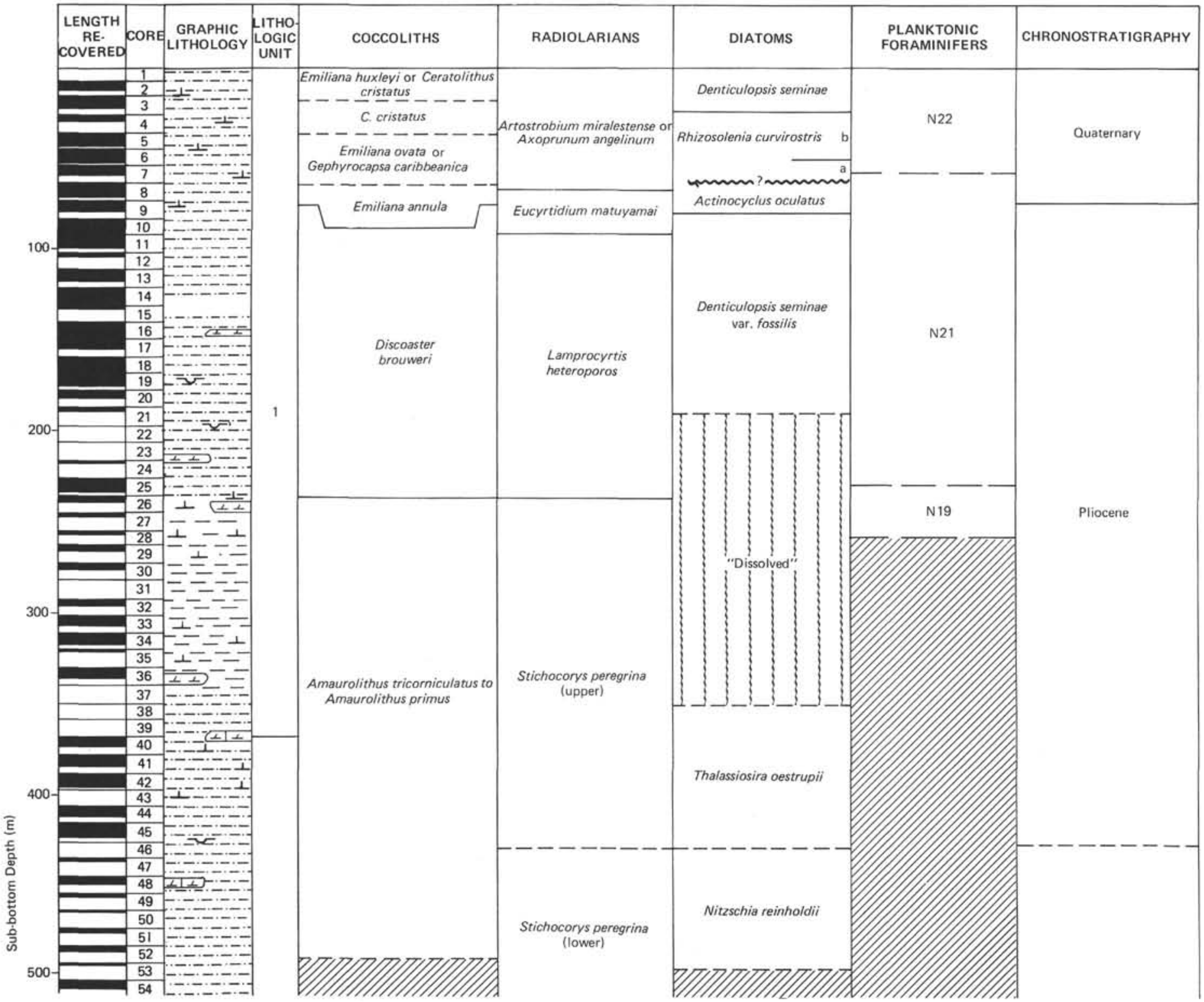


Figure 2. Biostratigraphic framework and time scale used on Leg 63. The diatom genus *Denticulopsis* has recently been erected for marine *Denticula* (Barron, this volume.)


LENGTH RE-COVERED
CORE
GRAPHIC LITHOLOGY
LITHO-LOGIC UNIT
COCCOLITHS
RADIOLARIANS
DIATOMS
PLANKTONIC FORAMINIFERS
CHRONOSTRATIGRAPHY
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
100
200
300
400
500
Sub-bottom Depth (m)
1
Emiliana huxleyi or Ceratolithus cristatus
C. cristatus
Emiliana ovata or Gephyrocapsa caribbeanica
Emiliana annula
Discoaster brouweri
Amaurolithus tricorniculatus to Amaurolithus primus
Artostrobium miralestense or Axoprunum angelinum
Eucyrtidium matuyamai
Lamprocyrtis heteroporos
Stichocorys peregrina (upper)
Stichocorys peregrina (lower)
Denticulopsis seminae
Rhizosolenia curvirostris
b
a
?
Actinocyclus oculatus
Denticulopsis seminae var. fossilis
"Dissolved"
Thalassiosira oestrupii
Nitzschia reinholdii
N22
N21
N19
Quaternary
Pliocene

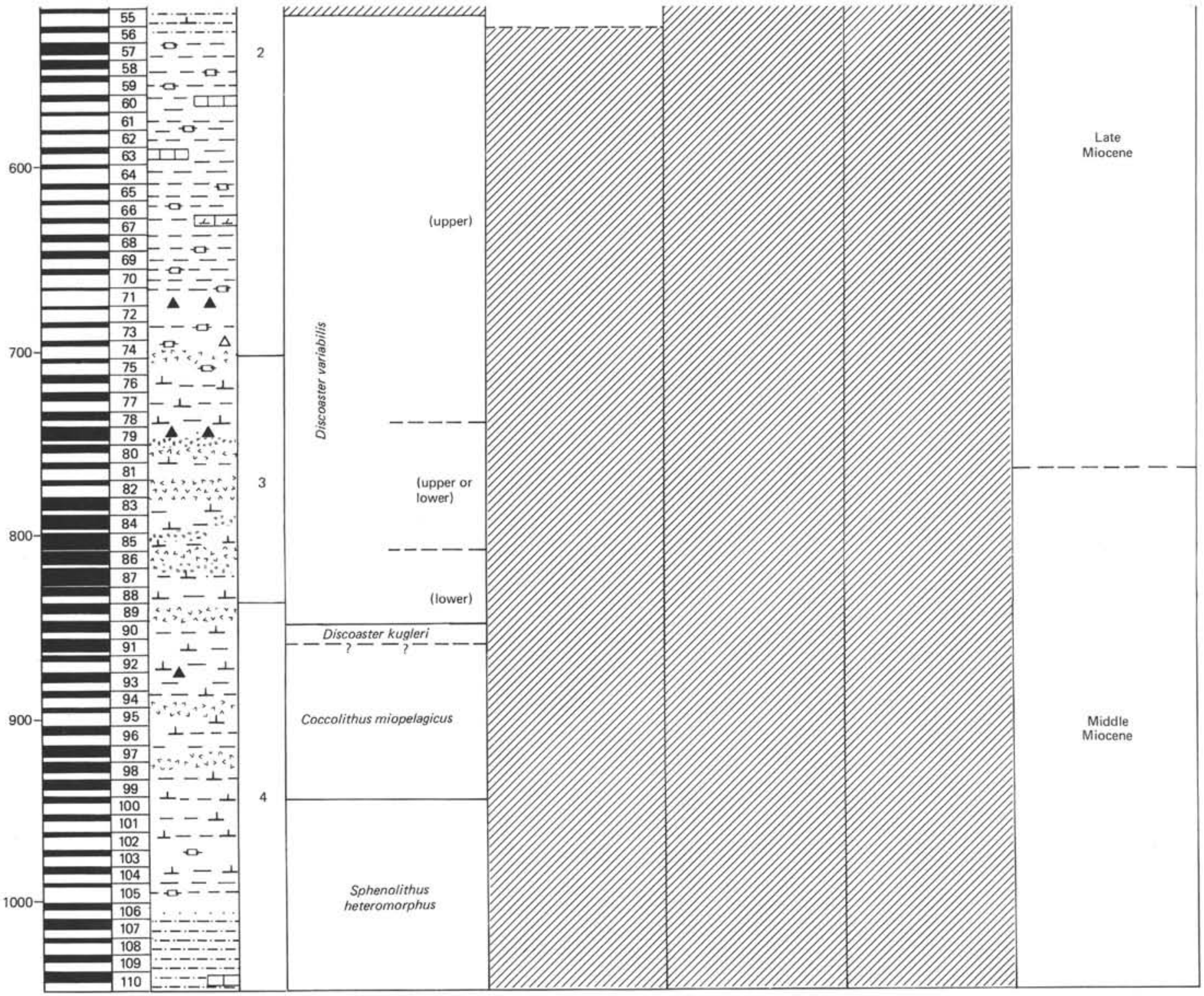


Figure 3. Lithologic and biostratigraphic summary, Hole 467. (See Introduction and Explanatory Notes, Yeats et al., this volume, for lithologic symbols.)

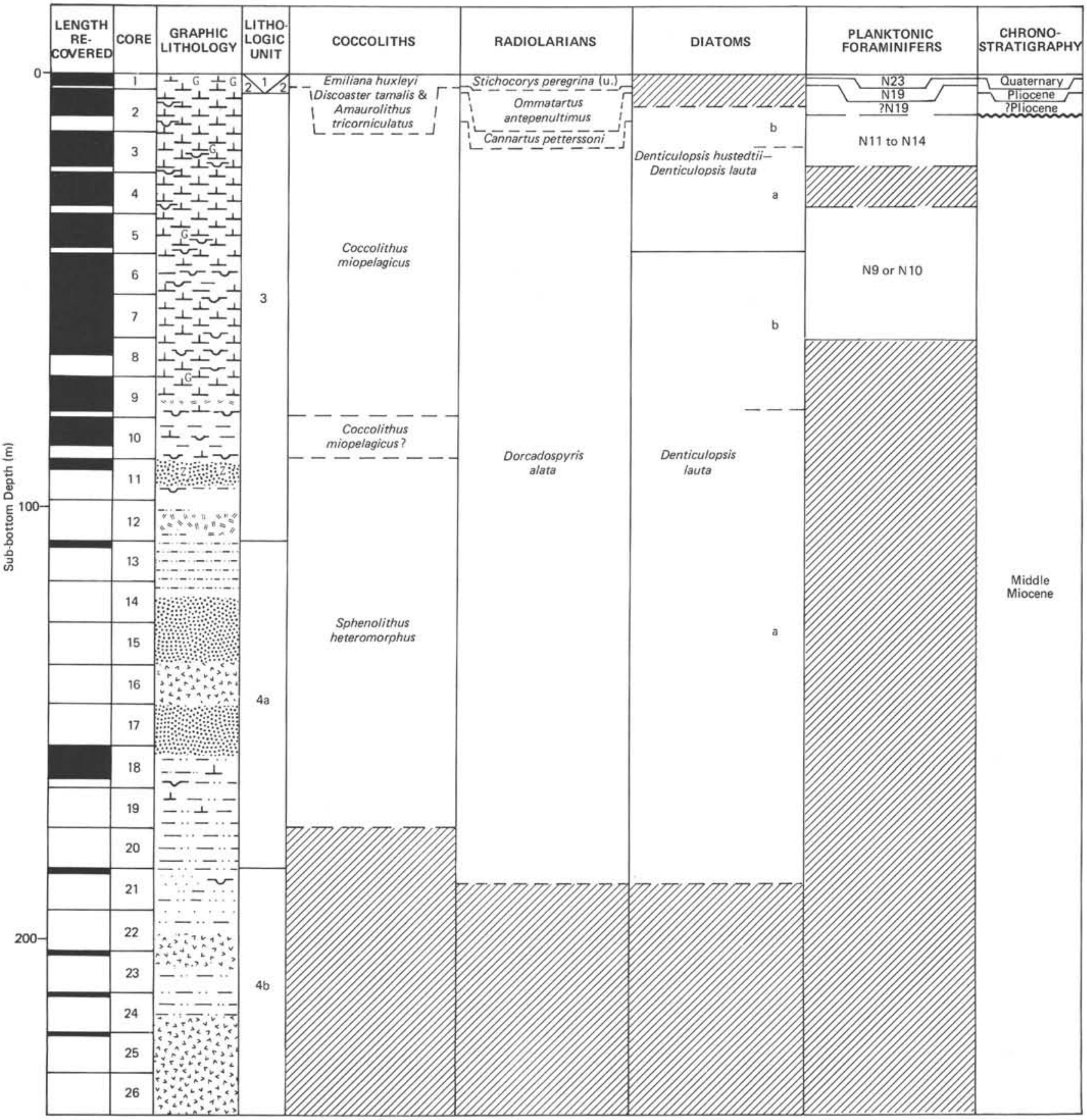


Figure 4. Lithologic and biostratigraphic summary, Hole 468.

intersected the trench off southern California and subduction ceased. A probable unconformity occurs in Core 18 where upper Miocene *Discoaster neohamatus* Zone coccoliths overlie the middle Miocene *Discoaster exilis* Zone coccoliths of Core 19.

Abundant to rare middle Miocene through Quaternary radiolarians are present in Hole 469 above Core 35. Very scarce and poorly preserved radiolarians in Cores 35, 36, and 38 probably reflect silica diagenesis rather than a primary lack of radiolarians in the early middle Miocene. The cold-water zonation of Kling (1973) is applied in the Pliocene and Quaternary, although a few specimens of equatorial species occur in Cores 1 through 8. The lower Pliocene and Miocene assemblages contain warm-water species for the most part, the number of which decreases into the Pliocene. Absence of *Ommatartus* marker species, however, prevents subdivision of the upper Miocene into zones.

Abundant to few diatoms occur in the middle Miocene to lower Quaternary section recovered at Site 469. Diatoms are sparse in the upper Quaternary (Cores 1–3) and in the middle part of the Pliocene (Cores 8–10).

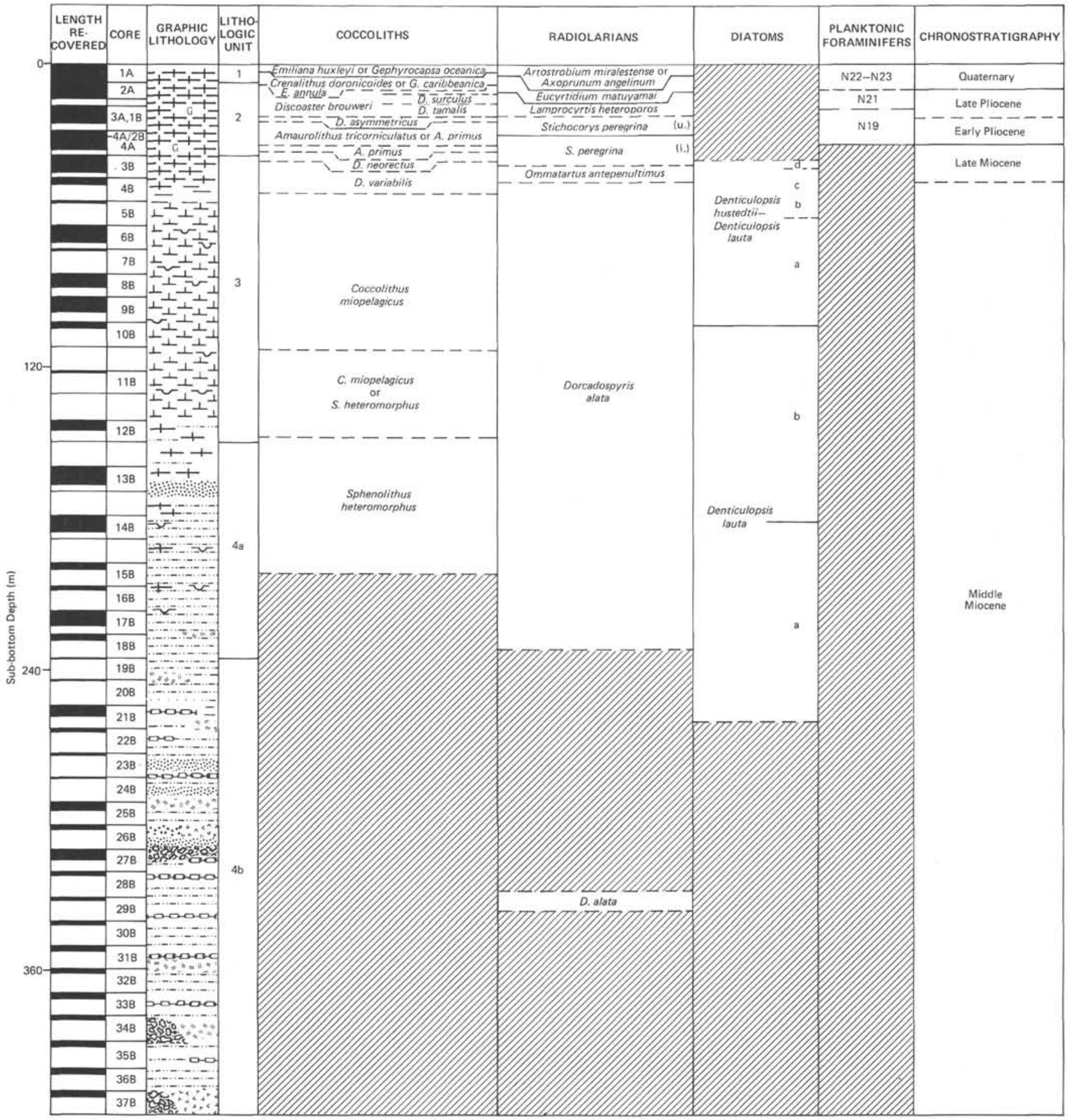


Figure 5. Lithologic and biostratigraphic summary, Holes 468A and 468B.

Diagenesis below Core 25 has removed all but the robust, long-ranging species such as *Coscinodiscus marginatus*.

A normal sequence from lower middle Miocene Subzone b of the *Denticulopsis lauta* Zone through the lower Quaternary *Actinocyclus oculatus* Zone occurs at Site 469, with the exception of the middle Pliocene interval (Cores 8–10), which contains sparse diatoms that are not zonable. This middle Pliocene interval contains mainly reworked middle and upper Miocene diatoms and is stratigraphically equivalent to a similar diatom-poor interval at Site 467. These diatom-poor intervals at Sites 467 and 469 may reflect a period of reduced diatom productivity due to decreased upwelling off southern California during the middle part of the Pliocene.

Diatom biostratigraphy supports the uppermost middle Miocene to lowermost upper Miocene unconformity proposed by coccolith biostratigraphy in Core 18 (Barron, this volume). An additional hiatus occurs in Core

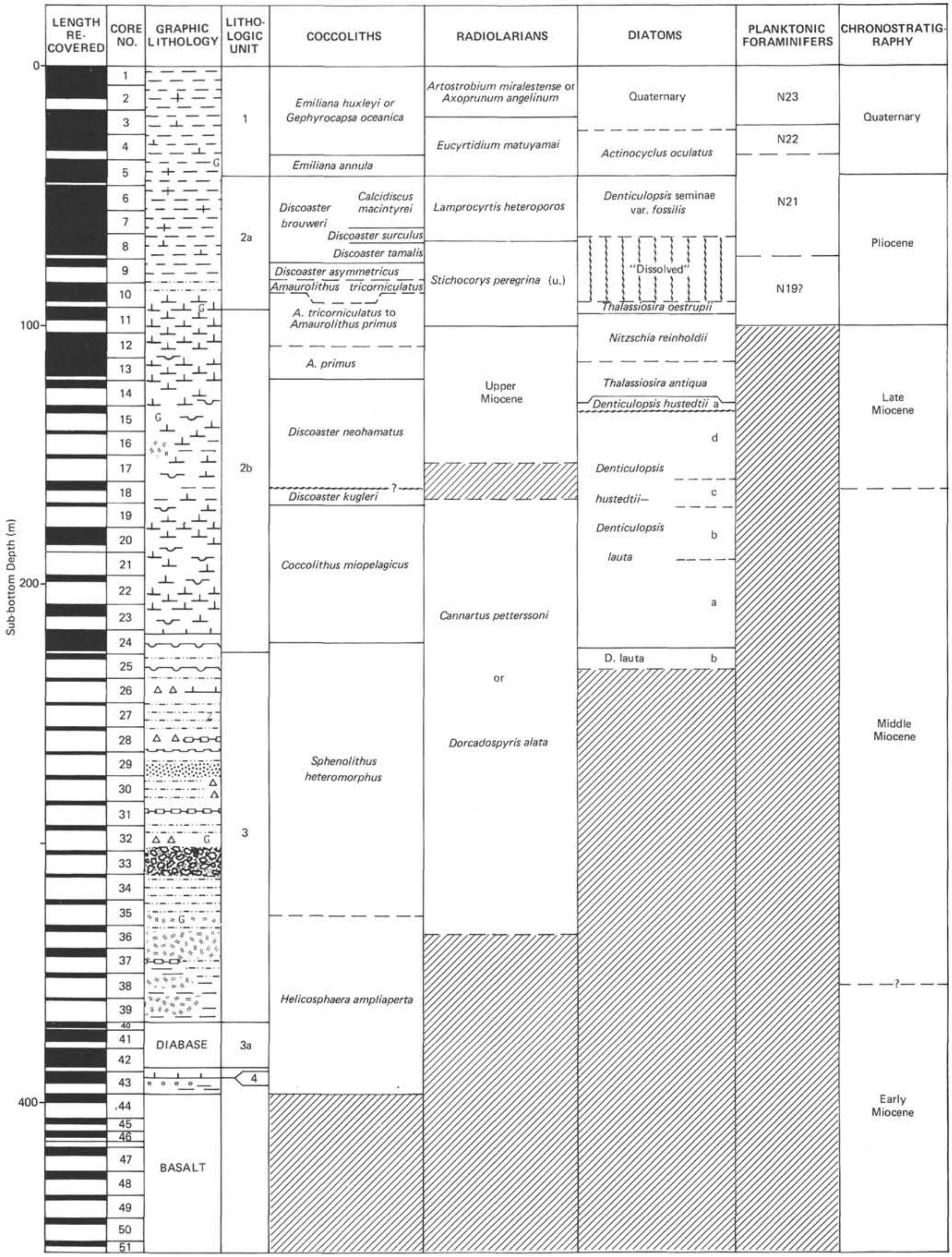


Figure 6. Lithologic and biostratigraphic summary, Hole 469.

15 where the major part of Subzone a of the lower upper Miocene *Denticulopsis hustedtii* Zone is missing.

Planktonic foraminifers are common to abundant in the upper 10 cores and sparse or absent in the remaining sediment cores taken at Site 469. All planktonic assemblages show signs of dissolution. Fragments of foraminifers, glauconite, and the presence of foraminifer sands suggest that the abundance of foraminifers in the upper portion of the sedimentary section at this relatively deep (3800 m) location is due to downslope displacement from the adjacent Patton Escarpment. Pliocene and Quaternary sediments in Cores 1 through 11 are zoned according to the middle- to high-latitude stratigraphy developed by Poore (this volume).

Zonal assignments of the various microfossil groups show little or no conflict at Site 469 (Fig. 2).

SITE 470

Pioneer ocean drilling in 1961 at the Experimental Mohole Drilling Site (east of Guadalupe Island off Baja California) provided cores that have been studied intensively by micropaleontologists. Reports on coccoliths (Martini and Bramlette, 1963; Martini, 1971), diatoms (Kanaya, 1971; Schrader, 1974), silicoflagellates (Ling, 1972; Martini, 1972; Bukry and Foster, 1973), and foraminifers (Parker, 1964; Bandy and Ingle, 1970) from Experimental Mohole cores have significantly influenced the development of Neogene biostratigraphic standards and have been a major source of proposed Miocene correlations between middle-latitude California assemblages and low-latitude planktonic biostratigraphy.

Site 470 was drilled to core continuously the sediment section that was only partially recovered in 1961. A location 8 km south-southwest of the old Mohole Site at 28°54.46′N, 117°31.11′W and at a water depth of 3549 meters was drilled. Hole 470 was continuously cored to basalt at 163 meters sub-bottom depth. Hole 470A was drilled to resample critical sediment intervals from 47.5 to 95 meters and from 161.6 meters to the top of the basalt and to continuously core the basalt. However, severe drilling disturbance in Cores 1 to 5 of Hole 470A limits their usefulness. Microfossil zonation of Holes 470 and 470A is shown on Figure 7.

Coccoliths are abundant and moderately well preserved in the sediment cores above the basalt at Site 470. Poorly preserved coccoliths of the lower middle Miocene *Sphenolithus heteromorphus* Zone are present in a limestone within the basalt section (Hole 470A, Core 12) as well as in the sediments directly above the basalt. The sequence of coccolith zones in Holes 470 and 470A shows good agreement with the ranges and zones of the nearby Experimental Mohole Site reported by Martini and Bramlette (1963) and Martini (1971). Pliocene and Miocene assemblages are generally warm temperate, although cool-water coccolith facies are interspersed in the upper Miocene. Quaternary assemblages show low diversity and are temperate in character. Coccolith biostratigraphy suggests short unconformities in the middle part of the Pliocene (Core 6 of Hole 470) and in the lower upper Miocene *Discoaster neohamatus* Zone (between Cores 4 and 5 of Hole 470A) (Bukry, this volume).

Few to abundant lower Pliocene to middle Miocene radiolarians of moderate to good preservation were recovered from Cores 7 through 17 of Hole 470 and from Cores 2 through 5 of Hole 470A. For the most part, these assemblages are composed of warm-water species, and low-latitude zones are easily recognized. The lower part of the *Stichocorys peregrina* Zone, however, cannot be separated from the *Ommatartus penultimus* Zone. In addition, as at Site 469, the total lack of *Dorcadospyris alata* in the middle Miocene points to a certain cool-water influence at that time. The middle Pliocene through Quaternary (Cores 1–6 of Hole 470; Core 1 of Hole 470A) is characterized by sparse radiolarians and zonation is difficult.

Abundant to few diatoms are present in the middle and upper Miocene of Site 470. Diatoms decrease markedly in abundance upsection at a sub-bottom depth of 70 meters (Core 8 of Hole 470; Core 3 of Hole 470A), and diagenesis immediately above the basalt (Core 18 of Hole 470; Core 6 of Hole 470A) resulted in complete dissolution of the diatoms. Preservation in the diatomaceous section is generally good to moderate, with the exception of Core 470-13, where poorly preserved diatoms are present. Post-Miocene sediment contains rare and generally long-ranged diatoms.

The sequence of Miocene diatom zones recorded by Barron (this volume) from Site 470 (Fig. 7) and the Experimental Mohole site differs somewhat from that reported by Schrader (1974). Schrader (1974) correlates the Experimental Mohole section with the equivalent of Subzone a of the *Denticulopsis lauta* Zone through the *Nitzschia reinholdii* Zone. In contrast, Barron (this volume) assigns the same interval in the Experimental Mohole section and the equivalent interval at Site 470 to Subzone b of the *D. lauta* Zone through the *Thalassiosira antiqua* Zone (compare Fig. 2).

Diatom biostratigraphy supports the lower upper Miocene unconformity reported by coccolith biostratigraphy between Cores 4 and 5 of Hole 470A. Subzone a of the *Denticulopsis hustedtii* Zone is truncated at its top at this horizon in Hole 470A and in Hole 470 (between Cores 9 and 10).

A second Miocene hiatus is probably present at the top of the diatomaceous section (in Core 8 of Hole 470), where an extremely condensed nondiatomaceous uppermost Miocene section overlies diatoms that are no younger than 7.0 m.y. (Barron, this volume).

Planktonic foraminifers are more common and diverse in the Quaternary and Pliocene (Cores 1 through 7 of Hole 470) and middle Miocene (Cores 15 through 18) than in the intervening upper Miocene section (Cores 8 through 14), where extremely abundant siliceous microfossils effectively mask the planktonic foraminifers. Sporadic occurrences of marker taxa allow recognition of the middle Miocene zones and zonal intervals.

Planktonic foraminiferal occurrences basically agree with the studies of Bandy and Ingle (1970) on Ex-

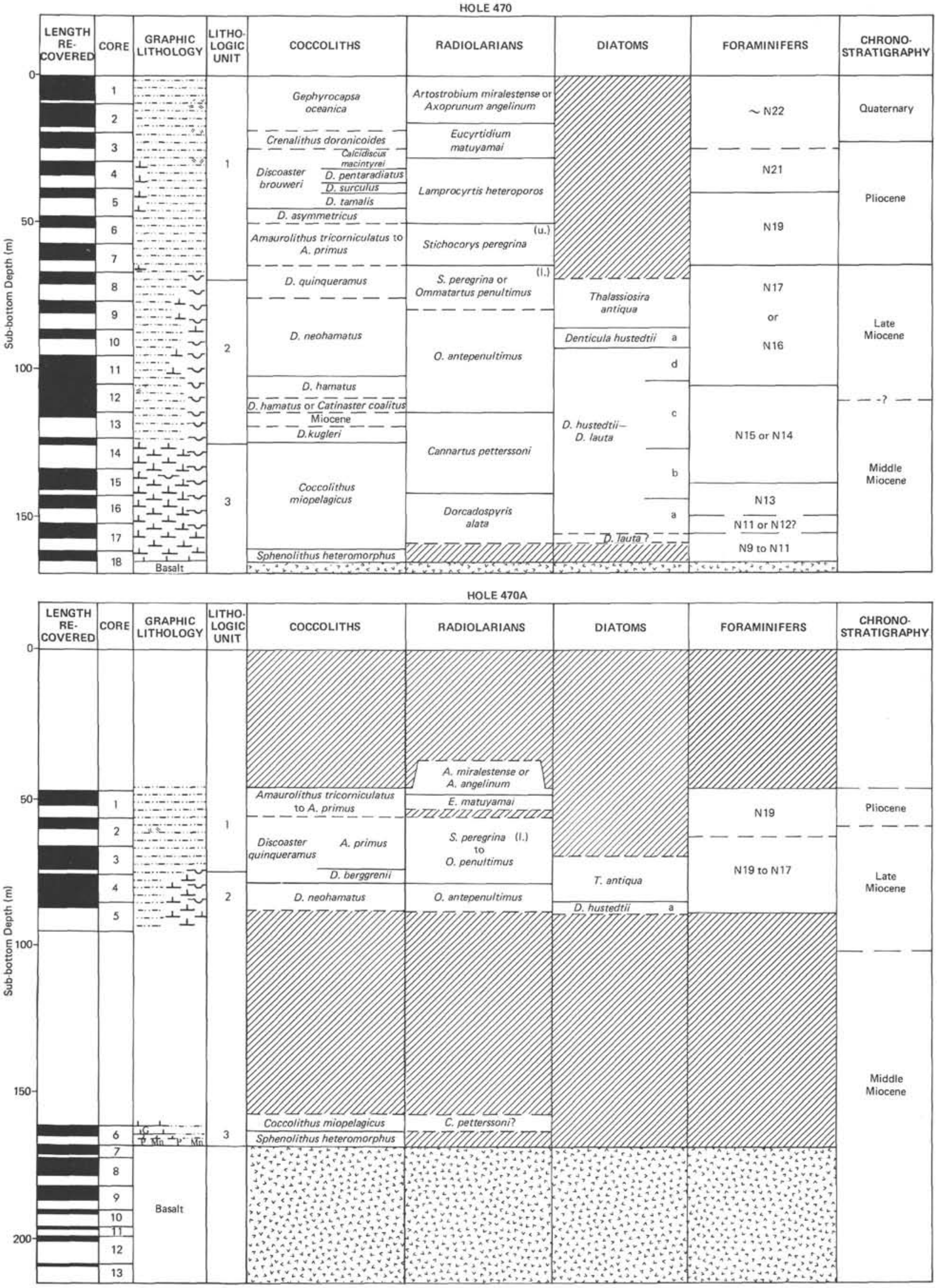


Figure 7. Lithologic and biostratigraphic summary, Holes 470 and 470A.

perimental Mohole cores. The minor discrepancies that exist between the two studies can be explained by different taxonomic concepts and by the sparse and sporadic occurrence of many of the species.

Two noticeable discrepancies occur in the microfossil zonal assignments of Holes 470 and 470A. Although equivalent in depth to Core 6 of Hole 470 (47.5–57.0 m), Core 1 of Hole 470A is assigned to the Quaternary (*Eucyrtidium matuyamai* through *Artostrobium miralestense* Zones) by radiolarians rather than to the middle part of the Pliocene. Coccoliths and planktonic foraminifers of Core 1 of Hole 470A indicate middle Pliocene and imply that the radiolarian assemblage of that core may contain some downhole contamination.

A second discrepancy occurs in Core 15 of Hole 470, where diatoms and coccoliths suggest an age assignment as much as 1 m.y. older (13 versus 12 m.y.) than that proposed by planktonic foraminifers and radiolarians (Fig. 2). Identification of the bases of planktonic foraminifer Zones N13 and N14, however, is made on the basis of isolated single specimens of *Sphaeroidinellopsis subdehiscens* and *Globigerina nepenthes*, respectively, and probably represents downhole contamination (Poore and others, personal communication). It is more difficult to explain the association of *Cannartus petterssoni* Zone radiolarians in Core 15 of Hole 470 with coccoliths of the *Coccolithus miopelagicus* Subzone and diatoms of Subzone b of the *Denticulopsis hustedtii–D. lauta* Zone. Westberg and Riedel's (1978) base of the *C. petterssoni* Zone (first *Cannartus petterssoni*) is located at an horizon assigned to the *Discoaster kugleri* Subzone by Bukry (1971b, 1971c, 1972, 1975b) at equatorial Pacific Sites 77, 71, 289, and 62.1. Independent diatom correlations by Barron (1980; in press) suggest that the base of the *C. petterssoni* Zone should approximate the base of Subzone c of the *D. hustedtii–D. lauta* Zone. The possibility remains that *C. petterssoni* evolved earlier at middle-latitude Site 470 than in the equatorial Pacific or that the taxonomic concepts of Wolfart (this volume) differ from those of Westberg and Riedel (1978).

Studies are underway to integrate quantitative diatom and planktonic foraminiferal data for Hole 470 (Barron and Keller, in preparation); these studies support the age assignments of diatoms and coccoliths on Figure 7.

SITE 472

Site 472 (23°00.35′N, 113°59.71′W, 3831 m water depth) was proposed to obtain an upper Neogene pelagic section undiluted by terrigenous sediments off the southern tip of Baja California. Hole 472 was continuously cored into basement through 112 meters of sediment. Pelagic clay that is poor in microfossils (Cores 1–4) overlies a siliceous, noncalcareous interval (Cores 5–9), and calcareous microfossils are restricted to the lower 4 cores (Core 10–13) above the basalt. The microfossil zonation for Hole 472 is shown in Figure 8.

Middle Miocene coccolith assemblages are common to abundant and moderately well preserved and range from the *Sphenolithus heteromorphus* Zone just above the basalt in Core 13 to the *Catinaster coalitus* Zone in Core 10. Cores 1 to 9 are barren of coccoliths. The *Discoaster kugleri* Subzone was not recorded in Hole 472 due to either poor recovery in Cores 10 and 11 or a possible hiatus.

Cores 5 to 12 of Hole 472 contain rare to abundant, poorly to well preserved radiolarians deposited in the middle middle Miocene through early late Miocene. Cores 2 and 3 are barren of radiolarians, and most of Core 1 contains non-age-diagnostic radiolarians. Sample 472-1-1, 1–2 cm, however, contains sparse, poorly preserved Quaternary radiolarians with equatorial affinities. The Miocene radiolarian assemblages are composed of warm-water species, and individual low-latitude zones from the *Dorcadospyris alata* Zone through the *Ommatartus penultimus* Zone are recognized (Cores 12–5).

Diatoms are abundant to few in the middle to upper Miocene of Hole 472 (Core 12, Section 1 through Core 5) and are generally moderately well to well preserved. Poor preservation occurs at the base of the diatomaceous section, where diagenesis has removed all diatoms immediately above the basalt (Core 13 and most of Core 12). The typical sequence of middle and upper Miocene diatom zones from Subzone a of the *Denticulopsis hustedtii–D. lauta* Zone through the *Thalassiosira antiqua* Zone can be recognized, although the cool-water marker taxa are typically sparse. A short hiatus occurs within Subzone a of the *Denticulopsis hustedtii* Zone in Core 6. Along with Site 470, Site 472 contains a mixture of warm- and cool-water diatoms and allows correlation between low- and middle- to high-latitude diatom biostratigraphy (Barron, this volume).

Planktonic foraminifers are sparse to few in Cores 11 and 12. All assemblages recovered show effects of dissolution, which indicates that they were deposited near the CCD for foraminifers.

The various microfossil zonal assignments in Hole 472 show little or no discrepancy when compared to the time scale adopted for Leg 63 (Fig. 2).

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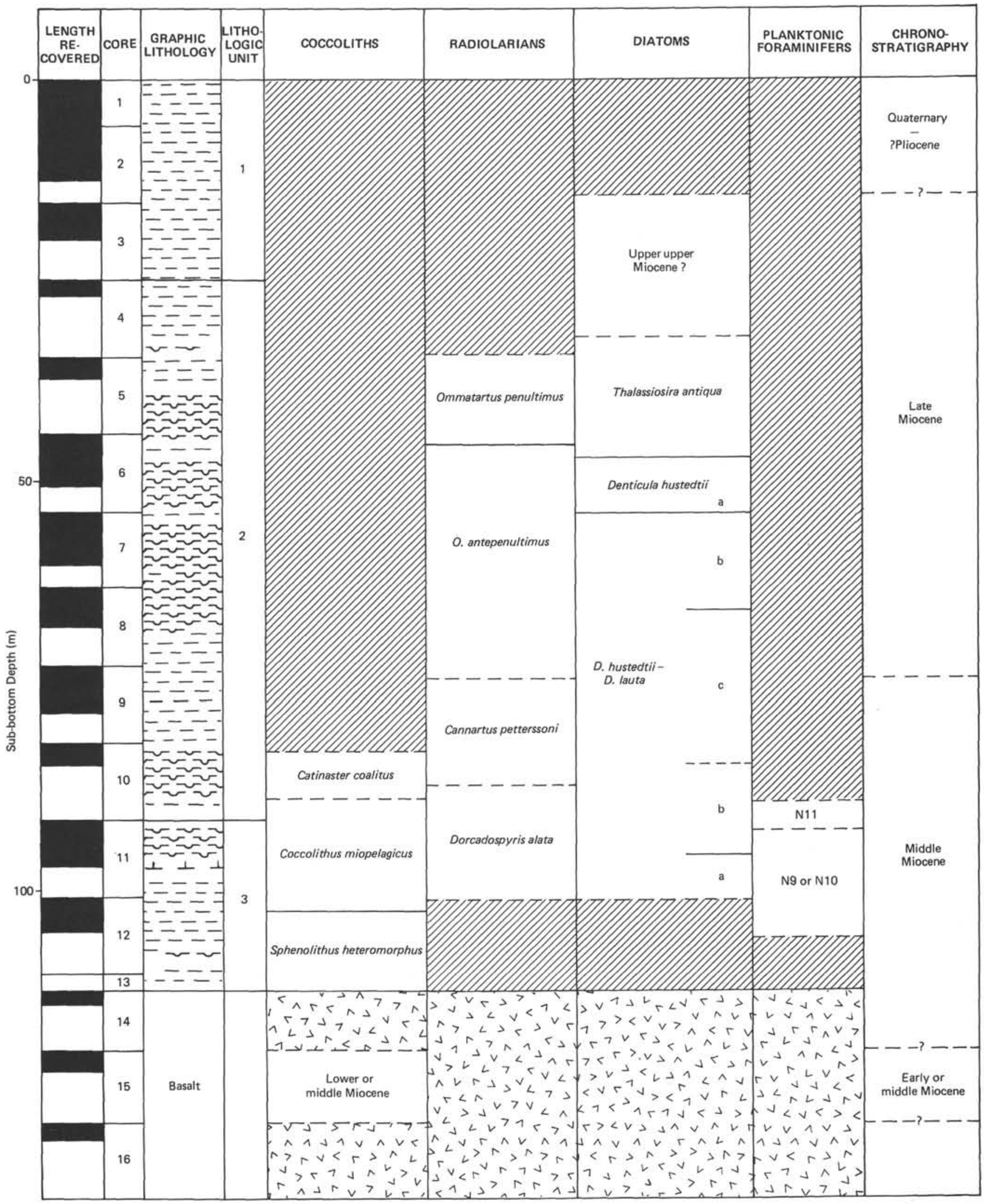

Figure 8. Lithologic and biostratigraphic summary, Hole 472.