

18. COCCOLITH AGE DETERMINATIONS LEG 5, DEEP SEA DRILLING PROJECT

David Bukry,¹ U. S. Geological Survey, La Jolla, California
and

M. N. Bramlette, Scripps Institution of Oceanography, La Jolla, California

This report combines the results of study of 168 coccolith samples from the 131 cores recovered during Leg 5 of the Deep Sea Drilling Project, April-June 1969. Light-microscope techniques have been used to identify the coccolith assemblages, and the species considered in this report are listed in Table 1. Following a brief summary of the coccolith stratigraphy at each drilling site, some age-diagnostic species in selected samples from each site are listed.

The material considered here consists of the nannoplankton samples for onshore examination that are routinely taken by the shipboard scientific staff immediately after core recovery, together with some additional slides of core-catcher material that were obtained from E. D. Milow. Many samples from Leg 5 proved to be barren of calcareous nannoplankton (a list of these is provided in Table 2).

TABLE 1
Coccolith Species Considered in This Report

<i>Campylosphaera dela</i> (Bramlette and Sullivan)
<i>Ceratolithus tricorniculatus</i> Gartner
<i>Chiphragmalithus quadratus</i> Bramlette and Sullivan
<i>Chiasmolithus grandis</i> (Bramlette and Riedel) Original designation: <i>Coccolithus grandis</i> Bramlette and Riedel, 1954. <i>J. Paleontology</i> . 28 (4), 391 (Plate 38, Figures 1a-1b).
<i>Chiasmolithus solitus</i> (Bramlette and Sullivan) Original designation: <i>Coccolithus solitus</i> Bramlette and Sullivan, 1961. <i>Micropaleontology</i> . 7 (2), 140 (Plate 2, Figures 4a-4c).
<i>Coccolithus bisectus</i> (Hay, Mohler, and Wade) of Bramlette and Wilcoxon
<i>Coccolithus</i> sp. aff. <i>C. bisectus</i> (Hay, Mohler, and Wade) of Bramlette and Wilcoxon
<i>Coccolithus crassus</i> Bramlette and Sullivan
<i>Coccolithus</i> sp. cf. <i>C. crassus</i> Bramlette and Sullivan
<i>Coccolithus</i> sp. cf. <i>C. doronicoides</i> Black and Barnes

TABLE 1 – Continued

<i>Coccolithus eopelagicus</i> Bramlette and Riedel
<i>Coccolithus pelagicus</i> (Wallich)
<i>Coccolithus pseudogammation</i> Bouche
<i>Coccolithus</i> sp. cf. <i>C. scissurus</i> (Hay, Mohler, and Wade) of Bramlette and Wilcoxon
<i>Cyclococcolithus leptoporus</i> (Murray and Blackman)
<i>Cyclococcolithus lusitanicus</i> (Black)
<i>Cyclococcolithus</i> sp. cf. <i>C. lusitanicus</i> (Black)
<i>Cyclococcolithus macintyreai</i> Bukry and Bramlette
<i>Cyclococcolithus neogammation</i> Bramlette and Wil- coxon
<i>Cyclolithella annula</i> (Cohen)
<i>Discoaster barbadiensis</i> Tan
<i>Discoaster</i> sp. aff. <i>D. bollii</i> Martini and Bramlette
<i>Discoaster brouweri</i> Tan
<i>Discoaster</i> sp. aff. <i>D. brouweri</i> Tan
<i>Discoaster challengerii</i> Bramlette and Riedel
<i>Discoaster deflandrei</i> Bramlette and Riedel
<i>Discoaster diastypus</i> Bramlette and Sullivan
<i>Discoaster exilis</i> Martini and Bramlette
<i>Discoaster</i> sp. aff. <i>D. exilis</i> Martini and Bramlette
<i>Discoaster lodoensis</i> Bramlette and Riedel
<i>Discoaster martinii</i> Stradner
<i>Discoaster</i> sp. cf. <i>D. ornatus</i> Stradner
<i>Discoaster pentaradiatus</i> Tan Sin Hok
<i>Discoaster quintatus</i> Bukry and Bramlette
<i>Discoaster saipanensis</i> Bramlette and Riedel
<i>Discoaster surculus</i> Martini and Bramlette
<i>Discoaster tani tani</i> Bramlette and Riedel
<i>Discoaster variabilis</i> Martini and Bramlette
<i>Gephyrocapsa oceanica</i> Kamptner
<i>Helicopontosphaera sellii</i> Bukry and Bramlette
<i>Isthmolithus recurvus</i> Deflandre
<i>Marthasterites</i> sp. aff. <i>M. contortus</i> (Stradner)

¹Publication authorized by the Director, U.S. Geological Survey.

TABLE 1 — *Continued*

<i>Marthasterites tribrachiatus</i> (Bramlette and Riedel)
<i>Pyrocyclus hermosus</i> Roth and Hay
<i>Reticulofenestra dictyoda</i> (Deflandre)
<i>Reticulofenestra insignita</i> Roth and Hay
<i>Reticulofenestra pseudoumbilica</i> (Gartner)
<i>Reticulofenestra umbilica</i> (Levin)
<i>Sphenolithus abies</i> Deflandre
<i>Sphenolithus</i> sp. aff. <i>S. belemnos</i> Bramlette and Wilcoxon
<i>Sphenolithus ciperoensis</i> Bramlette and Wilcoxon
<i>Sphenolithus distentus</i> (Martini)
<i>Sphenolithus furcatolithoides</i> Locker
<i>Sphenolithus neoabies</i> Bukry and Bramlette
<i>Sphenolithus predistentus</i> Bramlette and Wilcoxon
<i>Sphenolithus pseudoradians</i> Bramlette and Wilcoxon
<i>Sphenolithus radians</i> Deflandre
<i>Triquetrorhabdulus carinatus</i> Martini
<i>Triquetrorhabdulus</i> sp. cf. <i>T. carinatus</i> Martini
<i>Triquetrorhabdulus rugosus</i> Bramlette and Wilcoxon
<i>Zygolithus</i> sp. cf. <i>Z. dubius</i> Deflandre

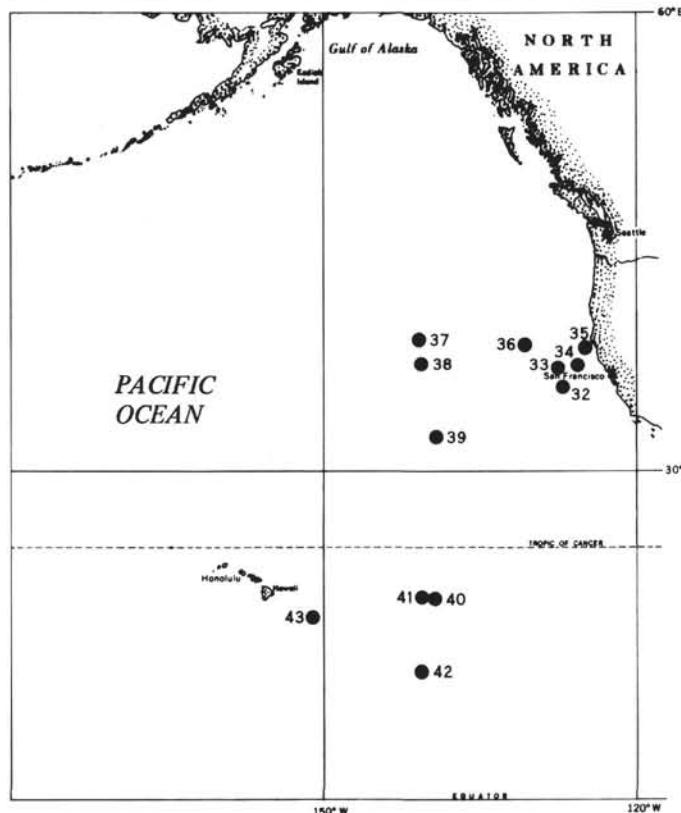


Figure 1. Drilling sites of Leg 5, Deep Sea Drilling Project.

The sample numbers, which identify the relative position of samples in holes, start with a series of numbered entries separated by hyphens in the following sequence: (cruise-leg number)-(drill-hole designation, consisting of site number plus a decimal suffix, if more than one hole)-(core designation)-(core-section number). This series is followed by the interval below the top of each core section in centimeters. For example, 5-42.0-6-6, 75-77 cm, means the sample came from Leg 5, Hole 42.0 (at Site 42), the sixth barrel of core recovered, the bottom section of that core, and 75-77 centimeters below the top of the section. Most core runs were 9.1 meters (30 feet) long, but occasionally the core liners were not full. In this report, recoveries are arbitrarily placed at the top of the core runs, and an approximate depth in meters below the sea floor follows each sample number.

TABLE 2
Leg 5 Samples in Which Calcareous Nannoplankton Were Not Found

5-32-6-6, 56-57 cm (116 m)
5-32-8-1, 74-75 cm (167 m)
5-32-8-6, 100-101 cm (175 m)
5-32-9-3, 100-101 cm (180 m)
5-33-1-4, 85-86 cm (5 m)
5-33-1-6, 75-76 cm (8 m)
5-33-3-6, 75-76 cm (55 m)
5-33-12-3, 71-72 cm (279 m)
5-34-5-6, 70-71 cm (124 m)
5-34-9-4, 76-77 cm (217 m)
5-34-9-6, 75-76 cm (220 m)
5-34-12-1, 118-119 cm (284 m)
5-34-14-2, 104-105 cm (338 m)
5-35-13-4, 131-132 cm (350 m)
5-35-14-4, 80-81 cm (358 m)
5-35-15-4, 77-78 cm (367 m)
5-35-16-2, 93-94 cm (374 m)
5-36-1-4, 73-75 cm (5 m)
5-37-1-2, 73-75 cm (1 m)
5-38-5-1, 70 cm (31 m)
5-38-5-3, 70 cm (34 m)
5-39-1-1, 77-79 cm (0 m)
5-39-2-4, 70 cm (14 m)
5-40-2-2, 70 cm (11 m)

TABLE 2 — *Continued*

5-40-3-2, 70 cm (20 m)
5-40-3-3, 70 cm (22 m)
5-40-5-2, 80 cm (38 m)
5-40-8-3, 70 cm (70 m)
5-40-14-3, 70 cm (125 m)
5-40-15-3, 80 cm (134 m)
5-40-15-4, 90 cm (135 m)
5-40-15-6, 70 cm (138 m)
5-40-16-3, 30 cm (141 m)
5-42-7-4, 77-79 cm (60 m)

HOLE 32
 (lat 37° 07.63'N., long 127° 33.38'W.,
 depth 4758 meters)

Summary of Coccolith Age Determinations

Samples were available from Cores 3 through 9. Assemblages of coccoliths present in the top of Core 3 are upper Pliocene. The assemblage in the top of Core 4 lacks diversity and abundance but is questionably considered upper Pliocene. From the middle of Core 4 to the base of Core 5 there are rather sparse upper Miocene or lower Pliocene assemblages. Discoasters are scarce in the assemblages, with *Discoaster brouweri* and *D. exilis* being the most common. With the presence of *Ceratolithus tricorniculatus*, *Discoaster quintatus*, and *Sphenolithus neobabies*, this assemblage suggests correlation to the *Ceratolithus tricorniculatus* or *C. rugosus* Zones of warmer-water areas. Samples from Cores 6, 7, 8 and 9 are barren of coccoliths or contain only rare specimens of non-diagnostic species. Although samples were not available from the lower Cores 10, 11 and 12, material from the core catcher of Core 12, provided by E. D. Milow, contains a coccolith assemblage diagnostic of the lower Oligocene *Helicopontosphaera reticulata* Zone.

Age-diagnostic Coccoliths in Selected Samples

Upper Pliocene (*Discoaster brouweri* Zone)

5-32-3-1, 77-78 cm, depth 81 m:
Coccolithus sp. cf. *C. doronicoides*, *Cyclococcolithus leptoporus*, *C. macintyreai*, *Discoaster brouweri* [6- and 4-rayed], *D. exilis*.

Upper Pliocene(?) (*Discoaster brouweri* Zone?)

5-32-4-1, 71-72 cm, depth 91 m:
Cyclococcolithus leptoporus, *C. macintyreai*, *Discoaster* sp., *Helicopontosphaera sellii*.

**Upper Upper Miocene or Lower Pliocene
 (*Ceratolithus tricorniculatus* or *C. rugosus* Zone)**

5-32-4-3, 72-73 cm, depth 94 m:
Ceratolithus tricorniculatus, *Cyclococcolithus leptoporus*, *C. macintyreai*, *Discoaster brouweri*, *D. exilis*, *D. quintatus*, *D. variabilis*, *Reticulofenestra pseudoumbilica*.

**Lower Oligocene
 (*Helicopontosphaera reticulata* Zone)**

5-32-12-core catcher, depth 212 m:
Coccolithus bisectus, *C. sp. cf. C. scissurus*, *Discoaster tani tani*, *Isthmolithus recurvus*, *Reticulofenestra umbilica* (this assemblage comes from a thin lamina in a dark yellowish-brown clay).

HOLE 33
 (lat 39° 28.48'N., long 127° 29.81'W.,
 depth 4284 meters)

Summary of Coccolith Age Determinations

Sparse Pleistocene coccolith assemblages are present in Cores 1 through 4. Cores 5 and 6 contain assemblages of upper Pliocene and upper upper Miocene or lower Pliocene coccoliths. The assemblages from Cores 7 through 11 lack *Ceratolithus tricorniculatus*, but they do contain a plexus of discoasters referable to *Discoaster exilis* and *D. variabilis*. The morphology of *Reticulofenestra pseudoumbilica* is also more variable than usual. These assemblages are probably cool-water equivalents of the lower upper Miocene *Discoaster neohamatus* Zone. No samples were available from Cores 13 and 14, but a sample from Core 15 is considered upper middle Miocene.

Age-diagnostic Coccoliths in Selected Samples

Pleistocene (*Gephyrocapsa oceanica* Zone)

5-33-2-1, 72-73 cm, depth 10 m:
Coccolithus sp. (small), *Gephyrocapsa oceanica*.

Lower Pleistocene (*Coccolithus doronicoides* Zone)

5-33-4-5, 75-76 cm, depth 102 m:
Coccolithus sp. cf. *C. doronicoides*, *Cyclococcolithus leptoporus*, *C. macintyreai* (rare), *Discoaster* sp. aff. *D. brouweri* (rare).

Upper Pliocene (*Discoaster brouweri* Zone)

5-33-5-3, 75-76 cm, depth 156 m:
Coccolithus sp. (small), *Cyclococcolithus leptoporus*, *Discoaster* sp. aff. *D. brouweri*, *D. challengerii*, *D. exilis*, *D. variabilis*.

Upper Upper Miocene or Lower Pliocene
(*Ceratolithus tricorniculatus* or *C. rugosus* Zone)

5-33-5-6, 75-76 cm, depth 161 m:
Ceratolithus tricorniculatus, *Cyclococcolithus leptoporus*, *C. macintyrei*, *Discoaster variabilis*, *Sphenolithus abies* (rare).

5-33-6-6, 88-89 cm, depth 228 m:
Ceratolithus tricorniculatus, *Discoaster challengerii*, *D. sp. aff. D. exilis*, *D. variabilis*, *Reticulofenestra pseudoumbilica*.

Lower Upper Miocene
(*Discoaster neohamatus* Zone?)

5-33-10-2, 64-65 cm, depth 258 m:
Cyclococcolithus leptoporus, *C. macintyrei*, *Discoaster challengerii*, *D. exilis* (and varieties), *D. variabilis*, *Reticulofenestra pseudoumbilica*, *Sphenolithus neoabies*.

Upper Middle Miocene?
(*Discoaster kugleri* Zone?)

5-33-15-1, 121-122 cm, depth 294 m:
Cyclococcolithus leptoporus, *Discoaster sp. aff. D. bollii*, *D. exilis*, *Reticulofenestra pseudoumbilica*, *Sphenolithus neoabies*.

HOLE 34
(lat $39^{\circ} 28.31'N.$, long $127^{\circ} 16.54'W.$,
depth 4322 meters)

Summary of Coccolith Age Determinations

Cores 1 and 2 contain Pleistocene coccolith assemblages. In Core 3, upper Pliocene coccolith assemblages are present. A series of samples from the top of Core 4 to the lower part of Core 8 contain upper upper Miocene to lower Pliocene assemblages of variable abundance characterized by *Ceratolithus tricorniculatus*, *Discoaster exilis* (with much intraspecific variation), *D. variabilis* (with much intraspecific variation), and *Reticulofenestra pseudoumbilica*. These assemblages, like similar ones at Sites 32 and 33, are considered to be cool-water equivalents of the *Ceratolithus tricorniculatus* or *C. rugosus* Zones. Assemblages from the bottom of Core 8 through Cores 9, 10 and 11 are poor, but they are considered to be upper Miocene. Samples from Cores 12 and 14 are barren of coccoliths. No samples were available from Cores 13, 15, 16 or 17, but a slide from Core 16 supplied by E. D. Milow contains an upper Oligocene to lower Miocene coccolith assemblage.

Age-diagnostic Coccoliths in Selected Samples

Lower Pleistocene (*Coccolithus doronicoides* Zone)

5-34-1-6, 74-75 cm, depth 28 m:
Coccolithus sp. cf. C. doronicoides, *C. pelagicus*, *Cyclococcolithus leptoporus*.

5-34-2-6, 72-73 cm, depth 37 m:
Coccolithus sp. cf. C. doronicoides, *C. pelagicus*, *Cyclococcolithus leptoporus*, *Cyclolithella annula*, *Helicopontosphaera sellii*.

Upper Pliocene (*Discoaster brouweri* Zone)

5-34-3-1, 76-77 cm, depth 76 m:
Coccolithus sp. cf. C. doronicoides, *C. pelagicus*, *Cyclococcolithus leptoporus*, *C. macintyrei*, *Discoaster brouweri*, *D. sp. aff. D. exilis*.

5-34-3-6, 71-72 cm, depth 83 m:
Coccolithus sp. cf. C. doronicoides, *C. pelagicus*, *Cyclococcolithus leptoporus*, *C. macintyrei*, *Discoaster brouweri*, *D. exilis*.

Upper Upper Miocene or Lower Pliocene
(*Ceratolithus tricorniculatus* or *C. rugosus* Zone)

5-34-4-1, 73-74 cm, depth 108 m:
Ceratolithus tricorniculatus, *Discoaster sp. [small]*, *Reticulofenestra pseudoumbilica*.

5-34-7-3, 123-124 cm, depth 138 m:
Ceratolithus tricorniculatus, *Cyclococcolithus leptoporus*, *C. macintyrei*, *Discoaster challengerii*, *D. exilis*, *D. variabilis*, *?Reticulofenestra pseudoumbilica* [small].

5-34-8-4, 127-128 cm, depth 171 m:
Ceratolithus tricorniculatus, *Coccolithus pelagicus*, *Cyclococcolithus leptoporus*, *Discoaster variabilis*, *Reticulofenestra pseudoumbilica*.

Lower Upper Miocene (*Discoaster neohamatus* Zone?)

5-34-8-6, 60-61 cm, depth 173 m:
Coccolithus pelagicus, *Discoaster brouweri*, *D. challengerii*, *D. exilis*, *D. variabilis*, *Reticulofenestra pseudoumbilica*.

Upper Oligocene or Lower Miocene
(*Triquetrorhabdulus carinatus* Zone)

5-34-16-core catcher, depth 350 m:
Coccolithus sp. aff. C. bisectus, *Cyclococcolithus neogammation*, *Discoaster deflandrei*, *Sphenolithus sp. aff. S. belemnos*, *Triquetrorhabdulus carinatus*.

HOLE 35
(lat $40^{\circ} 40.42'N.$, long $127^{\circ} 28.48'W.$,
depth 3373 meters)

Summary of Coccolith Age Determinations

Sparse Pleistocene coccolith assemblages are present in Cores 2 through 12. In the other cores, coccoliths appear to be lacking.

Age-diagnostic Coccoliths in Selected Samples

Pleistocene (*Gephyrocapsa oceanica* Zone)

5-35-2-4, 72-73 cm, depth 44 m:
Coccolithus pelagicus, *Gephyrocapsa oceanica*.

5-35-12-6, 120-121 cm, depth 329 m:
Coccolithus sp. [small], *Gephyrocapsa oceanica*.

HOLE 36
(lat $40^{\circ} 59.08'N.$, long $130^{\circ} 06.58'W.$,
depth 3273 meters)

Summary of Coccolith Age Determinations

Coccoliths are abundant in the 13 cores at this site and indicate that Cores 1 through 5 are Pleistocene, Cores 6, 7 and 8 are upper Pliocene, and Cores 9 through 12 are upper upper Miocene or lower Pliocene. In Core 13 an assemblage of questionably lower upper Miocene coccoliths is present. In the Pleistocene section, *Gephyrocapsa oceanica* is restricted to Cores 1 and 2; Cores 3, 4 and 5 are therefore considered to be lower Pleistocene. The upper Pliocene section here is characterized by the presence of *Cyclococcolithus macintyrei*, *Discoaster brouweri*, *D. exilis* (with much intraspecific variation), *D. pentaradiatus*, and *D. surculus*. The upper upper Miocene or lower Pliocene interval (Cores 9, 10, 11 and 12) is characterized by the presence of *Ceratolithus tricorniculatus*, *Reticulofenestra pseudoumbilica*, and a group of discoasters dominated by *D. exilis* and *Discoaster variabilis*. The absence of *C. tricorniculatus* in Core 13, when it is consistently present in cores directly above, is the only suggestion of a slightly earlier age for the poor coccolith assemblage present.

Age-diagnostic Coccoliths in Selected Samples

Pleistocene (*Gephyrocapsa oceanica* Zone)

5-36-1-1, 80-81 cm, depth 1 m:
Coccolithus pelagicus, *C. sp. [small]*, *Gephyrocapsa oceanica*.

Lower Pleistocene (*Coccolithus doronicoides* Zone)

5-36-3-1, 70-72 cm, depth 19 m:
Coccolithus sp. cf. *C. doronicoides*, *C. pelagicus*, *Cyclococcolithus leptoporus*, *Cyclolithella annula*.

Upper Pliocene (*Discoaster brouweri* Zone)

5-36-6-1, 74-75 cm, depth 49 m:
Coccolithus sp. cf. *C. doronicoides*, *C. pelagicus*, *Cyclococcolithus leptoporus*, *C. macintyrei*, *Discoaster exilis*, *D. pentaradiatus*, *D. surculus*.

5-36-8-6, 79-81 cm, depth 74 m:
Coccolithus sp. cf. *C. doronicoides*, *C. pelagicus*, *Cyclococcolithus leptoporus*, *C. macintyrei*, *Discoaster brouweri*, *D. exilis*.

Upper Upper Miocene or Lower Pliocene (*Ceratolithus tricorniculatus* or *C. rugosus* Zone)

5-36-9-2, 79-81 cm, depth 77 m:
Ceratolithus tricorniculatus, *Coccolithus pelagicus*, *Cyclococcolithus leptoporus*, *Reticulofenestra pseudoumbilica*.

5-36-10-6, 71-73 cm, depth 91 m:
Ceratolithus tricorniculatus, *Cyclococcolithus leptoporus*, *C. macintyrei*, *Discoaster brouweri* [small], *D. exilis*, *D. quintatus*, *D. variabilis*, *Reticulofenestra pseudoumbilica*.

5-36-12-5, 77-79 cm, depth 109 m:
Ceratolithus tricorniculatus [early variety], *Cyclococcolithus leptoporus*, *C. macintyrei* (rare), *Discoaster challenger*, *D. exilis*, *D. pentaradiatus*, *D. variabilis*.

Lower Upper Miocene (*Discoaster neohamatus* Zone?)

5-36-13-4, 74-76 cm, depth 115 m:
Discoaster sp. aff. *D. bollii*, *D. brouweri* (small), *D. challenger*, *D. exilis*, *D. variabilis*, *Reticulofenestra pseudoumbilica*.

HOLE 37
(lat $40^{\circ} 58.74'N.$, long $140^{\circ} 43.11'W.$,
depth 4682 meters)

Summary of Coccolith Age Determinations

Upper Pliocene coccolith assemblages are present in the upper two cores from which samples were available.

Age-diagnostic Coccoliths in Selected Samples

Upper Pliocene (*Discoaster brouweri* Zone)

5-37-1-4, 81-83 cm, depth 5 m:
Cyclococcolithus leptoporus, *C. macintyrei*, *Discoaster brouweri*, *D. exilis*, *D. surculus*.

5-37-2-1, 56-58 cm, depth 6 m:
Cyclococcolithus leptoporus, *C. macintyrei*, *Discoaster brouweri* (6- and 4-rayed), *D. exilis*, *D. pentaradiatus*.

HOLE 38
(lat $38^{\circ} 42.12'N.$, long $140^{\circ} 21.27'W.$,
depth 5137 meters)

Summary of Coccolith Age Determinations

Only a single sample from the bottom of this hole (Core 6, core catcher) contains calcareous nannoplankton. The assemblage is that of the upper lower Eocene *Discoaster lodoensis* Zone.

Age-diagnostic Coccoliths in Selected Sample

Lower Eocene (*Discoaster lodoensis* Zone)

5-38-6-core catcher, depth 48 m:

Campylosphaera dela, *Chiasmolithus grandis*, *C. solitus*, *Coccolithus crassus*, *C. pseudogammation*, *Cyclococcolithus* cf. *C. lusitanicus*, *Discoaster barbadiensis*, *Discoaster lodoensis*, *Reticulofenestra dictyoda*, *Sphenolithus radians*, *Zygolithus* sp. cf. *Z. dubius*.

HOLE 39

(lat 32° 48.28'N., long 139° 34.29'W.,
depth 4929 meters)

Summary of Coccolith Age Determinations

The only calcareous nannoplankton from this site is in the deepest sample, core catcher of Core 2, which consists of a dusky brown clay above basalt. An Eocene age is suggested by the presence of rare specimens of species representing an early Eocene assemblage.

Age-diagnostic Coccoliths in Selected Sample

Lower Eocene (*Marthasterites tribrachiatus* Zone?)

5-39-2-core catcher, depth 17 m:

Coccolithus sp. cf. *C. crassus*, *Discoaster barbadiensis*, *D. lodoensis*, *Marthasterites tribrachiatus*, *Sphenolithus radians*.

HOLE 40

(lat 19° 47.57'N., long 139° 54.08'W.,
depth 5183 meters)

Summary of Coccolith Age Determinations

Coccolith assemblages are present only in the core-catcher samples of the bottom cores, 18 and 19. Slides of this material, supplied by E. D. Milow, contain poor lower Eocene coccolith assemblages of the *Marthasterites tribrachiatus* Zone in Core 18 and the *Discoaster diastypus* Zone in Core 19.

Age-diagnostic Coccoliths in Selected Samples

Lower Eocene (low *Marthasterites tribrachiatus* Zone)

5-40-18-core catcher, depth 150 m:

Discoaster barbadiensis, *D. diastypus* (rare), *D. lodoensis* D. sp. cf. *D. ornatus*, *Marthasterites tribrachiatus*.

Lower Eocene (*Discoaster diastypus* Zone)

5-40-19-core catcher, depth 153 m:

Discoaster diastypus, *D. sp. cf. D. ornatus*, *Marthasterites* sp. aff. *M. contortus*.

HOLE 42.0

(lat 13° 50.51'N., long 140° 11.31'W.,
depth 4848 meters)

Summary of Coccolith Age Determinations

An upper Oligocene through middle Eocene sequence is present in Cores 1 through 11. The upper Oligocene to upper Eocene section in Cores 1, 2 and 4 is a calcareous ooze, whereas the succeeding upper through middle Eocene section in Cores 5 to 11 is rich in diatoms and radiolarians as well as calcareous nannoplankton.

Age-diagnostic Coccoliths in Selected Samples

Upper Oligocene (*Sphenolithus ciperoensis* Zone)

5-42.0-1-1, 76-78 cm, depth 1 m:

Coccolithus bisectus, *C. sp. aff. C. bisectus*, *Cyclococcolithus neogammation*, *Discoaster deflandrei*, *Sphenolithus* sp. aff. *S. belemnos*, *S. ciperoensis*, *Triquetrorhabdulus* sp. cf. *T. carinatus*.

Lower Oligocene (*Sphenolithus predistentus* Zone)

5-42.0-2-1, 75-77 cm, depth 11 m:

Coccolithus bisectus, *Cyclococcolithus neogammation*, *Discoaster deflandrei*, *D. tani tani* (small), *Pyrocyclus hermosus*, *Reticulofenestra insignita*, *Sphenolithus distentus*, *S. predistentus*, *S. pseudoradians*.

Lower Oligocene

(*Helicopontosphaera reticulata* Zone)

5-42.0-4-1, 75-77 cm, depth 28 m:

Coccolithus bisectus, *Cyclococcolithus lusitanicus*, *C. neogammation*, *Discoaster deflandrei*, *D. tani tani*, *Reticulofenestra umbilica*.

Upper Eocene (*Discoaster barbadiensis* Zone)

5-42.0-4-6, 75-77 cm, depth 35 m:

Coccolithus bisectus, *Cyclococcolithus lusitanicus*, *Discoaster barbadiensis*, *D. saipanensis*, *Reticulofenestra umbilica*.

Middle Eocene

(*Reticulofenestra umbilica* Zone)

5-42.0-8-1, 75-77 cm, depth 65 m:

Chiasmolithus grandis, *Coccolithus eopelagicus*, *Cyclococcolithus lusitanicus*, *Discoaster barbadiensis*, *Reticulofenestra umbilica*, *Sphenolithus furcatolithoides*.

Middle Eocene

(*Chiphragmalithus quadratus* Zone)

5-42.0-11-3, 67-69 cm, depth 95 m:

Chiasmolithus grandis, *Chiphragmalithus quadratus*, *Coccolithus bisectus*, *Cyclococcolithus lusitanicus*, *Discoaster barbadiensis*, *D. martinii*, *Reticulofenestra dictyoda*.

TABLE 3
Epochs for Which Calcareous Nannoplankton are Present
in Deep Sea Drilling Project Core Samples from Leg 5 Sites

SITE	EOCENE	OLIGOCENE	MIocene	PLIOCENE	PLEISTOCENE
32		X	X	X	
33			X	X	X
34		X	X	X	X
35					X
36			X	X	X
37				X	
38	X				
39	X				
40	X				
42	X	X			

TABLE 4
Age of Oldest Coccolith-Bearing Sediment Recovered at Each
Site During Leg 5. An Asterisk Follows the Age of Sediment That
Directly Overlies Recovered Basalt.

Site	Location (lat N - long W)	Epoch or Sub-Epoch
32	37° 07.63' - 127° 33.38'	Early Oligocene*
33	39° 28.48' - 127° 29.81'	Middle Miocene
34	39° 28.31' - 127° 16.54'	Late Oligocene or Early Miocene*
35	40° 40.42' - 127° 28.48'	Pleistocene
36	40° 59.08' - 130° 06.58'	Late Miocene*
37	40° 58.74' - 140° 43.11'	Late Pliocene*
38	38° 42.12' - 140° 21.27'	Early Eocene
39	32° 48.28' - 139° 34.29'	Early Eocene*
40	19° 47.57' - 139° 54.08'	Early Eocene
42	13° 50.51' - 140° 11.31'	Middle Eocene

CONCLUSIONS

The geologic epochs represented by coccolith-bearing samples from the cores at Leg 5 sites are given in Table 3; and, the precise age of the oldest sample at each site is shown in Table 4.

The Miocene and Pliocene cores from Leg 5 contain coccolith assemblages that are different from any others yet recovered during the Deep Sea Drilling Project. Cool water associated with the California Current is a likely contributor to the unusual composition of these assemblages. The absence of certain species in the Leg 5 cores indicates that age determinations to be accurate must be less precise than those for the more diverse assemblages known from tropical areas. For example, warm-water assemblages of the

upper Miocene and lower Pliocene can be effectively zoned by the use of such species as *Ceratolithus rugosus*, *C. tricorniculatus*, *Discoaster challengerii*, *D. quintatus*, *D. surculus* and *Reticulofenestra pseudoumbilica*. In the cool-water assemblages of Leg 5, however, a broader zonation must be used because, of these species, only *C. tricorniculatus* and *R. pseudoumbilica* are consistently present. The discoaster populations are dominated by *Discoaster exilis* and *D. variabilis*, both of which show a high degree of intraspecific variation.

Future study of the northern cores (Sites 32, 33, 34, 35 and 36) should add valuable information to aid in the zonation of extra-tropical deposits by calcareous nannoplankton.