9. LATE CRETACEOUS TO PLEISTOCENE CALCAREOUS NANNOFOSSILS FROM THE SOUTH ATLANTIC, DEEP SEA DRILLING PROJECT LEG 73[1]

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ABSTRACT

Six sites were drilled in the South Atlantic on DSDP Leg 73. The sediment recovered ranges in age from Late Cretaceous to Pleistocene. Five sites (519–523) were drilled on the Mid-Atlantic Ridge on Tertiary magnetic anomalies. One site (524) was drilled on the Walvis Ridge on Upper Cretaceous crust. Paleontologic dates agree well with magnetostratigraphic dates at the sites drilled on the Mid-Atlantic Ridge. As on Leg 3, a *Braarudosphaera* chalk is found at Sites 522 and 523 in the Oligocene. At the Walvis Ridge site, Site 524, a continuous section across the Cretaceous/Tertiary boundary was cored. Evidence suggests that the Cretaceous forms found mixed with Danian forms immediately above the boundary are *in situ* and not reworked.

INTRODUCTION

In total, 1000 samples were recovered from six sites that were drilled in the South Atlantic on DSDP Leg 73. The samples were examined for calcareous nannofossils for the purpose of making biostratigraphic age determinations. All samples were studied by light microscopy. The sediments ranged in age from Late Cretaceous to Pleistocene, and almost all contained a very abundant, moderately well preserved nannoflora. Tables 1 to 12 contain the species distribution for each sample and the nannofossil zonation recognized at each site. In the preservation code used in the tables, P = poor, F = fair, and G = good. All frequencies are estimated. The total flora frequencies are as follows: VR (very rare) = 1–4, R (rare) = 5–10, F (frequent) = 11–30, C (common) = 31–50, A (abundant) = 51–100, and VA (very abundant) = >100. The individual species frequencies are as follows: VR (very rare) = 1–2, R (rare) = 3–5, F (frequent) = 6–10, C (common) = 11–25, A (abundant) = 26–50, and VA (very abundant) = >50.

In the discussion below, the information that resulted from the examination of the samples is presented from two different perspectives. First it is organized by calcareous nannofossil zone, with the oldest zones discussed first. Then it is organized by hole and sediment age, with the oldest sediments discussed last.

CALCAREOUS NANNOFOSSIL ZONES

Cretaceous

The Cretaceous nannofossil zones used are those presented by Perch-Nielsen (1977).

Nondiagnostic Zone

Definition. Interval from the first occurrence of *Micula staurophora* to the first occurrence of *Nephrolithus frequens*.

Stratigraphic position. Upper Turonian to Maestrichtian.

Remarks. This zone is found at Hole 524. The low species diversity, poor to fair preservation, and absence of marker species account for the indefinite age determination.

Nephrolithus frequens Zone

Author of marker species. Čepek and Hay, 1969, emend. Perch-Nielsen, 1977.

Definition. Interval from the first occurrence of *Nephrolithus frequens* to the first occurrence of *Micula mura*.

Stratigraphic position. Upper Maestrichtian.

Remarks. This zone occurs as a thin interval in the sediments at Hole 524.

Micula mura Zone

Author of marker species. Martini, 1969, emend. this paper.

Definition. Interval from the first occurrence of *Micula mura* to the first occurrence of *Zygodiscus sigmoides*.

Remarks. The *Micula mura* Zone is found at Hole 524. At this site *Nephrolithus frequens* occurs throughout the range of *M. mura*. The use of the first occurrence of *Zygodiscus sigmoides* is necessitated by the occurrence of an abundance of typical Maestrichtian forms with an abundance of typical Danian forms for a considerable distance above the iridium concentration horizon (Hsü et al., 1982) at Hole 524. It was difficult to decide whether the Maestrichtian forms were reworked or *in situ*. Oxygen-isotope work by Hsü et al. (1982) suggests that the Maestrichtian forms are indeed *in situ*.

Tertiary and Quaternary

The zonation proposed by Martini (1971) is used for the six sites drilled on Leg 73. Zonations developed by Bukry (1973, 1975) and Okada and Bukry (1980) are used in addition to Martini's for the Paleogene sediments of

[1] Hsü, K. J., LaBrecque, J. L., et al., *Init. Repts. DSDP*, 73: Washington (U.S. Govt. Printing Office).

Holes 522 and 523. The author uses the species ranges of Martini (1971) and Bukry (1973).

At times the marker species used by Martini (1971) to define a particular zone are absent. Under these circumstances the author used secondary species to mark a zone, although the range of a secondary species may not be exactly the same as that of the primary species. Zones defined by secondary species are indicated by an asterisk. In the tables one may also find (for example) Zone NN11, followed by NN10/11, finally followed by NN10. In Zone NN10/11 in this sequence, the NN11 marker species is absent but a secondary species is present. Further, neither the marker species for Zone NN10 nor a secondary species is present; therefore, one cannot locate the top of NN10 strictly.

Markalius astroporus Zone, NP1*

Definition. Interval from the last occurrence of Cretaceous species to the first occurrence of *Cruciplacolithus edwardsii*.

Remarks. Herein, this zone is defined as the first occurrence of *Zygodiscus sigmoides* to the first occurrence of *Cruciplacolithus edwardsii* and *Coccolithus pelagicus* at Hole 524. The first occurrence of *Z. sigmoides* is used because of the abundance of Late Cretaceous species with an abundance of typical Danian forms, such as *Markalius astroporus, Thoracosphaera operculata, Neochiastozygus concinnus*, and *Biantholithus sparsus*. Thierstein and Okada (1979) attributed a similar occurrence to benthic mixing. *Cruciplacolithus edwardsii* is in part a junior synonym of *C. tenuis* (Romein, 1979).

Cruciplacolithus edwardsii Zone, NP2

Definition. Interval from the first occurrence of *Cruciplacolithus edwardsii* to the first occurrence of *Chiasmolithus danicus*.

Remarks. As at Hole 524, this zone is identified as the interval from the first occurrence of *Cruciplacolithus edwardsii* and *Coccolithus pelagicus* to the first occurrence of *Chiasmolithus danicus*.

Chiasmolithus danicus Zone, NP3

Definition. Interval from the first occurrence of *Chiasmolithus danicus* to the first occurrence of *Ellipsolithus macellus*.

Remarks. The above definition is followed in the identification of the zone at Hole 524.

Ellipsolithus macellus Zone, NP4

Definition. Interval from the first occurrence of *Ellipsolithus macellus* to the first occurrence of *Fasciculithus tympaniformis*.

Remarks. The primary guide species are used to recognize this zone at Hole 524.

Fasciculithus tympaniformis Zone, NP5

Definition. Interval from the first occurrence of *Fasciculithus tympaniformis* to the first occurrence of *Heliolithus kleinpellii*.

Remarks. At Hole 524 the above zonal definition is followed.

Heliolithus kleinpellii Zone, NP6

Definition. Interval from the first occurrence of *Heliolithus kleinpellii* to the first occurrence of *Discoaster mohleri*.

Remarks. Both of the above species occur in their anticipated order at Hole 524.

Discoaster mohleri Zone, NP7*

Definition. Interval from the first occurrence of *Discoaster mohleri* to the first occurrence of *Heliolithus riedeli*.

Remarks. Since *Heliolithus riedeli* is absent at Hole 524, the extinction datum of *Heliolithus kleinpellii* is used to approximate the upper boundary. The lower boundary is placed at the first occurrence of *Discoaster mohleri*.

Heliolithus riedeli Zone, NP8*

Definition. Interval from the first occurrence of *Heliolithus riedeli* to the first occurrence of *Discoaster multiradiatus*.

Remarks. As stated previously, *Heliolithus riedeli* is absent at Hole 524; therefore, the horizon at the extinction datum of *Heliolithus kleinpellii* is chosen to be the lower boundary. The upper boundary is delineated by the first appearance of *Discoaster multiradiatus*.

Discoaster multiradiatus Zone, NP9*

Definition. Interval from the first occurrence of *Discoaster multiradiatus* to the first occurrence of *Tribrachiatus bramlettei*.

Remarks. *Tribrachiatus bramlettei* is absent at Hole 524 and Hole 524A; thus, the last occurrence of the secondary species *Discoaster mohleri* is used to define the upper boundary. The lower boundary remains the same.

Tribrachiatus contortus Zone, NP10*

Definition. Interval from the first occurrence of *Tribrachiatus bramlettei* to the last occurrence of *T. contortus*.

Remarks. Since both primary species are absent at Holes 524, 524A, and 524B, the extinction datum of the secondary species *Discoaster mohleri* is used as the base and the last occurrence of *D. multiradiatus* as the top. The top was not encountered at Holes 524A and 524B.

Discoaster binodosus Zone, NP11*

Definition. Interval from the last occurrence of *Tribrachiatus contortus* to the first occurrence of *Discoaster lodoensis*.

Remarks. At Hole 524, *Tribrachiatus contortus* is missing, and the last occurrence of *Discoaster multiradiatus* is used as the base. For the top, the first occurrence of *D. lodoensis* is used. At Hole 524B NP11 is missing.

Tribrachiatus orthostylus Zone, NP12

Definition. Interval from the first occurrence of *Discoaster lodoensis* to the last occurrence of *Tribrachiatus orthostylus*.

Remarks. According to the above definition this zone was recognized at Holes 524 and 524B. The top is not reached at Hole 524.

Discoaster lodoensis Zone, NP13

Definition. Interval from the last occurrence of *Tribrachiatus orthostylus* to the first occurrence of *Discoaster sublodoensis*.

Remarks. As defined above, the base of this zone is found at Hole 524B; however, the top is not reached.

Discoaster sublodoensis Zone, NP14

Definition. Interval from the first occurrence of *Discoaster sublodoensis* to the first occurrence of *Nannotetrina fulgens*.

Remarks. This zone is not recognized at any of the sites.

Nannotetrina fulgens Zone, NP15*

Definition. Interval from the first occurrence of *Nannotetrina fulgens* to the last occurrence of *Rhabdolithus gladius.*

Remarks. At Hole 523, the base of this zone was not reached, and the last occurrence of *Chiasmolithus gigas* is used to approximate the top, since *Rhabdolithus gladius* is absent. This interval at Hole 523 equals the CP13b *C. gigas* Subzone of the CP13 *Nannotetrina fulgens* Zone of Okada and Bukry (1980).

Nannotetrina fulgens, NP15/*Discoaster tani nodifer* Zone, NP16

Remarks. This interval at Hole 523 is characterized by the presence of *Nannotetrina fulgens* without *Rhabdolithus gladius* and *Chiasmolithus gigas.* It correlates with the CP13c *Coccolithus staurion* Subzone of the CP13 *N. fulgens* Zone of Okada and Bukry (1980).

Discoaster tani nodifer Zone, NP16*

Definition. Interval from the last occurrence of *Rhabdolithus gladius* to the last occurrence of *Chiasmolithus solitus*.

Remarks. At Hole 523 the lower boundary is recognized by the last occurrence of *Nannotetrina fulgens.* The upper boundary is picked on the primary species mentioned above. This interval equals the upper part of the CP13c *Coccolithus staurion* Subzone of the CP13 *N. fulgens* Zone and the CP14a *Discoaster bifax* Subzone of the CP14 *Reticulofenestra umbilica* Zone of Okada and Bukry (1980).

Discoaster saipanensis Zone, NP17*

Definition. Interval from the last occurrence of *Chiasmolithus solitus* to the first occurrence of *C. oamaruensis*.

Remarks. The base of the zone at Hole 523 agrees with the definition of the zone. However, because of the rarity of *Chiasmolithus oamaruensis* the top is picked on the extinction of *C. grandis*. The interval correlates with the CP14b *Discoaster saipanensis* Subzone of the CP14 *Reticulofenestra umbilica* Zone of Okada and Bukry (1980).

Chiasmolithus oamaruensis Zone, NP18*

Definition. Interval from the first occurrence of *Chiasmolithus oamaruensis* to the first occurrence of *Isthmolithus recurvus*.

Remarks. As mentioned previously, the extinction of *Chiasmolithus grandis* is used for the base at Hole 523. The top is placed at the first occurrence of *Isthmolithus recurvus.* This interval equals much of the CP15a *C. oamaruensis* Subzone of the CP15 *Discoaster barbadiensis* Zone of Okada and Bukry (1980).

Isthmolithus recurvus Zone, NP19

Definition. Interval from the first occurrence of *Isthmolithus recurvus* to the first occurrence of *Sphenolithus pseudoradians.*

Remarks. This primary marker is present at Hole 523. This interval is extremely short and correlates with a small part of the CP15a *Chiasmolithus oamaruensis* Subzone of the CP15 *Discoaster barbadiensis* Zone of Okada and Bukry (1980).

Sphenolithus pseudoradians Zone, NP20

Definition. Interval from the first occurrence of *Sphenolithus pseudoradians* to the last occurrence of *Discoaster saipanensis*.

Remarks. The above definition is used to recognize this zone at Hole 523. At Holes 522, 522A, and 522B the base was not reached. This interval equals a small upper part of the CP15a *Chiasmolithus oamaruensis* Subzone and all of the CP15b *Isthmolithus recurvus* Subzones of the CP15 *Discoaster barbadiensis* Zone of Okada and Bukry (1980).

Ericsonia subdisticha Zone, NP21

Definition. Interval from the last occurrence of *Discoaster saipanensis* to the last occurrence of *Coccolithus formosus*.

Remarks. The above definition is used to identify this zone at Holes 522, 522A, and 523. This zone correlates with the CP16a *Ericsonia subdisticha* Subzone and the CP16b *Coccolithus formosus* Subzone of the CP16 *Helicosphaera reticulata* Zone of Okada and Bukry (1980).

Helicosphaera reticulata Zone, NP22

Definition. Interval from the last occurrence of *Coccolithus formosus* to the last occurrence of *Reticulofenestra umbilica.*

Remarks. At Holes 522, 522A, 522B, and 523 the above definition is used. The top and base are not reached at Hole 522B. This interval equals the CP16c *Reticulofenestra hillae* Subzone of the CP16 *Helicosphaera reticulata* Zone of Okada and Bukry (1980).

Sphenolithus predistentus Zone, NP23*

Definition. Interval from the last occurrence of *Reticulofenestra umbilica* to the first occurrence of *Sphenolithus ciperoensis.*

Remarks. The above definition is used at Holes 522 and 522A. However, *Sphenolithus ciperoensis* is extremely rare at Hole 523; therefore, the extinction of *S.*

pseudoradians is used. The latter species has its last occurrence well within NP23. This interval correlates with the CP17 *S. predistentus* Zone and CP18 *S. distentus* Zone of Okada and Bukry (1980).

Sphenolithus distentus Zone, NP24*

Definition. Interval from the first occurrence of *Sphenolithus ciperoensis* to the last occurrence of *S. distentus.*

Remarks. At Holes 522 and 522A the above definition is followed. At Hole 523, as mentioned previously, the last occurrence of *Sphenolithus pseudoradians* is used as the base. This zone correlates with the CP19a *Cyclicargolithus floridanus* Subzone of the CP19 *S. ciperoensis* Zone of Okada and Bukry (1980).

Sphenolithus ciperoensis Zone, NP25*

Definition. Interval from the last occurrence of *Sphenolithus distentus* to the last occurrence of *Helicosphaera recta.*

Remarks. The above definition is used to determine the base at Holes 522, 522A, and 523. However, the extinction of *Dictyococcites bisectus* is used to determine the top. This zone equals the CP19b *D. bisectus* Subzone of the CP19 *Sphenolithus ciperoensis* Zone of Okada and Bukry (1980).

Triquetrorhabdulus carinatus Zone, NN1*

Definition. Interval from the last occurrence of *Helicosphaera recta* to the first occurrence of *Discoaster druggi.*

Remarks. Again the secondary species *Dictyococcites bisectus* is used for the base of this zone at Holes 522, 522A and 523. The last occurrence of *Coccolithus eopelagicus* is used for the top at Holes 522A and 523. The first occurrence of *Discoaster druggi* is used for Hole 522.

Discoaster druggi, NN2/*Sphenolithus belemnos* Zone, NN3*

Remarks. This interval is characterized by the total range of *Discoaster druggi* at Hole 522. This species is the marker for the base of NN2. The extinction of *Sphenolithus belemnos* is the marker species for the top of NN3; however, it is absent at Hole 522.

Sphenolithus belemnos, NN3/*Sphenolithus heteromorphus* Zone, NN5*

Remarks. For this interval the total range of *Sphenolithus heteromorphus* is used at Hole 522. The base of NN3 was defined by Martini (1971) as the last occurrence of *Triquetrorhabdulus carinatus* and the top of NN5 as the last occurrence of *S. heteromorphus.*

Helicosphaera ampliaperta Zone, NN4*

Definition. Interval from the last occurrence of *Sphenolithus belemnos* to the last occurrence of *Helicosphaera ampliaperta.*

Remarks. The top is identified at Holes 521 and 521A by using the last occurrence of *Helicosphera euphratis*, which has the same top as *H. ampliaperta.* The base was not reached.

Helicosphaera ampliaperta, NN4/*Discoaster exilis* Zone, NN6*

Remarks. This interval is identified by the author at Hole 523 as the interval from the first occurrence of *Discoaster braarudii* to the last occurrence of *D. deflandrei.* The base of NN4 is usually identified as the last occurrence of *Sphenolithus belemnos.*

Sphenolithus heteromorphus Zone, NN5*

Definition. Interval from the last occurrence of *Helicosphaera ampliaperta* to the last occurrence of *Sphenolithus heteromorphus.*

Remarks. The base was not reached at Hole 520. At Holes 521 and 521A the base is characterized by the last occurrence of *Helicosphaera euphratis.*

Discoaster exilis Zone, NN6*

Definition. Interval from the last occurrence of *Sphenolithus heteromorphus* to the first occurrence of *Discoaster kugleri.*

Remarks. At Holes 520 and 521, this zone is identified by the extinction of *Sphenolithus heteromorphus* at the base and the extinction of the secondary species *Discoaster deflandrei* at the top.

Discoaster kugleri Zone, NN7*

Definition. Interval from the first occurrence of *Discoaster kugleri* to the first occurrence of *Catinaster coalitus.*

Remarks. This zone is identified herein as the total range of *Discoaster kugleri* at Hole 520 because there is no overlap of *D. kugleri* and *Catinaster coalitus.*

Discoaster kugleri, NN7/*Catinaster coalitus* Zone, NN8*

Remarks. This interval lies between the last occurrence of *Discoaster kugleri* and the first occurrence of *Catinaster coalitus* at Hole 520. This interval would normally be characterized by the first occurrence of *D. kugleri* at its base and the first occurrence of *D. hamatus* at its top.

Catinaster coalitus, NN8/*Discoaster calcaris* Zone, NN10*

Remarks. The base of this interval is defined by the first occurrence of *Catinaster coalitus;* the top, by the first occurrence of *Discoaster quinqueramus.* This is the definition used at Hole 520.

Discoaster hamatus, NN9/*Discoaster calcaris* Zone, NN10*

Remarks. At Hole 521A this interval is recognized as the total range of *Discoaster prepentaradiatus*, inasmuch as both *D. hamatus* and *D. quinqueramus*, the first occurrences of which indicate the base and top respectively, are absent.

Discoaster calcaris Zone, NN10*

Definition. Interval from the last occurrence of *Discoaster hamatus* to the first occurrence of *D. quinqueramus.*

Remarks. At Hole 520 the last occurrence of *Catinaster calyculus* is used as a top NN10 marker species, and the first occurrence of *Discoaster quinqueramus* is used as a base marker species for NN11. Since *D. quinqueramus* is absent at Hole 521A, the extinction of *D. prepentaradiatus* is used to define the top of NN10. Similarly, at Hole 519 *D. quinqueramus* is not present, and the last occurrence of *D. prepentaradiatus* and *C. calyculus* is used to indicate NN10. There is an apparent discrepancy in the lower range of *C. calyculus* that is resolved by considering the lower range at Hole 519 to be latitudinally controlled.

Discoaster calcaris, NN10/*Discoaster quinqueramus* Zone, NN11*

Remarks. At Hole 519 *Discoaster hamatus* and *D. quinqueramus* are absent, so this interval is defined as being from the last occurrence of *Catinaster calyculus* to the first occurrence of *Amaurolithus primus.*

Discoaster quinqueramus Zone, NN11*

Definition. Interval from the first to the last occurrence of *Discoaster quinqueramus.*

Remarks. Three different definitions of this zone are used. The primary definition (cited above) is used at Holes 520, 521, and 522. At Hole 519 the definition used is the interval from the first occurrence of *Amaurolithus primus* to the first occurrence of *A. amplificus.* At Holes 521 and 523 the definition used is the interval from the first occurrence of *Discoaster surculus* to the first occurrence of *A. delicatus.*

Discoaster quinqueramus, NN11/*Amaurolithus tricorniculatus* Zone, NN12*

Remarks. At Holes 519 and 519A, the author defines this interval as that between the first and last occurrence of *Amaurolithus amplificus.* At Hole 522 the interval is defined as being from the first occurrence of *Amaurolithus primus* and *A. delicatus* to the first occurrence of *Ceratolithus rugosus.* At Hole 523 this zone is defined as the interval from the first occurrence of *A. delicatus* to the first occurrence of *C. rugosus.* Both of these horizons are well within the boundaries of the zones they delimit.

Amaurolithus tricorniculatus Zone, NN12

Definition. Interval from the last occurrence of *Discoaster quinqueramus* to the first occurrence of *Ceratolithus rugosus.*

Remarks. The definition above is used at Holes 520 and 521. At Hole 519 the lower boundary is placed on the last occurrence of *Amaurolithus amplificus.*

Ceratolithus rugosus Zone, NN13

Definition. Interval from the first occurrence of *Ceratolithus rugosus* to the first occurrence of *Discoaster asymmetricus.*

Remarks. The type definition is used to recognize this zone at Holes 519, 519A, 521, and 522.

Discoaster asymmetricus Zone, NN14

Definition. Interval from the first occurrence of *Discoaster asymmetricus* to the last occurrence of *Amaurolithus tricorniculatus.*

Remarks. The above definition is used to identify this zone at Holes 519, 519A, 520, 522, and 523.

Discoaster asymmetricus, NN14/*Reticulofenestra pseudoumbilica* Zone, NN15*

Remarks. The last occurrence of *Amaurolithus tricorniculatus* defines the boundary between NN14 and NN15. Since this species is rare at Hole 521, the NN14/15 boundary is difficult to define.

Reticulofenestra pseudoumbilica Zone, NN15

Definition. Interval from the last occurrence of *Amaurolithus tricorniculatus* to the last occurrence of *Reticulofenestra pseudoumbilica.*

Remarks. The type definition is used at Holes 519, 519A, 520, 522, and 523.

Pseudoemiliania lacunosa Zone, NN19

Definition. Interval from the last occurrence of *Discoaster brouweri* to the last occurrence of *Pseudoemiliania lacunosa.*

Remarks. The above definition is used to recognize this zone at Holes 519, 520, 521, 522, and 523.

Gephyrocapsa oceanica Zone, NN20

Definition. Interval from the last occurrence of *Pseudoemiliania lacunosa* to the first occurrence of *Emiliania huxleyi.*

Remarks. The type definition is used to identify this zone at Hole 512, 520, 521, 522, and 523.

Emiliania huxleyi Zone, NN21

Definition. Interval above the first occurrence of *Emiliania huxleyi.*

Remarks. The above definition is used to identify this zone at Hole 519. Since this zone is normally thin in open-ocean sediments, it can often be missed during sampling.

SITE SUMMARIES

Six sites were drilled on DSDP Leg 73. More than one hole was drilled at some sites. Five of the sites drilled were on the Mid-Atlantic Ridge and one site drilled was on the Walvis Ridge. Each hole is discussed separately below.

Hole 519

Hole 519 was drilled on the Mid-Atlantic Ridge at 26°08.20′S, 11°39.97′W in 3769 m of water. Thirty-six hydraulic piston cores were taken in 151.5 m of sediment, and one was taken in basement. All sediment cores contain a moderately well to well preserved, very abundant calcareous nannoflora. Sediments range in age from Pleistocene to late Miocene. The hole is located on a negative magnetic anomaly between Anoma-

lies 5 and 5A. The assumed age is 9.8 m.y. The oldest calcareous nannofossil zone recovered is the NN10 *Discoaster calcaris* Zone*, if the first occurrences of the *Catinaster* spp. in this hole are not synchronous with their first occurrences in the Pacific. Such an interpretation would render the biostratigraphy in general agreement with the previously established magnetostratigraphy. An alternative interpretation assuming synchroneity of the first occurrences of the *Catinaster* spp. is discussed in the synthesis chapter (Hsü, Percival, et al., this vol.). Extensive slumping occurred at this site, so that the first 20 cores are stratigraphically mixed. The calcareous nannoflora of Pleistocene, Pliocene, and late Miocene age is mixed. Table 1 shows the stratigraphic distribution of calcareous nannofossils at Hole 519.

Pleistocene

The upper part of Section 519-1-1 contains an abundance of *Emiliania huxleyi*, which restricts it to the NN21 *E. huxleyi* Zone. The interval from the lower part of Section 519-1-1 to Section 519-2-3 represents the NN20 *Gephyrocapsa oceanica* Zone. This zone is recognized by the absence of both *E. huxleyi* and *Pseudoemiliania lacunosa*. The interval from Sample 519-2,CC to Section 519-11-1 contains *P. lacunosa*, which is the marker species for the NN19 *P. lacunosa* Zone. This interval also contains slumped sediments that can be assigned to Zones NN16, NN13, and NN11/12.

Pliocene

The interval from Section 519-11-2 to 519-12-2 is interpreted to be the NN18 *Discoaster brouweri* Zone. *D. brouweri* and *D. triradiatus* are abundant in this interval. A thin NN17 *D. pentaradiatus* Zone is found at Section 519-12-3, as indicated by the presence of the nominate species. From Sample 519-12,CC to Section 519-18-2, the NN16 *D. surculus* Zone is encountered. *D. surculus, D. pentaradiatus*, and *D. brouweri* are very abundant throughout this interval. In the middle of this interval the extinction datum of *D. asymmetricus* and *D. tamalis* occurs. Again, there is mixing of upper Miocene (NN11/12) sediments. The top of the early Pliocene NN15 *Reticulofenestra pseudoumbilica* Zone is found at Section 519-18-3, on the basis of the last occurrence of *R. pseudoumbilica*. This zone covers the interval from Section 519-18-3 to 519-21-2. *D. tamalis* has its first appearance within Section 519-19-2. The NN14 *D. asymmetricus* Zone is defined as the interval from the first occurrence of *D. asymmetricus* to the last occurrence of *Amaurolithus tricorniculatus*. These events indicate the zone that covers the interval from Section 519-21-3 to Sample 519-23,CC. From Section 519-24-1 to Sample 519-26,CC *Ceratolithus rugosus* is found without *D. asymmetricus*, which indicates the NN13 *C. rugosus* Zone. The absence of *C. rugosus* and *A. amplificus* from Section 519-27-1 to 519-28-1 suggests that the upper part of the NN12 *A. tricorniculatus* Zone, which is basal Pliocene, is present.

Miocene

The Miocene/Pliocene boundary is placed at the extinction datum of *Amaurolithus amplificus*. The interval from Section 519-28-2 to 519-29-2 is assigned to the NN11 *Discoaster quinqueramus*/NN12 *A. tricorniculatus* Zone* on the basis of the total range of *A. amplificus*. *D. quinqueramus*, the NN11 marker species, is very rare within Section 519-29-2. The first occurrence of *A. primus* and *A. delicatus*, as seen in Sample 519-29,CC, occurs in the middle of NN11. The interval from Section 519-30-1 to 519-33-1 belongs to the NN10 *D. calcaris*/NN11 *D. quinqueramus* Zone* undifferentiated. This assignment is suggested by the absence of *Catinaster calyculus* and *D. prepentaradiatus*. The concurrence of the latter two species marks the top of the NN10 Zone* at Section 519-33-2. The interval from Section 519-33-2 to Sample 519-36,CC belongs to the NN10 *D. calcaris* Zone* since *D. hamatus*, the NN9 *D. hamatus* Zone marker species, was not found. The first occurrence of *C. calyculus* may be latitudinally controlled here; it normally first appears within the NN8 *C. coalitus* Zone of middle Miocene age.

Hole 519A

Hole 519A was drilled on the Mid-Atlantic Ridge at 26°08.20′S, 11°39.97′W in 3769 m of water. Four rotary cores were taken intermittently in 150.5 m of sediments, and two were taken in basalt. Calcareous nannofossils are very abundant and moderately well to well preserved. Sediments range in age from Pliocene to late Miocene. Extensive slumping occurred at the hole; the four cores studied contain a mixed Pliocene and late Miocene nannoflora. Table 2 shows the stratigraphic distribution of the calcareous nannofossils at Hole 519A.

Pliocene

The NN16 *Discoaster surculus*/NN15 *Reticulofenestra pseudoumbilica* Zone boundary occurs between Sample 519A-1,CC and Section 519A-2-1. This boundary is recognized by the last occurrence of *R. pseudoumbilica*. Immediately below Section 519A-2-1 the sediments are slumped, and a mixed late Miocene and Pliocene nannoflora is visible.

Hole 520

Hole 520 was drilled on the Mid-Atlantic Ridge at 25°31.40′S, 11°11.14′W in 4217 m of water. Thirty-one rotary cores were taken in 449 m of sediment. The Pleistocene and Pliocene sections were spot cored and the Miocene was continuously cored. The sediments range in age from Pleistocene to middle Miocene. The hole is located on the younger boundary of Anomaly 5B (Epoch 15). The oldest calcareous nannofossil zone recovered is the NN5 *Sphenolithus heteromorphus* Zone*, which correlates with Anomaly 5B or Epoch 15. Table 3 shows the stratigraphic distribution of the calcareous nannofossils at Hole 520.

Pleistocene

In the interval from Sample 520-1,CC to 520-2,CC the NN19 *Pseudoemiliania lacunosa* Zone is present. *P. lacunosa* is very abundant, and *Discoaster brouweri* is absent.

Pliocene

The top of Core 3 is assigned to the NN16 *Discoaster surculus* Zone on the basis of the occurrence of *D. brouweri, D. pentaradiatus*, and *D. surculus*. The bottom of Core 4 is interpreted to be the early Pliocene NN15 *Reticulofenestra pseudoumbilica* Zone. *R. pseudoumbilica* is present. The NN14 *D. asymmetricus* Zone occurs from Section 520-5-1 to Sample 520-6,CC, as indicated by the concurrence of *Amaurolithus tricorniculatus* and *D. asymmetricus*.

Miocene

The next zone encountered is the NN12 *Amaurolithus tricorniculatus* Zone*, which is in the upper part of Section 520-8-2. It is recognized by the absence of *Ceratolithus rugosus* and *Discoaster quinqueramus*. This section is placed in the lower part of NN12, as indicated by the presence of *A. amplificus*. The interval from the lower part of Section 520-8-2 to Section 520-26-2 is placed in the NN11 *D. quinqueramus* Zone. The total range of *D. quinqueramus* defines this zone. The absence of *D. quinqueramus* and *Catinaster calyculus* correlates to the interval from Sample 520-26,CC to 520-29-1, 10–11 cm; that is, to the NN10 *D. calcaris* Zone*. The interval from Sample 520-29-1, 20–21 cm to 520-29-1, 110–111 cm is interpreted as the NN8 *C. coalitus*/NN10 *D. calcaris* Zone* undifferentiated on the basis of the occurrence of *C. calyculus* and *C. coalitus*. The interval from Sample 520-29-1, 120–121 cm to 520-29-1, 138–139 cm represents the NN7 *D. kugleri*/NN8 *C. coalitus* Zone* undifferentiated because of the absence of *D. kugleri* and *C. coalitus*. *D. kugleri* is present in the interval from Sample 520-29-1, 140–141 cm to 520-29-1, 149–150 cm. This interval is interpreted to belong to the NN7 *D. kugleri* Zone*. The NN6 *D. exilis* Zone* is recognized by the occurrence of *D. deflandrei* between Sample 520-29-2, 0 cm and 520-29-2, 49–50 cm. The NN5 *Sphenolithus heteromorphus* Zone occurs from Sample 520-29-2, 60–62 cm to 520-30-1, 50–51 cm on the basis of the occurrence of *S. heteromorphus*. The base of this zone was not reached.

Hole 521

Hole 521 was drilled on the Mid-Atlantic Ridge at 26°04.45′S, 10°15.87′W in 4141 m of water. Twenty-one hydraulic piston cores were taken continuously in 84 m of sediment to basement. Almost all samples contain a very abundant, moderately well to well preserved calcareous nannoflora. However, the last five cores contain a poorly preserved nannoflora. The sediments range in age from Pleistocene to middle Miocene. The hole was located on Anomaly 5C (Epoch 16), with an assumed age of 17 m.y. The oldest nannofossil zone recognized is the NN4 *Helicosphaera ampliaperta* Zone*, which correlates with Epoch 16. Table 4 shows the stratigraphic distribution of the calcareous nannofossils at Hole 521.

Pleistocene

The sample from Section 521-1-1 represents the NN20 *Gephyrocapsa oceanica* Zone, as indicated by the absence of both *Emiliania huxleyi* and *Pseudoemiliania lacunosa*. The interval from Section 521-1-2 to 521-4-1 is assigned to the NN19 *P. lacunosa* Zone. The nominate species is very abundant in this interval.

Pliocene

Discoaster brouweri is very abundant from Section 521-4-2 to 521-5-2 and is indicated as the NN18 *D. brouweri* Zone. The top of the next zone, the NN17 *D. pentaradiatus* Zone, is characterized by the last occurrence of *D. pentaradiatus*, as seen in Section 521-5-3. The NN16 *D. surculus* Zone is present from Sample 521-5,CC to Section 521-9-2, where *D. surculus* Zone is very abundant. *D. tamalis* and *D. asymmetricus* have their extinction near the top of Section 521-6-3. The interval from Section 521-9-3 to 521-10-2 is assigned to the NN14 *D. asymmetricus*/NN15 *Reticulofenestra pseudoumbilica* Zone* undifferentiated because the NN14/NN15 boundary species *Amaurolithus tricorniculatus* is so rare. *R. pseudoumbilica* and *D. asymmetricus* are also present in this interval. The absence of the latter species and the presence of *Ceratolithus rugosus* defines the NN13 *C. rugosus* Zone for the interval from Section 521-10-3 to 521-11-2.

Miocene

Amaurolithus amplificus defines the lower (Miocene) part of the NN12 *A. tricorniculatus* Zone, which spans the interval from Section 521-11-2 to 521-11-3. Sample 521-11,CC correlates with the NN11 *Discoaster quinqueramus* Zone* on the basis of the occurrence of *D. quinqueramus*. The interval from Section 521-12-1 to Sample 521-13,CC represents the NN11 Zone*, which is characterized by the presence of *D. surculus* and absence of *Catinaster calyculus*. The NN8 *C. coalitus*/NN10 *D. calcaris* Zone* undifferentiated is identified from Section 521-14-1 to Sample 521-14,CC by the presence of *C. calyculus* and *C. coalitus*. The last occurrence of *D. deflandrei* characterizes the top of the NN6 *D. exilis* Zone*. This zone occurs from Section 521-16-1 to Sample 521-16,CC. The NN5 *Sphenolithus heteromorphus* Zone* is found from Section 521-17-1 to 521-20-3. *S. heteromorphus* is abundant throughout this interval. Samples 521-20,CC and 521-21,CC represent the NN4 *Helicosphaera ampliaperta* Zone*, as indicated by the last occurrence of *H. euphratis*. The base of this zone was not reached.

Hole 521A

Hole 521A was drilled on the Mid-Atlantic Ridge at 26°04.54′S, 10°15.59′W (southeast of Hole 521) in 4125 m of water. Seventeen hydraulic piston cores were taken continuously in 71.1 m of sediment. All sediments except the bottom six cores contain a very abundant, moderately well preserved calcareous nannoflora. The bottom six cores contain a very abundant, poorly preserved nannoflora. Sediments range in age from Pleistocene to middle Miocene. This hole was located on Anomaly 5C. As at Hole 521, the calcareous nannofossil zone (NN4 *Helicosphaera ampliaperta* Zone) agrees with the paleomagnetic stratigraphy. Table 5 shows the stratigraphic distribution of the calcareous nannofossils at

Hole 521A. Only core-catcher samples were examined by the author, but a detailed shore-based study was carried out by von Salis (this vol.).

Pleistocene

The interval from Sample 521A-1,CC to 521A-3,CC represents the NN19 *Pseudoemiliania lacunosa* Zone, as indicated by the abundant occurrence of *P. lacunosa*.

Pliocene

The NN17 *Discoaster pentaradiatus* Zone occurs in Sample 521A-5,CC, where the nominate species is common. The interval from Sample 521A-6,CC to 521A-7,CC is assigned to the NN16 *D. surculus* Zone. The top of this zone is recognized by the last occurrence of *D. surculus*. In Sample 521A-8,CC, the early Pliocene NN14 *D. asymmetricus*/NN15 *Reticulofenestra pseudoumbilica* Zone* undifferentiated was found. The sample contains diagnostic species, such as *R. pseudoumbilica* and *D. asymmetricus* but lacks *Amaurolithus tricorniculatus*, the NN14/NN15 boundary species. The NN13 *Ceratolithus rugosus* Zone was found in Sample 521A-9,CC. *C. rugosus* occurs frequently, and the NN14 marker species, *D. asymmetricus*, is absent.

Miocene

The Miocene/Pliocene boundary is placed at the extinction of *Amaurolithus amplificus* in the NN12 *A. tricorniculatus* Zone*, which occurs in Sample 521A-10,CC. The NN10 *Discoaster calcaris* Zone*, which occurs in Sample 521A-11,CC, is characterized by the absence of *D. quinqueramus*. Sample 521A-12,CC correlates with the NN9 *D. hamatus*/NN10 *D. calcaris* Zone* undifferentiated on the basis of the occurrence of *D. prepentaradiatus*. *Sphenolithus heteromorphus*, the species used for the top of the NN5 *S. heteromorphus* Zone*, is present in the core-catcher samples from Cores 13 to 16. Sample 521A-17,CC contains *Helicosphaera euphratis*, which is the secondary index species for the NN4 *H. ampliaperta* Zone*.

Hole 522

Hole 522 was drilled on the Mid-Atlantic Ridge at 24°06.843′S, 05°07.784′W in 4441 m of water. Thirty-nine hydraulic piston cores were taken continuously in 148.7 m of sediment. Basement was not reached. Samples from Cores 1 to 12 contain a moderately well to well preserved, very abundant calcareous nannoflora. Cores 13 through 39 contain poorly preserved nannofossils. Sediments range in age from Pleistocene to late Eocene. The hole was located on Anomaly 16. The oldest calcareous nannofossil zone recognized was the NP20 *Sphenolithus pseudoradians* Zone, which is in agreement with Anomaly 16. Two *Braarudosphaera* chalk horizons found at this site are assigned to the NP23 *S. predistentus* Zone. Some Pliocene mixing with Pleistocene occurs in Cores 1 through 3. Table 6 shows the stratigraphic distribution of the calcareous nannofossils from Hole 522.

Pleistocene

The sample from Section 522-1-1 represents the NN20 *Gephyrocapsa oceanica* Zone. This sample lacks *Pseudoemiliania lacunosa* and *Emiliania huxleyi*. The occurrence of *P. lacunosa* in the interval from Section 522-1-2 to Sample 522-3,CC assigns this interval to the NN19 *P. lacunosa* Zone. Sediments from the late Pliocene NN18 *Discoaster brouweri* Zone are intermixed with NN19 in this interval.

Pliocene

Discoaster brouweri is present in the sample from Section 522-4-1, which indicates the NN18 *D. brouweri* Zone. The interval from Section 522-4-3 to Sample 522-6,CC is NN16 *D. surculus* Zone in age. Very abundant *D. surculus, D. brouweri*, and *D. pentaradiatus* are found in this interval. *D. tamalis* has its last occurrence in the sample from Section 522-5-2. The early Pliocene NN15 *Reticulofenestra pseudoumbilica* Zone is found from Section 522-7-2 to Sample 522-8,CC. *R. pseudoumbilica*, the marker species for NN15, is very abundant throughout this interval. The only occurrence of *Amaurolithus tricorniculatus* characterizes the top of the NN14 *D. asymmetricus* Zone, which occurs in Section 522-9-1. The NN13 *Ceratolithus rugosus* Zone is present from Section 522-9-2 to 522-9-3. This interval is characterized by the occurrence of *C. rugosus* and absence of *D. asymmetricus*.

Miocene

The Miocene/Pliocene boundary is placed within the NN11 *Discoaster quinqueramus*/NN12 *Amaurolithus tricorniculatus* Zone*, which is found in Sample 522-9,CC. The first occurrence of *A. primus* and *A. delicatus* define the base of the zone in Section 522-10-1. The NN11 *D. quinqueramus* Zone* is found in Section 522-10-3 after an indeterminate interval at 522-10-2. The first appearance of the secondary marker species, *D. surculus*, is encountered in Section 522-10-3. The interval from Sample 522-10,CC to Section 522-12-1 is barren of calcareous nannofossils, so that the lower limit of NN11 cannot be determined with certainty. The total range of *Sphenolithus heteromorphus* is used to define the NN3 *S. belemnos*/NN5 *S. heteromorphus* Zone* from Section 522-12-2 to Sample 522-13,CC. Similarly, the total range of *D. druggi* is used to define the NN2 *D. druggi*/NN3 *S. belemnos* Zone* from Section 522-14-1. The NN1 *Triquetrorhabdulus carinatus* Zone* is recognized by the absence of *D. druggi* and Oligocene species, such as *Dictyococcites bisectus* or *D. scrippsae*. This zone is found from Section 522-14-2 to 522-15-1.

Oligocene

The Oligocene/Miocene boundary is defined herein as the top of the NP25 *Sphenolithus ciperoensis* Zone*, which is recognized by the last occurrence of *Dictyococcites bisectus*. The extinction of *S. distentus* characterizes the top of the NP24 *S. distentus* Zone. The NP25

Zone covers the interval from Section 522-15-2 to 522-20-2. The concurrence of *S. ciperoensis* and *S. distentus* throughout the interval from Sample 522-20,CC to Section 522-22-3 restricts this section to the NP24 *S. distentus* Zone*. The occurrences of *S. distentus* above Sample 522-20,CC are considered reworked. The NP23 *S. predistentus* Zone* can be distinguished by the absence of *S. ciperoensis* and the last occurrence of *Reticulofenestra umbilica* at its base. This zone covers the interval from Sample 522-22,CC to Section 522-31-2. Two horizons of *Braarudosphaera* chalk were encountered in Cores 23 and 25. From Section 522-31-3 to 522-32-3 the NP22 *Helicosphaera reticulata* Zone is found. It contains *R. umbilica*. The NP21 *Ericsonia subdisticha* Zone is recognized from Sample 522-32,CC to Section 522-36-3. *Coccolithus formosus* has its last occurrence at the top of the NP21 Zone.

Eocene

The Eocene/Oligocene boundary is characterized by the last appearance of *Discoaster saipanensis*, which marks the top of the NP20 *Sphenolithus pseudoradians* Zone. This horizon occurs in Sample 522-36,CC. The NP20 Zone continues down to Sample 522-39,CC.

Hole 522A

Hole 522A was drilled on the Mid-Atlantic Ridge at 26°06.843′S, 05°07.784′W to recover a complete Oligocene/Eocene section for future paleomagnetic and paleontologic studies. The hole was drilled in 4441 m of water. Thirty-one hydraulic piston cores were taken continuously from early Miocene to basement. All samples contain a poorly preserved, very abundant calcareous nannoflora. The oldest calcareous nannofossil zone recognized is the NP20 *Sphenolithus pseudoradians* Zone, which correlates with Anomaly 16. This is in agreement with the paleomagnetic record, which determined the site to be on Anomaly 16. Two layers of *Braarudosphaera* chalk were encountered in the NP23 *S. predistentus* Zone. Table 7 shows the stratigraphic distribution of the calcareous nannofossils at Hole 552A. Most of the samples examined from this site were core-catcher samples.

Miocene

Sample 522A-1,CC is assigned to the NN6 *Discoaster exilis* Zone* on the basis of the occurrence of *D. deflandrei*. The interval from Sample 522A-2,CC to 522A-3-1, 20–21 cm, is assigned to the NN1 *Triquetrorhabdulus carinatus* Zone*, which is defined by the last occurrence of *Coccolithus eopelagicus*.

Oligocene

The extinction datum of *Dictyococcites bisectus* defines the top of the Oligocene. The presence of this species without *Sphenolithus distentus* from Sample 522A-3-1, 60–61 cm to 522A-4,CC indicates the NP25 *S. ciperoensis* Zone. The interval from Sample 522A-5,CC to 522A-9,CC is designated the NP24 *S. distentus* Zone on the basis of the occurrence of *S. distentus*. The very rare occurrences of *S. distentus* in the core-catcher samples from Cores 5 to 6 are considered reworked, which would lower the NP24/25 boundary to the core-catcher sample from Core 7. This is more in keeping with the interpretation of Hole 522. The first appearance of *S. ciperoensis* defines the top of the NP23 *S. predistentus* Zone. This species first appears in Sample 522A-9,CC. The NP23 zonal assignment continues from the core-catcher samples from Cores 10 to 18. Two *Braarudosphaera* chalk horizons were encountered in NP23 in Cores 11 and 12. The NP22 *Helicosphaera reticulata* Zone is characterized by the occurrence of *Reticulofenestra umbilica*. This form is seen in core-catcher samples from Cores 19 to 20. The last occurrence of *Coccolithus formosus* defines the top of the NP21 *Ericsonia subdistcha* Zone, which ranges from Sample 522A-22,CC to 522A-27,CC.

Eocene

The Eocene/Oligocene boundary is placed at Section 522A-28-1 on the basis of the extinction horizon of *Discoaster saipanensis*, which designates the top of the NP20 *Sphenolithus pseudoradians* Zone. This zone extends downward at least to Sample 522A-31,CC, the lowermost sample examined.

Hole 522B

Hole 522B was drilled on the Mid-Atlantic Ridge at 26°06.843′S, 05°07.784′W to recover basalt. It was drilled in 4441 m of water. Only three rotary cores were taken in sediments and three in basalt. The sediments contain a poorly preserved very abundant calcareous nannoflora. The sediments range in age from Oligocene to Eocene. The oldest nannofossil zone recovered is the NP20 *Sphenolithus pseudoradians* Zone, which is in agreement with the paleomagnetic pattern of Anomaly 16. Table 8 shows the distribution of calcareous nannofossils at Hole 522B.

Oligocene

The sample from Core 1 is assigned to the NP22 *Helicosphaera reticulata* Zone, which is characterized by the occurrence of *Reticulofenestra umbilia* without *Coccolithus formosus*.

Eocene

The next two cores, Cores 2 and 3, contain *Discoaster saipanensis*, which characterizes the late Eocene NP20 *Sphenolithus pseudoradians* Zone.

Hole 523

Hole 523 was drilled on the Mid-Atlantic Ridge at 28°33.131′S, 02°15.078′W in 4573 m of water. Fifty-one hydraulic piston cores were taken in 190.5 m of sediment. The calcareous nannoflora was moderately well preserved and very abundant. Sediments range in age from Pleistocene to Eocene. The site is located on Anomaly 21. The oldest sediment recovered represents the NP15 *Nannotetrina fulgens* Zone*, which correlates with Anomaly 20. The apparent discrepancy results from the failure to recover sediment immediately above basalt. Two *Braarudosphaera* chalk horizons were cored

Zone*. Table 9 shows the stratigraphic distribution of calcareous nannofossils at Hole 523.

Pleistocene

The samples from Sample 523-1,CC to Section 523-3-1 are assigned to the NN19 *Pseudoemiliania lacunosa* Zone. *P. lacunosa* is very abundant throughout this interval.

Pliocene

The NN18 *Discoaster brouweri* Zone occurs from Section 523-3-2 to Sample 523-3,CC. This zone is characterized by the occurrence of the nominate species. From Section 523-4-2 to 523-6-2, the *D. surculus* Zone is found, on the basis of the occurrence of *D. surculus*. *D. tamalis* has its last occurrence near the top of the zone. The occurrence of *Reticulofenestra pseudoumblica* defines the NN15 *R. pseudoumbilica* Zone. It occurs from Section 523-6-3 to 523-7-3. Sample 523-7,CC represents the NN14 *D. asymmetricus* Zone on the basis of the concurrence of *D. asymmetricus* and *Amaurolithus tricorniculatus*.

Miocene

The Miocene/Pliocene boundary is placed within the interval assigned to the NN11 *Discoaster quinqueramus*/NN12 *Amaurolithus tricorniculatus* Zone* undifferentiated which is indicated by the absence of *Ceratolithus rugosus* and presence of *A. delicatus*. This zone is found from Section 523-8-1 to Sample 523-10,CC. The NN11 *D. quinqueramus* Zone is characterized by the occurrence of *D. surculus* without *Amaurolithus* spp. as seen in Section 523-11-1. The concurrence of *D. deflandrei* and *D. brouweri* in Section 523-11-2 indicates the NN4 *Helicosphaera ampliaperta*/NN6 *D. exilis* Zone. The NN1 *Triquetrorhabdulus carinatus* Zone is found from Section 523-11-3 to Sample 523-11,CC on the basis of the occurrence of *Coccolithus eopelagicus* without typical Oligocene species.

Oligocene

The Oligocene/Miocene boundary is placed within Section 523-12-1 on the occurrence of *Dictyococcites bisectus*, which defines the top of NP25 *Sphenolithus ciperoensis* Zone*. This zone continues down to Sample 523-14,CC. *S. distentus*, which is the marker species for the NP24 *S. distentus* Zone*, is found in Sample 523-15, CC. The last occurrence of *S. pseudoradians* defines the top of the NP23 *S. predistentus* Zone*, as seen in Sample 523-17,CC. The interval from Sample 523-17,CC to Section 523-24-1 is assigned to the NP23 Zone. Two *Braarudosphaera* chalk horizons were encountered in the NP23 Zone in Cores 18 and 19. The presence of *Reticulofenestra umbilica* from Sections 523-24-3 to 523-25-1 indicates the NP21 *Helicosphaera reticulata* Zone. The basal Oligocene NP21 *Ericsonia subdisticha* Zone is encountered from Section 523-25-2 to Sample 523-27,CC on the basis of the occurrence of *Coccolithus formosus*.

Eocene

The Eocene/Oligocene boundary is placed at the extinction datum of *Discoaster saipanensis* at Section 523-28-1. This species characterizes the NP20 *Sphenolithus pseudoradians* Zone, which continues down to Sample 523-28,CC, where *S. pseudoradians* first occurs. The first appearance of *Isthmolithus recurvus* in Sample 523-29,CC indicates the NP19 *I. recurvus* Zone. The NP18 *Chiasmolithus oamaruensis* Zone* occurs from Section 523-30-1 to Sample 523-31,CC on the basis of the last occurrence of *C. grandis* in Section 523-32-1. The NP17 *D. saipanensis* Zone* is characterized by the absence of *C. solitus*. This zone ranges from Section 523-32-1 to Sample 523-37,CC. The NP16 *D. tani nodifer* Zone is found from Sections 523-38-1 to 523-42-2 on the basis of the occurrence of *C. solitus* and the absence of *Nannotetrina fulgens*. The location of the NP15 *N. fulgens*/NP16 *D. tani nodifer* Zone* boundary is impossible to determine because of the absence of *Rhabdolithus gladius*, the extinction of which defines the boundary. Therefore, the last occurrence of *N. fulgens* is used to define the NP15/NP16 Zone* undifferentiated, which covers the interval from Section 523-42-3 to Sample 523-45,CC. A definite NP15 *N. fulgens* Zone* is found from Section 523-46-1 to Sample 523-50,CC on the basis of the occurrence of *C. gigas*.

Hole 524

Hole 524 was drilled on the Walvis Ridge at 29° 29.055′S, 03°30.741′E in 4796 m water. Thirty-nine rotary cores were taken in 348.5 m of sediment, and six were taken in basalt.

Coring was continuous below the top of the Paleocene. Most samples contain a poor to moderately well preserved, very abundant calcareous nannoflora. The sediments range in age from Late Cretaceous to early Eocene. The hole was drilled on a magnetic quiet zone of probable Turonian age. Since we did not drill to basement, the paleontology cannot be correlated with the paleomagnetic pattern. Table 10 shows the stratigraphic distribution of calcareous nannofossils from Hole 524.

Eocene

The sample from Core 1 encountered the NP12 *Tribrachiatus orthostylus* Zone, which is characterized by the occurrence of *T. orthostylus* and *Discoaster lodoensis*. The samples from Core 2 are assigned to the NP11 *D. binodosus* Zone because of the absence of *D. lodoensis* and *D. multiradiatus*. Core 3 contains *D. multiradiatus* and was assigned to the NN10 *T. contortus* Zone.

Paleocene

The Paleocene/Eocene boundary is placed between Sample 524-3,CC and Section 524-4-1. The extinction datum of *Discoaster mohleri* is used to define this boundary. The presence of *Discoaster mohleri* with *D. multiradiatus* indicates the NP9 *D. multiradiatus* Zone. This zone occurs in the interval from Section 524-4-1 to 524-5-4. The absence of *D. multiradiatus* defines the

NP8 *D. mohleri* Zone*, which ranges from Section 524-5-5 to 524-6-3. The NP7 *Heliolithus riedeli* Zone* is characterized by the last occurrence of *H. kleinpellii* at its top and the first appearance of *D. mohleri* at its base. This zone is only identified in Sample 524-6,CC. The NP6 *H. kleinpellii* Zone occurs in Core 7 and is identified by the first appearance of *H. kleinpellii* at its base. The presence of *Fasciculithus tympaniformis* and the absence of *H. kleinpellii* characterize the NP5 *F. tympaniformis* Zone, as is seen from Section 524-8-1 to 524-10-4. The NP4 *E. macellus* Zone is defined by the absence of *F. tympaniformis* and the first appearance of *E. macellus* at its base. It is found from Section 524-10-5 to 524-11-6. The base of the next zone, the NP3 *Chiasmolithus danicus* Zone, is determined by the first appearance of the nominate species. This form first occurs in Section 524-17-4, and the zone ranges from Sample 524-11,CC to Section 524-17-4. The first appearance of *Cruciplacolithus edwardsii* is used herein to define the base of the NP2 *C. edwardsii* Zone*. This horizon is found in Sample 524-19,CC. The lowest Tertiary zone is the NP1 *Markalius astroporus* Zone. Its base is identified by the first appearance of *Zygodiscus sigmoides*. This zone occurs from Sample 524-20-1, 9–10 cm to 524-20-3, 106 cm. The Cretaceous/Tertiary boundary will be discussed in more detail below.

Cretaceous

Defining the Cretaceous/Tertiary boundary is very difficult because of a long section of mixed Maestrichtian and Danian calcareous nannofossils. Oxygen-isotope work by Hsü et al. (1982) on these samples indicates that the Cretaceous forms are in place and not reworked, as is the normal interpretation. This author decided to use the first occurrence of *Zygodiscus sigmoides* to define the Cretaceous/Tertiary boundary. This boundary agrees well with the iridium concentration horizon that occurs in Sample 524-20-3, 106 cm (Hsü et al., 1982). The *Micula mura* Zone as herein defined has none of the typical Danian forms, such as *Z. sigmoides, Thoracosphaera operculata, Markalius astroporus, Biantholithus sparsus*, and *Neochiastozygus concinnus*. The base of the *Micula mura* Zone is characterized by the first occurrence of *M. mura*. This zone covers the interval from Sample 524-20-1, 108–109 cm to Section 524-26-5. It is interesting that *Nephrolithus frequens*, the zonal marker for the next zone (*N. frequens* Zone), occurs throughout this zone. The first occurrence of *N. frequens* is at Section 524-28-5. The interval from Sample 524-28,CC to 524-35,CC cannot be zoned because of poor preservation and a decrease in diversity. Therefore, the interval is assigned to the Nondiagnostic Zone on the basis of the occurrence of *M. staurophora*, which ranges from late Turonian to Maestrichtian.

Hole 524A

Hole 524A was drilled on the Walvis Ridge at 29°29.055′S, 03°30.741′E in 4805 m of water. Two rotary cores were taken in sediments that contain moderately well preserved, very abundant calcareous nannofossils. The sediments range in age from Eocene to Paleocene. Table 11 shows the stratigraphic distribution of the calcareous nannofossils from Hole 524A.

Eocene

The NP10 *Tribrachiatus contortus* Zone* is found from Section 524A-1-1 to Section 524A-2-2 on the basis of the occurrence of *Discoaster multiradiatus* without Paleocene marker species.

Paleocene

The Paleocene/Eocene boundary occurs at Sample 524A-2,CC. This is the top of the NP9 *Discoaster multiradiatus* Zone*, which is defined by the occurrence of *Fasciculithus involutus* with *D. multiradiatus*.

Hole 524B

Hole 524B was drilled on the Walvis Ridge at 29°29.07′S, 03°30.7′E in 4805 m of water. Seven hydraulic piston cores were taken in sediments that contain a moderately well preserved, very abundant calcareous nannoflora. The sediments are early Eocene in age. Table 12 shows the stratigraphic distribution of the calcareous nannofossils at Hole 524B.

Eocene

Section 524B-1-1 is assigned to the early Eocene NP13 *Discoaster lodoensis* Zone on the basis of the occurrence of *D. lodoensis* and the absence of *Tribrachiatus orthostylus*. The occurrence of these two species from Section 524B-1-2 to 524B-3-2 indicates the NP12 *T. orthostylus* Zone. Apparently NP11 is missing, because the next zone is the NP10 *T. contortus* Zone*. NP10* is distinguished by the occurrence of *D. multiradiatus* and the absence of Paleocene marker species and is identified from Section 524B-3-3 to Sample 524B-7, CC.

ACKNOWLEDGMENTS

The author wishes to thank Dr. David Bukry, U.S. Geological Survey, La Jolla, California, and Mr. C. Howard Ellis, Sohio Petroleum Company, San Francisco, California, for their constructive criticism of this paper. He also wishes to thank Messrs. Rodolfo T. Guerra, Ronald W. Morin, and Stephan Root of Mobil Exploration and Producing Services, Dallas, Texas for their suggestions.

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Date of Initial Receipt: July 29, 1982

Table 1A. Distribution of calcareous nannofossils in Hole 519, Cores 1 to 14.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Emiliania huxleyi*	*Helicosphaera carteri*	*Cyclococcolithus leptoporus*	*Ceratolithus cristatus*	*Rhabdolithus stylifer*	*Ceratolithus telesmus*	*Coccolithus pelagicus*	*Gephyrocapsa* spp	*Rhabdolithus claviger*	*Gephyrocapsa oceanica*	*Pseudoemiliania lacunosa*	*Gephyrocapsa caribbeanica*	*Cyclococcolithus macintyrei*	*Ceratolithus rugosus.*	*Discoaster pentaradiatus*	*Discoaster tamalis*	*Discoaster triradiatus*	*Discoaster asymmetricus*	*Discoaster brouweri*	*Discoaster surculus*	*Discoaster variabilis*	*Discoaster challengeri*	*Reticulofenestra pseudoumbilica*	*Amaurolithus delicatus*	*Amaurolithus tricorniculatus*	*Amaurolithus amplificus*	*Amaurolithus primus*	*Sphenolithus abies*	*Sphenolithus neoabies*
NN21	1-1, 50–51	F	VA	VA																												
NN20	1-1, 64–65	F	VA		VA	VA	R	VA	VR	R	R	VA																				
	1-2, 65–65	G	VA		VA	VA	VR	VA	VR	F	VA	VA																				
	1,CC	G	VA		R	F	VR	F	VR	VR	VA		R																			
	2-2, 74–75	G	VA		A		VR	A	VR	VR	VA																					
	2-3, 74–75	G	VA		A	R	R	C	VR		VA	C																				
NN19	2,CC	G	VA		F	C	VR	C			VA			C	VA																	
	3-1, 70–71	F	VA		VA	A	VR	A		VR	A	A		C																		
	3-2, 67–68	F	VA		VA	A	VR	VA	VR					C																		
	3-3, 68–69	G	VA		VA	C	VR	A	VR					C																		
	3,CC	F	VA		VA	A	VR	VA						A																		
	4-1, 86–87	F	VA		VA	A	VR	VA	VR					C																		
	4-2, 86–87	F	VA		VA	VA	VR	A	VR					A																		
	4-3, 97–98	F	VA		VA	A	VR	VA			VA		VR	VA																		
	4,CC	G	VA		A	A	VR	VA	VR		A	A	VR	VA																		
	5-1, 98–99	G	VA		VA	A	VR	A			VA			VA																		
NN16	5-2, 90–91	G	VA		VA	VA				VA				A		A	VR	VA	C	VR	VA	C	A									
	5-3, 90–91	G	VA		VA	VA		A		VR		C		A		A	R	VA	F		VA	VA	A	R								
	5,CC	F	VA		A	A		A		VR				A		VA	VR	VA	F	F	A	VA	F	F	VR							
	6-1, 115–116	F	VA		A	VA		VA		VR				A		VA		VA	VR		VA	VA	A	VR								
	6-2, 115–116	F	VA		R	VA				R				A		VA		A	R	VR	A	VA	A									
	6-3, 50–51	G	VA		A	A				R				A		A	R	VA	A	VR	A	A	A									
	6,CC	G	VA		R	VA								F		R		F	VR	VR	VA	VA	F									
	7-1, 130–132	G	VA		C	VA				VR				F		F	R	VA	F		VA	VA	F	VR								
	7-2, 130–132	F	VA		R	A								C		C	R	R	C	VR	A	VA	A		VR							
	7-3, 70–72	G	VA		VR	VA								C		VA	VR	A	F	VR	A	VA	C	R	VR							
NN13	7,CC, dark	P	VA		VR	VA											R	VA	VR	VR		VA	A		VR	VA	R	VR				
NN11/12	8-1, 83–84	F	VA			VA				F								VA				VA		VA	VR	VA	R		R	R		
NN16	8-2, 83–84	F	VA		R	VA								A		VA	VR		A		A	VA	VA									
	8-3, 83–84	G	VA			VA				VR				A		F	R	VA	R		VR	VA	C									
NN19	8,CC	G	VA		A	VA	VR	VA	VR		VR	VA		VA																		
	9-1, 42–43	G	VA		VA	VR	VR	VA	VR	VR	A	VA		VA																		
	9-2, 42–43	G	VA		A	VA	R	VA	F			VA		A		R																
	9-3, 42–43	G	VA		VA	VA		VA	R			VA		VA		VA																
	9,CC	G	VA		VA	VA	VR	VA	VR			A		VA		F																
	10-1, 60–61	F	VA		A	F	VR	VA				VA		VA		A																
NN16	10-2, 60–61	F	VA		A	VA				F				VA		VA		VA	A	VR	VA	VA	VA									
	10-3, 60–61	F	VA		R	VA				F				VA		VA	VR	VA	VA	VR	F	VA	VA	VR								
	10,CC	P	VA		C	VA				R				A		VA	VR	VA	A		VA	VA	VA	VR								
NN19	11-1, 120–121	G	VA		VA	VA		VA		VR		VA		C		VA	VR															
NN18	11-2, 120–121	F	VA		C	VA	VR	VA		R		VA		VA		VA	VR			C		VA										
	11-3, 20–21	G	VA		A	VA	VR	VA		VR		VA		VA		VA				VA		VA										
	11,CC	F	VA		VA	VA	VR	A				A		VA		VA				VA		VA										
	12-1, 50–51	F	VA		VA	VA	VR	VA	VR			VA		VA		VA				VA		VA										
	12-2, 50–51	F	VA		VA	VA	VR	VA		VR		VA		VA		VA	VR			R		VA										
NN17	12-3, 50–51	F	VA		A	VA		VA		A		VA		A		VA		VA				VA										
NN16	12,CC	G	VA		VA	VA		VA		A		VA		VA		VA		VA	R	VR		VA	VA	VR								
	13-2, 95–96	F	VA		VA	VA		VA		VR		VA		C		VA		VA				VA	A									
	13-3, 95–96	F	VA		VA	VA	R	VA		C		A		C		VA		VA				VA	VA									
	13,CC	F	VA		VA	VA		VA				A		A		VA	VR	VA				VA	VA									
	14-1, 78–79	F	VA		VA	VA	VR	F		VA				C		VA		VA	VA		VA	VA	VA									
NN12	14-2, 75–76	P	VA		VR	VA				VA								VA				VA	F	R	VA	VA	F		F	VR	VR	
	14-3, 75–76	P	VA		R	VA				VA								VA				VA			VA	VA	R		VR			

Table 1B. Distribution of calcareous nannofossils in Hole 519, Cores 14 to 29.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Helicosphaera carteri*	*Cyclococcolithus leptoporus*	*Coccolithus pelagicus*	*Pseudoemiliania lacunosa*	*Cyclococcolithus macintyrei*	*Ceratolithus rugosus*	*Discoaster pentaradiatus*	*Discoaster tamalis*	*Discoaster triradiatus*	*Discoaster asymmetricus*	*Discoaster brouweri*	*Discoaster surculus*	*Discoaster variabilis*	*Discoaster challengeri*	*Reticulofenestra pseudoumbilica*	*Amaurolithus delicatus*	*Amaurolithus tricorniculatus*	*Amaurolithus amplificus*	*Amaurolithus primus*	*Sphenolithus abies*	*Sphenolithus neoabies*	*Amaurolithus bizarrus*	*Discoaster quinqueramus*
NN11/12	14,CC	F	VA		VA	C		VA		VA				VA			VA	VA	R		VR	R				
	15-1, 68–69	P	VA		VA	A				VA				VA		VA	VA	VA	R		VR	F				
	15-2, 68–69	P	VA		VA	A				R				VA			VA	VA	VR			R				
NN16	15,CC	G	VA	A	VA	C	A	A	VR	VA	A		VA	VA	VA											
	16-1, 54–55	G	VA	A	VA	C	F	VA		VA	C		F	VA	VA	R										
	16-2, 54–55	G	VA	A	VA	A	C	C	VR	VA	A		C	VA	VA											
	16-3, 54–55	G	VA	A	VA	VA	VA	C	R	VA	A		C	VA	VA											
	16,CC	G	VA	VA	VA	A	C	VA	R	VA	F		A	VA	VA	R	R									
	17-1, 68–69	P	VA	F	VA		C	C		R	VR		R	VA	C	F										
	17-2, 79–80	P	VA	R	VA	R	C	C		F	R		R	VA	C											
	17-3, 48–49	F	VA	VA	VA		C	C	VR	VA	VA	VR	C	VA	VA		VR									
	17,CC	G	VA	VA	VA	C	C	C	VR	VA	A	VR	C	VA	VA											
	18-1, 80–81	F	VA	A	VA	F	A	C		VA	A		A	VA												
	18-2, 90–91	F	VA	C	VA	C	C	VA		VR	VA	VR	VA	VA	VA		VR									
NN15	18-3, 6–7	F	VA	VA	VA	F		VA	R		A	VR	VA	VA	VA		VR	F								
	18,CC	F	VA	R	VA			VA	VR	VR	R		VA	VA	VA		VR	F								
	19-1, 120–121	F	VA	VR	VA			VA	VR	VR	C		VA	VA	VA			VA								
	19-2, 120–121	F	VA	A	VA			VA	VR	VA	R		VA	VA	VA			VA	VR							
NN14	19-3, 120–121	P	VA		VA	A		A	F	VA			R	VA	VA	C	C	VA	R	VR		R		VR		
	19,CC	P	VA		VA	C		VA	VR	VA			R	VA	VA	VA	VR	VA	F			VR			VR	
NN15	20-2, 67–68	P	VA		VA			A	VR	VA			F	VA	VA			VA	R							
	20-3, 70–71	P	VA	R	VA			A	R	A			R	VA	VA			VA	F				VR			
	20,CC	P	VA		VA			A	R	VA			F	VA	VA			VA	R				VR			
	21-1, 80–81	P	VA	R	VA			F	VR	VA			R	VA	VA			VA	VR				R			
	21-2, 80–81	P	VA		VA			C	R	VA			R	VA	VA		VR	VA	VR			F				
NN14	21-3, 20–21	P	VA		VA			VR		VA			R	VA	VA	VR		VA		R		R				
	21,CC (Piece B)	P	VA	VR	VA			R	R	VA			R	VA	VA	VR		F		R		R	VR		VR	
	22-1, 60–61	F	VA		VA	C		VR		VA			R	VA		VA		VA	C	VR		F				
	22-2, 67–68	F	VA	F	VA			A	C	VA			VA	VA	VA			VA	R							
	22-2, 97–98	P	VA		VA			VA	R	VA			F	VA	VA	VA		VA	VR			F				
	23-1, 127–128	G	VA		VA	R		R		VA			R	VA	VA			VA	C	C		C			VR	
	23-2, 127–128	F	VA		VA			R	F	VA			R	VA	VA			VA	C	R		R				
	23-3, 35–36	F	VA	F	VA	VR		VA	R	VA			R	VA	VA	A		VA	VR			R				
	23,CC	F	VA		VA			C	R	VA			R	VA	VA	A		VA	R			R		R		
NN13	24-1, 80–81	F	VA	R	VA			A	C	VA				VA	VA	A		VA	R			R	VR	VR		
	24-2, 80–81	P	VA	F	VA	C		A	R	VA				VA	VA	A		VA	R	R		R	VR			
	24-3, 80–81	F	VA		VA			VR	R	VA				VA	VA	A	F	VA	VR							
	24,CC	F	VA		VA			F	F	VA				VA	VA		VR	VA	VR	VR		VR				
	25-1, 53–54	F	VA	R	VA			VA	VR	VA				VA	VA	VR	VR	VA	VR	VR		VR	C			
	25-2, 53–54	F	VA		VA			A	VR	VA				VA	VA	A		VA	R	VR						
	25,CC	F	VA	R	VA	A		A	VR	VA				VA	VA	C	F	VA	R	R		F				
	26-1, 72–73	G	VA		VA			A	VR	VA				VA	VA	F		VA	A	A		A				
	26-2, 40–41	G	VA	R	VA	VA		F		VA				VA	VA	VA	VR	VA	C	C		C				
	26,CC	F	VA		VA	C		R	R	VA				VA	VA			VA	C	VR		R				
NN12	27-1, 50–51	F	VA		VA	VA		R		A				VA	VA	VA		VA	A			VR				
	27-2, 50–51	F	VA		VA	VA		R		VA				VA	VA	VA		VA	F			VR				
	27,CC	F	VA		VA	VA				VA				A	A	VA		VA	R			R				
	28-1, 98–99	F	VA		VA	C		R		A				VA	A	VA		VA	F			R				
NN11/12	28-2, 93–94	F	VA		VA	A				VA				VA		VA		VA	C		R	F				
	28,CC	P	VA		VA	A				VA				VA		VA		VA	F		F	R				
	29-1, 76–77	F	VA		VA	VA				VA				VA		VA		VA	F	VR	R	F				
NN11	29-2, 76–77	F	VA		VA	A				VA				VA	VR	VA		VA	VR		VR					VR
	29,CC	P	VA		VA	R		R		VA				VA		VA		VA	VR			VR				

Table 1C. Distribution of calcareous nannofossils in Hole 519, Cores 30 to 36.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Cyclococcolithus leptoporus*	*Coccolithus pelagicus*	*Sphenolithus* spp.	*Discoaster neohamatus* ?	*Discoaster brouweri*	*Discoaster pentaradiatus*	*Discoaster variabilis*	*Reticulofenestra* cf. *R. pseudoumbilica*	*Discoaster challengeri*	*Cyclococcolithus macintyrei*	*Discoaster* aff. *brouweri*	*Discoaster prepentaradiatus*	*Catinaster calyculus*	*Catinaster* sp.
NN10/11	30-1, 93–94	P	VA	VA	VA	F	VA	VA	A	VA							
	30-2, 56–57	F	VA	VA	VA		VA	VA	VA	VA	VA	VR	R				
	30-3, 37–38	F	VA	VA	VA		VA	VA	F	VA			C				
	30,CC	P	VA	VA	VA	F	R	VA	R	VA	R		VA				
	31-1, 97–98	P	VA	VA	VA	A	VA	VA	R	VA	R		VA				
	31-2, 97–98	F	VA	VA	VA	A	VA	VA	VA	VA	VA		VA				
	31-3, 104–105	F	VA	VA			VR	VA	VR		VA		VA				
	31,CC	F	VA	VA	C		VR	VA	VA	F	VA		C				
	32-1, 26–27	F	VA	VA	C	VR		VA	R	VA	VA		R				
	32-2, 26–27	P	VA	VA			VR	VA	VR	VA	VA		C				
	32-3, 26-27	F	VA	VA	A		VR	VA	VR	VA	VA						
	32,CC	F	VA	VA	VA		VR			VA	VA		C	VA			
	33-1, 68–69	F	VA	VA	A		VR			VA	VA			VA			
NN10	33-2, 45–46	F	VA	VA	A					VA	VA			VA	VR	C	
	33-3, 63–64	F	VA	VA		A	VR			VA	VA		R	VA		C	
	33,CC	F	VA	VA	A					VA	VA			VA		VA	
	34-1, 70–71	F	VA	VA	VA					VA	VA			C		VA	
	34-2, 70–71	F	VA	VA	VA					VA	VA		A	R	VR		A
	34-3, 25–26	F	VA	VA	A					VA	VA		A	R			C
	34,CC	F	VA	VA	VA					VA	VA		C	R	VR		C
	35-1, 80–81	F	VA	VA	VA					VA	VA			VR	VR		C
	35-2, 79–80	F	VA	VA	VA					VA	VA			R	VR		C
	35-3, 80–81	F	VA	VA	C					VA	VA	R		R	VR		
	35,CC	F	VA	VA	A					VA	VA			R			
	36-1, 71–72	F	VA	VA	A					VA	VA			R	R		
	36-2, 55–56	P	VA	VA	A					VA	VA	R		R	R		
	36,CC	P	VA	VA	A					VA	VA			R	VR		

Table 2. Distribution of calcareous nannofossils in Hole 519A.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Cyclococcolithus leptoporus*	*Pseudoemiliania lacunosa*	*Helicosphaera carteri*	*Cyclococcolithus macintyrei*	*Ceratolithus rugosus*	*Coccolithus pelagicus*	*Discoaster surculus*	*Discoaster pentaradiatus*	*Discoaster brouweri*	*Discoaster asymmetricus*	*Discoaster tamalis*	*Amaurolithus delicatus*	*Amaurolithus tricorniculatus*	*Amaurolithus primus*	*Reticulofenestra pseudoumbilica*	*Discoaster variabilis*	*Sphenolithus* spp.	*Amaurolithus amplificus*
NN16	1-1, 64–65	G	VA	VA	A	A	VA	R	F	VA	VA	VA	F	F							
NN15	1-2, 104–105	F	VA	VA		F	F	R	F	VA	VA	VA	C	A	VR		VR	VA	C		
NN16	1-3, 104–105	G	VA	VA	VA	F		VR		VA	VA	VA	C	A							
	1-4, 104–105	G	VA	VA	VA		VR	VR		VA	VA	VA	A	A							
	1-6, 104–105	G	VA	VA	A	F	A	R	F	VA	VA	VA	A	A							
	1,CC	F	VA	VA	VA		R	R		VA	VA	VA	A	VA					VR		
NN15	2-1, 75–76	F	VA	VA		R	R	R		VA	VA	VA	C	R	R			VA	R		
NN14	2-2, 75–76	F	VA	VA				R		VA	VA	VA	VA		R	VR		VA	F		
NN15	2-3, 75–76	P	VA	VA			R	R		VA	VA	VA	R		VR		VR	VA	F		
	2-4, 75–76	F	VA	VA		R	R	R		VA	VA	VA			VR			VA	F		
	2-5, 75–76	F	VA	VA		R	R	R		VA	VA	VA	R		VR			VA	R	A	
	2-6, 75–76	F	VA	VA			R	R		VA	VA	VA	R		F		R	VA			
NN13	2-7, 9–10	G	VA	VA				F		VA	A	VA			C	R	F	VA	A		
NN14	2,CC	F	VA	VA				R		VA	VA	VA	R			VR	F	VA	VR		
NN13	3-1, 70–71	G	VA	VA				R		VA	VA	VA			F	R	F	VA	C		
NN15	3-2, 70–71	F	VA	VA				C		VA	VA	VA	F		F		F	VA	F		
NN11/12	3-3, 70–71	P	VA	VA					VA	VA	VA	VA			F		F	VA			F
	3-4, 70–71	F	VA	VA						A	A	A			C		F	VA	VA		VR
	3-5, 70–71	F	VA	VA					VA		A	A			C		VR	VA	VA		C
	3-6, 70–71	F	VA	VA					VA		VA	VA			C		C	VA	VA		F
NN15	4-2, 20–21	F	VA	VA		F		R		VA	VA	VA	R		F			VA	VR		
	4-3, 20–21	F	VA	VA				R		VA	VA	VA	R		F			VA	VR		
	4-4, 20–21	F	VA	VA		R	R	F		VA	VA	VA	R		R			VA	C	R	
	4-5, 20–21	F	VA	VA		R		R		VA	VA	VA	R		VR			VA	R		
	4-6, 20–21	F	VA	VA		R	R	R		VA	VA	VA	R		R		VR	VA	C		
NN14	4-7, 20–21	F	VA	VA		F	R	R	C	VA	VA	VA	R		F	VR	VR	VA			

Table 3A. Distribution of calcareous nannofossils in Hole 520, Cores 1 to 23.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Gephyrocapsa oceanica*	*Pseudoemiliania lacunosa*	*Ceratolithus cristatus*	*Ceratolithus telesmus*	*Helicosphaera carteri*	*Cyclococcolithus leptoporus*	*Coccolithus pelagicus*	*Rhabdolithus stylifer*	*Rhabdolithus claviger*	*Gephyrocapsa* spp.	*Ceratolithus rugosus*	*Discoaster brouweri*	*Discoaster surculus*	*Discoaster pentaradiatus*	*Cyclococcolithus macintyrei*	*Reticulofenestra pseudoumbilica*	*Amaurolithus delicatus*	*Amaurolithus primus*	*Discoaster tamalis*	*Discoaster asymmetricus*	*Discoaster variabilis*	*Amaurolithus tricorniculatus*	*Amaurolithus amplificus*	*Discoaster challengeri*	*Discoaster quinqueramus*	*Triquetrorhabdulus rugosus*
NN19	1,CC	F	VA	C	VA	C	F	A	VA	R	VA	VA																	
	2,CC	P	VA	VR	F	C	F	VA	VA		VA	VA	VA																
NN16	3-7, top	F	VA		F	VR		VA	VA	C				VR	VA	VA	C	VR											
NN15	4, bottom	F	VA						VA					R	VA	VA	F		VA	F	R	VR	F	A					
NN14	5-1, 32–33	F	VA						VA	VA				R	VA	VA	VA		VA	VR	VR		VR	VA	R				
	5,CC	F	VA						VA					VR	VA	VA	VA		VA	F	R		F	VA					
	6,CC	F	VA						VA					R	VA	VA	C		VA	C	VR		R	A					
NN12	8-2, 10–11	G	VA						VA						VA	VA	F		VA	F	VR			VA	R	R	VR		
NN11	8-2, 62–63	F	VA						VA						R	VA	F		VA	VR				VA	VR			R	
	8, bottom	F	VA						VA						R	C	VA		VA	VR				VA				R	
	9-1, 110–111	F	VA						VA	A					VA	A	A	R	VA	VR	VR			VA			VR		VR
	9-2, 110–111	P	VA						VA	VA					VA	F	R	R	VA	VR	VR			VA	VR				
	9-3, 110–111	P	VA						VA	C					VA	F	R		VA	F	R			VA		VR		R	VR
	9-4, 110–111	F	VA						VA	A					VA	R	R		VA	VR	R			VA	VR			VR	
	9-5, 110–111	F	VA						VA	VA					A	R	VA		VA	R				VA				VR	
	9-5, 137–138	F	VA						VA	VA					A	R	F		VA	R				VA					VR
	9, bottom	F	VA						VA	VA					VA	R	C		VA	C	VR			VA					VR
	10,CC	F	VA						VA	F					A	R	R		VA	R				A					VR
	11-1, 44–45	F	VA						VA	VA					VA	R	VA		VA	F	F			VA					
	11-2, 44–45	P	VA						VA	VA					VA	VR	F		VA	VR				VA					R
	11-4, 44–45	F	VA						VA	VA					VA	VR	F		VA		VR			VA				VR	VR
	11-4, 44-45	F	VA						VA						VA	VR	R		VA	R	R			VA				R	
	11, bottom	P	VA						VA						C	R	R		R		VR			VA				R	
	12-1, 77–78	F	VA						VA	R					F	VR			VA	F	R			VA				R	VR
	12-2, 2–3	G	VA						VA	R					A	VR	R		VA		R			VA		VR		VR	VR
	12,CC	F	VA						R						R	VR	R		VA		R			VA				VR	
	13,CC	P	VA						VA	F					F		R		VA		VR			VA				VR	
	14-1, 20–21	F	VA														R		VA	VR	VR			VA		VR		VR	
	14-2, 20–21	F	VA						VA								R		VA	R				VA		R		R	
	14-3, 20–21	F	VA						C								R		VA	VR	R			VA		F		R	
	14,CC	F	VA						C								R		VA	R	R			VA		R		VR	
	15-1, 100–101	F	VA						F	R							VR		VA	VR				VA					
	15-2, 73–74	F	VA						F	F							F	R	VA	VR				VA		VR		R	
	15,CC	F	VA						F						A		VR		VA	VR	R			VA					VR
	16-1, 62–63	F	VA							R							R	VR	VA	VR	VR			VA				R	
	16-2, 25–26	F	VA						F	F					VA		F	VR	VA	VR	VR			VA					
	16-4, 46–47	F	VA						VA	F					VA		F		VA					VA				VR	
	16,CC	F	VA						R	R					F		VR		VA	R	R			VA					
	17-2, 122–123	F	VA						VA	C					F				VA		VR			VA					
	17,CC	P	VA							R					R				VA					VA					
	18-1, 74–75	P	VA						A	R					F		R		VA					VA					
	18,CC	P	VA						R						VA		VR	R	VA					VA					
	19-1, 66–67	F	VA						F						VA		VR	R	VA					VA					
	19,CC	P	VA							VR					A		VR	VR	C					VA					
	20-1, 83–84	P	VA						C						VA		VR	R	VA					VA					VR
	20-2, 79–80	P	VA						R	R					VA		R	VR	VA	VR				VA					
	20,CC	P	VA						R						VA		R	VR	VA					VA				VR	VR
	21-2, 49–50	F	VA						R						C	VR	F		VA	VR				VA				VR	
	21, bottom	P	VA												VA		VR	A	VA					VA					VR
	22-1, 37–38	P	VA						VR						C		R		A		VR			VA				R	VR
	22-1, 77–78	P	VA						C	VR					A		F		VA					VA				VR	
	22,CC	F	VA						VA	F					VA		C	F	VA					VA					R
	23-2, 73–74	F	VA							R							R		VA					VA				R	

Table 3B. Distribution of calcareous nannofossils in Hole 520, Cores 23 to 30.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Discoaster quinqueramus*	*Discoaster variabilis*	*Discoaster pentaradiatus*	*Reticulofenestra pseudoumbilica*	*Coccolithus pelagicus*	*Discoaster brouweri*	*Helicosphaera carteri*	*Cyclococcolithus macintyrei*	*Cyclococcolithus leptoporus*	*Discoaster surculus*	*Amaurolithus primus*	*Triquerorhabdulus rugosus*	*Discoaster berggrenii*	*Catinaster calyculus*	*Catinaster coalitus*	*Discoaster kugleri*	*Discoaster exilis*	*Discoaster deflandrei*	*Cyclicargolithus floridanus*	*Sphenolithus heteromorphus*
NN11	23-2, 73–74	F	VA	R	VA	R	VA	R															
	23,CC	F	VA		VA	R	R		C				VR										
	24-1, 49–51	F	VA	VR	VA	VR	VA		A	VR	R	A	R	VR	VR								
	24-2, 31–32	F	VA		VA	R	VA	A	VA	R		VA				VR							
	24, bottom	F	VA	VR	VA	R	VA	A	VA	VR	VR	VA											
	25, bottom	F	VA		VA	VA	VA	A	VA	R		VA											
	26-1, 126–127	F	VA		VA	R	A		VA	VR		F											
	26-2, 78–79	F	VA	VR	VA	A	VA	A	VA			VA											
NN10	26, bottom	F	VA		VA	R	C	VA	VA	VR		VA											
	27-1, 16–17	F	VA		VA	A	VA	VA	VA			VA											
	27,CC	P	VA		VA	VR	VA		VA			F											
	28-1, 18–19	F	VA		VA	R	VA		VA			VA											
	28,CC	F	VA		VA	VR	VA		VA			VA											
	29-1, 10–11	F	VA		VA	A	VA	A	VA			VA											
NN8/10	29-1, 20–21	F	VA		VA	A	VA	A	VA			VA					C						
	29-1, 32–33	P	VA		VA	R	VA		VA			VA					R						
	29-1, 40–41	F	VA		VA	VR	VA	A	VA		R	F					F	R					
	29-1, 50–51	F	VA		VA	VR	VA	VA	VA			VA											
	29-1, 60–61	P	VA		VA		VA		VA			VA											
	29-1, 70–71	P	VA		VA	R	VA	F	VA			VA					VA						
	29-1, 80–81	F	VA		VA	F	VA		VA		VR	F					VA	VR					
	29-1, 90–91	F	VA		VA		VA		VA		R						R						
	29-1, 100–101	P	VA		VA		VA		VA		VR												
	29-1, 110–111	F	VA		VA		VA		F								A	VR					
NN7/8	29-1, 120–121	P	R		VR		F		VR														
	29-1, 138–139	P	F		VR		F	VR	VR														
NN7	29-1, 140–141	F	VA		VA		VA												R	VA			
	29-1, 149–150	F	VA		VA		VA	R											R	VA			
NN6	29-2, 0–1	F	VA		VA		VA	F	R											VA	R		
	29-2, 10–11	F	VA				VA		R											VA	C		
	29-2, 18–19	P	VA		A															VA	A	VA	
	29-2, 30–31	P	VA		VA				R											VA	R	VA	
	29-2, 39–40	P	VA		VA															A	R	VA	
	29-2, 49–50	P	VA		VA															VA		VA	
NN5	29-2, 61–62	P	VA		VA															VA	R	VA	F
	29-2, 69–70	P	VA		VA															VA	R	VA	A
	29-2, 70–71	P	VA		A															A	F	VA	A
	29-2, 80–81	P	VA		VA															VA	R	VA	C
	29-2, 92–93	P	VA		A				C											A	A	VA	R
	29-2, 99–100	P	VA		VA				C											VA	VA	VA	F
	29-2, 110–111	P	VA		VA				F											VA	VA	VA	A
	29-2, 112–113	P	VA		VA				C											VA	VR	VA	A
	30-1, 50–51	P	VA		VA				C											VA	F	VA	VR

Table 4A. Distribution of calcareous nannofossils in Hole 521, Cores 1 to 14.

Zone	Core-Section (interval in cm)	Preservation	Abundance	Gephyrocapsa spp.	Cyclococcolithus leptoporus	Ceratolithus cristatus	Helicosphaera carteri	Gephyrocapsa oceanica	Ceratolithus telesmus	Rhabdolithus claviger	Rhabdolithus stylifer	Pseudoemiliana lacunosa	Cyclococcolithus macintyrei	Discoaster brouweri	Discoaster triradiatus	Coccolithus pelagicus	Discoaster pentaradiatus	Discoaster surculus	Ceratolithus rugosus	Discoaster tamalis	Discoaster asymmetricus	Discoaster variabilis	Reticulofenestra pseudoumbilica	Sphenolithus abies	Amaurolithus delicatus	Amaurolithus primus	Amaurolithus amplificus	Triquetrorhabdulus rugosus	Discoaster quinqueramus	Reticulofenestra aff. pseudoumbilica	Catinaster calyculus	Catinaster coalitus
NN20	1-1, 68–69	G	VA	VA	VA	C	A	R	C	A	A																					
NN19	1-2, 68–69	G	VA	VA	VA	R	A		VR	A	A	VA																				
	1,CC	G	VA	A	VA	R	C	R		VA	VA	VA																				
	2-1, 67–68	G	VA	C	VA		R			VA	VA	VA																				
	2-2, 67–68	G	VA		VA	VR	C		R	VA	VA	VA																				
	2-3, 67–68	G	VA		VA	R	C		R	VA	VA	VA																				
	2,CC	G	VA		VA		A	R		VA	VA	VA																				
	3-1, 87–88	G	VA	VA	VA	F	VA	R	VR	VA	VA	VA																				
	3-2, 87–88	G	VA	VA	VA	C	A		R	VA	VA	VA																				
	3-3, 87–88	G	VA		VA	R	A		R	VA	VA	VA	A																			
	3,CC	G	VA		VA	R	VA			VA	VA	VA	VA																			
	4, top	G	VA		VA	VR	VA		F	VA	VA	VA	VA																			
	4-1, 65–66	G	VA		VA		VA			VA	VA	VA	VA																			
NN18	4-2, 65–66	G	VA		VA	R	VA			VA	VA	VA	VA	VA	VA	F																
	4-3, 65–66	G	VA		VA		A			VA	VA	VA	VA	VA	A																	
	4,CC	G	VA		VA	VR	A			VA	VA	VA	VA	VA	VA																	
	5-1, 86–87	G	VA		VA	VR	F			VA	VA	VA	VA	VA	F	F																
	5-2, 86–87	G	VA		VA		F			VA	VA	C	VA	VA	F	F																
NN17	5-3, 86–87	G	VA		VA					VA	VA	VA	VA	VA		C	VA															
NN16	5,CC	G	VA		VA							A	VA	VA	VR	F	VA	VA														
	6-1, 94–95	G	VA		VA		F					A	VA	VA		F	VA	VA	R													
	6-2, 94–95	G	VA		VA	VR	F					A	VA	A	VR		VA	VA	R	R	R											
	6-3, 94–95	G	VA		VA		VA					VA	VA	VA		F	VA	VA		A	F											
	6,CC	G	VA		VA	R						VA	VA	VA		F	VA	VA	VR	F	VR											
	7-1, 40–41	G	VA		VA		A					VA	VA	VA			VA	VA	VR	F	F											
	7-2, 40–41	G	VA		VA							A	VA	VA		C	VA	VA		C	R											
	7-3, 40–41	G	VA		VA	R	F					VA	VA	VA		C	VA	VA	F	A	A	R										
	7,CC	G	VA		VA		F					VA	VA	VA		A	VA	VA	VR	C	R	VR										
	8-1, 60–61	G	VA		VA							VA	VA	VA	R		VA	VA	R	A	F											
	8-2, 60–61	G	VA		VA		R					A	VA	VA	R	F	VA	VA	R	A	F											
	8-3, 60–61	G	VA		VA	R						A	VA	VA			VA	VA	R	A	F	VR										
	8,CC	G	VA		VA							A	VA	VA		R	VA	VA	R	A	R											
	9-1, 103–104	G	VA		VA	VR						A	VA	VA			VA	VA	F	A	F	VR										
	9-2, 103–104	G	VA		VA								VA	VA			VA	VA			R	R										
NN14/15	9-3, 103–104	G	VA		VA								VA	VA	VR		VA	VA	VR	F	F		VA	VR								
	9,CC	P	VA		VA		F						VA	VA			VA	VA	VR	F	F	R	VA		R							
	10-1, 100–101	P	VA		VA		R						VA	VA			C	VA	R	R	F		VA		R	VR						
	10-2, 100–101	P	VA		VA								VA	VA	R		VA	VA	C		VR	VR	VA		A	F						
NN13	10-3, 100–101	P	VA		VA								VA	VA			VA	VA	A				VA		F	R						
	10,CC	P	VA		VA								VA	VA			VA	VA	C				VA	R	VR							
	11-1, 61–62	P	VA		VA								VA	VA			VA	VA	F			F	VA		F	F						
NN12	11-1, 90–91	F	VA		VA									R				VR				VA	VA		R	C	R					
	11-2, 30–31	F	VA		VA									F				VA				VA	VA		F	C	VR	VR				
NN11	11,CC	F	VA		F									F				VA				VA	VA		R			VR	R			
	12-1, 99–100	F	VA		VA								C	VA				C				VA								R		
	12-1, 109–110	F	VA		VA								F	VA		C		F				VA						F		R		
	12,CC	F	VA		VA								F	VA		R		VR				VA						VR				
	13-1, 100–101	F	VA		VA								VA	VA		F		A				VA								VA		
	13-2, 107–108	F	VA		VA								VA	VA		F		F				VA						VR		VA		
	13-3, 100–101	F	VA		VA								VA	VA				F				VA								VA		
	13,CC	F	VA		VA								VA	VA		A		F				VA								VA		
NN8/10	14-1, 115–116	P	VA		VA								VA	VA		VA						VA						VR		VA	VA	
	14-2, 73–74	F	VA		C								R	VA		C						VA								VA	C	
	14,CC	F	VA		A								C			F						VA								VA	VA	VA

Table 4B. Distribution of calcareous nannofossils in Hole 521, Cores 16 to 21.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Discoaster variabilis*	*Discoaster exilis*	*Discoaster brouweri*	*Discoaster deflandrei*	*Cyclococcolithus leptoporus*	*Cyclococcolithus macintyrei*	*Reticulofenestra* aff. *R. pseudoumbilica*	*Coccolithus pelagicus*	*Cyclicargolithus floridanus*	*Sphenolithus heteromorphus*	*Helicosphaera carteri*	*Helicosphaera euphratus*
NN6	16-1, 84–85	F	VA	VA	VA	C	C	VA	F	VA	F				
	16-2, 50–51	F	A		A	C			A						
	16,CC	F	VA	VA	A		R	A	F		R	VA			
NN5	17-1, 74–75	P	VA	VA								VA	A		
	17-2, 74–75	P	VA	VA		F	C					VA	F		
	17-3, 74–75	P	VA	VA		A	VA					VA	A		
	17,CC	P	VA	VA	F	A	A					VA	VA		
	18-1, 78–79	P	VA	VA	A	A	VA					VA	C		
	18-2, 78–79	F	VA	VA	A	A	VA				VR	VA	A		
	18-3, 78–79	P	VA	VA	VA		VA					VA	A		
	18,CC	P	VA	VA	A		VA					VA	VA		
	19-1, 105–106	P	VA	VA	A		VA				R	VA	VA		
	19-2, 103–104	P	VA	VA	F		VA					VA	VA		
	19-3, 107–108	P	VA	VA	VA		VA				F	VA	A		
	19,CC	P	VA	VA	VA		VA				R	VA	A		
	20-1, 65–66	P	VA	VA	C		VA				R	VA	VA		
	20-2, 65–66	P	VA				VA					VA	A		
	20-3, 65–66	P	VA	VA			VA					VA	VA		
NN4	20,CC	P	VA	VA			VA					VA	C	F	R
	21,CC	P	VA				A					VA	F	R	

Table 5. Distribution of calcareous nannofossils in Hole 521A.

Zone	Sample	Preservation	Abundance	*Pseudoemiliania lacunosa*	*Gephyrocapsa* spp.	*Cyclococcolithus leptoporus*	*Ceratolithus cristatus*	*Ceratolithus telesmus*	*Helicosphaera carteri*	*Rhabdolithus stylifer*	*Rhabdolithus claviger*	*Cyclococcolithus macintyrei*	*Discoaster brouweri*	*Discoaster tridradiatus*	*Discoaster pentaradiatus*	*Discoaster surculus*	*Discoaster asymmetricus*	*Discoaster tamalis*	*Ceratolithus rugosus*	*Coccolithus pelagicus*	*Reticulofenestra pseudoumbilica*	*Amaurolithus delicatus*	*Amaurolithus primus*	*Discoaster variabilis*	*Amaurolithus amplificus*	*Reticulofenestra* aff. *R. pseudoumbilica*	*Discoaster prepentaradiatus*	*Cyclicargolithus floridanus*	*Sphenolithus heteromorphus*	*Discoaster deflandrei*	*Helicosphaera euphratus*
NN19	1,CC	G	VA	VA	VA	F	R	R	F	A	A																			
	2,CC	G	VA	VA		VA	R		VA	VA	A																			
	3,CC	F	VA	VA		VA	VR	R	VA	VA	VA	C																		
NN17	5,CC	G	VA	VA		VA	VR		VA	VA	VA	VA	VA	VR	A															
NN16	6,CC	F	VA	VA		VA			R			F	VA		VA	VA	C	C	F	VA										
	7,CC	F	VA	A		VA			R			F	VA		VA	VA	F	R	F											
NN14/15	8,CC	F	VA			VA			R			R	VA	R	VA	VA	C	R	F		VA	F									
NN13	9,CC	P	VA			VA						F	VA		VA	VA			F	R	VA	F	F	VR							
NN12	10,CC	G	VA			VA						VR	R		VA	F					VA	F	C	VA	VR						
NN10	11,CC	G	VA			VA						R	VA		R					F				VA							
NN9/10	12,CC	P	VA										C											VA		VA	R				
NN5	13,CC	P	VA										F											VA				VA	C	A	
	14,CC	P	VA																					VA				VA	C	VA	
	15,CC	P	VA																					VA				VA	VA	VA	
	16,CC	P	VA																					A				VA	VA	VA	
NN4	17,CC	P	VA						R																			VA	VA	A	VR

Table 6A. Distribution of calcareous nannofossils in Hole 522, Cores 1 to 15.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Pseudoemiliania lacunosa*	*Cyclococcolithus leptoporus*	*Helicosphaera carteri*	*Gephyrocapsa* spp.	*Rhabdolithus stylifer*	*Rhabdolithus claviger*	*Ceratolithus cristatus*	*Gephyrocapsa oceanica*	*Ceratolithus telesmus*	*Cyclococcolithus macintyrei*	*Coccolithus pelagicus*	*Discoaster brouweri*	*Discoaster triradiatus*	*Discoaster pentaradiatus*	*Discoaster surculus*	*Discoaster asymmetricus*	*Ceratolithus rugosus*	*Discoaster tamalis*	*Discoaster variabilis*	*Reticulofenestra pseudoumbilica*	*Amaurolithus delicatus*	*Amaurolithus primus*	*Sphenolithus* spp.	*Amaurolithus tricorniculatus*	*Cyclicargolithus floridanus*	*Sphenolithus heteromorphus*	*Discoaster deflandrei*	*Discoaster druggi*	*Coccolithus eopelagicus*	*Sphenolithus dissimilis*
NN20	1-1, 108–109	G	VA		VA	F	VA	R	F	VR	R	VR																				
NN19	1-2, 108–109	G	VA	VA	VA	F	VA	C	C																							
	1,CC	G	VA	VA	VA	F		F	F	F																						
	2-1, 88–89	G	VA	VA	VA	A		VA	VA	F		R																				
	2-2, 60–61	G	VA	VA	VA	C		VA	C	R																						
NN18	2-3, 88–89	G	VA	F	VA	F		VA	C	R			A	F	VA	C																
NN19	2,CC	G	VA	C	VA	C		VA	C																							
	3-2, 21–22	G	VA	C	VA	C		VA	C	VR		R																				
NN18	3-3, 15–16	G	VA	VA	VA	F		VA	C				VA	F	VA	A																
NN19	3,CC	G	VA	VA	VA	A		VA	C	VR																						
NN18	4-1, 78–79	F	VA	VA	VA	R		VA	C	R		VR	VA	F	VA	C																
NN16	4-3, 67–69	F	VA	A	VA								VA		VA		VA	C	R	VR												
	4,CC	F	VA	VA	VA								VA	R	VA		VA	VA	R	R												
	5-1, 127–128	F	VA	VA	VA								VA	R	VA		VA	VA	R	R												
	5-2, 97–98	F	VA	F	VA	F							VA	F	VA		VA	VA	F	VR	F											
	5-3, 46–47	F	VA	F	VA								VA	A	A		VA	VA	VR	R	C											
	5,CC	F	VA	F	VA								VA	F	VA		VA	VA	R	VR	F											
	6-1, 122–124	F	VA	VA	VA	F							VA		VA		VA	VA	C		A	VR										
	6-2, 41–42	F	VA	F	VA								F		VA		VA	VA		VR	A											
	6-3, 22–23	F	VA	VA	VA								C		VA		VA	VA	F	F	A											
	6,CC	F	VA	F	VA								VA		VA		VA	VA	VR	R	A											
NN15	7-2, 67–68	P	VA		VA								VA		VA		A	VA	A	VR	R		VA	R								
	7-3, 67–68	P	VA		VA								R		VA		VA	VA	A	R	R		VA	F	R							
	7,CC	P	VA		VA								F		VA		VA	VA	F	F			VA	R	VR							
	8-1, 129–130	P	VA		VA								A		VA		VA	VA	R	F		R	VA	F								
	8-2, 15–17	P	VA		VA										VA		F	VA		VR		F	VA	VR	VR							
	8-3, 45–46	P	VA		VA								R		VA		VA	VA		F		C	VA	VR	R	VA						
	8,CC	P	VA		VA										VA		VA	VA	F	R			VA	F	VA							
NN14	9-1, 86–87	P	VA		VA										VA		VA	VA	R	R			VA	VR	VA		VR					
NN13	9-2, 102–103	G	VA		VA									A	F		VA	R				VA	VA	F	C							
	9-3, 41–42	G	VA		F								R	R	F		VA	VR		VR			F		R							
NN11/12	9,CC	G	VA		F								VR	R	F		VA					VA	F		R							
	10-1, 119–120	G	VA										C		F		VA	VR				VA	VA	VR	VA							
Indeter.	10-2, 47–48	F	A											VR	R							VA										
NN11	10-3, 25–26	F	A										VR	R			A	VR				A	R									
Indeter.	10,CC		B																													
	11-1, 106–108		B																													
	11-2, 5–6		B																													
	11,CC		B																													
	12-1, 49–50		B																													
NN3/5	12-2, 29–30	P	VA																			VA					VA	C	VA			
Indeter.	12-3, 15–16	P	VA																								VA		VA			
	12,CC	P	VA																								VA		VA			
NN3/5	13,CC	P	VA																								VA	VR	VA			
NN2/3	14-1, 106–107	F	VA																								VA		VA	C		
NN1	14-2, 101–102	P	VA																								VA		VA			
	14-3, 117–118	P	VA																								VA		VA		R	R
	14,CC	P	VA																								VA		VA		C	R
	15-1, 100–102	P	VA											VA													VA				VA	A

Table 6B. Distribution of calcareous nannofossils in Hole 522, Cores 15 to 29.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Sphenolithus dissimilis*	*Cyclicargolithus floridanus*	*Coccolithus eopelagicus*	*Discoaster deflandrei*	*Cyclicargolithus abisectus*	*Dictyococcites bisectus*	*Sphenolithus ciperoensis*	*Dictyococcites scrippsae*	*Coccolithus pelagicus*	*Sphenolithus distentus*	*Discoaster tani* s.l.	*Chiasmolithus altus*	*Helicosphaera bramlettei*	*Sphenolithus predistentus*	*Zygrhablithus?* sp.	*Braarudosphaera* sp.	*Sphenolithus pseudoradians*	*Helicosphaera compacta*	*Thoracosphaera ovalis*
NP25	15-2, 100–102	P	VA	VA	VA	VA	VA	F	R													
	15-3, 100–102	P	VA	VA	VA	VA	VA		F	R	C	F										
	15,CC	P	VA	VA	VA	VA	VA		R		F	F										
	16-1, 126–127	P	VA	VA	VA	VA	VA	C	R		F	F										
	16-2, 125–126	P	VA	A	VA	VA	VA		R		C	VA										
	16-3, 120–121	P	VA	VA	VA	VA	VA	R			C	VA										
	16,CC	P	VA	VA	VA	VA	VA	R	R	R	C	VA										
	17-1, 70–72	P	VA	VA	VA	R	VA		R	F	VA	VA	VR									
	17-2, 70–72	P	VA	VA	VA	VA	VA	R	R		C	VA										
	17-3, 70–72	P	VA	VA	VA	VA	VA		R			VA										
	17,CC	P	VA	VA	VA	VA	VA		R	VR	VA	VA										
	18-1, 83–85	P	VA	VA	VA	VA	VA	R	R		VA	VA										
	18-2, 40–42	P	VA	VA	VA	VA	VA	R	R	F	VA	VA										
	18-3, 50–52	P	VA	VA	VA	VA	VA	F		R	VA	VA										
	18,CC	P	VA	VA	VA	VA	VA	R		R	VA	VA	R									
	19-1, 104–106	P	VA	VA	VA	VA	VA	R	R	R	VA	VA										
	19-2, 57–59	P	VA	C	VA	VA	VA	F	F	R	VA	VA										
	19-3, 62–64	P	VA	C	VA	VA	VA	F	F	VR	VA	VA		R								
	19,CC	P	VA	VA	VA	VA	VA	F	R	F	VA	VA	R	F								
	20-1, 63–65	P	VA	VA	VA	VA	VA	VA		VR	R	VA		VR	R							
	20-2, 60–62	P	VA	VA	VA	VA	VA	R	F	VR	VA	VA		F	F							
NP24	20,CC	P	VA	F	VA	VA	VA			C	F	VA	R	R	VR							
	21-1, 70–72	P	VA	C	VA	VA	VA				R	VA	F	F		VR	R					
	21-2, 51–53	P	VA	VA	VA	VA	VA			R		A	F		VR		F					
	21-3, 53–55	P	VA	VA	VA	VA	VA				C	VA	C	F			C					
	21,CC	P	VA	VA	VA	VA	VA	R	R	VR	C	VA	F	F			F					
	22-2, 99–101	P	VA	VA	VA	VA	VA		R	VR	VA	VA	C	R	VR		C					
	22-2, 59–61	P	VA	VA	VA	VA	VA	R	R		VA	VA	C	R	VR		C					
	22-3, 32–34	P	VA	VA	VA	A	VA	R	F	VR	VA	VA	A	R	F		A					
NN23	22,CC	P	VA	VA	VA	R	VA		F		VA	VA	A	R	R		A	VR				
	23,CC	P	VA	VA	VA	A	VA		F		VA	VA	VA	R	VR		VA	F				
	24-3, 10–12	P	VA	VA	VA	F	F		R		VA	VA	A	R	VR		A					
	24,CC	P	VA	VA	VA	VA	VA		R		VA	A	A	VR			A	VA				
	25-1, 94–95	P	VA	VA	VA	VA	VA		R		VA	VA	A	R			A					
	25-2, 76–77	P	VA	VA	VA	VA	VA		R		VA	F	R	R			R					
	25-2, 92–93	P	VA		VA	F	R				F		VR				VR		VA			
	25-2, 117–118	P	VA	R	VA	C	VA		R		A	F	C	VR			C			R		
	25-3, 40–41	P	VA	R	VA	A	A				A	F	F				F					
	25,CC	P	VA	A	VA	A	A				VA	R	F	VR	F		F					
	26-1, 114–115	P	VA	A	VA	VA	VA		A		VA	VA	VR	F						VR		
	26-2, 18–20	P	VA	R	VA	VA	VA		F		C	VA	F	R			F	A				
	26-3, 110–112	P	VA	R	VA	C	VA		C		VA	F	VA	VR			VA			VR		
	26,CC	P	VA	R	VA	C	VA		F		VA	A	A	VR			A				VR	
	27-1, 128–130	P	VA	R	VA	C	VA		C		A	F	R	F			VA			VR		
	27-2, 78–80	P	VA		VA	VA	VA		F		VA	A	R	R	VR		VA			VR	R	
	27-3, 28–30	P	VA		VA	A	VA		R		VA	C		A	F		R			F	R	
	27,CC	P	VA		VA	A	A		F		VA	F		C			R			F		
	28-1, 101–103	P	VA		VA	A	C		F		A	A	VR	F			VA			R		
	28-2, 29–30	P	VA	R	VA	F	A		F		VA	A		C	R		VA				VR	
	28-3, 50–52	P	VA	R	VA	A	F		C		VA	VA	VR	A	R		F				R	
	28,CC	P	VA		VA	C	F		F		VA	VA		R	VR		VR					
	29-1, 39–41	P	VA	R	VA	VA	VA		R		VA	VA	VR		R		F	VR			A	R
	29-2, 130–132	P	VA		VA	F	F		C		VA	VA	F	C			C	VA			VR	VR

Table 6C. Distribution of calcareous nannofossils in Hole 522, Cores 29 to 39.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Sphenolithus dissimilis*	*Cyclicargolithus floridanus*	*Coccolithus eopelagicus*	*Discoaster deflandrei*	*Dictyococcites bisectus*	*Dictyococcites scrippsae*	*Coccolithus pelagicus*	*Sphenolithus distentus*	*Discoaster tani* s.l.	*Chiasmolithus altus*	*Sphenolithus predistentus*	*Zygrhablithus?* sp.	*Sphenolithus pseudoradians*	*Helicosphaera compacta*	*Thoracosphaera ovalis*	*Reticulofenestra* sp.	*Reticulofenestra umbilica*	*Reticulofenestra hillae*	*Coccolithus formosus*	*Bramletteius serraculoides*	*Isthmolithus recurvus*	*Helicosphaera reticulata*	*Discoaster saipanensis*	*Discoaster barbadiensis*	*Chiasmolithus oamaruensis*
NP23	29,CC	P	VA	R	VA	F	F	F	VA	VA		VR		R	VA			VR										
	30-1, 20–22	P	VA		VA	R	A	F	VA	VA		C		R		R	R											
	30-2, 60–62	P	VA		VA	R	A	F	VA	VA	F	F		VA	VR	F	VR		A									
	30-3, 100–102	P	VA	VR	VA	C	VA	F	VA	VA	VR	VA		A	VA				VA									
	30,CC	P	VA	R	VA	F	VA	F	VA	VA		VA		R	VA		VR		VA									
	31-1, 61–63	P	VA	F	VA	F	VA	C	VA	VA		VA		VR		VR	R											
	31-2, 49–51	P	VA	A	VA	A	VA	C	VA	VA		VA		C	F	R	VR											
NP22	31-3, 49–51	P	VA	R	VA	F	VA	C	VA	VA		VA	VR	VA	VA	C	F			F								
	31,CC	P	VA	R	VA	F	VA	F	VA	VA		VA	F	R	VA	R				R								
	32-1, 69–71	P	VA		VA	F	VA	C	VA	VA		F	R	VR	VA	F				R	R							
	32-2, 43–45	P	VA	R	VA	VR	VA	A	VA	VA		F	R	R	VA		VR			R	R							
	32-3, 59–61	P	VA	F	VA	F	A	F	VA	VA		A	VR	VR	VA	R	VR			R	R							
NP21	32,CC	P	VA		VA	C	C	F	VA	VA		C	R	F	VA	C	VR			R	R	VR						
	33-1, 60–62	P	VA	R	VA	R	A	R	VA	VA		R			VA					VR	R	A						
	33-2, 44–46	P	VA	R	VA	R	C	R	VA	VA		F	R	R		VR	R	VR		F	F	F	VA					
	33,CC	P	VA	R	VA	F	A	R	VA	VA		F	VR		VA		VR	VR		F	C	VA	R					
	34-1, 83–84	P	VA		VA	C	F	R	VA	VA		F			VA	VR	VR			R	C	C	A	VR				
	34-2, 53–55	P	VA	C	VA	A	A	F	VA	VA		F			VA	VR				R	F	VA	A		VR			
	34-3, 49–51	P	VA	R	VA	VR	A	R	VA	VA		F		R	VA		VR			F	C	C	VA	VR				
	34,CC	P	VA	F	VA	F	C	F	VA	VA		R		VA	VA	VR	VR			F	C	A	VA	R				
	35-2, 50–52	P	VA		VA	C	F	R	VA	VA		R		VR		R				F	C	A	VA	R				
	35,CC	P	VA	R	VA	F	VA	F	VA	VA		A		R		F	VR			F	C	A	VA					
	36-1, 64–66	P	VA	VA	VA	R	A	F	VA	VA		F			F	R				C	VA	C	F	F				
	36-2, 49–51	P	VA	A	VA	R	A	R	VA	VA		F			VA	VR				C	VA	R	F	F				
	36-3, 30–31	P	VA	F	VA	R	VA	C	VA	VA		A				F	VR	VR		A	VA	F	VA	VR				
NP20	36,CC	P	VA	VA	VA	R	VA	F	VA	VA		VA			VA	C		R		R	A	F	VA	VR		R		
	37-1, 100–102	P	VA	A	VA	F	VA	F	VA	VA		VA			VA	R				A	A	R	VA	VR				
	37-2, 119–121	P	VA	VA	VA	VR	VA	R	VA	VA		VA			VA	R				VA	VA	F	VA				VR	
	29,CC	P	VA	VA	VA	R	VA	F	VA	VA		VA			VA	R				A	A	F	VA	F		VR	R	
	37,CC	P	VA	VA	VA		VA	F	VA	VA		VA			VA	F				VA	F	F	VA	R		VR		
	38-1, 120–122	P	VA	VA	VA	R	VA	F	VA	VA		VA			VA	F	VR			VA	VA	C	VA	R		R	VR	
	38-2, 121–122	P	VA	F	VA	A	VA	R	VA	VA		VA			A	A				VA	A	C	VA			C	VA	F
	38,CC	P	VA	VA	VA		VA	R	VA	VA		VA			VA	R				VA	A	R	VA	R		VA	F	F
	39,CC	P	VA	VA	VA	F	VA	R	VA	VA		VA			VA	R	VA			A	C	F	VA	R		A	A	R

Table 7. Distribution of calcareous nannofossils in Hole 522A.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Discoaster deflandrei*	*Discoaster exilis*	*Cyclicargolithus floridanus*	*Coccolithus eopelagicus*	*Cyclicargolithus abisectus*	*Sphenolithus dissimilis*	*Dictyococcites scrippsae*	*Dictyococcites bisectus*	*Coccolithus pelagicus*	*Sphenolithus ciperoensis*	*Sphenolithus distentus*	*Discoaster tani* s.l.	*Sphenolithus predistentus*	*Zygrhablithus?* sp.	*Braarudosphaera* sp.	*Helicosphaera compacta*	*Sphenolithus pseudoradians*	*Reticulofenestra hillae*	*Reticulofenestra umbilica*	*Coccolithus formosus*	*Isthmolithus recurvus*	*Bramletteius serraculoides*	*Discoaster saipanensis*	*Discoaster barbadiensis*	*Thoracosphaera ovalis*	*Chiasmolithus oamaruensis*
NN6	1,CC	P	VA	VA	VR	VA																							
NN1	2,CC	P	VA	VA		VA	VA	VA	VA																				
	3-1, 20–21	P	VA	VA		VA		A	F																				
NP25	3-1, 60–61	P	VA	VA		VA	VA	VA	A	F	F																		
	3-1, 120–121	P	VA	VA		VA	F	F	VA	R	R																		
	3-2, 20–21	P	VA	VA		VA	VA	F	VA	R	F																		
	3-2, 60–61	P	VA	VA		VA	VA	F	VA	C		VA																	
	3-3, 20–21	P	VA	VA		VA	C	F	VA	F		VA																	
	3-3, 60–61	P	VA	VA		VA	F	F	VA			VA																	
	3,CC	P	VA	VA		VA	VA		VA	F		VA																	
	4,CC	P	VA	VA		VA	VA		VA	VA	C	VA																	
NP24	5,CC	P	VA	VA		VA	VA		VA	VA	F	VA	R	VR															
	6,CC	P	VA	VA		VA	VA	F	VA	VA	C	VA	F	VR	R														
	7,CC	P	VA	VA		VA	VA	A	VA	VA	F	VA	F		F														
	8,CC	P	VA	VA		VA	VA	F	VA	VA		VA		F	F	R													
	9,CC	P	VA	VA		VA	VA	R	VA	VA	F	VA	VR	A	R	A													
NP23	10,CC	P	VA	VA		VA	VA	R	VA	VA	VA	VA		R	R	R	R												
	11,CC	P	VA	F		VA	R		F	R		F					A	VA											
	13,CC	P	VA	VA		VA	VA		VA	VA	A	VA		VR	R														
	14,CC	P	VA	A		VA	VA		VA	VA	VA	VA		VA	F	VA			VR	R									
	15,CC	P	VA	VA		VA	VA		VA	VA	C	VA			C					F									
	16,CC	P	VA	F		VA	VA		F	VA	F	VA			F	C			VR										
	17,CC	P	VA	C		VA	VA		F	VA	F	VA		R	C	VA			R										
	18,CC	P	VA	VA		VA	VA		F	VA	F	VA		A	C	A	VA			VR									
NP22	19,CC	P	VA	VA		VA	VA		F	VA	F	VA			F		VA			R	R	R							
	20,CC	P	VA	A		VA	VA		F	VA	F	VA			F	VR	VA		VR	VR	R	R							
NP21	22,CC	P	VA	R		VA	A		F	VA	R	VA			R	VR					R	R	F						
	23,CC	P	VA	VA		VA	VA		F	VA		VA			VA	VR	VA		VR		R	R	F	VR					
	24,CC	P	VA	C		VA	C		F	VA	R	VA			F		VA			VR	A	A	C	R	VA				
	25,CC	P	VA	VA		VA	F		F	VA	C	VA			VA		VA			R	A	A	F	VR	VA				
	26,CC	P	VA	VA		VA	R		F	VA	R	VA			VA		VA		VR	F	VA	VA	F		VA				
	27,CC	P	VA	VA		VA	R		F	VA	F	VA			VA		VA		VR	R	VA	VA	F	A	VA				
NP20	28-1, 90–91	P	VA	VA		VA	R			VA	C	VA			VA		VA			F	VA	VA	R	F	VA	R			
	28-2, 90–91	P	VA	VA		VA	R		F	VA	A	VA			VA		VA			F	VA	VA	R		VA	R			
	28-3, 55–56	P	VA	VA		VA	F		F	VA	C	VA			VA		VA			F	VA	VA	F	R	VA	C	VR	VR	
	28,CC	P	VA	VA		VA	R		F	VA		VA			VA		VA			F	VA	VA	F		VA	F	F		
	29-1, 97–98	P	VA	VA		VA	F		A	VA	R	VA			VA		VA			VR	A	VA	F	R	VA	VA	F		
	29-2, 87–88	P	VA	VA		VA	VA		F	VA	F	VA			VA		VA				VA	VA	F	R	VA	VA	F		VA
	29-3, 58–59	P	VA	VA		VA	VA		F	VA	R	VA			F		VA				VA	VA	F	C	VA	VA	F	VR	VA
	29,CC	P	VA	VA		VA			A	VA	F	F			VA		VA				VA	VA			VA	VA	F		C
	30-1, 70–71	P	VA	VA		VA	F		A	VA		VA			VA		VA				VA	VA	R	VR	VA	VA	R	VR	R
	30-2, 28–29	P	VA	F		VA	VR		A	VA	C	VA			VA		VA			R	VA	VA	F		VA	F	F	VR	R
	30,CC	P	VA	F		VA	F		F	VA	F	VA			VA		VA			R	VA	VA	F		VA	F	F		F
	31-1, 70–71	P	VA	F		VA	VA		C	VA	F	VA			VA		VA			F	VA	VA	R		VA	VA	R	R	
	31,CC	P	VA	F		VA	VA			VA	R	VA			VA		VA			F	VA	VA	VR		VA	VA	F		

Table 8. Distribution of calcareous nannofossils in Hole 522B.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Sphenolithus dissimilis*	*Cyclicargolithus floridanus*	*Coccolithus eopelagicus*	*Discoaster deflandrei*	*Dictyococcites bisectus*	*Dictyococcites scrippsae*	*Coccolithus pelagicus*	*Discoaster tani* s.l.	*Zygrhablithus?* sp.	*Sphenolithus pseudoradians*	*Reticulofenestra* sp.	*Reticulofenestra umbilica*	*Reticulofenestra hillae*	*Coccolithus formosus*	*Bramletteius serraculoides*	*Isthmolithus recurvus*	*Discoaster saipanensis*	*Discoaster barbadiensis*	*Chiasmolithus oamaruensis*
NP22	1,CC	P	VA	F	VA	F	VA	A	VA	VA	VA	VA	R		A	A						VR
NP20	2,CC	P	VA	A	VA	R	VA	F	VA	VA	VA	VA			A	A	VR	VA	VR	R	R	VR
	3-2, 91–92	P	VA	F	VA		VA	R	VA	VA	VA	VA			VA	VA	R	VA		C	R	R
	3, sed/basalt contact	P	VA	F	VA			F	VA	VA	VA	VA	VR		VA	VA	R	VA	VR	VA	F	F
	3, sed. above basalt	P	VA		VA			R	VA	VA		R		VR	R	R						

Table 9A. Distribution of calcareous nannofossils in Hole 523, Cores 1 to 7.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Pseudoemiliania lacunosa*	*Gephyrocapsa* spp.	*Helicosphaera carteri*	*Coccolithus pelagicus*	*Ceratolithus telesmus*	*Cyclococcolithus leptoporus*	*Ceratolithus cristatus*	*Rhabdolithus claviger*	*Rhabdolithus stylifer*	*Gephyrocapsa oceanica*	*Cyclococcolithus macintyrei*	*Discoaster brouweri*	*Discoaster triradiatus*	*Discoaster surculus*	*Discoaster pentaradiatus*	*Discoaster asymmetricus*	*Ceratolithus rugosus*	*Discoaster challengeri*	*Discoaster tamalis*	*Discoaster variabilis*	*Reticulofenestra pseudoumbilica*	*Amaurolithus primus*	*Amaurolithus delicatus*	*Sphenolithus abies*	*Amaurolithus tricorniculatus*
NN19	1,CC	G	VA	VA	VA	VA	VR	VR	A	VR	A	A																
	2-1, 133–134	G	VA	VA	VA	VA			VA		VA	VA	VR															
	2-2, 25–26	G	VA	VA	VA	A	F		VA	F	VA	VA	VR															
	2,CC	G	VA	VA	VA	A	F		VA	R	VA	VA	VR															
	3-1, 102–103	G	VA	VA		VA	VA		VA		VA	VA		VA														
NN18	3-2, 25–26	F	VA	VA		C	F		VA		VA	VA		VA	VA	C												
	3-3, 16–17	F	VA	VA		F	VA	VR	VA	R	VA	VA		VA	VA	R												
	3,CC	F	VA	VA		F	A	VR	VA		VA	VA		VA	VA													
NN16	4-2, 100–101	F	VA	A		F	F		VA					VA	VA		VA	VA	VR	VR	VR							
	4-3, 65–66	F	VA	F		F	F		VA					VA	A		VA	VA	R	VR		A						
	4,CC	F	VA	F		F	A		F					VA	VA		VA	VA	F	R		F						
	5-1, 23–24	F	VA	F		R	VA		VA					VA	VA		VA	VA		VR								
	5,CC	F	VA	F		F	VA		VA					VA	VA	VR	VA	VA		R		VR						
	6-2, 71–72	F	VA	F		R	F		VA					VA	VA		VA	VA	A	R		A	VR					
NN15	6-3, 71–72	F	VA			R			VA					VA	VA		VA	F	VA	F		A	VR	VA	VR	VR		
	6,CC	F	VA			VR			VA					VA	VA	R	VA	F	VA	F		VA		VA	VR	VR		
	7-1, 79–80	F	VA			R	R		VA					VA	VA		VA	VA		F			C	VA	R	R	F	
	7-2, 39–40	F	VA						VA					VA	VA		VA	A		R			A	VA	R	VR	F	
	7-3, 39-40	F	VA			F			VA					VA	VA	VR	VA	F	R	R				VA	VR		F	
NN14	7,CC	F	VA						VA					VA	VA		VA	A	VR	R				VA	A	C		VR

Table 9B. Distribution of calcareous nannofossils in Hole 523, Cores 8 to 24.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Cyclococcolithus leptoporus*	*Reticulofenestra pseudoumbilica*	*Coccolithus pelagicus*	*Amaurolithus delicatus*	*Cyclococcolithus macintyrei*	*Discoaster variabilis*	*Discoaster brouweri*	*Discoaster surculus*	*Discoaster pentaradiatus*	*Discoaster challengeri*	*Amaurolithus tricorniculatus*	*Amaurolithus primus*	*Discoaster deflandrei*	*Cyclicargolithus floridanus ?*	*Coccolithus eopelagicus*	*Sphenolithus dissimilis*	*Dictyococcites bisectus*	*Dictyococcites scrippsae*	*Discoaster tani* s.l.	*Sphenolithus distentus*	*Sphenolithus predistentus*	*Zygrhablithus ?* sp.	*Sphenolithus pseudoradians*	*Braarudosphaera* sp.	*Helicosphaera compacta*
NN11/12	8-1, 51–52	F	VA	C	VA	F	F	F	VR	VA	A	A	VA	VR														
	8-2, 51–52	F	VA	VR	A		VR				R	R	A															
	8-3, 51–52	P	VA	R	A		F	R		R	R	R	VA															
	8,CC	P	VA	R	VA	VR	R				VR	R	VA		VR													
	10-1, 124–125	P	F		C		VR	R		VR	VR		VR		R													
	10-2, 58–59		B																									
	10-3, 50–51	P	VA	VR	VA		R		VR	VR	VR	R																
	10,CC	P	VA	A	VA		R	F			F	F	VR															
NN11	11-1, 145–146	P	R	R		VR			VR	F	R	VR																
NN4/6	11-2, 60–61	P	VA							R						VA	VA											
NN1	11-3, 5–6	P	VA													VA	VA	C	R									
	11,CC	F	VA													VA	VA	A	R									
NP25	12-1, 120–121	F	VA													VA	VA	A	VA	R	F							
	12-2, 65–66	F	VA													VA	VA	VA	F	F	F							
	12-3, 16–17	F	VA													VA	VA	A	F	F	VA							
	12,CC	F	VA			A										VA	VA	A	F	F	VA							
	13-1, 60–61	F	VA			F										VA	VA	F	F	F	VA							
	13-2, 60–61	F	VA			A										VA	VA	A	F		VA							
	13-3, 60–61	F	VA													VA	VA	F		F	VA							
	13,CC	F	VA													VA	VA	F	R		A							
	14-1, 105–106	F	VA			A										VA	VA	C		VA	VA	R						
	14-2, 86–87	P	VA			F										VA	VA	F			VA	R						
	14-3, 16–17	P	VA			VA										VA	VA	A			VA							
	14,CC	P	VA			VA										VA	VA	A			VA							
NP24	15,CC	F	VA			VA										VA	VA	VA	VA	R	VA		VR	F				
	16-1, 59–60	P	VA			C										R	VA	F		VA	VA							
	16-2, 48–49	P	VA			VA										F	VA	F		R	VA	F		VA				
	16,CC	F	VA			VA										R	VA	VA		F	VA	F		VA				
NP23	17,CC	F	VA			VA										VA	VA	F		R	VA	F		C	A	R		
	18,CC	F	VA			VA										VA	VA	VA	F	F	VA			VR			VA	
	19-1, 52–53	F	VA			R											C	VR			VR							
	19-1, 96–97	F	VA			VA										VA	VA	R	F	R	VA		VR					
	19-2, 64–65	F	VA			VA										VA	VA	A		C	VA							
	19-3, 16–17	F	VA			VA										VA	VA	VA		C	VA		R	R				
	19,CC	F	VA			VA										A	VA	C		A	VA			VR				
	20-1, 98–99	F	VA			VA										VA	VA	C		R	VA	R		R				
	20-2, 25–26	F	VA			VA										R	VA	F		R	VA	VR				R		
	20-2, 112–113	F	VA			R										F	VA	R		C	VA	F		VR				
	20,CC	F	VA			A										C	VA	R		F	VA	F	VR	A				
	21-1, 125–126	F	VA			C										A	VA	F		F	VA	F		R				
	21-2, 125–126	F	VA			VA										VA	VA	C	F	VA	VA	F		F				
	21-3, 66–67	F	VA			VA										A	VA	C		R	VA	A		R				
	21,CC	F	VA			VA										F	VA	R		A	VA	R		R				
	22-1, 87–88	F	VA			VA										F	VA	VR	R	F	VA	R						
	22-2, 87–88	F	VA			VA										F	VA	R		A	VA	R	VR	VR				
	22,CC	F	VA			VA										R	VA	R		R	VA		R					
	23-1, 93–94	F	VA			VA										R	VA			R	VA	VR				R		
	23-2, 93–94	F	VA			VA										R	VA	R		R	VA	VR		VR				
	23-3, 23–24	F	VA			VA										R	VA	R		R	VA	F		VR				
	23,CC	F	VA			VA										R	VA	VR		R	VA	A		R				VA
	24-1, 94–95	F	VA			VA										R	VA	R			VA	R		VR		R		

Table 9C. Distribution of calcareous nannofossils in Hole 523, Cores 24 to 41.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Sphenolithus pseudoradians*	*Helicosphaera compacta*	*Cyclicargolithus floridanus ?*	*Dictyococcites scrippsae*	*Coccolithus pelagicus*	*Coccolithus eopelagicus*	*Dictyococcites bisectus*	*Discoaster tani* s.l.	*Discoaster deflandrei*	*Reticulofenestra umbilica*	*Reticulofenestra hillae*	*Zygrhablithus ?* sp.	*Sphenolithus predistentus*	*Coccolithus formosus*	*Bramletteius serraculoides*	*Isthmolithus recurvus*	*Discoaster barbadiensis*	*Discoaster saipanensis*	*Chiasmolithus oamaruensis*	*Chiasmolithus grandis*	*Sphenolithus radians*	*Sphenolithus furcatolithoides*	*Chiasmolithus solitus*	*Triquetrorhabdulus inversus*	*Zygolithus dubius*	*Thoracosphaera ovalis*	*Campylosphaera dela*	*Thoracosphaera* sp.
NP23	24-2, 94–95	F	VA	VR	F	VA	VA	VA	R	R	R	R																			
NP22	24-3, 52–53	F	VA		VR	VA	VA	VA	R	R			F	R	R																
	24,CC	F	VA		VR	VA	VA	VA	F	A	R	A	R	F		A															
	25-1, 82–83	F	VA	R	R	VA	VA	VA	R	R	R	A		VR		F															
NP21	25-2, 82–83	F	VA		R	VA	VA	VA	R		R	R	A	A			F	F	R												
	25-3, 82–83	F	VA	F	VR	VA	VA	VA	R		F	VA	F	VA			VR	A													
	25,CC	F	VA		R	VA	VA	VA	R		R	F		A			F	A	R												
	26-1, 59–60	F	VA	VR		VA	VA	VA	C		F	A	VR	VA			VA	A	R												
	26,CC	F	VA	VR		VA	VA	VA	R	F	VA	F	VR	VA			VA	C	A												
	27-1, 87–88	F	VA	VR	VR	VA	VA	VA	A		A	A	F	VA			VA	VA	A												
	27-2, 97–98	F	VA			VA	VA	VA	C	VA	F		VA	VA			VA		R												
	27,CC	F	VA			VA	VA	VA	VR	VA	C		F	VA			F		VR												
NP20	28-1, 72–73	F	VA	VR		VA	VA	VA		VA	A		C	VA			F		C	VR	VR										
	28-2, 72–73	F	VA			VA	VA	VA		C			F	VA			R		R												
	28-3, 72–73	F	VA	VR		VA	VA	VA		F	A			VA			VR				R										
	28,CC	F	VA	VR		VA	VA	VA	R		A		R	VA			R		F		F										
NP19	29,CC	F	VA			VA	VA	VA	VR	R	A		VA	VA			C	VA	F	F	F	F									
NP18	30-1, 120–121	F	VA			VA	VA	VA		F	R		VA	VA			VR	VA		F	VA										
	30-2, 120–121	F	VA			VA	VA	VA	C	C	F		R					VA		F	VA										
	30,CC	F	VA			VA	VA	A	A		C		R				R	VA		R	VA										
	31-1, 87–88	F	VA			VA	VA	C	A		A		VA				VR	VA		VR	A										
	31-2, 87–88	F	VA			VA	VA	C	VR	R	F		VA				VR	VA		A	VA	VR									
	31,CC	F	VA			VA	VA	F	A		VA		VA				VR	VA		F	VA										
NP17	32-1, 57–58	F	VA			VA	VA	A	F		VA		VA				R				VA		C	F							
	32-2, 57–58	F	VA			VA	VA	VA	A		R		VA				VR			F	VA		VR								
	32,CC	F	VA			VA	VA	A	A	R	F		VA				F			F	VA		F	VR							
	33-1, 95–96	F	VA			VA	VA	VR	VA		F		VA				VR			R	VA		F	R							
	33-2, 95–96	F	VA			VA	VA	A	F	F	R		F				R	F		F	VA		C	VR							
	33,CC	F	VA			VA	VA	F	A	R			C				VR			R	VA		F	R							
	34-1, 44–45	F	VA			VA	VA	C	F				VA				R			R	VA		F	R							
	34-2, 6–7	F	VA			VA	VA	VA	C				A				R			F	VA		F								
	34,CC	F	VA			VA	VA	VA	C				C							F	VA		F	VR							
	35-1, 66–67	F	VA			VA	VA	VA	R				A				F			F	VA		F								
	35-2, 66–67	F	VA			VA	VA	C	F				A				F			F	VA		C	VR							
	35,CC	F	VA			VA	VA	A	F				A				F			R	VA		C								
	36-1, 66–67	F	VA			VA	VA	VA	C				A				R			F	VA		F	F							
	36,CC	F	VA			VA	VA	A	A				A							F	VA		R	VR							
	37-1, 97–98	F	VA			VA	VA	VA	C				VA				F			F	VA		C								
	37-2, 97–98	F	VA			VA	VA	VA	C				VA				R			R	VA		C	VR							
	37-3, 27–28	F	VA			VA	VA	VA	A				VA				VR				VA		A	R							
	37-3, 81–82	F	VA			VA	VA	A	R				VA				VR			R	VA		R								
	37,CC	F	VA			VA		VA	A				VA				F			F	VA		F								
NP16	38-1, 89–90	F	VA			VA		VA	VR				VA		VA		A			A	R		R	F	C	R	F	R	F		
	38-2, 89–90	F	VA			VA		VA	F				VA		VA		F			A	F		F	VR	F	F	R	VR	F		
	38,CC	F	VA			VA		VA	C				VA		C		A			VA	F		F	VR	A	F			F		
	39-1, 34–35	F	VA			VA		VA	R				VA				F			C	VR		F	VR	F					VR	
	39-2, 34–35	F	VA			VA		VA	R				VA				A			C			F	F	C	VR			F		
	39-3, 4–5	F	VA			VA		VA	F				VA		C		VR			F			A	R	C						F
	39,CC	F	VA			VA		VA	R				A		A		A			A			C	VR	F	VR		VR		VR	VR
	40-1, 116–117	F	VA			VA		VA	C				A				R			C			C	F	A				VR		
	40-2, 116–117	F	VA			VA		VA	C				A				F			C			C	VR	C	R		VR	VR		
	40,CC	F	VA			VA		VA	F				VA				VR			A			C	VR	R	VR					
	41-1, 59–60	F	VA			VA		VA	F						VA		F			C			C	F	VA						

Table 9D. Distribution of calcareous nannofossils in Hole 523, Cores 41 to 50.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Sphenolithus furcatolithoides*	*Coccolithus pelagicus*	*Sphenolithus radians*	*Chiasmolithus grandis*	*Chiasmolithus solitus*	*Coccolithus eopelagicus*	*Coccolithus formosus*	*Cyclicargolithus floridanus?*	*Triquetrorhabdulus inversus*	*Thoracosphaera circularis*	*Discoaster barbadiensis*	*Zygrhablithus?* sp.	*Thoracosphaera ovalis*	*Nannotetrina fulgens*	*Zygolithus dubius*	*Chiasmolithus gigas*
NP16	41-2, 59–60	F	VA	VA	VA	C	F	VR	F	F	VA	VR	VR	R					
	41,CC	F	VA	VA	VA	C	C		VR	R	VA		VR	F	VA				
	42-1, 60–61	F	VA	VA	VA	C	C		R	F	VA		VR	C	C	R			
	42-2, 62–63	F	VA	A	VA	VR	F			F	VA			F	F	VR			
NP15/16	42-3, 54–55	F	VA	VA	VA	F	C		F	F	VA	F		F		VR	VR		
	42,CC	F	VA	A	VA	R	F	VR		C	VA	R		F	VA		R		
	43-1, 60–61	F	VA	R	VA	C	VA	R	F	F	VA	F		A	VA	F			
	43-2, 60–61	F	VA	VA	VA	F	C	VR	F	VR	VA			F	VA	VR			
	43-3, 60–61	F	VA	F	VA	F	C		VR	R	VA	F		C	VA				
	43,CC	F	VA	R	VA	A	A	R	F	A	VA	C		VA	VA	R	VR		
	44-1, 100–101	F	VA		VA	F	F			F	VA	VA		C	VA				
	44-2, 100–101	F	VA	C	VA	A	VA	VR	R	C	VA	A		C	VA				
	44,CC	F	VA		VA	R	VA			F	VA	VA		C	VA		C		
	45-1, 77–78	F	VA		VA	VR	A	VR	R	R	VA	VA		F	VA		VR		
	45-2, 77–78	F	VA	R	VA	VR	F	VR	VR	F	VA	VA		C	VA		R	VR	
	45-3, 77–78	F	VA		VA	R	C	R		R	VA	VA		F	VA		VR		
	45,CC	F	VA	R	VA	R	VA	VR		C	VA	A		F	VA				
NP15	46-1, 70–71	F	VA		VA	R	C		R	F	VA	A		F	VA	F			R
	46-2, 21–22	F	VA	VR	VA	R	F	R		R	VA	VA		C	VA				F
	46,CC	F	VA	VR	VA	VR	C			R	VA	VA		R					F
	47-1, 45–46	F	VA	VR	VA	VR	C			R	VA	VA		VA		VR			F
	47-2, 45–46	F	VA		VA		C	VR		R	VA	F		F	VA				F
	47-3, 45–46	F	VA		VA	VR	A	R		R	VA	C		F	F		F		C
	47,CC	F	VA	R	VA		F	VR		R	VA	C		R	VA				F
	48-1, 107–108	F	VA	F	VA		C			F	VA	C		F	VA				F
	48-2, 43–44	F	VA	R	VA		F			F	VA	VA		C	VA				F
	48,CC	F	VA	VR	VA		F	VR		F	VA	A		A	VA				F
	49-1, 56–57	F	VA		VA	R	A			F	VA	VA		C	VA		VR		F
	49-2, 56–57	F	VA		A	R	A	VR		R	VA	A		C	VA				R
	49-3, 56–57	F	VA		A		A	VR		R	VA	A		A	VA				F
	49,CC	F	VA		A		C	R		R	VA	A		F	VA				F
	50-1, 110–111	F	VA		A	VR	C	F		F	VA	A		A	VA		VR		F
	50-2, 110–111	F	VA		A		C	VR		VR	VA	A		A	VA				F
	50-3, 3–4	F	VA		A	R	A	VR		R	VA	F		F	VA				F
	50,CC	F	VA		A	R	A	F		VR	VA	VA		C	VA				F

Table 10A. Distribution of calcareous nannofossils in Hole 524, Cores 1 to 11.

Zone	Core-Section (interval in cm)	Preservation	Abundance	Discoaster lodoensis	Tribrachiatus orthostylus	Discoaster lodoensis	Chiasmolithus grandis	Coccolithus formosus	Chiasmolithus solitus	Coccolithus pelagicus	Discoasteroides kuepperi	Sphenolithus radians	Chiasmolithus eograndis	Ellipsolithus macellus	Chiasmolithus bidens	Chiasmolithus consuetus	Discolithina rimosa	Discoaster diastypus	Zygrhablithus? sp.	Discoaster multiradiatus	Coccolithus bisulcus	Fasciculithus tympaniformis	Toweius craticulus	Toweius eminens	Discoaster mohleri	Zygodiscus sigmoides	Cyclolithus robustus	Ellipsolithus distichus	Fasciculithus involutus	Markalius astroporus	Neochiastozygus concinnus	Ericsonia subpertusa	Heliolithus kleinpellii	Cruciplacolithus tenuis	Chiasmolithus danicus	Thoracosphaera operculata
NP12	1,CC	P	VA	VA	VA	VR	R	VR	VR	VA	R	VA	VA																							
NP11	2-1, 89–90	P	VA		R					VA				R	A	R	VR	VA																		
	2-2, 35–36	P	VA		R					VA			VA	R	VA	R	VR	F	VA																	
	2,CC	F	VA		VR					VA			A	F	VA	F		C	R																	
NP10	3-1, 39-140	F	VA							VA			F		VA			R	A	VA	A															
	3-1, 139–140	F	VA							VA			F		VA				VA	VA	VA															
	3-2, 139–140	F	VA							VA			R		VA					A	R															
	3-4, 25–26	F	VA							VA					VA	R			VA	F	F															
	3,CC	F	VA							VA			C		VA				VA	VA																
NP9	4-1, 100–101	F	VA							VA					VA					VA		VA	VA	VA	R											
	4-2, 100–101	F	VA							VA					VA					A		VA	F			VR										
	4-3, 100–101	F	VA							VA					VA					VA		VA	VA	R	R	VR										
	4-4, 17–18	F	VA							VA					VA					VA		VA	VA	VA	VR											
	4,CC	F	VA							VA				VR	VA	R				VA		VA	VA	VA	VR											
	5-1, 65–66	F	VA							VA					VA	A				F		F	VA	R	R	VR	R	R								
	5-2, 39–40	F	VA							VA					VA	R				F		VA	VA	R	R	VR		VR	VA	VR						
	5-3, 55–66	F	VA							VA					VA	VR				R		VA	VA		VR		VA		VA							
	5-4, 65–66	F	VA							VA					VA					VR		VA	VA		R		VA		VA		VR					
NP8	5-5, 65–66	F	VA							VA					VA	R						VA	VA	VR	F		F	R	VA		R	VR				
	5,CC	F	VA							VA					VA	F						VA	VA	R	C			VR	VA			R				
	6-1, 94–95	F	VA							VA					VA	R						VA	VA	R	F	R					VR	R				
	6-2, 94–95	F	VA							VA					VA	R						VA	VA	R	C	R										
	6-3, 94–95	F	VA							VA					VA	F						VA	VA		C	C					VR					
NP7	6,CC	F	VA							VA					VA	R						VA	VA	A	C				R				VR			
NP6	7-1, 79–80	F	VA							VA					R	VR						VR	VA	F		C							A			
	7-2, 79–80	F	VA							VA					C	VR						R	VA			C							VA			
	7,CC	F	VA							VA					R	R						F	VA	A		VA	VR				R		F	VR	F	
NP5	8-1, 64–65	F	VA							VA						VR						F	VA	R		A	A		R						F	
	8-2, 64–65	P	VA							VA					F	VR						R	VA	R		F	F		R						F	
	8-3, 64–65	P	VA							VA				R	F	F						A	VA			F	F		C	R	R				A	
	8-4, 64–65	F	VA							VA					F	C						C	VA			VA	VR				VA	R		R	VA	VR
	8-5, 64–65	F	VA							VA						R						F	VA			VA	R		R		VR	VA			C	
	8-6, 40–41	P	VA							VA					R	R						F	VA	R		F	F		R		R	VA		VR	VA	
	8,CC	P	VA							VA					F							R	VA	R		VA			R	VR		VA			VA	
	9-1, 91–92	P	VA							VA					R	R						R	VA			VR			R		R	VA		F	VA	
	9-2, 91–92	F	VA							VA												R	VA			F			R			VA		F	VA	VR
	9-3, 91–92	F	VA							VA						R						C	R			C			VA		VR	VA		R	VA	
	9-4, 91–92	F	VA							VA				VR		R						R	F			VA					VR	VA		F	VA	R
	9-5, 91–92	F	VA							VA				R								R	F			A			R			VA		R	VA	
	9,CC	F	VA							VA				R								R	R			F		VR	R	VR	C	VA		C	VA	R
	10-1, 84–85	F	VA							VA						R						R				A			R		C	F		F	VA	VR
	10-2, 83–84	F	VA							VA						R						VR				C					F	F		F	VA	
	10-3, 83–84	F	VA							VA						F						R				VA			VR		VR	A		A	VA	VR
	10-4, 83–84	P	VA							VA												R				R					R	R		R	VA	
NP4	10-5, 94–95	P	VA							VA																VA					C	A		F	VA	
	10,CC	P	VA							VA				VR												VA					VA	VA		F	VA	
	11-1, 89–90	P	VA							VA				VR												VA					VA	VA		VR	VA	
	11-2, 89–90	P	VA							VA				VR												C					R	VA		C	VA	
	11-3, 89–90	P	VA							VA																VA					F	C		F	VA	
	11-4, 89–90	P	VA							VA				VR												VA					VR	C		F	VA	
	11-5, 89–90	P	VA							VA				R												C		VR				VA		F	VA	
	11-6, 19–20	P	VA							VA				VR												C						VA		VR	VA	VR
NP3	11,CC	P	VA							VA																A					C	VA		A	VA	VR

Table 10B. Distribution of calcareous nannofossils in Hole 524, Cores 12 to 20.

Zone	Core-Section (interval in cm)	Preservation	Abundance	Coccolithus pelagicus	Chiasmolithus danicus	Zygodiscus sigmoides	Ericsonia subpertusa	Neochiastozygus concinnus	Cruciplacolithus tenuis	Markalius astroporus	Thoracosphaera operculata	Thoracosphaera spp.	Braarudosphaera bigelowii	Markalius reinhardtii	Cruciplacolithus edwardsii	Cruciplacolithus subrotundus	Biantholithus sparsus	Cruciplacolithus primus
NP3	12-1, 67–68	P	VA	VA	VA	VA	VA	C	VA									
	12-2, 82–83	P	VA	VA	VA	A	VA	A	VA	VR	VR							
	12-3, 48–49	P	VA	VA	VA	C		VR	F									
	12-4, 72–73	P	VA	VA	VA	C			F	VR	VR							
	12-5, 72–73	P	VA	VA	VA	VA		F	F									
	12-6, 93–94	P	VA	VA	R	R	R	R	R		VR							
	12,CC	P	VA	VA	R	R	F	R	R									
	13-1, 44–45	P	VA	VA	R	R	R	VR	R		VR							
	13-3, 44–45	P	VA	VA	VR	F	R	VR	R									
	13-5, 44–45	P	VA	VA	F	VR		VR	R	VR								
	14-2, 81–82	F	VA	VA	F	C		VR	C		VR							
	14,CC	F	VA	VA	C	VA		VR	A	VR								
	15-1, 85–86	F	VA	VA	VA	VA		R	VA	VR	VA							
	15-3, 100–101	F	VA	VA	VA	VA		F	C		C	VR						
	15-5, 34–35	G	VA	VA	F	VA			VA		VA	F						
	15, bottom	F	VA	VA	F	VA		VR	A		A	R	VR					
	16-2, 54–55	F	VA	VA	F	VA		VR	VA		VA	VR						
	16-4, 125–126	F	VA	VA	F	VA			R	VR	VA	VR						
	16,CC	F	VA	VA	F	VA			R	R	C	F						
	17-1, 133–135	F	VA	VA	F	VA			A	VR	VA							
	17-2, 92–94	F	VA	VA	R	VA			R	VR	F		VR	VR	R			
	17-3, 48–49	F	VA	VA	R	VA			F	VR	C	VR			F			
	17-4, 22–24	F	VA	VA	R	VA			VR	VR	F			F	R			
NP2	17-5, 33–35	F	VA	VA		VA				F		VR			F			
	17,CC	F	VA	VA		VA				VR	VR			VR	F	VR		
	18-1, 153–155	G	VA	VA		VA				VR	R			VR	C	VR		
	18-2, 56–57	F	VA	VA		VA					R			R	A	VR		
	18-3, 53–54	F	VA	VA		VA				R	F	VR		R	F	VR		
	18-4, 76–77	P	VA	VA		VA								A	A			
	18-5, 55–56	F	VA	VA		VA				R	A	VR		F	VA		VR	
	18-6, 47–48	F	VA	VA		VA				VR	VA	R		R	C		R	
	18,CC	F	VA	VA		VA					VA			R	A			
	19-1, 137–138	F	VA	VA		VA					C	VR	R	VR	F		VR	
	19-2, 94–95	F	VA	VA		VA				R	F			F	F			
	19-3, 83–84	F	VA	VA		VA				R	F	VR		VR	VA			
	19,CC	F	A	A		A				VR	F				F			VR
NP1	20-1, 9–10	F	VA			VA				A	VA	R		R			R	VR
	20-1, 15–16	F	VA			VA				A	VA			VR				C
	20-1, 26–27	F	VA			VA				C	VA						R	VR
	20-1, 30–31	F	A			VA				C	VA	VR		VR				
	20-1, 35–36	F	A			VA				F	C	VR		VR			VR	
	20-1, 40–41	F	A			VA				A	VA	F		VR			R	
	20-1, 45–46	F	A			VA				A	VA	F		VR			R	
	20-1, 50–51	F	C			A				R	A	VR		VR			VR	VR
	20-1, 55–56	F	A			VA				C	VA	VR		R			R	
	20-1, 57–59	F	A			VA				VA	VA			VR			VR	
	20-1, 60-61	F	A			VA				VA	VA			F			R	
	20-1, 65–66	F	A			VA				VA	VA	VR		VR			VR	
	20-1, 71–72	F	VR			R				R	R							
	20-1, 75–76	F	A			VA				F	VA			VR			VR	
	20-1, 80–81	F	C			F				C	A						VR	
	20-1, 84–85	F	A			A				A	A	R		VR				
	20-1, 90–90	F	C			A				A	A	F						

Table 10C. Distribution of calcareous nannofossils in Hole 524, Core 20.

Zone	Core-Section (interval in cm)	Preservation	Abundance (Tertiary species)	Abundance (Cretaceous species)	*Zygodiscus sigmoides*	*Markalius astroporus*	*Thoracosphaera operculata*	*Thoracosphaera* spp.	*Markalius reinhardtii*	*Biantholithus sparsus*	*Braarudosphaera bigelowii*	*Cribrosphaera ehrenbergi*	*Zygodiscus spiralis*	*Watznaueria barnesae*	*Cribrosphaera linea*	*Eiffellithus turriseiffeli*	*Cretarhabdus surirellus*	*Prediscosphaera cretacea*	*Micula staurophora*	*Lithraphidites quadratus*	*Arkhangelskiella cymbiformis*	*Microrhabdulus decoratus*	*Micula mura*	*Cyclindralithus gallicus*	*Prediscosphaera decora*	*Kamptnerius magnificus*	*Cretarhabdus crenulatus*	*Actinozygus regularis*	*Biscutum* spp.	*Parhabdolithus embergeri*	*Prediscosphaera intercisus*	*Nephralithus frequens*	*Micula prinsii*	*Cyclindralithus serratus*	*Microrhabdulus stradneri*	*Cretarhabdulus conicus*	*Chiastozygus amphipons*	*Vekshinella elliptica*
NP1	20-1, 95–96	P	VR	VR	R	R	R																														
	20-1, 99–101	P	R	VR	F		F			F																												
	20-1, 100–101	P	VR	VR	R	VR	F	R																													
	20-1, 105–106	P	VR	VR	R	R	C		VR																												
	20-1, 110–111		B																																		
	20-1, 119–120		B																																		
	20-1, 124–125	P	VR	VR	R		VR																														
	20-1, 129–130	P	VR	VR	VR	VR	VR		R	VR																											
	20-1, 135–136	P	VR	VR	R	VR	R																														
	20-1, 140–141	P	VR	VR	F	F	F																														
	20-1, 145–146		B	B																																	
	20-2, 14–15	F	A	VR	VA	A	VA	VR		VR	VR																										
	20-2, 23–24	F	A	VR	C	A	VA																														
	20-2, 42–43	F	A	VR	VA	VA	VA		VR	R																											
	20-2, 52–53	F	VA	VR	VA	VA	VA			VR																											
	20-2, 53–54	F	A	VR	VA	A	VA			R																											
	20-2, 60–61	F	A	VR	A	VA	A			VR																											
	20-2, 67–69	F	C	VR	VA	A	A		VR			R	VR	R	R	R	VR	R	R	VR																	
	20-2, 74–75	F	VA	C	VA	VA	VA	VR	VR	R	VR	R		C	VR	C	VR	C	F		F	R															
	20-2, 91–92	F	VA	C	VA	A	VA		VR	F		VR	VR	F		F	VR	F	F		F		VR	VR													
	20-2, 98–99	P	VR	F		F	R			F				R	VR		VR		VR		VR	VR															
	202, 104–105	F	VA	VR	VA	A	VA		VR	F			VR	F		F		F	F		F	VR			VR	VR											
	20-2, 110–111	F	VA	F	VA	F	VA		VR	F			VR	F		F		F	F		F	VR					VR	VR									
	20-2, 116–117	F	VA	VR	A	VA	VA	F	R	VR			VR	F		VR					VR	VR							R								
	20-2, 123–124	F	A	F	A	F	A			VR		VR		F		F		F	F		F	R		VR			VR		VR	VR							
	20-2, 131–132	F	F	F	A	F	F			F			VR	F		F		VR	F		R	R					VR										
	20-2, 137–138	F	C	F	C	R	VA		VR	R		VR		F		F	VR	VR	F		R				VR						R						
	20-2, 143–144	F	A	A	A	R	VA		R	C		R	VR	F		C	VR	F	VA	F	C	VR										VR	R				
	20-2, 148–149	F	VA	C	VA	F	VA	R	R	C		VR		C		VR		C	A		VR	VR										VR	VR				
	20-3, 5–6	F	VA	A	VA	A	A	F		A			VR	A	VR	C		C	VA	F	C	VR		VR	VR				VR	VR		VR	VR				
	20-3, 10–11	F	VA	VA	VA	A	VA			C				F	VR	F		C	VA	VR	C			VR	VR					VR	VR	F		VR	VR		
	20-3, 15–16	F	VA	A	VA	VA	VA			F		VR	VR	F	VR	F	R	A	VA	F	A	VR			VR				VR			R					
	20-3, 20–21	F	VA	VA	VA	C	VA			C		VR	VR	F		VA	VR	C	VA	F	R	VR		VR			VR					VR	R		VR	VR	
	20-3, 25–26	F	VA	A	VA	VA	VA		A	C		VR	VR	F		C	VR	C	VA	F	F				VR		VR					VR			VR		VR	
	20-3, 30–31	F	VA	A	VA	F	VA		VA	C		VR	VR	R		VR		F	VA		A		R			VR			VR		VR		R		VR		
	20-3, 36–37	F	VA	VA	VA	VA	VA		VA	F		VR	R	F		VR	VR	A	VA	F	A	VR						R		VR	VR	R		VR		VR	VR
	20-3, 42–43	F	A	A	A	F	A		F	C		F	VR	F		F	VR	A	VA		F	F			R	VR		VR	VR			R	R		VR		
	20-3, 47–48	F	VA	A	VA	A	VA		C	C		R	VR	F	R	C	VR	C	VA	F	C	VR			VR	VR			F			R	VR				VR
	20-3, 52–53	F	VA	VA	VA	F	VA		VA	C		R	VR	F		A	VR	A	VA	F	VA	F			VR			VR	VR			R	VR		VR		
	20-3, 61–62	F	VA	VA	C	C	VA		VA	F		VR	VR	F		C		A	VA	VR	A	F			VR				VR				VR				
	20-3, 66–67	F	VA	A	F	F	VA		VA	VA		VR	R	F	VR	A	R	C	VA	F	A	VR										R	VR				
	20-3, 73–74	F	VA	VA	F	VR	VA		VA	R		VR	VR	F	R	A	R	VR	VA	VR	VA	VR	VR	VR					VR		VR	R	VR			VR	
	20-3, 79–80	F	VA	VA	F	R	VA		VA	VR		VR	R	C	VR	VA	R	A	VA	F	VA	R	VR	R	VR	R					VR	VR	VR			VR	VR	
	20-3, 85–86	F	VA	VA	F	VR	A		VA	VR		R	VR	F	VR	A	VR	VR	VA	VR	VA	VR			R	VR		VR	VR		VR	VR	R				
	20-3, 91–92	F	A	VA	F	VR	F		VA			R	R	C	VR	A	R	VA	VA	F	VA	VR		R	R	VR	VR		VR		VR	R	R				
	20-3, 96–97	F	C	C	F		R		A			VR		C		A	VR	VR	VA		VA	R		VR			VR				VR	VR				VR	
	20-3, 98–99	F	R	VA	R	VR	R		F			VR	VR	F	R	VA		VA	VA	VR	VA	VR						VR			VR	VR	VR			VR	
	20-3, 99–100	F	VR	VA	R		R		R			VR	R	VA		VA		VA	VA	R	VA	R			VR	VR		VR			VR	C	R			VR	
	20-3, 102–103	F	VR	VA	R		R		R			F		A	R	A	VR	VA	VA	VR	VA	R		VR	R	R			VR	VR	VR	F	R			VR	
Micula murus	20-3, 108–109	P		F					R									VR	A		R						VR		VR					VR			
	20-3, 112–113	P		VA					VR			VR	R	C	VR	F	VR	VA	VA	VR	VA	R				VR					F	VR			R			
	20-3, 114–116	P		VA								VR	VR	C	F	A	R	VA	VA		VA	F	R	R	VR	VR	VR			R		F		VR	VR		

Table 10D. Distribution of calcareous nannofossils in Hole 524, Cores 20 to 27.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Markalius reinhardtii*	*Cribrosphaera ehrenbergi*	*Zygodiscus spiralis*	*Watznaueria barnesae*	*Cribrosphaera linea*	*Eiffellithus turriseiffeli*	*Cretarhabdus surirellus*	*Prediscosphaera cretacea*	*Micula staurophora*	*Lithraphidites quadratus*	*Arkhangelskiella cymbiformis*	*Microrhabdulus decoratus*	*Micula mura*	*Cylindralithus gallicus*	*Prediscosphaera decora*	*Kamptnerius magnificus*	*Cretarhabdus crenulatus*	*Actinozygus regularis*	*Biscutum* spp.	*Parhabdolithus embergeri*	*Prediscosphaera intercisus*	*Nephrolithus frequens*	*Micula prinsii*	*Cylindralithus serratus*	*Microrhabdulus stradneri*	*Cretarhabdus conicus*	*Chiastozygus amphipons*	*Vekshinella elliptica*	*Ahmuellerella octoradiata*	*Cretarhabdus splendens*	*Tetralithus obscurus*	*Prediscosphaera spinosa*	*Vekshinella dibrachiata*	*Micula premura*
Micula mura	20-3, 124–125	P	VA	VR	C	VR	VA	R	C	R	VA	VA	R	A	F		VR	VR	VR	VR					R	R	VR									
	20-3, 135–136	P	VA		VR		A		A	VR	VA	VA	VR	VA	VR	R	R	VR	VR	VR				VR	VR	VR	R	R								
	20-3, 149–150	F	VA		C	VR	A	F	C	F	VA	VA	A	VA	F		F	R	VR	F			R	VR		F				F			VR			
	20-4, 8–9	F	VA		F	R	A	VR	C	F	VA	VA	VR	VA	VR		F	R		VR				VR		F		VR		VR						
	20-3, 24–25	F	VA		C	VR	A	F	C	VR	VA	VA	F	VA	R		R			F						F	VR			VR		VR				
	20-4, 31–32	F	VA		C		VA	F	VA	VR	VA	VA	F	VA	F		VR	R		F	VR			R		VR	VR	VR	VR	VR						
	20-4, 42–44	F	VA		A		VA	VR	C		VA	VA	C	VA	F	VR	VR			VR					VR	F										
	20-4, 50–51	F	VA		A	VR	VA	F	VA	VR	VA	VA	F	VA	F	R		VR	VR		VR		VR			F								VR		
	20,CC	F	VA		VA	VR	VA	F	VA	F	VA	VA	VA	VA	C		R	VR	VR		R			R	R	VR		F		R	VR		VR		VR	
	21-1, 67–68	F	VA			R	VA		R	VR	VA	VA	VR	VA	F						R	R		R		F	R	VR								
	21-1, 62–63	P	C				C			R	VR	C					R									VR										
	21-3, 110–111	F	VA		VR	VR	VA		F	R	C	VA	F	A				VR									R										
	21-4, 29–30	F	VA		C	R	VA	R	R	F	VA	VA	C	VA		VR	VR		VR					F				VR	VR							
	21-5, 118–119	F	VA		C	R	VA	R	A	R	VA	VA	R	VA	VR		VR	VR		VR	VR					F				VR		R		VR		
	21,CC	P	F				VR					C		R		VR										VR										
	22-1, 55–56	F	VA		C	R	VA	VR	C		VA	VA	F	VA	VR	R		VR	VR		R		VR		VR	F				VR		VR				
	22-2, 103–104	F	VA		C	VR	VA		C	VR	VA	VA	R	C	R		VR							R		F			VR						VR	
	22-3, 58–59	F	VA		A		VA	VR	C	C	VA	VA	F	VA	R	VR			VR					R												
	22-4, 81–82	F	VA				VR		R	VR	VR	VA		A	VR	VR					VR															
	22-5, 38–39	F	VA		VR		A		R		A	VA	VR	A	R		VR		VR		VR															
	22,CC	F	VA		F	R	VA	R	R	VR	VA	VA	VR	C	F	VR	R				VR						VR									
	23-1, 116–117	F	VA		A	F	VA	F	A	F	VA	VA	A	A	F				VR	VR	R			VR					VR				R			
	23-2, 132–133	P	VA			VR	A	F	VA		VA	VA		A	VR		VR								VR											
	23-4, 132–133	P	VR									R																								
	23-5, 86–87	P	VA		VR		A		F		VA	VA	VR	VA	F		R										VR									
	23-5, 132–133	F	VA				VA		VR		VA	A	VR	VA	VR		R		VR																	
	23,CC	F	VA				VA		C	VR	VA	VA	F	VA	F		VR		VR		VR				VR			VR				VR				
	24-1, 124–125	F	VA		VA		VA		F	R	VA	VA	VR	A	F		F		R	VR	R								VR	VR					VR	
	24-2, 86–87	F	VA		A		VA	F	C	VR	VA	VA	VR	C	VR			VR	F					VR	R				VR	R						
	24-3, 27–28	F	VA		F		VA	F	F	F	VA	VA	VR	A	R			VR	R	F		VR					VR									
	24-4, 49–50	F	VA				F		R		VR	VA		F	VR																					
	24-5, 24–25	F	VA		C	R	C		C	F	VA	VA	F	VA	F		VR		R	VR				R				R	R		VR		VR			
	24-6, 5–6	F	VA		A	R	VA		C	F	VA	VA	R	A	A				VR	VR					VR			C	F	R			R			
	24,CC	P	VR		VR		R					R		R																						
	25-1, 140–141	F	VA		C	VR	A		F	F	VA	VA	VR	A	R					VR	VR															
	25-2, 145–146	F	VA		VR	VR	VA	VR	A	F	VA	VA	VR	VA	R				R	VR	R				F					R	VR		R		VR	
	25-3, 70–71	F	VA		A	VR	VA	VR	A		VA	VA	R	VA	R		VR		VR	VR	VR		VR		F			VR	VR	VR	VR			VR		
	25-4, 133–134	F	VA		C		VA	R	A	R	VA	VA	F	VA	F				R	VR	C		R		F			R	R		R	VR			VR	
	25-5, 106–107	F	VA		C	R	VA	R	VA	VR	VA	VA	F	VA	C				VR	VR	R				R				VR	VR			R			
	25-6, 60–61	P	VA		F	VR	VA		F		A	VA		VA	VR		VR			VR	VR															
	25,CC	F	VA		F	F	VA		VR		A	VA	VR	VA	VR		VR			F	R				R			R		VR			VR			
	26-1, 88–89	P	VA		F	VR	VA	VR	F	VR	A	VA		VA	VR				R		R		VR		VR				VR					VR	
	36-2, 75–76	F	VA		F	R	VA	VR	F		VA	VA	R	C	F			VR		R	F			VR	VR					R		R	VR			
	26-3, 81–82	F	VA		F	VR	VA	VR	F	R	VA	VA		C			VR		F		VR							VR								
	26-4, 52–53	F	VA		F	VR	A	VR	F	R	C	VA	VR	C	F		VR		R		R									VR			VR			
	26-5, 39–40	P	VA		VR		VA	VR			A	VA		A		VR				VR																
Nephrolithus frequens zone	26-6, 83–84	F	VA		A	VR	VA	F	C		VA	VA	VR	A					R	F										VR						
	26,CC	P	VA		C		A	R	F		A	VA		A	F			VR	R	R	VR								VR			VR		VR			R
	27-1, 75–76	P	VA		C		VA	VR		R	VA	VA	VR	A	F			VR	VR	C															VR	
	27-2, 103–105	P	VA		F		C		F	F	C	VA		F						F	VR				VR			VR					VR			VR
	27-3, 15–17	P	VA				F				VR	VA																								
	27-4, 60–62	P	A		R		A		R	VR	R	VA		F	R					VR																
	27,CC	F	VA		F	VR	VA		R	F	VR	VA	VR	A	R		VR												VR							F

Table 10E. Distribution of calcareous nannofossils in Hole 524, Cores 28 to 35.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Micula staurophora*	*Arkhangelskiella cymbiformis*	*Watznaueria barnesae*	*Cyclindralithus gallicus*	*Prediscosphaera cretacea*	*Cribrosphaera ehrenbergi*	*Kamptnerius magnificus*	*Cretarhabdus surirellus*	*Eiffellithus turriseiffeli*	*Zygodiscus spiralis*	*Micula premura*	*Cretarhabdus crenulatus*	*Cretarhabdus splendens*	*Kamptnerius magnificus*	*Ahmuellerella octoradiata*	*Microrhabdulus decoratus*	*Parhabdolithus embergeri*	*Prediscosphaera intercisus*	*Microrhabdulus stradneri*	*Nephrolithus frequens*	*Cretarhabdus conicus*	*Actinozygus regularis*	*Cribrosphaera linea*
Nephrolithus frequens zone	28-1, 21–22	F	VA	VA	C	VA	VR	VA	VR	VR	VR															
	28-2, 29–30	F	VA	VA	C	VA		A	C			F	VR	VR	VR	VR	VR									
	28-3, 39–40	F	VA	VA	A	VA		C	R			R	R	VR			VR	VR	R	VR						
	28-4, 91–92	F	VA	VA	C	VA		A	VR		VR	VR	VR	F	R		VR		F							
	28-5, 40–42	F	VA	VA	A	VA		VA	A		F	F	VR	R	VR		R		F	R	R	VR	VR			
Nondiagnostic zone	28,CC	F	VA	VA	R	F		R	VR																	
	29-1, 61–62	F	VA	VA	VA	VA		A	C		C	F	VR		VR	VR	F		F	F				VR		
	29,CC	F	VA	VA	VA	VA		VA	A		VR	F			VR		VR		F	VR					VR	VR
	32-1, 126–127	F	VA	VA	R	A					VR								VR		VR					VR
	32-1, bottom	F	VA	VA	R	A		R	VR			F							VR		VR					
	32-2, 102–103	P	VA	VA	VR	VA		F			VR								VR							
	35-1, 146–147	P	A	A	R	C	VR	VR									VR									
	35,CC	P	VA	VA	F	VR						VR														VR

Table 11. Distribution of calcareous nannofossils in Hole 524A.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Coccolithus pelagicus*	*Chiasmolithus bidens*	*Zygrhablithus?* sp.	*Discoaster multiradiatus*	*Chiasmolithus consuetus*	*Ellipsolithus macellus*	*Coccolithus bisulcus*	*Discoaster diastypus*	*Fasciculithus involutus*	*Fasciculithus tympaniformis*	*Toweius eminens*	*Toweius craticulus*
NP10	1-1, 76–77	F	VA	VA	VA	F	A	VR	VR	A					
	1-2, 76–77	F	VA	VA	VA	C	C	VR	VR	A					
	1-3, 76–77	F	VA	VA	VA	A	A	VR	VR	A	R				
	1-4, 76–77	F	VA	VA	VA	F	F	VR		F	F				
	1-5, 76–77	F	VA	VA	VA	F	F	VR	VR	A					
	1,CC	F	VA	VA	VA	R	C			A	F				
	2-1, 96–97	F	VA	VA	VA		F			A					
	2-2, 96–97	F	VA	VA	VA		C	VR		F					
NP 9	2,CC	F	VA	VA	VA		VA	VR				R	VA	R	VA

Table 12. Distribution of calcareous nannofossils in Hole 524B.

Zone	Core-Section (interval in cm)	Preservation	Abundance	*Sphenolithus radians*	*Chiasmolithus eograndis*	*Coccolithus pelagicus*	*Zygrhablithus bijugatus ?*	*Discoaster lodoensis*	*Discoaster barbadiensis*	*Chiasmolithus grandis*	*Tribrachiatus orthostylus*	*Chiasmolithus consuetus*	*Discoaster diastypus*	*Chiasmolithus solitus*	*Ellipsolithus macellus*	*Discoaster multiradiatus*	*Chiasmolithus bidens*
NP13	1-1, 101–102	F	VA	VA	VA	VA	F	VA	C	F							
NP12	1-2, 101–102	F	VA	VA	VA	VA	VA	VA	R	R	C						
	1,CC	F	VA	A	VA	VA		VA	F		VA	R	F				
	2-1, 145–146	F	VA	VA	VA	VA					VA	C	C	VA			
	2-2, 145–146	F	VA	VA	VA	VA	C				VA	F	R	F	R		
	2-3, 68–69	F	VA	VA	A	VA	VA			R	A	R	F	F			
	2,CC	F	VA	VA	A	VA	VR				VA	C	VA				
	3-1, 107–108	F	VA	A	A	VA	R	F			R	F	A	VA	VR		
	3-2, 107–108	F	VA	VA	F	VA	VA	R			C	F	A	VA	R		
NP10	3-3, 107–108	F	VA		F	VA	VA				VA	F	R		F	VA	VA
	3,CC	F	VA		VA	VA	R				F		R			VA	VA
	4-1, 31–32	F	VA		VA	VA	R				A	F	F		C	F	VA
	4,CC	F	VA		R	VA					R	F	R		VR	C	VA
	5-1, 81–82	F	VA		C	VA						R	C		R	R	A
	5-2, 45–46	F	VA		VA	VA						R	A			R	VA
	5-3, 45–46	F	VA			VA						F	C			R	VA
	5,CC	F	VA			VA						VR	F		R	F	VA
	6,CC	F	VA			VA						R	A		F	VA	VA
	7-2, 138–139	F	VA		A	VA							F			A	VA
	7-3, 75–76	F	VA		R	VA	F					R	F			VA	VA
	7,CC	F	VA			VA	VA						R			A	VA