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5. Calcareous Nannofossil Biostratigraphy of Upper Cretaceous to Paleocene Sediments from Leg 173, Iberia Abyssal Plain, Sites 1067–1069[1]

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ABSTRACT

Drilling on the Iberia Abyssal Plain during Ocean Drilling Program Leg 173 allowed us to recover Upper Cretaceous through Paleocene sediments at Sites 1068 and 1069 and only upper Paleocene sediments at Site 1067, which expands considerably the Upper Cretaceous to Paleocene record for this region. Of these three sites, Site 1068 recovered uppermost Cretaceous sediments as well as the most complete Paleocene record, whereas Site 1067 yielded only uppermost Paleocene sediments (Zone CP8). Site 1069 provided a rather complete upper Campanian through Maastrichtian section but a discontinuous Paleocene record.

After a detailed calcareous nannofossil biostratigraphy was documented in distribution charts, we calculated mass accumulation rates for Holes 1068A and 1069A. Sediments in Hole 1068A apparently record the final stages of burial of a high basement block by turbidity flows. Accumulation rates through the Upper Cretaceous indicate relatively high rates, 0.95 g/cm^2/k.y., but may be unreliable because of the lack of datum points and/or possible hiatuses. Accumulation rates in the Paleocene section of Hole 1068A fluctuated every few million years from lower (~0.35 g/cm^2/k.y.) to higher rates (~0.85 g/cm^2/k.y.) until the latest Paleocene, when rates increased to an average of ~2.0 g/cm^2/k.y.

Mass accumulation rates for the Upper Cretaceous in Hole 1069A indicate a steady rate of ~0.60 g/cm^2/k.y. from 75 to 72 Ma. There may have been one or more hiatuses between 72 and 68 Ma (combined Zone

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CC24 through Subzone CC25b), as indicated by the very low accumulation rate of 0.15 g/cm²/k.y. The Paleocene section of Hole 1069A does not show the same continuous record, which may result from fluctuations in the carbonate compensation depth and poor recovery (average = 40%). Zones CP4 and CP5 are missing within a barren interval; this and numerous other barren intervals affect the precision of the nannofossil zonation and calculation of mass accumulation rates. However, in spite of these missing zones, mass accumulation rates do not seem to indicate the presence of hiatuses as the rates for this barren interval average ~1.0 g/cm²/k.y.

This study set out to test the hypothesis that a reliable biostratigraphic record could be constructed from sediments derived from turbidity flows deposited below the carbonate compensation depth. As illustrated here, not only could a reliable biostratigraphic record be determined from these sediments, but sedimentation and mass accumulation rates could also be determined, allowing inferences to be drawn concerning the sedimentary history of this passive margin. The reliability of this record is confirmed by independent verification by the establishment of a magnetostratigraphy for the same cores.

INTRODUCTION

Calcareous nannofossils are primarily the skeletal remains of golden-brown unicellular algae called coccolithophores. These nannofossils have proven useful for marine biostratigraphy in sediments ranging from the Late Triassic to the Holocene in age. Nannofossil biostratigraphic zones are defined by first appearances, extinctions, or acmes and must be recognizable over large regions of the world in order to be useful.

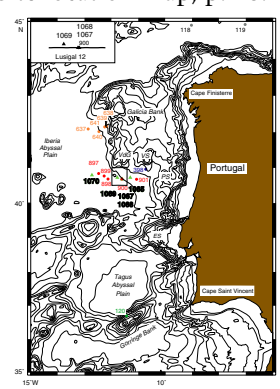
During Ocean Drilling Program (ODP) Leg 173, six sites were drilled in the Iberia Abyssal Plain (IAP), which is located off the western coast of the Iberia peninsula (Fig. F1). We recovered Upper Cretaceous sediments from Sites 1068 and 1069 and Paleocene sediments from Sites 1067, 1068 and 1069. Leg 173 was intended as a follow-up to Leg 149; thus, it had similar objectives of sampling oceanic and continental crusts to determine their origin and history (Whitmarsh, Beslier, Wallace, et al., 1998). However, its important secondary objective was to determine the sedimentary history of the passive margin.

Site 1067, drilled over a high buried basement block (Fig. F2), yielded only uppermost Paleocene sediments. Site 1068 was drilled farther down the flank of the same basement block; from it we recovered Upper Cretaceous sediments and the most complete Paleocene section in the area. The only other reasonably complete Upper Cretaceous to Paleocene section in the IAP was recovered adjacent to the nearby Vigo Seamount at Deep Sea Drilling Project (DSDP) Site 398 (Fig. F1) (Sibuet, Ryan, et al., 1979). An uppermost Paleocene section was recovered at Site 900 of Leg 149 (Sawyer, Whitmarsh, Klaus, et al., 1994).

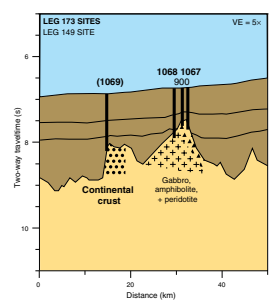
Of the three Leg 173 sites discussed here, Site 1069 was the farthest from the continent and was drilled over the next westward basement block from Sites 1067 and 1068. Site 1069 contained a fairly continuous record of nannofossils from the upper Campanian through the Paleocene but was the most difficult to zone because of the absence of key biostratigraphic marker species.

Much of the sedimentation during the Cretaceous to Paleocene on the IAP was made up of carbonate-bearing turbidites. The main purpose

F1. Site location map, p. 18.



F2. Relative depth of basement blocks, p. 19.



of this study is to describe the abundance, preservation, and biostratigraphic distribution of Cretaceous to Paleocene calcareous nannofossils recovered from these sediments during Leg 173. Using these data, we will determine sedimentation rates and mass accumulation rates to help elucidate the sedimentation history of the IAP.

We believe that a reliable biostratigraphic model can be constructed, despite the fact that the nannofossils are found in turbidites. Weaver (1994) demonstrated that most turbidites in the Canary Basin were essentially nonerosive and generally consisted of a mixture of sediments that ranged from 200 to 500 ka in age. A working hypothesis in this paper will be that the turbidites found on the IAP are similar to the turbidites found in the Canary Basin and that they can yield a usable nannofossil biostratigraphy.

Calcareous nannofossils species considered in this report are listed in the **"Appendix,"** p. 15, where they are arranged in alphabetical order by genera. Bibliographical references for these taxa can be found in Perch-Nielsen (1985) and Bown (1998); any references not listed therein are cited in the references of this paper.

PREVIOUS STUDIES

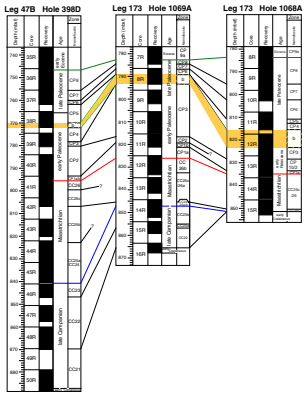
Drilling occurred in the area of the IAP during four previous DSDP and ODP legs: DSDP Legs 13 and 47B and ODP Legs 103 and 149 (Fig. **F1**). The DSDP Leg 13 crew drilled one site on the southernmost edge of the IAP (Site 120) but recovered only six partial cores that contained sediments ranging in age from Late Jurassic to Early Cretaceous (Ryan, Hsü, et al., 1973). The crew of DSDP Leg 47B, however, recovered sediments that range in age from Barremian to Holocene at Site 398. This site also included a nearly complete section from the upper Campanian through the Paleocene (Fig. **F3**) (Sibuet, Ryan, et al., 1979).

ODP Leg 103 occupied five sites in an east-west transect on the western margin of the Galicia Bank to the north of the study area (Boillot, Winterer, Meyer, et al., 1987). Three of the sites (637, 638, and 639) contain middle to upper Miocene to Holocene sediments that rest unconformably on Lower Cretaceous sediments. Site 640 contains 150 m of barren clays resting on top of Aptian sediments. Site 641 contains Upper Cretaceous to Pleistocene sediments. As a result of poor recovery, only a few stringers of nannofossil-bearing upper Campanian to lower Maastrichtian marl were recovered (Boillot, Winterer, Meyer, et al., 1987).

ODP Leg 149 drilled five sites in an east-west transect on the eastern margin of the Iberia Abyssal Plain. Of these sites, at only one, Site 900, did we penetrate Paleocene sediments. A little more than 2 m of uppermost Paleocene sediments was recovered. These sediments fall within nannofossil Zone CP8 (Sawyer, Whitmarsh, Klaus, et al., 1994, p. 227), which represents only the last 1 m.y. of the Paleocene. At three sites, Sites 897, 898, and 899, we recovered Holocene to middle Eocene, upper Eocene, and Oligocene sediments, respectively. From Site 901 we recovered only Jurassic sediments (Sawyer, Whitmarsh, Klaus, et al., 1994).

Previous works on calcareous nannofossils from Upper Cretaceous to Paleocene sediments in the area have been published by Perch-Nielsen (1971a, 1971b) and Blechschmidt (1979). Blechschmidt reported on a nearly complete Upper Cretaceous to Paleocene section from Hole 398D (DSDP Leg 47B). Most nannofossils contained within these sec-

F3. Graphic correlations, p. 20.



tions were moderately well to poorly preserved. There were some sections that were barren of nannofossils, but there were no indicated hiatuses.

Perch-Nielsen (1971a, 1971b) described many new upper Paleocene taxa from ODP Leg 12, Site 119, in the Bay of Biscay. The Bay of Biscay is northeast of the study area and is bordered by the northern margin of Spain and the western margin of France. Many of the fasciculithids, one sphenolithid, two heliolithids, and one *Toweius* recorded here were originally described from Site 119.

Calcareous nannofossils have been previously reported from Leg 173 in the *Initial Reports* volume (Whitmarsh, Beslier, Wallace, et al., 1998). There were no planktonic foraminifers reported from the sediments recovered. The shipboard work included a reconnaissance study of the nannofossils, mostly from core-catcher samples (every 9 m), and produced sedimentation rates based upon those findings. The present study, however, reports a much higher resolution of at least one sample per core section (at least one every 150 cm).

METHODS

The nannofossil biostratigraphy presented here is based on examination of smear slides prepared from unprocessed sediments and viewed using phase contrast and cross-polarized light microscopy at a magnification of 1550×. The biostratigraphic zonation scheme used for the Paleocene (Fig. F4) is that of Martini (1971) and Okada and Bukry (1980). The Martini zonation is widely used for Cenozoic, low-latitude, open-marine sediments, whereas the Okada and Bukry zonation is widely used for low- to mid-latitude, open-marine sections. Biostratigraphic zonation of Cretaceous sediments follows Sissingh (1977) as modified and illustrated in Perch-Nielsen (1985) (Fig. F5).

Abundances of individual taxa are represented by letter codes and were recorded according to the following definitions:

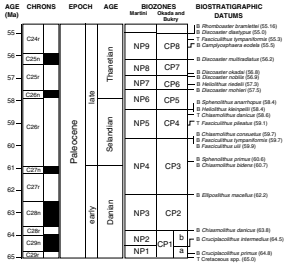
S = single, 1 specimen observed.
R = rare, 1 specimen per 101–1000 fields of view.
F = few, 1 specimen per 11–100 fields of view.
C = common, 1 specimen per 2–10 fields of view.
A = abundant, 1–10 specimens per field of view.
V = very abundant, 10–100 specimens per field of view.

The same definitions were used for estimates of total abundance in each sample, with an added definition: B (barren of nannofossils).

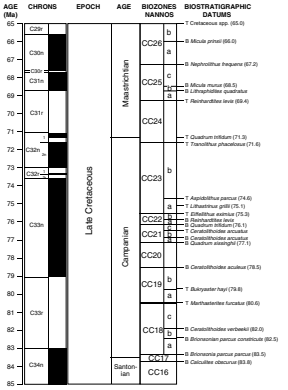
The preservation of nannofossils can vary significantly because of etching, dissolution, or calcite overgrowth. Finding pristine specimens in the same sample as specimens that are severely overgrown or etched is not uncommon. The state of preservation of the nannofossil assemblages in this paper was recorded as follows:

G = good preservation, little or no evidence of dissolution and/or overgrowth, primary diagnostic features preserved, specimens are identifiable to the species level.
M = moderate preservation, specimens exhibit some etching and/or overgrowth, primary diagnostic features somewhat altered but most specimens are identifiable to the species level.

F4. Cenozoic biostratigraphic zonation, p. 21.



F5. Cretaceous biostratigraphic zonation, p. 22.



P = poor preservation, specimens are severely etched or exhibit overgrowth, primary diagnostic features largely destroyed, fragmentation has occurred, many specimens cannot be identified to the species and/or generic level.

Sedimentation rates were calculated using the nannofossil datums only. Ages for the nannofossil datums in the Cenozoic were obtained from Berggren et al. (1995); ages for the nannofossil datums in the Cretaceous were obtained from Gradstein et al. (1995) and Erba et al. (1995).

Mass accumulation rates were calculated using the following equation from Davies et al. (1995):

$$\mathrm{MAR} = \{T \times [BD - (P \times \mathrm{WD})]\}/t,$$

where *BD* is wet bulk density (in grams per cubic centimeter), *P* is porosity (in weight percent), WD is seawater density (1.025 g/cm^3), and *T* is the thickness of sediment accumulated at time *t* (10^3 yr). Limited numbers of multisensor track data were available from shipboard measurements and can be found in the Leg 173 *Initial Reports* volume in the appropriate chapters (Whitmarsh, Beslier, Wallace, et al., 1998).

NANNOFOSSIL BIOSTRATIGRAPHY AND ZONATION

Hole 1067A

Site 1067 is situated near the northern edge of the southern Iberia Abyssal Plain at 40°40.95´N, 11°35.75´W, in 5020.90 m of water. Coring began at 648.00 meters below the seafloor (mbsf) at Hole 1067A and continued over the next 207.60 m; we recovered only 77.67 m of sediment (average recovery = 37.4%) to a total depth of 855.6 mbsf. We recovered sediments from Cores 173-1067A-1R through Section 14R-1 (648.00–763.08 mbsf). These sediments range from middle Eocene to latest Paleocene in age and consist of greenish gray calcareous claystones, calcareous silty claystones, and light gray calcareous siltstones and sandstones. Relative abundances of species and biostratigraphically identified units from Site 1067 are presented in Table **T1.**

T1. Calcareous nannofossils, p. 27.

Paleocene sediments were encountered at Sample 173-1067A-13R-1, 47–48 cm (754.67 mbsf), just below the first occurrence of *Discoaster diastypus* (see McGonigal and Wise, **Chap. 4,** this volume). Based on the occurrence of *Discoaster multiradiatus,* this section was assigned to Zone CP8. This zone was traced downhole to Sample 173-1067A-13R-2, 28–29 cm (755.98 mbsf), which is barren of nannofossils. This barren interval persisted downhole to Sample 173-1067A-14R-1, 0–3 cm (763.80 mbsf), where a rare occurrence of *Coccolithus pelagicus* indicates that the sediments are still Cenozoic in age; however, no other significant datums were encountered in this sample. This last sample represents the lowest occurrence of sediments that rest directly upon basement rock.

Hole 1068A

Site 1068 is situated near the southern edge of the IAP, at 40°40.955´N, 11°36.720´W, in 5043.90 m of water. Coring began at 711.30 mbsf in Hole 1068A and continued over the next 244.50 m, re-

covering only 180.59 m of sediment (average recovery = 73.9%), to a total depth of 955.80 mbsf. Sediments were recovered from Core 173-1068A-1R through Section 15R-5 (711.30–853.02 mbsf). These sediments range from middle Eocene to Maastrichtian in age and consist of claystones, calcareous claystones, nannofossil chalk, and calcareous siltstones. The Paleocene section is dominated by carbonate turbidites and upward-darkening sequences that contain a record of all Okada and Bukry (1980) zones (Table T2).

Paleocene sediments were encountered at Sample 173-1068A-8R-4, 44–45 cm (783.84 mbsf), based on the absence of *D. diastypus* (see McGonigal-Roessig and Wise, **Chap. 4,** this volume) and the presence of *D. multiradiatus*. The first occurrence (FO) of *D. multiradiatus,* which marks the lowest boundary of Subzone CP8a, was noted in Sample 173-1068A-9R-6, 28–29 cm (796.28 mbsf). Within Zone CP8 are occurrences of *Fasciculithus shaubii, Fasciculithus lillianae,* and single occurrences of many other fasciculithids (Plate P1). The FO of *Discoaster nobilis* was noted in Sample 173-1068A-10R-3, 123–125 cm (802.33 mbsf), which marks the bottom of Zone CP7.

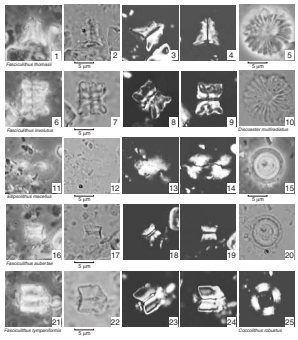
The FO of *Discoaster mohleri,* which marks the lowest boundary of Zone CP6, is found in Sample 173-1068A-11R-3, 15–17 cm (810.85 mbsf). The occurrence of *D. mohleri* in Sample 173-1068A-11R-4, 35–36 cm (812.55 mbsf), is considered to be reworked because it was found in the same sample as the FO of *Heliolithus kleinpellii*. Within Zone CP6, in Sample 173-1068A-11R-2, 8–9 cm (809.28 mbsf), is the FO of *Heliolithus riedelii*. *Discoaster bramlettei* (Plate P2) was also noted within this section and persists to the bottom of Zone CP5. The FO of *H. kleinpellii* in Sample 173-1068A-11R-4, 35–36 cm (812.55 mbsf), marks the lower boundary of Zone CP5. The lower boundary of Zone CP4 is marked by *Fasciculithus tympaniformis;* its last observed occurrence is found in Sample 173-1068A-11R-CC, 3–4 cm (815.41 mbsf). Below this level is a long interval that is barren of calcareous nannofossils. This barren interval persists to Sample 173-1068A-12R-5, 35–36 cm (823.65 mbsf), in which *F. tympaniformis* is absent, placing the lower boundary of Zone CP4 in Sample 173-1068A-12R-4, 140–143 cm (823.20 mbsf).

The CP3 lower zonal boundary is marked by the FO of *Ellipsolithus macellus,* which was noted as a single occurrence in Sample 173-1068A-13R-2, 20–21 cm (828.60 mbsf). Zone CP2 and Subzone CP1b had to be combined because we could not distinguish *Chiasmolithus danicus* in any sample in this part of the column. The FO of *Cruciplacolithus tenuis* in Sample 173-1068A-13R-5, 78–79 cm (833.68 mbsf), marks the base of this combined zone. The Cretaceous/Tertiary (K/T) boundary was placed between Sample 173-1068A-13R-6, 52–53 cm (834.92 mbsf), and Sample 173-1068A-13R-6, 69–70 cm (835.09 mbsf), based on the lack of Cenozoic forms in the latter sample.

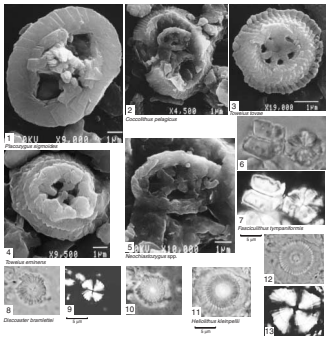
The interval from Sample 173-1068A-13R-6, 82–83 cm (835.22 mbsf), to Sample 173-1068A-15R-4, 10–11 cm (850.39 mbsf), is classified here as Subzone CC25c/Zone CC26 (Table T3), based on the FO of *Micula murus*. The sediments in this interval are dominated by *Arkhangelskiella cymbiformis, Cribrosphaerella ehrenbergii, Micula decussata, Prediscosphaera cretacea, Retecapsa crenulata,* and *Watznaueria barnesae* (Plate P3). The lack of *Micula prinsii* and reliable *Nephrolithus frequens* makes it impossible to resolve a more precise zonation. The interval from Sample 173-1068A-15R-4, 12–13 cm (850.41 mbsf), to Sample 173-1068A-15R-4, 101–102 cm (851.30 mbsf), is assumed to belong to Subzone CC25b; however, the absence of reliable datums makes it difficult to assign this

T2. Calcareous nannofossils, Paleocene interval, p. 28.

P1. Plate P1, p. 47.

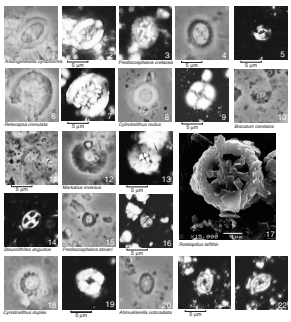


P2. Plate P2, p. 48.



T3. Calcareous nannofossils, Cretaceous interval, p. 34.

P3. Plate P3, p. 49.



section to any zone. The latter sample represents the lowest occurrence of Upper Cretaceous sediments at Site 1068.

Hole 1069A

Site 1069 is situated in the southern IAP, at 40°43.612´N, 11°46.633´W, in 5074.80 m of water. Coring began at 718.80 mbsf at Hole 1069A and continued over the next 240.50 m, recovering only 96.30 m of sediment (average recovery = 40.0%) to a total depth of 959.30 mbsf. Sediments were recovered from Core 173-1069A-1R through Section 17R-1 (718.80–873.70 mbsf). These sediments range from middle Eocene to Late Jurassic in age and consist of claystones, calcareous claystones to nannofossil claystones, nannofossil chalk, and calcareous siltstones. The upper Campanian to Paleocene section is dominated by carbonate turbidites and upward-darkening sequences.

Paleocene sediments were encountered at Sample 173-1069A-7R-5, 18–19 cm (782.98 mbsf), based on the absence of *D. diastypus* (see McGonigal and Wise, **Chap. 4,** this volume) and the presence of *D. multiradiatus* (Table **T4**). The FO of *D. multiradiatus,* which marks the lowest boundary of Zone CP8, is noted in Sample 173-1069A-7R-CC, 20–22 cm (784.58 mbsf). Within Zone CP8 are occurrences of *F. shaubii, F. lillianae,* and *Fasciculithus alanii*, as well as many other fasciculithids. The only occurrence of *D. nobilis* was noted in Sample 173-1069A-8R-1, 33–34 cm (786.73 mbsf), which marks the bottom of Zone CP7.

T4. Calcareous nannofossils, Paleocene interval, p. 35.

The FO of *D. mohleri*, found in Sample 173-1069A-8R-2, 70–71 cm (788.6 mbsf), marks the lower boundary of Zone CP6. Within this zone in Sample 173-1069A-8R-1, 87–90 cm (787.27 mbsf), is a single rare occurrence of *H. riedelii;* this sample also marks the lowest observed occurrence of *H. kleinpellii*. From Sample 173-1069A-8R-2, 117–118 cm (789.07 mbsf), to Sample 173-1069A-8R-5, 62–63 cm (793.02 mbsf), is a long barren interval, below which assigning a zonation to the samples becomes very difficult because of a lack of reliable markers and the presence of numerous barren intervals. The absence of *H. kleinpellii* and *F. tympaniformis* below this interval indicates that these samples belong to Zone CP3. The lower boundary of Zone CP3 is tentatively marked as the first common occurrence of *Prinsius martinii* in Sample 173-1069A-11R-1, 128–129 cm (816.58 mbsf). Perch-Nielsen (1979) showed that *P. martinii* could be used to approximate the lower boundary of Zone CP3, although it appears slightly lower than *E. macellus*.

A single occurrence of *C. danicus* and the last occurrence of a generic *Chiasmolithus* spp. mark the lower boundary of Zone CP2 in Sample 173-1069A-11R-3, 91–92 cm (819.21 mbsf), below which is the first common occurrence of *Prinsius dimorphosus* in Sample 173-1069A-11R-4, 79–81 cm (820.59 mbsf). Perch-Nielsen (1979) showed that *P. dimorphosus* falls within the middle of Subzone CP1b. The lower boundary of Subzone CP1b is marked here by *C. tenuis* in Sample 173-1069A-12R-1, 1–2 cm (825.01 mbsf).

The K/T boundary was found between Sample 173-1069A-12R-1, 113–114 cm (826.13 mbsf), and Sample 173-1069A-12R-1, 120–122 cm (826.20 mbsf). The absence of Cenozoic forms in the latter and the presence of *Bianolithus sparsus* in Sample 173-1069A-12R-1, 62–64 cm (825.62 mbsf), make it possible to place the boundary here despite the fact that Sample 12R-1, 113–114 cm (826.13 mbsf), is barren.

Upper Cretaceous nannofossils indicate a fairly continuous section from the upper Campanian to the end of the Cretaceous; however, the lack of certain key markers made the combination of some zones neces-

sary (Table T5). Most of the combined zones occur in the Maastrichtian and could be the result of hiatuses or poor preservation that results from deposition at or below the carbonate compensation depth (CCD). Preservation throughout the Cretaceous is moderate to poor (Plate P4), and samples generally contain abundant nannofossils with the exception of a few short barren intervals.

The lower boundary of Subzone CC26b is located in Sample 173-1069A-12R-5, 135–137 cm (832.35 mbsf), and is marked by the FO of *M. prinsii*. Subzones CC25c and CC26a had to be combined here because of the absence of *N. frequens*. The FO of *M. murus* in Sample 173-1069A-14R-1, 77–79 cm (845.17 mbsf), marks the lower boundary of this combined zone. Zone CC24 through Subzone CC25b were combined as a result of the absence of *Lithraphidites quadratus* and *Reinhardtites levis*. The lower boundary of this combined zone is approximated here by the last common occurrence (LCO) of *Uniplanarius trifidus* in Sample 173-1069A-14-2, 16–18 cm (846.06 mbsf). There may possibly be hiatuses in this section that cannot be resolved by our zonation.

In the Campanian, all zones are present through Subzone CC22a. The lower boundary of Subzone CC23b is marked by the LCO *Broinsonia parca constricta* in Sample 173-1069A-15R-1, 138–141 cm (855.38 mbsf). There are two uphole occurrences of *Broinsonia parca constricta* that are considered here as reworked. The lower boundary of Subzone CC23a is marked by the LO of *Eiffellithus eximius* in Sample 173-1069A-15R-3, 19–21 cm (857.77 mbsf). The FO of *U. trifidus* marks the lower boundary of Zone CC22 and was found in the lowermost sample studied in this hole, Sample 173-1069A-16R-2, 38–41 cm (865.48 mbsf). The absence of reliable occurrences of *R. levis* and *Lithastrinus grillii* makes it impossible to distinguish subzones within Zone CC22.

Hole 398D

Site 398 is situated on the southern flank of the Vigo Seamount, at 40°57.6´N, 10°43.1´W, in 3910 m of water. Continuous coring began at 489.5 mbsf (nine spot cores were taken over the first 489.5 m) in Hole 398D and continued over the next 1298.0 m, recovering only 936.6 m of sediment (average recovery = 72.2%), to a total depth of 1740.0 mbsf. Sediments were recovered from Cores 47B-398D-1R through 138R-2 (0.0 to 1740.0 mbsf). These sediments range from Holocene to Early Cretaceous in age and consist of claystones, calcareous claystones to nannofossil claystones, nannofossil chalk, and calcareous siltstones.

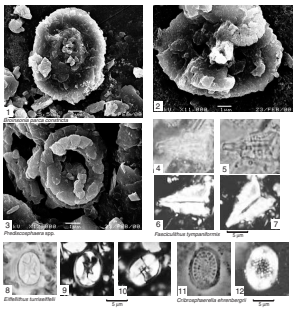
The Cretaceous nannofossil zonation performed by Blechschmidt (1979) was loosely based upon a zonation scheme proposed by Thierstein (1976) with her own modifications. The Cenozoic nannofossil zonation was loosely based upon Martini (1971). Samples were obtained near zonal boundaries in both the Cretaceous and Cenozoic sections for the purpose of updating the Blechschmidt zonal scheme to the zonal schemes used in this paper. The result of our review is shown in Figure F3, where Hole 398D is correlated with Holes 1069A and 1068A.

Nearly all Okada and Bukry (1980) biozone markers were present in the Cenozoic section of Hole 398D with the exception *C. tenuis*, which could not be recognized due to poor preservation. The lack of this marker made it necessary to combine Subzones CP1a and CP1b.

Poor preservation in the Cretaceous made it impossible to recognize many subzones. Zones CC26, CC23, and CC22 were not subdivided because of the lack of reliable datums. Zone CC24 and Subzone CC25a

T5. Calcareous nannofossils, Cretaceous interval, p. 39.

P4. Plate P4, p. 50.



were combined because of the absence of *R. levis*. This part of the section may harbor hiatuses that cannot be resolved by our zonation.

LINEAR SEDIMENTATION AND MASS ACCUMULATION RATES

Hole 1068A

The datums used to determine linear sedimentation rates (LSRs) (Fig. F6) for the Paleocene section of Hole 1068A are biostratigraphic zonal markers, with the exception of the last occurrence (LO) of *F. tympaniformis* and the FO of *Cruciplacolithus primus* (Table T6). The LO of *F. tympaniformis* was placed at Sample 173-1068A-8R-6, 99–100 cm (787.39 mbsf), based on LCO, because the few occurrences upsection are considered to be a result of reworking. The sedimentation rate over the barren interval is an estimate based on the datums directly above and below the interval. Note that there are also many smaller barren intervals throughout the Paleocene section of Hole 1068A (Table T2). These barren intervals may have an effect on the values of the sedimentation rates, depending on sample spacing.

The datums used for the Cretaceous section of Hole 1068A are biostratigraphic zonal markers. The sedimentation rate for this section should be seen as an approximation because there are few markers to use for a reliable determination.

Mass accumulation rates (MARs) were calculated for Hole 1068A (Fig. F7) using 22 physical properties measurements collected on the ship during Leg 173. Data used for MAR determination are listed in Table T7. Because of the scarcity of sample spacing, some measurements were averaged to obtain useful data for all sections. Mass accumulation rates vary between 0.35 g/cm²/k.y. and 0.95 g/cm²/k.y. in the Upper Cretaceous and lower to middle Paleocene to >1.5 g/cm²/k.y. in the upper Paleocene.

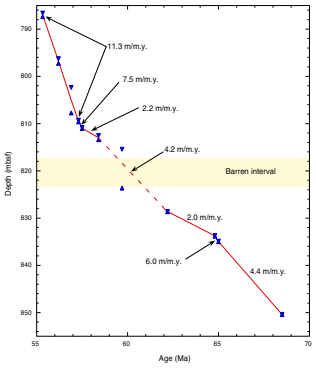
Hole 1069A

The datums used for determination of LSRs in Hole 1069A (Fig. F8) are biostratigraphic zonal markers, with the exceptions of the LO of *F. tympaniformis* and the FO of *Sphenolithus primus* (Table T8). The use of *F. tympaniformis* was based on the LCO noted in Sample 173-1069A-7R-5, 18–19 cm (782.98 mbsf). Many of the markers that were used to calculate the sedimentation rate for Hole 1068A could not be used here because of poor recovery or because these markers were not encountered. The sedimentation rate over the barren interval is an estimate that is based on the datums directly above and below the interval.

Datums used in the Cretaceous section of Hole 1069A are biostratigraphic markers with the exception of *U. trifidus,* which is used here to approximate the Subzone CC23b/Zone CC24 boundary. Because most of the stratigraphy is determined from turbidite-derived sediments, it is possible that last occurrences may be reworked uphole. This may affect the sedimentation rates of sections that are determined using last occurrences.

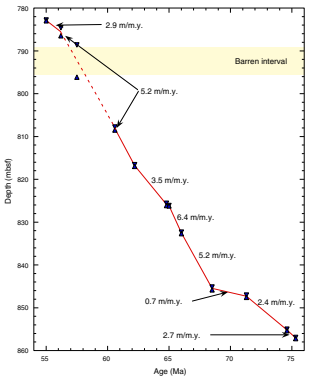
Mass accumulation rates were calculated for Hole 1069A (Fig. F9) using 16 physical properties measurements that were collected on the ship during Leg 173. Data used for MAR determination are listed in Table T9. As in Hole 1068A, some measurements were averaged to accom-

F6. Age vs. depth plot, p. 23.



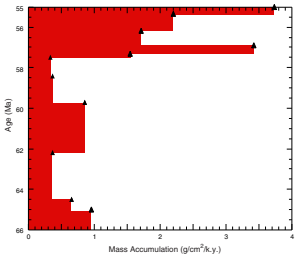
T6. Age vs. depth plot datums, p. 43.

F7. Mass accumulation rates, p. 24.



T7. Mass accumulation rates data, p. 44.

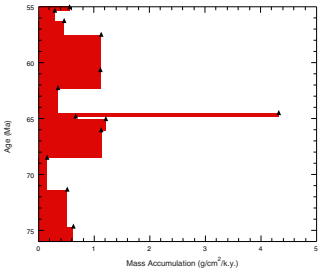
F8. Age vs. depth plot, p. 25.



T8. Age vs. depth plot datums, p. 45.

modate sparse measurement spacing. MARs in Hole 1069A are fairly low in the upper Campanian, varying from 0.6 g/cm²/k.y. in the lowest part of the hole (~75 Ma) to 0.15 g/cm²/k.y. around the Campanian/Maastrichtian boundary. This extremely low rate may indicate the presence of hiatuses in this part of the section. MARs are high again near the end of the Maastrichtian (~1.0 g/cm²/k.y.), peaking to 2.75 g/cm²/k.y. at the K/T boundary. However, this peak of mass accumulation may be a result of poor recovery just above the K/T boundary and/or sample spacing. MARs are low again in the lower Paleocene (averaging ~0.35 g/cm²/k.y.), increase to over 1.0 g/cm²/k.y. through the mid-Paleocene, and then drop off again in the upper Paleocene to an average of ~0.40 g/cm²/k.y.

F9. Mass accumulation rates, p. 26.



T9. Mass accumulation rates data, p. 46.

DISCUSSION

The majority of sedimentation on the Iberia Abyssal Plain during the Late Cretaceous to Paleocene resulted from turbidite emplacement and may be the sole reason that calcareous nannofossils have been preserved here at all. To illustrate this idea, Sites 1067, 1068, and 1069 might be compared with the outlying Site 1170: where turbidites were absent, no nannofossils were preserved in that interval (Whitmarsh and Wallace, **Synthesis,** this volume). Because of the great depth of the IAP (>5000 meters below sea level), most sedimentation during the interval in question took place below the CCD. The turbidity currents that dominated the area during the Late Cretaceous and Paleocene brought in nannofossils that were previously deposited on either the nearby Vasco da Gamma and Vigo Seamounts or from the more distant Porto Seamount and continental margin.

We consider reliable the biostratigraphic record that is found at Sites 1067, 1068, and 1069, despite the fact that the nannofossils used to construct the biostratigraphic column were transported to the IAP by turbidity currents. Turbidity currents over the Madeira Abyssal Plain acted essentially as nonerosive transport currents that contained a mixture of sediments ranging in age from 200 to 500 ka (Weaver, 1994). Because a time span of >500 k.y. separates most of the biozone markers in the Upper Cretaceous and Paleocene, there should be relatively few cases of adjacent biozone markers overlapping as a result of mixing that would confuse the biostratigraphic record.

Hole 1068A probably represents the most complete sedimentation record for this area. Because this site was drilled on a topographic high, we assume that the turbidites that dominate this area would largely bypass this feature until the basins filled to the level of the high. Primarily for this reason there is no sedimentation record below the uppermost Maastrichtian. After the site began to accumulate sediments, MARs seemed to fluctuate, depending on the frequency of the turbidity currents (fluctuating from higher rates in the late Maastrichtian to lower rates in the early Paleocene).

The MARs almost seem to have a cyclic trend, remaining higher for a couple of million years then lower for a couple of million years, finally ending with very high rates at the end of the Paleocene. A similar pattern is seen in Hole 1069A, although the periods of higher and lower sedimentation are more on the order of 3–4 m.y. long. However, the MARs at the end of the Paleocene in Hole 1069A are much lower than what is found in Hole 1068A. This may be a result in a shift in the source of the turbidites, farther from Hole 1069A, or a shift in the path-

ways of the turbidites that may lead them to deposit sediments in another location.

MARs do not indicate any hiatuses, despite the numerous combined zones in the Cretaceous sections of both Holes 1068A and 1069A and the numerous barren intervals found throughout all sections of the Cretaceous and Paleocene. We believe that the long barren interval found in the mid-Paleocene in Holes 1068A and 1069A is a result of a very high CCD that dissolved calcareous nannofossils that would usually be deposited in the source area for the turbidites. This barren interval is also seen in Hole 398D (Fig. F3), which was drilled 1100 m shallower on the flanks of the Vigo Seamount, indicating that the CCD must have been shallower than ~3900 m.

There is a difference in the grain sizes of the turbidites in Hole 1068A relative to those in Hole 1069A. Turbidites in Hole 1069A generally contain a coarser fraction than the turbidites in Hole 1068A; smear-slide data collected on the ship during Leg 173 indicate that there is a greater percentage of the sand-sized fraction (Whitmarsh, Beslier, Wallace, et al., 1998, pp. 496–499). This may be a result of different sources for these two areas or may result from the coarser fraction bypassing the higher block on which Hole 1068A was drilled (Fig. F2).

The result of this report supports the idea that nannofossil-bearing turbidites can be used to construct a reliable biostratigraphic profile in an area where normal pelagic sedimentation is barren as a result of deposition below the CCD. An independent test of this assumption is provided by paleomagnetic study of these same cores, which has produced a workable magnetostratigraphy for the Leg 173 sections that does not contradict the biostratigraphy (Zhao et al., Chap. 11, this volume).

SUMMARY

From drilling on the Iberia Abyssal Plain during Leg 173, we recovered Upper Cretaceous through Paleocene sediments at two sites (1068 and 1069) and only upper Paleocene sediments at Site 1067, which expands considerably the Upper Cretaceous to Paleocene record for this region. Of these three sites, Site 1068 recovered uppermost Cretaceous sediments as well as the most complete Paleocene record, whereas Site 1067 yielded only uppermost Paleocene sediments (Zone CP8). Site 1069 provided a rather complete upper Campanian through Maastrichtian section, including Zones CC22 through CC26, but a discontinuous Paleocene record, missing Zones CP4 and CP5.

After a detailed calcareous nannofossil biostratigraphy was documented in distribution charts, mass accumulation rates were calculated for Holes 1068A and 1069A. Sediments in Hole 1068A apparently record the final stages of burial of a high basement block by turbidity flows. Accumulation rates through the Upper Cretaceous indicate relatively high rates, 0.95 g/cm^2/k.y., but may be unreliable because of the lack of datum points and/or possible hiatuses. Accumulation rates in the Paleocene section of Hole 1068A fluctuated every few million years from lower (~0.35 g/cm^2/k.y.) to higher rates (~0.85 g/cm^2/k.y.), until the latest Paleocene, when rates increased to an average of ~2.0 g/cm^2/k.y.

Mass accumulation rates for the Upper Cretaceous in Hole 1069A indicate a steady rate of ~0.60 g/cm^2/k.y. from 75 to 72 Ma. There may have been one or more hiatuses between 72 and 68 Ma (Zone CC24 through Subzone CC25b), as indicated by the very low accumulation

rate of 0.15 g/cm²/k.y. The Paleocene section of Hole 1069A does not show the same continuous record, which may result from fluctuations in the CCD and poor recovery (average = 40%). Zones CP4 and CP5 are missing within a barren interval; this and numerous other barren intervals affect the precision of the nannofossil zonation and calculation of mass accumulation rates. However, in spite of these missing zones, mass accumulation rates do not seem to indicate the presence of hiatuses as the rates for this barren interval average ~1.0 g/cm²/k.y.

This study set out to test the proposal that a reliable biostratigraphic record could be constructed from sediments derived from turbidity flows deposited below the CCD. As illustrated here, not only could a reliable biostratigraphic record be determined from these sediments, but sedimentation and mass accumulation rates could also be determined, allowing inferences to be drawn concerning the sedimentary history of this passive margin. The reliability of this record is confirmed by independent verification by the establishment of a magnetostratigraphy for the same cores.

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APPENDIX

Nannofossil Species Encountered in this Study

References not cited herein can be found in Perch-Neilsen (1985) or Bown (1998).

Cenozoic

Bianolithus sparsus Bramlette and Martini (1964)
Bomolithus elegans Roth (1973)
Braarudosphaera bigelowii (Gran and Braarud, 1935) Deflandre (1947)
Campylosphaera eodela Bukry and Percival (1971)
Chiasmolithus bidens (Bramlette and Sullivan, 1961) Hay and Mohler (1967)
Chiasmolithus consuetus (Bramlette and Sullivan, 1961) Hay and Mohler (1967)
Chiasmolithus danicus (Brotzen, 1959) Hay and Mohler (1967)
Chiasmolithus solitus (Bramlette and Sullivan, 1961) Locker (1968)
Chiastozygus ultimus Perch-Nielsen (1981a)
Coccolithus pelagicus (Wallich, 1877) Schiller (1930)
Coccolithus robustus Bramlette and Sullivan (1961)
Coccolithus subpertusus (Hay and Mohler, 1967) Wei and Pospichal (1991)
Cruciplacolithus edwardsii Romein (1979)
Cruciplacolithus frequens (Perch-Nielsen, 1977) Romein (1979)
Cruciplacolithus intermedius Van Heck and Prins (1987)
Cruciplacolithus latipons Romein (1979)
Cruciplacolithus primus Perch-Nielsen (1977)
Cruciplacolithus tenuis (Stradner, 1961) Hay and Mohler in Hay et al. (1967)
Discoaster bramlettei (Bukry and Percival, 1971) Romein (1979)
Discoaster delicatus Bramlette and Sullivan (1961)
Discoaster elegans Bramlette and Sullivan (1961)
Discoaster falcatus Bramlette and Sullivan (1961)
Discoaster limbatus Bramlette and Sullivan (1961)
Discoaster megastypus (Bramlette and Sullivan, 1961) Perch-Nielsen (1985)
Discoaster mohleri Bukry and Percival (1971)
Discoaster multiradiatus Bramlette and Riedel (1954)
Discoaster nobilis Martini (1961a)
Discoaster splendidus Martini (1960)
Ellipsolithus bollii Perch-Nielsen (1977)
Ellipsolithus distichus (Bramlette and Sullivan, 1961) Sullivan (1964)
Ellipsolithus lajollaensis Bukry and Percival (1971)
Ellipsolithus macellus (Bramlette and Sullivan, 1961) Sullivan (1964)
Fasciculithus alanii Perch-Nielsen (1971b)
Fasciculithus aubertae Haq and Aubry (1981)
Fasciculithus billii Perch-Nielsen (1971b)
Fasciculithus bitectus Romein (1979)
Fasciculithus bobii Perch-Nielsen (1971b)
Fasciculithus clinatus Bukry (1971a)
Fasciculithus hayi Haq (1971)
Fasciculithus involutus Bramlette and Sullivan (1961)
Fasciculithus janii Perch-Nielsen (1971b)
Fasciculithus lilianae Perch-Nielsen (1971b)
Fasciculithus magnicordis Romein (1979)
Fasciculithus magnus Bukry and Percival (1971)
Fasciculithus mitreus Gartner (1971)
Fasciculithus pileatus Bukry (1973d)
Fasciculithus richardii Perch-Nielsen (1971b)
Fasciculithus shaubii Hay and Mohler (1967)
Fasciculithus thomasii Perch-Nielsen (1971b)
Fasciculithus tonii Perch-Nielsen (1971b)
Fasciculithus tympaniformis Hay and Mohler in Hay et al. (1967)
Fasciculithus ulii Perch-Nielsen (1971b)

Heliolithus cantabriae Perch-Nielsen (1971c)
Heliolithus kleinpellii Sullivan (1964)
Heliolithus riedelii Bramlette and Sullivan (1961)
Heliolithus? floris Haq and Aubry (1981)
Hornibrookina edwardsii Perch-Nielsen (1977)
Hornibrookina teuriensis Edwards (1973a)
Markalius inversus (Deflandre in Deflandre and Fert, 1954) Bramlette and Martini (1964)
Micrantholithus entaster Bramlette and Sullivan (1961)
Micrantholithus pinguis Bramlette and Sullivan (1961)
Neochiastozygus chiastus (Bramlette and Sullivan, 1961) Perch-Nielsen (1971c)
Neochiastozygus digitosus Perch-Nielsen (1971c)
Neochiastozygus distentus (Bramlette and Sullivan, 1961) Perch-Nielsen (1971c)
Neochiastozygus perfectus Perch-Nielsen (1971c)
Neochiastozygus primitivus Perch-Nielsen (1981a)
Neococcolithites protenus (Bramlette and Sullivan, 1961) Black (1967)
Placozygus sigmoides (Bramlette and Sullivan, 1961) Romein (1979)
Prinsius bisulcus (Stradner, 1963) Hay and Mohler (1967)
Prinsius dimorphosus (Perch-Nielsen, 1969) Perch-Nielsen (1977)
Prinsius martinii (Perch-Nielsen, 1969) Haq (1971)
Prinsius petalosus (Ellis and Lohmann, 1973) Romein (1979)
Semihololithus kerabyi Perch-Nielsen (1971b)
Sphenolithus anarrhopus Bukry and Bramlette (1969a)
Sphenolithus primus Perch-Nielsen (1971b)
Thoracosphaera spp. Kamptner (1927)
Toweius eminens (Bramlette and Sullivan, 1961) Perch-Nielsen (1971b)
Toweius pertusus (Sullivan, 1965) Romein (1979)
Toweius tovae Perch-Nielsen (1971b)

Mesozoic

Acuturris scotus (Risatti, 1973) Wind and Wise in Wise and Wind (1977)
Ahmuellerella octoradiata (Gorka, 1957) Reinhardt (1964)
Arkhangelskiella cymbiformis Vekshina (1959)
Biscutum constans (Gorka, 1957) Black in Black and Barnes (1959)
Braarudosphaera bigelowii (Gran and Braarud, 1935) Deflandre (1947)
Broinsonia parca constricta Hattner et al. (1980)
Calculites obscurus (Deflandre, 1959) Prins and Sissingh in Sissingh (1977)
Ceratolithoides aculeus (Stradner, 1961) Prins and Sissingh in Sissingh (1977)
Ceratolithoides arcuatus Prins and Sissingh in Sissingh (1977)
Ceratolithoides kamptneri Bramlette and Martini (1964)
Chiastozygus platyrhethus Hill (1976)
Corollithion exiguum Stradner (1961)
Corollthion signum Stradner (1961)
Cretarhabdus conicus Bramlette and Martini (1964)
Cribrosphaerella daniae Perch-Nielsen (1973)
Cribrosphaerella ehrenbergii (Arkhangelsky, 1912) Deflandre in Piveteau (1952)
Cyclagelosphaera margerelii Noël (1965)
Cylindralithus duplex Perch-Nielsen (1973)
Cylindralithus nudus Bukry (1969)
Dodekapodorhabdus noeliae Perch-Nielsen (1968)
Eiffellithus eximius (Stover, 1966) Perch-Nielsen (1968)
Eiffellithus turriseiffelii (Deflandre in Deflandre and Fert, 1954) Reinhardt (1965)
Glaukolithus compactus (Bukry, 1969) Perch-Nielsen (1984a)
Lithastrinus grillii Stradner (1962)
Lithraphidites carniolensis Deflandre (1963)
Lithraphidites quadratus Bramlette and Martini (1964)
Lucianorhabdus cayeuxii Deflandre (1959)
Manivitella pemmatoidea (Deflandre in Manivit, 1965) Thierstein (1971)
Markalius apertus Perch-Nielsen (1979b)
Markalius inversus (Deflandre in Deflandre and Fert, 1954) Bramlette and Martini (1964)
Marthasterites furcatus (Deflandre in Deflandre and Fert, 1954) Deflandre (1959)

Microrhabdulus belgicus Hay and Towe (1963)
Microrhabdulus decoratus Deflandre (1959)
Micula concava (Stradner in Martini and Stradner, 1960) Verbeek (1976b)
Micula decussata Veksina (1959)
Micula murus (Martini, 1961) Bukry (1973)
Micula prinsii Perch-Nielsen (1979a)
Neocrepidolithus watkinsii Pospichal and Wise (1990)
Nephrolithus frequens Gorka (1957)
Percivalia fenestrata (Worsley, 1971) Wise (1983)
Petrarhabdus copulatus (Deflandre, 1959) Wind and Wise in Wise (1983)
Prediscosphaera cretacea (Arkhangelsky, 1912) Gartner (1968)
Prediscosphaera ponticula (Bukry, 1969) Perch-Nielsen (1984a)
Prediscosphaera spinosa (Bramlette and Martini, 1964) Gartner (1968)
Prediscosphaera stoveri (Perch-Nielsen, 1968) Shafik and Stradner (1971)
Quadrum gartneri Prins and Perch-Nielsen in Manivit et al. (1977)
Uniplanarius gothicus (Deflandre, 1959) Hattner and Wise (1980)
Uniplanarius sissinghii Perch-Nielsen (1986b)
Uniplanarius trifidus (Stradner in Stradner and Papp, 1961) Hattner and Wise (1980)
Reinhardtites anthophorus (Deflandre, 1959) Perch-Nielsen (1968)
Reinhardtites levis Prins and Sissingh in Sissingh (1977)
Repagulum parvidentatum (Deflandre and Fert, 1954) Forchheimer (1972)
Retecapsa angustiforata Black (1971a)
Retecapsa crenulata (Bramlette and Martini, 1964) Grün in Grün and Alleman (1975)
Rhagodiscus angustus (Stradner, 1963) Reinhardt (1971)
Sollasites horticus (Stradner et al. in Stradner and Adamiker, 1966) Cepek and Hay (1969)
Staurolithites angusta (Stover, 1966) Crux (1991b)
Staurolithites imbricatus (Gartner, 1968) Burnett (1998b)
Staurolithites mielnicensis (Gorka, 1957) Perch-Nielsen (1968) sensu Crux in Lord (1982)
Tetrapodorhabdus decorus (Deflandre in Deflandre and Fert, 1954) Wind and Wise in Wise and Wind (1977)
Tranolithus orionatus (Reinhardt, 1966a) Reinhardt (1966b)
Tranolithus phacelosus Stover (1966)
Watznaueria barnesae (Black, 1959) Perch-Nielsen (1968)
Zeughrabdotus diplogrammus (Deflandre in Deflandre and Fert, 1954) Burnett in Gale et al. (1996)

Figure F1. Location map showing ODP Sites 1067, 1068, 1069, and 900 and DSDP Site 398. Triangles = Leg 173 sites, circles = sites from previous legs. Bathymetry contours are at 200, 500, 1000, and 1500 through 5500 m. VdG = Vasco da Gama Seamount, VS = Vigo Seamount, PS = Porto Seamount, ES = Estremadura Seamount. Inset shows drill site locations relative to the seismic reflection profile used to create the composite section in Figure F2, p. 19 (adapted from Whitmarsh, Beslier, Wallace, et al., 1998, p. 9).

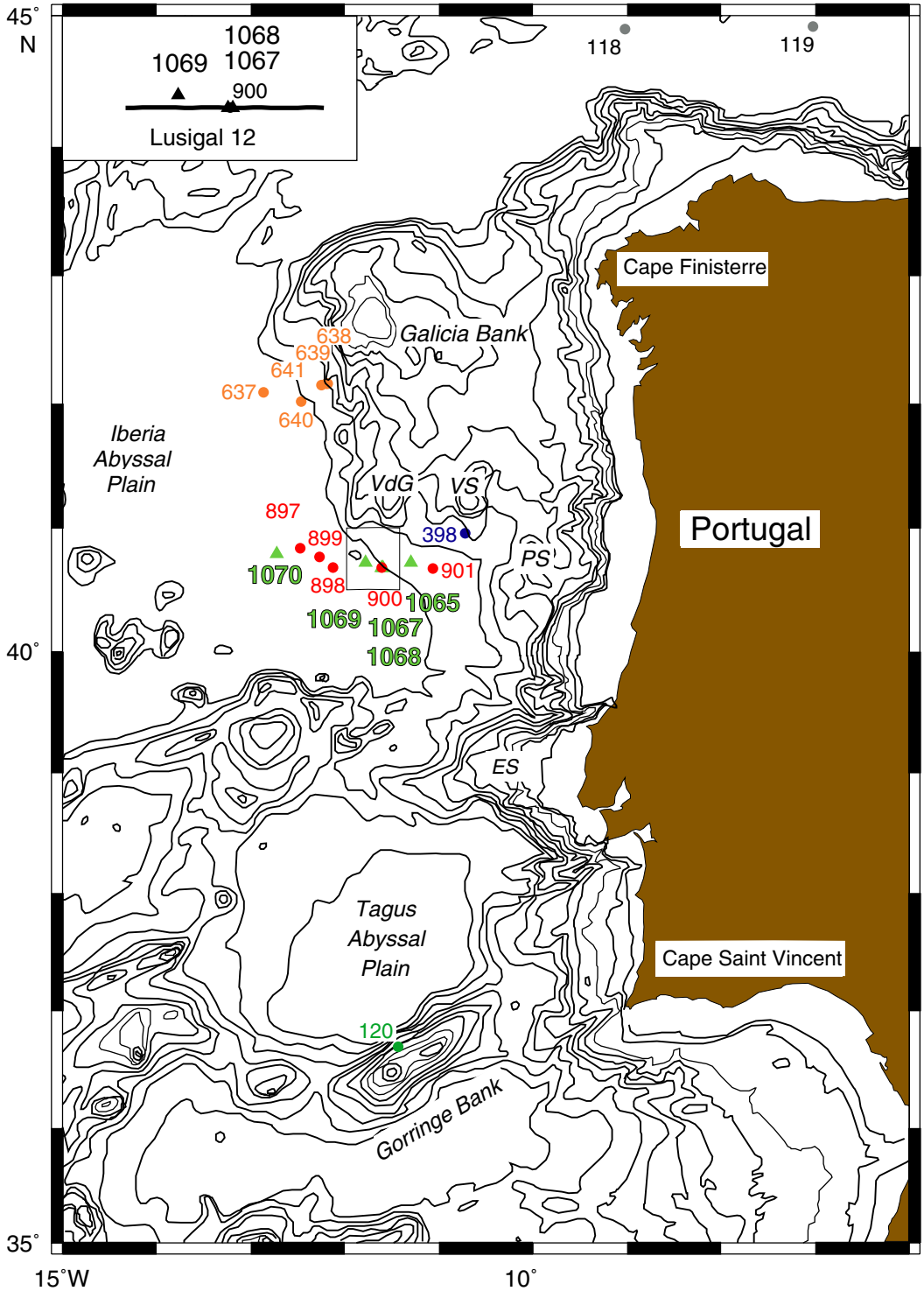


Figure F2. Cross section through Leg 149 and Leg 173 drill sites along the track shown on Figure F1 (inset), p. 18, showing relative depth of basement blocks on which ODP Sites 1067, 1068, 1069, and 900 were drilled. The site in parentheses is offset a short distance from the profile. Triangles = gabbro and amphibolite, circles = continental crust, + = peridotite. VE = vertical exaggeration (adapted from Whitmarsh, Beslier, Wallace, et al., 1998, p. 12).

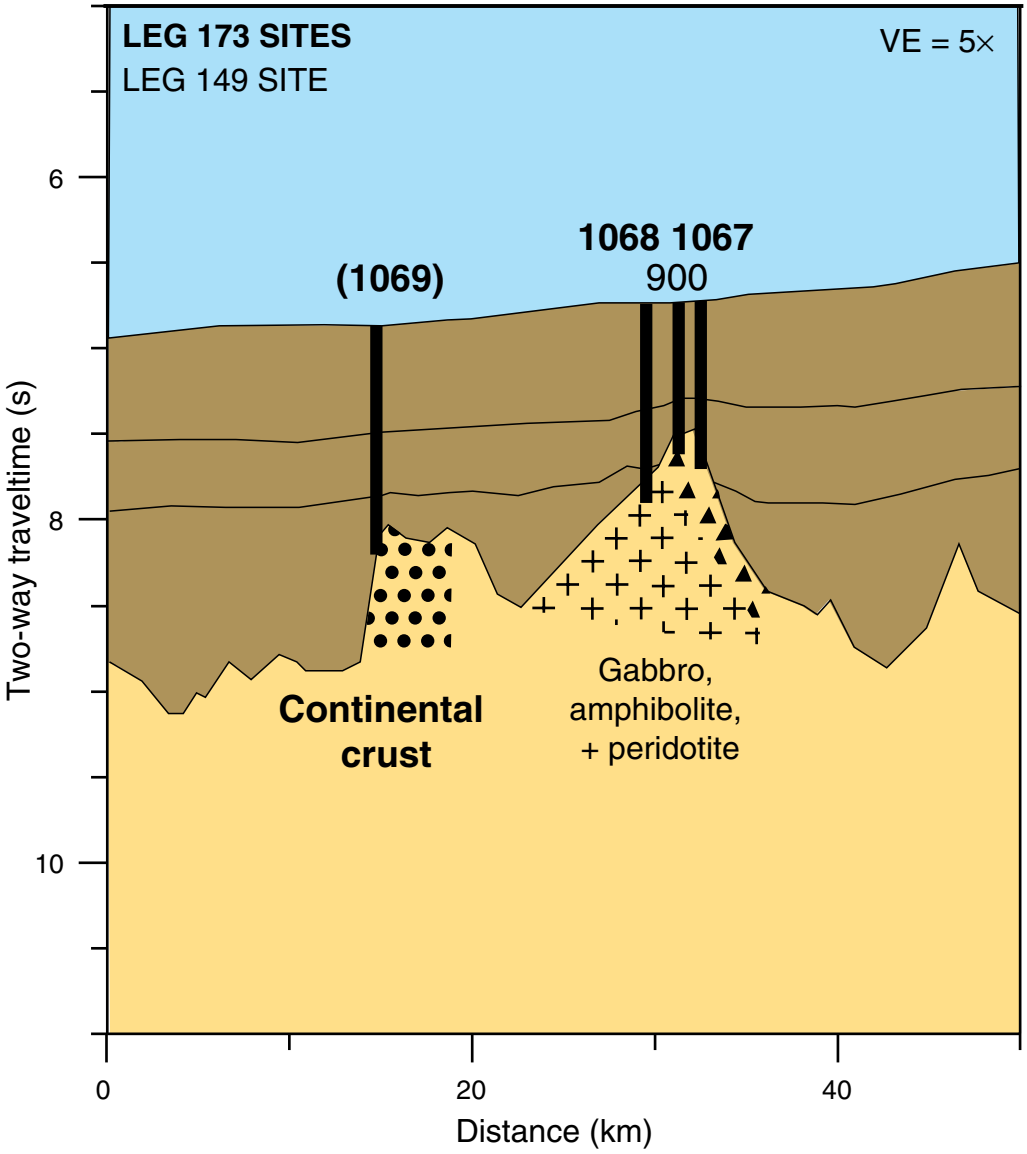


Figure F3. Correlation of DSDP Hole 398D and ODP Holes 1069A and 1068A.

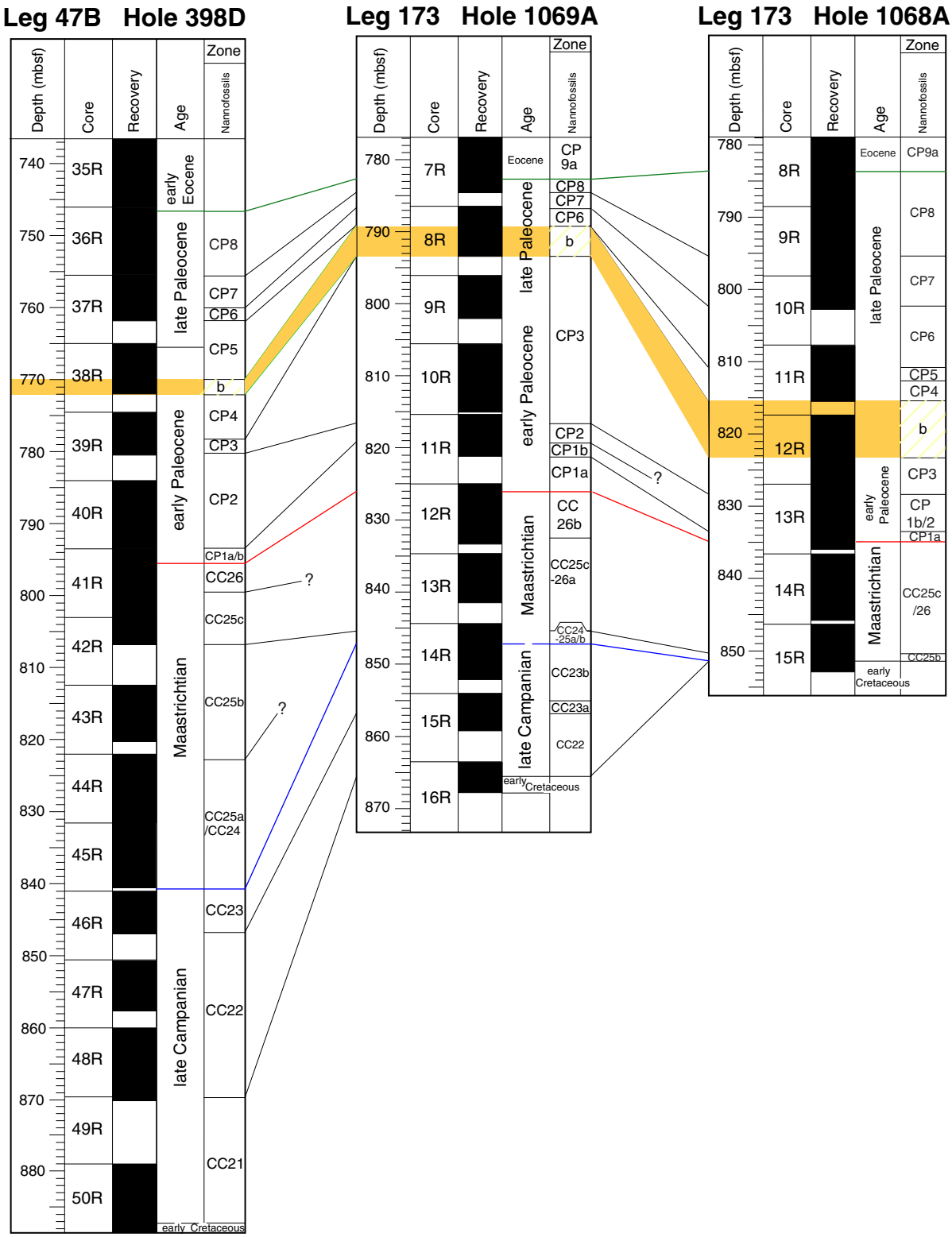


Figure F4. Biostratigraphic zonation used in this chapter for the Cenozoic follows Okada and Bukry (1980) and Martini (1971). Datums for each boundary are listed with their age as determined by Berggren (1995) (adapted from Whitmarsh, Beslier, Wallace, et al., 1998, p. 30).

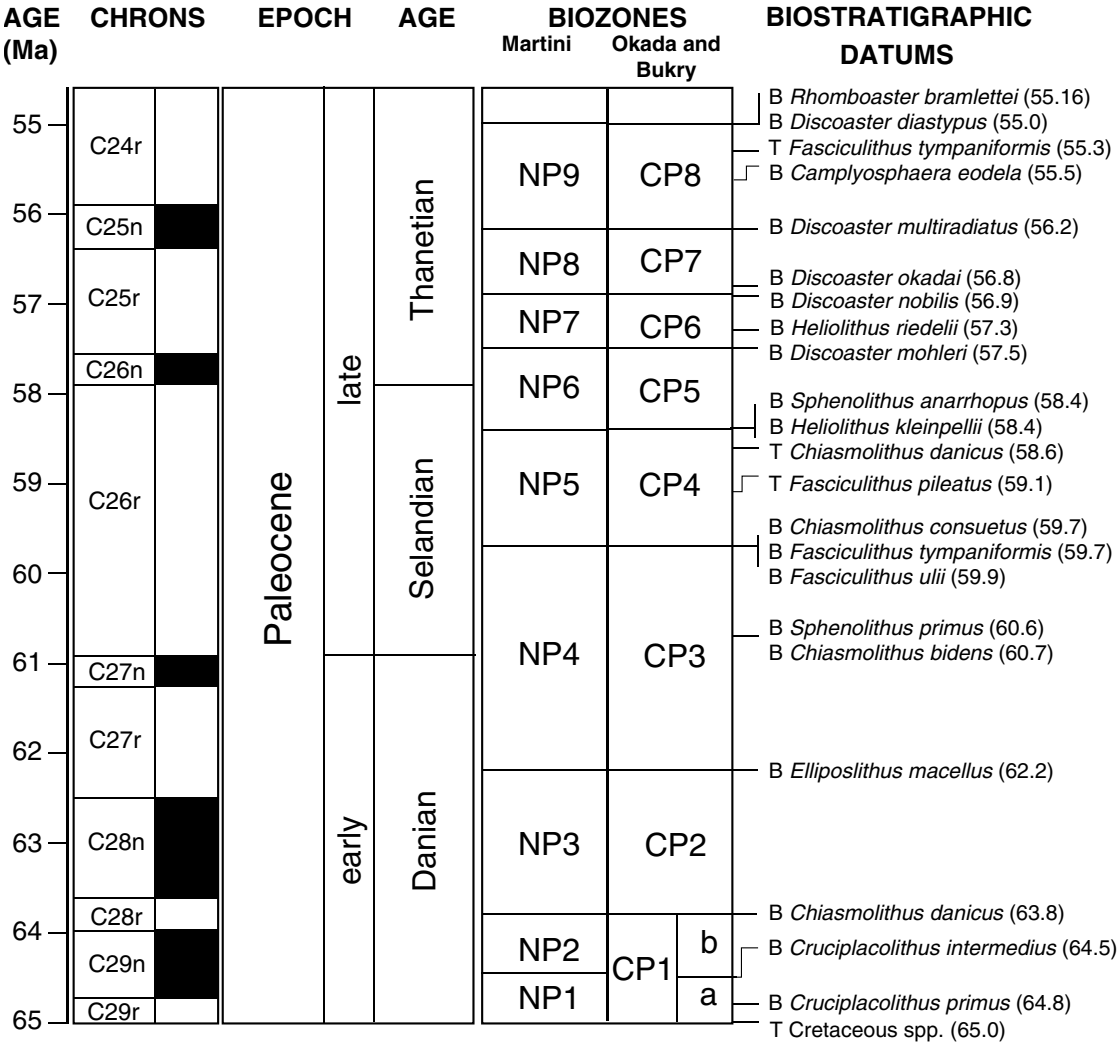


Figure F5. Biostratigraphic zonation used in this chapter for the Cretaceous follows Sissingh (1977) as modified and illustrated by Perch-Nielsen (1985). Datums for each boundary are listed with their age as determined by Erba et al. (1995) and Gradstein et al. (1995) (adapted from Whitmarsh, Beslier, Wallace, et al., 1998, p. 31).

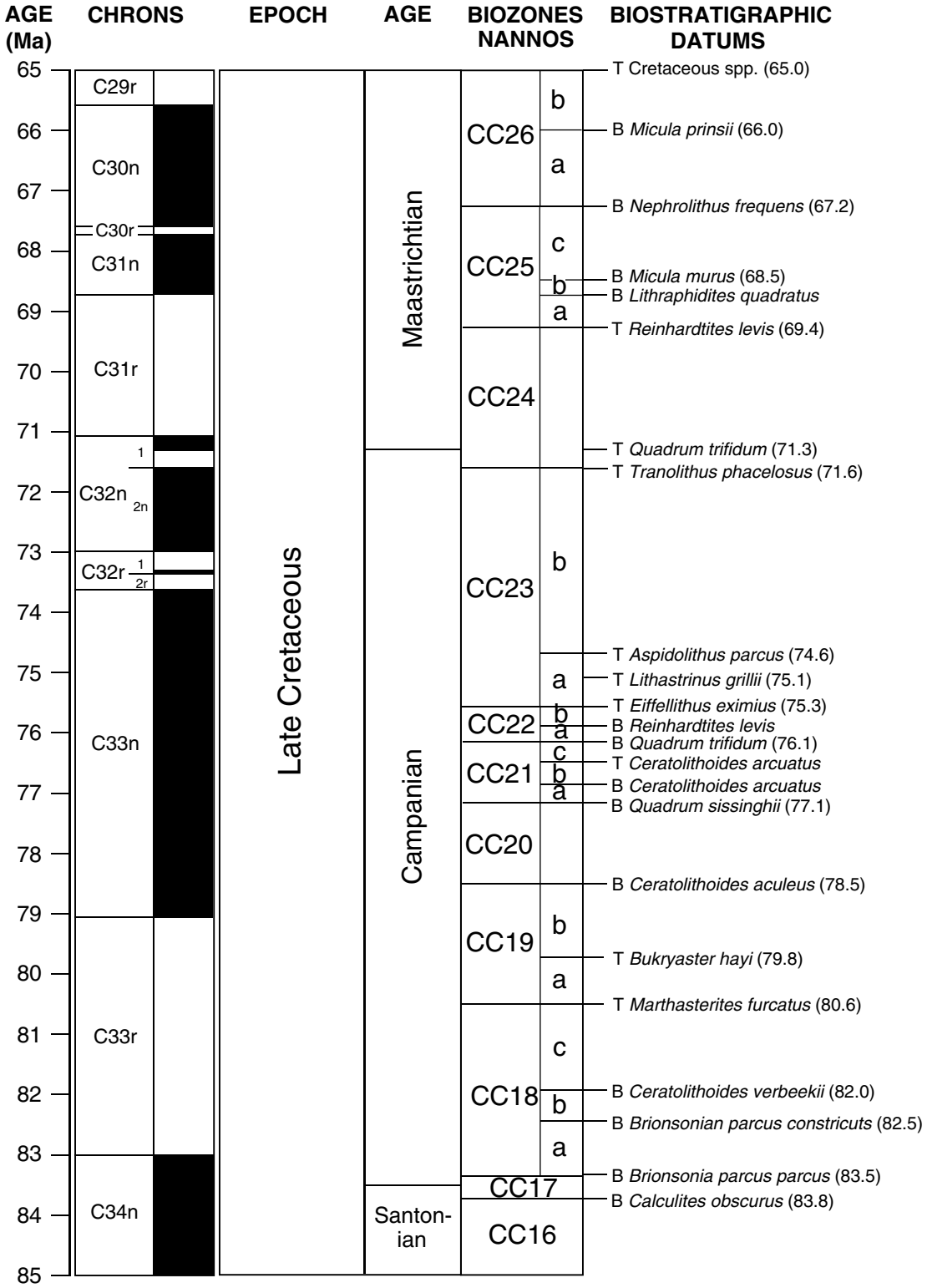


Figure F6. Age vs. depth plot for Hole 1068A. Datums used for constructing the plot are given in Table T6, p. 43.

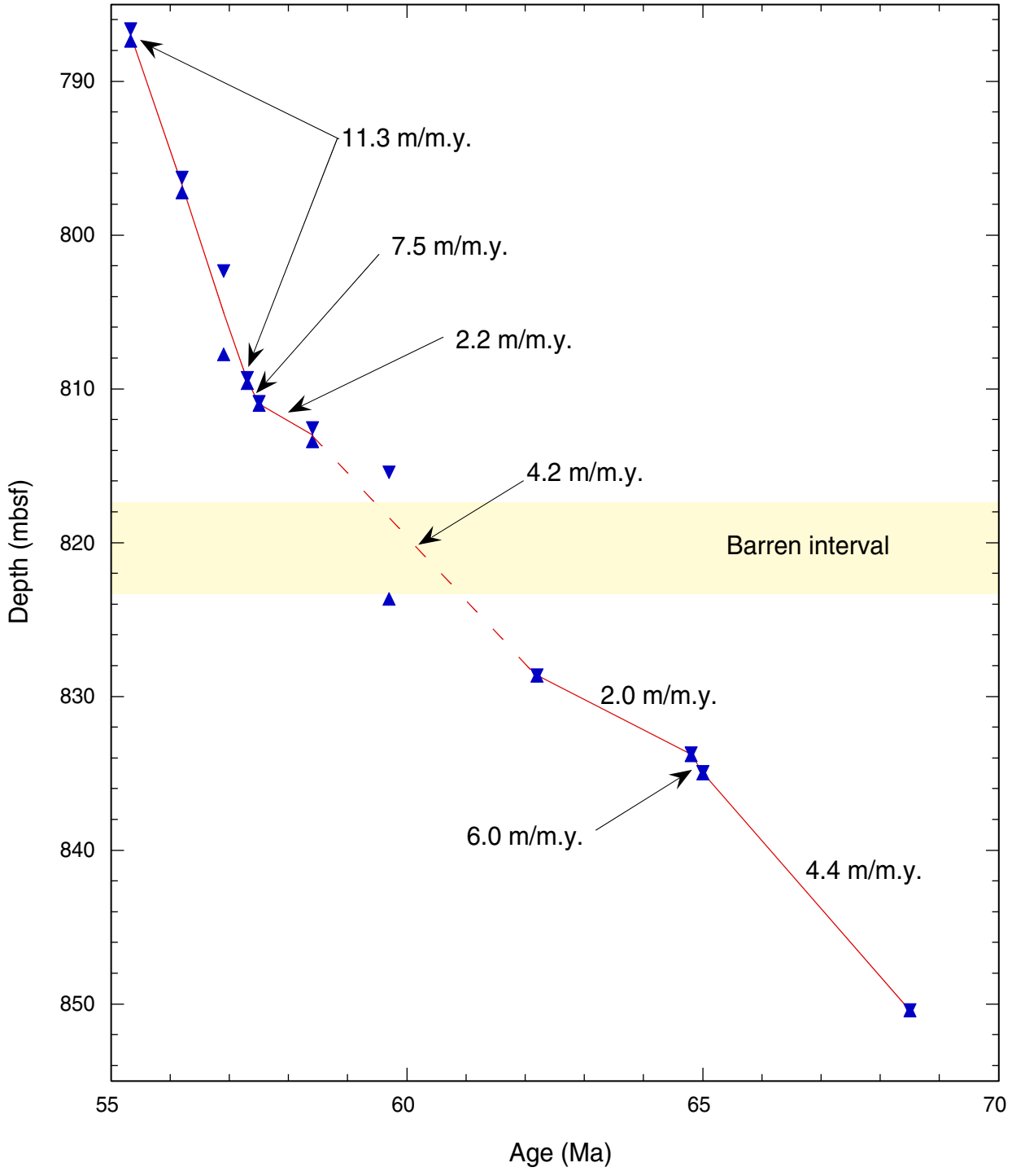


Figure F7. Mass accumulation rates for Hole 1068A. Data used for constructing the plot are given in Table T7, p. 44.

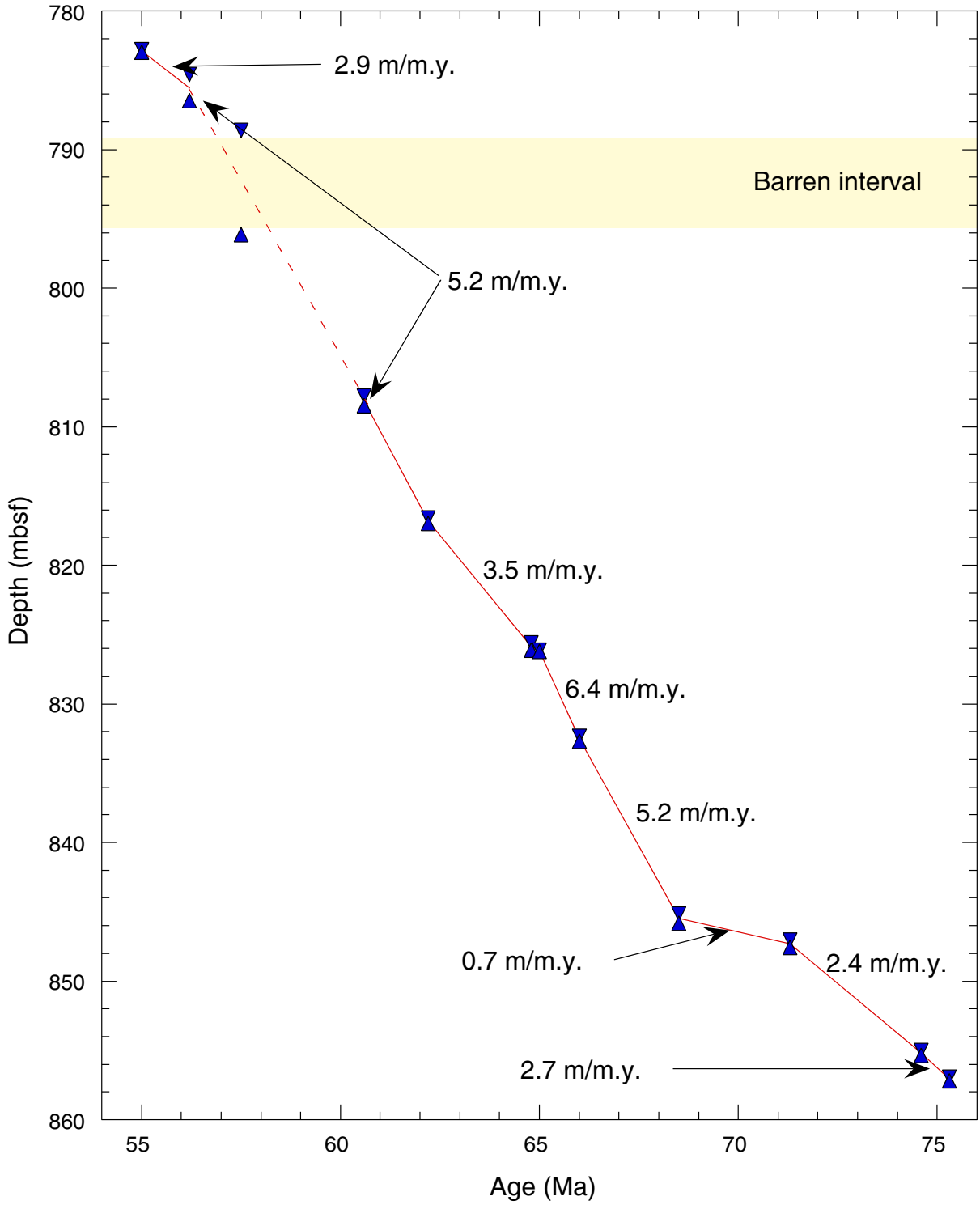


Figure F8. Age vs. depth plot for Hole 1069A. Datums used for constructing the plot are given in Table T8, p. 45. Triangles = individual datum points from Table T8.

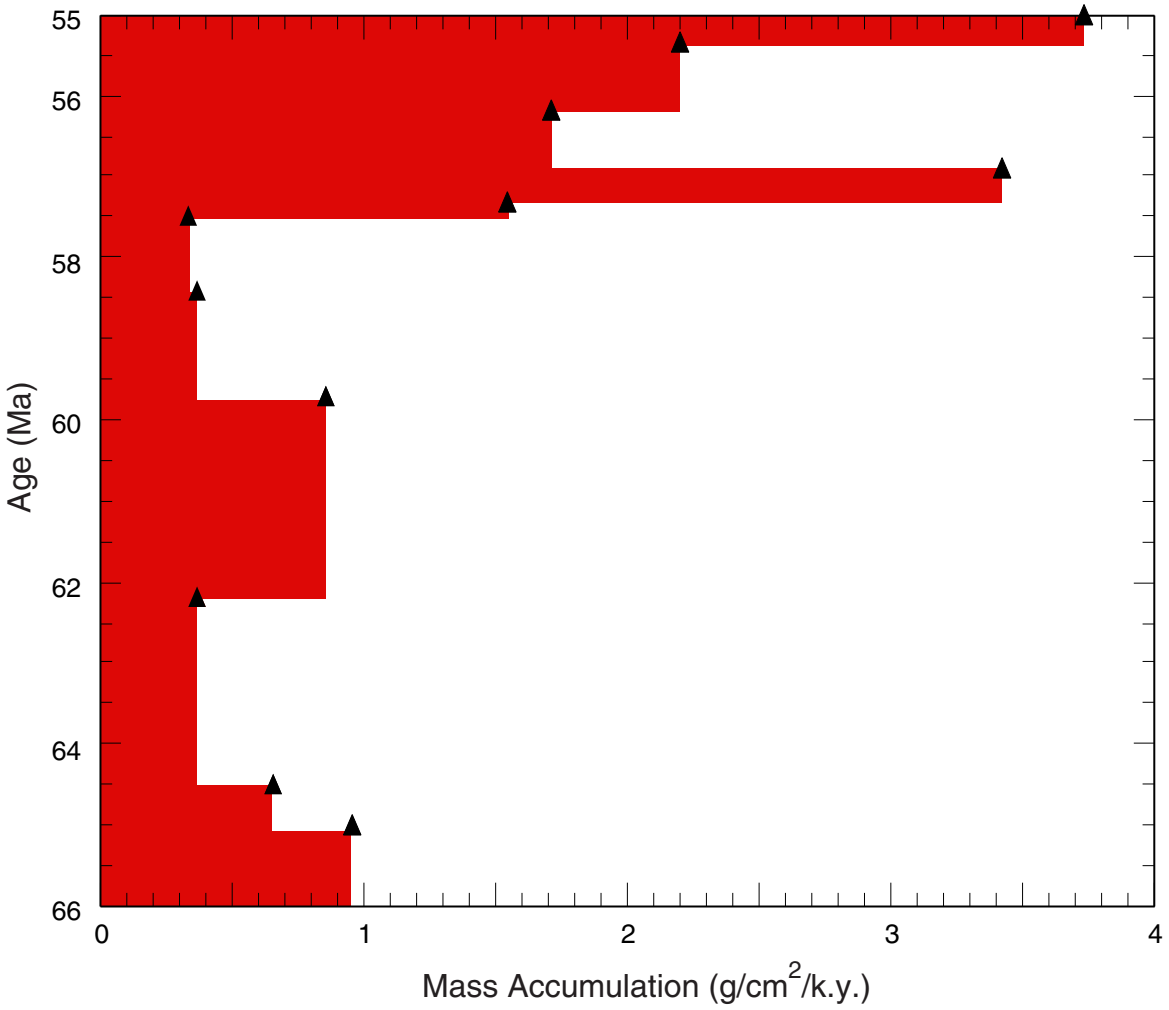


Figure F9. Mass accumulation rates for Hole 1069A. Data used for constructing the plot are given in Table T9, p. 46. Triangles = individual datum points from Table T9.

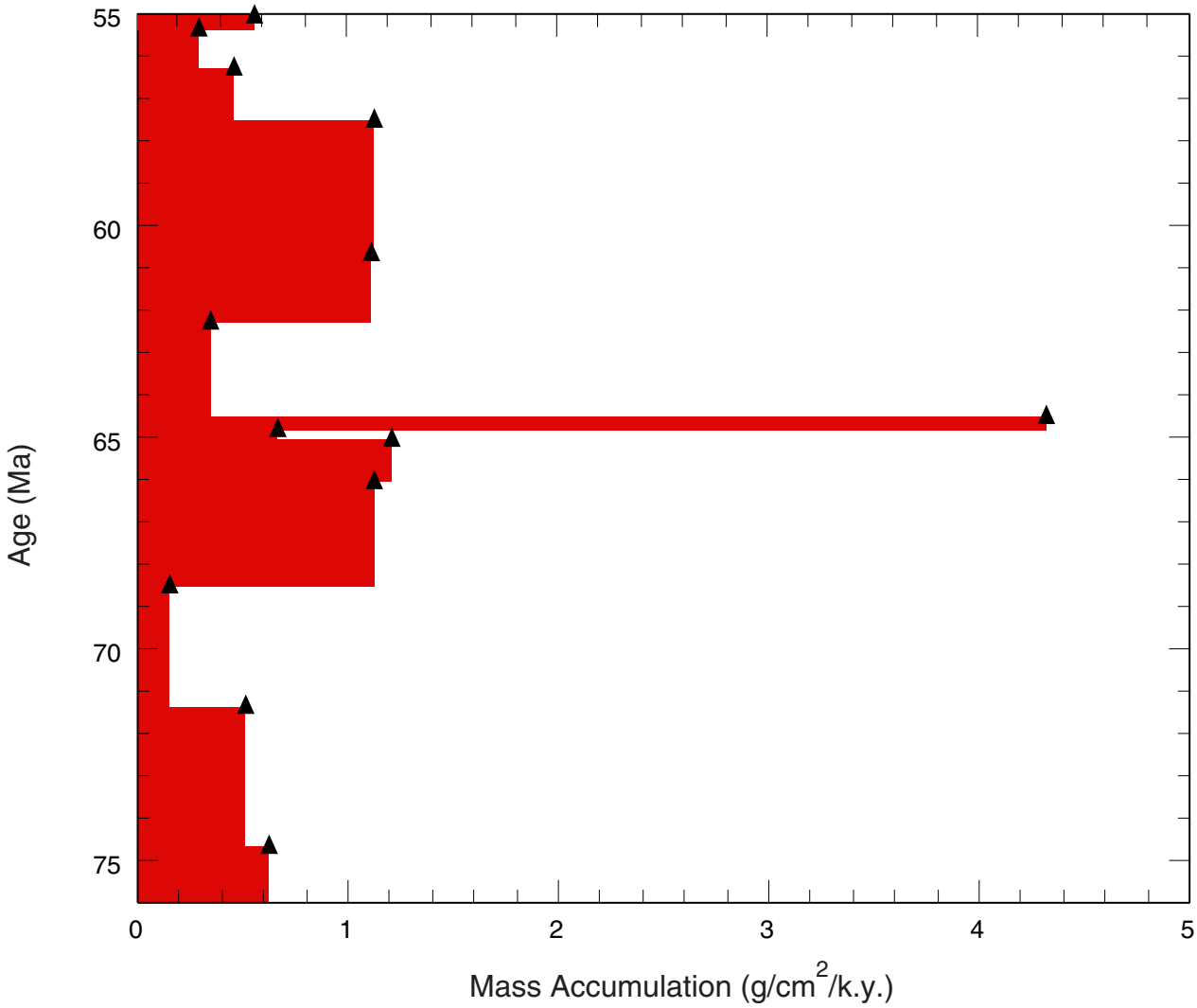


Table T1. Distribution of calcareous nannofossils in Hole 1067A.

Okada and Bukry (1980) Zone	Core, section, interval (cm)	Depth (mbsf)	Total abundance	Preservation	Reworked Cretaceous	*Chiasmolithus bidens*	*Coccolithus pelagicus*	*Coccolithus subpertusus*	*Discoaster multiradiatus*	*Ellipsolithus macellus*	*Fasciculithus alanii*	*Fasciculithus hayi*	*Fasciculithus involutus*	*Fasciculithus mitreus*	*Fasciculithus shaubii*	*Fasciculithus thomasii*	*Fasciculithus tympaniformis*	*Markalius inversus*	*Neochiastozygus chiastus*	*Prinsius bisulcus*	*Sphenolithus primus*	*Toweius eminens*	*Toweius pertusus*	*Toweius tovae*
	173-1067A-																							
CP8	13R-1, 47-48	754.67	A	G		S	A	F	F	S	S	S	C	S	C	F	F		R		F	F	C	C
	13R-1, 64-65	754.84	A	M	S		A		F				F		F	F	F			S	F	F	C	C
	13R-1, 80-81	755.00	A	M			C		S	F							C					S		C
	13R-1, 112-113	755.32	A	M			A		R	S			S				R	R		F	S	R	S	A
	13R-2, 28-29	755.98	B	B																				
	13R-2, 50-51	756.20	B	B																				
	13R-CC, 16-17	756.55	B	B																				
	14R-1, 0-3	763.80	R	P			R																	

Notes: Abundance: A = abundant, C = common, F = few, R = rare, S = single, B = barren. Preservation: G = good, M = moderate, P = poor.

Table T2. Distribution of calcareous nannofossils in the Paleocene interval of Hole 1068A. (**See table notes.** Continued on next five pages.)

Martini (1971)	Okada and Bukry (1980)	Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	Reworked Cretaceous	*Bomolithus elegans*	*Braarudosphaera bigelowii*	*Camplylosphaera eodela*	*Chiasmolithus bidens*	*Chiasmolithus consuetus*	*Chiasmolithus danicus*	*Chiasmolithus* spp.	*Coccolithus pelagicus*	*Coccolithus robustus*	*Coccolithus* spp.	*Coccolithus subpertusus*	*Cruciplacolithus edwardsii*	*Cruciplacolithus frequens*	*Cruciplacolithus intermedius*	*Cruciplacolithus latipons*	*Cruciplacolithus primus*	*Cruciplacolithus* spp.	*Cruciplacolithus tenuis*	*Discoaster bramlettei*	*Discoaster delicatus*	*Discoaster elegans*	*Discoaster mahmoudii*	*Discoaster mohleri*	*Discoaster multiradiatus*	*Discoaster nobilis*	*Discoaster splendidus*	*Discoaster* spp.	*Ellipsolithus bollii*	*Ellipsolithus distichus*	*Ellipsolithus macellus*	*Fasciculithus alanii*	*Fasciculithus aubertae*	*Fasciculithus billii*	*Fasciculithus bitectus*	*Fasciculithus bobii*	*Fasciculithus clinatus*	*Fasciculithus hayi*	*Fasciculithus involutus*	*Fasciculithus janii*	*Fasciculithus lilianae*
		173-1068A-																																												
NP9	CP8b	8R-4, 44-45	783.84	A	G	R								C																S						S	F								
		8R-4, 95-96	784.35	R	P									R																																
		8R-5, 17-18	785.07	A	M	S								C																R		S				S										R
		8R-5, 65-66	785.55	A	M	S								C					S											F	F				S						S		F		
		8R-6, 19-20	786.59	A	M					S				C																													F		F
		8R-6, 99-100	787.39	A	M	S				S				C															F	C					S	S		S							F
		8R-6, 139-140	787.79	A	M								S	C																F				S			F								
		8R-7, 20-21	788.10	A	M	S								C															S	C				S	S		F						F		F
		8R-7, 55-56	788.45	A	P									C																F															
		9R-1, 36-37	788.86	A	M	R			F				S	C													S		S	S							S				F	S		C		S
	CP8a	9R-1, 121-122	789.71	C	P	S								F																F															
		9R-2, 30-31	790.30	F	P									R																															
		9R-2, 120-121	791.20	B	B																																								
		9R-2, 130-131	791.30	A	M	S								C							S				S				F	F								S				F			
		9R-3, 35-36	791.85	B	B																																								
		9R-3, 126-127	792.76	A	M									C																S								S						F		
		9R-4, 37-38	793.37	A	M									C																S				S												
		9R-4, 113-114	794.13	A	M	R					R		R	C					S			S			S				S	F				S			S									
		9R-5, 35-36	794.85	A	M									C															R	S										S	F					
		9R-5, 110-112	795.61	A	M									C			S													F																
		9R-6, 28-29	796.28	A	M	R	C						R	C	R		S												S	F					S	S					F					
		9R-6, 121-123	797.21	A	M	F	F						F	C	F		S						R		S	S					S						S					F					
NP8	CP7	9R-CC, 00-01	798.10	A	M	F	F						F	C														R	S				S								S					
		10R-1, 20-21	798.30	A	M	R	F						S	C																												S				
		10R-1, 126-127	799.36	A	M	S	S						S	C	S		F														S						S					F					
		10R-2, 122-123	800.82	A	M	F	S						S	C	F		S												F								S					F	F				
		10R-3, 08-10	801.18	A	M	F	S						S	C	F		S												F								S					F	F				
		10R-3, 33-34	801.43	C	M	S	F							F	F														F		F															
		10R-3, 84-86	801.94	A	M	F							S	C	F														F		F		F													
		10R-3, 118-119	802.28	B	B																																									
		10R-3, 123-125	802.33	A	M	F				S				A									S						C		S															
	CP6	11R-1, 05-06	807.75	A	M	F	R							C	C		F								S				R																	
		11R-1, 30-32	808.00	A	M	R	R						S	C			C								F								S			S						S				
		11R-1, 119-120	808.89	A	M	R	R			S			R	C			C						S		R											S					R	S				
		11R-2, 08-09	809.28	V	M	F	R			R			R	A			C			S			R		S				S							S					R					
		11R-2, 44-45	809.64	A	M	R	F						R	C			C						S																							
NP7		11R-2, 118-120	810.38	A	M	R							R	A			C						R						F												S	S				
		11R-2, 139-141	810.59	B	B																																								
		11R-3, 15-17	810.85	A	M	R		S					R	A			C						R		R				S												S				

Table T2 (continued).

Martini (1971)	Okada and Bukry (1980)	Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	Reworked Cretaceous	*Fasciculithus magnicordis*	*Fasciculithus magnus*	*Fasciculithus mitreus*	*Fasciculithus pileatus*	*Fasciculithus richardii*	*Fasciculithus shaubii*	*Fasciculithus* spp.	*Fasciculithus thomasii*	*Fasciculithus tonii*	*Fasciculithus tympaniformis*	*Heliolithus cantabriae*	*Heliolithus kleinpellii*	*Heliolithus riedelii*	*Hornibrookina edwardsii*	*Hornibrookina teuriensis*	*Markalius inversus*	*Micrantholithus entaster*	*Micrantholithus pinguis*	*Neochiastozygus chiastus*	*Neochiastozygus digitosus*	*Neochiastozygus distentus*	*Neochiastozygus perfectus*	*Neochiastozygus primitivus*	*Placozygus sigmoides*	*Prinsius bisulcus*	*Prinsius dimorphosus*	*Prinsius martinii*	*Semihololithus kerabyi*	*Sphenolithus anarrhopus*	*Sphenolithus primus*	*Thoracosphaera* spp.	*Toweius eminens*	*Toweius pertusus*	*Toweius* spp.	*Toweius tovae*
		173-1068A-																																							
NP9	CP8b	8R-4, 44-45	783.84	A	G	R								S		F	S														F					F		S	F		A
		8R-4, 95-96	784.35	R	P																																				S
		8R-5, 17-18	785.07	A	M	S			S		S			S		S																				S		C	C		C
		8R-5, 65-66	785.55	A	M	S						F			S															R							C	S		F
		8R-6, 19-20	786.59	A	M					S	S	C																								F	C	C		
		8R-6, 99-100	787.39	A	M	S										F															S					F	C	C		
		8R-6, 139-140	787.79	A	M								S			C															S						C	F		
		8R-7, 20-21	788.10	A	M	S		S				F				C															F					C	C			S
		8R-7, 55-56	788.45	A	P								F			F																				C	F	R		F
		9R-1, 36-37	788.86	A	M	R						S				C														S	F					C	C	C		C
	CP8a	9R-1, 121-122	789.71	C	P	S						S	S	S																	S						F	R		
		9R-2, 30-31	790.30	F	P											S															S						S	S		
		9R-2, 120-121	791.20	B	B																																				
		9R-2, 130-131	791.30	A	M	S		S								C						S									R						F	F		
		9R-3, 35-36	791.85	B	B																																				
		9R-3, 126-127	792.76	A	M						R			S		S															F					S	C	F		C
		9R-4, 37-38	793.37	A	M								F			F															S						S		C	F
		9R-4, 113-114	794.13	A	M	R							F			F															F			F		F	C	F		C
		9R-5, 35-36	794.85	A	M									S		C											S				F					C	F	F		C
		9R-5, 110-112	795.61	A	M								C			C															C					C	C	C		C
		9R-6, 28-29	796.28	A	M	R							C			C															F						F	C	S	C
NP8	CP7	9R-6, 121-123	797.21	A	M	F							C			F																				F	C	F		C
		9R-CC, 00-01	798.10	A	M	F							F			F																			S	C	F	F		C
		10R-1, 20-21	798.30	A	M	R							S			F									S						F			S	S	F	F	C		C
		10R-1, 126-127	799.36	A	M	S																														F	F	C		C
		10R-2, 122-123	800.82	A	M	F							C			F			S												F			S	F	F	F	F		C
		10R-3, 08-10	801.18	A	M	F							C			F			S												F			S			F	F		C
		10R-3, 33-34	801.43	C	M	S							S																							S			F	
		10R-3, 84-86	801.94	A	M	F							F			F			R						S						F			F	F	C	C			C
		10R-3, 118-119	802.28	B	B																																				
		10R-3, 123-125	802.33	A	M	F							F			F			S												F			F	F		F		S	
	CP6	11R-1, 05-06	807.75	A	M	F										C		R							F						R					F	C			C
		11R-1, 30-32	808.00	A	M	R		S								C		C	R						S										F	F	C			F
		11R-1, 119-120	808.89	A	M	R							R			F		C							S										C	C	C	S		C
		11R-2, 08-09	809.28	V	M	F										C		C	S						S						C				C	A	C	S		C
NP7		11R-2, 44-45	809.64	A	M	R										F		C							S										C	C	C			C
		11R-2, 118-120	810.38	A	M	R		R								F		C																	C	C	C	S		C
		11R-2, 139-141	810.59	B	B																																				
		11R-3, 15-17	810.85	A	M	R		R								F		F													S				C	C	A			C

Table T2 (continued).

Martini (1971)	Okada and Bukry (1980)	Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	Reworked Cretaceous	*Bomolithus elegans*	*Braarudosphaera bigelowii*	*Camplylosphaera eodela*	*Chiasmolithus bidens*	*Chiasmolithus consuetus*	*Chiasmolithus danicus*	*Chiasmolithus* spp.	*Coccolithus pelagicus*	*Coccolithus robustus*	*Coccolithus* spp.	*Coccolithus subpertusus*	*Cruciplacolithus edwardsii*	*Cruciplacolithus frequens*	*Cruciplacolithus intermedius*	*Cruciplacolithus latipons*	*Cruciplacolithus primus*	*Cruciplacolithus* spp.	*Cruciplacolithus tenuis*	*Discoaster bramlettei*	*Discoaster delicatus*	*Discoaster elegans*	*Discoaster mahmoudii*	*Discoaster mohleri*	*Discoaster multiradiatus*	*Discoaster nobilis*	*Discoaster splendidus*	*Discoaster* spp.	*Ellipsolithus bollii*	*Ellipsolithus distichus*	*Ellipsolithus macellus*	*Fasciculithus alanii*	*Fasciculithus aubertae*	*Fasciculithus billii*	*Fasciculithus bitectus*	*Fasciculithus bobii*	*Fasciculithus clinatus*	*Fasciculithus hayi*	*Fasciculithus involutus*	*Fasciculithus janii*	*Fasciculithus lilianae*
NP6	CP5	11R-3, 36-37	811.06	B	B																																									
		11R-3, 70-72	811.40	A	M	F	S	F						C			F																								S					
		11R-3, 139-141	812.09	A	M	S	R							C			C						S										S									S				
		11R-4, 07-09	812.27	A	M	F	S							C			F						S		S											F										
		11R-4, 35-36	812.55	A	M	R	S						S	C			F												F													F				
		11R-4, 120-122	813.40	A	M	F	F	S		S			S	C			F						F													S						S				
		11R-5, 09-11	813.79	A	M	R	S						S	C			F				F		R													S										
		11R-5, 116-118	814.86	A	M	F	F					F	S	C			C						F													F			S			S			S	
		11R-CC, 03-04	815.41	A	M	F	F	R					R	C			F					F																								
NP5	CP4	12R-1, 36-37	817.66	B	B																																									
		12R-1, 39-43	817.69	B	B																																									
		12R-1, 110-112	818.40	B	B																																									
		12R-1, 121-122	818.51	B	B																																									
		12R-2, 35-36	819.15	B	B																																									
		12R-2, 86-87	819.66	B	B																																									
		12R-2, 108-109	819.88	B	B																																									
		12R-2, 121-122	820.01	B	B																																									
		12R-2, 147-150	820.27	B	B																																									
		12R-3, 11-14	820.41	B	B																																									
		12R-3, 39-41	820.69	B	B																																									
		12R-3, 90-92	821.20	B	B																																									
		12R-4, 33-34	822.13	B	B																																									
		12R-4, 140-143	823.20	B	B																																									
NP4	CP3	12R-5, 35-36	823.65	C	P	F								F			F						S																							
		12R-5, 120-121	824.50	C	M	S								C			F						R																							
		12R-6, 34-35	825.14	B	B																																									
		12R-6, 56-57	825.36	A	M	F	S							C			F					S	F	F												S									R	
		12R-6, 104-105	825.84	A	M	C		R						C			C					R	F	R												R										
		12R-6, 120-121	826.00	R	P	S								S			R							S																						
		12R-6, 146-147	826.26	A	M	C		S						C			F	S					F	F																						
		12R-7, 04-05	826.34	A	M	C		S						C			C					F	F	F																						
		12R-7, 13-14	826.43	A	M	C	R	R						C			C						C	C																						
		12R-CC, 0-4	827.01	A	M	F	S	S						C			F							F																						
		13R-1, 09-10	826.99	A	M	C		S						C			C					F	F	F																						
		13R-1, 34-35	827.24	B	B																																									
		13R-1, 121-122	828.11	A	M	C		F						C			F	F		F		F	F	F	S											F										
		13R-2, 20-21	828.60	A	M	C								C			F					F	F													S										

Table T2 (continued).

Martini (1971)	Okada and Bukry (1980)	Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	Reworked Cretaceous	*Fasciculithus magnicordis*	*Fasciculithus magnus*	*Fasciculithus mitreus*	*Fasciculithus pileatus*	*Fasciculithus richardii*	*Fasciculithus shaubii*	*Fasciculithus* spp.	*Fasciculithus thomasii*	*Fasciculithus tonii*	*Fasciculithus tympaniformis*	*Heliolithus cantabriae*	*Heliolithus kleinpellii*	*Heliolithus riedelii*	*Hornibrookina edwardsii*	*Hornibrookina teuriensis*	*Markalius inversus*	*Micrantholithus entaster*	*Micrantholithus pinguis*	*Neochiastozygus chiastus*	*Neochiastozygus digitosus*	*Neochiastozygus distentus*	*Neochiastozygus perfectus*	*Neochiastozygus primitivus*	*Placozygus sigmoides*	*Prinsius bisulcus*	*Prinsius dimorphosus*	*Prinsius martinii*	*Semihololithus kerabyi*	*Sphenolithus anarrhopus*	*Sphenolithus primus*	*Thoracosphaera* spp.	*Toweius eminens*	*Toweius pertusus*	*Toweius* spp.	*Toweius tovae*
NP6	CP5	11R-3, 36-37	811.06	B	B																																				
		11R-3, 70-72	811.40	A	M	F		F					S			C		F					S					S							C	S		F	S	S	C
		11R-3, 139-141	812.09	A	M	S							F					F									S								C	C		C			F
		11R-4, 07-09	812.27	A	M	F							F			C		C							S										F			F		S	C
		11R-4, 35-36	812.55	A	M	R										F		F													F				C	F		C			C
		11R-4, 120-122	813.40	A	M	F		F								F							S	S	S						F				F			C			C
NP5		11R-5, 09-11	813.79	A	M	R		S					F			C						S	S			F					F				S	C		S		C	C
		11R-5, 116-118	814.86	A	M	F		F					F			S										S						C	C			C					
		11R-CC, 03-04	815.41	A	M	F		F					C			F															F		F			F	R			F	
		12R-1, 36-37	817.66	B	B																																				
		12R-1, 39-43	817.69	B	B																																				
		12R-1, 110-112	818.40	B	B																																				
		12R-1, 121-122	818.51	B	B																																				
		12R-2, 35-36	819.15	B	B																																				
		12R-2, 86-87	819.66	B	B																																				
		12R-2, 108-109	819.88	B	B																																				
		12R-2, 121-122	820.01	B	B																																				
		12R-2, 147-150	820.27	B	B																																				
		12R-3, 11-14	820.41	B	B																																				
		12R-3, 39-41	820.69	B	B																																				
		12R-3, 90-92	821.20	B	B																																				
		12R-4, 33-34	822.13	B	B																																				
		12R-4, 140-143	823.20	B	B																																				
		12R-5, 35-36	823.65	C	P	F																																			
		12R-5, 120-121	824.50	C	M	S															R	R									R										
		12R-6, 34-35	825.14	B	B																																				
		12R-6, 56-57	825.36	A	M	F																S																			
		12R-6, 104-105	825.84	A	M	C														S		F									F										
		12R-6, 120-121	826.00	R	P	S																																			
NP4	CP3	12R-6, 146-147	826.26	A	M	C															F	S									S										
		12R-7, 04-05	826.34	A	M	C	R																								F						R				
		12R-7, 13-14	826.43	A	M	C	R						S								F	R									F						F				
		12R-CC, 0-4	827.01	A	M	F	F	S												S										R	F										
		13R-1, 09-10	826.99	A	M	C															F									F			F				F				
		13R-1, 34-35	827.24	B	B																																				
		13R-1, 121-122	828.11	A	M	C														F	S	F							F			C	F				F				
		13R-2, 20-21	828.60	A	M	C																F										F	R								

Table T2 (continued).

Martini (1971)	Okada and Bukry (1980)	Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	Reworked Cretaceous	*Bomolithus elegans*	*Braarudosphaera bigelowii*	*Camplylosphaera eodela*	*Chiasmolithus bidens*	*Chiasmolithus consuetus*	*Chiasmolithus danicus*	*Chiasmolithus* spp.	*Coccolithus pelagicus*	*Coccolithus robustus*	*Coccolithus* spp.	*Coccolithus subpertusus*	*Cruciplacolithus edwardsii*	*Cruciplacolithus frequens*	*Cruciplacolithus intermedius*	*Cruciplacolithus latipons*	*Cruciplacolithus primus*	*Cruciplacolithus* spp.	*Cruciplacolithus tenuis*	*Discoaster bramlettei*	*Discoaster delicatus*	*Discoaster elegans*	*Discoaster mahmoudii*	*Discoaster mohleri*	*Discoaster multiradiatus*	*Discoaster nobilis*	*Discoaster splendidus*	*Discoaster* spp.	*Ellipsolithus bollii*	*Ellipsolithus distichus*	*Ellipsolithus macellus*	*Fasciculithus alanii*	*Fasciculithus aubertae*	*Fasciculithus billii*	*Fasciculithus bitectus*	*Fasciculithus bobii*	*Fasciculithus clinatus*	*Fasciculithus hayi*	*Fasciculithus involutus*	*Fasciculithus janii*	*Fasciculithus lilianae*
NP2/NP3	CP1b/CP2	13R-2, 25-27	828.65	A	M	C		R						C			C	S		R		F	C																							
		13R-2, 58-59	828.98	A	M	C		R						C			C	F		C			C																							
		13R-2, 104-106	829.44	A	M	F		F						C			C					F	C	F																						
		13R-2, 138-140	829.78	A	M	F		F						C			C					F	C	F																						
		13R-3, 03-04	829.93	A	M	F		F						C			C					F	C	F																						
		13R-3, 44-45	830.34	C	M	S								C			F						S																							
		13R-3, 63-64	830.53	A	M	C								C			C					F	C																							
		13R-4, 32-33	831.72	A	M									F			C			F		F	C																							
		13R-4, 100-101	832.40	A	M	F								F			C					F	C																							
		13R-4, 132-133	832.72	A	M	C		F						F			F	F				F	C																							
		13R-5, 01-02	832.91	A	M	C								F			F					F	C	F																						
		13R-5, 78-79	833.68	A	M	C								C			F					F	C	F																						
NP1	CP1a	13R-5, 93-96	833.83	F	P	F																																								
		13R-5, 139-141	834.29	F	P	F										S																														
		13R-6, 52-53	834.92	B	B																																									

Notes: Abundance: A = abundant, C = common, F = few, R = rare, S = single. Preservation: G = good, M = moderate, P = poor.

Table T2 (continued).

Martini (1971)	Okada and Bukry (1980)	Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	Reworked Cretaceous	*Fasciculithus magnicordis*	*Fasciculithus magnus*	*Fasciculithus mitreus*	*Fasciculithus pileatus*	*Fasciculithus richardii*	*Fasciculithus shaubii*	*Fasciculithus* spp.	*Fasciculithus thomasii*	*Fasciculithus tonii*	*Fasciculithus tympaniformis*	*Heliolithus cantabriae*	*Heliolithus kleinpellii*	*Heliolithus riedelii*	*Hornibrookina edwardsii*	*Hornibrookina teuriensis*	*Markalius inversus*	*Micrantholithus entaster*	*Micrantholithus pinguis*	*Neochiastozygus chiastus*	*Neochiastozygus digitosus*	*Neochiastozygus distentus*	*Neochiastozygus perfectus*	*Neochiastozygus primitivus*	*Placozygus sigmoides*	*Prinsius bisulcus*	*Prinsius dimorphosus*	*Prinsius martinii*	*Semihololithus kerabyi*	*Sphenolithus anarrhopus*	*Sphenolithus primus*	*Thoracosphaera* spp.	*Toweius eminens*	*Toweius pertusus*	*Toweius* spp.	*Toweius tovae*
NP2/NP3	CP1b/CP2	13R-2, 25-27	828.65	A	M	C																R										F	F				R				
		13R-2, 58-59	828.98	A	M	C																								F		C									
		13R-2, 104-106	829.44	A	M	F																										C	C				F				
		13R-2, 138-140	829.78	A	M	F																										C	C				F				
		13R-3, 03-04	829.93	A	M	F																										C	C								
		13R-3, 44-45	830.34	C	M	S																										C									
		13R-3, 63-64	830.53	A	M	C																F										C									
		13R-4, 32-33	831.72	A	M																											C	F								
		13R-4, 100-101	832.40	A	M	F																								F		A					F				
		13R-4, 132-133	832.72	A	M	C																								F		A									
		13R-5, 01-02	832.91	A	M	C																								F		A					F				
		13R-5, 78-79	833.68	A	M	C																F										F									
NP1	CP1a	13R-5, 93-96	833.83	F	P	F																																			
		13R-5, 139-141	834.29	F	P	F																																			
		13R-6, 52-53	834.92	B	B																																				

Table T3. Distribution of calcareous nannofossils in the Cretaceous interval of Hole 1068A.

Nannofossil zones/ subzones																																					
Sissingh (1977)	Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	*Arkhangelskiella cymbiformis*	*Biscutum constans*	*Braarudosphaera bigelowii*	*Ceratolithoides aculeus*	*Ceratolithoides arcuatus*	*Chiastozygus platyrhethus*	*Cribrosphaerella daniae*	*Cribrosphaerella ehrenbergii*	*Cyclagelosphaera margerelii*	*Eiffellithus eximius*	*Eiffellithus turriseiffelii*	*Lithraphidites carniolensis*	*Lithraphidites quadratus*	*Markalius apertus*	*Markalius inversus*	*Microrhabdulus belgicus*	*Microrhabdulus decoratus*	*Micula concava*	*Micula decussata*	*Micula murus*	*Micula* spp.	*Prediscosphaera cretacea*	*Prediscosphaera stoveri*	*Retecapsa angustiforata*	*Retecapsa crenulata*	*Rhagodiscus angustus*	*Staurolithites angustus*	*Tetrapodorhabdus decorus*	*Thoracosphaera operculata*	*Thoracosphaera* spp.	*Watznaueria barnesae*
	173-1068A-																																				
CC25c/CC26	13R-6, 69-70	835.09	A	M	F		C					F	F		F	F	F		F		F	C	C	F		F			F	F			C		C
	13R-6, 82-83	835.22	B	P																															S
	13R-6, 96-97	835.36	A	P			C			F		F	F			F			F		F	F	C	F		F								F	C
	13R-6, 105-106	835.45	C	P																										F				F	
	13R-6, 116-117	835.56	A	P	S		S					F									S	C	F			S			F					F	C
	13R-CC, 01-02	835.62	R	P																			R							S				S	S
	14R-1, 06-08	836.66	A	M	F		F					F			F				F	F	F	C	C			F				F				F	C
	14R-1, 52-54	837.12	C	P	F		F					F			F					F		F	F											F	F
	14R-2, 14-16	838.24	A	M	C					F		C	F		F					F	C	C	C			F			C	C					C
	14R-2, 122-123	839.32	A	M	C							F			F						F	F	C			C			C	F					C
	14R-3, 35-36	839.95	B	B																															
	14R-3, 36-37	839.96	A	M	C					F		C			F					F	C	C	C			C			C	F					C
	14R-3, 120-121	840.80	C	P	S							F			S							F	F												F
	14R-3, 121-122	840.81	C	P	F																		C			F			F						F
	14R-3, 140-141	841.00	A	M	C							C				C					C	C	C			C			C	C					C
	14R-4, 00-01	841.10	A	P	F							F										C	C						F						F
	14R-4, 36-37	841.46	A	M	F							F										C	C			F			F						C
	14R-4, 62-63	841.72	A	M	F					F		C	F		F	F	F				F	C	C			F			C	F					C
	14R-4, 75-76	841.85	A	M						F		C			F	F			F			C	C			C			C						C
	14R-4, 121-122	842.31	A	M	C					C		C			F	F	F		F		C	C	C			C			C	F					C
	14R-4, 122-123	842.32	A	M	F			F		F		C				C	C		F		F	C	C		F	C				C					C
	14R-5, 00-01	842.60	A	M						F		C			F						F	C	C			F	F		C	C					C
	14R-5, 123-124	843.83	F	M																		F	F	S		S									
	14R-5, 149-150	844.09	A	M	F							F			F						F	F	C			F	F		F	F					C
	14R-6, 36-37	844.46	A	M	C							F			F	F	F			F	F	C	C			C		F	C						C
	14R-6, 99-100	845.09	A	M	C	F						F										C	C			C			F						C
	14R-7, 07-08	845.17	A	M	C							C			F	C		F			F		C	F		C		C							C
	14R-7, 35-36	845.45	A	M	F							C			F	C				F		C	F		F	C			C	F					C
	14R-7, 53-54	845.63	A	M	C			F				F									F	C	C	F	F	C			C	F					C
	15R-1, 17-18	846.47	A	M	C					F		C			F						F	F	C		F	C			C	C					C
	15R-1, 34-35	846.64	A	M	C			C		C		C				F					C	C	C			C			C						C
	15R-1, 35-36	846.65	A	M	F			F		F		C			F	F				F	C	F	C			F			C	F					C
	15R-1, 71-72	847.01	A	M	F							C			F	F				F	F	C	C			C			F						C
	15R-1, 122-123	847.52	A	M	F					F					F	F			F			C	C			C			C						C
	15R-2, 08-10	847.88	A	M	C			F				C				F			F	C	F		C			C			C						A
	15R-2, 33-34	848.13	A	M	C							F			C	F							F			C			C	F	F	F			C
	15R-2, 92-93	848.72	A	M	C			F		F		F			C	F					F		C			C			C	C					A
	15R-2, 124-125	849.04	A	M	C			F				C			F						F		C			F			C						C
	15R-3, 22-23	849.52	A	M	C			F				F									C		C			F			C	F					A
	15R-3, 24-25	849.53	A	M	C			F		F		C				F					F		F						C						C
	15R-3, 34-35	849.64	A	M	C			F			C			F					F		C		C			F			C	F					A
	15R-3, 35-36	849.65	A	M	F				F			F			F				F		F		C			F			C	F					C
CC25b	15R-3, 71-72	850.01	A	M	C			F			F				F						C		C			C			C	C					C
	15R-3, 72-73	850.02	A	M	F						C	F			C						C		C	C		C		F	C						C
	15R-3, 98-100	850.28	A	M	C							C							F		C		C	C					C						C
	15R-4, 10-11	850.40	A	M	C							F							F		C		C	F		C			F						C
	15R-4, 12-13	850.41	A	M	C	F		F				C			F						C		C			C			C						C
	15R-4, 34-35	850.64	A	M	F							C			F	F					C		C			C			C		F				C
	15R-4, 82-83	851.12	A	M	C			F				C			C						C		C			C			C	F	F				C
	15R-4, 83-84	851.13	A	P	C			F				C			F	C					F		C			C			F	F					C
	15R-4, 100-101	851.30	A	G	C			C		F		C			F	F			F		F	F	C		F	F			C						C
	15R-4, 101-102	851.31	A	M	C			C			C	C		F	F						C	F	C			C		C	F			F			A

Notes: Abundance: A = abundant, C = common, F = few, S = single, B = barren. Preservation: M = moderate, P = poor.

Table T4. Distribution of calcareous nannofossils in the Paleocene interval of Hole 1069A. (See table notes. Continued on next three pages.)

Nannofossil zones/subzones: Martini (1971)	Okada and Bukry (1980)	Core, section, interval (cm)	Depth (mbsf)	Total abundance	Sample preservation	Reworked Cretaceous	*Biantholithus sparsus*	*Bomolithus elegans*	*Braarudosphaera bigelowii*	*Chiasmolithus bidens*	*Chiasmolithus consuetus*	*Chiasmolithus danicus*	*Chiasmolithus* spp.	*Coccolithus pelagicus*	*Coccolithus robustus*	*Coccolithus* spp.	*Coccolithus subpertusus*	*Cruciplacolithus edwardsii*	*Cruciplacolithus intermedius*	*Cruciplacolithus primus*	*Cruciplacolithus* spp.	*Cruciplacolithus tenuis*	*Cyclagelosphaera margerelii*	*Discoaster falcatus*	*Discoaster mohleri*	*Discoaster multiradiatus*	*Discoaster nobilis*	*Discoaster* spp.	*Ellipsolithus macellus*	*Fasciculithus alanii*	*Fasciculithus aubertae*	*Fasciculithus billii*	*Fasciculithus bobii*	*Fasciculithus clinatus*	*Fasciculithus involutus*	*Fasciculithus janii*	*Fasciculithus lilianae*	*Fasciculithus magnus*	*Fasciculithus pileatus*	*Fasciculithus shaubii*	*Fasciculithus* spp.	*Fasciculithus thomasii*	*Fasciculithus tympaniformis*	*Heliolithus kleinpellii*	*Heliolithus riedelii*	*Markalius inversus*
		173-1069A-																																												
NP9	CP8	7R-5, 18-19	782.98	A	M	F		R						C										R		C				R					F				F	R	C	C				
		7R-5, 19-20	782.99	A	M	R		S		F				C	R						R				F	C				F			F								F	F				
		7R-5, 55-56	783.35	A	M									C							F				F	F				F			F		F		F					F	F				
		7R-5, 61-63	783.41	A	M	F								C											C	C		F		F	F			F	F		F			F		F	F				
		7R-5, 82-84	783.62	A	M								F	C			R								F	F			R	F				F	F						C		F				
		7R-5, 90-93	783.70	A	M	F				S			S	C											F	C				F			F		F		F			F		F					
		7R-CC, 20-22	784.58	A	M					F				C												R							F	F	F								F	F				
NP8	CP7	8R-1, 09-11	786.49	A	M	F		S					F	C			F				F				F									F	F						C	F	C				
		8R-1, 33-34	786.73	A	M	F		R					F	C			F								C		R							F	F						C		F	R			
		8R-1, 59-60	786.99	A	P	R							F	C			C				F				C								C	C	F						C	F	C				
NP8	CP6	8R-1, 87-90	787.27	A	P									F											C									F						C		C	F	R		
		8R-1, 117-118	787.57	B	B																																										
		8R-2, 35-36	788.25	B	B																																										
		8R-2, 70-71	788.60	C	P	F																			C			F														R					
		8R-2, 117-118	789.07	B	B																																										
		8R-3, 35-36	789.75	B	B																																										
		8R-3, 118-120	790.58	B	B																																										
		8R-3, 128-130	790.68	B	B																																										
		8R-4, 35-37	791.25	B	B																																										
		8R-4, 46-50	791.35	B	B																																										
		8R-4, 74-75	791.64	B	B																																										
		8R-4, 89-90	791.79	B	B																																										
		8R-4, 120-122	792.10	B	B																																										
		8R-5, 36-37	792.76	B	B																																										
		8R-5, 62-63	793.02	B	B																																										
NP4	CP3	9R-1, 13-15	796.13	A	M	C							R				F															F						F			F						
		9R-1, 26-28	796.26	B	B																																										
		9R-1, 38-40	796.38	C	M	F		F																								F															
		9R-1, 93-95	796.93	A	M	F							F	C			C					F										F						F	F		F						
		9R-2, 18-19	797.68	F	P	F																																									
		9R-2, 32-34	797.82	A	P	F				F			F	C			F															F							F		F						
		9R-2, 110-111	798.60	A	M	C								C			F				F											F									F						
		9R-2, 148-149	798.98	A	M	F				F				F			C				F											F									F						
		9R-3, 10-12	799.10	B	B																																										
		9R-3, 70-73	799.70	A	M	C							F	C			F															F															
		9R-3, 140-141	800.40	A	M	F				F	F			C			F				F	F																			F						
		9R-4, 51-52	801.01	A	M	C					C			C			C	F	F													F															
		9R-4, 53-54	801.03	A	P	F					F		F	C			F																			F											

Table T4 (continued).

Nannofossil zones/ subzones: Martini (1971)	Okada and Bukry (1980)	Core, section, interval (cm)	Depth (mbsf)	Total abundance	Sample preservation	Reworked Cretaceous	*Microrhabdulus decoratus*	*Neochiastozygus chiastus*	*Neochiastozygus digitosus*	*Neochiastozygus perfectus*	*Neochiastozygus primitivus*	*Placozygus sigmoides*	*Prinsius bisulcus*	*Prinsius dimorphosus*	*Prinsius martinii*	*Semihololithus kerabyi*	*Sphenolithus anarrhopus*	*Sphenolithus primus*	*Thoracosphaera* spp.	*Toweius eminens*	*Toweius pertusus*	*Toweius* spp.	*Toweius tovae*
		173-1069A-																					
NP9	CP8	7R-5, 18-19	782.98	A	M	F												F		C	F		F
		7R-5, 19-20	782.99	A	M	R										R		F		C		F	C
		7R-5, 55-56	783.35	A	M			S										C		C	F	C	F
		7R-5, 61-63	783.41	A	M	F												F		F		F	F
		7R-5, 82-84	783.62	A	M															F			
		7R-5, 90-93	783.70	A	M	F												F		C	C	F	C
		7R-CC, 20-22	784.58	A	M								F					F		F		F	F
NP8	CP7	8R-1, 09-11	786.49	A	M	F											F			F		C	
		8R-1, 33-34	786.73	A	M	F												F	R	F		F	
NP8	CP6	8R-1, 59-60	786.99	A	P	R																F	
		8R-1, 87-90	787.27	A	P													F		F		C	
		8R-1, 117-118	787.57	B	B																		
		8R-2, 35-36	788.25	B	B																		
		8R-2, 70-71	788.60	C	P	F																	
		8R-2, 117-118	789.07	B	B																		
		8R-3, 35-36	789.75	B	B																		
		8R-3, 118-120	790.58	B	B																		
		8R-3, 128-130	790.68	B	B																		
		8R-4, 35-37	791.25	B	B																		
		8R-4, 46-50	791.35	B	B																		
		8R-4, 74-75	791.64	B	B																		
		8R-4, 89-90	791.79	B	B																		
		8R-4, 120-122	792.10	B	B																		
		8R-5, 36-37	792.76	B	B																		
		8R-5, 62-63	793.02	B	B																		
NP4	CP3	9R-1, 13-15	796.13	A	M	C												R					
		9R-1, 26-28	796.26	B	B																		
		9R-1, 38-40	796.38	C	M	F																	
		9R-1, 93-95	796.93	A	M	F									F								
		9R-2, 18-19	797.68	F	P	F																	
		9R-2, 32-34	797.82	A	P	F												F					
		9R-2, 110-111	798.60	A	M	C												F				F	
		9R-2, 148-149	798.98	A	M	F									F								
		9R-3, 10-12	799.10	B	B																		
		9R-3, 70-73	799.70	A	M	C												F					
		9R-3, 140-141	800.40	A	M	F		F		F					F					F	C		
		9R-4, 51-52	801.01	A	M	C				F					C			F			C		
		9R-4, 53-54	801.03	A	P	F									F			F					

Table T4 (continued).

Nannofossil zones/ subzones: Martini (1971)	Nannofossil zones/ subzones: Okada and Bukry (1980)	Core, section, interval (cm)	Depth (mbsf)	Total abundance	Sample preservation	Reworked Cretaceous	*Biantholithus sparsus*	*Bomolithus elegans*	*Braarudosphaera bigelowii*	*Chiasmolithus bidens*	*Chiasmolithus consuetus*	*Chiasmolithus danicus*	*Chiasmolithus* spp.	*Coccolithus pelagicus*	*Coccolithus robustus*	*Coccolithus* spp.	*Coccolithus subpertusus*	*Cruciplacolithus edwardsii*	*Cruciplacolithus intermedius*	*Cruciplacolithus primus*	*Cruciplacolithus* spp.	*Cruciplacolithus tenuis*	*Cyclagelosphaera margerelii*	*Discoaster falcatus*	*Discoaster mohleri*	*Discoaster multiradiatus*	*Discoaster nobilis*	*Discoaster* spp.	*Ellipsolithus macellus*	*Fasciculithus alanii*	*Fasciculithus aubertae*	*Fasciculithus billii*	*Fasciculithus bobii*	*Fasciculithus clinatus*	*Fasciculithus involutus*	*Fasciculithus janii*	*Fasciculithus lilianae*	*Fasciculithus magnus*	*Fasciculithus pileatus*	*Fasciculithus shaubii*	*Fasciculithus* spp.	*Fasciculithus thomasii*	*Fasciculithus tympaniformis*	*Heliolithus kleinpellii*	*Heliolithus riedelii*	*Markalius inversus*
NP4	CP3	9R-4, 123-124	801.73	A	M	F			F		F		F	C			F		F													F				F					F					
		10R-1, 14-15	805.74	A	P	C					C		F	C			F		F			F													F						F					
		10R-1, 79-81	806.39	F	P									F																																
		10R-1, 110-113	806.70	A	M	F								C			C				F																				F					
		10R-2, 01-03	807.11	A	P	F							F	C			C				F																				C					F
		10R-2, 54-55	807.64	A	P	C							F	C			C				F	F											F				F									F
		10R-2, 69-71	807.79	A	M	C							F	C			F			F	F																									
		10R-2, 137-140	808.47	A	M								F	C			C	F			F	F																								
		10R-3, 9-10	808.69	C	P								F	F			F				F	F																								
		10R-3, 18-20	808.78	A	M	F								C			C			F	F	F																								
		10R-3, 126-129	809.86	A	M	C								C			C			F	C	F											R													
		10R-4, 63-68	810.73	C	P	C								F			F				F																									
		10R-5, 25-27	811.85	A	M	F								C			C		R		F	F																								
		10R-5, 40-43	812.00	A	M	C								C			C				F																									F
		10R-5, 74-76	812.34	A	M	C								C			C			F	C																									F
		10R-7, 48-50	813.38	C	P	F										F	F																													
		10R-7, 115-119	814.05	A	M	C								C			C	F		F	F	F																								F
		10R-7, 141-146	814.31	F	P											F					F																									
		10R-8, 01-06	814.41	A	M	C			F					C			C			F		C																								
		10R-8, 31-34	814.71	A	M	C			F					C			C	F			F	C																								
		11R-1, 30-32	815.60	A	P	C								C			C				F	F																								
		11R-1, 59-60	815.89	C	P	F								F			F					F																								
		11R-1, 128-129	816.58	A	M	A			F					C			C				F	C							S																	
NP3	CP2	11R-2, 19-21	816.99	C	P	F								C		F					F	F																								
		11R-2, 124-126	818.04	A	M	C							F	C			F	F			C	F																								
		11R-3, 22-23	818.52	A	P	C								C							F																								
		11R-3, 60-61	818.90	A	P	C								C						F	F	F																							F
		11R-3, 91-92	819.21	A	M	C						F	F	C			F					F																								
		11R-3, 134-136	819.64	A	P	F								F		F					F																								
NP2	CP1b	11R-4, 14-17	819.94	A	M	C								C			F	F		F		F	F																						F
		11R-4, 52-53	820.32	A	M	C								C						F	F																								F
		11R-4, 79-81	820.59	A	P	C								C		C	F			F	F	F	C																						F
NP1	CP1a	12R-1, 01-02	825.01	B	B																																								
		12R-1, 39-41	825.39	A	M	C			F					C		C			C		C		C																						F
		12R-1, 62-64	825.62	A	M	C	F							F					F	F	C																								
		12R-1, 113-114	826.13	B	B																																								

Notes: Abundance: A = abundant, C = common, F = few, R = rare, B = barren. Preservation: M = moderate, P = poor.

Table T4 (continued).

Nannofossil zones/ subzones: Martini (1971)	Nannofossil zones/ subzones: Okada and Bukry (1980)	Core, section, interval (cm)	Depth (mbsf)	Total abundance	Sample preservation	Reworked Cretaceous	*Microrhabdulus decoratus*	*Neochiastozygus chiastus*	*Neochiastozygus digitosus*	*Neochiastozygus perfectus*	*Neochiastozygus primitivus*	*Placozygus sigmoides*	*Prinsius bisulcus*	*Prinsius dimorphosus*	*Prinsius martinii*	*Semihololithus kerabyi*	*Sphenolithus anarrhopus*	*Sphenolithus primus*	*Thoracosphaera* spp.	*Toweius eminens*	*Toweius pertusus*	*Toweius* spp.	*Toweius tovae*
NP4	CP3	9R-4, 123-124	801.73	A	M	F						F			C			F					C
		10R-1, 14-15	805.74	A	P	C												F					
		10R-1, 79-81	806.39	F	P					F													
		10R-1, 110-113	806.70	A	M	F									C			C			C	C	
		10R-2, 01-03	807.11	A	P	F							F		F			C			C		
		10R-2, 54-55	807.64	A	P	C	F		F						F			F			F	F	
		10R-2, 69-71	807.79	A	M	C					F		F		C		F	F			C	C	
		10R-2, 137-140	808.47	A	M			F							C						C	F	
		10R-3, 9-10	808.69	C	P																		
		10R-3, 18-20	808.78	A	M	F		F					C	C	C				C		F	F	
		10R-3, 126-129	809.86	A	M	C		C				F	C	C	A				F		C		
		10R-4, 63-68	810.73	C	P	C								F	C								
		10R-5, 25-27	811.85	A	M	F							F		C				F		F		
		10R-5, 40-43	812.00	A	M	C							F		C				F				
		10R-5, 74-76	812.34	A	M	C							C		C				F		F		
		10R-7, 48-50	813.38	C	P	F							F		F							F	
		10R-7, 115-119	814.05	A	M	C						F	C		C				F				
		10R-7, 141-146	814.31	F	P																		
		10R-8, 01-06	814.41	A	M	C						F	C		C				F				
		10R-8, 31-34	814.71	A	M	C						F	C		C				C				
		11R-1, 30-32	815.60	A	P	C						F	C										
		11R-1, 59-60	815.89	C	P	F							F										
		11R-1, 128-129	816.58	A	M	A						F	C	F	C								
		11R-2, 19-21	816.99	C	P	F																	
NP3	CP2	11R-2, 124-126	818.04	A	M	C						F	F	F	F								
		11R-3, 22-23	818.52	A	P	C								C									
		11R-3, 60-61	818.90	A	P	C								C	F								
		11R-3, 91-92	819.21	A	M	C								F									
		11R-3, 134-136	819.64	A	P	F								A									
NP2	CP1b	11R-4, 14-17	819.94	A	M	C								A	F				C				
		11R-4, 52-53	820.32	A	M	C								C					F				
		11R-4, 79-81	820.59	A	P	C								C					C				
NP1	CP1a	12R-1, 01-02	825.01	B	B																		
		12R-1, 39-41	825.39	A	M	C													C				
		12R-1, 62-64	825.62	A	M	C													C				
		12R-1, 113-114	826.13	B	B																		

Table T5. Distribution of calcareous nannofossils in the Cretaceous interval of Hole 1069A. (See table notes. Continued on next three pages.)

Nannofossil zones/ subzones: Sissingh (1977)	Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	*Acuturris scotus*	*Ahmuellerella octoradiata*	*Arkhangelskiella cymbiformis*	*Biscutum constans*	*Braarudosphaera bigelowii*	*Broinsonia parca constricta*	*Broinsonia* spp.	*Calculites obscurus*	*Ceratolithoides aculeus*	*Ceratolithoides arcuatus*	*Ceratolithoides kamptneri*	*Chiastozygus platyrhethus*	*Corollithion exiguum*	*Corollthion signum*	*Cretarhabdus conicus*	*Cribrosphaerella daniae*	*Cribrosphaerella ehrenbergii*	*Cyclagelosphaera margerelii*	*Cylindralithus duplex*	*Cylindralithus nudus*	*Cylindralithus* spp.	*Dodekapodorhabdus noeliae*	*Eiffellithus eximius*	*Eiffellithus turriseiffelii*	*Glaukolithus compactus*	*Lithastrinus grillii*	*Lithraphidites carniolensis*	*Lithraphidites quadratus*	*Lucianorhabdus cayeuxii*	*Manivitella pemmatoidea*	*Markalius apertus*	*Markalius inversus*	*Microrhabdulus belgicus*	*Microrhabdulus decoratus*	*Micula concava*	*Micula decussata*	*Micula murus*	*Micula prinsii*	*Neocrepidolithus watkinsii*	*Nephrolithus frequens*
	173-1069A-																																												
CC26b	12R-1, 120-122	826.20	C	P			F		F				F								F															F		F	C	C				
CC26b	12R-2, 11-15	826.61	A	P			F		F				F								F															F		F	C	C				
CC26b	12R-2, 58-60	827.07	A	P			F	F					F								F							R								F			F	C			F	
CC26b	12R-2, 99-100	827.49	A	M			F						F			F					F		F					F								F		F	C	F				
CC26b	12R-2, 141-142	827.91	A	M			C		F												C		F					F			F								C	C	F			
CC26b	12R-2, 143-144	827.92	F	P																																				F				
CC26b	12R-3, 27-29	828.27	A	M				F								F					C	F	F					F								C			C			F		
CC26b	12R-3, 93-94	828.93	A	M			F									F					F		F													C			C	C		F		
CC26b	12R-3, 134-136	829.34	A	P			F														C	F														F				C	C			
CC26b	12R-4, 04-06	829.54	A	P			C									F					C		F					F			F				F	F	F	F		C	F			
CC26b	12R-4, 84-85	830.34	A	P			F														C							F								F			C	C	F			
CC26b	12R-4, 144-145	830.94	A	M			F									F					C										F						C	F	C	C				F
CC26b	12R-4, 146-147	830.95	A	P			F										S				C																		C	F	F	F		F
CC26b	12R-5, 48-50	831.48	A	P			C														F		F															F	C	C	F			
CC26b	12R-5, 135-137	832.35	C	P																																			F	C		F		
CC25c / CC26a	12R-6, 20-21	832.70	A	P											F																								C	C	C			
CC25c / CC26a	12R-6, 70-71	833.20	A	P			F															C	F								F							C	C	F	F			
CC25c / CC26a	12R-6, 71-72	833.21	R	M																	S																							
CC25c / CC26a	13R-1, 05-06	834.75	B	B																																								
CC25c / CC26a	13R-1, 71-72	835.41	A	P			F						F									F	F																F	C				
CC25c / CC26a	13R-2, 21-24	836.41	A	P			C						F																							F			C	C	C			
CC25c / CC26a	13R-2, 74-76	836.94	A	M			C													F	C	F									F							C	C	C	F			
CC25c / CC26a	13R-2, 106-108	837.26	A	M			C						F								C										F							F		C	C			
CC25c / CC26a	13R-3, 15-17	837.85	B	B																																								
CC25c / CC26a	13R-3, 65-67	838.35	A	M			C						C								C										F					F	R	C	C	C	F			
CC25c / CC26a	13R-3, 149-150	839.19	A	M			C						C								C							F								F		F	F	C				
CC25c / CC26a	13R-4, 31-33	839.51	A	P			F						F								R																	R	C	C				
CC25c / CC26a	13R-4, 72-73	839.92	A	M			C						F						F		C		F					F										F	C	C				
CC25c / CC26a	13R-4, 74-76	839.94	B	B																																								
CC25c / CC26a	13R-4, 148-149	840.68	A	M			C						F								C				F				F									C	C	C				
CC25c / CC26a	13R-4, 149-150	840.69	C	M			C						F								F							F										F	F	C	F			
CC25c / CC26a	13R-5, 04-08	840.74	A	M			F						F								F				F				F									F	F	C	F			
CC25c / CC26a	13R-5, 65-66	841.35	B	B																																								
CC25c / CC26a	13R-CC, 03-05	841.50	A	M			C						F					F			F																F	F	C	C				
CC25c / CC26a	14R-1, 10-12	844.50	B	B																																								
CC25c / CC26a	14R-1, 77-79	845.17	A	M			F														C										F	F					F	C		C	F			

Table T5 (continued).

Nannofossil zones/ subzones Sissingh (1977)	Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	*Percivalia fenestrata*	*Petrarhabdus copulatus*	*Prediscosphaera cretacea*	*Prediscosphaera ponticula*	*Prediscosphaera spinosa*	*Prediscosphaera stoveri*	*Quadrum gartneri*	*Reinhardtites anthophorus*	*Reinhardtites levis*	*Repagulum parvidentatum*	*Retecapsa angustiforata*	*Retecapsa crenulata*	*Rhagodiscus angustus*	*Sollasites horticus*	*Staurolithites angustus*	*Staurolithites imbricatus*	*Staurolithites mielnicensis*	*Tetrapodorhabdus decorus*	*Tetrapodorhabdus* spp.	*Thoracosphaera operulata*	*Thoracosphaera* spp.	*Tranolithus orionatus*	*Tranolithus phacelosus*	*Uniplanarius gothicus*	*Uniplanarius sissinghii*	*Uniplanarius trifidus*	*Watznaueria barnesae*	*Zeughrabdotus diplogrammus*
	173-1069A-																															
CC26b	12R-1, 120-122	826.20	C	P			F										F								C						C	
	12R-2, 11-15	826.61	A	P			F										F								C						C	
	12R-2, 58-60	827.07	A	P			F										F								C						C	
	12R-2, 99-100	827.49	A	M			C									C	F		F						F						C	
	12R-2, 141-142	827.91	A	M			C									F	F							F							C	
	12R-2, 143-144	827.92	F	P																												
	12R-3, 27-29	828.27	A	M			C									F	F		F					F							C	
	12R-3, 93-94	828.93	A	M			C									F	F		F						C						C	
	12R-3, 134-136	829.34	A	P																					F						F	
	12R-4, 04-06	829.54	A	P			C										C								C						C	
	12R-4, 84-85	830.34	A	P			C									F															C	
	12R-4, 144-145	830.94	A	M			C									C	C														C	
	12R-4, 146-147	830.95	A	P			F									C	F														C	
	12R-5, 48-50	831.48	A	P			C									F															F	
	12R-5, 135-137	832.35	C	P																												
CC25c / CC26a	12R-6, 20-21	832.70	A	P			F									F																
	12R-6, 70-71	833.20	A	P			C									C															C	
	12R-6, 71-72	833.21	R	M			S																								S	
	13R-1, 05-06	834.75	B	B																												
	13R-1, 71-72	835.41	A	P			F									F															F	
	13R-2, 21-24	836.41	A	P			F									C															C	
	13R-2, 74-76	836.94	A	M			F									C	F														A	
	13R-2, 106-108	837.26	A	M			C									F															C	
	13R-3, 15-17	837.85	B	B																												
	13R-3, 65-67	838.35	A	M			F									C	F														C	
	13R-3, 149-150	839.19	A	M			C							F		C	C														C	
	13R-4, 31-33	839.51	A	P			F									F															C	
	13R-4, 72-73	839.92	A	M			F									C															C	
	13R-4, 74-76	839.94	B	B																												
	13R-4, 148-149	840.68	A	M			C									F	F								F						C	
	13R-4, 149-150	840.69	C	M			C									C																
	13R-5, 04-08	840.74	A	M			C					F				C															F	
	13R-5, 65-66	841.35	B	B																												
	13R-CC, 03-05	841.50	A	M			C									C															C	
	14R-1, 10-12	844.50	B	B																												
	14R-1, 77-79	845.17	A	M			F									C															C	

Table T5 (continued).

Nannofossil zones/ subzones Sissingh (1977)	Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	*Acuturris scotus*	*Ahmuellerella octoradiata*	*Arkhangelskiella cymbiformis*	*Biscutum constans*	*Braarudosphaera bigelowii*	*Broinsonia parca constricta*	*Broinsonia* spp.	*Calculites obscurus*	*Ceratolithoides aculeus*	*Ceratolithoides arcuatus*	*Ceratolithoides kamptneri*	*Chiastozygus platyrhethus*	*Corollithion exiguum*	*Corollthion signum*	*Cretarhabdus conicus*	*Cribrosphaerella daniae*	*Cribrosphaerella ehrenbergii*	*Cyclagelosphaera margerelii*	*Cylindralithus duplex*	*Cylindralithus nudus*	*Cylindralithus* spp.	*Dodekapodorhabdus noeliae*	*Eiffellithus eximius*	*Eiffellithus turriseiffelii*	*Glaukolithus compactus*	*Lithastrinus grillii*	*Lithraphidites carniolensis*	*Lithraphidites quadratus*	*Lucianorhabdus cayeuxii*	*Manivitella pemmatoidea*	*Markalius apertus*	*Markalius inversus*	*Microrhabdulus belgicus*	*Microrhabdulus decoratus*	*Micula concava*	*Micula decussata*	*Micula murus*	*Micula prinsii*	*Neocrepidolithus watkinsii*	*Nephrolithus frequens*
CC24/CC 25a/b	14R-1, 140-142	845.80	A	M				R					F								F																	C		F					
	14R-2, 16-18	846.06	A	M			F				F			F		F				F	F	F						F						F			F		C					
	14R-2, 84-85	846.74	A	M			F	F					F								C			F							F						F	C		C				
	14R-2, 85-86	846.75	A	M			F	F					F								C			F							F						F	C		C				
	14R-2, 114-115	847.04	A	M			F	F					F								C												F					F	F	F				
	14R-2, 115-116	847.05	B	B																																								
CC23b	14R-3, 19-21	847.59	A	M			F						C								C										F						F	C		C				
	14R-3, 52-54	847.92	A	P									C																		F						F	C	F	C				
	14R-3, 139-141	848.79	A	M			F						C								C	F									F			F				F	F	F				
	14R-4, 05-07	848.95	A	P									C						R												R							F	F	F				
	14R-4, 69-72	849.59	A	P									C																		F								F					
	14R-4, 110-113	850.01	A	M				F		F											C																	F		F				
	14R-5, 06-08	850.46	A	M			F	F				F	C			F					C							F			F		F				F	F	F	C				
	14R-5, 59-61	850.99	A	P									C								F							F									F		C	C				
	14R-6, 42-44	851.82	A	M									C									F								F								F	C	C				
	15R-1, 51-52	854.51	A	M		F	F	F		F			C			F					C							F						F			F	C	C	C				
	15R-1, 53-55	854.53	A	P			F						C			F					C				F												F	F	C	C				
	15R-1, 97-100	854.97	A	P			F									F					C	F						F									F	F		F				
	15R-1, 97-98	854.98	B	B																																								
	15R-1, 99-100	854.99	A	M			F						F								C					F		F			F		F				F	F	F	C				
CC23a	15R-1, 138-141	855.38	A	M				F		C			C								C										F		F				C	F	F	F				
	15R-2, 33-36	855.83	A	M			F			F			C								F	F			F			F										C	C	C				
	15R-2, 71-72	856.21	B	B																																								
	15R-2, 73-75	856.23	A	M		F	F	F		C			F			C					C					F		C						F				F		C				
	15R-2, 143-146	856.93	A	M			F	F		C			C								C					F		F			C		C					C	C	C				
CC22	15R-3, 19-21	857.19	VA	M			F	C		C			F			F					C					F	F										C	C	C	C				
	15R-3, 77-79	857.77	VA	M			C			C		F	F			F					C					F	F	C			F		F					F		C				
	15R-3, 128-129	858.28	VA	M	F		F			C			C			C					C					F	F	F			F							C	C	C				
	15R-3, 129-130	858.29	VA	M			F	F		F			C			C	F				A	C				F	F										C	F	F	F				
	15R-4, 03-06	858.53	A	M				F		F			C			F					F						F			F	F							F	C	C				
	15R-4, 46-48	858.96	A	M	F					F			C								C	F				F		F					F					F	C	C				
	16R-1, 30-31	863.90	A	M			F			F			F								C					F		F					F					C	C	F				
	16R-1, 44-45	864.04	VA	M	F			C		F			C			F					C					F		F			F						F	C	C	C				
	16R-1, 75-76	864.35	A	M			F	C		F			C			F	F				C					F		F		F							F	C		F				
	16R-1, 76-77	864.36	A	M		F	F	F					C			F					C							F					F					F		F				
	16R-1, 142-144	865.02	A	P			F	F		F			F			F					F	F									F		F				F			F				
	16R-2, 03-04	865.13	B	B																																								
	16R-2, 38-41	865.48	A	P						C			C								F	F									F		F					C	C	F				

Notes: Abundance: A = abundant, C = common, F = few, S = single, B = barren. Preservation: M = moderate, P = poor.

Table T5 (continued).

Nannofossil zones/ subzones Sissingh (1977)	Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	*Percivalia fenestrata*	*Petrarhabdus copulatus*	*Prediscosphaera cretacea*	*Prediscosphaera ponticula*	*Prediscosphaera spinosa*	*Prediscosphaera stoveri*	*Quadrum gartneri*	*Reinhardtites anthophorus*	*Reinhardtites levis*	*Repagulum parvidentatum*	*Retecapsa angustiforata*	*Retecapsa crenulata*	*Rhagodiscus angustus*	*Sollasites horticus*	*Staurolithites angustus*	*Staurolithites imbricatus*	*Staurolithites mielnicensis*	*Tetrapodorhabdus decorus*	*Tetrapodorhabdus* spp.	*Thoracosphaera operulata*	*Thoracosphaera* spp.	*Tranolithus orionatus*	*Tranolithus phacelosus*	*Uniplanarius gothicus*	*Uniplanarius sissinghii*	*Uniplanarius trifidus*	*Watznaueria barnesae*	*Zeughrabdotus diplogrammus*
CC24/CC 25a/b	14R-1, 140-142	845.80	A	M												F															C	
	14R-2, 16-18	846.06	A	M			F			F					F	F	C			F		F									C	
	14R-2, 84-85	846.74	A	M			F									C	F		F											F	C	
	14R-2, 85-86	846.75	A	M			F						F			F	F													F	C	
	14R-2, 114-115	847.04	A	M			C			F					F	F						F									C	F
	14R-2, 115-116	847.05	B	B																												
CC23b	14R-3, 19-21	847.59	A	M			F								F	C	F												F	F	C	
	14R-3, 52-54	847.92	A	P											F	F													F	C	C	
	14R-3, 139-141	848.79	A	M			C									C	F												F	F	C	
	14R-4, 05-07	848.95	A	P			F									C	R												R	F	C	
	14R-4, 69-72	849.59	A	P												F													F	C		
	14R-4, 110-113	850.01	A	M			F									C													F	F	C	
	14R-5, 06-08	850.46	A	M			C					F			F	C	F					F							F	F	C	F
	14R-5, 59-61	850.99	A	P												F													F	F	C	
	14R-6, 42-44	851.82	A	M												F												F	F	C	C	
	15R-1, 51-52	854.51	A	M			C		F		F				F	C	F					F				F			F	F	C	
	15R-1, 53-55	854.53	A	P			F					F			F	C						F						F		C	C	
	15R-1, 97-100	854.97	A	P			F					F				C	F					F					F				C	
	15R-1, 97-98	854.98	B	B																												
	15R-1, 99-100	854.99	A	M			C								F	C	F					F						F		F	C	
CC23a	15R-1, 138-141	855.38	A	M			C		F			F			F	C						F						F	R	C	C	
	15R-2, 33-36	855.83	A	M			F									C												F		F	C	
	15R-2, 71-72	856.21	B	B																												
	15R-2, 73-75	856.23	A	M			C		C			F				C			F		F										C	F
	15R-2, 143-146	856.93	A	M				F							F	C	F											F		C	C	
CC22	15R-3, 19-21	857.19	VA	M	F		C		F				F		F	C				F		F			F			F		F	C	F
	15R-3, 77-79	857.77	VA	M	F	F	C		C			F				F	F		F			F	F					F		C	C	F
	15R-3, 128-129	858.28	VA	M	R		C		F	F		F			F	C		R	F						R	F		R	C	F	C	F
	15R-3, 129-130	858.29	VA	M			C		C			F	R		F	F						F				F			F	C	C	C
	15R-4, 03-06	858.53	A	M											F													F	F	C	C	F
	15R-4, 46-48	858.96	A	M								F				F												C		C	C	
	16R-1, 30-31	863.90	A	M		F	C		F			F			F	F						F				F		F	F	F	C	F
	16R-1, 44-45	864.04	VA	M	F		C					F			C	C	F	F								F		F	F	F	C	F
	16R-1, 75-76	864.35	A	M			C		C			F		F	F	C	F					F				F	F				C	F
	16R-1, 76-77	864.36	A	M		F	C					F			F										F			F			C	F
	16R-1, 142-144	865.02	A	P		F			F							F												F		F	C	F
	16R-2, 03-04	865.13	B	B																												
	16R-2, 38-41	865.48	A	P			F									F												F		F	C	

Table T6. Datums used to construct the age vs. depth plot for Hole 1068A.

Datum	Datum type	Sample containing datum: Core, section, interval (cm)	Sample containing datum: Depth (mbsf)	Next adjacent sample: Core, section, interval (cm)	Next adjacent sample: Depth (mbsf)	Age (Ma)	Median depth (mbsf)
		173-1068A-		173-1068A-			
Fasciculithus tympaniformis	LO	8R-6, 99-100	787.39	8R-6, 19-20	786.59	55.33	786.99
Discoaster multiradiatus	FO	9R-6, 28-29	796.28	9R-6, 121-123	797.21	56.20	796.75
Discoaster nobilis	FO	10R-3, 123-125	802.33	11R-1, 05-06	807.75	56.90	805.04
Heliolithus riedellii	FO	11R-2, 08-09	809.28	11R-2, 44-45	809.64	57.30	809.46
Discoaster mohleri	FO	11R-3, 15-17	810.85	11R-3, 36-37	811.06	57.50	810.96
Heliolithus kleinpellii/Sphenolithus anarrhopus	FO	11R-4, 35-36	812.55	11R-4, 120-122	813.40	58.40	812.98
Fasciculithus tympaniformis	FO	11R-CC, 03-04	815.41	12R-5, 35-36	823.65	59.70	819.53
Ellipsolithus macellus	FO	13R-2, 20-21	828.60	13R-2, 25-27	828.65	62.20	828.63
Cruciplacolithus primus	FO	13R-5, 78-79	833.68	13R-5, 93-96	833.83	64.80	833.76
K/T boundary		13R-6, 69-70	835.00	13R-6, 52-53	834.92	65.00	834.96
Micula murus	FO	15R-4, 10-11	850.40	15R-4, 12-13	850.41	68.50	850.41

Notes: FO = first occurrence, LO = last occurrence. Ages for the nannofossil datums were obtained from Berggren et al. (1995).

Table T7. Data used to determine mass accumulation rates for Hole 1068A.

MAR ($g/cm^2/k.y.$)	Thickness (cm)	Bulk density (g/cm^3)	Porosity (wt%)	Time (10^3 yr)	Bottom depth (mbsf)	Top depth (mbsf)	Bottom age (Ma)	Top age (Ma)
3.73	593.00	2.30	0.22	330	787.39	781.46	55.33	55.00
2.20	889.00	2.36	0.20	870	796.28	787.39	56.20	55.33
1.71	605.00	2.24	0.26	700	802.33	796.28	56.90	56.20
3.42	695.00	2.24	0.27	400	809.28	802.33	57.30	56.90
1.55	157.00	2.25	0.27	200	810.85	809.28	57.50	57.30
0.33	170.00	2.10	0.35	900	812.55	810.85	58.40	57.50
0.37	286.00	2.05	0.36	1300	815.41	812.55	59.70	58.40
0.86	1319.00	2.03	0.39	2500	828.60	815.41	62.20	59.70
0.37	508.00	2.05	0.37	2300	833.68	828.60	64.50	62.20
0.66	154.00	2.36	0.20	500	835.22	833.68	65.00	64.50
0.96	1518.00	2.40	0.19	3500	850.40	835.22	68.50	65.00

Note: MAR = mass accumulation rate.

Table T8. Datums used to construct the age vs. depth plot for Hole 1069A.

Datum	Datum type	Sample containing datum: Core, section, interval (cm)	Sample containing datum: Depth (mbsf)	Next adjacent sample: Core, section, interval (cm)	Next adjacent sample: Depth (mbsf)	Age (Ma)	Median depth (mbsf)
		173-1069A-		173-1069A-			
Discoaster diastypus	FO	7R-5, 1-3	782.81	7R-5, 18-19	782.98	55.00	782.90
Fasciculithus tympaniformis	LO	7R-5, 18-19	782.98	7R-5, 1-3	782.81	55.33	782.90
Discoaster multiradiatus	FO	7R-CC, 20-22	784.58	8R-1, 09-11	786.49	56.20	785.54
Discoaster mohleri	FO	8R-2, 70-71	788.60	9R-1, 13-15	796.13	57.50	792.37
Sphenolithus primus	FO	10R-2, 69-71	807.79	10R-2, 137-140	808.47	60.60	808.13
Ellipsolithus macellus	FO	11R-1, 128-129	816.58	11R-2, 19-21	816.99	62.20	816.79
Cruciplacolithus primus	FO	12R-1, 62-64	825.62	12R-1, 113-114	826.13	64.80	825.88
K/T boundary		12R-1, 120-122	826.20	12R-1, 113-114	826.13	65.00	826.17
Micula prinsii	FO	12R-5, 135-137	832.35	12R-6, 20-21	832.70	66.00	832.53
Micula murus	FO	14R-1, 77-79	845.17	14R-1, 140-142	845.80	68.50	845.49
Uniplanarius trifidus	LO	14R-3, 19-21	847.59	14R-2, 115-116	847.05	71.30	847.32
Broinsonia parca constricta	LO	15R-1, 138-141	855.38	15R-1, 99-100	854.99	74.60	855.19
Eiffellithus eximius	LO	15R-3, 19-21	857.19	15R-2, 143-141	856.93	75.30	857.06

Notes: FO = first occurrence; LO = last occurrence. Ages for the nannofossil datums were obtained from Berggren et al. (1995).

Table T9. Data used to determine mass accumulation rates for Hole 1069A.

MAR ($g/cm^2/k.y.$)	Thickness (cm)	Bulk density (g/cm^3)	Porosity (wt%)	Time (10^3 yr)	Bottom depth (mbsf)	Top depth (mbsf)	Bottom age (Ma)	Top age (Ma)
0.55	107	2.08	0.37	330	782.98	781.91	55.33	55.00
0.29	160	2.01	0.40	870	784.58	782.98	56.20	55.33
0.46	402	1.94	0.44	1300	788.60	784.58	57.50	56.20
1.13	1919	2.16	0.32	3100	807.79	788.60	60.60	57.50
1.11	879	2.27	0.24	1600	816.58	807.79	62.20	60.60
0.35	401	2.26	0.27	2300	820.59	816.58	64.50	62.20
2.75	561	2.50	0.05	500	826.20	820.59	65.00	64.50
1.21	615	2.25	0.27	1000	832.35	826.20	66.00	65.00
1.12	1282	2.38	0.20	2500	845.17	832.35	68.50	66.00
0.16	242	2.15	0.33	2800	847.59	845.17	71.30	68.50
0.52	779	2.40	0.20	3300	855.38	847.59	74.60	71.30
0.63	181	2.60	0.15	700	857.19	855.38	75.30	74.60

Note: MAR = mass accumulation rate.

Plate P1. Magnification for specimens is 2000×. Light micrography: PH = phase-contrast light, PL = plain transmitted light, XP = cross-polarized light. **1–4.** *Fasciculithus thomasii,* Sample 173-1068A-8R-6, 19–20 cm, PH (1), PL (2), and XP (3, 4). **5, 10.** *Discoaster multiradiatus,* Sample 173-1067A-13R-1, 64–65 cm, PH (5) and PL (10). **6–9.** *Fasciculithus involutus,* Sample 173-1068A-10R-1, 126–127 cm, PH (6), PL (7), and XP (8, 9). **11–14.** *Ellipsolithus macellus,* Sample 173-1068A-9R-6, 121–123 cm, PH (11), PL (12), and XP (13, 14). **15, 20, 25.** *Coccolithus robustus* Sample 173-1068A-9R-6, 121–123 cm, PH (15), PL (20), and XP (25). **16–19.** *Fasciculithus aubertae*, Sample 173-1068A-8R-6, 19–20 cm, PH (16), PL (17), and XP (18, 19). **21–24.** *Fasciculithus tympaniformis,* Sample 173-1068A-10R-3, 123–125 cm, PH (21), PL (22), and XP (23, 24).

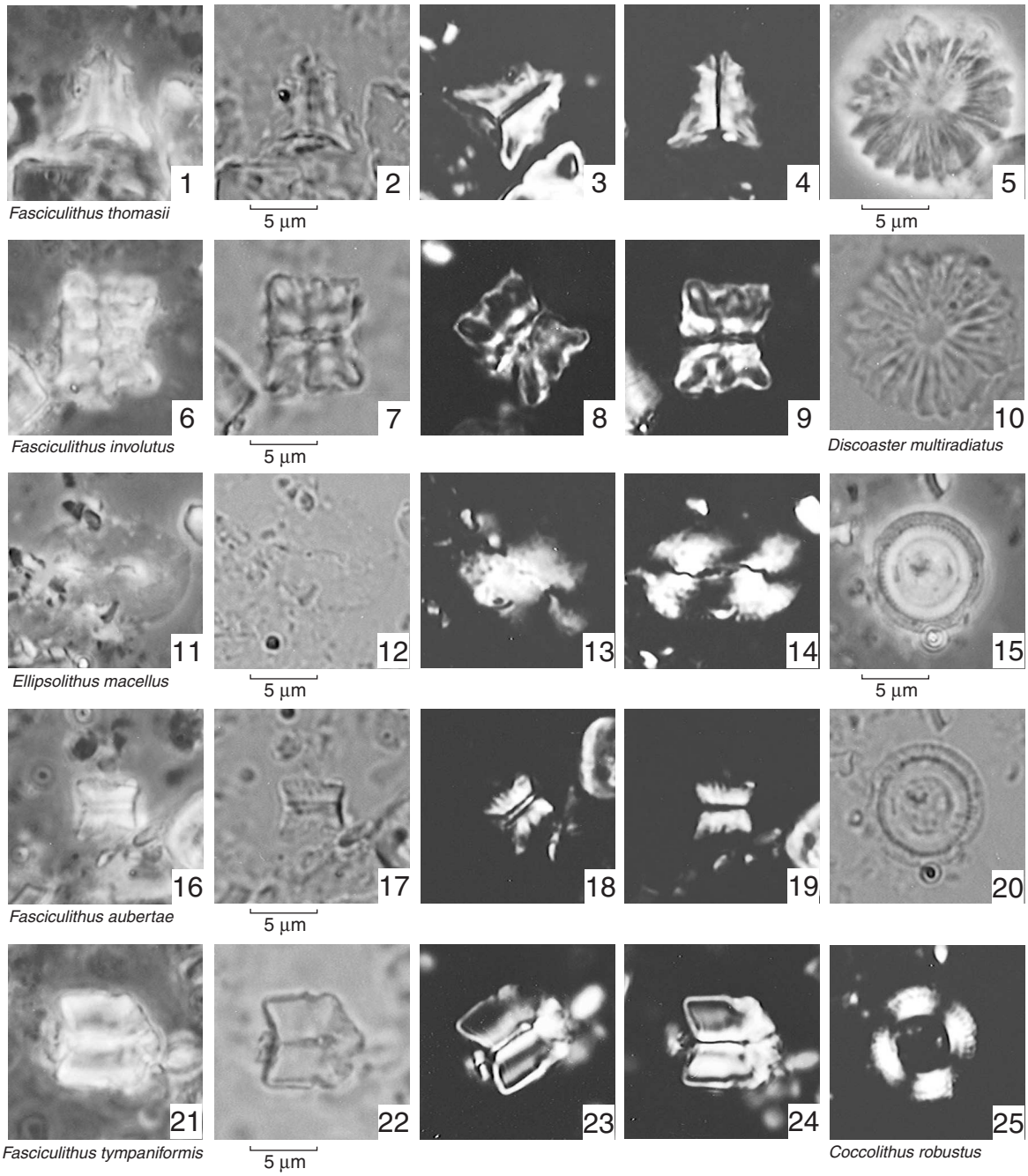


Plate P2. Magnification for light micrography is 2200×; magnification is indicated on electron micrography (SEM) specimens. Light micrography: PH = phase-contrast light, PL = plain transmitted light, XP = cross-polarized light. **1.** *Placozygus sigmoides,* Sample 173-1068A-11R-3, 70–73 cm, SEM. **2.** *Coccolithus pelagicus,* Sample 173-1068A-11R-3, 70–72 cm, SEM. **3.** *Toweius tovae,* Sample 173-1068A-11R-3, 70–72 cm, SEM. **4.** *Toweius eminens,* Sample 173-1068A-11R-3, 70–72 cm, SEM. **5.** *Neochiastozygus perfectus*(?), Sample 173-1068A-11R-3, 70–72 cm, SEM. **6, 7.** *Fasciculithus tympaniformis,* Sample 173-1068A-11R-3, 70–72 cm, PL (6) and XP (7). **8–10.** *Discoaster bramletteii,* Sample 173-1068A-11R-2, 118–120 cm, PL (8), XP (9), and PH (10). **11–13.** *Heliolithus kleinpellii,* Sample 173-1068A-10R-3, 123–125 cm, PH (11), PL (12), and XP (13).

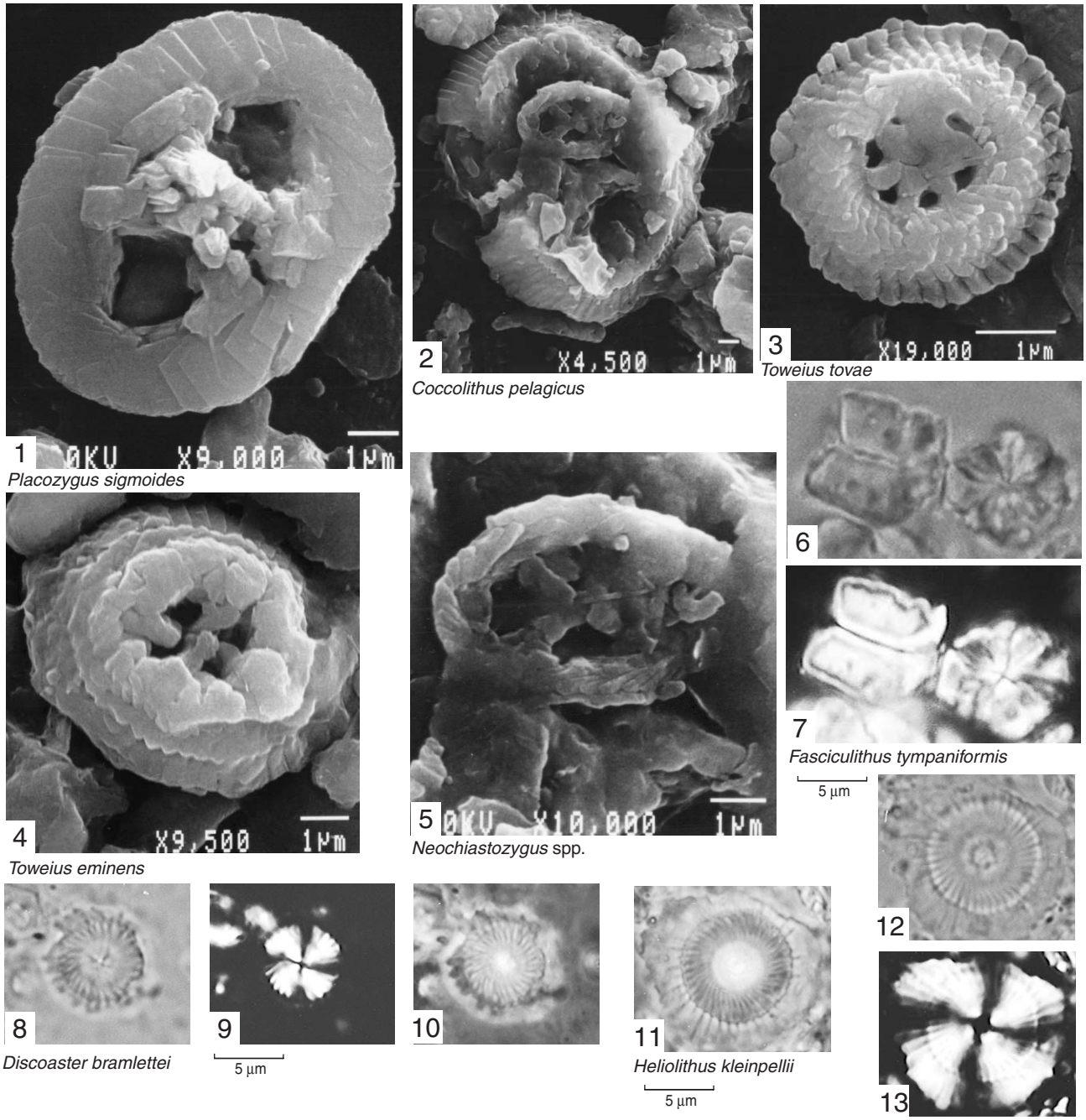


Plate P3. Magnification for light micrography is 2200×. Light micrography: PH = phase-contrast light, PL = plain transmitted light, XP = cross-polarized light, SEM = scanning electron micrography. **1, 2.** *Arkhangelskiella cymbiformis*, Sample 173-1068A-15R-3, 71–73 cm, PH (1) and XP (2). **3, 4.** *Prediscosphaera cretacea,* Sample 173-1068A-15R-3, 34–35 cm, PH (3) and XP (4). **5, 10.** *Biscutum constans*, Sample 173-1069A-12R-3, 27–29 cm, XP (5) and PH (10). **6, 7.** *Retecapsa crenulata*, Sample 173-1068A-15R-2, 92–93 cm, PH (6) and XP (7). **8, 9.** *Cylindralithus nudus*, Sample 173-1069A-12R-4, 4–6 cm, PH (8) and XP (9). **11, 14.** *Staurolithites angustus,* Sample 173-1069A-12R-3, 27–29 cm, PH (11) and XP (14). **12, 13.** *Markalius inversus*, Sample 173-1068A-14R-1, 6–8 cm, PH (12) and XP (13). **15, 16.** *Prediscosphaera stoveri*, Sample 173-1069A-12R-3, 134–136 cm, PH (15) and XP (16). **17.** *Rotelapillus laffittei,* Sample 173-1069A-15R-2, 71–75 cm, SEM, magnification indicated. **18, 19.** *Cylindralithus duplex,* Sample 173-1069A-12R-2, 99–100 cm, PH (18) and XP (19). **20–22.** *Ahmuellerella octoradiata*, Sample 173-1068A-14R-7, 35–36 cm, PH (20) and XP (21, 22).

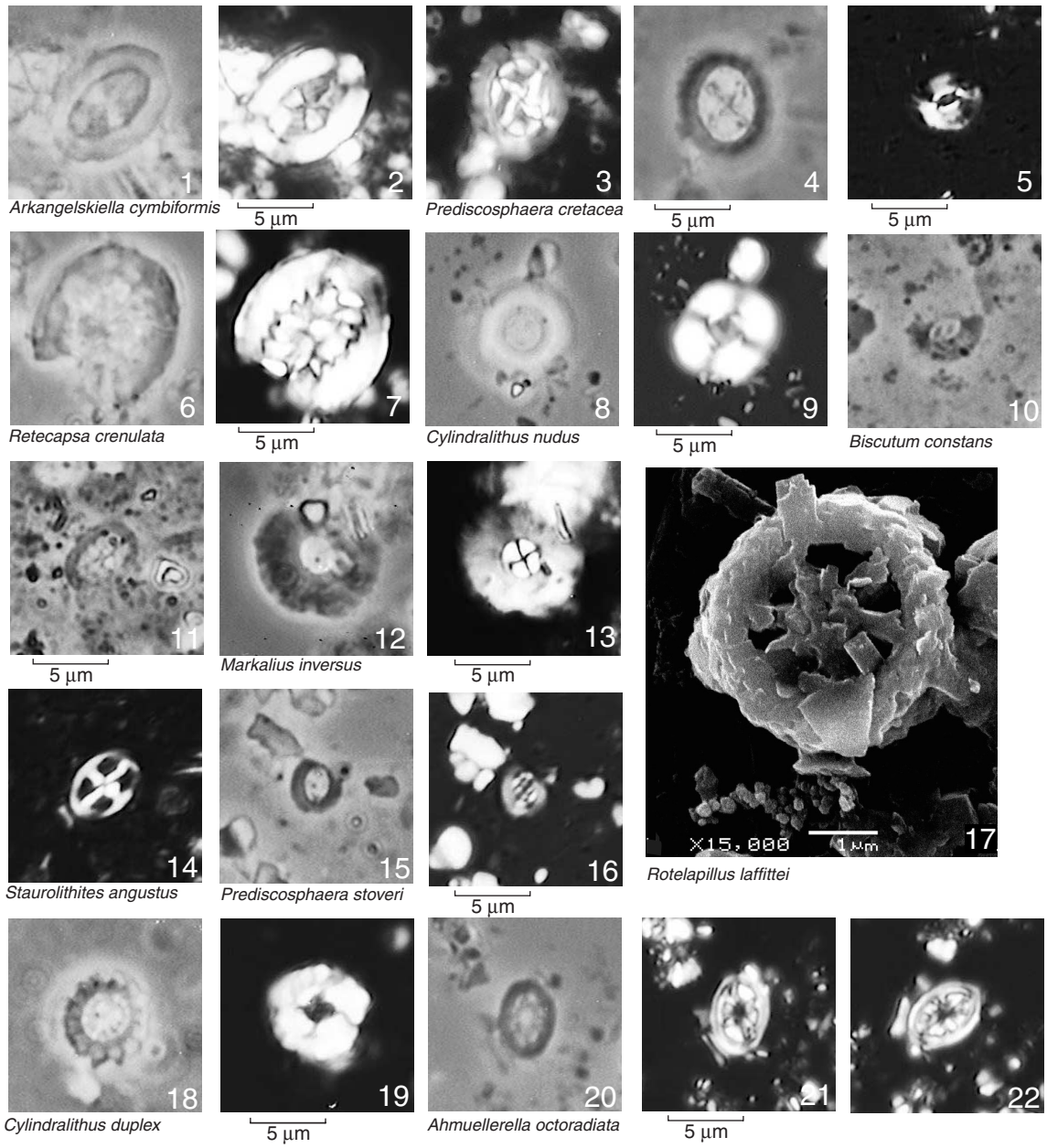
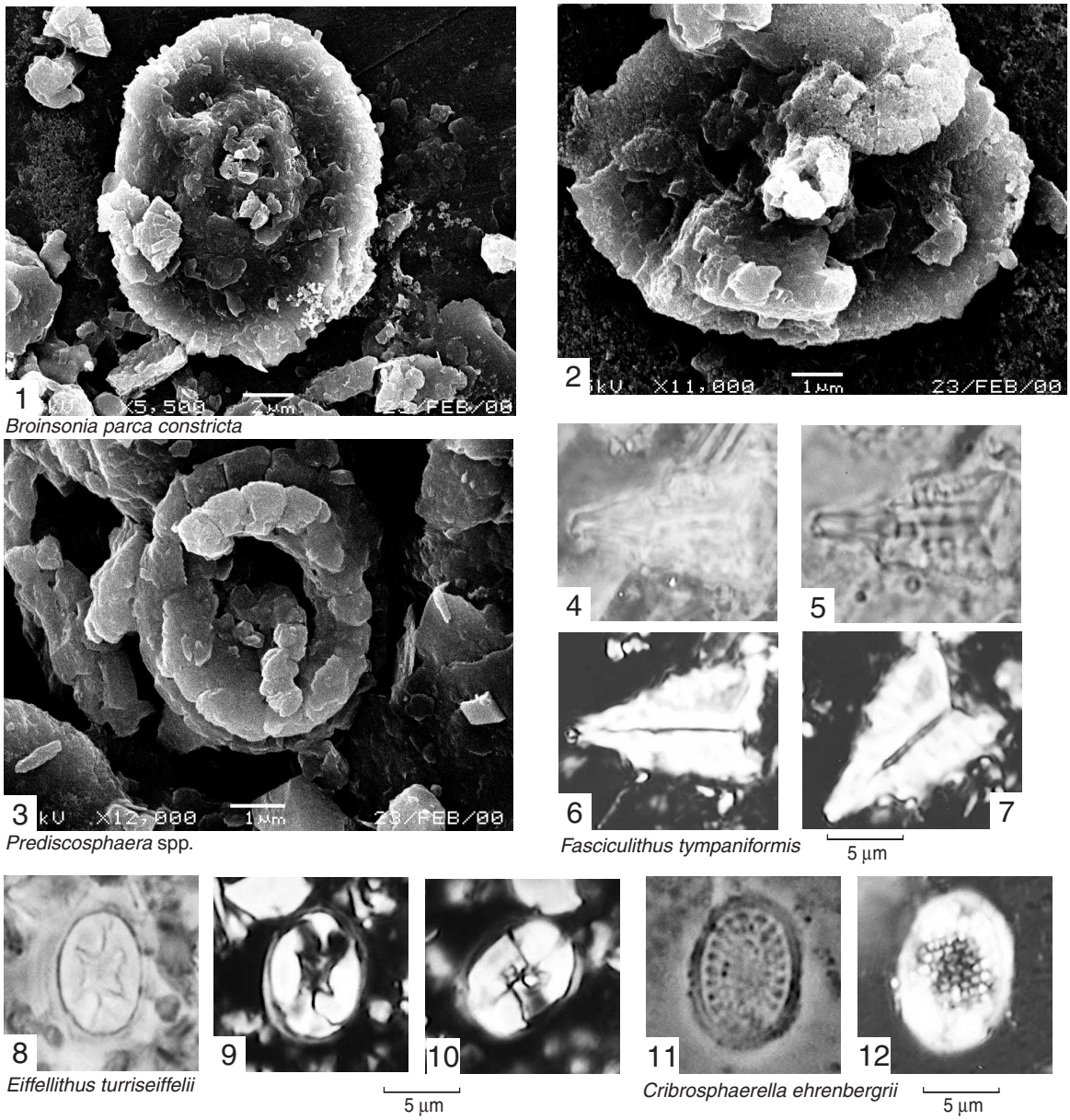


Plate P4. Magnification for light micrography is 2200×; magnification for scanning electron micrography (SEM) specimens is indicated. Light micrography: PH = phase-contrast light, PL = plain transmitted light, XP = cross-polarized light. **1.** *Broinsonia parca constricta,* Sample 173-1069A-15R-2, 71–75 cm, SEM. **2.** Unknown placolith used to illustrate preservation as seen in Sample 173-1069A-15R-2, 71–75 cm, SEM. **3.** *Prediscosphaera* spp., Sample 173-1069A-15R-2, 71–75 cm, SEM. **4–7.** *Fasciculithus schaubii,* Sample 173-1068A-8R-6, 19–20 cm, PH (4), PL (5), and XP (6, 7). **8–10.** *Eiffellithus turriseiffelii,* Sample 173-1068A-14R, 121–122 cm, PH (8) and XP (9, 10). **11, 12.** *Cribrospaerella ehrenbergii,* Sample 173-1069A-12R-3, 27–29 cm, PH (11) and XP (12).



Broinsonia parca constricta

Prediscosphaera spp.

Fasciculithus tympaniformis

Eiffellithus turriseiffelii

Cribrosphaerella ehrenbergrii