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Pleistocene calcareous nannofossil stratigraphy for ODP Leg 177 (Atlantic sector of the Southern Ocean)

José-Abel Flores [a,*], Maria Marino [b]

[a] Universidad de Salamanca, Departamento de Geología, 37008 Salamanca, Spain
[b] Universita degli Studi di Bari, Bari, Italy

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Abstract

Seven Ocean Drilling Program (ODP) sites recovered during ODP Leg 177 in the Atlantic sector of the Southern Ocean were analyzed to study the Pleistocene calcareous nannofossil record. Calcareous nannofossil events previously described from intermediate and low latitudes were identified and calibrated with available geomagnetic and stable isotope stratigraphic data. In general, Pleistocene southern high latitude calcareous nannofossil events show synchronicity with those observed from warm and temperate latitudes. The first occurrence (FO) of *Emiliania huxleyi* and the last occurrence (LO) of *Pseudoemiliania lacunosa* are observed in marine isotope stages (MIS) 8 and 12, respectively. A reversal in abundance between *Gephyrocapsa muellerae* and *E. huxleyi* is observed at MIS 5. MIS 6 is characterized by an increase in *G. muellerae* and MIS 7 features a dramatic decrease in the proportion of *Gephyrocapsa caribbeanica*. This latter species began to increase its proportions from MIS 14 to 13. The LO of *Reticulofenestra asanoi* is observed within subchron C1r.1r and the FO of *R. asanoi* occurs at the top of C1r.2r. A re-entry of medium-sized *Gephyrocapsa* can be identified in some cores during subchron C1r.1n. The LO of large morphotypes of *Gephyrocapsa* is well correlated through the studied area, and occurs during the middle-low part of subchron C1r.2r, synchronous with other oceanic regions. The FO of *Calcidiscus macintyrei* and FO of medium-sized *Gephyrocapsa* occur in the studied area close to 1.6 Ma.

Keywords: Southern Ocean; Pleistocene; calcareous nannofossils; biostratigraphy; isotope stratigraphy; geomagnetic stratigraphy; Ocean Drilling Program

1. Introduction

During the last decades, calcareous nannofossil biostratigraphy of Pleistocene sediments has shown great potential, with a clear relationship with paleoceanographic studies. Examples of biochronological data include Thierstein et al. (1977), Gartner (1977), Pujos-Lamy (1977), Matsuoka and Okada (1990), Giraudeau and Pujos (1990), Wei (1993), Raffi et al. (1993), Weaver and Thomson (1993), Pujos and Giraudeau (1993), Wells and Okada (1997), Hine and Weaver (1998), Bollmann et al. (1998) amongst others. However, most of these studies focus on middle and low latitude sections and only a few of them are based

* Corresponding author. Tel.: +34-923-294497; Fax: +34-923-294514.
E-mail address: flores@usal.es (J.-A. Flores).

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on material recovered in the Southern Ocean, which plays an important role in climatic and oceanic evolution (Kennett and Barron, 1992; Shipboard scientific Party, 1999). Most of the stratigraphic studies carried out on Pleistocene material from the Southern Ocean in general report low sedimentation rates and/or hiatuses of different stratigraphic extents (Wise and Wind, 1977; Wise, 1983; Crux, 1991; Wei and Wise, 1992). In other cases, at these latitudes the calcareous plankton is diluted by siliceous organisms or is affected by dissolution. Consequently, the number of sections available is restricted. To these factors should be added restrictions in ecological calcareous nannofossil marker species.

The Ocean Drilling Program (ODP) Leg 177 (Southern Ocean Paleoceanography) offered the opportunity to study the evolution of calcareous nannofossil assemblages in the Southern Ocean, covering different environmental sectors. Additionally, an excellent geomagnetic record and siliceous microfossil biostratigraphy, together with a high resolution isotopic record in selected intervals, permits us to correlate and/or calibrate a number of important calcareous nannofossil events. The present study focuses on the identification and calibration of calcareous nannofossil biostratigraphic data in order to improve the stratigraphic framework for southern high latitude paleoceanographic studies.

2. Material and methods

2.1. Core location and lithology

During ODP Leg 177 seven sites were drilled. These sites are situated in the Atlantic sector of the Southern Ocean on a transect that starts close to the Subtropical Front, and crosses the Subantarctic and Polar fronts. Location and general oceanographic features are indicated in Fig. 1 and Table 1. Lithological details are given in Figs. 2–8 and 9. The lithology varies from pure calcareous nannofossil ooze to pure diatom ooze, with variable proportions of terrigenous material. A detailed description of sedimentology, physical properties and additional characteristics can be found in Gersonde et al. (1999). The location of calcareous nannofossil events and other stratigraphic information is given as meters composite depth (mcd), based on the correlation carried out on board the Joides *Resolution* vessel (Shipboard Scientific Party, 1999).

2.2. Calcareous nannofossil preparation technique and estimation of abundance

Smear slides were made directly from unprocessed samples and examined with a cross-polarized light microscope at 1000×.

The total abundance of calcareous nannofossils

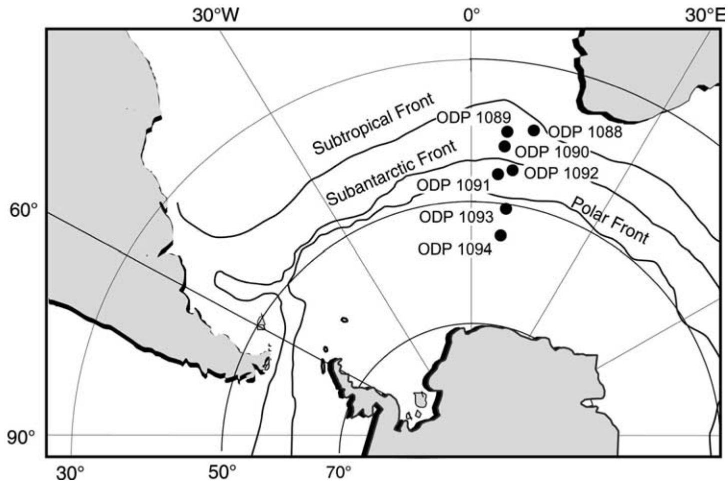


Fig. 1. Location of cores used in this study and main oceanographic features.

Table 1
Site locations of ODP Leg 177 sites

Hole	Latitude	Longitude	Water depth (m)
1088A	41°8.163′S	13°33.770′E	2082.2
1088B	41°8.163′S	13°33.770′E	2081.2
1088C	41°8.165′S	13°33.772′E	2082.9
1089A	40°56.187′S	9°53.645′E	4619.3
1089B	40°56.182′S	9°53.640′E	4623.8
1089C	40°56.169′S	9°53.637′E	4621.2
1089D	40°56.187′S	9°53.632′E	4617.5
1090A	42°54.821′S	8°53.984′E	3698.6
1090B	42°54.821′S	8°53.984′E	3699.4
1090C	42°54.812′S	8°53.990′E	3703.7
1090D	42°54.814′S	8°53.998′E	3702.1
1090E	42°54.818′S	8°53.994′E	3704.2
1091A	47°5.681′S	5°55.120′E	4360.5
1091B	47°5.682′S	5°55.125′E	4356.6
1091C	47°5.689′S	5°55.166′E	4366.4
1091D	47°5.689′S	5°55.166′E	4366.8
1091E	47°5.695′S	5°55.152′E	4366.2
1092A	46°24.708′S	7°4.792′E	1976.3
1092B	46°24.705′S	7°4.794′E	1972.9
1092C	46°24.697′S	7°4.796′E	1973.3
1092D	46°24.704′S	7°4.787′E	1972.9
1093A	49°58.596′S	5°51.924′E	3623.9
1093B	49°58.592′S	5°51.933′E	3630.6
1093C	49°58.593′S	5°51.946′E	3631.7
1093D	49°58.591′S	5°51.934′E	3623.7
1093E	49°58.578′S	5°51.933′E	3623.7
1093F	49°58.578′S	5°51.933′E	3623.7
1094A	53°10.812′S	5°7.824′E	2807.6
1094B	53°10.824′S	5°7.830′E	2806.7
1094C	53°10.828′S	5°7.808′E	2807.3
1094D	53°10.816′S	5°7.821′E	2807.7

for each sample was estimated as follows: V (very abundant) = > 100 nannoliths per field of view; A (abundant) = 10–100 nannoliths per field of view; C (common) = 1–10 nannoliths per field of view; R (rare) = < 1 nannolith per 10 fields of view; B (barren) = calcareous nannofossils absent.

Additionally, the abundance of calcareous nannofossil species in each sample was estimated according to: D (dominant) = > 50% of the total assemblage; A (abundant) = 10–50% of the total assemblage; C (common) = 1–10% of the total assemblage; F (few) = 0.1–1% of the total assemblage; R (rare) = < 0.1% of the total assemblage.

As regards nannofossil preservation, etching and overgrowth are the most important features. In order to establish a ranking of preservation we followed previous coding systems, such as that used by Shipboard Scientific Party (1999), considering both effects (etching and overgrowth): G = good (little or no evidence of dissolution and/or secondary overgrowth of calcite; diagnostic characters fully preserved); M = moderate (dissolution and/or secondary overgrowth; partially altered primary morphological characteristics; however, nearly all specimens can be identified at species level); P = poor (severe dissolution, fragmentation, and/or secondary overgrowth with primary features largely destroyed; many specimens cannot be identified at species level and/or generic level).

Data concerning calcareous nannofossil abundance and preservation from different samples are given in the Appendix, Tables A1–A7. These tables only include the species used in the definition of biostratigraphic events.

The slides are stored in the archives of the Micropaleontological Collections of the University of Salamanca and the University of Bari.

3. Calcareous nannofossil taxonomy

The species involved in this study are mainly included within the family Noelaerhabdaceae (reticulofenestrids including the genera *Emiliania*, *Pseudoemiliania*, *Gephyrocapsa* and *Reticulofenestra*) (Thierstein et al., 1977; Pujos-Lamy, 1977; Wei, 1993; Raffi et al., 1993; Weaver and Thomson, 1993). However, the taxonomy of this group is complex and confusing, mainly due to a proliferation of species names and morphotypes. Here we adopted the ideas of Raffi et al. (1993) and Flores et al. (2000) for the morphological features of gephyrocapsids, using coccolith diameter, bridge angle, etc., which are readily identifiable under cross-polarized light. A complete list of the taxa considered is included in the Appendix.

4. Age model

Geomagnetic records are available for all sites except 1088 (Shipboard Scientific Party, 1999; Channell and Stoner, 2002). Boundaries between

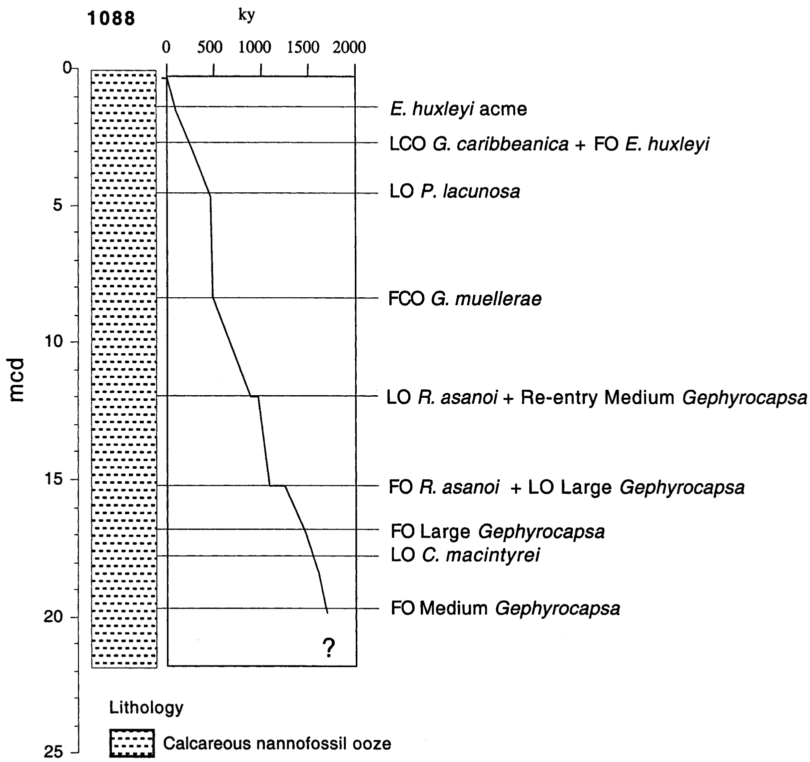


Fig. 2. Pleistocene calcareous nannofossil events identified in ODP Site 1088 and comparison of calcareous nannofossil calibration using the 'expected' nannofossil ages (after Thierstein et al., 1977; Raffi et al., 1993; Wei, 1993; Bollmann et al., 1998; Flores et al., 2000).

geomagnetic units were used to generate age models for the studied sites. Additionally, in Sites 1089 and 1094, between marine isotope stages (MIS) 1 and 12, the age model is refined using stable isotope stratigraphy (Hodell et al., 2001); for Site 1090 we follow the stable isotope stratigraphy of Venz and Hodell (2002). Between the studied cores the degree of resolution and availability of chronological data are rather variable. In Site 1088 we have followed a direct calibration with the calcareous nannofossil events identified in middle and low latitudes (Thierstein et al., 1977; Raffi et al., 1993; Wei et al., 1993; Bollmann et al., 1998), due to the absence of paleomagnetic and isotopic data. In some cases we have observed discrepancies in the age assignment. Sampling resolution, differential preservation (dissolution), dilution by the siliceous matrix, absence of nannofossils, and diachronism can explain these inconsistencies.

5. Results

The results of our analyses are compiled in the Appendix, Tables A1–A7. In these tables only species involved in the stratigraphic definition of events and significant samples are considered. The position and calibration of the calcareous nannofossil events identified in the sites are given in Tables 2–8.

According to the adopted age model, a correlation between event and isotope stage is also proposed. A comparison between the adopted age model, based on geomagnetic and isotope stratigraphy data, and that obtained by comparison of the 'expected' ages using previously calibrated calcareous nannofossil events, is also included in Figs. 2–8.

It is important to point out the great differences in sedimentation rates in the studied area (Shipboard Scientific Party, 1999); this also causes dif-

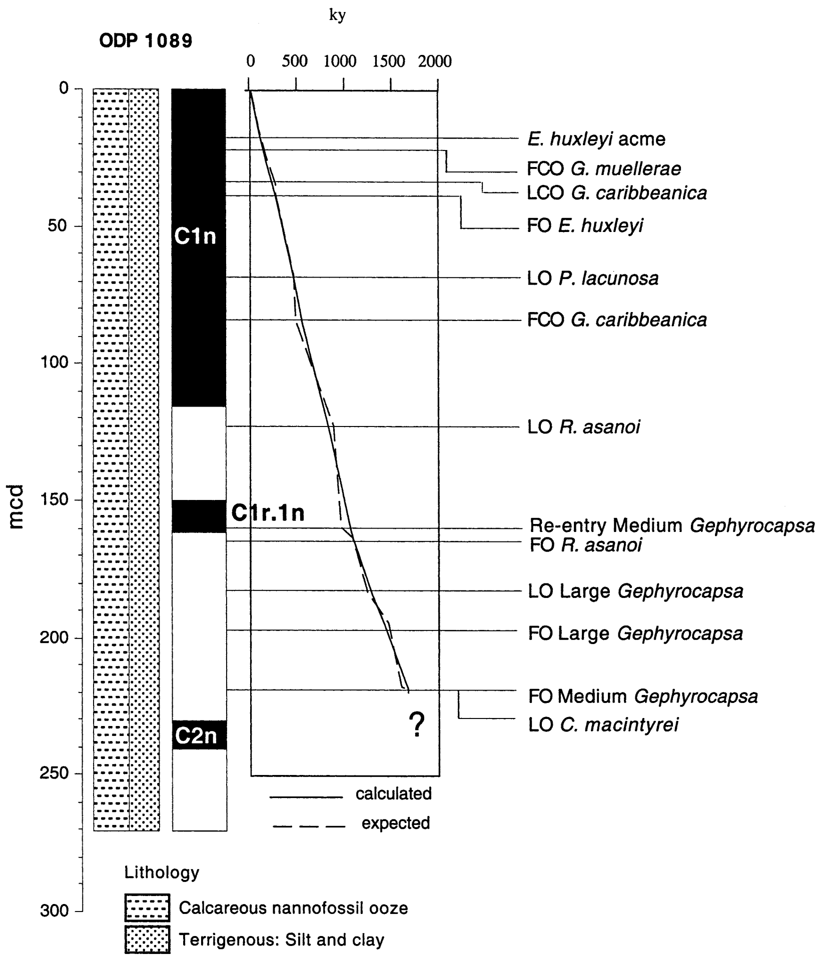


Fig. 3. Pleistocene calcareous nannofossil events identified in ODP Site 1089 and comparison of calcareous nannofossil calibration using the 'expected' nannofossil ages (after Thierstein et al., 1977; Raffi et al., 1993; Wei, 1993; Bollmann et al., 1998; Flores et al., 2000) vs. the geomagnetic and stable isotope events. Isotope data from Hodell et al. (2001). Geomagnetic interpretation by Shipboard Scientific Party (1999) and Channell and Stoner (2002).

ferences in the resolution of events. Additionally, strong dissolution in some intervals, or the absence of calcareous nannofossils in some intervals, precludes the identification of some events.

6. Calcareous nannofossil events (Tables 2–8 and Appendix, Tables A1–A7)

6.1. *Emiliania huxleyi* acme base

The base of the *Emiliania huxleyi* acme is a diachronous event and is difficult to recognize in certain areas of the ocean (Jordan et al., 1996). The meaning of 'acme' or 'zone of dominance' is confusing because in different regions the proportion of *E. huxleyi* may be altered with respect to other species (ecologically controlled), or it may be due to a relative reduction arising from dissolution (Thierstein et al., 1977). Gartner (1977) dated the *E. huxleyi* acme base at 70 kyr, although other authors dated this event between 61 and 40 kyr ago (Gard, 1989; Novacyzk and Baumann, 1992).

In our cores this event in not easy to identify, so we use for this proposal semiquantitative data.

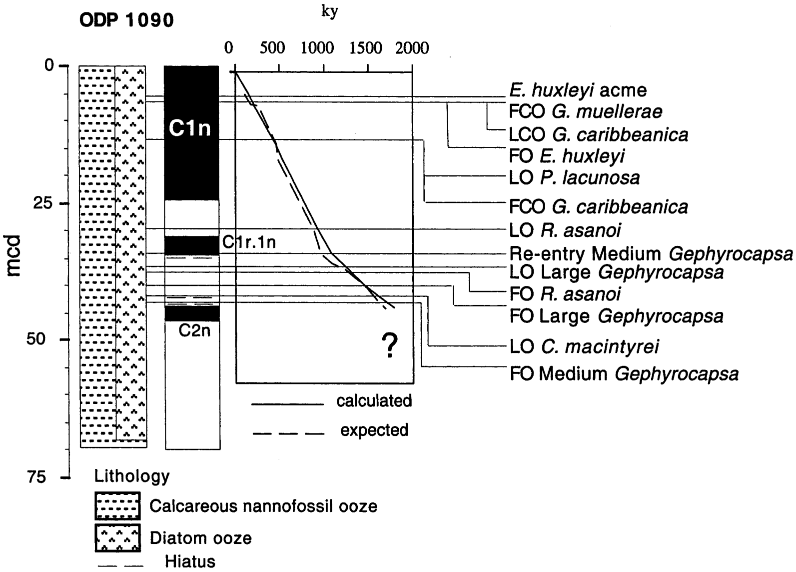


Fig. 4. Pleistocene calcareous nannofossil events identified in ODP Site 1090 and comparison of calcareous nannofossil calibration using the 'expected' nannofossil ages (after Thierstein et al., 1977; Raffi et al., 1993; Wei, 1993; Bollmann et al., 1998; Flores et al., 2000) vs. the geomagnetic and stable isotope events. Isotope data from Venz and Hodell (2002). Geomagnetic interpretation by Shipboard Scientific Party (1999).

In Sites 1089, 1090 and 1092 we observed a clear increase of *Emiliania huxleyi* at ca. 100 kyr (MIS 5), prior to the expected age of the acme event. However, in Site 1089 a clear abundance reversal between *Gephyrocapsa muellerae* and *E. huxleyi* is observed at ca. 70 kyr (Flores et al., in preparation), where *E. huxleyi* represents more than 40% of the total assemblage. This is consistent with the 'Reversal in abundance of *Gephyrocapsa caribbeanica–Emiliania huxleyi*' (= *Gephyrocapsa muellerae–Emiliania huxleyi*) dated at 73–85 kyr by Thierstein et al. (1977). Gard and Crux (1991) identified this event as having occurred at the MIS 4/5 boundary in ODP Site 704, in the Subantarctic of the Atlantic sector. In several areas this event coincides with a regular increase in *E. huxleyi* and is considered to be the base of the *E. huxleyi* acme zone (or zone of dominance).

A more precise quantitative analysis would be necessary to constrain the age of this event. In any case, a drastic increase of *Emiliania huxleyi* occurs within MIS 5. In Sites 1091 and 1093, the increase of *E. huxleyi* occurs at 40–50 kyr, according to the adopted age model. In the case of Site 1091, we interpret a hiatus, based on the record of associated events (such as the first occurrence (FO) of *E. huxleyi*, see below). In Site 1093 the inconsistency is due to the absence of this taxon in an interval dominated by diatoms.

6.2. First occurrence of *Emiliania huxleyi*

The FO of *Emiliania huxleyi* was dated by Thierstein et al. (1977) at 268 kyr (late in MIS 8). In Sites 1089, 1090, 1092, 1093 and 1094 this event is relatively easy to detect, although sometimes dissolution may make identification difficult. The event is close to the expected age (ca. 260 kyr) at the top of MIS 8. Small discrepancies may be due to the low accuracy of the age model adopted (e.g. Site 1093, where only a few control points exist).

Between the FO of *Emiliania huxleyi* and the acme of this species, we recognize two useful events: the first common occurrence (FCO; continuous record after a significant increase in abundance) of *Gephyrocapsa muellerae* was reported in MIS 6 (at ca. 170 kyr) and the last common occurrence (LCO; dramatic reduction) of *Gephyro-*

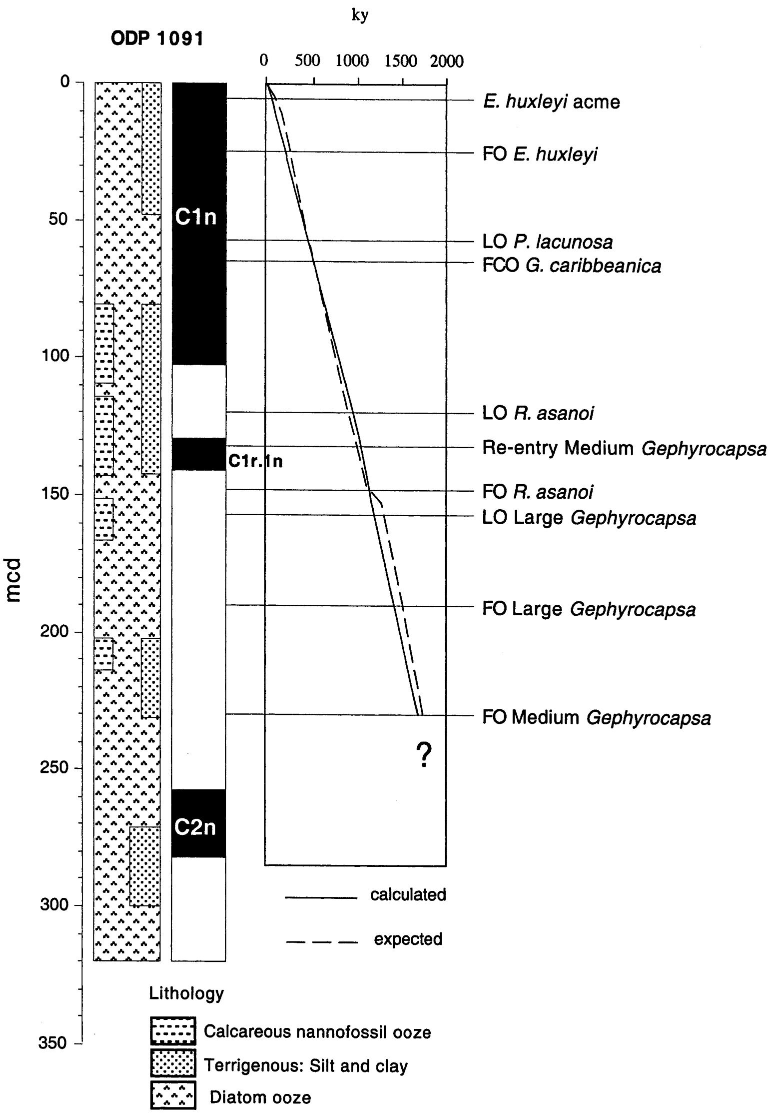


Fig. 5. Pleistocene calcareous nannofossil events identified in ODP Site 1091 and comparison of calcareous nannofossil calibration using the 'expected' nannofossil ages (after Thierstein et al., 1977; Raffi et al., 1993; Wei, 1993; Bollmann et al., 1998; Flores et al., 2000) vs. the geomagnetic and stable isotope events. Geomagnetic interpretation by Shipboard Scientific Party (1999) and Channell and Stoner (2002).

capsa caribbeanica at the bottom of MIS 7 (Weaver and Thomson, 1993; Pujos and Giraudeau, 1993; Bollmann et al., 1998; Flores et al., 1999).

The FCO of *Gephyrocapsa muellerae* is well defined in Site 1089 where it is dated at ca. 150 kyr, in MIS 6. In cores 1090 and 1092, according to the proposed age models, this event occurs prior to the expected age. As commented before, this discrepancy could be related to the accuracy of the age model. A hiatus prevents a good calibration of this event at Site 1091. In the other cores studied, poor preservation or absence of this taxon prevents the identification of this event.

The LCO of *Gephyrocapsa caribbeanica* is close to the FO of *Emiliania huxleyi* in the studied cores. However, the assigned ages differ depend-

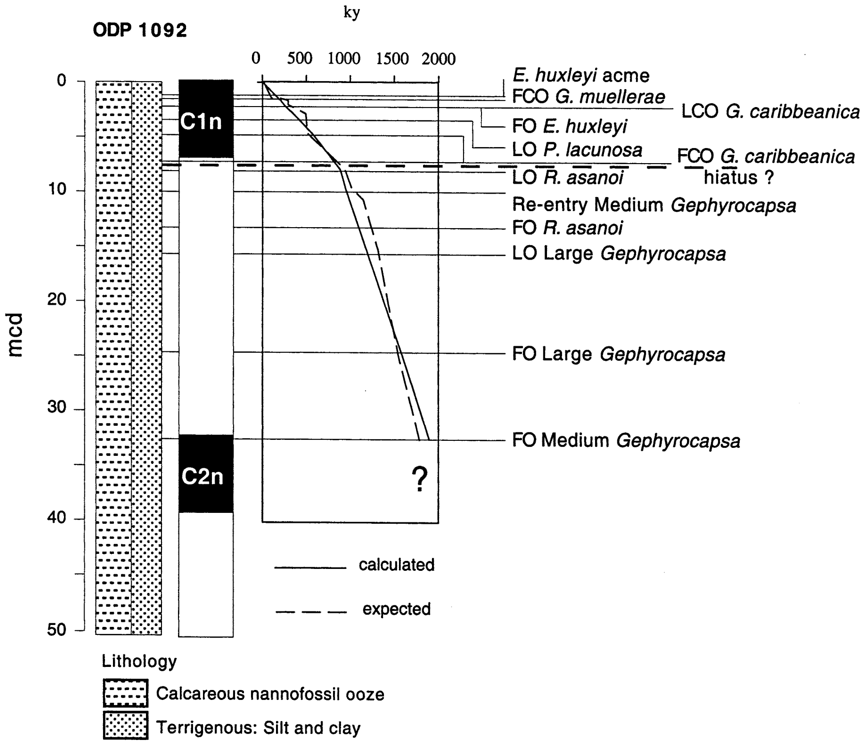


Fig. 6. Pleistocene calcareous nannofossil events identified in ODP Site 1092 and comparison of calcareous nannofossil calibration using the 'expected' nannofossil ages (after Thierstein et al., 1977; Raffi et al., 1993; Wei, 1993; Bollmann et al., 1998; Flores et al., 2000) vs. the geomagnetic and stable isotope events. Geomagnetic interpretation by Channell and Stoner (2002).

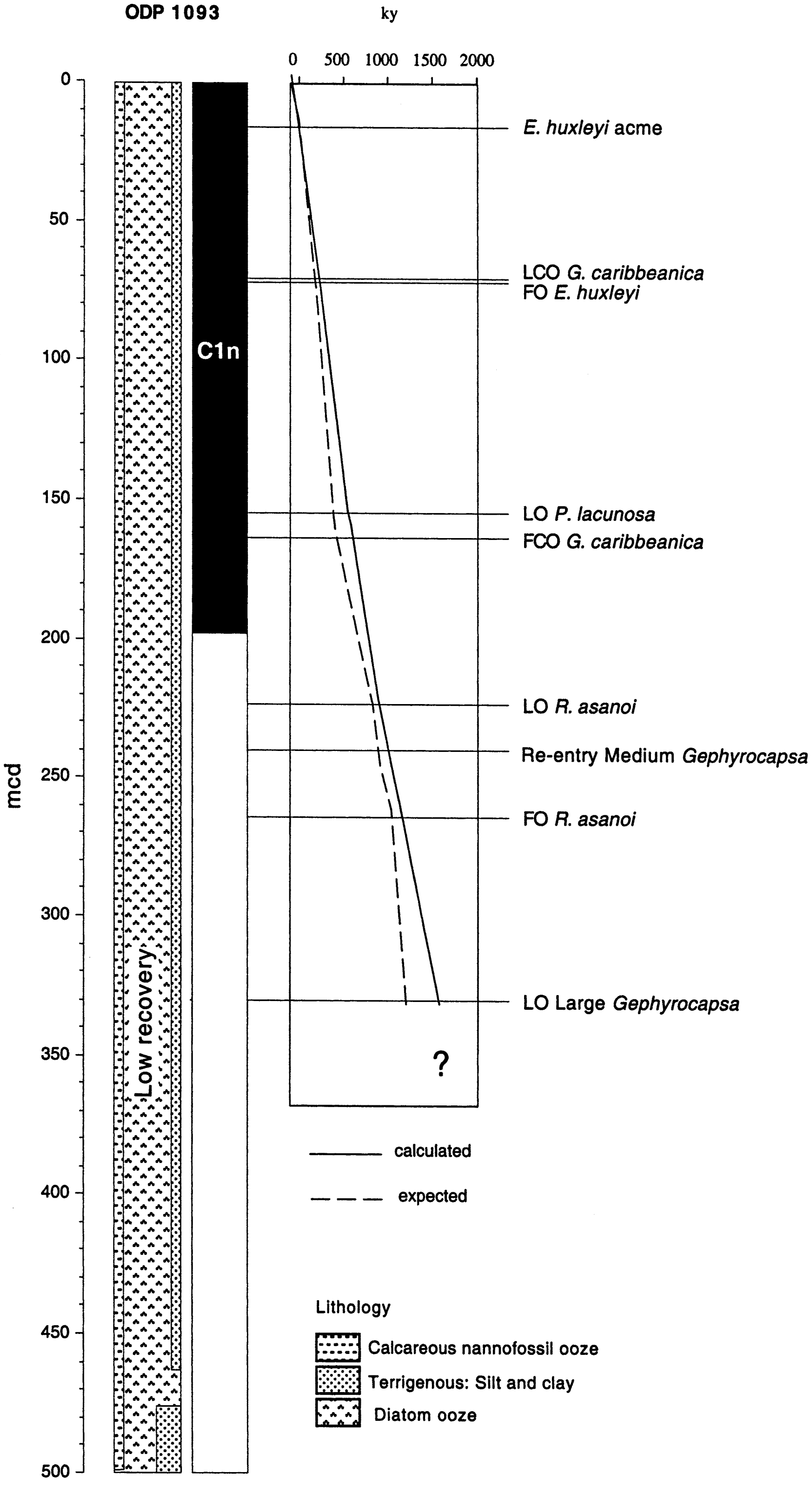
ing on the accuracy of the age model. A clear reduction in the abundance of *G. caribbeanica* occurs at the base of MIS 7 in Sites 1089 and 1094. In the other studied cores, the position relative to the FO of *E. huxleyi* is similar, but strong discrepancies in ages are observed.

6.3. Last occurrence of *Pseudoemiliania lacunosa*

Thierstein et al. (1977) identified the globally synchronous last occurrence (LO) of *Pseudoemiliania lacunosa* within MIS 12. At Site 1089 this event is clearly identified and dated as 450 kyr. Similar ages are calculated for Sites 1090 and 1091, indicating a synchronicity across the study area. The ages referred to in Tables 6 and 7 for Sites 1092 and 1093 are consistent with inaccuracies in the age models. At Site 1094 (Table 8) this event coincides with an interval barren of calcareous nannofossils.

A clear increase in the abundance of *Gephyrocapsa caribbeanica* can be identified within MIS 13 (Matsuoka and Okada, 1990; Pujos and Giraudeau, 1993; Bollmann et al., 1998; Flores et al., 1999), although prior to this dominance, this species increases progressively from MIS 15. In Sites 1089, 1090 and 1092 the FCO of *G. caribbeanica* occurs at the top of MIS 14, at Site 1091 within MIS 13. In Site 1093 the estimated age is inconsistent with the nannofossil record in the area. In

Fig. 7. Pleistocene calcareous nannofossil events identified in ODP Site 1093 and comparison of calcareous nannofossil calibration using the 'expected' nannofossil ages (after Thierstein et al., 1977; Raffi et al., 1993; Wei, 1993; Bollmann et al., 1998; Flores et al., 2000) vs. the geomagnetic and stable isotope events. Geomagnetic interpretation by Channell and Stoner (2002).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C1n
Low recovery
E. huxleyi acme
LCO G. caribbeanica
FO E. huxleyi
LO P. lacunosa
FCO G. caribbeanica
LO R. asanoi
Re-entry Medium Gephyrocapsa
FO R. asanoi
LO Large Gephyrocapsa
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calculated
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Lithology
Calcareous nannofossil ooze
Terrigenous: Silt and clay
Diatom ooze

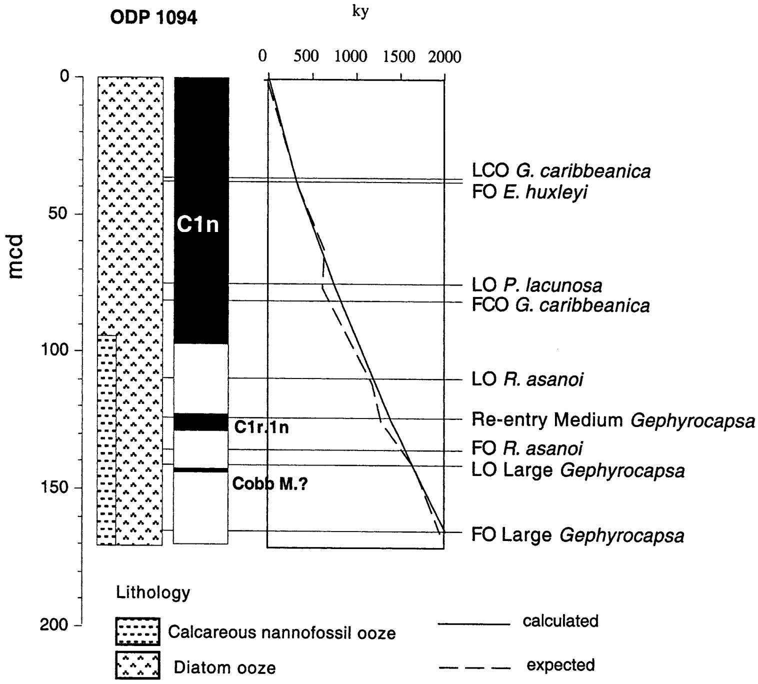

Fig. 8. Pleistocene calcareous nannofossil events identified in ODP Site 1094 and comparison of calcareous nannofossil calibration using the 'expected' nannofossil ages (after Thierstein et al., 1977; Raffi et al., 1993; Wei, 1993; Bollmann et al., 1998; Flores et al., 2000) vs. the geomagnetic and stable isotope events. Geomagnetic interpretation by Shipboard Scientific Party (1999) and Channell and Stoner (2002).

Site 1093 this event is identified at MIS 12, after an interval barren in calcareous nannofossils.

6.4. Last occurrence of *Reticulofenestra asanoi*

The LO of *Reticulofenestra asanoi* is known to be a synchronous event in low and relatively high latitudes, which occurred late in MIS 22 (Sato and Takayama, 1992; Wei, 1993). In Sites 1089 and 1092 the event is dated at ca. 830 kyr, in subchron C1r.1r (MIS 22). However, in Sites 1090, 1091, 1093 and 1094, the estimated age is close to 900 kyr.

6.5. Re-entry of medium *Gephyrocapsa*

Raffi et al. (1993) reported the re-entry of so-called medium *Gephyrocapsa* between MIS 29 and 16, with a marked degree of diachronism. This event is easy to identify in cores 1089, 1090, 1091 and 1094. According to the adopted age models, this event occurs prior to the reported age, at ca. 1000 kyr, in the Jaramillo subchron (C1r.1n).

6.6. First occurrence of *Reticulofenestra asanoi*

The FO of *Reticulofenestra asanoi* is not easy to identify owing to the occurrence of intermediate forms between this species and small reticulofenestrids (Wei, 1993). We therefore only consider specimens with a maximum diameter larger than 6 μm, following the original description of Sato and Takayama (1992). Taking into account this problem, Wei (1993) observed the FO of the species between MIS 35 and 29. Sato and Takayama (1992) dated the event at 1.06 Ma (around MIS 30) in the northeastern Atlantic (ODP Leg 94) and the Boso Peninsula (western Pacific). In our material, the FO of *R. asanoi* can be identified in most of the studied sites, at the top of subchron C1r.2r.

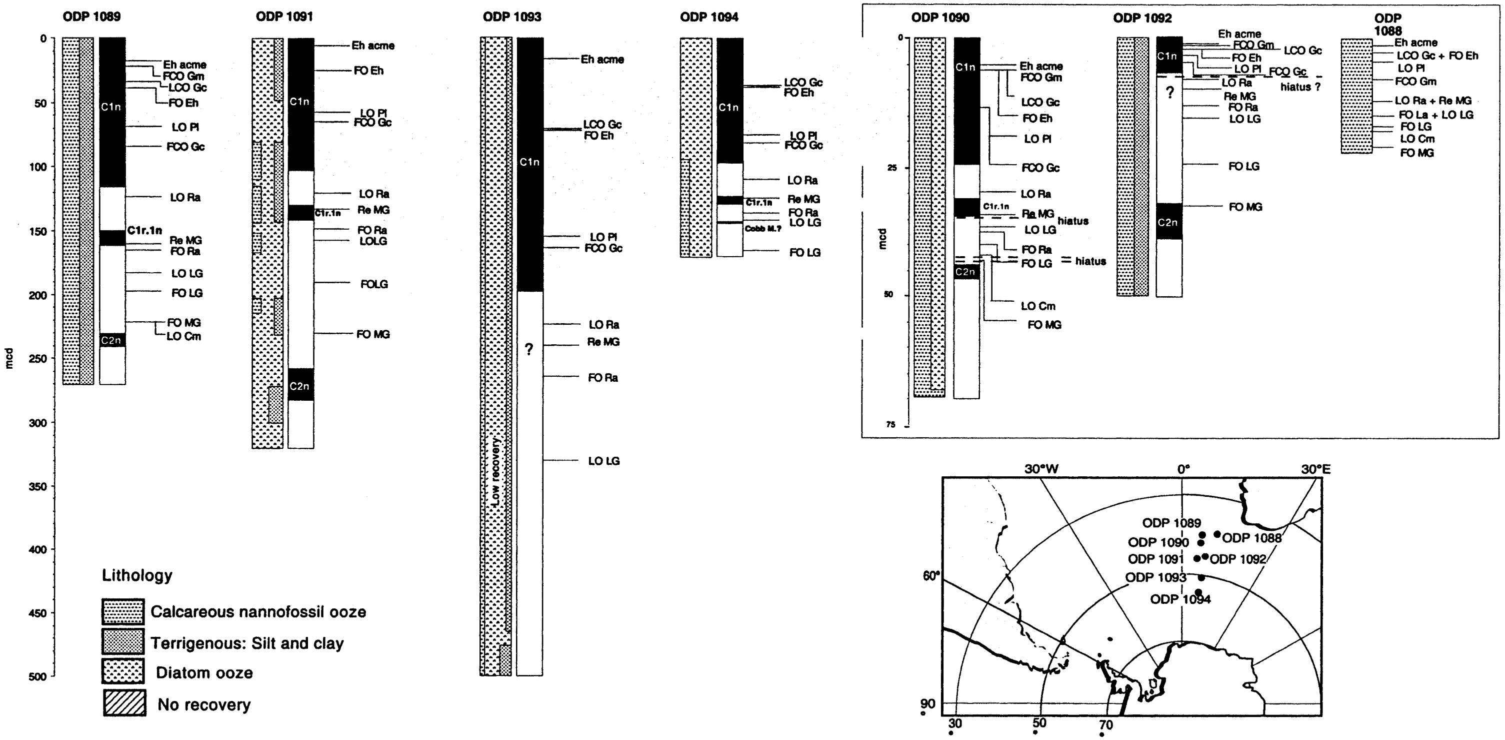

Fig. 9. Geomagnetic and calcareous nannofossil event correlation between the ODP Leg 177 sites. Geomagnetic data from Shipboard scientific Party (1999) and Channell and Stoner (2002). Note different depth scale in the squared sites. Taxa nomenclature in the Appendix. Eh = *Emiliania huxleyi*; Gc = *Gephyrocapsa caribbeanica*; Pl = *Pseudoemiliania lacunosa*; Ra = *Reticulofenestra asanoi*; MG = medium *Gephyrocapsa*; LG = large *Gephyrocapsa* and Cm = *Calcidiscus macintyrei*.

Table 2
Pleistocene calcareous nannofossil events, position and calibration in ODP Site 1088

Nannofossil event	ODP sample		mcd (cm)		kyr
	Top	Bottom	Top	Bottom	
Emiliania huxleyi acme (base)	B-1H-1, 110–110	B-1H-1, 120–120	1.10	1.20	85
LCO *Gephyrocapsa caribbeanica*	B-1H-2, 100–100	B-1H-2, 130–130	2.50	2.80	262
FO *Emiliania huxleyi*	B-1H-2, 100–100	B-1H-2, 130–130	2.50	2.80	268
LO *Pseudoemiliania lacunosa*	B-1H-3, 120–120	B-1H-4, 10–10	4.20	4.60	458
FCO *Gephyrocapsa caribbeanica*	B-2H-2, 70–70	B-2H-2, 140–140	7.70	8.40	480
LO *Reticulofenestra asanoi*	B-2H-4, 140–140	B-2H-5, 70–70	11.40	12.20	880
Re-entry medium *Gephyrocapsa*	B-2H-4, 140–140	B-2H-5, 70–70	11.40	12.20	960
FO *Reticulofenestra asanoi*	B-2H-CC, 12–19	B-3H-1, 70–70	14.44	15.70	1080
LO large *Gephyrocapsa*	B-2H-CC, 12–19	B-3H-1, 70–70	14.44	15.70	1240
FO large *Gephyrocapsa*	B-3H-1, 140–140	B-3H-2, 70–70	16.40	17.20	1460
LO *Calcidiscus macintyrei*	B-3H-2, 140–140	B-3H-3, 70–70	17.90	18.70	1600
FO medium *Gephyrocapsa*	B-3H-3, 70–70	B-3H-4, 140–140	18.70	20.90	1690

The calibration of these events is based on Thierstein et al. (1977), Raffi et al. (1993), Wei (1993) and Bollmann et al. (1998).

6.7. Last occurrence of large Gephyrocapsa

The LO of the large *Gephyrocapsa* morphotype (large *Gephyrocapsa* sp. B, Matsuoka and Okada, 1990; LG, Raffi et al., 1993) is a globally synchronous event that has been recorded in MIS 37 (Raffi et al., 1993; Wei, 1993). In our material, this event is identified at ca. 1200 kyr in Sites 1089 and 1090, whereas in Sites 1091, 1092 and 1093 the estimated age is close to 1100 kyr. Age model accuracy, as well as absence of nannofossils in some of the critical intervals, can explain this discrepancy.

6.8. First occurrence of large Gephyrocapsa

The FO of large *Gephyrocapsa* is a diachronous event: Raffi et al. (1993) placed this event between MIS 46 and 49 and Wei (1993) observed the same event from MIS 47 to 51. In cores 1089, 1090, 1091, 1092 and 1094 this event is dated at ca. 1400 kyr, slightly younger than the ages reported

Table 3
Pleistocene calcareous nannofossil events, position and calibration in ODP Site 1089

Nannofossil event	ODP sample		mcd		MIS/Chron	kyr
	Top	Bottom	Top	Bottom		
Emiliania huxleyi acme (base)	D-2H-4, 4–4	D-2H-4, 25–25	8.36	8.57	5	44.25
FCO *Gephyrocapsa muellerae*	B-3H-4, 50.5–51	B-3H-4, 54–55	25.40	25.44	6	161.07
LCO *Gephyrocapsa caribbeanica*	B-4H-4, 141–141.5	B-4H-5, 14–14.5	36.02	36.25	base 7	242.95
FO *Emiliania huxleyi*	C-5H-2, 125–126	B-5H-2, 15–16	39.07	39.41	8	368.11
LO *Pseudoemiliania lacunosa*	C-8H-3, 50–51	C-8H-3, 100–101	68.77	69.27	12	444.75
FCO *Gephyrocapsa caribbeanica*	B-9H-4, 0–1	B-9H-4, 55–56	85.17	85.72	top 14	535.84
LO *Reticulofenestra asanoi*	B-13H-3, 30–30	B-13H-3, 130–130	123.86	124.86	22/top C1r.1r	829.32
Re-entry medium *Gephyrocapsa*	B-17H-2, 30–30	B-17H-2, 78–79	160.36	160.94	C1r.1r	1051.90
FO *Reticulofenestra asanoi*	B-17H-4, 120–120	B-17H-5, 30–30	164.26	164.86	top C1r.2r	1083.07
LO large *Gephyrocapsa*	B-19H-3, 78–79	B-19H-5, 120–120	183.42	185.34	C1r.2n	1288.81
FO large *Gephyrocapsa*	B-20H-6, 30–30	B-20H-CC, 0–10	195.56	197.83	C1r.2n	1416.64
FO medium *Gephyrocapsa*	B-23H-1, 30–30	B-23H-1, 130–130	219.70	220.70	base C1r.2n	1660.62
LO *Calcidiscus macintyrei*	B-23H-1, 130–130	B-23H-2, 30–30	220.70	221.20	base C1r.2n	1668.40

The calibration of these events is based on Shipboard Scientific Party (1999), Channell and Stoner (2002) and Hodell et al. (2002).

Table 4
Pleistocene calcareous nannofossil events, position and calibration in ODP Site 1090

Nannofossil event	ODP sample		mcd (cm)		MIS/Chron	kyr
	Top	Bottom	Top	Bottom		
Emiliania huxleyi acme (base)	D-1H-3, 56–57	D-1H-3, 86–87	3.90	4.20	5	130.85
FCO *Gephyrocapsa muellerae*	D-1H-4, 56–57	B-2H-2, 30–30	6	6.60	7?	203.97?
LCO *Gephyrocapsa caribbeanica*	D-1H-4, 146–147	D-1H-5, 26–27	6.30	6.60	7	203.97?
FO *Emiliania huxleyi*	E-1H-3, 52–53	E-1H-3, 82–83	6.90	7.20	8	227.78
LO *Pseudoemiliania lacunosa*	D-2H-3, 95–96	D-2H-3, 125–126	13.5	13.8	12	441.03
FCO *Gephyrocapsa caribbeanica*	B-3H-3, 78–79	B-3H-3, 130–131	16.23	16.75	C1r.1r	527.17
LO *Reticulofenestra asanoi*	B-4H-3, 30–30	B-4H-3, 130–130	29.01	30.01	base C1r.1r	915.28
Re-entry medium *Gephyrocapsa*	B-4H-6, 30–30	B-4H-6, 130–130	33.51	34.51	base C1r.1n	1069.10
FO *Reticulofenestra asanoi*	B-4H-CC, 12–17	B-5H-1, 35–35	35.02	36.66	top C1r.2r	1172.89
LO large *Gephyrocapsa*	B-5H-1, 35–35	B-5H-1, 130–130	36.66	37.61	C1r.2r	1256.31
FO large *Gephyrocapsa*	B-5H-3, 30–30	B-5H-3. 110–110	39.61	40.41	C1r.2r	1435.0
LO *Calcidiscus macintyrei*	B-5H-5, 30–30	B-5H-5, 130–130	42.31	43.31	base C1r.2r	1647.06
FO medium *Gephyrocapsa*	B-5H-6, 30–30	B-5H-6, 130–130	43.81	44.81	base C1r.2r	1761.66

The calibration of these events is based on Shipboard Scientific Party (1999) and Venz and Hodell (2002).

by Raffi et al. (1993) and Wei (1993). In core 1093 an interval barren of calcareous nannofossils at the base of this event prevents a precise assignment.

6.9. Last occurrence of Calcidiscus macintyrei

Raffi et al. (1993) and Wei (1993) dated this event between 1.59 and 1.64 Ma (MIS 55–57). In our material, this species occurs only in Sites 1089 and 1090, and always in low proportions. However, the age we calculate for this event in the mentioned cores is close to the reported age from middle and low latitudes. The absence of this species in the other studied cores seems linked to ecological restrictions.

6.10. First occurrence of medium-sized Gephyrocapsa

This event was reported by Raffi et al. (1993) and Wei (1993) (FO spp. A-B), and dated as 1.67–1.70 Ma. In our material, this event is not easy to recognize due to the low proportion of this morphotype. However, sporadic specimens can be observed between 1600 and 1700 kyr in most of the studied sites.

Table 5
Pleistocene calcareous nannofossil events, position and calibration in ODP Site 1091

Nannofossil event	ODP sample		mcd (cm)		MIS/Chron	kyr
	Top	Bottom	Top	Bottom		
Emiliania huxleyi acme (base)	A-1H-1, 78–78	A-1H-3, 78–78	?	5.28?	?	40.13
FCO *Gephyrocapsa muellerae*	?	A-2H-2, 40–40	?	11.72	6?	88.95
LCO *Gephyrocapsa caribbeanica*	?	A-3H-6, 78–79	?	26.86	7?	203.86
FO *Emiliania huxleyi*	A-3H-6, 26–26	A-3H-CC, 12–17	26.34	27.58	8	204.63
LO *Pseudoemiliania lacunosa*	A-6H-CC, 7–17	A-7H-3, 26–26	57.44	60.41	12	447.05
FCO *Gephyrocapsa caribbeanica*	A-7H-3, 28–28	?	60.43	?	13?	458.66
LO *Reticulofenestra asanoi*	A-12H-CC, 0–10	A-13H-4, 104–104	16.51	123.48	C1r.1r	913.17
Re-entry medium *Gephyrocapsa*	A-13H-4-CC, 6–16	A-14H-2, 136–136	127.62	132.37	C1r.1n	989.97
FO *Reticulofenestra asanoi*	A-15H-5, 136–136	A-15H-CC, 11–21	147.60	148.21	C1r.2r	1083.12
LO large *Gephyrocapsa*	A-15H-CC, 11–21	A-16H-3, 130–130	148.21	158.06	C1r.2r	1115.75
FO large *Gephyrocapsa*	A-19H-3, 130–130	A-19H-CC, 8–14	188.33	191.82	C1r.2r	1340.72
FO medium *Gephyrocapsa*	A-23H-3, 30–30	A-23H-5, 110–110	231.60	233.90	C1r.2r	1613.40

The calibration of these events is based on Shipboard Scientific Party (1999) and Channell and Stoner (2002).

Table 6
Pleistocene calcareous nannofossil events, position and calibration in ODP Site 1092

Nannofossil event	ODP sample		mcd (cm)		MIS/Chron	kyr
	Top	Bottom	Top	Bottom		
Emiliania huxleyi acme (base)	C-1H-2, 7–7.5	C-1H-2, 12–12.5	1.57	1.62		177.17
FCO *Gephyrocapsa muellerae*	C-1H-2, 17–17.5	C-1H-2, 20–20.5	1.67	1.70	6?	187.20
LCO *Gephyrocapsa caribbeanica*	C-1H-2, 20–20.5	C-1H-2, 27–27.5	1.70	1.77	7?	193.88
FO *Emiliania huxleyi*	C-1H-2, 62–62.5	C-1H-2, 67–67.5	2.12	2.17	8	239.57
LO *Pseudoemiliania lacunosa*	C-1H-3, 32–32.5	C-1H-3, 37–37.5	2.73	3.31	12	336.51
FCO *Gephyrocapsa caribbeanica*	B-1H-3, 122–122	B-1H-3, 127–127.5	4.77	4.82	13?	533.74
LO *Reticulofenestra asanoi*	B-1H-5, 100–100	D-1H-5, 0–0	7.55	8.55	C1r.1n?	821.92
Re-entry medium *Gephyrocapsa*	B-2H-1, 44–44	B-2H-2, 115–115	8.69	10.90	C1r.1n?	888.31
FO *Reticulofenestra asanoi*	B-2H-3, 80–80	A-2H-1, 0–0	10.05	11.6	C1r.2r	928.29
LO large *Gephyrocapsa*	B-2H-5, 40–40	B-2H-6, 30–30	14.65	16.05	C1r.2r	1104.14
FO large *Gephyrocapsa*	B-3H-5, 40–40	B-3H-5, 140–140	24.54	25.54	C1r.2r	1480.31
FO medium *Gephyrocapsa*	B-4H-3, 140–140	B-4H-4, 140–140	32.01	33.51	C2n	1776.68

The calibration of these events is based on Channell and Stoner (2002).

7. Conclusions

Eleven Pleistocene calcareous nannofossil events calibrated with oxygen isotope and geomagnetic stratigraphies and correlated with low and middle latitude stratigraphies are discussed. Calcareous nannofossil events identified in sites where carbonate proportion is relatively high, and isotope and geomagnetic stratigraphies are well developed, show minimal diachronism with respect to the same events identified in middle and low latitudes. We infer that some of the discrepancies observed in the age assignments are due to inaccuracies in the adopted age models. A comparison with other micropaleontological stratigraphies will help to establish a more precise age model.

'Standard' events such as the FO of *Emiliania huxleyi* and the LO of *Pseudoemiliania lacunosa*, as calibrated by Thierstein et al. (1977) at MIS 8 and 12, respectively, are recorded at the same levels in our cores.

Other events observed at different latitudes and oceans identified and calibrated here include:

(a) The base of the *Emiliania huxleyi* acme is observed within MIS 5. This event is diachronous in comparison with the existing low latitude and North Atlantic data.

(b) The FCO of *Gephyrocapsa muellerae* is identified within MIS 6, showing a good correla-

Table 7
Pleistocene calcareous nannofossil events, position and calibration in ODP Site 1093

Nannofossil event	ODP sample		mcd (cm)		MIS/Chron	kyr
	Top	Bottom	Top	Bottom		
Emiliania huxleyi acme (base)	A-2H-3, 30–30	A-2H-5, 30–30	11.98	14.98	?	52.96
LCO *Gephyrocapsa caribbeanica*	A-7H-CC, 24–29	A-8H-1, 25–25	71.83	73.28	7?	285.08
FO *Emiliania huxleyi*	A-8H-1, 140–140	A-8H-2, 65–65	74.43	75.18	8	293.90
LO *Pseudoemiliania lacunosa*	A-15H-6, 40–40	A-16H-3, 129–129	152.43	159.20	12	598.96
FCO *Gephyrocapsa caribbeanica*	A-16H-5, 94–94	?	161.81	?	13?	635.82
LO *Reticulofenestra asanoi*	A-22H-2, 30–30	D-8H-3, 0–0.5	220.80	227.30	C1r	928.70
Re-entry medium *Gephyrocapsa*	A-24H-5, 15–15	A-24H-5, 140–140	245.50	246.80	C1r	1057.30
FO *Reticulofenestra asanoi*	A-26H-6, 50–50	A-26H-6CC, 19–24	262.80	263.10	C1r	1155.09
LO large *Gephyrocapsa*	D-18H-CC, 0–2	D-21X-CC. 0–1	323.60	345.10	C1r	1570.65

The calibration of these events is based on Channell and Stoner (2002).

Table 8
Pleistocene calcareous nannofossil events, position and calibration in ODP Site 1094

Nannofossil event	ODP sample		mcd (cm)		MIS/Chron	kyr
	Top	Bottom	Top	Bottom		
LCO *Gephyrocapsa caribbeanica*	?	A-5H-3, 74–74	?	39.25		234.21
FO *Emiliania huxleyi*	A-5H-3, 146–146	A-5H-4, 30–30	39.97	40.31	8	246.4
LO *Pseudoemiliania lacunosa*	?	A-9H-2, 17–17	?	75.57	?	552.09
FCO *Gephyrocapsa caribbeanica*	A-7H-6, 40–40	A-7H-6, 90–90	62.10	62.60	13?	428.23
LO *Reticulofenestra asanoi*	A-12H-4, 119–119	A-13H-3, 132–132	106.87	114.36	C1r.1r	887.22
Re-entry medium *Gephyrocapsa*	A-14H-3, 66–66	A-14H-3, 88–88	125.07	125.29	C1r.1n	1025.64
FO *Reticulofenestra asanoi*	A-15H-1, 30–30	A-15H-2, 112–112	130.72	133.04	C1r.2r	1107.86
LO large *Gephyrocapsa*	D-13H-CC, 14–19	A-16H-3, 98–98	139.23	143.90	C1r.2r (close top Cobb M.)	1210.00
FO large *Gephyrocapsa*	D-16H-2, 30–30	D-16H-2, 87–87	165.29	165.86	C1r.2r	1485.18

The calibration of these events is based on Shipboard Scientific Party (1999) and Channell and Stoner (2002).

tion according to the data from other oceanic areas.

(c) The LCO of *Gephyrocapsa caribbeanica* is also observed in our material within MIS 7.

(d) The FCO of *Gephyrocapsa caribbeanica* occurs between MIS 14 and 13, although the exact level of this event is not well defined using semi-quantitative data.

(e) The LO of *Reticulofenestra asanoi* is here placed close to MIS 22, at the top of subchron C1r.1r.

(f) The re-entry of medium-sized *Gephyrocapsa* occurs in the studied area during subchron C1r.1n, clearly diachronous with existing calibrations for other oceanic areas.

(g) The FO of *Reticulofenestra asanoi* is observed at the top of subchron C1r.1n, probably another diachronous event that has been reported to occur at younger ages in low latitudes of the Pacific and Atlantic Oceans.

(h) The LO of large *Gephyrocapsa*, a globally synchronous event that has also been identified within MIS 37 in the Southern Ocean, is observed in the middle part of subchron C1r.2r, consistent with the previously reported ages.

(i) The FO of large *Gephyrocapsa* is recorded at ca. 1400 kyr, close to the ages reported for mid and low latitudes

(j) Due to ecological restrictions, *Calcidiscus macintyrei* is only observed in the carbonate-rich sites. However, the LO of *C. macintyrei*, where present, occurs at ca. 1600 kyr, similar to those records observed in middle and low latitudes. Slightly before, but very close to the above-mentioned event, we observed the FO of medium-sized *Gephyrocapsa*.

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Appendix

Details and graphic information about the considered taxa can be found in Perch-Nielsen (1985), Young (1998) and Hine and Weaver (1998). For species and morphotypes included in the family Noelaerhabdaceae we followed the morphological criteria in Raffi et al. (1993) and Flores et al. (2000).

List of species used considered in this study

Pseudoemiliania lacunosa (Kamptner, 1963) Gartner, 1969

Reticulofenestra asanoi Sato and Takayama, 1992

Calcidiscus macintyrei (Bukry and Bramlette, 1969) Loeblich and Tappan, 1978
Emiliania huxleyi (Lohmann, 1902) Hay and Mohler in Hay et al., 1967
Small *Gephyrocapsa*
Gephyrocapsa aperta Kamptner, 1963
Gephyrocapsa ericsonii McIntyre and Bé, 1967
Gephyrocapsa caribbeanica Boudreaux and Hay, 1967
Gephyrocapsa muellerae Bréhéret, 1978
Gephyrocapsa oceanica Kamptner, 1943
Medium Gephyrocapsa
Gephyrocapsa omega Bukry, 1973
= *Gephyrocapsa parallela* (Hay and Beaudry, 1973)

Abundance of marker species and morphotypes used in the studied cores

Total abundance of the calcareous nannofossil assemblage for each sample, observed at a magnification of 1000×, was estimated as follows: A = > 50 nannoliths per field of view, C = 1–50 nannoliths per field of view. Samples with less than one specimen per field of view are not included in the tables. The ranking of preservation was established as: G = good, M = moderate, and P = poor. The relative abundances of taxa or morphotypes were estimated as follows: V = very abundant (> 50%); A = abundant (> 20–< 50%); C = common (> 10–< 20%); F = few (> 1–< 10%); R = rare (< 1%).

Table A1

Leg	Site	Hole	Core	Type	Section	Sample top (cm)	Sample bottom (cm)	Depth (mbsf)	Depth (mcd)	Abundance	Preservation	*Gephyrocapsa* small	*Calcidiscus macintyrei*	*Gephyrocapsa caribbeanica*	*Pseudoemiliania lacunosa* (4–5.5 μm)	*Gephyrocapsa* medium (>5.5 μm)	*Gephyrocapsa* large	*Reticulofenestra asanoi*	*Emiliania huxleyi*
177	1088	B	1	H	1	110	110	1.1	1.1	A	M								D
177	1088	B	1	H	1	120	120	1.2	1.2	A	M								C
177	1088	B	1	H	2	20	20	1.7	1.7	A	M								C
177	1088	B	1	H	2	60	60	2.1	2.1	A	M								C
177	1088	B	1	H	2	100	100	2.5	2.5	A	M								C
177	1088	B	1	H	2	130	130	2.8	2.8	A	M			A					
177	1088	B	1	H	2	140	140	2.9	2.9	A	M			A					
177	1088	B	1	H	3	120	120	4.2	4.2	A	M			A					
177	1088	B	1	H	4	10	10	4.6	4.6	A	M			A	F				
177	1088	B	1	H	4	25	25	4.75	4.75	A	M			A	F				
177	1088	B	1	H	4	40	40	4.9	4.9	A	M			D	F				
177	1088	B	1	H	4	70	70	5.2	5.2	A	M			D	A				
177	1088	B	1	H	CC	7	12	5.41	5.41	A	M			A	C	C			
177	1088	B	2	H	1	70	70	6.2	6.2	A	M			D	C	C			
177	1088	B	2	H	1	140	140	6.9	6.9	A	M			F	C	C			
177	1088	B	2	H	2	70	70	7.7	7.7	A	M			F	C	C			
177	1088	B	2	H	2	140	140	8.4	8.4	A	M	D			C	C			
177	1088	B	2	H	3	70	70	9.2	9.2	A	M	D			C	C			
177	1088	B	2	H	3	140	140	9.9	9.9	A	M	A			C	C			
177	1088	B	2	H	4	70	70	10.7	10.7	A	M	D			C	C			
177	1088	B	2	H	4	140	140	11.4	11.4	A	M	F			C	F			
177	1088	B	2	H	5	70	70	12.2	12.2	A	M	A			F	F		F	
177	1088	B	2	H	5	140	140	12.9	12.9	A	M	D			C	F		A	
177	1088	B	2	H	6	70	70	13.7	13.7	A	M				C			F	
177	1088	B	2	H	CC	12	19	14.44	14.44	A	M	D			C			A	
177	1088	B	3	H	1	70	70	15.7	15.7	A	M				C		C		
177	1088	B	3	H	1	140	140	16.4	16.4	A	M				C		C		
177	1088	B	3	H	2	70	70	17.2	17.2	A	M				C				
177	1088	B	3	H	2	140	140	17.9	17.9	A	M		R		C	C			
177	1088	B	3	H	3	70	70	18.7	18.7	A	M		F		C	C			
177	1088	B	3	H	3	140	140	19.4	19.4	A	M		F			C			
177	1088	B	3	H	4	70	70	20.2	20.2	A	M		F		C	F			
177	1088	B	3	H	4	140	140	20.9	20.9	A	M		F		C				
177	1088	B	3	H	5	70	70	21.7	21.7	A	M		R		C				
177	1088	B	3	H	5	140	140	22.4	22.4	A	M		R		C				
177	1088	B	3	H	6	70	70	23.2	23.2	A	M		F		C				
177	1088	B	3	H	6	130	130	23.8	23.8	A	M		R		C				
177	1088	B	3	H	CC	14	19	23.97	23.97	A	M		F		C				
177	1088	B	4	H	1	70	70	25.2	25.2	A	G		R		C				
177	1088	B	4	H	1	140	140	25.9	25.9	A	G		R						
177	1088	B	4	H	2	70	70	26.7	26.7	A	G		R		C				
177	1088	B	4	H	2	140	140	27.4	27.4	A	M		F		C				
177	1088	B	4	H	3	70	70	28.2	28.2	A	G		F		F				
177	1088	B	4	H	3	140	140	28.9	28.9	A	M		R		C				
177	1088	B	4	H	4	70	70	29.7	29.7	A	G		F		C				

Table A2

Leg	Site	Hole	Core	Type	Section	Sample top (cm)	Sample bottom (cm)	Depth (mbsf)	Depth (mcd)	Abundance	Preservation	*Gephyrocapsa caribbeanica*	*Calcidiscus macintyrei*	*Gephyrocapsa* small	*Gephyrocapsa* medium (4–5.5 μm)	*Gephyrocapsa muellerae*	*Gephyrocapsa* large (>5.5 μm)	*Reticulofenestra asanoi*	*Pseudoemiliania lacunosa*	*Emiliania huxleyi*
177	1089	A	1	H	CC	17	22	7.27	7.03	A	G			D						C
177	1089	B	2	H	3	131	132	9.1	14.8	A	G			C						A
177	1089	B	2	H	4	5	5	9.4	15.1	A	G			C		R				C
177	1089	A	2	H	CC	16	21	16.9	16.5	A	M			A	C	R				C
177	1089	B	2	H	6	31.5	32	12.9	18.6	A	M			C		F				F
177	1089	B	2	H	6	81.5	82	13.1	18.8	A	M			C		C				F
177	1089	B	2	H	CC	10	15	13.7	19.4	A	C			C	C					C
177	1089	B	3	H	3	54	55	18.1	23.5	A	M			C		C				F
177	1089	B	3	H	3	75	75.5	18.6	23.7	A	M			C		F				F
177	1089	A	3	H	CC	13	18	21.2	24	A	M			D		C				C
177	1089	B	3	H	4	50.5	51	19.3	24.8	A	M			A		C				F
177	1089	B	3	H	4	54	55	19.3	24.8	A	M			C		F				F
177	1089	B	3	H	CC	8	16	23.1	28.6	A	M			A	C	F				C
177	1089	B	4	H	4	91.5	92	29.2	34.8	A	M	R		C		R				F
177	1089	B	4	H	4	114	114	29.4	35	A	M	F		C						F
177	1089	B	4	H	5	14	14.5	29.9	35.5	A	M	F		C						F
177	1089	B	4	H	5	41.5	42	30.2	35.8	A	M	C		C						F
177	1089	B	4	H	CC	12	17	32.4	38	A	M	A		A	A					R
177	1089	A	5	H	2	70	70	38	39	A	M									F
177	1089	C	5	H	2	125	126	35.7	39.1			C								
177	1089	A	5	H	2	100	100	38.3	39.3	A	M									F
177	1089	B	5	H	2	15	16	34.9	39.4	A	M	C								
177	1089	B	5	H	2	30	30	35.1	39.6	A	M	F		C						F
177	1089	A	5	H	2	149	149	38.8	39.8	C	M									
177	1089	B	5	H	2	130	130	36.1	40.6	B	M									
177	1089	B	5	H	3	30	30	36.6	41.1	F	M	A								R
177	1089	B	5	H	3	130	130	37.6	42.1	A	P	F								?
177	1089	B	5	H	4	30	30	38.1	42.6	C	M									?
177	1089	B	5	H	4	120	120	39	43.5	F	M									?
177	1089	B	5	H	2	125	126	34.6	39.1	C	M	C								R
177	1089	C	5	H	2	15	16	31.2	39.4	C	M	C								
177	1089	A	5	H	CC	14	19	43.4	44.3	C	M									
177	1089	B	5	H	CC	16	21	41.9	46.4	B										
177	1089	B	6	H	1	30	30	43.1	49.3	A	M	A								?
177	1089	B	6	H	1	120	120	44	50.2	A	M			C						
177	1089	A	6	H	CC	18	23	52.3	54.1	A	M				C					
177	1089	B	6	H	CC	11	16	51.2	57.4	A	M	C		A	R					
177	1089	A	7	H	1	120	120	56	60.1	C	P	A		A	R					
177	1089	A	7	H	1	130	130	56.1	60.2	A	M	A		A	R					
177	1089	A	7	H	2	30	30	56.6	60.7	C	M			D						
177	1089	A	7	H	2	120	120	57.5	61.6	C	M			D						
177	1089	A	7	H	3	30	30	58.1	62.2	A	G			D						
177	1089	A	7	H	CC	51	56	63.4	67.5	A	G	A			C				?	
177	1089	B	7	H	6	80	80	60.6	68	A	M								R	
177	1089	B	7	H	CC	8	14	60.7	68.2	A	M	D								
177	1089	C	8	H	3	105	106	65.4	69.3			F							F	
177	1089	A	8	H	1	30	30	64.6	69.4	C	M								R	
177	1089	C	8	H	4	5	5.5	65.9	69.8											
177	1089	B	8	H	1	30	30	62.1	70.2	A	M								F	
177	1089	A	8	H	1	120	120	65.5	70.3	A	M								R	
177	1089	A	8	H	2	30	30	66.1	70.9	A	G	D			C				R	
177	1089	B	8	H	1	120	120	63	71.1	A	M								R	
177	1089	B	8	H	2	30	30	63.6	71.7	A	M								F	
177	1089	A	8	H	2	120	120	67	71.8	A	M	D			F				R	
177	1089	A	8	H	3	30	30	67.6	72.4	A	M	D		D	F				F	
177	1089	B	8	H	2	120	120	64.5	72.6	A	M	A							R	
177	1089	A	8	H	3	120	120	68.5	73.3	C	P	A			C				F	

Table A2 (*Continued*).

Leg	Site	Hole	Core	Type	Section	Sample top (cm)	Sample bottom (cm)	Depth (mbsf)	Depth (mcd)	Abundance	Preservation	*Gephyrocapsa caribbeanica*	*Calcidiscus macintyrei*	*Gephyrocapsa* small	*Gephyrocapsa* medium (4–5.5 μm)	*Gephyrocapsa muellerae*	*Gephyrocapsa* large (> 5.5 μm)	*Reticulofenestra asanoi*	*Pseudoemiliania lacunosa*	*Emiliania huxleyi*
177	1089	A	8	H	4	30	30	69.1	73.9	A	P	A							F	
177	1089	C	3	H	3	50	51	64.4	68.8	C	M	A							C	
177	1089	C	3	H	3	100	101	64.9	69.3	C	M	A							C	
177	1089	A	8	H	4	120	120	70	74.8	C	M	C			F				C	
177	1089	A	8	H	5	30	30	70.6	75.4	A	M								A	
177	1089	A	8	H	5	120	120	71.5	76.3	F	P			C	R				F	
177	1089	A	8	H	6	30	30	72.1	76.9	C	M								F	
177	1089	A	8	H	6	120	120	73	77.8	C	M	D							F	
177	1089	B	8	H	CC	20	25	70	78.1	A	M	A		D					F	
177	1089	A	8	H	7	10	10	73.4	78.2	A	P	D		C					R	
177	1089	A	8	H	7	60	60	73.9	78.7	A	M	A		C					C	
177	1089	A	8	H	CC	9	14	74	78.8	A	M	A		A					C	
177	1089	A	9	H	CC	10	15	75.2	81.4	A	G	C		A	F				C	
177	1089	B	9	H	4	0	1	75.8	85.2	A	G	C		A					C	
177	1089	B	9	H	4	55	56	76.4	85.7	A	G	R		A					C	
177	1089	B	9	H	CC	15	20	80.2	89.6	A	P			D					C	
177	1089	A	10	H	CC	0	15	93	97.5	A	M			A	C			R	C	
177	1089	B	10	H	CC	15	20	88.3	99.5	A	M			C					C	
177	1089	A	11	H	CC	53	58	97.9	104	A	M			A	A			R	C	
177	1089	B	11	H	CC	9	14	99.1	110	A	M			A					C	
177	1089	A	12	H	3	30	30	106	111	C	M							R	C	
177	1089	A	13	H	CC	0	5	112	112	A	M			D	C			F	C	
177	1089	A	12	H	4	120	120	108	114	A	M								F	
177	1089	A	12	H	6	30	30	110	116	C	M							F	C	
177	1089	A	12	H	7	30	30	112	117	F	M							F		
177	1089	B	12	H	CC	8	13	108	120	A	M			D					C	
177	1089	B	13	H	1	30	30	110	121	F	M								F	
177	1089	B	13	H	1	130	130	111	122	C	M							R	F	
177	1089	B	13	H	2	130	130	112	123	C	M							R	C	
177	1089	B	13	H	3	30	30	113	124	C	M								F	
177	1089	B	13	H	3	130	130	114	125	C	M							R	F	
177	1089	B	13	H	4	130	130	115	126	A	M				F			F	C	
177	1089	B	13	H	6	108	108	118	129	A	M				F			F	C	
177	1089	A	14	H	CC	11	16	130	136	A	G			D	F			R	C	
177	1089	B	14	H	CC	14	19	127	138	A	M				C			C	C	
177	1089	B	15	H	1	130	130	130	141	A	M				C			A	C	
177	1089	A	15	H	CC	21	26	137	142	F	M			A	C			F	C	
177	1089	B	15	H	6	30	30	136	147	A	M				C			C	A	
177	1089	B	16	H	1	30	30	138	149	A	M				C				F	
177	1089	B	16	H	5	130	130	145	156	A	M				C			C	C	
177	1089	B	16	H	6	30	30	146	157	A	M							R	C	
177	1089	B	17	H	1	30	30	148	159	A	M				R			R	C	
177	1089	B	17	H	1	120	120	149	160	C	M				F			C	A	
177	1089	B	17	H	2	120	120	150	161	C	M							C	C	
177	1089	B	17	H	4	30	30	152	163	A	G							R	C	
177	1089	B	17	H	4	120	120	153	164	A	G							C	C	
177	1089	B	17	H	5	30	30	154	165	A	M								C	
177	1089	B	17	H	5	120	120	155	166	C	P								C	
177	1089	B	17	H	CC	18	23	155	167	A	M								A	
177	1089	A	18	H	1	30	30	160	168	C	M							F	C	
177	1089	A	18	H	2	30	30	161	169	C	M							F	F	
177	1089	B	18	H	1	120	120	158	169	F	P								F	
177	1089	A	18	H	2	130	130	162	170	C	M							F	F	
177	1089	B	18	H	2	120	120	160	171	B										
177	1089	A	18	H	3	130	130	164	172	C	M							F	C	
177	1089	A	18	H	4	130	130	165	173	B										
177	1089	A	18	H	5	30	30	166	174	C	M								F	
177	1089	A	18	H	5	70	70	166	174	C	M								C	

Table A2 (*Continued*).

Leg	Site	Hole	Core	Type	Section	Sample top (cm)	Sample bottom (cm)	Depth (mbsf)	Depth (mcd)	Abundance	Preservation	*Gephyrocapsa caribbeanica*	*Calcidiscus macintyrei*	*Gephyrocapsa* small	*Gephyrocapsa* medium (4–5.5 μm)	*Gephyrocapsa muellerae*	*Gephyrocapsa* large (>5.5 μm)	*Reticulofenestra asanoi*	*Pseudoemiliania lacunosa*	*Emiliania huxleyi*
177	1089	A	8	H	4	30	30	69.1	73.9	A	P	A							F	
177	1089	A	18	H	CC	21	26	166	174	A	M									
177	1089	A	19	H	1	30	30	169	177	F	M								F	
177	1089	A	19	H	1	120	120	170	178	C	M						F		C	
177	1089	A	19	H	2	30	30	171	179	B										
177	1089	A	19	H	3	30	30	172	180	C	M						C		A	
177	1089	A	19	H	4	30	30	174	182	C	M						F		F	
177	1089	A	19	H	5	30	30	175	183	B										
177	1089	A	19	H	5	120	120	176	184	B										
177	1089	B	19	H	5	120	120	174	185	A	G	A			C		A		C	
177	1089	A	19	H	CC	0	10	178	186	A	M						C		C	
177	1089	B	20	H	1	120	120	177	190	A	G				A		A		C	
177	1089	B	20	H	4	120	120	182	194	A	G	A			A		C		A	
177	1089	B	20	H	5	20	20	182	195	A	G				A		C		C	
177	1089	B	20	H	6	30	30	183	196	C	G	C			C		C		C	
177	1089	B	20	H	CC	0	10	185	198	R	P								R	
177	1089	B	21	H	5	30	30	192	207	B										
177	1089	A	21	H	CC	21	26	195	209	F	M								A	
177	1089	B	21	H	CC	11	16	194	209	R	P	R			R				R	
177	1089	B	22	H	2	130	130	198	213	A	G	A			A				C	
177	1089	B	22	H	5	130	130	202	217	A	G				C				C	
177	1089	A	23	H	1	30	30	207	219	F	M				F				C	
177	1089	B	23	H	1	30	30	205	220	R	P				F				R	
177	1089	A	23	H	2	30	30	209	221	A	M		F		F				C	
177	1089	B	23	H	2	30	30	206	221	A	M		R						A	
177	1089	A	23	H	2	120	120	210	222	A	M		F		F				C	
177	1089	A	23	H	3	120	120	211	223	A	M		R						C	
177	1089	B	23	H	3	130	130	209	224	F	P								C	
177	1089	A	23	H	4	30	30	212	224	A	M		F		F				F	
177	1089	B	23	H	4	30	30	209	224	A	M		F						C	
177	1089	A	23	H	4	120	120	213	225	A	M		F						A	
177	1089	B	23	H	4	130	130	210	225	A	M		R						C	
177	1089	A	23	H	5	130	130	214	226	A	M		R						R	
177	1089	A	23	H	6	20	20	215	227	A	M		F						F	
177	1089	A	23	H	6	60	60	215	227	B										
177	1089	A	23	H	CC	31	41	215	228	A	M		R						C	
177	1089	B	24	H	5	30	30	220	235	B										
177	1089	B	24	H	6	30	30	222	237	F	P		R							
177	1089	B	24	H	CC	23	28	223	239	A	P								D	
177	1089	B	25	H	3	130	130	228	243	F	P								C	
177	1089	B	25	H	5	130	130	231	246	C	P		F						C	
177	1089	B	25	H	CC	14	19	233	248	F	P								A	
177	1089	B	26	H	4	130	130	239	254	B										
177	1089	B	26	H	6	130	130	242	257	R	P		R							

Table A3

Leg	Site	Hole	Core	Type	Section	Sample top (cm)	Sample bottom (cm)	Depth (mbsf)	Depth (mcd)	Abundance	Preservation	*Pseudoemiliania lacunosa*	*Gephyrocapsa caribbeanica*	*Calcidiscus macintyrei*	*Gephyrocapsa* medium (4–5.5 μm)	*Gephyrocapsa muellerae*	*Gephyrocapsa* large (> 5.5 μm)	*Reticulofenestra asanoi*	*Emiliania huxleyi*
177	1090	B	1	H	3	30	30	3.8	2.8	A	G					R			D
177	1090	D	1	H	3	56	57	3.56	3.9	A	M					F			A
177	1090	D	1	H	3	86	87	3.86	4.2	A	M					F			D
177	1090	B	2	H	1	130	130	5.8	5.5	A	M					C			C
177	1090	D	1	H	4	56	57	5.66	6	A	G					F			F
177	1090	B	2	H	2	30	30	6	6	A	G					C			R
177	1090	D	1	H	4	146	147	5.96	6.3	A	M					R			R
177	1090	B	2	H	2	30	30	6.1	6.6	A	G					R			R
177	1090	D	1	H	5	26	27	6.26	6.6	A	M		R			R			R
177	1090	E	1	H	3	52	53	3.52	6.9	A	M		F						R
177	1090	B	2	H	2	130	130	7	7	A	M		C						?
177	1090	E	1	H	3	82	83	3.82	7.2	A	M		F						
177	1090	B	2	H	4	30	30	7.5	9	A	M		C						
177	1090	D	2	H	3	95	96	16.9	13.5	A	M		C						
177	1090	D	2	H	3	125	126	17.2	13.8	A	M		C						
177	1090	B	2	H	CC	0	10	13.8	13.8	A	G		C						
177	1090	B	3	H	1	40	40	14.1	15.9	A	M		C						
177	1090	B	3	H	1	130	130	15	16.8	A	G	F	F						
177	1090	B	3	H	2	130	130	16.5	18.3	F	G	C	R						
177	1090	B	3	H	3	130	130	18	19.8	A	G	C	R						
177	1090	B	3	H	4	130	130	19.5	21.3	A	M	F							
177	1090	B	3	H	CC	13	18	22.3	24	A	M	A							
177	1090	B	4	H	3	30	30	26.5	29	A	M	C							
177	1090	B	4	H	3	130	130	27.5	30	A	M	C						C	
177	1090	B	4	H	4	130	130	29	31.5	A	M	C						C	
177	1090	B	4	H	5	30	30	29.5	32	A	G	C			C			F	
177	1090	B	4	H	5	130	130	30.5	33	A	M	F			F			F	
177	1090	B	4	H	6	30	30	31	33.5	A	M	C			F			C	
177	1090	B	4	H	CC	12	17	32.5	35	A	M	R						F	
177	1090	B	5	H	1	35	35	33.1	36.7	A	G	C							
177	1090	B	5	H	1	130	130	34	37.6	A	G	A			F		A		
177	1090	B	5	H	2	30	30	34.5	38.1	A	G	F			F		A		
177	1090	B	5	H	2	130	130	35.5	39.1	A	G	C			C		C		
177	1090	B	5	H	3	30	30	36	39.6	A	G	A			F		C		
177	1090	B	5	H	3	110	110	36.8	40.4	A	G	C			C				
177	1090	B	5	H	4	30	30	37.5	40.8	A	M	A			C				
177	1090	B	5	H	4	130	130	38.5	41.8	A	G	A			C				
177	1090	B	5	H	5	30	30	39	42.3	A	G	A			C				
177	1090	B	5	H	5	130	130	40.3	43.3	A	G	C		R	R				
177	1090	B	5	H	6	30	30	40.5	43.8	A	G	C		F	R				
177	1090	B	6	H	1	30	30	42.5	44.1	A	M	C		R					
177	1090	B	5	H	6	130	130	41.5	44.8	A	G	C		R					
177	1090	B	5	H	CC	14	19	41.4	45	A	M	A		F					
177	1090	B	6	H	2	130	130	45	46.6	A	M	C		R					
177	1090	B	6	H	6	130	130	51	52.6	A	P	C							
177	1090	B	6	H	7	30	30	51.5	53.1	A	M	C							
177	1090	B	6	H	CC	9	14	51.8	53.4	A	M	C							
177	1090	B	8	H	1	30	30	61.5	65.2	A	M	F		R					
177	1090	B	7	H	CC	12	17	59.3	65.6	A	M	C		F					
177	1090	B	8	H	1	120	120	62.4	66.1	A	M	F							
177	1090	B	8	H	2	140	140	64.1	67.8	A	M			R					
177	1090	B	8	H	4	30	30	66	69.7	A	M								
177	1090	B	8	H	5	30	30	67.5	71.2	A	P								

Table A4

Leg	Site	Hole	Core	Type	Section	Sample top (cm)	Sample bottom (cm)	Depth (mbsf)	Depth (mcd)	Abundance	Preservation	*Pseudoemiliania lacunosa*	*Calcidiscus macintyrei*	*Gephyrocapsa* small	*Gephyrocapsa caribbeanica*	*Gephyrocapsa* medium (4–5.5 μm)	*Gephyrocapsa* large (> 5.5 μm)	*Reticulofenestra asanoi*	*Emiliania huxleyi*
177	1091	A	1	H	1	30	30	0.3	0.3	A	M			A		A			A
177	1091	A	1	H	1	76	76	0.76	0.76	A	M			A		A			F
177	1091	A	1	H	3	83	83	3.83	3.83	A	P			C		F			A
177	1091	A	2	H	1	30	30	7.2	10.1	R	P			F					R
177	1091	A	2	H	2	28	28	8.68	11.6	A	M			A		A			C
177	1091	A	2	H	2	40	40	8.8	11.7	A	M			D		A			C
177	1091	A	2	H	3	120	120	11.1	14	R	P			R					R
177	1091	A	2	H	CC	9	14	14.4	17.4	B									
177	1091	A	3	H	6	26	26	24.2	26.3	A	M				D	F			R
177	1091	A	3	H	CC	12	17	25.4	27.6	R	P			A					
177	1091	A	4	H	CC	9	14	34.7	37.9	R	M			A					
177	1091	A	5	H	6	10	10	43	45.3	R	M			D		C			
177	1091	A	5	H	6	51	51	43.4	45.7	C	M			D	C			R	
177	1091	A	5	H	6	57	57	43.5	45.8	A	M			D	C			R	
177	1091	A	5	H	6	58	58	43.5	45.8	A	M			D	C			R	
177	1091	A	5	H	CC	9	15	44.1	46.4	B									
177	1091	A	6	H	1	66	66	45.6	49	A	M			D	F	F			
177	1091	A	6	H	1	80	80	45.7	49.2	A	M			D	F	C			
177	1091	A	6	H	1	120	120	46.1	49.6	C	M			D	C	F			
177	1091	A	6	H	1	135	135	46.3	49.7	C	M			D	C	F			
177	1091	A	6	H	CC	7	17	54	57.4	B									
177	1091	A	7	H	3	26	26	56.6	60.4	R	M	R		C	F	C		R	
177	1091	A	7	H	3	28	28	56.6	60.4	C	M	R		C	F	C			
177	1091	A	7	H	CC	15	20	63.7	67.5	B									
177	1091	A	8	H	5	10	10	70	74.9	C	M	C		R				F	
177	1091	A	8	H	CC	15	20	70.6	75.5	R	P	R							
177	1091	A	9	H	4	127	127	79.2	83.6	C	M	F		F		F		R	
177	1091	A	9	H	4	128	128	79.2	83.6	C	M			C		F		R	
177	1091	A	9	H	CC	11	16	81.5	85.9	R	P	R		R		R			
177	1091	A	10	H	2	99	99	85.4	90.8	A	G	C		D		C			
177	1091	A	10	H	2	130	130	85.7	91.1	A	M	A		A		A		R	
177	1091	A	10	H	3	3	3	85.9	91.3	A	M	A		A		C			
177	1091	A	10	H	5	145	145	90.4	95.7	C	P	A		C		C			
177	1091	A	10	H	6	120	120	91.6	97	C	P	A		A		F		R	
177	1091	A	10	H	CC	11	21	92.1	97.5	R	P	R		R		R			
177	1091	A	11	H	2	65	65	94.6	100	A	P	A		A		R			
177	1091	A	11	H	3	100	100	96.4	102	A	M	C		D		F			
177	1091	A	11	H	6	45	45	100	106	A	P	C		A		F			
177	1091	A	11	H	6	110	110	101	107	F	P	C		A		F			
177	1091	A	11	H	CC	17	22	102	107	R	P	R		R		R			
177	1091	A	12	H	1	13	13	102	109	C	P	C		C		F			
177	1091	A	12	H	CC	0	10	109	117	B									
177	1091	A	13	H	4	104	104	117	123	A	M	A				F		C	
177	1091	A	13	H	6	146	146	120	127	C	P	A						R	
177	1091	A	13	H	7	5	5	120	127	A	P	A		C				R	
177	1091	A	13	H	7	58	58	121	128	A	P	A		C		R		F	
177	1091	A	13	H	CC	6	16	121	128	A	M	C				R		R	
177	1091	A	14	H	2	136	136	124	132	F	P	C		A					
177	1091	A	14	H	4	67	67	126	135	A	P	C							
177	1091	A	14	H	4	130	130	127	135	F	P	C		C				R	
177	1091	A	14	H	5	30	30	127	136	A	M	C		F				F	
177	1091	A	14	H	5	108	108	128	137	A	P	C		F				R	
177	1091	A	14	H	CC	11	21	130	139	B									
177	1091	A	15	H	4	60	60	136	145	F	M	A						C	
177	1091	A	15	H	4	100	100	136	146	C	M	C						F	
177	1091	A	15	H	4	135	135	136	146	C	M	C						F	
177	1091	A	15	H	5	10	10	137	146	C	M	C						R	

Table A4 (*Continued*).

Leg	Site	Hole	Core	Type	Section	Sample top (cm)	Sample bottom (cm)	Depth (mbsf)	Depth (mcd)	Abundance	Preservation	*Pseudoemiliania lacunosa*	*Calcidiscus macintyrei*	*Gephyrocapsa* small	*Gephyrocapsa caribbeanica*	*Gephyrocapsa* medium (4–5.5 μm)	*Gephyrocapsa* large (> 5.5 μm)	*Reticulofenestra asanoi*	*Emiliania huxleyi*
177	1091	A	15	H	5	35	35	137	147	C	M	C							
177	1091	A	15	H	5	85	85	137	147	F	M	C						R	
177	1091	A	15	H	5	110	110	138	147	C	M	F						R	
177	1091	A	15	H	5	136	136	138	148	F	M	C						F	
177	1091	A	15	H	CC	11	21	138	148	B									
177	1091	A	16	H	3	130	130	144	158	C	M	F				C	F		
177	1091	A	16	H	4	20	20	145	158	F	M	F		F		F	F		
177	1091	A	16	H	CC	7	16	148	162	R	M								
177	1091	A	17	H	5	105	105	156	169	F	P	C		F		F	A		
177	1091	A	17	H	5	121	121	157	169	C	M	C		F		C	A		
177	1091	A	17	H	5	140	140	157	170	F	M	F		F		F	A		
177	1091	A	17	H	5	145	145	157	170	C	M	C		C		F	C		
177	1091	A	17	H	CC	11	14	158	171	R	M								
177	1091	A	18	H	3	4	4	162	176	F	M	C		A		F	C		
177	1091	A	18	H	3	40	40	162	177	F	M	C		C		F	C		
177	1091	A	18	H	4	77	77	164	179	F	P	F		C		F	A		
177	1091	A	18	H	6	36	36	167	181	F	P	F		C		A	A		
177	1091	A	18	H	CC	9	16	167	181	C	M	R				F	A		
177	1091	A	19	H	2	30	30	170	186	R	M	R					F		
177	1091	A	19	H	2	70	70	171	187	F	M	R		F		C	F		
177	1091	A	19	H	3	70	70	172	188	C	M	R		C		A	F		
177	1091	A	19	H	3	102	102	172	189	C	M	F		F		F	F		
177	1091	A	19	H	3	130	130	173	189	F	M	C		R		A	R		
177	1091	A	19	H	CC	8	14	176	192	B									
177	1091	A	20	H	1	90	90	179	196	C	P	F		R		C			
177	1091	A	20	H	2	90	90	180	198	F	P	C				C			
177	1091	A	20	H	3	90	90	182	199	R	P			R					
177	1091	A	20	H	4	43	43	183	200	C	P	F				C			
177	1091	A	20	H	4	60	60	183	200	A	M	F	R			A			
177	1091	A	20	H	CC	8	15	185	202	B									
177	1091	A	21	H	CC	9	14	195	212	B									
177	1091	A	22	H	CC	8	13	204	223	F	M	R		F		A			
177	1091	A	23	H	1	30	30	207	227	R	P	R		C		C			
177	1091	A	23	H	2	110	110	209	229	C	P					C			
177	1091	A	23	H	3	30	30	210	230	A	P	C				C			
177	1091	A	23	H	4	30	30	211	232	C	P	R				F			
177	1091	A	23	H	5	110	110	214	234	A	P	C							
177	1091	A	23	H	CC	8	13	214	234	C	M	F							
177	1091	A	24	H	CC	10	15	225	247	B									

Table A5

Leg	Site	Hole	Core	Type	Section	Sample top (cm)	Sample bottom (cm)	Depth (mbsf)	Depth (mcd)	Abundance	Preservation	*Pseudoemiliania lacunosa*	*Calcidiscus macintyrei*	*Gephyrocapsa* small	*Gephyrocapsa caribbeanica*	*Gephyrocapsa* medium (4–5.5 µm)	*Gephyrocapsa muellerae*	*Gephyrocapsa* large (> 5.5µm)	*Reticulofenestra asanoi*	*Emiliania huxleyi*
177	1092	B	1	H	1	10	10	0.1	0.65	A	G			R						D
177	1092	B	1	H	1	60	60	0.6	1.15	A	G			C			F			A
177	1092	C	1	H	2	7	7.5	1.57	1.57	F	M						F			A
177	1092	C	1	H	2	12	12.5	1.62	1.62	F	M						F			F
177	1092	C	1	H	2	17	17.5	1.67	1.67	F	M						F			R
177	1092	C	1	H	2	20	20.5	1.7	1.7	F	M				R		R			R
177	1092	B	1	H	1	117	117	1.17	1.72	A	M			C	F					C
177	1092	C	1	H	2	27	27.5	1.77	1.77	F	M				F					R
177	1092	C	1	H	2	62	62.5	2.12	2.12	F	M				C					R
177	1092	B	1	H	2	10	10	1.6	2.15	F	M			A	C					?
177	1092	C	1	H	2	67	67.5	2.17	2.17	F	M				C					
177	1092	C	1	H	3	32	32.5	2.73	2.73	F	M				F					
177	1092	B	1	H	2	70	70	2.2	2.75	A	G			D	F					
177	1092	A	1	H	1	30	30	0.3	2.85	F	P				D					
177	1092	B	1	H	2	126	126	2.76	3.31	A	M	F			A					
177	1092	C	1	H	3	37	37.5	3.31	3.31	F	M	F			C					
177	1092	A	1	H	1	110	110	1.1	3.65	F	P	C		C	D					
177	1092	A	1	H	2	0	0	1.5	4.05	F	P	C		A	F					
177	1092	B	1	H	3	50	50	3.5	4.05	C	M	F		C	C					
177	1092	B	1	H	3	100	100	4	4.55	A	M	R		A	F					
177	1092	B	1	H	3	122	122	4.22	4.77	A	M	F			F					
	1092	B	1	H	3	127	128	4.27	4.82	A	M	F			R					
177	1092	A	1	H	3	0	0	3	5.55	A	P	C		A		A				
177	1092	B	1	H	4	68	68	5.18	5.73	F	M	F		A		F		R	?	
177	1092	B	1	H	4	130	130	5.8	6.35	A	M	F		D		C				
177	1092	A	1	H	4	0	0	4.5	7.05	F	P	R		D						
177	1092	B	1	H	5	84	84	6.84	7.39	A	M	F		D		R				
177	1092	B	1	H	5	100	100	7	7.55	A	M	F		D						
177	1092	A	1	H	5	0	0	6	8.55	A	M	F		A					C	
177	1092	B	2	H	1	44	44	7.84	8.69	C	M	F		A		F			F	
177	1092	A	1	H	6	0	0	7.5	10.1	A	M	C		A					C	
177	1092	B	2	H	6	80	80	9.2	10.1	A	M	C		A					F	
177	1092	B	2	H	2	115	115	10.1	10.9	A	G	F		D					R	
177	1092	A	2	H	1	0	0	8	11.6	A	M	C		D						
177	1092	B	2	H	3	80	80	11.2	12.1	C	M	F		D					R	
177	1092	A	2	H	2	0	0	9.5	13.1	A	M	A		A						
177	1092	B	2	H	4	80	80	12.8	13.6	A	M	C		A						
177	1092	B	2	H	4	80	80	12.7	13.6	C	M	F		A						
177	1092	A	2	H	3	0	0	11	14.6	A	P	C		A				R		
177	1092	B	2	H	5	40	40	13.8	14.7	C	M	C								
177	1092	B	2	H	6	30	30	15.2	16.1	C	M	F		C				C		
177	1092	A	2	H	4	0	0	12.5	16.1	A	M	C		A				C		
177	1092	B	2	H	7	30	30	16.2	17.1	C	M	F		R				A		
177	1092	A	2	H	5	0	0	14	17.6	A	P	C		F		F		A		
177	1092	B	3	H	1	40	40	17.3	18.5	A	M	C		C		A		A		
177	1092	A	2	H	6	0	0	15.5	19.1	C	P	C				R		R		
177	1092	A	2	H	CC	9	14	16.1	19.7	A	M	F				F		C		
177	1092	B	3	H	2	120	120	19.6	20.8	C	P	C		C		C		C		
177	1092	B	3	H	3	40	40	20.3	21.5	A	M	F				C		A		
177	1092	A	3	H	1	0	0	17.5	22.2	A	P	A		A		F		C		
177	1092	B	3	H	4	40	40	21.8	23	A	M	F				F		F		
177	1092	A	3	H	2	0	0	19	23.7	A	P	F		A		C				
177	1092	B	3	H	5	40	40	23.3	24.5	A	M	C				A		F		
177	1092	A	3	H	3	0	0	20.5	25.2	A	P	C		C		C				
177	1092	B	3	H	5	140	140	24.3	25.5	A	M	C				C				
177	1092	A	3	H	4	0	0	22	26.7	C	P	C		A		C				
177	1092	B	4	H	1	40	40	26.8	28	A	M	F		A		F				
177	1092	A	3	H	5	0	0	23.5	28.2	A	M					F				

Table A5 (*Continued*).

Leg	Site	Hole	Core	Type	Section	Sample top (cm)	Sample bottom (cm)	Depth (mbsf)	Depth (mcd)	Abundance	Preservation	*Pseudoemiliania lacunosa*	*Calcidiscus macintyrei*	*Gephyrocapsa* small	*Gephyrocapsa caribbeanica*	*Gephyrocapsa* medium (4–5.5 µm)	*Gephyrocapsa muellerae*	*Gephyrocapsa* large (> 5.5µm)	*Reticulofenestra asanoi*	*Emiliania huxleyi*
177	1092	B	4	H	1	90	90	27.3	28.5	A	M	C		C		C				
177	1092	A	3	H	6	0	0	25	29.7	A	M	C				F				
177	1092	B	4	H	2	140	140	29.3	30.5	A	M	F				F				
177	1092	A	3	H	CC	9	14	26.2	31	F	P	F			R	R				
177	1092	B	4	H	3	40	40	29.8	31	A	M	R		F		C				
177	1092	A	4	H	1	0	0	27	31.9	F	P	F		F						
177	1092	B	4	H	3	140	140	30.8	32	A	M	R		C		R				
177	1092	B	4	H	3	140	140	30.8	32	C	M	F		F						
177	1092	B	4	H	4	40	40	31.3	32.5	A	M	F		F						
177	1092	A	4	H	2	0	0	28.5	33.4	C	P	C		C		?				
177	1092	B	4	H	4	140	140	32.3	33.5	C	M	F		F						
177	1092	A	4	H	3	0	0	30	34.9	A	P	C								
177	1092	B	4	H	6	60	60	34.5	35.7	C	M	F								
177	1092	A	4	H	4	0	0	31.5	36.4	A	P	C		C						
177	1092	A	4	H	5	0	0	33	37.9	A	M	C								
177	1092	A	4	H	6	0	0	34.5	39.4	A	P	C		F						
177	1092	B	5	H	1	130	130	37.2	39.4	C	M	F		F						
177	1092	B	5	H	2	30	30	37.7	39.9	C	M	C		F						
177	1092	A	4	H	7	0	0	36	40.9	A	M	F								
177	1092	A	4	H	CC	9	14	36.7	41.6	A	M	F								
177	1092	B	5	H	3	140	104	40.3	42.5	C	M	F		F						
177	1092	B	5	H	5	40	40	42.3	44.5	C	M	F		R						
177	1092	B	6	H	1	30	30	45.7	49.5	C	M	R								
177	1092	A	5	H	CC	10	15	45.8	51.7	A	G	C								
177	1092	A	6	H	3	100	100	50	57.9	A	G	F								
177	1092	B	7	H	1	60	60	55.5	58.2	C	M	?		F						
177	1092	A	6	H	4	100	100	51.5	59.4	A	M	F								
177	1092	A	6	H	5	100	100	53	60.9	A	M	C	R	D						
177	1092	A	6	H	6	0	0	53.5	61.4	A	M	F		A						
177	1092	A	6	H	6	100	100	54.5	62.4	A	M	R		A						
177	1092	A	6	H	CC	0	10	54.8	62.7	A	M	R		R						
177	1092	A	7	H	1	0	0	55.5	64.2	C	P	F								
177	1092	A	7	H	1	100	100	56.5	65.2	A	M									
177	1092	A	7	H	2	100	100	58	66.7	A	M		R							
177	1092	A	7	H	3	100	100	59.5	68.2	A	M		F							
177	1092	A	7	H	4	100	100	61	69.7	A	M									
177	1092	A	7	H	5	100	100	62.5	71.2	A	M									
177	1092	A	7	H	CC	15	20	64.8	73.5	A	M									
177	1092	A	8	H	1	100	100	66	75.5	A	M									
177	1092	A	8	H	2	100	100	67.5	77	A	M									
177	1092	A	8	H	3	100	100	69	78.5	A	M									
177	1092	A	8	H	4	100	100	70.5	80	A	M		R							
177	1092	A	8	H	5	100	100	72	81.5	A	M									
177	1092	A	8	H	6	100	100	73.5	83	A	M									
177	1092	A	8	H	CC	11	16	73.7	83.2	A	P									
177	1092	A	9	H	1	70	70	75.2	84.5	A	M									
177	1092	A	9	H	2	70	70	76.7	86	A	M									
177	1092	A	9	H	3	70	70	78.2	87.5	A	M									
177	1092	A	9	H	4	70	70	79.7	89	A	M									
177	1092	A	9	H	5	70	70	81.2	90.5	A	M									
177	1092	A	9	H	6	70	70	82.6	91.9	A	M									
177	1092	A	9	H	CC	10	15	84	93.3	A	M		R							
177	1092	A	10	H	CC	15	20	93.6	104	A	M									
177	1092	A	11	H	CC	0	10	103	115	A	M									
177	1092	A	12	H	CC	28	33	113	125	A	M									
177	1092	A	13	H	CC	10	15	122	136	A	M		R							
177	1092	A	14	H	CC	10	15	131	147	A	M		R							
177	1092	A	15	H	CC	14	19	141	159	A	M									

Table A5 (*Continued*).

Leg	Site	Hole	Core	Type	Section	Sample top (cm)	Sample bottom (cm)	Depth (mbsf)	Depth (mcd)	Abundance	Preservation	*Pseudoemiliania lacunosa*	*Calcidiscus macintyrei*	*Gephyrocapsa* small	*Gephyrocapsa caribbeanica*	*Gephyrocapsa* medium (4–5.5 µm)	*Gephyrocapsa muellerae*	*Gephyrocapsa* large (> 5.5µm)	*Reticulofenestra asanoi*	*Emiliania huxleyi*
177	1092	A	17	H	1	0	0	151	169	A	M									
177	1092	A	16	H	CC	14	19	150	169	A	M									
177	1092	A	17	H	2	0	0	152	170	A	M									
177	1092	A	17	H	5	0	0	156	174	A	M		R							
177	1092	A	17	H	6	0	0	157	176	A	M		R							
177	1092	A	17	H	CC	32	37	159	177	A	M									

Table A6

Leg	Site	Hole	Core	Type	Section	Sample top (cm)	Sample bottom (cm)	Depth (mbsf)	Depth (mcd)	Abundance	Preservation	*Pseudoemiliania lacunosa*	*Calcidiscus leptoporus*	*Calcidiscus macintyrei*	*Gephyrocapsa* small	*Gephyrocapsa caribbeanica*	*Gephyrocapsa* medium (4–5.5 μm)	*Gephyrocapsa* large (> 5.5 μm)	*Reticulofenestra asanoi*	*Emiliania huxleyi*
177	1093	A	1	H	1	80	80	0.8	0.8	C	G		C		A					D
177	1093	A	1	H	4	60	60	5.1	5.1	F	G		A		A					A
177	1093	A	1	H	6	80	80	8.3	8.3	R	M		C				F			A
177	1093	A	1	H	CC	12	17	8.49	8.49	R	M		F		A		F			A
177	1093	A	2	H	3	30	30	11.8	12	R	P		R		C					A
177	1093	A	2	H	5	30	30	14.8	15	R	P				A		R			C
177	1093	A	2	H	6	30	30	16.3	16.5	R	M		R		C		C			C
177	1093	A	2	H	CC	12	17	18.1	18.3	B										
177	1093	A	3	H	1	30	30	18.3	19.7	A	M		C		D					A
177	1093	A	3	H	2	30	30	19.8	21.2	A	M		F		A					D
177	1093	A	3	H	4	30	30	22.8	24.2	C	P		C		A		C			D
177	1093	A	3	H	CC	11	16	27.7	29.1	R	P		C		R					A
177	1093	A	4	H	1	30	30	27.8	31.8	A	P		A				F			A
177	1093	A	4	H	2	40	40	29.4	33.4	A	M		A		A		C			A
177	1093	A	4	H	2	120	120	30.2	34.2	A	M		A		A		C			F
177	1093	A	4	H	3	30	30	30.8	34.8	R	P		C		A					?
177	1093	A	4	H	4	30	30	32.3	36.3	B										
177	1093	A	4	H	CC	10	15	37.5	41.5	B										
177	1093	A	5	H	3	30	30	40.3	43.7	B										
177	1093	A	5	H	6	30	30	44.8	48.2	R	P		C		C		C			
177	1093	A	5	H	7	20	20	46.2	49.6	R	M		F		C		F			F
177	1093	A	5	H	CC	15	20	46.9	50.2	B										
177	1093	A	6	H	2	69	69	48.7	54	B										
177	1093	A	6	H	6	30	30	54.3	59.6	B										
177	1093	A	6	H	CC	0	10	56	61.4	R	M				C		C			
177	1093	A	7	H	1	132	132	57.3	63.7	R	P		F		C		D			F
177	1093	A	7	H	2	35	35	57.9	64.2	R	M		C		C		F			R
177	1093	A	7	H	CC	24	29	65.5	71.8	R	M		C		A		C			
177	1093	A	8	H	1	25	25	65.8	73.3	C	M		F			A				F
177	1093	A	8	H	1	140	140	66.9	74.4	C	M		C		A	A				C
177	1093	A	8	H	2	65	65	67.7	75.2	F	P				A	A				?
177	1093	A	8	H	CC	0	10	75.1	82.6	B										
177	1093	A	9	H	CC	15	20	84.8	92.4	B										
177	1093	A	10	H	CC	0	10	93.9	103	F	M	?	R		D					
177	1093	A	11	H	1	30	30	94.3	105	F	M		F		D		F			
177	1093	A	11	H	2	10	10	95.6	106	C	M				A	A	F			
177	1093	A	11	H	4	40	40	98.9	109	B										
177	1093	A	11	H	CC	16	21	104	114	B										
177	1093	A	12	H	2	30	30	105	117	B										
177	1093	A	12	H	5	120	120	111	122	B										
177	1093	A	12	H	7	30	30	113	124	A	M				D	F	F			
177	1093	A	12	H	CC	0	10	113	125	A	M				D		R			
177	1093	A	13	H	1	80	80	114	125	A	P		F			D	F			
177	1093	A	13	H	3	80	80	117	128	C	M		F		D		F			
177	1093	A	13	H	4	30	30	118	129	C	M				D		A			
177	1093	A	13	H	5	60	60	120	131	C	M		F		D		C			
177	1093	A	13	H	CC	15	20	122	134	B										
177	1093	A	14	H	5	110	110	130	142	R	P				D		F			
177	1093	A	14	H	CC	10	15	132	144	B										
177	1093	A	14	H	5	110	110	130	142	R	P				D		F			
177	1093	A	15	H	2	40	40	134	146	R	P				D		F			
177	1093	A	15	H	5	40	40	138	151	R	M	?			A		F			
177	1093	A	15	H	6	40	40	140	152	R	M	R			A		F			
177	1093	A	15	H	7	40	40	141	154	R	M	R	R		D		F			
177	1093	A	15	H	CC	11	16	142	154	R	P				R		R			
177	1093	A	16	H	3	129	129	146	159	A	P	F	R			D	R			
177	1093	A	16	H	4	23	23	146	160	C	P	R				A	C			
177	1093	A	16	H	5	94	94	148	162	C	P		R		C	A	F			?

Table A6 (*Continued*).

Leg	Site	Hole	Core	Type	Section	Sample top (cm)	Sample bottom (cm)	Depth (mbsf)	Depth (mcd)	Abundance	Preservation	*Pseudoemiliania lacunosa*	*Calcidiscus leptoporus*	*Calcidiscus macintyrei*	*Gephyrocapsa* small	*Gephyrocapsa caribbeanica*	*Gephyrocapsa* medium (4–5.5 μm)	*Gephyrocapsa* large (> 5.5 μm)	*Reticulofenestra asanoi*	*Emiliania huxleyi*
177	1093	A	16	H	CC	0	10	151	164	B										
177	1093	A	17	H	3	119	119	155	168	C	P	C	F		C		R			
177	1093	A	17	H	4	12	12	156	169	C	P	F	F		A		F			
177	1093	A	17	H	5	12	12	157	170	A	M	A	C		A		A			
177	1093	A	17	H	5	126	126	158	171	A	M	A	C				C		R	
177	1093	A	17	H	CC	24	29	161	174	R	P	R			R					
177	1093	A	18	H	2	10	10	162	176	C	P	A	C				F			
177	1093	A	18	H	3	44	44	164	178	C	P	A	C	R			C			
177	1093	A	18	H	5	30	30	167	181	C	P	C	C				A			
177	1093	A	18	H	6	20	20	168	182	C	P	A	C				A			
177	1093	A	18	H	7	70	70	170	184	C	P	C	C				F			
177	1093	A	18	H	CC	10	15	170	185	F	M	C	C		F		R		R	
177	1093	A	19	H	1	44	44	170	188	R	M	F	R		C				1	
177	1093	A	19	H	6	44	44	178	195	B										
177	1093	A	19	H	7	60	60	180	197	R	M	C			D		F			
177	1093	A	19	H	CC	17	22	180	197	B										
177	1093	A	20	H	2	30	30	181	200	C	P	F	R		D					
177	1093	A	20	H	4	60	60	185	204	C	M	C	C		A				R	
177	1093	A	20	H	6	50	50	188	207	R	M	C	F		R					
177	1093	A	20	H	CC	17	22	189	208	B										
177	1093	A	21	H	2	110	110	192	212	C	M	F	C		D					
177	1093	A	21	H	4	22	22	194	214	A	M	R	C		D		F			
177	1093	A	21	H	6	40	40	197	217	A	M	F	C		D					
177	1093	A	21	H	CC	48	53	198	219	B										
177	1093	A	22	H	1	30	30	199	219	C	P	F	C		A		R			
177	1093	A	22	H	1	90	90	199	220	C	P	C	C			C	F			
177	1093	A	22	H	2	30	30	200	221	A	M	C	C		C		F			
177	1093	A	22	H	CC	0	10	207	228	R	P	R					R		R	
177	1093	A	23	H	3	90	90	212	233	R	P		R				R		F	
177	1093	A	23	H	3	122	122	212	233	R	P	C	C				R		F	
177	1093	A	23	H	5	43	43	214	236	F	P								C	
177	1093	A	23	H	5	128	128	215	236	C	P	C	C				F		A	
177	1093	A	23	H	6	54	54	216	237	F	P		F						C	
177	1093	A	23	H	CC	0	10	218	239	F	M	C	A				R		C	
177	1093	A	24	H	2	130	130	220	242	A	P	C	A				F		C	
177	1093	A	24	H	5	15	15	224	246	A	P		C		A		R		R	
177	1093	A	24	H	5	140	140	225	247	A	M		C		A		cf.		F	
177	1093	A	24	H	6	50	50	226	247	A	P	A	C		A				R	
177	1093	A	24	H	CC	35	40	227	249	C	M	C	A						R	
177	1093	A	25	H	CC	25	30	235	256	B										
177	1093	A	26	H	6	50	50	243	263	A	P	A	C		A				R	
177	1093	A	26	H	CC	19	24	244	264	F	P	F	F		F					
177	1093	A	28	X	2	100	100	254	274	C	M	C	F							
177	1093	A	28	X	3	34	34	254	275	C	M	C								
177	1093	A	28	X	CC	12	17	258	279	R	P	D								
177	1093	A	29	X	1	30	30	261	282	F	R	F	F							
177	1093	A	29	X	CC	13	18	265	285	B										
177	1093	A	30	H	1	50	50	271	292	F	M	A	F							
177	1093	A	30	H	2	31	31	272	293	F	M	A	C							
177	1093	B	1	H	2	8	13	7.1	6.86	B										
177	1093	B	2	H	3	0	10	16.2	17	R	P				C					A
177	1093	B	3	H	4	8	13	21.9	30.3	A	M		C		A		C			F
177	1093	B	4	H	1	9	14	35.8	35.7	B										
177	1093	B	5	H	1	4	12	45.2	47.7	B										
177	1093	B	6	H	5	15	20	53.1	65.9	B										
177	1093	B	7	H	6	10	15	63.9	76	B										
177	1093	B	8	H	6	7	12	73.4	86.1	R	M		R		A	D	R			?
177	1093	B	9	H	CC	10	15	83.2	99.3	B										

Table A6 (*Continued*).

Leg	Site	Hole	Core	Type	Section	Sample top (cm)	Sample bottom (cm)	Depth (mbsf)	Depth (mcd)	Abundance	Preservation	*Pseudoemiliania lacunosa*	*Calcidiscus leptoporus*	*Calcidiscus macintyrei*	*Gephyrocapsa* small	*Gephyrocapsa caribbeanica*	*Gephyrocapsa* medium (4–5.5 μm)	*Gephyrocapsa* large (> 5.5 μm)	*Reticulofenestra asanoi*	*Emiliania huxleyi*
177	1093	B	10	H	CC	17	22	91.9	108	B										
177	1093	B	11	H	CC	12	17	102	121	B			F		D	A				
177	1093	B	12	H	2	40	40	104	124	A	M		R		D		F			
177	1093	B	12	H	3	40	40	106	125	A	M		F		D		F			
177	1093	B	12	H	4	100	100	108	127	C	M		C		D		C			
177	1093	B	12	H	CC	18	23	110	130	C	M									
177	1093	B	13	H	1	94	94	113	131	C	M		F		D		C			
177	1093	B	13	H	CC	16	21	121	140	B										
177	1093	B	14	H	1	110	110	122	142	R	P				D		R			
177	1093	B	14	H	CC	11	16	130	150	R	M		F			C	R			
177	1093	B	15	H	5	40	40	136	157	R	M		R		D		F			
177	1093	B	15	H	6	40	40	138	159	R	M	R			D		F			
177	1093	B	15	H	6	70	70	138	159	R	M	C	R		D		F			
177	1093	B	15	H	CC	6	40	139	159	F	R	R	R		D		R			
177	1093	B	16	H	CC	7	12	149	170	F	M	C	F		D		F			
177	1093	B	17	H	CC	7	12	159	180	R	P	A			F		F			
177	1093	B	18	H	CC	0	7	167	192	B										
177	1093	B	19	H	CC	6	11	178	203	F	R	C	F		D		F			
177	1093	B	20	H	CC	23	28	187	215	R	P		R		C		R			
177	1093	B	21	H	CC	14	19	195	224	B										
177	1093	B	22	H	CC	15	20	205	233	R	P	F							R	
177	1093	B	23	H	CC	24	29	216	245	A	M	C	F		C				R	
177	1093	B	24	H	CC	0	10	222	252	C	P	C	A		C				F	
177	1093	C	1	H	CC	0	12	7.88	14.9	R	P			C		R	C			F
177	1093	C	2	H	CC	0	10	13.8	23.3	R	P		C				R			C
177	1093	C	3	H	CC	14	19	25.1	35.3	R	P		R		F					R
177	1093	C	4	H	CC	11	16	36.6	48.1	B										
177	1093	C	5	H	CC	11	16	44.5	58.9	R	P		R			C	A			
177	1093	C	6	H	CC	17	22	52.2	68	B										
177	1093	C	7	H	CC	0	10	64.6	78.4	B										
177	1093	C	8	H	CC	24	29	74.1	89.3	B										
177	1093	C	9	H	CC	15	20	83	100	B										
177	1093	C	10	H	CC	8	15	91.1	109	B										
177	1093	C	11	H	CC	13	18	101	120	B										
177	1093	C	12	H	CC	6	11	111	131	F	P				D		F			
177	1093	C	13	H	CC	13	18	114	138	B										
177	1093	C	14	H	CC	15	20	128	147	R	P	R			D		C			
177	1093	C	15	H	CC	9	14	137	161	R	M	F			D					
177	1093	C	16	H	CC	0	7	144	168	A	P	C	C		A		F			
177	1093	C	17	H	CC	9	14	155	181	A	P	A	A				F			
177	1093	C	18	H	CC	11	16	162	189	B										
177	1093	D	1	H	CC	0	4	143	159	C	P	R			C	C				
177	1093	D	2	H	CC	20	25	148	164	B										
177	1093	D	3	H	CC	0	10	160	175	F	P	F	F		C		R			
177	1093	D	4	H	CC	14	19	173	191	B										
177	1093	D	5	H	3	0	0	177	195	C	P	C	C		C		F			
177	1093	D	5	H	6	0	0	182	200	C	P	C	C		A		F			
177	1093	D	5	H	CC	0	10	183	201	C	P	C	C		A					
177	1093	D	6	H	1	0	0	184	205	C	P	C	C		C		F			
177	1093	D	6	H	CC	0	10	189	211	C	P	F	C		A		F			
177	1093	D	7	H	1	0	0	193	214	A	M	F	C		D		R			
177	1093	D	8	H	3	0	0	206	227	R	P	D							R	
177	1093	D	8	H	4	0	0	207	229	F	P	C	F						F	
177	1093	D	8	H	CC	10	15	208	230	B										
177	1093	D	10	H	3	0	0	225	249	A	M	C	C		A				F	
177	1093	D	10	H	4	0	0	226	251	A	G	C	C		C				C	
177	1093	D	10	H	CC	0	10	227	251	A	M	C	A		A				C	
177	1093	D	11	H	2	0	0	233	255	R	P	C	C						R	

Table A6 (*Continued*).

Leg	Site	Hole	Core	Type	Section	Sample top (cm)	Sample bottom (cm)	Depth (mbsf)	Depth (mcd)	Abundance	Preservation	*Pseudoemiliania lacunosa*	*Calcidiscus leptoporus*	*Calcidiscus macintyrei*	*Gephyrocapsa* small	*Gephyrocapsa caribbeanica*	*Gephyrocapsa* medium (4–5.5 μm)	*Gephyrocapsa* large (> 5.5 μm)	*Reticulofenestra asanoi*	*Emiliania huxleyi*
177	1093	D	11	H	3	0	0	234	256	A	P	C	F						?	
177	1093	D	11	H	4	0	0	236	258	A	M	C	C		C				C	
177	1093	D	11	H	5	0	0	237	259	A	M	A	C						R	
177	1093	D	11	H	CC	0	10	238	260	A	M	A	C		A				F	
177	1093	D	12	H	1	0	0	241	266	C	P	R	C							
177	1093	D	12	H	4	0	0	245	270	C	P	A	C		C					
177	1093	D	12	H	CC	15	20	246	271	R	P	C	C							
177	1093	D	13	H	4	0	0	255	276	C	P	A	C		C			R		
177	1093	D	14	H	CC	0	10	260	286	R	P	A	F		C			R		
177	1093	D	15	H	CC	0	5	270	296	F	M	A	F		R					
177	1093	D	15	H	1	0	0	269	295	R	M	C	R				R			
177	1093	D	16	H	CC	0	5	279	305	R	P									
177	1093	D	17	H	CC	0	10	288	315	R	P	C	F		F			C		
177	1093	D	18	H	CC	0	2	298	324	R	P	R	F				C	A		
177	1093	D	21	X	CC	0	1	319	345	C	P	R	R				F			
177	1093	D	27	X	CC	9	14	373	399	A	P	C	C		A		?			
177	1093	D	28	X	CC	5	15	379	405	C	P	C	F		C		?			
177	1093	D	32	X	CC	20	24	415	441	B										
177	1093	D	33	X	CC	13	18	434	460	B										
177	1093	D	34	X	CC	24	29	441	467	B										
177	1093	D	35	X	2	30	30	446	472	C	M	F	F	R						
177	1093	D	35	X	4	40	40	449	475	C	M	C			F					
177	1093	D	35	X	5	80	80	451	477	C	M	F	F		R					
177	1093	D	35	X	CC	0	1	453	479	B										
177	1093	D	36	X	3	90	90	457	483	C	M	F								
177	1093	D	36	X	4	90	90	459	485	C	M	F								
177	1093	D	36	X	5	90	90	460	486	F	M	F	A				R			
177	1093	D	36	X	6	70	70	462	488	C	M	F								
177	1093	D	36	X	CC	24	29	463	489	B										
177	1093	D	37	X	CC	20	25	473	499	B										
177	1093	D	38	X	CC	48	53	480	506	B										
177	1093	D	39	X	CC	13	18	489	515	B										
177	1093	D	40	X	CC	4	6	496	522	R	P	R			F					
177	1093	D	41	X	1	0	0	501	527	F	P		F							
177	1093	D	41	X	CC	26	31	503	529	B										
177	1093	D	44	X	1	0	0	530	556	R	P	R			R					
177	1093	D	45	X	3	0	0	543	569	C	P		F							
177	1093	D	46	X	1	0	0	550	576	C	P	R								
177	1093	D	47	X	1	0	0	559	585	C	P	R	F							
177	1093	D	48	X	CC	17	19	569	595	B										
177	1093	D	50	X	CC	0	2	589	615	C	P									
177	1093	E	1	H	CC	10	15	10.5	11.1	B										
177	1093	E	2	H	CC	13	18	37.9	44.4	B										

Table A7

Leg	Site	Hole	Core	Type	Section	Sample top (cm)	Sample bottom (cm)	Depth (mbsf)	Depth (mcd)	Abundance	Preservation	*Pseudoemiliania lacunosa*	*Calcidiscus leptoporus*	*Gephyrocapsa* small	*Gephyrocapsa caribbeanica*	*Gephyrocapsa* medium (4–5.5 μm)	*Gephyrocapsa* large (> 5.5μm)	*Reticulofenestra asanoi*	*Emiliania huxleyi*
177	1094	A	1	H	2	120	120	2.7	2.7	B									
177	1094	A	1	H	3	80	80	3.8	3.8	B									
177	1094	A	1	H	CC	15	20	4.57	4.57	B									
177	1094	A	2	H	1	30	30	4.9	6.44	B									
177	1094	C	1	H	CC	19	24	8.89	9.17	B									
177	1094	B	1	H	CC	7	12	9.24	9.76	B									
177	1094	A	2	H	6	95	95	13.1	14.6	B									
177	1094	A	2	H	6	136	136	13.5	15	R	P		F	F		F			
177	1094	A	2	H	CC	14	19	13.8	15.3	B									
177	1094	A	3	H	1	50	50	14.6	17	B									
177	1094	A	3	H	3	30	30	17.4	19.8	B									
177	1094	B	2	H	CC	10	15	18.9	19.9	B									
177	1094	C	2	H	CC	13	18	18.8	20.5	B									
177	1094	A	3	H	5	130	130	21.4	23.8	B									
177	1094	A	3	H	6	20	20	21.8	24.2	C	P		C	F		F			A
177	1094	A	3	H	6	50	50	22.1	24.5	F	P		F	F		F			R
177	1094	A	3	H	CC	13	18	22.3	24.7	R	P		A	A		R			F
177	1094	C	3	H	CC	6	13	28	29.7	B									
177	1094	D	2	H	1	40	40	29	32.7	B									
177	1094	A	4	H	CC	14	19	31.8	35.2	B									
177	1094	B	4	H	CC	30	35	33.1	36	B									
177	1094	D	2	H	3	116	116	32.8	36.4	B									
177	1094	D	2	H	CC	9	14	33.8	37.5	C	M		C		F	F			F
177	1094	A	5	H	3	110	110	37.2	39.6	C	M		C	A	D	F			A
177	1094	A	5	H	3	146	146	37.6	40	A	M		C		A	F			D
177	1094	A	5	H	4	30	30	37.9	40.3	C	P		C		C	F			
177	1094	A	5	H	CC	12	17	41.2	43.6	R	P		F	C	C				
177	1094	C	5	H	CC	13	18	45.7	47.4	B									
177	1094	D	3	H	CC	0	10	47	49.5	B									
177	1094	A	6	H	5	122	122	49.8	52.8	A	M		R	D					
177	1094	D	4	H	2	90	90	50	52.9	A	M		R	D	A	R			
177	1094	A	6	H	5	147	147	50.1	53	A	M			D	F	R			
177	1094	A	6	H	6	15	15	50.3	53.2	A	M			D	C				
177	1094	D	4	H	2	139	139	50.5	53.4	A	M		R	A	A	R			
177	1094	D	4	H	CC	0	10	56	58.9	B									
177	1094	D	5	H	CC	0	5	57.1	60	A	M				A				
177	1094	A	7	H	5	110	110	59.2	61.3	C	M		F	D	F	F			
177	1094	A	7	H	6	40	40	60	62.1	F	M			D	F	R			
177	1094	A	7	H	6	90	90	60.5	62.6	C	M			D	R	F			
177	1094	A	7	H	CC	9	16	60.8	62.9	C	P			D		F			
177	1094	A	8	H	3	140	140	66	68.1	R	M			D	F	C			
177	1094	D	6	H	1	5	5	66.7	68.4	B									
177	1094	C	8	H	CC	0	2	67.2	69.5	B									
177	1094	D	6	H	2	90	90	69	70.8	B									
177	1094	A	8	H	CC	8	13	70.6	72.7	B									
177	1094	A	9	H	2	17	17	72.8	75.6	R	P	A	C						
177	1094	D	6	H	CC	0	10	76	77.8	F	P		R		C				
177	1094	D	7	H	2	30	30	77.9	80.5	F	M		C	D					
177	1094	D	7	H	2	87	87	78.5	81.1	R	M		F			F			
177	1094	A	9	H	CC	14	19	79.1	81.9	B									
177	1094	D	7	H	4	149	149	82.1	84.7	R	M	A				C			
177	1094	D	7	H	5	5	5	82.2	84.8	R	P	A	C						
177	1094	D	7	H	CC	0	10	82.2	84.8	R	P	A	C						
177	1094	A	10	H	CC	0	10	89.7	92.1	B									
177	1094	D	8	H	CC	13	18	93.2	96.5	R	P	F			R				
177	1094	A	11	H	5	120	120	97.3	100	F	M	F	A	D					
177	1094	A	11	H	CC	12	17	98	101	C	P		F	D					
177	1094	D	9	H	3	24	24	98.3	101	F	M	F	C	D		F			
177	1094	A	1	H	2	120	120	2.7	2.7	B									

Table A7 (*Continued*).

Leg	Site	Hole	Core	Type	Section	Sample top (cm)	Sample bottom (cm)	Depth (mbsf)	Depth (mcd)	Abundance	Preservation	*Pseudoemiliania lacunosa*	*Calcidiscus leptoporus*	*Gephyrocapsa* small	*Gephyrocapsa caribbeanica*	*Gephyrocapsa* medium (4–5.5 μm)	*Gephyrocapsa* large (> 5.5μm)	*Reticulofenestra asanoi*	*Emiliania huxleyi*
177	1094	D	9	H	4	80	80	100	103	R	M	A		C					
177	1094	D	9	H	CC	12	17	101	103	B									
177	1094	A	12	H	3	127	127	104	105	R	M	A	F	C		C			
177	1094	D	10	H	1	10	10	105	106	R	M	C		R		C			
177	1094	A	12	H	4	119	119	105	107	R	M	F	A	A					
177	1094	D	10	H	2	120	120	107	109	R	M	F		F					
177	1094	A	12	H	CC	0	10	108	110	B									
177	1094	D	10	H	CC	13	18	111	112	B									
177	1094	A	13	H	2	132	132	112	114	F	P	C	C					F	
177	1094	A	13	H	3	42	42	113	115	F	P	F	C					F	
177	1094	A	13	H	3	140	140	114	116	F	P	F				F		R	
177	1094	D	11	H	1	30	30	114	116	R	M	F				F		F	
177	1094	A	13	H	4	65	65	114	117	A	M	F	C	C		F		R	
177	1094	D	11	H	1	116	116	115	117	F	M	F		C		F		F	
177	1094	A	13	H	CC	0	10	117	119	F	P	F				R		R	
177	1094	D	11	H	CC	22	27	120	121	B									
177	1094	A	14	H	1	137	137	120	123	B									
177	1094	A	14	H	3	3	3	122	124	F	P	R	F			R		R	
177	1094	A	14	H	3	25	25	122	125	R	P		R			F		R	
177	1094	A	14	H	3	66	66	122	125	C	P	R	F	C		F		R	
177	1094	A	14	H	3	88	88	122	125	F	R	F	F			cf.		R	
177	1094	A	14	H	4	30	30	123	126	C	P	F						R	
177	1094	A	14	H	CC	0	10	124	126	A	P	C	R	F				R	
177	1094	D	12	H	2	117	117	126	128	F	M	R				R		F	
177	1094	D	12	H	3	126	126	128	129	F	P	R							
177	1094	A	15	H	1	30	30	128	131	C	P	C	R					R	
177	1094	D	12	H	4	120	120	129	131	C	P	F	R	F					
177	1094	A	15	H	2	112	112	131	133	F	P	C	F						
177	1094	D	12	H	CC	11	16	132	133	F	P	C	F						
177	1094	A	15	H	3	24	24	131	134	C	P	A	F						
177	1094	D	13	H	3	102	102	137	139	A	M	C	R	C		R			
177	1094	D	13	H	CC	14	19	137	139	C	P	A	F						
177	1094	A	15	H	CC	15	20	137	140	F	P	C	C						
177	1094	A	16	H	1	40	40	138	140	F	M	A	F						
177	1094	A	16	H	3	98	98	142	144	R	M	R	C	R			C		
177	1094	A	16	H	3	130	130	142	144	R	M	R	C	R			C		
177	1094	A	16	H	4	12	12	142	145	F	M	F					F		
177	1094	A	16	H	6	92	92	145	147	R	M		F				C		
177	1094	A	16	H	CC	0	10	145	147	C	P	F				R	C		
177	1094	D	14	H	3	110	110	147	150	C	P	F				C	C		
177	1094	D	14	H	4	10	10	147	151	C	P	R				C	R		
177	1094	D	14	H	5	20	20	149	153	F	P	R	R			F	R		
177	1094	D	14	H	5	120	120	150	154	F	P	R	F	F		C	R		
177	1094	D	14	H	6	17	17	150	154	R	P		F			R	C		
177	1094	D	15	H	2	30	30	154	156	P	P	F	F	R		F	F		
177	1094	D	15	H	3	50	50	156	157	C	P	C				F	R		
177	1094	D	15	H	4	117	117	158	160	F	P	F	F			C	R		
177	1094	A	18	H	CC	18	23	158	160	F	P	R	F			C			
177	1094	D	15	H	6	80	80	160	162	F	P	R	F			C	F		
177	1094	D	15	H	CC	10	15	161	163	B									
177	1094	D	16	H	1	34	34	162	164	F	P	R	R			F	F		
177	1094	D	16	H	1	140	140	163	165	C	P	F	F			F	C		
177	1094	D	16	H	2	30	30	163	165	C	P	F	F			C	C		
177	1094	D	16	H	2	87	87	164	166	C	P	F	R			C			
177	1094	D	16	H	3	50	50	165	167	F	P	C	C			R			
177	1094	D	16	H	3	100	100	166	167	F	P	F	F			F			
177	1094	D	16	H	3	140	140	166	168	F	P	F	F			F			
177	1094	D	16	H	4	24	24	166	168	R	P	F	R			F			
177	1094	D	16	H	CC	0	5	168	170	R	M	F		F		A			

References

Bollmann, J., Baumann, K.H., Thierstein, H.R., 1998. Global dominance of *Gephyrocapsa* coccoliths in the late Pleistocene: Selective dissolution, evolution, or global environmental change? Paleoceanography 13, 517–529.

Channell, J.E.T., Stoner, J.S., 2002. Plio–Pleistocene magnetic polarity stratigraphies and diagenetic magnetite dissolution at ODP Leg 177 Sites (1089, 1091, 1093 and 1094). Mar. Micropaleontol. 45, S0377-8398(02)00032-4.

Crux, J.A., 1991. Calcareous nannofossils recovered by Leg 114 in the Subantarctic South Atlantic Ocean. In: Ciesielski, P.F., Kristoffersen, Y. et al. (Eds.), Proc. ODP Sci. Results 114, 155–177.

Flores, J.A., Gersonde, R., Sierro, F.J., 1999. Pleistocene fluctuations in the Agulhas Current Retroflection based on the calcareous plankton record. Mar. Micropaleontol. 37, 1–22.

Flores, J.A., Sierro, F.J., Gersonde, R., Niebler, H.S., 2000. Southern Ocean Pleistocene calcareous nannofossil events: Calibration with the isotope and geomagnetic stratigraphies. Mar. Micropaleontol. 40, 377–402.

Gard, G., 1989. Quaternary calcareous nannofossil biostratigraphy: The eastern Arctic Ocean record. In: Herman, Y. (Ed.), The Arctic Seas. Climatology, Oceanography, Geology and Biology. Van Norstrand Reinhold, New York, pp. 445–459.

Gard, G., Crux, J., 1991. Preliminary results from Hole 704A: Arctic–Antarctic correlation through nannofossil biochronology. In: Ciesielski, P.F., Kristoffersen, Y. et al. (Eds.), Proc. ODP Sci. Results 114, 193–200.

Gartner, S., 1977. Calcareous nannofossil biostratigraphy and revised zonation of the Pleistocene. Mar. Micropaleontol. 2, 1–25.

Gersonde, R., Hodell, D.A., Blum, P. et al., 1999. Proc. ODP, Init. Rep. 177 [CD-ROM].

Giraudeau, J., Pujos, A., 1990. Fonction de transfer basée sur les nannofossiles calcaires du Pleistocène des Caribes. Oceanol. Acta 13, 453–469.

Hine, N., Weaver, P.P.E., 1998. Quaternary. In: Bown, P.R. (Ed.), Calcareous Nannofossil Biostratigraphy. Chapman and Hall, London, pp. 266–283.

Hodell, D., Charles, C.D., Sierro, F.J., 2001. Late Pleistocene evolution of the ocean's carbonate system. Earth Planet. Sci. Lett. 192, 109–124.

Jordan, R.W., Zhao, M., Eglinton, G., Weaver, P.P.E., 1996. Coccolith and alkenone stratigraphy and palaeoceanography at an upwelling site off NW Africa (ODP 658C) during the last 130 000 years. In: Whatley, R., Moguilevsky, A. (Eds.), Microfossils and Oceanic Environments. University of Wales, Aberystwyth Press, Aberystwyth, pp. 111–130.

Kennett, J.P., Barron, J.A., 1992. Introduction. In: Kennett, J.P., Warnke, D.A. (Eds.), The Antarctic Paleoenvironment: A Perspective on Global Change 56. American Geophysical Union, Washington, DC, pp. 1–6.

Matsuoka, H., Okada, H., 1990. Time-progressive morphometrical changes of the genus *Gephyrocapsa* in the Quaternary sequence of the tropical Indian Ocean, Site 709. In: Duncan, R.A., Backman, J., Peterson, L.C. et al. (Eds.), Proc. ODP Sci. Results 115, 255–270.

Novacyzk, N.R., Baumann, M., 1992. Combined high-resolution magnetostratigraphy and nannofossil biostratigraphy for late Quaternary Arctic Ocean sediments. Deep-Sea Res. 39, 567–601.

Perch-Nielsen, K., 1985. Cenozoic calcareous nannofossils. In: Bolli, H.M., Saunders, J.B., Perch Nielsen, K. (Eds.), Plankton Stratigraphy. Cambridge University Press, Cambridge, pp. 427–554.

Pujos, A., Giraudeau, J., 1993. Repartition des Noelaerhabdaceae (nannofossils calcaires) dans le Quaternaire moyen et superieur des oceans Atlantique et Pacifique. Oceanol. Acta 16, 349–362.

Pujos-Lamy, A., 1977. *Emiliania* et *Gephyrocapsa* (Nannoplancton calcaire): Biometrie et interet biostratigraphique dans le Pleistocene superieur marin des Açores. Rev. Esp. Micropaleontol. 9, 69–84.

Raffi, I., Backman, J., Rio, D., Shackleton, N.J., 1993. Plio–Pleistocene nannofossil biostratigraphy and calibration to Oxygen Isotope stratigraphies from Deep Sea Drilling Project Site 607 and Ocean Drilling Program Site 677. Paleoceanography 8, 387–408.

Sato, T., Takayama, T., 1992. A stratigraphically significant new species of the calcareous nannofossil *Reticulofenestra asanoi*. In: Ishizaki, K., Saito, T. (Eds.), Centenary of Japanese Micropaleontology. Terra Scientific, Tokyo, pp. 457–460.

Shipboard Scientific Party, 1999. Leg summary: Southern Ocean paleoceanograpy. In: Gersonde, R., Hodell, D.A., Blum, P. et al. (Eds.), Proc. ODP Init. Rep. 177, 1–67.

Thierstein, H.R., Geitzenauer, K.R., Molfino, B., Shackleton, N.J., 1977. Global synchroneity of late Quaternary coccolith datum levels: Validation by oxygen isotopes. Geology 5, 400–404.

Venz, K.A., Hodell, D.A., 2002. New evidence for changes in Plio–Pleistocene deepwater circulation from Southern Ocean ODP Leg 177 Site 1090. Palaeogeograph. Palaeoclimatol. Palaeoecol. 182(3–4), 197–220.

Weaver, P.P.E., Thomson, J., 1993. Calculating erosion by deep-sea turbidity currents during initiation and flow. Nature 364, 136–138.

Wei, W., 1993. Calibration of Upper Pliocene–Lower Pleistocene nannofossil events with Oxygen Isotope stratigraphy. Paleoceanography 8, 85–99.

Wei, W., Wise, S.W., 1992. Oligocene–Pleistocene calcareous nannofossils from Southern Ocean Sites 747, 748 and 751. In: Wise, S.W., Schlich, R. et al. (Eds.), Proc. ODP Sci. Results 120, 368–373.

Wells, P., Okada, H., 1997. Response of nannoplankton to major changes in sea-surface temperature and movements of hydrological fronts over Site DSDP 594 (south Chatham Rise, southeastern New Zealand), during the last 130 kyr. Mar. Micropaleontol. 32, 341–363.

Wise, S.W., 1983. Mesozoic and Cenozoic calcareous nannofossils recovered by Deep Sea Drilling Project Leg 71 in the Falkland Plateau region, southwest Atlantic Ocean. In:

Ludwig, W.J., Krasheninnikov, V.A. et al. (Eds.), Init. Rep. DSDP 71, Pt. 2, 481–550.

Wise, S.W., Wind, F.H., 1977. Mesozoic and Cenozoic calcareous nannofossils recovered by DSDP Leg 36 drilling on the Falkland Plateau, southwest Atlantic sector of the Southern Ocean. In: Barker, P.F., Dalziel, I.W.D. et al. (Eds.), Init. Rep. DSDP 36, 269–492.

Young, J.R., 1998. Neogene. In: Bown, P.R. (Ed.), Calcareous Nannofossil Biostratigraphy. Chapman and Hall, London, pp. 225–265.