Duncan, R.A., Tarduno, J.A., Davies, T.A., and Scholl, D.W. (Eds.)
Proceedings of the Ocean Drilling Program, Scientific Results Volume 197

4. Data Report: Paleocene–Miocene Nannofossil Biostratigraphy, ODP Leg 197 Holes 1203A and 1204A (Detroit Seamount, Northwestern Pacific)[1]

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ABSTRACT

Calcareous nannofossils were studied in sedimentary successions recovered from two holes on the Detroit Seamount in the northwestern Pacific Ocean. Preservation of calcareous nannoflora assemblages varies from poor to good throughout the sediments recovered from both Holes 1203A and 1204A.

Biostratigraphic investigation allowed the identification of 19 nannofossil zones in Hole 1203A and 7 in Hole 1204A. The sedimentary cover in Hole 1203A ranges from lower Eocene (Zone NP12) to upper Miocene (Zone NN9). The sedimentary interval investigated directly overlying the basalt recovered at Hole 1204A is late Campanian in age (Zones CC22–CC23), and the top of the section is middle Eocene (Zone NP15) in age.

Major unconformities were observed in Hole 1204A between upper Campanian (Zones CC22–CC23) and lower Thanetian (Zone NP7) sediments and between upper Thanetian (Zone NP8) and upper Ypresian (Zone NP12) sediments.

INTRODUCTION

The main objective during Ocean Drilling Program (ODP) Leg 197 was to test the hypothesis that the Hawaiian hotspot migrated with re-

[1]Tremolada, F., and Siesser, W.G., 2005. Data report: Paleocene–Miocene nannofossil biostratigraphy, ODP Leg 197 Holes 1203A and 1204A (Detroit Seamount, northwestern Pacific). *In* Duncan, R.A., Tarduno, J.A., Davies, T.A., and Scholl, D.W. (Eds.), *Proc. ODP, Sci. Results,* 197, 1–12 [Online]. Available from World Wide Web: <http://www-odp.tamu.edu/publications/197_SR/VOLUME/CHAPTERS/003.PDF>. [Cited YYYY-MM-DD]
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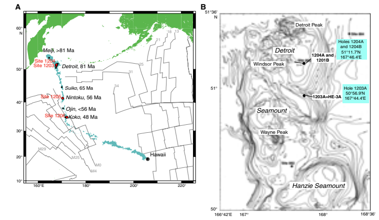
Initial receipt: 5 January 2004
Acceptance: 4 November 2004
Web publication: 18 January 2005
Ms 197SR-003

spect to the Earth's spin axis during Late Cretaceous to early Tertiary times.

During Leg 197, the Detroit (Sites 1203 and 1204), Nintoku (Site 1205), and Koko (Site 1206) seamounts were drilled (Fig. F1A) to obtain accurate and precise paleolatitude and age estimates. In particular, Detroit Seamount was chosen to sample the oldest (Late Cretaceous) part of the Emperor Seamount trend (Fig. F1).

F1. Detroit Seamount topography and location of Sites 1203–1206, p. 8.



This study focuses on biostratigraphic investigation of calcareous nannofossils in soft sediments recovered from Detroit Seamount. Dating the sedimentary succession and, in particular, the contact between the sedimentary cover and basalts provides a time-control tool for radiometric age estimates (Duncan and Keller, in press).

In the last three decades, calcareous nannofossils have become a very important fossil group for age dating and correlation of Mesozoic and Cenozoic pelagic carbonates.

Mesozoic and Cenozoic biostratigraphy have achieved considerable stability, and cosmopolitan zonations have been proposed (e.g., Bramlette and Wilcoxon, 1967; Martini and Worsley, 1970; Martini, 1971; Okada and Bukry, 1980; Thierstein, 1971, 1973, 1976; Sissingh, 1977; Roth, 1978; Perch-Nielsen, 1985; Berggren et al., 1995). More detailed biozonations were proposed for several paleoprovinces, but their reliability is geographically restricted (e.g., Perch-Nielsen, 1979; Raffi and Rio, 1979; Theodoridis, 1984; Mortimer, 1987; Burnett, 1990; Varol, 1991, 1999; Fornaciari et al., 1996; Watkins et al., 1996).

Samples analyzed in this work are from carbonate and siliceous sediments from Ocean Drilling Program Holes 1203A and 1204A. Site 1203 (50°57.00′N, 167°44.40′E) is located toward the central region of the summit area of Detroit Seamount (Fig. F1A). Hole 1204A was drilled at 51°11.68′N, 167°46.36′E, toward the northern end of the summit platform of Detroit Seamount (Fig. F1B).

MATERIAL AND METHODS

Biostratigraphic analyses were performed on soft-sediment samples collected from Holes 1203A and 1204A. A total of 312 samples were prepared as smear slides from well-mixed and unsettled sediment suspensions. No ultrasonic cleaning or centrifuge concentration was applied in order to retain the original nannofossil composition. Smear slides were examined using standard light microscope techniques under crossed polarizers and transmitted light at 1000× and 1250× magnification.

Nannofossil taxa were identified following the taxonomic schemes of Thierstein (1971, 1973, 1976), Aubry (1984, 1988, 1989, 1990), Perch-Nielsen (1985), Young (1999), Burnett (1999), and Varol (1999).

The Cretaceous nannofossil biozonation adopted in this study is that of Sissingh (1977).

The nannofossil biozonation of Martini (1971) with modifications from Young (1999) was used to provide the biozonal assignments in the Cenozoic stratigraphic interval.

NANNOFOSSIL BIOSTRATIGRAPHY

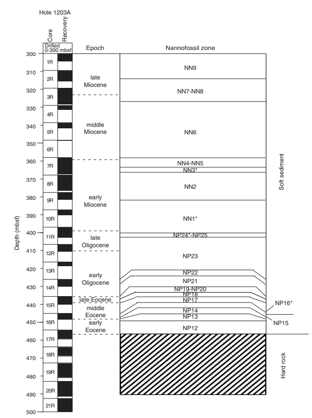
Hole 1203A

Hole 1203A was drilled ahead to 300 meters below seafloor (mbsf) with the rotary core bit in a water depth of 2594 m. Seventeen sediment cores were recovered above basalt (462 mbsf).

Preservation and abundance of calcareous nannofossil species may vary significantly as a result of dissolution or overgrowth. Nannofossil preservation in Hole 1203A ranges from poor to moderate from Core 197-1203A-1R to 13R, whereas from Core 14R to 17R, preservation is moderate to good. The sedimentary interval from Core 197-1203A-1R to 10R mainly consists of diatom ooze, where calcareous nannofossils are rare or represent only a small fraction of the total microfossil assemblage.

The sediments recovered above basalt in Core 197-1203A-17R contain *Discoaster lodoensis*, *Coccolithus crassus,* and *Tribrachiatus orthostylus*, which clearly indicate nannofossil Zone NP12 (Fig. F2).

F2. Biostratigraphic zonation, Hole 1203A, p. 9.



The last occurrence (LO) of *T. orthostylus* was found in the core catcher of Core 197-1203A-16R (448.6 mbsf). This bioevent defines the base of nannofossil Zone NP13 (Table T1) and predates the LO of *C. crassus* in Sample 197-1203A-16R-2, 82–83 cm (447.42 mbsf).

The NP13/NP14 zonal boundary is placed at the first occurrence (FO) of *Discoaster sublodoensis*, which was recognized at 447.21 mbsf in Sample 197-1203A-16R-2, 61–62 cm (Table T1). *D. sublodoensis* has a continuous occurrence, although it shows low abundances.

The FO of *Nannotetrina fulgens* was observed at 446.80 mbsf in Sample 197-1203A-16R-2, 20–21 cm, and allows the identification of the base of Zone NP15. The NP15/NP16 zonal boundary was not placed, owing to the absence of the diagnostic marker species *Blackites gladius* throughout the section. The base of Zone NP16 may be approximated using the FO of the secondary marker *Reticulofenestra umbilica* at 445.92 mbsf.

The NP17 boundary marker *Chiasmolithus solitus* displays a continuous distribution pattern, and its LO at 445.39 mbsf postdates the FO of *R. umbilica* (Table T1).

T1. Bioevents and biozones, Hole 1203A, p. 11.

The FOs of *Chiasmolithus oamaruensis* and *Isthmolithus recurvus* define the bases of Zones NP18 and NP19–NP20 and lie at 439.03 and 437.7 mbsf, respectively.

The LO of *Discoaster saipanensis*, which has an extremely patchy distribution, was observed in Sample 197-1203A-15R-1, 132–134 cm, indicating the base of Zone NP21 (Fig. F2). This event, together with the extinction of the disk-shaped *Discoaster barbadiensis,* has been used to approximate the Eocene/Oligocene boundary in terms of calcareous nannofossils (Perch-Nielsen, 1985).

The interval between 436.02 (Sample 197-1203A-15R-1, 32–33 cm) and 430.15 mbsf (Sample 14R-CC) is characterized by the shift in abundance of the placolith *Ericsonia subdisticha* (i.e., *E. subdisticha* acme). The base of Zone NP22 is characterized by the LO of *Ericsonia formosa,* which lies at 429.32 mbsf in Sample 197-1203A-14R-3, 32–33 cm.

The extinction of *R. umbilica* at 426.32 mbsf (Sample 197-1203A-14R-1, 32–33 cm) defines the base of Zone NP23, but a few reworked specimens of this taxon were observed in Cores 13R and 12R.

The interval from the LO of *R. umbilica* at 426.32 mbsf to the LO of *Reticulofenestra bisecta* (*scissura*) at 390.35 mbsf was not zoned using the standard biostratigraphic scheme of Martini (1971) owing to the absence of *Sphenolithus ciperoensis*, *Sphenolithus distentus,* and *Helicosphaera recta*. The FO of *S. ciperoensis* indicates the base of Zone NP24. When *S. ciperoensis* is absent, the base of Zone NP24 can be roughly approximated by the FO of *Cyclicargolithus abisectus* (Müller, 1976), which occurs at 402.78 mbsf. The LO of *S. distentus* is the bioevent that defines the base of Zone NP25. This bioevent can be replaced at temperate and high latitudes by the FO of *Pontosphaera enormis* (Martini, 1981a), but no specimens of this taxon were detected in this section.

The LO of *R. bisecta* (*scissura*), which was observed in Sample 197-1203A-10R-CC at 390.35 mbsf (Table **T1**), was used to define the base of Zone NN1 (Perch-Nielsen, 1985; Berggren et al., 1995; Fornaciari et al., 1996) instead of the LOs of *H. recta* or *S. ciperoensis*.

The FO of *Discoaster druggii* at 381.50 mbsf defines the base Zone NN2. This taxon, although fairly rare, shows a continuous occurrence in the samples investigated.

The NN2/NN3 boundary was placed at the FO of *Sphenolithus belemnos* (Young, 1999) owing to the absence of the zonal marker *Triquetrorhabdulus carinatus*. Furthermore, poor nannofossil preservation renders it very difficult to distinguish *T. carinatus* from other elongate calcitic particles (Perch-Nielsen, 1985); thus, the FO of *S. belemnos* seems to be a more reliable event in Hole 1203A.

The LOs of *S. belemnos* at 364.42 mbsf and *Sphenolithus heteromorphus* at 359.43 mbsf define the base of Zones NN4 and NN6. The LO of *Helicosphaera ampliaperta*, which defines the NN4/NN5 boundary of Martini (1971), was not recorded in this section. The base of Zone NN5 may be marked by secondary events such as the FO of *Calcidiscus premacintyrei* (Gartner, 1992; de Kaenel and Villa, 1996), the FO of *Discoaster exilis* (Martini, 1981b; Theodoridis, 1984), the LO of *Helicosphaera perch-nielseniae* (Theodoridis, 1984; de Kaenel and Villa, 1996), and the first common occurrence of *Helicosphaera walbersdorfensis* (Müller, 1981; Fornaciari et al., 1996); however, these species were also not found on Detroit Seamount.

The interval from 350 mbsf to the top of the section is characterized by a sharp drop in abundance of calcareous nannofossils and by the dominance of siliceous plankton. Despite the scarcity of calcareous nannofossils, the LO of *Cyclicargolithus floridanus* and the FO of *Discoaster hamatus* were observed (Table **T1**). The LO of *C. floridanus* together with the FO of *Discoaster kugleri* defines the base of Zone NN7, whereas the FO of *D. hamatus* marks the NN8/NN9 boundary. The base of Zone NN8 is defined by the FO of *Catinaster coalitus* (Martini, 1971), which is lacking in this section.

Hole 1204A

Hole 1204A was drilled ahead to 761.9 mbsf with the rotary core barrel in a water depth of 2371 m. Basalt was reached at Section 197-1204A-6R-5, 10 cm.

Calcareous nannofossil assemblages are etched and overgrown in Core 197-1204A-6R but display a moderate preservation from Cores 2R to 5R.

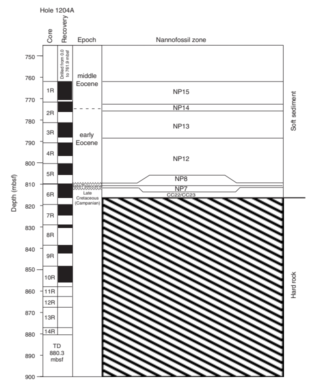
Calcareous nannofossil assemblages in sediments directly overlying basalt in Core 197-1204A-6R indicate a Campanian age (Zones CC22–CC23), based on the presence of the nannolith *Quadrum trifidum* (= *Uniplanarius trifidus*). The absence of the CC22/CC23 zonal boundary marker *Eiffellithus eximius* prevents a more refined biozonation (see discussion in "Biostratigraphy" in Shipboard Scientific Party, 2002b).

Sample 197-1204A-6R-1, 107–108 cm, shows a Cenozoic calcareous nannofossil assemblage indicating an unconformity (Fig. F3). In particular, this assemblage contains the taxon *Discoaster mohleri*, which defines the base of the NP7 nannofossil zone, whereas *Heliolithus kleinpellii* is absent (Table T2). The FO of *Heliolithus riedelii*, observed at 810.15 mbsf, indicates the base of Zone NP8 and postdates the FO of *H. kleinpellii* at 810.97 mbsf (Fig. F3). Section 197-1204A-5R-CC is characterized by a completely different nannofossil assemblage. The presence of *D. lodoensis*, *T. orthostylus,* and *C. crassus* clearly indicates Zone NP12. Thus, a second unconformity is recorded between Zones NP8 and NP12.

The LO of *T. orthostylus* is in Sample 197-1204A-6R-CC and defines the base of NP13 (Table T2).

Core 197-1204A-2R shows the FOs of *D. sublodoensis* at 775.32 mbsf and *N. fulgens* at 771.82 mbsf, which indicate the base of Zones NP14 and NP15, respectively.

F3. Biostratigraphic zonation, Hole 1204A, p. 10.



T2. Nannofossil bioevents and biozones, Hole 1204A, p. 12.

CONCLUSIONS

The calcareous nannofossil biostratigraphy performed on soft sediments overlying basalts in ODP Holes 1203A and 1204A provides a good sequence of nannofloral bioevents.

Sediments from Hole 1203A allow the identification of 19 nannofossil zones ranging from lower Eocene (Zone NP12) to lower upper Miocene (Zone NN9). The absence of *Sphenolithus* species such as *S. ciperoensis* and *S. distentus*, the taxon *B. gladius,* and the genera *Helicosphaera* and *Catinaster* prevent a more detailed nannofossil zonation of this hole.

The sedimentary sequence in Hole 1204A consists of only six cores of soft sediments that contain nannofossil assemblages indicating seven nannofossil zones spanning from upper Campanian to lower Eocene. The nannofossil biostratigraphy in Hole 1204A revealed the presence of two major unconformities in the sedimentary succession. The first unconformity is between nannofossil Zones CC22–23 and NP7, indicating that at least Maastrichtian, Danian, Selandian, and lower Thanetian sediments are lacking. The second hiatus is between Zones NP8 and NP12, which corresponds to the time interval between late Thanetian and early Ypresian.

ACKNOWLEDGMENTS

This research used samples and data provided by the Ocean Drilling Program (ODP). ODP is sponsored by the U.S. National Science Foundation (NSF) and participating countries under management of Joint Oceanographic Institutions (JOI), Inc. We warmly thank I. Raffi and L. Peters for reviews. Work by F.T. was sponsored by Cofin 2001 to I. Premoli Silva.

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Figure F1. A. Location map of Sites 1203–1206 (Shipboard Scientific Party, 2002a). **B.** Topography of the Detroit Seamount and locations of Holes 1203A and 1204A.

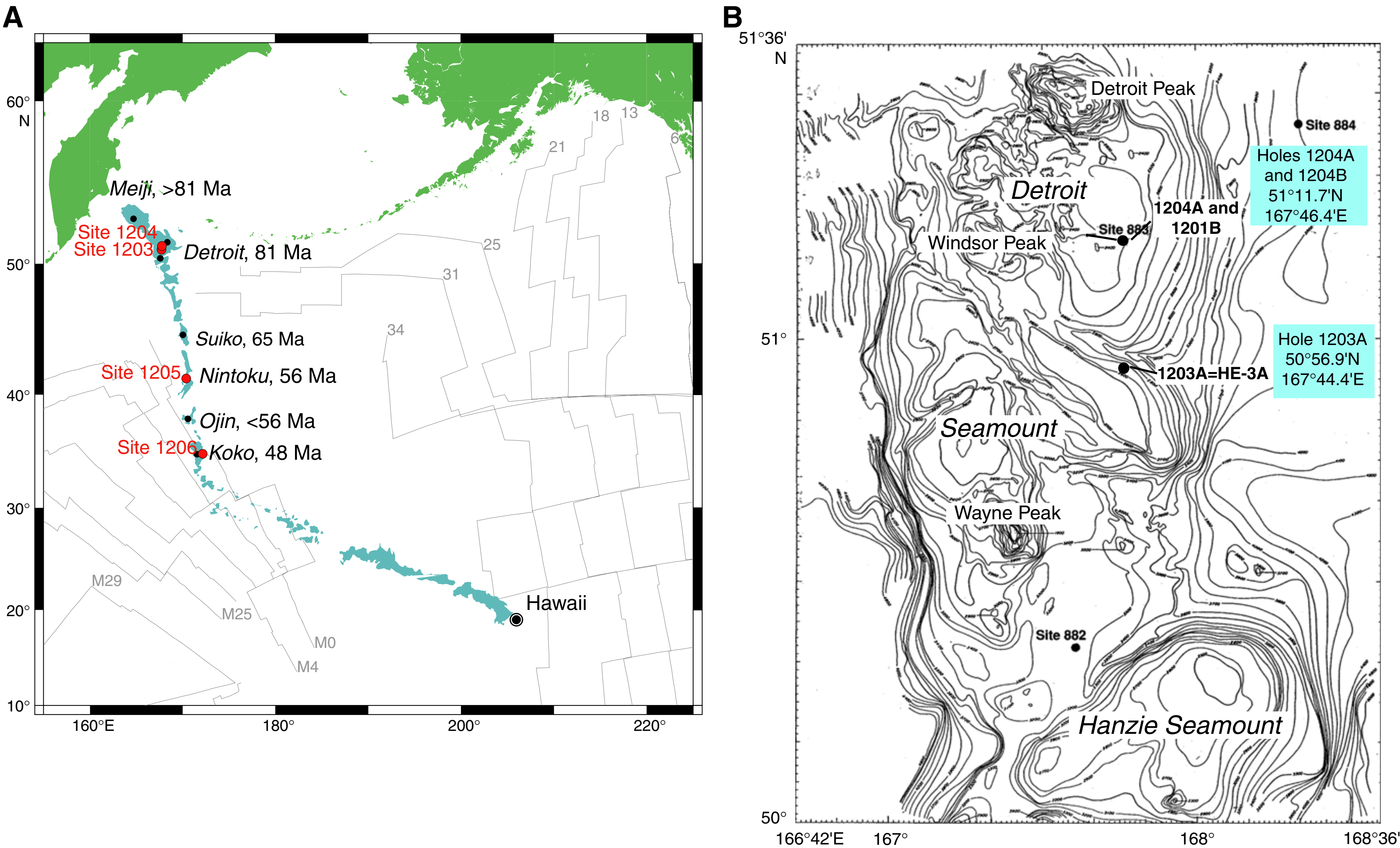

Figure F2. Biostratigraphic zonation of Hole 1203A. * = modifications to the original nannofossil biostratigraphic scheme of Martini (1971).

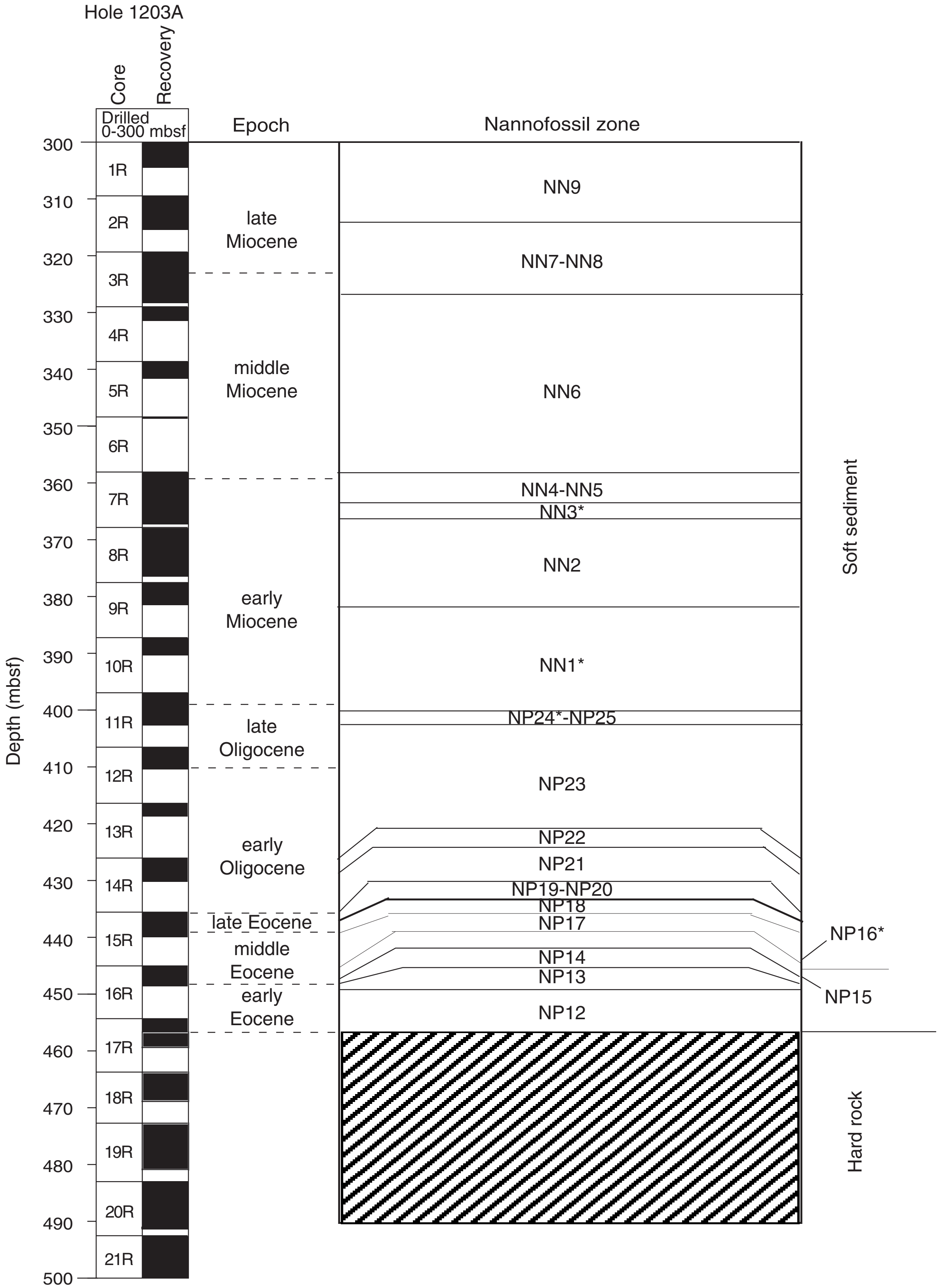

Figure F3. Biostratigraphic zonation of Hole 1204A. NP nannofossil zonation after Martini (1971). TD = total depth.

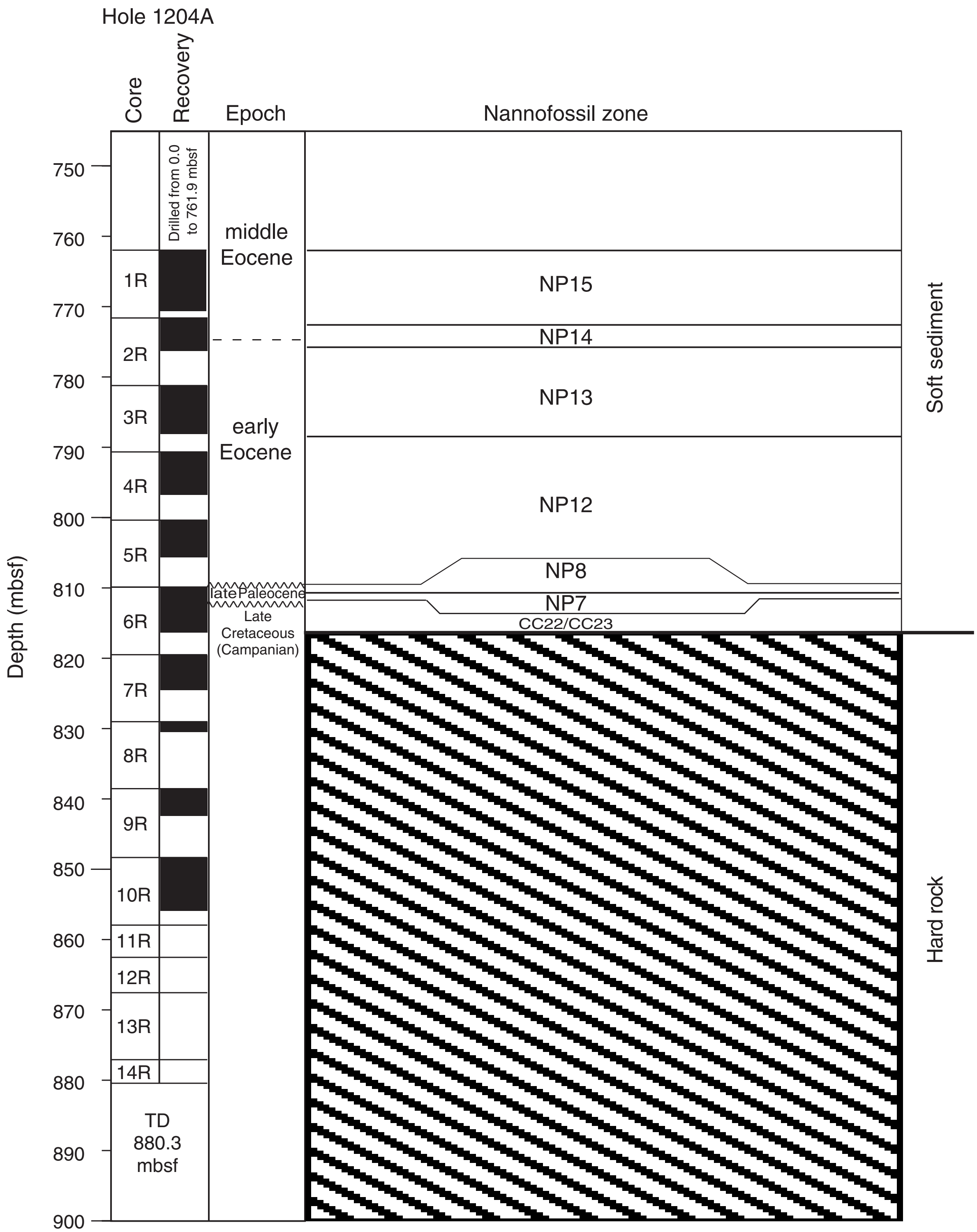

Table T1. Summary of bioevents and biozones observed in Hole 1203A.

Datum event	Core, section, interval (cm)	Depth (mbsf)	Zonal marker
	197-1203A-		
FO *Discoaster hamatus*	2R-4, 32–33	314.42	Base NN9
LO *Discoaster deflandrei*	3R-3, 32–34	322.62	
LO *Cyclicargolithus floridanus*	3R-6, 132–134	326.62	Base NN7
FO *Reticulofenestra pseudoumbilica* >7 µm	4R-2, 82–83	331.32	
LO *Sphenolithus heteromorphus*	7R-1, 133–134	359.43	Base NN6
LO *Sphenolithus belemnos*	7R-5, 32–33	364.42	Base NN4
FO *Sphenolithus heteromorphus*	7R-5, 82–83	364.91	
FO *Sphenolithus belemnos*	7R-6, 82–84	366.42	Base NN3*
FO *Discoaster druggii*	9R-CC	381.50	Base NN2
LO *Cyclicargolithus abisectus*	10R-2, 82–83	389.52	
LO *Reticulofenestra bisecta* (*scissura*)	10R-CC	390.35	Base NN1*
FO *Cyclicargolithus abisectus*	11R-CC	402.78	Base NP24*
LO *Reticulofenestra umbilica*	14R-1, 32–33	426.32	Base NP23
LO *Ericsonia formosa*	14R-3, 32–33	429.32	Base NP22
Top acme *Ericsonia subdisticha*	14R-CC	430.15	
Base acme *Ericsonia subdisticha*	15R-1, 32–33	436.02	
LO *Discoaster saipanensis*	15R-1, 132–134	437.02	Base NP21
FO *Isthmolithus recurvus*	15R-2, 50–51	437.70	Base NP19
FO *Chiasmolithus oamaruensis*	15R-3, 33–34	439.03	Base NP18
LO *Chiasmolithus grandis*	15R-3, 50–51	439.20	
LO *Chiasmolithus solitus*	16R-1, 29–30	445.39	Base NP17
FO *Reticulofenestra umbilica*	16R-1, 82–83	445.92	Base NP16*
FO *Nannotetrina fulgens*	16R-2, 20–21	446.80	Base NP15
FO *Nannotetrina* sp.	16R-2, 50–51	447.10	
FO *Discoaster sublodoensis*	16R-2, 61–62	447.21	Base NP14
LO *Coccolithus crassus*	16R-2, 82–83	447.42	
LO *Tribrachiatus orthostylus*	16R-CC	448.6	Base NP13

Notes: FO = first occurrence. LO = last occurrence. * = nannofossil zones were recognized using secondary or additional events.

Table T2. Summary of nannofossil bioevents and biozones observed in Hole 1204A.

Datum event	Core, section, interval (cm)	Depth (mbsf)	Zonal marker
	197-1204A-		
FO *Nannotetrina fulgens*	2R-1, 32–33	771.82	Base NP15
FO *Nannotetrina* sp.	2R-1, 50–51	772.00	
FO *Discoaster sublodoensis*	2R-3, 82–83	775.32	Base NP14
LO *Coccolithus crassus*	3R-1, 50–52	781.60	
LO *Tribrachiatus orthostylus*	3R-CC	788.10	Base NP13
FO *Coccolithus crassus*	5R-CC	805.56	
FO *Tribrachiatus orthostylus*	5R-CC	805.56	
FO *Discoaster lodoensis*	5R-CC	805.56	Base NP12
FO *Heliolithus riedelii*	6R-1, 25–26	810.15	Base NP8
FO *Heliolithus kleinpellii*	6R-1, 107–108	810.97	
FO *Discoaster mohleri*	6R-1, 107–108	810.97	Base NP7

Note: FO = first occurrence, LO = last occurrence.