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

3. Data Report: Calcareous Nannofossils in Campanian Volcaniclastic Sediment, Detroit Seamount: An Environmental Application[1]

William G. Siesser[2]

ABSTRACT

Calcareous nannofossils occur in numerous layers within a thick volcaniclastic succession encountered on the Detroit Seamount. Nannofossils present in a given bed confirm a marine depositional environment for the bed, add to our understanding of depositional events occurring between times of lava flow, and contribute to the interpretation of the overall physical volcanological history of the seamount.

INTRODUCTION

During Ocean Drilling Program (ODP) Leg 197 (July–August 2001) we drilled a series of holes on the Emperor Seamounts (Detroit, Nintoku, and Koko). The principal objective of Leg 197 was to obtain cores from lava flows for paleomagnetic paleolatitude and radiometric age determinations (Leg 197 *Scientific Prospectus* [**http://www-odp.tamu.edu/publications/prosp/197_prs/197toc.html**]). Important secondary objectives were to investigate other aspects of paleomagnetism, evaluate petrological and geochemical variations of the volcanic products with time, and gain a better understanding of the physical volcanology of the seamounts. It is to this last objective, physical volcanology, that the data presented here make their main contribution.

[1] Siesser, W.G., 2004. Data report: Calcareous nannofossils in Campanian volcaniclastic sediment, Detroit Seamount: an environmental application. *In* Duncan, R.A., Tarduno, J.A., Davies, T.A., and Scholl, D.W. (Eds.), *Proc. ODP, Sci. Results,* 197, 1–10 [Online]. Available from World Wide Web: <http://www-odp.tamu.edu/publications/197_SR/VOLUME/CHAPTERS/002.PDF>. [Cited YYYY-MM-DD]
[2] Department of Geology, Vanderbilt University, Nashville TN 37235, USA. **william.g.siesser@vanderbilt.edu**

Initial receipt: 4 November 2003
Acceptance: 18 August 2004
Web publication: 1 November 2004
Ms 197SR-002

PHYSICAL VOLCANOLOGY AND VOLCANICLASTIC SEDIMENT

Thick successions of volcaniclastic sediments were recovered on Detroit and Koko Seamounts; a negligible amount of volcaniclastic material was recovered on Nintoku Seamount. The Leg 197 igneous petrology-volcanology team sought to determine the types of eruptive volcanic activity and the nature of the eruptive environments represented by various volcaniclastic lithofacies (Shipboard Scientific Party, 2002a). Determination of the environmental setting (e.g., subaerial or subaqueous) was a particularly important question. Hyaloclastites and peperites certainly indicate subaqueous deposition because of quenched fragmentation, and cross-bedding structures suggest current flow, but these rock types and structures were not always present. Other lines of evidence would clearly be helpful in interpreting the environment of deposition for the volcaniclastic succession. One such line of evidence, the presence of marine calcareous nannofossils, is used in this study.

Calcareous Nannofossils in Volcaniclastic Sediment

Calcareous nannoplankton are minute (average size range = ~4–25 µm) one-celled plantlike protists that live in great abundance in the upper surface water of the oceans. Fossils of these organisms ("calcareous nannofossils") have long been used during Deep Sea Drilling Project (DSDP) and ODP cruises to determine the "age" (stratigraphic position) of sediments rapidly and with a high degree of stratigraphic resolution. Using calcareous nannofossils in biostratigraphy has been applied almost exclusively to unconsolidated sediments and sedimentary rocks overlying oceanic basalt. Occasionally, nannofossils have been found in sediments intercalcated with basalts, but rarely has preservation of the contained nannofossils been good enough to allow more than a tentative stratigraphic determination (e.g., Leg 192 *Preliminary Report*).

On the Detroit Seamount, 140 m of volcaniclastic sediments was recovered from Hole 1203A, and 8 m was recovered from Holes 1204A and 1204B. Numerous layers within these volcaniclastic beds contain calcareous nannofossils. Moreover, nannofossil preservation is good enough in many cases to make conclusive age determinations, thereby constraining the age of the enclosing flows of basalt (Shipboard Scientific Party, 2002b). In Hole 1203A, lava flows were assigned to the Campanian, nannofossil Zones CC22 and/or CC23 (zonation of Sissingh, 1977) near the top of the basalt-volcaniclastic sequence and further restricted to Zone CC22 (estimated age = 75.0–76.0 Ma) near the bottom of the sequence. In Holes 1204A and 1204B, nannofossils again dated volcaniclastic sediments as Campanian, Zones CC22 and/or CC23. A few volcaniclastic samples from Koko Seamount (Hole 1206A) contain trace amounts of poorly preserved nannofossils (Shipboard Scientific Party, 2002d). The age is indeterminate.

During shipboard work on Detroit Seamount, the focus was entirely on biostratigraphy and detailed sampling of the volcaniclastic sediment sequence was not done. Sampling strategy was based on the recognition that a great many of the volcaniclastic intervals were obviously too well indurated to provide biostratigraphically usable nannofossils. In well-indurated rocks, most nannofossils in the original sediment have been severely altered or, more often, totally destroyed by the diagenetic processes involved in the lithification process. Even if fragments of nannofossils are obtained by scraping such rocks, only non-biostratigraphically useful, partial specimens are produced. Thus, such well-indurated layers are not routinely sampled aboard ship for biostratigraphic examination if better lithologies are available. Also, if volcaniclastic units in, for example, Core 39 and Core 44 from the same hole were both found to be in Zone CC22, few, if any, volcaniclastic samples were examined from the intervening cores.

The project described here entails a study of nannofossils in the entire volcaniclastic sequence with environmental interpretation as the main goal. Clearly, the presence of nannofossils in a bed will confirm that the bed was deposited in a marine environment. A given bed of volcaniclastic sediment might have been emplaced on the seafloor as a windblown ash/lapilli deposit, as an explosive hyaloclastite, or by erosion and fluvial transport out to sea of a volcaniclastic deposit originally emplaced on the volcano's slopes. Turbidity currents subsequently might have transported these sediments to deeper waters. Calcareous nannofossils continued to drift downward from the surface water during and between episodes of volcaniclastic deposition, mixing with the volcaniclastic sediment forming on the seafloor. The simple presence of nannofossils in these units provides unequivocal evidence of marine deposition for the rocks in which the fossils are found. Even fragments of nannofossils in significant numbers indicate marine conditions.

METHODS

I selected samples using visual core descriptions, barrel sheets, core photos, and information from the "Physical Volcanology and Igneous Petrology" sections of the site chapters in the Leg 197 *Initial Reports* volume (Shipboard Scientific Party, 2002c, 2002d). A total of 223 previously unexamined sample intervals were chosen for investigation (Table **T1**; **"Appendix,"** p. 8). Hard layers required rigorous disaggregation treatment in the laboratory. Samples were first crushed in a mortar with a pestle, followed by repeated settling and decantation. Microscope slides were prepared from the processed residue and examined at a standard magnification of 1000×.

T1. Volcaniclastic and other lithologies, p. 9.

RESULTS

Table **T1** lists the volcaniclastic samples examined during this study that contain calcareous nannofossils. The lithology of the sample, the preservation and abundance of the nannofossil assemblage in each sample, and the relative abundance of each taxon are also shown in Table **T1.** For completeness, volcaniclastic samples previously examined during the Leg 197 cruise by the author and the other shipboard micropaleontologist, Dr. Fabrizio Tremolada, are also included in Table **T1** and the **"Appendix,"** p. 8, and are marked by an asterisk. Volcaniclastic samples in which no nannofossils were found are listed in the **"Appendix,"** p. 8.

I found no apparent correlation between nannofossil abundance categories and volcaniclastic lithologic types. Nannofossils occurred in varying amounts in all lithologies examined except lapillistone, hyaloclastite lapilli breccia, and, of course, basalt.

Biostratigraphy

Taxonomic List

Aspidolithus parcus (Stradner) Noël, 1969.
Braarudosphaera bigelowii (Gran & Braarud) Deflandre, 1947.
Ceratolithoides aculeus (Stradner) Prins & Sissingh in Sissingh, 1977.
Cretarhabdus conicus Bramlette & Martini, 1964.
Cribrosphaerella ehrenbergii (Arkhangelsky) Deflandre in Piveteau, 1952.
Eiffellithus eximius (Stover) Perch-Nielsen, 1968.
Eiffellithus turriseiffelii (Deflandre) Reinhardt, 1965.
Marthasterites inconspicuous Deflandre, 1959.
Micula decussata Vekshina, 1959.
Microrhabdulus decoratus Deflandre, 1959.
Pervilithus varius Crux, 1981.
Prediscosphaera cretacea (Arkhangelsky) Gartner, 1968.
Retecapsa crenulata (Bramlette & Martini) Grun in Grun & Allemann, 1975.
Rhagodicus angustus (Stradner) Reinhardt, 1971.
Uniplanarius gothicus (Deflandre) Hattner & Wise, 1980.
Uniplanarius sissinghii Perch-Nielsen, 1986.
Uniplanarius trifidus (Stradner in Stradner & Papp) Hattner & Wise, 1980.
Watznaueria barnesae (Black) Perch-Nielsen, 1968.
Zeugrhabdotus embergeri (Noël) Perch-Nielsen, 1984.
Broinsonia sp.
Reinhardites sp.
Unidentified specimens
Nannofossil fragments

Relative abundance of nannofossils in Table T1 are designated as follows:

A = abundant (>10 specimens of a species per field-of-view at 1000×).
C = common (1–10 specimens per field of view).
F = few (1 specimen per 2–10 fields of view).
R = rare (1 specimen per 11–100 fields of view).
V = very rare (1 specimen per 101–1000 fields of view).

Relative preservation of nannofossils in Table T1 are designated as follows:

VG = very good (no dissolution or secondary overgrowths of calcite; all specimens can be identified with certainty).
G = good (little dissolution or secondary overgrowths; essentially all specimens can be identified at the species level).
M = moderate (slight to moderate dissolution and/or overgrowths; identification of some species is impaired, but most species can still be identified).
P = poor (severe dissolution, breakage, or secondary overgrowths have largely destroyed the primary morphological features; many specimens cannot be identified at the species level, and some cannot be identified at the generic level).

Most of the samples listed in Table T1 contain rare, poorly preserved, non-age-diagnostic specimens. The poor preservation results in an unusually large number of unidentifiable specimens.

No new biostratigraphic information was obtained during this study. Some samples do contain the age-diagnostic species *Uniplanarius trifidus*

(=*Quadrum trifidum*) reported by Shipboard Scientific Party (2002b, 2002c), thereby confirming the assignment of those samples, and this volcaniclastic sequence, to Sissingh's (1977) Zones CC22 and/or CC23. The stratigraphically uppermost volcaniclastic sample in Hole 1203A for which a definite zonal assignment can be made is 197-1203A-20R-6, 47–48 cm (Zone CC22 and/or CC23) and the lowermost is 63R-5, 136–137 cm (Zone CC22). *Uniplanarius trifidus* first appears (first appearance datum; FAD) at the base of Zone CC22 and becomes extinct high in Zone CC23 (Shipboard Scientific Party, 2002a). The last appearance datum (LAD) of *Eiffellithus eximius* coincides with the Zone CC22/CC23 boundary. *Uniplanarius trifidus* is a consistently occurring species in Hole 1203A from Section 197-1203A-20R-6 down to Section 63R-6 and from above the sediment/basalt contact down to Section 197-1204B-17R-3 in Hole 1204B (Table T1). *Eiffellithus eximius*, on the other hand, occurs in only a few samples in Hole 1203A (Table T1). Its highest occurrence in Hole 1203A is in Sample 197-1203A-39R-3, 61–62 cm; volcaniclastic samples below that level are assigned to Zone CC22, and samples above that level are assigned to Zone CC22 or CC23. *Eiffellithus eximius* was not found in Holes 1204A or 1204B, and volcaniclastics in those holes are assigned to Zones CC22 and/or CC23 based on the presence of *U. trifidus*.

Recent estimates of the ages of these zonal boundaries/nannofossil biochrons are as follows (see Shipboard Scientific Party, 2002a, for sources of age estimates):

Base Zone CC22 (FAD of *U. trifidus)* = 76.0 Ma;
Zone CC22/CC23 boundary (LAD of *E. eximius*) = 75.0 Ma; and
LAD of *U. trifidus* in Zone CC23 = 71.3 Ma.

Paleoenvironment

Hole 1203A

Samples from Section 197-1203-20R-6 down to Section 65R-1 contain calcareous nannofossils in widely varying numbers. Most samples contain "rare" amounts, although "rare" would translate into probably dozens or hundreds of specimens in a complete count of most microscope slides. I believe the samples containing "R," "F," or "C" abundances are unequivocal evidence for deposition in a marine environment. Samples recorded as "V" are more problematic. In some cases the "V" represents only a single specimen found after a long search. A single nannofossil specimen can get to many unexpected places (e.g., washed onto a beach by storm waves, then blown inshore, eventually to be incorporated in a terrestrial ash fall). Granted, such a scenario is unlikely, and probably most of the "V" samples also represent marine volcaniclastic deposition, but the evidence is less conclusive.

Hole 1204A

I found nannofossils in volcaniclastic samples only in Section 197-1204A-6R-5, ranging from very rare to common (Table T1) and indicating marine deposition for at least the interval in which they are found.

Hole 1204B

I found nannofossils only in Sample 197-1204B-17R-3, 80–81 cm (Table **T1**). Relative abundance is few; marine deposition is indicated for this sample.

ACKNOWLEDGMENTS

This research used samples and/or 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. I thank the JOI/U.S. Science Support Program for a grant to support this research. I also thank Elizabeth Birkos for dedicated perseverance in sample disaggregation and slide preparation work.

REFERENCES

Shipboard Scientific Party, 2001. Leg 192 Preliminary Report: Basement drilling of the Ontong Java Plateau. *ODP Prelim. Rpt.,* 192 [Online]. Available from World Wide Web: <http://www-odp.tamu.edu/publications/prelim/192_prel/192PREL.PDF>. [Cited 2001-07-01]

Shipboard Scientific Party, 2002a. Explanatory notes. *In* Tarduno, J.A., Duncan, R.A., Scholl, D.W., et al., *Proc. ODP, Init. Repts.,* 197, 1–89 [CD-ROM]. Available from: Ocean Drilling Program, Texas A&M University, College Station TX 77845-9547, USA.

Shipboard Scientific Party, 2002b. Site 1203. *In* Tarduno, J.A., Duncan, R.A., Scholl, D.W., et al., *Proc. ODP, Init. Repts.,* 197, 1–171 [CD-ROM]. Available from: Ocean Drilling Program, Texas A&M University, College Station TX 77845-9547, USA.

Shipboard Scientific Party, 2002c. Site 1204. *In* Tarduno, J.A., Duncan, R.A., Scholl, D.W., et al., *Proc. ODP, Init. Repts.,* 197, 1–125 [CD-ROM]. Available from: Ocean Drilling Program, Texas A&M University, College Station TX 77845-9547, USA.

Shipboard Scientific Party, 2002d. Site 1206. *In* Tarduno, J.A., Duncan, R.A., Scholl, D.W., et al., *Proc. ODP, Init. Repts.,* 197, 1–117 [CD-ROM]. Available from: Ocean Drilling Program, Texas A&M University, College Station TX 77845-9547, USA.

Sissingh, W., 1977. Biostratigraphy of Cretaceous calcareous nannoplankton. *Geol. Mijnbouw,* 56:37–65.

APPENDIX

Samples Barren of Nannofossils

Core, section, interval (cm)	Lithology
197-1204A-	
20R-6, 5–6	B
20R-6, 79–80	RBT
20R-6, 95–96	RBT
21R-1, 133–134	BT
21R-2, 7–8	BT
21R-2, 22–23	BT
21R-2, 37–38	BT
21R-2, 71–72	BT
21R-2, 106–107	BT
21R-3, 29–30	BT
21R-4, 28–29	BT
21R-4, 105–106	BT
22R-1, 54–55	BT
22R-1, 135–136	BT
22R-2, 45–46	BT
22R-2, 117–118	BT
22R-3, 13–14	BT
22R-3, 68–69	BT
22R-3, 98–99	BT
22R-4, 46–47	BT
22R-4, 142–143	BT
22R-5, 12–13	BT
22R-5, 40–41	RSBT
22R-5, 76–77	RSBT
22R-5, 106–107	RSBT
22R-5, 135–136	RSBT
23R-2, 137–138	LTBSS
23R-3, 10–11	LTBSS
24R-1, 24–25	RBT
24R-1, 80–81	RBT
24R-2, 4–5	RBT
24R-2, 23–24	BLT
24R-2, 49–49	RSBT
24R-2, 71–72	RSBT
24R-2, 91–92	RSBT
24R-3, 7–8	RBT
26R-4, 79–80	BViSS
26R-4, 99–100	BViSS
26R-4, 125–126	BViSS
26R-5, 8–9	BViSS
26R-5, 28–29	BViSS
26R-5, 45–46	BViSS
27R-1, 4–5	BViSS
27R-1, 26–27	BViSS
27R-1, 50–51	BViSS
27R-1, 59–60	BViSS
27R-1, 143–144	BViSS
27R-2, 5–6	BViSS
27R-2, 98–99	BViSS
27R-2, 129–130	BViSS
28R-2, 9–10	BViSS
28R-CC, 3–4	BViSS
29R-1, 3–4	BViSS
29R-1, 81–82	BViSS
29R-1, 88–89	BViSS
29R-1, 94–95	BViSS
29R-1, 109–110	BViSS
29R-2, 85–86	LVSS
29R-2, 93–94	LVSS
29R-2, 102–103	LVSS
29R-3, 11–12	LVSS
29R-3, 16–17*	LVSS
29R-3, 21–22	LVSS
29R-3, 38–39	LVSS
29R-3, 49–50	LVSS
29R-3, 69–70	LVSS
29R-3, 89–90	LVSS
29R-4, 2–3	LVSS
29R-4, 124–125	BT
29R-5, 36–37	BT
30R-1, 12–13	BT
32R-1, 83–84	BVoSS
32R-1, 90–91*	BVoSS
32R-1, 100–101	BVoSS
32R-1, 114–115	BVoSS
32R-1, 116–117*	BVoSS
32R-2, 3–4	BVoSS
32R-4, 75–76	BVoSS
32R-4, 102–103	BVoSS
32R-6, 7–8	BVoSS
33R-1, 2–3	BVoSS
33R-1, 17–18	BVoSS
34R-1, 84–85	PBHB
34R-2, 24–25	PBHB
34R-3, 36–37	PBHB
34R-3, 132–133	PBHB
35R-1, 49–40	PBHB
35R-2, 46–47	PBHB
35R-3, 44–45	PBHB
35R-4, 2–3	PBHB
36R-7, 41–42	BViSS
36R-7, 57–58	BViSS
36R-7, 86–87	BViSS
36R-8, 75–76	BViSS
36R-8, 121–122	BViSS
37R-1, 25–26*	CVSS
37R-1, 29–30	CVSS
37R-1, 43–44	CVSS
37R-1, 69–70	CVSS
37R-1, 70–71*	CVSS
38R-2, 18–19	BOPBT
38R-3, 7–8	BOPBT
38R-5, 26–27	BOPBT
39R-1, 53–54	BOPBT
39R-2, 142–143	BOPBT
51R-1, 58–59	L
51R-2, 2–3	L
51R-2, 138–139	L
51R-3, 32–33	L
51R-3, 75–76	L
54R-1, 1–2*	B
63R-6, 29–30	VS
63R-6, 38–39	VS
63R-6, 55–56	VS
63R-6, 42–43*	VS
64R-1, 2–3	VS
64R-1, 67–68	VB
64R-1, 93–94	VB
64R-1, 140–141	VB
64R-2, 63–64	VB
64R-2, 73–74*	VS
65R-1, 42–43	VB
66R-1, 98–99*	B
66R-2, 98–99*	B
68R-1, 136–137*	B
68R-4, 12–13*	B
7R-1, 2–3	VB
7R-1, 50–51	VB
7R-1, 103–104	VB
197-1204B-	
6R-3, 64–65*	HLB
6R-3, 80–81*	HLB
6R-4, 106–107*	HLB
16R-1, 73–74	HLB
16R-1, 129–130	HLB
16R-2, 42–43	HLB
16R-2, 93–94	HLB
16R-3, 62–63	HLB
16R-3, 123–124	HLB
16R-4, 7–8	HLB
16R-4, 75–76	HLB
17R-3, 119–120*	HLB
17R-3, 146–147*	HLB

Notes: * = volcaniclastic samples previously examined during the Leg 197 cruise by the author and the other shipboard micropaleontologist, Dr. Fabrizio Tremolada. B = basalt, RBT = resedimented basalt-tuff, BT = basalt-tuff, RSBT = resedimented-synvolcanic basalt-tuff, LTBSS = laminated-thinly bedded siltstone-sandstone, BLT = basalt-lapilli-tuff, BViSS = bedded vitric siltstone-sandstone, LVSS = laminated volcaniclastic siltstone-sandstone, BVoSS = bedded volcaniclastic siltstone-sandstone, PBHB = plagioclase basalt-hyaloclastite breccia, CVSS = calcareous vitric siltstone and sandstone, BOPBT = bedded olivine-plagioclase-basalt tuff, L = lapillistone, VS = volcaniclastic sandstone, VB = volcaniclastic breccia, HLB = hyaloclastite lapilli breccia.

Table T1. Volcaniclastic and other lithologies. (See table notes. Continued on next page.)

Core, section, interval (cm)	Lithology	Preservation	Abundance	*Aspidolithus parcus*	*Braarudosphaera bigelowii*	*Ceratolithoides aculeus*	*Cretarhabdus conicus*	*Cribrosphaerella ehrenbergii*	*Eiffellithus eximius*	*Eiffellithus turriseiffelii*	*Marthasterites inconspicuous*	*Micula decussata*	*Microrhabdulus decoratus*	*Pervilithus varius*	*Prediscosphaera cretacea*	*Retecapsa crenulata*	*Rhagodicus angustus*	*Uniplanarius gothicus*	*Uniplanarius sissinghii*	*Uniplanarius trifidus*	*Watznaueria barnesae*	*Zeugrhabdotus embergeri*	*Broinsonia* sp.	*Reinhardites* sp.	Unidentified specimens	Nannofossil fragments
197-1203A-																										
20R-6, 19–20	NSC	P–M	C			R	F	R				R					R	R		R	C		R	R	F	C
20R-6, 36–37*	NSC	M	F			R–F					R	R						R	R	R–F	F				R	
20R-6, 47–48	RBT	P–M	F			R	R	R			R	R					R	R		R	F				F	F
20R-6, 65–66	RBT	P	V																		V					
21R-1, 7–8	RBT	P	F					R													R				F	F
21R-1, 35–36	RSBT	P	V																						V	
21R-1, 73–74	RSBT	P	V																		V					
21R-1, 75–76	RSBT	P	V																						V	
21R-3, 136–137	LBT	P	V																						V	
21R-4, 10–11*	BT	P	R									R									R				R	
21R-4, 15–16*	BT	P	R																						R	
22R-5, 124–125	RSBT	P	R																						R	R
23R-2, 36–37	RSBT	P	R																						R	R
23R-2, 69–70	LTBSS	P	F																						R	R
23R-2, 102–103	LTBSS	M	C	R		R	R	R				R–F					R			R	C	V			F	
23R-3, 44–45	LTBSS	P	F				F										R	R		R	F				R	F
23R-3, 140–141	RBT	P	V																							V
26R-4, 17–18	BViSS	P	R																		R					
26R-4, 21–22	BViSS	P	R																						V	
26R-4, 37–38	BViSS	P	R			R												R		R	R				R	R
27R-1, 10–11	BViSS	P	V									V						V		V						
27R-1, 119–120	BViSS	P	R–F			R						R		V						R	R				R	R
27R-2, 29–30	BViSS	P	R							V		V													R	
27R-2, 87–88	BViSS	P	R																	V					R	
27R-2, 129–130	BViSS	P	F			R														R	R				R	R
27R-2, 144–145	BViSS	P	R																	V					R	R
27R-CC, 8–9	BViSS	P	V																		V					
28R-1, 21–22	BViSS	P	V																		V					
28R-1, 13–14	BViSS	P	R–F			V						R									R		V	R	R	R
28R-1, 20–21	BViSS	P	V																						V	
28R-1, 28–29	BViSS	P	R–F				R														R				R	R
28R-1, 47–48	BViSS	P	V																						V	
28R-1, 92–93	BViSS	P–M	F				R	R				R					R			R	R				R	R
28R-1, 110–111	BViSS	P	R–F					R									R				R				R	R
28R-1, 145–146	BViSS	P	R																		R				R	R
29R-1, 21–22	BViSS	P	V																						V	
29R-1, 37–38	BViSS	P	R									R													R	R
29R-1, 66–67	BViSS	P	V																						V	
29R-1, 122–123	BViSS	P	F									R									R				R	R
29R-1, 143–144	LVSS	P	V																						V	
29R-2, 21–22	LVSS	P	V																						V	
29R-2, 31–32	LVSS	P	R									R									R				R	R
29R-2, 66–67	LVSS	P	R									R									R					
29R-2, 74–75	LVSS	P	R																		R				R	
29R-2, 116–117*	LVSS	M	R			R						R						R	R	R	R					
29R-2, 145–146	LVSS	P	F–C			R						R					R			R	F				F	
29R-3, 19–20*	LVSS	P	R			R				R								R	R	R	R					
29R-3, 122–123*	LVSS	P	R									R						R		R	R					
29R-3, 133–134	LVSS	P	F	R								R								R	R				R	F
29R-3, 146–147	LVSS	P	R–F																	R	R				R	
32R-1, 79–80	BVoSS	P	F–R				R				R	R					R				R		R		R	
32R-4, 94–95	BVoSS	P	V																							V
32R-6, 29–30	BVoSS	P	V																							V
33R-1, 8–9	BVoSS	P	R				R											R		R	R					
33R-1, 87–88	BVoSS	M	C	R		F–R	R					R–F					R	R	R	F	F		R		F	
33R-2, 50–51	BVoSS	P	C									R			R				R	F	F		R		F	
33R-2, 142–143	BVoSS	M	C	V		R	R				R	R					R		R	R	F				F	R
33R-3, 22–23	BVoSS	M	F			R						R	R				R	R		F	F				F	R
33R-3, 54–55	BVoSS	P	F			R															R				F	
33R-3, 68–69	BVoSS	P	R																		R				R	
33R-3, 82–83	BVoSS	P	R														R				R				R	
33R-3, 133–134	BVoSS	P	R																		R				R	

Table T1 (continued).

Core, section, interval (cm)	Lithology	Preservation	Abundance	*Aspidolithus parcus*	*Braarudosphaera bigelowii*	*Ceratolithoides aculeus*	*Cretarhabdus conicus*	*Cribrosphaerella ehrenbergii*	*Eiffellithus eximius*	*Eiffellithus turriseiffelii*	*Marthasterites inconspicuous*	*Micula decussata*	*Microrhabdulus decoratus*	*Pervilithus varius*	*Prediscosphaera cretacea*	*Retecapsa crenulata*	*Rhagodicus angustus*	*Uniplanarius gothicus*	*Uniplanarius sissinghii*	*Uniplanarius trifidus*	*Watznaueria barnesae*	*Zeugrhabdotus embergeri*	*Broinsonia* sp.	*Reinhardites* sp.	Unidentified specimens	Nannofossil fragments
33R-CC	PBHB	M	F			R					R	R					R		R	R	R				R	
33R-CC*	PBHB	M	C		R	F	F				R	R			R		F	R		F	F				R	R
34R-1, 2–3	PBHB	P	V																	V						
34R-1, 13–14	PBHB	P	V																							V
34R-2, 105–106	PBHB	P	V																		V					
35R-1, 14–15	PBHB	P	V																						V	
35R-1, 94–95	BViSS	P	R																		R				R	R
36R-7, 116–117	BVoSS	P	R																						R	R
36R-8, 4–5	BVoSS	P	R																		V					R
36R-8, 9–10	BVoSS	P	F–R														R				R				R	R
36R-8, 129–130	CVSS	P	V																						V	
37R-1, 11–12	BOPBT	P	F			R		R				R								V	R				F	R
38R-2, 64–65	BOPBT	P	V																						V	
38R-2, 111–112	BOPBT	P	R			R						R					R				R				R	R
38R-3, 55–56	BOPBT	P	R			R		R									R									
38R-3, 68–69	BOPBT	P	R														R	R	R	V	R				R	
38R-3, 94–95	BOPBT	P	R																		R				R	R
38R-3, 124–125	BOPBT	P	R			R						V									R		R		R	
38R-4, 5–6	BOPBT	P	R		R														V		R		R		R	
38R-4, 84–85	BOPBT	P	V																		V					
38R-4, 127–128	BOPBT	P	R			R						R							V	V	R				R	
38R-5, 90–91	BOPBT	P	F			R						R									R				R	R
38R-5, 102–103	BOPBT	M	C			R		R			R	R					R			R	F				F	F
38R-5, 106–107	BOPBT	P	C–F			R	R			R		R					R			R	F				F	F
39R-1, 36–37	BOPBT	P	F			R		R													F				F	R
39R-1, 98–99	BOPBT	M–P	F																	R	F				R	
39R-2, 13–14	BOPBT	P	F			V				R		R									F				F	R
39R-2, 93–94	BOPBT	P	R			R						V					R				R					R
39R-2, 112–113	BOPBT	P	R–F			R						R					R				R				R	
39R-2, 127–128	BOPBT	P	C			R				V			R		V		R				C–F				F	R
39R-3, 9–10	BOPBT	M–G	C			R–F	R	R		R–F		R				R	F				F		R		F	
39R-3, 45–46	BOPBT	G–M	F–C	R		F	R	R		R–F	R	R	R				F		R	R	F	R			F	R
39R-3, 57–58	BOPBT	M	R	R		R			R			R			R					R	R	R			R	
39R-3, 61–62*	BOPBT	M	C	R		R	R			R	R	R	R		R	R	F		V	R	F	R			F	
39R-3, 80–81	BOPBT	M	F			R	R	R					R		R		F			V	F				F	
39R-3, 92–93	BOPBT	M	F–C				R	R		R							F	V		R	F	R	R		F	
39R-3, 115–116	BOPBT	P	R						V	R											R					
39R-4, 18–19*	BOPBT	P	R						V	R											R					
39R-4, 21–22	BOPBT	M	F			R	R	F		R			R				F				F		R		F	R
63R-5, 19–20	VS	P	F–R			R				R		R					R			R	R				R	
63R-5, 55–56*	VS	P	R–F			R–F						R		R						R	F					
63R-5, 74–75*	VS	P	R						R											R						
63R-5, 94–95	VS	P	F					R					R				R				F				R	
63R-5, 118–119*	VS	P	R						R		R	R			R						R					
63R-5, 136–137	VS	P	R										R				R			V	R					
63R-6, 10–11*	VS	M	R	R		R				R		R	R				R		R	R	R	R				
64R-1, 112–113*	VB	P	R	R		R						R								R	R				R	
65R-1, 7–8*	VB	P	R			R											R				R					
65R-1, 117–118*	VB	P	R																		R					
197-1204A-																										
6R-5, 16–17	VB	M–P	F–C			R						R				F	R	V	R	R	F				R	
6R-5, 33–34	VB	P	R			R														R	R				R	
6R-5, 85–86	VB	P	V																						V	
197-1204B-																										
17R-3, 80–81*		M	F			R	R	R		R	R	R		R	R		R	R	R	R	F	R			R	

Notes: * = volcaniclastic samples previously examined during the Leg 197 cruise by the author and the other shipboard micropaleontologist, Dr. Fabrizio Tremolada. NSC = nannofossil-silty-chalk, RBT = resedimented basalt-tuff, RSBT = resedimented-synvolcanic basalt-tuff, LBT = laminated basalt-tuff, BT = basalt-tuff, LTBSS = laminated-thinly bedded siltstone-sandstone, BViSS = bedded vitric siltstone-sandstone, LVSS = laminated volcaniclastic siltstone-sandstone, BVoSS = bedded volcaniclastic siltstone-sandstone, PBHB = plagioclase basalt-hyaloclastite breccia, CVSS = calcareous vitric siltstone and sandstone, BOPBT = bedded olivine-plagioclase-basalt tuff, VS = volcaniclastic sandstone, VB = volcaniclastic breccia. Abundance: C = common, F = few, R = rare, V = very rare. Preservation: G = good, M = moderate, P = poor.