Shipley, T.H., Ogawa, Y., Blum, P., and Bahr, J.M. (Eds.), 1997
Proceedings of the Ocean Drilling Program, Scientific Results, Vol. 156

3. CALCAREOUS NANNOFOSSILS FROM LEG 156, NORTHERN BARBADOS RIDGE COMPLEX[1]

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ABSTRACT

Oligocene to lower Pleistocene calcareous nannofossils were recovered at Ocean Drilling Program Leg 156 Sites 948 and 949 on the frontal portion of the Barbados Ridge accretionary complex. Upper Miocene to lower Pliocene and lower Pleistocene nannofossils are generally well preserved, but those of the lower to middle Miocene are absent or poorly preserved as a result of intense dissolution. Oligocene sediments, introduced as turbidites, contain well-preserved nannofossils.

A important finding is a nannofossil stratigraphic inversion in the upper part of the cored section at Hole 949B, where lower Pliocene to upper Miocene sediments (Zones CN9 and 10) lie stratigraphically below those of middle Miocene Zone CN7. This, in conjunction with discontinuities in index properties, acoustic impedance, and pore-water composition, suggests the presence of a reverse fault formed by imbricate thrusting within the unrecovered interval of Core 156-949B-6X.

INTRODUCTION

Ocean Drilling Program (ODP) Leg 156 investigated the frontal portion of the Barbados Ridge accretionary complex to understand the active margin processes in the Lesser Antilles Forearc region (Figs. 1, 2). Leg 156 was the third cruise to this area, the primary objective of the leg being the investigation of the temporal and spatial interrelationship of fluids, tectonic features, and geochemical signatures in an accretionary prism, with chief focus on the décollement.

On two previous legs, Deep Sea Drilling Project (DSDP) Leg 78A (Biju-Duval, Moore, et al., 1984) and ODP Leg 110 (Mascle, Moore, et al., 1988; Moore, Mascle, et al., 1990), seven sites in the Barbados accretionary prism were drilled, successfully penetrating the décollement at Sites 671, 675, 676 and the underthrust sediments at Site 671; two sites (543 and 672) were drilled on the Atlantic abyssal plain as oceanic reference sites. The oldest sediments recovered at the oceanic reference sites are of Late Cretaceous age (Site 543, DSDP Leg 78A). The oldest sediments recovered in the holes penetrating the prism are upper Oligocene underthrust sediments (Site 671, ODP Leg 110). The low calcium compensation depth, advantageously depressed in the equatorial Atlantic Ocean, resulted in good biostratigraphic records that made it possible to document reverse faults in the accretionary prism by means of calcareous nannofossils (Bergen, 1984; Clark, 1990). During Leg 156, eight holes were drilled at three sites in the toe of the accretionary prism (Fig. 1). Site 947 was dedicated entirely to logging. Cores from Holes 948B, 948C, 949A, 949B, and 949C were examined in this paper for calcareous nannofossils.

METHODS

Smear slides were prepared for all the samples taken using Norland Optical Adhesive as a mounting medium. Sediments from each hole were examined at a spacing of one sample per section, except for the barren interval. The calcareous nannofossils were observed through the light microscope using cross-polarized and phase-contrast light at approximate magnifications of 1562× for the Pleistocene assemblages and 625× for the rest of the assemblages.

The relative abundance of individual species was estimated using the scale below, which is adapted from Hay (1970). Counts were made at a magnification of 625× and then adjusted for 1562× accordingly:

VA (very abundant) = 100 specimens per field of view,
A (abundant) = 10–100 specimens per field of view,
C (common) = 1–10 specimens per field of view,
F (few) = 1 specimen per 1–10 fields of view,
R (rare) = 1 specimen per 10–100 fields of view, and
P (present) = a few specimens per slide.

Occurrences of reworked species are indicated by a lowercase letter "p" on the range charts.

The overall abundance of nannofossil taxa in each sample is expressed in the following fashion after Bergen (1984):

A (abundant) = nannofossils constitute over 50% of each slide,
C (common) = between 10 and 50% of each slide,
F (few) = between 1 and 10%,
R (rare) = less than 1%, and
B (barren) = none.

The criteria for evaluating the overall preservation of each sample are based on the conditions of the placoliths in the sample, because the discoasters and ceratoliths did not show a great range of preservational patterns (Bergen, 1984). The following codes were used to depict the preservation state of the nannofossil assemblages after Bergen (1984):

G (good) = assemblages contained placoliths that showed no signs of etching;
M (moderate) = placoliths were slightly etched and the number of delicate forms was reduced; and
P (poor) = placoliths were noticeably etched and many isolated shields remained; delicate forms were not present and discoasters and ceratoliths were broken.

The standard low-latitude Cenozoic nannofossil zonation scheme proposed by Bukry (1973, 1975), and modified by Okada and Bukry (1980), is used for Oligocene through Pliocene sediments. The zonation scheme of Gartner (1977) is used for Pleistocene sediments, because it provides better resolution for this section.

This report adopted the emendations to the above zonation schemes suggested by Bergen (1984) for the assemblages recovered

[1]Shipley, T.H., Ogawa, Y., Blum, P., and Bahr, J.M. (Eds.), 1997. *Proc. ODP, Sci. Results,*156: College Station, TX (Ocean Drilling Program).

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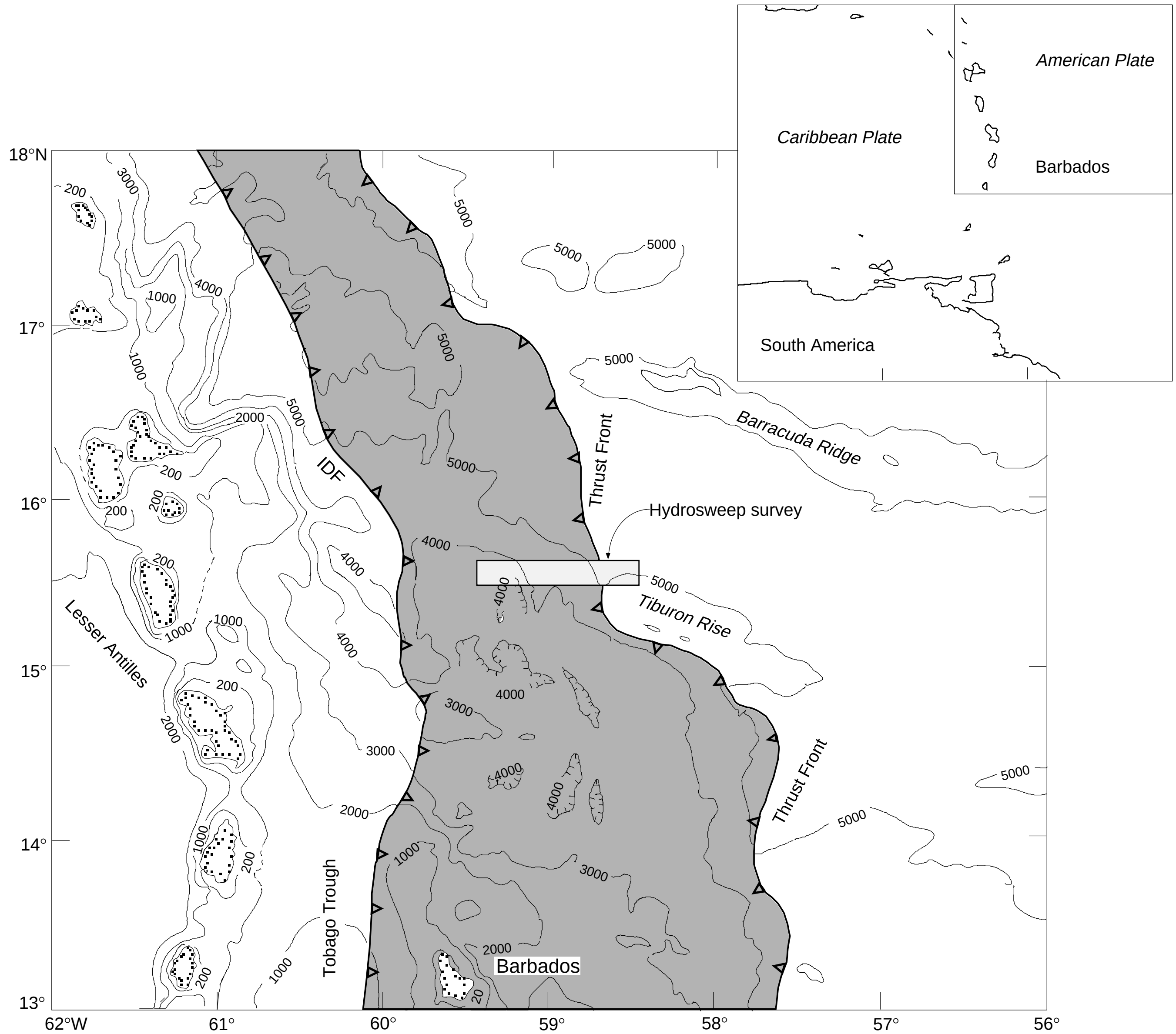

Figure 1. Location of study area. Shaded zone is the extent of the northern Barbados Ridge accretionary prism. The rectangular box is approximately the size of the multibeam bathymetric map shown in Figure 2.

from DSDP Leg 78A, which correspond closely to those preserved in the Leg 156 sediments (Fig. 3).

Calcareous nannofossil taxa considered in this report are listed in the Appendix, where they are arranged alphabetically by species. Bibliographic references for these taxa can be found in Perch-Nielsen (1985).

SITE SUMMARIES

Site 948

Site 948 was drilled near the toe of the Barbados accretionary complex, located approximately 5 km arcward of the deformation front (Fig. 2). It calibrates the décollement with a positive-polarity seismic signature indicative of normal porosity (Shipley et al., 1994). It is also close to Hole 671B, which penetrated the 40-m-thick décollement and 151 m into the underthrust section during Leg 110 (Fig. 2). Hole 948A was dedicated to logging, and Hole 948D was cased for special experiments.

Hole 948B

Hole 948B was a jet-in test site. A mudline core was taken and recovered 3.7 m of sediments. The core-catcher sample of the mudline core contains *Pseudoemiliania lacunosa, Calcidiscus leptoporus, Gephyrocapsa oceanica, Gephyrocapsa caribbeanica, Ceratolithus cristatus,* and *Helicosphaera carteri. Helicosphaera sellii* was absent from this sample, which was therefore placed within the lower Pleistocene *Pseudoemiliania lacunosa* zone. The assemblage also contains reworked discoasters. The nannofossils are moderately well preserved. Upper Pleistocene sediments were not found.

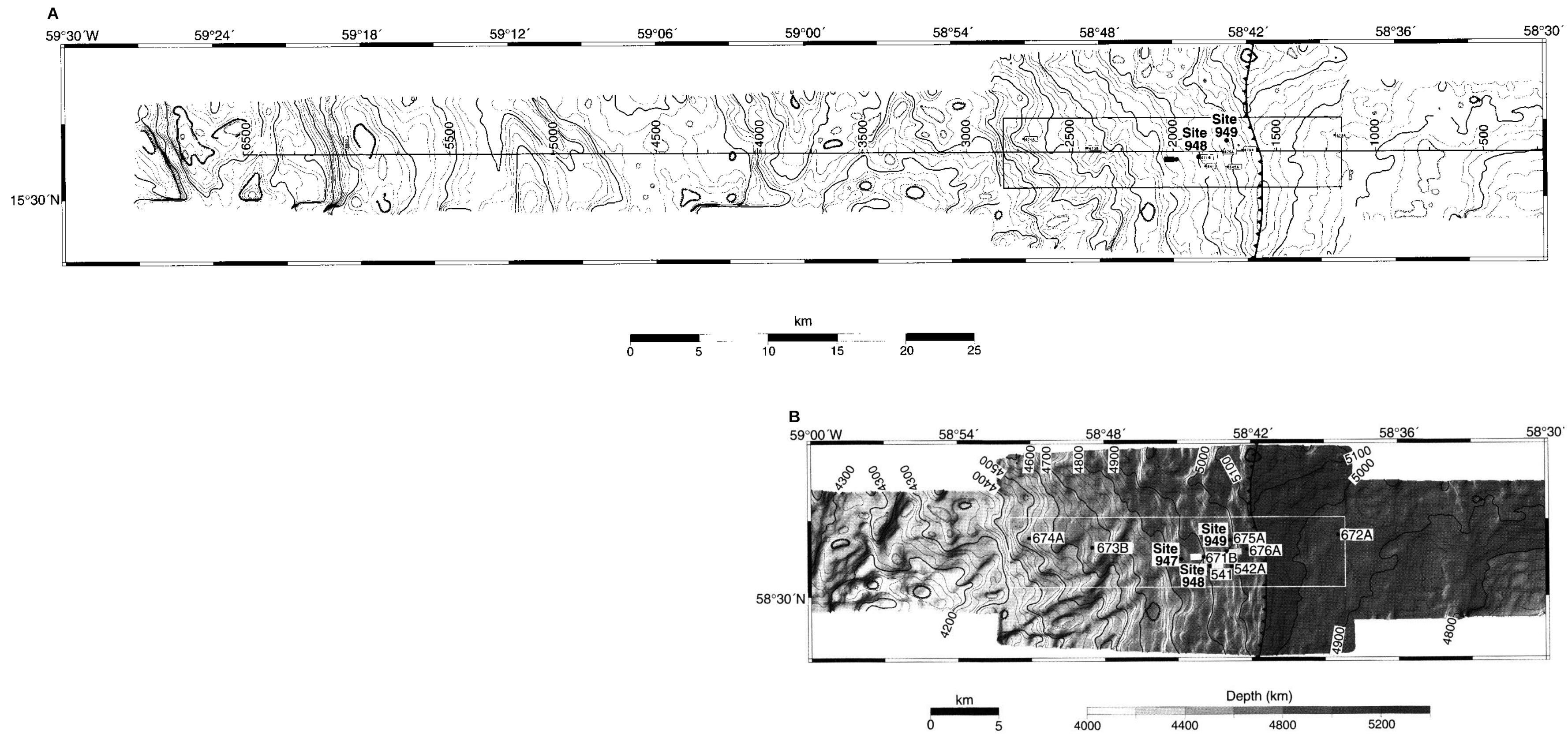

Figure 2. Regional hydrosweep bathymetry and locations of Leg 156 Sites 948 and 949 and other DSDP and ODP sites previously drilled in the area. See Figure 1 for location. Contour is 25 m; barbed line is a thrust front. **A.** Contour map of entire survey. **B.** Shaded relief map of eastern half of survey.

Age		Zone		Subzone		Datum
Pleistocene	late	*Emiliania huxleyi* Acme Zone				FAD *E. huxleyi* acme
		Emiliania huxleyi zone				FAD *E. huxleyi*
		Gephyrocapsa oceanica Zone				LAD *P. lacunosa*
	early	*Pseudoemiliania lacunosa* Zone				LAD *H. sellii*
		Helicosphaera sellii Zone				LAD *C. macintyrei*
		Calcidiscus macintyrei Zone				LAD *D. brouweri*
Pliocene	late	CN12	*Discoaster brouweri*	CN12d	*Calcidiscus macintyrei*	LAD *D. pentaradiatus*
				CN12c	*Discoaster pentraradiatus*	LAD *D. surculus*
				CN12b	*Discoaster surclus*	LAD *D. tamalis*
				CN12a	*Discoaster tamalis*	LAD *R. pseudoumbilica*
	early	CN11	*Reticulofenestra pseudoumbilica*	CN11b	*Discoaster asymmetricus*	FAD *D. asymmetricus*
				CN11a	*Sphenolithus neoabies*	LAD *A. tricorniculatus*
		CN10	*Amaurolithus tricorniculatus*	CN10c	*Ceratolithus rugosus*	LAD *C.acutus* / FAD *C. cristatus*
				CN10b	*Ceratolithus acutus*	FAD *C. acutus*
Miocene	late			CN10a	*Triquetrorhabdulus rugosus*	LAD *D. quinqueramus*
		CN9	*Discoaster quinqueramus*	CN9b	*Amaurolithus primus*	FAD *A. primus*
				CN9a	*Discoaster berggrenii*	FAD *D. berggrenii*
		CN8	*Discoaster neohamatus*	CN8b	*Discoaster neorectus*	FAD *D. neorectus / D. loeblichii*
				CN8a	*Discoaster bellus*	LAD *D. hamatus*
		CN7	*Discoaster hamatus*	CN7b	*Catinaster calyculus*	FAD *C. calyculus*
	middle			CN7a	*Helicosphaera carteri*	FAD *D. hamatus*
		CN6	*Catinaster coalitus*			FAD *C. coalitus*
		CN5	*Discoaster exilis*	CN5b	*Discoaster kugleri*	FAD *D. kugleri*
				CN5a	*Coccolithus miopelagicus*	LAD *S. heteromorphus*
		CN4	*Sphenolithus heteromorphus*			LAD *H. ampliaperta*
	early	CN3	*Helicosphaera ampliaperta*			FAD *S. heteromorphus*
		CN2	*Sphenolithus belemnos*			FAD *S. belemnos*
		CN1	*Triquetro-rhabdulus carinatus*	CN1c	*Discoaster druggii*	FAD *D. druggii*
				CN1b	*Discoaster deflandrei*	LAD *C. abisectus* acme
Oligocene	late			CN1a	*Cyclicargolithus abisectus*	LAD *S. ciperoensis*
		CP19	*Sphenolithus ciperoensis*	CP19b	*Dictyococcites bisectus*	LAD *S. distentus*
				CP19a	*Cyclicargolithus floridanus*	FAD *S. ciperoensis*
	early	CP18	*Sphenolithus distentus*			FAD *S. distentus*
		CP17	*Sphenolithus predistentus*			LAD *R. umbilica / R. hillae*

Figure 3. Nannofossil zonation used in this study modified from Bukry (1973, 1975), Gartner (1977), Okada and Bukry (1980), and Bergen (1984). FAD = first appearance datum, LAD = last appearance datum.

Hole 948C

Hole 948C was located close to logging-while-drilling Hole 948A (and Hole 671B). It began with a mudline core that recovered 10.1 m of sediment. The hole was then drilled without coring from 9.5 meters below seafloor (mbsf) down to 420.8 mbsf. Coring resumed with Cores 156-948C-2X through 19X at 592.0 mbsf. The uppermost mudline core is Pleistocene. Nannofossiliferous sediments of late Miocene age and late Oligocene age are found above and below the décollement, respectively. Miocene sediments were confined to Sections 156-948C-4X-2 to 6X-1.

Mudline core Samples 156-948C-1H-1, 20–21 cm, through 1H-4, 135–136 cm, are assigned to the lower Pleistocene *Pseudoemiliania lacunosa* zone because of the presence of *P. lacunosa* and the absence of *Helicosphaera sellii.* Samples 156-948C-1H-5, 140–141 cm, through 1H-CC contain *H. sellii* but lack *Calcidiscus macintyrei,* and were thus assigned to the *H. sellii* zone. A few reworked *H. sellii* were present in Sample 156-948C-1H-2, 130–131 cm. Reworked discoasters were found throughout the whole interval (Table 1). The assemblage is moderately well preserved.

The interval from Core 156-948C-2X through Sample 156-948C-4X-2, 25–26 cm, is devoid of calcareous nannofossils.

Sections 156-948C-4X-2 through 6X-1 contain an assemblage composed largely of discoasters. Preservation of the samples is usually poor. Samples 156-948C-4X-2, 134–135 cm, through 5X-7, 36–37 cm, are placed in the upper Miocene *Discoaster berggrenii* subzone (CN9a), based on the presence of *Discoaster berggrenii* and the lack of *Amaurolithus primus.* Although the preservation is poor, the lack of *Amaurolithus primus* here is not likely to be the result of dissolution because the placoliths, which are less solution-resistant than the amauroliths (Bergen, 1984), are present in the samples. *Discoaster surculus,* another marker for the base of Subzone CN9a, was not found in these samples.

Samples 156-948C-5X-CC, through 6X-1, 131–132 cm, do not contain any of the above marker species. No other age-diagnostic species are present in these samples. Most discoasters are broken and could not be identified with certainty. However, few *Discoaster bollii* and *Discoaster bellus,* as well as some broken *D. neohamatus,* are found in the interval; they are indicative of the upper Miocene *D. neohamatus* zone (CN8; Table 2).

Samples 156-948C-6X-2, 46–47 cm, through 13X-2, 139–140 cm, are barren of calcareous nannofossils. The décollement, which occurs within this interval as suggested by geochemical, structural, and sedimentological evidence, therefore could not be dated using nannofossils. The radiolarian data show an early to middle Miocene age for the interval from Core 156-948C-9X through 12X. The large-scale dissolution of the Miocene assemblages may have been the result of the upward excursions of the carbonate compensation depth (CCD) during the Miocene (Berger and von Rad, 1972; Van Andel, 1975).

Below the long barren interval is a thick section of upper Oligocene, undeformed, underthrust sediments. Well-preserved nannofossils were found in the laminated layers of nannofossil chalk and in the silty claystone, which were punctuated by nannofossil-barren intervals of hemipelagic claystones low in carbonate content. The interbeds of the nannofossil chalk and terrigeneous claystone in the green hemipelagic background clays, which were deposited predominantly below the CCD, were the result of turbidites as noted by Dolan et al. (1990). Nannofossil oozes were demobilized from sources located above the CCD and buried rapidly enough below the CCD to survive the dissolution.

Samples 156-948C-13X-3, 121 cm, through 18X-2, 141–142 cm, contain *Sphenolithus ciperoensis,* but *Sphenolithus distentus* is not observed within this interval. This interval is therefore placed within the upper Oligocene *Dictyococcites bisectus* subzone (CP19b). *S. distentus* appears in Samples 156-948C-18X-3, 118–119 cm, through 156-948C-19X-CC. It does not overlap with *S. ciperoensis* in this interval, so this interval is assigned to the upper Oligocene.

Site 949

Site 949 is located 1.6 km west of the trench thrust front and about 0.8 km north-northwest of Leg 110, Site 675 (Fig. 2). It targeted the reversed-polarity seismic signature of the décollement thought to represent high-porosity zones of high-fluid pressure (Shipley et al., 1994). Overall recovery at Site 949 is very poor. Yet nannofossil stratigraphic information from Hole 949B documented a stratigraphic inversion, indicating a reverse fault in the prism above the décollement.

Hole 949A

Hole 949A was cored from 0 to 2.95 mbsf as a mudline core (Core 156-949A-1H). The sediments contain few to abundant nannofossils of early Pleistocene age. Nannofossil species found between Sample 156-949A-1H-1, 63–64 cm, and 1H-CC, include *Pseudoemiliania lacunosa, Calcidiscus leptoporus, Gephyrocapsa oceanica, Gephyrocapsa caribbeanica, Ceratolithus cristatus, Helicosphaera carteri,* and *Helicosphaera sellii.* The interval is assigned to the *H. sellii* zone, based on the absence of *Calcidiscus macintyrei.* This mudline core is slightly older than the mudline cores of Site 948. Nannofossils are moderately well preserved, except for those found in the bottom of Sample 156-949A-1H-CC. Reworked discoasters from the Pliocene and Miocene are found throughout these cores.

Hole 949B

Hole 949B was drilled without coring to a depth of 244.1 mbsf, from which point it was cored to 464.2 mbsf. Sediment recovery was very limited. Nannofossil-bearing sediments range in age from late Oligocene to early Pliocene. Pliocene and Oligocene sediments generally contain common and moderately well-preserved calcareous nannofossils. The Miocene sediments contain relatively few and often poorly preserved floras.

Sample 156-949B-1X-1, 5–6 cm, is barren. Sample 156-949B-1X-1, 89–90 cm, contains rare broken discoasters and is assigned to the *Discoaster hamatus* zone (CN7) because of the presence of *D. hamatus.* Further subzone designation is not possible. The better preserved Samples 156-949B-1X-CC, through 2X-2, 2–3 cm, are placed in the upper middle Miocene *Helicosphaera carteri* subzone (CN7a) because of the presence of *D. hamatus* and the lack of *Catinaster calyculus.*

A barren interval occurs between Samples 156-949B-2X-2, 38–39 cm, and 6X-CC, and virtually no sediment was recovered in Core 6X.

A major biostratigraphic reversal was identified in Section 156-949B-7X-1, which places lower Pliocene to upper Miocene sediments of Core 156-949B-7X stratigraphically below those of the middle Miocene sediments recovered in Cores 156-949B-1X and 2X (see Shipboard Scientific Party, 1995, Fig. 24).

The lower Pliocene *Ceratolithus acutus* subzone (CN10b) is recognized in Samples 156-949B-7X-1, 7–8 cm, through 7X-1, 24–25 cm, because of the rare but consistent appearance of the well-preserved range marker *C. acutus.* The assemblage also includes *Amaurolithus delicatus, C. acutus, Discoaster braarudii, Discoaster challengeri,* and *Discoaster pentaradiatus.* The base of the *C. acutus* subzone defines the Miocene/Pliocene boundary.

The *Triquetrorhabdulus rugosus* subzone (CN10a) of late Miocene age is a gap zone between the last occurrence of *Discoaster quinqueramus* and first occurrence of *Ceratolithus acutus.* Samples 156-949B-7X-1, 66–67 cm, through 7X-6, 25–26 cm are placed within Subzone CN10a, owing to the absence of both *Discoaster*

Table 1. Nannofossil species present in the Hole 948C mudline core.

Age	Nannofossil zone	Depth (mbsf)	Sample (core-section, interval in cm)	Abundance	Preservation	*Helicosphaera carteri*	*H. colombiana*	*H. kampteri*	*H. sellii*	*Calcidiscus leptoporus*	*C. macintyrei*	*Gephyrocapsa caribbeanica*	*G. oceanica*	*Pseudoemiliania lacunosa*	*Ceratolithus cristatus*	*Discoaster spp.*	*Umbilicosphaera angustiforamen*	*U. maceria*	*U. sibogae*	*Syracospheara pulchra*	*Scapholithus fossils*	*Thoracosphaera albatrosiana*	*Rhobdosphaera clavigera*	*Coccolithus pelagicus*
early Pleistocene	*Pseudoemiliania lacunosa* zone		1H-1, 20-21	R	P	R							R	P				P						
			1H-2, 130-131	A	M	F			p	C		F	A	F	F		F	R	C	R	R	F	R	R
			1H-3, 110-111	R	P	R				P			F											
			1H-4, 135-136	P	M					R		P	A	P	R	p	P	R	R					
	Helicosphaera sellii zone		1H-5, 140-141	A	M	C	F		R	C		R	A	A	F	p	F	F	F	F		F		
			1H-6, 130-131	A	M	C	R	F	R	C		R	A	C	R	p		R	R	F		F	C	
			1H-7, 70-71	A	M	F	F		R	C	p	R	A	C	F	p	R	R	R	F		R		
		9.5	1, CC	B																				

Note: Abbreviations are defined in the text.

quinqueramus and *C. acutus.* The nannofossil species present in the assemblage are *T. rugosus, Amaurolithus delicatus,* and *Discoaster challengeri.*

Samples 156-949B-7X-6, 57–58 cm, through 7X-7, 3–4 cm are assigned to the *Amaurolithus primus* subzone (CN9b) because of the co-appearances of *Discoaster quinqueramus* and *Amaurolithus primus.* The assemblage also includes *Amaurolithus delicatus, Discoaster surculus, Discoaster variablilis, Discoaster braarudii, Coccolithus pelagicus, Calcidiscus leptoporus,* and *Reticulofenestra pseudoumbilica.* The interval from Samples 156-949B-7X-7, 38–39 cm, through 7X-CC are placed in the *Discoaster berggrenii* subzone (CN9a) because of the absence of *A. primus* in the presence of *D. quinqueramus* and *D. surculus.* The absence of *A. primus,* however, could be an artifact of sample preservation because it is moderately vulnerable to dissolution (Berger, 1984).

Recovery of Cores 156-949B-8X through 12X was 0%, except for a very small amount of sediment from Sample 156-949B-11X-CC, which contains few poorly preserved *Discoaster berggrenii* and *Discoaster quinqueramus.* It is indicative of the upper Miocene *D. berggrenii* subzone (CN9a). Thus, the whole interval from Cores 156-948B-8X through 11X might also belong to Subzone CN9a. If this is the case, Subzone CN9a is slightly expanded in comparison with the general sedimentation rate for this portion in this area (Wright, 1984). The expansion may be attributed to one of two possible reasons: either there is additional undocumented faulting between Cores 156-949B-8X and 11X, resulting in structural thickening of the section, or the sedimentation rate increased during the late Miocene

Sample 156-949B-13X-1, 23–24 cm, is barren. Samples 156-949B-13X-1, 46–47 cm, through 13X-2, 20–21 cm, contain a poorly preserved Miocene assemblage that includes six-rayed *Discoaster hamatus, Discoaster neohamatus,* and *Discoaster bollii.* It is assigned to the *D. hamatus* zone (CN7) of late middle Miocene age based on the range of *D. hamatus.* Further subzone designation is not possible for this sparse assemblage. Samples 156-949B-13X-2, 59–60 cm, through 13X-CC, are barren.

A long barren interval persists from Cores 156-949B-14X through 24X that may have resulted from a shallowing of the CCD during the Miocene. The décollement contained within this interval could not be dated using nannofossils. Radiolarian data found in Cores 156-949B-19X through 22X indicate an interval of early Miocene age sediments.

Below the décollement zone, the upper Oligocene *Dictyococcites bisectus* subzone (CP19b) is recognized in Samples 156-949B-25H-1, 106–107 cm, through 25H-2, 55–56 cm. The nannofossil assemblage includes common *Sphenolithus ciperoensis,* very abundant *Cyclicargolithus floridanus,* and *Cyclicargolithus abisectus.*

Hole 949C

The recovery from Hole 949C was extremely low, averaging only 3.5%. Samples 156-949C-2R-CC through 6R-CC are barren of nannofossils. Sample 156-949C-7R-CC is placed within upper Oligocene *Dictyococcites bisectus* subzone (CP19b) based on the presence of *Sphenolithus ciperoensis* and the absence of *S. distentus.*

CONCLUSIONS

Two sites drilled during Leg 156 cored the décollement, which was situated within the lower Miocene. Sediments containing nannofossils range in age from late Oligocene to early Pleistocene. As a result of increased dissolution and/or tectonic disturbance, calcareous nannofossils are either absent or suffered intense dissolution in the lower to middle Miocene interval. Upper Miocene to lower Pliocene and lower Pleistocene nannofossils are generally well preserved. No record of upper Pleistocene sediment was recovered. Oligocene nannofossiliferous sediments, which are the result of turbidites, contain well-preserved nannofossils.

An important finding of this study is a nannofossil stratigraphic inversion in the upper part of the cored section at Site 949. This, in conjunction with discontinuities in index properties, acoustic impedance, and pore-water compositions, suggests the presence of a fault in the unrecovered interval of Core 156-949B-6X. The reverse fault formed by imbricate thrusting apparently displaces the middle Mio-

Table 2. Nannofossil species present in Cores 156-948C-4X through 6X.

Age	Nannofossil zone or subzone	Depth (mbsf)	Sample (Core-section, interval in cm)	Abundance	Preservation	*Triquetrorhabdulus rogusus*	*Discoaster asymmetricus*	*D. berggrenii*	*D. braarudii*	*D. brouweri*	*D. bollii*	*D. bellus*	*D. challengeri*	*D. neohamatus*	*D. pentaradiatus*	*D. quinqueramus*	*D. surculus*	*D. variabilis*	*Calcidiscus leptoporus*	*C. macintyrei*	*Sphenolithus moriformis*	*S. neoabies*	*Coccolithus pelagicus*	*Reticulofenestra pseudoumbilica*	*Thoracosphaera albatrosiana*	*Umbilicasphaera sibogae*	*Minylitha convalis*
late Miocene	*Discoaster berggrenii* Subzone (CN9a)		4X-1, 133-134	B																							
			4X-2, 134-135	R	P			R	P				R					R									R
			4X-3, 133-134	C	P			F	F	F			F	R	R			C	F			R					
			4X-4, 133-134	C	M			R	C									C	F		F	F	C	R	R	R	R
			4X-5, 100-101	R	P													R									
			4X-6, 29-30	A	P			F	F									C	F								
		449.8	4, CC	A	M	R		C	C	C			F		F	F		A	C	R	R	F	C	C	F	F	
			5X-1, 41-42	B																							
			5X-2, 32-33	B																							
			5X-3, 142-143	C	M	F		C	F	F			F	R	F	F		C	C	R	F	F	C	C	P	F	
			5X-4, 33-34	B																							
			5X-5, 45-46	R	P			F	F					P				C									
			5X-6, 45-46	F	P			R	F					R		R		C									
			5X-7, 36-37	F	M	F		F	C	F			C		R	F		C	F		F	R	C	F	F	F	
	Discoaster neohamatus Subzone ? (CN8)	459.4	5, CC	F	P				F		F	R						C	F			R		R			
			6X-1, 29-30	R	P				F		R	P						R									
			6X-1, 131-132	R	P						P							P									
			6X-2, 29-39	B																							
			6X-3, 29-30	B																							

Note: Abbreviations are defined in the text.

cene sediments upwards by a significant amount (Shipboard Scientific Party, 1995).

ACKNOWLEDGMENTS

We thank Drs. David K. Watkins, Yujiro Ogawa, and Laura Stokking for their helpful science and/or editorial reviews, and Mrs. Gigi Delgado for her usual yet extraordinary assistance manifested in many ways. The research was supported by a grant from the U.S. Sciences Advisory Committee.

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Date of initial receipt: 6 May 1996
Date of acceptance: 28 August 1996
Ms 156SR-008