13. DIATOM BIOSTRATIGRAPHY OF SITES 495, 496, AND 497, DEEP SEA DRILLING PROJECT LEG 67[1]

Howard E. Harper, Jr., Arco Oil and Gas Co., Dallas, Texas
Jonathan Rider, Consultant, Loomis, California
and
William H. Abbott, Mobil Exploration and Producing Services, Inc., Dallas, Texas

INTRODUCTION

Samples from Leg 67 sites were taken by shipboard personnel for this shore-based study of diatom biostratigraphy. Data from only three sites are presented in this paper because of the authors' time restrictions. Each author studied the samples from one site: Site 495, 12° 29.78′N, 91°2.26′W (Howard Harper, Jr.), Site 496, 13°03.82′N, 90°47.71′W (William Abbott), and Site 497, 12°59.23′N, 90°49.68′W (Jonathan Rider).

DIATOM ZONATION

The studies of Burckle (1972, 1977, in press) are the most important references for diatom biostratigraphy in the tropical Pacific. The datum levels and zonation published by Burckle are cited in this study and used for correlation and age assignments (Fig. 1). The taxa referenced in this report are listed in Table 1.

Site 495

Site 495 is located on the oceanic plate west of the Middle America Trench (Fig. 2). Well-preserved diatoms are present in samples from Cores 3 to 19. Diatoms in Cores 20 to 23 are poorly preserved, when present, and several samples were barren. The occurrence of key stratigraphic taxa is shown in Table 2 and Figure 3. The diatom zonation developed by Burckle (1972, 1977) is easily recognized in the section from Core 3 to Core 19. An unconformity is present between Samples 495-18-1, 20–21 cm and 495-19-1, 20–21 cm. The sample from Core 18 contains *Hemidiscus cuneiformis* and *Nitzschia miocenica* and is no older than Paleomagnetic Epoch 7. The sample from Core 19 contains *Denticulopsis hustedtii* and *Coscinodiscus paleaceus*, lacks any *H. cuneiformis*, and is no younger than Paleomagnetic Epoch 12 (Fig. 1). The section between Cores 19 and 24 is barren of any age diagnostic diatoms. Poorly preserved diatoms occur in Core 24, and preservation is good in samples from Cores 26 through 31, 35, and 36. The assemblage from these samples contains several middle to early Miocene diatoms (*Annellus californicus, Raphidodiscus marylandicus, Coscinodiscus lewisianus, Borgorovia veniamini, Craspedodiscus coscinodiscus*), but also present are several forms that Jousé (1974) restricts to the Oligocene (*Coscinodiscus oligocenicus, Cestodiscus ssp.*). Data from the other microfossil groups shown in Figure 3 agree with an early and middle Miocene age assignment for these sediments (P. Thompson, personal communication, 1981).

Site 496

Site 496 is located on the continental slope of the Middle America Trench (Fig. 2). It is the most landward site of those examined in this report. Diatoms are well-preserved in Cores 1 to 28 and poorly preserved in Cores 29 to 40. Several of Burckle's zones are recognized (Table 3), but there are three noticeable uncomformities in the sequence. The first occurs between the Pleistocene and the Pliocene. The base of the Pleistocene is located below the base of *Pseudoeunotia doliolus* in Core 25. Sample 496-26-1, 20–21 cm contains *Nitzschia jouseae* and *Thalassiosira convexa* and probably is in the *N. jouseae* Zone (Pliocene), because *Rhizosolenia praebergonii* is not present. This means the *R. praebergonii* Zone is missing or is very thin and falls between the studied samples. The second unconformity occurs between Samples 496-26-1, 20–21 cm and 496-27-2, 20–21 cm. The sample in Core 26 is in the *N. jouseae* Zone; Core 27 contains *N. miocenica* and *T. convexa* and is in the *T. convexa* Zone (upper Miocene). The third unconformity occurs between Core 28 (still within the *T. convexa* Zone) and Cores 30 to 40, which contain *Craspedodiscus coscinodiscus, Synedra jouseana*, and sporadic occurrences of several other middle Miocene diatoms.

The diatom biostratigraphy of Hole 496 indicates a thick Pleistocene section overlying thin units of Pliocene, upper Miocene, and middle Miocene, each bounded by unconformities.

Site 497

Site 497 is located on the landward side of the Trench slope (Fig. 2). The stratigraphic order of Pliocene and Pleistocene diatom datum levels at Site 497 generally supports the findings of Burckle (1972, 1977) and Barron (1980) in their investigations of diatom floras in equatorial Pacific sediments (Fig. 1). The distribution of datum levels at Site 497 indicates episodic deposition with minor discontinuities, especially in the upper part of the section where the high abundance of nonmarine diatoms suggests a change in the depositional processes.

[1] Aubouin, J., von Huene, R., et al., *Init. Repts. DSDP*, 67: Washington (U.S. Govt. Printing Office).

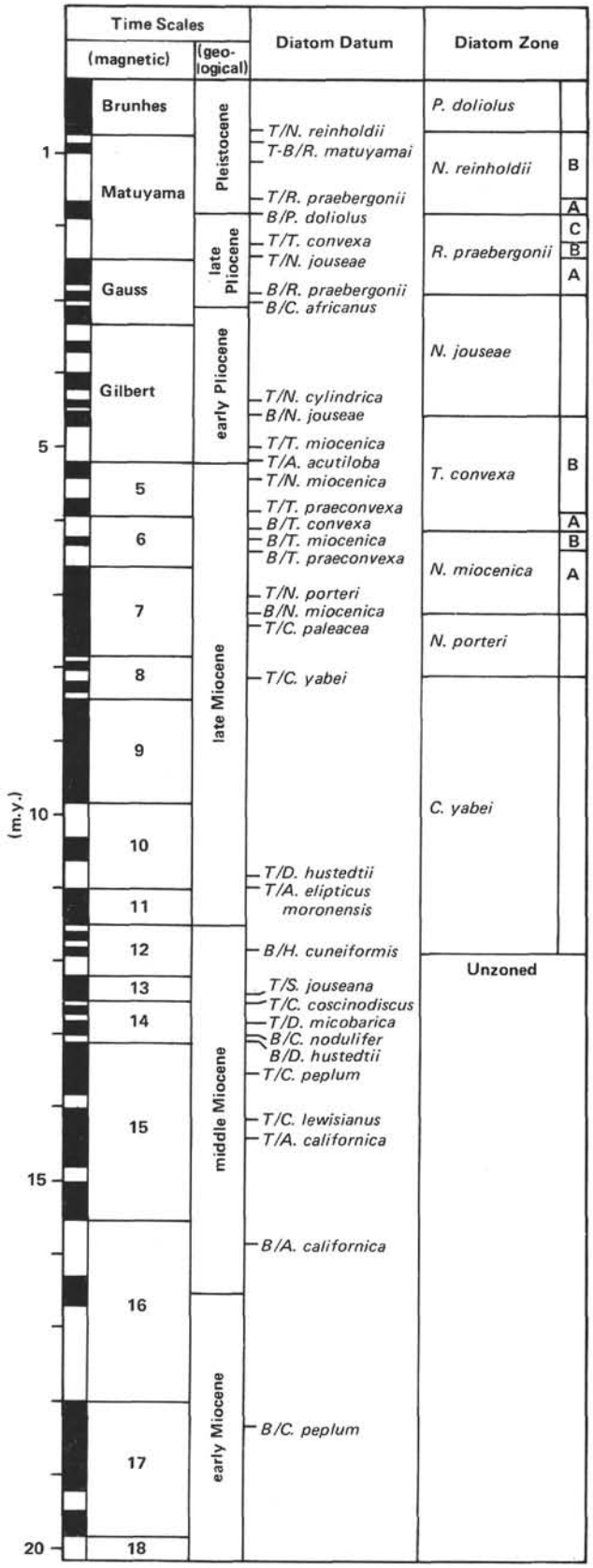

Figure 1. Eastern equatorial Pacific diatom chronology (data from Burckle, 1972, 1977; *T* = top, *B* = base; ■ = normal polarity, □ = reversal polarity; A, B, and C = diatom subzones).

Many of the uppermost cores (generally from Samples 497-29-2, 20–21 cm to 497-1-2, 20–21 cm) contain well-preserved diatoms mixed with partially dissolved and fragmented specimens. Generally, below Core 29, increasing dissolution of the diatom valves occurs, with the exception of Samples 497-33-1, 20–21 cm and 497-34-2, 49–50 cm, which contain well-preserved floras. Sample 497-30-2, 20–21 cm contains very sparse diatoms; Sample 497-39-2, 20–21 cm is barren of diatoms.

The occurrences of stratigraphically significant diatom taxa are shown in Table 4. The youngest four zones of Burckle (1977) are identified in Hole 497, representing Pleistocene to middle Pliocene sediments. The Pliocene/Pleistocene boundary is placed between Cores 24 and 25, using the base of *Pseudoeunotia doliolus*. Within the Pleistocene section (Cores 1–24), the tops of *Nitzschia reinholdii, N. fossilis*, and *Mesocena quadrangula* all fall between Samples 497-15-2, 20–21 cm and 497-14-2, 20–21 cm. Burckle (1977) and Barron (1980) find the top of *N. reinholdii* above those of *N. fossilis* and *M. quadrangula*. Their co-occurrence in Holes 497 and 495 may be the result of small hiatuses or the size of the sampling interval. However, in Hole 496, *M. quadrangula* occurs above the youngest occurrence of *N. reinholdii*, and *N. fossilis* was not found. This suggests that the youngest occurrences of these three taxa are affected by environmental factors in this area.

Within the *N. reinholdii* Zone (Cores 15–24) there are two significant datum levels. The youngest is the occurrence of *Rhizosolenia matuyamai* in Sample 497-17-2, 20–21 cm. The single occurrence represents the entire range of this short-lived taxa, which has been dated as 0.9 to 1.0 m.y old (see Fig. 1). The other datum level is the top of *R. praebergonii*, which is correlated to just above the Olduvai Event, near the Pliocene/Pleistocene boundary.

Below the base of *P. doliolus*, in Sample 497-25-2, 20–21 cm, is the top of *Thalassiosira convexa*, indicating deposition in the late Pliocene and establishing the *R. praebergonii* Zone. Just below this datum level is the top of *N. jouseae*, which is correlated to the middle of the late Pliocene. The base of *R. praebergonii* identifies the top of the *N. jouseae* Zone and occurs between Samples 497-27-2, 20–21 cm and 497-28-2, 20–21 cm, along with the base of *Coscinodiscus africanus*. These two datum levels are correlated to just above the upper/lower Pliocene boundary. No other datum levels are recognized from Core 28 to the bottom of the hole (Core 42). It is possible that the base of *N. jouseae* occurs in Core 41, but poor preservation and sporadic occurrences of *N. jouseae* higher in the hole make this interpretation tentative. The samples from Cores 28 to 42 were deposited in the early Pliocene, and no later than the middle early Pliocene.

ACKNOWLEDGMENTS

We would like to thank J. Bennett and F. Michael for reviewing the manuscript and G. Adian for typing it. We also appreciate the helpful discussions with J. Barron and L. Burckle.

Table 1. Diatom and silicoflagellate taxa referenced in this report.

Actinocyclus ellipticus Grunow	*Nitzschia cylindrica* Burckle
Actinocyclus ellipticus javanicus Reinhold	*Nitzschia fossilis* (Frenguelli)
Actinocyclus ingens Rattray	*Nitzschia jouseae* Burckle
Annellus californicus Tempere	*Nitzschia marina* Grunow
Asterolampra acutiloba Forti	*Nitzschia miocenica* Burckle
Borgorovia praepaleacea (Schrader)	*Nitzschia porteri* sensu Burckle
B. tatsunokuchiensis (Koizumi)	*Nitzschia reinholdii* Kanaya
B. veniamini Jousé	*Pseudoeunotia doliolus* (Wallich)
Coscinodiscus africanus Janisch	*Raphidodiscus marylandicus*
Coscinodiscus lewisianus Greville	*Rhaphoneis parilis* Hanna
Coscinodiscus marginatus Ehrenberg	*Rhizosolenia bergonii* Peragallo
Coscinodiscus nodulifer Schmidt	*Rhizosolenia matuyamai* Burckle
Coscinodiscus oligocenicus Jousé	*Rhizosolenia praebergonii* Muchina
Coscinodiscus paleaceus Grunow	*Rhizosolenia praebergonii robusta* Burckle and Trainer
Coscinodiscus symbolophorus Grunow	*Roperia tesselata* (Roper)
Coscinodiscus temperei Brun	*Roperia tesselata* var. *ovata* Heiden and Kolbe
Coscinodiscus yabei Kanaya	*Rouxia naviculoides* Schrader
Craspedodiscus coscinodiscus Ehrenberg	*Synedra jouseana* Sheshukova-Poretzkaya
Denticulopsis hustedtii (Simonsen and Kanaya)	*Thalassiosira convexa* Muchina
Denticulopsis nicobarica (Grunow)	*Thalassiosira leptopus elliptica* (Kolbe)
Hemidiscus cuneiformis Wall	*Thalassiosira miocenica* Schrader
Mesocena quadrangula Ehrenberg	*Thalassiosira oestrupii* (Ostenfeld)

REFERENCES

Abbott, W., 1978. Correlation and zonation of Miocene strata along the Atlantic Margin of North America using diatoms and silicoflagellates. *Mar. Micropaleontol.*, 3:15–34.

Barron, J., 1980. Upper Pliocene and Quaternary diatom biostratigraphy of Deep Sea Drilling Project Leg 54, Tropical eastern Pacific. *In* Rosendahl, B. R., Hekinian, R., et al., *Init. Repts. DSDP*, 54: Washington (U.S. Govt. Printing Office), 455–485.

Burckle, L., 1972. Late Cenozoic planktonic diatom zones from the eastern equatorial Pacific. *Nova Hedwigia Beih.*, 39:217–246.

_____, 1977. Pliocene and Pleistocene diatom datum levels from the Equatorial Pacific. *Quat. Res.*, 7:330–340.

_____, in press. Early Miocene to Pliocene diatom datum levels for the Equatorial Pacific. *Proc. Indonesian Neogene Symposium.*

Jousé, A., 1974. Diatoms in The Oligocene-Miocene biostratigraphic zones of the tropical areas of the Pacific Ocean. *Nova Hedwigia Beih.*, 45:333–357.

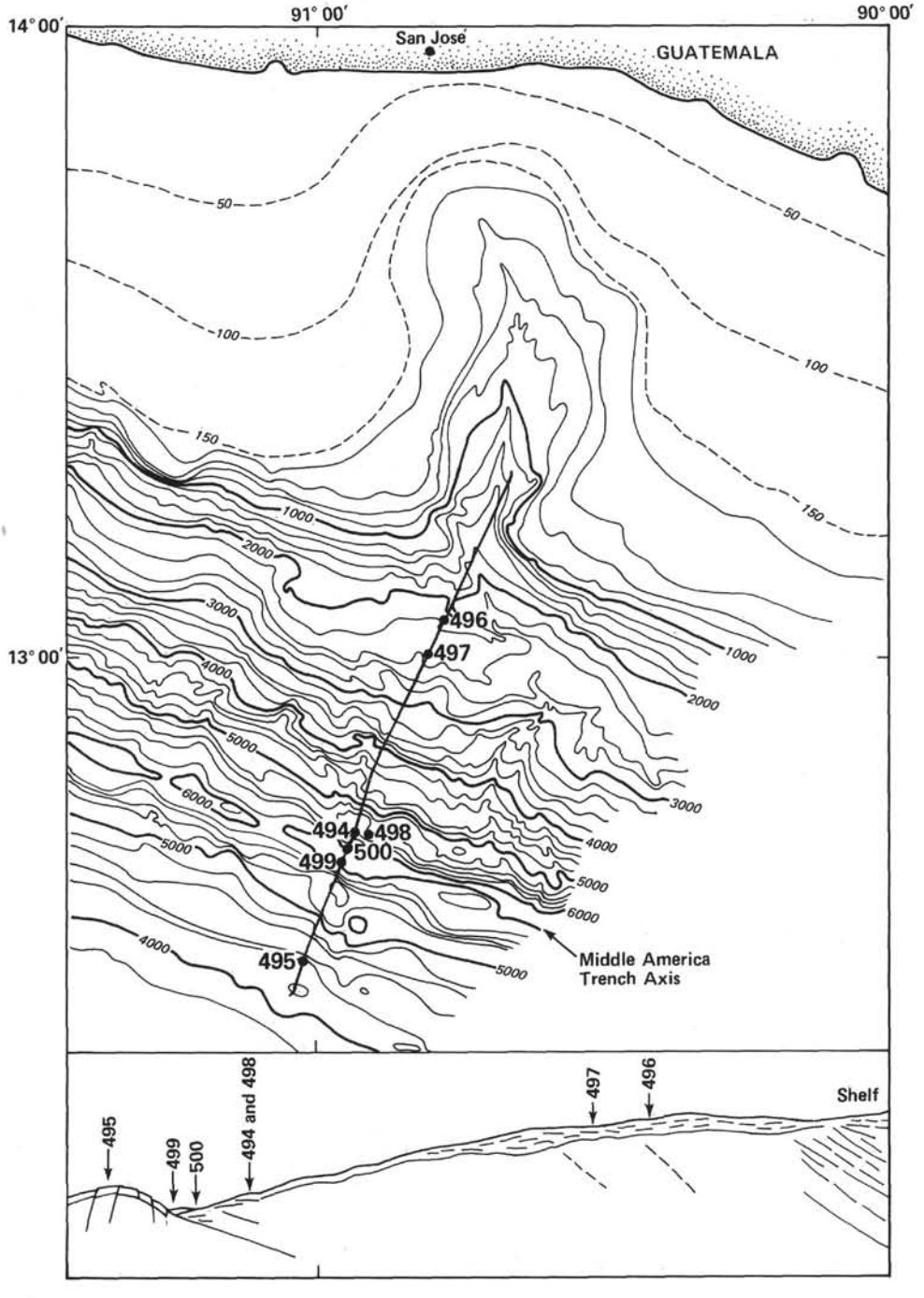

Figure 2. Locations of DSDP sites.

Table 2. Diatom occurrence chart and zonal and age assignments for the upper part of Hole 495.

Sample (core-section, interval in cm)	*Actinocyclus ellipticus*	*Actinocyclus ellipticus javanicus*	*Actinocyclus ingens*	*Annellus californicus*	*Asterolampra acutiloba*	*Borgorovia praepaleacea*	*Coscinodiscus africanus*	*Coscinodiscus lewisianus*	*Coscinodiscus marginatus*	*Coscinodiscus nodulifer*	*Coscinodiscus paleaceus*	*Coscinodiscus symbolophorus*	*Coscinodiscus temperei*	*Coscinodiscus yabei*	*Craspedodiscus coscinodiscus*	*Borgorovia tatsunokuchiensis*	*Denticulopsis hustedtii*	*Denticulopsis nicobarica*	*Hemidiscus cuneiformis*	*Mesocena quadrangula*	*Nitzschia cylindrica*	*Nitzschia fossilis*	*Nitzschia jouseae*	*Nitzschia marina*	*Nitzschia miocenica*	*Nitzschia porteri*	*Nitzschia reinholdii*	*Pseudoeunotia doliolus*	*Rhizosolenia bergonii*	*Rhizosolenia matuyamai*	*Rhizosolenia praebergonii*	*Rhizosolenia praebergonii robusta*	*Roperia tesselata*	*Roperia tesselata* var. *ovata*	*Rouxia naviculoides*	*Synedra jouseana*	*Thalassiosira convexa*	*Thalassiosira leptopous elliptica*	*Thalassiosira miocenica*	*Thalassiosira oestrupii*	Diatom Zone	Age
3-1, 20–21	•								•	•									•	•				•															*P. doliolus*	Pleistocene
4-1, 20–21									•	•									•	•				•																
5-1, 20–21									•	•									•	•		•		•															*N. reinholdii*	
6-1, 20–21									•	•									•	•				•																
7-1, 20–21	•						•		•	•									•	•		•		•																
8-1, 19–20							•		•	•									•	•		•		•															*R. praebergonii*	Pliocene
9-1, 75–76	•								•	•						•			•	•			•	•							•								
10-1, 80–81							•		•	•									•	•			•	•															*N. jouseae*	
11-1, 42–43									•	•						•			•	•	•		•	•																
12-1, 45–46	•								•	•		•				•			•	•	•	•		•															*T. convexa*	
13-3, 10–12	•								•	•						•						•		•													•			
14-1, 20–21	•								•	•												•		•			•													
15-1, 20–21	•								•	•																	•													
16-1, 20–21	•								•	•									•								•												*N. miocenica*	
17-1, 20–21	•							•	•	•												•					•													
18-1, 20–21	•							•											•			•			•															
19-1, 20–21	•										•						•																							
20-1, 20–21																																								
21-1, 20–21																																								
22-1, 20–21																																								
23-1, 62–64																																								
24-2, 42–44																																								

Note: • indicates presence in sample. The occurrence of key stratigraphic taxa is also shown in Figure 3.

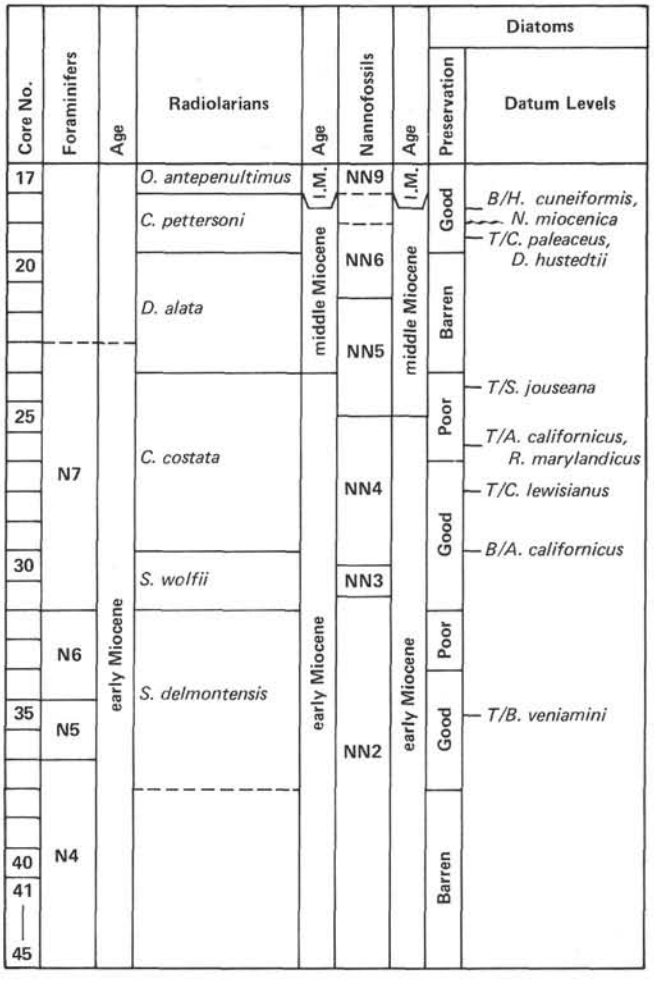

Figure 3. Diatom datum levels in the lower part of Hole 495 compared to other paleontology data.

Table 3. Diatom occurrence chart and zonal and age assignments, Site 496.

Sample (core-section, interval in cm)	*Actinocyclus ellipticus*	*Actinocyclus ellipticus javanicus*	*Annellus californicus*	*Borgorovia praepaleacea*	*Coscinodiscus africanus*	*Coscinodiscus lewisianus*	*Coscinodiscus marginatus*	*Coscinodiscus nodulifer*	*Coscinodiscus paleaceus*	*Coscinodiscus temperei*	*Coscinodiscus yabei*	*Craspedodiscus coscinodiscus*	*Cussia tatsunokuchiensis*	*Denticulopsis nicobarica*	*Hemidiscus cuneiformis*	*Mesocena quadrangula*	*Nitzschia miocenica*	*Nitzschia jouseae*	*Nitzschia marina*	*Nitzschia reinholdii*	*Pseudoeunotia doliolus*	*Rhizosolenia bergonii*	*Rhizosolenia matuyamai*	*Rhizosolenia praebergonii*	*Rhizosolenia praebergonii robusta*	*Roperia tesselata*	*Roperia tesselata* var. *ovata*	*Rouxia naviculoides*	*Synedra jouseana*	*Thalassiosira convexa*	*Thalassiosira leptopus elliptica*	*Thalassiosira oestrupii*	Diatom Zone	Age
1-2, 20–21							•	•							•						•										•		
2-2, 20–21							•	•							•						•										•		
3-2, 20–21	•						•	•							•						•	•				•					•		
4-2, 20–21							•	•							•	•					•					•					•		
5-2, 20–21							•	•							•				•		•	•									•		
6-2, 20–21							•	•							•				•		•										•		
7-2, 20–21	•						•	•							•				•		•	•				•					•		
8-2, 20–21	•														•				•		•					•					•		
9-2, 20–21								•							•				•		•					•					•		
10-2, 20–21	•							•							•				•		•	•				•					•	*P. doliolus*	
11-2, 20–21																																	
12-2, 20–21																																	
13-2, 20–21	•							•							•				•		•	•									•		Pleistocene
14-2, 20–21	•																		•		•					•					•		
15-2, 43–44	•						•												•		•										•		
16-1, 20–21															•	•					•										•		
17-1, 34–35	•														•				•		•		•								•		
18,CC							•								•				•		•	•				•					•		
19-1, 20–21															•						•					•					•		
20-1, 20–21							•	•							•						•										•		
21-1, 20–21							•	•											•	•	•										•		
22-1, 20–21															•				•	•	•	•									•		
23-2, 20–21															•					•	•										•	*N. reinholdii*	
24-2, 20–21																			•		•	•									•		
25-2, 20–21															•						•	•									•		
26-1, 20–21																		•												•		(*N. jouseae*)	(Pliocene)
27-2, 20–21	•									•		•			•		•			•											•		
28-2, 70–71								•							•		•			•										•	•	(*T. convexa*)	
29-2, 20–21																														•			
30-2, 20–21		•		•						•		•		•														•	•				
31-2, 11–12																																	
33-2, 20–21																																	
34-2, 20–21												•																					Miocene
35-2, 20–21																																	
36-2, 20–21			•			•						•																					
37,CC												•																	•				
38-1, 20–21												•																					
39-1, 20–21												•																					
40-2, 20–21						•						•																	•				

Note: • indicates presence in sample.

Table 4. Diatom occurrence chart and zonal and age assignments for the upper part of Hole 497.

Sample (core-section, interval in cm)	Diatom Taxa																			Diatom Zone	Age
	Actinocyclus ellipticus	*Coscinodiscus africanus*	*Coscinodiscus nodulifer*	*Cussia tatsunokuchiensis*	*Hemidiscus cuneiformis*	*Mesocena quadrangula*	*Nitzschia fossilis*	*Nitzschia jouseae*	*Nitzschia marina*	*Nitzschia reinholdii*	*Pseudoeunotia doliolus*	*Rhizosolenia bergonii*	*Rhizosolenia matuyamai*	*Rhizosolenia praebergonii*	*Rhizosolenia praebergonii robusta*	*Roperia tesselata*	*Roperia tesselata* var. *ovata*	*Thalassiosira convexa*	*Thalassiosira leptopus elliptica*	*Thalassiosira oestrupii*		
1-2, 20–21	•		•		•				•		•	•				•				•	*P. doliolus*	Pleistocene
2-2, 20–21	•		•		•				•		•	•				•				•		
3-2, 20–21		•	•		•				•		•	•				•				•		
4-1, 20–21	•	•	•		•				•		•	•				•				•		
5-2, 20–21	•		•		•				•		•	•				•				•		
6-1, 20–21			•		•				•		•	•				•				•		
8-2, 20–21	•		•		•				•		•	•				•	•			•		
9-2, 20–21	•		•						•		•	•				•				•		
10-2, 20–21	•		•		•				•		•	•				•				•		
11-2, 20–21	•		•		•				•		•	•				•				•		
12-2, 20–21	•	•	•		•				•		•	•				•	•			•		
13-2, 60–61		•	•						•		•	•				•				•		
14-2, 20–21	•	•	•		•				•		•	•				•				•		
15-2, 20–21			•		•	•	•		•	•	•	•				•				•	*N. reinholdii*	
16-2, 20–21			•		•	•	•		•	•	•					•				•		
17-2, 20–21		•	•		•	•			•	•	•		•			•				•		
18-2, 20–21		•	•		•		•		•							•				•		
19-2, 20–21		•	•		•		•		•	•	•					•				•		
20-2, 20–21		•	•		•	•	•		•	•	•	•								•		
23-2, 20–21		•	•		•		•		•	•	•			•	•	•				•		
24-2, 20–21		•	•		•		•		•	•	•					•				•		
25-2, 20–21	•	•	•		•		•		•	•				•	•			•		•	*R. praebergonii*	
26-2, 20–21	•	•	•		•		•	•	•	•								•				
27-2, 20–21	•	•	•	•	•		•	•	•	•		•		•				•				
28-2, 20–21			•		•		•	•	•	•								•				
29-2, 20–21			•					•	•	•								•			*N. jouseae*	Pliocene
30-2, 20–21																						
31-2, 20–21			•	•	•			•	•			•						•		•		
32-1, 20–21			•	•				•	•									•		•		
33-1, 20–21			•	•	•			•	•	•								•		•		
34-2, 49–50			•	•				•	•									•				
35-2, 9–10			•	•				•	•	•								•				
36-2, 47–48			•	•	•			•	•									•		•		
37-2, 73–74					•				•													
38-1, 10–11			•	•	•			•	•									•		•		
39-2, 20–21																						
40-2, 20–21			•	•	•			•	•	•								•		•		
41-1, 20–21			•		•			•	•	•								•		•		
42-2, 20–21			•		•		•		•	•										•		

Note: • indicates presence in sample.