

14. COCCOLITH STRATIGRAPHY, LEG 8, DEEP SEA DRILLING PROJECT¹

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Leg 8 of the Deep Sea Drilling Project, October-December 1969, from Hawaii to Tahiti, recovered 181 cores at eight drilling sites (Figure 1). Light-microscope techniques were used to study the coccoliths of 297 samples from these cores. Following a summary of the coccolith stratigraphy at each drilling site, coccolith species identified in selected samples are listed by time-stratigraphic series and biostratigraphic zone. The coccolith zones used in this report are based on

tentative zones described in the report on coccoliths from DSDP Leg 3 (Bukry and Bramlette, 1970), which were developed from the work of M. N. Bramlette and co-authors, and W. W. Hay and co-authors (see References). Recent improvements in Neogene zonation by Gartner (1969), which were briefly discussed in conjunction with the study of coccoliths from DSDP Leg 7 (Bukry, 1971), have been adopted. Zonal assignment of cores from Leg 8 holes is summarized in Table 3. The identified species are listed below in alphabetic order by genus name with authorship indicated and are then indexed in alphabetic order by trivial name.

¹Publication authorized by the Director, U. S. Geological Survey.

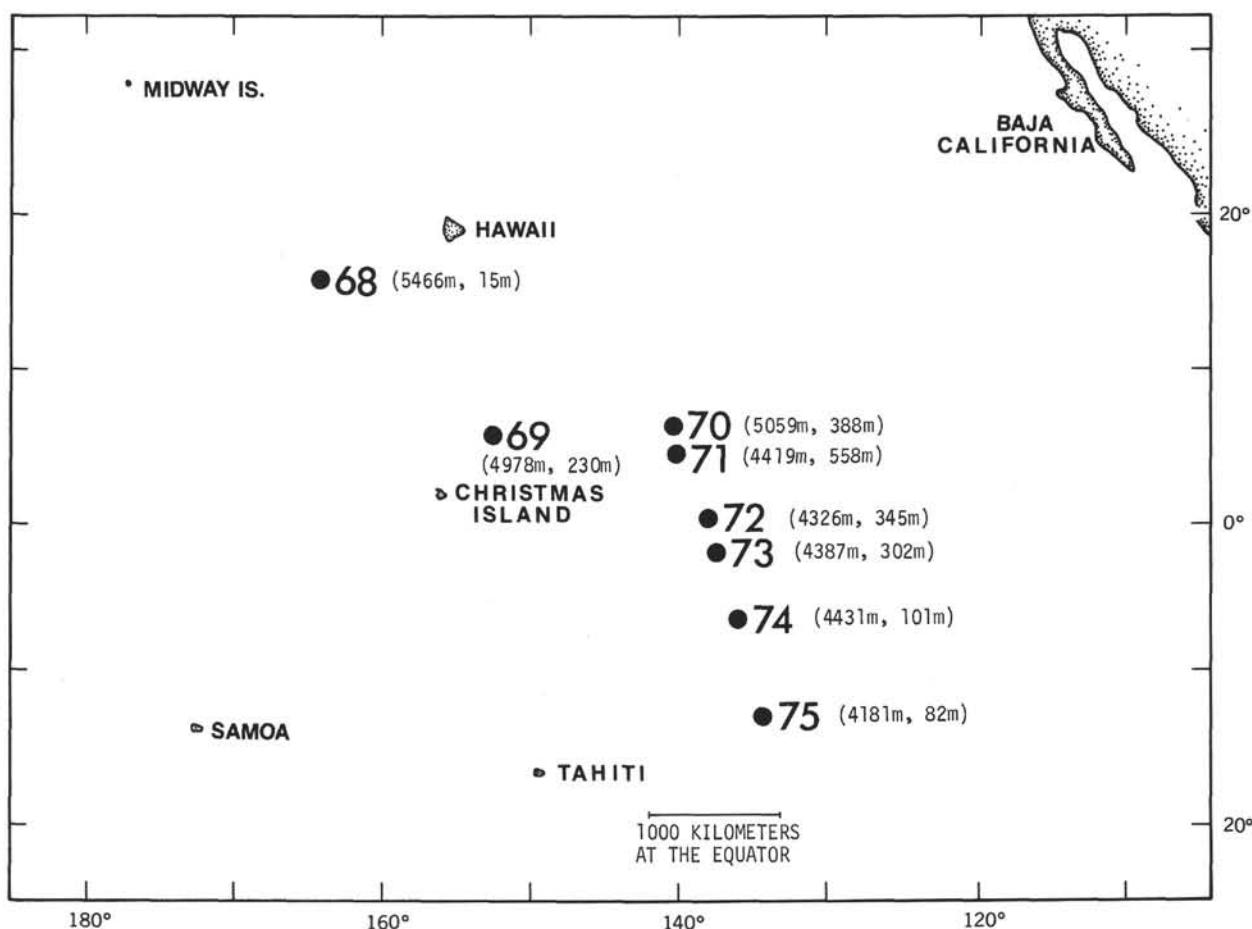


Figure 1. Location of drilling sites, Leg 8, Deep Sea Drilling Project. Site numbers are followed (in parentheses) by water depth and deepest drilling penetration.

TABLE 1
Coccolith Species Considered

<i>Bramletteius serraculoides</i> Gartner	<i>Discoaster tani tani</i> Bramlette and Riedel
<i>Campylosphaera dela</i> (Bramlette and Sullivan)	<i>Discoaster variabilis</i> Martini and Bramlette
<i>Ceratolithus cristatus</i> Kamptner	<i>Discoaster wemmelensis</i> Achutan and Stradner
<i>Ceratolithus rugosus</i> Bukry and Bramlette	<i>Emiliania annula</i> (Cohen)
<i>Ceratolithus tricorniculatus</i> Gartner	<i>Emiliania huxleyi</i> (Lohmann)
<i>Chiasmolithus grandis</i> (Bramlette and Riedel)	<i>Gephyrocapsa oceanica</i> Kamptner
<i>Chiasmolithus oamaruensis</i> (Deflandre)	<i>Helicopontosphaera compacta</i> (Bramlette and Wilcoxon)
<i>Coccolithus bisectus</i> (Hay, Mohler, and Wade) of Bramlette and Wilcoxon	<i>Helicopontosphaera kamptneri</i> Hay and Mohler
<i>Coccolithus doronicoides</i> Black and Barnes	<i>Helicopontosphaera parallela</i> Bramlette and Wilcoxon
<i>Coccolithus eopelagicus</i> (Bramlette and Riedel)	<i>Helicopontosphaera sellii</i> Bukry and Bramlette
<i>Coccolithus fenestratus</i> (Deflandre and Fert) basionym: <i>Discolithus fenestratus</i> Deflandre and Fert, 1954, Ann. Paleont. 40, p. 139, pl. 11, fig. 25; text-fig. 52.	<i>Isthmolithus recurvus</i> Deflandre
<i>Coccolithus pelagicus</i> (Wallich)	<i>Orthorhabdus serratus</i> Bramlette and Wilcoxon
<i>Coccolithus stvensis</i> Levin and Joerger	<i>Pontosphaera vadosa</i> Hay, Mohler, and Wade
<i>Coronocyclus serratus</i> Hay, Mohler, and Wade	<i>Reticulofenestra gartneri</i> (Roth and Hay)
<i>Cyclococcolithina formosa</i> (Kamptner)	<i>Reticulofenestra pseudoumbilica</i> (Gartner)
<i>Cyclococcolithina leptopora</i> (Murray and Blackman)	<i>Reticulofenestra umbilica</i> (Levin)
<i>Cyclococcolithina macintyreai</i> (Bukry and Bramlette)	<i>Sphenolithus abies</i> Deflandre
<i>Cyclococcolithina neogammation</i> (Bramlette and Wilcoxon)	<i>Sphenolithus belemnos</i> Bramlette and Wilcoxon
<i>Discoaster adamanteus</i> Bramlette and Wilcoxon	<i>Sphenolithus ciperoensis</i> Bramlette and Wilcoxon
<i>Discoaster asymmetricus</i> Gartner	<i>Sphenolithus distentus</i> (Martini)
<i>Discoaster barbadiensis</i> Tan	<i>Sphenolithus furcatolithoides</i> Locker
<i>Discoaster brouweri</i> Tan	<i>Sphenolithus heteromorphus</i> Deflandre
<i>Discoaster brouweri rutellus</i> Gartner	<i>Sphenolithus moriformis</i> (Bronnimann and Stradner)
<i>Discoaster challengerii</i> Bramlette and Riedel	<i>Sphenolithus neoabies</i> Bukry and Bramlette
<i>Discoaster deflandrei</i> Bramlette and Riedel	<i>Sphenolithus predistentus</i> Bramlette and Wilcoxon
<i>Discoaster dilatus</i> Hay	<i>Sphenolithus pseudoradians</i> Bramlette and Wilcoxon
<i>Discoaster druggii</i> Bramlette and Wilcoxon	<i>Triquetrorhabdulus carinatus</i> Martini
<i>Discoaster exilis</i> Martini and Bramlette	<i>Triquetrorhabdulus rugosus</i> Bramlette and Wilcoxon
<i>Discoaster hamatus</i> Martini and Bramlette	
<i>Discoaster kugleri</i> Martini and Bramlette	
<i>Discoaster lidzi</i> Hay	
<i>Discoaster neohamatus</i> Bukry and Bramlette	
<i>Discoaster pentaradiatus</i> Tan	
<i>Discoaster perplexus</i> Bramlette and Riedel	
<i>Discoaster quinqueramus</i> Gartner	
<i>Discoaster saipanensis</i> Bramlette and Riedel	
<i>Discoaster surculus</i> Martini and Bramlette	
<i>Discoaster tani nodifer</i> Bramlette and Riedel	

TABLE 2
Index of Coccolith Trivial Names Considered

<i>abies</i> , <i>Sphenolithus</i>
<i>adamanteus</i> , <i>Discoaster</i>
<i>annula</i> , <i>Emiliania</i>
<i>asymmetricus</i> , <i>Discoaster</i>
<i>barbadiensis</i> , <i>Discoaster</i>
<i>belemnos</i> , <i>Sphenolithus</i>
<i>bisectus</i> , <i>Coccolithus</i>
<i>brouweri</i> , <i>Discoaster</i>
<i>brouweri rutellus</i> , <i>Discoaster</i>
<i>carinatus</i> , <i>Triquetrorhabdulus</i>
<i>challengeri</i> , <i>Discoaster</i>

ciperoensis, *Sphenolithus*
compacta, *Helicopontosphaera*
deflandrei, *Discoaster*
dela, *Campylosphaera*
dilatus, *Discoaster*
distentus, *Sphenolithus*
doronicoides, *Coccolithus*
druggii, *Discoaster*
eopelagicus, *Coccolithus*
exilis, *Discoaster*
fenestratus, *Coccolithus*
formosa, *Cyclococcolithina*
furcalithoides, *Sphenolithus*
gartneri, *Reticulofenestra*
grandis, *Chiasmolithus*
hamatus, *Discoaster*
heteromorphus, *Sphenolithus*
huxleyi, *Emiliania*
kamptneri, *Helicopontosphaera*
kugleri, *Discoaster*
leptopora, *Cyclococcolithina*
lidzi, *Discoaster*
macintyrei, *Cyclococcolithina*
moriformis, *Sphenolithus*
neoabies, *Sphenolithus*
neogammation, *Cyclococcolithina*
neohamatus, *Discoaster*
oamaruensis, *Chiasmolithus*
oceania, *Gephyrocapsa*
parallela, *Helicopontosphaera*
pelagicus, *Coccolithus*
pentaradiatus, *Discoaster*
perplexus, *Discoaster*
predistentus, *Sphenolithus*
pseudoradians, *Sphenolithus*
pseudoumbilica, *Reticulofenestra*
quinqueramus, *Discoaster*
recurvus, *Isthmolithus*
rugosus, *Ceratolithus*
rugosus, *Triquetrorhabdulus*
saipanensis, *Discoaster*
sellii, *Helicopontosphaera*
serraculoides, *Bramletteius*

serratus, *Coronocyclus*
serratus, *Orthorhabdus*
stavensis, *Coccolithus*
surculus, *Discoaster*
tani nodifer, *Discoaster*
tani tani, *Discoaster*
tricorniculatus, *Ceratolithus*
umbilica, *Reticulofenestra*
vadosa, *Pontosphaera*
variabilis, *Discoaster*
wemmelensis, *Discoaster*

Sample numbers given under the biostratigraphic zones for each site consist of elements in the following sequence: cruise-leg number; drill-hole designation, consisting of site number plus a letter, if more than one hole; core designation; core-section number; interval in centimeters below the top of each core section. For example, 8-69A-1A-6, 58-59 cm, indicates that the sample came from Leg 8, Hole 69A (at Site 69), the first barrel of core recovered, the sixth section of that core and from 58 to 59 centimeters below the top of the section. Most core runs were 9.1 meters long, but occasionally the core liners were not full. In this report, the tops of recoveries are arbitrarily placed at the top of the core runs, and an approximate depth in meters below the sea floor follows each sample number.

HOLES 68 AND 68A (lat 16° 43.32'N., long 164° 10.36'W., depth 4978 meters)

[No samples available; see report of shipboard scientists.]

HOLES 69 AND 69A (lat 06° 00.00'N., long 152° 51.93'W., depth 4978 meters)

Summary of Coccolith Stratigraphy

Coccolith assemblages at this site range from middle Miocene at 15 meters to lower Oligocene at 143 meters. Most cores from the predominantly siliceous ooze encountered here contain few and poorly preserved coccoliths. Partial dissolution of heliolithid (radially constructed ring) coccoliths, such as *Coccolithus eopelagicus*, and of star-shaped discoasters, such as *Discoaster brouweri* s.l., is prevalent in Miocene sediment to a depth of 60 meters. Certain species generally typical for this interval—*Reticulofenestra pseudoumbilica*, *Sphenolithus abies*, and *S. heteromorphus*—are missing. Their absence makes difficult the assignment of Core 3 to either the *Sphenolithus heteromorphus* Zone or *Discoaster exilis* Zone, but

TABLE 3
Series and Zone Assignment of Cores From Leg 8

Series		Hole											
			Zone	69	69A	70	70A	71	72	72A	73	74	75
PLEISTOCENE AND HOLOCENE		<i>Emiliania huxleyi</i>						1		1		1	
		<i>Gephyrocapsa oceanica</i>							1		1		
		<i>Coccolithus doronicoides</i>							1	1		2-4	
PLIOCENE		<i>Discoaster brouweri</i>						1-2		2-4	4-5		
		<i>Reticulofenestra pseudoumbilica</i>						2		5			
		<i>Ceratolithus rugosus</i>						3	2	5	6-7, 8		
		<i>Ceratolithus tricorniculatus</i>						4	2-3	6	7-8		
		<i>Discoaster quinqueramus</i>						5-7	3			8?	
		<i>Discoaster neohamatus</i>											
		<i>Discoaster hamatus</i>						8					
		<i>Catinaster coalitus</i>											
		<i>Discoaster exilis</i>	2-3		3			9-15	4		8-9		
		<i>Sphenolithus heteromorphus</i>			4			16-24	5		10-11		
MIOCENE		<i>Helicopontosphaera ampliaperta</i>						24					
		<i>Sphenolithus belemnos</i>						25-26					
		<i>Triquetrorhabdulus carinatus</i>	3-4		6-12	1-3	28-40	6			12	3-5	1-4
		<i>Sphenolithus ciperoensis</i>		1-2		4-5	42-44					6-7	4-5
		<i>Sphenolithus distentus</i>		3-5		6-14	46-48	7-8			13		
OLIGOCENE		<i>Sphenolithus predistentus</i>	5	6		14-25		8			14-17	8-10	8-9
		<i>Helicopontosphaera reticulata</i>		7-8		25-27		9			18	11	
		<i>Discoaster barbadiensis</i>						10-11			19-21		
		<i>Reticulofenestra umbilica</i>									12		
EOCENE													

evidence provided by the abundance of *Discoaster deflandrei* among the discoasters indicates that the assemblage is lower middle Miocene. Ortholithid genera such as *Triquetrorhabdulus* and *Discoaster* seem to be the best preserved coccoliths in this siliceous ooze and are especially common in Core 4. The lowest definitive coccolith assemblages representing the lower Oligocene *Helicopontosphaera reticulata* Zone are present in Cores 7A and 8A (129 to 144 meters). Samples from Cores 9A through 12A (151 meters to 224 meters) are siliceous ooze with only rare coccoliths that probably represent drilling contamination from higher Oligocene deposits.

Coccoliths in Selected Samples, Hole 69

Middle Miocene (*Discoaster exilis* Zone)

8-69-2-1, 63-65 cm; 15 m:

Coccolithus eopelagicus, *Discoaster brouweri* s.l., *D. deflandrei*, *D. exilis*, *Triquetrorhabdulus rugosus*.

Middle Miocene (*Discoaster exilis* Zone or *Sphenolithus heteromorphus* Zone)

8-69-2-6, 63-65 cm; 22 m:

C. eopelagicus [centerless], *Cyclococcolithina leptoporus*, *D. brouweri* [centerless], *D. deflandrei*, *D. exilis*.

8-69-3-4, 63-64 cm; 28 m:

C. eopelagicus [centerless], *Cyclococcolithina neogammation?*, *D. deflandrei*, *D. exilis*.

Lower Miocene (*Triquetrorhabdulus carinatus* Zone)

8-69-3-6, 63-64 cm; 31 m:

C. eopelagicus, *C. pelagicus*, *C. neogammation* [centerless], *Discoaster* sp. cf. *D. deflandrei*, *Sphenolithus moriformis*, *Triquetrorhabdulus carinatus*.

8-69-4-6, 63-64 cm; 60 m:

C. eopelagicus [centerless], *D. sp. cf. D. deflandrei*, *S. moriformis*, *T. carinatus* [abundant].

Middle Oligocene (*Sphenolithus predistentus* Zone)

8-69-5-6, 63-64 cm; 125 m:

Coccolithus bisectus, *C. eopelagicus*, *C. sp. cf. C. scissurus*, *C. neogammation*, *D. deflandrei*, *D. tani nodifer*, *D. tani tani*, *Sphenolithus* sp. aff. *S. belemnios*, *S. moriformis*, *S. predistentus*.

Coccoliths in Selected Samples, Hole 69A

Upper Oligocene (*Sphenolithus ciperoensis* Zone)

8-69A-1A-6, 58-59 cm; 69 m:

Coccolithus sp. aff. *C. bisectus*, *C. eopelagicus*, *Cyclococcolithina neogammation*, *Discoaster* sp. cf. *D. deflandrei*, *Sphenolithus ciperoensis*, *S. sp. aff. S. belemnios*, *Triquetrorhabdulus carinatus*.

8-69A-2A-6, 63-64 cm; 78 m:

Coccolithus bisectus, *C. sp. aff. C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *Discoaster deflandrei*, *D. sp. cf. D. tani nodifer*, *Reticulofenestra gartneri*, *S. ciperoensis*, *S. moriformis*, *S. sp. aff. S. belemnios*, *T. carinatus*.

Middle Oligocene (upper *Sphenolithus distentus* Zone)

8-69A-3A-1, 63-64 cm; 80 m:

C. sp. aff. C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *Sphenolithus distentus*, *S. moriformis*, *S. predistentus*, *T. carinatus*.

8-69A-3A-3, 63-64 cm; 83 m:

C. bisectus, *C. sp. aff. C. bisectus*, *C. eopelagicus*, *C. neogammation*, *D. deflandrei*, *R. gartneri*, *S. distentus*, *S. moriformis*, *T. carinatus*.

8-69A-3A-5, 6-7 cm; 85 m:

C. bisectus, *C. sp. aff. C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *Sphenolithus* sp. cf. *S. ciperoensis*, *S. distentus*, *S. moriformis*, *T. carinatus*.

Middle Oligocene (lower *Sphenolithus distentus* Zone)

8-69A-4A-6, 63-64 cm; 97 m:

C. eopelagicus, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *S. distentus*, *S. predistentus*.

8-69A-5A-6, 63-64 cm; 106 m:

C. bisectus, *C. sp. aff. C. bisectus* [rare], *C. eopelagicus*, *C. neogammation*, *D. deflandrei*, *D. sp. cf. D. tani nodifer*, *D. tani tani* [rare], *R. gartneri*, *Sphenolithus* sp. cf. *S. ciperoensis*, *S. distentus*, *S. predistentus*.

Middle Oligocene (*Sphenolithus predistentus* Zone)

8-69A-6A-6, 63-64 cm; 115 m:

C. bisectus, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *D. tani nodifer*, *D. tani tani*, *R. gartneri*, *S. predistentus*, *S. pseudoradians*.

Lower Oligocene

(*Helicopontosphaera reticulata* Zone)

8-69A-7A-3, 73-74 cm; 129 to 135 m:

C. bisectus, *C. eopelagicus*, *C. pelagicus*, *Coccolithus stvensis*, *D. deflandrei*, *D. tani nodifer*, *Pontosphaera vadosa*, *R. gartneri*, *R. umbilica*, *S. moriformis* [small], *S. predistentus*.

8-69A-8A-6, 63 cm; 143 m:

Bramletteius serraculoides, *C. bisectus*, *C. eopelagicus*, *Coccolithus stvensis*, *Cyclococcolithina formosus*, *C. neogammation*, *D. deflandrei*, *D. tani nodifer*, *P. vadosa*, *R. gartneri*, *R. umbilica*, *S. moriformis* [small], *S. predistentus*.

8-69A-9A-5, 63-64 cm; 151 m:

8-69A-10A-6, 63 cm; 161 m:

8-69A-11A-6, 63 cm; 222 m:

8-69A-12A-1, 150 cm; 224 m:

[Barren siliceous ooze or siliceous ooze with rare Oligocene contamination.]

HOLES 70 AND 70A

**(lat 06° 20.08'N, long 140° 21.72'W,
depth 5059 meters)**

Summary of Coccolith Stratigraphy

As at Site 69, definitive coccolith assemblages are present for middle Miocene to lower Oligocene, and the upper cores consist of a siliceous-ooze facies in which coccolith assemblages show strong dissolution effects. A significant feature of this site is the expanded succession of well-preserved Oligocene coccolith assemblages from the *Sphenolithus ciperoensis* Zone at 148 meters to the *Helicopontosphaera reticulata* Zone at 322 meters.

Coccoliths in Selected Samples, Hole 70

Middle Miocene

(*Discoaster exilis* Zone, *Discoaster kugleri* Subzone)

8-70-3-3, 63-64 cm; 21 m:

Coccolithus eopelagicus, *Cyclococcolithina macintyreai*, *Discoaster brouweri* s.l., *D. exilis*, *D. kugleri*.

8-70-3-4, 63-64 cm; 22 m:

C. eopelagicus, *Cyclococcolithina leptoporus*, *C. macintyreai*, *Discoaster dilatus*, *D. exilis*, *D. kugleri*, *Reticulofenestra pseudoumbilica*.

Middle Miocene

(*Discoaster exilis* Zone, *Coccolithus eopelagicus* Subzone)

8-70-3-5, 63-64 cm; 24 m:

C. eopelagicus, *C. leptoporus*, *C. macintyreai*, *Discoaster deflandrei*, *D. sp. cf. D. exilis*, *Helicopontosphaera kamptneri*, *R. pseudoumbilica*, *Triquetrorhabdulus rugosus*.

Middle Miocene

(*Sphenolithus heteromorphus* Zone)

8-70-4-5, 63-64 cm; 33 m:

C. eopelagicus, *Cyclococcolithina neogammation*, *D. brouweri* s.l., *D. deflandrei*, *D. exilis*, *D. sp. aff. D. variabilis*, *Sphenolithus heteromorphus*.

Lower Miocene

(*Triquetrorhabdulus carinatus* Zone)

8-70-6-6, 63-64 cm; 52 m:

C. eopelagicus, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *Sphenolithus* sp. cf. *S. belemnos*, *Triquetrorhabdulus carinatus*.

8-70-8-6, 63-64 cm; 70 m:

Coccolithus sp. aff. *C. bisectus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *T. carinatus*.

8-70-10-6, 63-64 cm; 89 m:

C. eopelagicus, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *S. sp. cf. S. belemnos*, *S. moriformis*, *T. carinatus* [short].

8-70-11-6, 63-64 cm; 103 m:

C. eopelagicus, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *D. druggii*, *S. moriformis*, *T. carinatus* [short].

8-70-12-5, 63-64 cm; 111 m:

C. eopelagicus, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *S. moriformis*, *T. carinatus*.

Coccoliths in Selected Samples, Hole 70A

Lower Miocene

(*Triquetrorhabdulus carinatus* Zone)

8-70A-1A-6, 63-64 cm; 121 m:

C. pelagicus, *C. neogammation*, *D. deflandrei*, *S. moriformis*, *T. carinatus*.

Lower Miocene

(*Triquetrorhabdulus carinatus* Zone, *Coccolithus* sp. aff. *C. bisectus* Subzone)

8-70A-2A-6, 63-64 cm; 130 m:

C. sp. aff. C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *Reticulofenestra gartneri*, *Sphenolithus* sp. aff. *S. belemnos*, *S. moriformis*, *T. carinatus*.

8-70A-3A-6, bottom; 140 m:

C. sp. aff. C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *Reticulofenestra gartneri*, *Sphenolithus* sp. aff. *S. belemnos*, *S. moriformis*, *T. carinatus*.

8-70A-3A-6, bottom; 140 m:

C. sp. aff. C. bisectus, *C. neogammation*, *D. deflandrei*, *T. carinatus*.

Upper Oligocene
(Sphenolithus ciperoensis Zone)

8-70A-4A-6, 63-64 cm; 148 m:

Coccolithus bisectus [rare], *C.* sp. aff. *C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *S.* sp. aff. *S. belemnos*, *S. ciperoensis* [rare], *T. carinatus*.

8-70A-5A-6, 63-64 cm; 157 m:

C. bisectus, *C.* sp. aff. *C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *S.* sp. aff. *S. belemnos*, *S. ciperoensis*, *S. moriformis*.

Middle Oligocene
(Sphenolithus distentus Zone)

8-70A-6A-6, 63-64 cm; 166 m:

C. sp. aff. *C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *Sphenolithus distentus*, *S. moriformis* [small], *S. predistentus*, *T. carinatus* [rare].

8-70A-7A-5, 63-64 cm; 175 m:

C. sp. aff. *C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *Reticulofenestra gartneri*, *S. distentus*, *S. moriformis*.

8-70A-8A-5, 63-64 cm; 184 m:

Chiasmolithus sp. aff. *C. oamaruensis*, *C. bisectus*, *C.* sp. aff. *C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *C. sp.* cf. *C. scissurus*, *C. neogammation*, *D. deflandrei*, *D.* sp. cf. *D. tani tani* [small], *Helicopontosphaera* sp. cf. *H. parallela*, *S. distentus*, *S. moriformis*.

8-70A-12A-4, 63-64 cm; 215 m:

C. bisectus, *C.* sp. aff. *C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *D. tani nodifer*, *R. gartneri*, *Sphenolithus* sp. cf. *S. ciperoensis*, *S. distentus*.

Middle Oligocene
(Sphenolithus predistentus Zone)

8-70A-14A-3, 63-64 cm; 232 m:

C. bisectus, *C.* sp. aff. *C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *D. tani nodifer*, *D. tani tani*, *S. distentus*, *S. moriformis* [small], *S. predistentus*.

8-70A-17A-4, 63-64 cm; 261 m:

C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *D. tani nodifer*, *D. tani tani*, *Helicopontosphaera compacta*, *R. gartneri*, *S. moriformis*, *S. predistentus*, *S. pseudoradians*.

8-70A-18A-2, 63-64 cm; 264 m:

C. bisectus, *C. eopelagicus*, *Coccolithus stvensis*, *C. neogammation*, *D. deflandrei*, *D. tani nodifer*, *D. tani tani*, *Reticulofenestra gartneri*, *S. predistentus*, *S. moriformis*.

8-70A-19A-3, 63-64 cm; 273 m:

C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. stvensis*, *C. neogammation*, *D. deflandrei*, *D. tani tani*, *Pontosphaera vadosa*, *R. gartneri*, *S. moriformis*, *S. predistentus*.

8-70A-23A-2, 64 cm; 295 m:

C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. stvensis*, *C. neogammation*, *D. deflandrei*, *D. tani nodifer*, *D. tani tani*, *R. gartneri*, *S. moriformis*, *S. predistentus*.

8-70A-24A-1, 112-113 cm; 299 m:

C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. stvensis*, *C. neogammation*, *D. deflandrei*, *D. tani nodifer*, *D. tani tani*, *H. compacta*, *S. moriformis*, *S. predistentus*.

8-70A-25A-2, 63 cm; 306 m:

C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. stvensis*, *D. deflandrei*, *D. tani nodifer*, *D. tani tani*, *P. vadosa*, *R. gartneri*, *S. moriformis* [small form, abundant], *S. predistentus*.

Lower Oligocene

(upper Helicopontosphaera reticulata Zone)

8-70A-25A-3, 63-64 cm; 308 m:

C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. stvensis*, *C. neogammation*, *D. deflandrei*, *D. tani nodifer*, *D. tani tani*, *H. compacta*, *P. vadosa*, *R. gartneri*, *R. umbilica*, *S. moriformis*, *S. predistentus*.

8-70A-26A-2, Bottom; 314 m:

Same as above.

Lower or Middle Oligocene (? Zone)

[Rare specimens in siliceous ooze]

8-70A-26A-3, 63-64 cm; 315 m:

C. bisectus, *C.* sp. aff. *C. bisectus*, *C. pelagicus*, *C. stvensis*, *Cyclococcolithina formosus*, *C. neogammation*, *S. moriformis*.

Lower Oligocene

(Helicopontosphaera reticulata Zone)

8-70A-27A-1, 175-176 cm; 320 m:

Bramletteius serraculoides, *Chiasmolithus oamaruensis*, *C. bisectus*, *C. eopelagicus*, *C.* sp. cf. *C. fenestratus*, *C. pelagicus*, *C. stvensis*, *Coronocyclus* sp. cf. *C. serratus*, *C. formosus*, *D. deflandrei*, *D. tani nodifer*, *D. tani tani*, *H. compacta*, *P. vadosa*, *P. umbilica*, *S. moriformis*, *S. predistentus*.

8-70A-27A-2, 63-64 cm; 322 m:

C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. stvensis*, *C. formosus*, *D. deflandrei*, *D. tani tani*, *P. vadosa*, *R. umbilica*.

HOLES 71 AND 71A
 (lat 04° 28.28'N., long 140° 18.91'W.,
 depth 4419 meters)

Summary of Coccolith Stratigraphy

The 48 cores taken at Hole 71 provide an almost complete stratigraphic sequence from Holocene to middle Oligocene. The only missing assemblages are upper Miocene. In Cores 4 to 6, which contain the upper Miocene *Ceratolithus tricorniculatus* Zone and *Discoaster quinqueramus* Zone or *Discoaster neohamatus* Zone, five-rayed specimens of *Discoaster* are abnormally uncommon. From 252 to 380 meters, the lowermost Miocene *Triquetrorhabdulus carinatus* Zone is well developed. Most of the specimens in assemblages of this zone from Site 71 show thick overgrowths of secondary calcite. The usual division of the zone into upper assemblages based on the presence of *Discoaster druggii*, *Orthorhabdus serratus*, and short forms of *Triquetrorhabdulus carinatus* and lower assemblages based on the abundance of *Coccolithus* sp. aff. *C. bisectus* and long forms of *T. carinatus* is applicable here, but the anomalous occurrence of a sample in Core 35 with common *D. druggii* is an exception. As in most mid-Tertiary tropical carbonate ooze, tiny and difficultly distinguished species of *Sphenolithus* are abundant and form a consistent background in most Oligocene samples examined from these cores.

Mid Pleistocene to Holocene
(Gephyrocapsa oceanica Zone or
Emiliania huxleyi Zone)

8-71-1-1, 63-64 cm; 1 m:
Ceratolithus cristatus, *Cyclococcolithina leptoporus* [small], *Gephyrocapsa oceanica*, *Helicopontosphaera kampfneri*, *H. sellii*, *Syracosphaera* sp.

Lower Pleistocene
(Coccolithus doronicoides Zone)

8-71-1-2, 63-64 cm; 2 m:
C. cristatus, *Coccolithus* sp. cf. *C. doronicoides*, *C. leptoporus*, *H. kampfneri*, *Syracosphaera* sp.

Upper Pliocene
(Discoaster brouweri Zone,
Cyclococcolithina macintyrei Subzone)

8-71-1-3, 63-64 cm; 4 m:
Ceratolithus rugosus, *C. sp. cf. C. doronicoides*, *C. pelagicus*, *C. leptoporus*, *Cyclococcolithus macintyrei*, *Discoaster brouweri*, *D. sp. aff. D. exilis*.

Upper Pliocene
(Discoaster brouweri Zone,
Discoaster pentaradiatus Subzone)

8-71-2-2, 25-26 cm; 11 m:
C. rugosus, *C. leptoporus*, *C. macintyrei*, *D. brouweri*, *D. pentaradiatus*, *D. sp. cf. D. variabilis*.

Lower Pliocene
(Reticulofenestra pseudoumbilica Zone,
Discoaster asymmetricus Subzone)

8-71-2-3, 63-64 cm; 13 m:
C. rugosus, *C. pelagicus*, *C. leptoporus*, *C. macintyrei*, *Discoaster asymmetricus*, *D. brouweri*, *D. exilis*, *D. pentaradiatus*, *D. variabilis*, *Reticulofenestra pseudoumbilica*.

Lower Pliocene
(Reticulofenestra pseudoumbilica Zone,
Sphenolithus neobabies Subzone)

8-71-2-5, 63-64 cm; 16 m:
C. rugosus, *C. macintyrei*, *Discoaster challenger*, *D. exilis*, *D. pentaradiatus*, *D. surculus*, *D. variabilis*, *R. pseudoumbilica*.

Lower Pliocene or Upper Miocene
(Ceratolithus rugosus Zone)

8-71-3-1, 63-64 cm; 19 m:
C. rugosus, *C. tricorniculatus*, *C. leptoporus*, *C. macintyrei*, *D. brouweri*, *D. challenger*, *D. pentaradiatus* [rare], *D. quinqueramus* [rare], *D. surculus*, *R. pseudoumbilica*.

8-71-3-6, top; 51 m:
C. rugosus, *C. tricorniculatus*, *C. leptoporus*, *C. macintyrei*, *D. brouweri*, *D. challenger*, *D. pentaradiatus*, *D. surculus*, *D. variabilis*, *R. pseudoumbilica*.

Upper Miocene
(Ceratolithus tricorniculatus Zone)

8-71-4-5, 63-64 cm; 34 m:
C. tricorniculatus, *C. pelagicus*, *C. macintyrei*, *D. brouweri* s.l., *D. challenger*, *D. exilis* [abundant], *D. surculus*, *Triquetrorhabdulus rugosus*.

Upper Miocene
(Discoaster quinqueramus Zone or
Discoaster neohamatus Zone)

8-71-5-4, 63 cm; 39 m:
C. pelagicus, *C. macintyrei*, *D. brouweri*, *D. challenger*, *D. surculus*, *T. rugosus*.

8-71-6-4, 63 cm; 48 m:
C. pelagicus, *C. leptoporus*, *C. macintyrei*, *D. asymmetricus* [rare], *D. brouweri*, *D. challenger*, *D. surculus*, *Sphenolithus neobabies*, *T. rugosus*.

8-71-7-2, 63 cm; 54 m:
C. pelagicus, *C. macintyrei*, *D. brouweri*, *D. challenger*, *D. neohamatus*, *D. sp.* [small, 5 tapering rays], *R. pseudoumbilica*, *T. rugosus*.

Upper Miocene
(*Discoaster hamatus* Zone)

8-71-8-5, 63-64 cm; 68 m:

C. pelagicus, *C. leptoporus*, *C. macintyrei*, *D. challengerii*, *D. hamatus*, *D. sp.* undescribed [small, 5 tapered rays, no central knob], *R. pseudoumbilica*, *T. rugosus*.

Middle Miocene
(*Discoaster exilis* Zone)

8-71-9-5, 63 cm; 77 m:

Coccolithus eopelagicus, *C. macintyrei*, *D. sp.* cf. *D. challengerii*, *D. sp.* cf. *D. exilis*, *R. pseudoumbilica*, *Sphenolithus neoabies*, *T. rugosus*.

Middle Miocene
(*Discoaster exilis* Zone,
Discoaster kugleri Subzone)

8-71-10-2, 63 cm; 81 m:

C. eopelagicus, *C. pelagicus*, *C. macintyrei*, *D. brouweri* s.l., *D. sp.* cf. *D. exilis*, *D. kugleri*, *H. kamptneri*, *R. pseudoumbilica*, *S. neoabies*, *T. rugosus*.

8-71-10-5, 63 cm; 86 m:

C. eopelagicus, *C. leptoporus*, *C. macintyrei*, *D. sp.* cf. *D. exilis*, *D. kugleri*, *H. kamptneri*, *R. pseudoumbilica*, *T. rugosus*.

Middle Miocene
(*Discoaster exilis* Zone,
Coccolithus eopelagicus Subzone)

8-71-10-6, 63 cm; 87 m:

C. eopelagicus, *C. pelagicus*, *C. macintyrei*, *Discoaster deflandrei*, *D. sp.* cf. *D. exilis*, *R. pseudoumbilica*, *S. neoabies*, *T. rugosus*.

8-71-13-5, 64 cm; 114 m:

C. eopelagicus, *C. leptoporus*, *D. sp.* cf. *D. exilis*, *H. kamptneri*, *R. pseudoumbilica*, *Sphenolithus sp.* cf. *S. abies*, *T. rugosus*.

8-71-15-5, 63 cm; 132 m:

C. eopelagicus, *C. pelagicus*, *C. leptoporus*, *C. macintyrei*, *D. sp.* cf. *D. exilis*, *R. pseudoumbilica*.

Middle Miocene
(*Sphenolithus heteromorphus* Zone)

8-71-16-2, 93-94 cm; 136 m:

C. eopelagicus, *C. pelagicus*, *Cyclococcolithina neogammation*, *D. deflandrei*, *D. sp.* cf. *D. exilis*, *Sphenolithus heteromorphus*.

8-71-20-6, 63 cm; 178 m:

C. eopelagicus, *C. neogammation*, *D. deflandrei*, *D. sp.* cf. *D. exilis*, *H. kamptneri*, *S. heteromorphus*.

8-71-24-4, 63 cm; 212 m:

C. eopelagicus, *C. neogammation*, *D. deflandrei*, *D. dilatus*, *D. exilis*, *S. heteromorphus*.

Lower Miocene
(*Helicopontosphaera ampliaperta* Zone)

8-71-24-6, 63 cm; 215 m:

C. pelagicus, *C. neogammation*, *D. deflandrei* [abundant], *S. heteromorphus* [few], *S. moriformis*.

Lower Miocene
(*Sphenolithus belemnos* Zone?)

8-71-26-6, 63 cm; 233 m:

C. eopelagicus, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *Sphenolithus belemnos*.

Lower Miocene
(*Triquetrorhabdulus carinatus* Zone,
Discoaster druggii Subzone)

8-71-28-6, 63 cm; 252 m:

Coccolithus sp. aff. *C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *D. sp.* cf. *D. druggii*, *Orthorhabdus serratus*, *Reticulofenestra gartneri*, *Sphenolithus sp.* aff. *S. belemnos*.

8-71-30-2, 63 cm; 264 m:

C. eopelagicus, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *D. sp.* cf. *D. druggii*, *S. moriformis*, *Triquetrorhabdulus carinatus*.

8-71-30-4, 63 cm; 267 m:

C. eopelagicus, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *D. druggii*, *D. perplexus* [fragmented], *S. sp.* aff. *S. belemnos*, *T. carinatus*.

Lower Miocene
(*Triquetrorhabdulus carinatus* Zone,
Coccolithus sp. aff. *C. bisectus* Subzone)

8-71-30-6, 63 cm; 270 m:

C. sp. aff. *C. bisectus*, *C. eopelagicus*, *C. neogammation*, *D. deflandrei*, *T. carinatus*.

8-71-32-6, 63 cm; 288 m:

C. sp. aff. *C. bisectus*, *C. eopelagicus*, *C. neogammation*, *D. deflandrei*, *R. gartneri*, *S. sp.* aff. *S. belemnos*, *T. carinatus*.

8-71-33-6, 58 cm; 298 m:

C. sp. aff. *C. bisectus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *D. perplexus*, *Helicopontosphaera parallela*, *S. sp.* aff. *S. belemnos*, *S. moriformis*, *T. carinatus*.

8-71-34-6, 63 cm; 307 m:

C. eopelagicus, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *H. parallela*, *S. belemnos* [rare], *S. sp.* aff. *S. belemnos*.

Lower Miocene

(*Triquetrorhabdulus carinatus* Zone,
Discoaster druggii Subzone)

8-71-35-6, 63 cm; 316 m:

C. neogammation, *D. deflandrei*, *D. druggii* [common],
T. carinatus.

Lower Miocene

(*Triquetrorhabdulus carinatus* Zone,
Coccolithus sp. aff. *C. bisectus* Subzone)

8-71-36-6, 63 cm; 325 m:

C. sp. aff. *C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *T. carinatus* [abundant].

8-71-38-6, 63 cm; 344 m:

C. sp. aff. *C. bisectus*, *C. neogammation*, *D. deflandrei*,
S. belemnos, *S. moriformis*, *T. carinatus*.

8-71-40-5, 63 cm; 361 m:

C. sp. aff. *C. bisectus*, *C. pelagicus*, *C. neogammation*,
D. deflandrei, *S.* sp. aff. *S. belemnos*, *S. moriformis*.

Upper Oligocene

(*Sphenolithus ciperoensis* Zone)

8-71-42-6, 63 cm; 380 m:

C. sp. aff. *C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *R. gartneri*, *S.* sp. aff. *S. belemnos*, *S. ciperoensis* [rare], *S. moriformis*, *T. carinatus*.

8-71-44-6, 63 cm; 398 m:

Coccolithus *bisectus*, *C.* sp. aff. *C. bisectus*, *C. pelagicus*, *Coccolithus* *stavensis*, *C. neogammation*, *R. gartneri*, *S. ciperoensis* [rare], *S. moriformis* [large and small varieties], *T. carinatus*.

Middle Oligocene

(*Sphenolithus distentus* Zone)

8-71-46-6, 63 cm; 416 m:

C. bisectus, *C.* sp. aff. *C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *Sphenolithus* *distentus*, *S. moriformis*, *S. predistentus*, *T. carinatus*.

8-71-48-3, 63 cm; 429 m:

C. bisectus, *C.* sp. aff. *C. bisectus*, *C. pelagicus*, *D. neogammation*, *D. deflandrei*, *R. gartneri*, *S. distentus*, *S. moriformis* [small], *S. predistentus*.

Coccoliths in Selected Samples, Hole 71A

[No samples available. See report of shipboard scientists].

HOLES 72 AND 72A

(lat 00° 26.49'N., long 138° 52.02'W.,
depth 4326 meters)

Summary of Coccolith Stratigraphy

Cores from the surface to 344 meters recovered coccolith assemblages from Holocene to upper Eocene. Below the upper Miocene at 114 meters, coring gaps are present and several zones are not represented (Table 3). Several unusual species are present in Miocene and Pliocene sediment that contains common diatoms and radiolarians. Near the Miocene-Pliocene boundary in Cores 2 and 5A several types of *Ceratolithus* transitional between *C. rugosus* and *C. tricorniculatus* are present. Within the upper Miocene Core 3, a gigantic discoaster similar to *Discoaster brouweri* occurs that has been observed in upper Miocene samples from other Deep Sea Drilling Project sites. In the middle Miocene Core 4, other noteworthy coccoliths include a variety of *Triquetrorhabdulus rugosus* that shows refraction in polarized light and a variety of *Sphenolithus abies* that has very elongate spines, giving the appearance of a pincushion.

Coccoliths in Selected Samples, Hole 72

Pleistocene

(*Gephyrocapsa oceanica* Zone)

8-72-1-1, 63 cm; 1 m:

Coccolithus sp. cf. *C. doronicoides*, *Cyclococcolithina leptoporus*, *Gephyrocapsa oceanica*, *Helicopontosphaera kampfneri*, *H. sellii*.

Pleistocene

(*Coccolithus doronicoides* Zone)

8-72-1-2, 63 cm; 2 m:

Ceratolithus cristatus, *Coccolithus doronicoides*, *C. leptoporus*, *Emiliania annula*, *H. kampfneri*.

8-72-1-6, 63 cm; 8 m:

C. cristatus, *C. doronicoides*, *C. leptoporus*, *Gephyrocapsa* sp., *H. kampfneri*.

Upper Miocene or Lower Pliocene

(*Ceratolithus rugosus* Zone)

8-72-2-1, 126 cm; 61 m:

Ceratolithus sp. cf. *C. rugosus*, *C. tricorniculatus*, *Coccolithus pelagicus*, *C. leptoporus*, *C. macintyreai*, *Discoaster brouweri*, *D. surculus*, *Reticulofenestra pseudoumbilica*.

8-72-2-3, 63 cm; 64 m:

C. sp. cf. *C. rugosus*, *C. tricorniculatus*, *C. pelagicus*, *C. leptoporus*, *C. macintyreai*, *Discoaster asymmetricus*, *D. brouweri*, *D. surculus*, *H. sellii*, *R. pseudoumbilica*.

Upper Miocene
(*Ceratolithus tricorniculatus* Zone)

8-72-2-4, 63 cm; 65 m:

C. tricorniculatus, *C. leptoporus*, *C. macintyrei*, *Discoaster perplexus* [rare], *D. quinqueramus*, *D. surculus*, *R. pseudoumbilica*, *Triquetrorhabdulus rugosus*.

8-72-2-6, 63 cm; 68 m:

C. tricorniculatus, *C. pelagicus*, *C. leptoporus*, *C. macintyrei*, *D. brouweri*, *D. exilis*, *D. pentaradiatus*, *D. quinqueramus*, *D. surculus*, *D. variabilis*, *R. pseudoumbilica*, *Sphenolithus neoabies*, *T. rugosus*.

8-72-3-2, 63 cm; 108 m:

C. tricorniculatus, *C. pelagicus*, *C. leptoporus*, *C. macintyrei*, *D. brouweri*, *D. challenger*, *D. exilis*, *D. surculus*, *D. variabilis*, *T. rugosus*.

8-72-3-3, 63 cm; 110 m:

C. tricorniculatus [early variety, rare], *C. pelagicus*, *C. leptoporus*, *C. macintyrei*, *D. brouweri* s.l., *D. variabilis*, *Sphenolithus abies*, *T. rugosus*.

Upper Miocene
(*Discoaster quinqueramus* Zone or
Discoaster neohamatus Zone)

8-72-3-4, 63 cm; 111 m:

C. pelagicus, *C. leptoporus*, *C. macintyrei*, *D. brouweri* s.l. [some abnormally large], *D. challenger* s.l., *H. kampfneri*, *R. pseudoumbilica*, *S. abies*, *T. rugosus*.

8-72-3-5, 63 cm; 113 m:

8-72-3-6, 63 cm; 114 m:

Same as above with a few *Discoaster* sp. cf. *D. quinqueramus*.

Middle Miocene
(*Discoaster exilis* Zone)

8-72-4-1, 63 cm; 151 m:

Coccolithus eopelagicus, *C. pelagicus*, *C. macintyrei*, *Discoaster deflandrei*, *D. sp. cf. D. exilis*, *R. pseudoumbilica*, *T. rugosus*.

8-72-4-5, 63 cm; 157 m:

C. eopelagicus, *C. leptoporus*, *C. macintyrei*, *D. brouweri* s.l., *D. deflandrei*, *D. sp. cf. D. druggii*, *D. sp. cf. D. exilis*, *R. pseudoumbilica*, *T. rugosus* [many with slight refraction].

Middle Miocene
(*Sphenolithus heteromorphus* Zone)

8-72-5-1, 63 cm; 212 m:

C. eopelagicus, *C. pelagicus*, *C. leptoporus*, *C. neogammation*, *D. brouweri* s.l., *D. deflandrei*, *D. sp. cf. D. exilis*, *R. pseudoumbilica*, *Sphenolithus heteromorphus*.

Lower Miocene
(*Triquetrorhabdulus carinatus* Zone,
Coccolithus sp. aff. *C. bisectus* Subzone)

8-72-6-2, 63 cm; 268 m:

Coccolithus sp. aff. *C. bisectus*, *C. pelagicus* [abundant], *C. neogammation*, *D. deflandrei*, *Sphenolithus belemnios*, *S. sp. aff. S. belemnios*, *Triquetrorhabdulus carinatus* [abundant].

8-72-6-6, 63 cm; 274 m:

C. sp. aff. C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *S. sp. aff. S. belemnios*, *S. moriformis*, *T. carinatus*.

Middle Oligocene
(*Sphenolithus distentus* Zone)

8-72-7-6, 63 cm; 320 m:

Coccolithus bisectus, *C. sp. aff. C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *Reticulofenestra gartneri*, *Sphenolithus distentus*, *S. predistentus*.

Middle Oligocene
(*Sphenolithus distentus* Zone or
Sphenolithus predistentus Zone)

8-72-8-6, 64 cm; 329 m:

C. bisectus, *C. sp. aff. C. bisectus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *R. gartneri*, *S. sp. cf. S. distentus*, *S. predistentus*, *S. pseudoradians*.

Lower Oligocene
(*Helicopontosphaera reticulata* Zone)

8-72-9-2, 63 cm; 332 m:

Bramletteius serraculoides, *C. bisectus* [abundant], *C. eopelagicus*, *C. pelagicus*, *Cyclococcolithina formosus*, *D. deflandrei*, *D. tani tani*, *Helicopontosphaera compacta*, *Pontosphaera vadosa*, *R. gartneri*, *R. umbilica*.

8-72-9-6, 63 cm; 338 m:

C. bisectus, *C. pelagicus*, *C. formosus*, *D. deflandrei*, *D. tani nodifer*, *D. tani tani*, *P. vadosa*, *R. umbilica*.

Upper Eocene
(*Discoaster barbadiensis* Zone)

8-72-10-3, 100-110 cm; 339 to 342 m:

B. serraculoides, *C. bisectus*, *C. formosus*, *Discoaster barbadiensis*, *D. deflandrei*, *D. saipanensis*, *R. umbilica*. Miocene or Pliocene taxa present as drilling contaminants: *C. leptoporus*, *D. brouweri*, *D. exilis*, *D. variabilis*.

8-72-10-5, 120-135 cm; 339 to 342 m:

C. bisectus, *C. eopelagicus*, *C. formosus*, *D. barbadiensis*, *D. deflandrei*, *D. saipanensis*, *R. umbilica*.

8-72-11-1, 42-43 cm; 344 m:
C. bisectus, *C. eopelagicus*, *C. formosus*, *D. barbadiensis*, *D. deflandrei*, *D. saipanensis* [abundant], *D. tani nodifer*, *R. umbilica*.

Coccoliths in Selected Samples, Hole 72A

Holocene or Pleistocene (*Emiliania huxleyi* Zone or *Gephyrocapsa oceanica* Zone)

8-72A-1A-1, 110 cm; 9 m:
Cyclococcolithina leptoporus, *Helicopontosphaera kampfneri*, [a myriad of tiny coccoliths, possibly *Emiliania huxleyi*].

8-72A-1A-4, 63 cm; 13 m:
Ceratolithus cristatus, *C. leptoporus*, *Gephyrocapsa oceanica*, *H. kampfneri*, *H. sellii*.

Upper Pliocene (*Discoaster brouweri* Zone, *Cyclococcolithina macintyrei* Subzone)

8-72A-2A-5, 63 cm; 25 m:
Ceratolithus rugosus, *Coccolithus pelagicus*, *C. leptoporus*, *C. macintyrei*, *Discoaster brouweri*, *H. kampfneri*.

8-72A-3A-4, 63 cm; 31 m:
C. rugosus, *C. pelagicus*, *C. leptoporus*, *C. macintyrei*, *D. brouweri*, *H. kampfneri*, *H. sellii*.

Upper Pliocene (*Discoaster brouweri* Zone, *Discoaster pentaradiatus* Subzone)

8-72A-3A-5, 63 cm; 33 m:
C. rugosus, *C. pelagicus*, *C. macintyrei*, *Discoaster asymmetricus*, *D. brouweri*, *D. pentaradiatus*, *D. surculus*.

8-72A-4A-3, 63 cm; 40 m:
C. rugosus, *C. pelagicus*, *C. macintyrei*, *D. asymmetricus* [common], *D. brouweri*, *D. pentaradiatus*, *D. surculus*, *D. sp. cf. D. variabilis*.

Lower Pliocene (*Reticulofenestra pseudoumbilica* Zone)

8-72A-5A-2, 63 cm; 47 m:
C. rugosus, *C. leptoporus*, *C. macintyrei*, *D. brouweri*, *D. pentaradiatus*, *D. variabilis*, *Reticulofenestra pseudoumbilica*, *Sphenolithus neoabies*.

Upper Miocene or Lower Pliocene (*Ceratolithus rugosus* Zone)

8-72A-5A-4, 63 cm; 50 m:
C. rugosus, *C. sp. aff. C. tricorniculatus*, *C. leptoporus*, *C. macintyrei*, *D. asymmetricus* [rare], *D. brouweri*, *D. exilis*, *D. pentaradiatus*, *D. surculus*, *D. variabilis*, *R. pseudoumbilica*, *Sphenolithus abies*, *S. neoabies*.

8-72A-5A-6, 63 cm; 53 m:
C. rugosus, *C. tricorniculatus*, *C. pelagicus*, *C. leptoporus*, *C. macintyrei*, *D. brouweri*, *D. pentaradiatus* [rare], *D. surculus*, *R. pseudoumbilica*.

Upper Miocene (*Ceratolithus tricorniculatus* Zone)

8-72A-6A-6, 63 cm; 62 m:
C. tricorniculatus, *C. pelagicus*, *C. leptoporus*, *C. macintyrei*, *D. asymmetricus* [rare], *D. brouweri*, *D. challengerii*, *D. exilis*, *D. pentaradiatus* [rare], *D. surculus*, *D. variabilis*, *H. kampfneri* [rare], *R. pseudoumbilica*, *Triquetrorhabdulus rugosus* [rare].

HOLE 73 (lat 01° 54.58'S., long 137° 28.12'W., depth 4387 meters)

Summary of Coccolith Stratigraphy

Upper Pleistocene assemblages are present in Core 1 at 2 meters, and Tertiary assemblages in the Pliocene, upper upper Miocene, middle Miocene, and Oligocene are well developed at this site as at Sites 71 and 72. The hole terminates at 302 meters in upper Eocene radiolarian-rich sediment. *Ceratolithus* specimens transitional between *C. rugosus* and *C. tricorniculatus* occur in cores with Miocene-Pliocene boundary assemblages. A re-occurrence of *Ceratolithus rugosus* Zone assemblages at the top of Core 7 is probably the result of inhole slumping, as the older *Ceratolithus tricorniculatus* Zone assemblage is present at the bottom of the overlying Core 6. An unconformity is probably represented in Core 8, as an upper upper Miocene *Discoaster quinqueramus* Zone to *Ceratolithus tricorniculatus* Zone assemblage occurs at 63 meters and an upper middle Miocene assemblage of the *Discoaster kugleri* Subzone occurs at 66 meters.

Coccoliths in Selected Samples, Hole 73

Pleistocene (*Gephyrocapsa oceanica* Zone)

8-73-1-2, 63 m; 2 m:
Ceratolithus cristatus, *Cyclococcolithina leptoporus*, *Gephyrocapsa oceanica*.

Pleistocene (*Coccolithus doronicoides* Zone)

8-73-2-5, 63 cm; 8 m:
C. cristatus, *Coccolithus doronicoides*, *C. leptoporus*, *C. macintyrei*, *Emiliania annula*.

8-73-4-1, 63 cm; 22 m:
C. cristatus, *C. doronicoides*, *C. pelagicus*, *C. leptoporus*, *C. macintyrei*, *E. annula*, *Helicopontosphaera sellii*.

Upper Pliocene
*(Discoaster brouweri Zone,
Cyclococcolithina macintyrei Subzone)*

8-73-4-2, 63 cm; 23 m:
Ceratolithus rugosus, *C. pelagicus*, *C. leptoporus*, *C. macintyrei*, *Discoaster brouweri* [rare].

8-73-4-3, 63 cm; 25 m:
C. rugosus, *C. pelagicus*, *C. leptoporus*, *C. macintyrei*, *D. brouweri* [abundant], *Helicopontosphaera kampfneri*.

Upper Miocene or Lower Pliocene
(Ceratolithus rugosus Zone)

8-73-6-6, 63-64 cm; 48 m:
Ceratolithus sp. cf. *C. rugosus*, *C. tricorniculatus*, *C. macintyrei*, *D. brouweri*, *D. exilis*, *D. surculus*, *R. pseudoumbilica*.

8-73-7-1, 63-64 cm; 50 m:
C. rugosus, *Ceratolithus* sp. aff. *C. tricorniculatus*, *C. pelagicus*, *C. macintyrei*, *Discoaster asymmetricus*, *D. brouweri*, *D. exilis*, *D. surculus*, *D. variabilis*, *H. kampfneri*, *R. pseudoumbilica*.

8-73-7-3, 63-64 cm; 53 m:
C. rugosus, *C. leptoporus*, *C. macintyrei*, *D. brouweri*, *D. deflandrei*, *D. exilis*, *D. surculus*, *R. pseudoumbilica*.

8-73-7-4, 63-64 cm; 54 m:
C. rugosus, *C. sp. aff. C. tricorniculatus*, *C. pelagicus*, *C. leptoporus*, *C. macintyrei*, *D. asymmetricus*, *D. brouweri*, *D. pentaradiatus*, *H. sellii*, *R. pseudoumbilica*.

8-73-7-5, 63-64 cm; 56 m:
C. sp. cf. C. rugosus, *C. tricorniculatus*, *C. pelagicus*, *C. leptoporus*, *C. macintyrei*, *D. brouweri*, *D. deflandrei*, *D. exilis*, *D. surculus*, *D. variabilis*.

Upper Miocene
(Ceratolithus tricorniculatus Zone)

8-73-7-6, 63-64 cm; 57 m:
C. tricorniculatus, *C. leptoporus*, *C. macintyrei*, *D. brouweri rutellus*, *D. exilis*, *D. quinqueramus*, *D. surculus*, *D. variabilis*, *R. pseudoumbilica* [small], *Triquetrorhabdulus rugosus*.

Upper Miocene or Lower Pliocene
(Ceratolithus rugosus Zone) [Slumped downhole?]

8-73-8-1, 63-64 cm; 59 m:
C. sp. cf. C. rugosus, *C. tricorniculatus*, *C. sp. aff. C. tricorniculatus*, *C. pelagicus*, *C. leptoporus*, *C. macintyrei*, *D. asymmetricus*, *D. brouweri*, *D. deflandrei*, *D. exilis*, *D. surculus*, *R. pseudoumbilica*.

8-73-8-3, 6-7 cm; 61 m:
C. tricorniculatus, *C. sp. aff. C. tricorniculatus*, *C. pelagicus*, *C. leptoporus*, *D. asymmetricus* [rare], *D. brouweri*, *D. challenger*, *D. exilis*, *D. surculus*, *R. pseudoumbilica*, *T. rugosus* [rare].

Upper Miocene
(Ceratolithus tricorniculatus Zone)

8-73-8-3, 63-64 cm; 62 m:
C. tricorniculatus, *C. leptoporus*, *D. brouweri* [large], *D. deflandrei*, *D. exilis*, *D. quinqueramus*, *D. surculus*, *R. pseudoumbilica*, *T. rugosus* [rare].

Upper Miocene
*(Discoaster quinqueramus Zone or
Ceratolithus tricorniculatus Zone)*

8-73-8-4, 63-64 cm; 63 m:
C. pelagicus, *C. leptoporus*, *C. macintyrei*, *D. brouweri* s.l., *D. challenger*, *D. deflandrei*, *D. exilis*, *D. surculus*, *D. variabilis*, *R. pseudoumbilica* [rare], *T. rugosus*.

Middle Miocene
*(Discoaster exilis Zone,
Discoaster kugleri Subzone)*

8-73-8-6, 63 cm; 66 m:
Coccolithus eopelagicus, *C. leptoporus*, *C. macintyrei*, *D. brouweri* s.l., *D. deflandrei*, *D. exilis* [abundant, with a few five-rayed specimens], *D. kugleri*, *D. variabilis* [abundant], *R. pseudoumbilica*, *T. rugosus*.

8-73-9-6, 63 cm; 75 m:
C. eopelagicus, *C. pelagicus*, *C. leptoporus*, *C. macintyrei*, *D. kugleri*, *D. exilis*, *R. pseudoumbilica*, *T. rugosus*.

Middle Miocene
(Sphenolithus heteromorphus Zone)

8-73-10-6, 63 cm; 84 m:
C. eopelagicus, *C. pelagicus*, *C. leptoporus*, *C. neogammation*, *D. deflandrei*, *D. sp. cf. D. exilis*, *Sphenolithus heteromorphus*.

8-73-11-6, 63 cm; 93 m:
C. eopelagicus, *C. pelagicus*, *C. leptoporus*, *C. neogammation*, *D. deflandrei*, *D. exilis*, *S. heteromorphus*.

Lower Miocene
(Triquetrorhabdulus carinatus Zone)

8-73-12-2, 63 cm; 142 m:
C. eopelagicus, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *Sphenolithus* sp. aff. *S. belemnos*, *S. moriformis*, *Triquetrorhabdulus carinatus*.

Lower Miocene

(*Triquetrorhabdulus carinatus* Zone,
Coccolithus sp. aff. *C. bisectus* Subzone)

8-73-12-6, 63 cm; 148 m:

Coccolithus sp. aff. *C. bisectus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *Reticulofenestra gartneri*, *S. sp. aff. S. belemnos*, *S. moriformis*, *T. carinatus*.

Middle Oligocene

(*Sphenolithus distentus* Zone)

8-73-13-2, 63 cm; 208 m:

Coccolithus bisectus, *C. sp. aff. C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *R. gartneri*, *Sphenolithus distentus*, *S. pseudoradians*.

Middle Oligocene

(*Sphenolithus predistentus* Zone)

8-73-14-2, 63 cm; 245 m:

C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *D. tani nodifer*, *D. tani tani*, *Pontosphaera vadosa*, *S. moriformis*, *S. predistentus*.

8-73-17-6, 63 cm; 278 m:

C. bisectus, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *D. tani tani*, *Helicopontosphaera compacta*, *R. gartneri*, *R. umbilica* [rare], *S. predistentus*.

Lower Oligocene

(*Helicopontosphaera reticulata* Zone)

8-73-18-6, 63 cm; 287 m:

Bramletteius serraculoides [rare], *C. bisectus*, *C. pelagicus*, *Cyclococcolithina formosus*, *C. neogammation*, *D. deflandrei*, *D. tani tani*, *R. umbilica*.

Upper Eocene
(*Discoaster barbadiensis* Zone)

8-73-19-2, 63 cm; 290 m:

C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. formosus*, *Discoaster barbadiensis*, *D. saipanensis*, *D. tani nodifer*, *R. umbilica*.

8-73-19-4, 63 cm; 293 m:

B. serraculoides, *C. eopelagicus*, *C. pelagicus*, *C. formosus*, *D. barbadiensis*, *D. saipanensis*, *D. tani tani*, *R. umbilica*.

8-73-19-6, 63 cm; 296 m:

C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. formosus*, *D. barbadiensis*, *D. saipanensis*, *D. tani tani*, *R. umbilica*, *Sphenolithus* sp. cf. *S. predistentus*.

8-73-21-2, 63 cm; 300 m:

C. bisectus, *C. eopelagicus*, *C. pelagicus*, *D. barbadiensis*, *D. saipanensis*, *H. compacta*, *R. umbilica*. Taxa representing Pliocene contamination: *C. rugosus*, *C. macintyreai*, *D. brouweri*.

HOLE 74

(lat 06° 14.20'S., long 136° 05.80'W.,
depth 4431 meters)

Summary of Coccolith Stratigraphy

Sparse Pleistocene to Holocene coccoliths are present in the siliceous ooze of Core 1 at 2 meters, but basal Miocene sediment with abundant coccoliths is present in Core 3 at 21 meters [no intervening samples available], suggesting a greater hiatus than is present at Site 73. Oligocene sediment is present in Cores 6 through 11; and Core 12 at 102 meters is middle Eocene, the occurrence of centerless coccoliths indicating partial dissolution of calcite from this oldest sediment.

Coccoliths in Selected Samples, Hole 74

Pleistocene or Holocene (? Zone)

8-74-1-2, 63 cm; 2 m:

[All coccoliths rare] *Ceratolithus cristatus*, *Coccolithus pelagicus*, *Cyclococcolithina leptoporus*, *Gephyrocapsa oceanica*. Reworked taxa: *Cyclococcolithina macintyreai*, *Discoaster deflandrei*, *Reticulofenestra umbilica*.

Lower Miocene

(*Triquetrorhabdulus carinatus* Zone)

8-74-3-4, 63 cm; 21 m:

Coccolithus sp. aff. *C. bisectus*, *C. eopelagicus*, *Cyclococcolithina neogammation*, *D. deflandrei*, *Sphenolithus moriformis*, *Triquetrorhabdulus carinatus*.

8-74-4-4, 63 cm; 31 m:

C. sp. aff. C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *Helicopontosphaera parallela* [rare], *Sphenolithus* sp. aff. *S. belemnos*, *S. moriformis*, *T. carinatus*.

8-74-5-2, 63 cm; 38 m:

C. eopelagicus, *C. pelagicus*, *C. neogammation*, *Discoaster adamanteus*, *D. deflandrei*, *D. sp. cf. D. lidzi*, *T. carinatus* [abundant].

8-74-5-6, 63 cm; 44 m:

C. eopelagicus, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *S. sp. aff. S. belemnos*, *T. carinatus* [abundant].

Upper Oligocene

(*Sphenolithus ciperoensis* Zone)

8-74-6-2, 63 cm; 48 m:

Coccolithus bisectus, *C. sp. aff. C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *D. sp. cf. D. lidzi*, *S. sp. aff. S. belemnos*, *S. ciperoensis*, *S. moriformis*, *T. carinatus*.

8-74-7-5, 63-64-cm; 61 m:

C. sp. aff. C. bisectus, *C. eopelagicus*, *C. neogammation*, *D. deflandrei*, *S. sp. aff. S. belemnos*, *S. ciperoensis*, *S. moriformis*, *T. carinatus*.

Middle Oligocene

(*Sphenolithus predistentus* Zone)

8-74-8-2, 63-64 cm; 66 m:

C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *D. tani nodifer*, *D. tani tani*, *Sphenolithus predistentus*, *S. pseudoradians* [rare].

8-74-8-3, 63-64 cm; 68 m:

C. eopelagicus, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *D. tani nodifer*, *D. tani tani*, *Sphenolithus distentus*, *S. predistentus*, *S. moriformis*, *S. pseudoradians*.

8-74-9-5, 63-64 cm; 79 m:

C. bisectus, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *D. tani nodifer*, *D. tani tani*, *Helicopontosphaera compacta*, *S. moriformis*, *S. predistentus*.

8-74-10-1, 19-20 cm; 82 m:

C. bisectus, *C. eopelagicus*, *C. pelagicus*, *Coccolithus stvensis*, *C. neogammation*, *D. deflandrei*, *D. sp. cf. D. lidzi*, *D. tani tani*, *Pontosphaera vadosa*, *Reticulofenestra gartneri*, *S. distentus*, *S. predistentus*, *S. moriformis*.

Lower Oligocene

(*Helicopontosphaera reticulata* Zone)

8-74-11-1, 63 cm; 91 m:

Bramletteius serraculoides, *C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *C. stvensis*, *C. formosus*, *C. neogammation*, *D. deflandrei*, *D. tani nodifer*, *D. tani tani*, *H. compacta*, *Isthmolithus recurvus* [rare], *P. vadosa*, *Reticulofenestra umbilica*, *S. distentus*, *S. predistentus*, *S. moriformis*.

Middle Eocene

(*Reticulofenestra umbilica* Zone)

8-74-12-3, 24-25 cm; 102 m:

Campylosphaera dela, *Chiasmolithus grandis*, *Coccolithus eopelagicus*, *C. formosus*, *Discoaster barbadensis*, *D. wemmelensis*, *Helicopontosphaera* sp. cf. *H. compacta*, *Sphenolithus furcatolithoides*.

HOLE 75

(lat 12° 31.00'S., long 134° 16.00'W.,
depth 4181 meters)

Summary of Coccolith Stratigraphy

Lower Miocene sediment of the *Discoaster druggii* Subzone is present in Core 1 at 4 meters below the sea floor. The lowest Miocene sample occurs in Core 4 at about 31 meters. Below, upper and middle Oligocene

assemblages are present to the deepest sample available in Core 9 at 80 meters. The very shallow occurrence of lower Miocene strata at this site is the culmination of a trend in which the base of the Miocene occurs at progressively shallower depth southward from Site 71 (Figure 2). The Oligocene-Miocene boundary is at approximately 370 meters at Site 71 (latitude 4° 28.28'N.), 270 meters at Site 72 (latitude 0° 26.49'N.), 148 meters at Site 73 (latitude 1° 54.58'S.), 64 meters at Site 74 (latitude 6° 14.20'S.), and 32 meters at Site 75 (latitude 12° 31.00'S.). This relationship is apparently a joint result of diminishing sedimentation rate and, as at Site 73, of unconformity within the middle to upper Miocene section south of the equatorial zone.

Coccoliths in Selected Samples, Hole 75

Lower Miocene

(*Triquetrorhabdulus carinatus* Zone, *Discoaster druggii* Subzone)

8-75-1-4, 63 cm; 4 m:

Coccolithus eopelagicus, *C. pelagicus*, *Cyclococcocolithina neogammation*, *Discoaster deflandrei*, *D. druggii*, *D. sp. cf. D. exilis*, *Orthorhabdus serratus*, *Sphenolithus* sp. aff. *S. belemnos*, *Triquetrorhabdulus carinatus*.

Lower Miocene

(*Triquetrorhabdulus carinatus* Zone, *Coccolithus* sp. aff. *C. bisectus* Subzone)

8-75-2-5, 63 cm; 16 m:

Coccolithus sp. aff. *C. bisectus*, *C. eopelagicus*, *C. neogammation*, *D. deflandrei*, *Sphenolithus belemnos*, *S. sp. aff. S. belemnos*, *T. carinatus*.

8-75-4-2, 63-64 cm; 29 m:

C. sp. aff. C. bisectus, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *S. sp. aff. S. belemnos*, *S. moriformis*, *T. carinatus*.

Upper Oligocene

(*Sphenolithus ciperoensis* Zone)

8-75-4-5, 63-64 cm; 34 m:

C. sp. aff. C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *S. sp. aff. S. belemnos*, *S. ciperoensis*, *S. moriformis*, *T. carinatus*.

8-75-5-5, 63-64 cm; 43 m:

C. sp. aff. C. bisectus, *C. eopelagicus*, *C. pelagicus*, *C. neogammation*, *D. deflandrei*, *S. ciperoensis*, *S. distentus*, *S. moriformis*, *T. carinatus*.

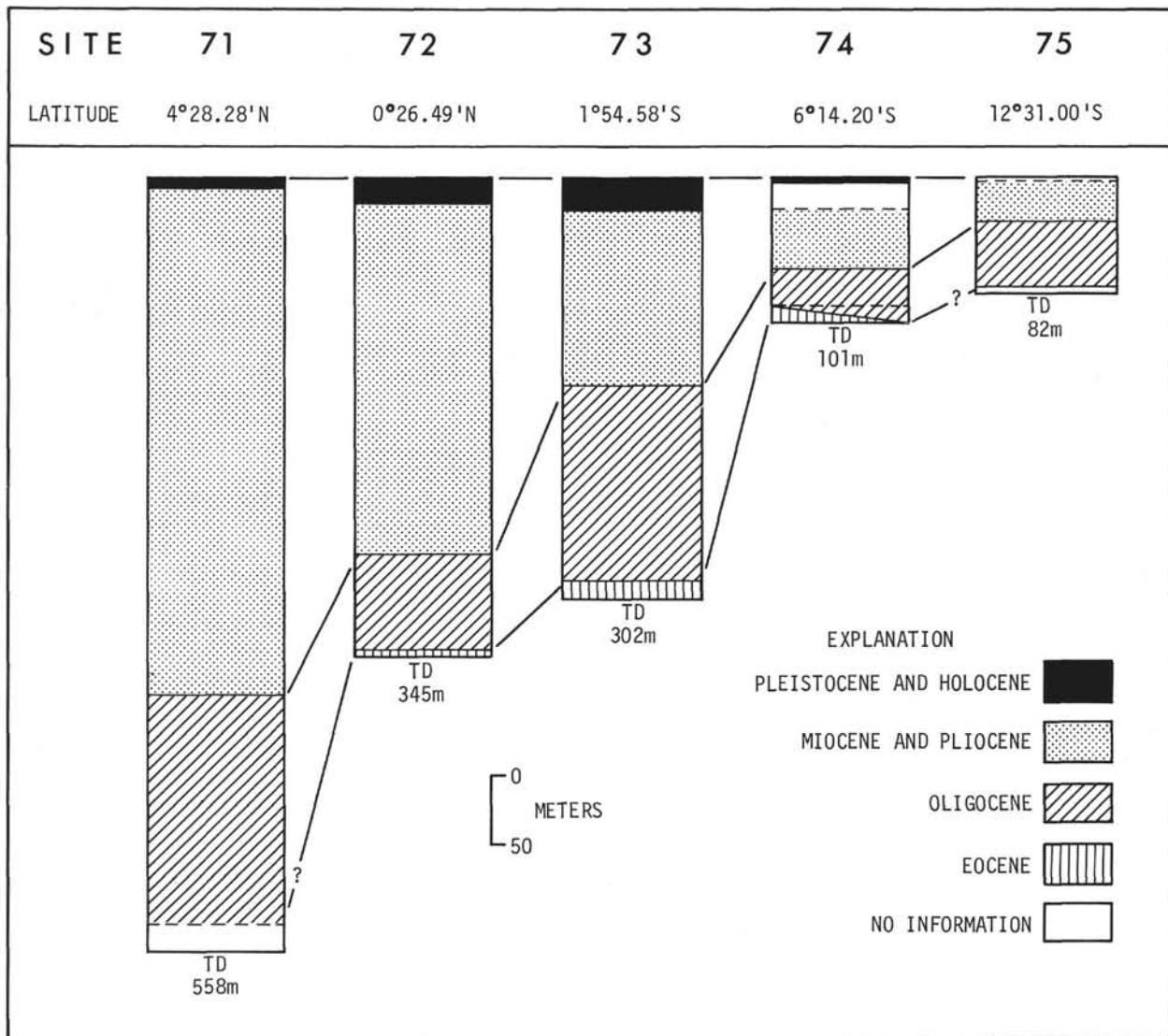


Figure 2. Comparative thickness of Cenozoic series along a south-trending transect in the central Pacific as indicated by the coccolith stratigraphy of cores from Leg 8, Deep Sea Drilling Project.

**Middle Oligocene
(*Sphenolithus predistentus* Zone)**

8-75-8-5, 63-64 cm; 71 m:
Coccolithus bisectus, *C. sp. aff. C. bisectus*, *C. eopelagicus*, *C. neogammation*, *D. deflandrei*, *D. tani tani*, *Helicopontosphaera compacta*, *S. distentus*, *S. predistentus*, *S. pseudoradians*.

8-75-9-2, 63-64 cm; 75 m:
C. bisectus, *C. sp. aff. C. bisectus*, *C. eopelagicus*, *C. neogammation*, *D. deflandrei*, *D. sp. cf. D. tani nodifer*, *D. tani tani*, *S. distentus*, *S. predistentus*, *S. pseudoradians*.

8-75-9-5, 63-64 cm; 80 m:

C. bisectus, *C. sp. aff. C. bisectus*, *C. eopelagicus*, *C. pelagicus*, *Coccolithus stvensis*, *D. deflandrei*, *D. tani nodifer*, *D. tani tani*, *Pontosphaera vadosa*, *S. distentus* [rare], *S. moriformis*, *S. predistentus*.

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