4. SITE 78

The Shipboard Scientific Party¹

MAIN RESULTS

One hole was drilled at this site and continuously cored. A complete stratigraphic section from lower Oligocene to lower middle Miocene, 320 meters thick, was recovered. There is no evidence of substantial hiatuses provided by any of the fossil groups, which include foraminifera, Radiolaria, coccoliths, diatoms and silicoflagellates, except for the large hiatus at the top of the section between the lower middle Miocene and Recent. The bit was stopped by a hard layer which, judging by a few chips recovered from the roller cones, was basalt overlain by about 2.5 meters of baked limestone. The estimated age of basement at this site is about 33 ±1 million years B.P. Lithologies in this sequence are siliceous-calcareous ooze and chalk, and calcareous-siliceous ooze and chalk. The lithologic and biostratigraphic similarity of the sediments at this site and Site 77 is evidence for the regional continuity of deposition in this region from Oligocene to lower Middle Miocene. The average rate of deposition is about 14 m/m.y. The sediment accumulation rates decrease from the base of the hole to the top and abruptly drop to near zero in the Middle Miocene.

INTRODUCTION

Background and Objectives

The original position of Site 78 at 08° 00'N and 124° 30'W was chosen by the JOIDES Pacific Panel to determine the biostratigraphy, age of basement and rate of sea floor spreading north of the Clipperton Fracture Zone. Leg 8 had drilled sites on either side of the Clipperton Fracture Zone (Sites 70 and 71), but were stopped by chert before reaching basement thereby preventing them from determining basement age. Piston core data in the vicinity of this site show that Miocene sediments either crop out or nearly crop out over a broad area (Riedel and Funnell, 1964; Hays and others, 1969) (Figure 1). Site 78 is the northernmost of the scheduled sites of Leg 9, providing an

opportunity not only to compare spreading rates on either side of the Clipperton Fracture Zone but also to compare the Tertiary history of a more northern site with that obtained from the continuous sequence of Site 77. Since the sedimentation rates varied with time at Site 77, an examination of sedimentation rates through time was an important objective of our coring at Site 78. Reasoning that the age of the basal sediments in this part of the Pacific increases westward, it was decided to move Site 78 from its originally scheduled location to latitude 07° 57.37'N, longitude 127° 21.39'W, thereby increasing the possibility of encountering older sediments and at the same time not adding appreciably to the length of our track (Figure 1). Because of its stratigraphic significance it was decided to continuously core this site.

Between Sites 77 and 78 the seismic profiler records were very poor despite the nearly constant attention of the ship's electronic technicians. What could be gleaned from the sparse data was that the sediments gradually become thinner away from Site 77, thinning to as little as 0.2 second of reflection time a few tens of miles before we reached Site 78. In the neighborhood of Site 78, the sediments thicken again to between 0.3 and 0.4 seconds reflection time. The sediments are draped conformably over the basement and have a nearly constant thickness, with minor thickening in basement valleys and thinning over basement highs (Figure 2). The relief of the sea floor is small amounting to about 50 fathoms. No region of rough topography was recorded that might indicate the position of the Clipperton Fracture Zone, However, at 0730 hours on December 24, we crossed a region with a few small seamounts and greater relief than normal. This is about the position of the Clipperton Fracture Zone as reported by Menard (1964).

Operations

Site Survey

Upon reaching the location of Site 78, the *Challenger* made a survey since there had been no survey of this site by the *Argo*. The survey was made over a sequence of sediments about 0.3 to 0.4 second (reflection time) thick. *Challenger* made a square survey, the length of the sides of the square being 2 miles and the diagonals connecting the corners of the square running east-west and north-south. The thickest sediments encountered were at the western corner of the survey and have a thickness of 0.37 second. The upper 0.13 second

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Figure 1. Location of Site 78; sediment isopachs in hundreds of meters after Ewing et al. (1968); distribution of piston core ages after Hays et al. (1969).

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Figure 2. Sketch of seismic reflection record in vicinity of Site 78 showing interval cored.

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contains two prominent reflectors and the remaining 0.24 second of sediment is nearly transparent.

Coring

Upon arrival at the drilling site a Burnett beacon was dropped. Its signal was satisfactory and the drill string with the roller bit was lowered. The bit encountered the sea floor at a depth of 4363 meters and we proceeded to continuously core the hole. Pertinent data concerning the coring operation are presented in Tables 1 and 2. Coring went smoothly and quickly until a resistant layer was encountered at a depth of 315 meters below the sea floor. About 6 inches of hard limestone were cut in approximately an hour of drilling. While drilling on a hard layer, probably basalt below the limestone, the drill string began to vibrate severely. It was thought that one of the bit cones had been lost or had locked. When the bit was recovered it showed no signs of skidding but one of the cones was locked. After some effort the cone was freed but all the cones had noisy bearings and it was decided that the bit could be rebuilt but was unsuitable for further use on this leg.

LITHOLOGY

Three formations are present at Site 78: the cyclic unit (0 to 51.7 meters) of the Clipperton Oceanic Formation which consists of interbedded orange calcareous and dusky brown siliceous oozes; the Marquesas Oceanic Formation (51.7 to 310.5 meters) which consists of gray and brown calcareous oozes and chalks; and the dark brown amorphous iron-oxide, calcareous chalks of the Line Islands Oceanic Formation (310.5 to 320.3 meters). Basement at this site is interpreted to be an intrusive basalt which has baked and hydrothermally altered the overlying chalks.

Clipperton Oceanic Formation

Cyclic Unit (0 to 51.7 meters)

The cyclic unit is mainly characterized by its orange and dark brown colors; for descriptive purposes it is divided into an upper and lower part. Thin, wellbedded orange and brown lithologies are characteristic of the upper 20 meters. Individual beds range in thickness from about 5 to 25 centimeters. Within beds no laminations were seen; however, because these oozes are intensely disturbed by coring primary depositional structures are rarely preserved. The main lithologies of the upper part are:

1. Pale yellowish-brown (10YR2/2) clay (2 to 10 per cent)-calcareous nannofossil (90 per cent) chalk ooze with about 5 to 10 per cent foraminifera and radiolarians.

2. Pale orange (10YR7/2) clay (2 to 10 per cent)-calcareous nannofossil (90 per cent) chalk ooze with less than 1 per cent foraminifera and radiolarians.

3. Pale yellowish-orange (10YR8/6) clay (3 to 5 per cent)-foraminiferal (10 to 15 per cent)-radiolarian (10 to 15 per cent)-calcareous nannofossil (70 to 80 per cent) chalk ooze.

4. Dark yellowish-brown (10YR4/2) clay (5 to 10 per cent)-foraminiferal (5 to 10 per cent)-radiolarian (5 to 10 per cent)-calcareous nannofossil (70 to 85 per cent) chalk ooze.

The boundary between the upper and lower parts of the cyclic unit is gradational over a 1.5-meter interval. This boundary is recognized by the presence of cyclic, interbedded, high and low siliceous chalk oozes starting at about 20 meters from the top of the hole.

The lower part of this unit is similar to the upper part in overall color, but its cyclic bedding of high and low siliceous oozes serves to set it apart. It is distinguished by the 20 to 100 centimeter-thick interbeds of very pale orange calcareous chalk oozes and dark yellowishbrown siliceous chalk oozes (Figure 99):

1. Very pale orange (10YR8/2) radiolarian (10 to 15 per cent)-foraminiferal (10 to 15 per cent)calcareous nannofossil (65 to 75 per cent) chalk ooze.

2. Dark yellowish-brown (10YR4/2) clay (10 to 15 per cent)-calcareous nannofossil (30 to 50 per cent)-radiolarian (30 to 50 per cent) chalk ooze.

3. Pale orange (10YR7/2) calcareous nannofossil (90 per cent) chalk ooze with 10 per cent foraminifera and radiolarians.

4. Very dark yellowish-brown (10YR3/2) clay (5 per cent)-calcareous nannofossil (40 to 50 per cent)-radiolarian (50 to 60 per cent) chalk ooze.

5. Very pale orange (10YR8/2) calcareous nannofossil (30 to 40 per cent)-radiolarian (40 to 60 per cent) chalk ooze.

6. Pale yellowish-brown (10YR6/2) clay (1 to 5 per cent)-radiolarian (10 to 15 per cent)-calcareous nannofossil (80 per cent) chalk ooze.

7. Very pale yellowish-brown (10YR7/2) clay (5 per cent)-radiolarian (15 per cent)-calcareous nanno-fossil (80 per cent) chalk ooze.

This part of the cyclic unit grades into the underlying Marquesas Oceanic Formation over a 2.5-meter interval from pale yellowish-brown calcareous and siliceous sediments to very pale orange calcareous sediments.

Marquesas Oceanic Formation

Brown Unit (51.7 to 101.1 meters)

Distinguishing characteristics of this unit include its very pale orange color, massive bedding with no

TABLE 1 Site Operational Summary

Site 78

Latitude 07° 57.00'N; Longitude 127° 21.35'W.

Time of arrival: 0438 hours, 12/25/69; Time of departure: 2115 hours, 12/28/69.

Time on site: 3 days, 16 hours, 37 minutes.

Water depth: 4363 meters.

Sediment thickness determined by drilling: 320.3 meters.

Acoustical thickness: 0.3 second.

Average sound velocity of sediments: 2.1 km/sec.

Hole	Penetration	Cores	Cores	Per Cent	Recovery	Per Cent
	(m)	Attempted	Recovered	Cored	Meters	Recovered
78	320.3	37	36	100	301.7	94.2

apparent laminations, and high carbonate content:

1. Very pale orange (10YR8/2) radiolarian (10 to 15 per cent)-foraminiferal (40 to 50 per cent)calcareous nannofossil (50 to 60 per cent) ooze.

2. Very, very pale orange (10YR9/2) radiolarian (10 to 15 per cent)-foraminiferal (15 to 20 per cent)-calcareous nannofossil (70 to 80 per cent) ooze.

3. Very pale orange (10YR8/2) radiolarian (10 to 20 per cent)-calcareous nannofossil (30 to 50 per cent)-foraminiferal (40 to 50 per cent) ooze.

4. Grayish-orange (10YR7/4) clay (2 to 3 per cent)-radiolarian (10 to 15 per cent) calcareous nannofossil (80 to 85 per cent) chalk ooze.

The oranges of this unit grade into pastel shades of gray and light blue and green of the underlying gray unit of the Marquesas Oceanic Formation over a 1meter interval.

Gray Unit (101.1 to 272.4 meters)

This unit is easily recognized because of its light gray, green and blue colors with occasional dusky purple laminations. Individual colors usually persist over long intervals with no apparent laminations which results in massive-appearing beds.

1. Dominant light greenish-gray (5G8/1) foraminiferal (10 to 15 per cent) radiolarian (10 to 15 per cent)—calcareous nannofossil (70 to 80 per cent) chalk and ooze chalk.

2. Common bluish-white (5B9/1) foraminiferal (10 to 15 per cent)-radiolarian (10 to 15 per cent)calcareous nannofossil (70 to 80 per cent) chalk. 3. Rare pale yellowish-orange (10YR6/2) foraminiferal (15 to 20 per cent)-radiolarian (15 to 20 per cent)-calcareous nannofossil (60 to 70 per cent) ooze chalk.

4. Rare very dusky purple (5P2/2) manganese (?) (5 to 10 per cent)-foraminiferal (10 to 20 per cent)-radiolarian (30 to 40 per cent) calcareous nannofossil (40 to 60 per cent) ooze.

5. Common light greenish-gray (5G8/1) foraminiferal (15 to 25 per cent)-calcareous nannofossil (70 to 80 per cent) chalk with less than 5 to 10 per cent Radiolaria.

6. Common bluish-white (5B9/1) to light greenishgray (5G8/1) foraminiferal (15 to 25 per cent)calcareous nannofossil (70 to 80 per cent) chalk.

This unit grades into another brown unit of the Marquesas Oceanic Formation over a 1 to 2 centimeterthick transitional color change from light gray to very pale orange.

Brown Unit (272.4 to 310.5 meters)

These sediments are massive with no apparent laminations. The dominant lithologies are:

1. Dominant very pale yellowish-orange (10YR9/6) for a miniferal (15 to 20 per cent)-calcareous nannofossil (80 to 85 per cent) chalk, with radiolarians about 5 to 10 per cent.

2. Common very pale orange (10YR8/2) foraminiferal (20 to 30 per cent)-calcareous nannofossil (70 to 80 per cent) chalk, with about 1 to 3 per cent radiolarians.

Interva Sea	al Below Floor			Core	Cut	Core Rec	overed	Drill Stem	Pump	Drilling Rate
(m)	(ft)	Drilled	Core	(m)	(ft)	(m)	(ft)	Rotated	Circ	(ft/min)
0-9.1	0-30.0		1	9.10	30.0	9.10	30.0	-	-	3.3
9.1-18.3	30.0-60.0		2	9.10	30.0	9.10	30.0	—	_	1.7
18.3-27.4	60.0-90.0		3	9.10	30.0	9.10	30.0	-		2.3
27.4-36.6	90.0-120.0		4	9.10	30.0	9.10	30.0		_	3.0
36.6-45.7	120.0-150.0		5	9.10	30.0	9.10	30.0	-	_	3.0
45.7-54.9	150.0-180.0		6	9.10	30.0	9.10	30.0	-	_	2.5
54.9-64.0	180.0-210.0		7	9.10	30.0	8.80	29.0	-	-	3.0
64.0-73.2	210.0-240.0		8	9.10	30.0	2.40	8.0	-	_	2.5
73.2-82.3	240.0-270.0		9	9.10	30.0	8.80	29.0	-		1.0
82.3-91.4	270.0-300.0		10	9.10	30.0	9.10	30.0			1.1
91.4-100.6	300.0-330.0		11	9.10	30.0	9.10	30.0		Int	1.0
100.6-109.8	330.0-360.0		12	9.10	30.0	8.20	27.0		Int	2.1
109.8-118.9	360.0-390.0		13	9.10	30.0	9.10	30.0		Int	3.3
118.9-128.0	390.0-420.0		14	9.10	30.0	9.10	30.0		Int	2.0
128.0-137.2	420.0-450.0		15	9.10	30.0	9.10	30.0		Int	2.5
137.2-146.3	450.0-480.0		16	9.10	30.0	9.10	30.0		Int	?
146.3-155.5	480.0-510.0		17	9.10	30.0	7.30	24.0		Int	1.9
155.5-164.6	510.0-540.0		18	9.10	30.0	9.10	30.0		Int	?
164.6-173.7	540.0-570.0		19	9.10	30.0	9.10	30.0		Int	1.5
173.7-182.9	570.0-600.0		20	9.10	30.0	9.10	30.0		Int	1.1
182.9-192.0	600.0-630.0		21	9.10	30.0	9.10	30.0		Int	1.0
192.0-201.2	630.0-660.0		22	9.10	30.0	9.10	30.0		Int	1.0
201.2-210.3	660.0-690.0		23	9.10	30.0	9.10	30.0		Int	1.1
210.3-219.5	690.0-720.0		24	9.10	30.0	2.70	9.0		Int	1.0
219.5-228.6	720.0-750.0		25	9.10	30.0	9.10	30.0		Int	0.8
228.6-237.7	750.0-780.0		26	9.10	30.0	9.10	30.0		Int	1.1
237.7-246.9	780.0-810.0		27	9.10	30.0	8.50	28.0		Int	1.5
246.9-256.0	810.0-840.0		28	9.10	30.0	9.10	30.0		Int	1.2
256.0-265.2	840.0-870.0		29	9.10	30.0	9.10	30.0		Int	1.5
265.2-274.3	870.0-900.0		30	9.10	30.0	9.10	30.0		Int	1.1
274.3-283.5	900.0-930.0		31	9.10	30.0	9.10	30.0		Cont	0.9
283.5-292.6	930.0-960.0		32	9.10	30.0	9.10	30.0		Int	0.8
292.6-301.8	960.0-990.0		33	9.10	30.0	9.10	30.0		Int	0.8

TABLE 2Hole Drilling Summary, Site 78(Latitude 07° 57.00'N, Longitude 127° 21.35'W; 4363 meters depth)

Hole 78

Hole 78 - Continued

Interv Sea	al Below Floor			Core	Cut	Core Re	covered	Drill Stem	Pump	Drilling Rate
(m)	(ft)	Drilled	Core	(m)	(ft)	(m)	(ft)	Rotated	Circ	(ft/min)
301.8-310.9	990.0-1020.0		34	9.10	30.0	9.10	30.0		Int	0.9
310.9-320.1	1020.0-1050.0		35	9.10	30.0	7.60	25.0		Cont	3.8
320.1-320.3	1050.0-1050.5		36	0.15	0.5	0.15	0.5		Cont	3.0
320.3-320.3	1050.5-1050.5		37	0.00	0.0	0.00	0.0		Cont	?
Total 320.3	1050.5		37	320.35	1050.5	301.75	989.5			

This unit grades into the Line Islands Oceanic Formation over a 30-centimeter interval. This change is marked by a darkening of color from very pale orange to grayish orange.

Line Islands Oceanic Formation

As at other sites, these brown sediments have varying amounts of reddish brown amorphous iron and (?) manganese oxides which lie directly above basaltic basement. No crystalline phases of iron or manganese oxide were detected in the samples submitted for X-ray analyses (Cook and Zemmels, 1971). At this site, the Line Islands Oceanic Formation is characterized by its orange and light brown color, massive bedding, and well-indurated nature:

1. Grayish-orange (10YR7/4) clay (1 to 3 per cent)-radiolarian (15 to 20 per cent)-calcareous nannofossil (80 to 85 per cent) chalk, with about 1 to 2 per cent foraminifera.

2. The basal few inches are a white (N9) to very pale orange (10YR8/2) calcareous nannofossil (25 to 50 per cent)-foraminiferal (50 to 75 per cent) packstone limestone.

The contact with the underlying basalt is baked. This baked zone exhibits partial replacement of foraminifera and nannofossils by opaque euhedral iron oxides and moderate greenish-yellow (10YR7/4) clay both of which are probably hydrothermal in origin.

Basaltic Basement

A basement core was not recovered, but basalt chips were on the bit at a depth directly below the baked limestone. The chips are a black (N1), very fine-grained basalt.

PHYSICAL PROPERTIES

Natural Gamma

Natural gamma readings ranged from 784 counts to 1000 counts/75 sec except in Cores 1, 4 and 33 where small increases up to 1079 counts were noted.

The cyclic unit of the Clipperton Oceanic Formation yielded counts from 813 to 1079. The top two thirds of the cyclic unit is irregularly marked by counts of about 1000, whereas the bottom third of the cyclic unit yields average readings of about 900 counts. Within the upper two thirds of the cyclic unit potassic mica and montmorillonite are present, and probably are responsible for the higher readings.

The Marquesas Oceanic Formation yielded counts of 785 to 950 with the exception of Core 33 where one reading of 1016 was noted. No reason for this slight increase in Core 33 is apparent.

The Line Islands Oceanic Formation yielded counts from 807 to 951.

The lower third of the cyclic unit of the Clipperton Oceanic Formation, the Marquesas Oceanic Formation, and the Line Islands Oceanic Formation are not distinguishable from one another at this site on the basis of natural gamma radiation.

Porosity

Porosity at Site 78 ranges from 48 to 80 per cent. There may be an overall porosity decrease with depth, but if there is, it is less than 10 per cent (Figures 4 and 6). Porosity fluctuates irregularly and does not seem to correspond to lithology at this site. Rough seas increased drilling disturbance in the cores and made true measurements of porosity difficult.

Sonic Velocity

Sound velocities range from 1415 to 1708 m/sec. The velocities tend to increase downhole, as would be expected due to sediment compaction; however, the velocities fluctuate irregularly at the bottom of the hole. This fluctuation probably reflects the interbedded unconsolidated oozes and consolidated chalks. Whether these different degrees of consolidation over 5 to 20-centimeter intervals are natural or were artificially created by drilling procedures is uncertain. No distinct changes in velocity are directly attributable to a change in lithologic type.

Bulk Density

At Site 78 the bulk densities range from 1,408 g/cc at the top to 1,686 g/cc at the bottom and show a slight increase with depth. However, this trend is broken by sharp fluctuations in the readings some of which are probably due to water injected into the sediments during drilling. In Core 4 the lower density readings are possible due to an abundance of Radiolaria forming a more open framework.

Penetrometer

The general trend of the readings decrease downhole even though on a detailed scale the readings fluctuate erratically from 0.1 centimeter to over 3 centimeters. The sea was rough at this site and the vertical movement of the ship probably forced sea water into the core barrel. This resulted in sediments being mixed with sea water throughout much of the hole. Probably the highest reliable reading was 2 centimeters which occurs at the top of the hole. Any minor fluctuations in the penetrometer readings due to cementation, compaction, and/or lithologic variation are obliterated by coring disturbances.

BIOSTRATIGRAPHY

Foraminifera

The record for this site is anomalous compared to the other sites because the youngest sediments cored were middle Miocene.

Except for a few Pliocene-Recent specimens of *Globorotalia tumida* and *G. tumida flexuosa* in the first core recovered, no evidence was found to indicate the occurrence of younger sediments.

In the cored interval from the middle Miocene Globorotalia fohsi-G. peripheroacuta Zone to the lower Oligocene Pseudohastigerina barbadoensis Zone, sedimentation was very rapid at certain intervals when compared to similar intervals at Site 77. In particular, the Globorotalia kugleri and Globigerina ampliapertura Zones comprise over half of the total cored interval for the hole. Coring was nearly continuous at the site and unlike Site 77, no continuous intervals were encountered without abundant well-preserved foraminiferal specimens. Diversity fluctuations occurred in the faunas but these were found to be far more subtle than similar fluctuations at Site 77. Low diversity intervals in Hole 78 appear somewhat lower in the section, e.g., *Globorotalia opima* Zone, than those of Site 77. As at Site 77, these fluctuations in the faunal diversity cannot be correlated to any apparent solution or accelerated sedimentation.

A short interval of hard limestone immediately above the basalt yielded a typical lower Oligocene fauna including the zonal species *Pseudohastigerina barbad*oensis.

Radiolaria

Radiolaria are abundant and well preserved in all of the 35 sediment cores from Site 78. In this respect, Site 78 differs from Sites 77, 80 and 81, in which Radiolaria were either absent or rare in the ten meters of sediment directly overlying basement rock. The section at Site 78 differs from the section of equivalent age at Site 77 in the general scarcity of orosphaerid Radiolaria and the presence of diatoms throughout the recovered intervals.

Down-section reworking of younger material appears to have occurred to variable degrees throughout the cores. This contamination may reach ten per cent in Cores 9 through 20, and extreme care must be exercised in determining stratigraphic ranges.

The radiolarian assemblages at Site 78 range from the Theocyrtis tuberosa Zone to the Cannartus laticonus Zone. The discussion in the Site Report for Site 77 regarding the stratigraphic ranges of Artophormis gracilis and Cannartus prismaticus also applies to Site 78. Several discrepancies exist between the stratigraphic ranges of the same radiolarian species in these two sites. In Site 78, Cannartus tubarius first appears simultaneously with Lychnocanium bipes, whereas in Site 77, C. tubarius first appears 15 meters above the first appearance of L. bipes and after the first appearance of Brachiospyris simplex and Tympanidium binoctonum. In Core 14 of Site 78, Dipodospyris forcipata, Tympanidium binoctonum, Liriospyris mutuaria and Cyrtocapsella tetrapera first appear simultaneously, whereas approximately 13 meters of sediment exist between the first appearances of L. mutuaria and D. forcipata in Site 77. These two discrepancies may be the result of minor hiatuses in the sections.

Three other inconsistencies exist which cannot be explained by unconformities. In Site 78, *Cannartus violina* first appears above the first appearance of Giraffospyris annulispina, whereas the opposite is true in Site 77. Cyclampterium (?) tanythorax and Lithopera renzae first appear above the first appearance of Brachiospyris alata in Site 78, whereas the former two species occur in the Calocycletta costata Zone in Site 77. In Cores 1 and 2 of Site 78, the polar columns of specimens belonging to Cannartus are generally absent. Consequently, the true stratigraphic range of Cannartus laticonus may be lower than is indicated on the Biostratigraphic Chart. Except for these three inconsistencies there is good agreement between the radiolarian stratigraphic ranges in Sites 78 and 77, and with the other sites.

DISCUSSION AND INTERPRETATION

The sediments at this site are similar in lithology to those recovered at Site 77 but the upper part of the section from the middle of the Middle Miocene to Recent is missing. There is some reworking of Pleistocene foraminifera into the Middle Miocene faunas of the top several cores suggesting that a very thin veneer of Quaternary might be present but was not recovered. The total absence of sediments younger than middle Miocene could be accounted for if sediments of this age were not deposited at this site or if they had been subsequently eroded. A number of facts favor the former interpretation. First, the sediments at this site are not appreciably more consolidated than they were at the previous site (Site 77), and much less consolidated in their upper 100 meters than sediments of equivalent age at Site 77. Second, studies of piston cores (Riedel and Funnell, 1967; and, Hays et al., 1969) from this region have shown that sediments of Miocene age outcrop over a broad area so the results at this site are probably representative for the region, indicating an extensive area of outcropping Miocene sediments that is clearly not the result of local slumping or erosion. Regional erosion that would remove a thickness of sediment equivalent to the upper Miocene through Quaternary of Site 77 (200 meters) is improbable. Also the rates of accumulation decrease rapidly toward the top of our section at Site 78, suggesting that the absence of sediment younger than Middle Miocene in age is due to the fact that it was not deposited rather than eroded away.

Important to the problem of the missing section are the accumulation rates (Table 3). At Site 77 the rates are 18 m/m.y. down to the top of the Lower Miocene and average 10 m/m.y. above this. At Site 78 the rates in the Oligocene and lower Miocene up to the *G*. *dissimilis* Zone are 16 m/m.y. above which they fall off rapidly approaching zero above the middle Miocene. The foraminiferal diversity is reduced in the middle Miocene as compared to the Oligocene and lower Miocene probably due to solution. Also, there is evidence of etching of coccoliths probably indicating solution resulting from slower sedimentation rates.

The sediment types at this site are generally similar to those at Site 77. The upper part of both is the cyclic unit of the Clipperton Oceanic Formation. Also present are the well indurated chalks of the Marquesas Oceanic Formation and the brown iron-manganese rich clays of the Line Islands Oceanic Formation.

Penetration was slowed at the bottom of this hole as the bit encountered hard limestone. This limestone contained euhedral magnetite and shows signs of being baked. It also contains well-preserved foraminifera, indicating that its genesis is tied to some kind of contact metamorphism. Six inches of this material were recovered. After the limestone was recovered the bit was lowered again and drilling continued for 1.5 hours with no appreciable penetration. When the bit was recovered, small pieces of basalt were removed from the cones indicating that basalt immediately underlies the limestone. This evidence of baking indicates that the basalt is a sill.

Radiolaria, nannofossils and planktonic foraminifera are all present in samples from near the base of this site, but the only zonal boundary close to the base of the section is the upper boundary of the *Pseudohastigerina barbadoensis* planktonic foraminiferal zone. The top of this zone has an estimated age of 33.5 ± 1 million years and falls within a few centimeters of the base of the hole. Therefore the best estimate for the basement age at this site is 33.5 ± 1 million years.

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	BIOSTRATIGRAPHY	Y					Τ				
FORAMINIFERA	NANNOFOSSILS	RADIOLARIANS	SERIES- SUBSERIES	METERS	CORES	FORMATION		LITHOLOGIC DESCRIPTION	COLUMN	Ca CO3 %	SILICEOUS BIOTA %
G. fohsi fohsi G. peri- pheroacuta G. periphe- roronda	S. hetero- morphus T. rugosus Subzone S. hetero- morphus H. ampliaperta	C. laticomus D. alata	MIDDLE MIOCENE		1	RTON FM.	UNIT	PALE YELLOWISH BROWN Clay-Nanno Chalk Ooze. * PALE ORANGE Clay-Nanno Chalk Ooze. DARK YELLOWISH BROWN Clay-Nanno-Chalk Ooze.		}	
P. glomerosa curva G. bisphericus G. venezuelana	Subzone <i>I. carinatus -</i> <i>S.heteromorphus</i> Subzone	C. costata		25 —	4	CLIPPE	CACLIC	VERY PALE ORANGE Rad- Foram-Nanno Chalk Ooze. + DARK YELLOWISH BROWN Clay-Nanno-Rad Chalk Ooze.		WWW	<u></u>
G. dissimilis	T. carinatus - S. belemnos Subzone			50 —	5		-			Ş	<u> </u>
	T. carinatus - C. neogammation Subzone	Calocycletta	ENE		7			VERY PALE ORANGE Rad- Foram-Nanno Ooze. + VERY PALE ORANGE Rad- Nanno-Foram Ooze.			
G. kugleri	Trigue tror-	virginis	LOWER MIOC	75 -	8 9 10 11	TIMI MUDDO	BROWN UNIT				
G. kugleri	habdulus carinatus - Coccolithus bisectus var. Subzone	Lychnocanium bipes		125 -	12 13 14 15	MARQUESAS FM.		DARK BLUISH WHITE Foram- Nanno Ooze Chalk and Chalk. + LIGHT GREENISH GRAY Foram-Rad-Nanno Chalk. + VERY DUSKY PURPLE Foram-Nanno-Rad Ooze.			
				150 —	16 17	DAV INTT	RAY UNIT				
G. angulisutu-		D. papilio	OLIGOCENE		T8 19		5				
G. angulisutu- ralis	C. bisectus - T. carinatus Subzone	Theooyrtis annosa	UPPER	175 — 200 —	20 21 22						

Figure 3. Site 78 summary.

						Р	OROSITY-g/cm ³		SOUND VELO	OCITY	
						~ GRAPE	O SYRINGE SAMPI	E	km/sec		
FORAMS	NANNOS	SILICA CLAY	VOLCANIC GLASS	SEDIMEN	TA-	2	50 100	16	۱ 	2,0	PENETROM-
20	70	%	R.I. R A B	m/10 ⁶ v	TS	~ GRAPE ▲ SECTION	N WT.	10 ³ counts	GAMMA /75 sec		ener
20 40 40	0 60 80	20 40	1.50 1.58	10	20	SYRINGE SAMP	LE 12	مى مى			10 20
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Figure 4. Site 78 summary.

1	BIOSTRATIGRAPH	Y	ES			N		SIC		
FORAMINIFERA	NANNOFOSSILS	RADIOLARIANS	SERIES- SUBSERI	METERS	CORES	FORMATIC	LITHOLOGIC DESCRIPTION	COLUMN	Ca CO 3 %	SILICEOUS BIOTA % 20 40
G. opima	C. bisectus T. carinatus Subzone				23		LIGHT GREENISH GRAY Foram-Nanno Chalk and			
C. cubensis	Coccolithus bisectus - Sphenolithus distentus Subzone	Theocyrtis annosa		225-	24 25 26	CDAV INIT	Ooze Chalk. + BLUISH WHITE Foram- Nanno Chalk.			}
			UPPER OLIGOCENE	250—	27 28 29	MARQUESAS FM.				
G.ampliapertura	Coacolithus bisectus - Heliooponto- sphaera compacta Subzone	Theocyrtis tuberosa		275-	30 31 32 33	BROWN LINIT	VERY PALE ORANGE Foram- Nanno Chalk. + VERY PALE YELLOWISH ORANGE Foram-Nanno Chalk. + VERY PALE ORANGE Nanno- Foram Chalk.			
		Thyrocyrtis bromia			34	LINE ISL.	GRAYISH ORANGE Clay- Rad-Nanno Chalk. ₩HITE BAKED Foram Packstone - Grainstone.			
.Pbarbadoensis			LOWER OLIGOCENE	325-	30	BASE MENT T.D. 320.	Basalt			
				375-						

Figure 5. Site 78 summary (continued).

FORAMS	NANNOS	SILICA CLAY	VOLCANIC	SEDIMENTA-	~ GRAPE	POROSITY-g/cm ³ O SYRINGE SAMP 50 100	LE	SOUND VELOCITY km/sec	PENETROM-
% 20. 40.	%	%	R.I. R A B	TION RATE m/10 ⁶ yrs	DENSITY - ~ GRAPE & SECTIO □ SYRINGE SAM	% NN WT PLE	NATURA 10 ³ coun	GAMMA ts/75 sec	ETER cm
				10 20			*		
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Figure 6. Site 78 summary (continued).

Geologic Interval	Duration Geologic Interval (m.y.)	Sediment Thickness (meters)	Accumulation Rate (m/10 ⁶ yrs)
Pleistocene	1.8	0	0
Pliocene	3.2	0	0
Upper Miocene	5.0	0	0
Middle Miocene	4.0	18	4.5
Lower Miocene	8.5	132	15.5

TABLE 3 Rates of Sedimentation, Site 78



Figure 7. Site 78 Biostratigraphic Chart Foraminifera (0 to 200 feet).

SERIES	ZONES SUBZONES	DEPTH BELOW SEA FLOOR FT. M.	SECTIONS	BARRELS	SAMPLES	ТАХА	
SERIES	ZONES	DEPTH BELOW SEA FLOOR FT. M. 225 70 225 70 80 80 275	SECTIONS 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 7 7 7 7 7 7 7 7 7 7 7 7 7	9 BARREIS	+ + + + SAMPLES		
LOWER MIOCENE	G. kugleri	90 300 - - - - - - - - - - - - -	3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 2 3 4 5 6 1 2 2 3 4 5 6 6 1 1 2 5 6 6 1 1 2 5 6 6 1 1 2 5 5 6 6 1 1 2 5 5 6 6 6 1 1 2 2 1 2 5 5 6 6 1 1 2 5 5 6 6 1 1 2 5 5 6 6 1 1 2 5 5 6 6 1 1 2 5 5 6 6 1 1 2 5 5 6 6 1 1 2 5 5 6 6 1 1 2 5 5 6 6 1 1 2 5 5 6 6 1 1 2 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	10 11 12 13	+ + + + +	G. anguitation and a constraint of the constrain	

Figure 8. Site 78 Biostratigraphic Chart Foraminifera (200 to 400 feet).

SERIES SUBSERIES	ZONES SUBZONES	DEPTH BELOW SEA FLOOR FT. M.	SECTIONS	BARRELS	SAMPLES									ТАХ	(A			
			3 4 5 6	14	+	G. venezuelana sis G. tritohus					G. kugleri							
LOWER MIOCENE	G. kugleri	425130 	1 2 3 4 5	15	+	G. siaken	- G. Juvenilis				G. primordius	npliapertura						
		450 140	6 1 2 3	16	+			olensis O. muutussum				-G. ciperoensis						
		475	5 6 1 2		+			C. chip	G. dissimilis				G. opina nana					
		500	3 4 5 6	17	+				G. tripartita.	G. suteri			tdokugleri					
JPPER OLIGOCENE	G. angulisuturalis	525 160	1 2 3 4 5 6	18	+													
		550 170	1 2 3 4 5 6	19	+									nguisa uraits				
		575 - - - - - - - - - - - - - - - - - -	1 2 3 4 5 6	20	+								t	3.5				

Figure 9. Site 78 Biostratigraphic Chart Foraminifera (400 to 600 feet).



Figure 10. Site 78 Biostratigraphic Chart Foraminifera (600 to 800 feet).

SERIES	ZONES	DEPTH BELOW SEA FLOOR FT. M.	SECTIONS	BARRELS	SAMPLES							ТАХА	
		_	5	27	Π	П	П	Π	Π	T			
			6	F	+								
		82 <u>5</u> 250	1 2 3 4 5 6	28	+	- C. chipolensis - is -							
			1		+	issimil		ralis -					
		850 - 260	2 3 4 5 6	29		-G. tripartita		G. angulisatu	G. euapertura				
		875	1		+		suteri		cube				
IGOCENE	pertura	- - - - 270	2 3 4 5	30			G. ampliapertura	na nana -		G. gortanii	suma		
R OL	mplia	900	1	-	+	111		undo -			-0.8 -		
UPPE	G. a	925 280	1 2 3 4 5 6	31	+			5					
		950 2990	2 3 4 5 6	32	+						- G. tapurtensis		
		97 <u>5</u>	2 3 4 5 6	33	+						.G. selli		
		300	1 2	34	+								

BIOSTRATIGRAPHIC CHART FORAMINIFERA

Figure 11. Site 78 Biostratigraphic Chart Foraminifera (800 to 1000 feet).

SERIES	ZONES	DEPTI BELOV SEA FLC FT.	H W XOR M.	SECTIONS	BARRELS	SAMPLES										TAX	N.				
DCENE	tura			3 4 5 6	34	+	-G. dissimilis	Complete Contraction	G. ampuapernua	G. euapertura	G. gemma		- G. angiporoides								
UPPER OLIGO	G. ampliaper	1025	<u>5</u> 10	2 3 4 5 6	35	+	C. chipolensis	G. suteri	G. opima nana	in marking		G. tapuriensis	P. barbadoensis	1							
LOWER OLIGOCENE	P. barbadoensis	1075 - 3 - 1075 - 3 - 3 - 1100 - 3 - 11150 - 3 - 3 - 11150 - 3 - 3 - 11150 - 3 - 3 - 11150 - 3 - 3 - 3 - 11150 - 3 - 3 - 3 - 3 - 3 - 3 - 3 - 3	320 330 550		1 36	+								U. OURCHIEGENESS							

Figure 12. Site 78 Biostratigraphic Chart Foraminifera (1000 to 1200 feet).

						BIOS	STR	ATIC	RA	PHIC	C	IAR	RT	RAD	IOL/	ARI/	1						-		_		_	_			_
SERIES SUBSERIES	ZONES	DEPTH BELOW SEA FLOO FT. M	SECTIONS	SAMPLES													ТАХ	A													
MIDDLE MIOCENE	Brachicspyris alata U Camartus Inticonus		1 2 3 4 5 6 7 2 3 4 5 6 7	+ + + + + + + + + + + + + + + + + + +			s stauropora	riospyris reticulata	readospyris pentagona		martus mammiferus	Acrocubus octopylus	Giraffospyris toxaria	Brachiospyris alata	Cyclampterium (?) tanythorax	Lithopera renzae	Camartus Laticonus	?													
	Calooyeletta oostata		2 3 4 5 6 1 2 3 4 5 6	+ + + + + + + + + + + + + + + + + + + +	nartus violina Liriospuris alobosa	Doreadospyris dentata	Liriospyri	Γú	00	Calooyoletta costata	Ca					a	noetonum	laris	leptetrum	Stichocorys diploconus	Dendrospyris pododendros	Stichocorys delmontense	Giraffospyris annulispina	Tholospyris anthopora	Camartus tubarius	Liriospyris mutuaria	Cyrtocapsella tetrapera	Cyrtocapsella comuta	Calocycletta virginis	Dendrospyris danaecomis	
LOWER MIDCENE	Calocycletta virginis	125 - 40 - 150 - 175 - - - - - - - - - - - - - - - - - - -	1 2 3 4 5 6 7 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4		Cari						Brachiospyris simplex	Cannartus prismaticus	Cyrtocapsella elongata	Lychnocanium bipes	Gorgospyris schizopodia	Dipodospyris foreipat	Iymparidium bi	Tholospyris manni	Cyclampterium (?)												

Figure 13. Site 78 Biostratigraphic Chart Radiolaria (0 to 200 feet).

SERIES	ZONES	DEPTH BELOW SEA FLOOR FT. M.	SECTIONS	BARRELS	SAMPLES	ТАХА
LOWER MIDCENE SERIES SUBSERIES	Calocycletta virginis SUBZONES	DEPTH BELOW SEA FLOOR FT. M. - - - - - - - - - - - - - - - - - - -	Security Security 5 6 1 2 3 4 5 6 7 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4	9 9 10	+ + + + + + + + + + + + + + + + + + +	A oddantre loopyris artikopora loopyris artikopora loopyris artikopora looporatian bipos Canartus tukaria Dipotopyris artikopi Dipotoperlia artikopi Di
	L. bipes	- 325 100 - 350 - 110 - 110 - 120 400	1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 6 1 2 3 4 5 6 6 1 2 3 4 5 6 6 1 2 3 4 5 6 6 1 2 3 4 5 6 7 5 6 7 6 7 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 8	11 12 13	+ + + + + + + + + + + + + + + + + + + +	Theosyrtis annes Dendrospyris panosa Cyolampterium (?) pegetrum Tholospyris anthopora Cantarius p Lyo

BIOSTRATIGRAPHIC CHART RADIOLARIA

Figure 14. Site 78 Biostratigraphic Chart Radiolaria (200 to 400 feet).

					BIOSTRAT	IGRA	PHIC	CHART	RA	DIOLA	RIA	_		_		_	_	_	
SERIES SUBSERIES	ZONES SUBZONES	DEPTH BELOW SEA FLOOR FT. M.	SECTIONS BARRELS	SAMPLES							TA	XA							
LOWER MIOCENE		42 <u>5</u>	3 4 5 14 6 1 2 3	+ + + + +														yris simplex	
	chnocarium bipes	45 <u>0</u> - <u>14</u> 0	4 5 6 1 2	+++++++	1													Brachiospy	
	Ly	47 <u>5</u> -	3 4 5 6 1 2	+++++++++++++++++++++++++++++++++++++++									1		nea	m bipes	Camartus tubarius		
		<u>15</u> 0 50 <u>0</u> 	3 4 5 6 1	++++	118	teuthus	odendros	80	(?) pegetrum	ithopora	smaticus	longicomuta	papilio	ndrospyria pamosa	lathrobursa clathrobu	Lychnocaniu			
UPPER OLIGOCENE	s papilio	_ 52 <u>5</u> _ <u>16</u> 0 _ _ _	2 3 4 5 6 1	++++++	Artophormis grad	Cantharospyris a	Dendrospyris pod	Theocyrtis anno	Cyclampterium	Tholospyris a	Camartus pri	Liriospyris	Hexaspyris	De	0				
	Hewaspyri	55 <u>0</u> - - <u>1</u> 70	2 3 4 5 6	+++++++															
	Theocyrtis annosa	57 <u>5</u> - - - 180	2 3 4 5 6	+ + + +															

Figure 15. Site 78 Biostratigraphic Chart Radiolaria (400 to 600 feet).

SERIES	ZONES SUBZONES	DEPTH BELOW SEA FLOOR FT. M.	SECTIONS	BARRELS	SAMPLES							TAX	A				
UPPER OLIGOCENE SERVES SUBSERVES	Theoryptic annosa ZONES SUBSONES	DEPTH BELOW SEA FLOOR FT. M. 625 190 625 190 650 200 675 - 210 700 - 700 - 725 220	I I I 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 1 2 3	21 22 23 24	+ + + + + + + + + + + + + + + + + + +			vides	a costatescens	Dendrospyris podođenáros	Artophormis graditis	Cartharospyris atenthus	Theocyrtis amosa	Cyclampterium (?) pegetrum	Tholospyris arthopora	Camartus prismaticus	
		75 <u>0</u> - 230 - 230 - 240	3 4 5 6 1 2 3 4 5 6 1 2 3 4 1 2 3 4	25 26 27	+ + + + + + +	Lithocyclia angustum	Gamospyris circulus	Dendrospyris anthosyrtoid	Doroadospyrta (Der							

BIOSTRATIGRAPHIC CHART RADIOLARIA

Figure 16. Site 78 Biostratigraphic Chart Radiolaria (600 to 800 feet).

Figure 17. Site 78 Biostratigraphic Chart Radiolaria (800 to 1000 feet).



BIOSTRATIGRAPHIC CHART RADIOLARIA

Figure 18. Site 78 Biostratigraphic Chart Radiolaria (1000 to 1200 feet).

						BI	OSTRA	TIGR/	PHIC	CH	ART	NA	NN	OFO	SSI	LS			 	
SERIES	ZONES	DEPTH BELOW SEA FLOO FT. M	SECTIONS	BARRELS	SAMPLES										Т	АХА				
E MIOCENE	D. exilis Zone D. exilis - D. exilis - C. neogammation e Subzone	- - - 25	1 2 3 4 5 6	1						ter challengeri				era kamptneri	eri rutellus			sp. aff. D. variabilis		
MI DDLE	S. heteromorphus Zone S heteromor- S. heterom phus-H. selld phus-T. ru Subzone		1 2 3 4 5 6	2						Discoast			Discoaster variabilis	Helicopontospha	-cf. Discoaster brown			D.		
	eromorphus Subzone	20 	2 3 4 5 6	3		& var. A us			Discoaster stellulus		aster sp. aff. D. exili	aster aulakas	-2-		cf	aster subsurculus tiscus coscinodiscus				
u	T. carinatus - S. het	30	2 3 4 5 6	4		Orthorhabdus serratus Discoaster divaricat	ji trinidadensis voodringi nephados	dsii	00 000 000	-ur-	oosid Discourse	Disco				Disco iscus pulchellus & var Craspedod ra aff. R. pseudoumbi.		Denticula nicobarica		
LOWER MIOCEN	lus carinatus Zone natus - S. belennas Subzone	125 - 40 	2 3 4 5 6	5			Discoaster woodrin, Discoaster v	Discoaster woodringi li	anonimummi. Ian anooan	- I7- I7 I7 I7-						-cf- Coscinod Reticulofenest	-cfcf-			
	Triquetrorhabdul 8-D. druggii T. cari	50 175	2 3 4 5 6	6				-cf-			-cf -cf -						ter samdersii -cf- capricormutus			
	T. carinatu Subz	- - - - 60 200	2 3 4	7									5				Discoas Sphenolithus			

NANNOFOSSIL LEGEND: ----- Rare to infrequent occurrence. ----- Frequent occurrence. ----- Greater than frequent occurrence.

Figure 19. Site 78 Biostratigraphic Chart Nannofossils (0 to 200 feet).

SERIES	ZONES	DEPTH BELOW SEA FLOOR FT. M.	SECTIONS	BARRELS	SAMPLES											ТАХА
		-	5	7	Н			-cf-		1		Γ			aulako cf	
		225 70	1	8					I		I				Discoaster	
	e	250 - 80 	1 2 3 4 5 6	9												
OCENE	arinatus Zone coaster áruggii Subzon	275 - - 90 300	1 2 3 4 5 6	10		s obtusus codminai vaniadae	Biti						capri cornutus imilis	& var. A. woodrinoi		
LOWER MI	Triquetrorhabdulus c orhabdulus carinatus-Dis	325 100	1 2 3 4 5 6	11		BCOOBLET ADMANTENS Discocster admanteus Discocster w	Discoaster woodringi lig	R. pseudoumbilica	snestra gartneri	ladensis	r divaricatus	sr samdersii	Sphenolithus Sphenolithus dissi	Orthorhabdus servatus	-ci-	
	Triquetr	350 - 110	1 2 3 4 5 6	12		10	1	Reticulofenestra aff.	Reticulofe	soaster woodringi trinid	Discoaste	Discoaste				
	C. abisectus Subzone	37 <u>5</u> - - - 120 400	2 3 4 5 6 1 2	13						Disc			Coscinodiscus Inneeolotus			

BIOSTRATIGRAPHIC CHART NANNOFOSSILS

NANNOFOSSIL LEGEND: — Rare to infrequent occurrence. — Frequent occurrence. — Greater than frequent occurrence. Figure 20. Site 78 Biostratigraphic Chart Nannofossils (200 to 400 feet).



BIOSTRATIGRAPHIC CHART NANNOFOSSILS

NANNOFOSSIL LEGEND: —— Rare to infrequent occurrence. —— Frequent occurrence. —— Great Figure 21. Site 78 Biostratigraphic Chart Nannofossils (400 to 600 feet).

SERIES SUBSERIES	ZONES	DEPTH BELOW SEA FLOOR FT. M.	SECTIONS	BARRELS	SAMPLES		TAXA	
	natus Subzone	625 190	1 2 3 4 5 6	21				
	thus bisectus - I. cari	650 200	1 2 3 4 5 6	22			D. samdersii	
	Zone Coccolit	67 <u>5</u>	1 2 3 4 5 6	23			obtuaus cf- v. lidaii vilica 	
UPPER OLIGOCENE	Coccolithus bisectus ws Subzone	210 	12	24		D. adm <u>anteus</u> D. w. nephados	D. w. reptados R. aff. R. $pseudoumburk$ $\frac{-cf_{-}\frac{D.}{d}}{R.}$ C. $vigilane$	
	- Sphenolithus distent	725 220	1 2 3 4 5 6	25			D. tari nodifer	
	Coccolithus bisectus	230 	1 2 3 4 5 6	26			C. pulchellus a va	
		- - 240 - 800	1 2 3 4	27				

BIOSTRATIGRAPHIC CHART NANNOFOSSILS

NANNOFOSSIL LEGEND: —— Rare to infrequent occurrence. —— Frequent occurrence. —— Greater than frequent occurrence. Figure 22. Site 78 Biostratigraphic Chart Nannofossils (600 to 800 feet).



NANNOFOSSIL LEGEND: —— Rare to infrequent occurrence. —— Frequent occurrence. —— Greater than frequent occurrence. Figure 23. Site 78 Biostratigraphic Chart Nannofossils (800 to 1000 feet).

SUBSERIES	ZONES	DEP BEL SEA FI FT.	TH OW LOOR M.	SECTIONS	BARRELS	SAMPLES												ТАХА
OCENE	Zone ta Subzone	-	-	3 4 5 6	34		issums	ueus hados	teus	H. seminulum	us à vars.	eri	tus	ndes adrace llatus	-cf	N. biapiculata	ł	
UPPER OLIG	C. bisectus-H. compac	1025	310	1 2 3 4 5	35		C. cf. C. 80	D. u. nep	D. adaman	D. toni no	C. pulchell	R. gartn	Z. bijugo	excavatus var. qu		asmolithus altus	R. umbilica	
LOWER OLIGOCENE	2	1050 - 1075 - 1075 - 1100 - 1125 - - 1150 - - - 1200	<u>320</u> <u>330</u> <u>340</u> <u>350</u>	6	36											Christian Contraction Contraction		

BIOSTRATIGRAPHIC CHART NANNOFOSSILS

NANNOFOSSIL LEGEND: —— Rare to infrequent occurrence. —— Frequent occurrence. —— Greater than frequent occurrence. Figure 24. Site 78 Biostratigraphic Chart Nannofossils (1000 to 1200 feet).

BIOSTRATIGRAPHIC COMPARISON	CHART

DE BE SEAI	PTH LOW FLOOR	OVERY	RRELS	ERIES		FOR	RAMIN	IFE	RA				N	ANN	OFC	DSSILS		1		RAI	DIOLARIA		
FT.	М.	REC	ΒA	SUB	ZONES		ZON	AL	INDEX T	AX/	×	ZONES		Z	ONA	L INDEX TA	XA		ZONES		ZONAL INDI	X TA	XA
50-			1 2	MIDDLE MIDCENE	G. perip- heronda			G. peripheroacuta	G. plasiotumida G. fohsi		mosrp mos	D. exilis- C. neogam mation Subzone S. hetoro phus-H. sel Subzone S. hetoro hus - T. rugo Subzone	lii sue	var	f - ^{H. Sellut} D. kualeri	ilica orphus perta	Its & var.		B. alata	Camartus latioomus			rachio epyris alata
			3	G	P. glomerosa ourva bispheriou	8	G. bisphericus					I. carinatue - S. heteromorphua Subzone	tyrei 🔪 C. Tentopon		Ĭ	R. pseudoumb enclithus heterom contosphaera amplia	D. ext		0. oostata			1	ocyaletta costata Bi
150-	-40		5		G. dissinitia	eronda					1	T.carinatus - S. helemnos Subzone	C. L. maoin	-cf-		stithus belemina Sph Helicol							cato
200-	60		7			G. altispira G. periphe								-cf		Sphene	of-cf-					ลาน	
			8 9 10	LOWER MIOCENE]				- D. åruggit Subzone		ratus	S. belemos		3- 	and many many many	Calooyoletta virginie			Calooyoletta virgi	
			11		0. kuglert					G. venezuelana	G. kugleri	I. cartratus		etrorhabdulus carir	Sphenolithus sp. aff.		Cf	statute as propriote office			bites		
350			13											Triqu							Lychtrocartum		
	-130		14 15				mpliapertura	C. dissimilie				us - C. abisectus ubzone	lithue abisectus				-cf-		scarium bipee				
			16 17	1 OLIGOCENE	lisuturalie		6. 9		teuraties			- T. carthatu 8	otus Cocco			ioata	1		Lyohn		oilige papilio		
	-160		18	UPPER	angu				G. anguliau			. bissotus . carinatu Subzone	C. bised			H. true	1				Нехавр	510	

Figure 25. Site 78 Biostratigraphic Comparison Chart.

THE CONSTRUCTION AND A PROVIDE ADDRESS OF		
BIOSTRATIGRAPHIC	COMPARISON	CHART

BEL	PTH LOW FLOOR M.		RRELS	ERIES	FORAMINIFERA					NANNOFOSSILS								RADIOLARIA					
FT.			BA	SUB	ZONES	ZO	ZONAL INDEX TAXA				ZONES		ZONAL INDEX T				TA	XA		ZONES	ZONAL INDEX TAXA		
550			19 20 21	R LENE UPPER OLIGOCENE	G. angultenturalie						isectus - T. carinatus Subzone		istus	P. C. Ind'Ammen	**************************************					H. Poptico	Hemmepyais papilio		
650	-200 - -210 -		22 23 24		G. opima					С. ренезиегона	Coccolithus bisectus - Helicoponiosphasra compasta Subzone - Coccolithus bisectus - Sphenolithus distertus Subzone Coccolithus b	Codoo Lithue bisectue Connolithue anisectue	Triauetrorhabdulue cari	Crisonali tituo on af	Sphenolithue sp. af		Sphenolitthus cipervensis H. trancata		1	yrtis amosa		Theocyrtis amosa	
750	220 230		25 26		C. cubensia			610	G. opima				ictus							Theod			
	-240 - -250 - -250 - -250 - -250 - -280 - - -280 - - -300 - - -310 - - -320 - -		27 28 29 30 31 32 33 34 35 36		6. amplicaperture	P. harbadoenois C. aubenois C. annlinnostruss	c. diachritic	G. angulisuturais					Helicopontosphaera compacta	Sphenolithus pradictentus	Sphenolitine distentus	Sphenolitina distentua Disconster turi turi P vodosc	P. vadoea		cf - S. peeudoradian	Theocyrtis bramia Theocyrtis tuberoea	Theorystia tuberosaa	léthoyoláa angustum	

Figure 26. Site 78 Biostratigraphic Comparison Chart (continued).

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Figure 27. Hole 78, Core 1 (0 to 9.1 m).


Figure 28. Hole 78, Core 1, Sections 1-6, Physical Properties.



Figure 29. Hole 78, Core 2 (9.1 to 18.2 m).



Figure 30. Hole 78, Core 2, Sections 1-6, Physical Properties.



Figure 31. Hole 78, Core 3 (18.2 to 27.4 m).



Figure 32. Hole 78, Core 3, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SEC TIONS	LITH Column	SMEAR SLIDES	%CaCo3	LITHOLOGIC DESCRIPTION
	11111	1				CLIPPERTON FORMATION Cyclic Unit
	2	2		*)		About 80% is PALE YELLOWISH BROWN (10YR6/2), clay (3%- 5%) - radiolarian (20%-30%) - calcareous nannofossil (60%-70%) chalk ooze.
	-3			*	•	About 10% is VERY DARK YELLOWISH BROWN (10YR3/2), clay (15%-20%) - calcareous nannofossil (30%-40%) - radiolarian (40%-50%) chalk ooze.
) C E N E	4	3				About 10% is DARK YELLUWISH BROWN (10784/2), clay (5%) - calcareous nannofossil (40%-50%) - radiolarian (50%- 60%) chalk ooze. Rare VERY PALE ORANGE (10YR8/2), calcareous nannofossil (30%-40%) - radiolarian (40%-60%) chalk ooze.
OWER MI	5					Beds with clay tend to be less disturbed than beds without clay.
	4	4		*	•	
	7	5				
	0	6				

Figure 33. Hole 78, Core 4 (27.4 to 36.6 m).



Figure 34. Hole 78, Core 4, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SEC TIONS	lith Column	SMEAR	%CaCo3	LITHOLOGIC DESCRIPTION
		1				CLIPPERTON FORMATION Cyclic Unit Intensely disturbed. Interbedded 1 to 5 cm. thick beds with laminations:
	2	2		*		About 80% is PALE YELLOWISH BROWN (10YR6/2), clay (3%- 5%) - radiolarian (10%-15%) - calcareous nannofossil (95%) chalk ooze. About 20% is VERY PALE YELLOWISH BROWN (10YR7/2), clay (<5%) - radiolarian (15%) - calcareous nannofossil (80%) chalk ooze.
MIOCENE	4	3				Rare VERY PALE ORANGE (10YR8/2), radiolarian (10%-15%) - calcareous nannofossil (80%-90%) chalk ooze.
LOWER	5	4		*		
	7	5				
	8	6		*		

Figure 35. Hole 78, Core 5 (36.6 to 45.7 m).



Figure 36. Hole 78, Core 5, Sections 1-6, Physical Properties.



Figure 37. Hole 78, Core 6 (45.7 to 54.9 m).



Figure 38. Hole 78, Core 6, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SEC TIONS	LITH COLUMN	SMEAR SLIDES	%CaCo3	LITHOLOGIC DESCRIPTION
	1111111	1				MARQUESAS FORMATION Brown Unit Moderately disturbed. Interbedded in 25 to 100 cm. thick beds:
	2	2		*	•	VERY PALE ORANGE (10YR8/2), radiolarian (10%-15%) - foraminiferal (30%-50%) - calcareous nannofossil (50%-60%) ooze. VERY PALE ORANGE (10YR8/2), radiolarian (10%-20%) - calcareous nannofossil (30%-50%) - foraminiferal (40%-50%) ooze.
MIOCENE	4	3		*	•	VERY PALE ORANGE (10YR9/2), radiolarian (10%-15%) - foraminiferal (15%-20%) - calcareous nannofossil (70%-80%) ooze.
LOWER	5	4		*		
	7	5				
	8	6				

Figure 39. Hole 78, Core 7 (54.9 to 64.0 m).



Figure 40. Hole 78, Core 7, Sections 1-6, Physical Properties.



Figure 41. Hole 78, Core 8 (64.0 to 73.1 m).



Figure 42. Hole 78, Core 8, Sections 1 and 2, Physical Properties.



Figure 43. Hole 78, Core 9 (73.1 to 82.3 m).



Figure 44. Hole 78, Core 9, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SEC TIONS	LITH COLUMN	SMEAR	%CaCo3	LITHOLOGIC DESCRIPTION
		1		*		MARQUESAS FORMATION Brown Unit Moderately disturbed, massive bedding with no
	2 1 1 1 1 1 1	2				apparent laminations: VERY PALE ORANGE (10YR8/2), radiolarian (10%) - foraminiferal (20%-25%) - calcareous nannofossil (60%-70%) ooze to chalk ooze.
[0 C E N E	-3	3		*		
LOWERMIC	5 1 1 1 1 1	4		*		
	7	5		*		
	8 1 1 1 1 1	6				

Figure 45. Hole 78, Core 10 (82.3 to 91.4 m).



Figure 46. Hole 78, Core 10, Sections 1-6, Physical Properties.



Figure 47. Hole 78, Core 11 (91.4 to 100.6 m).



Figure 48. Hole 78, Core 11, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SEC TIONS	LITH Column	SMEAR	%CaCo3	LITHOLOGIC DESCRIPTION
			\bigvee			BASE MARQUESAS FORMATION Brown Unit
	1	1				TOP MARQUESAS FORMATION
						Gray Unit
	2	2				Massive with no apparent laminations:
		Z				DARK BLUISH WHITE (5B8/1), foraminiferal (15%-25%) - calcareous nannofossil (75%-85%) ooze chalk to chalk.
	-3					Rare VERY DUSKY PURPLE (5P2/2) laminations of foraminiferal (20%) - calcareous nannofossil (30%) - radiolarian (50%) ooze.
E E				*	•	
0 C E I	4	3				
ER MI						
LOWE	5					
		4				
	-6 -					
	7	5				
	8 1					
	1111	6		*		

Figure 49. Hole 78, Core 12 (100.6 to 109.7 m).



Figure 50. Hole 78, Core 12, Sections 1-6, Physical Properties.

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Figure 51. Hole 78, Core 13 (109.7 to 118.9 m).



Figure 52. Hole 78, Core 13, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SEC TIONS	LITH COLUMN	SMEAR SLIDES	%CaCo3	LITHOLOGIC DESCRIPTION
		1				MARQUESAS FORMATION Gray Unit Massive with no apparent laminations; probably would show laminations if core was not disturbed as suggest-
	2	2				More than 95% is VERY PALE GREEN (10G8/2), radiolarian (10%-15%) - foraminiferal (10%) - calcareous nanno- fossil (80%) ooze chalk. Less than 1% is PALE YELLOWISH ORANGE (10YR8/6), foraminiferal (15%-20%) - radiolarian (15%-20%) - calcareous nannofossil (60%-70%) ooze chalk
I O C E N E	-3 4	3				Less than 1% is VERY DUSKY PURPLE (5P2/2), foraminiferal (10%-20%) - radiolarian (30%-40%) - calcareous nanno- fossil (40%-60%) ooze.
LOWER M	5	4		*		
	7	5				
	8	6		*		

Figure 53. Hole 78, Core 14 (118.9 to 128.0 m).



Figure 54. Hole 78, Core 14, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SECTIONS	lith Column	SMEAR	%CaCo3	LITHOLOGIC DESCRIPTION
		1				MARQUESAS FORMATION Gray Unit Massive bedding with no apparent laminations. Beds generally 100 to 200 cm. thick.
	2	2				VERY PALE GREEN (10G8/2), foraminiferal (10%) - radiolarian (10%) - calcareous nannofossil (80%) ooze chalk and chalk. BLUISH WHITE (5B9/1), foraminiferal - radiolarian - calcareous nannofossil chalk.
IOCENE	4	3				Minor VERY DUSKY PURPLE (5P2/2), manganese (?) (10%) - foraminiferal (10%-15%) - radiolarian (10%-15%) - calcareous nannofossil (70%) ooze in 1 mm. thick laminations.
LOWER M	5-14	4				
	-6	5				
	8 1 1 1 1	6				

Figure 55. Hole 78, Core 15 (128.0 to 137.1 m).



Figure 56. Hole 78, Core 15, Sections 1-6, Physical Properties.



Figure 57. Hole 78, Core 16, (137.1 to 146.3 m).



Figure 58. Hole 78, Core 16, Sections 1-6, Physical Properties.



Figure 59. Hole 78, Core 17 (146.3 to 155.4 m).



Figure 60. Hole 78, Core 17, Sections 1-5, Physical Properties.

SERIES- SUBSERIES	METERS	SEC TIONS	lith Column	SMEAR	%CaCo3	LITHOLOGIC DESCRIPTION
	1	1				MARQUESAS FORMATION Gray Unit Massive, no apparent bedding features.
	2 111111	2				BLUISH WHITE (5B9/1) to LIGHT GREENISH GRAY (5G8/1), foraminiferal (10%-15%) - radiolarian (10%-15%) - calcareous nannofossil (70%-80%) chalk and ooze chalk. Rare streaks of VERY DUSKY PURPLE (5P2/2) manganese (?) rich ooze.
UPPER OLIGOCENE	4 1 1	3		*	•	
	5 1 1 1 1 1	4				
	7	5				
	8	6				

Figure 61. Hole 78, Core 18 (155.4 to 164.6 m).



Figure 62. Hole 78, Core 18, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SEC TIONS	LITH COLUMN	SMEAR	%CaCo3	LITHOLOGIC DESCRIPTION
	1	1				MARQUESAS FORMATION Gray Unit Massive, no apparent bedding features.
	2	2				BLUISH WHITE (5B9/1) to LIGHT GREENISH GRAY (5G8/1), foraminiferal (10%-15%) - radiolarian (10%-15%) - calcareous nannofossi1 (70%-80%) chalk and ooze chalk. Rare streaks of VERY DUSKY PURPLE (5P2/2) manganese (?) rich ooze.
UPPER OLIGOCENE	4	3				
	5	4 4				
	7	5				
	8	6				

Figure 63. Hole 78, Core 19 (164.6 to 173.7 m).


Figure 64. Hole 78, Core 19, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SEC TIONS	LITH COLUMN	SMEAR	%CaCo3	LITHOLOGIC DESCRIPTION
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1				MARQUESAS FORMATION Gray Unit Massive, no apparent bedding features.
	2	2				BLUISH WHITE (5B9/1) to LIGHT GREENISH GRAY (5G8/1), foraminiferal (10%-15%) - radiolarian (10%-15%) - calcareous nannofossil (70%-80%) chalk and ooze chalk. Rare streaks of VERY DUSKY PURPLE (5P2/2) manganese (?) rich ooze.
I G O C E N E	4	3				
UPPER OL	5 1 1 1 1 1	4		*		
	7	5				
	8	6		*		

Figure 65. Hole 78, Core 20 (173.7 to 182.9 m).



Figure 66. Hole 78, Core 20, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SEC TIONS	LITH Column	SMEAR SLIDES	%CaCo3	LITHOLOGIC DESCRIPTION
	1	1				MARQUESAS FORMATION Gray Unit Massive, no apparent bedding features.
	2	2		*		BLUISH WHITE (5B9/1) to LIGHT GREENISH GRAY (5G8/1), foraminiferal (10%-15%) - radiolarian (10%-15%) - calcareous nannofossil (70%-80%) chalk and ooze chalk. Rare streaks of VERY DUSKY PURPLE (5P2/2) manganese (?) rich ooze.
LIGOCENE	4	3				
UPPER 0	5	4		*		
	7	5				
	8	6		*		

Figure 67. Hole 78, Core 21 (182.9 to 192.2 m).



Figure 68. Hole 78, Core 21, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SEC TIONS	LITH Column	SMEAR	% CaCo 3	LITHOLOGIC DESCRIPTION
	1111111	1				MARQUESAS FORMATION Gray Unit Massive, no apparent bedding features.
	2	2				BLUISH WHITE (5B9/1) to LIGHT GREENISH GRAY (5G8/1), foraminiferal (10%-15%) - radiolarian (10%-15%) - calcareous nannofossil (70%-80%) chalk and ooze chalk. Rare streaks of VERY DUSKY PURPLE (5P2/2) manganese (?) rich ooze.
. I G O C E N E	4	3				
UPPER OL	5	4				
	-6	5				
	8	6		*		

Figure 69. Hole 78, Core 22 (192.2 to 201.2 m).



Figure 70. Hole 78, Core 22, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SEC TIONS	LITH Column	SMEAR SLIDES	%CaCo3	LITHOLOGIC DESCRIPTION
		1				MARQUESAS FORMATION Gray Unit Massive, no apparent bedding features. Chalks and ooze chalks interbedded in 5 to 25 cm. thick beds.
	2	2		*		BLUISH WHITE (589/1) to LIGHT GREENISH GRAY (568/1), foraminiferal (10%-15%) - radiolarian (10%-15%) - calcareous nannofossil (70%-80%) chalk and ooze chalk. Rare streaks of VERY DUSKY PURPLE (5P2/2) manganese (?) rich ooze.
. I G O C E N E	4 1 1	3				
UPPER OL	5	4		* * *		
	7	5				
	8	6		*		

Figure 71. Hole 78, Core 23 (201.2 to 210.3 m).



Figure 72. Hole 78, Core 23, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SECTIONS	LITH COLUMN	SMEAR SLIDES	%CaCo3	LITHOLOGIC DESCRIPTION
UPPER OLIGOCENE		1 2 3 4 5 6		*		MARQUESAS FORMATION Gray Unit Massive, no apparent bedding features. BLUISH WHITE (589/1) to LIGHT GREENISH GRAY (5G8/1), foraminiferal (10%-15%) - radiolarian (10%-15%) - calcareous nannofossil (70%-80%) chalk and ooze chalk. Rare streaks of VERY DUSKY PURPLE (5P2/2) manganese (?) rich ooze.

Figure 73. Hole 78, Core 24 (210.3 to 219.4 m).



Figure 74. Hole 78, Core 24, Sections 1 and 2, Physical Properties.

SERIES- SUBSERIES	METERS	SEC TIONS	LITH Column	SMEAR SLIDES	% CaCo 3 25 50 75	LITHOLOGIC DESCRIPTION
SUBSERIES	WETE	1		SUDE SUBE	%CaCo3 25 50 75	LITHOLOGIC DESCRIPTION MARQUESAS FORMATION Gray Unit Massive, no apparent bedding features. BLUISH WHITE (5B9/1) to LIGHT GREENISH GRAY (5G8/1), foraminiferal (10%-15%) - radiolarian (10%-15%) - calcareous nannofossil (70%-80%) chalk and ooze chalk. Rare streaks of VERY DUSKY PURPLE (5P2/2) manganese (?) rich ooze. LIGHT GREENISH GRAY (5G8/1), foraminiferal (15%-25%) - calcareous nannofossil (65%-80%) chalk with 5%-10% radiolarians. At about 224 m there is an increase in the total CaCO ₂ %.
I G O C E N E	4	3		*		This is reflected in the decrease in radiolarians and increase in the foraminifera (Figure 5). The color of the beds remains the same.
UPPER OL	5	4		*		calcareous nannofossil (70%-80%) chalk.
	7	5		* * * * * * * * *		
	8	6		*		

Figure 75. Hole 78, Core 25 (219.4 to 228.6 m).



Figure 76. Hole 78, Core 25, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SEC TIONS	lith Column	SMEAR SLIDES	%CaCo3	LITHOLOGIC DESCRIPTION
	1	1				MARQUESAS FORMATION Gray Unit LIGHT GREENISH GRAY (568/1), foraminiferal (15%-25%) - calcareous nannofossil (70%-80%) chalk.
	2	2				
. I G O C E N E	-3	3				
UPPER OL	5	4				
	7	5				
	8	6				

Figure 77. Hole 78, Core 26 (228.6 to 237.7 m).

	NATURAL GAMMA	SECTION 1	2	3	4	5	6
	10^3 counts/75 sec	[^{Ocm}					
		1					
		F 1					
	POROSITY SOUND VELOCITY	LI					
m 0	% Km/sec 50 100 1.4 1.6 1.8 2.0						
		-25					
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Figure 78. Hole 78, Core 26, Sections 1-6, Physical Properties.



Figure 79. Hole 78, Core 27 (237.7 to 246.9 m).



Figure 80. Hole 78, Core 27, Sections 1-6, Physical Properties.



Figure 81. Hole 78, Core 28 (246.9-256.0 m).



Figure 82. Hole 78, Core 28, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SEC TIONS	LITH Column	SMEAR SLIDES	% CaCo 3 25 50 75	LITHOLOGIC DESCRIPTION
	1111111	1				MARQUESAS FORMATION Gray Unit LIGHT GREENISH GRAY (568/1), foraminiferal (15%-25%) - calcareous nannofossil (70%-80%) chalk.
	2 1 1 1 1 1 1	2				
. I G O C E N E	4	3				
UPPER OL	5 111111	4				
	7	5		*		a R
	8 8	6				

Figure 83. Hole 78, Core 29 (256.0 to 265.1 m).

10 ³ counts/75 sec 0 0 2.0 4.0 1 1 POROSITY SOUND VELOCITY % % 50 100 1.4 1.4 1.6 -2 -25 -1 -25 -1 -25 -2 -25 -3 -3 -4 -75 -5 -75 -6 -75 -7 -75 -8 -7 -8 -7		NATURAL GAMMA	SECTION 1	2	3	4	5	6
POROSITY SOUND VELOCITY m 0 50 100 1.4 1.6 1.8 2.0 -1 -2 -2 -2 -2 -2 -2 -2 -2 -2 -2 -2 -2 -2		$10^3 \text{ counts/75 sec}$	[^{Ocm}					R
POROSITY SOUND VELOCITY m 0 50 100 1.4 1.6 1.8 2.0 -25 -25 -25 -25 -25 -25 -25 -1 -25 -25 -25 -25 -25 -25 -25 -2 -3 -50 -50 -50 -75 -50 -75 -3 -4 -75 -50 -75 -75 -75 -75 -4 -75 -75 -75 -76 -70 -77 -77 -5 -7 -75 -70 -70 -70 -70 -70 -70 -6 -7 -72 -72 -72 -72 -72 -73 -73 -73 -74 -75							a la	24
m 0 km/sec m 0 100 1.4 1.6 1.8 2.0 -25 -25 -25 -25 -25 -25 -1 -25 -25 -25 -25 -2 -2 -25 -25 -3 -5 -50 -75 -4 -75 0 100 -5 -7 -7 -100 -6 -7 -100 -7 -8 -7 -125 -100		POROSITY SOUND VELOCITY					· · · ·	0
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Figure 84. Hole 78, Core 29, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SECTIONS	lith Column	SMEAR	% CaCo 3 25 50 75	LITHOLOGIC DESCRIPTION
	111111	1				MARQUESAS FORMATION Gray Unit
	2	2				LIGHT GREENISH GRAY (5G8/1), foraminiferal (15%-25%) - calcareous nannofossil (70%-80%) chalk.
I C E N E	-3 -3 4	3				
UPPER OLIG	5	4				
	- 6 111111111	5		*		BASE MARQUESAS FORMATION
	7					Gray Unit ———— Transitional color break 2 cm. thick TOP MARQUESAS FORMATION
	8	6		*		Brown Unit Interbedded in 15 to 25 cm thick beds: About 80% is VERY PALE ORANGE (10YR8/2), foraminiferal (20%-30%) - calcareous nannofossil (70%-80%) chalk.
	Ξ					About 20% is LIGHT GREENISH GRAY (5G8/1), foraminiferal - calcareous nannofossil ooze chalk.

Figure 85. Hole 78, Core 30 (265.1 to 274.3 m).



Figure 86. Hole 78, Core 30, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SEC TIONS	LITH COLUMN	SMEAR SLIDES	%CaCo ₃ 25 50 75	LITHOLOGIC DESCRIPTION
	1	1				MARQUESAS FORMATION Brown Unit Massive with no bedding features.
	2	2				VERY PALE YELLOWISH ORANGE (10YR9/6), foraminiferal (15%-20%) - calcareous nannofossil (75%-80%) chalk.
. I G O C E N E	4	3				
UPPER OL	5	4				
	7	5				
	8	6		*		

Figure 87. Hole 78, Core 31 (274.3 to 283.5 m).



Figure 88. Hole 78, Core 31, Sections 1-6, Physical Properties.

SERIES- SUBSERIES	METERS	SEC TIONS	LITH COLUMN	SMEAR SLIDES	%CaCo3	LITHOLOGIC DESCRIPTION
UPPER OLIGOCENE	1	1				MARQUESAS FORMATION Brown Unit Massive with no bedding features.
	2	2				VERY PALE YELLOWISH ORANGE (10YR9/6), foraminiferal (15%-20%) - calcareous nannofossil (75%-80%) chalk.
	4	3				
	5	4				
	7	5		*	×	n
	8	6				

Figure 89. Hole 78, Core 32 (283.5 to 292.6 m).



Figure 90. Hole 78, Core 32, Sections 1-6, Physical Properties.

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SERIES- SUBSERIES	METERS	SEC TIONS	LITH COLUMN	SMEAR	%CaCo3	LITHOLOGIC DESCRIPTION
UPPER OLIGOCENE	W	1 2 3 4 5 6		SL SV		MARQUESAS FORMATION Brown Unit Massive with no bedding features. VERY PALE YELLOWISH ORANGE (10YR9/6), foraminiferal (15%-20%) - calcareous nannofossil (75%-80%) chalk.

Figure 91. Hole 78, Core 33 (292.6 to 301.7 m).



Figure 92. Hole 78, Core 33, Sections 1-6, Physical Properties.

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Figure 93. Hole 78, Core 34 (301.7 to 310.9 m).



Figure 94. Hole 78, Core 34, Sections 1-6, Physical Properties.



Figure 95. Hole 78, Core 35 (310.9 to 320.0 m).



Figure 96. Hole 78, Core 35, Sections 2-6, Physical Properties.



Figure 97. Hole 78, Core 36 (320.0 to 320.3 m).



Figure 98. Hole 78, Core 36, Section 1.



Figure 99. Hole 78, Core 3, Section 3.