
DEPARTMENT OF THE INTERIOR
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**Late Cenozoic Foraminifers
from Northern Chile:
Mejillones - Antofagasta Region**

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INTRODUCTION

The U.S. Geological Survey's PRISM Project is investigating climatic and oceanographic conditions of the Pliocene, and includes determination of sea surface temperatures and identification of major oceanographic boundaries and water masses within the world's oceans using quantitative analysis of planktic and benthic foraminifer census data and stable isotopic analyses. This report is part of a series of open-file reports that have been, and will be compiled to provide the basic faunal data for future work. This report includes benthic and planktic foraminifer census data for 25 samples collected from four coastal marine sections near the city of Antofagasta in northern Chile (Figure 1).

SETTING

The Pacific margin of South America contains spectacular exposures of Tertiary marine sequences ranging in age from Paleocene to Holocene. We will focus herein on the Pliocene - Pleistocene section of four marine sequences, La Portada, Cuenca del Tiburon, Caleta Herradura de Mejillones, and Mejillones, exposed in the Mejillones region of northern Chile, north of the city of Antofagasta (Figure 1). These sections contain a variety

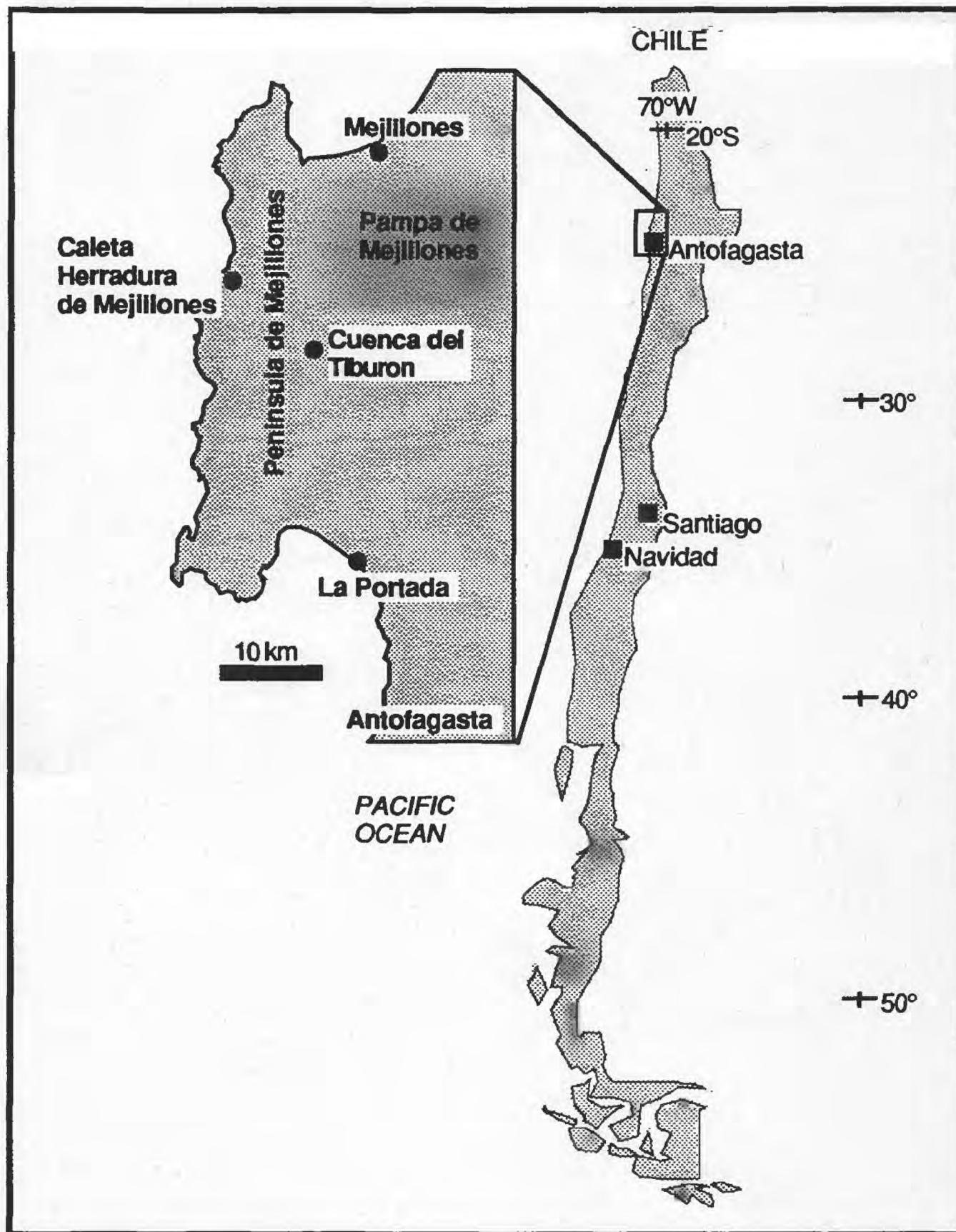


Figure 1: Map showing Chile and a blow-up of the Antofagasta - Mejillones Peninsula region showing the locations of the late Cenozoic sections (●) used in this study.

of lithologies including breccia, pebble conglomerate, coquina, fossiliferous sandstone, silty sandstone, mudstone, muddy diatomite and diatomite (Fig. 2), representing uplifted shoreface to deep-water offshore marine sequences deposited in shelf and outer slope

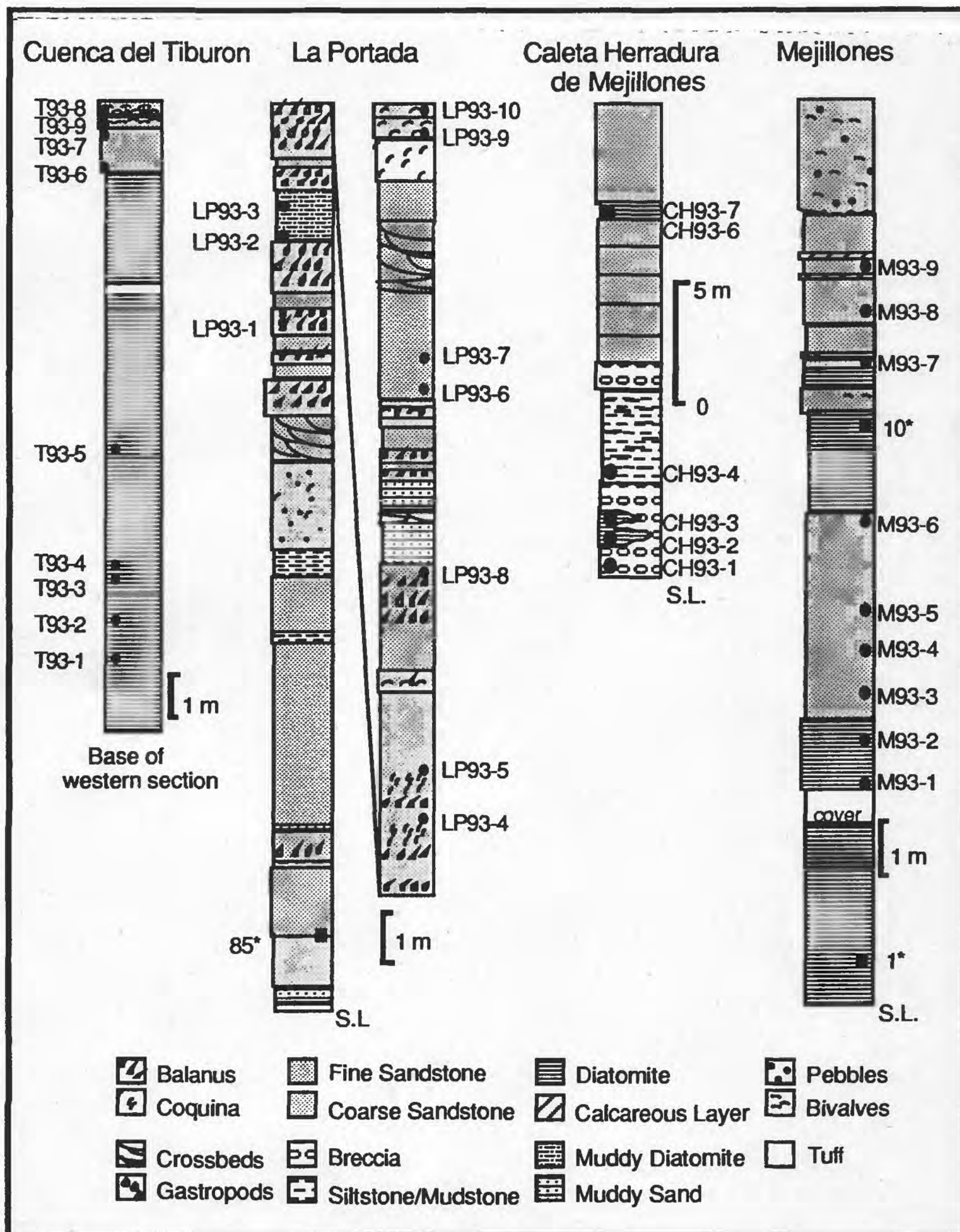


Figure 2: Pliocene to Pleistocene stratigraphic sections sampled for this study. Samples used in this study marked with a solid circle (•), samples referred to in text from previous work marked with a solid square (■) and labeled with an asterisk (modified from Tsuchi et al., 1988, 1990).

basins as part of a forearc basin complex. The sediments record a history of transgressive events and late Pliocene to Pleistocene uplift to their present exposure.

BACKGROUND

The stratigraphic sections used in this paper are well known, and their litho- and biostratigraphy has been studied and is described in Tsuchi (1988, 1990, and 1992). However, until now much of the focus has been on the Miocene and older portions of the stratigraphic records, leaving the Pliocene and Pleistocene sections poorly discussed. The Pliocene sequences in the Antofagasta - Mejillones region of northern Chile are rich in diatomaceous muds and diatomites (Fig. 2). An exception to this is the La Portada section in which bioclastic sandstones and siltstones predominate (Fig. 2). These lithologies are consistent with those exposed in the late Miocene and Pliocene deposits in the Pisco Basin of southern Peru (Dunbar, et al., 1990) suggesting their association with upwelling conditions. Dunbar et al. (1990) found an increase in biosiliceous sedimentation with decreasing age through the Neogene in the southern Pisco Basin, with the upper part of the Pisco Formation dominated by biosiliceous sediments (i.e. diatomites). These sediments have been correlated to the diatomites found within the upper part of the Caleta Herradura de Mejillones section and the Mejillones section (Dunbar, et al., 1990; Tsuchi, et al., 1992; Tsuchi, et al., 1990b; Tsuchi, et al., 1988a).

Previous micropaleontologic studies of the northern Chilean Tertiary marine sections include planktic foraminiferal biostratigraphy (Tsuchi, et al., 1988b; Ibaraki, 1990), and diatom studies of the Caleta Herradura de Mejillones diatomites (Krebs et al., 1992 and Koizumi, 1990). Nomura (1990) described the Miocene benthic foraminifer fauna from the Caleta Herradura de Mejillones section and concluded that changes in the benthic foraminifer fauna in northern Chile was consistent with the Miocene oceanographic changes observed in the Pacific Ocean (Woodruff, 1985; Thomas and Vincent, 1987; Thomas and Vincent, 1988). This includes an increase in productivity on the margin of northern Chile marked by a *Uvigerina peregrina* dominated assemblage.

METHODOLOGY

From August 2 through August 4, 1993, four stratigraphic sections of Pliocene and late Pleistocene age from the Mejillones region of northern Chile were sampled for micropaleontologic analyses by Dr. Scott E. Ishman (U.S. Geological Survey), Dr. Ruben Martinez-Pardo (Universidad de Chile), Dr. Eduardo Valenzuela (Universidad de Chile), and Emerson Polanco (U.S. Geological Survey). A total of 32 bulk samples (~400 grams each) were collected in the field and transported to the U.S. Geological Survey, Reston, VA for analyses. The stratigraphic positions of the samples are shown in Figure 2, and each sample is described in Table 1. Two samples were collected from a tuff horizon in the eastern exposure of the Cuenca del Tiburon section (Fig. 2) for fission track analysis.

Each sample was split into two approximately equal parts, one half for palynological analyses and the second for foraminiferal and nannoplankton analyses. The foraminiferal - nannoplankton samples were processed for micropaleontologic analyses using standard processing techniques. Each sample was weighed dry, and then soaked in water and agitated for 24 hours. Samples requiring additional treatment were soaked in a 5% calgon solution while agitated until fully disaggregated. Disaggregated samples were wet sieved at $\geq 150 \mu\text{m}$ and the residues dried at $< 50^\circ\text{C}$. The $< 150 \mu\text{m}$ size fraction was reserved for later analysis.

GENERAL STRATIGRAPHY

La Portada

The La Portada section is a high sea-cliff located approximately 15 km north of Antofagasta. The marine sediment sequence of La Portada rests unconformably on the Jurassic volcanic rocks of La Negra Formation, and consists of coquina and bioclastic sandstone interbedded with silty sandstone. Preliminary age control on this section is based on Tsuchi et al., (1988b) who place the sequence within planktic foraminifera zones N18-N22 (early Pliocene to Pleistocene) based on the occurrence of *Globorotalia crassaformis* in their sample 85 (indicated in figure 2), near the middle of the section.

~~*Caleta Herradura de Mejillones*~~

The Caleta Herradura de Mejillones section occurs as a long arcuate sea-cliff approximately 50 km north of Antofagasta. It is accessible by traveling approximately 35 km north, toward Mejillones, and traversing west off of the national highway across the Pampa de Mejillones to the coast. The section exposes a thick, gently southwest dipping marine sequence of Tertiary age. The lower part of the section consists of lower and middle Miocene buff colored shelly sandstones and conglomerates intercalated with calcareous concretionary horizons (formerly shell beds) referred to as the Caleta Herradura Formation (Krebs, et al., 1992). The lower part is overlain unconformably by younger diatomaceous silt, fine sand and breccia that Krebs et al., (1992) refer to as the La Portada Formation. Age control for this section was determined as early Miocene (planktic foraminifer zone N7) through middle Pliocene (calcareous nannoplankton zone NN15) (Tsuchi, et al., 1990a).

Cuenca del Tiburon

The Cuenca del Tiburon section is a composite of two sections, a west and an east section, both exposed in the Cuenca del Tiburon (Tiburon Basin) approximately 40 km north of Antofagasta and 5 km west of the national highway. The western section is an exposed bluff adjacent to a small quarried area. It is dominated by diatomite with thin interbeds of diatomaceous mudstone and sandy siltstone. The western exposure is capped by a well-cemented fossiliferous sandstone containing abundant mollusk shells.

The eastern exposure is a gently sloping escarpment into the Tiburon Basin approximately 2 km northeast of the western section. The eastern section is composed of massive diatomite with interbeds of sandy siltstone. A very distinct tuff bed (~40 cm in thickness) occurs about 20 meters from the top of the section. The outer surface of the tuff consists of a hard white crust that once broken through reveals a very clean, white glassy tuff unit. This section is capped by a bioclastic, calcareous cemented sandstone rich in mollusc shells.

The age of the western and eastern exposures is estimated as late Pliocene (planktic foraminifer zone N21) based on the occurrence of the planktic foraminifer *Neoglobobulimina asanoi*, and the occurrence of calcareous nannoplankton *Pseudoemiliana lacunosa* and *Helicosphaera sellii* (zones NN15-19) (Tsuchi, et al., 1988b).

Mejillones

The Mejillones section is a coastal exposure that faces the Bahia Mejillones, about 2 km east of the town of Mejillones, approximately 60 km north of Antofagasta. The section is dominated by massive diatomite and diatomaceous siltstone with occasional intercalations of sandstone that includes mollusk shells. The top of the section is marked by a resistant shelly sandstone. Age estimates for the Mejillones section place it within late Pliocene to Pleistocene (planktic foraminifer zones N18-22) based on the occurrence of *Globorotalia crassaformis* in the lower part of the section (sample 1 of Tsuchi et al., 1988b; figure 2), and calcareous nannoplankton *Gephyrocapsa caribbeanica* and *G. oceanica* (zones NN19-20) in the middle part (sample 10 of Tsuchi et al., 1988b; figure 2) of the section.

BENTHIC AND PLANKTIC FORAMINIFERA

Thirty-two samples were analysed for benthic and planktic foraminifera from the four sections described above, with 25 yielding foraminifera (Tables 2 and 3). Preliminary identification of the foraminifera show 54 benthic foraminifer species (Table 2) and 15 planktic foraminifer species (Table 3) in the >150 µm size fraction. Preservation ranges from excellent (sample T93-1) to poor (sample LP93-9). The following is a description of the benthic and planktic foraminifer assemblages from each section sampled.

La Portada

The foraminiferal fauna recovered from the La Portada section contained only benthic foraminifers. Twenty-one species were identified with two species being dominant, *Cibicides umbonatus* and *Valvulineria venezuelana*. Additional common species include *Höglundina pleurostomata* and *Hanzawaia cf. concentrica*.

Caleta Herradura de Mejillones

The foraminiferal fauna from the Caleta Herradura de Mejillones section contains 29 identifiable species of benthic foraminifers in four of the seven samples collected from the section. The assemblage from the lower part of the section (CH93-3 and CH93-1) is characterized by a buliminid-dominated assemblage including *Bolivina dispar*, *Brizalina arta*, *B. granti*, *Bulimina uvigerinaformis*, *B. marginata* and *Uvigerina marksii*. The upper part of the section (CH93-7 and CH93-6) is dominated by *Höglundina pleurostomata*, *Valvulineria venezuelana* and *Buccella peruviana*, similar to the assemblage from La Portada but lacking the predominant *Cibicides* spp.

Cuenca del Tiburon

The foraminiferal fauna from the Cuenca del Tiburon sections contain abundant benthic and planktic foraminifera. The benthic foraminiferal fauna is represented by 26 species from 7 samples (Table 2). Buliminids dominate the fauna in most of the samples represented by *Bulimina uvigerinaformis*, *Bulimina exilis*, *Brizalina granti* and *B. arta*. Additional abundant species include *Eilohedra levicula*, *Gyroidinoides planulata* and *Nonionella miocenica*.

Planktic foraminifera occur in four of the samples examined for foraminifera from the Cuenca del Tiburon section (Table 4). The dominant planktic foraminifers include *Neogloboquadrina acostaensis* and *Globigerina bulloides*. Other common planktic species include *Neogloboquadrina pachyderma* (both sinistral and dextral forms), *Neogloboquadrina humerosa*, and *Globigerinita glutinata*. Of stratigraphic importance are the occurrences of *Sphaeroidinellopsis paenedehiscens* and *Globorotalia crassaformis*.

Mejillones

The foraminiferal fauna recovered from the Mejillones section includes 16 species of benthic and 3 species of planktic foraminifera (Tables 2 and 3). The benthic foraminifer fauna is divided into two assemblages, one assemblage occurs in the lowermost part of the section (M93-1) and is dominated by *Brizalina arta* and *Buliminella elegantissima* and

~~*Nonionella miocenica*~~. The upper part of the section (M93-6 and M93-7) is dominated by *Buccella peruviana* with the uppermost sample containing *Quinqueloculina venusta*, the only miliolid recovered from the northern Chile samples. Planktic foraminifera were recovered from sample M93-1 (base of the section) and include *Globigerina bulloides* and *Neogloboquadrina pachyderma* (sinistral and dextral).

SUMMARY

The foraminiferal data presented here will be used to estimate middle to late Pliocene paleoceanographic conditions (sea surface temperature, upwelling, etc.) in the northern Chile region of the eastern Pacific Ocean. These data also will be compared to published Pliocene data from Peru and Ecuador in an attempt to establish latitudinal gradients in sea surface temperatures and upwelling intensity.

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Table 1: Lithologic description of units from which samples were recovered.

Sample	Description
LA PORTADA	
LP93-1	Sandy mudstone, yellowish gray in color (5Y 7/2), contains small shell fragments. (~20 cm thick)
LP93-2	Sandy mudstone overlying coquina bed, yellowish gray in color (5Y 7/2), contains rip-up clasts of underlying coquina, visible loading deformation of contact with overlying coquina bed. (~10 cm thick)
LP93-3	Sandy mudstone, yellowish gray color (5Y 7/2), cross laminated, rip-up clasts and "swirl" structures, gradational contact with underlying coquina. (~10 cm thick)
LP93-4	Bioclastic sandstone, yellowish gray in color (5Y 7/2). Large shells (barnacles) and coquina clasts suspended in matrix. lower contact gradational with underlying coquina. (~70 cm thick)
LP93-5	Bioclastic sandstone, dusky yellow (5Y 6/4) color. Large shells and coquina clasts suspended in matrix. (~80 cm thick)
LP93-6	Fine sandstone, dusky yellow (5Y 6/4) in color. Thin interbeds of coquina. (~50 cm thick)
LP93-7	Medium bioclastic sandstone, yellowish gray (5Y 7/2) in color. Contains large barnacle fragments. (~20 cm thick)
LP93-8	Bioclastic fine sandstone, dusky yellow (5Y 6/4) in color. Very thin coquina beds above and below. (~40 cm thick)
LP93-9	Bioclastic fine sandstone, dusky yellow (5Y 6/4) in color. Laminated with thin coquina interbeds.
LP93-10	Bioclastic fine sandstone, dusky yellow (5Y 6/4) in color. Laminated with coquina interbeds.
CALETA HERRADURA DE MEJILLONES	
CH93-1	Silty mudstone, yellowish gray (5y 7/2) in color. Contains visible fish scales and phosphatic nodules. (~107 cm thick)
CH93-2	Diatomite, yellowish gray (5Y 8/1) in color. Massive, in outcrop it has a greenish appearance. (~200 cm thick)
CH93-3	Diatomite, yellowish gray (5Y 8/1) in color. Massive with a pink weathered surface. (~310 cm)
CH93-4	Silty mudstone, light brown (5Y 6/4) in color. Sample collected from the base of the unit that is ~18 m thick.

Table 1 (continued): Lithologic description of units from which samples were recovered.

CH93-5	Sandy siltstone, yellowish gray (5Y 8/1) in color.
CH93-6	Bioclastic unconsolidated sand, yellowish gray (5Y 8/1) in color. Abundant macrofossil debris including large, high-spired gastropods.
CH93-7	Bioclastic unconsolidated sand, yellowish gray (5Y 8/1) in color. Abundant large pectens.
CUENCA DEL TIBURON	
T93-1	Siltstone, moderate greenish yellow (10Y 7/4), at the base of the section underlying massive diatomite.
T93-2, T93-3	Massive diatomite, yellowish gray (5Y 8/1) in color.
T93-4	Siltstone, moderate greenish yellow (10Y 7/4) in color, overlying diatomite. Thin unit, ~10 cm.
T93-5	Siltstone, moderate greenish yellow (10Y 7/4) in color. (~50 cm thick)
T93-6	Silty diatomite, pale greenish yellow (10Y 8/2), ~50 cm thick.
T93-7	Siltstone, yellowish gray (5Y 6/2), very indurated. (~15 cm thick)
T93-8	Fossiliferous sandstone, well cemented containing gastropods and pectens. Ledge forming.
T93-9	Fossiliferous sandstone, well cemented, underlying the unit from which T93-8 was collected. Contains abundant gastropods.
MEJILLONES	
M93-1 to M93-5	Massive diatomite, ranges in color from yellowish gray (5Y 8/1) to pale greenish yellow (10Y 8/2).
M93-6	Sandy mudstone, pale yellowish green (10GY 7/2) in color.
M93-7, M93-8	Muddy diatomite, ranges in color from yellowish gray (5Y 8/1) to light greenish yellow (5GY 8/1).
M93-9	Fossiliferous medium sandstone, yellowish gray (5Y 8/1) in color. Fairly well cemented.

Table 2: Benthic foraminifer counts from samples collected from Pliocene and Pleistocene sequences in the Mejillones region of northern Chile.

	Height above base (m)	Angulogerina sp.	Anomalina sp.	Bolivina costata	Bolivina sp.	Bolivina dispar	Brizalina arta	Brizalina granti	Brizalina pozoensis	Buccella peruviana	Bulimina exilis	Bulimina marginata	Bulimina striata	Bulimina uvigerinaformis	Buliminella curta	Cancris inflatus	Cibicides cf. mckennai	Cibicides umbonatus	Cibicides variabilis	Cibicides sp.
LA PORTADA																				
LP93-10	41.42											1						7		
LP93-9	38.93												1					1		
LP93-7	29.92									5								253		
LP93-6	29.26									9								188		
LP93-8	25.4									19					1	42		57		
LP93-5	21.18									10								54		1
LP93-4	20.39																5	190		
LP93-3	16.78															38	6	103		
LP93-2	16.02																	112		
LP93-1	14.32									5							8	51		6
CALETA DE HERRADURA																				
CH93-7	7									135										
CH93-6	5		1							42										
CH93-3	3.09													74	53	13				
CH93-1	1.06							15			1	6		57						
CUENCA DEL TIBURON																				
T93-8	21.38						55			72	61									
T93-9	21.1						70				93								4	
T93-6	15.69							142			16		3	80						
T93-5	10.28													247	7					
T93-3	5.41	1			24		169		1		15			42						
T93-2	3.6	1					7	9			6	2		22					1	
T93-1	1.8						42	194			4		12							

Table 2: Benthic foraminifer counts from samples collected from Pliocene and Pleistocene sequences in the Mejillones region of northern Chile.

		Height above base (m)	
	<i>Angulogerina</i> sp.		
	<i>Anomalina</i> sp.		2
	<i>Bolivina costata</i>		13
	<i>Bolivina</i> sp.		
	<i>Bolivina dispar</i>		
	<i>Brizalina arta</i>		4
	<i>Brizalina granti</i>		
	<i>Brizalina pozoensis</i>		
	<i>Buccella peruviana</i>		265
	<i>Bulimina exilis</i>		239 1
	<i>Bulimina marginata</i>		
	<i>Bulimina striata</i>		
	<i>Bulimina uvigerinaformis</i>		
	<i>Buliminella curta</i>		
	<i>Cancris inflatus</i>		65
	<i>Cibicides cf. mckennai</i>		
	<i>Cibicides umbonatus</i>		
	<i>Cibicides variabilis</i>		
	<i>Cibicides</i> sp.		
MEJILLONES			
M93-9		15.21	
M93-6		9.98	
M93-3		6.35	
M93-1		4.52	

Table 2: Benthic foraminifer counts from samples collected from Pliocene and Pleistocene sequences in the Mejillones region of northern Chile.

	Height above base (m)	
LA PORTADA		
LP93-10	41.42	<i>Dentalina cf. baggi</i> 24
LP93-9	38.93	<i>Eliohedra levicula</i>
LP93-7	29.92	<i>Epistominella subperuviana</i>
LP93-6	29.26	<i>Eponides tumidulus</i>
LP93-8	25.4	<i>Fontbotia wuellerstorfi</i>
LP93-5	21.18	<i>Glabrattella plicolus</i> 43
LP93-4	20.39	<i>Globocassidulina subglobosa</i>
LP93-3	16.78	<i>Gyrodina lamarkiana</i>
LP93-2	16.02	<i>Gyrodina neosoldanii</i>
LP93-1	14.32	<i>Gyrodinoides planulata</i> 98
		<i>Hanzawaia cf. concentrica</i> 29
		<i>Hanzawaia sp.</i> 89
		<i>Höglundina pleurostomata</i> 64
		<i>Lenticulina sp.</i> 25
		<i>Melonis affinis</i> 44
		<i>Melonis barleeanum</i> 65
		<i>Nodosaria sp.</i> 1
		<i>Nonionella auris</i> 2
		<i>Nonionella mloccanica</i> 55
		<i>Nonionella mloccanica</i> 57
		<i>Nonionella mloccanica</i> 23
		<i>Nonionella mloccanica</i> 42
		<i>Nonionella mloccanica</i> 65
		<i>Nonionella mloccanica</i> 44
		<i>Nonionella mloccanica</i> 25
		<i>Nonionella mloccanica</i> 89
		<i>Nonionella mloccanica</i> 64
		<i>Nonionella mloccanica</i> 6
CALETA DE HERRADURA		
CH93-7	7	<i>Gyrodina neosoldanii</i> 1
CH93-6	5	<i>Gyrodina neosoldanii</i> 47
CH93-3	3.09	<i>Gyrodina neosoldanii</i> 4
CH93-1	1.06	<i>Gyrodina neosoldanii</i> 19
		<i>Gyrodina neosoldanii</i> 9
CUENCA DEL TIBURON		
T93-8	21.38	<i>Gyrodina neosoldanii</i> 103
T93-9	21.1	<i>Gyrodina neosoldanii</i> 75
T93-6	15.69	<i>Gyrodina neosoldanii</i> 10
T93-5	10.28	<i>Gyrodina neosoldanii</i> 42
T93-3	5.41	<i>Gyrodina neosoldanii</i> 34
T93-2	3.6	<i>Gyrodina neosoldanii</i> 31
T93-1	1.8	<i>Gyrodina neosoldanii</i> 147
		<i>Gyrodina neosoldanii</i> 75

Table 2: Benthic foraminifer counts from samples collected from Pliocene and Pleistocene sequences in the Mejillones region of northern Chile.

		Height above base (m)	
	<i>Dentalina cf. baggi</i>		
	<i>Ellohedra levicula</i>		
	<i>Epistominella subperuviana</i>		
	<i>Eponides tumidulus</i>		1
	<i>Fontbotia wuellerstorfi</i>		
	<i>Glabratella pileolus</i>		
	<i>Globocassidulina subglobosa</i>		
	<i>Gyrodina lamarkiana</i>		2
	<i>Gyrodina neosoldanii</i>		
	<i>Gyroidinoides planulata</i>		
	<i>Hanzawaia cf. concentrica</i>		
	<i>Hanzawaia sp.</i>		1
	<i>Hedgundina pleurostomata</i>		
	<i>Lenticulina sp.</i>		
	<i>Melonis affinis</i>		
	<i>Melonis bartheaunum</i>		
	<i>Nodosaria sp.</i>		
	<i>Nonionella auris</i>		
	<i>Nonionella miocenica</i>		7
			1
			8
			78
MEJILLONES			
M93-9	15.21		
M93-6	9.98		
M93-3	6.35		
M93-1	4.52		

Table 2: Benthic foraminifer counts from samples collected from Pliocene and Pleistocene sequences in the Mejillones region of northern Chile.

	Height above base (m)	<i>Nonionella</i> sp. <i>Nuttallides umboniferus</i> <i>Ordosallia tener</i> <i>Pseudononion japonica</i> <i>Pseudononion obductus</i> <i>Pseudononion pizarrensis</i> <i>Pseudoparella exigua</i> <i>Quinqueloculina</i> sp. <i>Quinqueloculina venusta</i> <i>Rosalina globularis</i> <i>Rosalina</i> sp. <i>Textularia malovenssis</i> <i>Uvigerina marksi</i> <i>Uvigerina peregrina</i> <i>Valvulineria venezuelana</i>	Und.	TOTAL
LA PORTADA				
LP93-10	41.42			263
LP93-9	38.93			411
LP93-7	29.92			309
LP93-6	29.26			317
LP93-8	25.4	3		307
LP93-5	21.18			295
LP93-4	20.39	2		301
LP93-3	16.78			280
LP93-2	16.02	2	2	291
LP93-1	14.32		74	291
CALETA DE HERRADURA				
CH93-7	7	1		277
CH93-6	5		1	323
CH93-3	3.09		4 19	285
CH93-1	1.06		37 2	331
			122	
CUENCA DEL TIBURON				
T93-8	21.38			293
T93-9	21.1			307
T93-6	15.69	1	11	305
T93-5	10.28			294
T93-3	5.41		8	312
T93-2	3.6			332
T93-1	1.8		5	344

Table 2: Benthic foraminifer counts from samples collected from Pliocene and Pleistocene sequences in the Mejillones region of northern Chile.

		Height above base (m)		Nonionella sp.	Nuttallides umboniferus	Ordosailis tener	Pseudononion japonica	Pseudononion obductus	Pseudononion pizarrensis	Pseudoparella exigua	Quinqueloculina sp.	Quinqueloculina venusta	Rosalina globularis	Rosalina sp.	Textularia mallovensis	Uvigerina marksi	Uvigerina peregrina	Valvulineria venezuelana	Und.	TOTAL
MEJILLONES																				
M93-9		15.21										37		6						315
M93-6		9.98			4															248
M93-3		6.35																1	2	51
M93-1		4.52								5						1				284

Table 3: Planktic foraminifer counts from samples collected from Pliocene and Pleistocene sequences in the Mejillones region of northern Chile.

	MEJILLONES	Globigena bulloides	Globigena woodi	Neogloboquadrina pachyderma (S.)	Neogloboquadrina pachyderma (D.)	Neogloboquadrina acostaensis	Neogloboquadrina humerosa	Globorotalia crassatiformis	Globorotalia sp.	Globogeninoides obliquus	Globogeninoides ruber	Globogeninoides sacculifer	Dentoglobigena alispira	Globigenita glutinata	Orbulina sp.	Sphaeroidinellopsis paenedehiscens	Fragments	Non-I.D.	TOTAL
M93-1	6	18	2																26
CUENCA DEL TIBURON																			
T93-1	110	16	4	128	16				3			7	1	16	1	2		5	309
T93-2	30	1	5	126	10			4	2	3	1		4	19	6	2	6	13	234
T93-3	95	7	4	137	7			3	1	1				19	4	1		6	285