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14. CORRELATION OF CALCAREOUS NANNOPLANKTON AND PLANKTONIC FORAMINIFER BIOSTRATIGRAPHY OFF THE COAST OF SOUTHERN CHILE[1]

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ABSTRACT

The biostratigraphy established for ODP Leg 141 Sites 859 through 863, drilled off the coast of southern Chile, is based mainly on calcareous nannoplankton and planktonic foraminifers. Because of the scarcity of the fossils and the low diversity of the assemblages, the biostratigraphic resolution is quite low. The uppermost sediments contain well-preserved fossil assemblages that indicate warm surface water influences at the southern mid-latitudes. The oldest sediments may belong to the uppermost lower Pliocene. The Pliocene/Pleistocene boundary is determined by the first occurrence of the *Gephyrocapsa oceanica* group at 1.6 Ma.

INTRODUCTION

Five sites were drilled during the Ocean Drilling Program (ODP) Leg 141 on the Chile margin in the vicinity of the Nazca/Antarctica/ South America Plate Triple Junction (Fig. 1). Sites 859, 860, and 861 are located on a west-east transect across the accretionary complex at different water depths. Site 862 was drilled near the crest of the Taitao Ridge of oceanic origin, and Site 863 was drilled at the base of the trench slope of the Chile Trench at the point where the Chile Ridge is being subducted.

The biostratigraphy for these sites is based mainly on results from calcareous nannoplankton and planktonic foraminifer investigations obtained from the same samples.

In general, the foraminifers, the nannoplankton assemblages as well as the siliceous microfossils are of low species diversity as a result of low water temperatures, dissolution, and dilution by detrital material. Thus, the biostratigraphic resolution is poor. Observed fluctuations in the abundance and diversity of the fossil assemblages may be related to climatic changes.

METHODS

Samples were taken from the core catchers and about one sample per section of core. The preparation methods used to obtain foraminifers differed depending on the degree of sediment induration. Soft sediments were washed over a 63 µm screen. Slightly indurated sediments were soaked in diluted H_2O_2 solution and then washed. Indurated samples were freeze-dried, soaked in hot paraffin, and boiled in a soda lye until disintegration occurred. This method was repeated until a reasonable amount of loose particles was obtained. After the washed samples were dried, the fossils were separated under the binocular microscope. The planktonic/benthic ratios were calculated. The state of preservation of planktonic foraminifers is described as follows: G = good (little or no fragmentation, overgrowth, and/or dissolution); M = moderate (some signs of fragmentation, overgrowth, and/or dissolution); P = poor (severe fragmentation, heavy overgrowth, and/or dissolution). Samples with reworked foraminifers sometimes in different colors, translucent-white and yellow-orange, are marked in the tables as *c*. Deformed specimens of foraminifers are indicated as *d* and partly silicified ones as *s*. The abundances of foraminifers and nannofossils given in the range charts are based on semiquantitative estimate (B = barren, T = traces, R = rare, F = few, C = common, A = abundant). Smear slides were prepared for the investigation of calcareous nannoplankton. The samples were studied using a polarizing microscope.

BIOSTRATIGRAPHY

Calcareous Nannoplankton

Stratigraphic results of Leg 141 were obtained by the investigation of calcareous nannofossils from about 550 samples. Most of the samples are barren or nannoplankton poor. Age determinations are based on the Standard Nannoplankton Zonation (Martini, 1971; Martini and Müller, 1986).

The nannoplankton assemblages are of low diversity owing to cold-water temperatures, dissolution of the calcareous microfossils, and dilution by the high amount of detrital material. Only a few mainly long-ranging species are present, but not enough to establish a detailed biostratigraphy.

The Pleistocene sequence can be subdivided broadly into upper and lower Pleistocene by using the Zone NN19/NN20 boundary at 0.47 Ma. The Pliocene/Pleistocene boundary, normally determined by the extinction of the discoasters, is difficult to recognize because this group, typical of a warm water environment, is absent from the Leg 141 material. The last occurrence of *Cyclococcolithus macintyrei,* proposed by Bizon and Müller (1977) for the determination of the Pliocene/Pleistocene boundary at 1.6 Ma, is also not a useful biostratigraphic event within this region. *Cyclococcolithus macintyrei* found also in areas dominated by lower surface-water temperatures is generally a good substitute for the discoasters. However, only rare specimens of this species were observed in the studied samples. Because of these difficulties, we decided to use the first occurrence (FO) of the group *Gephyrocapsa oceanica* (Raffi and Rio, 1979), a *Gephyrocapsa* with a large central opening.

A subdivision of the upper Pliocene in Leg 141 sediments (nannoplankton Zones NN16–NN18) is impossible. At some sites, small specimens of the genus *Reticulofenestra* were found. But by using only the light microscope, it is not possible to determine if this form represents a small variety of *Reticulofenestra pseudoumbilica,* which would give an early Pliocene age (Zone NN15), or if it belongs to part of Zone NN16, because it has been observed from this stratigraphic level in other regions.

It is most likely that the entire recovered sequences belong to the Pleistocene and upper Pliocene; in any case, they are not older than 3.2–3.4 Ma. This is shown by the presence of a very small species of the genus *Gephyrocapsa,* which has its first appearance at about this

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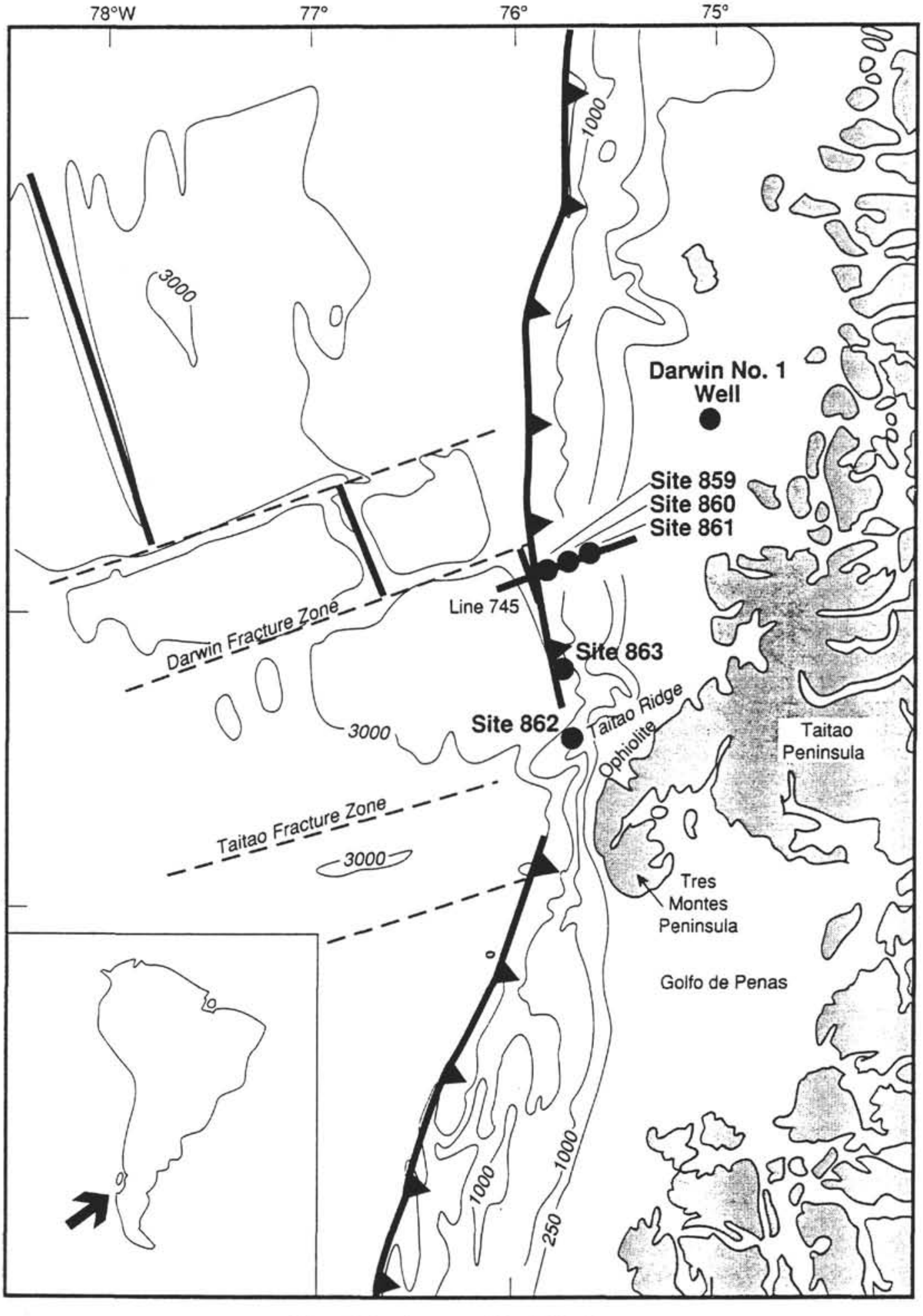


Figure 1. Location map of Sites 859–863.

time. Further on, *Pseudoemiliania lacunosa* was commonly observed, and this species is unknown from sediments older than Zone NN15.

Nannofossils are apparently more common in the sediments of the lower part of Zone NN16 indicating decreasing water temperature during the late Pliocene. Fluctuations in abundance throughout the Pliocene sequence were observed at Sites 860 and 861.

Reworked species from older strata (Eocene and lower Miocene) occur rarely throughout the series. Imbrications of the sedimentary sequences certainly exist. However, it was not possible for us to recognize them by biostratigraphic evidence.

Planktonic Foraminifers

Stratigraphic results and paleotemperature estimations for Leg 141 were obtained by the investigation of planktonic foraminifers from 653 samples. Most of them are poor in planktonic foraminifers, and only the uppermost sequences contain richer assemblages. To acquire a sufficient number of specimens, the entire residue was usually picked and to get a comparable value in abundance, the number of foraminifers in 20 cm^3 of sediment was calculated.

Temperature is one of the habitat-controlling factors of foraminifer distribution in modern oceans. The taxa of planktonic foraminifers can be divided roughly into warm-water assemblages and cold-water forms. The majority of the Holocene planktonic foraminiferal species lives in tropical and subtropical waters, whereas only a single species, *Neogloboquadrina pachyderma* (sinistral coiling form), lives in polar waters. The regions where warm-water and cold-water assemblages overlap in distribution, and where the greatest faunal contrast occurs, are designated the Transition Zone (Bé and Tolderlund, 1971). The investigated area falls in the Southern Transition Zone of recent planktonic foraminifers and is bounded and influenced by the Subtropical Zone in the north and by the Subantarctic Zone in the south. *Goboconella inflata* is the most common taxon in Leg 141 sediments. It appears to be indigenous and therefore a good indicator species of the Transition Zone. However, it is possible to recognize the *Truncorotalia truncatulinoides* Zone, the *Globoconella inflata* Zone, and the *Globorotalia crassaformis* Zone, respectively, the *Neogloboquadrina pachyderma* (sinistral coiling form) Zone. The FO of *Truncorotalia truncatulinoides* is strongly influenced by temperature, and, therefore, the base of this zone varies. The zonations used in this paper are summarized in Figure 2. Location, position, water depth, and penetration of each hole are given in Table 1.

Site 859

Site 859 is the westernmost site of the east-west profile of Sites 859 through 861, located most seaward at the deepest water depth.

Calcareous Nannoplankton

Cores 141-859A-1H and -2H belong to the uppermost Pleistocene (Zone NN21). Nannofossils are few to common (Table 2). The assemblages consist of following species: *Helicosphaera carteri, Cyclococcolithus leptoporus, Gephyrocapsa ericsonii, G. oceanica, Syracosphaera pulchra,* and *Emiliania huxleyi.* Reworked taxa from older strata are rare.

The entire underlying sequence is dated late Pliocene (Zones NN16–NN18) and can not be further subdivided. This age is based on the presence of *Cyclococcolithus macintyrei, Helicosphaera sellii,* a very small *Gephyrocapsa* sp. and small *Reticulofenestra* cf. *pseudoumbilica.* Thus, a significant unconformity of more than 1 Ma exists.

The Pliocene sediments are extremely poor in nannofossils. Most of the samples taken from Hole 859B are barren because of dissolution (Table 3), which may be related to compaction of the sediments and the circulation of fluids within the accretionary wedge. Reworked specimens from older strata (mostly Miocene) were observed in several samples from throughout the entire series.

The biostratigraphic results obtained from Holes 859A and 859B show that the sediments are not older than 3.4 Ma, as indicated by the presence of the small *Gephyrocapsa* sp. and *Pseudoemiliania lacunosa.* That means that the upper Pliocene has a thickness of almost 470 m. Imbrication within this thick pile of sediments is highly probable, but it is not possible to prove this assumption because of the poor biostratigraphic resolution.

Planktonic Foraminifers

The biostratigraphic results obtained by the investigation of planktonic foraminifers are based on 44 samples from Hole 859A (down to 145.5 m below seafloor [mbsf]) and 93 samples (54.10 through 80.90 mbsf, and 141.20 through 476.10 mbsf) from Hole 859B. Foraminifers occurred in Hole 859A in 60% of the observed samples and in 45% of the samples from Hole 859B. No foraminifers were obtained from the micrite-cemented stones in Cores 141-859B-18R, -27R, -29R, -37R, and -38R. Sample 141-859A-9P-CC from

Table 1. Location, position, water depth, and penetration of Leg 141 holes.

Hole	Position	Water depth (m)	Penetration (m)
859A	45°53.761'S, 75°51.165'W	2741.2	146.5
859B	45°53.720'S, 75°51.330'W	2748.9	476.1
860B	45°51.972'S, 75°45.101'W	2145.9	617.8
861A	45°51.025'S, 75°41.531'W	1667.0	9.5
861B	45°51.025'S, 75°41.531'W	1667.0	9.5
861C	45°51.025'S, 75°41.531'W	1652.2	353.1
861D	45°51.008'S, 75°41.499'W	1652.2	496.3
862A	46°30.475'S, 75°49.603'W	1274.9	22.1
862B	46°30.475'S, 75°49.603'W	1268.6	42.9
862C	46°30.510'S, 75°49.566'W	1228.6	102.1
863A	46°14.210'S, 75°46.371'W	2564.2	297.3
863B	46°14.210'S, 75°46.371'W	2564.2	742.9

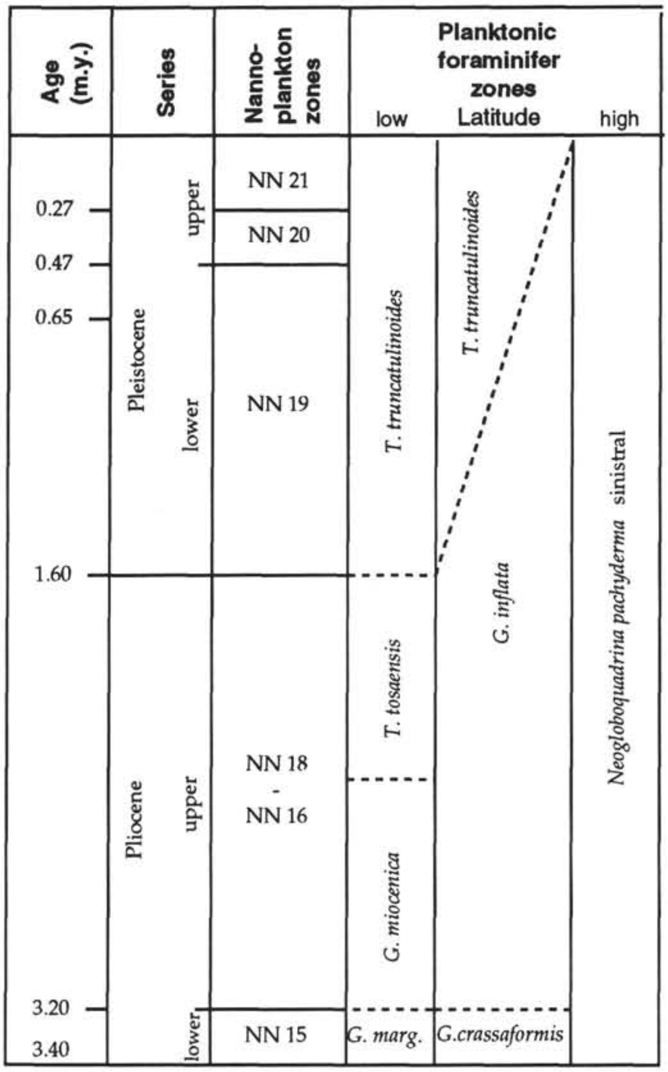


Figure 2. Correlation of nannoplankton and planktonic foraminiferal zones.

58.40 mbsf contains a mixed assemblage of taxa of the *Truncorotalia truncatulinoides* Zone together with some orange-stained *Neogloboquadrina pachyderma* (sin.) and is considered to represent in part downhole contamination.

At Site 859 two planktonic foraminiferal events to consider are the FO of *T. truncatulinoides* in Sample 141-859A-2H-CC and the FO of *G. inflata* in Sample 141-859B-29R-CC. Unfortunately, both events are followed downhole by assemblages dominated by mainly *N. pachyderma* (sin.). Consequently, these FO are not thought to

Table 2. Distribution of calcareous nannoplankton and planktonic foraminifers in Hole 859A.

ODP 141-859A				Calcareous nannoplankton														Planktonic foraminifers																			
Samples (Core, section, interval in cm)	Depth (mbsf)	Abundance	Preservation	B. bigelowi	C. pelagicus	C. leptoporus	C. macintyrei	D. japonica	E. huxleyi	G. ericsonii	G. sp.	H. carteri	H. sellii	P. lacunosa	R. cf. pseudoumbilica	S. pulchra	Nannoplankton zones	Number of foraminifers in 20 cm3 sediment	Planktonic foraminifers %	Preservation	G. hexagonus	N. dutertrei	G. apertura	G. bulloides	T. truncatulinoides	O. universa	G. inflata	G. scitula	G. aff. bulloides	G. quinqueloba	G. crassaformis	G. glutinata	G. cf. inflata	N. pachyderma sin.	N. pachyderma dex.	Remarks	Planktonic foraminifer zones
1H-CC	1.20	F	M		C	F			F	C		C					NN21	>10000	85	G	R	F	R	C	F	R	R	R	R	R				F	R		T. truncatulinoides
2H-2, 70-72	3.20	B															NN21	>10000	85	G			R	C			C		R		R	R		R			T. truncatulinoides
2H-4, 75-77	6.45	B															NN21	5000	90	G			R	R	R		C		R	R							T. truncatulinoides
2H-5, 82-84	9.03	B															NN21	15000	95	G		R	R	A	F		A	R				R		R	C		T. truncatulinoides
2H-6, 108-110	9.79	B															NN21	10000	90	G			R	C	R		F	R					R		R		T. truncatulinoides
2H-CC	10.74	F	M			F			F	C		F				R		>10000	85	G			R	C	F	R	C	R	R		R	R		R	R		T. truncatulinoides
3H-2, 67-70	12.87	B															?	100	80	M							R				R			R		c	N. pachyderma sinistral
3H-3, 40-45	14.10	B															?	0	-	-																	N. pachyderma sinistral
3H-4, 56-60	15.76	B															?	0	-	-																	N. pachyderma sinistral
3H-CC	16.70	R	M	T	R	R					R	R	R			T		10	-	M														R			N. pachyderma sinistral
4H-2, 70-73	18.90	F	M		F		R	R			F	R			F	R	NN 16 - NN 18	50	95	P									R					R		c	N. pachyderma sinistral
4H-3,130-133	21.00	B															NN 16 - NN 18	25	80	P									R			R		R			N. pachyderma sinistral
4H-5, 63-66	23.33	F	M		F		R				R	F	R		F		NN 16 - NN 18	50	90	P									R					R		c	N. pachyderma sinistral
4H-CC,17-19	25.04	B															NN 16 - NN 18	25	95	P														R		c	N. pachyderma sinistral
4H-CC	25.00	R	M				R	T			F	R	F	R			NN 16 - NN 18	1000	90	M							R	R			R	R		F		c	N. pachyderma sinistral
5H-2, 69-71	26.69	R	M		R		R						T		R		NN 16 - NN 18	10	95	P									R					R			N. pachyderma sinistral
5H-3, 10-12	27.14	B															NN 16 - NN 18	25	80	M									R					R			N. pachyderma sinistral
5H-5, 40-42	29.44	B															NN 16 - NN 18	25	80	M										R		R		R			N. pachyderma sinistral
5H-CC	34.70	R	M		F		R						F	R	F		NN 16 - NN 18	250	85	M									R	R		R		F	R	c	N. pachyderma sinistral
6X-2, 35-40	36.55	R	M		F						R	R	R		R		NN 16 - NN 18	0	-	-																	N. pachyderma sinistral
6X-CC	41.00	R	M		F		R				R	R	R				NN 16 - NN 18	5	-	M														R		c	N. pachyderma sinistral
7X-1, 18-23	41.18	B															NN 16 - NN 18	15	-	M				R										R		c	N. pachyderma sinistral
7X-CC	49.00	R	P		F	R					F	R	F		F		NN 16 - NN 18	10	-	M										R				R	R		N. pachyderma sinistral
8X-CC, 3-8	50.53	B	M														NN 16 - NN 18	0	85	-																	N. pachyderma sinistral
8X-CC	57.40	R	M		R	R					R	R	T		R		NN 16 - NN 18	0	90	-																	N. pachyderma sinistral
9P-CC	58.40	R	M		R	R					R	R	R		R		NN 16 - NN 18	5000	90	M			R	C	R		R		R	C			R	R	R	*	N. pachyderma sinistral
10X-CC	68.00	R	M		F	R	R				F	R	R		R		NN 16 - NN 18	200	90	M										R				F		c	N. pachyderma sinistral
11X-1, 70-75	69.00	B															NN 16 - NN 18	150	90	M										R				F		c	N. pachyderma sinistral
11X-2, 42-47	70.22	B															NN 16 - NN 18	100	95	P										R				F		c	N. pachyderma sinistral
11X-2, 69-74	70.49	B															NN 16 - NN 18	250	-	M						R		R	R		R			F	R	c	N. pachyderma sinistral
11X-3, 55-60	71.85	B															NN 16 - NN 18	150	-	M										R	R			C			N. pachyderma sinistral
11X-3,129-134	72.59	B															NN 16 - NN 18	2	90	P								R						R			N. pachyderma sinistral
11X-4, 55-60	73.35	B															NN 16 - NN 18	10	90	M														R			N. pachyderma sinistral
11X-CC	77.00	B															NN 16 - NN 18	150	80	P								R			R			F	R	c	N. pachyderma sinistral
13X-CC	87.60	T	P		T										T		NN 16 - NN 18	100	-	P										R	R			F	R	c	N. pachyderma sinistral
14X-1, 62-67	88.22	B															NN 16 - NN 18	35	-	P										R				R		IRD	N. pachyderma sinistral
14X-3, 71-77	91.23	B															NN 16 - NN 18	10	-	P										R				R		c	N. pachyderma sinistral
14X-CC	97.30	B															NN 16 - NN 18	25	-	M								R						R			N. pachyderma sinistral
16X-CC, 7-9	100.62	B															NN 16 - NN 18	3	-	P										R							N. pachyderma sinistral
16X-CC	106.90	B															NN 16 - NN 18	10	85	P														R		IRD	N. pachyderma sinistral
17X-CC	116.50	R	P		R										F		NN 16 - NN 18	25	-	M								R						R		c	N. pachyderma sinistral
18X-CC	126.20	B															NN 16 - NN 18	100	-	M														F	R	c	N. pachyderma sinistral
19X-CC	135.90	T	P		R						R						NN 16 - NN 18	0	-	-																	N. pachyderma sinistral
20X-CC	145.50	B															NN 16 - NN 18	0	-	-																	N. pachyderma sinistral

Note. * = downhole contamination, IRD = Ice-rafted debris, c = different colors

correlate with the general first-appearance datum (FAD) of the taxa, but they are not older than the generally mentioned FAD. According to Srinivasan and Kennett (1981) the FAD of *T. truncatulinoides* is younger than 2.0 Ma and the FAD of *G. inflata* falls together with the NN15/NN16 nannofossil zone boundary at 3.2 Ma. Consequently, Sample 141-859A-2H-CC must be younger than approximately 2 Ma, and Sample 141-859B-29R-CC can be dated younger than 3.2 Ma.

In the sequences of Hole 859A it is possible to recognize the Pleistocene *T. truncatulinoides* Zone from the top down to 10.74 mbsf (Cores 141-859A-1H through -2H-CC). Planktonic foraminifers are abundant and well preserved, mainly in the uppermost 1.20 m. The assemblages consist of 15 species including tropical/subtropical taxa such as *Globorotaloides hexagonus* and *Neogloboquadrina dutertrei.* The calculated number of foraminifers in 20 cm^3 sediment is usually more than 10,000 specimens. Below 10.74 mbsf the whole sequence in Hole 859A and also in Hole 859B is extremely poor or barren in planktonic foraminifers (no more than 1000 specimens in 20 cm^3 sediment) and of low diversified assemblages with less than six taxa. *N. pachyderma* in its sinistral coiling mode characterizes the entire sequence, therefore, and because of the inconsistent appearance of other taxa the sequence down to the base of Hole 859B at 476.10 mbsf is placed in the *Neogloboquadrina pachyderma* Zone. The assemblages commonly contain colored foraminifers. The in-situ specimens are gray-white. The yellow-red displaced specimens are mostly small specimens of *N. pachyderma* (sin.). In Sample 141-859A-5H-5, 40–42 cm, at 29.44 mbsf *Bolboforma reticulata* indicates reworked sediments of middle Miocene age. Downhole from Sample 141-859B-22R-CC (321.90 mbsf), the foraminifers are decalcified and deformed, indicating fluids and stress in the wedge. Below Sample 141-859B-32R-CC at 418.30 mbsf, fewer than five foraminifers in 20 cm^3 sediment were found.

Site 860

Calcareous Nannoplankton

Core 141-860B-1H through Sample -2H-3, 60 cm, belongs to the upper Pleistocene (Zone NN21) with following assemblage (Table 4): *Coccolithus pelagicus, Helicosphaera carteri, Cyclococcolithus leptoporus, Emiliania huxleyi, Gephyrocapsa ericsonii,* and *G. oceanica.* Nannofossils are common. No age determination is possible for Sections 141-860B-2H through -2H-CC owing to the absence of nannofossils.

Zone NN20 was determined in Core 141-860B-3H by the presence of *Gephyrocapsa caribbeanica,* but nannofossils are rare in the core.

Core 141-860B-4H through Section 141-860B-17X-2 belong to the lower Pleistocene (Zone NN19), as shown by the presence of *Gephyrocapsa oceanica, G. caribbeanica,* and *Pseudoemiliania lacunosa.* Nannofossils are common only in Cores 141-860B-7H and -16X. All other samples of the lower Pleistocene sequences are poor in nannoplankton. These results show that the Pliocene/Pleistocene boundary lies about 60 m deeper than given in Behrmann, Lewis, Musgrave, et al. (1992).

Beside changes in the abundance of nannofossils, the assemblages are the same from Section 141-860B-17X-3 down to Core 141-860B-70X. This sequence is placed in the upper Pliocene (Zones NN16–NN18). It was not possible to confirm repetitions within the Pliocene sequence as evidenced by the study of planktonic foraminifers. However, repeated changes in abundance of nannofossils throughout the sequences may indicate imbrications and repetitions. Cores 141-860B-17X, -21X, to Section -22X-2, -31X, -32X, and -58X are rich in nannoplankton with following species: *Coccolithus pelagicus, Cyclococcolithus leptoporus, C. macintyrei, Gephyrocapsa* sp., *Pseudoemiliania lacunosa, Helicosphaera carteri, H. sellii, Discolithina japonica, Pontosphaera pacifica,* and the small variety of *Reticulofenestra* cf. *pseudoumbilica.* The more common occurrence of *Discolithina japonica* and *Pontosphaera pacifica* has been observed within the upper Pliocene in other regions (Müller, 1979).

The lowermost part of the sequence (Cores 141-860B-62X to -70X) might belong to the lower Pliocene, owing to the presence of small *Reticulofenestra* cf. *pseudoumbilica.* But this is not a clear evidence for this age assignment.

Large parts of the Pliocene sequence are almost barren (Cores 141-860B-24X to -29X, and 141-860B-33X to -70X); only a few samples yielded rare nannofossils. However, the entire sequence is not older than 3.4 Ma as indicated by the presence of *Pseudoemiliania lacunosa* and the small *Gephyrocapsa* sp. down to at least Core 141-860B-61X.

Planktonic Foraminifers

The biostratigraphy based on planktonic foraminifers from Site 860 is based on 157 samples from Hole 860B from the top down to 617.82 mbsf. Planktonic foraminifers occur in 85% of the investigated samples.

At Site 860 the FO of *T. truncatulinoides* was observed in Sample 141-860B-16X-3, 32–38 cm. Therefore, the sequence down to 120.12 mbsf belongs to the *T. truncatulinoides* Zone. The uppermost 6.50 m of this sequence contain rich assemblages with *T. truncatulinoides, Globorotaloides hexagonus, Neogloboquadrina dutertrei, Orbulina universa, Globigerina apertura,* and *G. bulloides.* The presence of these species and *G. inflata* indicates that tropical/subtropical taxa occurred together in transitional water masses and that warm temperatures had influenced the assemblages in the latest Pleistocene. The downhole occurrences of *N. pachyderma* indicate that more subpolar temperatures influenced the assemblages of planktonic foraminifers. The index fossil *T. truncatulinoides* occurs below 6.50 mbsf only sporadically in two samples (Samples 141-860-12X-2, 35–39 cm, and -16X-3, 32–38 cm). Therefore, the placement of the lower boundary of the *T. truncatulinoides* Zone is very uncertain. Nevertheless, in Hole 860B it corresponds well with the Zone NN19/NN18 boundary determined by calcareous nannofossils. The FO of *T. truncatulinoides* lies in a sequence common in *G. inflata,* which indicates transitional water masses.

The sediments below 24.70 mbsf contain translucent white and yellow-orange foraminifers together, indicating debris flows or other downslope sedimentation. No differences exist in the diversity of the white and the colored shells, which also show no difference in age. The calculated number of foraminifers in the samples of the *T. truncatulinoides* Zone fluctuated cyclically between zero and more than 25,000 specimens in 20 cm^3 of sediment. The uppermost cycle extends to 9.50 mbsf. The underlying cycle to 49 mbsf has its highest abundances of foraminifers between 20 and 33 mbsf. The next cycle is to 91.90 mbsf, and until 116.80 mbsf most of the samples are barren in foraminifers, except that samples between 107.20 and 110.80 mbsf contain small amounts of stained, and therefore displaced, foraminifers. These fluctuations in the abundance of foraminifers may reflect different water paleotemperatures, but temperature assignments are difficult and tentative.

Below 120.12 mbsf the sequence can generally be described as an alternation of assemblages with and without *G. inflata.* This fact may indicate imbrication and repetitions. *G. inflata* was not observed between 155.50 through 192.02 mbsf, 203.70 and 242.50 mbsf, and 272.78 and 300.10 mbsf. Below 328.70 mbsf, *G. inflata* occurs sporadically at 376.90, 425.30, 451.20 and 532.49 through 535.04 mbsf, where the deepest observation of *G. inflata* was fixed. The FAD of *G. inflata* usually marks the boundary between early and late Pliocene, which is the boundary between the *Globorotalia crassaformis* Zone and the *G. inflata* Zone, respectively (Kennett and Srinivasan, 1983; Srinivasan and Kennett, 1981). The LO of *Globorotalia* cf. *sphericomiozea* may indicate the lower Pliocene in Sample 141-860B-65X-CC and below (Table 4).

Site 861

Site 861 is the easternmost site of the west-east transect of Leg 141 approximately parallel along to the 45°S latitude. This site is located the farthest landward and at the shallowest water depth. Sediments recovered in Holes 861A through Hole 861D from the seafloor to 496.30 mbsf represent a stratigraphic sequence ranging from Quaternary to Pliocene.

Calcareous Nannoplankton

The sediments of Core 1H from Holes 861A and 861B are rich in nannofossils typical of the late Pleistocene *Emiliania huxleyi* Zone (NN21; Tables 5 and 6). The more diversified assemblages indicate the influence of warmer surface-water masses.

Nannofossils are few within the Pleistocene of Hole 861C, and they become rare throughout the Pliocene with exception of the lower part of Zone NN16 (Table 7). Their scarcity is the result of dissolution and dilution by a large amount of detrital material. The assemblages are of low species diversity, and the species are smaller than normal, owing probably to low surface-water temperatures. However, this may also partially reflect a relative enrichment related to selective dissolution that destroys the larger specimens first. The low diversity of the assemblages precludes conclusions about paleoclimatic changes.

Cores 141-861C-1H through -4H belong to nannoplankton Zone NN21 as shown by the presence of *Emiliania huxleyi.* Nannofossils are few to common, and they show signs of dissolution in Core 141-861C-1H. The assemblages consist of the following species: *Helicosphaera carteri, Coccolithus pelagicus, Gephyrocapsa ericsonii, G. oceanica, Cyclococcolithus leptoporus,* and *Emiliana huxleyi.* Other species such as *Syracosphaera pulchra, S. mediterranea, Rhabdosphaera claviger, Braarudosphaera bigelowi, Pontosphaera syracusana,* and *Scapholithus fossilis* were observed only sporadically.

The sediments belonging to nannoplankton Zone NN20 contain only rare nannofossils. The assemblages are very poor, containing only *Helicosphaera carteri, Cyclococcolithus leptoporus, Coccolithus pelagicus,* and *Gephyrocapsa ericsonii.* Core 141-861C-7H to Section 141-861C-15X-4 is almost barren of nannoplankton. Nannofossils become more common within the lowermost part of Core 141-861C-15X. The boundary between nannoplankton Zones NN19 and NN20 lies probably at the base of Core 141-861C-15X, where the last occurrence of *Pseudoemiliania lacunosa* was observed. Nannofossils are more frequent within the sediments attributed to Zone NN19.

The upper part of the Pliocene section is very poor in nannoplankton. Apart from core-catcher Sample 141-861C-24X, the sediments from Cores 141-861C-21X through -30X are barren. Nannofossils

Table 3. Distribution of calcareous nannoplankton and planktonic foraminifers in Hole 859B.

ODP 141-859B		Calcareous nannoplankton															Planktonic foraminifers																
Samples (Core, section, interval in cm)	Depth (mbsf)	Abundance	Preservation	B. bigelowi	C. pelagicus	C. leptoporus	C. macintyrei	D. japonica	G. sp.	H. carteri	H. sellii	P. pacifica	P. lacunosa	R. cf. pseudoumbilica	S. pulchra	Nannoplankton zone	Number of foraminifers in 20 cm3 sediment	Planktonic foraminifers %	Preservation	G. inflata	G. scitula	G. aff. bulloides	G. quinqueloba	G. crassaformis	G. glutinata	G. puncticulata	G. ruber	G. crassula	G. cf. inflata	N. pachyderma sin.	N. pachyderma dex.	Remarks	Planktonic foraminifer zones
1R-2, 66-71	54.16	R	G		F		R		F					R		NN16 - NN 18	250	95	G		R	R		R	R					C			N. pachyderma sinistral
1R-3, 63-68	55.63	R	G		F		R		F	R				F			50	95	G			R		R	R			R		F			
1R-CC	61.60	R	G		F		R		F	F			R	R			0																
2R-1, 38-42	62.27	R	G		R				R	R	R			R			10	90	M									R		R			
2R-2, 70-72	63.48	T	M		R				R								25	90	M			R								R			
2R-4, 62-67	66.72	R	G		R				R	R							0																
2R-CC	71.30	R	G		R		R		R		R		R	R			10		M						R					R			
3R-2, 66-71	73.46	R	G		R				R						R		200	95	M											F	R	c	
3R-4, 77-82	75.29	T	M		R				R								200	95	M					R						F	R	c	
3R-6, 68-73	77.98	R	G		R		R		R								100	95	M			R		R						F	R		
3R-CC	80.90	R	G		F	R			F	F	R			F			50	95	M			R	R	R		R				R	R		
4R-1,120-122	141.20	B															1													R			
4R-CC	148.50	R	G			R	R		R	R			R	R			250	80	M	R		R		R						F	R		
5R-CC	158.10	B															100	95	M			R								F	R		
9R-CC	196.70	B															10		P			R								R			
10R-2,68-70	198.88	B															0																Barren
10R-3,119-125	200.89	B															0																
10R-5, 68-74	203.38	B															0																
10R-CC	206.40	R	G		R		R						R	R			0																
11R-1, 58-62	206.98	B	G														0																
11R-CC	216.00	T	M		R	R			R								0																
12R-2, 70-72	217.50	B															0																
12R-3, 91-93	219.21	B															0																
12R-5, 66-67	221.52	B															0																
12R-CC	225.60	B															0																
13R-2, 57-62	226.47	B															0																
13R-3,140-145	228.80	B															0																
13R-5, 70-75	230.25	B															0																
13R-CC	235.30	B															0																
14R-2, 70-72	237.50	B															0																
14R-3,130-134	239.60	B															0																
14R-4, 70-74	240.50	B															0																
14R-CC	245.00	B															0																
15R-2, 27-33	246.77	B															0																
15R-3, 27-33	248.27	B															0																
15R-5, 28-33	250.78	B														NN16 - NN 18	0																
15R-CC	254.60	B															0																
16R-1, 70-72	255.30	B															0																
16R-2, 20-22	256.30	B															1		G								R						
16R-CC	264.30	R	G		R	R				R			R	R			2		P														
17R-1,122-124	265.52	B															1		G											R			
17R-4,120-122	270.00	B															0																
17R-6, 70-72	272.50	B															0																
17R-CC	274.00	B															0																
18R-1, 0-1	274.10	B															0																
18R-4, 28-30	278.78	B															0																
18R-CC	283.50	B															1		P											R			
19R-2,120-122	286.20	B															0																
19R-4, 55-57	288.55	B															0																
19R-5, 4-7	289.54	R	M								T			T			0																

become more common in Core 141-861C-34X, but decrease again in Core 141-861C-35X through -37X. The assemblages are of very low diversity containing *Cyclococcolithus macintyrei, Helicosphaera carteri, H. sellii, Pseudoemiliania lacunosa,* and *Gephyrocapsa* sp. The Pliocene/Pleistocene boundary is determined tentatively between Cores 141-861C-20X and -21X by the FO of *Gephyrocapsa oceanica.* Cores 141-21X through -25X were barren of calcareous nannoplankton. Small specimens of *Reticulofenestra* cf. *pseudoumbilica* are present from Core 141-861C-34X. This lowermost part of the sequence most probably belongs to the lower part of Zone NN16 (2.6–3.2 Ma.). This age agrees with the results obtained by foraminifers.

Hole 861D was washed down to 342.30 mbsf. The entire sequence is assigned to the upper Pliocene (Zones NN16–NN18; Table 8). Further subdivision is impossible because of the scarcity of nannofossils.

Core 141-861D-1R belongs to the upper Pliocene (Zone NN16–NN18) with the following assemblage: *Coccolithus pelagicus, Gephyrocapsa* sp., *Cyclococcolithus macintyrei, C. leptoporus, Pseudoemiliania lacunosa, Discolithina japonica, Helicosphaera carteri,* and *H. sellii.* Sample 141-861D-2R-2, 83–88 cm, is rich in strongly overgrown nannoplankton, which may be due to the circulation of fluids. The same nannofossil species found in the core-catcher sample of Core 141-861D-2R are well preserved without any sign of overgrowth. There was no recovery from Cores 141-861D-3R through -5R. Core 141-861D-6R contains only a few nannofossils whereas they are common in Cores 141-861D-7R through -9R. The nannoplankton assemblages of this part in Hole 861D correspond with those observed within the lower part in Hole 861C in containing the small variety of *Reticulofenestra* cf. *pseudoumbilica.* In addition, the presence of extremely rare discoasters in Cores 141-861D-7R and -12R may indicate warmer surface-water temperatures, as was also the case for Core 141-861D-16R. Very rare reworked specimens from Eocene and Miocene sediments occur in several samples.

Based on foraminifers Cores 141-861D-8R through -16R belong to the lower Pliocene *G. crassaformis* Zone corresponding to nannoplankton Zone NN15. However, there is no real evidence for this zone from the nannofossil occurrences.

Table 3 (continued).

ODP 141-859B		Calcareous nannoplankton															Planktonic foraminifers																
Samples (Core, section, interval in cm)	Depth (mbsf)	Abundance	Preservation	*B. bigelowi*	*C. pelagicus*	*C. leptoporus*	*C. macintyrei*	*D. japonica*	*G.* sp.	*H. carteri*	*H. sellii*	*P. pacifica*	*P. lacunosa*	*R.* cf. *pseudoumbilica*	*S. pulchra*	Nannoplankton zone	Number of foraminifers in 20 cm3 sediment	Planktonic foraminifers %	Preservation	*G. inflata*	*G. scitula*	*G.* aff. *bulloides*	*G. quinqueloba*	*G. crassaformis*	*G. glutinata*	*G. puncticulata*	*G. ruber*	*G. crassula*	*G.* cf. *inflata*	*N. pachyderma* sin.	*N. pachyderma* dex.	Remarks	Planktonic foraminifer zones
19R-CC	293.20	B	B														0																
20R-3, 63-38	296.83	R	G		R				F		R			R			0																
20R-4, 7-12	297.77	R	G		R						R						0																
20R-CC	302.80	B															10		P											R			
21R-2, 79-84	305.09	B															25	1	P			R											
21R-4, 59-64	307.89	T	M		R				R								1		G											R		c	
21R-CC	312.20	B															0																
22R-1, 56-60	312.76	B															0																
22R-CC	321.90	B															10																
23R-CC	331.50	B															50																
25R-2, 27-30	342.97	B															100		P											R		d	
25R-CC	350.80	B															50	20	P											R		d	
26R-2, 0-2	352.30	B															0	80	P	R				R						F	R	d	*N. pachyderma* sinistral
26R-CC	360.40	T	M		R												15	85	P					R						R	R	d	
27R-2, 52-57	362.42	R	G		R				R					R			50																
27R-3, 44-48	363.84	B															1000		P											R			
27R-4, 27-31	365.17	T	M						R								250	90	P									R		F			
27R-CC	370.10	R	M		F		R	T	F	R			R	F			0	80	P			R		R						F	R	d	
28R-3, 128-130	374.38	B															2	90	P											F		d	
28R-CC	379.50	B															50																
29R-3, 87-93	383.38	B															100		P											R			
29R-5, 18-22	385.69	R	G		F					R	R			R			0		P											F		d	
29R-CC	389.20	B														NN16 - NN 18	150	95	P	R		R								F		d	
30R-2, 70-75	391.40	B															25																
30R-3,130-135	393.50	T	M		R									R			100	80	P					R				R		F	R	d	
30R-5, 70-75	395.90	B															3	90	P					R						R		d	
30R-CC	398.90	B															3	90	P					R						F		d	
32R-1, 70-75	409.30	B															0		P											R			
32R-CC	418.30	T	M		R									R			50		P											R			
33R-2, 21-26	420.01	T	M		R									R			2																
33R-CC	427.90	T	M						R					R			0	70	P											F		d	
34R-2, 68-70	430.08	B															3		P														
34R-3,134-136	432.24	B															1																
34R-CC	437.60	B															0		P														
35R-1, 90-92	438.50	B															0		M											R			
35R-3, 90-92	441.50	B															0																
35R-CC	447.10	B															0																
36R-2, 69-74	449.29	B															4																
36R-2, 74-77	449.34	B															0																
36R-CC	456.70	T	M		R				R								0		P						R					R			
37R-1, 55-59	457.25	B															3																
37R-CC	466.40	R	M		R				R	R			R	R			0																
38R-CC	476.10	B															0		P													d	

Note: c = different colors, d = deformed specimen.

Planktonic Foraminifers

The biostratigraphic results obtained from planktonic foraminifers are based on investigation of nine samples from Hole 861A and six samples from Hole 861B, which penetrates only the upper 10 m of the sequence, as well as on studies of 131 samples from Hole 861C (353.10 m total depth) and 35 samples from Hole 861D (344.48 to 496.30 mbsf).

At Site 861 two recognized planktonic foraminifer events are the FO of *T. truncatulinoides,* which defines the lower boundary of the *T. truncatulinoides* Zone in Sample 141-861C-16X-4, 30–35 cm, at 133.70 mbsf, and the FO of *G. inflata,* which marks the lower boundary of the *G. inflata* Zone in Sample 141-861D-8R-1, 46–51 cm, at 410.26 mbsf. On the basis of planktonic foraminifers three zones are distinguishable in the Quaternary and Pliocene series: the *T. truncatulinoides* Zone, the *G. inflata* Zone, and the *G. crassaformis* Zone.

Paleotemperatures are apparently reflected by the foraminiferal assemblages. The uppermost 3 m of the *T. truncatulinoides* Zone contain well-preserved and rich assemblages with *Globorotaloides hexagonus, Beella digitata, Neogloboquadrina dutertrei, Globigerina apertura, G. bulloides, Orbulina universa,* and *T. truncatulinoides* accompanied by *G. inflata.* This indicates the occurrence of tropical/subtropical taxa during the late Pleistocene in transitional water masses. Down to 69.50 mbsf most of the samples contain *T. truncatulinoides* and *N. pachyderma,* which indicate lower temperatures. The FO of *T. truncatulinoides* is documented only by one whole and a broken specimen, which shows the uncertainty of the zonal boundary. Cyclic fluctuations in abundances of foraminifers as observed in the *T. truncatulinoides* Zone of Hole 860B were also recognized within the sequences from Site 861. Low number of foraminifers (Tables 5, 6, and 7) coincides roughly with even isotope stages, corresponding to cool intervals (e.g. at 7.15 mbsf = oxygen isotope event 2.2 according Schönfeld and Spiegler (this volume), between 12 and 14 mbsf = event 4.2, at 27.59 mbsf = event 6.2, and around 48 mbsf = oxygen isotope event 8). Below 42.80 mbsf most of the samples contain yellow- to red-colored foraminifers together with white specimens, which documents downslope redeposition also described from Site 860.

Site 862

Site 862 was drilled to determine the basement lithology of the Taitao Ridge which was reached in Hole 862C.

Table 4. Distribution of calcareous nannoplankton and planktonic foraminifers in Hole 860B.

ODP 141-860B Samples (Core, section, interval in cm)	Depth (mbsf)	Abundance	Preservation	B. bigelowi	C. pelagicus	C. leptoporus	C. macintyrei	D. japonica	E. huxleyi	G. caribbeanica	G. ericsonii	G. oceanica	G. sp.	H. carteri	H. sellii	P. pacifica	P. lacunosa	R. cf. pseudoumbilica	S. mediterranea	S. pulchra	Nannoplankton zones	Number of foraminifer in 20 cm3 sediment	Planktonic foraminifers %	Preservation	T. truncatulinoides	O. universa	N. dutertrei	G. inflata	G. bulloides	G. cf. inflata	G. glutinata	G. apertura	G. hexagonus	G. aff. bulloides	G. quinqueloba	G. crassaformis	N. pachyderma sin.	N. pachyderma dex.	G. scitula	G. crassula	S. ruber	S. margaritae	G. puncticulata	G. cf. sphericomiozea	Remarks	Planktonic foraminifer zones
1H-1, 57-62	0.57	F	G		F	C			F											R		3500	80	G	R	R	R	F	C	R	R															
1H-CC	1.40	C	G		C	C			F		C	F		F								25000	80	G	R	R	F	F	A	R	R	F	R													
2H-1, 20-22	1.60	C	G		C	C		R	F		C			F					R	R	NN 21	3000	70	G	R	R	R	F	A		R	R														
2H-1, 60-61	2.00	C	G						F		C			F					R	R		25000	95	G	R	R	R	F	A		R	R														
2H-2, 60-61	3.50	C	G			C			C		C			C					R	R		10000	98	G	R	R	R	C	A		R	F	R													
2H-3, 60-61	5.00	C	G	R	F	C					C			F								1600	95	G	R		R	C	F		R	R														
2H-4, 60-61	6.50	B																				200	80	M	R			F	F		R															
2H-5, 60-61	8.00	T	M		R																-	50	70	P				R			R			R	R	R	R									
2H-6, 60-61	9.50	B																				1	-	P													R									
2H-CC	10.90	B																				150	50	M		R		R	R	R				R	R	R	R									
3H-1,137-142	12.27	R	M		R					R												150	70	M				F	R		R															
3H-2,118-123	13.58	T	G							R												50	60	M				R	R					R			R									
3H-3,135-140	15.25	B																			NN 20	750	70	G				C	C							R										
3H-5, 70-75	17.60	R	G							R	R											250	20	M				R	R					R		R										
3H-6,145-150	19.85	R	M			R				R	R											2500	80	M		R		C	F		R	R		R		R										
3H-CC	20.40	F	G		R	F					C	F		F								20000	80	G		R		A	F		F	R		R		R	R	R	R							
4H-2, 69-74	22.59	F	G		F	F					F	R		R			R					13000	85	G				C	C						R				R							
4H-3,130-135	24.70	C	G			F					C	F		F			F					2000	95	M				F	C																	
4H-5, 70-75	27.10	B																				1500	50	G				F	C					F											c	
4H-CC	29.90	F	G		F	F					F	R					R					10000	50	G				C	F																	
5H-2, 31-34	31.71	R	G			R					F	R		R			R					10000	50	G				C	F					F		R									c	
5H-3, 28-31	33.18	F	G		F	F				F	C	F		R								10000	50	G		R		A	F					F		R									c	
5H-5, 27-32	36.17	T	M			R					R											5000	50	G		R		C	F					F		R				R					c	
5H-CC	39.40	R	G		F	R				F	F	R		R								1000	40	G		R		C	R					F											c	
6H-2, 69-74	41.59	B																				100	85	M				R	F					F						R					c	
6H-3,129-134	43.69	B																				.15	-	G				R						R											c	
6H-5, 69-74	46.09	B																				50	20	M				R						R	R			R							c	
6H-CC	48.90	B																				1	-	-					R																	
7H-2,105-107	51.45	F	G		F	F				F	C	R					R					4000	90	G		R		A	C					R												
7H-4,102-104	54.42	C	G		F					F	C	R										2000	70	M				C	F					C	R		R									
7H-6,100-102	57.40	A	G		R					C	C	R										1000	50	M				F	F					R			R	R								Truncorotalia truncatulinoides
7H-CC	58.40	C	G		C	F				F	F	R		F			R			R		>10000	60	G		R		C	F							R			R							
9H-CC	68.70	F	G		F	F				R	F	R					R			R	NN 19	10000	60	G		R		A	C							R			R						c	
10H-CC	78.10	F	G		F	F		R					F	F	R					R		100	60	M		R		F								R	R	R	R						c	
12X-2, 35-39	89.55	T	G							R				R								500	60	G	R	R		F	C					C				R			R				c	
12X-3,120-122	91.90	R	G		R	R							F	R								500	60	G		R		R	R					F		R									c	
12X-CC	97.60	R	G		R	R							cf F	R								0																								
13P-1-46-48	98.06	B																				0																								
14X-1, 62-68	99.72	R	G		R	R							R									0																								
14X-CC	107.20	B																				50	15	M				R	R							R				R					c	
15X-2, 70-75	109.40	R	G		R	R					F											50	25	G				R	R	R								R							c	
15X-3, 60-65	110.80	B																				75	90	M		R											R	R		R					c	
15X-4,124-129	112.94	R	G		F	R							cf F									0																								
15X-CC	116.80	T	M		R	R							R			R						0																								
16X-1, 68-73	117.48	A	G		C	F					C	cf		F								5000	80	G		R	R	A	F							R		R		R						
16X-2,107-112	119.37	C	G		F					C		cf										1000	75	G					F																s	
16X-3, 32-38	120.12	A	G		C	C				C	C	cf		F					R	R		7000	90	G	R	R		F	C						R		R	R		R						
16X-CC	126.50	F	G		R	F					F									R		10000	90	G				F	C		R			C		R	A		R	R						
17X-2, 7-12	128.07	C	G	R	C	C					C			C			F					22000	70	G		R		F			R					R	R		R	R						
17X-3,128-133	130.78	A	G			R	T						A	R								35000	95	G		R		R							R	C			R						•	
17X-5, 67-72	133.17	F	G		F	F							C									5000	90	G				R	C		R					R	R	R	F							
17X-CC	136.10	F	G		R								F	R			R					500	80	G				R	F							F	F		R	R						
18P-CC	137.10	F	G		F	F	R						F	R			R					100	80	G					R							R	R	R								
19X-1, 26-31	137.36	R	M										R									15000	90	G				R	F							C		R								
19X-4, 48-53	142.08	R	G		R								R				R					1000	98	G		R			C		R					F			R							
19X-CC	145.80	C	G	T	R	R							C	R			R		R			7000	90	G		R		R	A							C		R	R	R						
20X-1,120-125	147.00	B												F								750	60	M		R		R	R		R				R	F	R									
20X-2, 24-26	147.50	B																				500	50	G				F	R							F						R				
20X-CC	155.50	F	G			R	R						F				R					10000	95	G					A		R			A		C	R		R							
21X-1, 80-82	156.30	A	G		R	C	F	F					A			R	F					10000	90	M		R			F		R					R	C	R								

Calcareous Nannoplankton

Cores 141-862A-1H and -2H are almost barren of autochthonous nannofossils (Table 9). However, reworked taxa from Paleogene and Miocene sediments are present in several samples. Only Core-catcher Sample 141-862A-3H contains a few nannoplankton. The following species were observed: *Coccolithus pelagicus, Cyclococcolithus leptoporus, C. macintyrei, Pseudoemiliania lacunosa,* and *Gephyrocapsa* sp., which indicates a late Pliocene age (Zones NN16–NN18).

Planktonic Foraminifers

Planktonic foraminifers are well preserved and abundant in the uppermost 25 cm of soft green clay. *Globorotaloides hexagonus, Beella digitata, Neogloboquadrina dutertrei, Orbulina universa, Globigerina apertura, G. bulloides* together with *Truncorotalia truncorotaloides,* and *Globoconella inflata* indicate a subtropical influence during the *T. truncorotaloides* Zone of latest Pleistocene, as mentioned also for Sites 859, 860, and 861. The FO of *T. truncorota-*

Table 4 (continued).

ODP 141-860B Samples (Core, section, interval in cm)	Depth (mbsf)	Abundance	Preservation	Calcareous nannoplankton: B. bigelowi	C. pelagicus	C. leptoporus	C. macintyrei	D. japonica	E. huxleyi	G. caribbeanica	G. ericsonii	G. oceanica	G. sp.	H. carteri	H. sellii	P. pacifica	P. lacunosa	R. cf. pseudoumbilica	S. mediterranea	S. pulchra	Nannoplankton zones
21X, CC	165.10	C	G		R	T	F	F									F				
22X-1, 84-89	165.94	A	G		R	C	C	F					A	C		R	R	F			
22X-3, 49-54	168.59	B																F			
22X-CC	174.80	R	M			C		R										F			
23X-CC	184.40	F	G	R	C	F	F	F							R						
24X-1,103-107	185.43	B																			
24X-CC	194.10	T																R			
25X-1, 92-98	195.02	R					R						R								
25X-2, 8-13	195.68	B																			
25X-CC	203.70	B																			
27X-CC	223.10	T	M		R									R							
28X-1,103-104	224.13	B																			
28X-CC	232.80	B																			
29X-1,110-113	233.90	T											F	R			R				
29X-CC	242.50	R	M		R	F	F														
30X-2,138-143	244.45	F	G		F		R	F					F				F				
30X-CC	251.90	F	G		F	F	F	R						F			F	F			
31X-1, 28-32	252.18	C	G		F	R	F	F					F				F	F			
31X-2, 70-74	254.10	C	G		C	F	F	R									F	F			
31X-3, 86-92	255.76	R	G		R												R	F			
31X-CC	261.60	C	G		C		F	F						R			R				
32X-2, 65-70	263.01	A	G		C		F						A	C			F	R			
32X- CC	271.20	F	G		R		F							F			F	F			
33X-2, 8-13	272.78	B																			
33X-CC	280.80	R	G		R		R						F	R				F			
34X-1,111-114	281.91	B																			
34X-3, 42-45	284.22	B																F			
34X-CC	290.40	B																			
35X-1, 49-51	290.89	R	M														R				
35X-CC	300.10	R	G				R														
36X-1, 42-47	300.52	R	G		R		R							R				R			
36X-3, 41-46	303.51	B																R		R	
36X-CC	309.80	B																			
37X-4, 39-41	314.70	B																			
37X-CC	319.40	C	G	R	C	F	F								F	A	R				
38X-2, 87-89	321.68	B																			
38X-CC	328,70	R	G			R							R					F			
39X-2,80-83	331.00	B																			
39X- CC	338.40	B																			
40X-CC	348.00	B																			
41X-2, 68-72	352.30	B																			
41X-3,130-135	354.70	B																			
41X-5, 70-75	359.64	B																			
41X-CC	357.70	B																			
43X-1, 44-48	359.64	B																			
43X-CC	367.30	T	M		R																
44X- CC	376.90	R	G			R										R					
45X-CC	386.60	B																			
46X-2, 23-25	388.12	B																			NN 16 - NN 18
46X-CC	396.30	B																			
47X-CC, 16-18	396.46	B																			
47X-CC	406.00	B																			
48X-1,129-134	407.29	B																			
48X-3, 130-135	409.34	B																			
48X-5, 27-32	411.31	B																			
48X-CC	415.70	B																			
49X-01,68-70	416.38	B																			
49X-CC	425.30	R	M		R								R								
50X-2, 2-4	426.82	B																			
50X-5, 28-31	430.23	B																			

ODP 141-860B Samples (Core, section, interval in cm)	Planktonic foraminifers: Number of foraminifer in 20 cm3 sediment	Planktonic foraminifers %	Preservation	T. truncatulinoides	O. universa	N. dutertrei	G. inflata	G. bulloides	G. cf. inflata	G. glutinata	G. apertura	G. hexagonus	G. aff. bulloides	G. quinqueloba	G. crassaformis	N. pachyderma sin.	N. pachyderma dex.	G. scitula	G. crassula	S. ruber	S. margaritae	G. puncticulata	G. cf. sphericomiozea	Remarks	Planktonic foraminifer zones
21X, CC	20000	75	M		R			C					F		F	F	R		R			R			
22X-1, 84-89	12000	90	G					C							R	R	R	R	R						
22X-3, 49-54	1000	80	M					F		R			F	R		F									
22X-CC	500	90	M					F							R	F			R					c	
23X-CC	1000	60	M					C							C	R			R					c	
24X-1,103-107	1000	50	M		R			C					F		F	R		R						c	
24X-CC	500	45	M					R					R		R	F								c	
25X-1, 92-98	500	45	M					R					R		R	F									
25X-2, 8-13	250	80	M				R	R					R		R	F								c	
25X-CC	100	85	P										R			R		R							
27X-CC	100	10	P										R			R								s	
28X-1,103-104	25	90	M										R		R	F								c	
28X-CC	10	90	P													R									
29X-1,110-113	0																								
29X-CC	0																								
30X-2,138-143	250	80	M				R	R		R			R		R	F			R					c	
30X-CC	0																								
31X-1, 28-32	500	20	M				R									R									
31X-2, 70-74	500	70	M																						
31X-3, 86-92	800	70	M				R			R				R		R	R								
31X-CC	500	70	P				R								R	R			R			R			
32X-2, 65-70	7000	80	G		R		F	R		R					F										
32X- CC	500	80	G				C	R								R									
33X-2, 8-13	300	70	M										R		R	F								c	
33X-CC	300	90	P					R					R		F	R	R								
34X-1,111-114	200	90	M					R					R			F									
34X-3, 42-45	0																								
34X-CC	50	60	P												R	R	R								
35X-1, 49-51	100	50	M							R					R	R									
35X-CC	200	50	P					R							R	R			R						
36X-1, 42-47	500	50	M		R		F						R				R							c	
36X-3, 41-46	100	10	P														R								
36X-CC	10	10	P												R										
37X-4, 39-41	30	20	P				R	R		R			R		R	R	R							c	
37X-CC	50	50	P				R	R							R	R								c	G. inflata with displaced older sediments
38X-2, 87-89	25	0	P																						
38X-CC	50	80	P		R		R								R	R									
39X-2,80-83	200	10	M												R									c	
39X- CC	50	50	P					R								R									
40X-CC	25	20	P													R									
41X-2, 68-72	150	20	M													F									
41X-3,130-135	30	25	P												R	R								c	
41X-5, 70-75	150	30	M							R			R		R	F		R						c	
41X-CC	100	50	P													F								c	
43X-1, 44-48	50	80	P												R	R								c	
43X-CC	0																								
44X- CC	100	50	P				R						R		R	F								c	
45X-CC	0																								
46X-2, 23-25	0																								
46X-CC	0																								
47X-CC, 16-18	30	10	P													R									
47X-CC	10	-	P													R			R						
48X-1,129-134	50	5	P							R				R											
48X-3, 130-135	50	50	P							R			R		R	R									
48X-5, 27-32	25	90	P												R	R									
48X-CC	10	-	P													R									
49X-01,68-70	50	80	P							R						F	R								
49X-CC	500	90	P				R						R		R	C									
50X-2, 2-4	150	30	P												R	F	R		R						
50X-5, 28-31	0																								

loides in Sample 141-862A-1H-1, 101–104 cm (1.01 mbsf) indicates the base of the *T. truncorotaloides* Zone and the FO of *G. inflata* is to observe in Sample 141-862A-1H-CC (5.40 mbsf). Below 1.01 mbsf stained foraminifers document reworking as observed in the other Pleistocene/Pliocene sequences off Chile. Downhole, *N. pachyderma* (sin.) dominates the assemblages, indicative of a cold-water environment. Sample 141-862C-6R-1 from Piece 6 is a layer of indurated sandstones intercalated between basaltic rocks above and below. The marine origin of the coarse sandstone is documented by sea urchin-spines and traces of miliolid foraminifers. In addition, Forsythe et al. (this volume) decribed from a fine-grained portion of this sandstone foraminifers late Paleocene in age.

Site 863

Site 863 was drilled at the base of the trench slope at the point where the ridge is being subducted.

Table 4 (continued).

ODP 141-860B Samples (Core, section, interval in cm)	Depth (mbsf)	Abundance	Preservation	B. bigelowi	C. pelagicus	C. leptoporus	C. macintyrei	D. japonica	E. huxleyi	G. caribbeanica	G. ericsonii	G. oceanica	G. sp.	H. carteri	H. sellii	P. pacifica	P. lacunosa	R. cf. pseudoumbilica	S. mediterranea	S. pulchra	Nannoplankton zones
50X-CC	434.80	B																			
51X-2, 7-10	436.37	B																			
51X-CC	444.40	F	G		C		R						F							R	
52X-CC	449.10	B	G		R		R										R				
53X-1, 14-19	449.24	B	G			R												R			
53X-2, 60-65	451.20	R	G				R						R								
53X-CC	453.70	R	G		F	F	R										F	F			
54X-CC	463.80	B																			
55X-CC	473.40	B																			
56X-CC	483.10	B																			
57X-CC	492.80	B																			
58X-CC	502.40	C	G		F	F	C	F					C	F		R	F				
59X-CC	512.00	B																			
60X-1, 40-42	512.40	B																			
60X-2, 40-42	514.80	B																			
60X-3, 40-42	516.30	B																			
60X-CC	521.70	B																			
61X-2, 57-62	523.77	T	G										R								
61X-4, 35-37	526.55	R	G		R		R						R								
61X-6,34-38	529.54	R	G		R		R						R					R			
61X-CC	530.70	R	G	R	R	R							R	R							- - - NN 15 ?
62X-2, 9-12	532,49	B																			
62X-3,114-117	535,04	F	G		R	R	R						R				R				
62X-CC	540.50	R	G		R	R	R							R	R						
63X-CC	550.20	R	G		R									R	R					T	
64X-4, 73-75	553.93	R	M		R		R														
64X-CC	559.90	B																			
65X-CC	569.50	T	M		R																
66X-1, 78-83	570.28	B																			
66X-2, 52-57	571.52	B																			
66X-CC, 12-17	572.00	B																			
66X-CC	572.12	T	G		R		R									R	T				
67X-2, 59-63	581.29	B																			
67X-3, 7-11	582.27	R	G		R	R	R							R			R				
67X-CC	588.80	B																			
69X-CC	608.20	B																			
70X-CC	617.80	B																			

ODP 141-860B Samples (Core, section, interval in cm)	Number of foraminifer in 20 cm3 sediment	Planktonic foraminifers %	Preservation	T. truncatulinoides	O. universa	N. dutertrei	G. inflata	G. bulloides	G. cf. inflata	G. glutinata	G. apertura	G. hexagonus	G. aff. bulloides	G. quinqueloba	G. crassaformis	N. pachyderma sin.	N. pachyderma dex.	G. scitula	G. crassula	S. ruber	S. margaritae	G. puncticulata	G. cf. sphericomiozea	Remarks	Planktonic foraminifer zones
50X-CC	0																								G. inflata with displaced older sediments
51X-2, 7-10	600	80	M										R	R	R	C									
51X-CC	600	80	M										R		R	C									
52X-CC	500	85	P													F	R								
53X-1, 14-19	2000	90	G										R		F	A			R						
53X-2, 60-65	1000	80	G				R			R			R		R	F	R								
53X-CC	25	85	P													R									
54X-CC	200	30	P												R	R			R					c	
55X-CC	10	0	M																						
56X-CC	50	50	M			(R)							R		R	R	R							c	
57X-CC	0																								
58X-CC	100	60	M							R			R		R	F									
59X-CC	0																								
60X-1, 40-42	100	80	G										R			F									
60X-2, 40-42	100	80	G							R			R			F									
60X-3, 40-42	250	90	G										R			C									
60X-CC	10	-	P												R	R									
61X-2, 57-62	50	10	P													R									
61X-4, 35-37	250	80	M										R			C									
61X-6,34-38	200	80	M										R		R	C	R							c	
61X-CC	10		P												R									c	
62X-2, 9-12	250	80	P				R								R	C								c	
62X-3,114-117	150	50	M		R		R								R	F								c	
62X-CC	50	60	P												R	R	R							c	G. crassaformis
63X-CC	10	-	P												R	R								c	
64X-4, 73-75	150	60	M										R		R	F								c	
64X-CC	0																								
65X-CC	50	80	M												F	R						R	R		
66X-1, 78-83	500	80	G												F									c	
66X-2, 52-57	3	0	-																						
66X-CC, 12-17	250	80	M										R		F	F	R								
66X-CC	50	10	M																				R		
67X-2, 59-63	50	10	P											R	R	R	R								
67X-3, 7-11	100	10	P					R										R						c	
67X-CC	3	-	P													R									
69X-CC	150	10	P										R			R	R		R						
70X-CC	10	-	P													R									

Note: * = downhole contamination, c = different colors.

Table 5. Distribution of calcareous nannoplankton and planktonic foraminifers in Hole 861A.

ODP 141-861A Samples (Core, section, interval in cm)	Depth (mbsf)	Abundance	Preservation	B. bigelowi	C. pelagicus	C. leptoporus	E. huxley	G. ericsonii	G. oceanica	H. carteri	R. claviger	S. mediterranea	S. pulchra	Nannoplankton zone	Number of foraminifer in 20 cm3 sediment	Planktonic foraminifers %	Preservation	N. dutertrei	G. apertura	G. bulloides	T. truncatulin.	O. universa	G. inflata	G. scitula	G. cf. bulloides	G. quinqueloba	G. glutinata	N. pachyd. dex.	N. pachyd. sin.	Planktonic foraminifer zone
1H-1, 8-13	0.08	A	G	F	R	F	F	F	R	R	R	R	R	NN 21	40000	95	G	R		A	F	F	A	R				A	R	T. truncatulinoides
1H-1,130-135	1.30	R	G		R	R	R	F		R					4500	90	G		R	A	R		A			R			R	
1H-2, 28-33	1.78	C	M		F	F	F	A	R	F					2500	90	M			A	R		F		R	R	R		R	
1H-3, 9-13	3.09	C	G		C	F	F	F					R		2500	80	G			F	R		F		R	R			R	
1H-4,109-114	5.59	B													5000	80	G			C	R		R	R	R	R	R	F	C	
1H-5,118-123	7.18	R	G		R			F							1500	70	G			F	R		R		R			R	C	
1H-6, 87-92	8.37	T	M		R			F							180	50	M			R	R		R		R		R	R	R	
1H-7, 20-25	9.20	F	G		F	R	R	R							1500	70	G			C	R		F					R	R	
1H-CC	9.50	F	M		F	R	C	C	R	R					1500	75	G			F	R		C		R					

Calcareous Nannoplankton

The biostratigraphic results obtained by the investigation of calcareous nannofossils are based on 77 samples from Hole 863A and 76 samples from 863B.

The upper part of the sequence encountered in Hole 863A is poor in nannofossils (Cores 141-863A-1H through -23X). Only Sample 141-863A-8H-CC contains common nannoplankton with the following species: *Cyclococcolithus leptoporus, Coccolithus pelagicus, Gephyrocapsa ericsonii, G. oceanica,* and *Helicosphaera carteri,* which are typical for the upper Pleistocene, and probably indicate Zone NN20. Reworked species from the Miocene were observed in several samples. Nannofossils are common from Cores 141-863A-24X through -28X, and the assemblage gives an early Pleistocene age (Zone NN19) with *Gephyrocapsa oceanica, G. ericsonii, Pseudoemiliania lacunosa, Helicosphaera carteri, Coccolithus pelagicus,* and *Cyclococcolithus leptoporus.* The same assemblage was found in Sample 141-863A-31-CC (Table 10).

Table 6. Distribution of calcareous nannoplankton and planktonic foraminifers in Hole 861B.

ODP 141-861B Samples (Core, section, interval in cm	Depth (mbsf)	Calcareous nannoplankton: Abundance	Preservation	*C. pelagicus*	*C. leptoporus*	*E. huxleyi*	*G. ericsonii*	*G. oceanica*	*H. carteri*	*0. fragilis*	*R. stylifer*	*S. mediterranea*	*S. pulchra*	Nannoplankton zone
1H-1, 75-77	0.75	A	G	R	C	F	F		C			R	R	NN 21
1H-2,131-133	2.81	F	G	R	F	R	F							
1H-4, 41-43	4.91	T	M						R					
1H-5, 115-117	7.15	T	M	T				R						
1H-6, 106-105	8.53	R	M	R	R			R						
1H- CC	9.90	F	M	C	R	C	C	R		T	T			

Samples (Core, section, interval in cm	Planktonic foraminifers: Number of foraminifers in 20 cm^3 sediment	Planktonic foraminifers %	Preservation	*N. dutertrei*	*G. apertura*	*G. bulloides*	*T. truncatulinoides*	*O. universa*	*G. inflata*	*G. scitula*	*G. cf. bulloides*	*G. quinqueloba*	*G. glutinata*	*N. pachyderma* dex.	*N. pachyderma* sin.	*G. crassaformis*	*G. cf. inflata*	Planktonic foraminifer zone
1H-1, 75-77	2000	95	G			R	F	R	R		F	R	F	R	F			*T. truncatulin.*
1H-2,131-133	40000	95	G	R	F	A	F	F	F	R		R		F		F	R	
1H-4, 41-43	4000	90	G			F	F		A				R					
1H-5, 115-117	1000	85	G			F	R		F									
1H-6, 106-105	1200	80	M			F			F			R	R	R		R		
1H- CC	0	-	-															

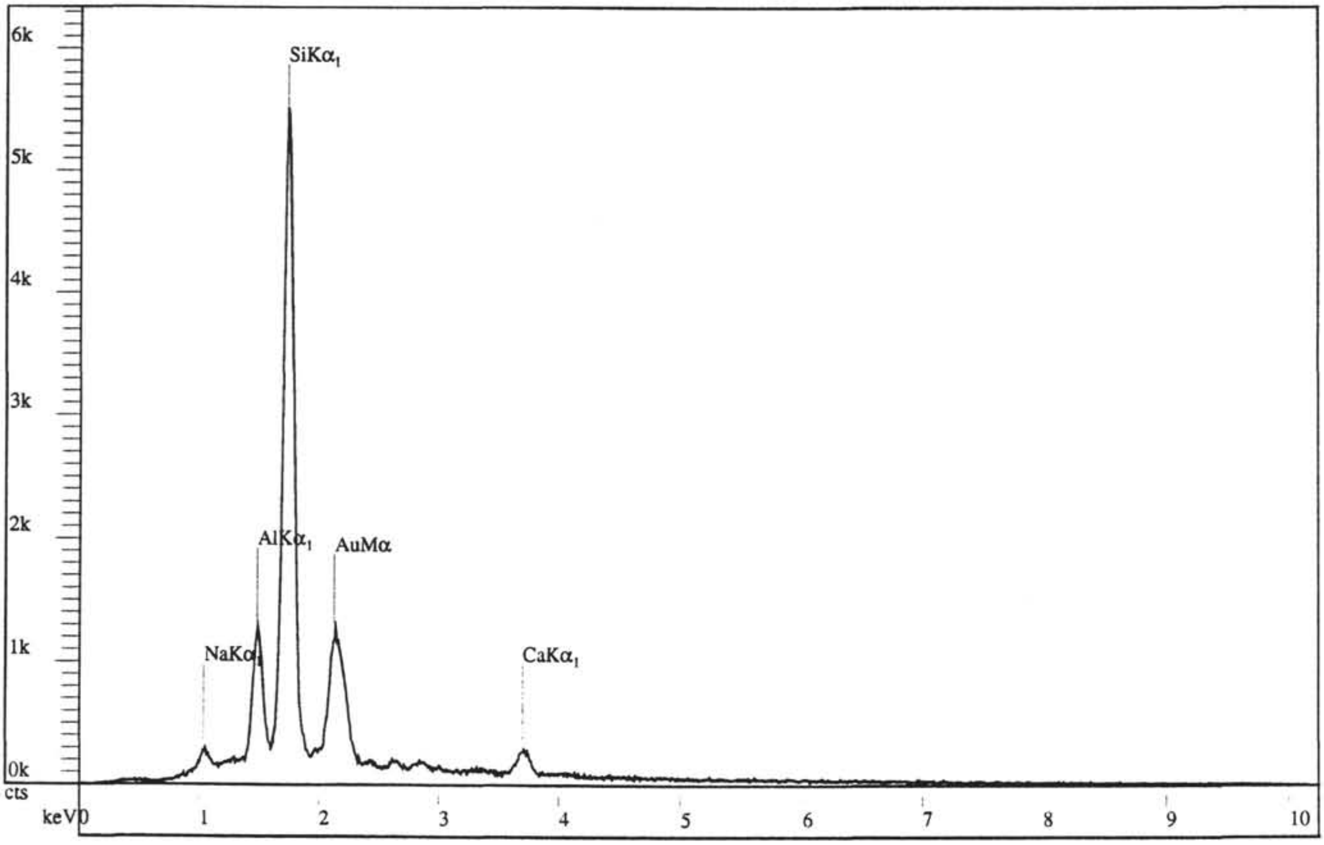


Figure 3. EDAX analysis of a silicified *Gibicidoides* sp. from Sample 141-863B-30X-CC (569.10 mbsf).

Hole 863B was drilled about 10 m to the east of Hole 863A. Nannofossils are abundant but they are of small size. The assemblages observed from the top to the base of the sequence are the same, and are dominated by *Gephyrocapsa ericsonii* and *G. caribbeanica.* Species such as *Gephyrocapsa oceanica, Helicosphaera carteri, Cyclococcolithus leptoporus,* and *Coccolithus pelagicus* are less frequent. The entire sequence is placed in the Zone NN20 of upper Pleistocene (Table 11).

Planktonic Foraminifers

The results are based on the investigation of 78 samples taken from Hole 863A and 73 samples from Hole 863B. The analysis of planktonic foraminifers placed the sequence in the *G. inflata* Zone. In Sample 141-863A-1H-1, 18–20 cm (0.18 mbsf) orange-stained foraminifers indicate displacement. *T. truncatulinoides* are observed between 15.30 and 23.74 mbsf and again between 68.53 and 75.45 mbsf. Sample 141-863A-3H-4, 114–119 cm (23.74 mbsf), contains a very rich assemblage with subtropical indicators like *N. dutertrei, G. aequilateralis, G. hexagonus,* and some large specimens of *O. universa,* which have been normally observed within the uppermost meters of the recovered sequences off the southern Chilean coast. These sediment intercalations are characterized by typical assemblages of the upper *T. truncatulinoides* Zone and could be interpreted as tectonic imbrication of the sequence. The tectonical influence is also documented by strongly deformed foraminifers below 435 mbsf. Below 355 mbsf silica partly replaces the carbonate of the tests. Inner parts of the foraminifers show often residues of calcite. In samples containing high amounts of diagenetic carbonate only silicified and broken specimens were found. An EDAX analysis of a silicified benthic foraminifer *Cibicidoides* sp. shows the high amount of silica and some signals for clayey minerals (Fig. 3). This may indicate the influence of fluids circulating within the accretionary wedge.

Table 7. Distribution of calcareous nannoplankton and planktonic foraminifers in Hole 861C.

Calcareous nannoplankton

ODP 141-861C Samples (Core, section, interval in cm)	Depth (mbsf)	Abundance	Preservation	B. bigelowi	C. pelagicus	C. leptoporus	C. macintyrei	D. japonica	E. huxleyi	G. caribbeanica	G. ericsonii	G. oceanica	G. sp.	H. carteri	H. sellii	P. pacifica	P. lacunosa	R. cf. pseudoumbil.	S. mediterranea	S. pulchra	Nannoplankton zones
1H-1, 45-49	0.45	F	M		F	F		R	F		F	R		F					R		NN 21
1H-2, 87-92	2.37	C	G	R		F			F		C	F		R					R		
1H-CC	3.00	F	G		C	F					C	R		F							
2H-3, 9-14	6.09	F	M	R		F			F		C	F		F							
2H-4, 60-65	8.10	C	M		C	F					C	R		F					R	R	
2H-6, 52-57	11.02	F	M		R	F					C	R									
2H-CC	12.50	C	G		R	F			C		C	C		F							
3H-2, 70-75	14.70	C	G		R	F			F		A	C							R		
3H-3, 131-136	16.81	F	M		F	F					C	R		F							
3H-5, 60-65	19.10	R	P		R	R					F			R							
3H-CC	22.00	C	G		R	F			C		A	F		C					F		
4H-1, 37-42	22.37	C	G	R	F	C					C	F		C					R		
4H-2, 70-75	24.20	C	G		C	C					C	F		F							
4H-4, 109-114	27.59	R	G			R					F			R							
4H-5, 68-73	28.68	R	M		R	R					F			R							
4H-6, 66-71	30.16	R	M		R	R			R		F	R		R							
4H-CC	31.50	F	G			R			F		C			R							
5H-2, 10-12	31.90	F	M			F					C	F		F					R		NN 20
5H-3, 129-131	34.59	F	M		R	F					C	R		R							
5H-4, 70-72	35.50	R	P								R										
5H-5, 59-61	36.89	C	G		F	R					A	F		R							
5H-6, 130-132	39.10	R	M		R						R		R								
5H-7, 7-5	39.35	R	G		F								R	R							
5H-7, 10-12	39.40	R	G		F								R								
5H-CC	41.00	R	P	T	F	R					R		R								
6H-2, 38-42	42.88	F	G		R	F					F	cf			T				R	R	
6H-2, 77-81	43.27	R	M		R						R										
6H-3, 56-60	44.56	R	G		F	R					R	cf		R					R		
6H-5, 67-71	47.67	R	M							R	R										
6H-7, 16-20	50.16	B																			
6H-CC	50.50	R	P		F	R															
7H-2, 80-85	52.80	B																			
7H-3, 39-44	53.89	F	G		F	F					F	F								R	
7H-6, 10-15	58.10	B																			
7H-7, 109-11	60.59	B																			
7H-7, 124-129	60.74	B																			
7H-CC	60.00	B																			
8H-3, 140-142	64.40	B																			
8H-CC	69.50	R	G		F	R								R							
9H-CC	71.00	B																			
10H-2, 73-78	73.23	B																			
10H-3, 131-136	75.31	B																			
10H-5, 68-73	77.68	R	M		R									R							
10H-CC	80.50	B																			
11H-CC	90.10	B																			
12H-1, 103-105	91.13	R	G		R	R								R							
12X-CC	99.80	R	G		R	R					F										
13X-1, 66-71	100.46	R	G		R	R							R								
13X-CC	109.40	R	G		R	R				R		R									
14X-1, 93-98	101.33	B																			
14X-2, 42-47	111.32	R	M		R								R								
14X-CC	119.00	R	G		F	F		R					R	F							
15X-1, 92-97	119.92	B																			
15X-2, 6-10	120.56	R	G		R								R								
15X-3, 123-127	123.23	R	G		R								R								
15X-4, 51-56	124.01	R	G		R								R								
15X-5, 69-73	125.69	C	G		C	F							C								
15H-CC	128.90	F	G		R	F					C			F			F		R	R	
16X-2, 49-51	130.89	R	M		R								R	R							
16X-3, 84-86	132.74	C	G		F	F					F		R				F				
16X-4, 30-35	133.70	F	G		F	F							cf	F					R		
16X-4, 89-91	134.29	F	G		F	F					F		R						R		
16X-CC, 3-6	136.01	B																			
16X-CC	138.70	F	M		C	F					F			R							
17X-1, 60-65	139.30	R	G			R					R	R		R							

Planktonic foraminifers

ODP 141-861C Samples (Core, section, interval in cm)	Number of foraminifers in 20 cm3 sediment	Planktonic foram. %	Preservation	G. hexagonus	B. digitata	N. dutertrei	G. apertura	G. bulloides	T. truncatulinoides	O. universa	G. inflata	G. scitula	G. crassaformis	G. aff. bulloides	G. quinqueloba	G. glutinata	G. cf. inflata	G. crassula	G. conomiocea	N. pachyd. sin.	N. pachy. dex.	Remarks	Planktonic foraminifer zones
1H-1, 45-49	13000	85	G	R		R	F	A	F	F	R			R	F								T. truncatulinoides
1H-2, 87-92	51000	95	G	R		R	C	F	F	F	C			R	F								
1H-CC	A	-	G		R	R	C	R	F	R	C	R		R									
2H-3, 9-14	12000	75	G				C	F	F	R	A				R	R							
2H-4, 60-65	9000	85	G				C	A	F	R	A				R					R	R		
2H-6, 52-57	400	60	P					F			F			R	R	R				R			
2H-CC	A	-	G				R	C	F		A									R	R		
3H-2, 70-75	6500	80	G				C	A	F		A				R	R				R	R		
3H-3, 131-136	2000	70	M					F	R		F			R	R	R				R	R		
3H-5, 60-65	2100	40	M					F	R		F			C						R	F		
3H-CC	A	-	G				R	A	F	R	A				R								
4H-1, 37-42	16000	90	G				F	A	F	R	A			R	R	R				R	F		
4H-2, 70-75	8000	90	G				R	A	F		R	R			R					F	R		
4H-4, 109-114	250	75	P					F			F									F			
4H-5, 68-73	2500	60	P				R	R	R		C												
4H-6, 66-71	140	80	P					F			R			R	R					R	R		
4H-CC	A	-	G					R	R		A				R								
5H-2, 10-12	1600	90	G				R	A	R		A												
5H-3, 129-131	450	80	M					F			R			R						R	R		
5H-4, 70-72	100	50	P					R			F									R			
5H-5, 59-61	3000	95	M						R		A			R						F			
5H-6, 130-132	700	75	M					C	R		F									R			
5H-7, 7-5	400	60	M					C			C			R									
5H-7, 10-12	3000	80	M				R	F	R		F												
5H-CC	A	-	G					C	F	R	A	R											
6H-2, 38-42	5000	90	M					C	F	R	C									F	R		
6H-2, 77-81	700	70	M					C			C									R		c	
6H-3, 56-60	2000	75	P								F			R									
6H-5, 67-71	15	80	P												R	R				R			
6H-7, 16-20	200	65	G					R			F			F						F	R		
6H-CC	F	-	M					C	R		C	R								F	C		
7H-2, 80-85	30	50	P					R			R			R	R								
7H-3, 39-44	5000	75	G				R	C	R		C		R	R						R	R	c	
7H-6, 10-15	2000	50	G					C		R	R			R	R					R			
7H-7, 109-11	3000	50	G					R	R		A			R									
7H-7, 124-129	1200	40	M					R	R	R	C			R									
7H-CC	C	-	G					F	R		C			R									
8H-3, 140-142	C	-	G					R			F			R									
8H-CC	C	-	G					R	R	R	C		R	R									
9H-CC	C	-	G				R	C		R	C		R			R							
10H-2, 73-78	4000	80	G					A			F			R						R		c	
10H-3, 131-136	250	70	G					F			F					R				F		c	
10H-5, 68-73	1500	70	G								R					R				R	R		
10H-CC	R	-	P					R			R												
11H-CC	C	5	G								R												
12H-1, 103-105	1500	85	M				R	A			A	R					R			R		c	
12X-CC	C	-	G					C			R		R							R	R	c	
13X-1, 66-71	2000	85	G				R	A			F			R	R					R		c	
13X-CC	R	-	M					R			F	R			R	R				R	R	c	
14X-1, 93-98	70	70	M					R			R				R					R		c	
14X-2, 42-47	200	80	G					R			R				R					F	R	c	
14X-CC	F	-	M					F			F	R		F						R	R	c	
15X-1, 92-97	1500	80	G				R	A			R				R					R		c	
15X-2, 6-10	1400	50	M				R	R		R	F		R	F	R						R	c	
15X-3, 123-127	300	95	M					F			R			R	F					R	R	c	
15X-4, 51-56	100	95	M					R			F	R		R		R				R		c	
15X-5, 69-73	3200	95	M					A			F				R							c	
15H-CC	C	-	G					F			F												
16X-2, 49-51	12000	45	G					F			F					R						c	
16X-3, 84-86	600	70	G					C			C	R		R									
16X-4, 30-35	1500	95	P				R	F	R	R	C	R	R			R							
16X-4, 89-91	15000	60	G					C		R	C	R				R	R						
16X-CC, 3-6	R	-	P					R			R												
16X-CC	R	-	P					R			R		R										
17X-1, 60-65	20000	30	G					F		R	C						R					c	

SUMMARY

Age determination of the sediments recovered during Leg 141 are difficult owing to the scarcity of the calcareous fossils and the low diversified assemblages. However, it was possible to establish a correlation between the calcareous nannoplankton and planktonic foraminifer zones (Fig. 4), except for Site 860, which contains some ambiguities and contradictions. It was not possible to confirm by calcareous nannofossils the imbrications and repetitions of upper and lower Pliocene sediments in Hole 141-860B below 120 mbsf as stated by planktonic foraminifers.

Based on calcareous nannoplankton, the Quaternary was broadly subdivided into the upper and lower Pleistocene by using the Zone NN20/NN19 boundary. The Pleistocene is represented by the *T. truncatulinoides* foraminifer Zone.

The Pliocene/Pleistocene boundary at 1.6 Ma was determined by the FO of specimens of the *Gephyrocapsa oceanica* group and the FO of *T. truncatulinoides*, respectively. Owing to paleoenvironmental

Table 7 (continued).

ODP 141-861C — Calcareous nannoplankton

Samples (Core, section, interval in cm)	Depth (mbsf)	Abundance	Preservation	B. bigelowi	C. pelagicus	C. leptoporus	C. macintyrei	D. japonica	E. huxleyi	G. caribbeanica	G. ericsonii	G. oceanica	G. sp.	H. carteri	H. sellii	P. pacifica	P. lacunosa	R. cf. pseudoumbilicus	S. mediterranea	S. pulchra	Nannoplankton zones
17X-2, 29-34	140.49	R	G		R	R					R						R				NN 19
17X-CC	148.50	R	G			F					F			R							
18X-2, 60-65	150.60	R	G			R					F	R					R				
18X-3, 127-132	152.77	R	G		R						R	cf		R							
18X-4, 59-64	153.59	R	G										R	R							
18X-CC	158.30	F	G		F	F					F		R	R							
19X-1, 59-64	158.89	F	G		F	F						R		R			R				
19X-CC	168.20	C	G		F	F					C	cf		R			R				
20X-CC	170.20	F	G		F	R	R					F	F	F			R				
21X-1, 44-49	170.64	B																			?
21X-2, 20-25	171.90	B																			
21X-CC	179.90	B																			
22X-5, 53-55	186.43	B																			
22X-5, 73-76	186.63	B																			
22X-CC	189.60	B																			
24X-CC	208.90	B																			
25X-2, 8-12	210.48	B																			
25X-3, 128-132	213.18	B																			
25X-5, 68-72	215.58	B																			
25X-CC	218.60	R	M		R		R										R				NN16 - NN 18
27X-3, 49-54	223.10	B																			
27X-5, 64-69	225.65	B																			
27X-CC	228.10	R	G		R	R	R						F								
28X-2, 60-65	230.20	B																			
28X-4, 52-57	233.12	R	G		R		R								R						
28X-CC	237.70	R	G		R		R						R	R	R		R				
29X-1, 129-131	238.99	B																			
29X-CC	247.30	R	M		R	R							F		R		R				
30P-CC	248.30	B																			
31X-2, 12-14	249.92	R	G		R									R	R		R				
31X-2, 130-132	251.10	R	G		R		R	R									R				
31X-3, 72-74	252.02	R	G		R		R	R					F	R			R				
31X-CC	257.00	R	G		R		R	R						R			R				
32X-2, 72-77	259.22	B												R							
32X-CC, 22-27	260.01	R	G		R																
32X-CC	266.60	R	G		R	R	R	R					R	R			R				
33X-1, 61-63	267.21	B																			
33X-2, 59-61	268.69	R	G		R										R						
33X-CC	276.20	B																			
34X-2, 9-14	276.54	R	G		R	R	R	R					F	R	R	R	R	F			
34X-3, 67-71	278.12	R	M		R			R							R			R			NN 16
34X-5, 68-72	280.45	B																			
34X-CC	285.90	R	G		R		R														
35X-2, 7-12	286.60	R	G		R									R	R		R	R			
35X-3, 130-135	289.33	R	G		R	R							F	R	R		R				
35X-4, 69-72	290.22	B																			
35X-CC	295.60	B																			
36X-2, 69-74	297.97	B																			
36X-3,130-135	299.90	B																			
36X-CC	304.90	B																			
37X-1, 59-61	305.49	R	M				R										R	R			
37X-2, 29-31	306.69	B																			
37X-CC	314.50	B																			
38X-CC, 2-4	314.52	C	G		F	F	F	F						F	F		F				
38X-CC	324.20	F	G		C		F	R						R	F			F			
39X-2, 10-13	325.80	R	G		R								F	R	R		R	F			
39X-3,130-133	327.62	R	G	R	R									R	R		R	F			
39X-CC	333.90	F	G	R	F	R	R							R	F						
40X-2, 67-70	336.07	C	G		F	F	F	R						F	F	R					
40X-3,131-134	338.21	B																			
40X-6,132-135	340.74	B																			
40X-CC	343.40	R	G		R													R			
41X-2, 64-69	345.54	R	G				R	R							R		R				
41X-3,127-132	347.67	R	G		R		R								R		R	R			
41X-4, 70-75	348.60	R	G		R									R	R						
41X-CC	353.10	R	G		R	R	R							R	R		R	F			

ODP 141-861C — Planktonic foraminifers

Samples (Core, section, interval in cm)	Number of foraminifers in 20 cm3 sediment	Planktonic foram. %	Preservation	G. hexagonus	B. digitata	N. dutertrei	G. apertura	G. bulloides	T. truncatulinoides	O. universa	G. inflata	G. scitula	G. crassaformis	G. aff. bulloides	G. quinqueloba	G. glutinata	G. cf. inflata	G. crassula	G. conomiozea	N. pachyd. sin.	N. pachy. dex.	Remarks	Planktonic foraminifer zones
17X-2, 29-34	1500	90	M				R	R		R	R	R					R			R		c	G. inflata
17X-CC	C	-	G					F			R		R									c	
18X-2, 60-65	650	80	M					C			C			R		R				R		c	
18X-3, 127-132	400	85	M					C			C			R	R	R				R	R		
18X-4, 59-64	20	50	P																	R			
18X-CC	C	-	G					F			F	R		R						R			
19X-1, 59-64	14000	90	G				R	C			C		R	R				F		F	R		
19X-CC	F	-	G					R			R	R	R										
20X-CC	C	-	G					F			F	R				R		R					
21X-1, 44-49	B	-	-																				
21X-2, 20-25	30	5	P											R									
21X-CC	B	-	-																				
22X-5, 53-55	F	-	M					C		R	R	R	R					R					
22X-5, 73-76	20	30	P																	R	R		
22X-CC	B	-	-																				
24X-CC	R	30	M					F			F		R										
25X-2, 8-12	50	30	M					R						R						R		c	
25X-3, 128-132	300	80	G					R						R				R		A		c	
25X-5, 68-72	B	-	-																				
25X-CC	R	30	P															R		R			
27X-3, 49-54	15	5	P					R						R									
27X-5, 64-69	150	60	P										R	R				R		F		c	
27X-CC	R	-	M					R					R					R		R	R	c	
28X-2, 60-65	150	10	P					F			R	R	R			R						d	
28X-4, 52-57	100	50	P					R				R		R		R	F						
28X-CC	R	-	P					R					R							F			
29X-1, 129-131	10	10	P																		R		
29X-CC	R	-	M					R					R	R						R			
30P-CC																							
31X-2, 12-14	350	35	P								R			R	R						R	c	
31X-2, 130-132	40	10	P					R										R					
31X-3, 72-74	50	50	P					R			R		R						(R)	R		c	
31X-CC	R	-	P								R	R	R					R		R	R		
32X-2, 72-77	50	50	P					R			R		R										
32X-CC, 22-27	1500	70	M					F			R			R	R					F		c	
32X-CC	R	70	M					F												F			
33X-1, 61-63	20	0	-																				
33X-2, 59-61	10	10	P												R								
33X-CC	R	-	M					R			R	R	R	R	R					R			
34X-2, 9-14	350	50	P					R		R	R		R	R						R	R	c	
34X-3, 67-71	150	70	P											R				R		R		c	
34X-5, 68-72	B	-	-																				
34X-CC	R	-	M								R		R		R					F			
35X-2, 7-12	80	50	P					R					R		R					R		c	
35X-3, 130-135	50	60	P					R					R	R						R		c	
35X-4, 69-72	B	-	-																				
35X-CC	R	-	P					R				R								R			
36X-2, 69-74	150	50	P										R							F		c	
36X-3,130-135	B	-	-																				
36X-CC	R	-	P					R			R											c	
37X-1, 59-61	20	40	P					R						R									
37X-2, 29-31	500	30	M					R					R	R				R		R			
37X-CC	R	-	P								R		R					R		R			
38X-CC, 2-4	B	-	-																				
38X-CC	R	-	P					R					R							R			
39X-2, 10-13	60	25	P											R						F			
39X-3,130-133	100	40	P					R			R		R	R						F	R		
39X-CC	R	-	P							R	R	R	R										
40X-2, 67-70	200	50	P					R			R			F						R		c	
40X-3,131-134																							
40X-6,132-135	80	30	P											R						R	R	c	
40X-CC	R	-	P							R	R			R									
41X-2, 64-69	200	30	G								R									R			
41X-3,127-132	400	40	M								R			R									
41X-4, 70-75	30	25	M					R															
41X-CC	B	-	-																				

Note: c = different colors, d = deformed

conditions this occurrence may not always represent the real biostratigraphic event, and the determination of the boundary by using different fossil groups is difficult, and it does not fall in all cases at the same level.

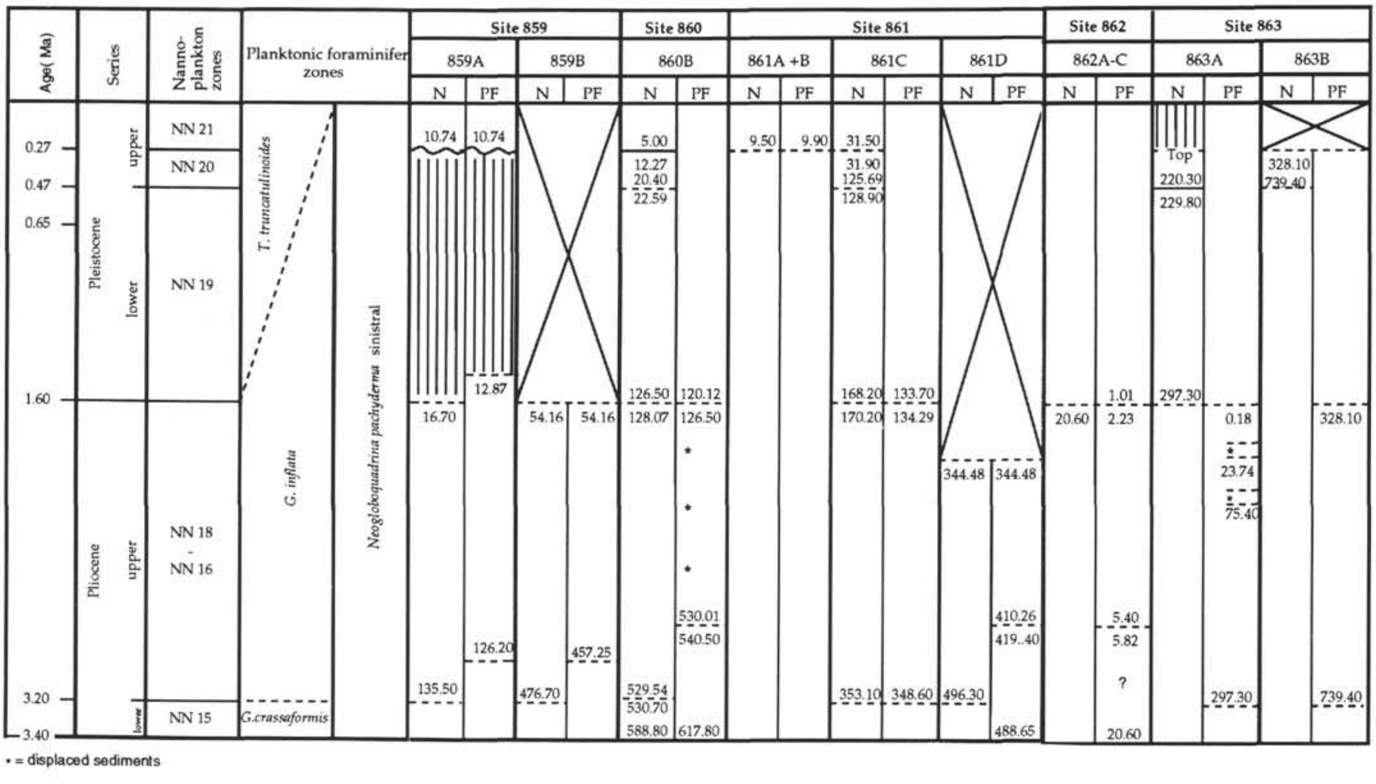
A subdivision of the upper Pliocene sequences is impossible owing to low diversified fossil assemblages. The upper Pliocene is represented by the stratigraphic interval of nannoplankton Zones NN16 to NN18, which corresponds to the foraminiferal zone of *G. inflata*, and ranges in age from 3.2 to 1.6 Ma. The base of the upper Pliocene corresponds to the Zone NN15/NN16 boundary, which is placed together with the *G. crassaformis/G. inflata* foraminiferal Zone boundary at 3.2 Ma (Fig. 5).

The scarcity of the calcareous micro- and nannofossils may be related to dissolution owing to deposition below the CCD or to pressure solution effects within the wedge caused by tectonic deformation. Another factor is dilution by the large amount of detrital material. The

Table 8. Distribution of calcareous nannoplankton and planktonic foraminifers in Hole 861D.

ODP141-861D		Calcareous nannoplankton																Planktonic foraminifers																			
Samples (core, section, interval in cm)	Depth (mbsf)	Abundance	Preservation	B. bigelowi	C. pelagicus	C. leptoporus	C. macintyrei	D. japonica	G. sp.	H. carteri	H. sellii	P. pacifica	P. lacunosa	R. cf. pseudoumbilica	S. mediterranea	S. pulchra	Nannoplankton zone	Number of foraminifers in 20 cm3 sediment	Planktonic foram. %	Preservation	G. bulloides	O. universa	G. inflata	G. scitula	G. crassaformis	G. aff. bulloides	G. quinqueloba	G. cf. inflata	G. crassula	G. praesiphonifera	G. conomiozea	G. pachyderma sin.	G. pachyderma dex.	G. aff. rubescens	G. cf. sphericomiozea	Remarks	Planktonic foraminifer zones
1R-2, 68-71	344.48	C	G		F	R	R			F			C			R	NN 16	1500	50	M	F		F	R		F	R	R					F				G.inflata
1R-3, 127-130	346.57	F	M	R	F		R	R		F	F		R					1250	40	M			R			R						R					
1R-CC	351.90	F	M		F		R			R	F		R			R		R	-	M			F		R												
2R-1, 40-45	352.30	B																6	80	M				R									R				
2R-2, 83-88	354.23	C	R		C	F												1600	85	M	R	R	C		F	R										c	
2R-CC	361.60	R	M		F	R	R		F	F	R		R	R				2	0	P																	
6R-2, 60-63	391.87	R	P		R					R				F		R		600	65	M		R	F	R	R	R										c	
6R-3, 127-130	393.17	B																12	10	P					R												
6R-CC	400.10	F	R		R		R			R		T	R	F				R	-	P	R			R	R	R						R					
7R-1, 35-38	400.45	A	G		C		F	R		C			C	R				1200	65	M		R	F	R	R	R											
7R-2, 70-73	402.30	C	G		C		R	R		F			F	F				700	50	M		F		R	R	R				R							
7R-3, 130-133	404.25	C	G		R	F	F			F	F				R	R		1000	80	M		R	R	R	R	R	R	R	R			R					
7R-CC	409.80	C	G		F	F	F	R					F					R	-	P			R		R	R						R					
8R-1, 46-51	410.26	C	G	T	F	R	R			F		R		F		R		500	60	M			R	R	R	R								R			
8R-CC	419.40	C	G	T	F		F		F			T	C	T	R			R	-	P	R	R															G.crassaformis
9R-1, 120-122	420.60	F	M		F		R			F				R		T		500	80	M		R		R		F	R		R			R					
9R-CC	429.10	C	G	R	C	F	F	R					R					R	-	P						R					R	R					
10R-1, 17-22	429.27	B																B	-	-																d	
10R-CC	438.80	B																R	20	P		R				R	R						R				
11R-1, 43-48	439.23	B																50	80	M												R					
11R-2, 52-57	440.52	F	M		F			R		F	R							50	20	P	R	R				R											
11R-CC	448.50	F	G		F				R				F	F				R	-	P						R											
12R-1, 86-91	449.36	C	G	F	F		F	R				R		F	R			1000	80	M		R		R	R	F						R		R	R		
12R-3, 77-82	451.77	C	G	T	F		F	R				R	R	F				1200	80	M		R		R	R	F	R			R				R			
12R-CC	458.10	C	G	T	F	F	F	F	F	R			C	F		R		R	-	P		R			R	R						R					
13R-1, 73-76	458.83	R	P		F			R										1000	30	M					R	R											
13R-3, 60-63	461.13	R	P		R													B	-	-																	
13R-CC	467.70	R	P		R		R		R				R					R	-	P					R							R			R		
14R-1, 52-57	468.22	F	M		F		R			R	F		R	F				B	-	-																	
14R-CC	476.30	T	M		T					T								B	-	-																	
15R-2, 40-45	477.70	B																100	60	P				R	R	R											
15R-CC	486.00	R	M	T	F									T				R	-	P					R							R					
16R-2, 35-40	487.85	R	M		R		R											B	0	P																	
16R-3, 50-55	488.65	R	M		R		R			R								150	60	P		R				R							R				
16R-CC	496.30	T	M		R	R	R	T		R	C	F	T	F				R	0	P																	

Note: c = different colors, d = deformed



• = displaced sediments

Figure 4. Biostratigraphy of Sites 859 through 863 based on calcareous nannoplankton (N) and planktonic foraminifers (PF).

Table 9. Distribution of calcareous nannoplankton and planktonic foraminifers in Holes 862A, 862B, and 862C.

ODP 141-862A Samples (Core, section, interval in cm)	Depth (mbsf)	Calcareous nannoplankton: Abundance	Preservation	C. pelagicus	C. leptoporus	C. macintyrei	G. sp.	H. carteri	P. lacunosa	Nannoplankton zone	Planktonic foraminifers: Numbers of Forams in 20 cm3 sediment	Plankt. foram. %	Preservation	G. hexagonus	B. digitata	N. dutertrei	T. truncatulinoides	G. apertura	G. bulloides	G. cf. bulloides	G. inflata	G. scitula	O. universa	N. pachyderma dex.	N. pachyderma sin.	G. crassaformis	Remarks	Planktonic foraminifer zones
1H-1, 14-18	0.14	B									1000	95	G	R	R	R	F	R	C		R	R	R	R				T. truncatulinoides
1H-1, 18-21	0.18	B									1000	95	G	R	R	R	R	F	A	R	R	R	R		R			
1H-1, 62-64	0.62	B									100	80	M							R		R		R	R			
1H-1, 88-91	0.88	B									8	-	P												R			
1H-1, 101-104	1.01	B									50	80	M				R		R	R	R			R	R			
1H-2, 73-76	2.23	T	M	T	T						250	90	G							R				F	F			N. pachyderma sinistral
1H-2, 131-134	2.81	B									500	90	M							R		R		F	C	R	c	
1H-4, 31-34	4.81	B									25	10	M												F			
1H-CC	5.40	B									5	-	M							R	R			R				
2H-1, 42-43	5.82	B									100	60	P												C		c	
2H-1, 95-97	6.35	B									3	-	G												R			
2H-4, 103-105	10.93	B									50	95	P											R	F		c	
2H-5, 80-82	12.20	B									0	-																
2H-6, 111-113	14.01	T	M	T				T			15	95	P												R			
2H-CC	14.90	B									0	-																
3H-1, 38-41	15.28	B									1	-												R				
3H-2, 60-63	17.00	B									5	-													R			
3H-4, 48-51	19.88	B									1	0																
3H-4, 85-88	20.25	B									0	-																
3H-4, 106-109	20.46	B									0	-																
3H-CC	20.60	F	M	F	R	T	R	R	R	NN16-18	100	90	M						R						R	R	c	
4H-CC	21.10	B									0	-																
ODP 141-862B																												
2X-1, 96-98	18.46	B									0	-													R			N. pach.
2X-CC	27.10	B									15	90	M															
ODP 141-862C																												
1W-1.10-12	-	B									25	10	G						R						R			N. pach.
1W-1.32-39	-	B									50	5	G							R						R		
6R-1, 37-39	Piece 6	B									0																	

Note: c = different colors.

generally poorly diversified assemblages can also be explained by cold surface-water. However, the fossil assemblages observed within the uppermost meters of the sequences indicate the influence of warmer surface-water off southern Chile in further times. Planktonic foraminifers from Leg 141 sites are documented on Plate 1.

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*Abbreviations for names of organizations and publications in ODP reference lists follow the style given in *Chemical Abstracts Service Source Index* (published by American Chemical Society).

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Table 10. Distribution of calcareous nannoplankton and planktonic foraminifers in Hole 863A.

ODP 141-863A		Calcareous nannoplankton															Planktonic foraminifers																					
Samples (Core, section, interval in cm)	Depth (mbsf)	Abundance	Preservation	*B. bigelowi*	*C. pelagicus*	*C. leptoporus*	*D. japonica*	*E. huxleyi*	*G. caribbeanica*	*G. ericsonii*	*G. oceanica*	*H. carteri*	*H. sellii*	*P. lacunosa*	*S. pulchra*	Nannoplanton zones	Numbers of foraminifer s in 20 cm3 sediment	Plankz. foram. %	Preservation	*G. inflata*	*G. crassaformis*	*G. cf. bulloides*	*G. quinqueloba*	*G. bulloides*	*N. pachyd.* sin.	*N. pachyd.* dex.	*G. apertura*	*O. universa*	*T. truncatulin.*	*G. scitula*	*G. hexagonus*	*N. dutertrei*	*G. aequilateralis*	*G. glutinata*	*G. crassula*	*G. cf. inflata*	Remarks	Planktonic foraminifer zones
1H-1, 18-20	0.18	B															3400	90	G	F	F	R	R		F	C											c	
1H-1, 64-67	0.64	B															750	75	G	R		R	C	R	R	R	R											
1H-2, 129-132	2.79	T	G			T				T							2000	80	G	C	R	C	R	F	C		R											
1H-3, 37-39	3.37	B															800	90	M	R	R		R	F	R	R	R											
1H-3, 66-68	3.66	B															700	80	M	R	R	R	R	F	F	R											c	
1H-3, 107-109	4.07	B															500	50	M	R	R	R	R	R	R												c	
1H-3, 127-129	4.27	B															100	50	P	R		R			R													
1H-4, 110-113	5.60	F	G			R				F	R						150	10	G						R												c	*G. inflata*
1H-5, 83-86	6.83	B															65	5	G	R																		
1H-6, 69-72	8.19	R	G		F					F	T						2500	90	G	C	R	C	R	F	C	R	R										c	
1H-CC	8.60	B															3000	75	G	F	R	R		F	R	R	R	R		R								
2H-2, 62-65	10.72	R	G		R	R				F							3500	95	M	F		R		C	F	R											c	
2H-3, 130-133	12.90	R	G		T	F				F		T					1000	80	M	R		F	R	F	R	R											c	
2H-5, 70-73	15.30	A	G	T	T	A					R	C			R		10000	95	G	C			R	F			C	F	R	R								
2H-CC	18.10	B															1000	80	M	F		R		C	R	R	R	R		R								*T. trunc.*
3H-1, 18-23	18.28	B															3000	85	G	F	R	R	F	C	R			R										?
3H-2, 89-94	20.49	B															25	80	M		R		R		R	R												
3H-3, 124-129	22.34	F	G			F				C	F	R					2500	90	G			R	R	C		R	R	F			R	R						
3H-4, 16-21	22.76	C	G	R	T	C	T			F	C	C			R		10000	95	G	R		F	F	C				F	R	R		R						*T. trunc.*
3H-4, 114-119	23.74	B															32000	90	G	F	R	R	F	A	R	R	R	C	R	R	R	R	R					
3H-CC	27.60	B															250	60	M	R	R	R	R	R	R	R				R							c	
4H-1, 17-22	27.77	T	G		T					R		T					2000	75	G	F	R		R	F		F											c	
4H-1, 114-119	28.74	B															1000	50	G	R	R			R	R	R											c	
4H-2, 12-17	29.22	T	G		T	T											500	75	M	F		C	R		F													
4H-CC	37.10	R	G		R												500	50	M	R	R	F		F		R												
5H-1, 130-133	38.40	T	G	T	T					T		T					5	-	M	R				R													c	
5H-2, 71-74	39.31	B															100	50	M	R		R	R			R				R							c	
5H-3, 16-21	40.26	T								T		T					300	40	G	R	R		F		R	R												
5H-CC	46.60	B															300	30	M	F	R			R													c	
6H-1, 65-70	47.25	R	G	R	R				R							NN 20	75	90	M	C			F		R												c	
6H-CC	56.10	B															100	80	M	F				F	R	R		R		R							c	*G. inflata*
7X-1, 57-60	56.67	T							T								100	90	M				R	R	F												c,d	
7X-2, 69-74	58.29	B															10	-	M						R					R								
7X-3, 129-134	60.39	B															B																					
7X-4, 138-143	61.98	R	G		F	R				C	R						2000	80	G	F			R	C			R											
7X-5, 88-93	62.98	R	G		R	R					R						75	80	M	F		C		R													c	
7X-CC	65.50	T	G		T				T								300	50	M	R		R	R	F	R	R												
8X-1, 137-139	66.87	C	G		F	F				F	F	F			R		500	90	M		R	C		R														
8X-3, 3-5	68.53	A	G		R	F				C	F				R		800	90	G	F				C	R	R	R		R			R		R				
8X-4, 65-67	70.65	F	G		R	F				C	R	R					5500	95	G	F				A		R				R								*T. trunc.*
8X-CC	75.40	F	G		R	R				R	T	R					3000	90	G	A	R			C				R	R									
9X-1, 54-59	75.94	T	G			T				R							2500	90	G	F	F	R		F	R												c	
9X-CC, 16-21	76.31	C	G		R	R				C		R					250	85	G	R				R	F										R			
9X-CC	85.10	T	G		T					T							300	80	G	R	F	R	R	C	F	F				R					R			
10X-CC	94.70	B															B																					
11X-CC	104.40	B															B																					
14X-2, 50-55	125.20	B															B																					
14X-CC	133.40	B															10	-	P	R																		
15X-CC	143.00	B															B																					
16X-CC	152.70	R	G		R					R					T		20	-	P	R	R			R														
17X-CC	162.40	B															B																					
18X-CC	172.00	R	M							R							B																					
19X-CC	181.60	B															B																					
20X-CC	191.30	B															4		P	R	R																	
21X-1, 15-18	191.45	B															40	50	P			R			R										R		c	
21X-CC	200.90	B															R		P						R													
22X-CC	210.60	B															B																					
23X-CC	220.30	B															R	10	P						R													
24X-1, 3-5	220.33	F	G							F		R					75	30	M	R					R									R				
24X-CC	229.80	C	G		R					C		R		R			50	80	P	R	R	R			R									R				*G. inflata*
25X-2, 20-23	230.53	F	G	T	F	F				F				R			50	20	P	R						R									R			
25X-CC	239.50	A	G		F	F				C		F		F			100	50	P	R					F	F												
26X-1, 50-53	240.00	C	G		F	F				C	R	F		F			400	50	M	F					R	R										R		
26X-CC	249.20	A	G		F	F				C		F		F			400	60	P	R	R			R	R	R				R								
27X-1, 29-32	249.49	B	G								R				R		600	95	M	R	R	C	F							R						R		
27X-CC, 33-38	250.45	F	G		R					C	R	R		F			500	95	M	R		R		R	R									R				
27X-CC	258.80	C	G		F	F				C		F		F			350	90	P	R	R	R			R	R				R						R		
28X-1, 91-96	259.71	F	G		R	F				F	R	R		R			300	95	M	R	R	R		R										R		R		
28X-CC, 15-20	260.21	B															300	50	G	R				R												R		
28X-CC	268.40	C	G		F	F				C	R			R		NN 19	100	10	P		R				R	R												
29X-1, 53-58	268.93	F	G							F					T		100	10	P			R			R													
29X-CC, 15-20	270.01	B															50	0	-																			
29X-CC	278.10	R	G							R		R		R			100	80	M	R		R														R		
30X-1, 38-42	278.48	B															250	85	M	R		R			F											R		
30X-2, 39-43	279.99	F	G		T	R				F		R		R			10	-	M				R	R														
30X-CC	287.60	B															100	70	P	R					R	R				R						F	c	
31X-1, 22-27	287.82	R	G							R		R		R			25	90	P						R												c	
31X-CC	297.30	F	G			R				F	R	R		R			150	90	P	R																R	c	

Note: c = different colors, d = deformed.

Table 11. Distribution of calcareous nannoplankton and planktonic foraminifers in Hole 863B.

ODP 141-863B		Calcareous nannoplankton									Planktonic foraminifers														
Samples (core, section, interval in cm)	Depth (mbsf)	Abundance	Preservation	*C. pelagicus*	*C. leptoporus*	*G. caribbeanica*	*G. ericsonii*	*G. oceanica*	*H. carteri*	*S. mediterranea*	Nannoplankton zone	Numbers of foraminifer in 20 cm3 sediment	Plankt. foram.%	Preservation	*G. inflata*	*G. crassaformis*	*G. crassula*	*N. pachyderma* sin.	*N. pachyderma* dex	*G. scitula*	*G.* cf. *bulloides*	*G. quinqueloba*	*O. universa*	*G. glutinata*	Remarks	Planktonic foraminifer zones
4X-2, 70-73	328.10	F	G	T			F					50	85	M	F		R	R								
4X-3, 52-55	329.42	R	G				R					50	60	M	R				R	R	R	R				
4X-5, 48-51	332.38	F	G	R	R		F					10	-	P			R	R	R							
4X-CC	335.60	F	G									25	-	P	R	R		R								
5X-CC	345.20	F	G	R			F		R			20	-	P		R		R			R					
6X-CC	354.90	F	G	R	R		F					300	90	M	R	R		F			F		R		s	
7X-1, 71-73	355.61	F	G	F	R		C	T				500	95	M	F		R	F			F			R	s	
7X-CC	357.40	B										10	-	P				R								
8X-CC	361.40	C	G	R			C		R			0														
9X-CC	371.00	C	G	R			C		R			0														
10R-1, 45-48	371.45	R	G	R			R					25	-	M	R	R										
10R-CC	376.60	B										0														
11R-1, 47-49	377.07	F	G	R	R		F					2500	95	G	F			A			R	R		R	c	
11R-CC	386.30	B										0														
12R-CC	395.80	B										2	-	P	R										s	
13R-1, 46-48	396.26	R	G	R			R					3	-												s	
13R-CC	405.50	B										0														
14R-CC	415.20	B										4		P	R										s	
15R-CC	424.70	F	G	R			C					10				R									d	
16R-CC	434.40	F	G	R	R		F	R				20		M	F	R		R							s	
17R-2, 46-49	436.36	F	G	R	R		F					13000	90	P	C	F		R			C				s,d	
17R-4, 14-16	439.04	B										1500	90	P	R			R	R		C				s	
17R-6, 3-7	441.93	C	G	F	R	R	C					6000	80	P	F	R		F			C				s,d	
17R-CC	444.00	C	G	R		F	C					0														
18R-1, 100-104	445.00	C	G	F	R		C	R				10000	90	P	C	F	R	R	R		A				s,d	
18R-3, 82-86	447.82	C	G	F	R		C					2500	90	P	F	R	R	R			A				s,d	
18R-CC	453.70	F	G	R	R	F	F					80	100	P	R			R							s	
19R-3, 80-83	457.50	C	G	R	R	C	F	R				250	90	M	F			R			R				s,d	
19R-CC	463.40	C	G	R	R	F	C	R				200	90	M	F	R		R							s,d	
20R-2, 83-85	465.59	F	G	R	F	F	F					300	90	P	F						R	R			s	
20R-CC	473.00	R	M			F	R					10	90	P	R	R									s	
21R-CC	482.70	F	G	R	R	F	F					25	20	P	R										s	
22R-CC	492.40	C	G	R	R	F	C	R				50	80	P	F	R		R							s	
23R-4,79-83	497.69	C	G	R	R		F	R	R		NN 20	50	80	P	R	R		R			R	R			s	
23R-CC	502.00	B										3	-	P	R	R					R				s	
24R-CC	511.70	B										1	-	P	R										s	*G. inflata*
25R-CC	521.40	F	G	R	R	F	F	R				20	50	P	R						R		R		s	
26R-1, 7-9	521.47	C	G	C			F	R	F			10	-	P	R						R					
26R-2, 50-53	522,45	C	G	C	R	C			F			200	80	P	R			R			C				s,d	
26R-CC	530.60	C	G	F	R	F	C					25	50	P	R						R		R		s,d	
27R-01, 71-74	531.31	B										25	80	P	R	R		R							s	
27R-CC	540.20	B										30	50	P	R			F								
28R-CC	549.70	C	G	R	R	F	C	R	R	R		1	-	G	R											
29R-CC	559.40	C	G	R	R	F	C	R	R			50	90	G	F	R					R				s	
30R-CC	569.10	C	G	F	R	F	C	R				1000	90	G	F	R	R				C		R	R	s	
31R-CC	578.80	C	G	R	R	F	C	R	R			25	90	P	R	R									s	
32R-CC	588.40	B	G									10	0	P											s	
33R-CC	598.10	F		R	R	F	F		R	R		10	-	P	R			R							s	
34R-CC	607.70	B	G									0			R											
35R-6, 45-47	615.65	F		R	R	F	F		R			5	-	P	R						R				s	
35R-CC	617.40	B	G									0														
36R-CC	627.00	F	G	R	R	F	F	R				2	-	P	R			R								
37R-CC	636.60	R	G				R					2	-	P	R										s	
38R-CC	646.30	C	G	R	R	F	C	R				0														
39R-CC, 4-10	650.34	B										100	80	P	R						R				s,d	
39R-CC	655.90	F	G	R	R		F					50	-	P	R			R	R		R				s	
40R-1, 45-48	656.35	R	G		R		R					200	80	P	F	R		F			F				s,d	
40R-3, 84-88	659.44	R	M				R					200		M	F	R		F					F		s,d	
40R-CC	665.50	F	G				F					100	80	P	R	R		R							s	
41R-2, 92-95	667.92	R	G	R			F		R			150	80	P	F			R							s	
41R-4, 32-36	670.32	F	G	R	R		F					250	90	P	C						R				s,d	
41R-CC	675.20	C	G	R	R	F	C					100	95	P	F	R		R							s	
42R-CC	684.80	C	G	R	R	C	C	R	R			100	95	P	F	R									s	
43R-3, 47-52	687.77	F	G	R			F					50	90	P	R			R							s,d	
43R-CC	694.50	C	G	R	R	C	C		R			150	95	M	C						R				s	
44R-CC	704.20	C	G	R	R	C	C					5	-	P	R						R				s	
45R-CC	706.80	C	G	R	F	C	C					4	-	P	R										s	
46R-CC	713.80	C	G	R	R	C	C	R	R			0														
47R-CC	723.50	C	G	R	R	C	C					0														
48R-CC, 20-22	725.69	C	G	F	F		C	R				100	90	P	R			R			R			R	s	
48R-CC	733.20	C	G	R	R	C	C					50	90	P	F						R				s	
49R-1,19-22	733.39	C	G	F	F		C		R			100	90	P	F	R		F			R				s	
49R-CC	739.40	C	G	R	R	C	A	R				100	80	M	F	R					R				s	

Note: c = different colors, d = deformed, s = silicified.

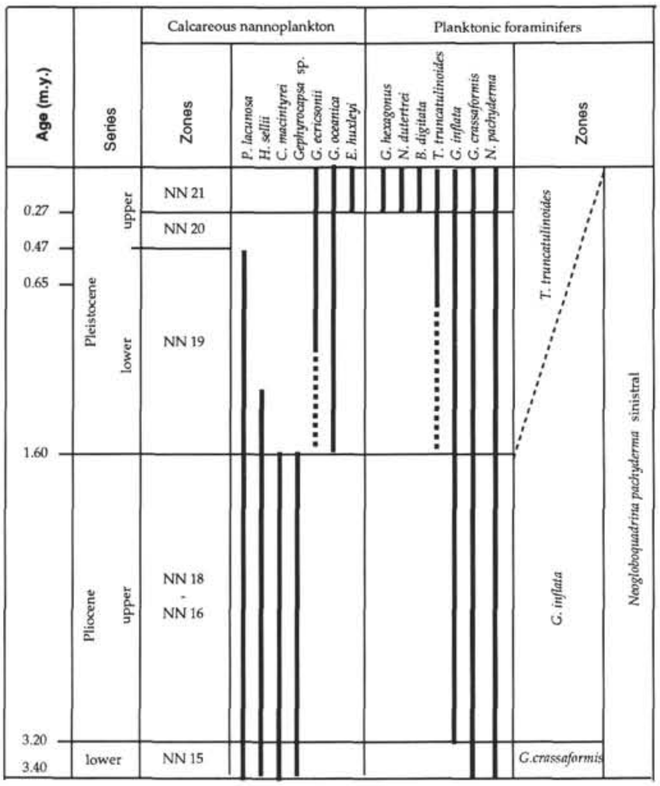

Figure 5. Range chart of Leg 141 index species.

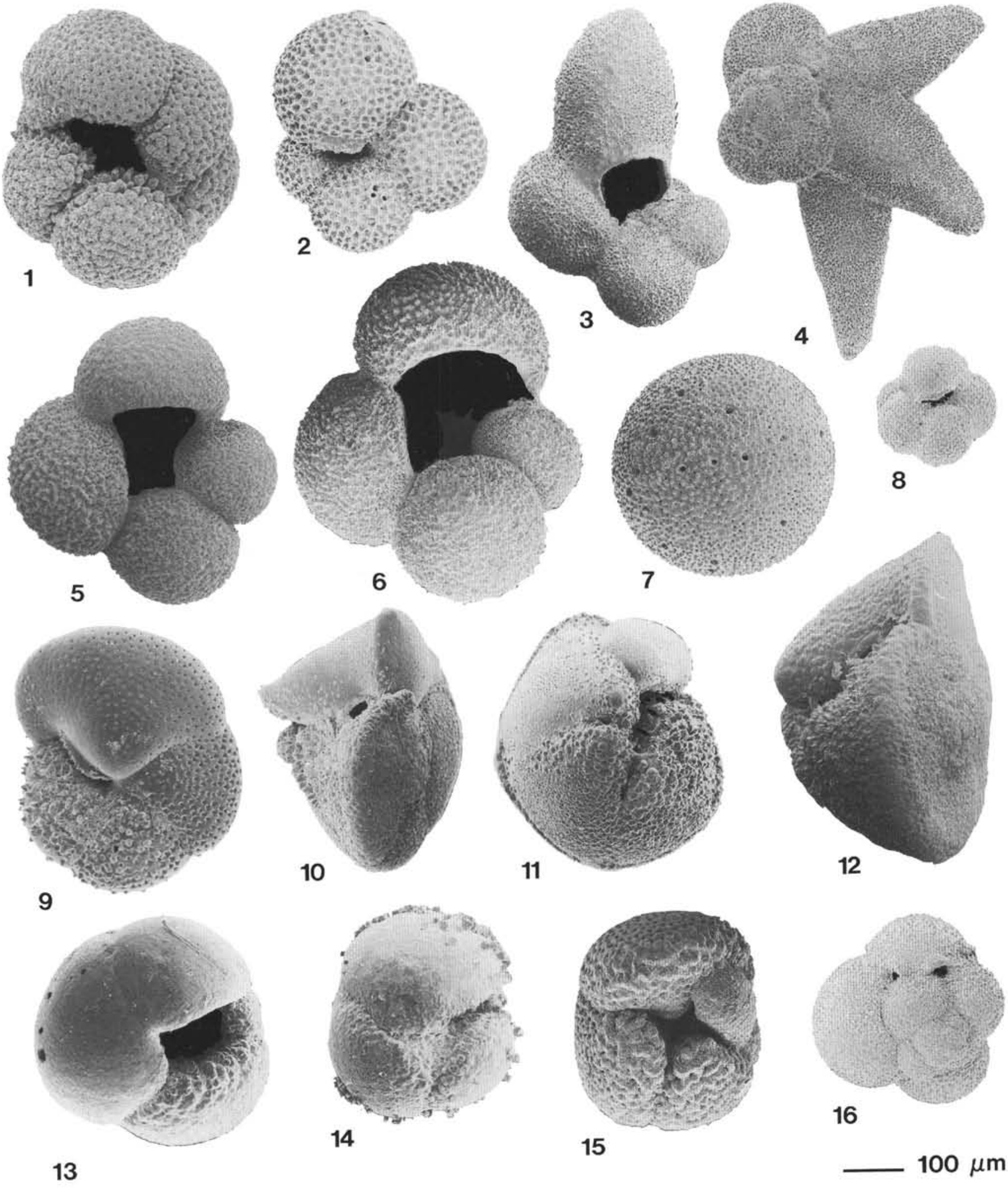

Plate 1. Pleistocene planktonic foraminifers from Leg 141 sites. **1.** *Neogloboquadrina dutertrei* (Orbigny, 1839); Sample 141-861C-1H-1, 45–49 cm. **2.** *Globorotaloides hexagonus* (Natland, 1938); Sample 141-862A-1H-1, 14–18 cm. **3, 4.** *Beella digitata* (Brady, 1879). (3) Sample 141-861C-1H-CC, (4) Sample 141-862A-1H-1, 18–21 cm. **5.** *Globigerina bulloides* Orbigny, 1826; Sample 141-861C-1H-1, 45–49 cm. **6.** *Globigerina apertura* Cushman, 1918; Sample 141-861C-1H-CC. **7.** *Orbulina universa* Orbigny, 1839; Sample 141-861C-15X-2, 6–10 cm. **8.** *Turborotalia quinqueloba* (Natland, 1938); Sample 141-861C-3H-CC. **9.** *Globorotalia scitula* Brady, 1882; Sample 141-8612A-1H-1, 14–18 cm. **10–12.** *Truncorotalia truncatulinoides* Orbigny, 1839; (10) Sample 141-862A-1H-1, 18–21 cm, (11–12) Sample 141-861C-1H-CC. **13–14.** *Globoconella inflata* (Orbigny, 1839), (13) Sample 141-861C-4H-4, 109–114 cm, (14) Specimen covered with carbonate appositions, Sample 141-862A-1H-1, 18–21 cm. **15.** *Globorotalia crassaformis* (Galloway and Wiesner, 1927); Sample 141-861C-16X-4, 30–35 cm. **16.** *Globigerinita glutinata* (Egger, 1893) with two supplementary apertures on the spiral sutures of the final chamber as shown at tropical *Globigerinita parkerae* (Bermudez, 1961); Sample 141-861C-3H-2, 70–75 cm.