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7. Neogene Planktonic Foraminiferal Biostratigraphy of the Japan Trench, ODP Leg 186[1]

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ABSTRACT

The planktonic foraminiferal biostratigraphy of Sites 1150 and 1151 drilled in the Japan Trench region during Ocean Drilling Program Leg 186 has been examined. At these drill sites, more than 1100 m of sediment, reaching to the middle Miocene, were obtained with good core recovery. Although planktonic foraminiferal records of the two sites are discontinuous, probably because of carbonate dissolution beneath the carbonate compensation depth, 16 stratigraphically important taxa of planktonic foraminifers were detected. Eight biohorizons were recognized in same stratigraphic order between these two sites. With respect to the diatom data, these eight planktonic foraminiferal biohorizons are possibly synchronous for correlating marine strata from the upper Miocene to Pleistocene in the Japan Trench region. The last occurrence of *Neogloboquadrina asanoi* falls within Olduvai Subchron. Therefore, the Pliocene/Pleistocene boundary of both sites is situated a little above this biohorizon.

INTRODUCTION

The scientific objective of Ocean Drilling Program (ODP) Leg 186 is to investigate past and present tectonic and paleoceanographic conditions of the Japan Trench region (Sacks, Suyehiro, Acton, et al., 2000). For this objective, integration of various stratigraphic data, including biostratigraphy, magnetostratigraphy, and volcanic ash stratigraphy, is required.

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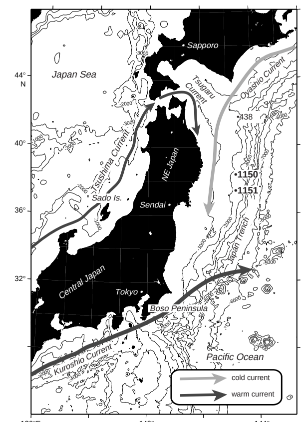
Previous studies of foraminiferal biostratigraphy based on deep-sea drilling sites in the Japan Trench region were conducted at six sites (Sites 434, 435, and 436 of Leg 56 and Sites 438, 439, and 440 of Leg 57) of the Deep Sea Drilling Project (DSDP) (Thompson, 1980; Keller, 1980). The foraminiferal records of those sites were discontinuous probably owing to carbonate dissolution beneath the carbonate compensation depth (CCD) (Keller, 1980). Despite such discontinuities, a number of foraminiferal biohorizons have been recognized at those sites and some of these biohorizons, namely, the first and last occurrences of *Globoquadrina asanoi* (= *Neogloboquadrina asanoi*) and the evolutional lineage of *Globorotalia inflata* group, have been correlated with Japanese onland sections (Keller, 1980).

Sites 1150 and 1151 of Leg 186 are located on the deep-sea terrace along the Japan Trench (Site 1150: 39°11′N, 143°20′E, water depth = 2680 m; Site 1151: 38°45′N, 143°20′E, water depth = 2180 m) (Fig. **F1**). These sites are located in an active plate subduction zone where the oldest part of the Pacific plate (>100 Ma) is being subducted (Sacks, Suyehiro, Acton, et al., 2000). In addition, these sites are well located for monitoring the paleoceanographic change of the North Pacific because of their position relative to both warm Kuroshio and cold Oyashio Current systems (Fig. **F1**). At Site 1150, ocean-bottom sediments down to a subbottom depth of 1182 meters below seafloor (mbsf) were obtained. The cored sequence reached to the upper Miocene with an average recovery rate of 70%. At Site 1151, the core penetrated to 1113 mbsf and reached to the middle Miocene with an average recovery rate of 68%.

F1. Index map, p. 10.



We report a preliminary planktonic foraminiferal biostratigraphy based on Neogene sediments from Sites 1150 and 1151 during ODP Leg 186. We then correlated our results with diatom biostratigraphic data, which we consider to be the best biostratigraphic scheme in the northwest Pacific realm, to estimate the reliability of each planktonic foraminiferal biohorizon.

MATERIAL AND METHODS

Samples used for this study came from recovered cores following the rule of 1–3 samples per one core. We treated 122 samples obtained from Holes 1150A and 1150B and 135 samples from Hole 1151A, ranging in age from Holocene to the middle Miocene. The major lithologies of both sites are composed of diatomaceous silty clay with intercalations of minor lithologies such as volcanic ash, sand, and silt layers (Sacks, Suyehiro, Acton, et al., 2000). These lithologies of the present sites gradually become firmer with increasing depth and are identified as four lithologic units (I, II, III, and IV). The sediment samples of the present sites yield abundant siliceous biogenic grains with rare or few calcareous biogenic ones.

Dried sediments (20 cm^3) were disaggregated using a sodium sulfate solution and naphtha, and occasionally the sodium tetraphenylborate method (Hanken, 1979) for very hard rocks. After the samples became macerated, each sample was gently wet sieved through a 200-mesh screen (74-µm opening) and oven-dried. Planktonic foraminiferal specimens >125 µm were taken from the dried residues. If a sample contained a large amount of planktonic foraminifers (>500 individuals), the dried residues were split into 2–16 aliquots by using a sample splitter. Semiquantitative estimates of stratigraphically important taxa were made of the relative abundance (very abundant: ≥20%, abundant:

≥10%, common: ≥5%, rare: <5%) for each sample yielding more than a total of 100 individuals. Stratigraphically important taxa from samples yielding less than a total of 100 individuals were recorded as "+" in occurrence tables. Other taxa were not recorded. Scanning electron microscope (SEM) photographs of some important species were taken by a field-emission-type SEM (JSM-6330F: JEOL Co. Ltd., Tokyo, Japan).

Based on the stratigraphic distributions of selected foraminiferal species, we recognized biohorizons such as the first occurrence (FO) and last occurrence (LO). We recognized each biohorizon between the sample showing the base or top of the occurrence and the nearest sample yielding more than a total of 100 individuals. A biohorizon might have an ambiguous range in its stratigraphic position associated with the distance of the nearest significant sample owing to the sampling interval and the state of the foraminiferal preservation.

RESULTS

Site 1150

The sedimentary sequence at Site 1150 yields common to rare planktonic foraminifers, with the exception of the upper part of Subunit IA, where foraminifers are abundant (Table T1). This sequence includes 10 intervals barren of planktonic foraminifers (Fig. F2), especially in Subunit IIIC. The preservation of foraminiferal tests is generally poor to moderate, due to slight deformation and agglutination by secondary calcification.

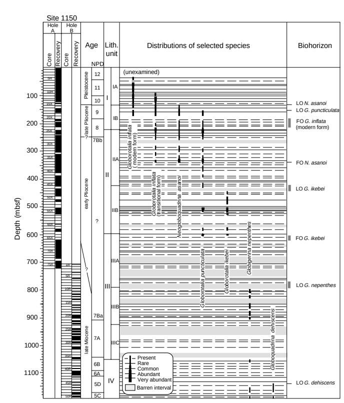
We identified seven stratigraphically important taxa of planktonic foraminifers from 94 samples from Holes 1150A and 1150B (Table T1). The fauna of Site 1150 is characterized by abundant occurrences of *Neogloboquadrina* spp. throughout the sequence. A few specimens of the tropical to subtropical species such as *Globigerina nepenthes* and *Globoquadrina dehiscens* sporadically occur. According to stratigraphic distributions of fossil species (Fig. F2), eight biohorizons are recognized for Site 1150 in descending stratigraphic order as follows: the LO of *Neogloboquadrina asanoi* is recognized between Samples 186-1150A-14X-5, 42–44 cm, and 16X-1, 40–44 cm, around the boundary between Subunits IA and IB. The LO of *Globorotalia puncticulata* is detected between Samples 186-1150A-17X-2, 40–42 cm, and 18X-4, 38–42 cm, in the Subunit IB. The FO of *Globorotalia inflata* (modern form) is present between Samples 186-1150A-18X-4, 38–42 cm, and 25X-2, 40–44 cm, in Subunit IB. The FO of *N. asanoi* is identified between Samples 186-1150A-36X-6, 40–42 cm, and 39X-4, 40–42 cm, in Subunit IIA. The LO of *Globorotalia ikebei* is recognizable between Samples 186-1150A-44X-6, 40–44 cm, and 48X-6, 39–43 cm, in Subunit IIB. The FO of *G. ikebei* is found between Samples 186-1150A-64X-2, 39–42 cm, and 66X-6, 40–43 cm, just below the boundary of Subunits IIB and IIIA. The LO of *G. nepenthes* is recognized between Samples 186-1150B-7R-1, 40–44 cm, and 11R-1, 40–43 cm, near the boundary of Subunits IIIA and IIIB. The LO of *G. dehiscens* is detected between Samples 186-1150B-45R-2, 40–42 cm, and 46R-4, 39–41 cm, in Unit IV.

Site 1151

Planktonic foraminifers of Site 1151 are more abundant than those of Site 1150, generally common to abundant (Table T2), with the excep-

T1. Stratigraphically important taxa of planktonic foraminifers, Site 1150, p. 15.

F2. Stratigraphic distributions of selected planktonic foraminifers, Site 1150, p. 11.

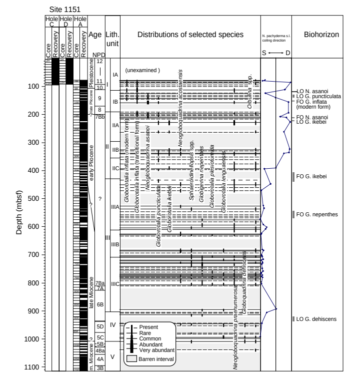


T2. Stratigraphically important taxa of planktonic foraminifers, Site 1151, p. 18.

tion of 11 intervals of barren of planktonic foraminifers (Fig. F3). The preservation of foraminiferal fossils is generally moderate, due to slight deformation and agglutination by secondary calcification.

We detected 16 stratigraphically important taxa from 87 samples from Hole 1151A (Table T2). The planktonic foraminiferal faunas of this site are dominated by *N. pachyderma* (sensu lat.), *Globigerina bulloides,* and *Globigerinita glutinata* throughout the sequence. Tropical key species such as *G. dehiscens, Globorotalia plesiotumida,* and *Sphaeroidinellopsis* spp., sporadically occur (Fig. F3). Eight biohorizons are recognized for Site 1151 in descending stratigraphic order as follows: the LO of *N. asanoi* is recognized between Samples 186-1151A-6R-1, 42–45 cm, and 7R-3, 40–44 cm, just below the boundary between Subunits IA and IB. The LO of *G. puncticulata* is detected between Samples 186-1151A-7R-3, 40–44 cm, and 9R-1, 40–43 cm, in Subunit IB. The FO of *G. inflata* (modern form) is present between Samples 186-1151A-9R-3, 40–43 cm, and 10R-5, 40–44 cm, in Subunit IB. The FO of *N. asanoi* is identified between Samples 186-1151A-16R-1, 40–43 cm, and 16R-3, 40–43 cm, in Subunit IIA. The LO of *G. ikebei* is recognizable between Samples 186-1151A-16R-5, 40–44 cm, and 18R-1, 40–43 cm, in Subunit IIA. The FO of *G. ikebei* is found between Samples 186-1151A-35R-1, 55–57 cm, and 41R-1, 38–41 cm, in Subunit IIC. The LO of *G. nepenthes* is recognized between Samples 186-1151A-50R-1, 40–43 cm, and 54R-1, 39–43 cm, in Subunit IIIA. The LO of *G. dehiscens* is detected between Samples 186-1151A-89R-3, 40–43 cm, and 92R-5, 40–44 cm, in Unit IV.

F3. Stratigraphic distributions of selected planktonic foraminifers, Site 1151, p. 12.



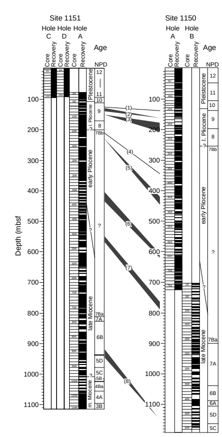
AGE ASSIGNMENT

The LO of *N. asanoi* ([1] of Fig. F4; Table T3) has been chronologically determined to be in the base of the Olduvai Subchron at Lamont-Doherty Earth Observatory drilling Site RC10-161 in the North Pacific (Maiya, 1978) and the Boso Peninsula (Oda, 1979). The top of the Olduvai Subchron is just above the Pliocene/Pleistocene boundary (Berggren et al., 1995a, 1995b). The LO of *N. asanoi* at both Sites 1150 and 1151 is also consistent with a position just below the Pliocene/Pleistocene boundary. This consideration is supported by the diatom results of both sites corresponding to the upper part of Zone NPD 9 (top boundary: 2.0 Ma) (Yanagisawa and Akiba, 1998).

Planktonic foraminiferal zonation and determination of each zonal boundary are difficult at Sites 1150 and 1151 because only seven stratigraphically important species occur and their ranges are discontinuous. According to Kennett and Srinivasan (1983), *G. puncticulata* occurred from the early to late Pliocene. Therefore, Subunits IIB and IIA of Site 1150 and Subunits IIC and IIA of Site 1151, containing *G. puncticulata,* might have a Pliocene age.

Globorotalia plesiotumida, Neogloboquadrina acostaensis, and *Neogloboquadrina praehumerosa* appeared in the late Miocene period (Kennett and Srinivasan, 1983; Natori, 1976), whereas *Globorotalia lenguaensis* disappeared (Berggren et al., 1995a, 1995b) in the same period. Therefore, Subunits IIIC and IIIB of Site 1151, consisting of sporadic occurrences of *G. plesiotumida, Neogloboquadrina acostaensis, Neogloboquadrina praehumerosa,* and *G. lenguaensis,* seem to be correlated with the upper Miocene.

F4. Correlation of ODP Leg 186 sites with DSDP Hole 438A, p. 13.



T3. Planktonic foraminiferal biohorizons compared to diatom data, p. 21.

DISCUSSION

The following eight biohorizons are recognized of both Sites 1150 and 1151 (Table T3; Fig. F4): (1) the LO of *N. asanoi;* (2) the LO of *G. puncticulata;* (3) the FO of *G. inflata* (modern form); (4) the FO of *N. asanoi;* (5) the LO of *G. ikebei;* (6) the FO of *G. ikebei;* (7) the LO of *G. nepenthes;* and (8) the LO of *G. dehiscens*. The stratigraphic order of the eight biohorizons is conformable in both present sites.

With respect to the diatom biostratigraphic data (Maruyama and Shiono, this volume) (Fig. F4; Table T3), the eight planktonic foraminiferal biohorizons have no contradiction with diatom zonations at both sites: the LO of *N. asanoi,* the LO of *G. puncticulata,* and the FO of *G. inflata* (modern form) are located in the diatom Zone NPD 9. The FO of *N. asanoi,* the LO and FO of *G. ikebei,* and the LO of *G. nepenthes* are placed in the diatom Zone NPD 7B. The LO of *G. dehiscens* is located within the diatom Zone NPD 5D. We consider that these eight biohorizons are possibly synchronous in the Japan Trench region.

Keller (1980) reported planktonic foraminiferal data from DSDP Sites 438 and 440, ~60 km northward of Site 1150. We correlated foraminiferal data from both Sites 1150 and 1151 with those of Hole 438A (40°38′N, 143°14′E, water depth = 1558 m) (Fig. F1), which have been stratigraphically well determined by the diatom biostratigraphy (Maruyama, 1984; Yanagisawa and Akiba, 1998). Stratigraphic distributions of planktonic foraminiferal species at Hole 438A are strongly discontinuous because of dissolution of foraminiferal tests and discontinuous coring. Despite these discontinuities, four of the eight biohorizons, namely, the FO of *N. asanoi,* the FO of *G. ikebei,* the LO of *G. nepenthes,* and the LO of *G. dehiscens*, show no contradiction in their stratigraphic relationships between the present sites and DSDP Hole 438A with respect to the diatom zonation.

According to stratigraphic relationship between the foraminiferal and diatom data (Fig. F3; Table T3), it can be noticed that the LO of *G. dehiscens* in the Japan Trench region is significantly older than tropical to subtropical age compared to data of Berggren et al (1995a). At the present sites, the LO of *G. dehiscens* is placed within diatom Zone NPD 5D (9.2 to 10.0 Ma). At DSDP Hole 438A, *G. dehiscens* disappeared just below the boundary top of the *Denticulopsis dimorpha* Zone (NPD 5D), ~9.2 Ma (Maruyama, 1984; Yanagisawa and Akiba, 1998). This event is assigned to 5.80 Ma in tropical to subtropical regions (Berggren et al., 1995a). We consider that this biohorizon is a diachronous event related to a latitudinal climatic change. Oda et al. (1984) reported that the LO of *G. dehiscens* became progressively older from the equator to the mid-latitude region along the western Pacific margin. The LO of *G. dehiscens* is placed just below the Am-40 tuff dated at 8.5 ± 0.5 Ma by fission-track dating in the Boso Peninsula located at ~35°N (Oda, 1977; Tokuhashi et al., 2000). The similar trend of the LO of *G. dehiscens* is also observed on the eastern Pacific margin (Keller and Barron, 1981). The progressive equatorward restriction of the biogeographic province of *G. dehiscens* occurred during the late Miocene, and the LO of *G. dehiscens* ranges from 9.5 Ma at 40°S to 5.0 Ma at the equator (Spencer-Cervato et al., 1994).

CONCLUSIONS

We examined the planktonic foraminiferal biostratigraphy of Pliocene to Miocene obtained from Sites 1150 and 1151 of ODP Leg 186. We detected 16 stratigraphically important taxa of planktonic foraminifers from these sites. In spite of the stratigraphic discontinuities of these species, owing to calcite dissolution, the following eight planktonic foraminiferal biohorizons were recognized in the same descending stratigraphic order at both sites: (1) the LO of *N. asanoi;* (2) the LO of *G. puncticulata;* (3) the FO of *G. inflata* (modern form); (4) the FO of *N. asanoi;* (5) the LO of *G. ikebei;* (6) the FO of *G. ikebei;* (7) the LO of *G. nepenthes;* and (8) the LO of *G. dehiscens.* According to the stratigraphic relationship between foraminiferal and diatom biohorizons (**Maruyama and Shiono,** this volume), the eight foraminiferal biohorizons seem to be synchronous in the Japan Trench region. The LO of *N. asanoi,* which occurs between Samples 186-1150A-14X-5, 42–44 cm, and 16X-1, 40–44 cm (122.8–136.0 mbsf), and between Samples 186-1151A-6R-1, 40–43 cm, and 7R-3, 40–44 cm (113.0–125.9 mbsf), occurs just below the Pliocene/Pleistocene boundary.

FAUNAL REFERENCES

The following is a list of taxonomic references concerning the 16 species identified. The descriptions of these species are denoted by the original references, and brief remarks are added as necessary. All specimens shown in the figures are deposited at the Institute of Geology and Paleontology, Graduate School of Science, Tohoku University.

Globigerina nepenthes Todd, 1957
(Pl. **P1,** fig. 1a–c)
Globigerina nepenthes Todd, 1957, p. 301, pl. 78, fig. 7a–c.

Globoquadrina dehiscens Chapman, Parr, and Collins, 1934
(Pl. **P1,** fig. 2a–c)
Globorotalia dehiscens Chapman, Parr, and Collins, 1934, p. 569, pl. 11, fig. 36a–c.

Globorotalia ikebei Maiya, Saito, and Sato, 1976
(Pl. **P1,** fig. 3a–c)
Globorotalia ikebei Maiya, Saito, and Sato, 1976, p. 410, pl. 1, fig. 4a–c.

Globorotalia inflata (d'Orbigny), 1839b
(Pl. **P1,** figs. 4a–c, 5a–c)
Globigerina inflata d'Orbigny, 1839b, p. 134, pl. 12, figs. 7–9.

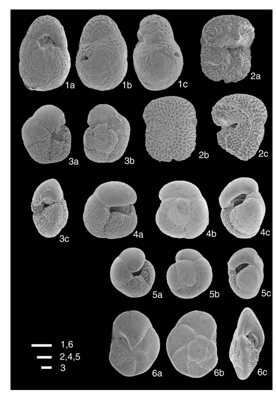
Remarks: We discriminated *G. inflata* into two morphological types, the early "transitional" form and the later "modern" form. The "modern" form (Plate **P1,** fig. 4a–c) differs from the "transitional" form (Plate **P1,** fig. 5a–c) in having three chambers in its last whorl, in contrast with the four chambers in that of the "transitional" form.

Globorotalia lenguaensis Bolli, 1957
(Pl. **P1,** fig. 6a–c)
Globorotalia lenguaensis Bolli, 1957, p. 120, pl. 29, fig. 5a–c.

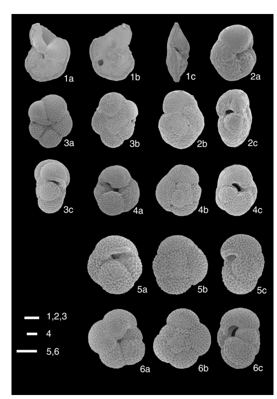
Globorotalia plesiotumida Blow and Banner, 1965
(Pl. **P2,** fig. 1a–c)
Globorotalia (Globorotalia) plesiotumida Blow and Banner, 1965, p. 207, fig. 2a–c.

Globorotalia puncticulata (Deshayes), 1832
(Pl. **P2,** fig. 2a–c)
Globigerina puncticulata Deshayes, 1832, p. 170.

P1. SEM photographs of planktonic foraminifers, p. 22.



P2. SEM photographs of planktonic foraminifers, p. 23.



Remarks: This species is characterized by its strongly vaulted umbilical side in the axial profile, having four rhomboid chambers in the last whorl, and a high-arched aperture lacking a rim or lip. The present criterion of *G. puncticulata* includes the morphological type of *Globorotalia praeinflata* Maiya, Saito, and Sato, 1976.

Neogloboquadrina acostaensis (Blow), 1959
(Pl. **P2,** fig. 3a–c)

Globorotalia acostaensis Blow, 1959, p. 208, pl. 17, fig. 106.

Neogloboquadrina asanoi (Maiya, Saito, and Sato), 1976
(Pl. **P2,** fig. 4a–c)

Globoquadrina asanoi Maiya, Saito, and Sato, 1976, p. 409, pl. 3, figs. 1a–c, 2a–c, 3.

Neogloboquadrina pachyderma (Ehrenberg), 1861 (s. lat.)
(Pl. **P2,** fig. 5a–c)

Aristerospira pachyderma Ehrenberg, 1861, pp. 276, 277, and 303.

Neogloboquadrina pachyderma (Ehrenberg). Saito, Thompson, and Breger, 1981, pp. 106 and 107, pl. 34, fig. 1a–c.

Remarks: This species varies widely in the size and shape of its test. In this study, we treat the present taxa as s. lat., including the morphological type of *Neogloboquadrina pseudopachyderma* (Cita, Premoli-Silva, and Rossi), 1965.

Neogloboquadrina praehumerosa (Natori), 1976
(Pl. **P2,** fig. 6a–c)

Globorotalia (Turborotalia) humerosa praehumerosa Natori, 1976, p. 227, pl. 2, figs. 1a–c, 3a–c.

Orbulina suturalis Brönnimann, 1951

Orbulina suturalis Brönnimann, 1951, p. 135, text figure 2, nos. 1–2, 5–8, 10, text figure 3, nos. 3–8, 11, 13–16, 18, 20–22, text figure 4, nos. 2–4, 7–12, 15–16, 19–22.

Orbulina universa d'Orbigny, 1839a

Orbulina universa d'Orbigny, 1839a, p. 2, pl. 1, fig. 1.

Sphaeroidinellopsis seminulina (Schwager), 1866

Globigerina seminulina Schwager, 1866, p. 256, pl. 7, fig. 112.

Sphaeroidinellopsis subdehiscens (Blow), 1959

Sphaeroidinella dehiscens subdehiscens Blow, 1959, p. 195, pl. 12, figs. 71a–72.

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Figure F1. Index map showing ODP Sites 1150 and 1151 and DSDP Site 438.

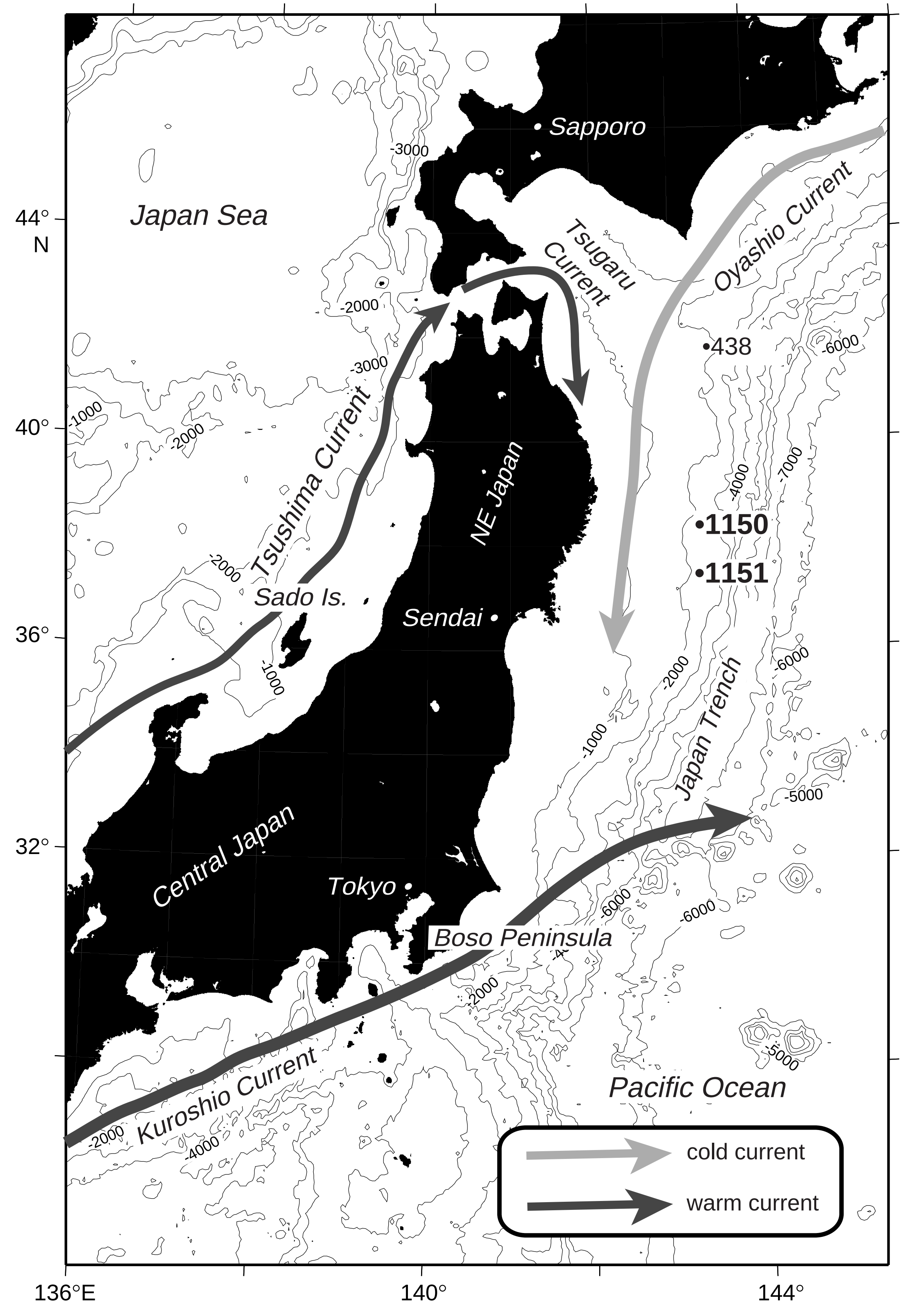

Figure F2. Stratigraphic distributions of selected planktonic foraminifers from Site 1150. Broken lines represent samples showing rare occurrences (number of total individuals is <100). NPD = North Pacific diatom zone (Yanagisawa and Akiba, 1998); diatom data are cited from Maruyama and Shiono (this volume).

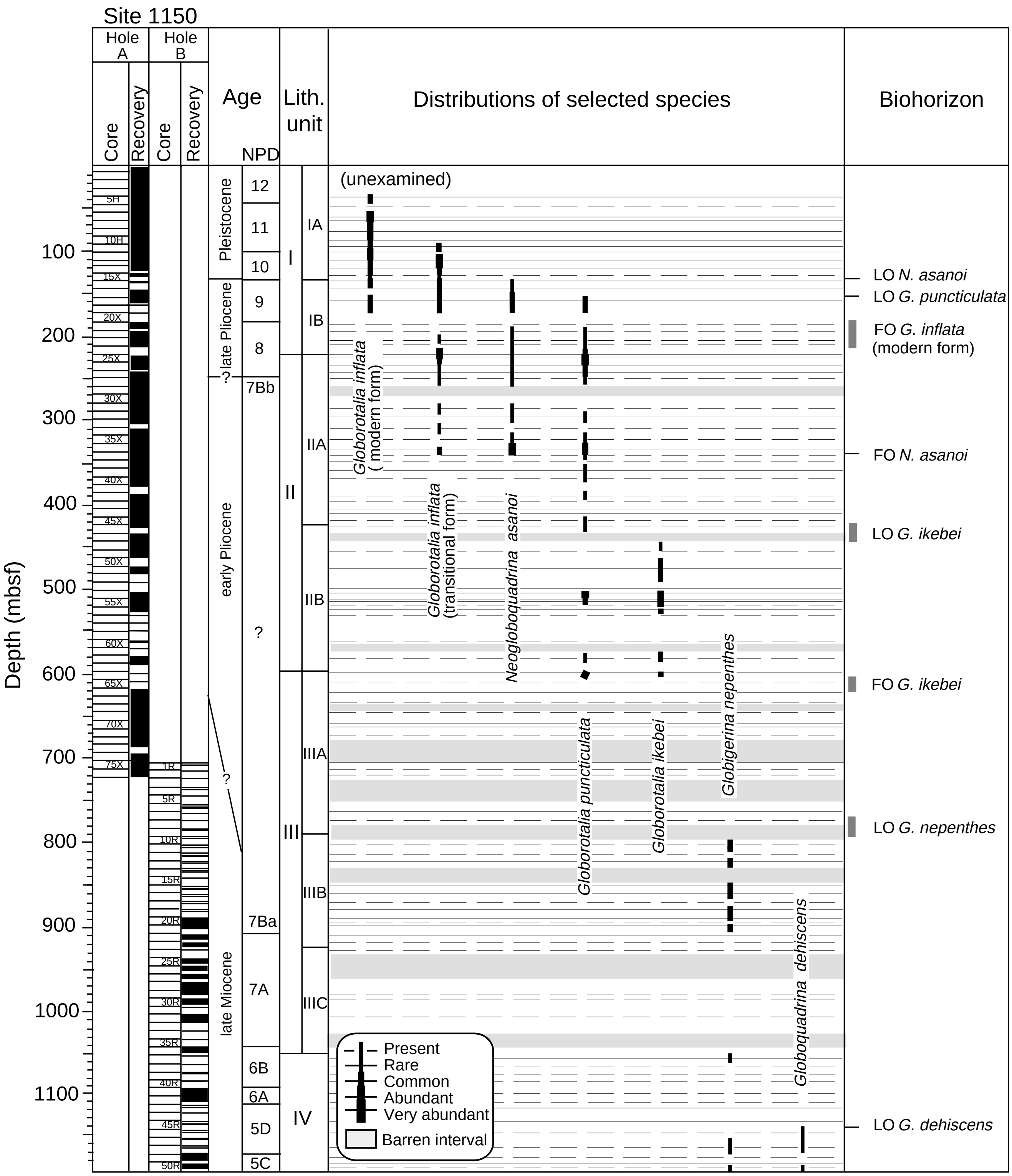

Figure F3. Stratigraphic distributions of selected planktonic foraminifers from Site 1151. Broken lines represent samples showing rare occurrences (number of total individuals is <100). NPD = North Pacific diatom zone (Yanagisawa and Akiba, 1998); diatom data are cited from Maruyama and Shiono (this volume).

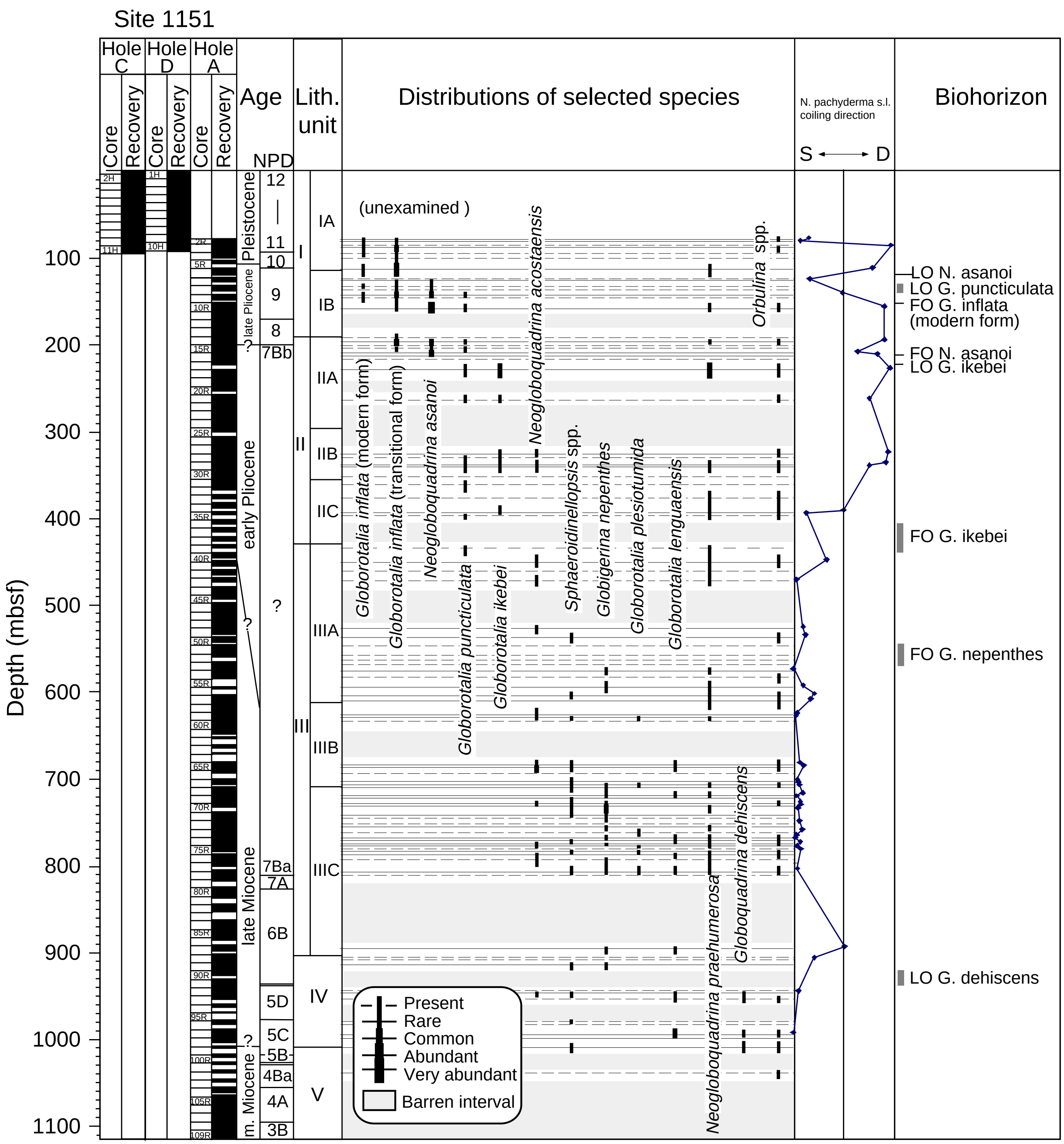

Figure F4. Correlation of ODP Leg 186 sites with DSDP Hole 438A. (1) LO *Neogloboquadrina asanoi;* (2) LO *Globorotalia puncticulata;* (3) FO *Globorotalia inflata* (modern form); (4) FO *N. asanoi;* (5) LO *Globorotalia ikebei;* (6) FO *G. ikebei;* (7) LO *Globigerina nepenthes;* and (8) LO *Globoquadrina dehiscens*. Biohorizons displayed by gray belts are ambiguously defined as a result of barren or rare occurrences in their stratigraphic distributions. NPD = North Pacific diatom zone. (**Figure shown on next page.**)

Figure F4 (continued). (Caption shown on previous page.)

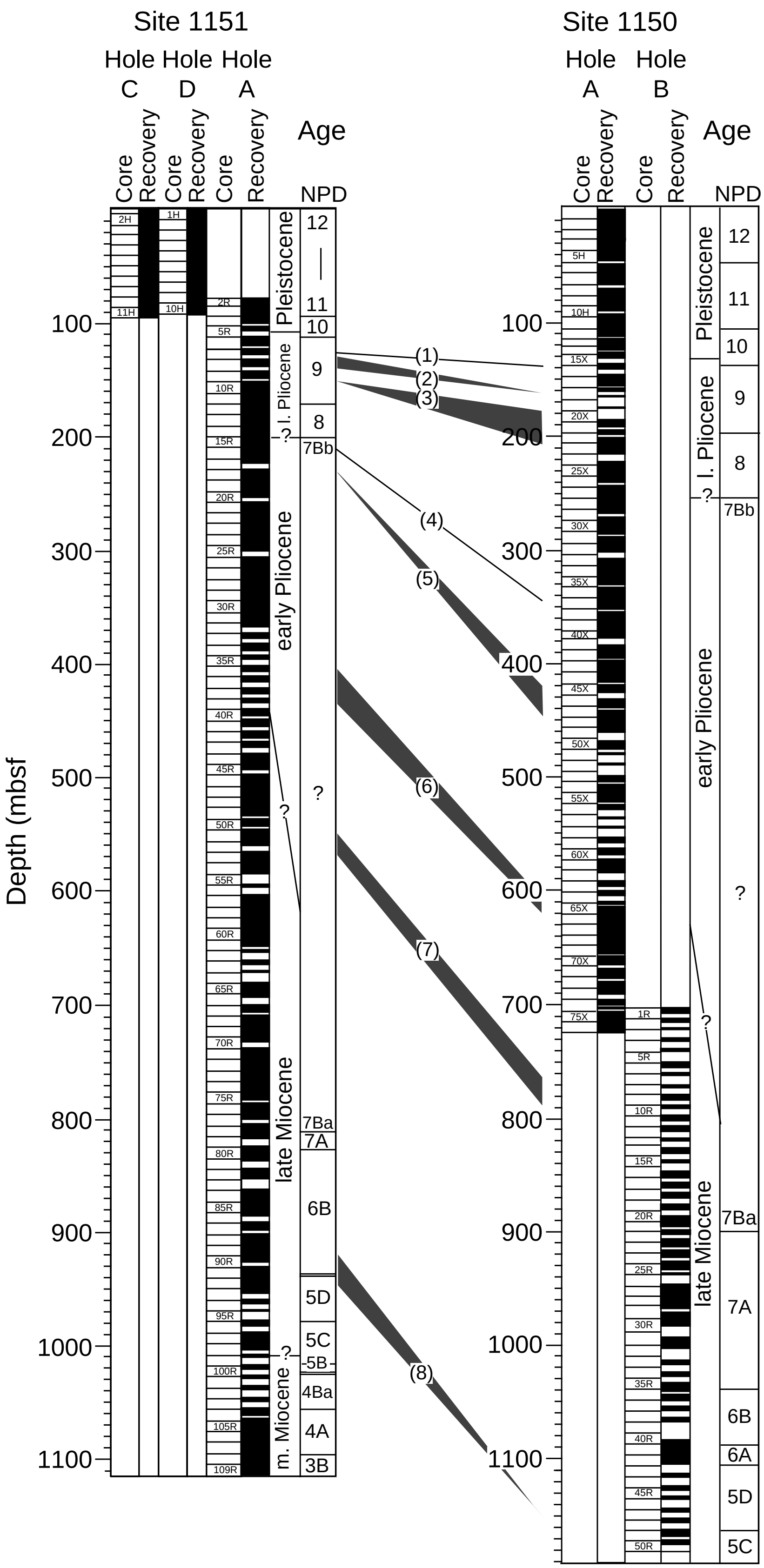

Table T1. Stratigraphically important taxa of planktonic foraminifers, Site 1150. (See table notes. Continued on next two pages.)

Age	Lithologic unit	Core, section, interval (cm)	Depth (mbsf)	Preservation	Total extracted individuals	Abundance	Divided	*Globigerina nepenthes* Todd	*Globoquadrina dehiscens* (Chapman, Parr, and Collins)	*Globorotalia ikebei* (Maiya, Saito, and Sato)	*Globorotalia inflata* (d'Orbigny) (modern form)	*Globorotalia inflata* (d'Orbigny) (transitional form)	*Globorotalia puncticulata* (Deshayes)	*Neogloboquadrina asanoi* (Maiya, Saito, and Sato)
		186-1150A-												
		5H-2, 40–44	38.10	M	458	C	1/16				R			
		6H-2, 40–44	47.60	M	2	R	1							
Pleistocene		7H-6, 35–38	63.05	M	193	C	1/2				VA			
		8H-2, 37–41	66.57	M	955	A	1/16				A			
	IA	9H-4, 40–44	79.08	M	345	C	1/8				A			
		10H-6, 40–44	90.88	M	169	C	1/2				C			
		11H-4, 40–45	97.97	M	304	C	1/2				C	R		
		12H-2, 35–38	104.55	M	452	C	1/4				A			
		13X-1, 40–44	112.60	M	249	C	1				C	VA		
		14X-5, 42–44	122.82	M	191	C	1/8				C	R		
		15X-3, 40–44	129.40	M	45	R	1				+	+		
		16X-1, 40–44	136.00	M	198	C	1/4				C	R		R
		17X-2, 40–42	147.10	M	335	C	1/2					R		R
late Pliocene		18X-4, 38–42	159.68	M	239	C	1				R	R	R	C
	IB	21X-1, 40–42	182.00	M	12	R	1							
		22X-2, 40–44	195.20	M	55	F	1						+	+
		23X-3, 40–44	206.06	M	26	R	1					+	+	+
		23X-7, 40–44	211.54	M	52	F	1						+	+
		25X-2, 40–44	224.10	M	315	C	1/2					A	C	R
		25X-5, 40–42	228.60	M	138	C	1					C	VA	R
		26X-4, 40–44	236.80	M	495	C	1					R	R	R
?		27X-4, 40–44	246.40	M	250	C	1/2					R	R	R
		28X-2, 40–44	253.10	M	28	R	1/2					+	+	+
		29X-4, 39–43	265.69	B	0	B	1							
		30X-6, 30–42	278.20	B	0	B	1							
		31X-5, 46–49	285.73	M	13	R	1					+		+
		32X-6, 38–42	297.06	M	157	C	1						R	R
		34X-2, 37–42	310.97	M	12	R	1					+		
		35X-4, 38–43	322.94	M	56	F	1						+	+
		36X-6, 40–42	335.78	M	158	C	1/2					R	A	C
	IIA	37X-4, 38–42	342.88	M	43	R	1						+	
		38X-2, 37–41	349.47	M	28	R	1							
		39X-4, 40–42	362.10	M	169	C	1						+	
		40X-2, 40–44	368.70	M	14	R	1/2						+	
		41X-1, 39–43	376.79	B	0	B	1							
		42X-3, 40–44	389.40	M	43	R	1						+	
		43X-1, 40–45	396.00	M	46	R	1							
		44X-2, 40–44	407.10	M	278	C	1							
		44X-6, 40–44	413.10	M	133	C	1							
		45X-4, 40–42	419.70	M	57	F	1/2						+	
		46X-2, 40–42	426.02	M	5	R	1						+	
		47X-2, 40–44	436.00	B	0	B	1							
early Pliocene		48X-6, 39–43	451.59	M	32	R	1/2			+				
		49X-2, 40–44	455.20	M	33	R	1							
		51X-4, 40–44	477.50	M	274	C	1/2			R				
		54X-1, 40–43	502.10	M	179	C	1							
		54X-4, 40–44	506.62	M	119	C	1/2			A			C	
	IIB	55X-2, 40–43	513.20	M	360	C	1			R			R	
		55X-4, 40–43	516.11	M	203	C	1			A			R	
		55X-6, 40–43	518.98	M	99	F	1							

Table T1 (continued).

Age	Lithologic unit	Core, section, interval (cm)	Depth (mbsf)	Preservation	Total extracted individuals	Abundance	Divided	*Globigerina nepenthes* Todd	*Globoquadrina dehiscens* (Chapman, Parr, and Collins)	*Globorotalia ikebei* (Maiya, Saito, and Sato)	*Globorotalia inflata* (d'Orbigny) (modern form)	*Globorotalia inflata* (d'Orbigny) (transitional form)	*Globorotalia puncticulata* (Deshayes)	*Neogloboquadrina asanoi* (Maiya, Saito, and Sato)
		56X-4, 40–44	525.80	M	406	C	1/2			R				
		57X-1, 40–44	531.00	M	3	R	1							
		60X-2, 37–41	561.37	M	10	R	1							
		61X-2, 40–42	571.00	B	0	B	1							
		62X-4, 40–42	583.60	M	66	F	1			+			+	
		63X-1, 40–43	588.80	B	0	B	1							
		64X-1, 40–43	598.40	B	0	B	1							
		64X-2, 39–42	599.89	M	243	C	1			R			C	
		65X-2, 37–40	609.57	M	5	R	1							
		66X-6, 40–43	625.20	M	139	C	1							
		67X-6, 40–43	634.60	M	3	R	1							
		68X-2, 40–44	638.40	B	0	B	1							
	IIIA	69X-2, 40–44	647.70	M	26	R	1							
		70X-4, 40–43	660.30	M	145	C	1							
		71X-1, 40–43	665.20	M	110	C	1							
		71X-6, 40–43	672.70	M	34	R	1							
?		72X-2, 40–44	676.30	B	0	B	1							
		72X-6, 40–46	682.30	B	0	B	1							
		73X-2, 41–42	685.91	B	0	B	1							
		74X-2, 41–43	695.61	B	0	B	1							
		75X-2, 40–43	705.20	B	0	B	1							
		76X-2, 40–43	714.90	M	20	R	1							
		76X-6, 40–43	720.90	M	19	R	1							
		186-1150B-												
		1R-1, 40–42	703.70	M	127	C	1							
?		2R-1, 40–44	710.10	B	0	B	1							
		3R-1, 41–44	719.71	B	0	B	1							
		4R-1, 44–46	729.44	B	0	B	1							
		5R-1, 39–41	738.99	B	0	B	1							
	IIIA	6R-4, 40–42	752.43	M	266	C	1							
		7R-1, 40–44	758.30	M	117	C	1							
		8R-1, 28–30	767.88	M	65	F	1/2							
		9R-2, 40–43	779.10	B	0	B	1							
		10R-3, 40–43	790.26	B	0	B	1							
		11R-1, 40–43	796.90	M	39	R	1	+						
		11R-4, 40–43	801.28	M	386	C	1	R						
		12R-4, 40–43	810.78	M	82	F	1							
		13R-2, 40–43	817.55	M	499	C	1	R						
		14R-2, 40–43	827.23	B	0	B	1							
		15R-2, 40–42	836.90	B	0	B	1							
		16R-2, 37–40	846.47	M	293	C	1/2	R						
		17R-2, 40–42	856.10	M	194	C	1/2	R						
	IIIB	18R-1, 40–42	864.20	P	43	R	1							
		19R-2, 40–42	875.40	M	273	C	1/2	R						
		20R-3, 40–43	886.48	M	158	C	1	R						
		20R-6, 40–43	890.98	M	13	R	1							
late Miocene		21R-2, 43–45	894.73	M	148	C	1	R						
		22R-4, 40–43	906.34	P	177	C	1							
		23R-1, 28–30	912.08	P	66	F	1							
		24R-2, 40–42	922.90	M	25	R	1							
		25R-4, 43–45	935.95	B	0	B	1							
		26R-5, 40–44	946.94	B	0	B	1							

Table T1 (continued).

Age	Lithologic unit	Core, section, interval (cm)	Depth (mbsf)	Preservation	Total extracted individuals	Abundance	Divided	*Globigerina nepenthes* Todd	*Globoquadrina dehiscens* (Chapman, Parr, and Collins)	*Globorotalia ikebei* (Maiya, Saito, and Sato)	*Globorotalia inflata* (d'Orbigny) (modern form)	*Globorotalia inflata* (d'Orbigny) (transitional form)	*Globorotalia puncticulata* (Deshayes)	*Neogloboquadrina asanoi* (Maiya, Saito, and Sato)
		27R-2, 40–43	952.10	B	0	B	1							
	IIIC	29R-4, 37–40	974.00	P	54	F	1							
		30R-2, 33–34	980.93	P	27	R	1							
		31R-2, 32–34	990.34	B	0	B	1							
		32R-2, 42–44	1000.06	P	62	F	1							
		35R-2, 40–43	1029.00	B	0	B	1							
		36R-2, 40–43	1038.60	B	0	B	1							
		37R-4, 40–42	1050.64	M	237	C	1	R						
		38R-2, 40–44	1058.07	P	3	R	1							
		39R-2, 36–39	1067.52	P	2	R	1							
		40R-2, 40–43	1077.60	P	5	R	1							
		41R-6, 36–39	1093.05	P	41	R	1							
		42R-6, 37–39	1102.78	M	84	F	1							
	IV	43R-4, 40–42	1109.45	M	151	C	1							
		44R-1, 57–61	1114.77	B	0	B	1							
		45R-2, 40–42	1125.80	P	165	C	1							
		46R-4, 39–41	1138.16	P	50	F	1		+					
		48R-2, 45–50	1154.75	M	86	F	1	+	+					
		49R-4, 40–42	1167.17	P	4	R	1							
		50R-2, 40–43	1173.90	P	325	C	1							
		50R-6, 40–43	1179.90	P	27	R	1	+	+					
		186-1150B-												
		1R-1, 40–42	703.70	M	127	C								
?		2R-2, 40–44	710.10	B	0	B								
		3R-1, 41–44	719.71	B	0	B								
		4R-1, 44–46	729.44	B	0	B								
		5R-1, 39–41	738.99	B	0	B								

Notes: Preservation: G = good, M = moderate, P = poor, B = barren. Abundance: VA = very abundant (>500 total individuals), A = abundant (>200), C = common (>100), R = rare (>0). Relative abundance of species: VA = very abundant (>20%), A = abundant (10%–19%), C = common (5%–9%), R = rare (<5%), + = present.

Table T2. Stratigraphically important taxa of planktonic foraminifers, Site 1151. (See table notes. Continued on next two pages.)

Age	Lithologic unit	Core, section, interval (cm)	Depth (mbsf)	Preservation	Total extracted individuals	Abundance	*Globigerina nepenthes* Todd	*Globoquadrina dehiscens* (Chapman, Parr, and Collins)	*Globorotalia ikebei* (Maiya, Saito, and Sato)	*Globorotalia inflata* (d'Orbigny) modern form	*Globorotalia inflata* (d'Orbigny) transitional form	*Globorotalia lenguaensis* Bolli	*Globorotalia plesiotumida* Blow and Banner	*Globorotalia puncticulata* (Deshayes)	*Neogloboquadrina acostaensis* (Blow) (dextral)	*Neogloboquadrina acostaensis* (Blow) (sinistral)	*Neogloboquadrina asanoi* (Maiya, Saito, and Sato)	*Neogloboquadrina pachyderma* (Ehrenberg) s.l. (dextral)	*Neogloboquadrina pachyderma* (Ehrenberg) s.l. (sinistral)	*Neogloboquadrina praehumerosa* (Natori)	*Orbulina suturalis* Brönnimann	*Orbulina universa* d'Orbigny	*Sphaeroidinellopsis seminulina* (Schwager)	*Sphaeroidinellopsis subdehiscens* (Blow)
		178-1151A-																						
Pleistocene		2R-1, 40–43	78.42	G	1418	VA				R	R							C	VA		R			
		2R-3, 40–43	81.42	G	526	VA				R	R							VA	R					
	IA	3R-1, 40–43	84.12	M	65	R				+	+							+						
		3R-3, 40–43	87.12	G	841	VA				R	C							VA	R			R		
		4R-1, 40–43	93.72	M	79	R				+	+							+						
		4R-5, 40–44	99.72	P	2	R					+													
late Pliocene		5R-1, 40–43	103.32	B	0	B																		
		6R-1, 42–45	113.04	P	134	A				R	A							VA	C	R				
		7R-1, 40–42	122.61	P	14	R												+	+					
		7R-3, 40–44	125.62	M	288	VA					R						R	A	VA					
		8R-1, 41–44	132.23	P	36	R				+	+						+							
	IB	8R-3, 40–44	135.22	M	7	R					+						+	+						
		9R-1, 40–43	141.82	M	252	VA				R	C			R			C	A	A					
		9R-3, 40–43	144.82	P	10	R				+	+													
		10R-5, 40–44	157.42	P	216	A					R			R			VA	R	R	R		R		
		11R-1, 42–45	161.04	B	0	B																		
		12R-1, 40–43	170.62	B	0	B																		
		13R-3, 40–44	183.22	B	0	B																		
		14R-1, 39–42	189.91	M	15	R					+							+	+					
?		14R-5, 39–42	195.91	M	172	A					A			R			C	VA	R	R		R		
		15R-1, 40–42	199.61	P	10	R											+	+						
		15R-3, 40–42	202.61	R	29	R					+			+			+	+	+					
		16R-1, 40–43	209.32	M	125	C											A	C	R					
		16R-3, 40–43	212.32	M	121	C												A	R					
		16R-5, 40–44	215.32	M	34	R												+						
	IIA	17R-1, 40–43	218.92	B	0	B																		
		18R-1, 40–43	228.52	G	364	VA			C					R				A	R	A	R	R		
		19R-1, 40–43	238.12	B	0	B																		
		20R-1, 40–43	247.72	B	0	B																		
		21R-5, 40–41	263.31	M	96	R			+					+				+	+		+	+		
		22R-1, 43–46	267.05	B	0	B																		
		23R-1, 40–43	276.62	B	0	B																		
		24R-1, 40–44	286.32	B	0	B																		
early Pliocene		25R-1, 40–43	296.02	B	0	B																		
		26R-1, 40–42	305.71	B	0	B																		
		27R-1, 36–39	315.28	B	0	B																		
	IIB	28R-1, 40–43	325.02	M	258	VA			R						R			A	R			R		
		28R-3, 40–43	328.02	M	14	R			+					+				+	+					
		29R-3, 40–43	337.62	P	127	C			R					R	R			A	R	R	R			
		29R-5, 40–44	340.62	M	303	VA			R					R	R	R		VA	C	R	R	R		
		30R-5, 40–44	350.32	P	53	R												+	+					
		31R-5, 40–44	360.02	P	4	R								+				+						
		32R-1, 40–43	363.62	B	0	B																		
		33R-3, 40–43	376.32	P	19	R													+	+		+		
		34R-1, 40–43	382.92	B	0	B																		
	IIC	35R-1, 55–57	392.66	G	179	A			R									VA	VA	R		R		
		35R-3, 38–40	395.49	M	93	R								+				+	+	+		+		

Table T2 (continued).

Age	Lithologic unit	Core, section, interval (cm)	Depth (mbsf)	Preservation	Total extracted individuals	Abundance	*Globigerina nepenthes* Todd	*Globoquadrina dehiscens* (Chapman, Parr, and Collins)	*Globorotalia ikebei* (Maiya, Saito, and Sato)	*Globorotalia inflata* (d'Orbigny) modern form	*Globorotalia inflata* (d'Orbigny) transitional form	*Globorotalia lenguaensis* Bolli	*Globorotalia plesiotumida* Blow and Banner	*Globorotalia puncticulata* (Deshayes)	*Neogloboquadrina acostaensis* (Blow) (dextral)	*Neogloboquadrina acostaensis* (Blow) (sinistral)	*Neogloboquadrina asanoi* (Maiya, Saito, and Sato)	*Neogloboquadrina pachyderma* (Ehrenberg) s.l. (dextral)	*Neogloboquadrina pachyderma* (Ehrenberg) s.l. (sinistral)	*Neogloboquadrina praehumerosa* (Natori)	*Orbulina suturalis* Brönnimann	*Orbulina universa* d'Orbigny	*Sphaeroidinellopsis seminulina* (Schwager)	*Sphaeroidinellopsis subdehiscens* (Blow)
		36R-1, 40–43	401.82	B	0	B																		
		37R-1, 40–44	411.42	B	0	B																		
		38R-1, 40–43	421.02	B	0	B																		
		39R-3, 40–43	433.72	P	22	R								+				+	+	+				
		41R-1, 38–41	449.90	G	369	VA									R	R		A	A	R		R		
		42R-1, 37–41	459.60	M	82	R												+	+	+				
		43R-3, 40–42	472.21	M	82	R										+		+	+	+				
		44R-1, 39–41	478.80	B	0	B																		
		45R-1, 37–40	488.39	B	0	B																		
		46R-1, 40–43	498.02	B	0	B																		
		47R-1, 39–42	507.61	B	0	B																		
		48R-1, 43–44	517.24	B	0	B																		
?		49R-1, 40–43	526.82	M	303	A									R	R		R	VA					
	IIIA	50R-1, 40–43	536.42	G	316	A												C	VA		R			R
		51R-1, 40–43	546.12	P	9	R													+					
		52R-1, 40–43	555.82	P	21	R												+	+					
		52R-5, 40–44	561.82	P	6	R												+	+					
		53R-3, 40–43	568.52	M	36	R												+	+					
		54R-1, 39–43	575.11	P	106	C	R											R	VA	R				
		54R-5, 40–45	581.13	M	74	R												+	+			+		
		56R-1, 40–43	594.32	M	296	A	R											R	VA	R				
		57R-1, 39–41	603.90	M	392	VA												C	VA	R		R		R
		57R-5, 38–41	609.90	P	118	A												C	VA	R	R			
		58R-1, 40–41	613.61	B	0	B																		
		59R-3, 38–41	626.30	M	210	VA									R			R	VA					
		59R-5, 35–39	629.27	M	231	VA							R			R		R	VA	R			R	
		60R-1, 40–43	632.92	P	7	R													+					
		61R-1, 33–36	642.45	B	0	B																		
	IIIB	62R-1, 40–43	652.02	B	0	B																		
		63R-1, 40–43	661.62	B	0	B																		
		65R-3, 40–43	683.62	M	250	A						R			R	R		R	VA		R	R	R	R
		65R-5, 40–44	686.62	G	173	A						R				C		R	VA			R	R	
late Miocene		66R-3, 40–43	693.22	P	8	R													+					
		67R-3, 40–43	702.82	P	104	C												R	VA				R	
		67R-5, 40–42	705.81	M	345	VA	R						R					R	VA	R	R	R	R	
		68R-1, 40–43	709.42	G	458	VA	R											R	VA				R	R
		69R-1, 39–42	719.01	M	340	A	R					R						R	VA	R				
		69R-3, 40–43	722.02	M	355	A												R	VA					R
		70R-1, 40–43	728.72	M	133	A	R								R			C	VA		R		R	
		70R-3, 38–42	731.70	P	121	C	C											R	A	R			R	R
		71R-3, 39–42	735.57	M	153	A	R											R	VA				R	
		71R-5, 41–43	738.58	P	89	R	+												+					
		72R-3, 25–27	750.96	M	8	R													+					
		72R-5, 37–40	754.09	M	208	A	R											R	VA	R				
		73R-3, 41–43	760.72	M	37	R							+						+					
		74R-1, 41–44	767.33	G	399	VA	R					R						R	VA	R	R	R		
	IIIC	74R-3, 43–46	770.35	G	625	VA						R						R	VA	R	R	R	R	
		74R-6, 63–65	775.04	M	170	C	R								R	R		R	VA	R	R	R		
		75R-1, 37–41	776.89	G	369	VA							R			R		R	VA	R				
		75R-3, 39–40	779.90	M	56	R												+	+					
		75R-5, 40–44	782.92	G	518	VA							R					R	VA	R	R	R	R	
		76R-1, 40–43	789.52	G	216	A						R				R		R	VA	R		R		

Table T2 (continued).

Age	Lithologic unit	Core, section, interval (cm)	Depth (mbsf)	Preservation	Total extracted individuals	Abundance	*Globigerina nepenthes* Todd	*Globoquadrina dehiscens* (Chapman, Parr, and Collins)	*Globorotalia ikebei* (Maiya, Saito, and Sato)	*Globorotalia inflata* (d'Orbigny) modern form	*Globorotalia inflata* (d'Orbigny) transitional form	*Globorotalia lenguaensis* Bolli	*Globorotalia plesiotumida* Blow and Banner	*Globorotalia puncticulata* (Deshayes)	*Neogloboquadrina acostaensis* (Blow) (dextral)	*Neogloboquadrina acostaensis* (Blow) (sinistral)	*Neogloboquadrina asanoi* (Maiya, Saito, and Sato)	*Neogloboquadrina pachyderma* (Ehrenberg) s.l. (dextral)	*Neogloboquadrina pachyderma* (Ehrenberg) s.l. (sinistral)	*Neogloboquadrina praehumerosa* (Natori)	*Orbulina suturalis* Brönnimann	*Orbulina universa* d'Orbigny	*Sphaeroidinellopsis seminulina* (Schwager)	*Sphaeroidinellopsis subdehiscens* (Blow)
		76R-5, 40–44	792.52	G	67	R	+									+		+	+	+				
		77R-3, 40–43	799.12	B	0	B																		
		78R-1, 40–43	805.82	G	739	VA	R					R	R					R	VA	R		R		R
		78R-3, 40–43	808.82	M	7	R													+					
		79R-1, 40–43	815.42	B	0	B																		
		80R-1, 38–41	825.00	B	0	B																		
		81R-1, 39–43	834.61	B	0	B																		
		82R-1, 38–41	844.20	B	0	B																		
		84R-1, 39–43	863.51	B	0	B																		
		85R-1, 33–34	873.14	B	0	B																		
		86R-1, 42–46	882.74	B	0	B																		
		87R-3, 43–45	895.34	M	214	A	R					R						R	R					
		88R-3, 40–43	905.32	M	5	R																		
		88R-5, 44–47	908.36	P	3	R																		
		89R-3, 40–43	914.62	M	362	A	R											R	R				R	
		90R-1, 38–41	921.20	B	0	B																		
		91R-1, 40–43	930.82	B	0	B																		
		92R-3, 40–43	943.52	P	5	R													+					
	IV	92R-5, 40–44	946.52	M	640	VA		R				R				R		R	VA				R	
		93R-3, 40–43	953.12	M	28	R		+				+						+	+			+		
		94R-1, 40–43	959.72	B	0	B																		
		95R-1, 40–43	969.32	B	0	B																		
		96R-1, 40–45	979.03	P	38	R																	+	
		96R-3, 40–43	982.02	M	86	R																		
?		97R-5, 40–44	994.62	P	609	VA		R				C							R		R	R		
		98R-1, 28–30	998.09	M	77	R																		
		99R-1, 24–26	1007.65	G	24	R		+											+		+		+	
		100R-1, 19–21	1017.20	B	0	B																		
		101R-1, 23–25	1026.84	B	0	B																		
		102R-1, 41–44	1036.63	G	27	R																+		
		103R-1, 50–52	1046.41	B	0	B																		
middle Miocene	V	104R-1, 40–43	1056.02	B	0	B																		
		105R-1, 40–43	1065.72	B	0	B																		
		106R-1, 40–43	1075.42	B	0	B																		
		107R-1, 30–31	1084.91	B	0	B																		
		108R-1, 23–24	1094.54	B	0	B																		
		109R-1, 41–45	1104.33	B	0	B																		

Notes: Preservation: G = good, M = moderate, P = poor, B = barren. Middle Miocene abundance: VA = very abundant (>500 total individuals), A = abundant (>200), C = common (>100), R = rare (>0). Relative abundance of species: VA = very abundant (>20%), A = abundant (10%–19%), C = common (5%–9%), R = rare (<5%), + = present.

Table T3. Planktonic foraminiferal biohorizons, ODP Sites 1150 and 1151.

	Planktonic foraminiferal biohorizon	Diatom biohorizon	Age (Ma)	Core, section, interval (cm)	Core, section, interval (cm)	Depth (mbsf)	Core, section, interval (cm)	Depth (mbsf)
				178-1150A-	178-1150B-		178- 1151A-	
		LO *Proboscia curvirostris*	0.300	5H-CC/6H-CC	ND	46.33/55.73	ND	ND
		LO *Actinocyclus oculatus*	1.01–1.46	11H-CC/12H-CC	ND	102.66/112.15	3R-CC/4R-CC	92.50/99.51
(1)	LO *Neogloboquadrina asanoi*			14X-5, 42–44/16X-1, 40–44	ND	122.82/136.00	6R-1, 42–45/7R-3, 40–44	113.04/125.62
		LO *Neodenticula koizumii*	2.000	15X-CC/16X-CC	ND	130.20/139.58	5R-CC/6R-CC	105.90/118.07
(2)	LO *Globorotalia puncticulata*			17X-2, 40–42/18X-4, 38–42	ND	147.10/159.68	7R-3, 40–44/9R-1, 40–43	125.62/141.82
(3)	FO *Globorotalia inflata* (modern form)			18X-4, 38–42/25X-2, 40–44	ND	159.68/224.10	9R-3, 40–43/10R-5, 40–44	144.82/157.40
		LCO *Neodenticula kamtschatica*	2.61–2.68	21X-CC/22X-CC	ND	192.01/202.94	11R-CC/12R-CC	168.86/179.96
		FO *N. koizumii*	3.53–3.95	27X-CC/28X-CC	ND	251.16/260.33	14R-CC/15R-CC	199.19/208.87
(4)	FO *N. asanoi*			36X-6, 40–42/39X-4, 40–42	ND	335.78/362.10	16R-1, 40–43/16R-3, 40–43	209.32/212.32
(5)	LO *Globorotalia ikebei*			44X-6, 40–44/48X-6, 39–43	ND	413.10/451.59	16R-3, 40–43/18R-1, 40–43	212.32/228.52
(6)	FO *G. ikebei*			64X-2, 39–42/66X-6, 40–43	ND	599.89/625.20	35R-1, 55–57/41R-1, 38–41	392.66/449.90
(7)	LO *Globigerina nepenthes*			ND	7R-1, 40–44/11R-1, 40–43	758.30/796.90	50R-1, 40–43/54R-1, 39–43	536.42/575.11
		FCO *N. kamtschatica*	6.400	ND	21R-CC/22R-CC	898.32/910.67	77R-CC/79R-CC	800.62/816.95
		LCO *Thalassionema schraderi*	7.600	ND	35R-CC/36R-CC	1031.50/1044.70	79R-CC/80R-CC	816.95/834.47
		LCO *Denticulopsis simonsenii*	8.600	ND	40R-CC/41R-CC	1079.20/1094.50	90R-CC/91R-CC	926.10/939.54
		LO *Denticulopsis dimorpha*	9.16	ND	42R-CC/43R-CC	1103.90/1111.30	90R-CC/91R-CC	926.10/939.54
(8)	LO *Globoquadrina dehiscens*			ND	45R-2, 40–42/46R-4, 39–41	1125.80/1138.16	89R-3, 40–43/92R-5, 40–44	914.62/946.52
		FO *D. dimorpha*	9.90	ND	48R-CC/49R-CC	1157.70/1170.60	95R-CC/99R-CC	970.00/1009.53

Note: The interval in which the first/last occurrence was observed and the actual depth (mbsf) shown for all three holes. The diatom data of Sites 1150 and 1151 are quoted from Maruyama and Shiono (this volume). ND = no data. LO = last occurrence, FO = first occurrence, LCO = last common occurrence, FCO = first common occurrence.

Plate P1. **1a–c.** *Globigerina nepenthes* Todd; Sample 186-1151A-87R-3, 43–45 cm. **2a–c.** *Globoquadrina dehiscens* (Chapman, Parr and Collins); Sample 186-1151A-92R-5, 40–44 cm. **3a–c.** *Globorotalia ikebei* Maiya, Saito, and Sato; Sample 186-1151A-35R-1, 55–57 cm. **4a–c, 5a–5c.** *Globorotalia inflata* (d'Orbigny); Sample 186-1151A-9R-1, 40–43 cm; 4a–c, modern form, 5a–c, transitional form. **6a–c.** *Globorotalia lenguaensis* Bolli; Sample 186-1151A-74R-1, 41–44 cm. Scale bar = 100 µm.

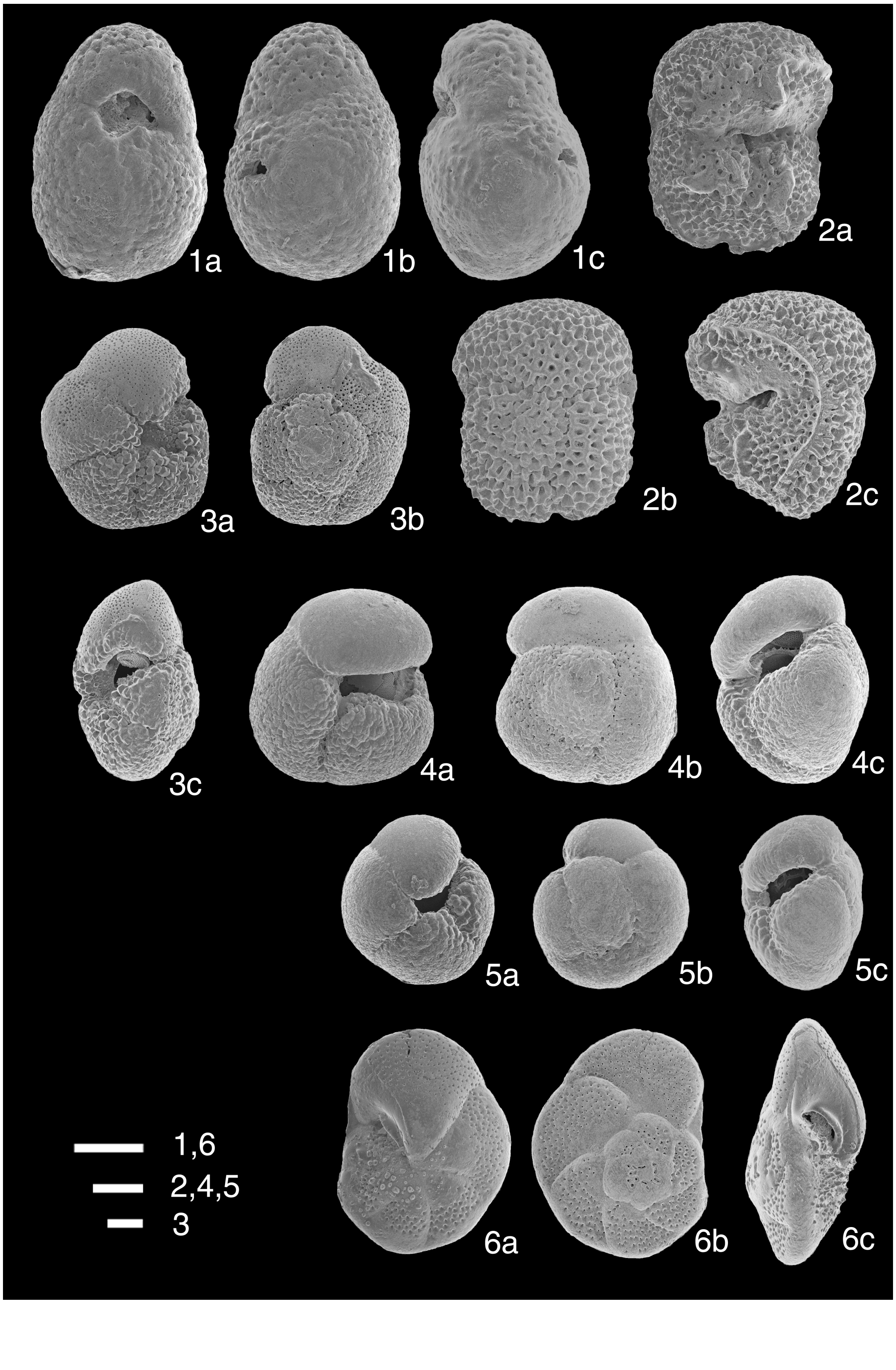

Plate P2. **1a–c.** *Globorotalia plesiotumida* Blow and Banner; Sample 186-1151A-75R-5, 40–44 cm. **2a–c.** *Globorotalia puncticulata* (Deshayes); Sample 186-1151A-21R-5, 40–41 cm. **3a–c.** *Neogloboquadrina acostaensis* (Blow); Sample 186-1151A-59R-3, 38–41 cm. **4a–c.** *Neogloboquadrina asanoi* (Maiya, Saito and Sato); Sample 186-1151A-9R-1, 40–43 cm. **5a–c.** *Neogloboquadrina pachyderma* (Ehrenberg) s. lat.; Sample 186-1151A-78R-1, 40–43 cm. **6a–c.** *Neogloboquadrina praehumerosa* (Natori); Sample 186-1151A-75R-5, 40–44 cm. Scale bar = 100 µm.