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Late Quaternary foraminifera and paleoceanography off eastern Gaspe Peninsula, Gulf of St. Lawrence.

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LATE QUATERNARY FORAMINIFERA AND PALEOCEANOGRAPHY OFF EASTERN GASPÉ PENINSULA, GULF OF ST. LAWRENCE

by

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ABSTRACT

Changes in the temperature and salinity of the waters off eastern Gaspé Peninsula following the Late Quaternary deglaciation are recognized on the basis of benthonic foraminiferal zones in box, trigger weight and piston cores from depths of 373 and 109 m in the Laurentian Channel and Chaleur Trough respectively. The deglacial stage in the Laurentian Channel was characterized by oscillating low- (<25‰) and high- (ca. 35‰) salinity bottom water. This was followed by bottom water with salinity between 34 and 35‰, and then a salinity minimum (30 - 34‰). The temperature of the bottom water was <3°C from the deglacial stage up to the salinity minimum which was followed by increasing temperature and salinity, resulting in the modern, deep watermass layer (temperature 4 - 6°C and salinity 34.5 - 34.8‰). The planktonic foraminiferal assemblages indicate corresponding changes in the salinity of the upper part of the water column after deglaciation. The oscillations in salinity of the bottom water in the Laurentian Channel are related to changes in the composition of the water entering the channel from the Atlantic Ocean, except for the low-salinity intervals during the deglacial stage, which are related to the meltwater flux from the ice margin. Radiocarbon ages for foraminifera and pelecypods indicate that the deglacial stage began before 14 ka BP and ended approximately 13.5 ka BP; the salinity minimum began about

12.1 ka BP in the Laurentian Channel.

Benthonic foraminiferal zones show that the temperature of the bottom water in Chaleur Trough has remained close to 0°C since deglaciation. However, the salinity of the bottom water has increased from between 28 and 30‰ during the deglacial stage to about 33‰ at present. Radiocarbon ages for pelecypod valves indicate that Chaleur Trough was deglaciated by 12.4 ka BP and that the increase in salinity of the bottom water occurred approximately 5.9 ka BP. Low sediment accumulation rates and seismic evidence suggests that an unconformity may be present in Chaleur Trough which appears to be related to the lowering of sea level in Chaleur Bay between 10 and 8 ka BP.

To my parents and Angie

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INTRODUCTION

The Gulf of St. Lawrence covers approximately 250,000 km^2 and is connected to the Atlantic Ocean through Cabot Strait and the Strait of Belle Isle (Fig. 1). Our understanding of the deglacial and post-glacial history of the Gulf of St. Lawrence is based on the distribution and age of glacial and post-glacial deposits around the Gulf (Dyke and Prest, 1987). Previous studies of foraminifera in cores from the Gulf of St. Lawrence have recognized changes in paleoceanographic conditions after the Late Quaternary deglaciation (Bartlett and Molinsky, 1972; Schafer, 1977). However, these studies do not include adequate chronological data which are required to establish the timing of events in submarine areas and for correlation with deposits around the Gulf.

Seismic surveys in the Gulf of St. Lawrence show that glacial deposits rest unconformably on bedrock and are overlain by glaciomarine and post-glacial sediments (Syvitski and Praeg, 1989; Vilks et al., 1990; Josenhans et al., 1990). Cores were collected during the seismic surveys and subsequent oceanographic cruises to document the late glacial and post-glacial paleoceanography of the Gulf of St. Lawrence. The benthonic foraminiferal zonation of cores collected at two sites off eastern Gaspé Peninsula is described in this paper. The cores penetrated glaciomarine

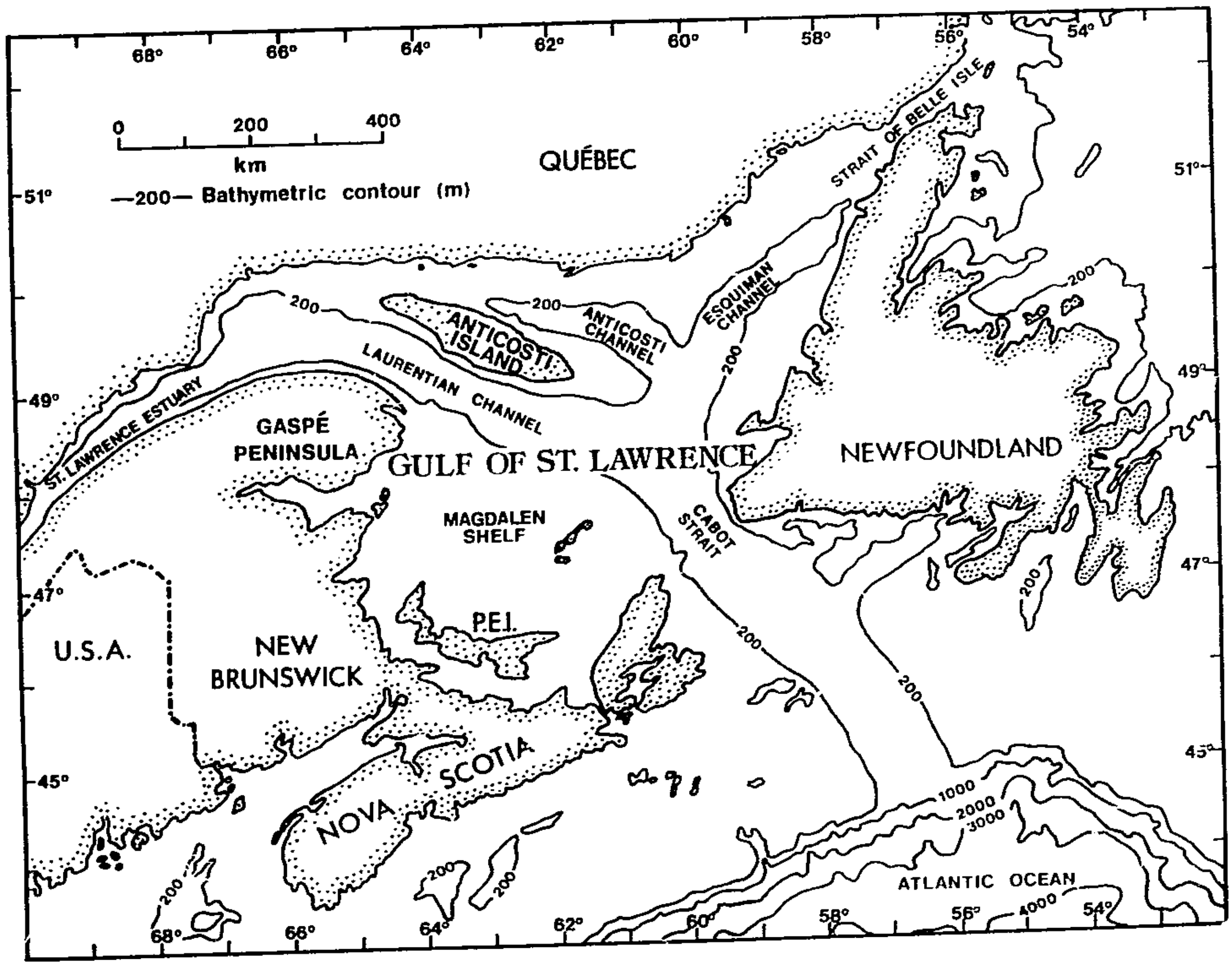

Figure 1. Map of the Gulf of St. Lawrence.

and post-glacial sediments. Accordingly, the foraminiferal zones are used to interpret paleoceanographic conditions following deglaciation at the core sites. Eleven radiocarbon ages for biogenic carbonate from the cores are also presented herein; they provide time control for the foraminiferal zones.

STUDY AREA

Physiography

The submarine topography of the Gulf of St. Lawrence is characterized by three deep channels bordered by shelves of varying width (Loring and Nota, 1973). The Laurentian Channel is the longest and deepest channel with a maximum water depth of about 535 m (Fig. 1). The maximum water depths in the shallower Anticosti and Esquiman channels are about 285 and 335 m respectively. The Magdalen Shelf is the largest shelf in the Gulf and is incised by small valleys or troughs, which range in depth from 20 to 200 m.

Oceanography

Three watermass layers are recognized in the Gulf of St. Lawrence (Forrester, 1964; Rodrigues and Hooper, 1982a; Dickie and Trites, 1983). The surface layer is from 0 to 60 m in depth, with a temperature range of <0 to >12°C and salinity <33‰. The intermediate layer, temperature <0 to

1°C and salinity 31 to 33‰, lies between 60 and 125 m. The deep layer, temperature 4 to 6°C and salinity 34 to 34.9‰, is from 200 to 535 m in depth. Temperature and salinity range from 1 to 4°C and 33 to 34‰, repectively, in the transitional zone, which is present between the intermediate and deep layers.

The deep layer is formed at the edge of the continental shelf off southern Newfoundland and consists of a mixture of either Labrador and Slope Waters (Lauzier and Trites, 1958) or Labrador and Western North Atlantic Waters (Bugden, 1991). Changes in the temperature of the deep layer of up to 2°C have been reported over the past several decades. Lauzier and Trites (1958) concluded that the deep layer consists of relatively constant proportions of Labrador and Slope Waters and that variations in the temperature of the deep layer are related to fluctuations in the temperature of the Labrador component. However, Gatien (1976) disputed the existence of Slope Water sensu Lauzier and Trites (op. cit.). Bugden (1991) reported that the proportion of Western North Atlantic Water in the deep layer varied from 65 to 80% and that this range can produce the observed temperature fluctuation.

Tremblay and Lauzier (1940) reported that the cold water of the intermediate layer originated in the Greenland and Labrador seas and entered the Gulf through Cabot Strait. Lauzier and Bailey (1957) and Lauzier (1957) concluded that a portion of the cold layer was formed in situ. Banks (1966) pointed out that in situ winter cooling is the dominant mechanism which produces the cold intermediate layer. The external component amounts to only 14% and is a result of inflow through the Strait of Belle Isle.

PREVIOUS WORK

Foraminifera

Some studies of foraminifera in the Gulf of St. Lawrence have dealt with the distribution of species in surface sediments and the relationship between species distribution and environmental factors (Vilks, 1968; Schafer and Cole, 1978; Rodrigues, 1980). The other studies describe paleoceanographic conditions following the Late Quaternary deglaciation on the basis of foraminiferal assemblages from piston cores.

Bartlett and Molinsky (1972) discussed the Holocene paleoceanography of the Gulf of St. Lawrence on the basis of foraminiferal assemblages in cores collected from the shelves and the channels. They concluded that the Holocene history of the area is one of transition from a rapidly fluctuating brackish-water environment, to one similar to the present environment. The planktonic foraminiferal assemblages indicate cold surface waters except for three levels in a core from the Laurentian Channel, which contain species indicative of warm Gulf Stream Water.

Rashid *et al*. (1975) presented lists of foraminiferal species in two cores from depths of 78 and 127 m in Chaleur Trough. The assemblages indicate that the salinity of the bottom water was ≤33‰ at both core sites. Schafer (1977) discussed changes in sea level based on foraminiferal assemblages in two cores from depths of about 51 and 78 m in Chaleur Bay. He compared assemblages from the cores to those from surface samples collected in the bay and concluded that water depths were shallower between 10 and 8 ka BP, because the glacial rebound was rapid relative to the eustatic sea-level rise. This period of shallower water, *i.e*. lower sea level, is associated with intervals characterized by high numbers of *Eggerella advena* in the cores.

Ceman (1990) compared foraminiferal assemblages from a box core, trigger weight core and upper part of a piston core collected in Esquiman Channel. He concluded that temperature and salinity ranged from 0 to 6°C and 30 to 34.8‰ respectively, during deposition of the sediments in the cores. Ceman (*op. cit*.) pointed out that about 1 m of the upper part of the section was not recovered by the piston core.

Rodrigues and Vilks (1991) divided the late Quaternary marine submergence of the Gulf of St. Lawrence and St. Lawrence Estuary (Goldthwait Sea), into five phases on the basis of benthonic foraminiferal assemblages in cores collected from water depths of >250 m in the Laurentian, Anticosti and Esquiman channels. The oldest phase, Goldthwait Sea I, is related to glaciomarine conditions during deglaciation of the Gulf and was followed by marine conditions during Goldthwait Sea II to V phases. Bottom-water salinity was highest during Goldthwait Sea II and V and lowest during Goldthwait Sea I and IV. They concluded that the oscillation in salinity is related to variations in the proportion of Atlantic Slope Water entering the Gulf (cf. Rodrigues and Vilks, 1990).

Seismostratigraphy

Five seismic units are recognized for the Quaternary sequence in the Gulf of St. Lawrence (Syvitski and Praeg, 1989; Vilks et al., 1990; Josenhans et al., 1990). Unit I unconformably overlies Paleozoic sedimentary rocks and is acoustically unstratified and unstructured. Unit II is acoustically strongly stratified and unit III is moderately stratified. Unit IV is present in Chaleur Bay and in the St. Lawrence Estuary (Syvitski and Praeg, 1989). The acoustic signature of this unit ranges from strongly to weakly stratified. Unit V is present in the upper part of the sequence and is generally acoustically transparent. Unit I has been interpreted as till or ice contact sediments. Units II and III were deposited in a glaciomarine environment, whereas unit IV is related to fluvial discharge from a nearby, rapidly ablating, ice sheet. Unit V has been interpreted as post-glacial sediments.

MATERIALS AND METHODS

Cores collected at two sites during Cruise 90031 of the CSS Hudson are used in this study. The core sites were selected to sample specific acoustic units identified on seismic profiles obtained from the Huntec Deep Tow System (DTS). A box core (BC) and piston core (PC) with accompanying trigger weight core (TWC) were collected at each site. The core sites are located in the Laurentian Channel, between Gaspé Peninsula and Anticosti Island, and in Chaleur Trough, east of Gaspé Peninsula (sites 1 and 2, respectively, Fig. 2 and Table 1).

Sediment colour, texture and other features were described on the basis of visual examination of the working halves of the freshly split cores. A videoscanner x-radiograph system developed at the Bedford Institute of Oceanography was also used to identify textural features, which are not normally observed during visual inspection.

The box cores were sampled at 1 to 10 cm intervals and the other cores were sampled at 5 to 20 cm intervals. Samples consisting of 5 cm^3 of sediment were washed by hand in running water through a 63 μm mesh sieve to remove the silt and clay fractions. After most of the silt and clay

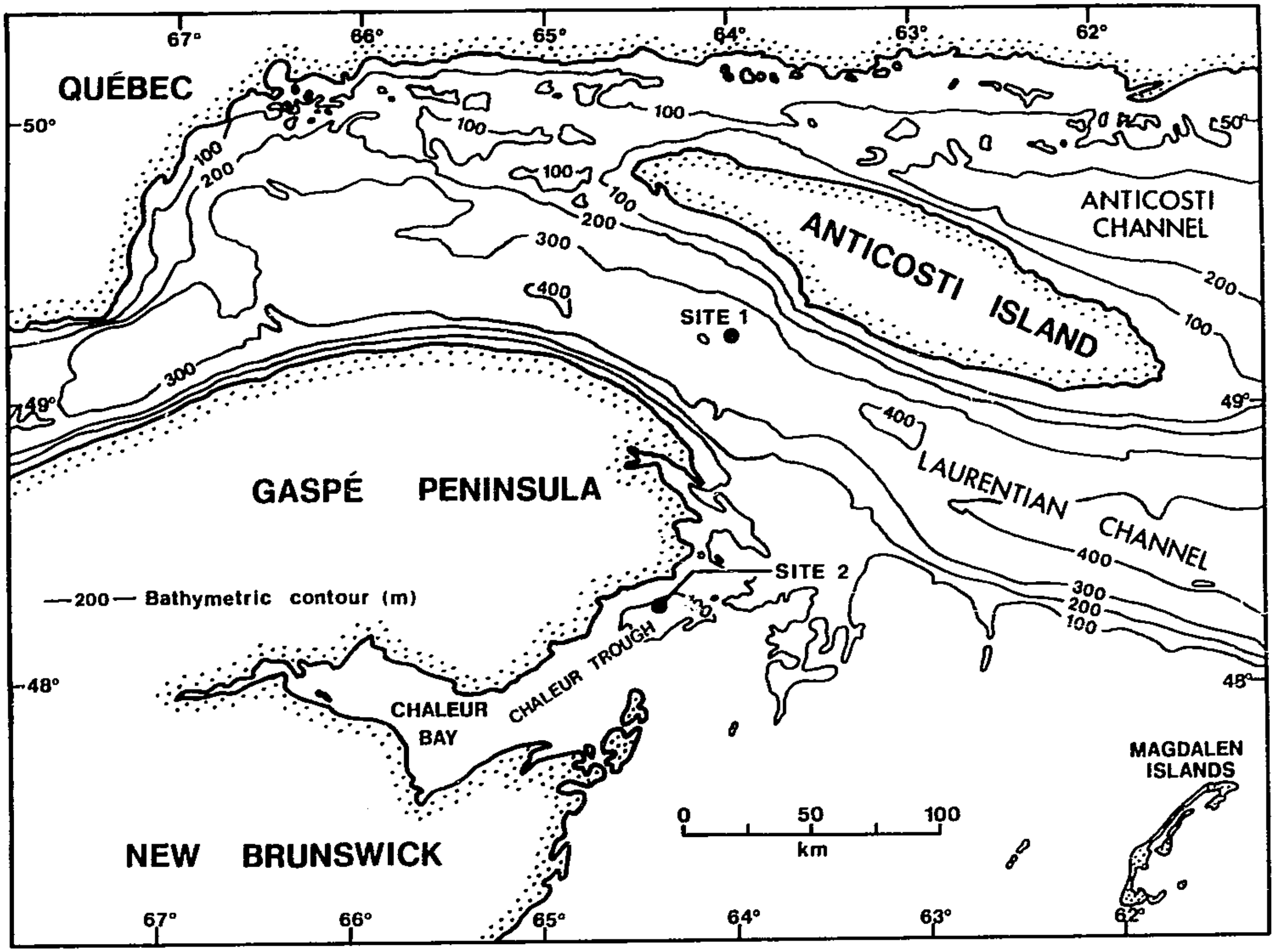

Figure 2. Location of core sites.

Table 1. Location, length and water depth of cores.

Site	Area	Location		Water Depth (m)	Core	
		Latitude (N)	Longitude (W)		Number	Length (cm)
1	Laurentian Channel	49°17.44'	63°59.57'	373	90031017BC[1]	50
					90031019TWC[2]	99
					90031019PC[3]	1154
2	Chaleur Trough	48°19.48'	64°23.54'	109	90031025BC	50
					90031027TWC	108
					90031027PC	1116

1 BC .... Box core
2 TWC ... Trigger weight core
3 PC .... Piston core

were washed out the residue was cleaned ultrasonically, dried and sieved using 850, 425, 250, 180, 150 and 75 μm sieves. Foraminiferal tests were picked from each sieve fraction and mounted on 60-grid micropaleontological slides. For samples containing large amounts of sand, foraminiferal tests were concentrated by floatation, using a mixture of tetrabromoethane and acetone, density 1.9 $g{\cdot}cm^{-3}$. The sinks were scanned and the tests which did not float were picked out. The planktonic and most of the benthonic foraminifers were identified to specific level. References used for specific identification are listed in Appendix I.

Benthonic foraminiferal diversities were computed using the Shannon-Wiener Information Function,

$$H(S) = -\sum_{i=1}^{S} p_i \ln p_i$$

where $H(S)$ is the diversity, S is the number of species, p_i is the proportion of the ith species and ln is the natural logarithm. The minimum value of $H(S)$ is 0.00 for S equals to 1. The maximum value of $H(S)$ for a given value of S occurs when all S species are equally distributed.

The counts of benthonic and planktonic foraminiferal species were processed by computer using a spreadsheet and QTAB which was developed by C.G. Rodrigues to convert the raw data into percent abundances. QTAB also produced tables listing statistics for the samples and abundances of selected species which were used with graphical software packages to generate profiles for the cores.

Radiocarbon ages were obtained for foraminiferal tests and pelecypod valves from the piston cores. The age determinations were carried out at IsoTrace Laboratory, University of Toronto using the Accelerator Mass Spectrometry (AMS) method.

RESULTS

A total of 111,499 foraminiferal tests were counted and 138 benthonic species and 4 planktonic species were identified in 174 samples from the cores used in this study. The numbers of foraminiferal tests and species from each core are listed in Table 2. Radiocarbon ages for biogenic carbonate from the cores are listed in Table 3.

Site 1 (Laurentian Channel)

Four seismic units overlie bedrock at the core site (Fig. 3). The piston core (90031019PC) penetrated units II, III and V. The trigger weight and box cores, 90031019TWC and 90031017BC respectively, bottomed in the upper part of unit V. Unit IV is not present at the site.

Core 90031019PC The sediments in the core (Fig. 4) consist of mud to about 4 m, alternating mud and sandy mud or muddy sand with minor pebbles between 4 and 7.8 m, and sandy mud and muddy sand with minor pebbles to the bottom of

Table 2. Summary of counts for benthonic and planktonic foraminifers.

Site	Core	Number of samples	Benthonic foraminifera: Number of species: Calcareous	Benthonic foraminifera: Number of species: Agglutinated	Benthonic foraminifera: Number of tests: Calcareous	Benthonic foraminifera: Number of tests: Agglutinated	Planktonic foraminifera: Number of species	Planktonic foraminifera: Number of tests
1	90031017BC[1]	11	53	11	4,797	132	3	1776
	90031019TWC[2]	9	64	3	5,563	29	4	2919
	90031019PC[3]	84	103	3	45,322	31	4	4495
2	90031025BC	6	8	3	293	5	0	0
	90031027TWC	6	12	0	183	0	0	0
	90031027PC	58	50	2	45,940	2	1	9

[1] BC .... Box core
[2] TWC ... Trigger weight core
[3] PC .... Piston core

Table 3. **Radiocarbon ages for biogenic carbonate from piston cores.**

Core	Interval (cm)	Dated Material	Laboratory Number	Corrected ^{14}C AMS age[1] (years BP)
90031019PC	698-701	Foraminifera[2]	TO-2542	12,150 ± 90
	812-814	<u>Nuculana</u> sp.	TO-2892	13,280 ± 80
	920-923	Foraminifera[2]	TO-2544	13,540 ± 190
	948-951	Foraminifera[2]	TO-2545	13,500 ± 440
	1089-1092	Foraminifera[3]	TO-2547	14,040 ± 240
90031027PC	235	Pelecypod fragments	TO-2473	2,520 ± 60
	499	Pelecypod fragments	TO-2475	5,950 ± 60
	655	Pelecypod fragments	TO-2474	8,750 ± 80
	733	<u>Nuculana</u> sp.	TO-2476	11,720 ± 90
	820-822	Pelecypod fragments	TO-2893	12,090 ± 80
	970	Pelecypod valves	TO-2477	12,230 ± 120

TO ... Isotrace Laboratory, University of Toronto

1 Ages are reported at 68.3% probability (1 σ criterion) and are corrected for natural, preparation and sputtering fractionation to a base of $\delta^{13}C = 0$ ‰ (PDB), equivalent to a reservoir correction of 410 years.

2 Mixed benthonic foraminiferal species.

3 Mixed benthonic and planktonic foraminiferal species.

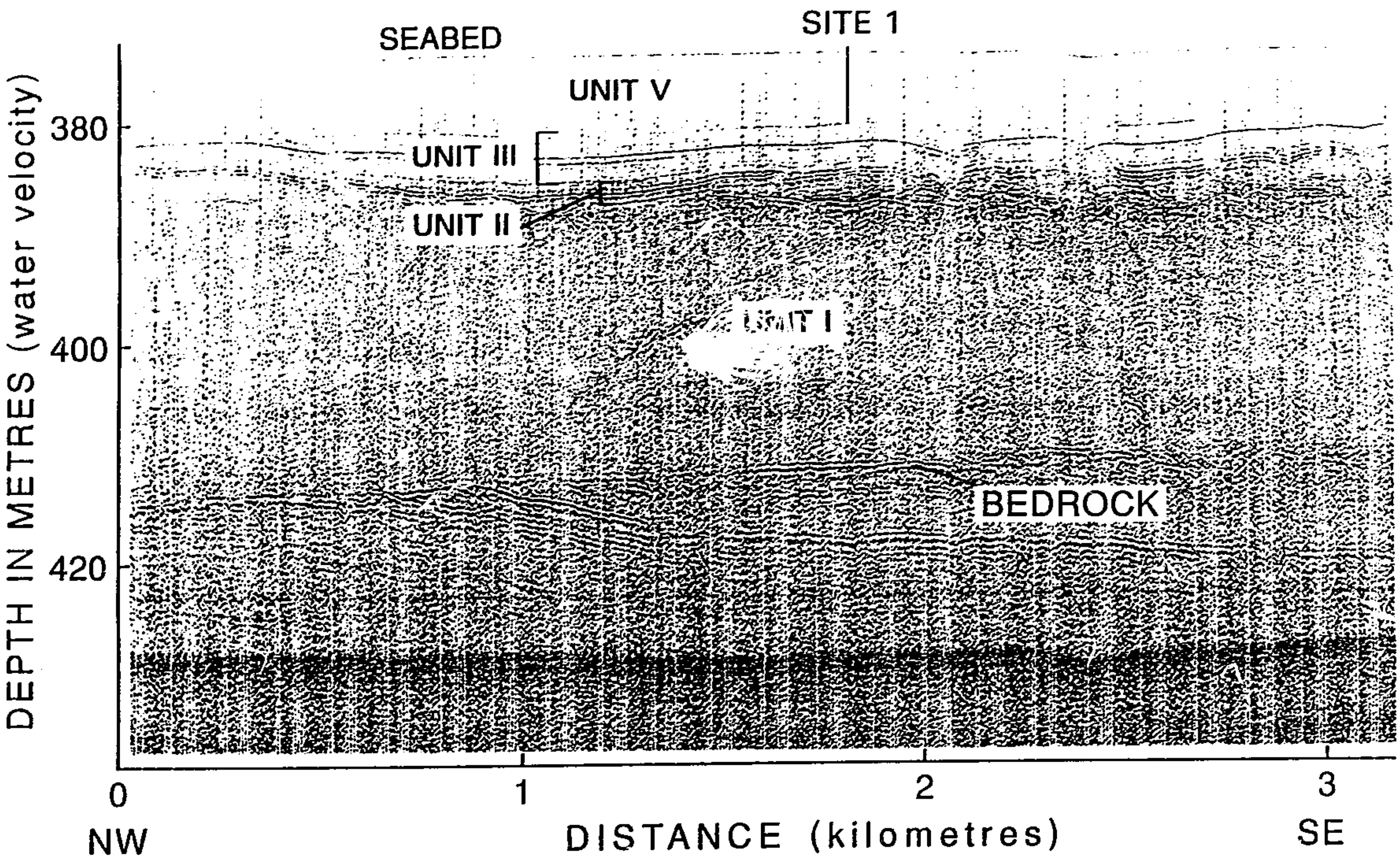

Figure 3. Huntec DTS seismic profile across site 1.

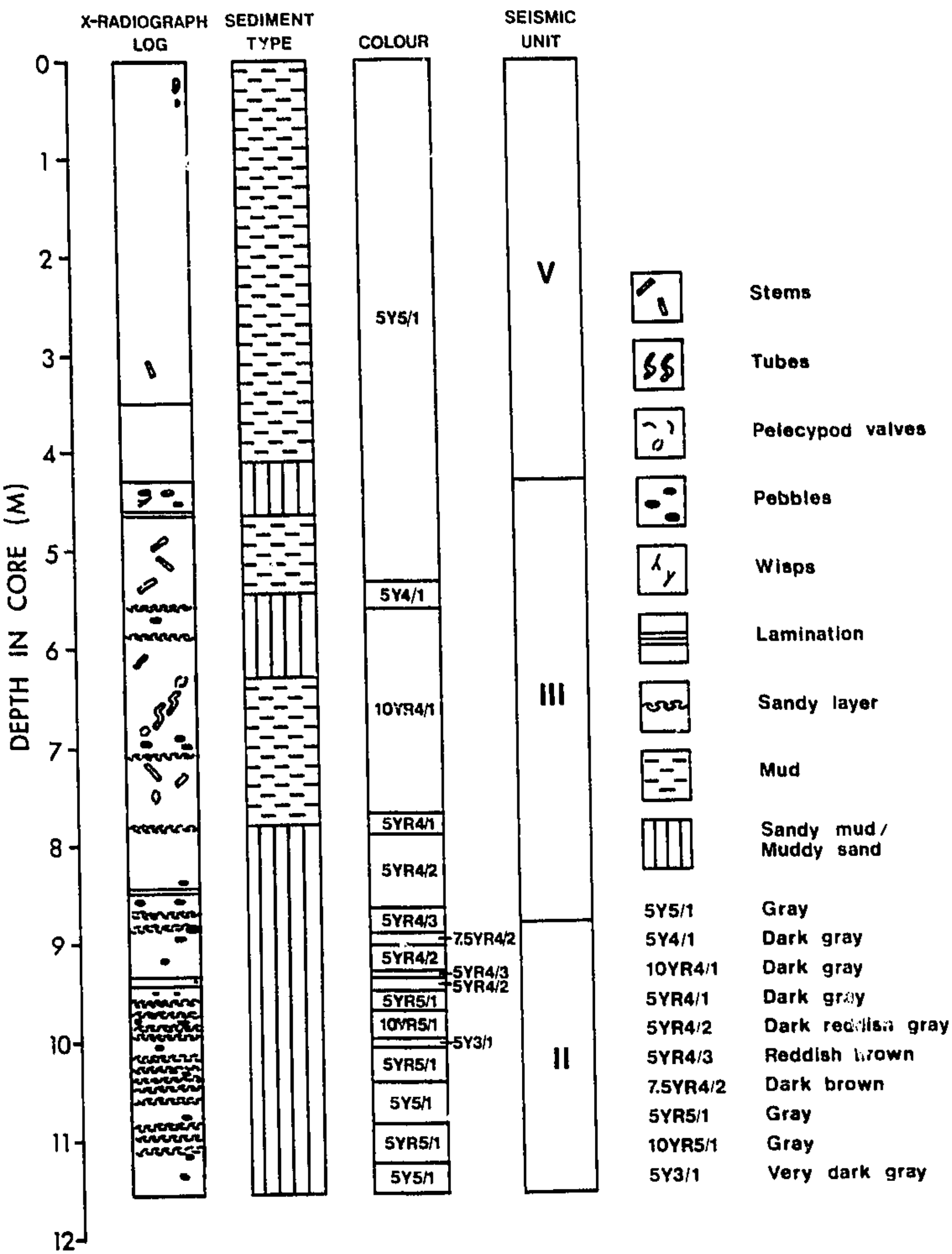

Figure 4. X-radiograph log, sediment type and seismic units for core 90031019PC.

the core (11.54 m). The colour of the sediments is gray and dark gray to a depth of 8 m and from 10.0 to 11.54 m with gray, reddish gray, reddish brown and brown layers between 8 and 10 m. Five radiocarbon ages were obtained on foraminiferal tests and pelecypod valves from the lower part of the core (Table 3 and Fig. 5). The ages range from 12,150 ± 90 years BP at about 7.0 m to 14,040 ± 240 years BP at about 10.9 m.

The percent abundances of benthonic and planktonic foraminifers, the number of tests, and benthonic foraminiferal diversities for core 90031019PC are listed in Tables 4 and 5 (in pocket). The benthonic assemblages are characterized by calcareous species throughout the core. Agglutinated species are present above 3.1 m, where they account for <2% of the assemblages.

The piston core is divided into five zones on the basis of selected benthonic foraminiferal species which are abundant over relatively short intervals (Fig. 5). These species have a similar distribution in other cores from the Laurentian, Anticosti and Esquiman channels (C.G. Rodrigues and G. Vilks, personal communication, 1992) and are useful for recognition of regional paleoceanographic patterns. The oldest zone (no. 1) is characterized by barren samples or assemblages containing low numbers of foraminiferal tests and assemblages in which Cassidulina laevigata, C. reniforme, Elphidium excavatum forma clavata, Oridorsalis

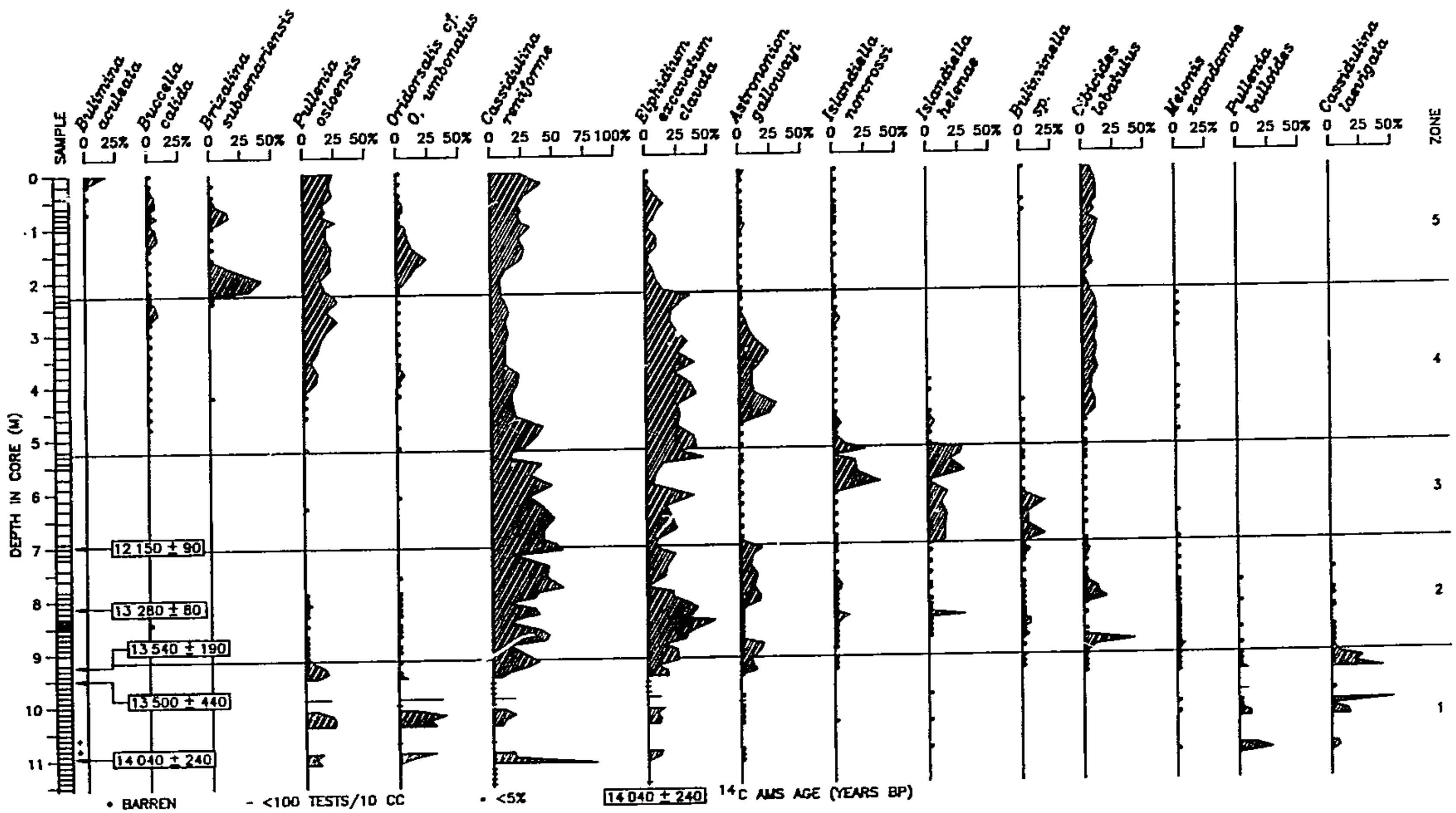

Figure 5. Benthonic foraminiferal zonation of core 90031019PC.

sp. cf. O. umbonatus, Pullenia bulloides and P. osloensis predominate. The boundary between zones 1 and 2 is marked by a decline in abundance of Cassidulina laevigata and Pullenia osloensis and a corresponding rise in abundance of Cibicides lobatulus. A rise in the abundance of Islandiella helenae accompanied by a decline in the abundance of Astrononion gallowayi characterize the boundary between zone 2 and zone 3. The abundance of Islandiella helenae declines in the middle and upper parts of zone 3. The second decline in abundance of Islandiella helenae defines the boundary between zones 3 and 4. The first rise in abundance of Brizalina subaenariensis from the bottom of the core defines the boundary between zones 4 and 5.

Planktonic foraminifers are present in each of the zones defined above (Fig. 6). The planktonic foraminiferal assemblages are characterized by sinistrally coiled tests of Neogloboquadrina pachyderma. The other species in the core are Globigerina bulloides, G. quinqueloba and G. uvula. Globigerina bulloides occurs in the upper part of zone 5, G. quinqueloba is present in zones 1 - 3 and 5, and G. uvula is present in zones 1 and 4. The number of planktonic foraminiferal tests is highest in zone 5 (up to 2,100 tests•10 cm^{-3}) and in the samples characterized by the Cassidulina laevigata-dominant assemblage in zone 1 (up to 336 tests•10 cm^{-3}). The number of tests is <100•10 cm^{-3} in the samples from the other zones.

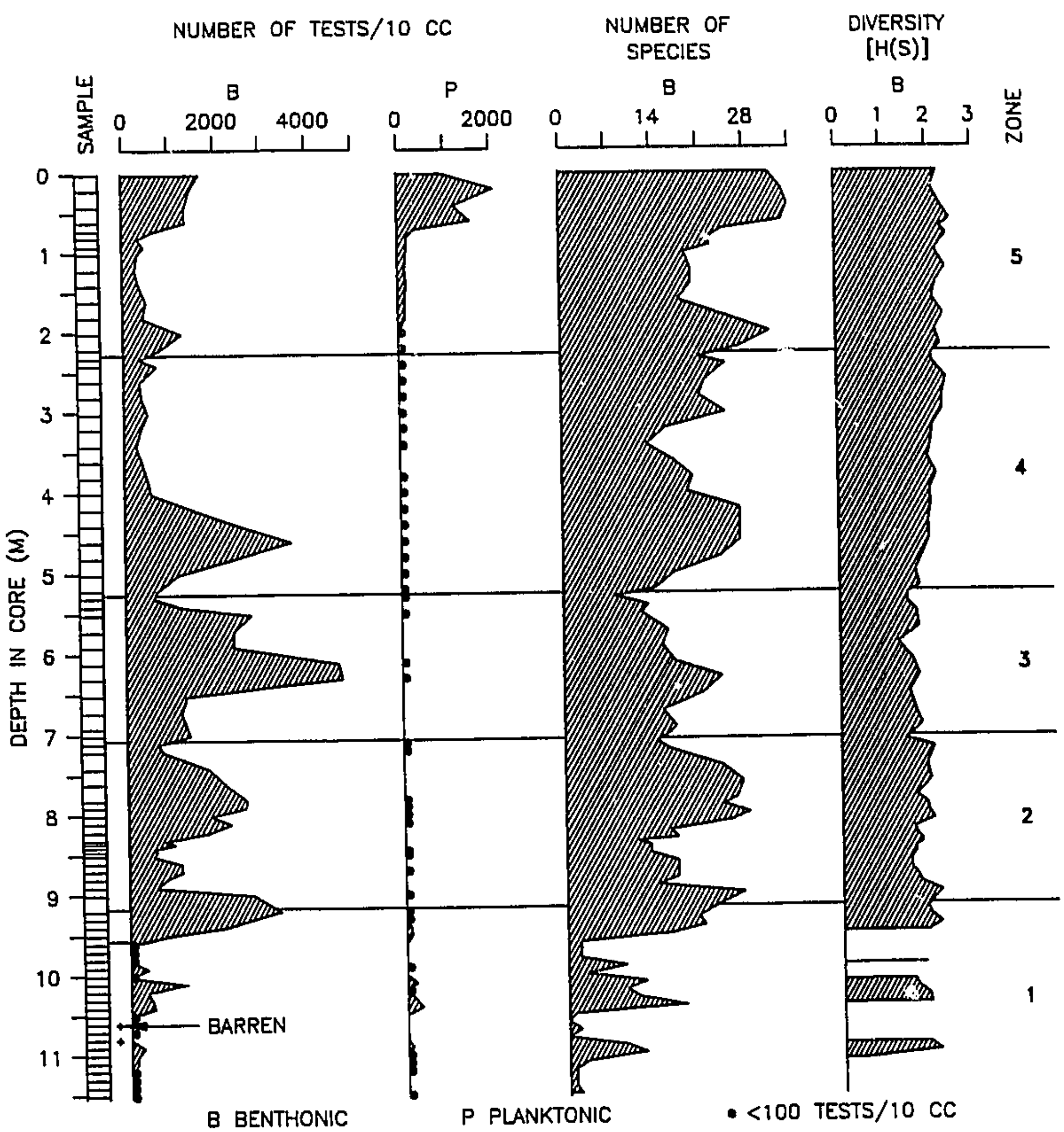

Figure 6. Number of foraminiferal tests, number of benthonic foraminiferal species and benthonic foraminiferal species diversity for samples from core 90031019PC.

The number of benthonic foraminiferal tests ranges from 2 to 3,316•10 cm^{-3} in zone 1 except for the two barren samples in the lower part of the zone (Fig. 6). The number of tests fluctuates between 530 and 4,718•10 cm^{-3} from the base of zone 2 to the middle part of zone 4, decreasing to between 258 and 1,702•10 cm^{-3} in the upper part of zone 4 and in zone 5. The number of benthonic foraminiferal species per sample is from 1 to 35, excluding the barren samples. The samples from zone 1 contain up to 22 species and those from zones 2 through 5 generally contain >14 species. Benthonic foraminiferal species diversity (H[S]) is between 1.27 and 2.53. The diversity is >2.0 in some samples from zones 1 and 2, and in most of the samples from the upper part of zone 4 and in zone 5.

Core 90031019TWC The trigger weight core consists of 0.99 m of dark gray mud (Fig. 7). The percent abundances of benthonic and planktonic foraminifers, the number of tests, and benthonic foraminiferal diversity for the core is listed in Table 6 (in pocket). The benthonic assemblages are characterized by calcareous species. Agglutinated species are present in most of the samples and are <2% of the assemblages.

The benthonic foraminiferal assemblages in the trigger weight core (Fig. 8) are similar to the uppermost assemblage in the piston core except for the relatively high abundance

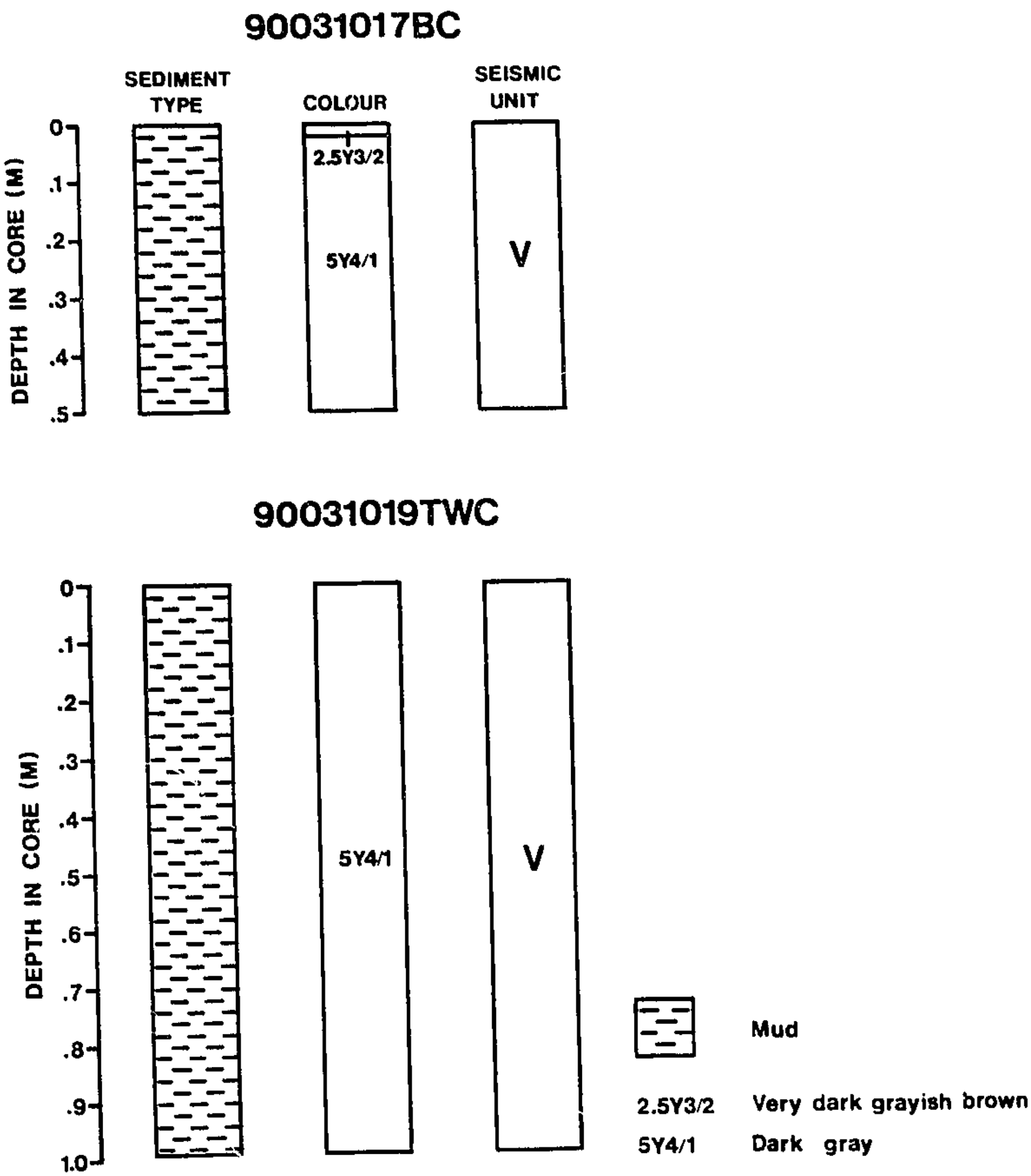

Figure 7. Sediments and seismic unit identified in cores 90031017BC and 90031019TWC.

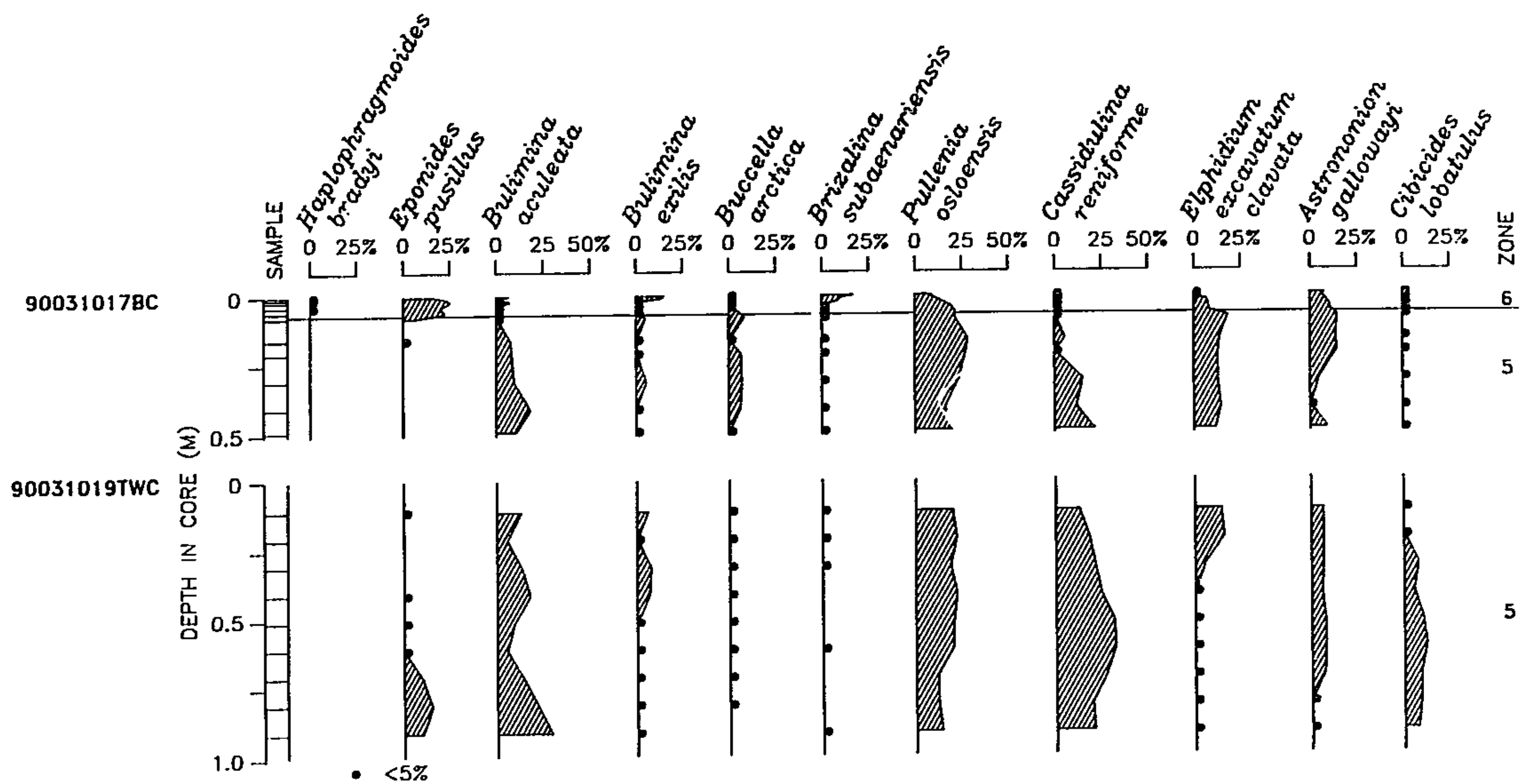

Figure 8. Benthonic foraminiferal zonation of cores 90031017BC and 90031019TWC.

of Eponides pusillus (9 - 15%) in the lower part of the trigger weight core. The abundance of Bulimina aculeata, Pullenia osloensis, Cassidulina reniforme, Astrononion gallowayi and Cibicides lobatulus is >5% in most of the samples from the trigger weight core and in the uppermost sample from the piston core. The assemblages from the trigger weight core are assigned to zone 5.

The planktonic foraminiferal species Globigerina quinqueloba and Neogloboquadrina pachyderma (mainly sinistrally coiled) are present in each sample from the trigger weight core. Globigerina bulloides and G. uvula are present in one sample from the middle part of the core. The abundance of Neogloboquadrina pachyderma is >82% and the number of tests of planktonic foraminifers ranges from 170 to 1,600•10 cm^{-3} in the core. The number of tests of benthonic foraminifers is generally >1,000•10 cm^{-3} and the number of species ranges from 26 to 43 (Fig. 9). Benthonic foraminiferal species diversity (H[S]) is >2.2 with a maximum value of 2.61 at the top of the core.

Core 90031017BC The box core consists of 0.5 m of dark gray and grayish brown mud (Fig. 7). The percent abundances of benthonic and planktonic foraminifers, the number of tests, and benthonic foraminiferal species diversities for the core are listed in Table 7 (in pocket). The benthonic assemblages are characterized by calcareous species and

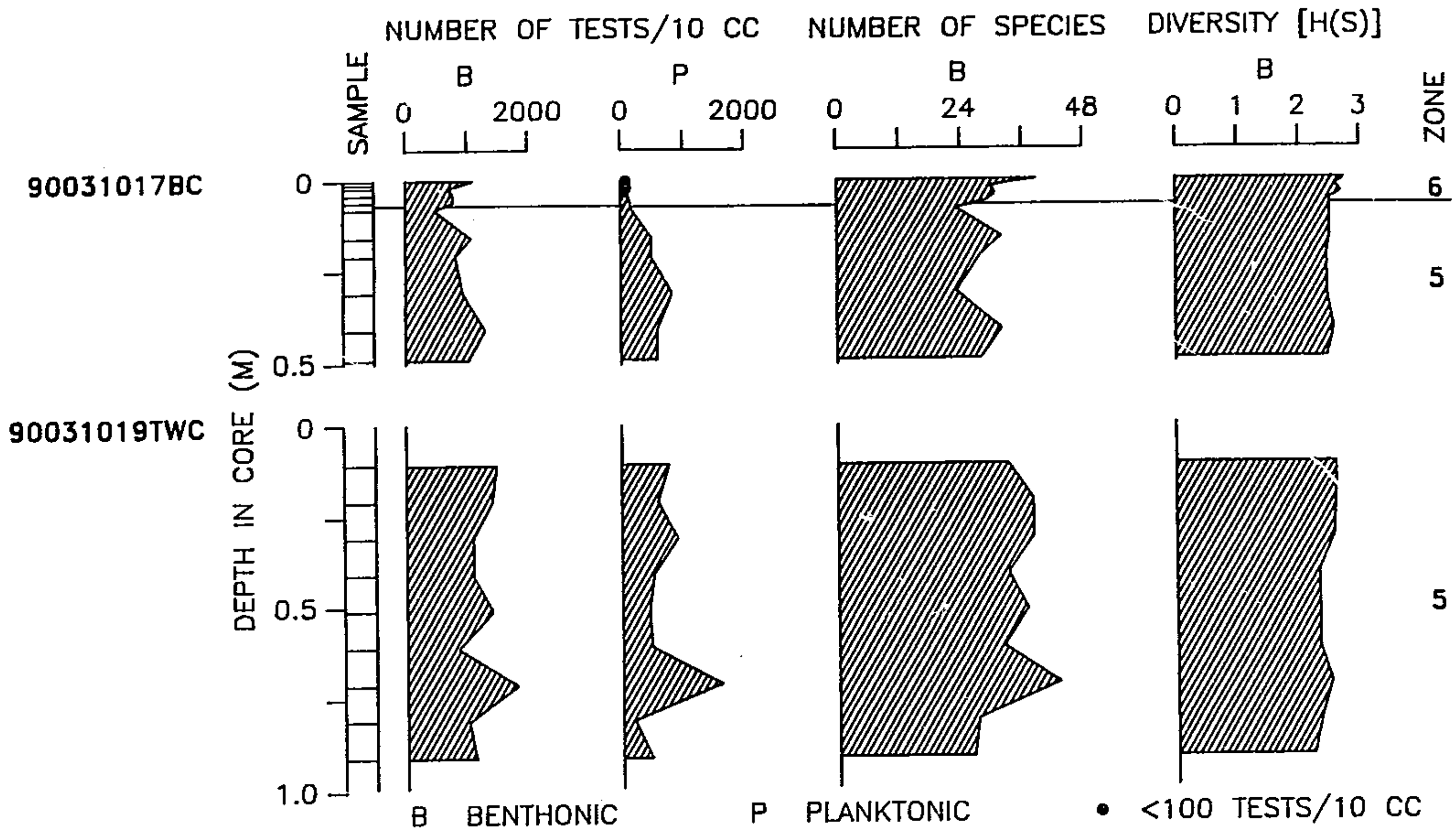

Figure 9. Number of foraminiferal tests, number of benthonic foraminiferal species and benthonic foraminiferal species diversity for samples from cores 90031017BC and 90031019TWC.

contain <4 agglutinated species, except for the upper two samples, which contain 8 agglutinated species each.

The box core is divided into two zones based on the benthonic foraminiferal assemblages (Fig. 8). Bulimina aculeata, Pullenia osloensis, Cassidulina reniforme, Elphidium excavatum forma clavata, Astrononion gallowayi and Buccella arctica are abundant in the assemblages from the lower part of the core. These assemblages are comparable to those from the upper part of the trigger weight core (Fig. 8) and are assigned to zone 5. In the upper part of the box core the abundance of Cassidulina reniforme decreases to <5% and that of Eponides pusillus increases to as high as 24.78%. The Eponides pusillus-dominant assemblages are assigned to zone 6; they are also present at the top of box cores from Esquiman Channel (Ceman, 1990), Anticosti and Laurentian channels (C.G. Rodrigues, personal communication, 1992).

The planktonic foraminiferal assemblages consist mainly of sinistrally coiled tests of Neogloboquadrina pachyderma. Globigerina quinqueloba and G. uvula are present in some samples. The number of tests of planktonic foraminifers ranges from a maximum of 836•10 cm^{-3} in zone 5 to <50•10 cm^{-3} in zone 6 (Fig. 9). The number of tests of benthonic foraminifers ranges from 470 to 1,302•10 cm^{-3} and is generally lowest in zone 6. The number of benthonic species per assemblage is >20 in both zones with a maximum of 39 in zone 6. Benthonic foraminiferal species diversity (H[S]) is from 2.44 to 2.76. The abundant benthonic foraminiferal species and other invertebrate fossils of the zones recognized in the box, trigger weight and piston cores from site 1 are listed in Table 8.

Site 2 (Chaleur Trough)

Five seismic units overlie bedrock at the core site (Fig. 10). The piston core (90031027PC) penetrated units II to V. The trigger weight and box cores, 90031027TWC and 90031025BC respectively, bottomed in the upper part of unit V.

Core 90031027PC The sediments in the core (Fig. 11) consist mainly of mud to about 6.2 m with a sandy interval between 4.8 and 5.1 m, and sandy mud or muddy sand from about 6.2 m to the bottom of the core (11.16 m). Pebbles are abundant between 6.3 and 6.7 m. The sediments are olive gray to dark gray above 6.5 m and mainly reddish gray below 6.5 m. Six radiocarbon ages were obtained for pelecypod valves from the core (Table 3 and Fig. 12). The ages range from 2,520 ± 60 years BP at about 2.35 m to 12,230 ± 120 years BP at about 9.7 m.

The percent abundances of benthonic and planktonic foraminifers, the number of tests, and benthonic foraminiferal species diversities for core 90031027PC are listed in Table 9 (in pocket). The benthonic foraminiferal

Table 8. Abundant benthonic foraminiferal species and occurrence of other fossils in zones from site 1.

Zone	Abundant benthonic foraminiferal species	Other invertebrate fossils
6	*Astrononion gallowayi* *Elphidium excavatum clavata* *Eponides pusillus* *Pullenia osloensis*	diatoms rare; radiolaria common; ostracodes rare; sponge spicules common; bryozoans rare; echinoderm elements common; mollusks[1] rare.
5	*Brizalina subaenariensis* *Bulimina aculeata* *Cassidulina reniforme* *Cibicides lobatulus* *Elphidium excavatum clavata* *Oridorsalis* cf. *O. umbonatus* *Pullenia osloensis*	diatoms common; radiolaria common; ostracodes common; sponge spicules common; bryozoans rare; echinoderm elements common; mollusks[1] common.
4	*Astrononion gallowayi* *Cassidulina reniforme* *Cibicides lobatulus* *Elphidium excavatum clavata* *Pullenia osloensis*	diatoms rare; radiolaria common; ostracodes common; sponge spicules common; bryozoans absent; echinoderm elements common; mollusks[1] rare.
3	*Buliminella* sp. *Cassidulina reniforme* *Elphidium excavatum clavata* *Islandiella helenae* *Islandiella norcrossi*	diatoms common; radiolaria absent; ostracodes common; sponge spicules common; bryozoans absent; echinoderm elements common; mollusks[1] rare.
2	*Astrononion gallowayi* *Cassidulina reniforme* *Cibicides lobatulus* *Elphidium excavatum clavata*	diatoms common; radiolaria rare; ostracodes common; sponge spicules rare; bryozoans rare; echinoderm elements common; mollusks[2] common.
1	*Cassidulina laevigata* *Cassidulina reniforme* *Elphidium excavatum clavata* *Oridorsalis* cf. *O. umbonatus* *Pullenia bulloides* *Pullenia osloensis*	diatoms rare; radiolaria rare; ostracodes rare; sponge spicules absent; bryozoans absent; echinoderm elements rare; mollusks absent.

[1] Pelecypods only.

[2] Includes pelecypods, gastropods and pteropods.

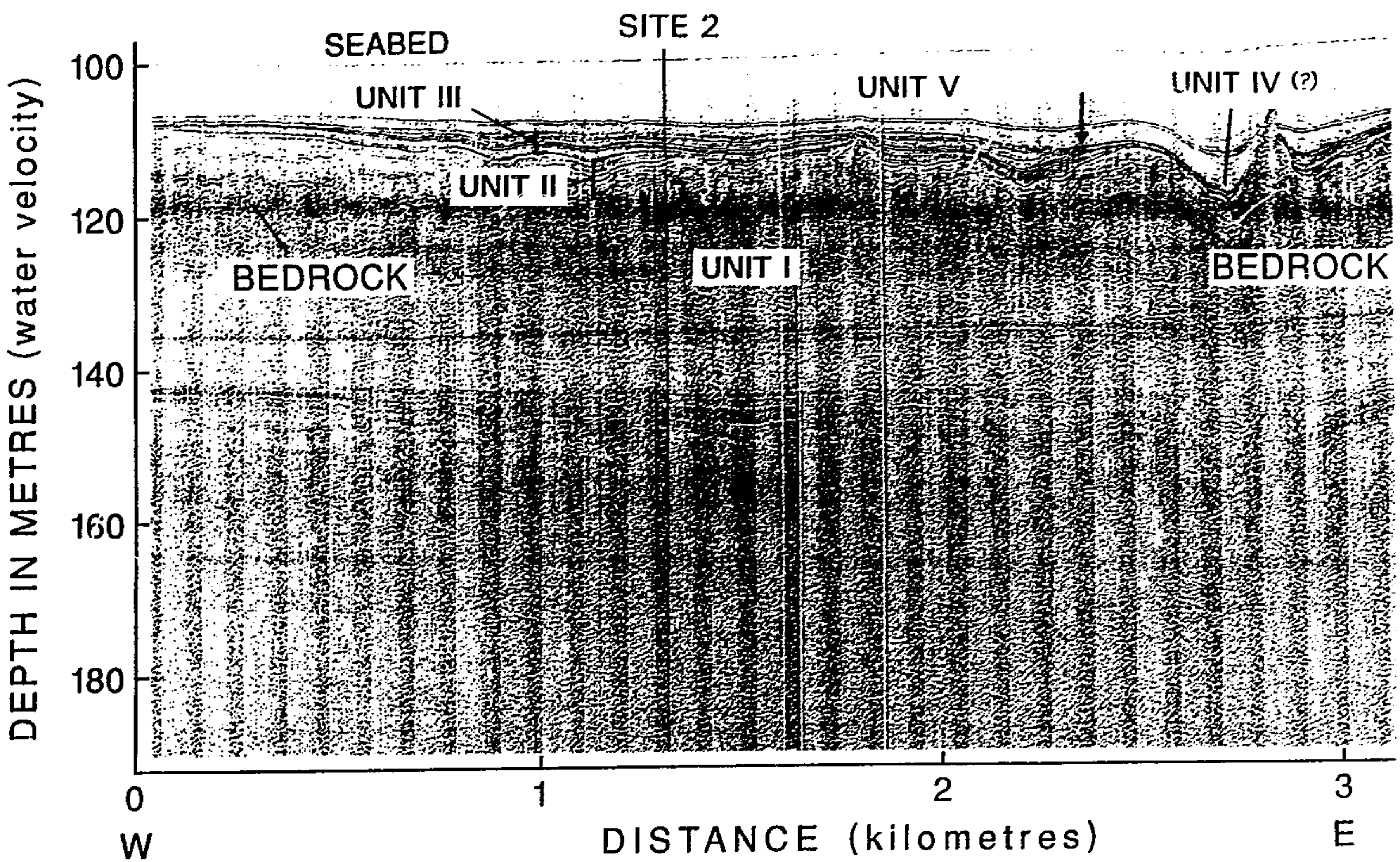

Figure 10. Huntec DTS seismic profile across site 2. The arrow indicates the location where seismic unit III is absent.

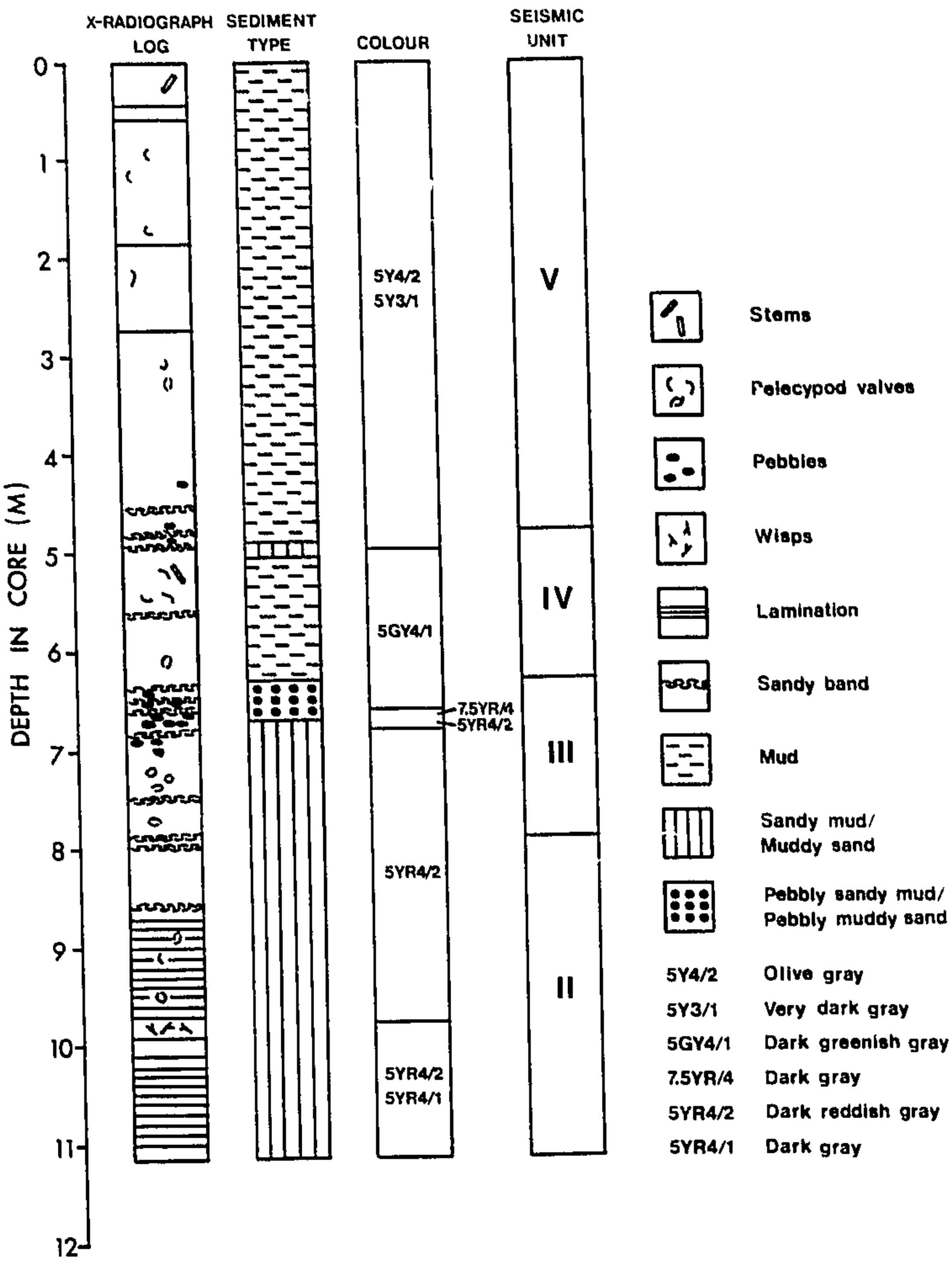

Figure 11. X-radiograph log, sediment type and seismic units for core 90031027PC.

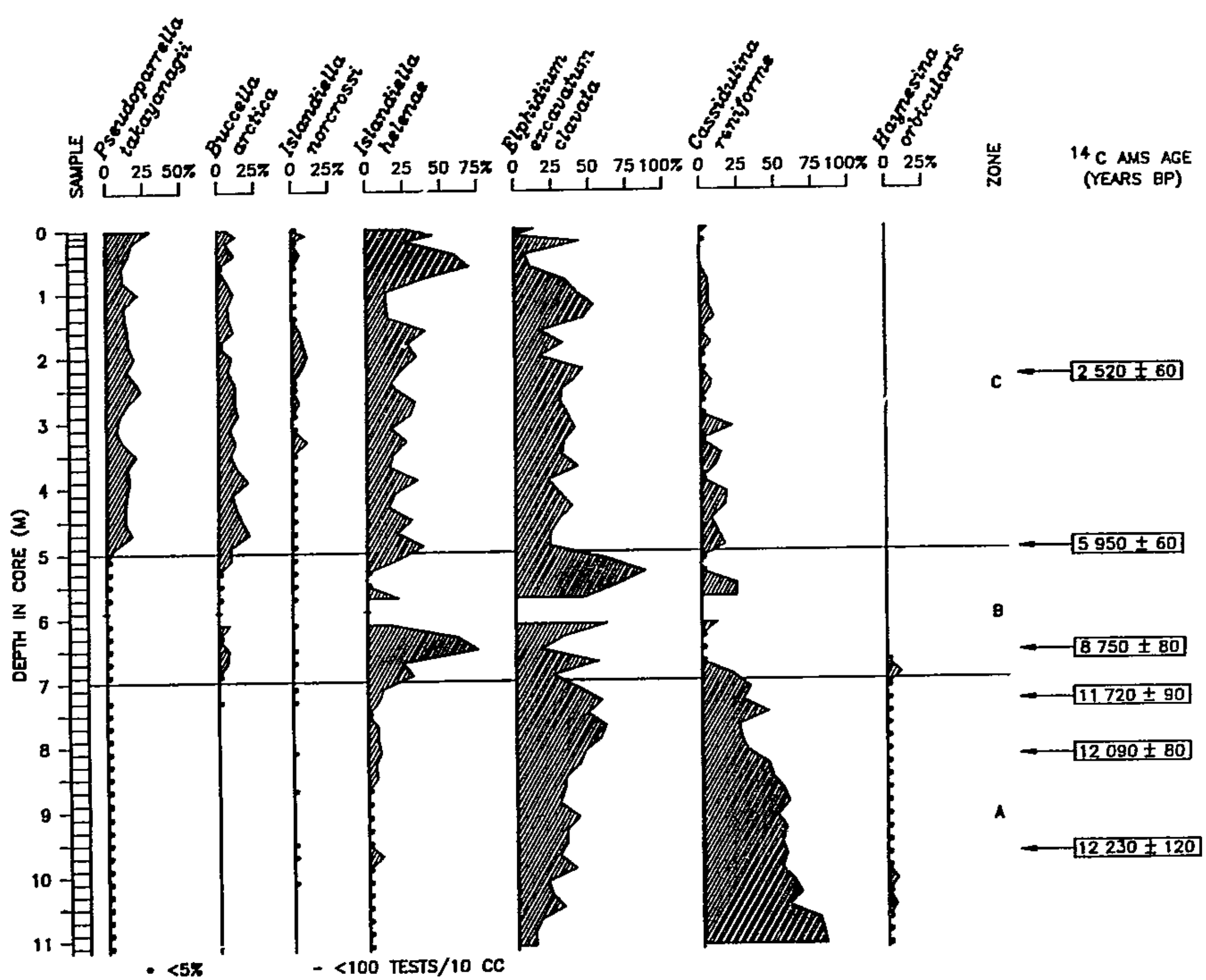

Figure 12. Benthonic foraminiferal zonation of core 90031027PC.

assemblages are dominated by calcareous species. Agglutinated species are present in two samples, one at the top and the other in the lower part of the core, where they represent <1.5% of the assemblages.

The piston core is divided into three zones on the basis of selected benthonic foraminiferal species (Fig. 12). Cassidulina reniforme and Elphidium excavatum forma clavata are the abundant species in the oldest zone (A). The abundance of Cassidulina reniforme decreases and that of Elphidium excavatum forma clavata increases from the base to the top of zone A. The boundary between zones A and B is defined by a decline in the abundance of Cassidulina reniforme and a concomitant rise in the abundance of Islandiella helenae. Elphidium excavatum forma clavata and Islandiella helenae are the abundant species in zone B. A decline in the abundance of Elphidium excavatum forma clavata and a rise in the abundance of Pseudoparrella takayanagii mark the boundary between zones B and C. The abundant species in zone C are Elphidium excavatum forma clavata, Islandiella helenae, Pseudoparrella takayanagii and Buccella arctica.

The only planktonic foraminiferal species present in the core is Neogloboquadrina pachyderma (sinistrally coiled). The species occurs in low numbers (<10 tests$\cdot$10 cm^{-3}) in six of the fifty-eight samples (Fig. 13). The number of benthonic foraminiferal tests increases from

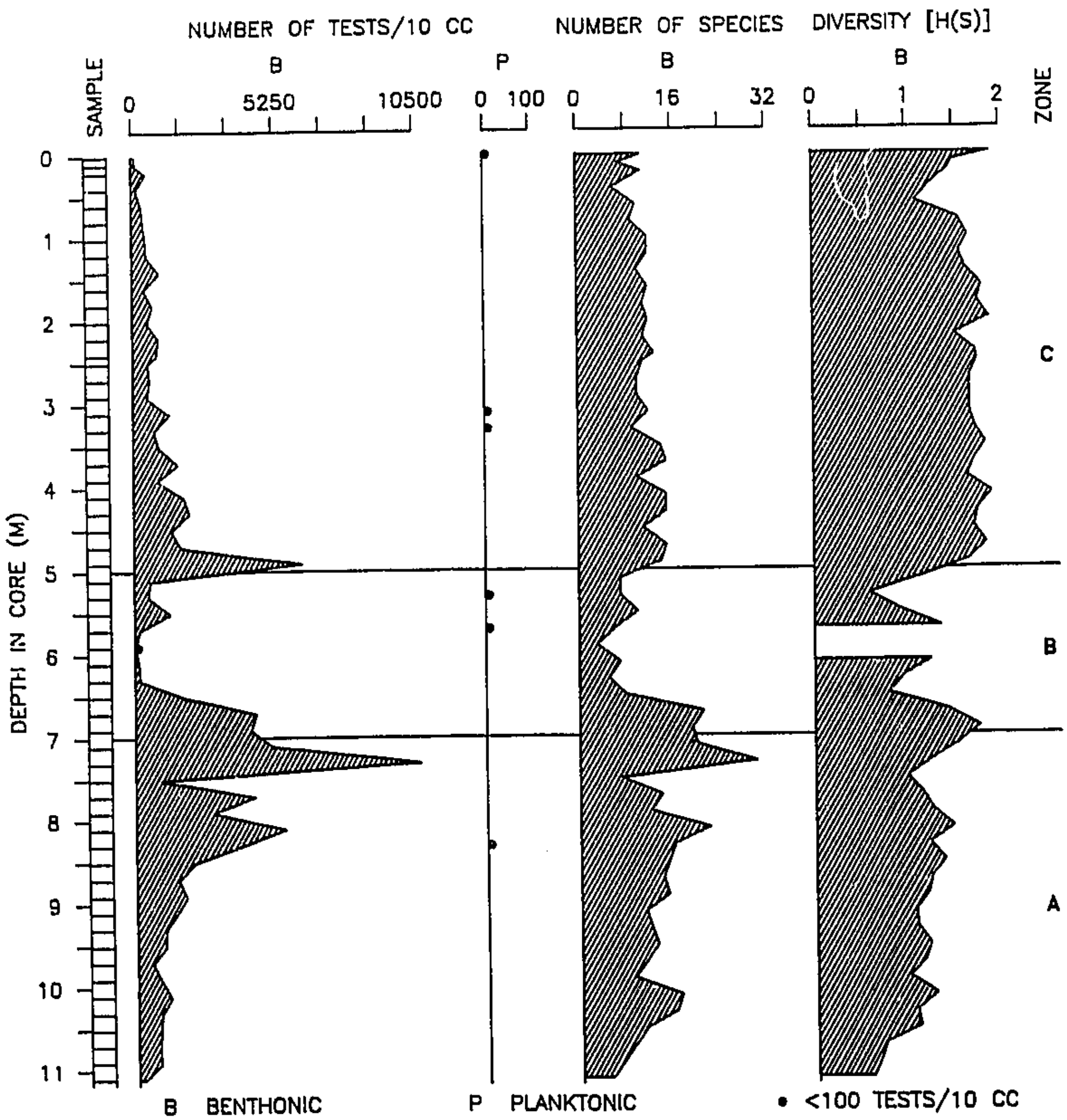

Figure 13. Number of foraminiferal tests, number of benthonic foraminiferal species and benthonic foraminiferal species diversity for samples from core 90031027PC.

228•10 cm^{-3} at the bottom of zone A to as high as 10,646•10 cm^{-3} in the upper part of the zone and is generally <1,750•10 cm^{-3} in zones B and C.

The number of benthonic foraminiferal species per assemblage ranges from 5 to 30 in zone A, decreasing to as low as 3 per assemblage in zone B and increasing to a maximum of 17 per assemblage in zone C. Benthonic foraminiferal species diversity (H[S]) ranges from 0.59 to 1.53 in zone A, 0.59 to 1.77 in zone B, and 1.10 to 1.91 in zone C.

Core 90031027TWC The trigger weight core consists of 1.08 m of dark and olive gray mud (Fig. 14). The percent abundances of benthonic foraminiferal species and number of species for the core is listed in Table 10 (in pocket). Tests of planktonic foraminifers and agglutinated benthonic foraminifers were not observed in the samples from the core.

The benthonic assemblages from the core contain <100 tests•10 cm^{-3} except for one sample from the upper part of the core. However, the proportions of the abundant species in the trigger weight core are similar to those of the abundant species in the upper part of the piston core (Fig. 15). The assemblages from the trigger weight core are assigned to zone C. The number of benthonic species per assemblage ranges from 4 to 9 and benthonic foraminiferal species diversity (H[S]) for one sample containing >100

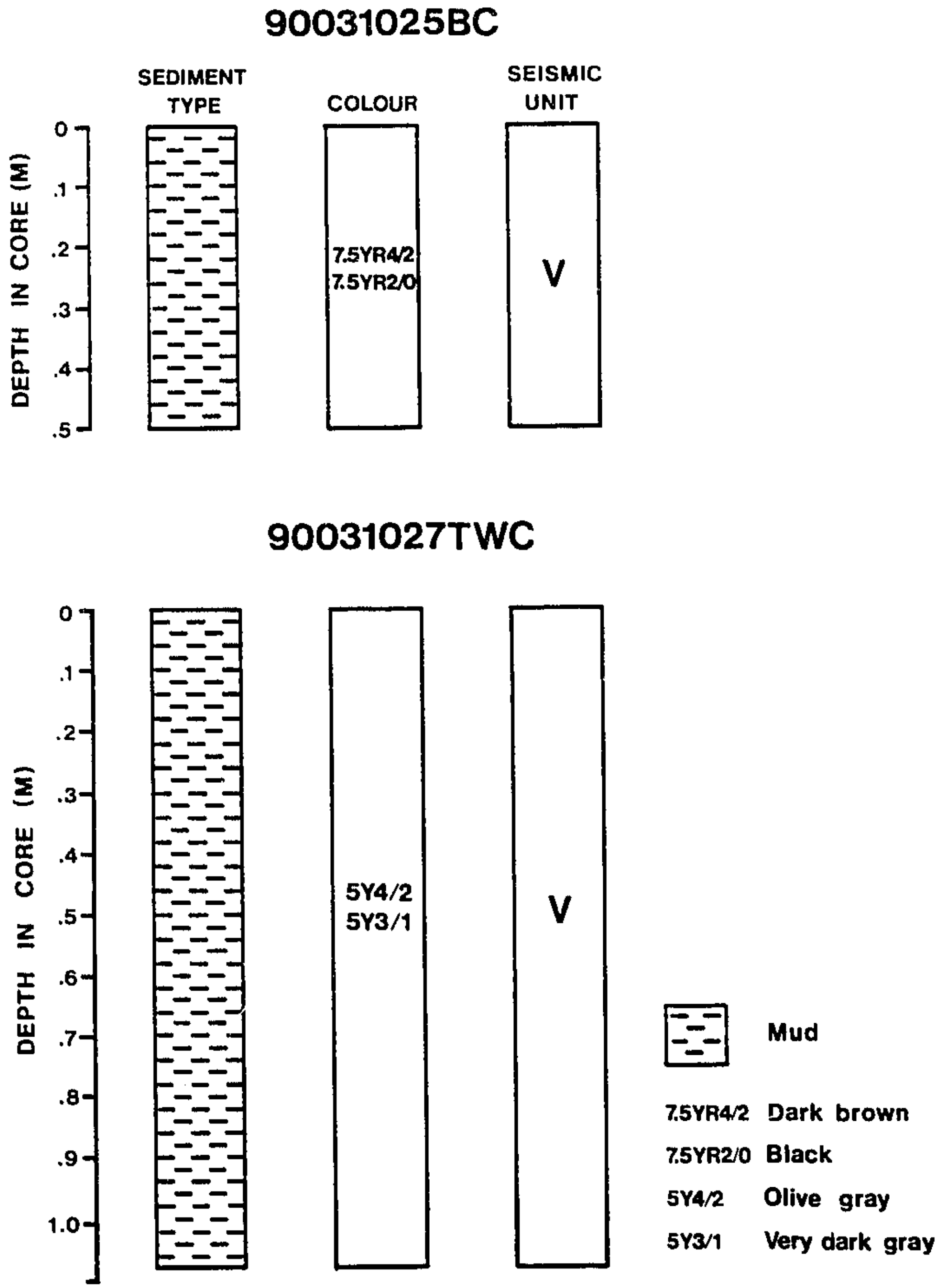

Figure 14. Sediments and seismic unit identified in cores 90031025BC and 90031027TWC.

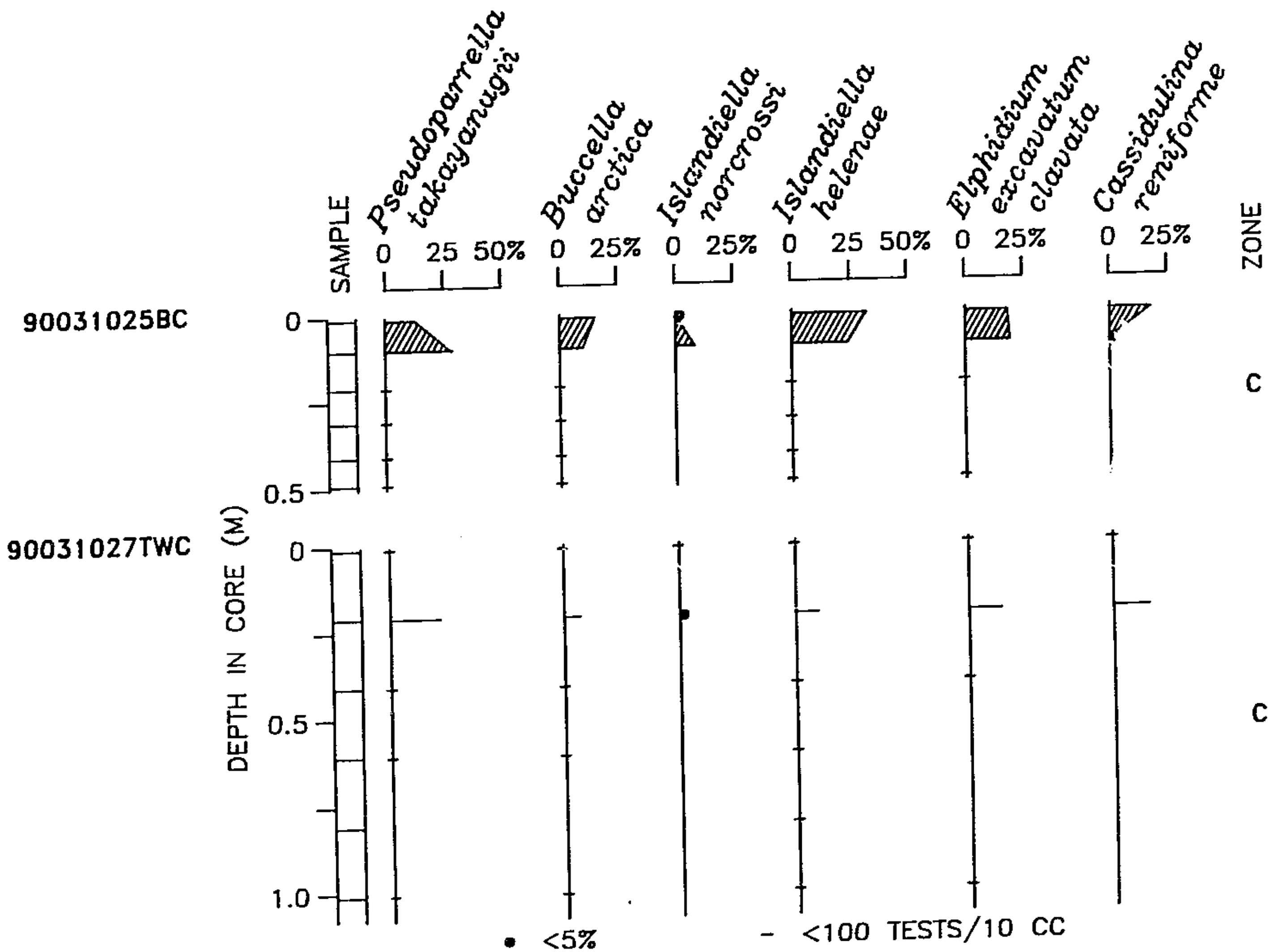

Figure 15. Benthonic foraminiferal zonation of cores 90031025BC and 90031027TWC.

tests•10 cm^{-3} of sediment is 2.01 (Fig. 16).

<u>Core 90031025BC</u> The box core consists of 0.5 m of brown and black mud (Fig. 14). The percent abundances of benthonic foraminifers and number of tests for the core are listed in Table 11 (in pocket). Tests of planktonic foraminifers were not observed in the samples from the core.

The benthonic foraminiferal assemblages from the core contain <100 tests•10 cm^{-3} of sediment, except for two samples from the upper part of the core, which contain 182 and 186 tests•10 cm^{-3}. The proportions of the abundant species in the samples from the box core are similar to those from the trigger weight core (Fig. 15). The samples from the box core are assigned to zone C. The number of species (calcareous and agglutinated) per assemblage ranges from 4 to 9 (Fig. 16). One or two agglutinated species are present in three of the six samples from the box core. Benthonic foraminiferal species diversity (H[S]) for the two samples containing >100 tests•10 cm^{-3} are 1.67 and 1.78. The abundant benthonic foraminiferal species and other invertebrate fossils of the zones recognized in the box, trigger weight and piston cores from site 2 are listed in Table 12.

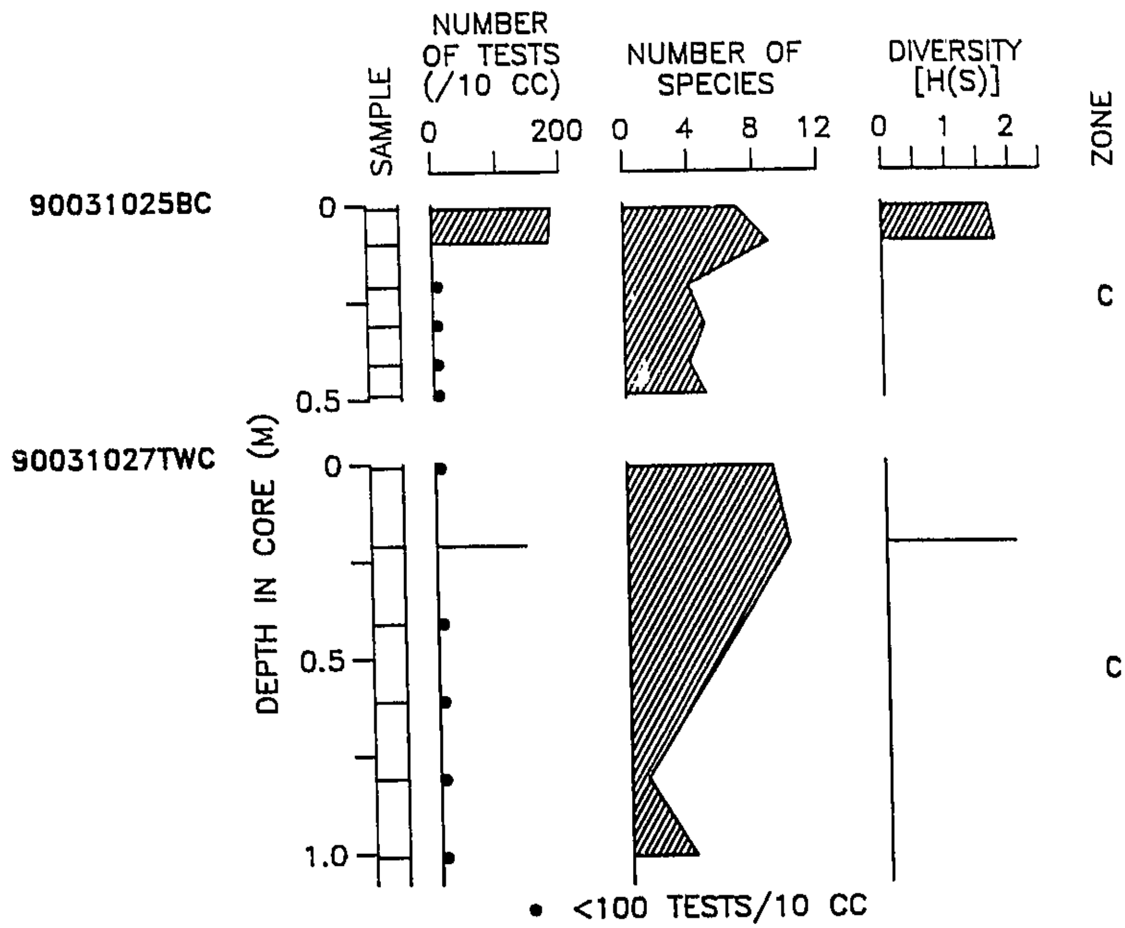

Figure 16. Number of benthonic foraminiferal tests and species and benthonic foraminiferal species diversity for samples from cores 90031025BC and 90031027TWC.

Table 12. Abundant benthonic foraminiferal species and occurrence of other fossils in zones from site 2.

Zone	Abundant benthonic foraminiferal species	Other invertebrate fossils
C	*Buccella arctica* *Cassidulina reniforme* *Elphidium excavatum clavata* *Islandiella helenae* *Pseudoparrella takayanagii*	diatoms common; radiolaria absent; ostracodes rare; sponge spicules rare; bryozoans absent; echinoderm elements rare; pelecypods rare.
B	*Cassidulina reniforme* *Elphidium excavatum clavata* *Islandiella helenae*	diatoms rare; radiolaria absent; ostracodes rare; sponge spicules rare; bryozoans rare; echinoderm elements rare; pelecypods rare.
A	*Cassidulina reniforme* *Elphidium excavatum clavata*	diatoms common; radiolaria absent; ostracodes common; sponge spicules rare; bryozoans rare; echinoderm elements common; pelecypods common.

PALEOCEANOGRAPHY

The paleoceanographic interpretation of the benthonic foraminiferal zones in the cores is based on modern distribution data for the abundant species of the zones and on the interpretation of similar foraminiferal assemblages from cores along the eastern Canadian continental margin. The modern distribution data for most of the abundant species in the cores are summarized in Table 13 and are based only on references, which include illustrations of the species.

Site 1 (Laurentian Channel)

Zone 1 This zone is characterized by barren samples or samples with low numbers of benthonic foraminiferal tests and assemblages, in which Cassidulina laevigata, C. reniforme, Elphidium excavatum forma clavata, Oridorsalis sp. cf. O. umbonatus, Pullenia bulloides and P. osloensis are abundant (Fig. 5). Two of the abundant species, Cassidulina laevigata and Pullenia bulloides, live in relatively cold (-1 to 3°C) and saline (34.7 to 35.1‰) bottom-water (Table 13). Cassidulina laevigata is associated with the Atlantic layer in the Arctic Ocean (Lagoe, 1977). Vilks et al. (1989) reported Cassidulina laevigata-dominant assemblages in cores from Hudson Strait and concluded that the assemblages are related to the presence of saline offshore water in Hudson Strait. Thus,

Table 13. Modern distribution data for (
foraminiferal species at sites

Species	Temperature (°C)	Salinity (‰)	Depth (m)	Abundance (%)
Bulimina aculeata	4.0 to 4.9	34.0 - 34.8	197 - 365	[1]24.5
d'Orbigny	5 to 12	34.5	150 - 220	-
Brizalina subaenariensis	4.1 to 4.8	34.5 - 34.9	390 - 520	[1]8.3
(Cushman)	5 to 12	34.5	150 - 220	-
Cassidulina laevigata	0 to 3	34.9 - 35.1	350 - 900	10 - 30
d'Orbigny	-1.0	34.9	1200 - 1600	50 - 70
Cassidulina reniforme	-0.5	28.0	100 - 200	5 - 30
Nørvang	-1 to 2	~33 - 34	70 - 370	5 - 25
Cibicides lobatulus	-0.9 to 3.6	32 - 34	46 - 105	23.8 - 56.
(Walker and Jacob)	-2.0 to 2.0	30.7 - 33.5	55 - 128	[1]48.8
	-1.5 to 2.0	~33 - 34	100 - 370	<10
Elphidium excavatum (Terquem)	1 to 2	30 - 32	<75	>40
forma clavata (Cushman)	-1.5 to 2.0	~33 - 34	100 - 370	5 - 40
	4.1 to 4.9	34.5 - 34.9	375 - 520	12.8 - 22.
	-2 to 12+	≤32	≤50	6 - 20
Haynesina orbicularis	-1.6 to 3.0	26.0 - 32.8	35 - 101	3 - 23
(Brady)				
Islandiella helenae	-1.8 to -1.0	30.4 - 33.3	51 - 230	3 - 18
Feyling-Hanssen and Buzas	-2.0 to 2.3	31.4 - 33.6	73 - 142	[1]42.5
	-1.5 to 2.0	~33 - 34	100 - 370	5 - 50
Islandiella norcrossi	-1.6 to -1.0	30.9 - 33.1	51 - 198	2 - 17
(Cushman)				
Pseudoparrella takayanagii	-1.8 to 0.5	32.4 - 33.4	93 - 230	6 - 18
(Isawa)				
Pullenia bulloides	-0.2 to 0.8	34.7 - 34.7	2500 - 4600	1 - 17
d'Orbigny	-1 to 0	34.9	700 - 1200	4 - 8
	2.39	34.8	~2700	≤ 8.8
Pullenia osloensis	4.1 to 4.9	34.5 - 34.9	375 - 520	8.8 - 13.
Feyling-Hanssen	-0.2 to 1.2	34.7 - 34.7	2500 - 4600	1 - 8

[1]average abundance
[2]identified as Bolivina subaenariensis
[3]identified as Cassidulina teretis
[4]identified as Elphidium clavatum
[5]identified as Protelphidium orbiculare
[6]identified as Cassidulina norcrossi

n data for characteristic benthonic
ies at sites 1 and 2.

epth (m)	Abundance (%)	Location	Reference
– 365	[1]24.5	Gulf of St. Lawrence	Rodrigues and Hooper (1982a)
– 220	–	Scotian Shelf	Williamson et al. (1984)
– 520	[1]8.3	Gulf of St. Lawrence	[2]Rodrigues and Hooper (1982a)
– 220	–	Scotian Shelf	[2]Williamson et al. (1984)
– 900	10 – 30	Arctic Ocean	[3]Lagoe (1977)
– 1600	50 – 70	Norwegian Slope	Sejrup et al. (1981)
– 200	5 – 30	Lake Melville	Vilks et al. (1982)
– 370	5 – 25	Labrador Shelf	Vilks et al. (1982)
– 105	23.8 – 56.3	Grand Banks	Sen Gupta (1971)
– 128	[1]48.8	Gulf of St. Lawrence	Rodrigues and Hooper (1982a)
– 370	<10	Labrador Shelf	Vilks et al. (1982)
<75	>40	Beaufort Shelf	[4]Vilks et al. (1979)
– 370	5 – 40	Labrador Shelf	Vilks et al. (1982)
– 520	12.8 – 22.7	Gulf of St. Lawrence	[4]Rodrigues and Hooper (1982a)
550	6 – 20	Gulf of St. Lawrence	[4]Rodrigues and Hooper (1982b)
– 101	3 – 23	Hudson Bay	[5]Leslie (1965)
– 230	3 – 18	Hudson Bay	[3]Leslie (1965)
– 142	[1]42.5	Gulf of St. Lawrence	Rodrigues and Hooper (1982a)
– 370	5 – 50	Labrador Shelf	Vilks et al. (1982)
– 198	2 – 17	Hudson Bay	[6]Leslie (1965)
– 230	6 – 18	Hudson Bay	[7]Leslie (1965)
– 4600	1 – 17	Indian Ocean	Corliss (1979)
– 1200	4 – 8	Norwegian Slope	Sejrup et al. (1981)
2700	≤ 8.8	Labrador Slope	Schafer and Cole (1982)
– 520	8.8 – 13.9	Gulf of St. Lawrence	[8]Rodrigues and Hooper (1982a)
– 4600	1 – 8	Indian Ocean	Corliss (1979)

um clavatum
hidium orbiculare
lina norcrossi

[7]identified as Epistominella takayanagii
[8]identified as Melonis sp.

the Cassidulina laevigata assemblages of zone 1 indicate that offshore water, temperature -1 to 3°C and salinity 34.7 to 35.1‰, was present in the deep part of the Laurentian Channel. The barren samples and samples containing low numbers of foraminiferal tests indicate low-salinity conditions (<25‰), which are related to meltwater flux from the ice margin. The meltwater flux was relatively low during the intervals characterized by the Cassidulina laevigata assemblages.

Large numbers of the planktonic foraminifer Neogloboquadrina pachyderma (mainly sinistrally coiled) accompany the Cassidulina laevigata assemblages (Fig. 6). Sinistrally coiled tests of the planktonic species live in the upper part of the water column where temperatures are ≤8°C (Loubere, 1981; Reynolds and Thunell, 1986; Sautter Reynolds and Thunell, 1989) and salinities range from 33 to 34‰ (Bé and Hutson, 1977; Sautter Reynolds and Thunell, 1989). Thus, the temperature and salinity of the upper part of the water column was ≤8°C and 33 to 34‰, respectively, during the intervals characterized by the Cassidulina laevigata assemblages. The absence of planktonic foraminifers in the intervals characterized by barren samples and low numbers of benthonic foraminiferal tests support the conclusion that these intervals indicate relatively low-salinity conditions.

Zone 2 Astrononion gallowayi, Cassidulina reniforme, Cibicides lobatulus and Elphidium excavatum forma clavata are the abundant species of this zone. These species live in bottom waters with wide temperature and salinity ranges (Table 13). The decrease in the abundance of Cassidulina laevigata in the lower part of the zone and the absence of the species in the upper part of the zone indicate lower salinity bottom-water by comparison with that for the Cassidulina laevigata assemblages of zone 1.

There is a rise in the abundance of Islandiella helenae in the middle part of zone 2 (Fig. 5). This species is most abundant in cold bottom water with salinity between 30 and 34‰ (Table 13). Thus, the salinity of the bottom water was lower (30 and 34‰) during the Islandiella helenae peak and higher (34 to 34.7‰) above and below the peak. The absence of benthonic foraminiferal species, which are restricted to warm bottom-water, suggests that the temperature of the bottom water was comparable to that of zone 1, i.e. ≤3°C. The presence of low numbers of Neogloboquadrina pachyderma in zone 2 (Fig. 6) indicates that the salinity of the upper part of the water column was <33‰.

Zone 3 The abundant benthonic foraminiferal species of this zone are Cassidulina reniforme, Elphidium excavatum forma clavata and Islandiella helenae. The latter species is most abundant in bottom water with temperature <2.3°C and salinity between 30 and 34‰ (Table 13). Vilks et al. (1989) pointed out that Islandiella helenae is associated with the cold waters on the Labrador Shelf, where the salinity is 32.5 to 33.5‰. Vilks *et al*. (1987) described *Islandiella helenae*-dominant assemblages in cores from Lake Melville and they concluded that the assemblages indicate bottom-water salinity between 30 and 34‰. Thus, the temperature of the bottom water was <2.3°C and salinity was between 30 and 34‰ in zone 3. *Neogloboquadrina pachyderma* is rare in zone 3 (Fig. 6). This indicates that the salinity of the upper part of the water column was <33‰ and probably less than in zone 2.

There is a decline in the abundance of *Islandiella helenae* in the middle of zone 3; it is associated with a rise in the abundance of *Islandiella norcrossi* and relatively high abundances of *Cassidulina reniforme* and *Elphidium excavatum* forma *clavata* (Fig. 5). These species live in bottom waters with wide temperature and salinity ranges. Thus, the decline in abundance of *Islandiella helenae* may be related to an increase or decrease in temperature and/or salinity.

Zone 4 The benthonic foraminiferal assemblages in this zone are similar to those of zone 2 (Table 8). *Pullenia osloensis* is abundant in the upper part of zone 4 and is present in low numbers in zone 2. This species is an indicator species of the modern, deep watermass layer in the Gulf of St. Lawrence (Rodrigues and Hooper, 1982a). The absence or low numbers of other indicator species of the deep watermass layer, e.g. Brizalina subaenariensis and Bulimina aculeata, suggests that the temperature and salinity of the bottom water was <4°C and <34.5‰, respectively. Thus, the temperature of the bottom water was between 2.3 and 4°C with salinity between 34 and 34.5‰.

Neogloboquadrina pachyderma occurs more frequently in zone 4 than in zone 3 (Fig. 6). Thus, the salinity of the upper part of the water column was higher than in zone 3. However, the low numbers of planktonic foraminiferal tests in the samples from zone 4 suggest that the salinity of the upper part of the water column remained <33‰.

Zones 5 and 6 Most of the abundant species of these zones, Brizalina subaenariensis, Bulimina aculeata, B. exilis, Eponides pusillus, Oridorsalis sp. cf. O. umbonatus and Pullenia osloensis, are indicator species of the modern, deep watermass layer in the Gulf of St. Lawrence (Rodrigues and Hooper, 1982a). Thus, the temperature and salinity of the bottom water ranged from 4 to 6°C and 34.5 to 34.8‰, respectively, in zones 5 and 6.

Planktonic foraminiferal tests, mainly sinistrally coiled Neogloboquadrina pachyderma, are abundant in the upper part of zone 5 (Fig. 6) and in the lower part of zone 6 (Fig. 9). Thus, the salinity of the upper part of the water column was as high as 33 to 34‰ in zones 5 and 6.

In summary, the temperature of the bottom water was ≤3°C from zone 1 to zone 3 and was as high as 4 to 6°C in zones 5 and 6. The salinity of the bottom water varied from <25‰ to between 34.7 and 35.1‰ in zone 1, decreasing to as low as 30 to 34‰ in zone 3, and increasing to between 34.5 and 34.8‰ in zones 5 and 6. The inferred temperature and salinity of the bottom water at site 1 following the Late Quaternary deglaciation are shown in Figure 17. The salinity of the upper part of the water column was as high as 33 to 34‰ in zones 1, 5 and 6 and lower in the other zones.

Site 2 (Chaleur Trough)

Zone A The abundant benthonic foraminiferal species of this zone are *Cassidulina reniforme* and *Elphidium excavatum* forma *clavata* (Fig. 12). Similar assemblages were reported from glaciomarine sediments overlying till in the lower part of cores from Notre Dame Channel, off eastern Newfoundland (Scott *et al*., 1984) and off Baffin Island (Osterman and Nelson, 1989). The benthonic foraminiferal assemblages from zone A are indicative of a glaciomarine environment with temperature close to 0°C and salinity between 28 and 30‰.

Zone B *Cassidulina reniforme*, *Elphidium excavatum* forma *clavata* and *Islandiella helenae* are the abundant species of this zone. The high abundance of *Islandiella helenae* indiates that the salinity of the bottom water was higher (30 to 34‰) in zone B in comparison to zone A. The

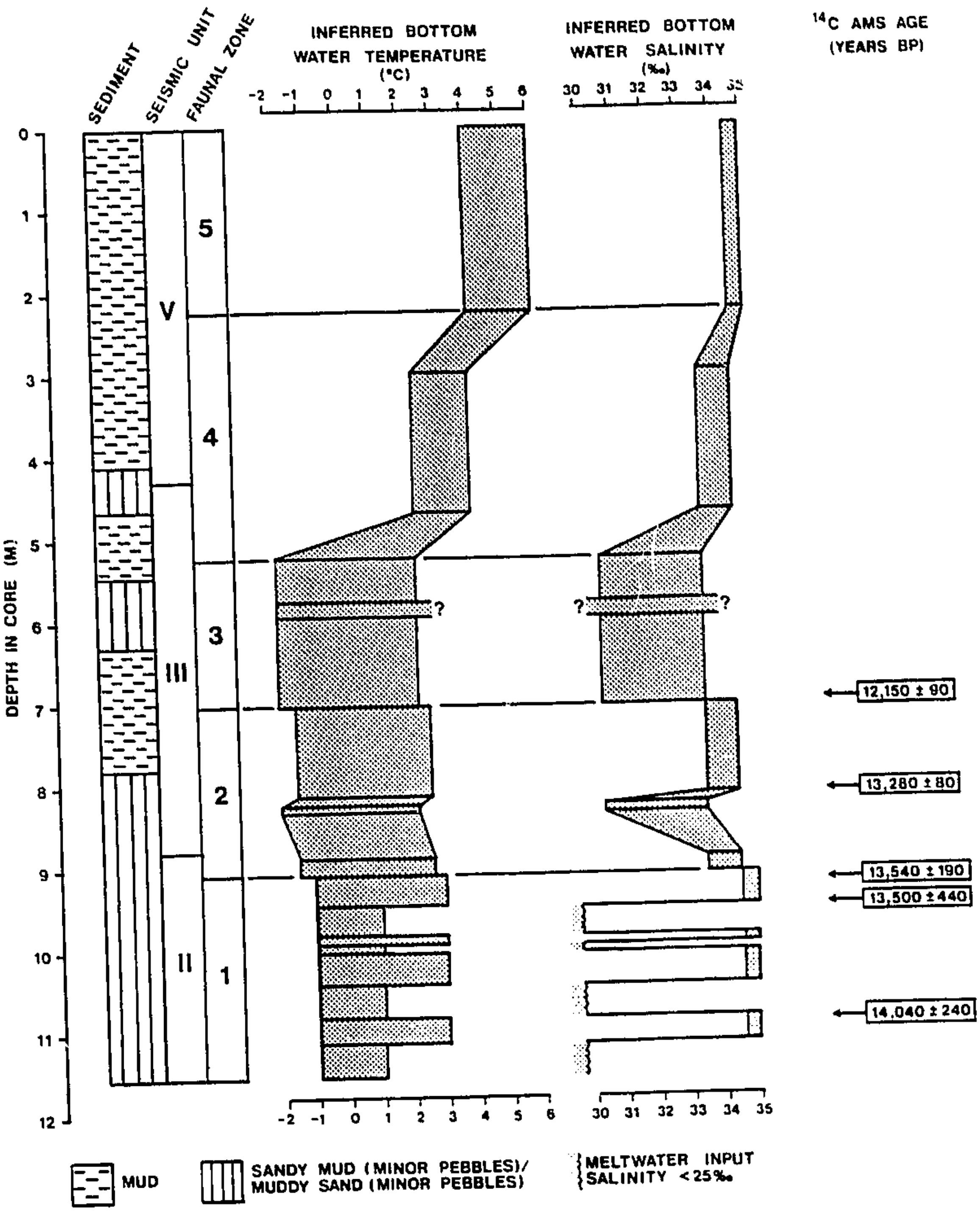

Figure 17. Summary of seismic units, faunal zones, chronology and paleoenvironmental interpretation for core 90031019PC.

temperature of the bottom water remained close to 0°C in zone B.

Zone C This zone is characterized by Buccella arctica, Elphidium excavatum forma clavata, Islandiella helenae and Pseudoparrella takayanagii. Modern distribution data for Buccella arctica and Pseudoparrella takayanagii are scarce. Buccella arctica is present in low numbers at depths corresponding to the cold intermediate layer and the saline deep layer in the Gulf of St. Lawrence (Rodrigues and Hooper, 1982a). Leslie (1965) reported that Pseudoparrella takayanagii (= Epistominella takayanagii) is most abundant in bottom waters with temperatures close to 0°C and salinities of 32.4 to 33.4‰ in Hudson Bay. These values overlap with those for Islandiella helenae. Thus, the temperature of the bottom water was close to 0°C and salinity was between 32 and 34‰ in zone C.

There is a decrease in the number of benthonic tests•10 cm^{-3} from the base to the top of zone C in the piston core (Fig. 13). Most of the samples from zone C in the trigger weight and box cores contain low numbers of benthonic foraminiferal tests (Figs. 15 and 16). The cause of the lower numbers of tests in the upper part of zone C is not known. An increase in sedimentation rate and/or factors other than temperature and salinity may explain the decline in the number of benthonic foraminiferal tests in the upper part of the zone. The inferred temperature and salinity of the bottom water at site 2 are shown in Figure 18. The salinity of the bottom water in the shallow Chaleur Trough has been lower than in the deep Laurentian Channel (cf. Figs. 17 and 18).

Planktonic foraminiferal tests are rare in the samples from the piston core and are absent in the samples from the trigger weight and box cores. This indicates that the salinity of the upper part of the water column was lower than 28 to 34‰, i.e. the inferred salinity range of the bottom waters for zones A to C.

LATE GLACIAL AND POST-GLACIAL HISTORY

The paleoceanographic interpretation of the faunal zones presented above and the radiocarbon ages for the zones (Fig. 19) provide new information on deglaciation and post-glacial events off eastern Gaspé Peninsula. They can also be used to correlate events in the Laurentian Channel and Chaleur Trough with those recognized on Anticosti Island and on Gaspé Peninsula.

Site 1 (Laurentian Channel)

The rapid retreat of the ice front was produced by the development of a calving bay along the Laurentian Channel (Thomas, 1977). The oldest age for zone 1 (Fig. 19) shows that site 1 was deglaciated by 14,040 ± 240 years BP. The

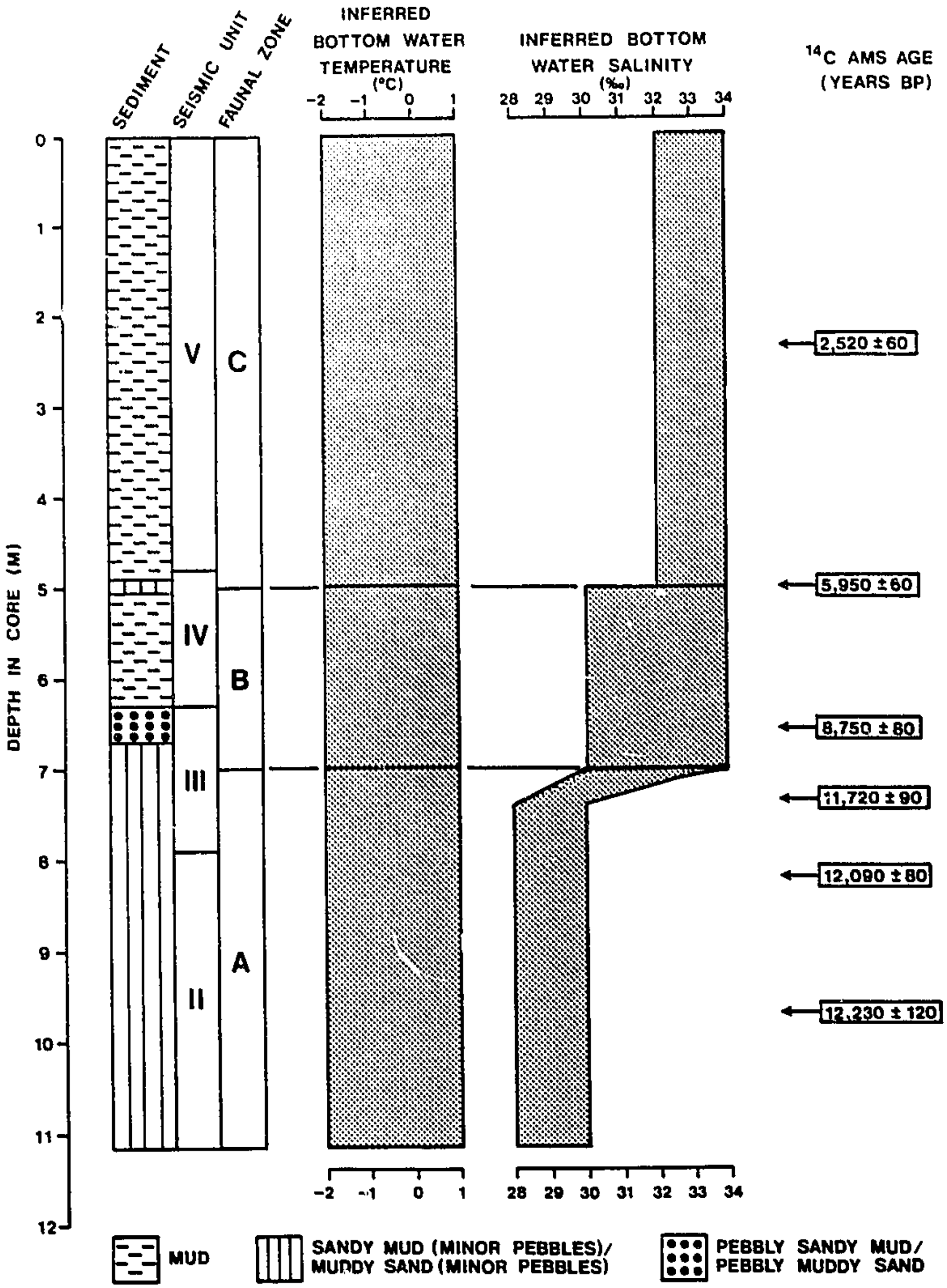

Figure 18. Summary of seismic units, faunal zones, chronology and paleoenvironmental interpretation for core 90031027PC.

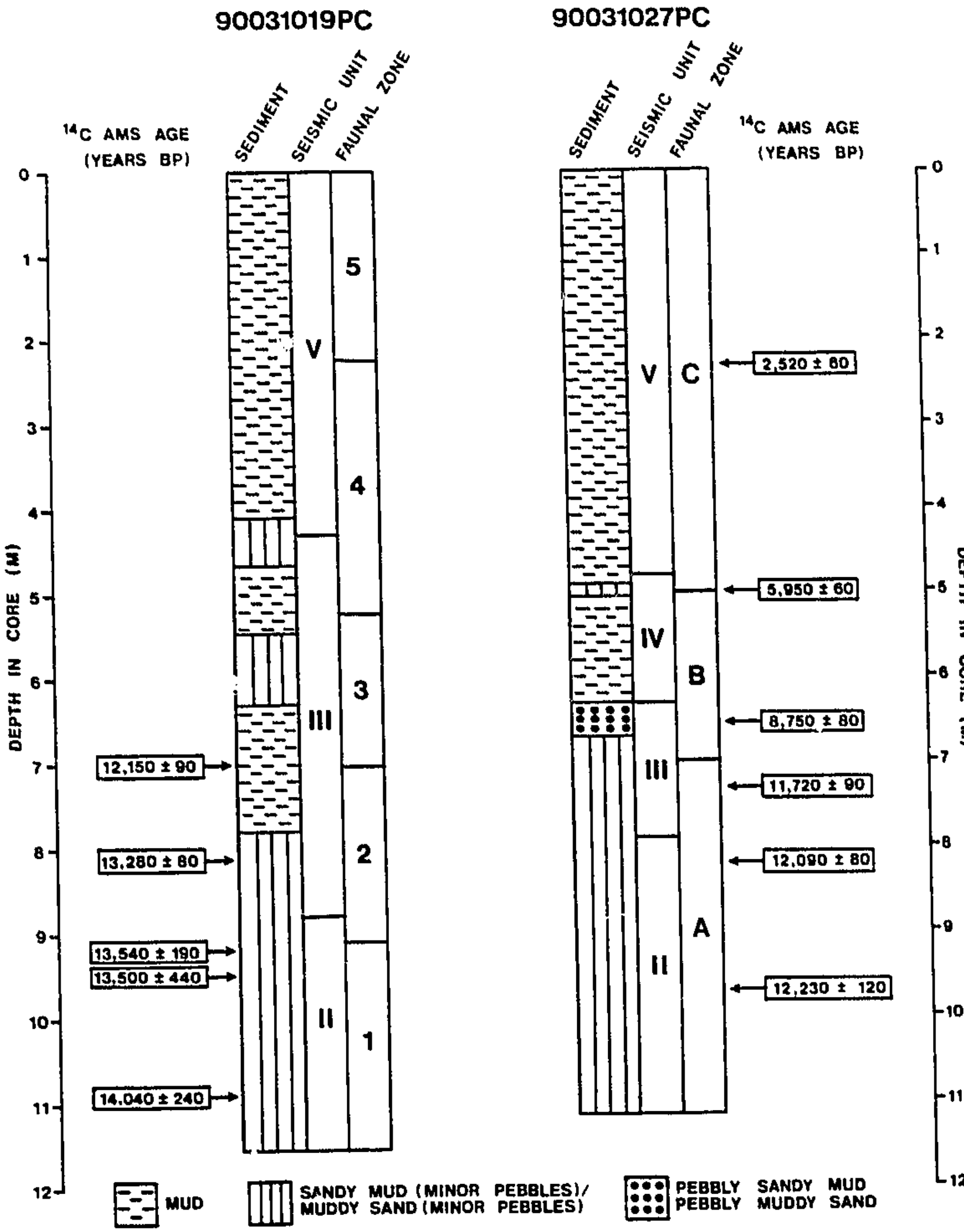

Figure 19. Summary of ^{14}C AMS ages for cores 90031019PC and 90031027PC.

radiocarbon ages for marine fossils, which are related to the Late Quaternary deglaciation of the north coast of Gaspé Peninsula and the south coast of Anticosti Island (Fig. 20 and Table 14) are within the range of radiocarbon ages for the upper part of zone 1 and the lower part of zone 2 (Fig. 19). Thus, those areas were deglaciated later than site 1.

The influence of the cold, saline, offshore water associated with the intervals of higher salinity in zone 1 (Fig. 17) ended about 13,540 ± 190 years BP and the change to the low-salinity zone 3 began about 12,150 ± 90 years BP (Fig. 19). Additional radiocarbon ages are required to determine the age of the end of the low-salinity zone 3 and the establishment of the modern, deep watermass layer (zone 4 - zone 5 boundary).

Rodrigues and Vilks (1990, 1991) concluded that the changes in the salinity of the bottom water in the deep part of the Gulf of St. Lawrence following the Late Quaternary deglaciation are related to the variations in the composition of offshore water entering the Gulf through Cabot Strait. This conclusion is based on the study by Lauzier and Trites (1958), who proposed that the modern, deep watermass layer is formed southeast of Newfoundland, and consists of a mixture of cold low-salinity Labrador Water and warmer higher-salinity Slope Water. More recently, Bugden (1991) showed that the mixture consists of

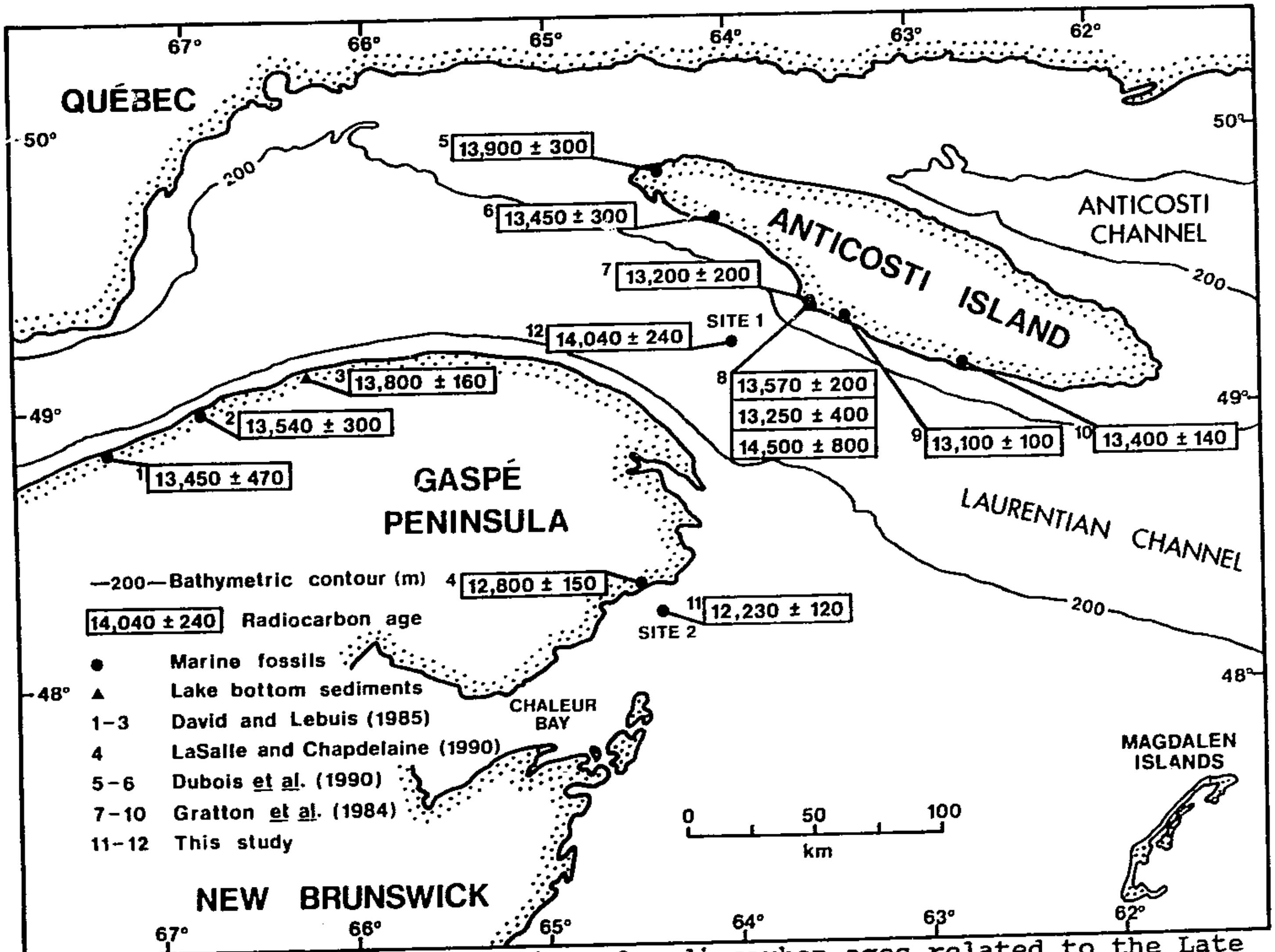

Figure 20. Map showing location of radiocarbon ages related to the Late Quaternary deglaciation of Gaspé Peninsula, Anticosti Island and core sites.

Table 14. Radiocarbon ages related to the Late Quaternary deglaciation of Gaspé Peninsula, Anticosti Island and core sites.

[1]Number	Location	Dated Material	Laboratory Number	^{14}C Age (years BP)	Reference
1	Gaspé Peninsula	Marine shells	QU-84	13,450 ± 470	David and Lebuis (1985)
2	Gaspé Peninsula	Marine shells	QU-85	13,540 ± 300	David and Lebuis (1985)
3	Gaspé Peninsula	Organic sediments	GSC-1908	13,800 ± 160	David and Lebuis (1985)
4	Gaspé Peninsula	*Hiatella arctica*	GSC-4810	12,800 ± 150	LaSalle and Chapdelaine (1990)
5	Anticosti Island	Shells	QU-1376	13,900 ± 300	Dubois *et al*. (1990)
6	Anticosti Island	Shells	UQ-1018	13,450 ± 300	Dubois *et al*. (1990)
7	Anticosti Island	Shells	UQ-505	13,200 ± 200	Gratton *et al*. (1984)
8	Anticosti Island	Shells	UQ-502	13,570 ± 200	Gratton *et al*. (1984)
8	Anticosti Island	Shells	UQ-496	13,250 ± 400	Gratton *et al*. (1984)
8	Anticosti Island	Shells	UQ-551	14,500 ± 800	Gratton *et al*. (1984)
9	Anticosti Island	Shells	UQ-512	13,100 ± 150	Gratton *et al*. (1984)
10	Anticosti Island	Shells	UQ-712	13,400 ± 140	Gratton *et al*. (1984)
11	Chaleur Trough	Pelecypod valves	TO-2477	12,230 ± 120	This study
12	Laurentian Channel	Foraminifera[2]	TO-2547	14,040 ± 240	This study

[1]See Figure 20

[2]Mixed benthonic and planktonic foraminiferal tests

Labrador and Western North Atlantic Waters. A similar origin for the bottom water at site 1 is proposed herein, except for the low-salinity intervals of zone 1 (Fig. 17) which are related to periods of high meltwater discharge from the ice margin west of the site. During the higher-salinity intervals of zone 1 (Fig. 17) the mixture entering the gulf was dominated by cold saline water. The proportion of the cold saline component decreased during zone 2 and was lowest during the salinity minimum associated with zone 3 (Fig. 17). In zone 4 the temperature and salinity of the bottom water at site 1 was higher than in zone 3. This indicates that the temperature and salinity of the mixture entering the Gulf increased probably in response to a decrease in the proportion of the cold low-salinity component in the mixture. At the beginning of zone 5 (Fig. 17) the mixture entering the Gulf consisted of Labrador and Western North Atlantic Waters.

Site 2 (Chaleur Channel)

The estimated age for the base of the piston core (90031027PC) based on the oldest ages from zone A (Fig. 19) is 12,400 years BP. This estimate is younger than the age age of 12,800 ± 150 years BP for marine fossils from a fossiliferous diamicton west of site 2 (Fig. 20) and the age of 14,000 years BP and 12,700 to 12,800 years BP proposed by Schafer (1977) and David and Lebuis (1985), respectively.

for the deglaciation of Chaleur Bay. The estimated age for the base of the piston core is a minimum age for the deglaciation of Chaleur Trough. The glaciomarine environment associated with zone A ended shortly after 11,720 ± 90 years BP (Fig. 19) and the shift to the highest salinity bottom-water in Chaleur Trough following deglaciation occurred about 5,950 ± 60 years BP.

Schafer (1977) concluded that sea level was lower between 8,000 and 10,000 years BP in Chaleur Bay based on the high abundance of the benthonic foraminifer Eggerella advena in cores from water depths of 52 and 78 m. The species is not present in the cores which were collected from a water depth of 109 m in Chaleur Trough (site 2, Fig. 2). The interval of lower sea-level corresponds, in part, to the interval between the levels dated at 11,720 ± 90 and 8,750 ± 80 years BP in core 90031027PC (Fig. 19). The estimated sediment accumulation rate between the dated levels is about 2.7 cm•100 radiocarbon years. This is much lower than the sediment accumulation rates between the other, adjacent, dated levels in the core. Thus, there appears to be an unconformity between the levels dated at 11,720 ± 90 and 8,750 ± 80 years BP in the piston core (90031027PC).

Syvitski and Praeg (1989) reported that seismic units II and III have been eroded in some parts of Chaleur Bay on the basis of Huntec DTS seismic profiles. They related the erosion to a period of lowered sea levels. About 1.1 km east of the site of core 90031027PC seismic unit II is overlain unconformably by seismic unit IV (arrow on Fig. 10). At the core site seismic unit III is present between seismic units II and IV and corresponds to the interval between 790 and 630 cm in core 90031027PC (Fig. 19). Thus, the interval between the dated levels (733 cm and 655 cm, Table 3) with the low sediment accumulation rate, is within seismic unit III (Fig. 19) and may include an unconformity.

CONCLUSIONS

Six benthonic foraminiferal zones are recognized in cores collected from a water depth of 373 m in the Laurentian Channel off Gaspé Peninisula. The oldest zone (no. 1) is characterized by oscillating high-salinity bottom water (34.7 - 35.1‰) in which Cassidulina laevigata assemblages are present and low-salinity bottom water (<25‰) related to periods of high meltwater discharge from the ice margin. Zone 2 is a transitional zone between zones 1 and 3 and is characterized by Astrononion gallowayi and Cibicides lobatulus. The salinity of the bottom water was between 34 and 34.7‰ except in the middle part of the zone where Islandiella helenae is abundant and the salinity of the bottom water was between 30 and 34‰. Islandiella helenae is the characteristic species of zone 3 and is indicative of salinities between 30 and 34‰. A decrease in the abundance of Islandiella helenae in the middle part of zone 3 may be related to an increase or decrease in temperature and/or salinity of the bottom water. Zone 4 is a transitional zone between zones 3 and 5, and is characterized by benthonic foraminiferal assemblages similar to those of zone 2. The salinity of the bottom water was between 34 and 34.5‰ in zone 4. Zones 5 and 6 are characterized by Brizalina subaenariensis, Bulimina aculeata, and Eponides pusillus, which are indicator species of the modern, deep watermass layer (temperature 4 to 6°C and salinity 34.5 to 34.8‰) in the Gulf of St. Lawrence. The temperature of the bottom water was ≤3°C in zones 1 to 3 and between 2.3 and 4° in zone 4.

The planktonic foraminiferal assemblages indicate that the temperature and salinity of the upper part of the water column was ≤8°C and 33 - 34‰, respectively, in the Cassidulina laevigata-dominant intervals of zone 1 and in zones 5 and 6. The salinity of the upper part of the water column was <33‰ in the other zones and was probably lowest in zone 3.

The variation in salinity of the bottom water in the Laurentian Channel following the Late Quaternary deglaciation is related to changes in the composition of the water entering the Gulf of St. Lawrence, except for the low-salinity intervals of zone 1, which are related to periods of high meltwater discharge from the ice margin. The proportion of the cold saline water in the mixture entering the Gulf was highest during the high salinity intervals of zone 1 and lowest in zone 3. During zones 5 and 6 the mixture entering the Gulf consisted of cold, low-salinity, Labrador Water and warm, saline, Western North Atlantic Water.

Radiocarbon ages for foraminieral tests from the lower part of one of the cores from the Laurentian Channel indicate that the core site was deglaciated by 14,040 ± 240 years BP, and before the northern coast of Gaspé Peninsula and the southern coast of Anticosti Island. The oscillating low- and high-salinity conditions associated with zone 1 ended by 13,540 ± 190 years BP and the salinity minimum (zone 3) began 12,150 ± 90 years BP.

Three benthonic foraminiferal zones are recognized in cores from a water depth of 109 m in Chaleur Trough east of Gaspé Peninsula. Cassidulina reniforme and Elphidium excavatum forma clavata are the abundant species of the oldest zone (A) and are indicative of a glaciomarine environment with bottom-water temperature close to 0°C and salinity between 28 and 30‰. The salinity of the bottom water increased in zone B (30 - 34‰) in which Islandiella helenae is abundant and in zone C (32 - 34‰). Buccella arctica, Elphidium excavatum forma clavata, Islandiella helenae and Pseudoparrella takayanagii are the abundant species in zone C. The temperature of the bottom water remained close to 0°C in zones B and C. The cause of the low numbers of foraminiferal tests in the upper part of zone C is not known with certainty. An increase in sedimentation rate and/or factors other than temperature and salinity may explain the low number of tests in the upper part of zone C.

Radiocarbon ages for marine fossils from other studies indicate that the estimated age of 12,400 years BP for the bottom of the longest core is a minimum age for the Late Quaternary deglaciation of Chaleur Trough. The low-salinity glaciomarine environment of zone A ended shortly after 11,720 ± 90 years BP. The shift to the highest salinity bottom-water in Chaleur Trough occurred about 5,950 ± 60 years BP. Unconformities were reported in glaciomarine sediments in Chaleur Bay and is also recognized in glaciomarine sediments 1.1 km east of the core site in Chaleur Trough. An unconformity may also be present in the upper part of the glaciomarine sediments penetrated by the piston core which was recovered from Chaleur Trough.

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APPENDIX I

List of foraminifers identified to specific level.

[1]Adercotryma glomerata (Brady) = Adercotryma glomeratum (Brady): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 26, Pl. 8, figs. 1-4.

Astacolus hyalacrulus Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 52, Pl. 9, figs. 1-4.

Astrononion gallowayi Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 90, Pl. 17, figs. 4-7.

Brizalina pseudopunctata Höglund = Bolivina pseudopunctata Höglund: Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 111, Pl. 20, figs. 13-14.

Brizalina subaenariensis (Cushman) = Bolivina subaenariensis Cushman: Bartlett and Molinsky, 1972, Can. Jour. Earth Sci., v. 9, Pl. 1, fig. 9.

Brizalina subspinescens (Cushman) = Bolivina subspinescens Cushman, 1922, U.S. Nat. Mus., Bull. 104, p. 48, Pl. 7, fig. 5.

Buccella arctica Voloshinova = Buccella hannai (Phleger and Parker) arctica Voloshinova: Rodrigues and Hooper, 1982, Jour. Foram. Res., v. 12, no. 4, p. 343, Pl. 1, figs. 2-3, 5-6, 10.

Buccella calida (Cushman and Cole): Rodrigues and Richard, 1986, Geol. Surv. Can., Paper 85-22, p. 20, Pl. 1, fig. 15.

Buccella frigida (Cushman): Schafer and Cole, 1978, Geol. Surv. Can., Paper 77-30, p. 27, Pl. 8, figs. 1a-b.

Buccella tenerrima (Bandy): Rodrigues and Hooper, 1982, Jour. Foram. Res., v. 12, no. 4, p. 343, Pl. 1, figs. 1, 4, 7.

Bulimina aculeata d'Orbigny: Rodrigues and Hooper, 1982, Jour. Foram. Res., v. 12, no. 4, p. 343, Pl. 2, figs. 2-4, 6-8, 10-12.

Bulimina exilis Brady = Bulimina elegans d'Orbigny var. exilis Brady, 1884, Rept. Sci. Results Voy. Challenger, Zool., v. 9, p. 399, Pl. 50, figs. 5-6.

Cassidulina laevigata d'Orbigny: Lagoe, 1977, Jour. Foram. Res., v. 7, no. 2, p. 127, Pl. 5, figs. 15-16.

Cassidulina neocarinata Thalmann: Rodrigues et al., 1980, Jour. Foram. Res., v. 10, no. 1, p. 58, Pl. 5, figs. 2, 5, 8; Pl. 6, figs. 3-4.

Cassidulina reniforme Nørvang: Rodrigues et al., 1980, Jour. Foram. Res., v. 10, no. 1, p. 58, Pl. 2, figs. 2, 4, 6; Pl. 3, figs. 3, 6, 9, 11-12; Pl. 5, figs. 10-12.

Cassidulinoides bradyi (Norman): Barker, 1960, Soc. Econ. Pal. Min., Spec. Publ., no. 9, p. 112, Pl. LIV, figs. 6-9.

Cibicides lobatulus (Walker and Jacob): Sen Gupta, 1971, Micropaleontology, v. 17, no. 1, p. 89, Pl. 2, figs. 34-36.

Cibicides pseudoungerianus (Cushman) = Truncatulina pseudoungerianus Cushman, 1922, U.S. Geol. Surv., Prof. Paper 129-E, p. 97, Pl. 20, fig. 9.

[1]Cribrostomoides crassimargo (Norman) = Alveolophragmium crassimargo (Norman): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 29, Pl. 3, figs. 1-3.

[1]Cribrostomoides jeffreysi (Williamson) = Alveolophragmium jeffreysi (Williamson): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 31, Pl. 3, figs. 4-7.

Cyclogyra involvens (Reuss) = Cornuspira involvens (Reuss): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 49, Pl. 7, figs. 4-5.

Dentalina baggi Galloway and Wissler: Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 54, Pl. 9, figs. 10-15.

Dentalina frobisherensis Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 55, Pl. 10, figs. 1-9.

Dentalina trondheimensis Feyling-Hanssen, 1964, Norges Geol. Unders., nr. 225, p. 275, Pl. 9, figs. 3-7.

[1]Eggerella advena (Cushman): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 36, Pl. 3,

figs. 8-10.

Elphidium asklundi Brotzen, 1943, in Hessland, I., 1943, Bull. Geol. Inst. Upsala, v. 31, p. 267, figs. 109-110.

Elphidium excavatum (Terquem) forma clavata Cushman: Miller et al., 1982, Jour. Foram. Res., v. 12, no. 2, p. 125, Pl. 1, figs. 5-8; Pl. 2, figs. 3-8; Pl. 3, figs. 3-8; Pl. 4, figs. 1-6; Pl. 5, figs. 4-8; Pl. 6, figs. 1-5.

Elphidium frigidum Cushman: Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 99, Pl. 18, figs. 4-9.

Elphidium groenlandicum Cushman = Elphidiella groenlandicum (Cushman): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 106, Pl. 19, figs. 13-14.

Elphidium incertum (Williamson): Feyling-Hanssen et al., 1971, Bull. Geol. Soc. Denmark, v. 21, pt. 2-3, p. 277, Pl. 12, figs. 11-12; Pl. 21, figs. 8-9.

Elphidium subarcticum Cushman: Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 105, Pl. 19, figs. 5-7.

Entolingulina translucida (Heron-Allen and Earland) = Lingulina translucida Heron-Allen and Earland, 1932, Discovery Reports, v. 4, p. 387, Pl. 12, figs. 9-11.

Eoeponidella pulchella (Parker): Rodrigues and Richard, 1986, Geol. Surv. Can., Paper 85-22, p. 20, Pl. 1, fig. 4.

Epistominella arctica Green, 1960, Micropaleontology, v. 6, no. 1, p. 71, Pl. 1, figs. 4a-b.

Eponides pusillus Parr: Schröder-Adams et al., 1990, Jour. Foram. Res., v. 20, no. 1, p. 33, Pl. 7, figs. 14-15.

Fissurina annectens annectens (Burrows and Holland) = Lagena annectens Burrows and Holland: Buchner, 1940, Nova Acta Leopoldina, Neue Folge, v. 9, no. 62, p. 482, Pl. 26, figs. 279-293.

Fissurina annectens (Burrows and Holland) forma pseudostaphyllearia (Buchner) = Lagena annectens Burrows and Holland forma pseudostaphylleria Buchner, 1940, p. 483, Pl. 15, figs. 285-291.

Fissurina cucurbitasema Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 76, Pl. 14, figs. 10-11.

Fissurina laevigata Reuss = Lagena laevigata forma typica Reuss: Buchner, 1940, Nova Acta Leopoldina, Neue Folge, v. 9, no. 62, p. 474, Pl. 13, figs. 239-244.

Fissurina marginata (Montagu): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 77, Pl. 14, figs. 6-9.

Fissurina reniformis (Sidebottom): Rodrigues and Richard, 1986, Geol. Surv. Can., Paper 85-22, p. 20, Pl. 1, fig. 9.

Fissurina varioperforata (Buchner) forma angusta (Buchner), 1940, Nova Acta Leopoldina, Neue Folge, v. 9, no. 62, p. 494, Pl. 18, figs. 353-356.

Fissurina ventricosa (Wiesner): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 79, Pl. 14, fig. 15.

Fursenkoina fusiformis (Williamson): Schröder-Adams et al., 1990, Jour. Foram. Res., v. 20, no. 1, Pl. 6, fig. 17.

Fursenkoina loeblichi (Feyling-Hanssen): Rodrigues and Hooper, 1982, Jour. Foram. Res., v. 12, no. 4, p. 344, Pl. 1, figs. 12-15.

Gavelinopsis praegeri (Heron-Allen and Earland) = Discorbina praegeri Heron-Allen and Earland, 1913, Roy. Irish Acad., Proc., v. 31, p. 122, Pl. 10, figs. 8-10.

Glandulina laevigata d'Orbigny: Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 81, Pl. 16, figs. 2-5.

Glandulinoides ittai (Loeblich and Tappan) = Dentalina ittai Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 56, Pl. 10, figs. 10-12.

[2]Globigerina bulloides d'Orbigny: Loeblich and Tappan, 1957, U.S. Nat. Mus. Bull. 215, p. 31, Pl. 4, fig. 1.

[2]Globigerina quinqueloba Natland, 1938, California Univ., Scripps Inst. Oceanogr. Bull. Tech. Ser., v. 4, p. 140, Pl. 6, fig. 7.

[2]Globigerina uvula (Ehrenberg) = Pylodexia uvula Ehrenberg, 1873, K. Akad. Wiss, Berlin, Abh., Jahr 1872, p. 241, Pl. 2, figs. 24-25.

<u>Globobulinima</u> <u>auriculata</u> (Bailey): Sen Gupta, 1971, Micropaleontology, v. 17, p. 88, Pl. 2, fig. 15.

<u>Globobulimina</u> <u>turgida</u> (Bailey): Höglund, 1947, Zool. Bidrag Uppsala, v. 26, p. 248, Pl. 20, fig. 5; Pl. 21, figs. 4, 8; Pl. 22, fig. 5; text-figs. 247-257, 271.

<u>Globocassidulina</u> <u>subglobosa</u> (Brady): Bremer <u>et</u> <u>al</u>., 1980, Jour. Foram. Res., v. 10, no. 1, p. 24, Pl. 2, figs. 7-8.

[1]<u>Haplophragmoides</u> <u>bradyi</u> (Robertson): Höglund, 1947, Zool. Bidrag Uppsala, v. 26, p. 134, Pl. 10, fig. 1; text-fig. 111.

<u>Haynesina</u> <u>nana</u> (Vilks) = <u>Protelphidium</u> <u>nanum</u> Vilks, 1979, Geol. Surv. Can., Bull. 303, p. 35, Pl. 1, figs. 1-4; text-fig. 1.

<u>Haynesina</u> <u>orbicularis</u> (Brady) = <u>Elphidium</u> <u>orbiculare</u> (Brady): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 102, Pl. 19, figs. 1-4.

<u>Islandiella</u> <u>helenae</u> Feyling-Hanssen and Buzas: Rodrigues <u>et</u> <u>al</u>., 1980, Jour. Foram. Res., v. 10, no. 1, p. 49, Pl. 1, figs. 1, 3, 5; Pl. 4, figs. 3, 6, 9; Pl. 6, figs. 1-2.

<u>Islandiella</u> <u>islandica</u> (Nørvang): Rodrigues <u>et</u> <u>al</u>., 1980, Jour. Foram. Res., v. 10, no. 1, p. 49, Pl. 1, figs. 2, 4, 6; Pl. 3, figs. 2, 5, 8.

<u>Islandiella</u> <u>norcrossi</u> (Cushman): Rodrigues <u>et</u> <u>al</u>., 1980, Jour. Foram. Res., v. 10, no. 1, p. 49, Pl. 4, figs. 1, 4, 7, 10; Pl. 6, figs. 8-9.

[1]<u>Karreriella</u> <u>bradyi</u> (Cushman): Corliss, 1979, Micropaleontology, v. 25, p. 5, Pl. 1, figs. 5-6.

<u>Lagena</u> <u>clavata</u> (d'Orbigny): Buchner, 1940, Nova Acta Leopoldina, Neue Folge, v. 9, no. 62, p. 416, Pl. 2, figs. 28-30.

<u>Lagena</u> <u>elongata</u> (Ehrenberg): Buchner, 1940, Nova Acta Leopoldina, Neue Folge, v. 9, no. 62, p. 413, Pl. 2, figs. 23-24.

<u>Lagena</u> <u>gracillima</u> (Seguenza): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 60, Pl. 11, figs. 1-4.

Lagena laevis (Montagu): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 61, Pl. 11, figs. 5-8.

Lagena mollis Cushman: Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 63, Pl. 11, figs. 25-27.

Lagena nebulosa Cushman = Lagena laevis (Montagu) var. nebulosa Cushman, 1923, U.S. Nat. Mus. Bull. 104, p. 29, Pl. 5, figs. 4-5.

Lagena semilineata Wright: Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 65, Pl. 11, figs. 14-22.

Lagena striata (d'Orbigny): Barker, 1960, Soc. Econ. Pal. Min., Spec. Publ., no. 9, p. 118, Pl. LVII, figs. 22-24.

Lagena sulcata (Walker and Jacob) var. laevicostata Cushman and Grey, 1946, Cushman Lab. Foram. Res., Contr., v. 22, p. 68, Pl. 12, figs. 12-13.

Marginulina glabra d'Orbigny: Feyling-Hanssen et al., 1971, Geol. Soc. Denmark Bull., v. 21, p. 204, Pl. 3, fig. 7.

Melonis zaandamae (van Voorthuysen) = Nonion zaandamae (van Voorthuysen): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 87, Pl. 16, figs. 11-12.

[2]Neogloboquadrina pachyderma (Ehrenberg) = Globorotalia pachyderma (Ehrenberg): Vilks, 1975, Jour. Foram. Res., v. 5, no. 4, Pl. 1, figs. 1a-b, 2a-b, 3a-b; Pl. 2, figs. 1a-b, 2a-b, 3a-b; Pl. 3, figs. 1a-b, 2a-b, 3a-b.

Nonionellina labradorica (Dawson) = Nonion labradoricum (Dawson): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 86, Pl. 17, figs. 1-2.

Nonionellina turgida (Williamson): Feyling-Hanssen, 1964, Norges Geol. Unders., nr. 225, p. 328, Pl. 17, figs. 2-6.

Oolina acuticostata (Reuss) = Lagena apiopleura Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 59, Pl. 10, figs. 14-15.

Oolina ampullo-distoma (Jones) = Lagena ampullo-distoma Rymer Jones: Buchner, 1940, Nova Acta Leopoldina, Neue Folge, v. 9, no. 62, p. 440, Pl. 11, fig. 90.

Oolina borealis Loeblich and Tappan = Oolina costata (Williamson): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 68, Pl. 13, figs. 4-6.

Oolina caudigera (Wiesner): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 67, Pl. 13, figs. 1-3.

Oolina costata (Williamson) = Entosolenia costata Williamson, 1858, Roy. Soc., p. 9, Pl. 1, fig. 18.

Oolina globosa (Montagu): Barker, 1960, Soc. Econ. Pal. Min., Spec. Publ., no. 9, p. 114, Pl. LVI, figs. 1-3.

Oolina hexagona (Williamson): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 69, Pl. 14, figs. 1-2.

Oolina lineata (Williamson): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 70, Pl. 13, figs. 11-13.

Oolina melo d'Orbigny: Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 71, Pl. 12, figs. 8-15.

Oolina squamosa (Montagu): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, Pl. 13, figs. 9-10.

Oridorsalis tener (Brady): Lohmann, 1978, Jour. Foram. Res., v. 8, p. 26, Pl. 4, figs. 5-7.

Parafissurina fovigera (Buchner) = Lagena fovigera Buchner, 1940, Nova Acta Leopoldina, Neue Folge, v. 9, no. 62, p. 541, Pl. 29, figs. 627-629.

Parafissurina himatiostoma Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 121, Pl. 14, figs. 12-14.

Parafissurina lateralis (Cushman) forma carinata (Buchner) = Lagena lateralis Cushman forma carinata Buchner, 1940, Nova Acta Leopoldina, Neue Folge, v. 9, no. 62, p. 521, Pl. 23, figs. 497-500.

Parafissurina lateralis (Cushman) forma simplex (Buchner) = Lagena lateralis Cushman forma simplex Buchner, 1940, Nova Acta Leopoldina, Neue Folge, v. 9, no. 62, p. 520, Pl. 23, figs. 487-492.

Patellina corrugata Williamson: Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 114, Pl. 21, figs. 4-5.

Pateoris hauerinoides (Rhumbler): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 47, Pl. 6, figs. 8-12.

Pseudoparrella takayanagii (Iwasa) = Epistominella takayanagii Iwasa, 1955, Jour. Geol. Soc. Japan, v. 61, p. 16, text-fig. 4.

Pullenia bulloides (d'Orbigny): Corliss, 1979, Micropaleontology, v. 25, no. 1, p. 8, Pl. 4, figs. 1-2.

Pullenia osloensis Feyling-Hanssen: Corliss, 1979, Micropaleontology, v. 25, no. 1, p. 9, Pl. 4, figs. 3-4.

Pullenia quinqueloba (Reuss): Cole, 1981, Bedford Inst. Oceanogr. Rept. Ser., BI-R-81-7, p. 111, Pl. 14, fig. 6.

Pyrgo williamsoni (Sylvestri): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 48, Pl. 6, figs. 1-4.

Quinqueloculina agglutinata Cushman: Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 39, Pl. 5, figs. 1-4.

Quinqueloculina seminulum (Linné): Feyling-Hanssen et al., 1971, Bull. Geol. Soc. Denmark, v. 21, pt. 2-3, p. 194, Pl. 1, figs. 18-20.

Quinqueloculina stalkeri Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 40, Pl. 5, figs. 5-9.

[1]Recurvoides turbinatus (Brady): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 27, Pl. 2, fig. 11.

[1]Reophax subfusiformis Earland, 1933, Discovery Repts., v. 7, p. 72, Pl. 2, figs. 16-19.

Robertina arctica d'Orbigny, 1846, Gide et Comp[e] (Paris), p. 203, Pl. 21, figs. 37-38.

[1]Saccammina atlantica (Cushman): Cole and Ferguson, 1975,

Bedford Inst. Oceanogr., Rept. Ser. BI-R-75-5, p. 41, Pl. 1, fig. 4.

Scutuloris tegminis Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 41, Pl. 5, fig. 10.

[1]*Silicosigmoilina groenlandica* (Cushman): Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 38, Pl. 4, figs. 7-9.

Trifarina hughesi (Galloway and Wissler): Rodrigues and Hooper, 1982, Jour. Foram. Res., v. 12, no. 4, p. 348, Pl. 2, figs. 1, 5, 9, 13-15.

Triloculina trihedra Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 45, Pl. 4, fig. 10.

[1]*Tritaxis conica* (Parker and Jones) = *Valvulina conica* Parker and Jones: Brady, 1884, Rept. Sci. Results Voy. Challenger, Zool., v. 9, p. 392, Pl. 49, figs. 15-16.

[1]*Trochammina quadriloba* Höglund: Loeblich and Tappan, 1953, Smithson. Misc. Coll., v. 121, no. 7, p. 51, Pl. 7, fig. 8.

Vaginulina spinigera Brady, 1884, Rept. Sci. Results Voy. Challenger, Zool., v. 9, p. 531, Pl. 67, figs. 13-14.

Valvulineria arctica Green, 1960, Micropaleontology, v. 6, no. 1, p. 71, Pl. 1, fig. 3.

[1]Agglutinated benthonic species

[2]Planktonic species

Others are calcareous benthonic species

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Table 11. Percent abundances of benthonic foraminiferal species and sample statistics for core 90031025BC.

Top of interval (cm)	0	9	20	30	40	48
Volume (cc)	5	5	5	5	5	5
Number of tests (B - Total)	93	91	24	13	38	39
Number of tests (B - Calc)	92	89	24	11	38	39
Number of tests (B - Agglut)	1	2	0	2	0	0
Number of tests (B/10 cc)	186	182	48	26	76	78
Number of species (B - Total)	7	9	4	5	4	5
Number of species (B - Calc)	6	8	4	3	4	5
Number of species (B - Agglut)	1	1	0	2	0	0
Diversity - B [H(S)]	1.67	1.78	1.08	1.38	0.94	1.27
Number of tests (P)	0	0	0	0	0	0
Adercotryma glomerata	1.08			7.69		
Buccella arctica	15.05	9.89	25.00	23.08	63.16	51.28
Buccella frigida		1.10			2.63	5.13
Cassidulina reniforme	18.28	4.40				
Eggerella advena				7.69		
Elphidium excavatum clavata	18.28	19.78	8.33			10.26
Islandiella helenae	32.26	24.18	58.33	46.15	26.32	25.64
Islandiella norcrossi	2.15	8.79				
Nonionellina labradorica		1.10				
Pseudoparrella takayanagii	12.90	28.57	8.33	15.38	7.89	7.69
Recurvoides turbinatus		2.20				

B...Benthonic P...Planhtonic Calc...Calcareous Agglut...Agglutinated

Table 10. Percent abundances of benthonic foraminiferal species and sample statistics for core 90031027TWC.

Top of interval (cm)	0	20	40	60	80	100
Volume (cc)	5	5	5	5	5	5
Number of tests (B - Total)	43	69	33	17	6	15
Number of tests (B - Calc)	43	69	33	17	6	15
Number of tests (B - Agglut)	0	0	0	0	0	0
Number of tests (B/10 cc)	86	138	66	34	12	30
Number of species (B - Total)	9	10	7	4	1	4
Number of species (B - Calc)	9	10	7	4	1	4
Number of species (B - Agglut)	0	0	0	0	0	0
Diversity - B [H(S)]		2.01				
Number of tests (P)	0	0	0	0	0	0
Brizalina pseudopunctata			3.03			
Buccella arctica	6.98	20.29	15.15	41.18		26.67
Buccella frigida	4.65	7.25	3.03	5.88		
Cassidulina reniforme	9.30	15.94				
Elphidium excavatum clavata	30.23	14.49	3.03			6.67
Eoeponidella pulchella	2.33					
Fursenkoina loeblichi	2.33	1.45				
Islandiella helenae	9.30	10.14	45.45	35.29	100.00	40.00
Islandiella norcrossi	9.30	4.35				
Lagena mollis		1.45				
Nonionellina labradorica		2.90	3.03			
Pseudoparrella takayanagii	25.58	21.74	27.27	17.65		26.67

B...Benthonic P...Planktonic Calc...Calcareous Agglut...Agglutinated

Table 4

Top of interval (cm)	0	20	41	60	71	80	91	100	121	140	160
Volume (cc)	5	5	5	5	5	5	5	5	5	5	5
Number of tests (B - Total)	851	744	689	688	331	163	236	165	134	179	255
Number of tests (B - Calc)	848	738	682	684	330	162	235	165	134	179	255
Number of tests (B - Agglut)	3	6	7	4	1	1	1	0	0	0	0
Number of tests (B/10 cc)	1702	1488	1378	1376	662	326	472	330	268	358	510
Number of species (B - Total)	32	34	35	34	25	23	23	19	20	20	18
Number of species (B - Calc)	30	33	34	33	24	22	22	19	20	20	18
Number of species (B - Agglut)	2	1	1	1	1	1	1	0	0	0	0
Diversity - B [H(S)]	2.26	2.12	2.32	2.53	2.31	2.46	2.28	2.18	2.42	2.20	2.11
Number of tests (P)	473	1050	614	790	171	96	100	86	75	95	69
Number of tests (P/10 cc)	946	2100	1228	1580	342	192	200	172	150	190	138
Number of species (P)	3	2	2	2	2	1	2	1	2	1	2
Astacolus hyalacrulus											
Astrononion gallowayi	5.05	3.63	3.77	3.49	4.23	2.45	0.85	5.45	3.73	3.35	1.96
Brizalina pseudopunctata											
Brizalina subaenariensis		1.21	3.19	5.09	14.50	15.34	8.05	3.03	3.73	1.68	3.14
Brizalina subspinescens	0.35										
Brizalina sp.											
Buccella arctica	1.41	1.75	0.15	1.02	0.91	1.23		0.61		0.56	0.78
Buccella calida	2.00	3.76	5.66	5.81	4.83	7.98	2.97	6.06	8.21	2.79	2.75
Buccella frigida								0.61			
Buccella tenerrima											
Buccella sp.				0.15	0.30						
Bulimina aculeata	16.69	2.15	0.44		0.30						
Bulimina exilis	5.76							1.21			
Buliminella sp.	0.12			0.15		0.61					
Cassidulina laevigata											
Cassidulina neocarinata		2.69	3.63	1.16	1.51	2.45	10.17	0.61	1.49	1.68	0.39
Cassidulina reniforme	23.97	40.73	27.87	21.66	[illegible]	22.09	24.58	32.12	22.39	27.37	24.71
Cassidulina sp.											
Cassidulinoides bradyi										0.56	
Cibicides lobatulus	6.46	10.08	11.90	11.48	7.25	9.82	4.66	12.73	10.45	7.26	5.88
Cyclogyra involvens											
Dentalina baggi											
Dentalina frobisherensis											
Dentalina trondheimensis		0.13		0.29							
Dentalina sp.											
Eggerella sp.					0.30						
Elphidiidae	0.47	0.40	1.02	2.18	2.42	1.84	2.54	1.21	2.24	2.23	1.18
Elphidium excavatum clavata	4.82	2.02	6.53	14.83	10.57	7.98	5.93	4.85	8.96	8.94	4.71
Elphidium frigidum											
Elphidium groenlandicum											
Elphidium sp.											
Eoeponidella pulchella		0.40	0.44								
Epistominella (?) arctica											
Fissurina annectens annectens											
Fissurina cucurbitasema											

le 4. Percent abundances of foraminiferal species and statistics for samples from C

160	180	200	220	231	240	260	280	301	320	341	360	380	399
5	5	5	5	5	5	5	5	5	5	5	5	5	5
255	212	639	387	173	360	168	189	261	183	129	192	251	288
255	211	639	385	173	360	167	188	258	183	129	192	251	288
0	1	0	2	0	0	1	1	3	0	0	0	0	0
510	424	1278	774	346	720	336	378	522	366	258	384	502	576
18	25	32	27	21	25	22	21	25	16	13	17	20	19
18	24	32	26	21	25	21	20	24	16	13	17	20	19
0	1	0	1	0	0	1	1	1	0	0	0	0	0
2.11	2.36	2.16	2.28	2.06	2.10	2.40	2.30	2.28	2.08	2.03	1.96	2.15	2.00
69	83	14	8	0	6	1	5	6	2	2	0	4	2
138	166	28	16	0	12	2	10	12	4	4	0	8	4
2	1	2	2	0	1	1	1	1	1	1	0	1	1
1.96	1.89	1.25	1.03	4.62	4.44	4.17	5.29	8.43	14.21	24.03	17.71	10.36	10.07
													0.35
3.14	18.40	41.78	31.78	4.05	1.94								
0.78	0.47		0.26	1.73	0.28	2.38		0.38			0.52	0.40	
2.75	3.77	2.82	1.81	2.89	5.00	8.33	3.70	4.98	1.64	3.88	4.17	3.59	0.35
		0.16											
	0.47	0.16							0.55		0.52		0.35
0.39	1.89	2.50	0.26				0.53	0.38				0.40	
4.71	12.26	7.04	8.53	8.67	11.39	14.88	11.64	14.56	11.48	11.63	11.46	22.71	21.18
	0.47												
		0.16						0.38					
5.88	8.96	3.60	5.17	6.36	9.17	11.90	11.11	12.26	9.29	11.63	9.38	12.75	7.64
			0.26										
.18	1.42	0.31	0.78	1.16	1.94	2.38	1.06	1.15	2.19		0.52	0.40	0.69
4.71	5.66	8.29	13.95	36.42	29.44	20.83	19.05	25.29	33.88	25.58	39.58	23.11	35.42
	0.47					0.60				0.78			0.35

statistics for samples from 0 to 7.0 m in core 90031019PC.

320	341	360	380	399	420	440	460	480	500	520	529	540
5	5	5	5	5	5	5	5	5	5	5	5	5
183	129	192	251	288	764	1262	1822	1188	573	337	311	603
183	129	192	251	288	764	1262	1822	1188	573	337	311	603
0	0	0	0	0	0	0	0	0	0	0	0	0
366	258	384	502	576	1528	2524	3644	2376	1146	674	622	1206
16	13	17	20	19	27	27	27	24	17	14	8	13
16	13	17	20	19	27	27	27	24	17	14	8	13
0	0	0	0	0	0	0	0	0	0	0	0	0
2.08	2.03	1.96	2.15	2.00	2.02	1.95	1.98	1.82	1.66	1.76	1.48	1.49
2	2	0	4	2	8	3	1	13	3	6	1	0
4	4	0	8	4	16	6	2	26	6	12	2	0
1	1	0	1	1	1	1	1	2	2	1	1	0
14.21	24.03	17.71	10.36	10.07	12.83	29.87	23.55	3.37	2.27	1.19		1.16
				0.35								
					0.92							
		0.52	0.40		0.13	0.32	0.22	0.08	0.17			0.33
1.64	3.88	4.17	3.59	0.35	1.31	0.16	0.05	0.08				
						0.08	0.05					
0.55		0.52		0.35	0.26							
						0.32		0.84	0.70	1.19		2.82
			0.40		0.13							
11.48	11.63	11.46	22.71	21.18	16.10	17.91	20.09	41.67	35.60	26.11	16.40	15.59
9.29	11.63	9.38	12.75	7.64	6.28	10.22	10.15	0.84	1.92	0.30	0.64	0.17
								0.08				
							0.05					
2.19		0.52	0.40	0.69				0.42				
33.88	25.58	39.58	23.11	35.42	40.97	25.20	27.83	25.00	38.05	40.95	27.65	46.27
	0.78			0.35	0.13		0.38	0.08	0.17			
						0.16	0.05	0.08				

540	550	571	590	611	630	651	672	691	700
5	5	5	5	5	5	5	5	5	5
603	1376	1169	1174	2312	2359	658	595	658	694
603	1376	1169	1174	2312	2359	658	595	658	694
0	0	0	0	0	0	0	0	0	0
1206	2752	2338	2348	4624	4718	1316	1190	1316	1388
13	12	16	15	17	24	21	15	17	16
13	12	16	15	17	24	21	15	17	16
0	0	0	0	0	0	0	0	0	0
1.49	1.68	1.73	1.27	1.59	1.73	1.51	1.63	1.78	1.63
0	1	0	0	2	3	0	0	0	0
0	2	0	0	4	6	0	0	0	0
0	1	0	0	1	2	0	0	0	0
1.16	1.31	1.97	1.19	0.74	2.59	0.61	0.17	2.58	5.62
	0.22	0.09		0.39	0.17	0.15	0.34		0.14
						0.15			0.29
0.33	2.98	1.54	0.09						
2.82	2.69	4.36	1.36	4.76	18.86	5.17	5.71	19.15	8.93
15.59	40.26	31.05	48.64	29.71	41.59	50.61	42.18	41.03	52.45
0.17	0.22	0.51	0.77	0.09	0.81	0.76	0.34		0.72
						0.30			
								0.15	
46.27	14.24	7.70	5.71	38.93	16.07	29.52	24.54	9.27	7.35
			0.09		0.08	0.30			
					0.04				
					0.04				
		0.09							
					0.08	0.15		0.15	

Tal

Top of interval (cm)	710	720	741	760	781	790	800	810	821	831	835
Volume (cc)	5	5	5	5	5	5	5	5	5	5	5
Number of tests (B - Total)	331	394	887	1065	1308	1282	905	1122	879	403	506
Number of tests (B - Calc)	331	394	887	1065	1308	1282	905	1122	879	403	506
Number of tests (B - Agglut)	0	0	0	0	0	0	0	0	0	0	0
Number of tests (B/10 cc)	662	788	1774	2130	2616	2564	1810	2244	1758	806	1012
Number of species (B - Total)	14	16	24	27	26	24	28	25	16	17	11
Number of species (B - Calc)	14	16	24	27	26	24	28	25	16	17	11
Number of species (B - Agglut)	0	0	0	0	0	0	0	0	0	0	0
Diversity - B [H(S)]	1.42	2.03	1.86	1.95	1.64	1.86	1.91	2.03	1.58	1.67	1.76
Number of tests (P)	1	2	0	0	1	1	1	5	0	0	0
Number of tests (P/10 cc)	2	4	0	0	2	2	2	10	0	0	0
Number of species (P)	1	1	0	0	1	1	1	1	0	0	0
Astacolus hyalacrulus					0.08						
Astrononion gallowayi	18.13	11.68	8.23	14.37	11.54	13.96	17.02	15.42	5.69	2.23	1.58
Brizalina pseudopunctata					0.15	0.16				0.50	
Brizalina subaenariensis											
Brizalina subspinescens											
Brizalina sp.											
Buccella arctica									0.11		
Buccella calida											
Buccella frigida											
Buccella tenerrima											
Buccella sp.											
Bulimina aculeata											
Bulimina exilis											
Buliminella sp.	2.11	6.85	2.93	3.10	3.29	2.11	0.99	1.16	1.14	3.47	3.75
Cassidulina laevigata				0.09			0.33	0.36		0.74	0.20
Cassidulina neocarinata											
Cassidulina reniforme	56.80	17.77	46.00	43.57	57.57	36.90	34.14	13.64	34.93	38.21	27.67
Cassidulina sp.											
Cassidulinoides bradyi											
Cibicides lobatulus	0.91	5.33	1.58	3.10	5.28	11.54	12.71	18.54	0.57		
Cyclogyra involvens											
Dentalina baggi			0.11								
Dentalina frobisherensis	0.30										
Dentalina trondheimensis											
Dentalina sp.											
Eggerella sp.											
Elphidiidae											
Elphidium excavatum clavata	11.18	23.35	17.02	15.12	4.43	21.27	21.10	22.00	41.07	36.97	35.97
Elphidium frigidum											
Elphidium groenlandicum											
Elphidium sp.											
Eoeponidella pulchella											
Epistominella (?) *arctica*							0.11				
Fissurina annectens annectens											
Fissurina cucurbitasema											
Fissurina laevigata				0.28	0.08	0.08	0.44				

ble 5. Percent abundances of foraminiferal species and statistics for samples from 7

840	845	850	860	870	880	890	900	920	930	940	950	960	97
5	5	5	5	5	5	5	5	5	5	6	5	5	
292	305	265	581	580	396	300	1358	1658	1349	1242	416	5	2
292	305	265	581	580	396	300	1358	1658	1349	1242	416	5	2
0	0	0	0	0	0	0	0	0	0	0	0	0	0
584	610	530	1162	1160	792	600	2716	3316	2698	2070	832	10	4
13	13	13	17	17	17	14	27	22	20	21	16	2	
13	13	13	17	17	17	14	27	22	20	21	16	2	
0	0	0	0	0	0	0	0	0	0	0	0	0	
1.74	1.60	1.62	1.50	1.52	1.66	1.75	2.15	1.85	1.94	2.15	1.86		
0	1	1	0	3	0	0	5	8	19	68	68	0	
0	2	2	0	6	0	0	10	16	38	113	136	0	
0	1	1	0	1	0	0	2	2	2	2	2	0	
2.40	1.97	3.40	1.72	2.07	3.79	19.00	17.01	9.17	10.16	13.37	4.33		
0.34					0.25		0.07			0.08			
								0.06					
								0.06					
	0.33												
2.05	4.26	7.17	6.54	1.03	5.81		3.90	0.78	0.22	0.08			
				0.52	0.51	0.67	0.44	6.33	25.20	20.37	41.11		
20.55	15.41	20.00	39.41	46.03	42.93	13.67	21.94	37.58	28.91	14.33	6.73	80.00	80.9
0.34				0.17	4.55	40.67	9.57	0.84	0.67	2.66	0.24		
27.40	54.43	50.19	39.93	32.41	31.06	14.00	24.37	25.57	8.30	16.18	17.31	20.00	19.0
							0.07						
			0.17										
			0.17										
							0.22						

tatistics for samples from 7.1 m to the end of core 90031019PC.

930	940	950	960	970	980	990	1000	1010	1020	1030	1040	1050
5	6	5	5	5	5	5	5	5	5	5	5	5
1349	1242	416	5	21	2	190	3	614	185	238	261	1
1349	1242	416	5	21	2	190	3	614	185	238	261	1
0	0	0	0	0	0	0	0	0	0	0	0	0
2698	2070	832	10	42	4	380	6	1228	370	476	522	2
20	21	16	2	2	2	9	3	12	9	11	18	1
20	21	16	2	2	2	9	3	12	9	11	18	1
0	0	0	0	0	0	0	0	0	0	0	0	0
1.94	2.15	1.86				1.79		1.56	1.67	1.89	1.91	
19	68	68	0	0	0	41	0	114	23	99	168	0
38	113	136	0	0	0	82	0	228	46	198	336	0
2	2	2	0	0	0	2	0	2	3	2	2	0
10.16	13.37	4.33				4.74	33.33	0.81	2.16	3.36	1.15	
	0.08											
											0.38	
0.22	0.08											
25.20	20.37	41.11				4.21		49.84	4.32	13.03	15.71	
								0.33				
28.91	14.33	6.73	80.00	80.95	50.00	16.84	33.33	10.10	18.92	10.08	7.66	
0.67	2.66	0.24										
8.30	16.18	17.31	20.00	19.05	50.00	9.47		13.68	7.57	11.76	8.81	
											0.38	
												100.00

1050	1060	1070	1080	1090	1100	1110	1120	1130	1140	1150
5	5	5	5	5	5	5	5	5	5	5
1	0	2	0	142	70	63	3	2	2	3
1	0	2	0	142	70	63	3	2	2	3
0	0	0	0	0	0	0	0	0	0	0
2	0	4	0	284	140	126	6	4	4	6
1	0	2	0	9	12	3	1	1	1	2
1	0	2	0	9	12	3	1	1	1	2
0	0	0	0	0	0	0	0	0	0	0
				1.87	2.11	0.52				
0	0	0	0	62	2	6	1	0	0	2
0	0	0	0	124	4	12	2	0	0	4
0	0	0	0	2	1	1	1	0	0	1
				4.93	4.29	3.17				
				5.63	7.14					
		50.00		16.[illegible]	20.00	84.13	100.00	100.00	100.00	33.33
				11.97	10.00					66.67
100.00										

Dentalina trondheimensis		0.13		0.29								
Dentalina sp.												
Eggerella sp.					0.30							
Elphidiidae	0.47	0.40	1.02	2.18	2.42	1.84	2.54	1.21	2.24	2.23	1.18	
Elphidium excavatum clavata	4.82	2.02	6.53	14.83	10.57	7.98	5.93	4.85	8.96	8.94	4.71	
Elphidium frigidum												
Elphidium groenlandicum												
Elphidium sp.												
Eoeponidella pulchella		0.40	0.44									
Epistominella (?) arctica												
Fissurina annectens annectens												
Fissurina cucurbitasema												
Fissurina laevigata	0.24		0.29	0.15								
Fissurina marginata												
Fissurina ventricosa												
Fissurina sp.	0.35	0.40	0.15				0.42					
Fursenkoina fusiformis		0.13			0.30							
Fursenkoina loeblichi	0.59	0.40	0.73	0.29	0.30		1.27		1.49	0.56	2.75	
Gavelinopsis praegeri		0.27										
Glabratella sp.	0.12	0.13		0.15								
Glandulina laevigata	0.24	0.54	0.44	1.31	0.30	1.23	1.69		0.75			[illegible]
Glandulinoides ittai												
Globobulimina auriculata	0.59			0.29		1.23		1.82	2.99	2.79	1.96	
Globobulimina turgida			0.15									
Globocassidulina subglobosa					0.30	0.61	0.42					[illegible]
Hanzawaia sp.	0.12	2.15	2.90	0.29	0.30	1.84	1.69	1.21		1.12	0.39	[illegible]
Haynesina nana												
Haynesina orbicularis												
Islandiella helenae												
Islandiella islandica	0.24	0.13	0.29	0.44	0.30				0.75	0.56	1.18	
Islandiella norcrossi	0.35	0.13	1.31	3.63	1.51	1.23	0.42	0.61	2.24	1.12	1.57	
Karreriella bradyi	0.24											
Lagena clavata				0.15								
Lagena elongata	0.12		0.15									
Lagena gracillima												
Lagena laevis									0.75			[illegible]
Lagena mollis	0.71	0.81	0.29	1.60	0.60	0.61		1.21	0.75	0.56	0.78	[illegible]
Lagena nebulosa			0.15									
Lagena semilineata												
Lagena striata		0.13	0.29	0.58		0.61	0.85		0.75	0.56		[illegible]
Lagena striata var.												
Lagena sulcata laevicostata				0.15								
Lagena sp.												
Marginulina glabra					0.30							
Melonis zaandamae												
Miliolid					0.30		0.42			0.56		
Nonionellina labradorica	1.76	0.40	0.15	1.02	0.60		0.42				0.78	
Nonionellina turgida				0.29								
Nonionellina sp. cf. *N. bradii*												
Oolina ampullo-distoma		0.13	0.29			0.61						
Oolina borealis												
Oolina caudigera	0.12											
Oolina costata												
Oolina globosa			0.15									
Oolina hexagona	0.12	0.27	0.15	0.15								
Oolina melo												

		0.26											
1.42	0.31	0.78	1.16	1.94	2.38	1.06	1.15	2.19		0.52	0.40	0.69	
5.66	8.29	13.95	36.42	29.44	20.83	19.05	25.29	33.88	25.58	39.58	23.11	35.42	40.
0.47					0.60				0.78			0.35	0.1
				0.28									
0.47	0.47			0.56									
	0.16	0.26	0.58									0.35	
	0.16			0.28									
1.42	2.03	3.10		0.83	0.60	1.59	1.53	2.73	3.10	2.08	2.39	3.82	2.6
	0.16												
0.47	0.94	1.29	1.16	0.56	1.19	1.59	0.77	0.55			0.40		0.1
	2.19	3.36		1.39	2.98	0.53	1.53	0.55	0.78	1.56			0.2
	0.16												
0.47													
0.94	0.31	0.78	0.58	0.28	0.60	1.59	0.77						
										0.52			
			0.58										0.2
												0.35	2.3
		0.26						1.64		0.52	0.40	1.04	0.5
	0.47	0.78	1.16	0.83	1.79	5.82	2.30	2.73	3.10	2.08	0.80	3.47	4.9
			0.58	0.28									
				0.28									
0.47					0.60				0.78				0.2
0.47	1.25	0.26	1.73	0.56	1.79	1.06	0.38	0.55	3.10	0.52	1.59		0.1
1.42			1.16				0.38				0.40		0.
	0.16												
				0.28	0.60	0.53	0.77				0.40		0.
						0.53							
	0.31	1.03			1.19	1.59	0.38	1.09		1.04	0.80	1.74	3.
	0.16			1.11									
	0.63					1.06							
	0.16	0.78											
			0.58										
												0.69	
			0.58				0.38						

							0.05						
2.19		0.52	0.40	0.69				0.42					
3.88	25.58	39.58	23.11	35.42	40.97	25.20	27.83	25.00	38.05	40.95	27.65	46.27	14.24
	0.78			0.35	0.13		0.38	0.08	0.17				
						0.16	0.05	0.08					
							0.05						
						0.08							
				0.35									
											0.32		
2.73	3.10	2.08	2.39	3.82	2.62	2.93	2.31	2.10	4.01	2.67	1.29		1.45
						0.16	0.05						
0.55			0.40		0.13								
									0.17				
0.55	0.78	1.56			0.26			0.08		0.89			
		0.52				0.40	0.55	0.93	1.05	0.30		0.17	
					0.26	0.16	0.05					0.83	
				0.35	2.36		1.04	6.14	3.14	2.37	27.65	25.21	17.81
1.64		0.52	0.40	1.04	0.52	0.95	2.25		1.22				
2.73	3.10	2.08	0.80	3.47	4.97	1.11	4.56	6.57	4.01	10.09	25.72	4.48	17.01
	0.78				0.26		0.05					0.17	
0.55	3.10	0.52	1.59		0.13	0.08							
			0.40		0.26			0.08					
			0.40		0.52	0.63	0.27		0.17				
							0.11	0.34					
1.09		1.04	0.80	1.74	3.14	2.38	3.90	5.30	6.81	5.64	0.32	2.49	0.51
						0.79	0.05						
				0.69		0.08							

46.27	14.24	7.70	5.71	38.93	16.07	20.52	24.54	9.27	7.35
			0.09		0.08	0.30			
					0.04				
					0.04				
		0.09							
					0.08	0.15		0.15	
		0.43	0.09	0.17	0.08	0.15			
	1.45	1.63	2.47	1.56	1.27	0.15	1.18	2.43	3.31
							0.17		
									0.29
0.17		0.17		0.26	0.64	0.61	0.50	0.30	0.14
0.83			0.09	0.13	0.08	0.15			
25.21	17.81	29.77	1.53	16.00	10.81	15.81	13.78	14.13	14.12
4.48	17.01	19.08	36.71	3.98	0.47	1.06	4.03	3.04	1.59
0.17								0.15	
							0.17		
		0.09							
						0.15			0.29
2.49	0.51	0.26	0.09	2.47	4.49	1.82	6.22	5.62	4.47

Dentalina trondheimensis											
Dentalina sp.											
Eggerella sp.											
Elphidiidae											
Elphidium excavatum clavata	11.18	23.35	17.02	15.12	4.43	21.37	21.10	32.00	41.07	36.97	35.97
Elphidium frigidum											
Elphidium groenlandicum											
Elphidium sp.											
Eoeponidella pulchella											
Epistominella (?) arctica							0.11				
Fissurina annectens annectens											
Fissurina cucurbitasema											
Fissurina laevigata				0.28	0.08	0.08	0.44				
Fissurina marginata			0.23	0.09							
Fissurina ventricosa			0.56	0.09	0.08	0.31		0.27			
Fissurina sp.							0.11	0.09			
Fursenkoina fusiformis	0.30					0.08		0.18		0.25	
Fursenkoina loeblichi	4.53	6.35	3.95	3.57	1.61	2.18	1.33	1.96	4.44	3.47	11.66
Gavelinopsis praegeri											
Glabratella sp.											
Glandulina laevigata											
Glandulinoides inai			0.11	0.09	0.08	0.16					
Globobulimina auriculata		0.25	0.11	0.56	0.54	0.08					
Globobulimina turgida											
Globocassidulina subglobosa											
Hanzawaia sp.											
Haynesina nana	0.60	1.02	0.90	0.75		0.31	0.77	0.18	0.11		
Haynesina orbicularis			0.11				0.11				
Islandiella helenae		0.76	3.72	1.41	0.23	0.47		0.36	3.64	3.23	6.92
Islandiella islandica	0.30		0.45	0.09	0.38		0.11	0.18		0.25	
Islandiella norcrossi	1.51	1.78	2.37	4.88	6.57	5.15	4.09	2.76	2.39	3.23	6.13
Karreriella bradyi											
Lagena clavata								0.09			
Lagena elongata											
Lagena gracillima											
Lagena laevis											
Lagena mollis			0.34	0.19	0.15		0.11			0.25	
Lagena nebulosa											
Lagena semilineata											
Lagena striata				0.09							
Lagena striata var.							0.11				
Lagena sulcata laevicostata											
Lagena sp.											
Marginulina glabra											
Melonis zaandamae		1.02	1.01	1.31	2.98	2.96	2.54	3.21	3.07	0.99	1.19
Miliolid											
Nonionellina labradorica	2.72	22.84	9.13	3.10	3.13	0.62		0.80	0.57	3.47	3.95
Nonionellina turgida					0.08		0.11				
Nonionellina sp. cf. *N. bradii*							0.11				
Oolina ampullo-distoma											
Oolina borealis											
Oolina caudigera							0.11				
Oolina costata					0.08						
Oolina globosa											
Oolina hexagona											
Oolina melo											

27.40	54.43	50.19	39.93	32.41	31.06	14.00	24.37	25.57	8.30	16.18	17.31	20.00	19[illegible]
							0.07						
			0.17										
			0.17										
							0.22						
			0.17										
		0.38			0.25		0.07						
2.74	3.93	6.79	2.75	5.17	2.27	2.33	4.64	1.69	1.33	1.37	0.48		
			0.17				0.07						
								0.48	0.59				
			0.34		0.51	0.33	0.22		0.07				
			0.69	0.17	0.51								
29.11	2.95	2.26	2.41	4.83	0.76								
							0.07						
11.64	6.89	5.28	2.41	0.86	3.03	2.67	3.53	0.24	0.07	0.08			
								0.06					
							0.07	0.12	0.67	0.24	0.24		
									0.07		0.24		
										0.08	0.24		
0.34	4.92	1.51	0.69	1.38	0.76	2.33	6.11	1.09	1.33	2.82	1.20		
2.40	3.93	1.51	1.89	3.45	2.53	2.00	2.21	6.27	2.15	0.97	1.68		
								0.18	0.22	1.45			
							0.07						
						0.33							

8.30	16.18	17.31	20.00	19.05	50.00	9.47		13.68	7.57	11.76	8.81	
											0.38	
												100.00
1.33	1.37	0.48				1.58		0.33	1.62	0.42		
0.59												
										0.42		
0.07											0.38	
											0.38	
						1.05					0.38	
0.07	0.08										0.38	
											0.38	
0.67	0.24	0.24									0.38	
0.07		0.24									0.38	
	0.08	0.24										
1.33	2.82	1.20						0.49		0.42		
2.15	0.97	1.68										
0.22	1.45										0.38	

				11.97	10.00					66.67
.00										
				0.70	2.86					
					1.43					
				1.41						
					4.29					

[illegible]											
Lagena mollis	0.71	0.81	0.29	1.60	0.60	0.61		1.21	0.75	0.56	0.78
Lagena nebulosa			0.15								
Lagena semilineata											
Lagena striata		0.13	0.29	0.58		0.61	0.85		0.75	0.56	
Lagena striata var.											
Lagena sulcata laevicostata				0.15							
Lagena sp.											
Marginulina glabra					0.30						
Melonis zaandamae											
Miliolid					0.30		0.42			0.56	
Nonionellina labradorica	1.76	0.40	0.15	1.02	0.60		0.42				0.78
Nonionellina turgida				0.29							
Nonionellina sp. cf. *N. bradii*											
Oolina ampullo-distoma		0.13	0.29			0.61					
Oolina borealis											
Oolina caudigera	0.12										
Oolina costata											
Oolina globosa			0.15								
Oolina hexagona	0.12	0.27	0.15	0.15							
Oolina melo											
Oolina squamosa			0.15								
Oolina sp.						0.61					
Oridorsalis sp. cf. *O. umbonatus*	2.00	0.94	1.16	5.23	5.14	4.29	3.81	7.27	8.96	12.85	24.31
Parafissurina fovigera											
Parafissurina himatiostoma											
Parafissurina lateralis simplex											
Patellina corrugata											
Pateoris hauerinoides											
Pseudoparrella takayanagii	0.71	0.27					0.42				
Pseudoparrella sp.											
Pullenia bulloides											
Pullenia osloensis	23.85	20.43	23.51	14.39	17.82	14.11	26.27	18.18	17.91	22.91	20.78
Pyrgo williamsoni		0.27	0.15					0.61			
Quinqueloculina agglutinata											
Quinqueloculina seminulum		1.75	0.87	1.60			0.85		0.75		
Quinqueloculina stalkeri		0.27					0.85	0.61	0.75		
Robertina arctica											
Robertina sp.											
Robulus sp.	0.12	0.27	0.44			0.61					
Rotalid											
Rosalina sp.											
Scutuloris tegminis											
Silicosigmoilina groenlandica	0.12	0.81	1.02	0.58		0.61	0.42				
Trifarina hughesi	0.24		0.29	0.15							
Triloculina trihedra											
Triloculina sp.				0.15							
Valvulineria arctica				0.15							
Globigerina bulloides	0.21										
Globigerina quinqueloba	0.63	0.86	0.49	0.13	0.58		1.00		1.33		1.45
Globigerina uvula											
Neogloboquadrina pachyderma S	97.25	98.19	99.35	99.62	98.83	100.00	95.00	100.00	92.00	78.95	98.55
Neogloboquadrina pachyderma D	1.90	0.95	0.16	0.25	0.58		4.00		6.67	21.05	

0.47	1.25	0.26	1.73	0.55	1.79	1.06	0.38	0.55	3.10	0.52	1.59		0.13
1.42			1.16				0.38				0.40		0.26
	0.16												
				0.28	0.60	0.53	0.77				0.40		0.52
						0.53							
	0.31	1.03			1.19	1.59	0.38	1.09		1.04	0.80	1.74	3.14
	0.16			1.11									
	0.63					1.06							
	0.16	0.78											
			0.58										
												0.69	
			0.58				0.38						
													0.13
14.15	7.36	3.62		0.56	2.98	2.65	2.30	3.28	0.78	2.08	6.77	1.04	0.26
		0.52	0.58	0.83	0.60		0.38						0.13
22.17	13.46	17.31	24.28	27.22	18.45	27.51	18.39	13.66	10.85	5.73	11.55	10.07	4.32
0.47		0.78									0.40		
	0.63	0.26				1.06							
0.47	0.47	1.29											
	0.31				0.60		0.38						
												1.04	
				0.28									
0.47		0.52			0.60	0.53	1.15						
			0.58				0.38						0.65
											0.40		
	7.14	12.50											
95.18	92.86	87.50		100.00	100.00	80.00	100.00	100.00	100.00		100.00	100.00	100.00
4.82						20.00							

0.55	3.10	[illegible]	1.59		0.13	0.05						
			0.40		0.26			0.08				
			0.40		0.52	0.63	0.27		0.17			
							0.11	0.34				
1.09		1.04	0.80	1.74	3.14	2.38	3.90	5.30	6.81	5.64	0.32	2.49
						0.79	0.05					
				0.69		0.08						
					0.13	0.08						
3.28	0.78	2.08	6.77	1.04	0.26			4.97		3.86		
					0.13	0.48	0.88	0.51	0.35	0.89		0.33
13.66	10.85	5.73	11.55	10.07	4.32	4.68	0.16			3.56		
			0.40					0.17				
								0.08				
						0.08						
				1.04		0.24	0.22					
									0.17			
					0.65	0.48	1.04	0.17				
			0.40									
								46.15	33.33			
100.00	100.00		100.00	100.00	100.00	100.00	100.00	53.85	66.67	100.00	100.00	

							0.17		
		0.09							
						0.15			0.29
2.49	0.51	0.26	0.09	2.47	4.49	1.82	6.22	5.62	4.47
				0.04					
					0.04				
								0.15	
0.33	1.31	1.28	1.11	0.65	1.40	1.06	0.50	1.37	0.14
				0.09	0.13	0.15	0.17	0.15	
					0.04				
								0.15	
				0.04	0.04			0.15	0.14
					0.04	0.15			
					0.13				
			0.09						
					33.33				
	100.00			100.00	66.67				

[illegible]											
Lagena mollis			0.34	0.19	0.15		0.11			0.25	
Lagena nebulosa											
Lagena semilineata											
Lagena striata				0.09							
Lagena striata var.							0.11				
Lagena sulcata laevicostata											
Lagena sp.											
Marginulina glabra											
Melonis zaandamae		1.02	1.01	1.31	2.98	2.96	2.54	3.21	3.07	0.99	1.19
Miliolid											
Nonionellina labradorica	2.72	22.84	9.13	3.10	3.13	0.62		0.80	0.57	3.47	3.95
Nonionellina turgida					0.08		0.11				
Nonionellina sp. cf. *N. bradii*							0.11				
Oolina ampullo-distoma											
Oolina borealis											
Oolina caudigera							0.11				
Oolina costata					0.08						
Oolina globosa											
Oolina hexagona											
Oolina melo											
Oolina squamosa						0.08					
Oolina sp.											
Oridorsalis sp. cf. *O. umbonatus*				0.09		0.39	0.22	1.43	0.11	0.50	
Parafissurina fovigera											
Parafissurina himatiostoma								0.09			
Parafissurina lateralis simplex				0.09							
Patellina corrugata								0.27			
Pateoris hauerinoides	0.30			0.19	0.46		0.11	0.53			
Pseudoparrella takayanagii		0.25	0.34	0.09	0.54		0.22	0.18	0.23	1.24	
Pseudoparrella sp.											
Pullenia bulloides					0.15				1.71		
Pullenia osloensis						0.23	1.22	5.88	0.23	0.99	
Pyrgo williamsoni	0.30	0.25	0.11	1.97	0.15	0.16	0.22				
Quinqueloculina agglutinata					0.15						
Quinqueloculina seminulum		0.25	0.34	1.50	0.23	0.55		0.36			0.99
Quinqueloculina stalkeri											
Robertina arctica		0.25	0.23			0.08					
Robertina sp.											
Robulus sp.							0.11				
Rotalid											
Rosalina sp.			0.11								
Scutuloris tegminis						0.08	1.33				
Silicosigmoilina groenlandica											
Trifarina hughesi											
Triloculina trihedra				0.19			0.11	0.09			
Triloculina sp.											
Valvulineria arctica											
Globigerina bulloides											
Globigerina quinqueloba							100.00				
Globigerina uvula											
Neogloboquadrina pachyderma S	100.00	100.00			100.00	100.00		100.00			
Neogloboquadrina pachyderma D											

							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
									0.07		0.24		
										0.08	0.24		
0.34	4.92	1.51	0.69	1.38	0.76	2.33	6.11	1.09	1.33	2.82	1.20		
2.40	3.93	1.51	1.89	3.45	2.53	2.00	2.21	6.27	2.15	0.97	1.68		
								0.18	0.22	1.45			
							0.07						
						0.33							
							0.15						
		0.38	0.17	0.34		0.33	0.66	0.06		0.72	7.93		
											0.24		
										0.08			
					0.25								
		0.38					0.07						
0.34	0.33		0.34	0.17					0.15	0.08			
	0.33												
				0.34			0.81	1.75	3.41	3.70	6.73		
		0.75		0.86	0.25	1.33	3.31	7.18	15.79	19.00	10.82		
0.34									0.37	0.40			
				0.17			0.07	0.36	0.30	1.93	0.48		
								0.06					
							0.07						
	0.33												
						0.33	0.15	0.06					
							40.00	12.50	5.26	5.88	5.88		
	100.00	100.00		100.00			60.00	75.00	94.74	94.12	94.12		
								12.50					

.67	0.24	0.24									0.38		
.07		0.24									0.38		
	0.08	0.24											
.33	2.82	1.20						0.49		0.42			
.15	0.97	1.68											
.22	1.45										0.38		
	0.72	7.93				34.74	33.33	12.21	38.38	25.21	30.27		
		0.24									0.38		
	0.08							0.33					
15	0.08												
41	3.70	6.73				6.84		3.09	3.78	9.66	9.20		
79	19.00	10.82				20.53		8.63	22.16	24.79	22.99		
37	0.40												
30	1.93	0.48						0.16	1.08	0.84			
26	5.88	5.88				4.88		3.51	4.35	1.01	1.19		
									4.35				
4	94.12	94.12				92.68		94.74	91.30	97.98	97.62		
						2.44		1.75		1.01	1.19		

					4.29					
		50.00		30.28	11.43					
				14.08	27.14					
				14.08	8.57	12.70				
					1.43					
					1.43					
				1.61						
				96.77	100.00	100.00	100.00			100.00
				1.61						

Table 6. Percent abundances of foraminiferal species and sample statistics for core 90031019TWC.

Top of interval (cm)	10	20	30	40	50	60	70	80	90
Volume (cc)	5	5	5	5	5	5	5	5	5
Number of tests (B - Total)	736	704	533	537	707	411	903	496	565
Number of tests (B - Calc)	734	702	527	535	704	409	894	496	562
Number of tests (B - Agglut)	2	2	6	2	3	2	9	0	3
Number of tests (B/10 cc)	1472	1408	1066	1074	1414	822	1806	992	1130
Number of species (B - Total)	33	38	38	33	37	32	43	27	26
Number of species (B - Calc)	32	37	36	31	36	30	41	27	25
Number of species (B - Agglut)	1	1	2	2	1	2	2	0	1
Diversity - B [H(S)]	2.61	2.57	2.56	2.29	2.32	2.31	2.50	2.32	2.21
Number of tests (P)	376	284	448	248	213	233	800	85	232
Number of tests (P/10 cc)	752	568	896	496	426	466	1600	170	464
Number of species (P)	2	2	2	2	4	2	2	2	2
Astrononion gallowayi	6.11	6.68	6.38	5.59	7.21	7.54	6.76	4.44	3.01
Brizalina pseudopunctata					0.14				
Brizalina subaenariensis	1.09	0.14	0.19			0.49			0.18
Brizalina subspinescens	0.41	0.99	0.19	0.19					
Buccella arctica	4.76	2.56	2.44	2.42	2.26	2.92	1.99	0.81	
Buccella calida	1.90	1.42	2.81	2.79	3.82	3.16	3.65	1.21	2.12
Buccella frigida			0.19						
Buccella tenerrima	0.14				0.14	0.73	0.44		
Buccella sp.							0.22		
Bulimina aculeata	11.82	5.26	13.13	17.69	8.91	5.11	14.17	22.18	29.20
Bulimina exilis	5.71	4.69	7.50	6.52	2.97	2.19	1.44	4.44	1.59
Buliminella sp.		0.43	0.19	0.19			0.11		
Cassidulina neocarinata	0.27	0.57	0.75	0.93	0.42	0.73	0.66	1.41	0.18
Cassidulina reniforme	12.64	18.04	21.58	24.21	30.98	31.87	26.91	19.15	20.53
Cassidulina sp.				0.19	0.14	0.24	0.11		
Cassidulinoides bradyi					0.14	0.24	0.11		
Cibicides lobatulus	2.45	2.13	7.69	5.21	10.18	11.92	8.97	9.07	6.73
Cibicides pseudoungerianus	0.14		0.38	0.19					
Dentalina trondheimensis	0.14								
Elphidiidae	0.41	1.42	1.13	1.12	1.27	0.97	1.99	0.81	0.88
Elphidium excavatum clavata	13.99	15.91	5.07	3.72	1.41	0.49	1.66	1.01	1.06
Eoeponidella pulchella	0.14		0.19	0.19			0.33	0.20	
Eponides pusillus	0.14			0.19	0.99	4.14	10.30	15.12	9.20
Fissurina annectens pseudostaphyllearia		0.28		0.19			0.11		
Fissurina cucurbitasema								0.20	
Fissurina laevigata	0.14	0.14	0.19						
Fissurina varioperforata angusta			0.19						
Fissurina sp.		0.28		0.19	0.14		0.55	0.20	
Fursenkoina fusiformis								0.20	
Fursenkoina loeblichi	2.72	2.70	1.50	0.74	0.71		0.55	0.20	
Gavelinopsis praegeri				0.19	0.28	0.24	0.33	0.40	1.77
Glabratella sp.		0.14			0.28	0.49	0.22	0.40	
Glandulina laevigata	0.27	0.28	0.19	0.37	0.28	0.24	0.78	0.20	0.18
Glandulinoides ittai		0.14							

Table 7. Percent abundances of foraminiferal species and sample statistics for core 90031017BC.

Top of interval (cm)	0	1	2	4	6	8	15	20	30	40	48
Volume (cc)	5	5	5	5	5	5	5	5	5	5	5
Number of tests (B - Total)	551	467	347	386	390	235	541	398	459	651	507
Number of tests (B - Calc)	476	420	345	385	387	235	540	398	459	647	505
Number of tests (B - Agglut)	75	47	2	1	3	0	1	0	0	4	2
Number of tests (B/10 cc)	1102	934	694	772	780	470	1082	796	918	1302	1014
Number of species (B - Total)	39	34	30	31	29	23	32	28	23	32	28
Number of species (B - Calc)	31	26	28	30	26	23	31	28	23	30	26
Number of species (B - Agglut)	8	8	2	1	3	0	1	0	0	2	2
Diversity - B [H(S)]	2.76	2.70	2.60	2.71	2.51	2.50	2.51	2.45	2.46	2.57	2.44
Number of tests (P)	23	29	39	52	71	83	247	234	418	289	291
Number of tests (P/10 cc)	46	58	78	104	142	166	494	468	836	578	582
Number of species (P)	1	1	1	2	1	1	1	2	3	2	2
Astrononion gallowayi	7.26	6.21	7.49	10.10	10.51	14.47	13.68	14.32	5.23	4.30	9.47
Bathysiphon sp.	1.45	1.93									
Brizalina pseudopunctata	0.36										
Brizalina subaenariensis	16.33	10.28	8.07	4.66	1.79	1.28	0.37	0.25	0.44	0.77	0.39
Brizalina subspinescens	1.09	0.86	0.29	0.26	0.51		1.48	0.25	0.65	0.31	0.59
Brizalina sp.					0.26						
Buccella arctica	1.45	4.07	4.32	3.89	5.13	8.09	3.51	6.53	6.75	5.84	3.16
Buccella calida	0.54	0.86	1.44	0.78	0.26	2.13	1.48	0.75	1.31	0.46	1.78
Buccella tenerrima		0.21									
Bulimina aculeata	5.99	4.93	6.63	4.40	3.59	3.83	7.58	8.29	9.15	18.13	10.06
Bulimina exilis	15.06	13.06	2.88	2.85	3.08	5.11	2.40	3.27	5.66	4.30	3.55
Buliminella sp.	0.18	0.21		0.52			0.37	0.50		0.15	
Cassidulina neocarinata	1.45	1.93	5.48	4.40	4.87	1.70	1.11	0.25	0.65	0.31	0.20
Cassidulina reniforme	0.73	1.93	1.44	2.85	4.36	1.28	5.55	4.77	15.25	11.37	21.10
Cassidulinoides bradyi		0.21									
Cibicides lobatulus	2.18	3.43	4.61	2.59	1.79	1.70	2.96	1.76	2.83	2.76	4.93
Cribrostomoides jeffreysi	0.36	0.21									
Dentalina trondheimensis								0.25			
Elphidium excavatum clavata	2.00	2.36	6.34	7.77	7.69	18.30	13.49	12.81	12.42	14.13	11.05
Eoeponidella pulchella	0.18			0.26				0.50			
Eponides pusillus	16.15	23.34	24.78	19.17	22.56	5.96	0.74				
Fissurina annectens pseudost.				0.26							0.20
Fissurina ventricosa							0.18				
Fursenkoina fusiformis		0.21	0.29					0.25			
Fursenkoina loeblichi	1.09	1.07	1.15	3.11	2.56	5.53	4.62	4.52	4.36	3.53	1.97
Glabratella sp.				0.26	0.26						0.20
Glandulina laevigata	0.18	0.21					0.18	0.25		0.15	0.20
Glandulinoides ittai							0.18				
Globobulimina auriculata	0.36	0.64		2.59	2.05	0.43	1.85	3.77	0.87	4.45	0.59
Globobulimina turgida	0.18										
Hanzawaia sp.	0.18	0.64	0.86	0.52	0.77	0.85		0.25			
Haplophragmoides bradyi	4.54	2.14		0.26							
Islandiella islandica	0.54		0.29								
Islandiella norcrossi	0.18		1.15	1.30	0.77	0.85	0.92		2.18	4.15	0.79
Karreriella bradyi											0.20

Eoeponidella pulchella	0.14		0.19	0.19			0.33	0.20	
Eponides pusillus	0.14			0.19	0.99	4.14	10.30	15.12	9.20
Fissurina annectens pseudostaphyllearia		0.28		0.19			0.11		
Fissurina cucurbitasema								0.20	
Fissurina laevigata	0.14	0.14	0.19						
Fissurina varioperforata angusta			0.19						
Fissurina sp.		0.28		0.19	0.14		0.55	0.20	
Fursenkoina fusiformis								0.20	
Fursenkoina loeblichi	2.72	2.70	1.50	0.74	0.71		0.55	0.20	
Gavelinopsis praegeri				0.19	0.28	0.24	0.33	0.40	1.77
Glabratella sp.		0.14			0.28	0.49	0.22	0.40	
Glandulina laevigata	0.27	0.28	0.19	0.37	0.23	0.24	0.78	0.20	0.18
Glandulinoides ittai		0.14							
Globobulimina auriculata	1.36	1.14	0.38					0.20	
Hanzawaia sp.			0.19	0.19	0.14	0.24	0.44		0.35
Islandiella islandica	0.14	0.28	0.19		0.14		0.33	0.20	0.18
Islandiella norcrossi	3.40	1.85	1.50		0.57	0.49	0.22		0.18
Karreriella bradyi			0.56	0.19	0.42	0.24	0.89		
Lagena elongata			0.19	0.19			0.33	0.81	0.18
Lagena laevis			0.19						
Lagena mollis	0.54	0.28	1.13	1.30	0.57	0.49		0.81	1.06
Lagena nebulosa	0.14				0.14	0.24	0.11		
Lagena striata		0.14					0.22		0.18
Lagena sulcata laevicostata					0.14				
Miliolid									1.06
Nonionellina labradorica	3.80	4.83	1.31	0.37		0.49	0.11	0.20	
Nonionellina sp. cf. *N. bradii*	0.27	0.14	0.38				0.22		
Oolina ampullo-distoma	0.14	0.14	0.19				0.11		
Oolina borealis							0.11		
Oolina globosa			0.19			0.24			
Oolina squamosa				0.19			0.11		
Oolina sp.		0.14					0.11		
Oridorsalis sp. cf. *O. umbonatus*	3.26	2.56	1.88	1.86	1.70	2.19	1.77	2.22	3.72
Parafissurina fovigera				0.19					
Parafissurina himatiostoma		0.14			0.14				
Parafissurina lateralis carinata			0.19						
Pseudoparrella takayanagii	0.95	0.85	0.75	0.19	0.57	0.49	0.33		
Pseudoparrella sp.					0.14				
Pullenia osloensis	19.70	21.73	18.20	21.97	19.80	19.22	11.18	11.90	13.81
Pyrgo williamsoni					0.42	0.24	0.11		0.18
Quinqueloculina seminulum		0.14			1.98	1.22	0.55	2.02	1.77
Robulus sp.		0.57		0.19	0.14	0.24	0.22		0.18
Saccammina atlantica		0.28							
Silicosigmoilina groenlandica	0.27		0.56	0.19		0.24	0.11		0.53
Trifarina hughesi	0.68	0.43	0.19		0.14				
Valvulineria arctica		0.14			0.14				
Globigerina bulloides					0.47				
Globigerina quinqueloba	1.86	2.11	0.67	3.63	7.04	1.29	2.13	14.12	5.60
Globigerina uvula					0.94				
Neogloboquadrina pachyderma S	96.28	96.13	97.77	94.35	90.14	97.85	96.88	82.35	93.97
Neogloboquadrina pachyderma D	1.86	1.76	1.56	2.02	1.41	0.86	1.00	3.53	0.43

B...Benthonic P...Planktonic Calc...Calcareous Agglut...Agglutinated S...Sinistral D...Dextral

Cribrostomoides jeffreysi	0.36	0.21									
Dentalina trondheimensis								0.25			
Elphidium excavatum clavata	2.00	2.36	6.34	7.77	7.69	18.30	13.49	12.81	12.42	14.13	11.05
Eoeponidella pulchella	0.18			0.26				0.50			
Eponides pusillus	16.15	23.34	24.78	19.17	22.56	5.96	0.74				
Fissurina annectens pseudost.				0.26							0.20
Fissurina ventricosa							0.18				
Fursenkoina fusiformis		0.21	0.29					0.25			
Fursenkoina loeblichi	1.09	1.07	1.15	3.11	2.56	5.53	4.62	4.52	4.36	3.53	1.97
Glabratella sp.				0.26	0.26						0.20
Glandulina laevigata	0.18	0.21					0.18	0.25		0.15	0.20
Glandulinoides ittai							0.18				
Globobulimina auriculata	0.36	0.64		2.59	2.05	0.43	1.85	3.77	0.87	4.45	0.59
Globobulimina turgida	0.18										
Hanzawaia sp.	0.18	0.64	0.86	0.52	0.77	0.85		0.25			
Haplophragmoides bradyi	4.54	2.14		0.26							
Islandiella islandica	0.54		0.29								
Islandiella norcrossi	0.18		1.15	1.30	0.77	0.85	0.92		2.18	4.15	0.79
Karreriella bradyi											0.20
Lagena elongata	0.18	0.21					0.18		0.22	0.15	0.39
Lagena laevis		0.21	0.29	0.26				0.25	0.22	0.46	
Lagena mollis	0.54	0.43	0.86	1.55	0.51	3.40	1.11	1.51	0.65	0.77	1.38
Lagena nebulosa			0.29			0.43	0.18			0.31	
Lagena striata			0.29							0.15	
Nonionellina labradorica	0.54		0.86	1.30	2.56	1.28	3.51	2.51	2.18	3.07	2.37
Nonionellina sp. cf. *N. bradii*							0.18				
Oolina ampullo-distoma			0.29	0.26		0.43				0.15	
Oolina lineata								0.25			
Oolina melo									0.22		
Oolina squamosa										0.15	
Oridorsalis tener	1.63	1.93	4.90	2.59	1.28	0.43	0.55				
Oridorsalis sp. cf. *umbonatus*	0.54	0.43		0.78	0.26	1.28	2.40	4.02	4.36	2.61	4.14
Parafissurina sp.											0.20
Pseudoparrella takayanagii	0.36		0.29	0.26	0.26		0.37	0.50	0.22	0.31	0.39
Pullenia osloensis	8.35	10.06	13.26	18.65	21.03	20.43	27.91	26.63	23.31	15.67	19.92
Pullenia quinqueloba	0.18		0.29	0.78	0.26		0.18	0.25			
Quinqueloculina seminulum					0.26						
Reophax subfusiformis	0.54	0.21									
Reophax sp.					0.26						
Robulus sp.										0.15	0.20
Rosalina sp.							0.18				
Saccammina atlantica	1.27	2.36	0.29		0.26					0.15	
Silicosigmoilina groenlandica			0.29		0.26		0.18			0.46	0.20
Trifarina hughesi	0.36		0.29	0.78		0.85	0.37	0.50	0.87	0.15	0.39
Tritaxis conica	2.72	1.93									
Trochammina quadriloba	1.81	0.86									
Trochammina sp.	0.91	0.43									
Vaginulina spinigera										0.15	
Globigerina quinqueloba				3.85				0.43	2.15	1.38	0.69
Globigerina uvula									0.24		
Neogloboquadrina pachyderma S	95.65	100.00	97.44	96.15	100.00	98.80	99.19	99.57	96.89	97.58	98.28
Neogloboquadrina pachyderma D	4.35		2.56			1.20	0.81		0.72	1.04	1.03

B...Benthonic P...Planktonic Calc...Calcareous Agglut...Agglutinated S...Sinistral D...Dextral

Top of interval (cm)	0	10	20	40	60	80	100	120	140	160	180
Volume (cc)	5	5	5	5	5	5	5	5	5	5	5
Number of tests (B - Total)	76	64	285	86	187	215	251	271	523	217	384
Number of tests (B - Calc)	75	64	285	86	187	215	251	271	523	217	384
Number of tests (B - Agglut)	1	0	0	0	0	0	0	0	0	0	0
Number of tests (B/10 cc)	152	128	570	172	374	430	502	542	1046	434	768
Number of species (B - Total)	11	7	11	6	10	9	11	12	10	12	11
Number of species (B - Calc)	10	7	11	6	10	9	11	12	10	12	11
Number of species (B - Agglut)	1	0	0	0	0	0	0	0	0	0	0
Diversity - B [H(S)]	1.91	1.50	1.45	1.25	1.10	1.56	1.63	1.56	1.64	1.80	1.75
Number of tests (P)	1	0	0	0	0	0	0	0	0	0	0
Number of tests (P/10 cc)	2	0	0	0	0	0	0	0	0	0	0
Number of species (P)	1	0	0	0	0	0	0	0	0	0	0
Astrononion gallowayi			1.05		0.53		0.40		0.76	0.92	0.78
Brizalina pseudopunctata								0.37			
Buccella arctica	6.58	12.50	5.61	11.63	3.74	6.05	11.16	6.64	7.84	10.60	4.69
Buccella calida	2.63										
Buccella frigida	5.26	1.56	0.70	1.16	1.60	0.93	2.79	1.48	0.57	2.76	1.82
Buliminella sp.								0.37			
Cassidulina reniforme	5.26		1.75		1.07	5.12	5.98	5.54	9.75	1.38	7.55
Cibicides lobatulus											0.26
Cribrostomoides crassimargo	1.32										
Dentalina baggi											
Dentalina frobisherensis											
Elphidium bartletti											
Elphidium excavatum clavata	13.16	3.13	44.21	6.98	10.70	33.49	42.23	53.14	46.27	17.05	32.29
Elphidium frigidum											
Elphidium asklundi/incertum											
Elphidium subarcticum											
Entolingulina translucida											
Eoeponidella pulchella			0.35								
Fissurina laevigata							0.40				
Fissurina marginata											
Fissurina reniformis											
Fissurina ventricosa											
Fursenkoina fusiformis										0.46	
Fursenkoina loeblichi	2.63										
Glabratella sp.											
Glandulinoides ittai											
Haynesina nana											
Haynesina orbicularis											
Islandiella helenae	27.63	45.31	26.32	59.30	69.52	37.67	13.15	13.65	15.11	40.09	27.86
Islandiella islandica											
Islandiella norcrossi	3.95	9.38	1.40	5.81	1.07	2.33	1.20	2.58	4.40	5.53	7.81
Lagena laevis											
Lagena mollis			0.35		0.53	0.93		0.37		0.46	
Lagena semilineata											
Lagena striata											

Table 9. Percent abundances

200	220	240	250	270	290	310	330	350	370	390	410	430	450
5	5	5	5	5	5	5	5	5	5	5	5	5	5
276	500	448	275	322	270	693	392	487	844	451	944	1053	718
276	500	448	275	322	270	693	392	487	844	451	944	1053	718
0	0	0	0	0	0	0	0	0	0	0	0	0	0
552	1000	896	550	644	540	1386	784	974	1688	902	1888	2106	1436
12	11	13	11	10	10	11	9	14	15	10	14	15	11
12	11	13	11	10	10	11	9	14	15	10	14	15	11
0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.88	1.51	1.73	1.75	1.67	1.67	1.66	1.72	1.84	1.71	1.64	1.89	1.74	1.71
0	0	0	0	0	0	4	1	0	0	0	0	0	0
0	0	0	0	0	0	8	2	0	0	0	0	0	0
0	0	0	0	0	0	1	1	0	0	0	0	0	0
0.72	0.20	0.89		0.62		0.14	0.51	0.21	0.47		0.64	0.28	0.14
						0.29		0.62			0.53		
9.42	6.40	11.16	12.00	11.18	13.70	7.50	11.99	8.21	12.68	19.96	9.53	12.06	16.02
1.09	0.20		1.09	0.93	1.48	1.59	1.53	0.62	2.96	3.99	2.12	2.28	1.53
	0.20												
3.99	3.20	7.59	6.55	2.48	4.07	21.65	3.83	13.55	9.72	0.89	17.48	16.05	6.55
		0.22				0.29						0.19	0.14
		0.22										0.09	
15.94	45.60	37.72	31.27	30.12	35.56	40.40	32.65	31.01	41.82	21.29	29.87	38.27	28.55
		0.45											
1.09					0.74				0.12	0.22			
0.36			0.36						0.12	0.22			
								0.21					
		0.67						0.21			0.21	0.09	
									0.47		0.21	0.19	
33.70	23.60	16.07	19.64	32.61	29.26	16.45	26.79	17.45	15.17	34.15	18.75	14.25	29.94
	0.20								0.12				
10.14	6.20	2.46	3.64	5.28	3.70	2.89	10.20	4.11	1.30	2.66	4.34	2.37	3.48
				0.31				0.21	0.12		0.21	0.19	

. Percent abundances of foraminiferal species and sample statistics for core 90031027

390	410	430	450	470	490	510	530	550	570	590	610	630	650
5	5	5	5	5	5	5	5	5	5	5	5	5	5
451	944	1053	718	886	3178	308	269	687	94	11	80	104	929
451	944	1053	718	886	3178	308	269	687	94	11	80	104	929
0	0	0	0	0	0	0	0	0	0	0	0	0	0
902	1888	2106	1436	1772	6356	616	538	1374	188	22	160	208	1858
10	14	15	11	15	17	7	7	10	6	3	7	5	8
10	14	15	11	15	17	7	7	10	6	3	7	5	8
0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.64	1.89	1.74	1.71	1.84	1.68	1.16	0.59	0.92	1.35		1.24	0.95	0.80
0	0	0	0	0	0	0	1	0	1	0	0	0	0
0	0	0	0	0	0	0	2	0	2	0	0	0	0
0	0	0	0	0	0	0	1	0	1	0	0	0	0
	0.64	0.28	0.14	0.11	0.25			0.29					
	0.53				0.13								
19.96	9.53	12.06	16.02	21.11	8.40	8.44	3.35	3.06	3.19	18.18	7.50	2.88	7.10
3.99	2.12	2.28	1.53	1.24	0.13								0.32
					0.03								
0.89	17.48	16.05	6.55	11.51	16.36	4.87	4.09	24.16	23.40		10.00	2.88	0.32
		0.19	0.14	0.11	0.22		0.74				1.25		
		0.09											
1.29	29.87	38.27	28.55	23.14	23.22	61.36	86.99	67.98	45.74		61.25	31.73	17.01
0.22													
0.22				0.23									
					0.06								
	0.21	0.09		0.45	0.25								
								0.15					
	0.21	0.19		0.11									
4.15	18.75	14.25	29.94	19.98	37.76	21.10	2.23	2.77	21.28	54.55	15.00	60.58	74.38
								0.15					
2.66	4.34	2.37	3.48	2.03	1.26	2.60	2.23	0.15	4.26		3.75		0.22
	0.21	0.19		0.23	0.03								
		0.09	0.14		0.03								
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]							

re 90031027PC.

630	650	670	690	710	730	750	770	790	810	830	850	
5	5	5	5	5	5	5	5	5	5	5	5	
104	929	2271	2155	2577	5323	482	2242	1461	2814	1964	1098	
104	929	2271	2155	2577	5323	482	2242	1461	2814	1964	1098	
0	0	0	0	0	0	0	0	0	0	0	0	
208	1858	4542	4310	5154	10646	964	4484	2922	5628	3928	2196	1
5	8	23	21	22	30	7	14	12	24	16	15	
5	8	23	21	22	30	7	14	12	24	16	15	
0	0	0	0	0	0	0	0	0	0	0	0	
0.95	0.80	1.44	1.77	1.53	1.23	0.99	1.15	1.26	1.48	1.22	1.38	
0	0	0	0	0	0	0	0	0	0	1	0	
0	0	0	0	0	0	0	0	0	0	2	0	
0	0	0	0	0	0	0	0	0	0	1	0	
		0.57	3.25	2.41	0.56			0.27	2.38	0.97	2.09	
			0.05		0.02		0.09	0.21	0.11	0.10		
2.88	7.10	5.90	0.19		0.13							
		0.75	0.88	1.36	1.63	3.94	1.12	2.40	3.06	1.99	2.28	
	0.32	0.18		0.08								
					0.02							
2.88	0.32	4.93	21.02	32.67	27.54	44.81	25.11	26.97	31.17	44.76	47.63	5
		1.41	4.50	3.30	0.90		0.36	0.14	2.03	0.81	2.28	
					0.02							
		0.04										
1.73	17.01	55.26	25.43	42.26	57.49	48.13	60.39	56.54	46.02	42.31	33.15	3
		0.09	0.37	0.12	0.08				0.04			
		0.22	1.53	0.19	0.02				0.18		0.18	
		1.81	0.32	0.12					0.14			
									0.04			
		1.19	0.23	0.19	0.21	0.41	0.18	1.16	0.11			
		0.04			0.02							
			0.09									
					0.06							
		0.04	0.23	0.35	0.08				0.11	0.15	0.09	
			0.09	0.04	0.13		0.04		0.04	0.05	0.09	
											0.09	
									0.04			
					0.02				0.04			
					0.02							
		2.51	9.65	4.46	2.16	1.45	2.45	2.67	4.05	2.75	4.64	1
.58	74.38	23.95	31.18	10.75	7.27	0.62	7.45	6.78	9.24	5.04	6.56	3
			0.05									
	0.22	0.22		0.58	0.21				0.32			

750	770	790	810	830	850	870	890	910	930	950	970	990
5	5	5	5	5	5	5	5	5	5	5	5	5
482	2242	1461	2814	1964	1098	794	952	751	540	527	284	462
482	2242	1461	2814	1964	1098	794	952	751	540	527	284	462
0	0	0	0	0	0	0	0	0	0	0	0	0
964	4484	2922	5628	3928	2196	1588	1904	1502	1080	1054	568	924
7	14	12	24	16	15	14	15	11	12	13	11	9
7	14	12	24	16	15	14	15	11	12	13	11	9
0	0	0	0	0	0	0	0	0	0	0	0	0
0.99	1.15	1.26	1.48	1.22	1.38	1.23	1.19	1.06	1.08	1.21	1.15	0.99
0	0	0	0	1	0	0	0	0	0	0	0	0
0	0	0	0	2	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0	0	0
		0.27	2.38	0.97	2.09	1.39	0.95	0.67	0.19	0.57	0.35	1.30
	0.09	0.21	0.11	0.10		0.38	0.95	0.67	0.93	0.95	0.70	0.22
3.94	1.12	2.40	3.06	1.99	2.28	2.64	2.21	2.13	1.67	1.52	0.70	0.22
44.81	25.11	26.97	31.17	44.76	47.63	54.66	58.72	50.33	57.41	53.51	57.04	53.46
	0.36	0.14	2.03	0.81	2.28	1.13	1.26	0.67	0.74	1.14	1.06	0.65
48.13	60.39	56.54	46.02	42.31	33.15	31.99	28.68	41.94	33.33	33.59	28.17	40.04
			0.04									
			0.18		0.18							
			0.14									
			0.04									
0.41	0.18	1.16	0.11									
			0.11	0.15	0.09	0.13	0.42	0.13	0.19	0.19	0.35	
	0.04		0.04	0.05	0.09		0.21					
					0.09	0.13						
			0.04									
			0.04									
						0.25		0.27	0.19			
1.45	2.45	2.67	4.05	2.75	4.64	1.89	1.89	1.07	0.56	1.14	1.06	1.08
0.62	7.45	6.78	9.24	5.04	6.56	3.78	3.78	1.46	2.96	4.74	9.86	1.52
			0.32			0.13				0.19	0.35	
										0.19		

890	910	930	950	970	990	1010	1030	1050	1070	1090	1110
5	5	5	5	5	5	5	5	5	5	5	5
952	751	540	527	284	462	638	445	432	408	430	114
952	751	540	527	284	462	638	444	432	408	430	114
0	0	0	0	0	0	0	1	0	0	0	0
1904	1502	1080	1054	568	924	1276	890	864	816	860	228
15	11	12	13	11	9	17	16	11	9	7	5
15	11	12	13	11	9	17	15	11	9	7	5
0	0	0	0	0	0	0	1	0	0	0	0
1.19	1.06	1.08	1.21	1.15	0.99	1.28	1.06	1.10	0.74	0.67	0.59
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0.95	0.67	0.19	0.57	0.35	1.30	3.61	1.35	0.23	0.98		
0.95	0.67	0.93	0.95	0.70	0.22	0.16	0.45	0.23	0.49		
2.21	2.13	1.67	1.52	0.70	0.22	1.72	0.45	0.93			
58.72	50.33	57.41	53.51	57.04	53.46	61.60	66.52	57.18	78.92	81.40	83.33
1.26	0.67	0.74	1.14	1.06	0.65	1.10	0.22		0.25		
28.68	41.9[illegible]	33.33	33.59	28.17	40.04	20.38	23.37	31.71	15.44	11.40	12.28
0.42	0.13	0.19	0.19	0.35		0.47	0.22	0.46		0.23	
0.21											
							0.22	0.23			
						0.16					
	0.27	0.19							0.25		
1.89	1.07	0.56	1.14	1.06	1.08	7.05	2.47	5.79	1.72	4.88	0.88
3.78	1.46	2.96	4.74	9.86	1.52	1.88	1.35	1.39	0.74	0.23	1.75
			0.19	0.35		0.16					
						0.16					
			0.19								
							0.22				

Elphidium subarcticum											
Entolingulina translucida											
Eoeponidella pulchella			0.35								
Fissurina laevigata							0.40				
Fissurina marginata											
Fissurina reniformis											
Fissurina ventricosa											
Fursenkoina fusiformis										0.46	
Fursenkoina loeblichi	2.63										
Glabratella sp.											
Glandulinoides ittai											
Haynesina nana											
Haynesina orbicularis											
Islandiella helenae	27.63	45.31	26.32	59.30	69.52	37.67	13.15	13.65	15.11	40.09	27.86
Islandiella islandica											
Islandiella norcrossi	3.95	9.38	1.40	5.81	1.07	2.33	1.20	2.58	4.40	5.53	7.81
Lagena laevis											
Lagena mollis			0.35		0.53	0.93		0.37		0.46	
Lagena semilineata											
Lagena striata											
Nonionellina labradorica		4.69	0.35		0.53	2.33	0.80	2.95	2.10	4.61	1.30
Oolina acuticostata											
Oolina caudigera											
Oolina lineata											
Oolina melo											
Oolina sp. cf. *O. striatopunctata*											
Parafissurina fovigera											
Patellina corrugata											
Pateoris hauerinoides											
Polymorphinid											
Pseudoparrella takayanagii	30.26	23.44	17.89	15.12	10.70	11.16	21.51	12.18	12.81	14.75	15.10
Quinqueloculina agglutinata											
Quinqueloculina seminulum											
Rosalina sp.											
Saccammina atlantica											
Trifarina hughesi	1.32						0.40	0.74	0.38	1.38	0.52
Triloculina trihedra											
Neogloboquadrina pachyderma S	100.00										

B...Benthonic P...Planktonic Calc...Calcareous Agglut...Agglutinated S...Sinistral

			0.45											
	1.09					0.74				0.12	0.22			
	0.36			0.36						0.12	0.22			
									0.21					
			0.67						0.21			0.21	0.09	
										0.47		0.21	0.19	
6	33.70	23.60	16.07	19.64	32.61	29.26	16.45	26.79	17.45	15.17	34.15	18.75	14.25	29.94
		0.20								0.12				
1	10.14	6.20	2.46	3.64	5.28	3.70	2.89	10.20	4.11	1.30	2.66	4.34	2.37	3.48
					0.31				0.21	0.12		0.21	0.19	
				0.36					0.41				0.09	0.14
0	3.62	0.80	1.12	1.09	1.86	1.85	2.02	1.28	3.08	0.95	0.67	2.44	0.85	1.11
	18.84	13.40	20.76	23.27	14.60	9.26	6.78	11.22	20.12	13.86	15.96	13.56	12.73	12.40
	1.09		0.67	0.73		0.37				0.12		0.11		
							100.00	100.00						

0.22													
0.22				0.23									
					0.06								
	0.21	0.09		0.45	0.25								
								0.15					
	0.21	0.19		0.11									
4.15	18.75	14.25	29.94	19.98	37.76	21.10	2.23	2.77	21.28	54.55	15.00	60.58	74.38
								0.15					
2.66	4.34	2.37	3.48	2.03	1.26	2.60	2.23	0.15	4.26		3.75		0.22
	0.21	0.19		0.23	0.03								
		0.09	0.14		0.03								
0.67	2.44	0.85	1.11	2.14	6.48	0.97		0.44					0.32
15.96	13.56	12.73	12.40	17.49	5.29	0.65	0.37	0.87	2.13	27.27	1.25	1.92	0.32
	0.11			0.11	0.09								
							100.00		100.00				

			0.22	[illegible].53	0.19	0.02				0.18		0.18	
			1.81	0.32	0.12					0.14			
										0.04			
			1.19	0.23	0.19	0.21	0.41	0.18	1.16	0.11			
			0.04			0.02							
				0.09									
						0.06							
			0.04	0.23	0.35	0.08				0.11	0.15	0.09	0.13
				0.09	0.04	0.13		0.04		0.04	0.05	0.09	
												0.09	0.13
										0.04			
						0.02				0.04			
						0.02							0.25
			2.51	9.65	4.46	2.16	1.45	2.45	2.67	4.05	2.75	4.64	1.89
15.00	60.58	74.38	23.95	31.18	10.75	7.27	0.62	7.45	6.78	9.24	5.04	6.56	3.78
				0.05									
3.75		0.22	0.22		0.58	0.21				0.32			0.13
		0.32	0.13	0.60	0.81	0.90		2.14	1.98	0.39	0.05	0.09	
			0.04		0.04								
				0.05	0.04	0.04				0.07	0.05	0.09	
											0.05		
			0.09	0.23	0.04	0.04				0.04			
						0.02							
						0.02							
								0.04	0.07				
			0.09		0.04	0.08							
1.25	1.92	0.32	0.31	0.05		0.19	0.62	0.54	0.82	0.21	0.71	0.55	1.39
						0.02		0.04		0.04			
					0.04								
			0.22		0.12	0.13		0.04		0.18	0.15	0.18	0.13
											0.05		
											100.00		

.02				0.18		0.18							
				0.14									
				0.04									
.21	0.41	0.18	1.16	0.11									
.02													
.06													
.08				0.11	0.15	0.09	0.13	0.42	0.13	0.19	0.19	0.35	
.13		0.04		0.04	0.05	0.09		0.21					
						0.09	0.13						
				0.04									
.02				0.04									
.02							0.25		0.27	0.19			
.16	1.45	2.45	2.67	4.05	2.75	4.64	1.89	1.89	1.07	0.56	1.14	1.06	1.08
.27	0.62	7.45	6.78	9.24	5.04	6.56	3.78	3.78	1.46	2.96	4.74	9.86	1.52
.21				0.32			0.13				0.19	0.35	
											0.19		
90		2.14	1.98	0.39	0.05	0.09							
04				0.07	0.05	0.09		0.11					
					0.05								
04				0.04									
02													
02													
		0.04	0.07					0.11					
08													
19	0.62	0.54	0.82	0.21	0.71	0.55	1.39	0.53	0.67	1.67	2.09	0.35	1.52
02		0.04		0.04				0.11			0.19		
13		0.04		0.18	0.15	0.18	0.13	0.11		0.19			
					0.05								
					100.00								

0.42	0.13	0.19	0.19	0.35		0.47	0.22	0.46		0.23	
0.21											
							0.22	0.23			
						0.16					
	0.27	0.19							0.25		
1.89	1.07	0.56	1.14	1.06	1.08	7.05	2.47	5.79	1.72	4.88	0.88
3.78	1.46	2.96	4.74	9.86	1.52	1.88	1.35	1.39	0.74	0.23	1.75
			0.19	0.35		0.16					
						0.16					
			0.19								
							0.22				
0.11											
0.11											
						0.31					
0.53	0.67	1.67	2.09	0.35	1.52	0.78	2.25	1.62	1.23	1.63	1.75
						0.16	0.22				
0.11			0.19			0.16	0.22				
							0.22				
0.11		0.19					0.22	0.23		0.23	
						0.16					