LATE QUATERNARY PALEOCEANOGRAPHY AND ENVIRONMENTS IN HUDSON STRAIT

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ABSTRACT

Airgun and high resolution Huntec seismic profiles show up to 130 m of glacial, glaciomarine and postglacial sediments on top of the bedrock. In a basin at the eastern entrance to Hudson Strait most of the sediment was deposited during the last deglacial cycle, but in western Hudson Strait multiple till sequences from previous glaciations were also recognized.

Five acoustic units were identified, at least three of which were penetrated with piston cores. Foraminifera of the stratigraphically deepest core in the eastern basin indicate a proximal glaciomarine environment and a possibility of an ice shelf. A ^{14}C date of 8060 ± 70 BP on molluscan shells gives a minimum age for the top of the acoustically laminated distal glaciomarine sediments. Extrapolated age for the ice shelf is circa 10000 BP.

The ratio of $^{18}O/^{16}O$ in the benthic foraminifer *Cibicides lobatulus* relates to bottom salinity. Downcore measurements of $\delta 18O$ on *C. lobatulus* tests indicate lower bottom paleosalinities by about 0.5 ‰ shortly before the dated horizon of 8000 BP. By this time Hudson Strait was sufficiently clear of glacial ice for establishment of the present tidal regime. The lower bottom salinities indicate that tidal mixing took place between glacial meltwater leaving Hudson Bay and the offshore counterflow. This process was reducing the salinity difference of the surface plume of Laurentide meltwater entering the ocean.

INTRODUCTION

The Late Quaternary marine environment in Hudson Strait was mainly governed by glacially related sedimentary and oceanographic processes. Hudson Strait was a key area along the marine margin of the Laurentide ice sheet, serving as a major outlet of glacial ice and influencing ice sheet stability and geometry throughout the Quaternary. During the Wisconsinan, Hudson Strait is thought to have been an active conduit of ice for the multiple glaciations in the Hudson Bay area (Andrews, *et al.*, 1983). Models of the Laurentide Ice Sheet based on glacial theories and field evidence show a major convergence of the ice flow towards Hudson Strait (Dyke and Prest, 1987) and an ice stream in Hudson Strait, with a calving front at the marine margin (Mayevski, *et al.*, 1981).

Hudson Strait is sufficiently wide and deep to have been a major area of ice drawdown. Deep sea sediment and foraminiferal data in the North Atlantic suggest that between 16,000 and 13,000 yBP marine drawdown rather than melting was important for the reduction of the Laurentide Ice Sheet (Ruddiman and McIntyre, 1981). The drawdown due to increased calving rates in Hudson Strait was postulated to be one of the mechanisms responsible for the rapid ablation of the central dome in the Hudson Bay region (Andrews and Peltier, 1976). Thus, during the period of ablation, large volumes of Laurentide ice must have moved through Hudson Strait.

As well as being a dispersal route for the eastward flowing ice, Hudson Strait may also have been affected by ice moving towards the north from Quebec/Labrador and south from Baffin Island. During a mid Foxe glacial event at circa 40000 yBP the northward flowing ice reached Loks Land to the north of Frobisher Bay (Osterman, *et al.*, 1985). During deglaciation late Labrador/Ungava ice is postulated to have crossed Hudson strait and impinged on Meta Incognita Penninsula (Mercer, 1956) and Resolution Island (Andrews, *et al.*, 1985; Stravers, 1986). Thus, eastern Hudson Strait may occasionally have been blocked by converging glacial ice. Because of the obstructed connection to the open sea, there may have been periods of time when Hudson Strait contained fresh or only partially saline water. Evidence for reduced salinities during deglaciation at the entrance to Hudson Strait was presented by Andrews, *et al.* (1987).

This paper discusses paleoceanographic and sedimentary environments in Hudson Strait derived from foraminiferal and seismic evidence. The seismic evidence is based on Huntec Deep Tow high resolution and single channel reflection data. Foraminifera were extracted from piston cores collected in sedimentary basins in eastern and western Hudson Strait. The changing environments and their chronology provide further evidence on the Late Wisconsinan deglaciation in Hudson Strait.

Previous work

The paleosedimentary history of the surficial sediments in Hudson Strait has been investigated by high resolution profiling and sediment sampling (eg. Grant and Manchester, 1970; Fillon and Harmes, 1982; MacLean, *et al.*, 1986). On the basis of seismic data, Josenhans, *et al.* (1986) recognized a glacial till unit overlying glacial marine sediments on the shelf at the eastern entrance to Hudson Strait. They interpreted this upper till as having been deposited by a late glacial ice surge. A reconnaissance survey of the strait by MacLean, *et al.* (1986) indicated a widespread presence of glacial drift, including multiple sequences and morainal deposits, and thick sequences of accustically stratified sediments in basins in the eastern and western parts of Hudson Strait. Up to five different tills are present on the shelf in the lee of the sill at the entrance to Hudson Strait (Josenhans, *et al.*, 1986) and four tills northeast of Resolution Island (MacLean, 1985; Praeg, *et al.*, 1986). These provide impressive evidence that Hudson Strait was a major ice dispersal route.

Methods

Sediment samples and oceanographic measurements were obtained during Cruise 82027 (Jones and Drinkwater, 1982) and acoustic profiles, piston cores and grab samples during Cruise 85027 (MacLean, *et al.*, 1986) (Figure 1, Table 1). The coring was carried out in conjunction with high resolution seismic surveys using 655 cu cm airgun and Huntec Deep Tow boomer systems. Piston core stations were positioned to sample specific acoustic units identified from the Huntec profiles. Split cores were x-rayed with a videoscanner x-radiograph system developed at Bedford Institute of

Oceanography and images stored on videotapes. Sediment color, texture and major depositional features are based on visual inspection of freshly split cores and interpretation of x-radiographs.

Foraminifera were collected from sediment subsample grain size fractions greater than 63 microns. Stable isotopes of oxygen and carbon of *C. lobatulus* were analysed under contract by the Stable Isotope Laboratory, Centre of Marine Geology, Dalhousie University, Halifax, N.S. (Table 2). Radiocarbon dates on molluscan shells were determined by ISOTRACE laboratory at the University of Toronto using the Accelerator Mass Spectrometry (AMS) method (Table 3).

Physical properties, including shear strength, water content, and density of the core samples were measured at the Atlantic Geoscience Centre geomechanics laboratory. Shear strength was measured using a modified Wykham Farrance vane shear device at a strain rate of 50 degrees per minute. The density was measured by subsampling the cores with a constant volume sampling device (piston operated) and measuring the mass of the subsample. Water content was determined following the methods of Noorany (1984).

Physical environment

Bedrock, bathymetry and sediments

Seismic reflection profiles and samples from Hudson Strait show the presence of Paleozoic and Precambrian bedrock overlain by unconsolidated sediment of various thicknesses (Grant and Manchester, 1970; MacLean, *et al.*, 1986; Miller and Williams, 1987). Paleozoic rocks are present on Akpatok Island and extend northward beneath Hudson Strait and contact Precambrian rocks offshore Meta Incognita Penninsula. The submarine section locally may also contain post-Paleozoic rocks. In Ungava Bay, south - southeast of Akpatok Island the Paleozoic bedrock terminates in a series of cuestas.

The bedrock geology largely determines the basic features of the sea floor morphology. Eastern and western parts of the Strait are half - grabens, but the central region is mostly synclinal in structure. The bottom is relatively smooth in the central part of Hudson Strait and Ungava Bay where the unconsolidated sediments are underlain by Paleozoic rocks (MacLean, *et al.*, 1986). The sea floor between the shoreline and the margins of the Paleozoic deposits is underlain by Precambrian rocks and is more irregular. Ungava Trough, which borders the southeastern margin of the Paleozoic sediments, is connected to the deep trough in Gray Strait to the northeast.

In the central part of Hudson Strait water depths range between 300 and 400 metres (Figure 2). At the western end of the Strait there are elongated depressions in which depths exceed 400 metres. At the eastern end of the Strait, a basin exceeding 900 metres occurs behind a sill shallower than 400 metres, which separates Hudson Strait from the adjacent continental shelf and Labrador Sea.

Unconsolidated sediments occur in thicknesses up to 130 m in the depressions at the eastern and western ends of Hudson Strait (MacLean, *et al.*, 1986; Grant and Manchester, 1970). The most widespread sediments are acoustically unstratified basal deposits interpreted to be glacial drift. They locally form moraines and contain multiple sequences. Acoustically stratified glaciomarine and postglacial sediments occur mainly in the eastern and western basins, where they make up a significant portion of the sedimentary section. Sediments in the eastern basin also include some debris flows, and the data suggest such sediments are also represented in the western basin sections.

Physical Oceanography

Major features of watermass characteristics in Hudson Strait have been summarized by Drinkwater (1986). The water in Hudson Strait is influenced by the runoff entering Ungava Bay, Foxe Basin and Hudson Bay and by the offshore bottom water counterflow from the Labrador Sea.

The mixing of these offshore and nearshore waters is enhanced by strong tidal currents. The net volume transport southeastward through Hudson Strait is about $10^9 m^3 s^{-1}$.

The basic circulation pattern of the water reflects its source. The Baffin Land Current enters Hudson Strait from the north around Resolution Island and becomes the northwesterly drift along the Baffin Island side of the strait (Figure 3). Cross channel flow is common between the eastern entrance and Big Island, by which point most of the northwestward drift has crossed the Strait to join the southeasterly flow along the coast of Quebec. Waters originating in Hudson Bay and Foxe Basin are the major contributors to the southeasterly flow. The Foxe Basin water may contain additions from the Arctic Channels through Fury and Hecla Strait at the northern entrance to the Foxe Basin.

For about eight months of the year Hudson Strait is covered with sea ice, but usually is ice free between the first week in August and second week in November (Drinkwater, 1986). In summer, most of the heat from solar insolation is lost in melting ice, therefore, the water is generally cold; between -1.5 and +2.0° C. Occasionally a warm surface layer of river runoff may reach 5° C. Because the low-salinity runoff and meltwater are major contributors to the Hudson Strait water, the stratification basically results from variations in salinity rather than temperature.

Salinity profiles based on the data collected during Cruise 82027 show the basic characteristics of the water in Hudson Strait. A wedge of deep water from the Labrador Sea is recognized by the 34 parts per thousand isohaline reaching the bottom at station 28 (Figure 4). The bottom water in the eastern basin is less saline by about 0.8 parts per thousand than the water on the continental slope at corresponding depths, and by about 0.3 parts per thousand less saline than the water on the continental shelf at sill depths.

RESULTS

Sediment lithologies

The sediment in the cores is basically gray mud to sandy mud. Pebble sized clasts are common and occasionally occur in bands of diamicton with the coarse fraction in a matrix of massive or poorly laminated sandy clay (Figure 5). An olive gray (5Y 4/2) surface layer is present in all cores. The subsurface layers are either dark gray (5Y 4/1) (cores 56 and 57) or gray (5Y 5/1) (cores 55, 68 and bottom of 57). A distinct brown (10YR 5/3) layer is present in all cores, except 55 and 65. Occasional black (2.5Y 2/0) or very dark gray (2.5Y 3/0) banding or mottling occurs throughout the cores.

The olive gray and dark gray sediments are bioturbated, the gray sediments are structureless or show sharp to diffuse laminae in the x - radiographs. Each core contains zones of shells and pyritized organic debris.

Radiocarbon dates

A bed containing well preserved *Portlandia arctica* was penetrated by cores 57 and 68. In Core 57 the shelly horizons were found in a sequence about one metre thick and gave a range of ^{14}C dates between 7730 and 8060 yBP (Table 3). The shells are well preserved and do not show evidence of transport, although a date of 7880, thirty cm above a younger date would suggest sediment reworking. The reworking may be limited to bioturbation in an environment of relatively fast sedimentation rates. Fast sedimentation is also suggested by the reduced foraminiferal numbers below 750 cm in Core 57 (Table 8). Of the series of ^{14}C dates in Core 57, the most reliable is 7730 ± 70 yBP at 814-822 cm interval, because the two valves of the individual were together in a living position. The date most likely records the age of the sediment-water interface, although it is younger than the 7890 average of the shell bed.

The ^{14}C age of 7903 ± 70 yBP from Core 68 (989-996 cm) was obtained from fresh fragments of the same individual of *Portlandia arctica*. Other small paired shells were also present in the sample, suggesting a time interval of high productivity of benthos. Foraminiferal numbers are low, most likely due to fast sedimentation rates. The youngest date of 6280 ± 50 was obtained from a single valve of *Clinocardium ciliatum* at the bottom of the relatively short core 65. The sample also contained many other shells of the same species that were only slightly abraded.

Foraminifera

Twenty nine grab samples and seven piston cores yielded 61 major species of benthic foraminifera (Table 4). Major species are those that rank up to 90% of total fauna. Seventeen species are arenaceous, of which *Trochammina* is the dominant genus.

Foraminifera in surface sediments

Fifty one species occur in the bottom grabs and surface intervals of the trigger weight cores. *C. lobatulus* is the most abundant species in the surface samples of Hudson Strait, closely followed by *B. frigida*, which is present in all samples. *N. pachyderma* is the only planktonic species and occurs between 98% and 100% as sinistrally coiled.

Different species dominate in samples from the inner (western) and outer (eastern) Hudson Strait (Table 5). To the west of Charles Island the two dominant species are *C. reniforme* and *E. excavatum clavatum*. In the eastern part of the strait and on the Labrador Shelf *C.lobatulus* and *B. frigida* are the two most abundant species, although *C. lobatulus* is also a major species in the remainder of the samples from western Hudson Strait. The dominance of *C. lobatulus* reflects the relatively coarse substratum and to a lesser degree, watermass characteristics, which influence the distribution of the other species. Because of its wide distribution, *C. lobatulus* does not define a facies, however, the marked difference in the occurrence of the other species do; notably *C. reniforme* and *E. excavatum* in the west and *B. frigida* and *I. helenae* in the east.

The distribution of *N. pachyderma* in surface sediments relates to surface currents. In the inner part of Hudson Strait and along the southern half where the currents are easterly, *N. pachyderma* represents about one percent or less of the total foraminifera. Along the northern half of the strait east of Charles Island where the currents flow westerly, the percentage is slightly higher. *N. pachyderma* occurrences are highest, up to 60%, in surface sediments at the entrance to Hudson Strait and on the continental slope. On average, the outer Strait foraminiferal facies contains 14.4% planktonic foraminifera from the total specimens counted and the inner Strait facies contains only 0.4‰.

$\delta^{18}O$ relationships with salinity

Fluvial runoff and meltwater contain less ^{18}O isotope because of the fractionation of stable oxygen isotopes during the phase change of water (Vilks and Deonarine, in press). As a result, the calcite in the tests of foraminifera living in diluted inner shelf waters have lower $^{18}O/^{16}O$ ratios in comparison to the offshore environment. The deficiency in ^{18}O is in proportion to the runoff content of the ambient seawater (Vilks and Deonarine, *op. cit.*).

In our study area, *Cibicides lobatulus* dominates the outer strait facies and is one of the major species of the inner strait, signifying its relatively wide range of salinity tolerance. Because of the abundance and epibenthic habitat, the species is useful for paleo-$\delta^{18}O$ studies in bottom waters. Comparison of the $\delta^{18}O$ content in *C. lobatulus* tests was used to interpret the processes active in the various depositional environments of the study area.

The stable isotope ratios of $^{18}O/^{16}O$ and $^{12}C/^{13}C$ were determined for *C. lobatulus* tests collected from surface sediments and piston core 57 (Table 2). Bottom salinities at surface sediment stations ranged between 32.89‰ and 34.91‰, while the corresponding $d^{18}O$ in *C. lobatulus* ranged between 0.963‰ and 2.792‰ (Figure 6). In Core 57 sufficient numbers of *C. lobatulus* tests were present for analysis only in the subsurface sediments, below 244cm downcore. There the $\delta^{18}O$ ranged between 1.427 and 2.421‰ (Figure 5).

The $^{13}C/^{12}C$ content in the tests are also reported in Table 2. It is not the intention to interpret these results in this report, mainly because of insufficient understanding of processes responsible for $\delta^{13}C$ in foraminiferal tests of the inner shelf environment. However, Table 2 shows that $\delta^{13}C$ values in the core are consistently lower than in the surface sediments.

Foraminifera in piston cores

Twenty ml of sediment were subsampled at approximately 40 cm intervals downcore. Samples containing less than 1 test per ml of sediment are not included in the analysis and are considered to be barren. The ranking species in piston cores are shown in Tables 6 to 10 and Figures 7 to 11.

In all cores *E. excavatum clavatum* and *C. reniforme* are the two most common species. Thus, both in the eastern and western basins the subsurface sediments are dominated by the inner strait facies. The dominance of the two species decreases towards the top of the cores as faunal diversity increases with the addition of new species.

Faunal zones were established with the appearance of new species in response to the change from a glacially influenced environment to the present setting. *E. excavatum clavatum* and *C. reniforme* define the lowermost Zone A that occurs in cores 55 and 68 (Figures 7 and 11). The diversity is low and some intervals are barren of fauna. The Zone A/B boundary is based on the first persistant appearance of *Fursenkoina fusiformis*, and except for Core 56, Zone B is present in all cores. In Core 55 Zone B extends almost to the top, including the Trigger Weight Core (Figure 7).

Zone C is unique to cores 56 and 57 collected in the deep basin in eastern Hudson Strait. It is defined by the first appearance of *Cassidulina laevigata*, with the addition of *Pullenia quinqueloba* and *Astrononion gallowayi*. Both *C. laevigata* and *P. quinqueloba* are rare in the surface sediments.

Zone D is represented in the top sediments of all cores and is defined by the appearance of *Nonionellina labradorica*, with the two *Islandiella* species *I. helenae* and *I. norcrossi* and with *Astrononion gallowayi*. Species diversity is the highest in this zone.

Physical properties of sediments

Sediment physical properties are primarily influenced by the state of consolidation or depth below seafloor. For example, bulk density normally increases with depth below sea floor due to gravitational consolidation. Consequently, any deviations from normal trends of increasing density are caused by changes in source material, depositional environment, or post-depositional loading. Due to this dependance upon depth below sea floor, the properties will be discussed starting with the shallowest Zone D.

Physical properties of Zone D were measured in Cores 56 and 57. The zone is characterized by low shear strength (<10 kPa), generally increasing with depth, but with a large variability (Figs. 13 and 14). The water content decreases with depth within this unit, from highs near 100% to low values near 50%. As expected, the bulk density increases with depth in a reverse trend to the water content.

Zone C is present in cores 56 and 57. The water content downcore decreases as the density increases (Figs. 13 and 14). The shear strength increases with depth, but as in Zone D, the profiles show some variability downcore. The foraminiferal boundary between Zones C and D distinctly coincides with the change in slope of all three physical property logs.

The physical properties of Zone B in Core 55 (Fig. 12) show two trends: (1) in the upper 2.5 m there is no shear strength change, although density increases and water content decreases; (2) between 2.5 and 6 metres, the shear strength increases and the rate of change of water content and density decreases. Zone B in Core 68 shows the same behaviour as the lower part of Core 55. In Core 57, the shear strength in Zone B shows no apparent trend. The water content profile shows an anamolous reverse trend of increasing values with depth in Zone B.

Zone A physical properties are very similar to those of Zone B as seen in the density and water content logs of Cores 55 and 68 (Figs. 12 and 15). The strength profiles are very similar in range to the lower part of Zone B with no evident trends.

Seismostratigraphy

Huntec high resolution and shallow seismic reflection profiles (Figs. 1, 16, 17) indicate the presence of up to 90 metres of Quaternary sediment at the sites of Cores 55, 56 and 57 in the western part of the eastern basin. Five main units are recognized on the basis of their acoustic character and relationships.

The sequence includes two basal acoustically unstratified units (Fig. 16, 17). The lowermost of these, Unit 1, lies on bedrock composed of Lower Paleozoic strata and possibly post-Paleozoic strata at the southern end of the section (MacLean *et al.*, 1986). Unit 1 is interpreted to be glacial drift on the basis of its acoustic character, stratigraphic position, morphology, and its apparent similarity to glacial drift identified in other offshore areas (e.g. Josenhans *et al.*, 1986; King and Fader, 1986; King *et al.*, 1987; Praeg *et al.*, 1986).

The succeeding Unit 2, is more acoustically transparent and generally thicker (Fig. 16, 17). The unit locally contains two sequences, one superimposed on the other with a thin interval of stratified sediments in between, 3 - 4 km along the section (Fig. 16). The acoustically unstratified character, stratigraphic position, and lateral extent of this unit suggest that it too may be glacial drift. However, its greater acoustical transparency and relatively smooth surface, raise the possibility that it is a debris flow or comprises previously deposited sediments remolded by debris flow or ice loading. Acoustically similar debris flow sediments are present at surface 8 - 10 km along section in Figure 17. These apparently originated upslope 4 - 7 km northward along the section. Unit 1, and possibly Unit 2 are interpreted to represent the last sediments deposited directly from grounded glacial ice in this part of the eastern basin. The overlying sequences consist entirely of acoustically stratified sediments.

Unit 3 is a distinctive sequence of laterally consistent acoustically stratified sediments overlying Unit 2. These sediments reach a maximum of about 35 m, but locally thin over the bedrock high midway along the section. South of the Core 55 locality the beds of Unit 3 change acoustically from stratified to unstratified (Fig. 16) adjacent to the bedrock high at the southern end of the cross-section (Fig. 17). This change apparently reflects different depositional or post-depositional conditions in that area. Unit 3 contains foraminiferal zones A and B. The unit outcrops in the core 55 area.

Sediments of unit 4 overlie those of Unit 3 in an essentially conformable relationship, but are variable in thickness, for example near the site of Core 56 and over the rise in Unit 3 and underlying strata midway along the section (Figs. 16, 17). South of Core 56 the upper part of the sequence appears locally to be disturbed, and the unit completely disappears a short distance north of the Core 55 site. The beds of Unit 4 approximately correspond to foraminiferal Zone C.

Acoustically stratified sediments of Unit 5 are the most recent sediments in this part of Hudson Strait. They unconformably overlie Unit 4, and between 11.8 km and 12.3 km (Fig. 16) briefly overstep the zero edge of Unit 4 and lap directly on Unit 3. The sediments of Unit 5 include foraminiferal Zone D and part of Zone C.

Core 55 lies near the southern margin of the thick sediment accumulation in the western part of the eastern basin (Figs. 1, 16, 17). It sampled the upper 10.4 m of Unit 3, the deepest stratigraphic sequence sampled in the basin.

The site of Core 56 is located 4.6 km northwest of Core 55 and 3.3 km west of the line of section. Its projected location is indicated on Fig. 16. All five of the acoustic stratigraphic units are present in the sedimentary section at this locality. Core 56 sampled 4 m of Unit 5 and penetrated 7.3 m of Unit 4.Core 57 was taken 11 km northeast of Core 56 (Fig. 16). It sampled Units 5 and 4, and the upper 3.8 m of Unit 3.

In western Hudson Strait up to 130 metres of sediments overlie Lower Paleozoic bedrock in the basin north and northwest of Charles Island (MacLean *et al.*, 1986). The section includes a diverse sequence of acoustic stratigraphic units (Figs. 18, 19).

The lowermost Unit 1 is up to 90 m thick, is extensive and of very massive acoustic character. It includes two and in places three members. The upper member has an irregular surface and locally forms mounds up to 35 m thick which resemble moraines. It lies for the most part on a smooth, relatively flat surface that marks the top of the underlying member (Fig. 19). The sediments of Unit 1 are acoustically unstratified except in a small area near the western end where there appears to be partial stratification. The setting in which this unit occurs suggests that it may represent either glacial deposits or post-Paleozoic, pre-Quaternary strata. Acoustically it does not resemble the apparent debris flow sediments present elsewhere in the stratigraphic section of the basins surveyed.

The unstratified acoustically massive character of the sediments, the presence of apparent multiple sequences, and the morphology of the unit suggest that it is composed of glacial drift. However, where intersected obliquely 2.5 km east of Station 68 by another survey line (Fig. 20) this unit occupies only part of the floor and southern flank of the basin and resembles an erosional remnant. Although the unit tentatively is interpreted to be glacial drift, the possibility that these sediments include or consist of pre-Quaternary material cannot be eliminated at this time.

Overlying the sediments of Unit 1, are the acoustically mainly unstratified and relatively transparent sediments of Unit 2, which reach an observed thickness of 45 m. In the western part of the basin the surface of this unit is well defined and relatively smooth, but eastward from Longitude 73° 30'W the boundary with the overlying sediments is less distinct. Unit 3 in the western part of this basin consists of acoustically stratified sediments up to 30 m thick. To the east, the lower 10 m or more of the unit becomes less distinct and more complex with zones and lenses of acoustically unstratified sediments, local unconformities, and some cut and fill structures. These and the acoustically unstratified beds of Unit 2 are interpreted to include debris flow deposits and originally stratified sediments deformed by debris flow loading and remodelling. The debris flows are likely to have originated from an area of relatively high relief (365 m above the basin floor) along the south side of the basin. The upper 15 m of Unit 3 are regularly stratified throughout the basin, but in the east the intensity of acoustic stratification becomes more variable and the beds locally are unconformable with the underlying parts of the unit.

Basin fill sediments of Unit 4 overlie Unit 3 north and northeast of Charles Island. These are acoustically weakly stratified and reach a maximum thickness of 13 m in the eastern part of the basin. Relationships with underlying sediments of Unit 3 commonly are conformable except near the margins where the lower beds of Unit 4 are progressively overstepped by the succeeding beds.

The acoustically stratified sediments of Unit 5 overlie the sediments of Unit 4 in a basin-fill relationship similar to that between Units 4 and 3. The maximum observed thickness of this unit is 7 metres. Unit 5 is locally overlain by up to 2 m of hummocky, acoustically unstratified sediments that appear to be related to debris flow activity. These possibly represent or contain remolded sediments of Unit 5.

Core 68 sampled the upper 10.6 m of Unit 3. Foraminiferal Zones A, B, and D were represented.

Core 65 was collected in the eastern part of a small basin that lies between the Charles Island high and the mainland of northern Quebec and extends westward south of Nottingham Island into northern Hudson Bay (Figs. 1,2). The core locality is 24 km north of the coast and 100 km north of the circa. 10,000 B.P. moraine system in the Baie de Deception region of northern Quebec described by Gray and Lauriol (1985).

Seismic profiles indicate that the bedrock in the floor of the basin consists of Lower Paleozoic and possibly younger sedimentary rocks. Acoustically unstratified sediments of Unit 1 fill depressions on the bedrock surface and represent the basal part of the Quaternary section in the southern part of this basin. Unit 1 is absent at the Core 65 site.

On top of Unit 1 is a wedge up to 23 m thick of acoustically unstratified and relatively transparent sediments of Unit 2. To the north, this unit partially onlaps and disappears over the rough surface of an acoustically massive deposit, that is 40 m thick and is thought to be a moraine. Unit 2 is conformably overlain by acoustically stratified sediments of Unit 3. These are 5.5 m thick at the site of Core 65 (Fig. 21). Unit 3 is overlain by acoustically transparent sediments which locally may be 6 m thick. The lower half of the sequence, Unit 4, is faintly stratified acoustically; the upper part, Unit 5, is apparently unstratified. Each are 2 m thick at the Core 65 site.

North of the Core 65 site both Units 3 and 4 become thinner. Eastward, Units 2 and 4 disappear and Unit 3 lies directly on the bedrock. It may be heavily reworked by ice scouring or may grade into glacial till upslope. Westward Unit 3 intertongues with a thick wedge of acoustically unstratified, relatively transparent sediments that thicken to 50 m. The relationships suggest that the latter are glacial drift, but they may also include or comprise former glacial marine sediments subsequently remolded by overriding glacial ice or debris flows.

Core 65 sampled Units 5, 4 and part of Unit 3. It contains representatives of foraminiferal Zones B and D.

DISCUSSION

Oxygen isotopes and salinity

The corelation between $\delta^{18}O$ values in the tests of *C. lobatulus* and salinity is less significant in the Hudson Strait sediments than on the Labrador Shelf as reported by Vilks and Deonarine (in press). The Hudson Strait regression line has a steeper slope (Figure 6) due to the low $\delta^{18}O$ values from inner Hudson Strait stations. The $\delta^{18}O$ values from grab sample stations across the approach to Foxe Basin are below the regression line by about 0.5 parts per mill and stations crossing the approaches to Hudson Bay by about 0.5 to 0.25 parts per mill. The lower $\delta^{18}O$ values between the salinities of 33.0 and 33.8 in comparison to the Labrador Shelf are likely due to the large runoff component and extensive formation of sea ice locally.

Foxe Basin contains mostly water from the Arctic Ocean which has been modified by the runoff of the large Siberian rivers and by the formation of sea ice. Patches of open water persist in Foxe Basin during winter (Dunbar, 1954), thus constant sea ice formation also takes place in Foxe Basin, increasing the salinities for corresponding $\delta^{18}O$ values. Campbell (1964) reported the presence of cold and saline (-1.90° C, 34.00 ‰) water in Foxe Basin and explained its origin due to freezing processes of sea water.

Of the two factors responsible for the lower $\delta^{18}O$ content, the formation of sea ice may be more important in the bottom waters than the reduction due to the addition of river runoff. The latter may never reach the bottom of the deeper basins before reaching the ocean. As sea ice freezes, the liberated brine sinks to the bottom increasing the salinity without changing the stable isotope content. The freezing of 2 metres of ice would increase the salinity by 0.6 parts per thousand (Redfield and Friedman, 1969). It is interesting to note that *C. lobatulus* tests record the low $\delta^{18}O$ values, which is a characteristic of winter conditions. This implies that the growth of the test is not limited to summer conditions.

Faunal zones downcore

The ^{14}C dates, textural, micropaleontological and high resolution seismic data indicate that some of the piston cores reached the late glacial sediments. Major species of the faunal zones allow us to speculate on possible changes in the environment as the glacial influence diminished. Of the many readjustments that have taken place, foraminiferal populations best reflect the variations in bottom paleosalinities. Water temperature is also commonly related to the distribution of foraminiferal species, but in the cold Arctic and subarctic inner shelf environments, post glacial readjustment in water temperature has been relatively small. For this study, only paleosalinities are used to describe postglacial changes.

For the purpose of late Quaternary biostratigraphy, *E. excavatum clavatum* and *C. reniforme* are the two most important foraminiferal species in North America and Europe (Vilks, 1981), and are the most common indicators of late glacial sediments on both sides of the North Atlantic. In the North

Sea, the two species dominate the Weichselian sediments, representing the glacial shallow water Arctic facies (Knudsen, 1986).

Foraminiferal Zone A found at the bottom of cores 55 and 68 is characterized by *Elphidum excavatum clavatum* and *Cassidulina reniforme*, low diversity of fauna and frequent barren intervals. Similar characteristics in sediment cores have been interpreted to represent proximal glacial marine environments in the nearshore waters of eastern Canada (Osterman and Andrews, 1983; Vilks, *et al.*, 1987) and in the southeastern channels of the Canadian Arctic Archipelago (MacLean, *et al.*, in press). In the modern environment, *C. reniforme* and *E. excavatum clavatum* are the two dominant species in front of a tidewater glacier in Spitsbergen (Elverhoi, *et al.*, 1980).

Zone B is identified by the addition of *Fursenkoina fusiformis* to the Zone A faunas. A similar faunal sequence has been observed on the Labrador Shelf (Vilks, *et al.*, 1984) and in eastern Barrow Strait, Canadian Arctic Archipelago (MacLean, *et al.*, in press) where *F. fusiformis* is found in abundance on top of sediments rich in *E. excavatum clavatum* and *C. reniforme*. In surface sediments of Hudson Strait *F. fusiformis* ranks low and is more abundant in the inner Strait sediments. Regionally *F. fusiformis* has been recorded in continental shelf sediments as far south as Cape Hatteras (Culver and Buzas, 1980). The species is very abundant in Gullmar Fjord, Sweden, in sediments deeper than 20 m of water depth, and in the Skagerrak in about 200 m of water ("*Bulimina*" *fusiformis* in Hoglund, 1947). At these depths the salinities range slightly over 35‰ in the Skagerrak (Larson and Rodhe, 1979) and between 33.0 and 34.6‰ in Gulmar Fjord (Rydberg, 1975). Bottom oxygens in Gulmar Fjord vary seasonally between 7 ml/l and 2 ml/l and April temperature between 6 and 7°C. In Baffin Island fiords *F. fusiformis* is important in the distal deep basin settings and it dominates glacier front sediments in Jones Sound, Canadian Arctic Archipelago (Schafer and Cole, submitted). In the Bay of Fundy, off Nova Scotia, *F. fusiformis* is common to dominant in muddy sediments where the bottom salinities range between 32 and 33 ‰ (unpublished data). Evidently, the species can tolerate a large salinity range and low oxygen levels and could be associated with an ice distal glaciomarine environment when found in sediment cores.

Zone C is characterized by the addition of *Cassidulina laevigata*, *Pullenia quingueloba* and *Astrononion gallowayi* and is present only in cores 55, 56 and 57 in water depths close to 800 metres. In the surface sediments of Hudson Strait *C. laevigata* ranks low in the outer Strait and is not present in the inner Strait. In the Canadian Arctic Archipelago *C. laevigata* is the dominant species in surface sediments at depths within the relatively warm and saline water of Atlantic origin (MacLean, *et al.*, in press). Across the Atlantic, in the Skagerrak, *C. laevigata* is associated with waters of Atlantic origin with salinities of 35.00‰ and greater (Van Weering and Qvale, 1983). On the Norwegian Shelf *C. laevigata* is considered to be a cosmopolitan species associated with both the Arctic and Boreal taxa (Vorren, *et al.*, 1983). In the North Sea, it was one of the major species during the Eemian in deep water environments and under the shallow-water Weichselian sediments dominated by *E. excavatum clavatum* and *C. reniforme* (Knudsen, 1986). The increased presence of *C. laevigata* suggests an increased influence of the more saline and warmer Labrador Sea waters. We conclude an early postglacial setting is indicated by Zone C.

Zone D is present in all cores as a surface layer. It is characterized by the addition of *Nonionellina labradorica*, *Islandiella helenae* and *Astrononion gallowayi*. These species rank high in the surface sediments in both inner and outer Hudson Strait. *N. labradorica* and *A. gallowayi* are common in Labrador Shelf sediments in bottom waters of wide salinity ranges (Vilks and Deonarine, in press). *I. helenae* prefers the cold waters of the Labrador Shelf within salinity ranges between 32.5‰ and 33.5‰. It is very common in the Beaufort Shelf sediments (Vilks, *et al.*, 1979) and is present on the Scotian Shelf (Williamson, *et al.*, 1984), which may be the limit of its southern range. The dominant Zone D species suggest an increasing effect of the Arctic - Subarctic inner shelf waters in a late postglacial setting.

Faunal Zones related to physical properties

Although sediment physical properties do not have a direct influence on foraminiferal assemblages, they are compared with faunal zones because both are affected by similar changes in depositional environment. The physical properties of Zones C and D clearly show distinct differences, indicating either a change in source sediment or depositional environment. The faunal boundary between the two units coincides with a change in physical properties (Cores 56 and 57), although visual description of the core lithologies and color did not show any sharp changes. In general, Zone D has the lowest strength and density and the highest water content, which is expected for the youngest (shallowest) sediment. In contrast, Zone C has the highest shear strength, which suggests slight overconsolidation. In Zones A and B, the shear strength seems to have been affected by bioturbation, pyritization and structure. For example, the shear strength shows no change in the upper Zone B of Core 55, suggesting remolded strength from bioturbation. Pyrite is seen below this depth with a concurrent sharp increase in strength, indicative of more brittle (early diagenetic ?) behaviour. Consequently, the shear strength profiles do not compare well with the faunal zones due to the more dominant influence of other processes. The density and water content, however, distinctly define differences between Zones D and C and show that the properties of these Zones are different from Zones A and B. The similarity in properties of Zones A and B suggests only a very subtle change in the depositional environment between the two zones with respect to geotechnical properties.

Faunal Zones related to ^{14}C dates

The ^{14}C dates are considered to be reliable because they were determined from well preserved *in situ* molluscan shells. The dates suggest that the faunal zones are time transgressive from east to west. The top of Zone B in Core 57 (Figure 6) from the eastern basin is 7730 ± 50 yBP (according to the most reliable date on a paired shell), whereas a 7903 ± 70 date was recorded in the middle of Zone A in Core 68, 500 km to the west of core site 57. Still farther to the west, but closer to the south shore of the strait, Core 65 yielded a date of 6280±50 yBP one metre below the top of Zone B. These dates indicate that at about 8000 yBP a proximal glacial marine environment prevailed in inner Hudson Strait, while in outer Hudson Strait the environment was more distal.

Fillon and Harmes (1982) reported an 8730±250 yBP date from molluscan shells in a core 60 km to the east of Core 57. The inspection of foraminifera in the vicinity of the sample horizon suggests that the shells were taken close to the top of the foraminiferal Zone B of this report. The older date by approximately 1000 years substantiates the westward migration of Zone B and the ablating glacial front in Hudson Strait. On the basis of these and other dates and seismic evidence Fillon and Harmes (1982) suggested that deglaciation in Hudson Strait was "well underway by 10450 BP". Our data support this statement.

About six kilometres to the north of Fillon and Harmes (1982) core locality, acoustically stratified sediments from interval 5.4 - 5.5 m of a second core yielded a total organic carbon date of 22,900 yBP (MacLean, *et al.*, 1986). The dated interval is underlain by 15 m of acoustically statified, presumably glaciomarine sediments. Although total organic carbon provides a date which likely is excessively old (Fillon and Harmes, 1982; Andrews, *et al.*, 1985), this date and the thickness of the stratified sediments underlying dated horisons in core 57 suggest that grounded glacial ice has not been present in the deep part of the eastern basin since early Late Wisconsinan time and probably earlier.

Deglaciation in Hudson Strait

Huntec and airgun seismic profiles show glacial drift, glacial marine sediments and postglacial hemipelagic deposits. The Unit 1 drift is in contact with bedrock and is interpreted as glacial till deposited by grounded ice. In eastern Hudson Strait the till could have been deposited during the last glacial maximum but parts of Unit 1 could be older. Ice must have been sufficiently thick to reach the bottom of the 900 m basin. In the western part of the strait, seismic sections record several till sequences, some of which could be of earlier Quaternary age.

Unit 2 has a massive seismic character, but less dense than Unit 1, suggesting possibly higher water content in the sediments. These deposits could have originated as waterlain till in a subglacial basin (Vorren, *et al.*, 1983) from a thinner and partly buoyant ice sheet as deglaciation progressed. Alternately, the sediments of Unit 2 originally may have been laminated glaciomarine outwash deposits which were subsequently remolded by gravity flows. Seismic profiles show evidence for sediment mass movement close to topographic highs along the southern margin of the basin. The basal units 1 and 2 have not been sampled with our piston cores.

The coherant and internally conformable acoustic laminae of the overlying Unit 3 were recognized on all the profiles in both the eastern and western basins. Unit 3 was penetrated with cores 55, 68 and partly by Cores 57 and 65 (Figure 17). X-radiographs of these cores show massive to laminated sediments with commonly occurring dropstones in Core 68, but less common in 55 and 57 (Figure 6). There is little evidence for bioturbation. The low diversity faunas of the proglacial zones A and B in Unit 3 are dominated by *E. excavatum clavatum* and *C. reniforme*. Core 55 penetrated deepest in the stratigraphic section with the bottom metre of the core dominated entirely by *E. excavatum clavatum* in addition to low numbers and small planktonic percentages.

The acoustic and textural data and faunal zones suggest sediment deposition from meltwater near the grounding line of an ice sheet. In Core 57 close to the top of Unit 3, the $\delta^{18}O$ values in *C. lobatulus* tests are lower by about 0.5 parts per thousand in comparison to Units 4 and 5 and on the basis of the present day $\delta^{18}O$ and salinity relationships, the bottom water in the deep basin at the eastern entrance of Hudson Strait was less saline by about the same amount. The presence of planktonic foraminifera in percentages close to and larger than the present, does not support the idea that there was a surface plume of low salinity water emanating from Hudson Strait at this time. This would suggest that extensive tidal mixing was already taking place in Hudson Strait.

Downsection in Core 55 there is some evidence for the deposition of sediments under ice proximal conditions, either near a glacial ice front or beneath an ice shelf. On the basis of the dominance of *E. excavatum clavatum* and the core lithologies, the bottom metre of the sediments in Core 55 may have been deposited under an ice shelf, using Osterman's (1982) definition of under ice shelf faunas in the region (exclusive dominance of *E. excavatum clavatum*). In contrast to the other cores, the sediments at the bottom of Core 55 also lack evidence for high organic productivity, such as, preserved diatom frustules or pyritized organic debris.

Stravers (1986) suggested extensive deglaciation in Hudson Strait between 9000 and 10000 yBP and a short lived readvance across outer Hudson Strait from Labrador/Ungava at around 8500 - 8600 yBP. The lobe of readvancing ice proposed by Stravers crosses our coring sites 55, 56 and 57. The oldest ^{14}C date in Core 57 is 8060 yBP in sediments of normal marine paleosalinities and near the top of foraminiferal Zone B (Figure 10). The trend towards lower paleosalinities based on oxygen isotopes begins about one metre below this date and assuming a sedimentation rate of 100 cm/1000 years, this change may have taken place at about 9000 yBP. On stratigraphic basis the evidence for ice shelf conditions in Core 55 is earlier than this date.

The glaciomarine sediments of Unit 3 are time transgressive from east to west. In the eastern basin, the top of Unit 3 coincides with the top of foraminiferal zone B, a horizon rich in molluscan shells. The ^{14}C age range of the sampled shells is from 7880 to 8060 yBP. A ^{14}C date from a shell at the bottom of Core 68 in the western basin yielded a 7903 yBP age well within Zone A. Thus, an ice distal glaciomarine environment prevailed in the eastern basin at about 8000 yBP, while at the same time an ice proximal environment was present at the western basin. Farther to the southwest and closer to the shores of Quebec, a specimen of *Clinocardium ciliatum* in Core 65 yielded a ^{14}C age of

6280 yBP. The shell was collected in the upper part of Unit 3 and foraminiferal Zone B. Here the younger age of the glaciomarine sediments signifies the direction of glacial ablation towards Quebec.

The acoustically laminated sediments of Unit 4 are locally.discontinuous and were penetrated only by the eastern basin cores 56, 57 and by core 65 in the southwestern Hudson Strait basin. X-radiographs show zones of bioturbated sediments containing distinct biogenic burrows and pyritized organic remains. Dropstones occur in concentrated beds that possibly could be correlated, eg., bottom of Core 56 with the 550-650 cm level in core 57.

The depositional and oceanographic environment of Unit 4 was characterized by higher energy levels and bottom salinities relative to Unit 3. The discontinuous character of the seismic reflectors, lense shaped accumulations, and local thickening and thinning, suggest increased bottom currents. By this time, the present tidal regime must have been in place, implying that the geometry of Hudson Strait was more or less similar to the present and that the Strait was clear of massive glacial ice.

Seismostratigraphic Unit 4 sediments coincide with foraminiferal zone C, in the eastern basin, representing the early post glacial environment at the entrance to Hudson Strait. It is dominated by species of deeper offshore waters. Thus, there was a period during the early post glacial times when the more saline and warmer offshore Labrador Sea water occupied the eastern basin in greater proportions than at present. The larger offshore component could reflect smaller amounts of Arctic water in the flow entering Hudson Strait from the north.

In the southwestern basin of core site 65, Unit 4 sediments appear to coincide with foraminiferal Zone B. The 6280 ± 50 14C date at the bottom of the core negates the possibility that both the faunal and acoustic data represent the same environmental connotation as in the eastern basin. This late in deglaciation Ungava Penninsula was ice free (Dyke and Prest, 1987) and the Zone B fauna may reflect early post glacial runoff and sedimentation in the western Hudson Strait.

Summary and conclusions

Seismic, lithologic and foraminiferal data show at least one glacial/deglacial cycle in Hudson Strait. Basal ice contact tills (Unit 1) lie on the bedrock. These are followed by an acoustically transparent unit interpreted as waterlain tills or remolded glacial marine sediments (Unit 2). The glacially derived acoustically massive sediments are followed by thick sequences of acoustically laminated glacial marine sediments (Unit 3). Foraminifera (Zones A and B) and core lithologies of the glacial marine sequences of Unit 3 suggest sedimentation from meltwater proximal and distal to a glacial ice sheet. The sediments are not bioturbated and in the eastern basin contain very few coarse ice rafted clasts. In the western basin coarse clasts are present throughout core 68.

The presence of planktonic foraminifera in percentages equal to the present, moderate faunal diversities and evidence for high or normal organic production (pyritized fossils) do not support the presence of an extensive ice shelf across eastern Hudson Strait late during deglaciation. The only evidence suggesting ice shelf conditions was found in Zone A in the bottom metre of the stratigraphically deepest Core 55.

Unit 4, which locally contains discontinuous and disturbed acoustic laminae, corresponds with Zone C containing faunas characteristic of higher bottom salinities in the deep eastern basin. The overlying Unit 5 contains present day faunas that are associated with slightly lower salinities. Thus, in the early post glacial setting, the offshore influence was more extensive in outer Hudson Strait than at the present.

The chronology of the deglaciation is established on three dated horizons. In the eastern basin, sediments close to the bottom of the early post glacial Zone C are dated at 7730 ±70 yBP on the basis of a ^{14}C date from a paired *Portlandia arctica* shell. In the western basin the late glacial Zone A environment still prevailed at 7903 ± 70 yBP, according to a ^{14}C date on fresh fragments of *P. arctica* shells in Core 68. Farther southwest and closer to the shore, the top of Unit 3 and the distal proglacial Zone B was dated at 6280 ± 50 yBP in Core 65.

We do not have direct evidence for the proposed glacial readvance across eastern Hudson Strait between 8500 - 8600 yBP as postulated by Stravers (1986). Closely spaced samples of Core 57 below the dated horizon contained Zone B faunas characteristic of a distal proglacial environment and high percentages of the planktonic foraminifer *N. pachyderma.* Although extrapolation of sedimentation rates in a glaciomarine environment could give spurious results, on the basis of the dated horizon the sedimentation rate should average 100 cm or more per 1000 years. Extrapolation of this rate downcore suggests that ice proximal glaciomarine conditions have not prevailed at the Core 57 locality in the eastern basin since at least 10,000 yBP and that glacial ice has not been grounded in the deep part of the basin since substancially earlier.

The oxygen isotope profile on the benthic foraminifer *C. lobatulus* suggests a period of slightly lower paleosalinities at about 9,000 yBP. The peak of lower oxygen isotopes possibly could be considered as evidence for the presence of an ice shelf behind the shallower sill at the entrance to the Strait where grounded ice would prevent the counterflow of the more saline Labrador Sea bottom waters. The event could have been sufficiently short lived that it did not leave more distinct evidence of its presence in the marine record.

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TABLES

1. Station locations, water depths, bottom salinity and temperature.
2. Oxygen and carbon stable isotope ratios in *Cibicides libatulus* tests and salinities and temperatures of bottom water from selected surface samples and from Core 57.
3. Radiocarbon dates from cores 85027-57, -65 and -68.
4. List of major species in surface grabs and sediment cores.
5. Relative percentages of major species in inner and outer Hudson Strait. Benthic foraminifera ranked according to average abundance.
6. Relative percentages of major species in Core 55. (TWC stands for Trigger Weight Core). Diversity is the Shannon - Wiener information function (Buzas and Gibson, 1969) and is defined as

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

where p_i is the proportion of the ith species and S is the total number of species present in a sample.

7. Relative percentages of major species in Core 56
8. Relative percentages of major species in Core 57
9. Relative percentages of major species in Core 65
10. Relative percentages of major species in Core 68

TABLE 1

CRUISE 82027

Station	Latitude N	Longitude W	Depth (m)	Salinity ‰	Temperature °C
14	58°10.4'	61°10.2'	205	33.24	-0.91
16	60°23.2'	63°24.0'	160	32.89	-0.23
21	60°18.6'	65°45.9'	232	33.57	-0.37
26	60°55.7'	65°31.0'	910	34.15	1.36
28	61°15.3'	67°22.0'	440	34.04	0.93
30	61°54.5'	68°32.8'	270	33.59	-0.44
31	61°40.0'	68°49.0'	305	33.62	-0.43
33	61°09.0'	69°21.0'	295	33.66	0.44
45	63°01.3'	77°52.2'	105	33.06	-0.89
46	62°51.0'	77°55.0'	353	33.29	-1.27
47	62°39.5'	78°00.0'	494	33.38	-1.28
48	62°00.4'	78°34.8'	118	33.11	-1.24
49	62°00.0'	79°00.0'	155	33.07	-1.29
59	63°56.0'	79°52.2'	320	33.76	-1.80
60	64°07.0'	79°06.0'	250	33.61	-1.74
66	64°15.4'	78°20.6'	225	33.24	-1.41
67	63°48.0'	77°50.0'	250	33.11	-1.12
68	63°34.3'	77°41.6'	243	33.33	-1.44
70	63°20.2'	72°46.0'	217	33.31	-1.44
71	63°08.0'	72°46.0'	289	33.45	-1.26
73	62°34.8'	72°45.0'	338	33.46	-1.23
74	62°20.0'	72°46.0'	185	33.17	-1.12
89	60°43.3'	60°56.3'	1233	34.91	3.69
90	60°39.0'	61°30.0'	470		
93	60°31.0'	62°50.7'		34.36	2.26
96	60°24.3'	63°37.5'	290		
97	60°23.0'	63°59.0'	240	32.76	0.49
104	61°04.9'	64°51.0'	385		
110	61°02.0'	65°20.0'	554		

TABLE 1 (CONTINUED)

CRUISE 85027 Piston Cores

Station	Latitude N	Longitude W	Depth (m)
55	60°56.7'	66°25.8'	805
56	60°58.1'	66°29.7'	777
57	61°04.3'	66°25.6'	790
65	62°21.6'	76°04.2'	333
68	63°04.5'	74°18.6'	435
92	61°12.0'	70°27.0'	171

TABLE 2

Stations	Salinity ‰	Temperature °C	δ18O‰	δ13C‰
16	32.89	-0.23	1.568	1.078
21	33.62	-0.37	1.682	0.938
28	34.04	0.92	1.925	0.640
45	33.06	-0.89	1.224	1.157
46	33.29	-1.27	1.528	1.001
47	33.38	-1.28	1.952	0.799
48	33.11	-1.24	1.170	1.021
49	33.07	-1.29	1.051	0.978
59	33.76	-1.80	1.039	0.866
60	33.61	-1.74	0.963	1.021
66	33.24	-1.41	1.033	1.176
67	33.11	-1.12	1.344	1.235
68	33.33	-1.44	1.264	1.185
70	33.31	-1.44	1.654	1.129
71	33.45	-1.26	1.614	1.083
73	33.46	-1.23	1.834	1.156
74	33.17	-1.12	1.601	1.161
89	34.91	3.69	2.792	1.356
90			1.590	1.138
97	32.76	0.49	1.444	1.141

CORE 85027-57

Interval (cm)	$\delta^{18}O$‰	$\delta^{13}C$‰
244 - 246	2.109	0.796
284 - 286	2.017	0.897
325 - 327	1.964	0.762
364 - 366	2.007	0.728
403 - 405	1.710	0.710
443 - 445	2.446	0.911
483 - 485	1.913*	0.471
683 - 685	1.981	0.734
774 - 776	2.210	0.847
825 - 827	1.803	0.572
870 - 878	2.299	0.889
904 - 906	2.122	0.659
944 - 952	1.875	0.834
1024 - 1032	1.427*	0.716
1072 - 1078	1.658	0.484

* The deviation from the standard is greater than 0.1‰

TABLE 3

Sample		Material	Weight (gm)	Lab. No.	Age*
85027-57	782-788 cm	*Portlandia arctica* Single valve	0.051	TO 748	7880 ± 70
	814-822 cm	*Portlandia arctica* Paired shell	0.260	TO 749	7730 ± 70
	862-870 cm	*Portlandia arctica* Single valve	0.041	TO 750	8060 ± 70
85027-68	989-996 cm	*Portlandia arctica* Fresh fragments	0.064	TO 751	7903 ± 70
85027-65	294-299 cm	*Clinocardium ciliatum* Single valve	0.610	TO 293	6280 ± 50

* By Accelerator Mass Spectrometry

TABLE 4

ADERCOTRYMA	*GLOMERATA* (Brady,1878)
ASTRONONION	*GALLOWAYI* Loeblich and Tappan, 1953
BOLIVINA	*PSEUDOPUNCTATA* Hoglund, 1947
BOLIVINA	*SUBSPINESCENS* Cushman, 1922
BUCCELLA	*FRIGIDA* (Cushman,1922)
BUCCELLA	*HANNAI ARCTICA* Voloshinova, 1960
BULIMINELLA	*BOREALIS* Haynes, 1973
CASSIDELLA	*COMPLANATA* (Egger, 1895)
CASSIDULINA	*LAEVIGATA* d`Orbigny, 1826
CASSIDULINA	*RENIFORME* Norvang, 1945
CIBICIDES	*LOBATULUS* (Walker and Jacob 1798)
CRIBROSTOMOIDES	*CRASSIMARGO* (Norman, 1892)
CRIBROSTOMOIDES	*JEFFREYSII* (Williamson, 1858)
CYCLAMMINA	*PUSILLA* Brady, 1881
EGGERELLA	*ADVENA* (Ccushman, 1922)
ELPHIDIELLA	*GROENLANDICA* (Cushman 1933)
ELPHIDIUM	*EXCAVATUM CLAVATUM* Cushman, 1930
ELPHIDIUM	*FRIGIDUM* Cushman, 1933
ELPHIDIUM	*SUBARCTICUM* Cushman, 1944
EOEPONIDELLA	*PULCHELLA* (Parker, F. 1952)
EPISTOMINELLA	*TAKAYANAGII* Iwasa, 1955
EPONIDES	*BRADYI* Earland, 1934
FISSURINA	*CUCURBITASEMA* Loeblich and Tappan, 1953
FISSURINA	*MARGINATA* (Montagu, 1803)
FURSENKOINA	*FUSIFORMIS* (Williamson, 1858)
GLOBOBULIMINA	*AURICULATA* (Bailey, 1851)
GYROIDINA	*ORBICULARIS* d`Orbigny, 1826
HAYNESINA	*ORBICULARE* (Brady, 1881)
ISLANDIELLA	*HELENAE* Feyling-Hanssen and Buzas, 1976
ISLANDIELLA	*NORCROSSI* (Cushman, 1933)
LENTICULINA	*ANGULATA* (Reuss,1851)
LAGENA	*LAEVIS* (Montagu) 1803
LAGENA	*STRIATA* (d'Orbigny) 1839
MELONIS	*ZAANDAMAE* (Van Voorthuysen, 1952)
NONIONELLA	*ATLANTICA* Cushman, 1947
NONIONELLA	*AURICULA* Heron-Allen and Earland, 1930
NONIONELLA	*TURGIDA* (Williamson) var *DIGITATA* Norvang
NONIONELLINA	*LABRADORICA* (Dawson, 1860)
OOLINA	*BOREALIS* Loeblich and Tappan, 1954
OOLINA	*LINEATA* (Williamson, 1848)
PSAMNOSPHAERA	*FUSCA* Shulze, 1875
PULLENIA	*BULLOIDES* (d`Orbigny, 1826)
PULLENIA	*QUINQUELOBA* Reuss, 1851
QUINQUELOCULINA	*SEMINULUM* (Linne, 1758)
REOPHAX	*ARCTICA* Brady,1881
REOPHAX	*FUSIFORMIS* (Williamson, 1858)
RHABDAMMINA	*DISCRETA* Brady, 1881
SACCAMMINA	*ATLANTICA* (Cushman, 1944)
SCUTULORIS	*TEGMINIS* Loeblich and Tappan, 1953
SPIROPLECTAMMINA	*BIFORMIS* (Parker and Jones, 1865)
TEXTULARIA	*TORQUATA* Parker, 1952
TRIFARINA	*FLUENS* (Todd, 1947)
TRILOCULINA	*TRICARINATA* d'Orbigny, 1826
TRILOCULINA	*TRIHEDRA* Loeblich and Tappan, 1953
TRITAXIS	*ATLANTICA* (Parker, 1952)
TROCHAMMINA	*ADVENA* Cushman, 1922
TROCHAMMINA	*BULLATA* Takayanagi, 1960
TROCHAMMINA	*NANA* (Brady, 1881)
TROCHAMMINA	*SQUAMATA* Jones and Parker, 1860
VALVULINERIA	*ARCTICA* Green, 1958

OUTER STRAIT

	Average
Planktonics	14.40
Benthics	
C. lobatulus	15.68
B. frigida	14.64
I. helenae	13.45
A. gallowayi	9.27
N. labradorica	7.09
C. reniforme	3.09
E. excavatum clav	2.95
A. glomerata	2.59
M. zaandamae	2.41
T. fluens	1.59
P. fusca	1.55
R. fusiformis	1.41
H. orbiculare	1.41
E. takayanagii	1.27
S. biformis	1.27
E. subarcticum	1.14
T. torquata	1.09
R. arctica	0.95
B. pseudopunctata	0.82
E. pulchella	0.77
N. auricula	0.77
C. laevigata	0.64
E. advena	0.59
B. subspinescens	0.59
F. fusiformis	0.36
E. groenlandica	0.27
T. atlantica	0.27
E. bradyi	0.27
V. arctica	0.23
P. bulloides	0.23
F. marginata	0.23
C. complanata	0.23
S. atlantica	0.18
C. crassimargo	0.14
G. auriculata	0.14
G. orbicularis	0.09
T. advena	0.09
Q. seminula	0.09
T. nana	0.09
B. hannai arctica	0.09
O. borealis	0.09
F. cucurbitasema	0.05
C. jeffreysi	0.05
P. quinqueloba	0.05
T. squamata	0.05
C. pusilla	0.05
N. turgida	0.05
O. lineata	0.05

INNER STRAIT

	Average
Planktonics	0.40
Benthics	
C. reniforme	19.17
E. excavatum clavatum	16.67
I. helenae	10.83
B. frigida	9.42
C. lobatulus	9.17
N. labradorica	6.08
A. gallowayi	5.83
H. orbiculare	2.00
E. groenlandica	1.67
C. complanata	1.42
R. arctica	1.33
F. fusiformis	1.17
A. glomerata	0.92
I. norcrossi	0.92
E. subarcticum	0.83
R. discreta	0.67
N. auricula	0.67
E. takayanagii	0.58
E. pulchella	0.58
R. fusiformis	0.50
B. pseudopunctata	0.33
S. biformis	0.25
T. fluens	0.17
T. atlantica	0.17
T. torquata	0.17
T. squamata	0.17
F. marginata	0.17
M. zaandamae	0.17

Table 5. Vilks et al

TWC 85027-55

Interval (cm)	1	42	82	92	131	149	172	205	Average
Total /10	281	141	122	263	109	288	45	60	
Diversity *100	190	197	171	131	224	90	173	155	
Planktonic %	7	7	8	5	20	2	28	11	
1 E. excavatum clav	3	39	55	67	22	7	29	26	31
2 C. lobatulus	0	9	2	10	22	12	41	46	18
3 F. fusiformis	0	0	0	4	22	76	0	12	14
4 N. labradorica	36	4	13	7	0	0	0	0	8
5 I. helenae	32	0	0	0	4	0	4	5	6
6 C. complanata	0	20	8	5	4	0	0	0	5
7 A. gallowayi	3	0	0	0	4	0	6	6	2
8 P. quinqueloba	0	5	7	0	3	0	4	0	2
9 M. zaandamae	6	6	4	0	0	0	0	0	2
10 C. laevigata	0	7	2	0	3	0	0	0	2
11 C. reniforme	0	0	0	0	3	0	7	0	1
12 B. frgida	7	0	0	0	0	0	0	0	1
13 I. norcrossi	0	0	0	0	3	0	0	0	0
14 G. auriculata	3	0	0	0	0	0	0	0	0

Core 85027-55

Interval (cm)	16	61	101	137	162	202	242	282	311	351	392	431	462	502	542	577	602	642	682	722	761	801	842	881	921	961	1000	1037	Average
Total /10	119	196	45	104	87	57	19	13	14	9	4	4	3	.3	1	2	3	1	2	2	2	2	2	2	1	2	5	1	
Diversity *100	203	242	139	161	150	189	173	163	138	182	154	151	126	128		133	152		154	24		93	120	159		22	23		
Planktonic %	8	25	13	21	21	24	21	16	7	18	10	19	21	3		15	7		22	25		0	23	17	0	6	6		
1 E. excavatum clav	45	20	14	25	22	28	28	21	45	10	23	20	13	43	0	44	32	0	33	0	0	52	63	26	0	94	94	0	28
2 C. reniforme	8	13	19	17	19	31	39	52	27	39	40	50	63	39	0	31	40	0	39	0	0	38	17	37	0	0	0	0	24
3 F. fusiformis	4	3	55	43	46	16	14	5	21	22	11	14	7	7	0	13	0	0	6	0	0	0	0	0	0	0	0	0	10
4 C. lobatulus	0	6	0	4	5	5	3	5	0	10	0	0	0	0	0	0	0	0	0	93	0	0	0	11	0	0	0	0	5
5 A. gallowayi	0	3	0	0	0	7	4	3	0	5	14	5	0	0	0	6	0	0	0	0	0	0	8	11	0	0	0	0	2
6 P. quinqueloba	8	14	0	0	0	2	2	3	0	0	0	0	0	0	0	0	8	0	6	0	0	0	0	0	0	0	0	0	2
7 I. helenae	0	5	5	0	0	3	2	0	0	5	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8 C. laevigata	5	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	1
9 H. orbiculare	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0
10 C. complanata	7	6	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
11 T. tricarinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	6	0	0	0	0	0	0	0	0	0	0
12 B. frgida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0
13 N. labradorica	9	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
14 S. tegminis	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 N. atlantica	3	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
16 I. norcrossi	0	3	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
17 M. zaandamae	2	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
18 V. arctica	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Lab 6 Vilks et al

TWC 85027-56

	Interval (cm)	2	36	82	121	
	Total /10	90	51	94	49	
	Diversity *100	216	199	238	265	
	Planktonic %	4	9	17	32	
						Average
1	I. helenae	40	38	28	8	29
2	N. labradorica	16	19	23	9	17
3	B. frigida	14	7	3	10	9
4	C. reniforme	2	0	8	22	8
5	E. excavatum clav	4	12	5	7	7
6	A. gallowayi	4	7	4	8	6
7	C. lobatulus	5	2	5	8	5
8	M. zaandamae	2	5	4	6	4
9	N. turgida digita	0	0	2	4	2
10	B. pseudopunctata	0	0	3	2	1
11	I. norcrossi	0	0	0	4	1
12	N. auricula	0	0	0	2	1
13	T. squamata	0	0	2	0	1
14	E. subarcticum	2	0	0	0	1
15	G. auriculata	0	0	2	0	1
16	F. fusiformis	0	0	2	0	1
17	E. takayanagii	2	0	0	0	1
18	P. quinqueloba	0	0	0	2	1
19	E. frigidum	0	0	2	0	1
20	S. biformis	1	0	0	0	0

CORE 85027-56

	Interval (cm)	2	42	82	115	161	201	242	282	322	362	401	442	481	522	560	600	640	679	722	762	802	832	882	922	962	1000	1041	1054	1061	1096	1133	
	Total /10	70	50	165	40	516	680	170	1299	777	714	456	1189	1047	784	1175	802	877	808	964	1527	1155	1568	770	2144	1561	141	37	29	297	111	176	
	Diversity *100	271	259	279	244	235	259	244	253	233	250	241	246	257	243	255	24	256	220	243	242	216	222	214	226	238	205	167	205	187	199	168	
	Planktonic %	15	5	10	12	4	3	5	4	5	9	11	11	18	12	20	28	21	22	24	23	14	17	15	18	17	16	4	7	22	5	9	
																																Average
1	E. excavatum clav	12	11	6	17	7	3	2	8	6	10	8	8	15	19	19	18	21	33	28	24	36	30	33	26	30	40	15	34	44	17	52	20
2	C. reniforme	3	11	17	13	21	24	15	17	13	15	15	9	10	10	18	20	14	16	17	21	15	17	18	21	13	13	10	6	8	0	8	14
3	A. gallowayi	11	7	13	0	4	8	11	16	22	16	20	13	11	8	14	14	13	9	9	15	6	7	10	11	10	0	0	0	0	0	0	9
4	C. laevigata	0	0	0	0	0	0	0	0	0	0	2	7	8	8	0	6	8	0	3	5	10	8	12	9	6	14	50	21	14	19	9	7
5	I. norcrossi	0	2	2	13	29	21	21	8	14	14	6	16	11	17	5	4	3	3	2	0	4	4	3	3	3	0	0	0	0	4	4	7
6	C. lobatulus	5	2	3	0	3	3	4	14	19	15	24	12	8	4	9	12	7	10	11	0	8	15	5	8	9	2	0	0	4	0	0	7
7	N. labradorica	14	14	9	8	5	7	8	5	7	6	2	13	11	11	6	6	4	5	2	3	6	3	3	3	5	5	10	10	4	3	9	7
8	I. helenae	18	18	5	8	9	1	15	6	4	4	2	0	4	4	3	0	5	3	8	5	3	3	0	0	0	0	0	0	0	0	0	4
9	P. quinqueloba	0	2	3	0	2	3	0	0	0	0	0	0	6	0	5	4	6	9	3	7	0	5	6	7	9	5	0	8	12	17	6	4
10	M. zaandamae	4	2	10	7	3	4	9	4	3	4	4	9	5	5	0	2	0	0	2	0	4	0	0	0	3	9	0	3	0	6	0	3
11	C. complanata	1	2	1	2	0	3	0	2	2	3	0	0	0	0	0	2	0	0	2	0	0	0	0	0	2	4	5	5	4	27	9	2
12	B. frigida	7	6	7	18	5	5	3	8	3	2	2	3	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
13	N. auricula	3	6	3	2	4	1	2	5	0	0	0	2	0	3	3	2	2	3	2	2	0	0	0	0	0	0	0	0	0	0	0	1
14	B. pseudopunctata	4	5	7	0	0	3	0	0	0	2	2	0	0	0	3	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	1
15	F. marginata	0	0	0	0	0	1	0	0	0	0	4	1	0	0	2	0	2	0	2	2	0	0	0	2	2	0	0	0	0	0	0	1
16	F. fusiformis	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	5	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
17	N. turgida digita	2	0	3	0	0	3	2	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
18	N. atlantica	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	6	0	0	0	0
19	E. takayanagii	2	2	0	0	0	1	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
20	V. arctica	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
21	E. pulchella	0	3	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
22	H. orbiculare	1	2	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
23	L. laevis	0	2	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
24	R. fusiformis	1	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
25	F. cucrbitasema	1	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
26	S. biformis	0	0	1	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
27	T. squamata	1	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
28	L. angulata	0	0	0	1	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

Table 7 Vilks et al

TWC 85027-57

	Interval (cm)	2	40	80	120	Average
	Total /10	486	134	798	68	
	Diversity *100	245	255	260	249	
	Planktonic %	15	10	13	26	
1	A. gallowayi	13	15	14	21	16
2	C. reniforme	4	6	22	17	12
3	N. labradorica	18	15	8	4	11
4	M. zaandamae	15	10	6	12	11
5	I. helenae	6	22	6	4	10
6	C. lobatulus	12	5	11	6	9
7	B. frigida	12	5	8	8	8
8	E. excavatum clav	3	3	8	12	7
9	N. auricula	0	3	2	1	2
10	E. takayanagii	3	0	1	0	1
11	I. norcrossi	0	0	1	3	1
12	T. fluens	3	0	1	0	1
13	E. subarcticum	0	3	0	0	1
14	E. pulchella	3	0	0	0	1
15	B. pseudopunctata	0	1	2	0	1
16	F. marginata	0	1	0	1	1
17	H. orbiculare	0	0	0	1	0
18	G. auriculata	0	1	0	0	0
19	T. squamata	0	0	1	0	0

CORE 85027-57

	Interval (cm)	2	41	81	120	157	197	242	282	323	362	401	441	481	522
	Total /10	209	206	1306	184	1303	239	3750	3370	748	574	1243	341	130	93
	Diversity *100	203	268	250	250	241	220	209	215	210	223	230	241	201	207
	Planktonic %	4	27	18	5	11	1	28	20	27	21	11	15	11	13
1	C. reniforme	0	12	28	7	26	6	13	23	27	18	23	19	24	10
2	E. excavatum clav	10	14	6	7	3	3	11	17	23	18	12	14	11	32
3	C. lobatulus	4	11	9	3	8	0	34	18	14	19	17	14	7	4
4	A. gallowayi	4	10	18	10	8	0	9	10	9	15	16	13	7	3
5	C. laevigata	0	0	0	0	0	0	3	11	10	8	5	9	11	23
6	F. fusiformis	0	0	0	0	1	0	0	5	0	0	0	0	0	0
7	P. quinqueloba	0	0	2	0	0	0	0	9	3	7	10	13	28	8
8	N. labradorica	18	8	5	22	11	18	11	0	0	2	3	3	0	6
9	I. helenae	36	7	2	3	3	15	5	0	0	0	0	0	0	0
10	M. zaandamae	12	12	5	7	4	9	0	0	0	0	0	0	0	5
11	B. frigida	5	10	5	16	9	10	0	0	2	0	0	0	0	0
12	I. norcrossi	0	2	3	11	13	26	5	0	0	0	0	0	0	0
13	C. complanata	0	0	0	0	0	0	0	0	0	4	2	2	3	0
14	E. pulchella	0	0	2	0	0	0	0	0	0	0	0	0	0	0
15	T. trihedra	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	F. marginata	0	1	0	0	0	0	0	0	1	0	3	4	0	0
17	B. pseudopunctata	0	2	6	0	0	0	0	0	0	0	0	0	0	0
18	N. auricula	0	2	0	0	0	0	0	0	0	0	0	1	0	0
19	V. arctica	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	G. auriculata	0	0	0	0	0	4	0	0	0	0	0	0	0	0
21	T. fluens	0	0	0	3	0	0	0	0	0	0	0	0	0	0
22	H. orbiculare	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	E. takayanagii	0	0	0	2	0	0	0	0	0	0	0	0	0	0
24	N. atlantica	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	S. biformis	0	0	2	0	0	0	0	0	0	0	0	0	0	0
26	L. striata	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	N. turgida digita	0	1	0	0	0	0	0	0	0	0	0	0	0	0
28	B. borealis	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Interval (cm)	537	577	617	635	657	697	742	779	822	862	902	942	982	1022	1061	1102	1130	Average
	Total /10	322	2040	45	15	63	215	270	70	20	35	18	3	7	2	12	8	5	
	Diversity *100	197	209	222	211	176	193	202	196	183	200	221	133	199	170	225	186	231	
	Planktonic %	2	14	20	12	8	13	20	31	13	24	18	39	15	44	36	23	30	
1	C. reniforme	22	20	31	19	11	4	28	21	25	32	31	3	39	30	36	43	28	21
2	E. excavatum clav	17	36	8	12	53	47	31	32	9	11	15	55	17	4	9	13	7	18
3	C. lobatulus	0	5	10	5	2	0	8	8	7	8	8	10	4	9	12	5	7	9
4	A. gallowayi	3	0	6	4	0	0	5	9	7	11	7	23	8	4	13	0	9	8
5	C. laevigata	19	7	15	30	10	12	8	3	0	5	4	0	3	4	2	14	7	7
6	F. fusiformis	0	4	0	0	0	0	0	17	41	22	18	0	4	35	6	5	20	6
7	P. quinqueloba	25	12	11	10	3	4	6	0	0	0	4	0	13	0	2	5	2	6
8	N. labradorica	0	0	0	6	6	6	0	0	0	0	0	0	1	0	0	0	0	4
9	I. helenae	0	0	0	0	0	0	3	0	0	0	4	0	0	0	2	5	2	3
10	M. zaandamae	0	3	0	0	0	9	2	0	0	0	0	0	0	0	2	0	2	2
11	B. frigida	0	0	0	0	0	0	0	0	3	0	0	0	1	0	4	3	2	2
12	I. norcrossi	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
13	C. complanata	6	4	3	6	5	9	0	0	0	0	0	0	0	0	0	0	0	1
14	E. pulchella	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	3	0	0
15	T. trihedra	0	0	6	0	0	0	0	0	0	0	2	0	0	0	0	3	0	0
16	F. marginata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	B. pseudopunctata	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
18	N. auricula	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	2	0
19	V. arctica	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	0
20	G. auriculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	T. fluens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	H. orbiculare	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
23	E. takayanagii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	N. atlantica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
25	S. biformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	L. striata	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
27	N. turgida digita	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	B. borealis	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

Table 8 [illegible]

TWC 85027-65

	Interval	2
	Total /10	69
	Diversity *100	235
	Planktonic %	0
1	C. reniforme	31
2	E. excavatum clavatum	17
3	I. helenae	9
4	N. labradorica	8
5	F. fusiformis	6
6	C. complanata	5
7	B. frigida	4
8	B. pseudopunctata	4
9	E. takayanagii	2
10	A. gallowayi	2
11	R. arctica	2

CORE 85027-65

	Interval	2	83	134	200	297
	Total /10	105	76	79	335	278
	Diversity *100	202	181	206	175	150
	Planktonic %	0	0	0	0	0
1	C. reniforme	36	46	33	39	32
2	E. excavatum clavatum	12	21	11	24	44
3	N. labradorica	11	10	8	6	8
4	F. fusiformis	0	0	25	17	0
5	I. helenae	11	6	5	2	8
6	I. norcrossi	24	2	0	0	0
7	A. gallowayi	0	4	3	2	0
8	B. frigida	4	2	0	0	0
8	B. pseudopunctata	0	0	5	0	0
9	C. complanata	3	0	0	0	0
10	E. subarcticum	0	0	2	0	0

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TWC 85027-68

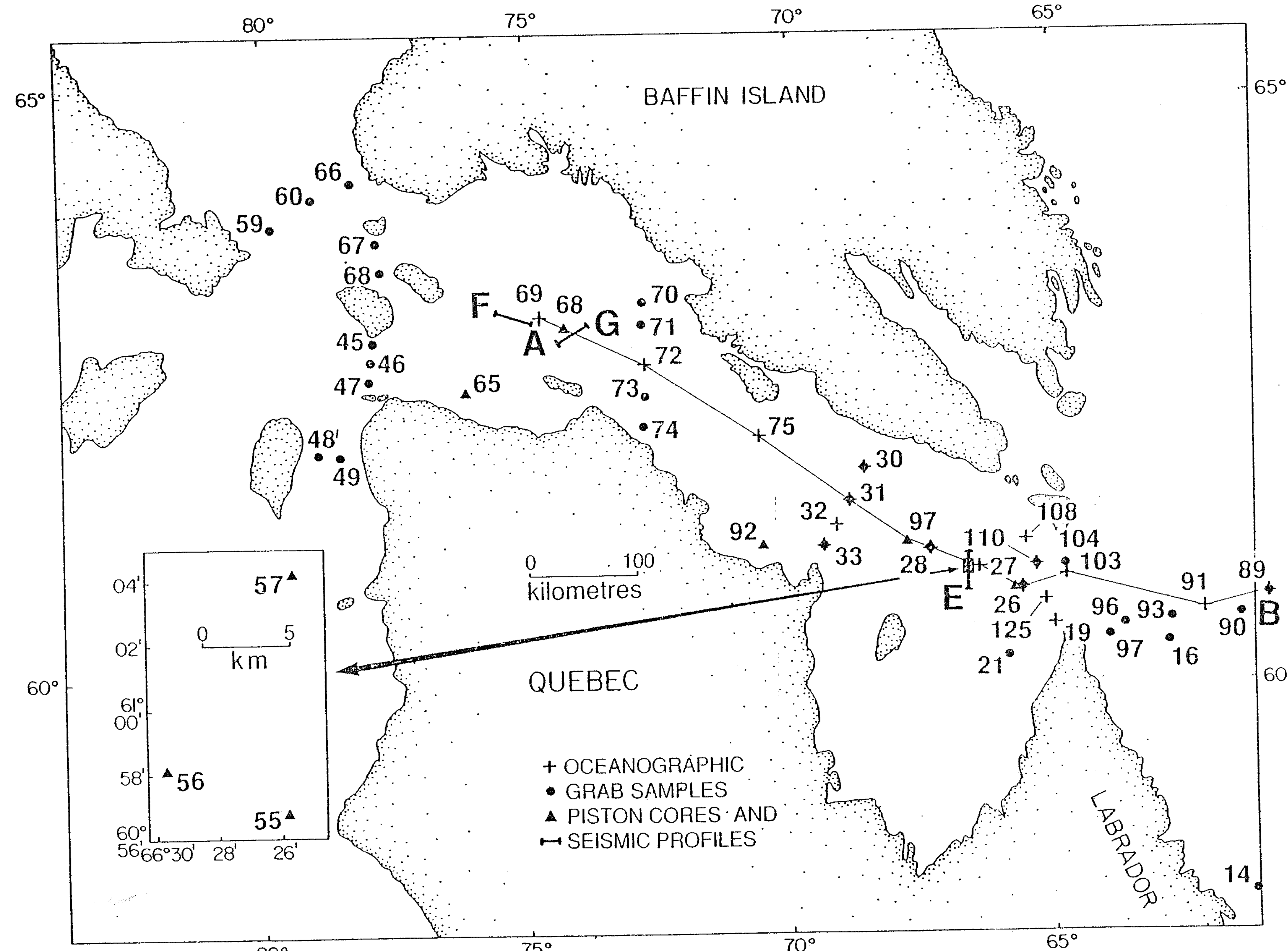
Interval (cm)	2	41	81	121	Average
Total /10	100	527	475	542	
Diversity *100	256	246	192	167	
Planktonic %	1	0	1	2	
1 C. reniforme	22	6	30	26	21
2 N. labradorica	10	10	20	42	21
3 E. excavatum cla	10	10	24	8	13
4 I. helenae	10	18	6	11	11
5 R. arctica	10	18	0	0	7
6 B. frigida	9	10	8	0	7
7 C. lobatulus	6	3	0	5	4
8 S. biformis	2	8	0	0	3
9 A. gallowayi	2	5	0	0	2
10 C. complanata	4	0	0	0	1
11 I. norcrossi	0	0	3	0	1
12 M. zaandamae	2	0	0	0	1
13 T. torquata	2	0	0	0	1
14 T. fluens	2	0	0	0	1
15 H. orbiculare	0	2	0	0	1
16 A. glomerata	2	0	0	0	1
17 E. takayanagii	0	2	0	0	1
16 T. atlantica	2	0	0	0	1
19 T. squamata	2	0	0	0	1

CORE 85027-68

Interval (cm)	4	40	80	128	160	201	241	282	322	332	382	422	461
Total /10	231	60	3018	185	224	71	310	122	11	11	53	21	14
Diversity *100	210	178	190	215	197	216	159	125	142	176	97	109	119
Planktonic %	1	1	1	3	1	2	1	2	5	0	1	0	1
1 C. reniforme	34	27	31	33	33	35	19	60	47	35	65	70	63
2 E. excavatum cla	25	32	27	24	26	15	56	26	28	26	13	16	14
3 F. fusiformis	3	0	0	0	0	2	0	3	15	0	21	7	14
4 N. labradorica	12	18	16	9	9	6	0	0	0	0	0	0	0
5 A. gallowayi	0	0	6	7	9	9	4	0	0	13	0	0	0
6 I. helenae	3	10	0	2	0	0	4	1	0	0	0	0	0
7 C. lobatulus	4	4	8	4	6	2	0	0	0	13	0	0	0
8 C. complanata	0	0	2	4	4	0	3	0	0	4	0	0	0
9 P. quinqueloba	0	0	0	2	4	14	0	0	0	0	0	0	0
10 B. pseudopunctat	3	0	0	6	0	0	0	0	0	0	0	0	0
11 C. laevigata	0	0	0	1	0	5	3	0	0	0	0	0	0
12 I. norcrossi	4	0	0	1	0	0	3	0	0	4	0	0	0
13 E. takayanagii	0	0	0	0	0	0	0	0	0	0	0	0	0
14 M. zaandamae	0	0	0	1	0	3	0	0	0	0	0	0	0
15 B. frigida	3	0	0	0	0	0	0	0	0	0	0	0	0
16 G. auriculata	0	0	0	1	0	0	0	0	0	0	0	0	0
17 F. marginata	0	0	0	1	0	0	0	0	0	0	0	0	0

Interval (cm)	502	541	577	602	642	682	722	762	801	842	882	919	959	998	1035	AVG
Total /10	29	12	12	32	33	5	1	2	0	2	0	1	20	39	35	
Diversity *100	96	108	106	22	86	40		71		68			78	77	66	
Planktonic %	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1 C. reniforme	49	42	45	0	55	14	0	13	0	57	0	0	65	54	67	35
2 E. excavatum cla	0	48	46	95	39	86	0	79	0	43	0	0	32	44	32	30
3 F. fusiformis	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
4 N. labradorica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
5 A. gallowayi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
6 I. helenae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7 C. lobatulus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8 C. complanata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
9 P. quinqueloba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
10 B. pseudopunctat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 C. laevigata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 I. norcrossi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 E. takayanagii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 M. zaandamae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 B. frigida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 G. auriculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 F. marginata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

FIGURES


BAFFIN ISLAND
QUEBEC
LABRADOR
80°
75°
70°
65°
60°
0
100
kilometres
+ OCEANOGRAPHIC
● GRAB SAMPLES
▲ PISTON CORES AND
SEISMIC PROFILES
A
B
E
F
G
59
60
66
67
68
45
46
47
48'
49
65
69
68
70
71
72
73
74
75
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31
32
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92
97
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27
110
108
104
103
26
125
19
21
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93
97
16
91
89
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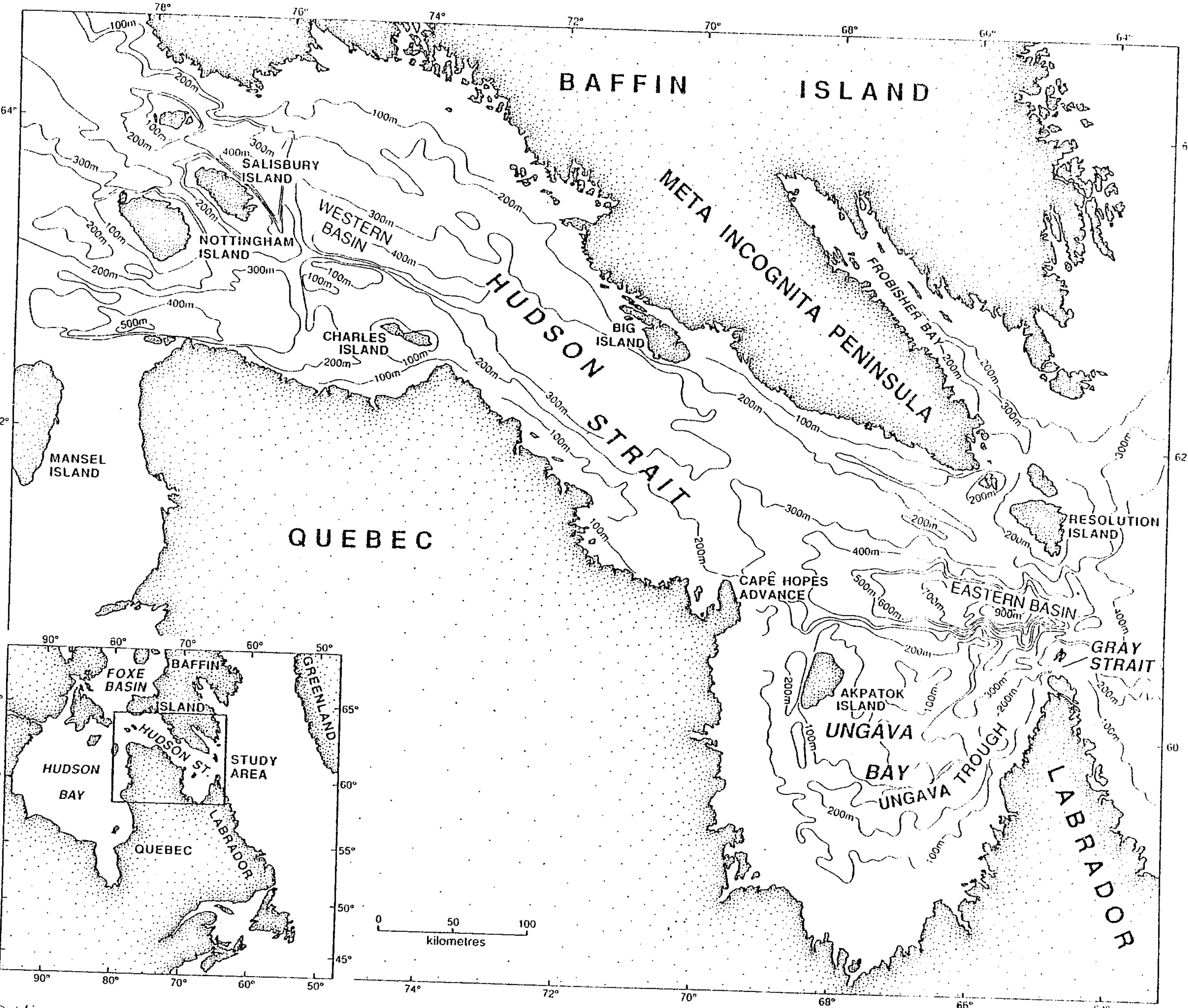
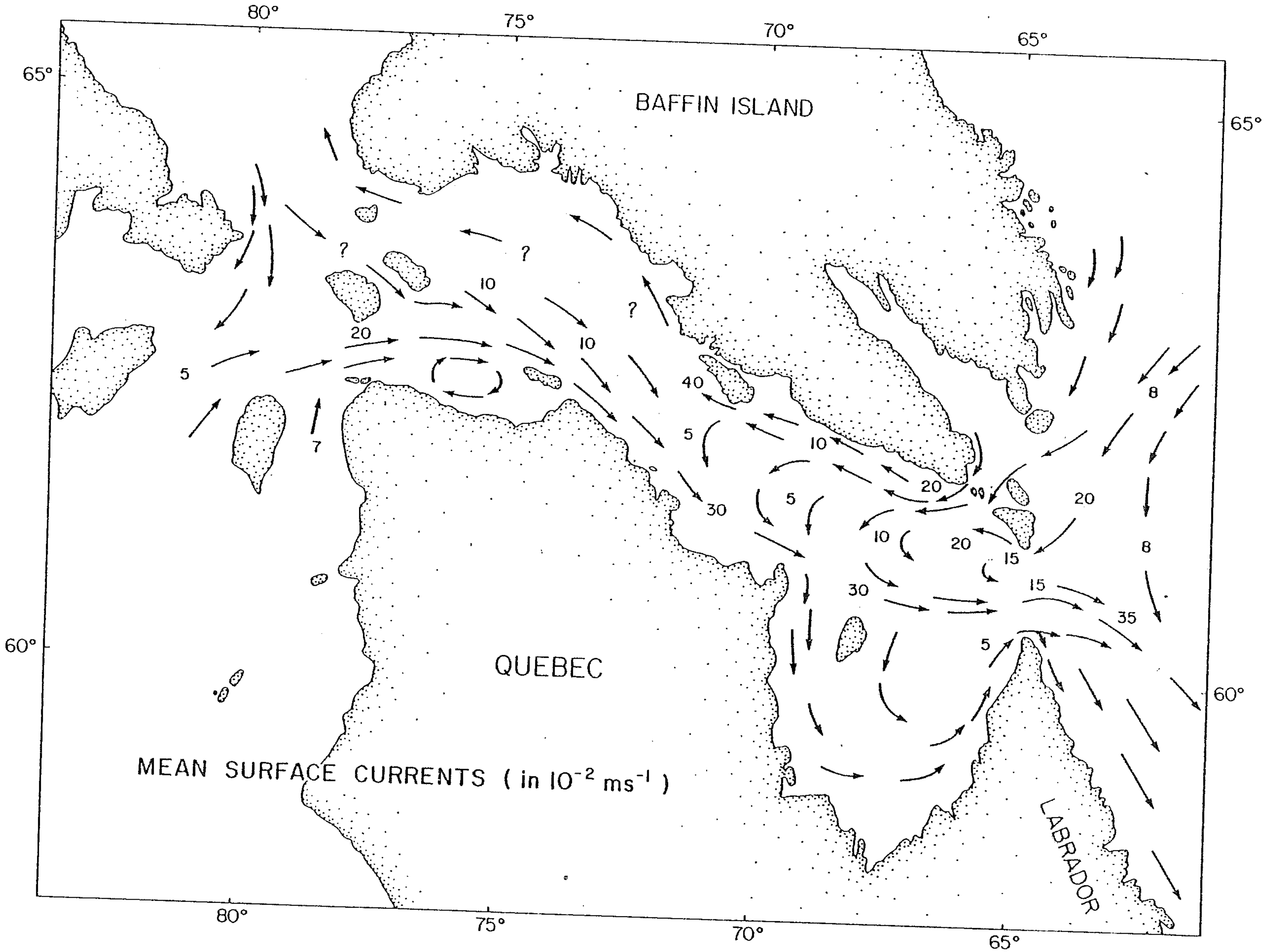
26'


BAFFIN ISLAND
META INCOGNITA PENINSULA
FROBISHER BAY
RESOLUTION ISLAND
GRAY STRAIT
LABRADOR
EASTERN BASIN
UNGAVA TROUGH
UNGAVA BAY
AKPATOK ISLAND
CAPE HOPES ADVANCE
HUDSON STRAIT
BIG ISLAND
QUEBEC
WESTERN BASIN
CHARLES ISLAND
SALISBURY ISLAND
NOTTINGHAM ISLAND
MANSEL ISLAND
100m
200m
300m
400m
500m
600m
700m
900m
78°
76°
74°
72°
70°
68°
66°
64°
62°
60
0
50
100
kilometres
FOXE BASIN
BAFFIN
ISLAND
GREENLAND
HUDSON BAY
HUDSON ST.
STUDY AREA
QUEBEC
LABRADOR
90°
80°
70°
60°
50°
65°
55°
45°

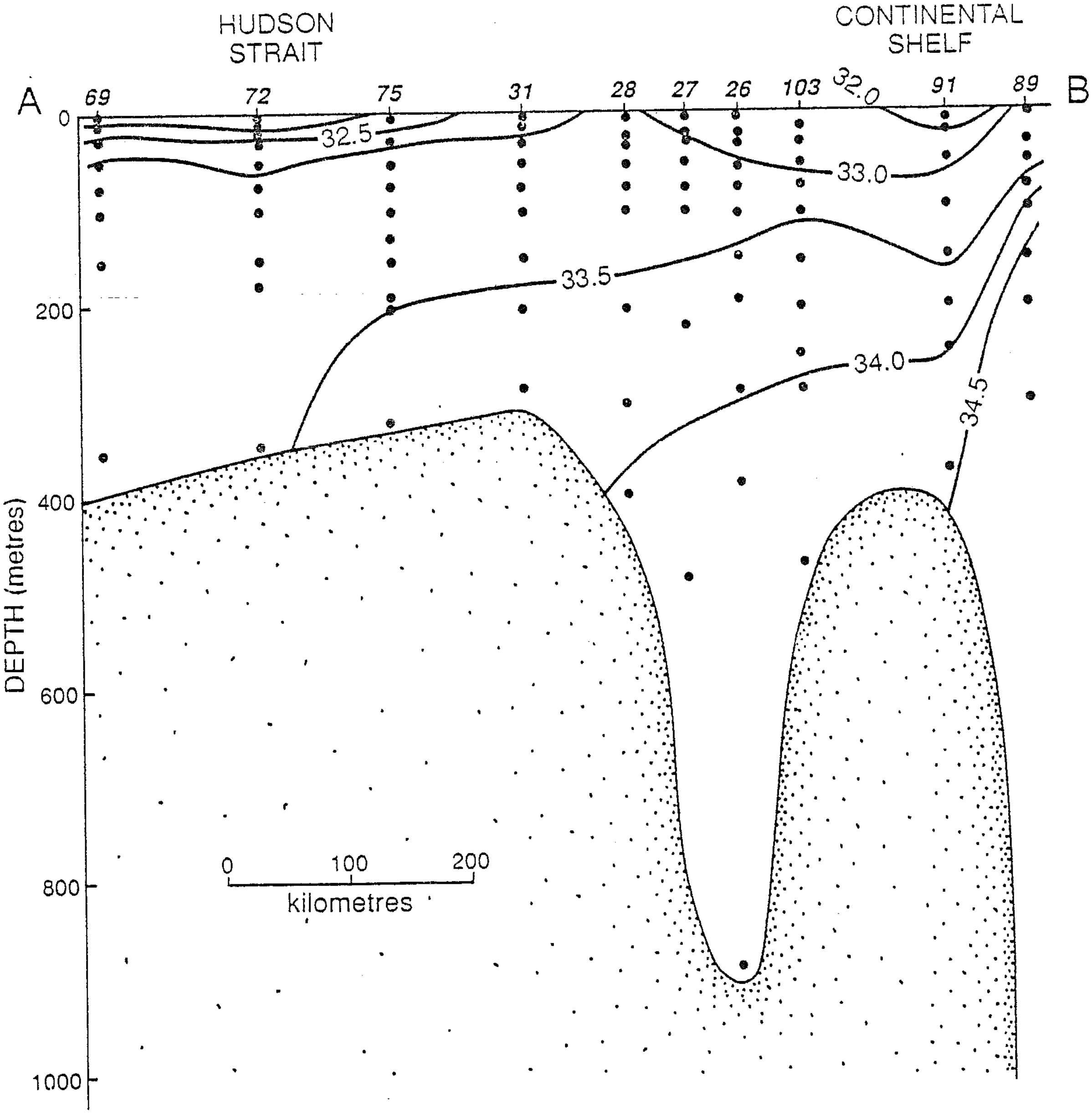
PCF 7.7" ↔

[illegible]



MEAN SURFACE CURRENTS (in 10^{-2} ms^{-1})

Fig 3. Hall et al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STRAIT
CONTINENTAL
SHELF
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B
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72
75
31
28
27
26
103
91
89
32.0
32.5
33.0
33.5
34.0
34.5
DEPTH (metres)
0
200
400
600
800
1000
0
100
200
kilometres

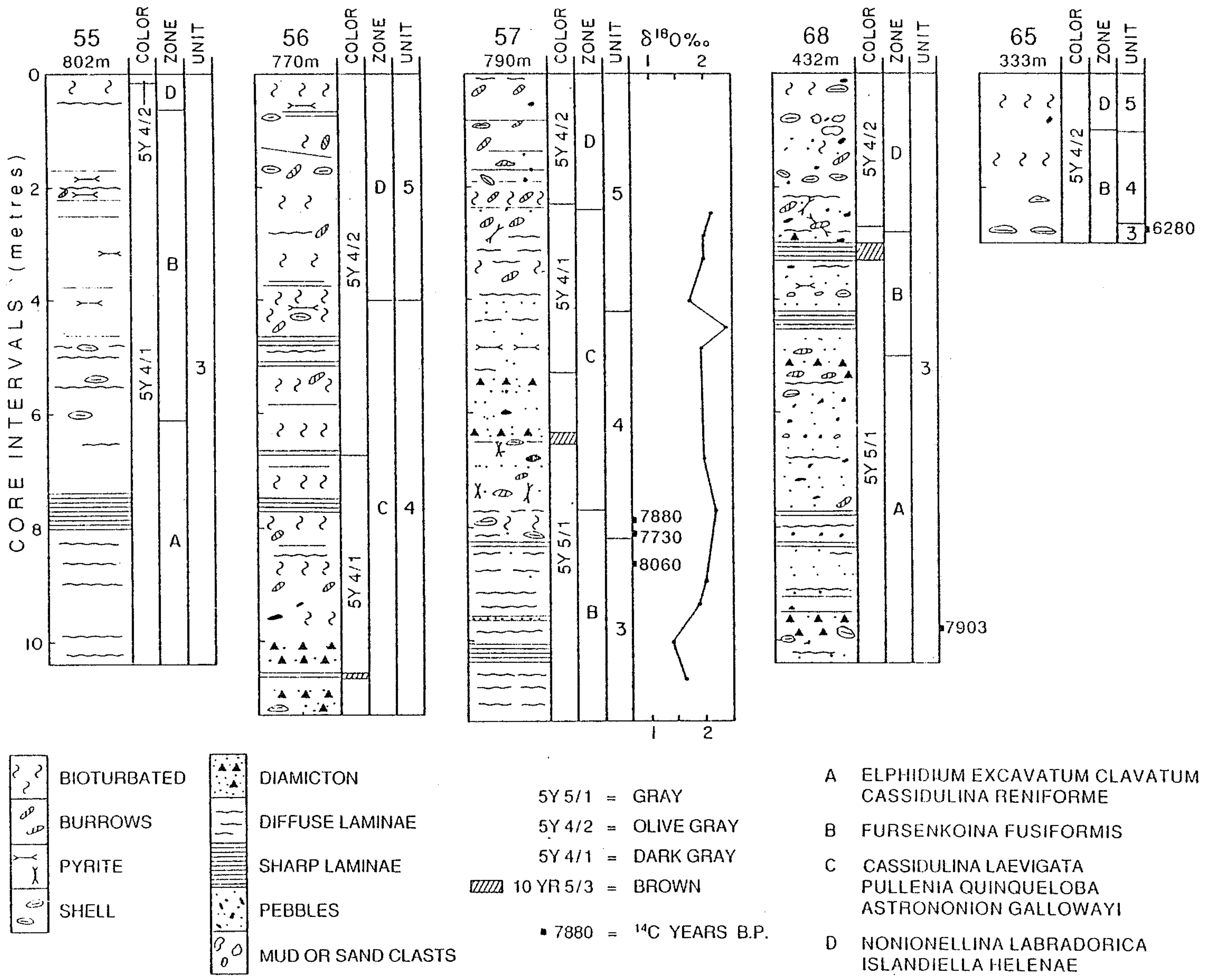


Fig 5 Vilks, et al

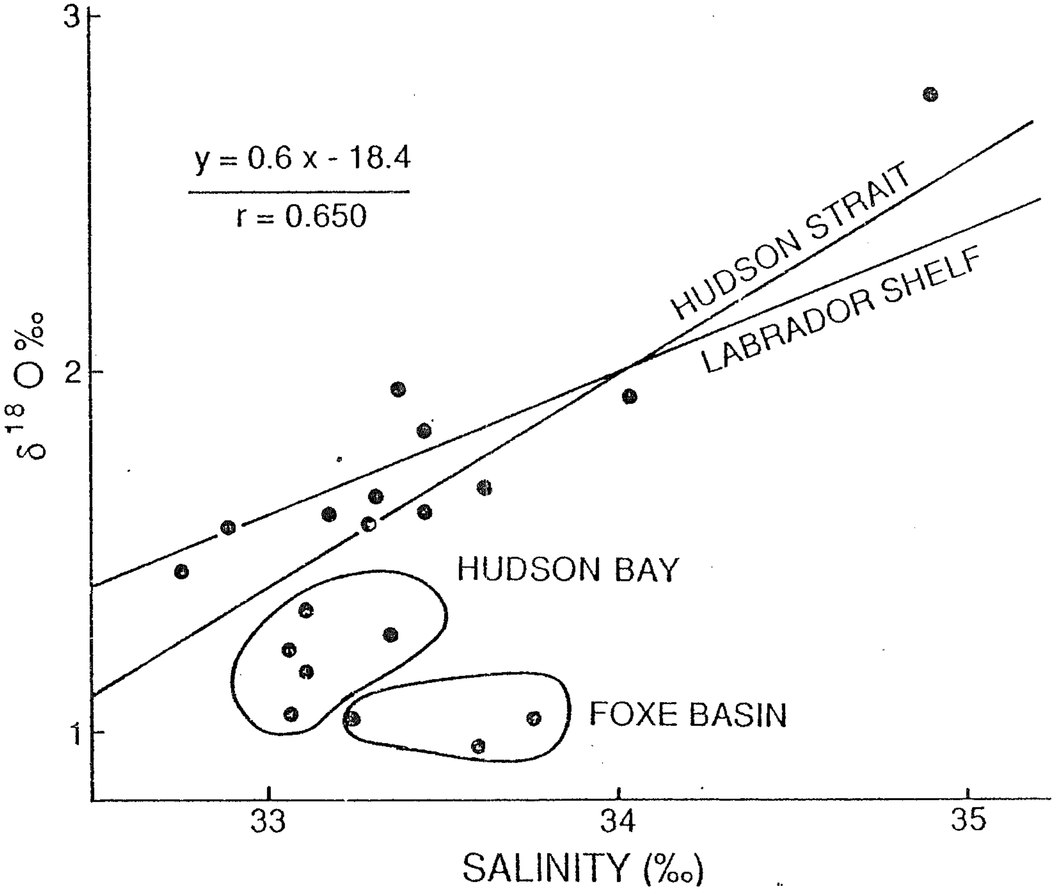
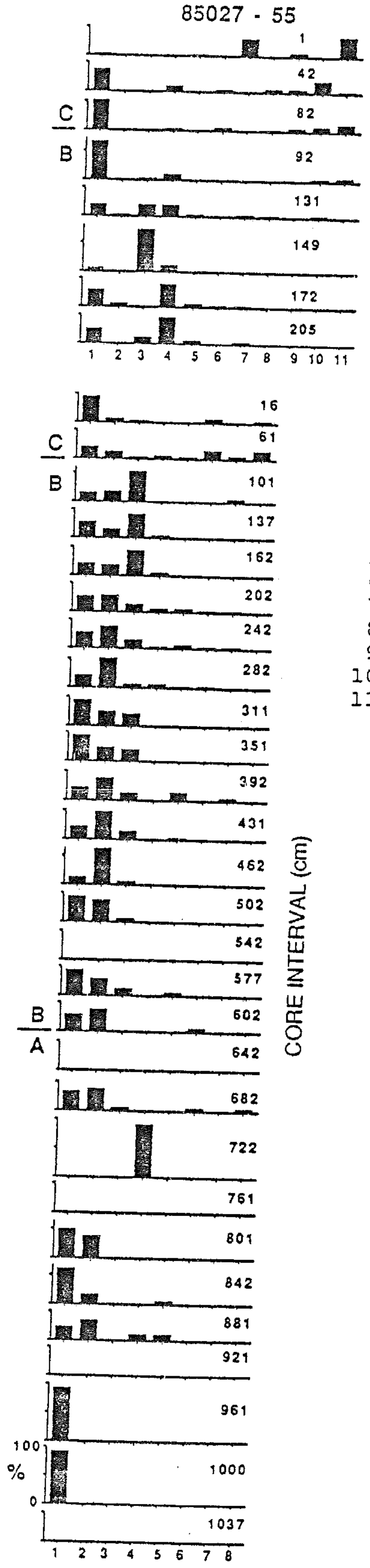
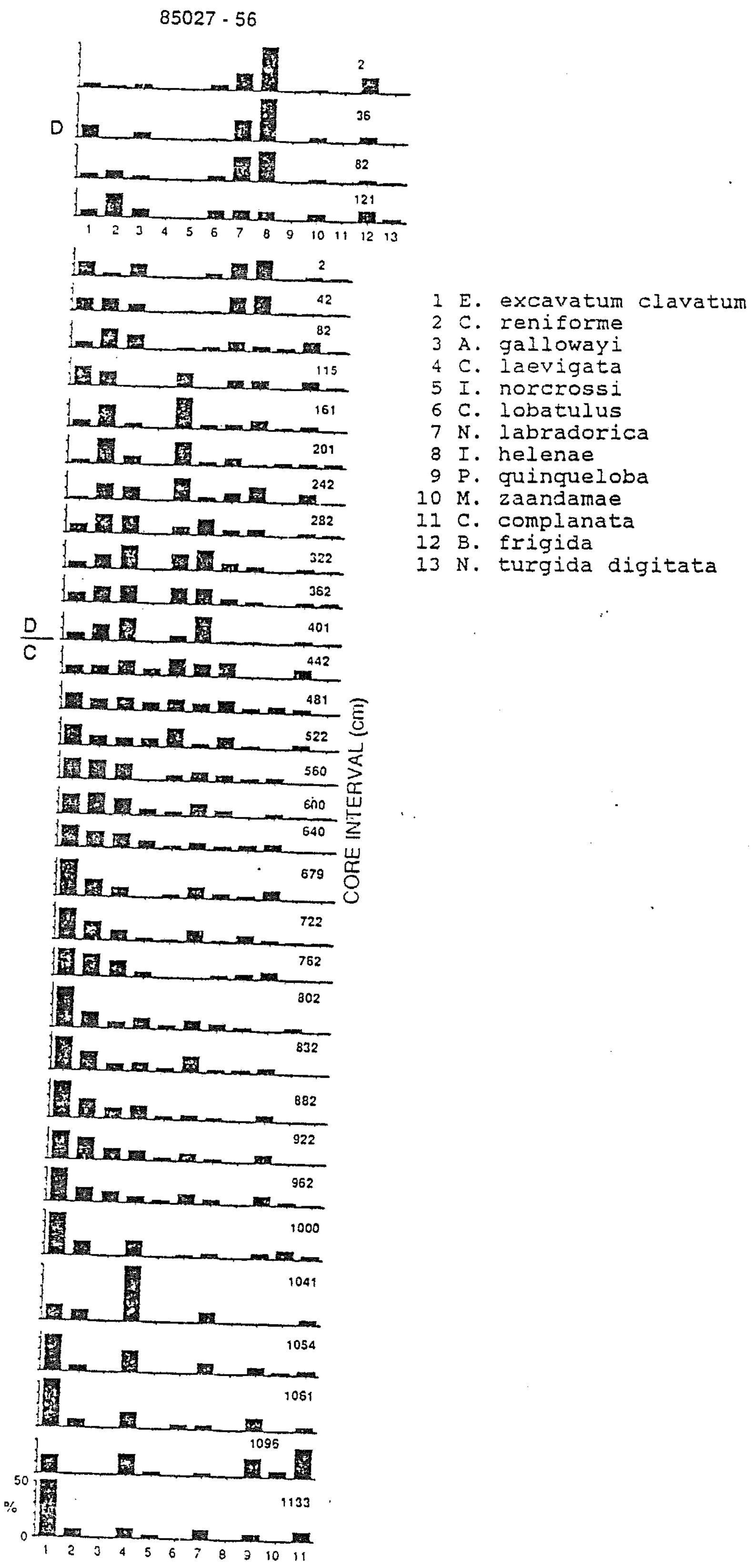


Fig. 6, Vilks, et al



1. E. excavatum clav
2. C. reniforme
3. F. fusiformis
4. C. lobatulus
5. A. gallowayi
6. P. quinqueloba
7. I. helenae
8. C. laevigata
9. M. zaandamae
10. C. complanata
11. N. labradorica


85027 - 56
D
D
C
2
36
82
121
1 2 3 4 5 6 7 8 9 10 11 12 13
2
42
82
115
161
201
242
282
322
362
401
442
481
522
560
600
640
679
722
762
802
832
882
922
962
1000
1041
1054
1061
1096
1133
50
%
0
1 2 3 4 5 6 7 8 9 10 11
CORE INTERVAL (cm)
1 E. excavatum clavatum
2 C. reniforme
3 A. gallowayi
4 C. laevigata
5 I. norcrossi
6 C. lobatulus
7 N. labradorica
8 I. helenae
9 P. quinqueloba
10 M. zaandamae
11 C. complanata
12 B. frigida
13 N. turgida digitata

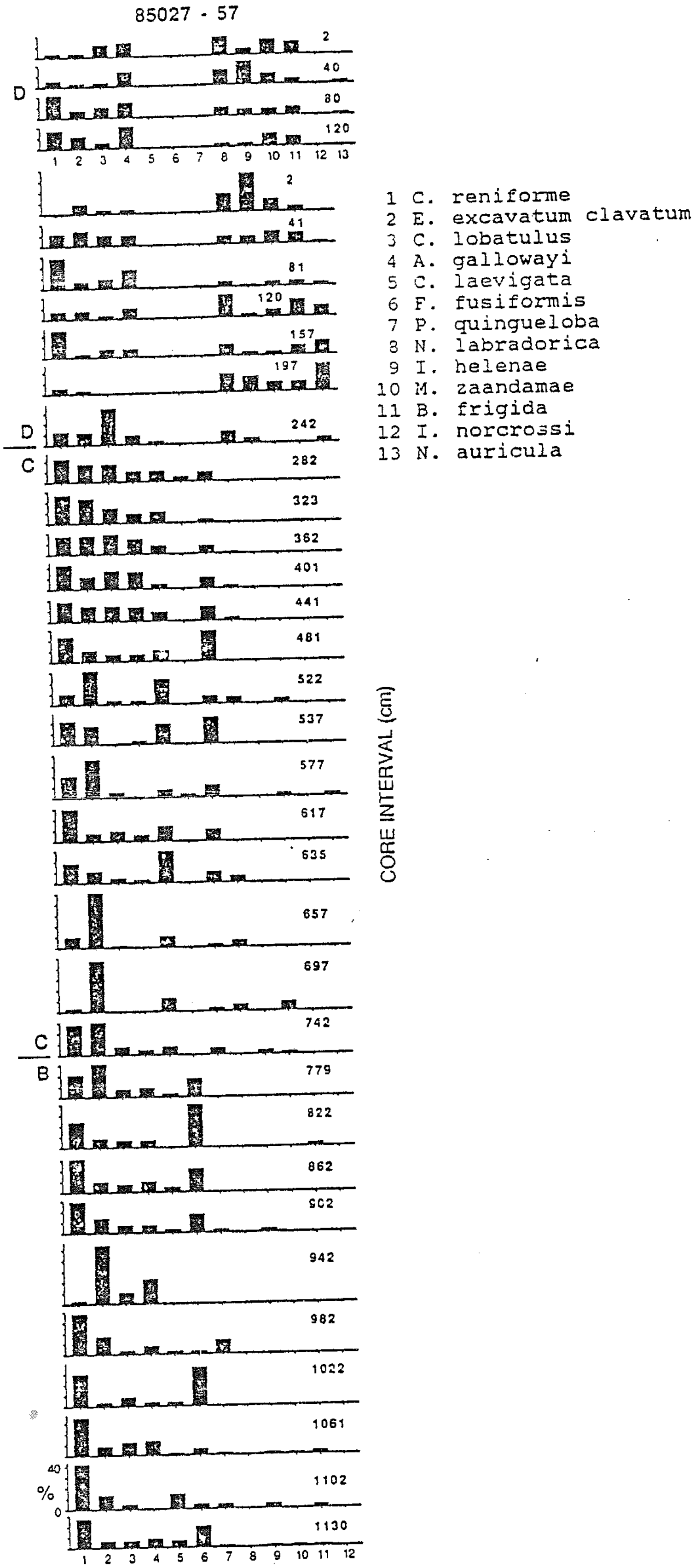


Fig. 8 Vilks et al

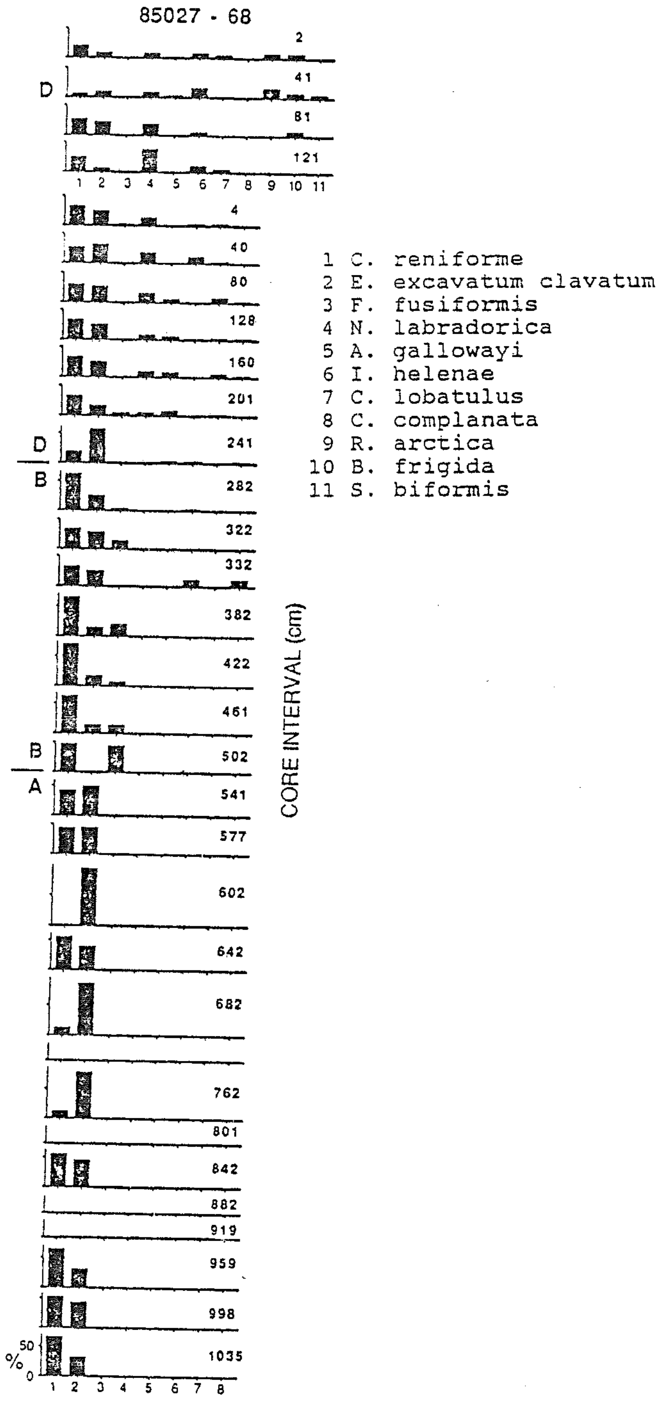
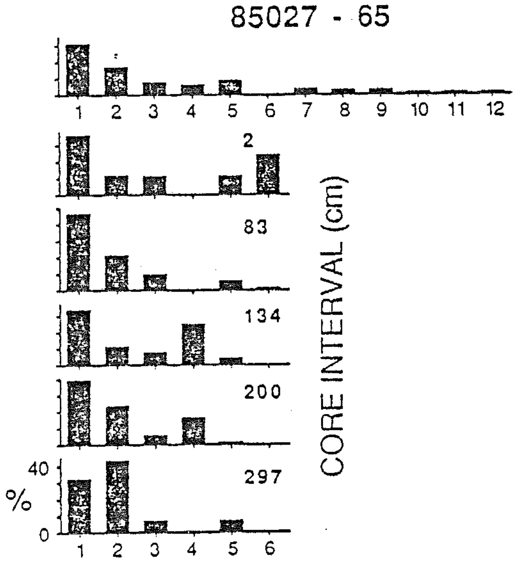
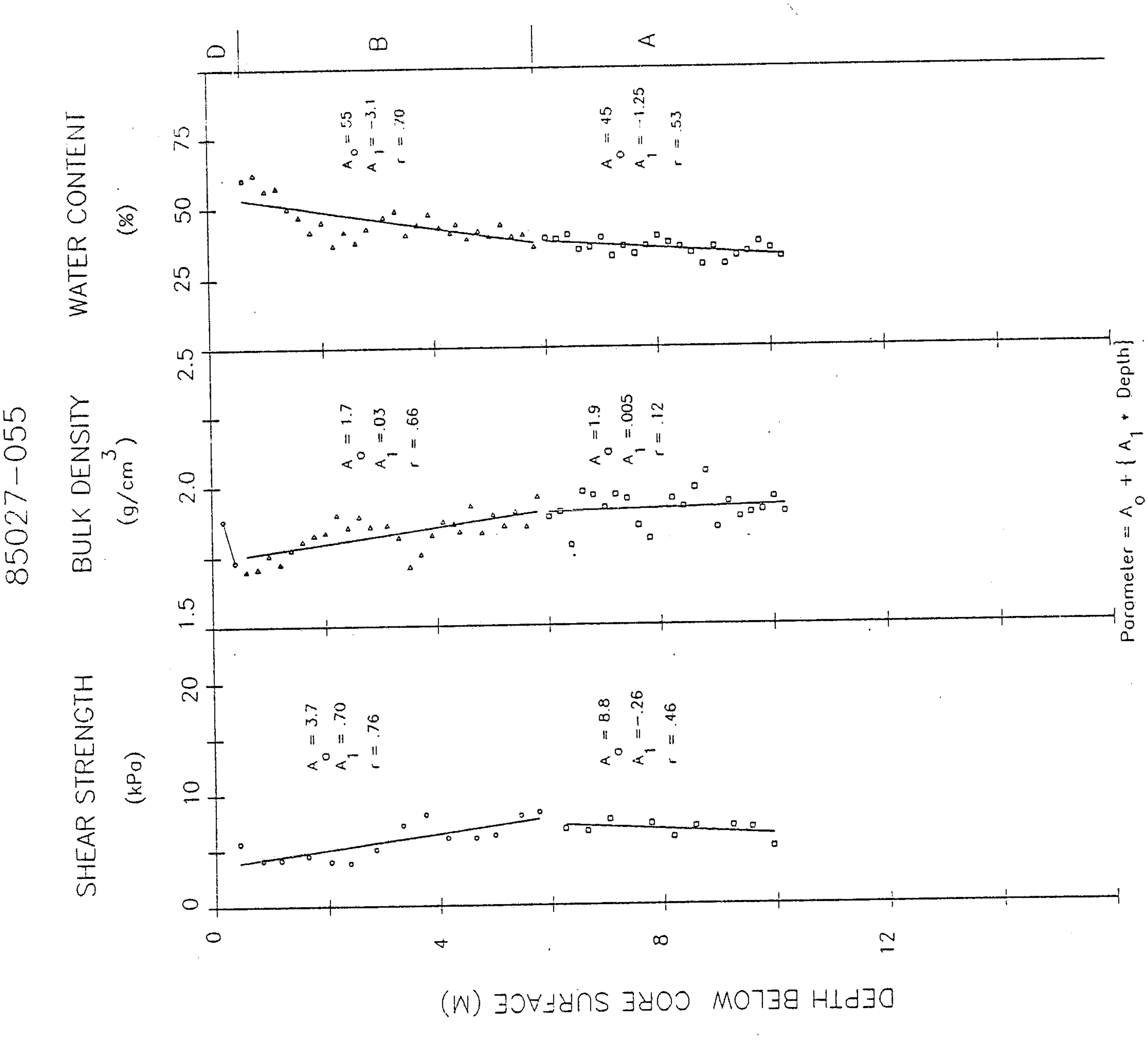


Fig 10 Vilks et al.

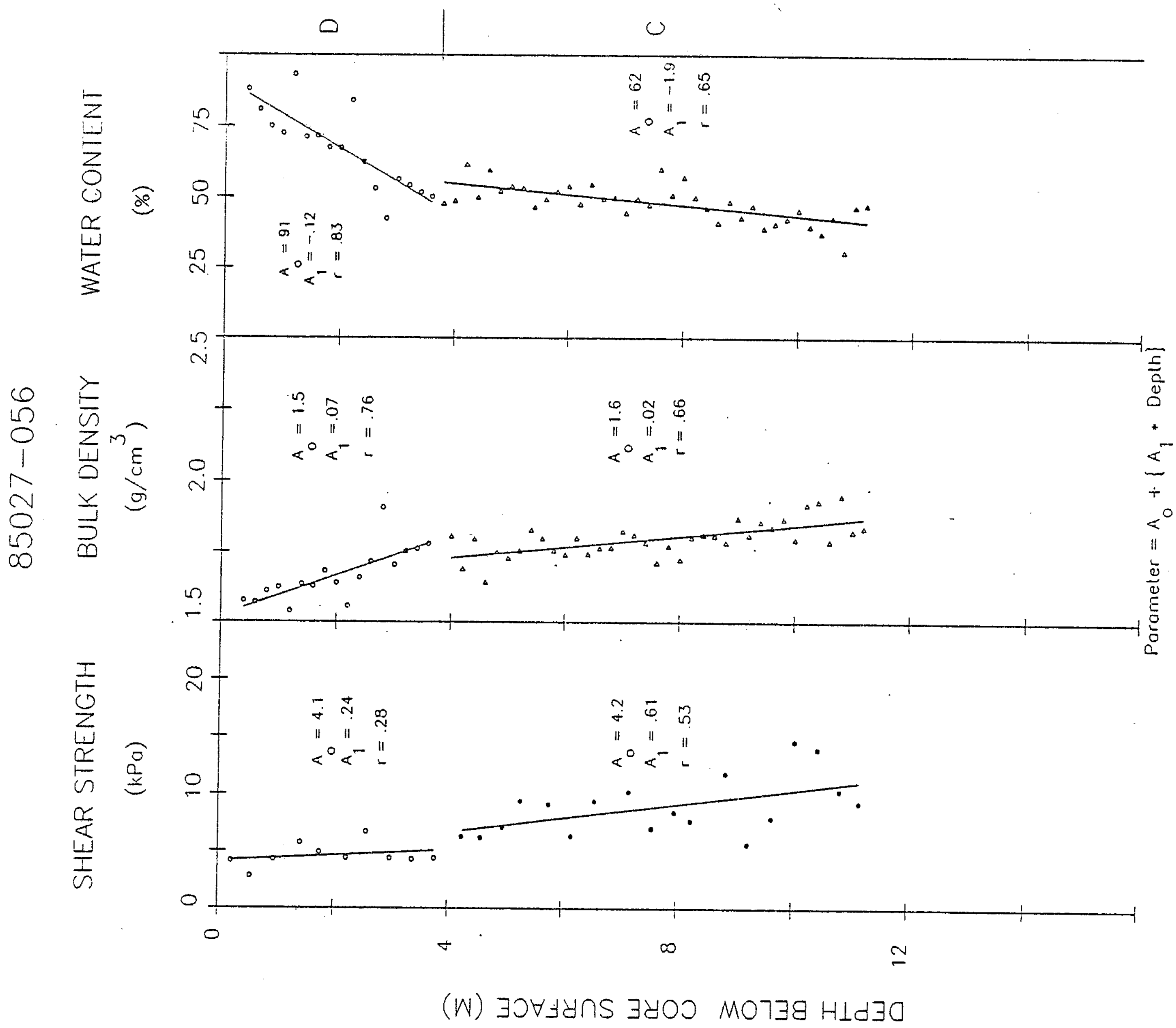


1 C. reniforme
2 E. excavatum clavatum
3 N. labradorica
4 F. fusiformis
5 I. helenae
6 I. norcrossi
7 C. complanata
8 B. frigida
9 B. pseudopunctata
10 E. takayanagii
11 A. gallowayi
12 R. arctica

Fig 11. VILKS, et al



g. 12 VILKS et al



. 13 Vilks et al

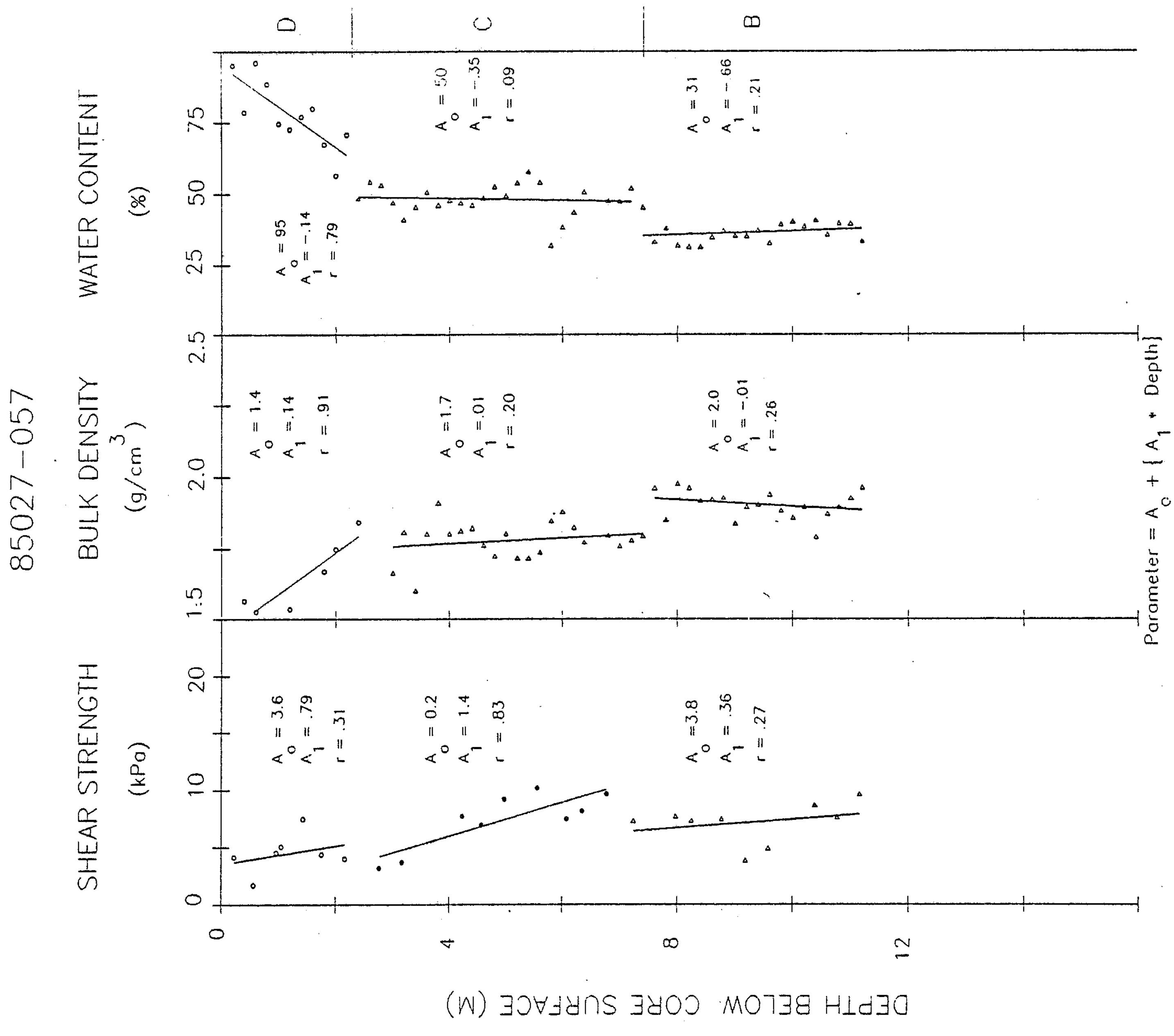


Fig. 14 Viles, et al

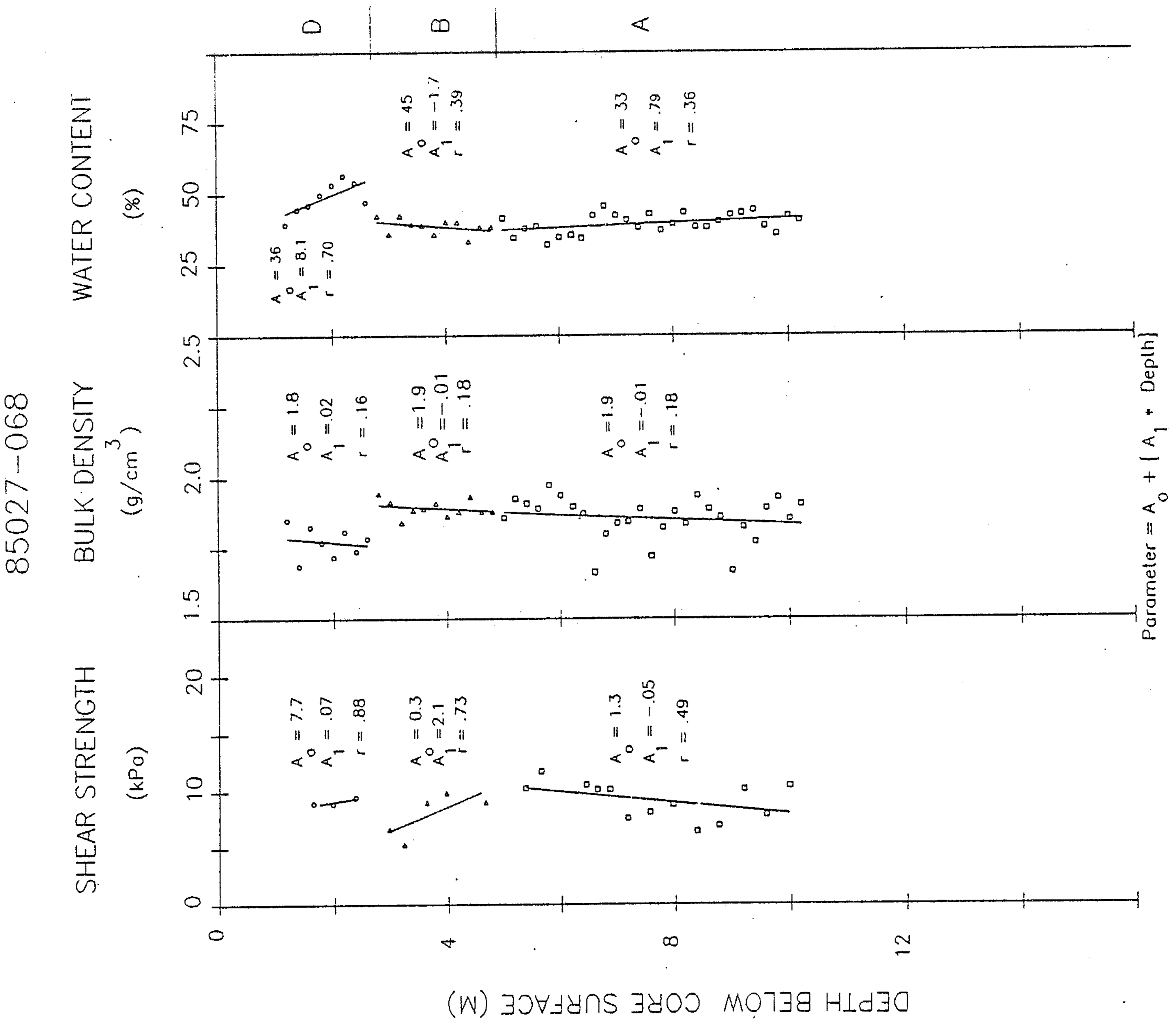


Fig. 15 Vilks et al

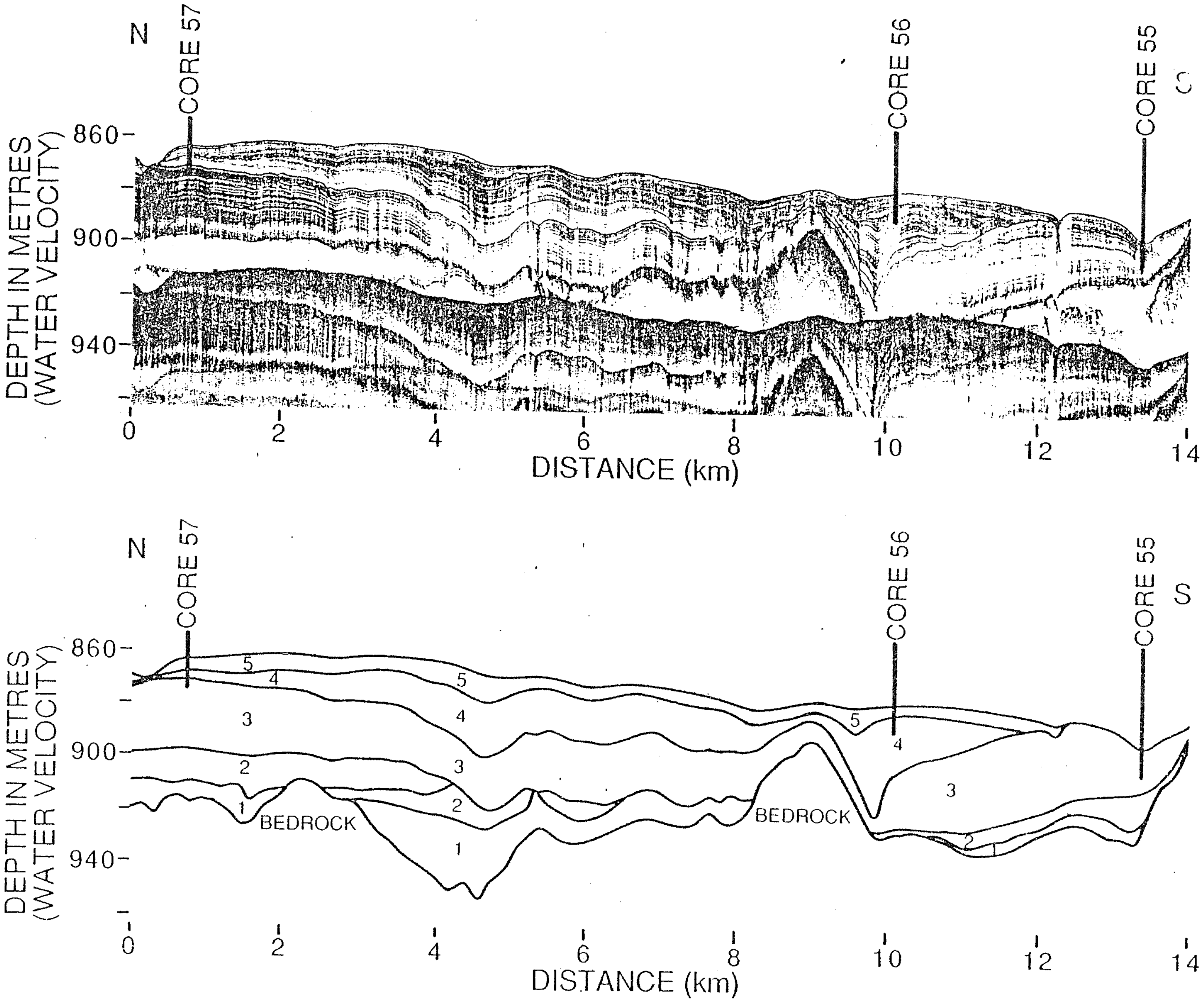


Fig. 16, Vilks et al

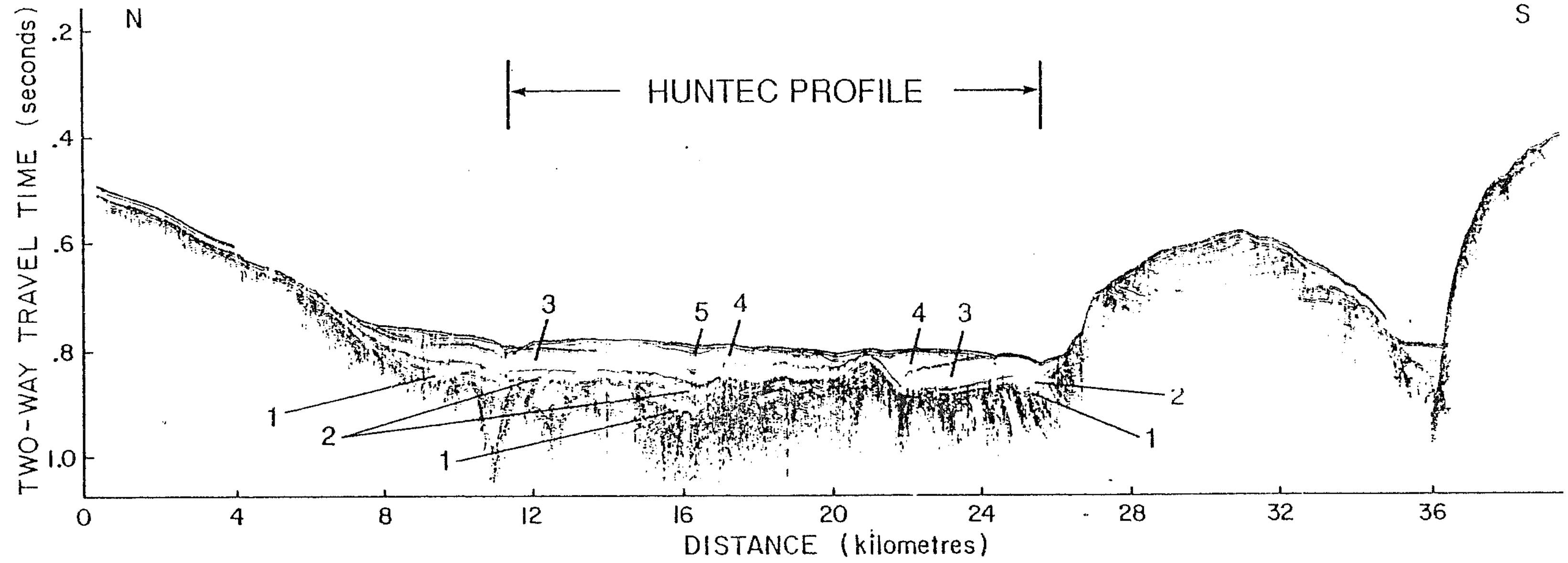


Fig. 17. Valley fill

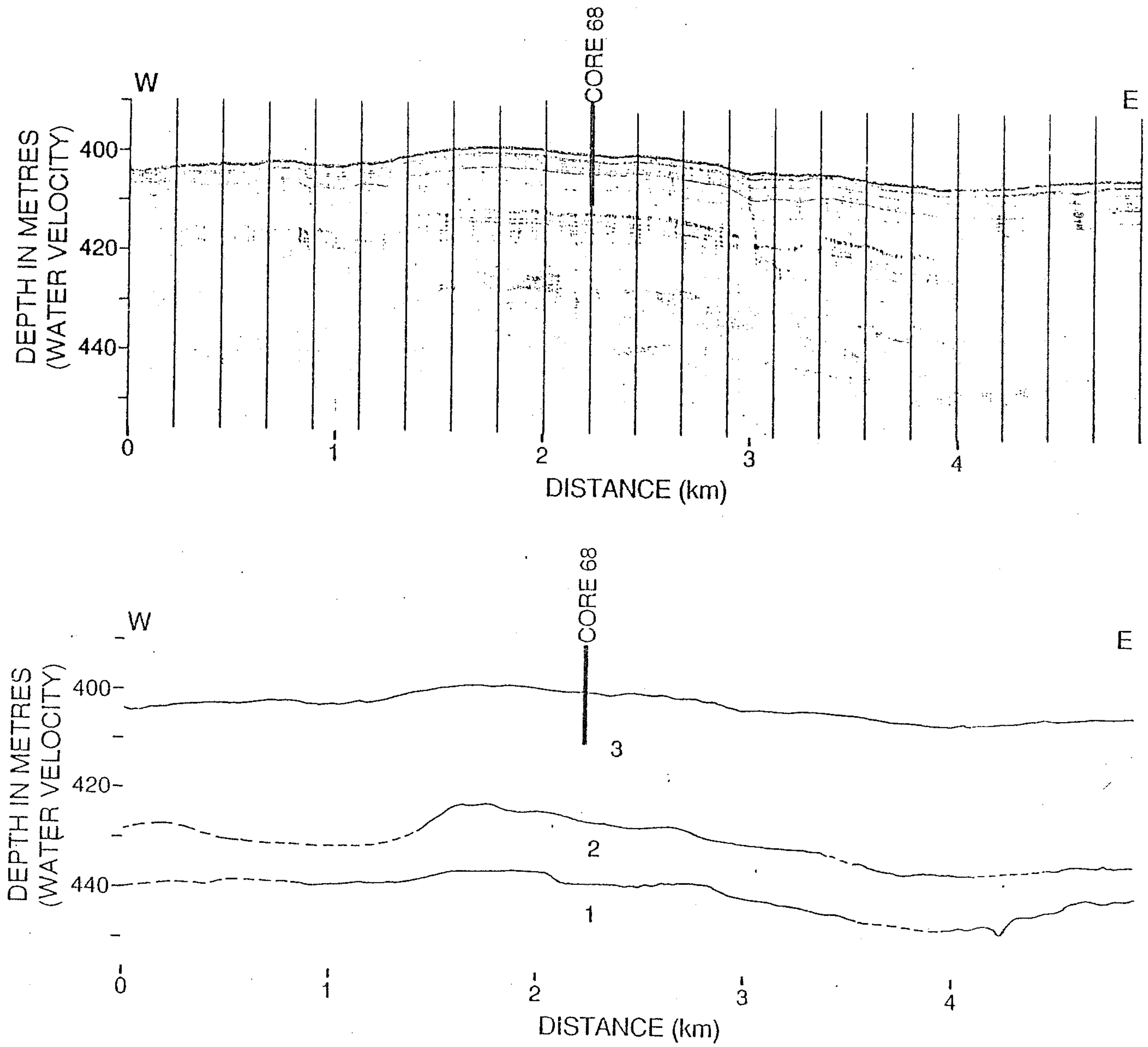
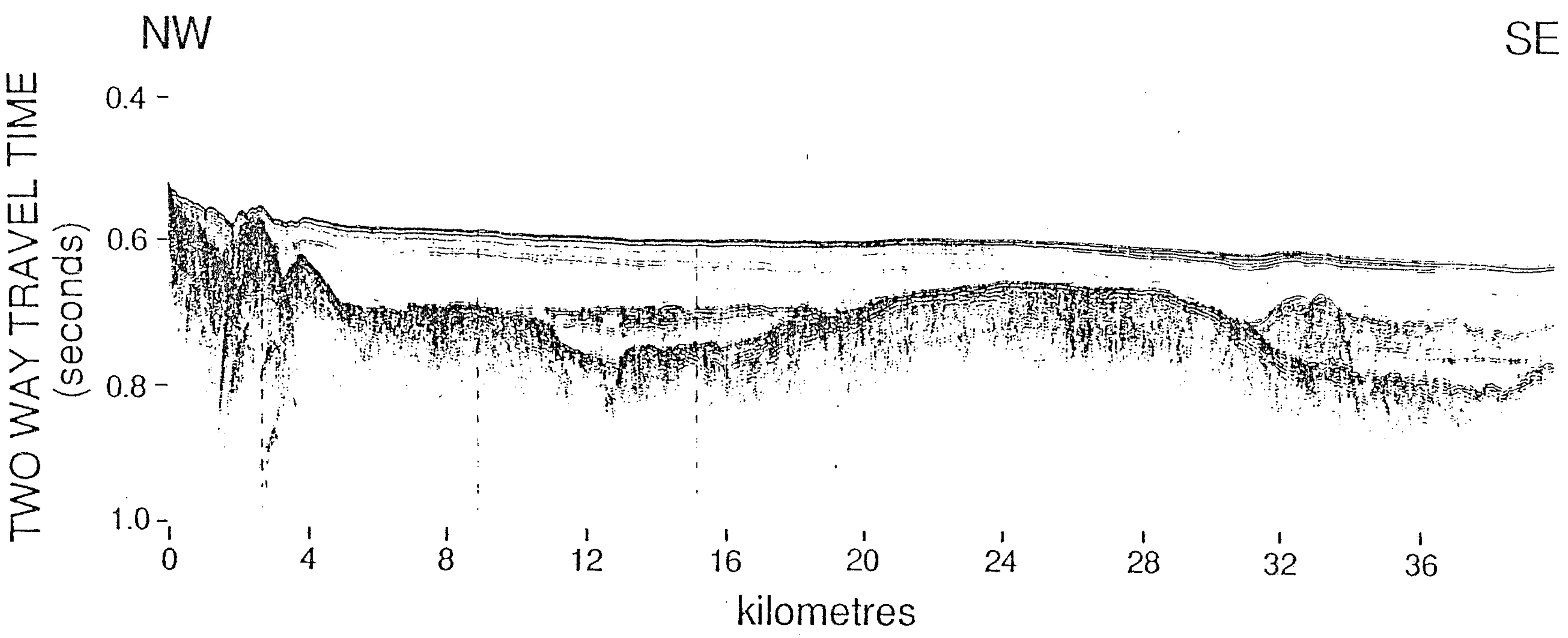
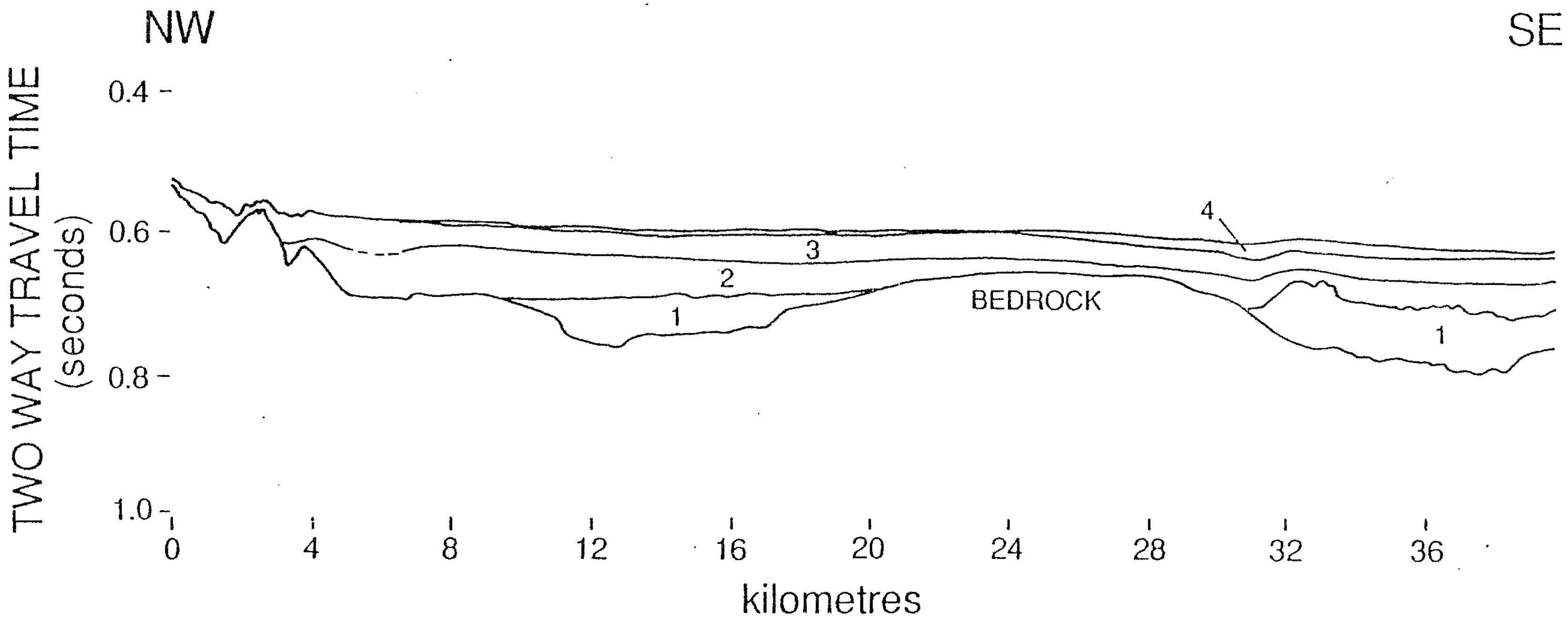


Fig. 13, Vilks et al.


NW
SE
TWO WAY TRAVEL TIME
(seconds)
0.4
0.6
0.8
1.0
0
4
8
12
16
20
24
28
32
36
kilometres


NW
SE
TWO WAY TRAVEL TIME
(seconds)
0.4
0.6
0.8
1.0
4
3
2
1
BEDROCK
1
0
4
8
12
16
20
24
28
32
36
kilometres

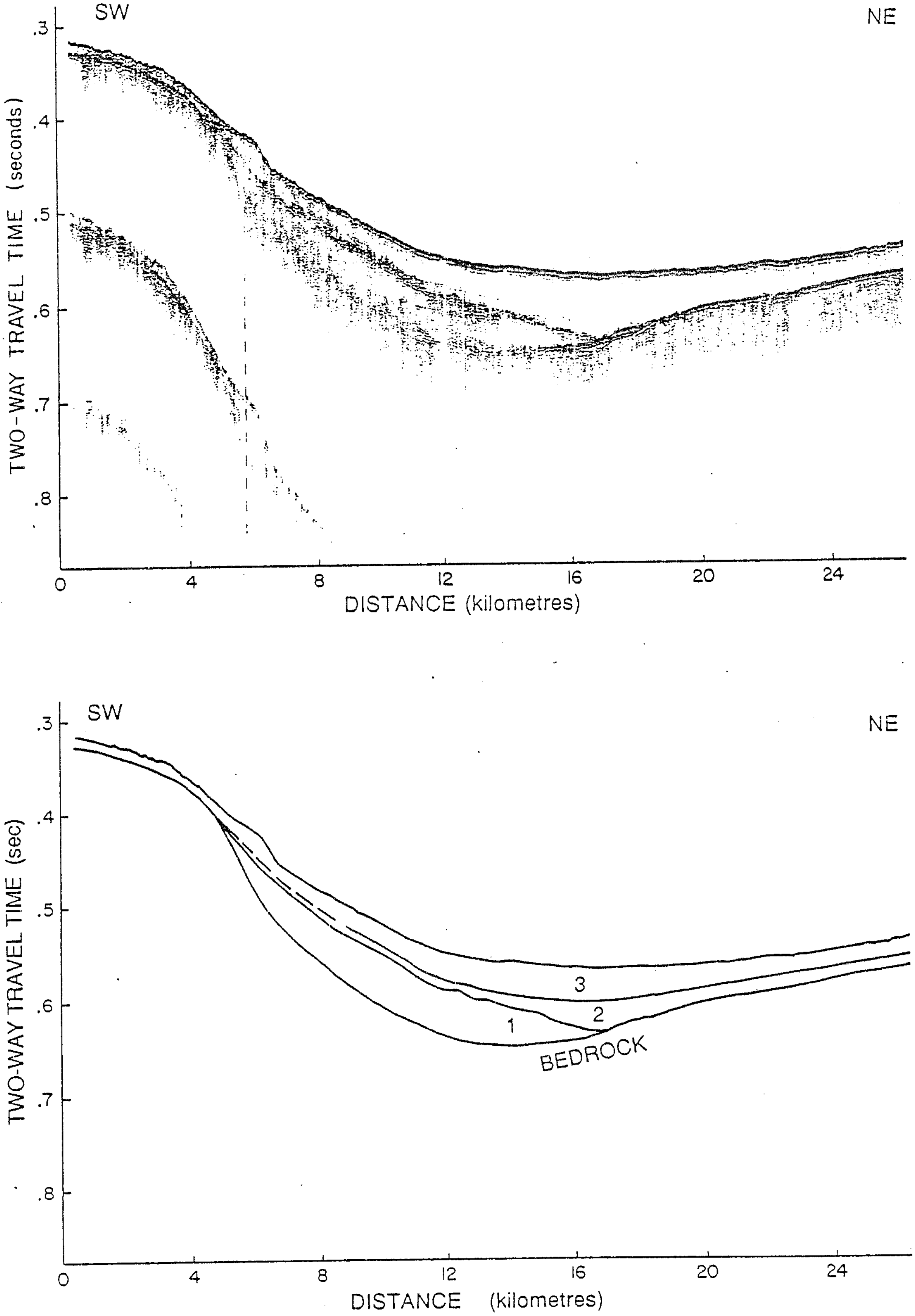


Fig 20. Wilkes, et al

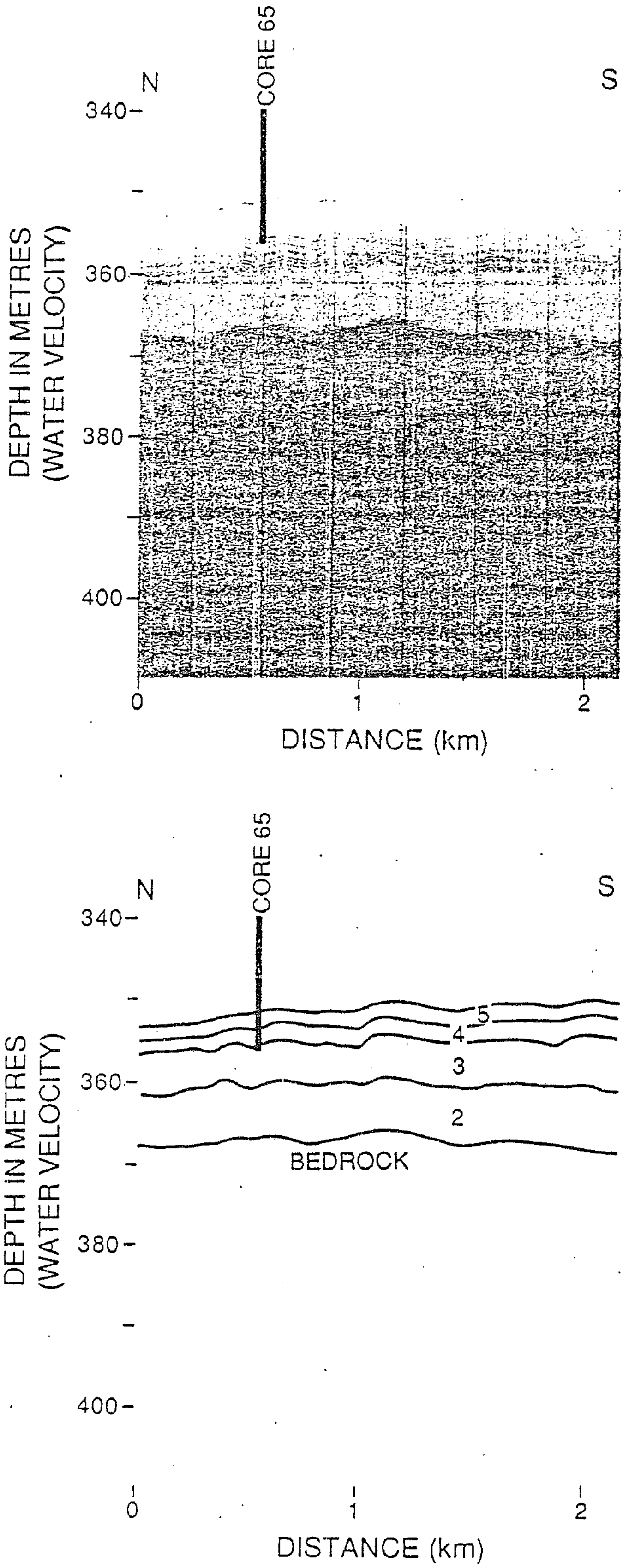


Fig. 21 Vilks, et al

```
ACOUSTIC                           CORES                  ACOUSTIC CHARACTERISTICS
 UNITS       55        56           57        68
==========================================================================================
                      | | |        |D|                    LAMINATED, PONDED
   5                  |D|          |-|
--------              |-|          | |                    ---------------------------
                      |C|          |C|                    LAMINATED,
   4                  | | |        | |        |D|         INTERNAL DISCONTINUITIES
-------------------------------    |-|    -?-|-|--?--------------------------------------
            |B|                    |B|        |B|         LAMINATED,
   3        |-|                               |-|         CONFORMABLE WITHIN
            |A|                               |A|
------------------------------------------------------------------------------------------
   2                                                      MASSIVE,
                                                          DRIFT OR DEBRIS FLOWS
------------------------------------------------------------------------------------------
   1                                                      MASSIVE,
                                                          DRIFT
------------------------------------------------------------------------------------------
                                                          BEDROCK

------------------------------------------------------------------------------------------

FORAM      A= PROGLACIAL             C= POSTGLACIAL
ZONES         PROXIMAL                  EARLY
           B= PROGLACIAL             D= POSTGLACIAL
              DISTAL                    LATE
```

Fig. 22 Vilks, et al