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QUATERNARY GEOLOGY OF THE SOUTHEAST BAFFIN ISLAND CONTINENTAL SHELF

D.B. Praeg
B. MacLean
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QUATERNARY GEOLOGY OF THE SOUTHEAST BAFFIN ISLAND CONTINENTAL SHELF

Abstract

The Quaternary sediments of the southeast Baffin Island continental shelf have been investigated using acoustic data (Huntec DTS and 655 cm^3 air gun seismic profiles, sidescan sonograms, echograms) supplemented by sample control (grabs and cores). Four acoustic units have been defined and informally named: (1) Baffin Shelf Drift – unstratified diamictons generally < 100 m thick but up to 300 m off Hudson Strait, which were deposited from grounded glacial ice, and which reach to the shelf edge in some areas; these sediments record repeated advances of glacial ice, of varied extent, of early late Foxe and older age; (2) Davis Strait Silt – sediments generally < 10 m but up to 70 m thick, which are stratified where unscoured by grounding icebergs (subunit A) and acoustically unstratified where scoured by grounding icebergs (subunit B); these sediments record deposition from mid-Foxe to Holocene time and contain microfossil evidence of ice-proximal to ice-distal glacial marine environments; (3) Tiniktartuq Silt and Clay – stratified basin-fill sediments up to 10 m thick which directly overlie the stratified sediments of Davis Strait Silt subunit A; these sediments indicate a change in depositional style in the late Foxe to Holocene; (4) Resolution Island Lag – subangular gravels and sands which occur in areas that appear largely devoid of cover to the limit of acoustic resolution (30-50 cm), and which may include areas of exposed bedrock; these sediments record current winnowing of areas of thin to discontinuous Baffin Shelf Drift or Davis Strait Silt. There is no evidence for a transgressive zone marking a relative sea level lowstand in the depths represented by the data (mainly >150 m). The immediate seabed of the southeast Baffin Shelf has been subjected to modification by currents in the Holocene, resulting in the formation of an extensive surface veneer which overlies the sediments of the acoustic units in thicknesses < 30-50 cm.

Résumé

Les sédiments quaternaires du plateau continental de la partie sud-est de l'île Baffin ont été étudiés au moyen de données acoustiques (profils sismiques obtenus à l'aide d'un canon pneumatique Huntec DTS et d'un canon pneumatique de 655 cm^3, sonogrammes obtenus par balayage latéral et échogrammes) et par contrôle des échantillons (échantillons prélevés au hasard et carottes). Quatre unités acoustiques ont été définies et nommées officieusement: (1) sédiments glaciaires du plateau de Baffin – il s'agit de diamictons non stratifiés dont l'épaisseur est généralement inférieure à 100 m mais peut atteindre 300 m au large du détroit d'Hudson; ils ont été déposés par la glace glaciaire échouée et, par endroits, se prolongent jusqu'au bord du plateau. Ils révèlent que la glace glaciaire s'est avancée plus ou moins loin à plusieurs reprises au début du Foxe récent et avant; (2) limon du détroit de Davis – ces sédiments ont une épaisseur généralement inférieure à 10 m mais qui peut atteindre 70 m; ils sont stratifiés là où ils n'ont pas été affouillés par des icebergs échoués (sous-unité A) et acoustiquement non stratifiés là où les icebergs échoués les ont affouillés (sous-unité B). Ces sédiments ont été déposés du Foxe moyen jusqu'à l'Holocène et contiennent des microfossiles qui révèlent qu'ils se sont accumulés dans des milieux marins glaciaires situés à proximité et loin de la glace; (3) limon et argile de Tiniktartuq – il s'agit de sédiments stratifiés dont l'épaisseur peut atteindre 10 m, qui sont sus-jacents aux sédiments stratifiés de la sous-unité A (limon du détroit de Davis); accumulés dans un bassin, ils révèlent que le mode d'accumulation a changé du Foxe récent à l'Holocène; (4) résidu de l'île Résolution – il s'agit de graviers et de sables subanguleux trouvés dans des zones qui, jusqu'à la limite de la résolution acoustique (de 30 à 50 cm), semblent être en grande partie dépourvues de couverture, y compris parfois des zones du socle rocheux découvert; ces sédiments révèlent qu'il y a eu vannage par les courants là où les sédiments glaciaires du plateau de Baffin ou le limon du détroit de Davis sont peu épais ou discontinus. Il n'exite aucune trace d'une zone de transgression marquant le plus bas niveau de la mer dans les profondeurs représentées par les données (pronfondeurs surtout supérieures à 150 m). Les courants ont modifié le fond marine de la partie sud-est du plateau de Baffin durant l'Holocène, produisant un vaste placage dont l'épaisseur est de moins de 30 à 50 cm au-dessus des sédiments des unités acoustiques.

INTRODUCTION

The southeast Baffin Island continental shelf (Fig. 1) is a broad platform which extends from Hudson Strait in the south to Cape Dyer in the north, and includes the deep basins of Frobisher Bay and Cumberland Sound (Fig. 2). This report presents an interpretation and synthesis of acoustic and sample data (Fig. 3, 4) collected on the Quaternary sediments of the area during the last 14 years, primarily on cruises of the Atlantic Geoscience Centre, Bedford Institute of Oceanography. The acoustic data consist of continuous single channel (655 cm^3 air gun) and Huntec deep-towed high-resolution seismic reflection profiles, sidescan sonograms, and echograms; sample data comprise piston and gravity cores, large (IKU) and small (Van Veen) grab samples and bottom photographs.

In carrying out the study, emphasis has been placed on interpretation of acoustic data to establish map units and to delineate their extent. Sample data have been used to help determine the nature and origin of the acoustic units and unravel the Quaternary history of the southeast Baffin Shelf.

Physiography

Generalized bathymetry of the study area is illustrated in Figure 2. The southeast Baffin Shelf is roughly divisible into a narrow (usually < 50 km), shallow, inner shelf outlined by the 200 m isobath, and a wide (up to 180 km), deep, outer shelf approximately delimited seaward by the 550 m isobath. To the south along the Labrador Sea margin the shelf break is well defined, but to the north in Davis Strait and southern Baffin Bay, it is less distinct.

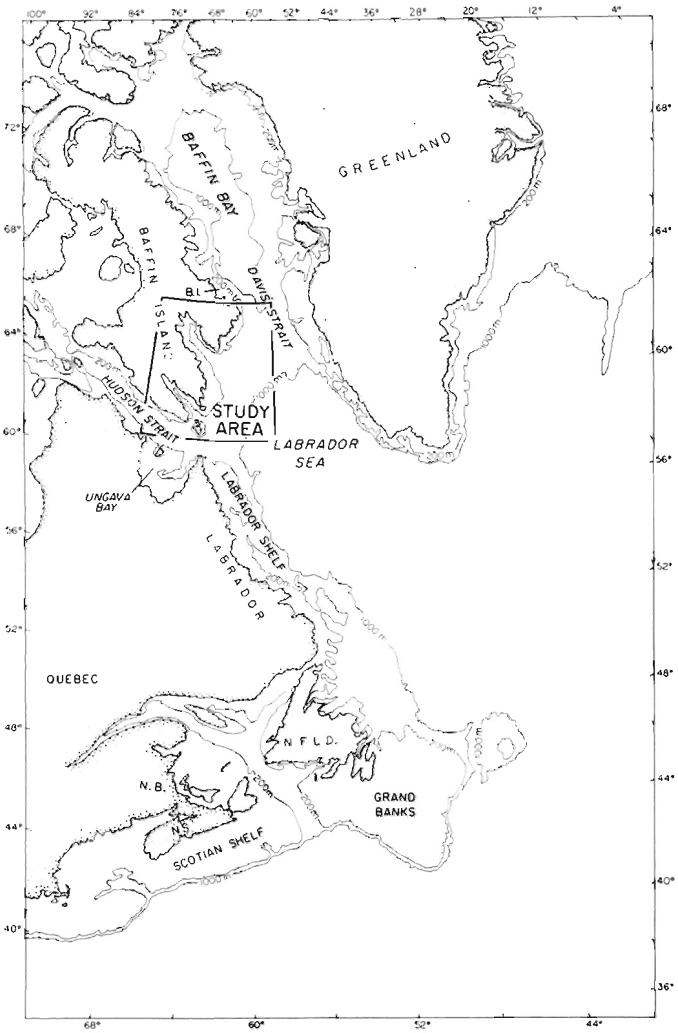

Figure 1. Location of study area and regional geographic localities referred to in the text. BI = Broughton Island.

The physiography of the southeast shelf differs distinctly from that of the adjacent northeast Baffin and Labrador shelves. Although some banks and basins are present on the southeast shelf (referred to by informal names in Fig. 2), the characteristic shallow bank and deep trough morphology of shelves to the north and south is absent. The prominent marginal channel of the Labrador Shelf is also largely absent, except in part of the area between Frobisher Bay and Cumberland Sound (McMillan, 1973) where it is represented by the 'Lemieux' and possibly 'Brevoort' Basins (Fig. 2). The large depressions of Frobisher Bay and Cumberland Sound, which extend inland 270-290 km and contain maximum water depths of 615 and 1289 m respectively, may result from a combination of tectonic subsidence (Srivastava, 1978; MacLean and Falconer, 1979) and glacial overdeepening.

Oceanography

The Baffin Bay-Davis Strait area is dominated by a counterclockwise pattern of circulation (Fig. 5), composed of the relatively warm, saline waters of the Greenland Current which flow north through Davis Strait and along the west Greenland coast to northern Baffin Bay, where they are joined by and mix with cold, less saline waters of the Arctic Archipelago. This water mass then flows south along the eastern Baffin Island coast (Baffin Current or Canadian Current), exiting Baffin Bay through western Davis Strait and flowing over the southeast Baffin Shelf (Collin and Dunbar, 1964).

Current measurements over the southeast shelf are sparse. General surface currents of 5 to 30 cm/s have been reported (Sailing Directions Arctic Canada, 1982; Anonymous, 1965). Drifter buoy measurements indicate surface currents of <1 to 30 cm/s in the outer shelf and Resolution Island areas (LeBlond et al., 1981). Variations observed in ships' speed during the geological surveys suggest that surface currents of up to 50-100 cm/s occur over the shelf. In some areas tidal currents are more significant than the Baffin Current; tidal currents of up to 350 cm/s are reported in the mouth of Frobisher Bay (Sailing Directions Arctic Canada, 1978), and of up to 250 cm/s in Gabriel Strait between Resolution Island and Meta Incognita Peninsula (Fig. 2) (Canadian Hydrographic Service Chart 7050). Frobisher Bay has a tidal range of up to 13.1 m, one of the highest in the world; Cumberland Sound has a smaller tidal range of up to 7.5 m (Sailing Directions Arctic Canada, 1982).

Subsurface current measurements over the southeast shelf are largely unavailable from the literature. However, subsurface values for the Baffin Current northeast of Cape Dyer and east of Hudson Strait have been calculated in 1100 m and 450 m water depth, respectively (Anonymous, 1965, p. 30-31). These profiles show currents of 20 cm/s and 45 cm/s respectively at surface, decreasing to 10 cm/s and 15 cm/s at 200 m depth and to <5 cm/s and 10 cm/s at 400 m depth. These subsurface values may broadly reflect the range of subsurface currents over the southeast Baffin Shelf.

Sea ice

The southeast Baffin Shelf is usually covered by sea ice for about nine or more months of each year. This includes mobile pack ice, icebergs, and landfast ice that extends up to several tens of kilometres seaward during winter months (Sailing Directions Arctic Canada, 1982). Much of the sea ice that traverses the southeast Baffin Shelf area originates to the north in Baffin Bay and adjacent Arctic channels. This ice consists of floes, icebergs and growlers carried southward by the cold Baffin Current along the east coasts of Baffin Island and Labrador. The ice trajectory is also influenced by winds as it passes through the area.

The straight to curvilinear troughs that are formed on the seabed as a result of iceberg grounding are referred to as iceberg scours (Pelletier and Shearer, 1972). Scouring of the seabed may occur to a depth of several metres and for distances up to several kilometres, depending on such factors as the nature of the seabed material, seabed gradient, iceberg size, and the strength of the currents and other forces propelling the berg (e.g. Lewis et al., 1979, 1982). Most areas of the Baffin Shelf have been subjected to intense scouring in this manner. Investigations east of Resolution Island in 1984 using Sea Marc I indicate the presence of iceberg scours to 700 m depth. Many scours, particularly in deep water, are believed to be relict, but others are the product of present day iceberg groundings (MacLean, 1985). Icebergs therefore represent a potential hazard to seafloor installations in this region.

PREVIOUS WORK

Bedrock[1] geology

The bedrock geology of the southeast shelf (Fig. 6), as delineated from acoustic, magnetic and shallow drillhole data, has been described by various researchers, e.g. Grant (1975), MacLean et al. (1977, 1978, 1982), MacLean and Falconer (1979), MacLean and Williams (1983), and Srivastava et al. (1981). Geological data from deep exploratory wells have been presented by Klose et al. (1981).

[1] 'Bedrock' is herein arbitrarily applied to all pre-Quaternary sediments and rocks.

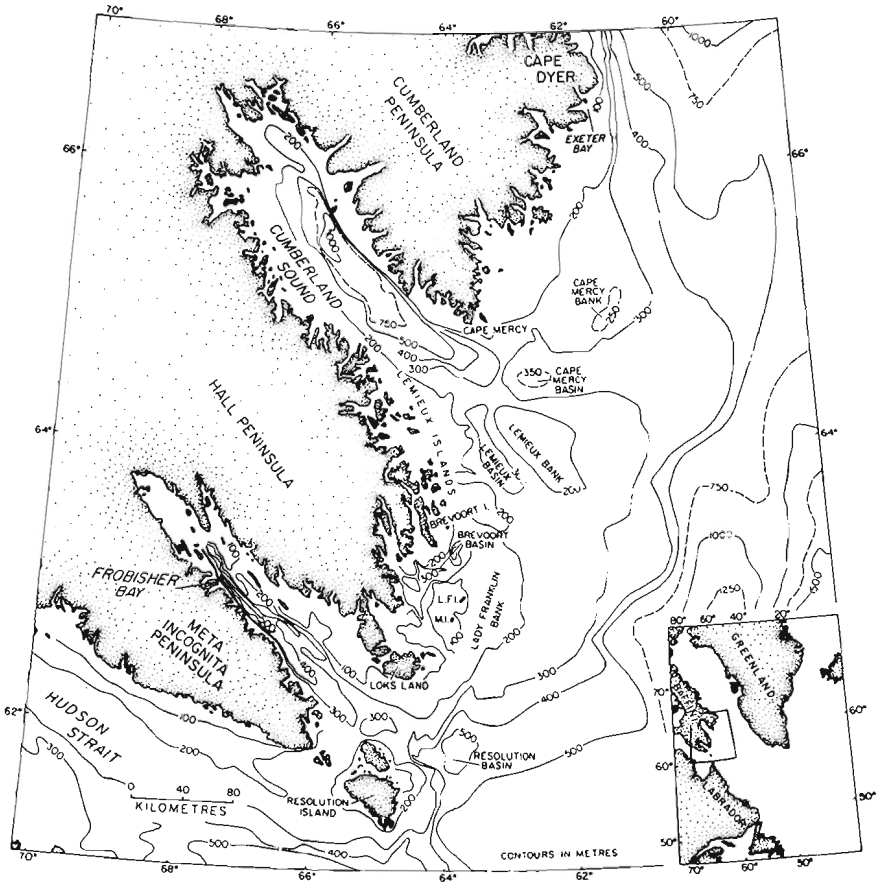

Figure 2

Generalized bathymetry and location of geographic localities referred to in the text. Some offshore features are informally named for convenience in description. Bathymetric contours were derived from published charts and from track data in Figure 3. LFI = Lady Franklin Island; MI = Monumental Island.

Precambrian metamorphic rocks, which comprise most of the eastern Baffin Island landmass (Blackadar, 1967; Douglas, 1969; Jackson and Taylor, 1972), extend offshore a short distance in most areas of the shelf. They are overlain by Ordovician limestone in parts of Frobisher Bay, Cumberland Sound, and along the shelf east of Hall and Cumberland peninsulas. Lower Cretaceous semiconsolidated sediments have been found in Cumberland Sound (MacLean and Williams, 1983), but elsewhere on the southeast shelf Mesozoic strata appear to occur only locally at the bedrock surface, e.g. in "diapiric" structures off Cumberland Sound (MacLean et al., 1982). Older rocks are overlain seaward by extensive Cenozoic sediments and volcanics. Paleocene basalts and continental sediments occur onshore in the Cape Dyer area (Clarke and Upton, 1971) and associated Tertiary basalts in the offshore to the southeast (MacLean et al., 1978). These are overlain by gently seaward dipping semiconsolidated Tertiary strata, which have been disrupted in the region offshore from Cumberland Peninsula by the emplacement of sedimentary or volcanic "diapirs". The tectonic history of the Davis Strait region has been dominated by a transform fault zone in which large amounts of volcanics were extruded and wrench related structures were formed (Klose et al., 1981). The rocks of the shelf were extensively bevelled by erosion after the early Eocene. The Tertiary sediments in places are unconformably overlain by flat lying strata of a semiconsolidated cover unit, of probable Plio-Pleistocene age[1] (MacLean et al., 1977).

Terrestrial Quaternary geology

Numerous studies have revealed a significant difference between the record of the last or Wisconsinan glaciation at the southern margins of the Laurentide Ice Sheet Complex (Prest, 1970) and the record of the last glaciation at the northeast Laurentide margin (Miller et al., 1977). The term 'Foxe Glaciation', proposed by Andrews (1968) for the glaciation which occurred between ca. 120 000 and 6000 B.P.[2] in the eastern Canadian Arctic is used herein as a northeast Laurentide correlative of the Wisconsinan Glaciation of southern regions.

The Quaternary deposits of southeast Baffin Island have been the subject of speculation since at least 1883, when Franz Boas traversed the shores of Cumberland Peninsula and noted raised marine features (Boas, 1884). However, most work has been conducted in the last 25 years by researchers from the Institute of Arctic and Alpine Research at the University of Colorado, the Geological Survey of Canada, the former Geographical Branch of the Canadian Department of Mines and Technical Surveys, and others.

Little is known about the number and periodicity of glaciations prior to the Foxe Glaciation (Andrews and Miller, 1976). Relative age dating of glacial deposits, based on studies of rock and soil weathering characteristics (Birkeland, 1974), has revealed a prominent weathering break that separates less weathered deposits of the Foxe Glaciation from one or more highly weathered zones related to pre-Foxe glaciations (Pheasant and Andrews, 1973; Dyke, 1977; Locke, 1980; Miller, 1980; Muller, 1980). The absolute ages of the pre-Foxe weathering zones are uncertain, but some of the most mature areas may not have been subjected to glacial erosion for the duration of the Quaternary (Osterman et al., 1984).

The Foxe Glaciation was preceded by the Flitaway Interglacial (Pheasant and Andrews, 1972); marine sediments of the Flitaway on northern Cumberland Peninsula have been U-series dated at 137 000 ± 12 000 years old (Pheasant and Andrews, 1973), and associated pollen assemblages suggest a

[1] For the purposes of this discussion, the Plio-Pleistocene cover unit will be considered a pre-Quaternary (bedrock) unit.

[2] The annotation B.P. is used herein to indicate "radiocarbon years before present", where present is taken as 1950 A.D.

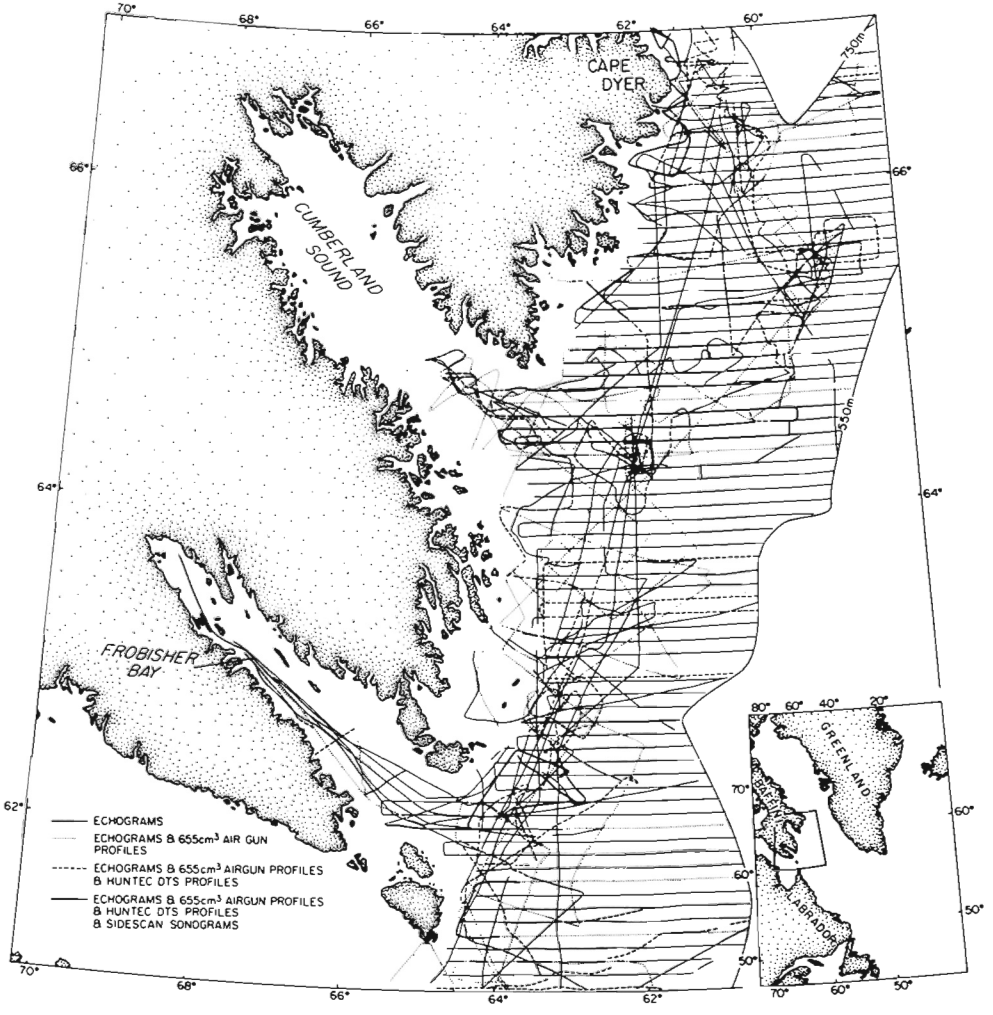

Figure 3. *Type and distribution of acoustic data. The 550 m and 750 m isobaths denote the seaward edge of mapping.*

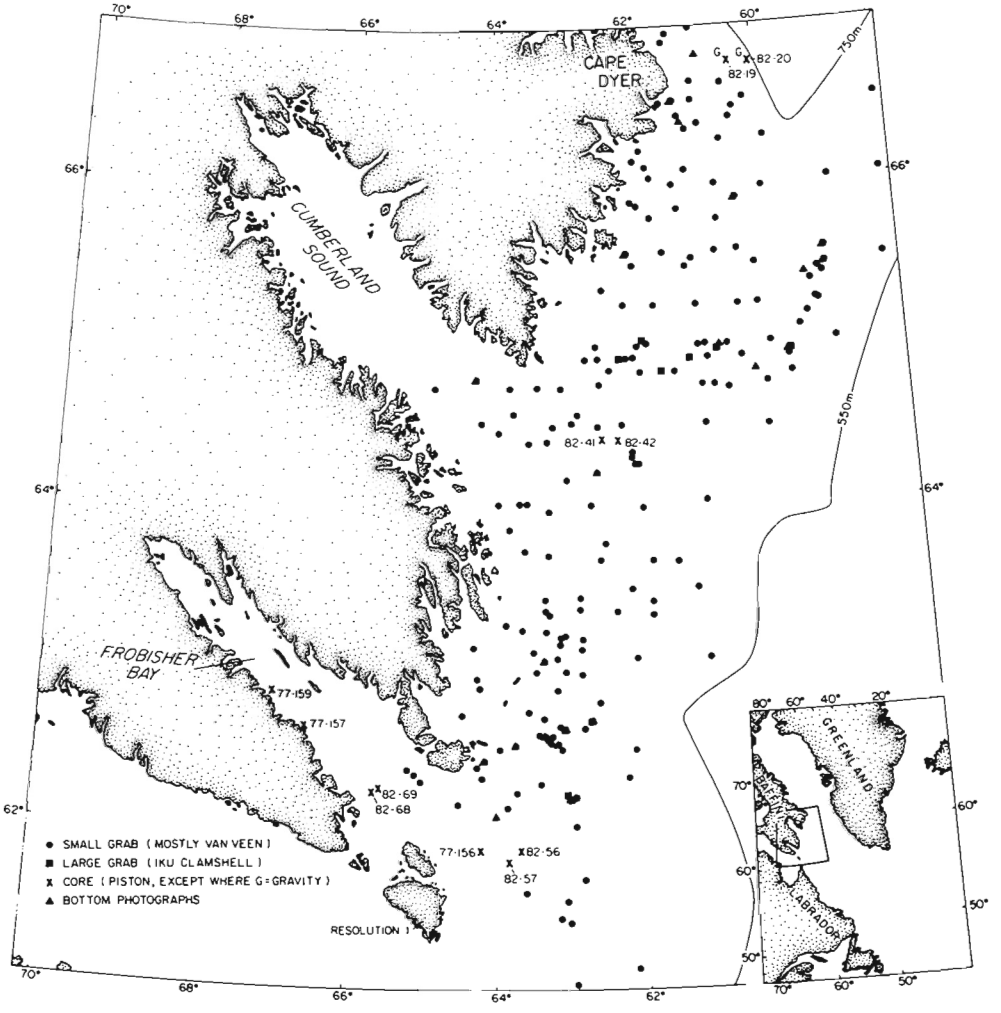

Figure 4. *Type and location of sample stations. Numbers identify core stations referred to in the text. The 550 m and 750 m isobaths denote the seaward edge of mapping.*

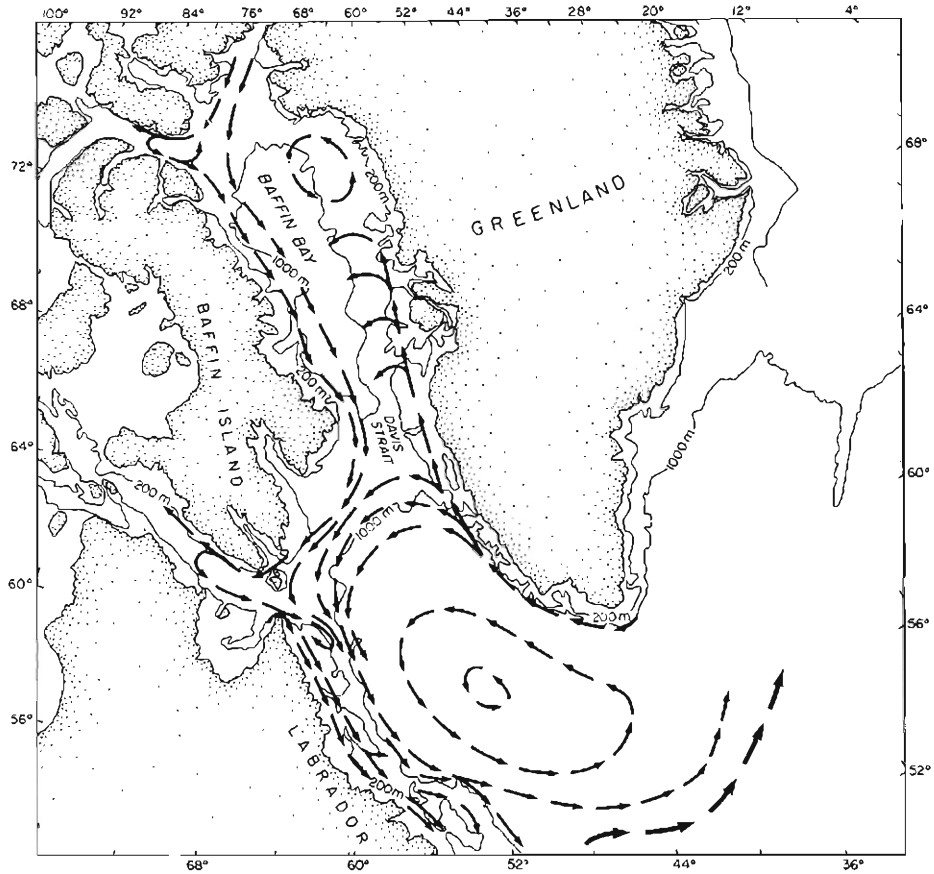

Figure 5

Major surface currents of the Baffin Bay-Labrador Sea area (from Akenhead et al., 1981).

duration for this event well in excess of 10 000 years (Miller et al., 1977). The deposits of the Foxe Glaciation include three glacial stades, early (ca. 120 000 to ca. 60 000 B.P.), middle (ca. 60 000 to ca. 28 000 B.P.) and late (ca. 28 000 to ca. 7500 B.P.) (see Miller, 1975). Each successive stade was of more restricted extent. Evidence for an early Foxe glacial advance on southeast Baffin Island is found in recessional glacial marine sediments on Allen Island, eastern Hall Peninsula (Osterman et al., 1984), in the Duval moraines of southwest Cumberland Peninsula (Dyke, 1977), and possibly in the Sunneshine drift of the Cape Dyer area (Locke, 1980). All three deposits are suggested correlatives of the Ayr Lake till of the Clyde Foreland Formation (Miller et al., 1977), deposited prior to 70 000 B.P. (Andrews et al., 1980). A mid-Foxe glacial advance is recorded in the recessional glacial marine sediments of Loks Land, radiocarbon dated at >40 000 B.P. (Miller, 1980; Osterman et al., 1984), and in the Outer Usualuk moraines of southwest Cumberland Peninsula (Dyke, 1977). The earliest evidence for a late Foxe glacial advance is the Hall moraine on Hall Peninsula, deposited immediately prior to 10 760 B.P. (Miller, 1980). Behind the Hall moraine, the Frobisher Bay moraine extends across Hall Peninsula from the head of Frobisher Bay to the head of Cumberland Sound (Blake, 1966; Miller, 1980), where it is correlated with the Ranger moraine complex (Dyke, 1977), which in turn is correlated with the Gilbert moraine of the Cape Dyer area (Locke, 1980). These three moraine systems are considered correlatives of the Cockburn moraine(s) of northeast Baffin Island, dated at ca. 8000-9000 B.P.

Holocene glacial history following the Cockburn advance has been dominated by local mountain glacier activity (Miller, 1976), and by fluctuations of the Penny and Terra Nivea ice caps (Miller, 1975; Muller, 1980). The period has been divided into the 'thermal maximum' from about 7500 to 5000 B.P. (Pheasant and Andrews, 1973), a partial equivalent to the Hypsithermal of Deevey and Flint (1957), and the Neoglacial from about 5000 B.P. to the present

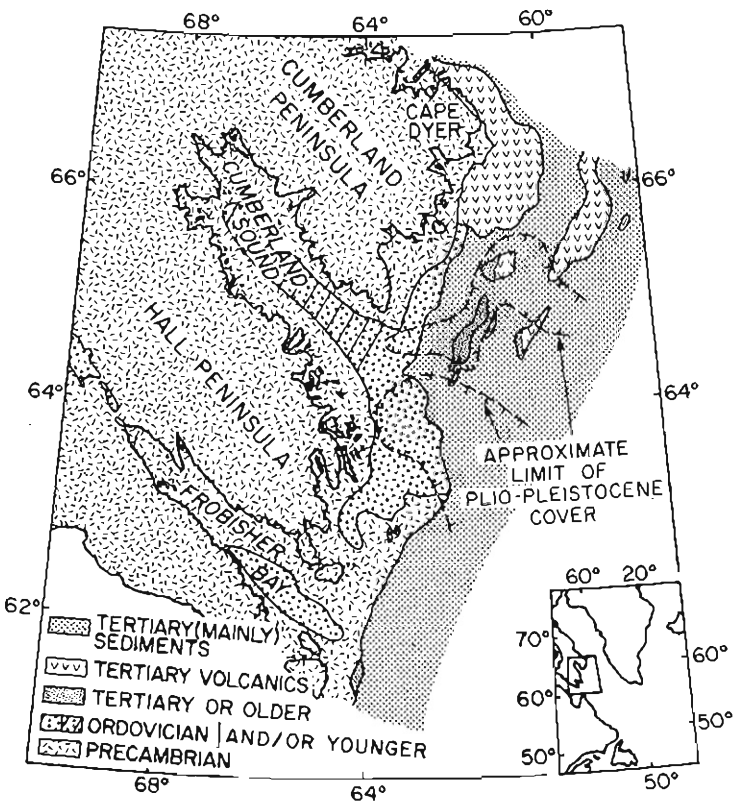

Figure 6. Generalized bedrock geology of the southeast Baffin region.

(Pheasant and Andrews, 1973), a time of climatic change associated with increased glacier activity (Porter and Denton, 1967).

A complementary aspect of terrestrial/coastal research on eastern Baffin Island has been the delineation of Foxe relative sea level (RSL) positions (e.g. England and Andrews, 1973; Miller, 1975; Miller et al., 1977; Dyke, 1977; Andrews, 1980; Miller, 1980). Glacial stades were roughly coincident with cycles of higher RSL (Andrews, 1980; Miller, 1980), which on southeast Baffin Island do not appear to have exceeded 120 m in height (Blake, 1966; Dyke, 1977; Miller, 1980), while interstadial/interglacial periods were associated with near-present or lowered RSL's. From observations on northeast Baffin Island, Andrews (1980) proposed a mid- to late-Foxe RSL lowstand of at least 80 m on the basis of (1) a consistent terrestrial stratigraphic unconformity, (2) apparent absence above present sea level of marine sediments between 10 200 and >40 000 B.P. in age, and (3) geomorphological evidence from echosounding off the Pigjoat Foreland northeast of Broughton Island (Fig. 1), which revealed submerged features interpreted as beach ridges and terraces. This lowstand, which he termed the Pigjoat, extended from ca. 50 000 to 10 000 B.P. and reached maximum regression ca. 18 000 B.P. There is a similar gap in the onshore depositional record to the south (e.g. Blake, 1966; Dyke, 1977; Miller, 1980) suggesting that a mid- to late Foxe RSL lowstand would also have affected southeast Baffin Island.

Quaternary geology of marine areas

Previous research offshore Eastern Canada has contributed much to our knowledge of both the Quaternary geology of the continental shelves and offshore investigative techniques. Early work on the Scotian Shelf by L.H. King and colleagues (e.g. King, 1970; King et al., 1972), using acoustic data from echo-sounders and shallow air gun and sparker seismic systems in conjunction with grab and core samples, served to define sediment units and outline the Quaternary history. The subsequent development of the Huntec deep-towed high-resolution seismic system (Hutchins et al., 1976) permitted investigation of the character and relationships of these sediment units in greater detail, e.g. King (1980), King and Fader (1985). These various studies have defined depositional environments of, and relationships among, glacial till, proglacial sediments, and postglacial sediments including lag sands and gravels.

Aspects of the Quaternary geology of the Labrador Shelf have been studied by a number of researchers, e.g. Fillon (1975), Fillon et al. (1981), Fillon and Harmes (1982), Josenhans (1983, 1984), Josenhans and Zevenhuizen (1984), Vilks and Mudie (1978), Vilks et al. (1974, 1984), Barrie and Piper (1982). The most recent studies (Josenhans, 1983, 1984; Josenhans and Zevenhuizen, 1984; Vilks et al., 1984) indicate the presence of three glacial tills, and pro-, sub-, and post-glacial sediments, some of which have been modified by iceberg scouring and current winnowing. The oldest till was deposited across virtually the entire shelf, while subsequent tills apparently were of more limited extent. An approximate age of 22 000-24 000 B.P. (Josenhans, 1984) is indicated for the youngest till in the central Labrador Shelf region.

North of the southeast Baffin Shelf study area, geological data on the Quaternary sediments of the shelf have been presented by Gilbert (1982), MacLean (1982, 1985) and MacLean et al. (1981). Studies have also been undertaken in Baffin Island fiords (see Syvitski and Blakeney, 1983 for details), and in deeper areas of Baffin Bay, e.g. Aksu (1980, 1983), Grant (1965), Marlowe (1966, 1968), Mudie (1980, 1982), Mudie and Deonarine (1983), and Pelletier et al. (1974).

On the nearby southwest Greenland Shelf preliminary studies indicate the presence of morainal accumulations of glacial material up to or greater than 100 m in thickness, which extend to the shelf edge and are partly overlain by ponded sediments. Iceberg scours are present in many locations to depths of 340 m, but may in part be relict (Brett and Zarudzki, 1979).

Marine geological investigations of the southeast Baffin Shelf began with the 1928 expedition of the **Marion** to Davis Strait and Baffin Bay, which collected 13 grab samples from the shelf that were described in terms of grain size, texture, and lithology (Trask, 1932). Perry (1961) collected three core and six grab samples from 34-650 m of water in Frobisher Bay, and described the sediments. Kranck (1966) studied 127 grab samples from the Exeter Bay area (Fig. 2) in terms of grain size, gravel lithology, heavy mineral distributions, and gravel texture. She concluded that inner sandy sediments could be derived from reworking of till by tidal currents among the nearshore islands. The presence of 'foreign' lithologies, particularly limestone, among the offshore gravel suggested deposition by ice rafting, kept free of fines by the Baffin Current. However, McMillan (1973) suggested the limestone gravel here and on the Labrador Shelf was derived primarily from glacial erosion of hitherto unmapped carbonate bedrock.

Regional studies by Grant (1975) and MacLean et al. (1977, 1978, 1982) have obtained data on both the Quaternary and bedrock geology of the southeast Baffin Shelf. Praeg (1982) presented a map of seafloor roughness for the southeast shelf. Praeg (1983) studied the surficial sediments of the Lady Franklin Bank area (Fig. 2) from 23 grab samples. More localized Quaternary studies have been undertaken on the shelf by researchers from the Centre for Cold Ocean Resources Engineering (C-CORE), namely Barrie (1980), Barrie et al. (1982), Pereira (1983), Pereira and Woodworth-Lynas (1983), Woodworth-Lynas (1983a,b), and Pereira et al. (1984). The exploration for hydrocarbons has resulted in other published and unpublished reports, e.g. MacLaren Atlantic Ltd. (1976), Hardy and Associates Ltd. (1977), and Pereira and Gillespie (1983).

Osterman (1982) conducted foraminiferal, lithologic, and chronologic zonation and correlation of three cores (77-021-156, -157 and -159; Table 1; Fig. 4) in the Frobisher Bay area, and recognized evidence for the advance and retreat of an ice shelf environment, which she correlated with the ice advance that deposited the Hall moraine on adjacent Hall Peninsula immediately prior to 10 760 B.P. (Miller, 1980). Osterman and Andrews (1983) discussed the significance of foraminiferal and lithologic changes in core 159 and presented paleomagnetic evidence to substantiate the earlier radiocarbon chronology. Osterman et al. (1984) presented additional evidence from core 156 at the mouth of Frobisher Bay which suggested a second (prior) glacial episode and an interstadial event.

The Quaternary palynology of Baffin Bay has been studied by Mudie (1980, 1982), Mudie and Deonarine (1983), and Mudie and Short (1985). This work shows that pollen and dinoflagellate assemblages in surface sediments correspond to climatic zones onshore and to surface water temperature/salinity characteristics in fiords and offshore. Mudie and Short (1985) have defined down-core pollen zones for core 77-021-159 from Frobisher Bay and for several cores from farther offshore.

METHODS

Many of the techniques employed in this study are similar to those used to investigate the surficial geology of parts of the Canadian east coast continental shelf farther south, e.g. King (1970), Josenhans (1983), King and

Table 1. Core stations referred to in the text (see Fig. 4 for locations)

Station number	Location Latitude	Longitude	Water depth (m)	Type	Length (cm)	Map unit
77-021-156	61°51.5'	64°12.3'	487	Piston	313	2A*
77-021-157	62°38.4'	66°35.9'	497	Piston	215	2A
77-021-159	62°50.5'	67°02.4'	570	Piston	969	2A
82-034-19	66°42.2'	60°19.2'	550	Gravity	44	2B**
82-034-20	66°44.6'	59°59.9'	690	Gravity	144	2A
82-034-41	64°25.5'	62°26.4'	340	Piston	368	2A
82-034-42	64°24.7'	62°13.0'	340	Piston	70	2B
82-034-56	61°51.0'	63°39.3'	523	Piston	152	2B
82-034-57	61°46.8'	63°49.7'	549	Piston	434	2A
82-034-68	62°13.3'	65°40.2'	311	Piston	594	2A
82-034-69	62°14.9'	65°35.0'	315	Piston	443	2A

*2A = Davis Strait Silt subunit A
**2B = Davis Strait Silt subunit B

Fader (1985). Marine geological investigations of the Baffin Shelf have included studies of both the bedrock and the Quaternary sediments. Underway data from towed and hull mounted systems required for both these studies have been acquired simultaneously in most areas (Fig. 3). Continuous single channel seismic reflection profiles were collected using a 655 cm^3 Bolt Associates air gun source with Seismic Engineering or Nova Scotia Research Foundation hydrophones. High resolution seismic reflection profiles were collected using a Huntec deep-towed seismic (DTS) system (for a detailed description of the Huntec DTS system, see Hutchins et al., 1976). A Bedford Institute of Oceanography dual channel 75 khz sidescan system with 750 m lateral range was used to produce sidescan sonograms. Echograms were collected primarily using 12 khz or 32 khz hull mounted sources, and Kelvin Hughes 26B (14.25 khz) records are available for some areas.

On the Scotian Shelf the occurrence of significant areas of clayey sediments permitted delineation of sediment types using 14.25 khz echosounder records, which were available along closely spaced tracks from Canadian Hydrographic Service bathymetric surveys (e.g. King, 1970). However, on the southeast Baffin Shelf (1) bathymetric track control is more widely spaced, and is virtually nonexistent in many areas within 10-20 km of the coast, and (2) sediments generally contain sufficient coarse components that they are not penetrated by ships' echosounders. Therefore data from Huntec DTS profiles have been used in conjunction with 655 cm^3 air gun records to define and delineate map units, while echosounder data have been utilized to assist in interpretation of some Huntec DTS profiles and in delineation of the boundaries of morphologically distinct units.

Sampling of the sediments to provide textural, paleontological and age control has included coring with Benthos piston and gravity corers, and grab sampling with Van Veen, Shipek and large Norwegian clamshell (IKU) samplers (Fig. 4). Of the grabs, the IKU clamshell sampler proved especially useful because of its ability to penetrate through the often coarse surface zone of current modification into the main components of the map units, and thus to provide material representative of both. The smaller, lighter Van Veen and Shipek samplers mainly sampled the current modified surface material. Additional data on seabed sediments and conditions were obtained from bottom photographs, and investigations in a few areas from the research submersible **Pisces IV** (MacLean, 1982).

Methods used to extract and analyze foraminiferal and palynomorph assemblages in surface samples and cores follow the standard techniques employed for Quaternary shelf sediments as reported by Mudie et al. (1983) for foraminifera, and by Mudie (1982) for pollen.

Navigational positioning for data acquired prior to 1975 was mainly by Satellite Navigation supplemented by radar ranges and bearings. Positioning of subsequent tracks and stations has utilized BIONAV, the Bedford Institute of Oceanography integrated navigation system, which embraces rho-rho Loran-C, Satellite Navigation and log and gyro, supplemented by radar ranges and bearings.

QUATERNARY SEDIMENTARY UNITS

The bedrock units of the southeast Baffin Shelf (Fig. 6) are extensively overlain by Quaternary sediments. Four units have been distinguished acoustically, and they are informally referred to as: the Baffin Shelf Drift, the Davis Strait Silt, the Tiniktartuq Silt and Clay, and the Resolution Island Lag. In addition both the Drift and the Silt are divided into subunits. The surficial distribution of each is shown in Figure 7, and they are discussed individually below. The surface of the seafloor sediment units has been texturally modified to varying degrees by bottom currents, as discussed later.

The variation in total thickness[1] of Quaternary sediments is illustrated in Figure 8. Greatest thicknesses occur in a large accumulation of sediments in the southern part of the study area: 300 m and 160 m southeast and northeast of Resolution Island, respectively. Thicknesses greater than 50 m and up to 100 m occur in the mouth of Cumberland Sound, and in three localities on the outer shelf east of Cape Mercy and east of Brevoort Island. Elsewhere on both the outer and inner shelves most sediments are less than 25 m thick. Large areas less than 5 m thick are present on the inner and outer shelves east and southeast of Cape Dyer and east of Loks Land, and in the area of the Lemieux Bank east of the Lemieux Islands.

Baffin Shelf Drift (map unit 1)

The Baffin Shelf Drift is an informal term proposed for diamictons interpreted to have been deposited on the Baffin Shelf by grounded glacial ice. The Drift constitutes a significant proportion of southeast shelf sediments, both in surface and subsurface extent. It unconformably overlies all 'bedrock' units (Fig. 6), directly underlies and in some areas

[1] Thicknesses discussed here and elsewhere in the text were measured from seismic profiles, and are based on an assumed velocity of sound in water of 1.46 km/s. Actual sediment thicknesses may be greater.

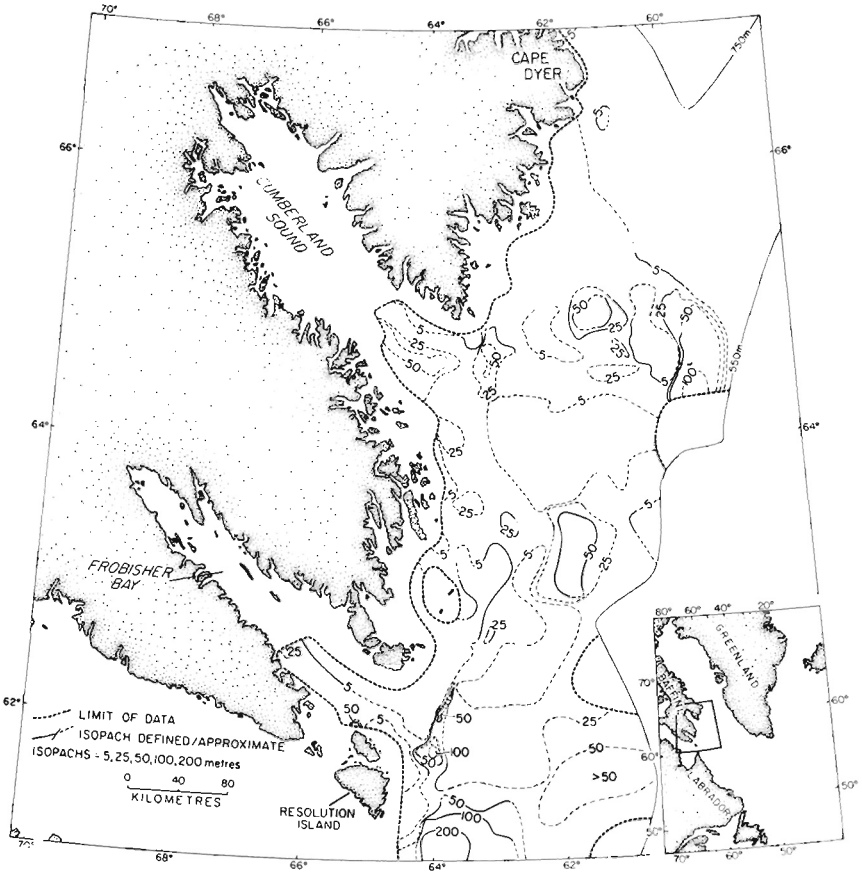

Figure 8

Isopach map of Quaternary sediments on the southeast Baffin Shelf. Thicknesses are interpreted from 655 cm^3 air gun and Huntec DTS system seismic reflection profiles and are based on the velocity of sound in water.

laterally interfingers with the Davis Strait Silt, underlies the Tiniktartuq Silt and Clay, and in places directly underlies the Resolution Island Lag.

Acoustic characteristics and lithology

Previous research offshore Eastern Canada using both acoustic data and sample control has demonstrated that diamictons deposited directly by grounded glacial ice (till) can be distinguished from water-laid, ice-proximal glacial marine diamictons on the basis of acoustic character (King, 1970; King, 1980; King et al., 1972). Glacial tills are characterized on Huntec DTS and 655 cm^3 air gun profiles by: (1) a general lack of coherent internal reflectors, (2) a commonly irregular to rough surface, which is independent of control by the surface on which the till lies, and (3) the local development of thick morainal accumulations. Similar features characterize the Baffin Shelf Drift. These sediments therefore are interpreted to comprise mainly glacial till. However, they may locally include undetected ice-contact stratified material, and are therefore referred to as drift.

The Baffin Shelf Drift is divided into three subunits (Fig. 7) on the basis of acoustic character.

Subunit A

This division comprises areas of the unit that conform to the criteria indicated above, and that are therefore confidently interpreted as glacial drift. These areas include occurrences of moraines, multiple till sequences and thin cover (e.g. Fig. 9, 10, 11). A few samples of subunit A have been obtained with IKU or smaller shallow surface grab samplers which penetrated the current-modified surface veneer. The sediments are poorly sorted, polymodal mixtures of sand and gravel in a cohesive silt and clay matrix.

Subunit B

This division consists of sediments of different but distinctive acoustic character, which are less confidently interpreted as glacial drift. Subunit B occurs east of Cape Mercy and Brevoort Island, where 655 cm^3 air gun profiles reveal moraine-like accumulations up to 100 m thick which include both stratified and unstratified intervals, and which unconformably overlie the Plio-Pleistocene cover unit or older bedrock units (Fig. 13). Where present at the seafloor these sediments are characterized by resistance to scouring by grounded icebergs (Fig. 14). East of Cape Mercy scarps are observed, primarily at the seaward limit of the sediments (Fig. 15). Subunit B has not been successfully sampled. Large unstratified intervals and moraine-like buildups suggest that these sediments are at least in part an ice contact deposit, and they are tentatively included in the Baffin Shelf Drift. The stratigraphic relationship between Drift subunits A and B is unclear, due to poor acoustic definition and limited coverage. Areas where division of the Drift into subunit A or B is uncertain are shown on Figure 7 as undifferentiated Drift.

Subunit C

This division occurs east of Cumberland Peninsula (Fig. 7) where Huntec DTS profiles and sidescan sonograms reveal subparallel ridges and troughs of glacial drift which are partly overlain by ponded sediments up to 6 m thick (Fig. 16, 17). The drift and the ponded sediments occur in such close association that they cannot be mapped separately with the present acoustic coverage (Fig. 3). The two sediment types appear to occupy approximately equal areas

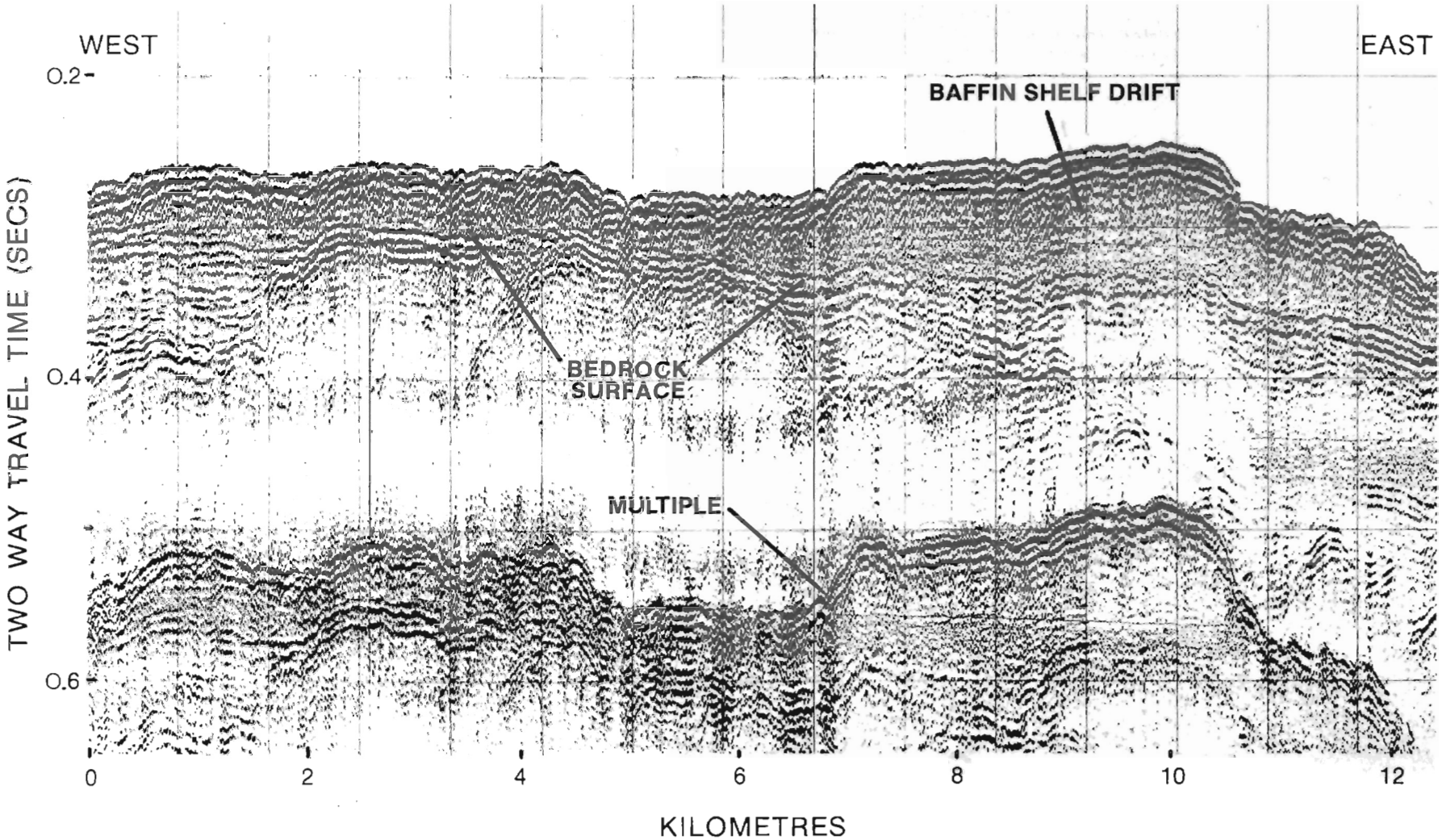

Figure 9. *655 cm³ air gun seismic reflection profile showing a moraine of the Baffin Shelf Drift subunit A overlying bedrock east of the Lemieux Islands (see Fig. 7 for location).*

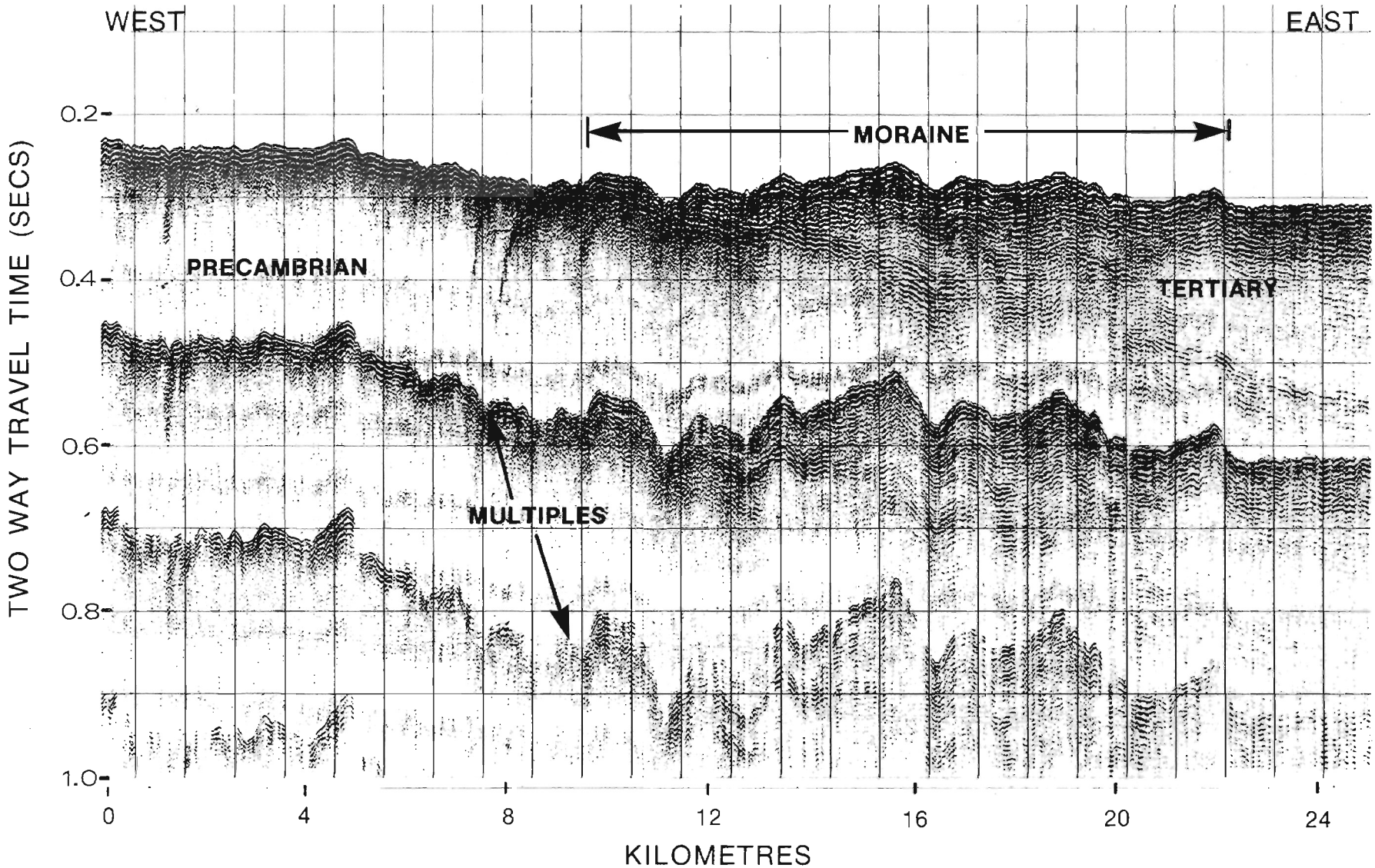

Figure 10. 655 cm^3 *air gun profile illustrating a moraine of the Baffin Shelf Drift subunit A on the east side of Lady Franklin Bank (see Fig. 7 for location), close to the contact between Precambrian metamorphic bedrock to the west and Tertiary sedimentary bedrock to the east.*

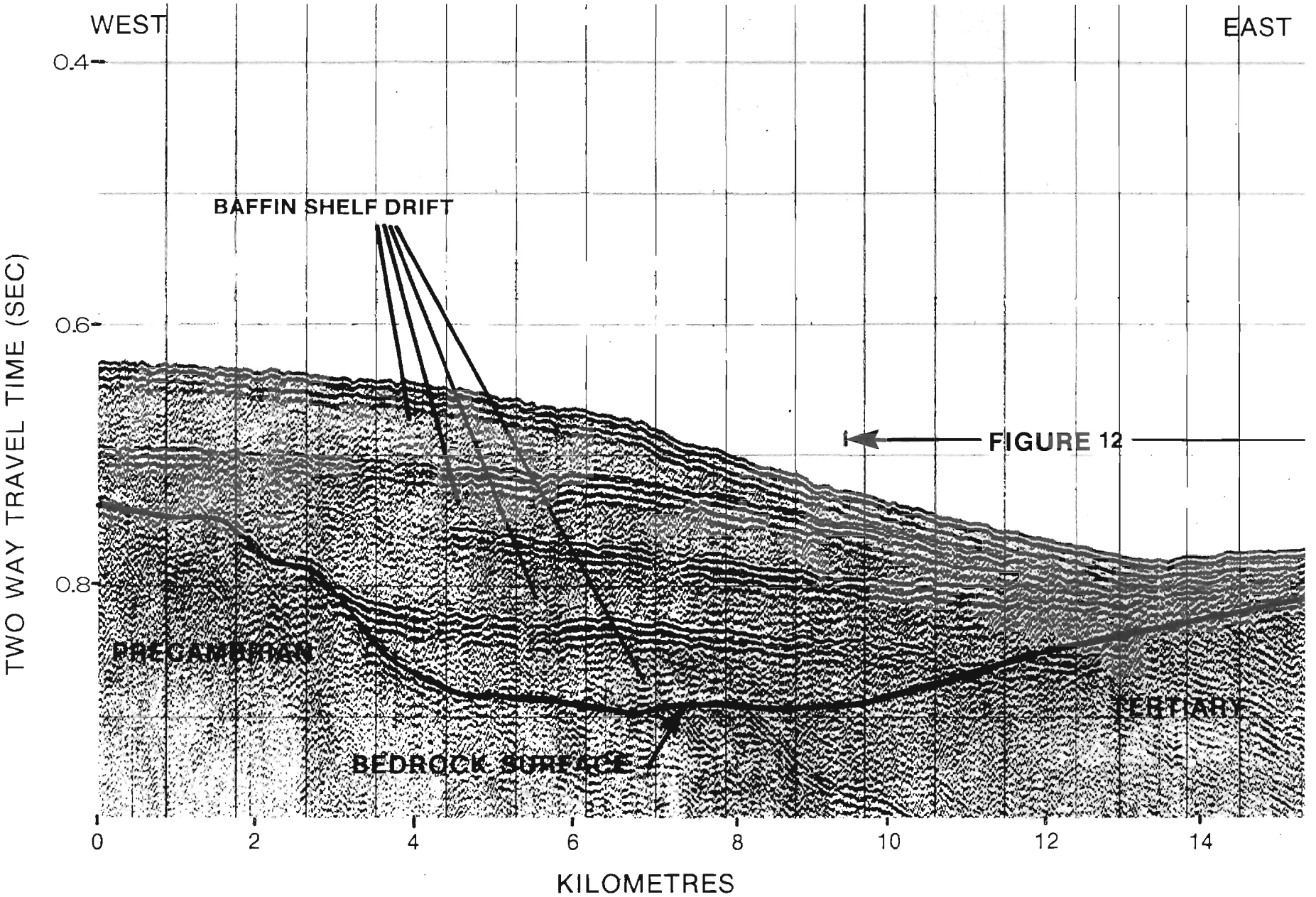

Figure 11. 655 cm^3 air gun profile illustrating a multiple sequence of tills in a moraine of the Baffin Shelf Drift subunit A, northeast of Resolution Island (see Fig. 7 for location). The moraine overlies the contact between Precambrian metamorphic bedrock to the west and Tertiary sedimentary bedrock to the east.

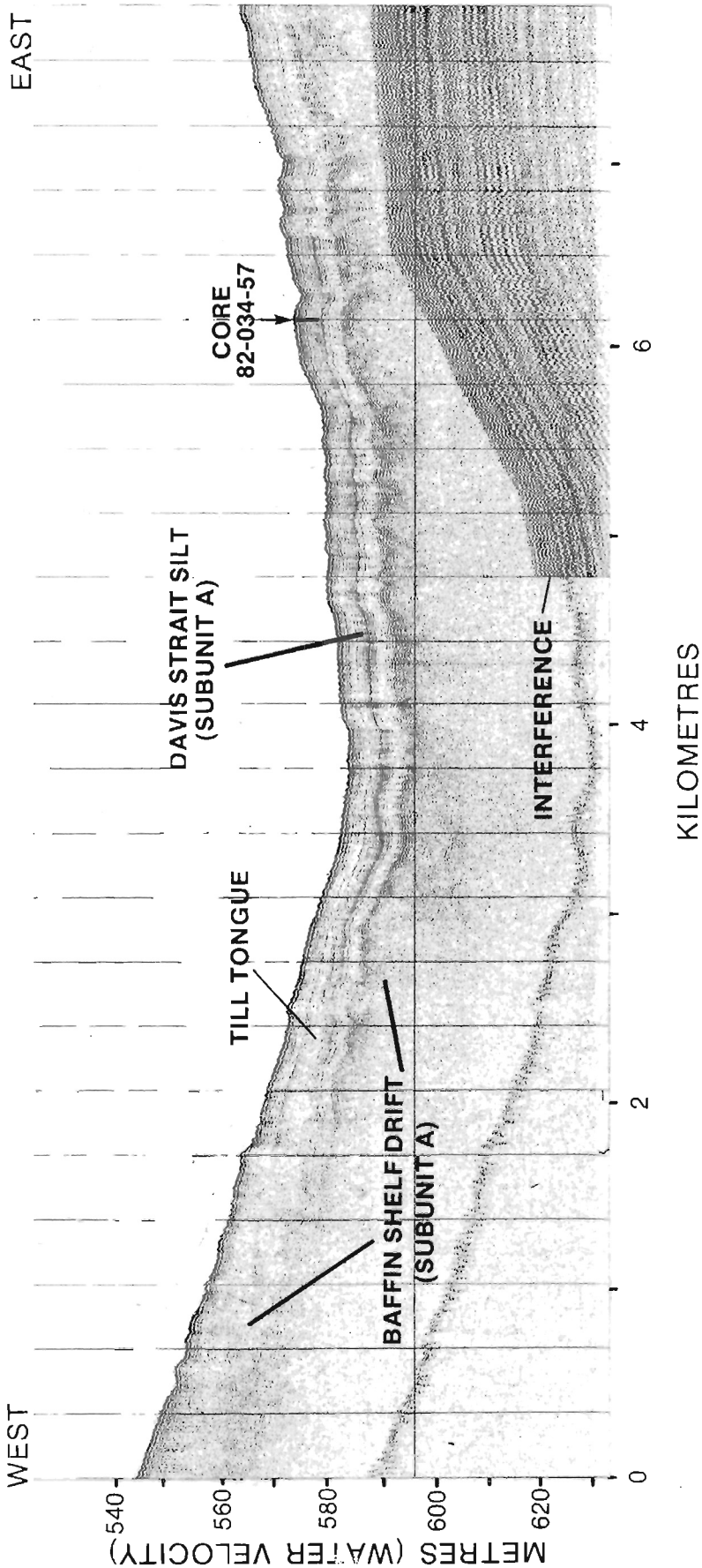

Figure 12. Huntec DTS high resolution seismic reflection profile illustrating the uppermost till of the multiple sequence northeast of Resolution Island (Fig. 11) interfingering with stratified sediments of the Davis Strait Silt subunit A (see Fig. 7 for location). The interfingering takes the form of a till tongue, which marks the seaward termination of grounded glacial ice at the time. The approximate location of core 82-034-57 along the profile is indicated. A small, thin occurrence of Tiniktartuq Silt and Clay is present from about 3-4 km along the profile.

of seafloor (Fig. 17), so the area is arbitrarily mapped within the Baffin Shelf Drift. Grab samples obtained from the current modified surface of the drift mainly consist of sands and gravels. In contrast, grab samples from areas of the ponded sediments are gravel free, consistent with textural differences suggested by sidescan sonar imagery (Fig. 17). The ponded sediments may be correlatives of either the Tiniktartuq Silt and Clay or the Davis Strait Silt.

Regional distribution and thickness

The regional variability in thickness and approximate subsurface extent of the Baffin Shelf Drift is illustrated in Figure 18. Drift subunit A attains maximum observed thicknesses of 300 m, 160 m and 100 m in morainal sequences of multiple tills located at the entrance to Hudson Strait, northeast of Resolution Island (Fig. 10), and in the mouth of Cumberland Sound, respectively. However, outside these areas subunit A is usually less than 25 m thick. Drift subunit B attains thicknesses of up to 100 m in three moraine-like accumulations east of Cape Mercy and east of Brevoort Island. It has not been recognized outside of these three areas. Glacial drift within subunit C is generally less than 25 m thick.

The Baffin Shelf Drift has a maximum seaward extent in the central part of the shelf, decreases in extent toward the north and the south, but appears to be present on the outer part of the shelf east of Hudson Strait and Resolution Island. Its approximate limit on the outer part of the shelf is shown by the zero isopach in Figure 18.

Sediments mapped as Baffin Shelf Drift on the outer part of the shelf east of Resolution Island and Hudson Strait (Fig. 7) appear to be the lateral equivalent of the Davis Strait Silt. Due to (1) a scale of relief much greater than that normally attributable to iceberg scouring, (2) a discontinuity between the Drift in this area and that of the multiple till sequence flanking the Hudson Strait sill (Fig. 18), and (3) the coincidence of this occurrence with a seaward decrease in water depth, the Drift in this area is thought to result from deposition or modification of seabed sediments by touchdown of a floating iceshelf (Josenhans, personal communication, 1984).

From Resolution Island to just north of Brevoort Island, and south and east of Cape Mercy, deposits of Drift subunit A are usually thin (<5 m) on the inner part of the shelf, but at greater depths abruptly increase in thickness (Fig. 18); e.g. up to 30 m in the moraine

east of Lady Franklin Bank (Fig. 10), and up to 160 m in the multiple till sequence northeast of Resolution Island (Fig. 11). The water depth at which the increase in thickness occurs varies from about 200 m east of Hall Peninsula (Fig. 10), to 325 m in the mouth of Frobisher Bay and south of Cape Mercy. This abrupt increase in drift thickness frequently is approximately coincident with the underlying bedrock contact between Precambrian metamorphic rocks or Ordovician limestone, and softer Cenozoic sedimentary rocks (Fig. 10, 11). This is analogous to the Labrador Shelf, where Josenhans (1983) noted a similar increase in drift thickness seaward of the Precambrian/Cenozoic bedrock contact in the Cartwright Saddle area. He attributed the change to differential resistance to glacial erosion between the crystalline Precambrian rocks and the semiconsolidated Cenozoic sediments. Praeg (1983) studied the surficial sediments of the Lady Franklin Bank area which is underlain by thin drift (<5 m) that thickens to the east (Fig. 10, 18). His data indicated modification of the drift surface by currents, but of insufficient degree to account for the westward reduction in drift thickness. He suggested the change in drift thickness was related to the composition of the underlying bedrock units.

East of Lady Franklin Bank, a reduction in thickness of the Baffin Shelf Drift separates a moraine of subunit A from a moraine-like accumulation of subunit B to the east (Fig. 18). Similarly, east of Cape Mercy an inner wedge of rough-surfaced Drift subunit A up to 25 m in thickness is separated by an expanse of seafloor apparently devoid of Drift from a wide, moraine-like accumulation of Drift subunit B (Fig. 13, 18). To the north, however, the two subunits merge, and an inner zone characterized by subparallel ridges of glacial drift mapped within Drift subunit C (Fig. 16) grades into an outer zone characterized by low relief, shallow iceberg scours, and seaward termination in scarps similar to those of Drift subunit B to the south (Fig. 15). The surface and subsurface extent of subunits A and B in this area is uncertain.

Between Cape Mercy and Cape Dyer glacial drift is present on the inner part of the shelf in thicknesses up to 25 m (Fig. 18), overlying Precambrian/Ordovician bedrock (Fig. 6) to the shoreward limit of acoustic data (Fig. 3). There is no significant seaward increase in thickness across the subsurface contact with the softer Cenozoic sediments at 200-250 m depth. The reason for 'thick' drift here over resistant Precambrian/Ordovician bedrock, in contrast to areas to the south, is unclear. East of Cape Dyer, thin (<5 m) drift occurs on the inner shelf, but there is little increase in thickness observed in greater water depths. This possibly is due to the presence of resistant Tertiary volcanic rocks (Fig. 6), which constitute the bedrock seaward to depths of 500-600 m.

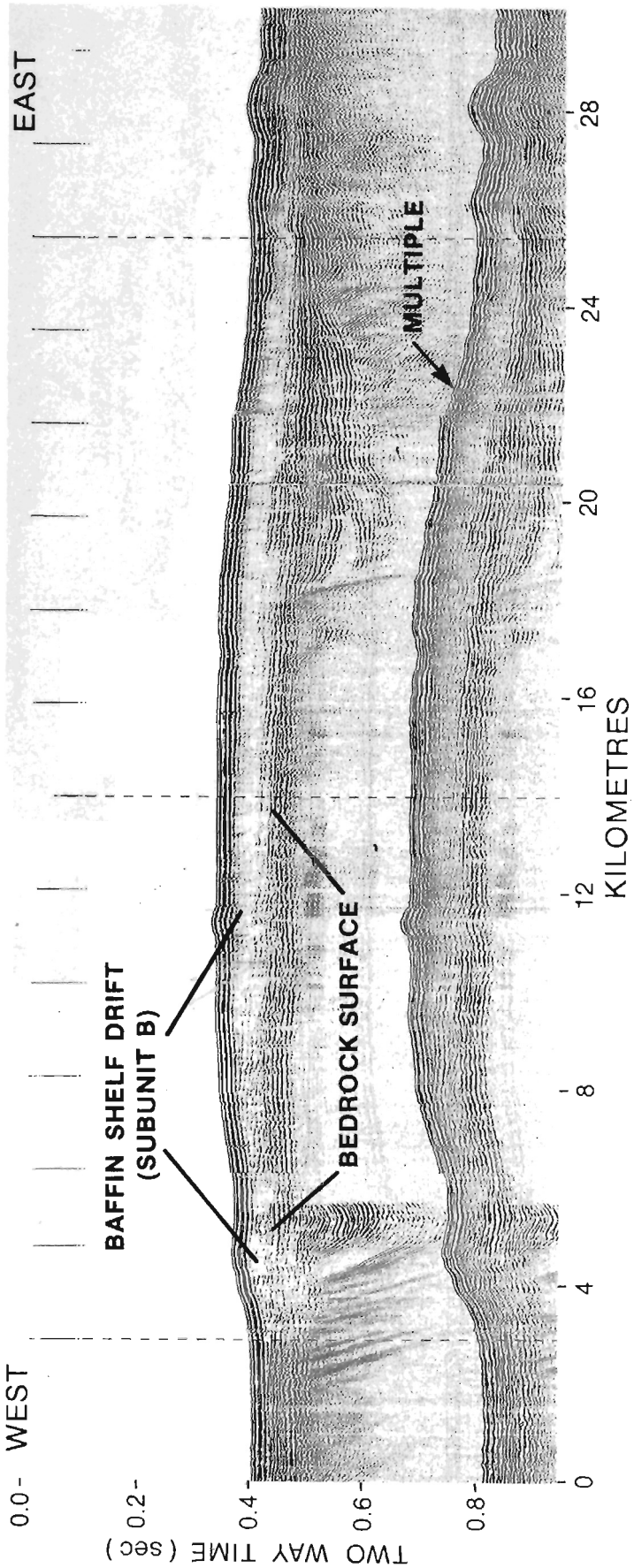

Figure 13. 655 cm^3 air gun profile showing a moraine-like accumulation of Baffin Shelf Drift subunit B on the central part of the shelf east of Cape Mercy (see Fig. 7 for location). The stratified and unstratified sediments of Drift subunit B overlie thin, flat lying strata of the Plio-Pleistocene cover unit and deformed Tertiary and other rocks.

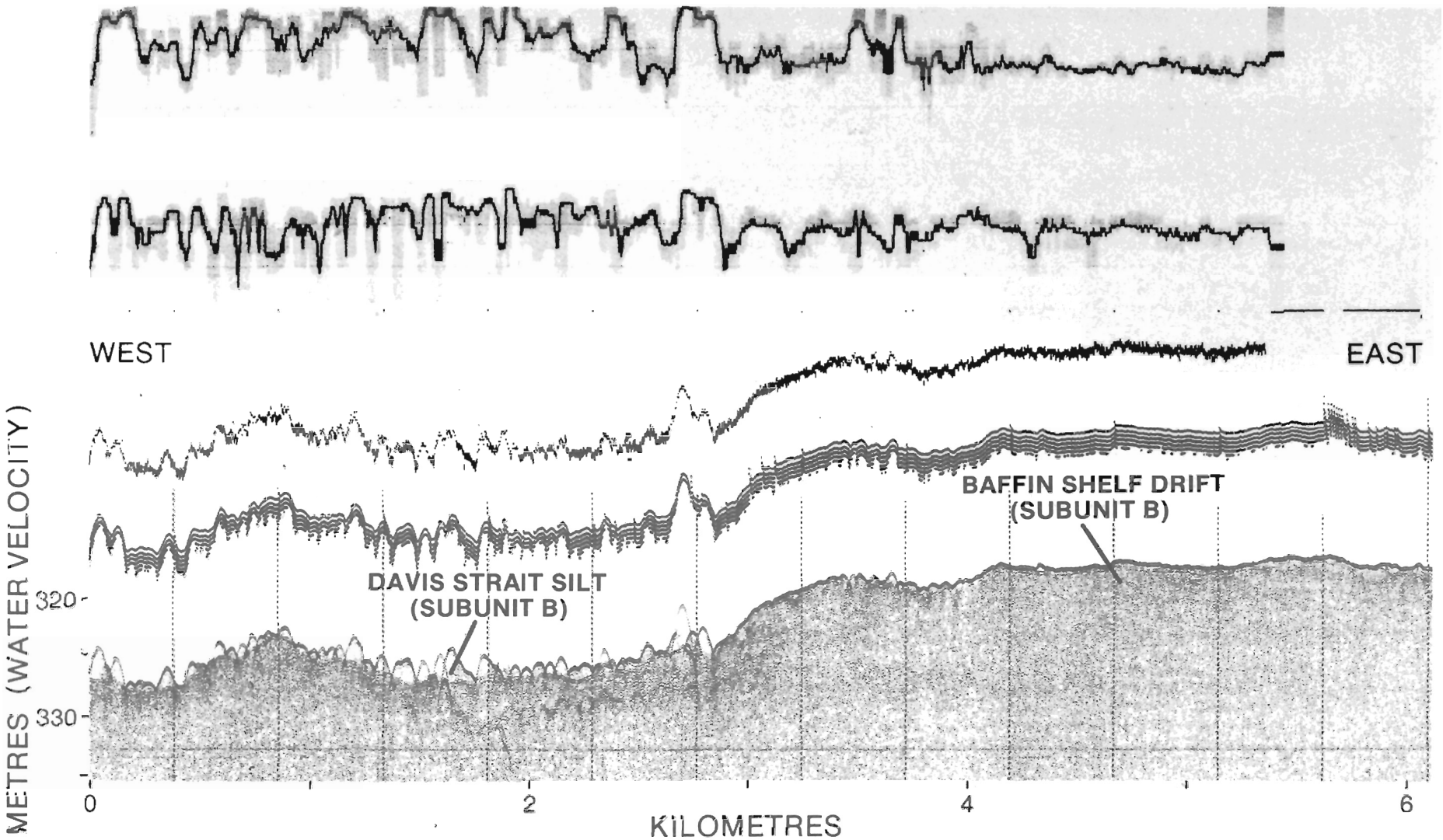

Figure 14. *Huntec DTS profile of the seabottom east of Cape Mercy, illustrating the greater resistance to iceberg scouring of the Baffin Shelf Drift subunit B on the right, compared to that of the Davis Strait Silt subunit B on the left (see Fig. 7 for location). Irregular lines across the upper part of this and other Huntec DTS profiles indicate acoustic reflectivities of the sediments (see Parrott et al., 1980 for description).*

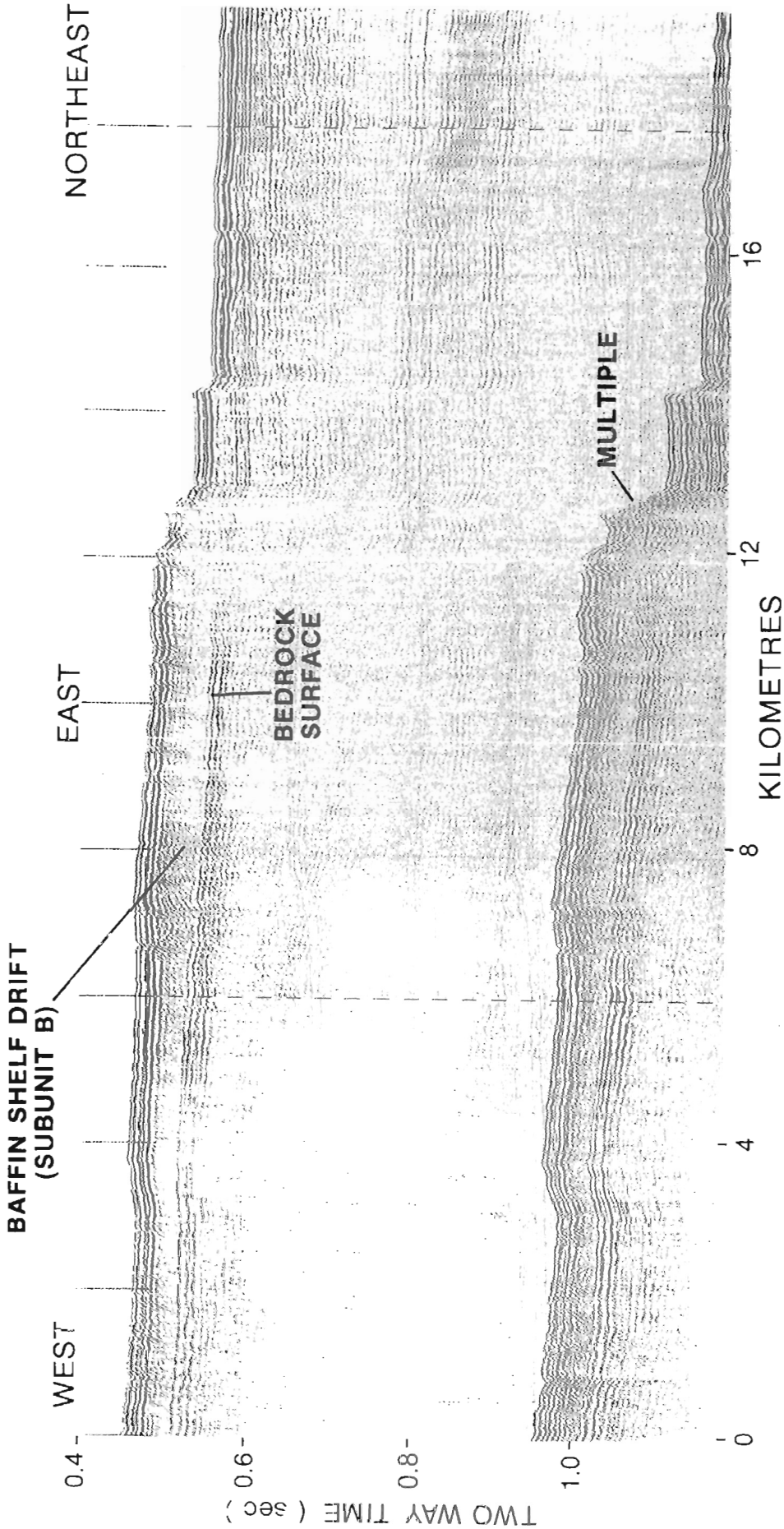

Figure 15. 655 cm^3 *air gun profile illustrating scarps at the seaward termination of Baffin Shelf Drift subunit B on the outer part of the shelf east of Cape Mercy (see Fig. 7 for location). Drift subunit B overlies gently seaward dipping strata of Tertiary sedimentary bedrock.*

On some areas of the Baffin inner shelf glacial drift and other sediments appear to be absent to the limit of resolution of the Huntec DTS system (30-50 cm) (Fig. 18). These areas are mapped as the Resolution Island Lag, and are discussed in the description of that unit.

Age constraints and interpretation

Northeast of Resolution Island a multiple sequence of up to four tills, totalling up to 160 m in thickness (Fig. 11, 18), occurs flanking the seaward slope of a sill at the entrance to Frobisher Bay (Fig. 2). The sequence thins to the north (Fig. 18) and only a single till is recognized on profiles east of Loks Land. To the south, the sequence similarly decreases in both number and thickness east of Resolution Island (Fig. 18), but increases again in the lee of the sill at the entrance to Hudson Strait (Fig. 2) where as many as five superimposed tills occur in thicknesses up to 300 m. The presence of more than one till sheet suggests repeated and possibly separate advances of glacial ice.

Northeast of Resolution Island the uppermost till interfingers with the stratified sediments of Davis Strait Silt subunit A (Fig. 12). This interfingering takes the form of a wedge-shaped till deposit which marks the seaward termination of grounded ice. Such relationships are widespread on the Scotian Shelf and Grand Banks of Newfoundland and have been described in detail by King and Fader (1985), who termed these features "till tongues". Northeast of Resolution Island the till tongue-stratified sediment interfingering indicates that the uppermost till and the Davis Strait Silt in this area are in part of equivalent age. Interfingering has also been recognized southeast of Resolution Island (Fig. 18) and in outer Frobisher Bay (Fig. 18, 19). The record of such relationships elsewhere may have been obscured by the intensive reworking of the Davis Strait Silt (subunit B) by grounding icebergs.

The age of the uppermost till northeast of Resolution Island is inferred from a radiocarbon date of 25 170 ± 420 B.P. (Table 2) on foraminifera from core 82-034-57 (Table 1; Fig. 4), which was collected from the

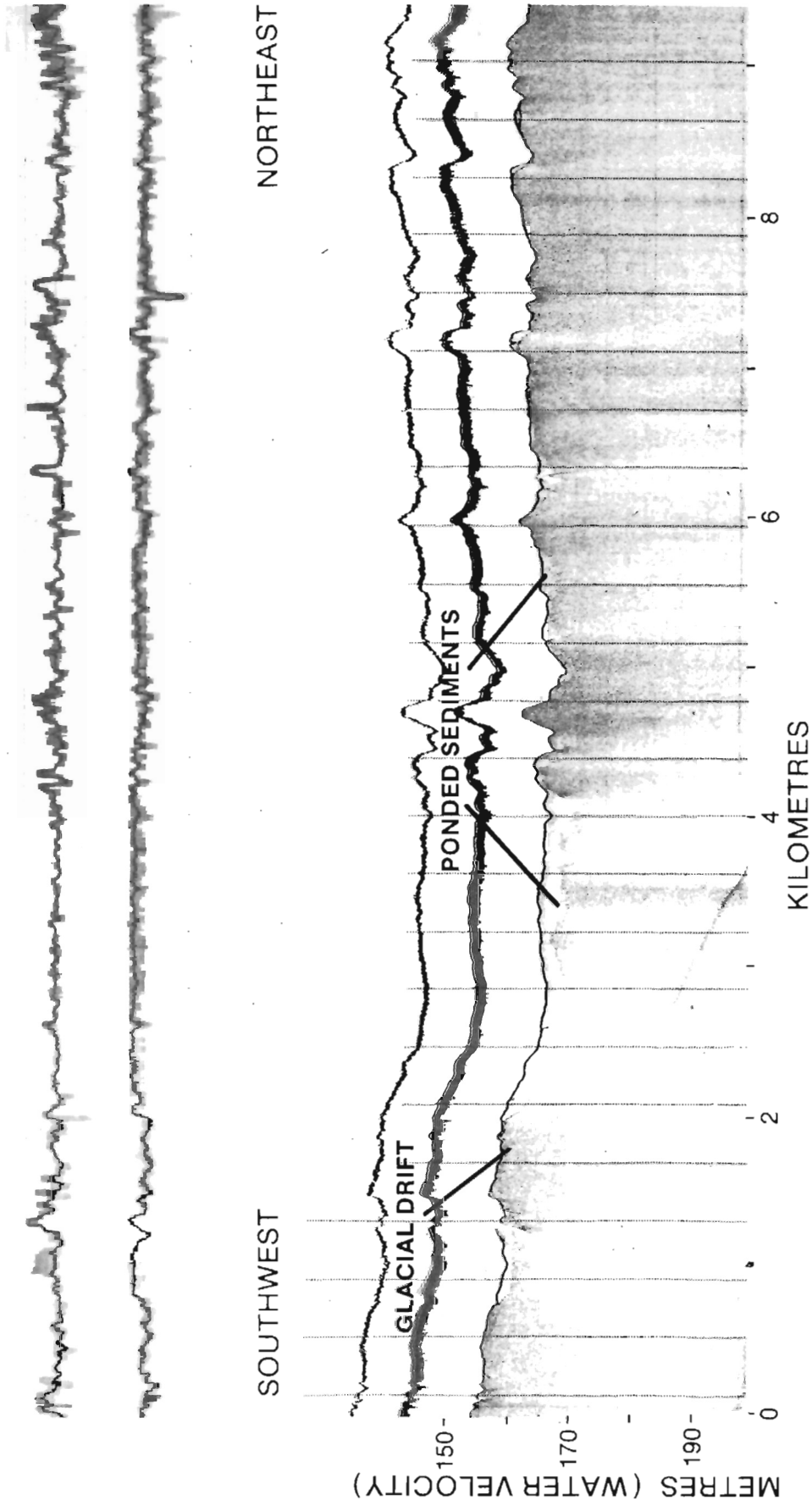

Figure 16. Huntec DTS profile illustrating rough surfaced glacial till partly overlain by ponded sediments east of Cumberland peninsula (see Fig. 7 for location). The two sediment types in this area are undifferentiated as Baffin Shelf Drift subunit C.

stratified sediments of the Davis Strait Silt subunit A approximately 3 km east of the seaward edge of the interfingering till tongue (Fig. 12). The date was obtained from 4.1-4.2 m core depth. Lateral correlation on a Huntec DTS profile across the area (Fig. 12) indicates that this depth is approximately stratigraphically equivalent with the seaward edge of the till tongue. This suggests that the uppermost till records a late mid-Foxe to early late Foxe glacial advance.

Land and marine evidence from the Frobisher Bay area are compatible with this age for the uppermost till of the multiple sequence. The Hall Moraine on Hall Peninsula, deposited immediately prior to 10 760 B.P. (Miller, 1980), represents the maximum seaward extent of late Foxe ice in that area; i.e. ice did not extend to the outer coast. On eastern Loks Land (Fig. 2) a radiocarbon date of 41 900 + 7100 -3700 B.P. (QC-446) was obtained from in situ paired valves of **Macoma calcarea** collected from undisturbed deltaic beds believed to be associated with deglaciation (Miller, 1980). This date is considered a minimum age (Miller, 1980; Osterman et al., 1984). These data indicate that the outer coast of Hall Peninsula has not been glacially overridden for at least 40 000 years. On southeast Meta Incognita Peninsula (Fig. 2), Blake (1966) reported ice flow indicators trending northeast and an associated limestone-rich till containing marine shells dated at 30 200 ± 1500 B.P. (GSC-414). He suggested this material was deposited by an advance of ice from Hudson Strait. Miller (1982) mapped ice flow directional indicators in the Meta Incognita Peninsula area, and interpreted the carbonate-rich drift to have been deposited by ice moving out of Ungava Bay from a major dispersal centre over Labrador, possibly during the mid-Foxe. This hypothesis was supported by northeast trending striae on the Hudson Strait coast of northern Quebec (Miller, 1982), and by later studies of foreign erratic clasts (slates, metabasalts, gneiss) from the

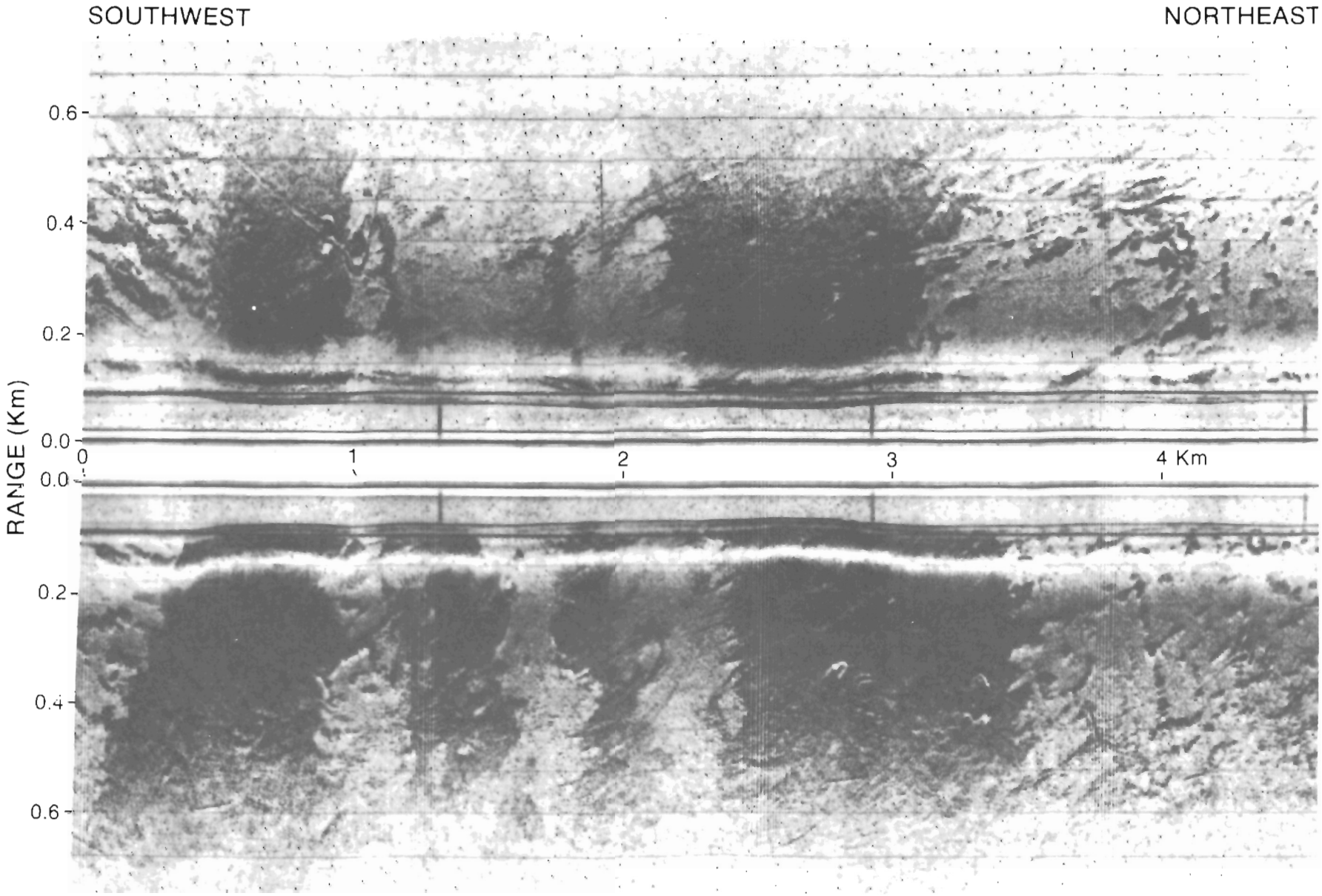

Figure 17. Sidescan sonogram from an area of Baffin Shelf Drift subunit C similar to that in Figure 15 (see Fig. 7 for location), showing the distribution of till (dark tone on sonogram) and overlying ponded sediments (light tone on sonogram).

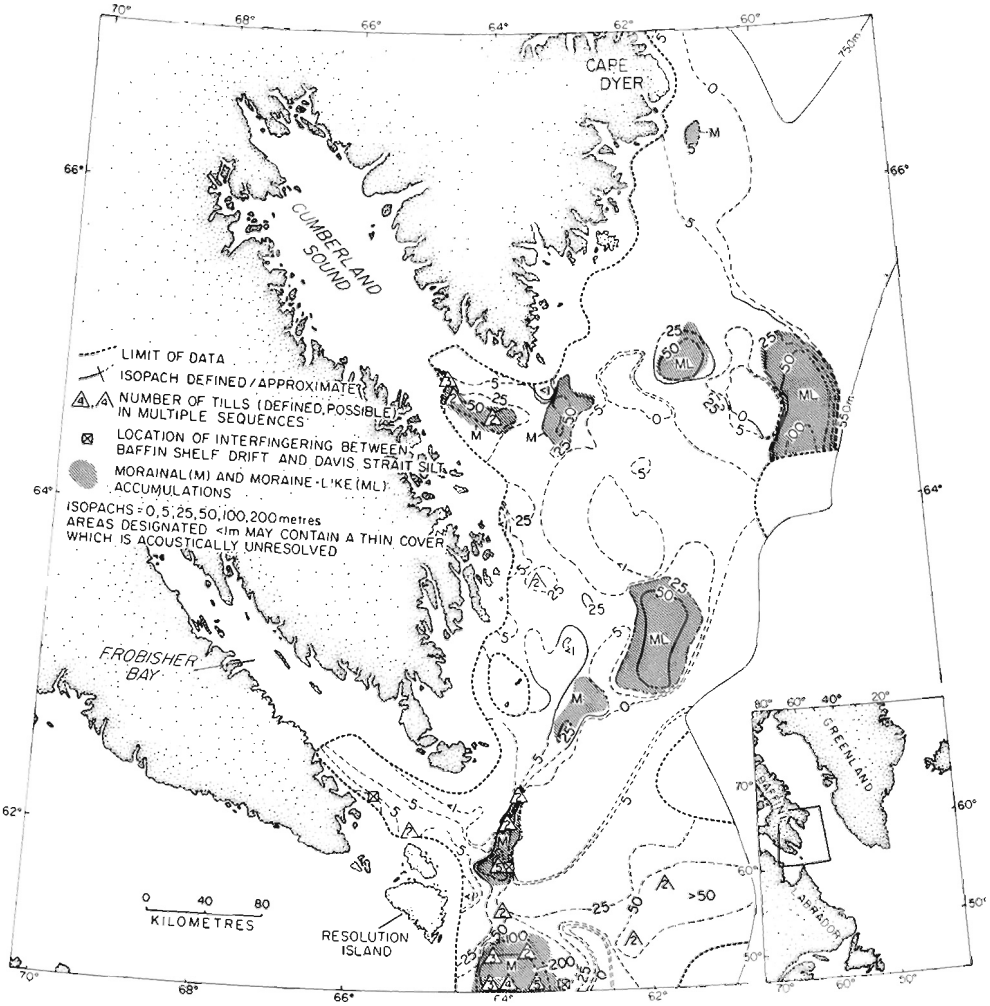

Figure 18. *Isopach map of the Baffin Shelf Drift. Locations of morainal and moraine-like accumulations, multiple till sequences, and till-stratified sediment interfingering are indicated. Thicknesses are interpreted from 655 cm³ air gun and Huntec DTS system seismic reflection profiles, and are based on the velocity of sound in water.*

Table 2. Radiocarbon dates from southeast Baffin Shelf cores

Sample location		Dated material	Laboratory number	Age ^{14}C Years Before Present
CORE	82-034-41 280-298 cm	total organic matter	BETA-7045	20,180 ± 295
CORE	82-034-57 410-420 cm	foraminifera* (Elphidium excavatum)	BETA-8898	25,170 ± 420
CORE	82-034-68 330-350 cm	total organic matter	BETA-8893	14,540 ± 1030
CORE	82-034-69 134-136 cm 215-230 cm	shells total organic matter*	BETA-8894 BETA-8895	11,300 ± 1420** 19,640 ± 480

* radiometrically dated using AMS (Accelerator Mass Spectrometer) technique
** corrected for $\delta^{13}C$ = 0.11‰

BETA - Beta Analytic Inc.

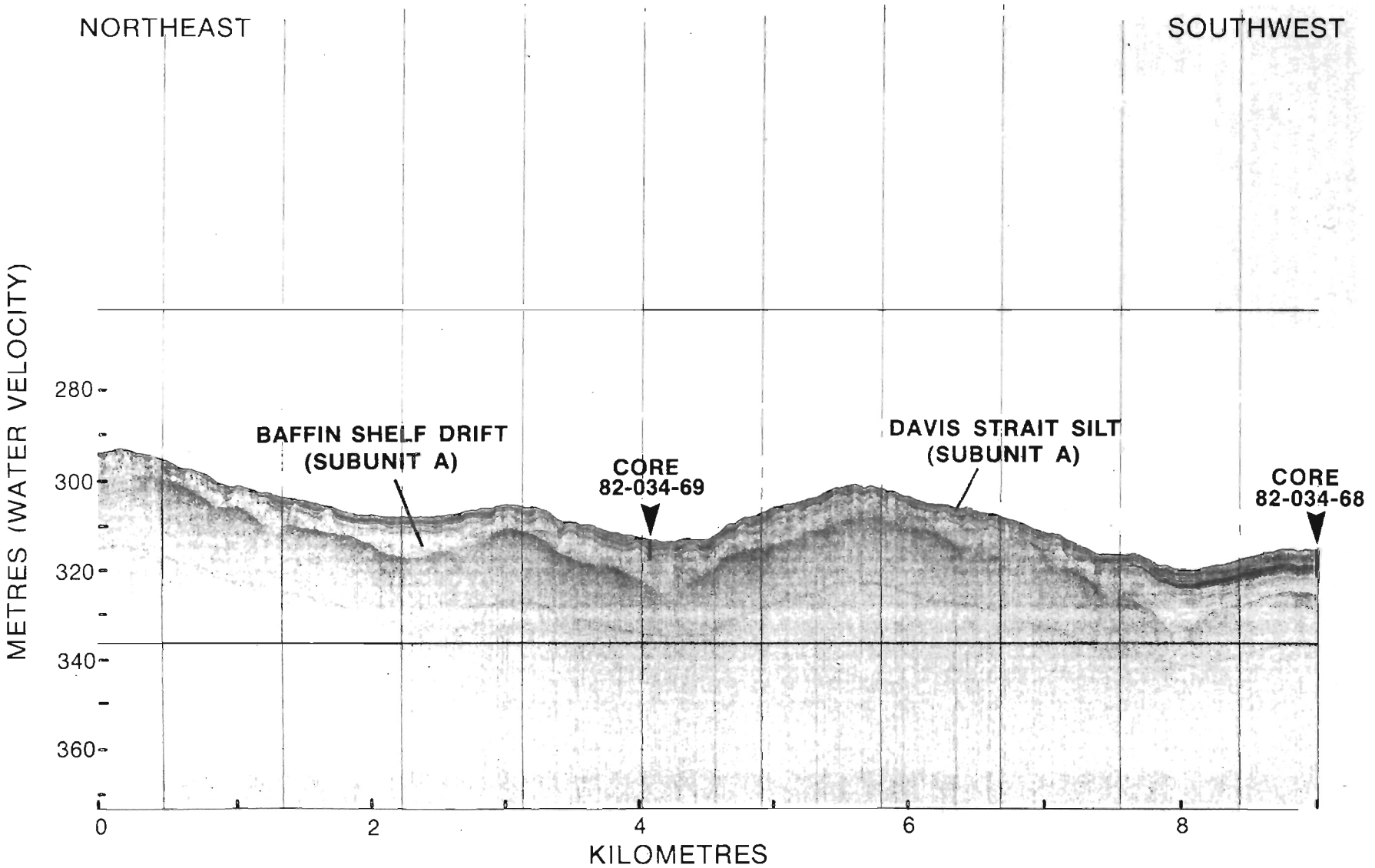

Figure 19. *Huntec DTS profile in the outer part of Frobisher Bay (see Fig. 7 for location), illustrating till of the Baffin Shelf Drift subunit A laterally interfingering with stratified sediments of Davis Strait Silt subunit A from 7.4 to 7.9 km along the profile. There is some suggestion of local interfingering to the northeast, where the Drift is overlain by the Silt. The approximate locations of cores 82-034-68 and -69 along the profile are indicated.*

drift on Meta Incognita Peninsula that were interpreted to be derived from source rocks in Labrador-Ungava (Osterman et al., 1984). Andrews and Miller (1983) and Osterman et al. (1984), on the basis of radiocarbon dates from ice-proximal marine sediments associated with deglaciation of the northeastern tip of Meta Incognita Peninsula, suggested that this Hudson Strait/Ungava ice advance occurred between ca. 8600 B.P. and possibly >37 000 B.P. The fact that the inferred age of the uppermost till of the multiple sequence northeast of Resolution Island falls within this age range, combined with the lack of evidence for a glacial advance on Hall Peninsula between >40 000 B.P. and ca. 12 000 B.P., suggests that the uppermost till is, at least in part, the product of the Hudson Strait/Ungava ice advance that deposited the carbonate-rich drift on southeast Meta Incognita Peninsula.

Osterman (1982) studied the foraminifera and sediments of core 77-021-156 from the mouth of Frobisher Bay (Table 1; Fig. 4), which we interpret to have been collected in Davis Strait Silt underlain by drift that we correlate with the uppermost of the multiple tills northeast of Resolution Island. A total organic carbon radiocarbon date of 27 255 ± 1250 B.P. (GX-7883) was obtained from core interval 190-205 cm (Osterman, 1982), but amino acid racemization ratios in **Cibicides lobatulus** from 2.6 m core depth suggest the cored interval only spans the last 18 000 years (Andrews and Miller, 1983; Osterman et al., 1984). Osterman et al. (1984) recognized two low diversity benthic foraminiferal zones in the upper part of the core, and interpreted these to represent ice-proximal glacial marine episodes. Based on the ca. 27 000 B.P. radiocarbon date, the upper zone was correlated with the Hall glacial advance of about 11 000 B.P. and the lower one was interpreted to mark an 18 000 B.P. event termed the Kneeland advance. The latter was thought to be either the product of a regional ice advance in Frobisher Bay, or to be related to the Hudson Strait/Ungava ice centre. However, the ambiguity in age control led to the alternate possibility that the two zones were younger, and that the lower one corresponded to the Hall glacial advance while the upper one corresponded to the Cockburn glacial advance. Osterman et al. (1984) interpreted the presence of **Cibicides lobatulus** in sandy sediments at the base of core 156 to represent interstadial conditions which occurred subsequent to the mid-Foxe (>40 000 B.P.) deglaciation of Loks Land (Miller, 1980), and which separated mid- and late Foxe glacial intervals.

Extrapolation of the two dates from core 156 down to 4 m depth assuming a uniform sedimentation rate gives alternate minimum ages of 54 000 B.P. (radiocarbon date) and 28 000 B.P. (amino acid date) for the top of the underlying till at 4-5 m depth, which we correlate with the uppermost till of the multiple sequence northeast of Resolution Island. Although such extrapolation down-core constitutes only a rough measure, it does suggest that the younger age is in reasonable accord with the ca. 25 000 B.P. age of the uppermost till inferred from core 57. This indicates that the younger amino acid 'date' for core 156 is more likely correct, and that the regional interstadial event recognized by Osterman et al. (1984) near the base of that core is late Foxe in age.

In outer Frobisher Bay a till sheet, locally up to 7 m thick, is observed on Huntec DTS profiles (Fig. 19). It underlies and partly interfingers with stratified sediments assigned to the Davis Strait Silt. Core 82-034-69 is from stratified sediments underlain by till, while the section at the site of core 82-034-68 is 5 km southwest of the ice lift-off point and consists entirely of stratified sediments (Fig. 19). Three radiocarbon dates (Table 2) were obtained from cores 68 and 69 (Table 1; Fig. 4), which were collected in the stratified sediments: 11 300 ± 1420 B.P. on shells from core 69 (approximately 3 m above the till); 19 640 ± 480 B.P. on total organic matter from core 69 (approximately 2 m above till); and 14 540 ± 1030 B.P. on total organic matter from core 68 (approximately 1 m above stratified sediments that laterally interfinger with the till). A. Aksu (personal communication, 1984) examined the isotopic record of both cores, and his preliminary interpretation places the sediments cored within Isotopic Stage 1 (the last ca. 13 000 years). However, he noted that if core 68 isotopic values were lighter than those for the Labrador Sea due to the location of the core within Frobisher Bay where local influences may predominate, the sediments in that core could include Isotopic Stage 2 (ca. 13 000-32 000 B.P.) and possibly extend to Stage 3 (ca. 32 000-64 000 B.P.). An examination of foraminifera in core 68 by Lisa Osterman (personal communication, 1984) indicates the following preliminary results: (1) a low diversity benthic zone from 25 cm to 100 cm, which possibly is related to the Cockburn and/or Hall glacial events; (2) an abundance peak at 300-400 cm interpreted to reflect deglaciation (meltwater); and (3) an underlying, increasingly barren (i.e. glacial) zone which extends to the base of the core. A similar sequence of foraminiferal assemblages is present in core 69. The radiocarbon ages strongly suggest that the till in the outer part of Frobisher Bay was not deposited by the Hall glacial advance, but is related to an earlier late Foxe or a mid-Foxe glacial event.

North of the Frobisher Bay area there are fewer data on the chronology of onshore and offshore events. Miller (1980) demonstrated that the outer coast of Hall Peninsula had not been glacially overridden since at least 40 000 B.P., which suggests that the Baffin Shelf Drift east of the area is of mid-Foxe age or older. Praeg (1983) examined the surficial sediments of the Lady Franklin Bank area, which consist of current modified Drift, and argued that variations of limestone abundance in gravel and sand fractions suggested the Drift was deposited by easterly moving ice, possibly channelled through the Brevoort Basin (Fig. 2) west of the bank. If this hypothesis is correct the Drift here and to the north is not associated with a possible mid-Foxe advance of northeast trending Hudson Strait/Ungava ice, which Osterman et al. (1984) suggested deposited glacial marine sediments dated at >40 000 B.P. on Loks Land, but is instead the product of a regional advance of Baffin Island ice.

Southeast of Cape Mercy, core 82-034-41 (3.7 m long; Table 1; Fig. 4) was collected in stratified sediments of the Davis Strait Silt, which Huntec DTS profiles indicate are underlain by till of Baffin Shelf Drift subunit A (Fig. 20). A total organic carbon radiocarbon date of 20 180 ± 295 B.P. (Table 2) was obtained from the cored sediments at a depth of 280-298 cm. Palynologic studies suggest that this date may be too old, due to the presence of reworked palynomorphs and coal fragments. Coarser texture (Fig. 21) and general lack of stratification below 3.2 m core depth suggest the core may have penetrated the top of the underlying Baffin Shelf Drift. However, regional Huntec DTS data show Davis Strait Silt thicknesses of at least 5 m in the vicinity of the core site (Fig. 20), suggesting either that part of the Davis Strait Silt sequence is missing at the core locality, or that the core did not in fact penetrate the underlying Baffin Shelf Drift. The radiocarbon date indicates that the Baffin Shelf Drift in the area predates at least ca. 20 000 B.P. The relationships observed on the acoustic data suggest that the Drift may be considerably older. These conclusions are compatible with terrestrial evidence which indicates that late Foxe ice did not extend to the outer coast on Hall Peninsula (Blake, 1966; Miller, 1980) or advance beyond the fiord heads on Cumberland Peninsula (Dyke, 1977).

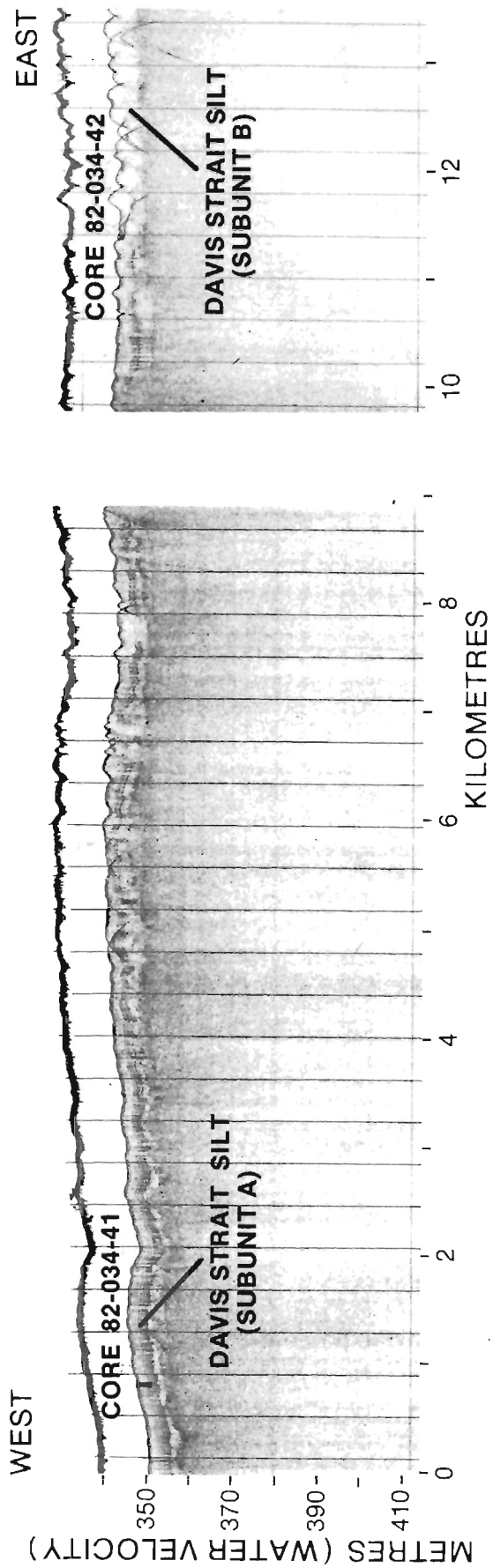

Figure 20. Huntec DTS profile of the Davis Strait Silt southeast of Cape Mercy (see Fig. 7 for location), showing the transition from the stratified sediments of subunit A to the unstratified sediments of subunit B. The approximate locations of cores 82-034-41 and -42 along the profile are indicated. At the core 41 locality stratified sediments are underlain by unstratified sediments that include till of the Baffin Shelf Drift subunit A.

The east coast of Cumberland Peninsula has been sparsely investigated, but relationships observed on both the northern and southern coasts of Cumberland Peninsula indicate that outlet glaciers of the Penny Ice Cap did not extend beyond the fiord heads in the late Foxe (Dyke, 1977; England and Andrews, 1975; Pheasant and Andrews, 1975; Miller, 1975). Thus it seems unlikely that late Foxe ice was responsible for much, if any, of the extensive Baffin Shelf Drift on the shelf adjacent to the east coast of Cumberland Peninsula. In the Cape Dyer-Exeter Bay area, studies by Locke (1980) suggest that glacial ice has not extended to the outer coast since at least 100 000 B.P. This indicates that Baffin Shelf Drift on the shelf east of this area must be of very early Foxe or pre-Foxe age.

Except in the area near the mouth of Frobisher Bay, the data do not permit differentiation of the age and chronological relationships of the till occurrences one to another across the shelf, but it is probable that tills from a number of major ice advances of variable age and extent are represented.

Davis Strait Silt (map unit 2)

Davis Strait Silt is an informal term proposed for sediments which are of variable but distinctive acoustic character on Huntec DTS profiles. The Davis Strait Silt is the most areally extensive sedimentary unit on the southeast Baffin Shelf, occupying most of the seabottom area below 200-250 m water depth on the southern part of the shelf (south of 65°N), and most of the area below 350-400 m water depth on the northern part of the shelf (Fig. 7). It is directly underlain by bedrock, or by the Baffin Shelf Drift with which it locally interfingers. It is overlain by the Resolution Island Lag in a few areas, and by the Tiniktartuq Silt and Clay in Cumberland Sound and a few small localities on the outer shelf. Ponded sediments mapped within Baffin Shelf Drift subunit C east of Cumberland Peninsula may be correlative to the Davis Strait Silt, or to the Tiniktartuq Silt and Clay. Along the southern shelf edge bordering the Labrador Sea, the Davis Strait Silt grades into the stratified sediments of the upper continental slope, but farther north in Davis Strait and along the Baffin Bay shelf edge, relationships seaward are not as well established.

Approximately 90 grab samples have been collected from areas of the Davis Strait Silt, but most represent only a surface veneer of current modification (discussed later). Cores which penetrated this surface veneer were collected from the unit at eight localities (Table 1; Fig. 4). The sediments in general comprise silty clay to clayey silt, with sand varying from 5% to 40%, and gravel from 0% to 35% (Fig. 21). Mean and modal values commonly lie in the very fine to medium silt size range, so the sediments are broadly termed 'silt'.

On the southern part of the shelf (south of 65°N) the Davis Strait Silt is primarily a 2-10 m thick cover, which thickens east of Resolution Island and within Frobisher Bay to an observed maximum of about 70 m in Frobisher Bay. Areas where the unit is less than 2 m thick are relatively minor and restricted primarily to its margins. In contrast, on the northern part of the shelf, the Silt unit is seldom more than 2 m thick. Only east of Cape Dyer, at water depths below 500-550 m, does it become as thick as 6 m.

Acoustic characteristics and distribution

The Davis Strait Silt has been defined and delineated on subbottom profiles almost exclusively using the Huntec DTS system. However, distinctive morphologic characteristics of the silt are recognizable on 655 cm^3 air gun profiles and echograms, which have been used to establish the presence and boundaries of the unit where Huntec DTS subbottom data are not available (Fig. 3).

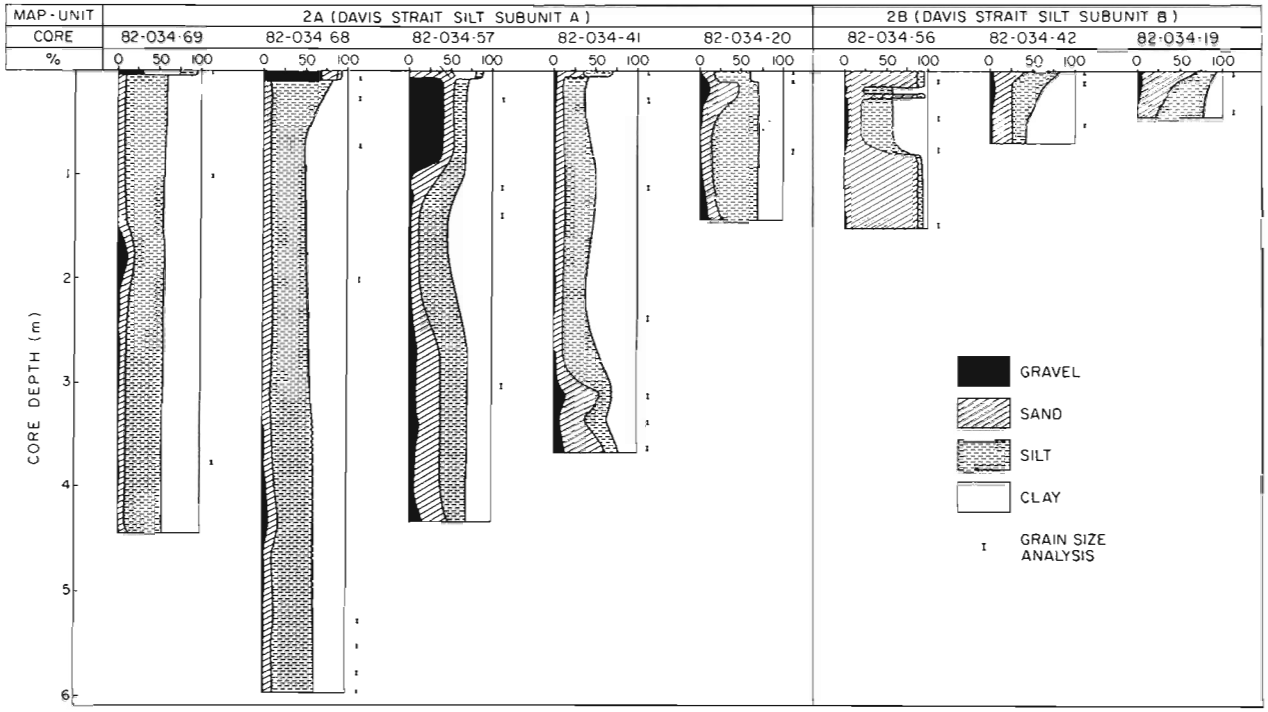

Figure 21. *Summary of grain size distributions of cores 82-034-19, -20, -41, -42, -56, -57, -68 and -69 from the Davis Strait Silt, as derived from grain size analyses, X-radiographs, and visual examination.*

On the basis of variations in acoustic character the Davis Strait Silt is divided into two subunits.

Subunit A

This division of the Davis Strait Silt is unmodified, in that it has not been scoured by grounding icebergs. Subunit A is characterized on Huntec DTS profiles by (1) coherent internal reflectors (stratification), (2) moderate transparency, and (3) a smooth surface which is generally conformable to the surface of the underlying bedrock or Baffin Shelf Drift. These characteristics are illustrated in Figures 12, 19, 20, 22 and 23. Subunit A varies in thickness from a few metres to 70 m regionally, but is often relatively consistent in thickness over large distances (e.g. Fig. 12, 20, 22). Subunit A occurs in bathymetric basins or depressions of varying scale, an association interpreted to reflect bathymetric sheltering from the effects of iceberg scouring, which has modified these sediments in most other areas (see subunit B).

Davis Strait Silt subunit A interfingers with till of the Baffin Shelf Drift east of the entrance to Hudson Strait (see Fig. 18), northeast of Resolution Island (Fig. 12), and in the outer part of Frobisher Bay (Fig. 19). These interfingering relationships are interpreted to mark ice lift-off points beyond which floatation or calving of glacial ice sheets occurred and deposition of till gave way to glacial marine deposition, in a manner similar to that described by King and Fader (1985) from the Scotian Shelf and Grand Banks of Newfoundland. This indicates that the Davis Strait Silt and the Baffin Shelf Drift are in part time-correlative. Relationships that may represent interfingering have been observed on seismic profiles in a few other localities on the shelf, e.g. east of Cape Mercy (Fig. 23).

Subunit B

This is the most widespread subunit of the Davis Strait Silt (Fig. 7). Sediments of subunit B have been modified through extensive scouring by grounding icebergs. On Huntec DTS profiles subunit B is characterized by (1) lack of coherent internal reflectors (stratification), (2) moderate transparency, and (3) a rough surface of 1-10 m relief which results from intense iceberg scouring of the sediment. These features are illustrated in Figures 14, 24, 25 and 26, and are evident in Figures 20, 22 and 23. Subunit B has a regional variance in thickness from <1 m to ≥15 m, but is often relatively consistent in thickness over large distances (e.g. Fig. 20, 22, 24).

Across much of the northern part of the shelf in Davis Strait subunit B thins to less than 2 m over a resistant substratum of Tertiary volcanics or sediments, the Plio-Pleistocene cover unit, or Baffin Shelf Drift subunit B. In these areas Silt subunit B is represented by morphologically distinctive isolated or paired iceberg scour berms (Fig. 27). These are separated by smooth stretches of seafloor up to 150 m long which have no sediment cover within the limit of resolution of the Huntec DTS system (30-50 cm). Sidescan imagery from a few of these areas show distinctive shallow iceberg scours with narrow berms (Fig. 28). Observations from the submersible **Pisces IV** in one of these areas (Fig. 28) east of Cape Mercy revealed low scour berms separated by areas containing a discontinuous, thin sediment cover overlying a resistant substratum. The bouldery surface of the berms seen in this area reflect winnowing by seabottom currents.

Subunit B is generally distinguished from the Baffin Shelf Drift by the former's: (1) usually higher transparency on Huntec DTS profiles, (2) greater depths of scouring by grounded icebergs, interpreted to reflect greater physical softness, (3) lack of thick morainal accumulations,

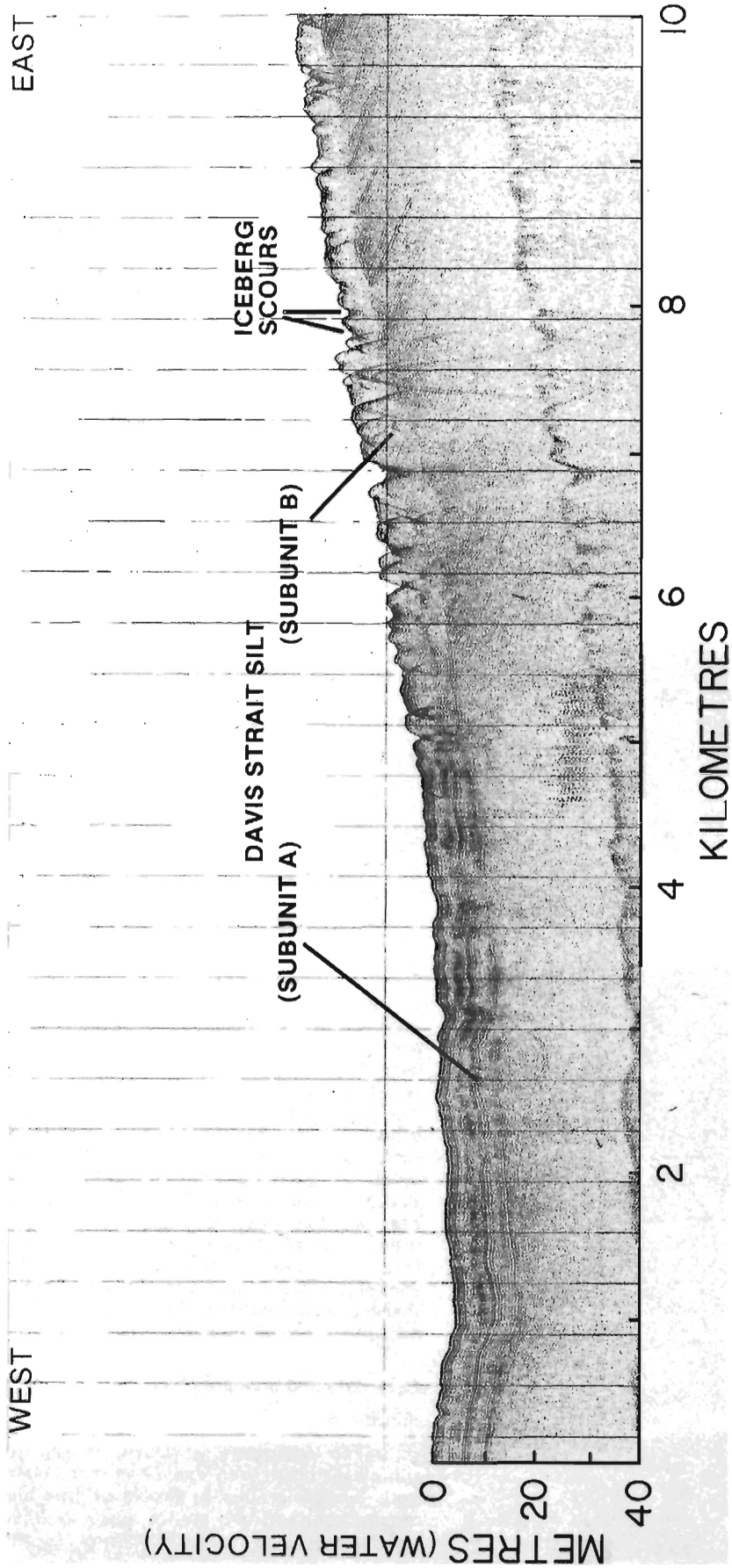

Figure 22. Huntec DTS profile of the Davis Strait Silt east of Frobisher Bay (see Fig. 7 for location), showing the transition from the stratified sediments of subunit A to the unstratified sediments of subunit B. Note the coincident absence and presence of iceberg scours. The section here is underlain by seaward dipping strata of Tertiary sedimentary bedrock.

(4) lateral gradation into the unscoured stratified sediments of subunit A in bathymetric depressions, and (5) lack of surface relief other than that attributable to iceberg scouring.

Davis Strait Silt subunit A and B relationships

The iceberg-scoured, unstratified sediments of subunit B and the unscoured, stratified sediments of subunit A grade laterally into each other (Fig. 20, 22, 23). This change from subunit A to B commonly corresponds to a decrease in water depth, and occurs in a transition zone hundreds of metres to kilometres in width. As iceberg scours appear and increase in intensity along Huntec DTS profiles, the well-defined acoustic stratification of subunit A becomes intermittent and discontinuous and finally disappears. Stratification sometimes persists longer in the subsurface (Fig. 20, 22). Although stratification is absent over very long distances within subunit B (Fig. 24, 15), local areas of weak remnant stratification are occasionally observed in areas of decreased iceberg scour intensity (Fig. 29).

On Huntec DTS profiles the absence of stratification persists to the base of subunit B, even though this may be more than 5 m below the maximum penetration of iceberg scours, and even though the reflector marking the base of subunit B is well defined (e.g. Fig. 24). However, short cores of the upper 1-2 m of these sediments (discussed below) show weak intermittent stratification, both visually and on X-radiographs, similar to that seen in nearby longer cores from sediments of subunit A. The lack of acoustic resolution of this stratification in subunit B may be due to either the sediments having insufficient impedance contrast, or the stratification being too discontinuous laterally, to return coherent reflections to the Huntec DTS system. Moreover, Huntec DTS profiles over the zone of transition of subunit A to B often show convolute or discontinuous stratification throughout the thickness of the Davis Strait Silt, even though iceberg scours only directly affect the upper several metres (Fig. 20). Taken together, these observations suggest that subunit B possesses stratification throughout its thickness, but that the effect of iceberg scouring has been to disturb the original stratification so that it is no longer resolvable by the Huntec DTS system.

The iceberg scouring which disrupted the original stratification of subunit B could be either post- or syn-depositional in nature. Apparent paleoscours have occasionally been observed in the subsurface of subunit A,

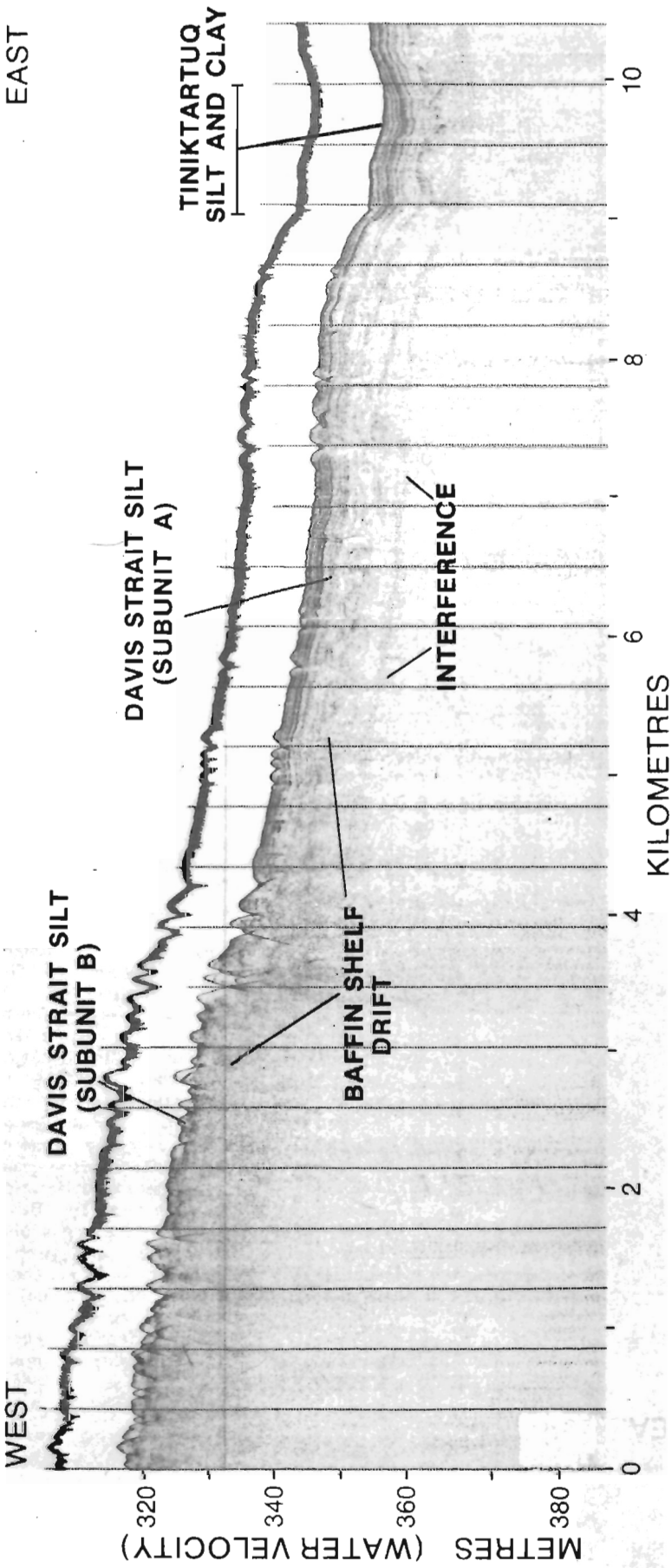

Figure 23. Huntec DTS profile of the Davis Strait Silt east of Cape Mercy (see Fig. 7 for location), showing the transition from the stratified sediments of subunit A to the unstratified sediments of subunit B 4.3 km along the profile. Note the reduction in thickness of the Davis Strait Silt west of 3.5 km, suggesting a possible interfingering with the underlying Baffin Shelf Drift. A small, thin occurrence of Tiniktartuq Silt and Clay is present from 9 to 10 km along the profile.

suggesting that iceberg scouring occurred, at least in part, contemporaneous with deposition. However, the record of such paleoscours within subunit B would largely have been destroyed by subsequent scouring. It is likely that both syn- and post-depositional iceberg scouring have been an influence in the history of the Davis Strait Silt.

The bathymetric depth at which the Davis Strait Silt subunit A to B transition occurs varies with locality. It is observed at 550-700 m east of Cape Dyer and in the mouth of Cumberland Sound, at 300-350 m east and southeast of Cape Mercy, and at 500-550 m northeast of Resolution Island. Smaller 'patches' of subunit A have been observed at depths from 250-500 m (Fig. 7). The variations in the water depth at which the subunit A to B transition occurs across the shelf could result from the interaction of several processes through time, including greater iceberg scouring depths during parts of the Foxe Glaciation, bathymetric sheltering in basins or down current from physiographic highs, differential isostatic adjustments, and changes in relative sea level.

The close proximity (75 km) of the deep transition of subunit A to B in Cumberland Sound (550-700 m) to the shallower transitions east and southeast of Cape Mercy (300-350 m) suggests that isostatic adjustments are a minor factor. Along the southern shelf edge bordering the Labrador Sea the lower limit of iceberg scouring of the upper continental slope sediments varies from 500-750 m depth. This and similar depth ranges observed at the subunit A to B transition in Cumberland Sound, east of Cape Dyer, and northeast of Resolution Island are deeper than reported maximum present day iceberg grounding limits in the Baffin Bay-Davis Strait region (e.g. Murray, 1969; Guigne et al., 1982) suggesting that the deep water transition of subunit A to B, and associated scours, are relict. This also suggests either that iceberg drafts were significantly greater during some part of the Foxe Glaciation, or that the iceberg scours on the deeper parts of the shelf reflect a period of lowered relative sea level, or both (e.g. Pereira, 1983). The shallower subunit A to B transition depths east and southeast of Cape Mercy and at other smaller occurrences of subunit A (Fig. 7) likely reflect bathymetric sheltering from the effects of deeper iceberg penetration in the shallow central part of the southeast shelf.

Core data and interpretation

Subunit A

The sediments of Davis Strait Silt subunit A have been examined from eight core localities: six in Frobisher Bay and approaches, and two on the open shelf to the north (Table 1; Fig. 4). Three of the

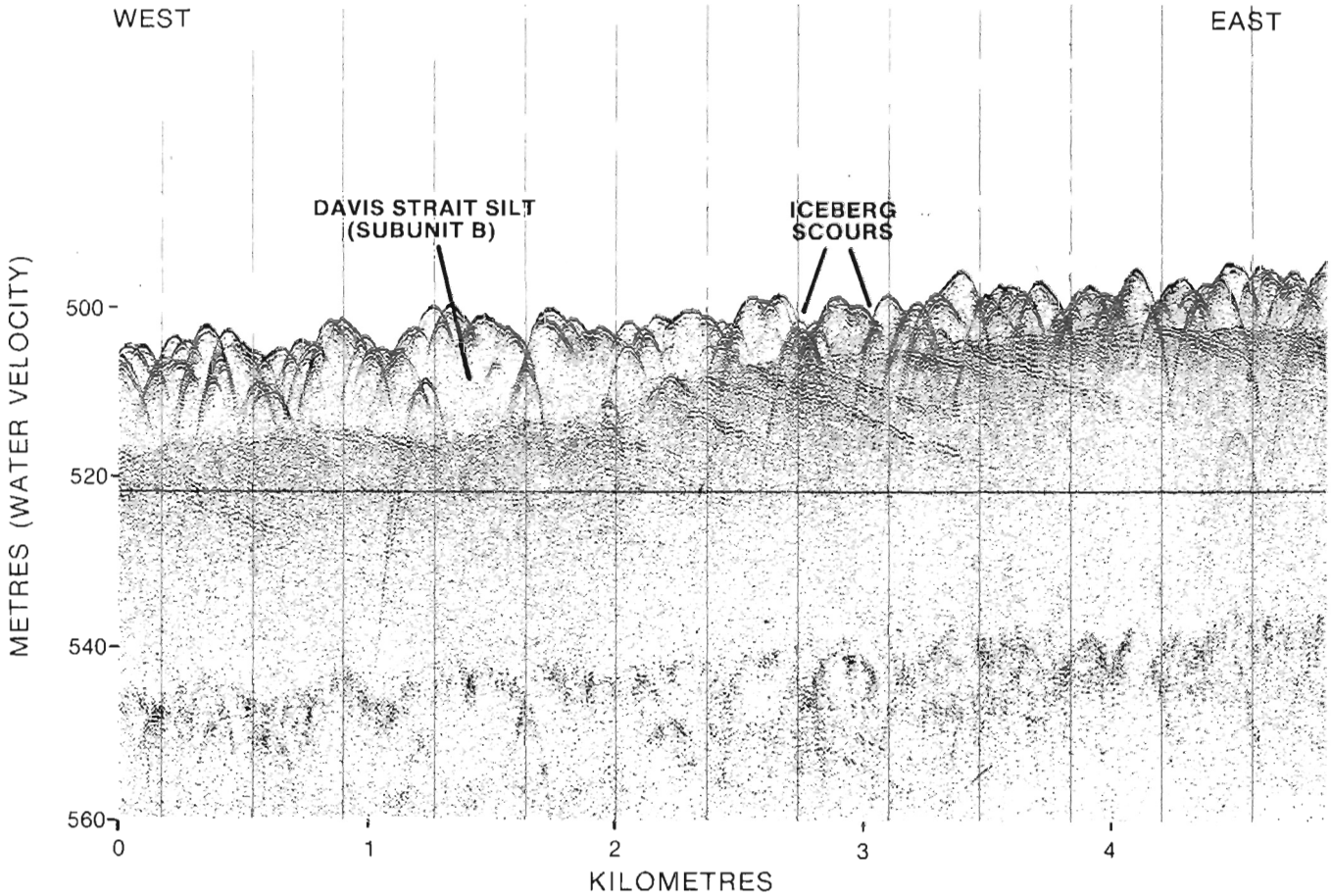

Figure 24. *Huntec DTS profile illustrating the intensely iceberg scoured sediment of Davis Strait Silt subunit B overlying seaward dipping Tertiary strata east of Frobisher Bay (see Fig. 7 for location).*

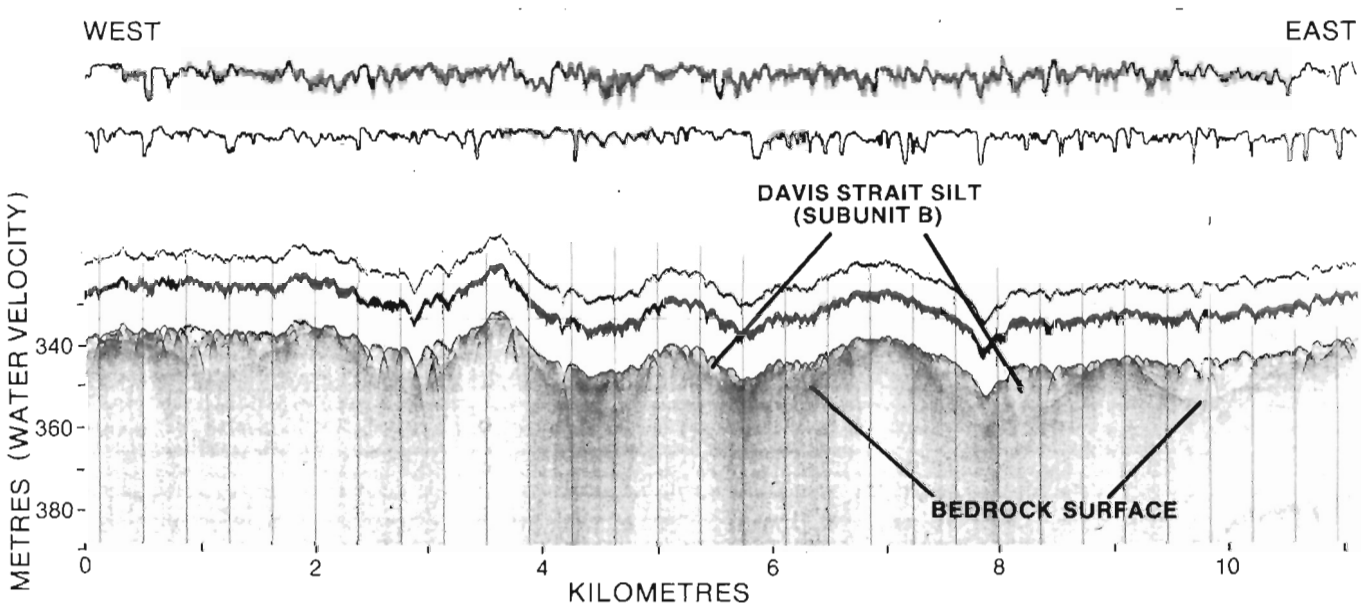

Figure 25. *Huntec DTS profile east of Frobisher Bay showing intensely iceberg scoured sediments of Davis Strait Silt subunit B overlying an erosional hill and valley topography cut in strata of Tertiary sedimentary rocks (see Fig. 7 for location).*

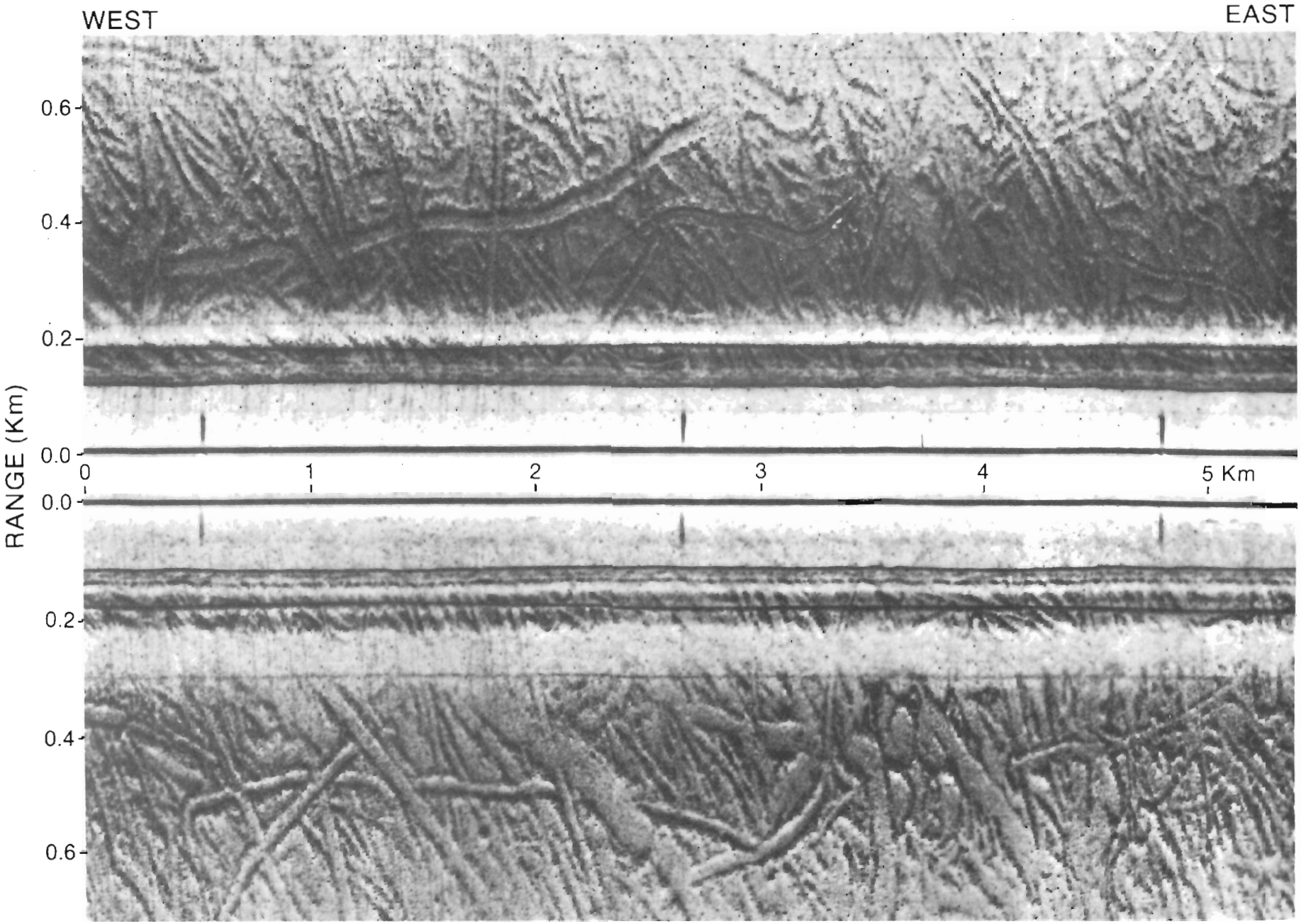

Figure 26. Sidescan sonogram illustrating intensely iceberg scoured surface of Davis Strait Silt subunit B east of Cumberland Sound (see Fig. 7 for location).

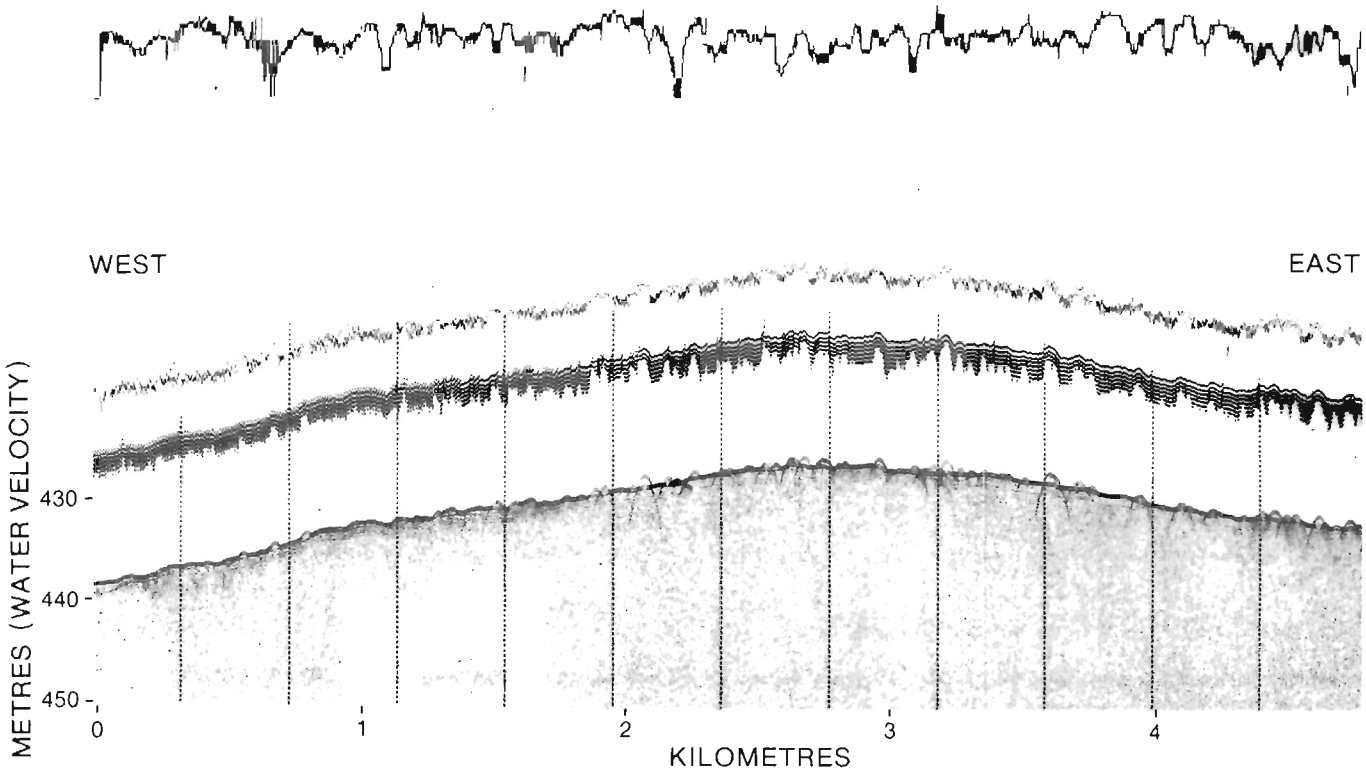

Figure 27. Huntec DTS profile showing thin, iceberg scoured Davis Strait Silt subunit B overlying a resistant substrate on the outer shelf east of Cumberland Peninsula (see Fig. 7 for location). The grounding bergs have scraped the thin surficial cover into the raised berms visible here, but for the most part have incised the underlying seabed very little.

cores in Frobisher Bay (77-021-156, -157, -159) were studied by Osterman (1982). The other cores (82-034-20, -41, -57, -68, -69) were collected in 1982, and are discussed in this report. The grain size distributions of cores 20, 41, 57, 68 and 69 are illustrated in Figure 21. The preliminary lithostratigraphy and biostratigraphy (foraminifera and palynomorphs) of cores 41, 57, 68 and 69, and a preliminary foraminiferal stratigraphy of core 68 by Osterman (personal communication, 1984), are summarized in Figure 30. Radiocarbon dates obtained from these cores (Table 2) are also included in Figure 30.

Osterman (1982) studied the foraminifera, grain size, grain texture, clay type and radiocarbon age variations of cores 77-021-156, -157, and -159, and proposed the following stratigraphy. The Griffin unit near the base of the cores 156 and 159 is a silty clay characterized by a dominance of the foraminifera **Islandiella helenae** and **Cassidulina reniforme**, which Osterman interpreted as recording open water conditions in an advancing glacial environment from approximately 12 000 B.P. The Griffin unit was not penetrated by core 157. The overlying Hall clay is a clay-rich interval characterized by a low diversity foraminiferal assemblage of **Elphidium excavatum** forma **clavata** which Osterman argued represented deposition beneath a floating ice shelf grounded on the Calanus Shelf of northern Frobisher Bay, possibly during the onshore Hall glacial advance of 10 760 B.P. (Miller, 1980). The Frobisher Bay unit above the Hall clay is a silty clay to clayey silt characterized by the same foraminiferal assemblage near its base as the Griffin unit, and by a more diverse assemblage in its upper part. Osterman interpreted the Frobisher Bay unit as indicative of the retreat of the ice shelf and a return to open water conditions. The overlying Labrador Unit is a silty clay containing a foraminiferal assemblage dominated by **Nonionellina labradorica**, which Osterman interpreted to reflect the gradual re-establishment of the cold coastal Baffin Current after about 5000 B.P. The uppermost Burton unit is a silty clay to sand-rich interval with a foraminiferal assemblage dominated by **Islandiella helenae** within Frobisher Bay (cores 157 and 159), and **Cibicides lobatulus** outside the bay (core 156), which Osterman associated with a subsequent strengthening of the Baffin Current. These cores did not penetrate the entire acoustic section, therefore Osterman's stratigraphy applies to only part of the Davis Strait Silt in this area.

A Huntec DTS profile extending southwest across Frobisher Bay from Loks Land shows that near the south side of the bay stratified sediments of Davis Strait Silt subunit A interfinger with and in part overlie glacial till of the Baffin Shelf Drift (Fig. 19). Towards Loks Land, the stratified sediments over the till thin, then become intermittent pockets on the till surface with some suggestion of further interfingering with the till, and finally are absent. Cores 82-034-68 and -69 were recovered from the stratified sediments along this profile: core 68 southwest of the till margin, and core 69 5 km to the northeast where the sequence is underlain by till (Fig. 19).

The two cores show striking similarities (Fig. 21, 30). Below 3.4 m in core 68 and 1.5 m in core 69 sediments consist of gravelly light to dark grey silts and clays that are weakly stratified on X-radiographs. The contact with overlying gravel-free sediments, which are well stratified both visually and on X-radiographs, is gradational. Three radiocarbon dates from the two cores bracket this transition (Table 2; Fig. 30). In both cores, the lowermost part of the gravelly sediments are characterized by a faunal zone mainly devoid of foraminifera (Fig. 30). Comparison of core length with the Huntec DTS profile collected across the core sites (Fig. 19) shows that the base of core 69 is less than one metre above unstratified sediments interpreted to be till, while the base

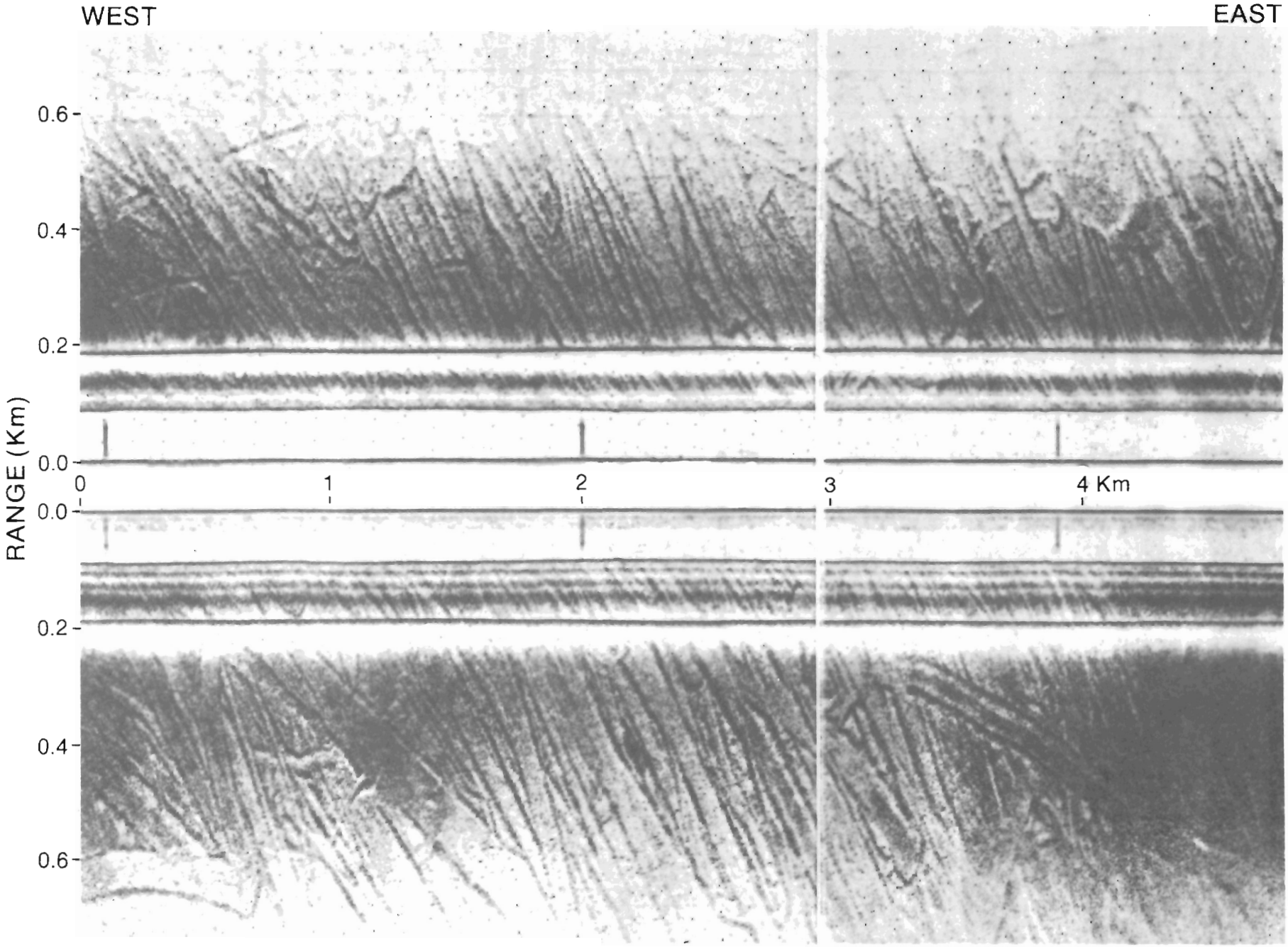

Figure 28. Sidescan sonogram over an area of Davis Strait Silt subunit B similar to that in Figure 27, showing shallow iceberg scours with narrow berms east of Cape Mercy (see Fig. 7 for location).

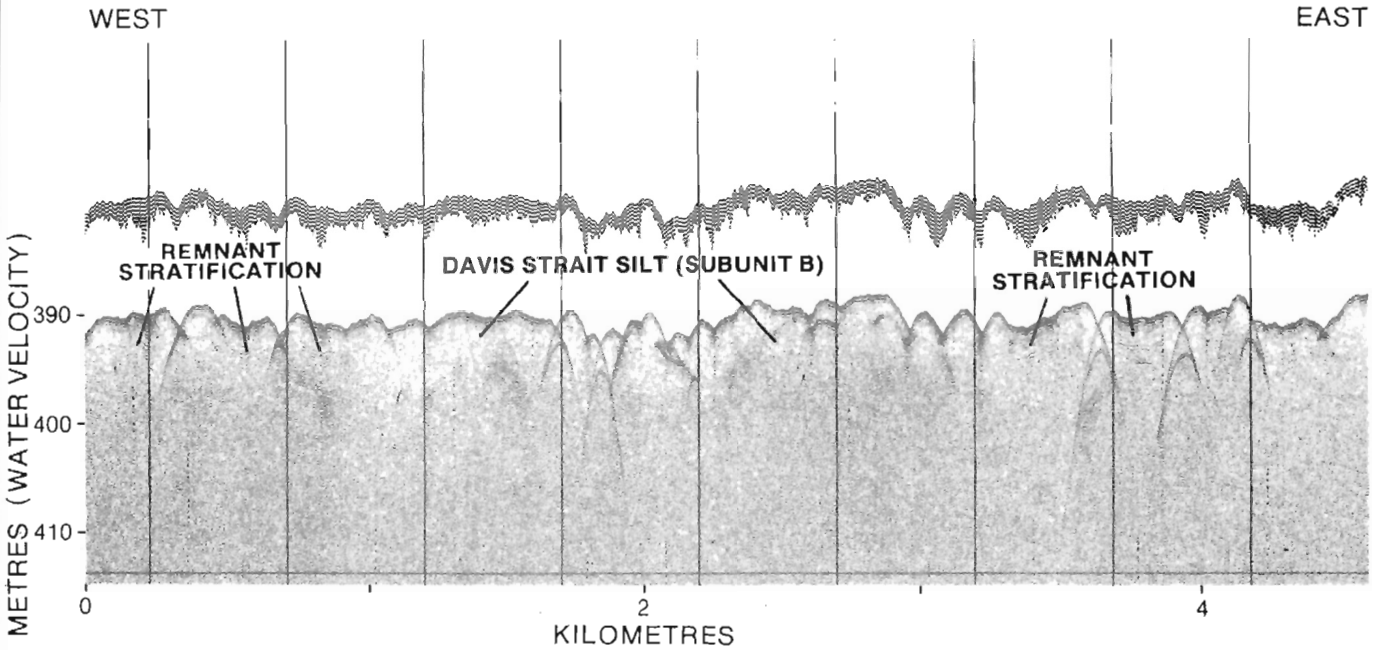

Figure 29. *Huntec DTS profile of Davis Strait Silt subunit B on the outer shelf east of Brevoort Island (see Fig. 7 for location), illustrating areas of weak remnant stratification within subunit B.*

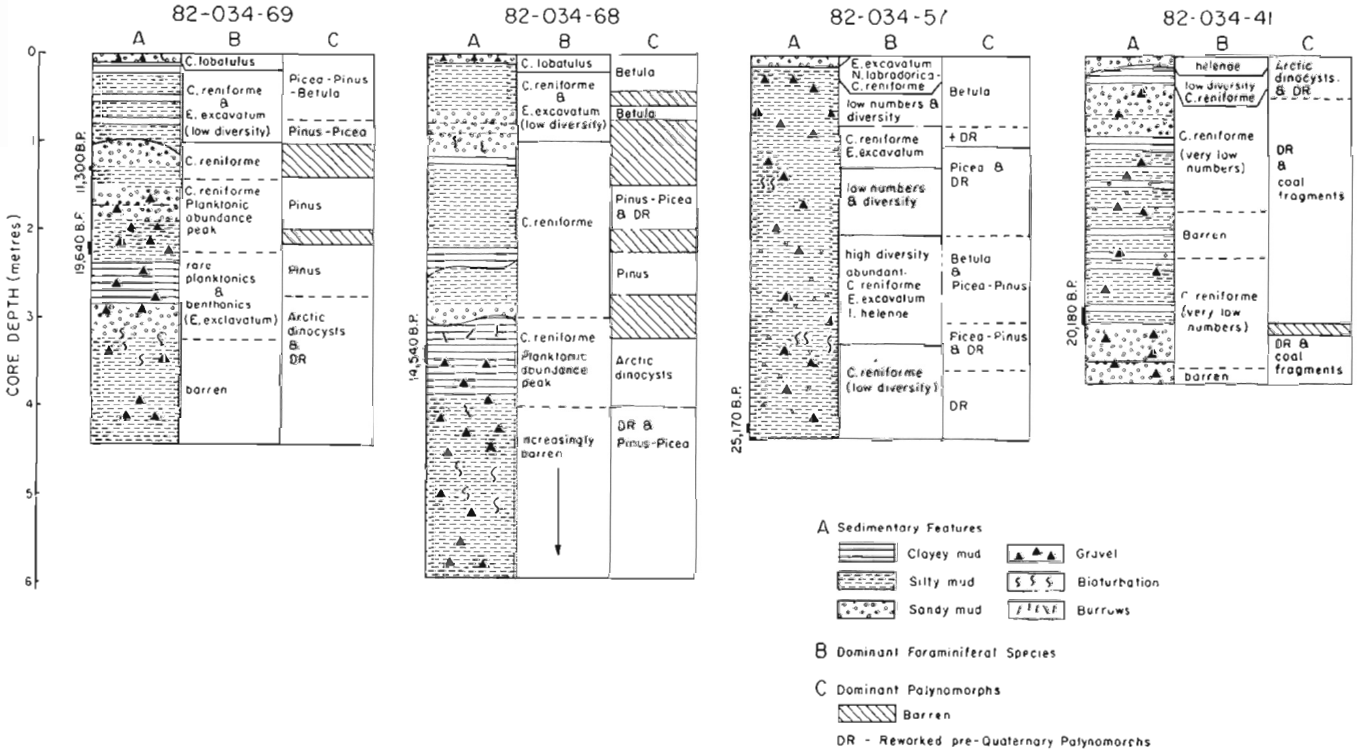

Figure 30. *Summary of the litho- and biostratigraphy (foraminifera and palynomorphs) of cores 82-034-41, -57, -68 and -69. Preliminary foraminiferal stratigraphy of core 68 was supplied by L. Osterman (personal communication, 1984).*

of core 68 lies within stratified sediments which laterally interfinger with the till. This strongly supports an interpretation of the lowermost faunal zone as reflecting ice-proximal glacial marine conditions adjacent to the grounded front of the ice sheet that deposited till at this locality. Overlying this zone in both cores is a faunal zone which contains a more diverse and abundant benthic foraminiferal assemblage dominated by **Cassidulina reniforme**, and which is coincident with peak abundances of **Neogloboquadrina pachyderma** (sinstrally coiled, normal form). It is interpreted to reflect a period of meltwater associated with deglaciation. The top of this faunal zone in both cores approximately corresponds with the top of the gravelly sediments. Pollen assemblages in the lower half of cores 68 and 69 are dominated by reworked pre-Quaternary pollen and contain only rare grains of Quaternary **Pinus** and **Picea** species. Similar assemblages characterize the glacial stage sediments of core 77-021-159 (Mudie and Short, 1985). Dinoflagellate assemblages in the lower parts of the cores are dominated by the Canadian Arctic indicator **Multispinula minuta**, which supports the interpretation of a cold, meltwater environment.

Overlying the gravelly interval in both cores are sediments containing a diverse and abundant benthic foraminiferal assemblage dominated by **Cassidulina reniforme**, which may reflect ice-distal glacial marine conditions. This zone is overlain by one in which low diversities and low faunal numbers suggest a return to ice-proximal glacial marine conditions (Vilks et al., 1984). Pollen assemblages in the upper part of this zone contain significant amounts of **Betula**, which is indicative of the Holocene hypsithermal interval in core 77-021-159 (Mudie and Short, 1985). The zone may reflect climatic fluctuations associated with the terrestrial Hall and/or Cockburn glacial events. The uppermost sandy, gravelly sediments in both cores are dominated by **Cibicides lobatulus**, a species that typifies a high-energy, winnowing environment (Mudie et al., 1983). This zone is a likely correlative of the uppermost Burton unit of Osterman (1982).

Northeast of Resolution Island the uppermost till of a multiple sequence (Fig. 11) interfingers with the stratified sediments of Davis Strait Silt subunit A (Fig. 12). Core 82-034-57 was collected in stratified sediments about 3 km east of the interfingering till tongue (Fig. 12). The core penetrated a thin sandy surface veneer into light to dark grey sandy and gravelly silts and clays (Fig. 21) which appear well to poorly stratified on X-radiographs. The lowermost sediments of the core contain a low diversity, low abundance benthic foraminiferal assemblage (Fig. 30). Lateral correlation on a Huntec DTS profile across the area (Fig. 12) suggests that the base of core 57 is approximately stratigraphically correlative with the seaward edge of the interfingering till tongue. This lowermost low diversity interval is thus interpreted to reflect ice-proximal glacial marine conditions adjacent to the lift off point of the ice sheet that deposited the uppermost till northeast of Resolution Island. A radiocarbon date on foraminifera from this interval (Table 2; Fig. 30) suggests that this ice advance took place ca. 25 000 B.P. Sediments overlying the lowermost interval of the core contain a high diversity, high abundance benthic foraminiferal assemblage (Fig. 30) which is coincident with peak abundances of **Neogloboquadrina pachyderma** (sinstrally coiled, normal form). This zone is interpreted to reflect meltwater conditions associated with deglaciation.

The upper half of core 57 (Fig. 30) contains two intervals of very low faunal abundance and diversity separated by a zone containing a diverse and abundant benthic foraminiferal assemblage dominated by **Cassidulina reniforme** and **Elphidium excavatum**. The two low diversity intervals suggest periods of ice-proximal glacial marine conditions, separated by a period during which ice was more distal. The low diversity intervals may be correlatives of two low diversity benthic foraminiferal zones recognized in the upper part of nearby core 77-021-156 (Osterman et al., 1984). Sediments overlying these intervals in core 57 contain a high diversity foraminiferal assemblage which is thought to reflect Holocene postglacial conditions. This is suggested by the abundance of **Nonionellina labradorica**, which is indicative of the Holocene interval in cores from the Labrador Shelf (Vilks and Mudie, 1978; Mudie et al., 1983). The sandy sediments of the surface veneer were not sampled. Core 57 appears to contain a continuous pollen record for the last 25 000 B.P. (Fig. 30), with assemblages that seem similar to those found in core 77-021-156 by Osterman (personal communication, 1983).

Southeast of Cape Mercy core 82-034-41 was collected in stratified sediments of Davis Strait Silt subunit A (Fig. 20). The core recovered a sequence of light to dark grey, well to poorly stratified, slightly gravelly silts and clays which are overlain by an olive green veneer of muddy sand (Fig. 21). Sediments below 3.2 m core depth are enriched in sand and gravel and largely unstratified, reflecting penetration of either the underlying Baffin Shelf Drift (Fig. 20) or a coarse horizon within the Davis Strait Silt. Benthic foraminiferal assemblages (Fig. 30) from 25 cm to the base of the core are characterized by low abundance and barren zones, similar to the ice-proximal glacial marine intervals recognized in cores 57, 68, and 69. Palynological study of this interval reveals only reworked pre-Quaternary palynomorphs or coal fragments below 50 cm, and the appearance of Quaternary marine palynomorphs from 25-50 cm. Sediments above 25 cm show a significant increase in benthic foraminiferal abundance, and contain pollen and dinoflagellate assemblages similar to those at the top of core 77-027-17 from Davis Strait (Mudie and Short, 1985). The sediments of the olive green sandy surface veneer contain a benthic foraminiferal assemblage dominated by **Islandiella helenae**, similar to the uppermost Burton unit in cores 77-021-157 and -159 (Osterman, 1982).

Subunit B

Three cores (82-034-19, -42, -56) were obtained from Davis Strait Silt subunit B in localities adjacent to cores 82-034-20, -41 and -57 from subunit A (Table 1; Fig. 4): core 19 east of Cape Dyer, core 42 in the Cape Mercy Basin area (Fig. 2, 20), and core 56 northeast of Resolution Island. The cores were analyzed for grain size (Fig. 21), and examined for foraminifera and palynomorphs. All three cores are considerably shorter than their counterparts from subunit A (Fig. 21; Table 1), indicating a more resistant composition possibly related to iceberg compaction. Cores 19 and 42 both penetrated a thin, coarse surface layer overlying sediments that are weakly stratified both visually and on X-radiographs, and which consist of light to dark grey, sandy silts and clays (Fig. 21) similar to those seen in adjacent cores 20 and 41 from subunit A. The stratification appears vertically uninterrupted. However, core 56 penetrated a sequence of unstratified, dark grey, well sorted medium to fine sand, interlayered with moderately stratified, light grey, sandy silts and clays similar to those seen in core 57 from subunit A (Fig. 21). The contacts between the two lithologies are abrupt and unconformable, while the grain size parameters of the sand are comparable to those of nearby samples from the surficial veneer of current modification. These factors suggest a possible origin of the cored sequence in iceberg plowing and mixing of the coarse surface layer and the subsurface sandy silts and clays.

Micropaleontologic examination of the three cores of subunit B shows assemblages of foraminifera and palynomorphs which are generally similar to those observed in cores of subunit A. Benthic foraminiferal assemblages in subunit B do, however, display a greater vertical homogeneity and generally lower abundances.

Depositional environment and age of Davis Strait Silt

The interfingering relationships with the Baffin Shelf Drift (e.g. Fig. 12, 19) and the foraminiferal and palynological evidence of cores 77-021-156, -157, -159 and 82-034-41, -57, -68, -69 demonstrate that the Davis Strait Silt is primarily a glacial marine deposit associated with advance and retreat of glacial ice on the southeast Baffin Shelf. However, the vast extent of the Davis Strait Silt, particularly seaward to the continental slope, makes it unlikely that the unit is laterally consistent in its mode of deposition; rather, it undoubtedly incorporates intervals and areas of diverse origin, including ice-proximal to ice-distal glacial marine environments.

Information on the age of the Davis Strait Silt comes from five radiocarbon dates on cores 82-034-41, -57, -68 and -69 (Table 1; Fig. 4), collected in subunit A. These dates (Table 2; Fig. 30) are all of late Foxe age. Downward extrapolation to the base of the stratified sequences recognized on accompanying Huntec DTS profiles yields age estimates for the base of the Silt of ca. 35 000-55 000 B.P. Such estimates are of questionable reliability due to probable variations in sedimentation rates, particularly in cores close to former grounded ice margins. Nevertheless, these rough measures suggest that the Davis Strait Silt comprises a record of deposition dating from the mid-Foxe.

Tiniktartuq Silt and Clay (map unit 3)

The Tiniktartuq[1] Silt and Clay is an informal term proposed for acoustically stratified basin-fill sediments, observed on Huntec DTS profiles to directly overlie Davis Strait Silt subunit A in Cumberland Sound and locally on the outer shelf northeast of Resolution Island and east of Cape Mercy. Approximate water depths at these localities are: >625 m, 550-575 m, and 350-375 m, respectively. The unit forms the uppermost sediment unit in the areas where it has been observed. Ponded sediments mapped within Baffin Shelf Drift subunit C east of Cumberland Peninsula (Fig. 16) may correlate with this unit, or with the Davis Strait Silt.

On Huntec DTS profiles the unit is characterized by: (1) coherent internal reflectors, (2) moderate to high transparency, (3) a smooth surface, and (4) onlapping basin-fill relationships with the underlying sediments of the Davis Strait Silt (Fig. 31; see also Fig. 12, 23). The unit attains an observed maximum thickness of 10 m in Cumberland Sound. No sample data are available for the unit. However, variable acoustic transparency and penetration on 14.25 khz and 32 khz echograms indicate that the sediments vary from dominantly silty to dominantly clayey in composition.

The sediments of the Tiniktartuq Silt and Clay are inferred to be of late Foxe to Holocene age, on the basis of their stratigraphic position. The distinctive onlapping basin-fill character of the unit indicates a change in depositional style in the late Foxe-Holocene in the localities where the unit occurs.

Resolution Island Lag (map unit 4)

Resolution Island Lag is an informal term proposed for a unit composed primarily of angular gravels and sands which occur as a thin lag deposit over bedrock, or over thin Baffin Shelf Drift or Davis Strait Silt, in areas which appear largely devoid of sediments to the limit of acoustic resolution (30-50 cm). It may include areas of exposed bedrock. The unit occurs in water depths less than 150-200 m east of Hall Peninsula, but has been observed to 250 m depth east of Resolution Island, and to 325 m depth in both the mouth of Frobisher Bay and south of Cape Mercy.

On Huntec DTS profiles, areas of the Lag consist of bedrock largely devoid of cover within the limits of acoustic resolution (30-50 cm) (Fig. 32). However, scattered grab sample stations usually recover sediments, indicating a thin cover. Samples generally consist of angular to subangular, poorly to moderately sorted gravel (0-90%) and fine to coarse sand (10-99%), with a minor (<1-10%) silt/clay mode. In both their grain size distribution and surface texture the sediments are similar to those of nearby samples from the current modified surface of the Baffin Shelf Drift or the Davis Strait Silt. They are thus interpreted to be lag sediments derived from winnowing of thin to discontinuous deposits of Drift or Silt. Thin (<50 cm) Drift or Silt may underlie the Lag in some areas, but may have been entirely removed by winnowing elsewhere.

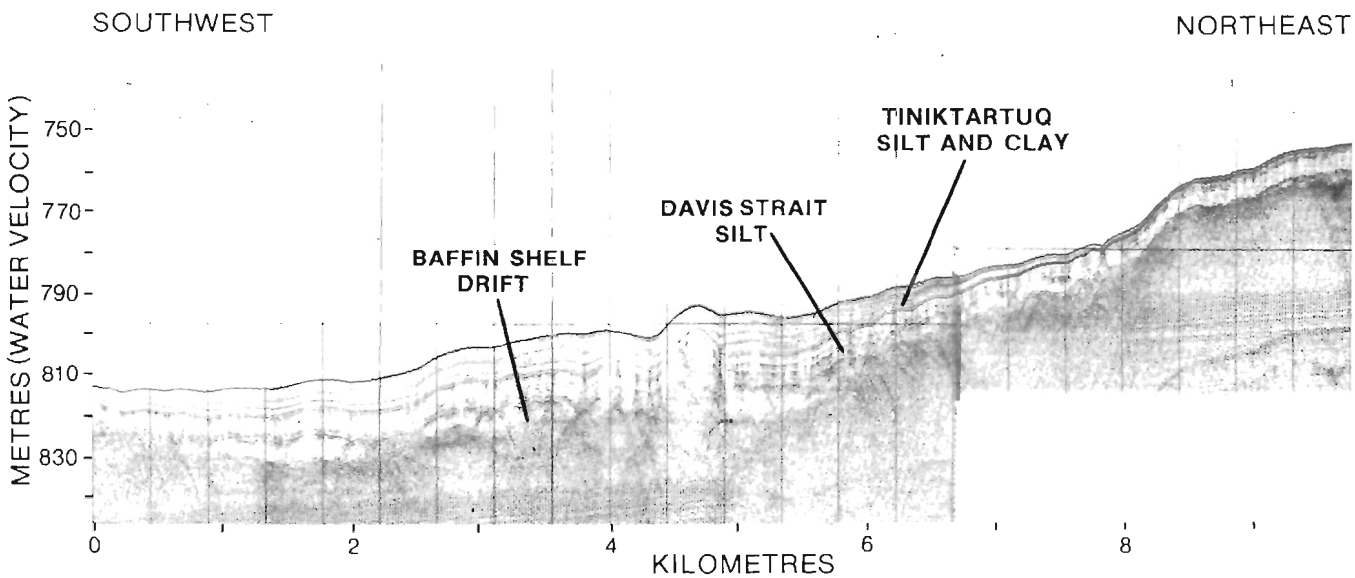

Figure 31. Huntec DTS profile from Cumberland Sound (see Fig. 7 for location), showing basin-fill sediments of the Tiniktartuq Silt and Clay overlying Davis Strait Silt subunit A, which in turn overlies Baffin Shelf Drift subunit A.

[1] Tiniktartuq is the name for Cumberland Sound in Inuktitut, the language of native peoples of the north.

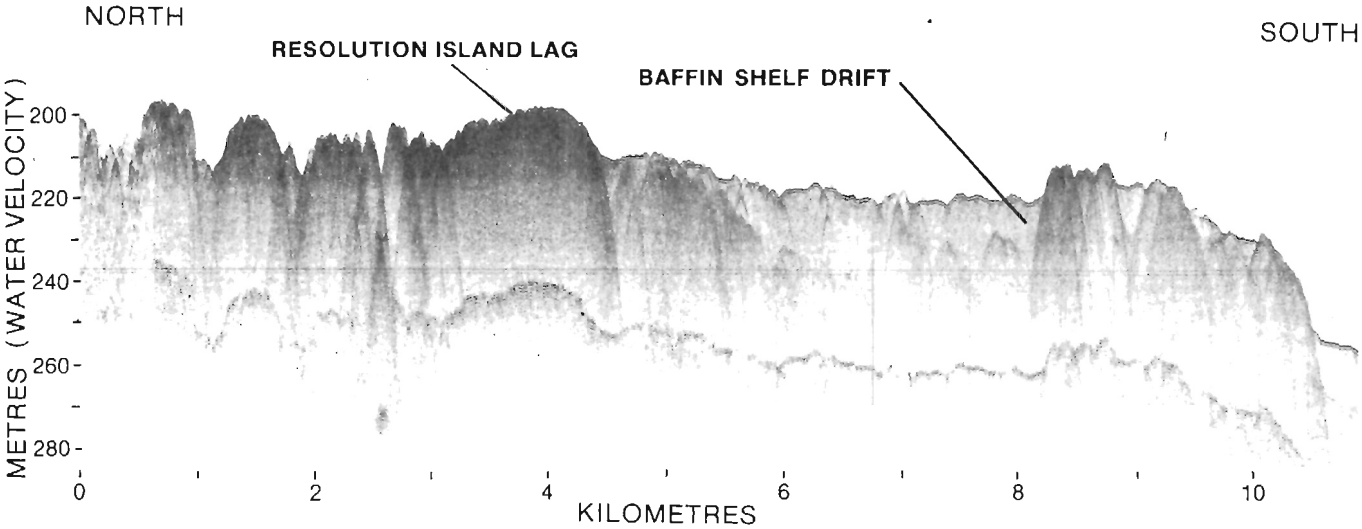

Figure 32. Huntec DTS profile adjacent to Resolution Island (see Fig. 7 for location), illustrating an area of Resolution Island Lag north of 4.5 km. Lag sediments too thin to be resolved acoustically lie on apparently bare bedrock to the north and on Baffin Shelf Drift subunit A to the south. The Lag may include areas of exposed bedrock.

The area of Resolution Island Lag east and southeast of Loks Land is texturally distinct. Here a group of samples composed of angular to subangular sands and gravels display coarser sand modes and better sorting, and have no silt/clay modes. These features distinguish the Lag in this area from nearby samples of the current-modified surface of the Baffin Shelf Drift, into which it appears to texturally grade. These samples of the Lag lie within an area of jagged Precambrian bedrock, like that seen in Figure 32. Praeg (1983) examined a few of these samples and found quartz grain surface textures indicative of mild current erosion of glacial surfaces, similar to textures in samples from the current modified surface of the Baffin Shelf Drift on the Lady Franklin Bank. This suggests that sediments of the Loks Land area are also the product of current winnowing of thin Drift or Silt. However, grain size and sorting parameters indicate the area may have been subjected to some of the strongest currents on the southeast shelf, possibly related to strong tidal flushing in the Frobisher Bay area.

The morphology of areas of Resolution Island Lag varies with bedrock lithology: areas underlain by Precambrian basement rocks are usually rough (10-100 m relief) (e.g. Fig. 32), while areas underlain by Ordovician limestone or Cenozoic sediments are usually smooth (1-5 m relief). Small scale relief is also sometimes observed in the form of shallow iceberg scours.

King (1970) was able to relate occurrences of rounded sands and gravels on the Scotian Shelf to extensive reworking of sediments in areas above 115-120 m during an 18 000-19 000 B.P. sea level lowstand and subsequent Holocene transgression. The record of such an event on the Baffin Shelf would be expected to be present in the form of (1) the development of terraces, (2) removal or marked thinning of overburden, or (3) formation of coarse lag deposits in areas transgressed or subjected to high wave energy. Terrace-like features are noted on the southeast Baffin Shelf at various depths and locations; however, it has not proved possible either to correlate these features across the shelf, or to relate them to the distribution of sand and gravel. Marked thinning of overburden relative to deeper offshore areas is noted in many localities (Fig. 8), sometimes in conjunction with the distribution of the Resolution Island Lag. However, the frequent coincidence of this thinning with the subsurface bedrock contact between resistant Precambrian or Ordovician rocks of the inner shelf and semiconsolidated Cenozoic sediments of the outer shelf (e.g. Fig. 10) suggests that the thinning is due primarily to limited deposition of glacial drift on the inner shelf, as noted by Josenhans (1983) on the Labrador Shelf, rather than to removal of overburden. Finally, the Baffin Shelf coarse lag deposits examined to date exhibit no textural evidence of having gone through a marine transgressive zone, nor do they have a consistent lower depth. Rather they possess textural characteristics which are compatible with an origin from bottom current winnowing.

As discussed earlier Andrews (1980) postulated a mid- to late-Foxe relative sea level lowstand of at least 80 m, termed the Pigjoat, in the eastern Baffin Island region. However, the portions of the southeast Baffin Shelf where this lowstand may be recorded are the nearshore and bank areas above the 150 m isobath, most of which have been neither bathymetrically charted, nor geologically investigated. Thus the lack of evidence for a relative sea level lowstand in our results should not be construed as indicative that such an event or events have not affected the shallower parts of the southeast Baffin Shelf.

MODIFICATION BY CURRENTS

Information from samples, bottom photographs, and seabed observations from the submersible **Pisces IV** indicate that the surface of the unconsolidated sediments of the southeast Baffin Shelf has been modified by seabottom currents. This modification is represented by a widespread veneer too thin to be resolved by the Huntec DTS system (<30-50 cm).

Modification has been recognized in two forms: (1) winnowing, and (2) sediment redeposition. Winnowing has produced a thin surface lag, composed mainly of sand and/or gravel. Information from both grab samples and visual observations indicate that gravel fragments of the surface lag often are only partly exposed at the seabed, and that the exposed surface is stained and encrusted with organisms while the buried surface is not. Data from the IKU grab

sampler, which collected samples of both the surface lag and the underlying sediment, indicate that gravel fragments of the lag correlate well in size and general composition with gravel sized components in the underlying sediment. In some areas deposition of a thin, usually <20 cm, surface layer composed dominantly of sand has occurred. This surface layer usually is recognized as a light to dark olive green sediment that abruptly overlies the finer grained grey to black sediments that constitute the main surficial units, e.g. cores 82-034-41, -57, -68 and -69 (Fig. 21).

Van Veen grab samplers mainly provided samples of the modified surface veneer, due to their limited subsurface penetration ability. Variations in the abundance of both gravel and mud (=silt+clay) in grab samples and core tops from the southeast shelf are illustrated in Figures 33 and 34. Although local variability can be quite high in some areas, e.g. east of Cape Mercy, where observations from **Pisces IV** revealed gravelly berms and gravel free scour troughs, the patterns in Figures 33 and 34 provide a general regional summary of seabottom texture. Variations in mud abundance show a general correspondence with the bathymetry (Fig. 2), with greater abundances in greater depths. Variations in gravel abundance show a partial correspondence with the bathymetry, as low abundances (<5%) occur in basins and depressions; however highest abundances tend to be confined to the inner part of the shelf. The textural patterns show poor correspondence to the boundaries of the underlying map units (Fig. 7).

Ice rafting by icebergs and pack ice presumably has contributed to the surficial sediments of the shelf, as suggested by some previous workers, e.g. Trask (1932), Kranck (1966), but that it is not the main agent responsible for the presence of the surface veneer is demonstrated by: (1) the partial exposure of gravel and the similarity of this lag material to the coarser components of the underlying sediments, and (2) the occurrence of extensive areas largely free of gravel (<5%; Fig. 33), many of which are in bathymetric depressions downcurrent from shallower areas which have a mainly sand and gravel veneer at the seafloor.

The main agent responsible for the formation of the surface veneer has been winnowing and local redeposition by seabottom currents. This is supported by the above observations, and by: (1) the association of high gravel and sand abundances in the Lady Franklin Bank area (Fig. 33) with the presence of a benthic foraminiferal species (**Cibicides lobatulus**) indicative of currents and current winnowed bottoms (Osterman, 1982; Fig. 22); (2) analysis of several grab samples from the surface veneer on Lady Franklin Bank, which showed grain surface textures and variations in grain size and lithology consistent with an origin in current winnowing (Praeg, 1983); and (3) the presence of strong currents in the southeast Baffin Shelf area, such as the southbound Baffin Current and tidal currents in the Frobisher Bay area.

The time span represented by the surface veneer is suggested by the work of Osterman (1982) on cores 77-021-156, -157, -159 (Table 1; Fig. 4) in the Frobisher Bay area. She associated her uppermost Burton unit, which on the outer shelf (core 156) is a sand rich zone characterized by a dominance of **Cibicides lobatulus**, with a strengthening of the Baffin Current and a change in the sedimentary regime. A radiocarbon date on total organic matter of 2745 ± 145 B.P. (GX-7881) was obtained from core 159 at 130-150 cm depth, 80 cm below the base of the Burton unit. This suggests that the change in sedimentary style took place sometime subsequent to ca. 2700 B.P.

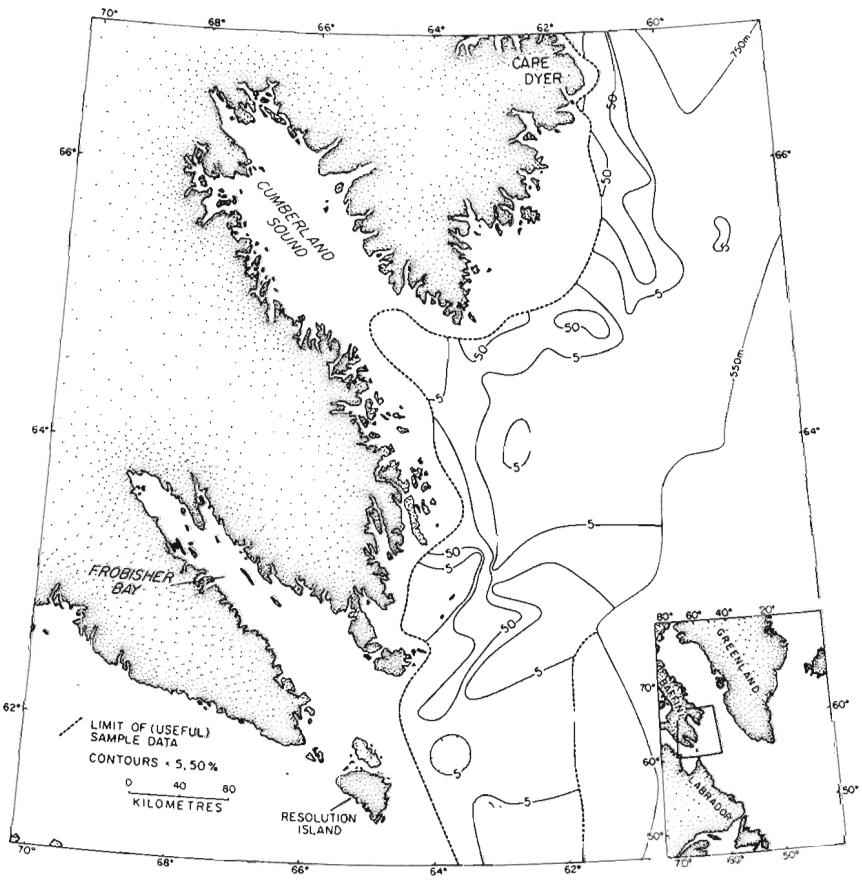

Figure 33

Generalized variation in the abundance of gravel in surface samples. See Figure 4 for sample density. Samples from the area of Baffin Shelf Drift subunit C east of Cumberland Peninsula (Fig. 7) have been excluded, due to significant local variability in gravel abundance (see Fig. 16, 17). The 550 m and 750 m isobaths denote the seaward edge of mapping.

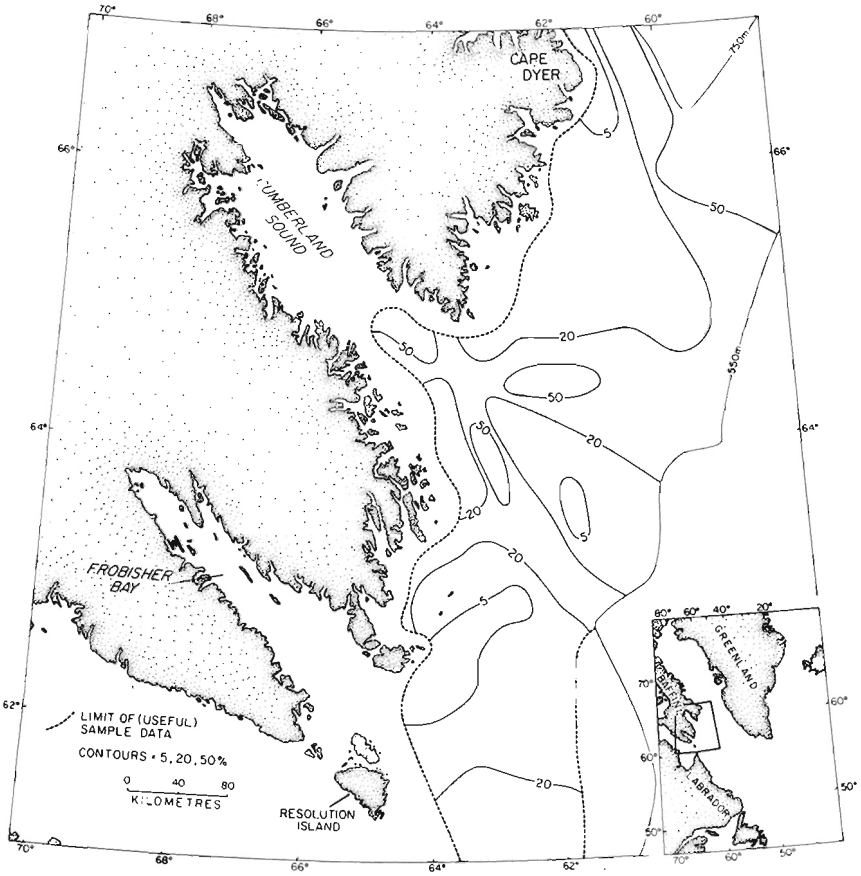

Figure 34

Generalized variation in the abundance of mud (=silt+clay) in surface samples. See Figure 4 for sample density. The 550 m and 750 m isobaths denote the seaward edge of mapping.

SUMMARY

Synthesis and interpretation of acoustic and sample data from the southeast Baffin Shelf has permitted definition of four acoustic units (named informally), delineation of their surficial distribution, and derivation of a preliminary Quaternary geologic history. The bedrock units of the shelf are extensively overlain by Quaternary sediments up to 300 m in thickness. The deposits of the Baffin Shelf Drift record repeated advances of glacial ice, of varied extent, some of which reached to the shelf edge; these sediments appear to be of early late Foxe or older age. The Drift is overlain and in some areas interfingers with sediments of the Davis Strait Silt, areally the most extensive unit. The acoustically stratified sediments of the Davis Strait Silt subunit A, which are unscoured by grounding icebergs, record deposition from mid-Foxe time to the Holocene and contain microfossil evidence of ice-proximal to ice-distal glacial marine environments. The acoustically unstratified sediments of the Davis Strait Silt subunit B are laterally equivalent, and reflect extensive post- and syn-depositional iceberg scouring which has disrupted the original stratification. Variations in the depth of transition from subunit A to B reflect a balance between bathymetric sheltering and variations in iceberg scouring depths through time. In the outer part of Cumberland Sound and in a few small localities on the open shelf the stratified sediments of the Davis Strait Silt are overlain by the stratified basin-fill sediments of the Tiniktartuq Silt and Clay, which indicate a change in depositional style in the late Foxe to Holocene at those localities. The angular to subangular sands and gravels of the Resolution Island Lag record winnowing of areas of thin to discontinuous Baffin Shelf Drift or Davis Strait Silt by seabottom currents. There is no evidence of a transgressive zone marking a RSL lowstand in the depths represented by the data (mainly >150 m). The immediate seabed of the southeast Baffin Shelf has been subjected to modification by currents, resulting in the formation of an extensive surface veneer which overlies the sediments of the acoustic units in thicknesses <30-50 cm.

The report provides information applicable to, and a framework for: (1) seabed engineering activities and potential hazards, e.g. pipeline routes and iceberg scouring, (2) fishing activities, e.g. trawling; and (3) further research on the Quaternary geologic history of the southeast Baffin Island continental shelf.

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