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Quaternary Geology of the Northeast Baffin Island Continental Shelf, Cape Aston to Buchan Gulf (70º to 72ºN)

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2007

NOTE:
This report was originally drafted in 1990 and subsequently revised, following input from the second and third authors, to allow release on Open File. Nonetheless the content remains substantially that of the original report; in particular no references have been added to work published subsequent to 1991

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Available from
Geological Survey of Canada
1 Challenger Drive, Dartmouth, NS B2Y 4A2

Praeg, D., MacLean, B., and Sonnichsen, G.
2007: Quaternary Geology of the Northeast Baffin Island Continental Shelf, Cape Aston to Buchan Gulf (70º to 72ºN); Geological Survey of Canada, Open File 5409, 1 CD-ROM.

Open files are products that have not gone through the GSC formal publication process.

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ABSTRACT

Shallow geophysical and geological data acquired from 1974-1985 across a part of the northeast Baffin Island continental shelf provide information on its morphologic and stratigraphic development since the late Tertiary, culminating in the deposition of late Quaternary glacial to post-glacial sediments. The study area contains four transverse troughs, up to 36 km wide and incised up to 800 m through bedrock units of Precambrian to Tertiary age, with glacial erosion indicated by axial overdeepening (including elongate depressions at the bedrock surface, up to 180 m in relief). Bedrock units are unconformably overlain by strata up to 180 m thick, divided into six stratigraphic units to which informal names have been applied. The *Cape Adair Sediments,* an irregularly stratified subsurface unit with thicknesses up to 100 m, is observed beneath inter-trough areas and within Clyde and Sam Ford troughs and is tentatively correlated to the glacial to glacial marine successions of the adjacent coastal forelands of Baffin Island, which in places date back to the Pliocene. An unconformity at the surface of the Cape Adair Sediments, in places resistant to iceberg scouring, corresponds to a mainly transverse system of depressions and ridges recognised within inter-trough areas. The *Scott Trough Sediments,* a well-stratified subsurface unit with thicknesses up to 75 m, onlaps bedrock depressions in Scott and Buchan troughs and may record either a long period of marine deposition prior to the last glaciation, or rapid glacial marine deposition during the last deglaciation of the shelf.

A conformable succession of four units that outcrop at seabed is interpreted to record a late Quaternary cycle of glacial ice-contact through glacial marine to post-glacial sedimentation. The *Baffin Shelf Drift* (unstratified, irregular geometry, up to 75 m thick) extends to the shelf edge and to depths of 850 m in Buchan Trough, consistent with full glacial occupation of the shelf. The unit interfingers in places with the *Davis Strait Silt* (stratified, mantling geometry, up to 7 m thick), which is inferred to record ice-proximal to distal marine deposition during deglacial withdrawal from the shelf. A single core sample of the Davis Strait Silt comprises mud with locally derived sand and gravel, yielding no dateable material. However, downward extrapolation of radiocarbon dates in cores of overlying post-glacial muds to the top of the unit yields an age of c. 15 ka for the end of glacial conditions on the shelf. Post-glacial deposition is recorded by the *Tiniktartuq Mud* (hemipelagic deposits in the troughs and inter-trough depressions, up to 7 m thick) and the *Cape Aston Sand* (coarse-grained deposits =1 m thick above depths of 80-120 m). Core samples indicate both units include significant components of deposition from ice rafting and, for the Cape Aston Sand, probable reworking of glacial sediments.

Grab samples from the two post-glacial units yield seabed muds and sands, consistent with ongoing deposition. Samples from the surfaces of the two glacial units yield variable textures, inferred to reflect the effects of current reworking, ice rafting and iceberg scouring. Iceberg scours (locally up to 8 m deep over glacial units) have extensively modified the seabed over most of the shelf, although abundances are reduced in inter-trough depressions and in Sam Ford and Clyde troughs. Scours extend to depths of 600 m on the upper continental slope and the outer walls of Scott and Buchan troughs. Most scours below depths of c. 300 m are inferred to be relict, whereas modern scours are recognized in shallower depths, including one observed in the process of formation in c. 90 m depth. Sediments on the floors of Scott and Buchan troughs contain a record of mass failure from the adjacent steep (up to 25°) slopes. Seepage of hydrocarbons from the seabed is also recognized on the walls of Scott and Buchan troughs, where it has resulted in indurated crusts, bacterial mats and possible pockmarks.

1. SUMMARY

This report deals with the seabed and shallow subsurface geology of a part of the continental shelf of Northeast Baffin Island, based on data collected from 1974 to 1985 in the course of reconnaissance surveys of the shelf and investigations of natural seepage of petroleum in the Scott Inlet – Buchan Gulf area. The data consist of acoustic records (seismic and echosounder profiles, sidescan sonar imagery) and seabed samples and observations (cores and grab samples, bottom photographs and submersible observations). New information is presented on the morphology of the shelf and upper slope, the stratigraphy of sediments overlying bedrock and the character of seabed sediments, which allows insights into the Pliocene to Quaternary development of this high-latitude continental margin.

The study area is marked by four transverse troughs, up to 36 km wide and 850 m deep, extending across the shelf from the mouths of one or more fiords. Seismic profiles show the troughs are incised through bedrock units of Precambrian to Tertiary age, up to 800 m in Scott Trough. Glacial overdeepening of the trough floors is indicated by linear depressions at the bedrock surface (up to 180 m in axial relief) and by bedrock sills (with relief up to 440 m) at their heads separating them from the adjacent fjords. The troughs are flanked by ridges that are here shown to be part of a system of mainly transverse ridges and depressions that extend across the inter-trough areas to shelf break depths (250-300 m). Seismic profiles indicate the system is developed within Quaternary strata (atop underlying Cape Adair Sediments). The ridges, including Hecla and Griper Banks, contain clinoform reflections suggestive of a depositional origin, but enhanced by erosion along the depressions, in places to the bedrock surface.

Bedrock units are unconformably overlain by sediments with thicknesses up to 180 m, divided into six stratigraphic units, to which informal names have been applied. The lower two units occur entirely in the subsurface. The *Cape Adair Sediments* extend beneath inter-trough areas, and within Clyde and Sam Ford troughs, with thicknesses up to 100 m. The unit is characterized by irregular reflectors, inclined within some transverse ridges, and a surface unconformity resistant to iceberg scour where occurring within 2 m of the seabed. The unit is correlated with the glacial to glacial marine successions of the Baffin Island coastal forelands, which in places date back to the Pliocene. The *Scott Trough Sediments* occur in the subsurface of Scott and Buchan troughs and are characterized by reflections that onlap bedrock depressions, with thicknesses up to 75 m. The unit is conformably overlain by younger surficial units and may record either a long period of marine deposition prior to the last glaciation, or rapid deposition of glacial marine turbidites during the last deglaciation.

The four seabed units are correlative to units previously recognized on the SE Baffin Shelf and interpreted to record a late Quaternary cycle of glacial to post-glacial sedimentation. Glacial deposition is recorded by the *Baffin Shelf Drift* and the overlying *Davis Strait Silt,* which interfingers in places. The Baffin Shelf Drift is mainly reflection free and of irregular geometry, typically <25 m thick but up to 75 m thick. It is absent in Scott Trough below water depths of 300-400 m, but otherwise occurs across the shelf to depths of at least 300 m, including the floors of Clyde and Sam Ford troughs, and to depths of 850 m in outer Buchan Trough. It is interpreted as ice-contact sediments, deposited or remolded in contact with grounded glacial ice. The overlying *Davis Strait Silt* is a stratified unit with a mantling geometry, typically 2-4 m thick but up to 7 m in places, that extends across water depths of 150-800 m. A single core sample from the wall of Scott Trough consists of mud with sand and gravel,

the coarse fraction dominated by lithologies locally derived from erosion of the trough wall. The unit is interpreted as glacial marine sediments deposited from widespread ice margin sediment sources in the absence of bottom current influence. The core did not yield dateable material, but downward extrapolation of radiocarbon dates on overlying post-glacial muds suggest that the top of the unit in Scott Trough dates from c. 15 ka.

The two uppermost units, the *Tiniktartuq Mud* and the *Cape Aston Sand,* record post-glacial sedimentation. The Tiniktartuq Mud has a ponded geometry, with thicknesses up to 7 m, and occurs in the transverse troughs and in depressions in inter-trough areas. Core samples consist mainly of mud (>75%) deposited from suspension, with minor ice-rafted sand and gravel. The Cape Aston Sand occurs above water depths of 80 – 120 m, with thicknesses up to 1 m. A single core sample 0.93 m long consists of muddy sand with gravel, presumably derived from reworking of material at shallower depths, as well as ice rafting. A radiocarbon date from the core, extrapolated to its base, indicates deposition over the last 17 ka, comparable to the age of the Tiniktartuq Mud.

The sediment units have been disturbed in places by mass failure and over wide areas by iceberg scouring. Mass failure is observed at seabed and in the subsurface of Scott and Buchan troughs, by unstratified lobes on their floors within the Tiniktartuq Mud, the Davis Strait Silt and the Scott Trough Sediments. The acoustically unstratified lobes are inferred to record *in situ* compression of sediments on the floors of the troughs during a history of failure from the adjacent slopes. Iceberg scours are present across the shelf in areas of Cape Aston Sand above depths of ca. 100 m and at the surfaces of glacial units (Baffin Shelf Drift and Davis Strait Silt) to depths of ca. 600 m on the upper continental slope and in outer Scott and Buchan troughs, although their abundance is reduced in seabed depressions within some inter-trough areas and within Sam Ford and Clyde troughs. Scours below about 300 m water depth are inferred to be mainly relict. Scours up to 8 m deep are observed at the surface of the Baffin Shelf Drift, but are typically <5 m deep over this unit and the Davis Strait Silt; scours are shallower (<2 m) and narrower in areas of Cape Aston Sand above water depths of 80-120 m or where glacial sediments thin over the resistant surface of the Cape Adair Sediments.

Seabed samples from areas of the post-glacial units consist of muds and sands, indicating ongoing deposition. Samples from the surfaces of glacial units consist of texturally variable mixtures of mud, sand and gravel, attributed to a combination of current winnowing of iceberg scours and deposition from ice-rafting. Gravel/granule lithologies in grab samples from glacial sediments in inter-trough areas are comparable to those in samples from post-glacial muds, suggesting a predominance of ice-rafted sources. However, several samples from the walls of Scott Trough contain distinctive sedimentary lithologies of local derivation, indicating seabed exposure of glacial sediments, probably due to mass failures along the trough walls. Natural seepage of hydrocarbons has produced indurated crusts, bacterial mats and possibly pockmarks on the walls of Scott and probably Buchan troughs.

Glacial chronologies proposed for Baffin Bay and Baffin Island provide a long-term context for the erosional and depositional events recognised in the study area. Glacial erosion of the shelf and troughs may date back to the Pliocene, ca. 3.5 Ma, when sedimentary lithologies typical of bedrock in the study area became abundant in sediments at nearby ODP site 645. Glacial to glacial marine depositional styles since the Pliocene are also recorded in the Baffin Island coastal forelands, which are inferred to extend offshore as the Cape Adair Sediments (although these may be younger in Sam Ford and Clyde troughs). Glacial erosion of Cape Adair Sediments to produce the transverse system of ridges and depressions in inter-trough areas may have taken place either during the last glaciation of the shelf or prior to a long period of restricted glaciations before the last, as suggested by weathering zone contrasts on Baffin Island. Similarly, marine deposition of the Scott Trough Sediments may have taken place either prior to or during the last full occupation of Scott and Buchan troughs by glacial ice.

The last glaciation of the shelf is recorded by the Baffin Shelf Drift, the distribution of which implies ice sheet extent to the shelf edge and to (modern) water depths of 850 m in outer Buchan Trough. Glacial marine sediments of the Davis Strait Silt, in part coeval, were deposited during ice margin withdrawal, which was complete by ca. 15 ka. Post-glacial conditions have subsequently been dominated by the influences of currents and icebergs, which have facilitated deposition from suspension and ice-rafting and reworking of the seabed by iceberg scouring and current winnowing.

2. INTRODUCTION
2.1 Scope of Report

The Geological Survey of Canada (Atlantic) collected shallow geophysical and geological data from the continental margin of Baffin Island for almost two decades, 1965-1985, in the course of reconnaissance surveys of the bedrock and Quaternary geology of the eastern Canadian offshore (see Keen & Williams, 1990). On the southeast Baffin shelf, south of Cape Dyer (Figure 1), these data contributed to an understanding of the bedrock geology (MacLean, 1985, MacLean et al., 1982, 1986) as well as of the overlying Quaternary sediments (Praeg et al., 1986, Jennings, 1989). On the northeast Baffin shelf, evidence of natural seepage of petroleum from the seabed (Loncarevic and Falconer, 1977) led to a concentration of survey activity in the area of Scott Inlet and Buchan Gulf (Figure 2). The bedrock geology underlying this area was outlined by MacLean et al. (1981) and its Quaternary features were discussed by MacLean (1985).

This report presents a synthesis of information available on the Quaternary geology of a somewhat wider area of the northeast Baffin Shelf, between Cape Aston and Buchan Gulf (Figures 1, 2). The data used consist of shallow geophysical records (Figure 2a) and seabed sediment samples and observations (Figure 2b) acquired during surveys from 1974 to 1985. These data allow new information to be presented on the morphology of the shelf, on the thickness and stratigraphic character of the Quaternary succession unconformably overlying bedrock units, on the sediments deposited during the last glaciation of the shelf and on the post-glacial sedimentary processes that affect the seabed. This information is summarized in a number of figures and in a 1:500,000 scale geological map of the seabed (Figure 19), which includes revised bathymetric contours constructed using the survey data. The report also includes a summary of the bedrock geology in the study area, slightly revised from one presented in a 1:5 million scale map of the geology of the eastern Canadian continental margin (Fader et al., 1989).

The information presented affords insights into the morphologic, stratigraphic and sedimentary evolution of this high-latitude continental margin. A record of glacial erosion and deposition is recognized that, by reference to work on Baffin Island and in Baffin Bay, is likely to extend back to the Pliocene in places. The deposits of the last glaciation provide evidence of the extent of glacial ice encroachment onto the shelf, which is in dispute in terrestrial reconstructions. Post-glacial sediments and seabed features document the processes that continue to modify the seabed. The report provides a basic framework for further investigations of the northeastern Baffin Island continental shelf.

2.2 Previous work in the study area

Scattered samples of the sediments of Baffin Bay and its margins were first obtained by oceanographic expeditions from Denmark (Riis-Carstensen, 1931) and the United States (Trask, 1932). From the 1960s, Canadian expeditions of the Bedford Institute of Oceanography (BIO) undertook sampling programmes that demonstrated the coarse-grained character of the continental shelves in contrast to the muddy character of the transverse troughs and central basin (Grant, 1965, 1971; Marlowe, 1966; Baker and Friedman, 1973; Pelletier et al., 1975). Latterly, echosounder profiles were used to examine the submarine geomorphology of the NE Baffin Shelf (Løken and Hodgson, 1971; Løken, 1973).

From the late 1970s, multiparameter geophysical data and samples acquired during reconnaissance surveys by BIO (Table 1, Figure 2) provided information on the bedrock and Quaternary geology of the NE Baffin Shelf. A sighting of an oil slick (Loncarevic and Falconer, 1977) led to a focus of attention on the Scott Inlet-Buchan Gulf area (Figure 2). The results of several surveys to the Scott-Buchan area were presented in a series of field reports (Loncarevic and Falconer, 1977; MacLean, 1978; MacLean and Falconer, 1979; Levy and MacLean, 1981; MacLean, 1982; MacLean and Williams, 1983; Grant et al., 1986) and a summary of the evidence for natural seepage of petroleum from the seabed in the area was presented by MacLean et al. (1981). Quaternary features of the Scott-Buchan area were discussed by MacLean (1985), who observed sediments overlying bedrock with thicknesses greater than 50 m both in and between the transverse troughs, including glacial sediments that extend to the shelf edge in most places. The seabed was found to consist of fine-grained sediments in the troughs and coarser sediments in inter-trough areas, with iceberg scours abundant on the seabed between the troughs (see also Lewis et al., 1979; Syvitski et al., 1982). The distribution of iceberg scours and seabed sediments in a small area off Cape Hunter (Fig. 2b) was discussed by Cameron (1984), using sidescan sonar imagery and samples.

Geophysical and sample data were also acquired during BIO surveys of ten northeast Baffin Island fiords for SAFE, the Sedimentology of Arctic Fiords Experiment (Syvitski and Blakeney, 1983; Syvitski, 1984; Gilbert, 1985). Cores recovered by BIO from both the fiords and the adjacent continental shelf have been examined by researchers at the Institute of Arctic and Alpine Research at the University of Colorado, who traced the textural, mineralogical and micropalaeontological changes associated with the last glacial to interglacial transition (Andrews et al., 1983; Andrews and Osterman, 1984; Andrews et al., 1985a,b.). This included a transect of cores from Scott Trough and adjacent Clark Fiord, examined by Jennings (1986). The Scott Trough cores (76023-26, 78029-24; Figure 2b) were further discussed by Osterman (1985) and Osterman and Nelson (1989), along with a vibrocore recovered from shallow water off Cape Aston (78029-36, Figure 2b).

Early versions of the information presented in this report, including some of the figures, were used in contributions to regional summaries of the bedrock and Quaternary geology of the eastern Canadian continental margin prepared for the Decade of North American Geology (Piper et al., 1988, 1990), as well as in a summary of the seabed geology of Canadian high-latitude continental shelves by Andrews et al. (1991). A preliminary version of this map was incorporated in a 1.5 million scale overview of the Quaternary geology of the eastern Canadian continental margin (Piper et al., 1988).

2.3 Data and Methods

The geophysical and geological data used in this report (Figure 2) were acquired during a series of BIO cruises (by CSS Hudson: 74026, 76023, 76025, 77027, 78029, 80028, 81045, 82031, 82034; CSS Baffin: 78026; and MV Pandora II: 81055/56, 85063), technical reports for each of which (Table 1, Figure 2) are on file with the Geological Survey of Canada. Data positioning during each of the surveys was achieved by a combination of rho-rho Loran C, transit satellite navigation, and log and gyro, integrated by the BIONAV system (Wells and Grant, 1981) and supplemented in some cases by radar ranges and bearings. Navigational accuracy varied with year and location, but comparison of seabed depths at common points indicates it was generally within 1 km and commonly within 500 m.

Multi-parameter geophysical survey lines (Figure 2a) were run at speeds of 5 – 10 km/hour, using up to four systems simultaneously (Table 1). All data was recorded in analog form on Raytheon or EPC graphic recorders. Single channel *seismic reflection profiles* were acquired using two main sources, air guns (or a 1 kJ sparker on one line) and Huntec DTS boomers. Air gun systems provided up to 500 msec of relatively low resolution (5 – 10 msec) subbottom information, used in distinguishing bedrock units and the thickness and character of overlying Quaternary sediments. The Huntec Deep-Towed Seismic reflection (DTS) boomer system provided up to 50 msec of high resolution (<1 m) subbottom information, used in distinguishing shallow stratigraphic units and their relationships. In addition, an acoustic reflectivity module used on the Huntec system in 1980 (Parrott et al., 1980) provided quantitative information on seabed sediment textures. *Sidescan sonar* systems provided seabed imagery across swaths up to 1.5 km wide, interpretable in terms of seabed morphology and sediment texture. Echosounders also provided information on seabed morphology, as well as several metres of subbottom penetration in fine-grained (muddy) sediments.

Seabed sediments were sampled using Van Veen or Shipek grabs. Subbottom sediments were sampled using Benthos gravity and piston corers, and an Aimers-MacLean vibrocorer. Bottom photographs were collected from the surface using Umel underwater cameras. In addition, video recordings, photographs and visual observations were made during dives of the submersible Pisces IV (MacLean, 1982; Grant et al., 1986).

Textural analyses were performed on grab and core sub-samples soon after their collection (Appendix 1). The proportions of gravel, sand, silt and clay were determined using sieve and pipette methods for most of the grab samples and core 78029-36. More detailed size frequency analyses were performed on selected grab samples, and on cores 80028-73 and 81045-25C, using settling tube and pipette determinations. Detailed textural analyses of cores 76026-23, 78029-24 and –36 were presented in Andrews and Osterman (1984) and Jennings (1986).

Stratigraphic units, for the purposes of this study, are intervals that can be identified on seismic reflection profiles (supplemented by sidescan imagery, echosounder profiles and cores) and traced laterally (i.e. mapped) based on distinctive reflector geometries (e.g. constructional, onlapping, mantling) and/or laterally variable facies characteristics (continuous to discontinuous reflectors versus incoherent tone) (e.g. Syvitski and Praeg, 1989). They are mappable units, but convey no formal group or formation status. This approach to stratigraphic analysis has been widely applied to the Quaternary successions offshore eastern and Arctic Canada (see Piper et al., 1990). In the absence of discordant reflector relations that might define unconformity-bounded seismic stratigraphic sequences, the units so defined correspond to the seismic facies of Mitchum et al. (1977).

Throughout this report sediment thicknesses are reported in metres, calculated from two-way travel times (TWT) using a velocity of 1.5 km/s, corresponding to the approximate velocity of sound in water. Thicknesses therefore represent minimum estimates, as actual sediment velocities may vary from 1.5 to 2.0 km/s (Hamilton, 1976).

2.3 Acknowledgements

The support of the captains, officers, crews and staffs of the various surveys and survey vessels involved in the collection of the data is gratefully acknowledged. C.F.M. Lewis was responsible for the acquisition of some of the data and engaged in several helpful discussions. C. Blakeney participated in the initial seismic compilation. G. Vilks examined the foraminifera in core 80028-73. Comments or discussions were helpfully provided by J.T. Andrews, A.C. Grant, A.E. Jennings, H.W. Josenhans, G.H. Miller, D.J.W. Piper, J.A. Stravers, and J.P.M. Syvitski.

3. REGIONAL SETTING

3.1 Physiography

The Barnes Ice Cap, last remnant of the Laurentide Ice Sheet in this region, lies on the interior uplands of Baffin Island to the west of the study area (Figure 1). The uplands are separated from Baffin Bay by the eastern coastal mountains of Baffin Island, which rise to elevations of 1500 – 1700 m and host numerous valley glaciers. The mountains are dissected by long fiords, some of which extend inland beyond height of land. The fiords contain water depths of up to 900 m below sea level and sediment thicknesses are commonly several hundreds of metres (Gilbert, 1985), so depths to bedrock may exceed 1000 m below sea level and overall relief is on the order of several kilometres. However, on the outer part of many inter-fiord peninsulas, low coastal forelands descend gently to sea level, underlain by sediments up to 40 m thick (Miller et al., 1977) that in places may date back to the Pliocene (Feyling-Hanssen, 1985).

The continental shelf in the study area is 50 –70 km wide (Figure 2b) and is marked by four transverse troughs, typical of high-latitude continental shelves (e.g. Løken, 1973). Marginal (coast parallel) troughs, which are common to other glaciated shelves, are largely absent on the Baffin Shelf (Løken and Hodgson, 1971; McMillan, 1973), but within the study area a short marginal extension of inner Scott Trough separates Baffin Island from Hecla and Griper Banks (Figure 2b). Scott and Buchan troughs are two of the deepest troughs on the northeast Baffin Shelf, with depths over 700 m; Sam Ford and Clyde troughs are much shallower, with depths over 250 m. The inter-trough areas are physiographic extensions of the adjacent coastal forelands and descend gently seaward at gradients of less than 1°. The shelf edge lies at water depths of 200 – 300 m, below which the continental slope descends seaward with gradients up to 4°.

3.2 Pliocene-Quaternary Glacial History

3.2.1 Baffin Island

A broad chronostratigraphic division of the Quaternary on Baffin Island is suggested by three surficial zones of differential weathering (Pheasant and Andrews, 1972; Boyer and Pheasant, 1974; Andrews, 1989). Weathering zone I occurs on highland areas, which may never have been glaciated by actively eroding ice. Zone II lies below zone I (at lower elevations) and contains moderately weathered till deposits interpreted to relate to extensive glaciations prior to the last. A sharp weathering break separates zone II from lowermost zone III, which is interpreted to represent deposits of the last (Foxe) glaciation.

The distinct change in weathering across the zone II/III boundary suggests that glacial advances immediately preceding the Foxe glaciation were less extensive than the still-earlier advances that deposited tills within zone II (Andrews and Miller, 1976). However, little is known about glaciations prior to the Foxe. Subdued lateral moraines that probably relate to several glaciations are present within weathering zone II (Andrews and Miller, 1976), but the ages and extents of the associated glacial advances are undefined. Multiple tills are recognized in coastal cliff sections of the coastal forelands (Miller, Andrews and Short, 1977; Andrews and Miller, 1984).

The term Foxe glaciation was proposed by Andrews (1968) as an eastern Canadian Arctic correlative to the Wisconsinan glaciation, and was defined by Andrews and Miller (1984) as the glaciation that occurred between the last interglacial (ca. 120,000 BP) and the disintegration of the Baffin Island ice cap (ca. 5,000 BP). The chronology of the Foxe glaciation is based primarily on radiocarbon dating and aminostratigraphy of cliff sections from the coastal forelands, and of raised marine deltas, which record marine transgressive/regressive cycles postulated to correlate with glacial advances and retreats (Miller, Andrews and Short, 1977; Andrews, 1979; Andrews and Miller, 1984). Marine sediments of the Kogalu aminozone, estimated at younger than 130 ka, are correlated with moraines of the early Foxe Ayr Lake stade, which is thought to be the only Foxe glacial advance to have reached the Baffin Island Shelf (Andrews et al., 1984). A second, younger, clustering of amino acid ratios within the Kogalu aminozone, radiocarbon dated at >39 ka, may be correlative to mid-Foxe glacial events (Andrews et al., 1984). The late Foxe Eglinton aminozone is correlated with the Baffinland stade, which formed the Cockburn moraines at the fiord heads ca. 8 – 9 ka.

The lack of dated marine sediments between the Kogalu and Eglinton aminozones, in association with unconformities in coastal cliff sections, has resulted in two different interpretations of the extent of the mid- to late Foxe glaciation on northeast Baffin Island. One interpretation is that a complex mid - to late Foxe interstadial was followed by a late Foxe advance of ice to the Cockburn moraines at the fiord heads (Andrews and Miller, 1984), during which time relative sea levels were 80 m lower than present (Andrews, 1980; Pheasant and Andrews, 1973). As a consequence, dateable marine sediments were deposited on the continental shelf, and have since been eroded or submerged. However, extrapolation of isostatic models based on relative sea level data and ice sheet reconstructions suggests only slightly lowered sea levels (up to 25 m) across the Baffin Shelf during the last 18 ka, and along the outer coast only during the last 10 ka (Quinlan,1985). An alternate explanation for the lack of dated marine sediments is that glacial ice occupied the outer coast and continental shelf in the mid - to late Foxe, and slowly receded to the Cockburn moraines (King, 1969;

Hodgson and Haselton, 1974; Blake, 1977; Denton and Hughes, 1981). However, glacial deposits associated with such a stadial have not been recognized (Andrews, 1980; Andrews and Miller, 1984).

3.2.2 Baffin Bay

Initial results from ODP site 645 in Baffin Bay (Figure 1) indicate that glaciation of the Baffin Bay region dates back to the late Pliocene (Srivastava et al., 1987). Dropstones and coarse material became abundant in sediments at least as old as 2.5 Ma, while pebbles are common in sediments as old as 3.5 Ma and are present in sediments as old as 8.5 Ma (late Miocene). Faunal and floral evidence support a glacial regime commencing at 3.5 Ma or earlier, as do interval sedimentation rates which increase sharply within the 465 m of sediment deposited after 3.5 Ma (Srivastava et al., 1987).

Aksu (1980, 1983) studied the upper 10 m of sediment across Baffin Bay using piston cores and recognized intervals c. 1 m thick characterized by cyclic associations of lithofacies and oxygen isotopes. Isotopically heavy periods coincide with deposition of turbidites and debris flow deposits interbedded with ice rafted debris and hemipelagic sediments, while isotopically lighter periods are dominated by hemipelagic sediments. Aksu interpreted the cycles as glacial/interglacial fluctuations and correlated them to oxygen isotope chronologies to infer a record dating back at least to the bottom of Isotopic Stage 9 (347 ka), implying an average cycle to represent 40 ka. However, the results from ODP 645 suggest that the oxygen isotope correlations must be incorrect, as such cycles are recognized throughout the upper 335 m of sediment deposited since 2.5 Ma, implying an average 1 m cycle to represent only 8 ka (Srivastava et al., 1987). The cycles were tentatively attributed to changes in sea-ice cover and the amount of ice-rafting in Baffin Bay (restricted sea ice and abundant ice-rafting during isotopically light periods), and may indicate episodic melting of sea ice and advance and retreat of glaciers surrounding Baffin Bay, concurrent with incursions of warm North Atlantic water with a subarctic flora and fauna (Srivastava et al., 1987).

3.3 Oceanography and Ice

Baffin Bay is dominated by a counterclockwise pattern of circulation. The relatively warm, saline waters of the West Greenland Current flow north and mix with cold, less saline waters from the Arctic Archipelago in northern Baffin Bay (Figure 1). This water mass then flows south along eastern Baffin Island as the Baffin (or Canadian) Current (Collin and Dunbar, 1964). Surface velocities of up to 40 cm/s are reported for the Baffin Current over the northeast Baffin Shelf (Collin and Dunbar, 1964; Sailing Directions Arctic Canada, 1982).

The Baffin Shelf is usually covered by sea ice for at least nine months of the year, from late autumn to late summer. This includes both mobile pack ice and landfast ice which extends tens of kilometers seaward. The annual distribution of sea ice is governed by several factors, including winds, currents, and air and water temperatures. The cold Baffin Current is an important factor, as it acts to promote freeze-up, retard break-up, and provide continuous southward transport of ice (Sailing Directions Arctic Canada, 1982).

It is estimated that 20,000 to 40,000 icebergs are calved into Baffin Bay annually, the majority from outlet glaciers of northwest Greenland (Figure 1) (Murray, 1969; Markham, 1981). An average of 4300 of these icebergs are estimated to traverse the northeast Baffin shelf to Cape Dyer each year

(Ebbesmeyer et al., 1980). Where iceberg drafts exceed water depths, grounding on the seabed occurs; the linear to equant features that are incised as a result are referred to as iceberg scours (Pelletier and Shearer, 1972). Iceberg drafts vary in relation to iceberg mass, dimensions and shape (Hotzel and Miller, 1983). Examination of several hundred icebergs in the northeast Baffin area by submarine showed drafts of up to 240 m (Wittman, in Murray, 1969). Comparison of the positions of thousands of stationary, apparently grounded icebergs, with hydrographic charts suggests maximum drafts of approximately 300m offshore eastern Canada, although some uncertainty exists due to poor bathymetric control on many northern charts (El-Tahan et al., 1985).

4. BEDROCK GEOLOGY

The bedrock geology of the northeast Baffin Shelf has been investigated using a combination of geophysical data and shallow borehole samples (see MacLean, 1985; MacLean and Williams, 1983; MacLean et al, 1990). The bedrock (pre-Quaternary) geology of the NE Baffin shelf north of Sam Ford Trough was presented by MacLean et al. (1981), after compilation at a scale of 1:350,000. The bedrock geology to the south was included in a1: 5 million scale regional overview by Fader et al. (1989). Here we present a slightly revised picture of the bedrock geology south of Sam Ford Trough, as summarized in Figure 3 and explained below.

Precambrian crystalline rocks of Baffin Island extend offshore a short distance, to be overlain by a complex succession of Cretaceous to Tertiary strata. Precambrian rocks outcrop locally as an inlier at the crest of a basement high in outer Scott Trough (Figure 3) and a comparable basement high is recognized in the subsurface of outer Buchan Trough. Samples of the semi-consolidated sedimentary strata include Upper Cretaceous siltstone and mudstone, and Eocene to Oligocene limestone and sandstone. Strata of Tertiary age form the bedrock beneath the majority of the continental shelf and slope. Undifferentiated strata in Scott Trough (Figure 3) are probably of Upper Cretaceous age (MacLean et al., 1981).

South of Sam Ford Trough, the regional summary of Fader et al. (1989) showed Precambrian crystalline rocks to extend almost halfway across the shelf. During the present study, seismic reflectors were recognized in places within this large area, indicating younger sedimentary strata to also be present (Figure 3). The character of the reflectors is similar to that of Ordovician strata recognized on the southeast Baffin Shelf, but could equally represent Cretaceous strata.

5. SEABED MORPHOLOGY

The large-scale morphologic features of the northeast Baffin Shelf have been previously described on the basis of bathymetric contours derived from spot-soundings on hydrographic charts (Shepard, 1963; Fortier and Morley, 1956; Pelletier, 1966), regional echosounder transects (Løken and Hodgson, 1971; Løken, 1973) and some seismic reflection profiles (Gilbert, 1982; MacLean, 1985). Two main features have been recognized: the transverse troughs that extend across the shelf from the mouths of fiords; and ridges along the margins of the larger troughs. The troughs clearly record glacial erosion, although it has been hypothesized that, along with the Baffin Island fiords, they may owe a part of their relief to prior fluvial erosion (Fortier and Morley, 1956; Pelletier, 1966; Gilbert, 1982) and/or graben-style faulting (Andrews and Miller, 1979; Gilbert, 1982; England, 1987). The ridges have been attributed to glacial deposition (e.g. Løken and Hodgson, 1971; Løken, 1973).

During this study, bathymetric contours were compiled using the seismic and echosounder profiles that cross the study area (Figure 2a), supplemented by spot soundings on hydrographic charts. The results reveal new details of seabed morphology, both within the transverse troughs and in inter-trough areas (Figure 4). In addition, the seismic profiles provide information on the thickness of sediments unconformably overlying bedrock units (Figure 5) and so the depth to the bedrock surface (cf. Figures 4, 5). The sediments overlying bedrock may in fact date back to the Pliocene in places, as will be seen in the next section, but are referred to as Quaternary for convenience.

The seabed and subsurface data together show that the transverse troughs are eroded into bedrock units and provide information on the magnitude of glacial overdeepening of their floors, which has resulted in elongate depressions at the bedrock surface, now partly infilled. Inter-trough areas are seen to contain a system of mainly transverse depressions and ridges, developed within Quaternary sediments; the ridges appear to be of depositional origin but their relief may have been enhanced by erosion along the depressions. In some instances, the depressions have been eroded to the bedrock surface.

5.1 Transverse troughs

Morphologic parameters of the troughs in the study area are summarized in Table 2. The troughs are characterized by steep-sided or parabolic cross-sections and axial over-deepening of their floors (cf. Pelletier, 1966; Løken and Hodgson, 1971). The troughs are broad (30-36 km) relative to their depths, which are wider than they are deep, with much greater depths in Scott and Buchan troughs (850 m maximum in the latter). Seabed gradients of up to 25° are observed along the walls of the two deeper troughs, although overall gradients are comparable to those of the shallower Sam Ford and Clyde troughs. All the troughs are narrower and have steeper gradients in their inner parts (Figure 4). In addition, all are over-deepened, that is they contain depths (to seabed and to bedrock) that decrease seaward, defining enclosed axial basins, within one or more elongate depressions that parallel the walls of the trough (Figure 6). Scott and Buchan troughs contain several such depressions (Figure 7), with enclosed axial relief of up to 75 m in Buchan Trough and up to 180 m in Scott Trough. Sam Ford and Clyde troughs contain axial depressions (Figures 4, 8, 9) with relief of at least 30 m and 120 m, respectively.

Seismic profiles show that sediments are generally thin (<25 m) on the trough walls but thicken to up to 180 m in bedrock depressions on their floors (Figures 4, 5, 6). Depths to bedrock are up to 890 m below sea level in Scott Trough and 775 m in Buchan Trough, the former representing erosion of up to 800 m below the adjacent bedrock surface (Table 2). Faults are recognized in places within the Cretaceous-Tertiary sedimentary strata that underlie the majority of the shelf, but none are coincident with or parallel to the walls of Buchan and Scott troughs (MacLean et al., 1981) or Sam Ford and Clyde troughs (this study). However, the marginal trough separating Hecla and Griper Banks from Baffin Island is coincident with the contact between sedimentary units and Precambrian crystalline basement (Figure 3), which may be fault-bounded (MacLean, 1985; MacLean et al., 1990). This geometry is similar to that of marginal channels on the Labrador Shelf, which are interpreted to result from selective erosion along lines of weakness rather than faulting (Josenhans and Zevenhuizen, 1987). The seaward side of the sills separating the heads of the transverse troughs from the fiords also approximately coincide with the basement contact, and at least in Scott Inlet consist entirely of Precambrian bedrock (Gilbert, 1985), suggesting that these features also reflects the lesser resistance to erosion of sedimentary strata on the shelf. Differential erosion of sedimentary strata and basement rocks is also evident on a small scale in outer Scott Trough, where a Precambrian basement high on the outer south wall (Figure 3) has resisted erosion and generated a bathymetric spur.

The steep-sided, over-deepened morphology of the transverse troughs has been attributed to glacial erosion during occupation by former outlet glaciers (Shepard, 1931; Pelletier, 1966). The greater depth of troughs such as Buchan and Scott has been suggested to reflect greater volumes of ice draining through the adjacent fiords (Løken and Hodgson, 1971). However, glacial erosion of the troughs and fiords may have been preceded by fluvial erosion (Fortier and Morley, 1956; Pelletier, 1966; Gilbert, 1982). Axial depressions along the troughs floors clearly show that glaciers have eroded into the bedrock surface, at least 180 m in Scott Trough. The minimum extent of glacial erosion may be estimated from the depths of the bedrock sills separating the troughs from the fiords, which represent a limit to any prior fluvial erosion. The bedrock sill separating Scott Trough from adjacent fiords (Gilbert, 1985) has axial relief of between 350 and 450 m (Jennings, 1986), implying a minimum of 440 m of glacial erosion or over half of the total erosional relief of Scott Trough.

5.2 Inter-trough areas

The bathymetric contours of Figure 4 show that ridges along the margins of Buchan, Scott and northern Clyde troughs (Løken and Hodgson, 1971; Løken, 1973) are in fact part of a larger system of transverse and longitudinal relief in inter-trough areas. Ridges and depressions extend transversely across inter-trough areas north of Clyde Trough (Figure 4). In addition, a longitudinal depression is recognized seaward of Hecla and Griper Banks, isolating a smaller bank to the northeast South of Clyde Trough, the shelf off Cape Aston is characterized by low relief, longitudinal outer banks (Figure 4).

Seismic profiles show that the ridges and depressions are developed within a succession up to 80 m thick (Figure 5) that is inferred in the next section to be part of the Quaternary succession. The ridges and depressions correspond to an unconformity developed at the top of an older (subsurface) Quaternary unit, which is mantled by younger (seabed) units generally <10 m thick (subsurface and surficial Quaternary stratigraphic units are discussed in the next section).

5.2.1 Depressions

Transverse depressions extend across inter-trough areas north of Clyde Trough to shelf break depths of 250 – 300 m (Figure 4), with relief of tens of metres and widths of several kilometres (e.g. right-hand side of Figure 8a). Seaward of Hecla and Griper Banks, two broad transverse depressions meet in an arcuate depression (enclosed by the 200 m contour) with relief up to 80 m and widths up to 10 km. Their shoreward extent above about 100 m water depth is poorly constrained as bathymetric contours in these depths are derived from spot soundings on hydrographic charts. However, some lie seaward of coastal streams, in particular the Kogalu River of the Clyde peninsula and smaller streams of the Cape Adair peninsula (Figure 4). Depressions seaward of Hecla and Griper Banks do not appear to extend above water depths of 150 m across the seaward face of the Banks, although a dissected topography is evident along the crest above depths of 25 m (Figure 4).

The transverse depressions correspond to a reduction in Quaternary sediment thickness (Figures 4, 5). Sediments thin to <25 m seaward of the Kogalu River on the Clyde Foreland and to 10 m seaward of Hecla and Griper Banks (Figures 4, 5); erosion has in places completely removed older (subsurface) sediments, so that younger surficial units lie directly on the bedrock (e.g. right-hand side of Figure 8a; Figure 10). An over-deepening of up to 20 m is evident in the inner parts of these depressions; this is expressed at the seabed as a 200 m deep basin seaward of Hecla and Griper Banks (Figure 4). Irregular axial relief is also apparent in the depression seaward of Cape Adair (Figure 4).

South of Clyde Trough, the shelf is characterized by low-relief outer banks in depths of 100 – 150 m that parallel the shelf edge and are separated from the inner shelf by low depressions (Figure 4). Relief above depths of ca. 100 m is poorly constrained by spot soundings derived from hydrographic charts. However, a small transverse depression was traversed on the inner shelf, which has a maximum water depth of 170 m, up to 60 m below the adjacent seabed (Figure 11b). The depression is eroded through older Quaternary sediments and into underlying bedrock (Figure 11b). This feature is not recognized to extend seaward into the mid-shelf depression; it could extend shoreward above 100 m water depth toward an adjacent coastal stream (see Figure 11b location on Figure 4).

The coastal streams of Baffin Island occupy channels of subdued relief across coastal forelands. Their apparent extension offshore as transverse depressions could indicate fluvial erosion during periods of lowered sea level. However, the observed overdeepening of depressions seaward of the Kogalu River and Hecla and Griper Banks suggests glacial erosion, also consistent with their widths and their seaward extension to depths of 250-300 m, well beyond the range of glacial-interglacial fluctuation (<150 m). The absence of channels across the seaward face of Hecla and Griper Banks above depths of 150 m argues against significant fluvial erosion, except perhaps above 25 m depth. Glacial activity therefore appears to have been the principal erosional agent on the shelf.

5.2.2 Ridges

Transverse ridges are recognised along the margins of Buchan, Scott, Sam Ford and northern Clyde troughs and in the inter-trough area seaward of Cape Adair (Figure 4). They have relief of up to 100 m, widths of several kilometers (up to 18 km) and extend seaward to water depths of at least 250-300 m. The ridge along southern Scott Trough has bathymetric expression to depths of 550 m (Figure 4). This feature, along with a transverse ridge along northern Sam Ford Trough, represent arcuate bathymetric extensions of Hecla and Griper Banks, itself a large longitudinal ridge seaward of the marginal headward extension of Scott Trough (Figure 4). Seaward of the Banks, an arcuate depression isolates a low bank on the outer shelf, referred to as the 150 m bank. Low longitudinal banks are also observed on the outer shelf south of Clyde Trough (Figure 4).

Seismic profiles show that the ridges along Scott and Buchan Troughs, including Hecla and Griper Banks, are in part a reflection of underlying bedrock relief (Figures 12, 13, 14a). The majority of the very broad ridge along southern Buchan Trough is a bedrock feature (cf. Figures 4, 5).

Nonetheless, the seismic profiles show that all ridges include a component of relief due to superimposed Quaternary sediments (cf. Figures 4, 5). However, it is not clear to what extent the ridges are the result of deposition versus erosion along the flanking depressions.

The ridges, like the depressions discussed above, are developed within the shelf-wide Quaternary sediments that overlie bedrock units outside Scott and Buchan troughs. In some areas the irregular reflectors characteristic of these sediments extend uninterrupted into the ridges (e.g. outer wall of northern Scott Trough, Figure 12). However, the ridges bordering Scott and Buchan troughs contain clinoform seismic reflectors indicative of local sediment progradation. The ridge that extends along the southern margin of Scott Trough from Hecla and Griper Banks (Figure 4) includes inclined reflectors dipping toward the trough in the area adjacent to Hecla and Griper Banks (Figure 13a) and dipping away from the trough in the outer part of the ridge (Figure 13c). The central part of the ridge contains discontinuous reflectors (Figure 13b), as does the inner part of the ridge along northern Scott Trough (Figure 12a). Inclined reflectors also occur in the inner part of a low ridge in the inter-trough area seaward of Cape Adair (Figure 14a) and in the outer part of a broad ridge along southern Buchan Trough, dipping away from the trough (Figure 14b), but are not evident elsewhere in these ridges.

In contrast, other ridges provide evidence of relief that is partly or mainly due to erosion along adjacent depressions. The ridge along southern Sam Ford Trough is mainly due to erosion along the adjacent transverse depression (e.g. Figure 8a, right-hand side). North of Sam Ford Trough, Hecla and Griper Banks and its transverse extensions to south and north are separated from the 150 m bank on the outer shelf by an arcuate depression that appears to represent erosion of sediments that previously connected the two features (Figures 4, 10). Erosion of sediment units is supported by evidence that, where the overlying seabed units thin, a surface resistant to iceberg scouring is exposed at seabed (Figure 10). This resistant surface will be discussed further in the next section (see Cape Adair Sediments).

The ridges bordering the transverse troughs have been inferred to be lateral moraines deposited by outlet glaciers occupying the troughs (Løken and Hodgson, 1971; Gilbert, 1982). Seismic profiles confirm that some form of deposition has contributed to the ridges flanking the troughs, as well as to a ridge in an inter-trough area east of Cape Adair. However, some component of the shelfal relief is attributable to the erosion responsible for the shelfal depressions, notably those bordering ridges along Sam Ford Trough and the low bank seaward of Hecla and Griper Banks.

6. SEABED AND SUBSURFACE STRATIGRAPHIC UNITS

Six stratigraphic units are identified within the Quaternary succession that unconformably overlies bedrock units on the northeast Baffin Shelf (Table 3), identified primarily on the basis of their characteristics on seismic reflection profiles (supplemented by sidescan sonar imagery, echosounder profiles and cores). The lower two units occur entirely in the subsurface, the upper four units outcrop at seabed (see Figure 19). Core samples are available from the upper three units and cores from the upper two units have yielded radiocarbon dates (Table 4). The names applied to them below are informal.

Two units are identified that occur only in the subsurface. The lowermost unit (*Cape Adair Sediments*) is widespread across inter-trough areas, and in Sam Ford and Clyde troughs, and is inferred to be an offshore extension of the Pliocene to Quaternary coastal foreland successions of Baffin Island. The second subsurface unit (*Scott Trough Sediments*) is restricted to depressions at the bedrock surface in Scott and Buchan troughs and may also record a long period of deposition, or may date from the last glaciation.

The four units that outcrop at seabed (see Figure 19) are interpreted to record a late Quaternary succession of glacial to post-glacial deposition dating from the last occupation of the shelf by glacial ice. The succession is similar to that mapped on the southeast Baffin Shelf (Praeg et al., 1986) and three of the unit names proposed for that area have been extended to the northeast Baffin Shelf. The glacial units, which interfinger in places, are interpreted as glacial ice-contact sediments (*Baffin Shelf Drift*), glacial marine sediments (*Davis Strait Silt*). The post-glacial units (*Tiniktartuq Mud, Cape Aston Sand*) record deposition over the last c. 17-15 ka. The succession on the Baffin Shelf is analagous to sequences mapped throughout the eastern and Arctic offshore of Canada and interpreted to record a cycle of glacial to post-glacial depositional styles (e.g. Josenhans et al., 1986; King and Fader, 1986; Syvitski and Praeg, 1989; MacLean et al., 1989; Vilks et al., 1989; see Piper et al., 1988, 1990).

6.1 Cape Adair Sediments

The name Cape Adair Sediments is proposed for a subsurface unit, characterized by irregular continuous to discontinuous reflectors, that unconformably overlies bedrock in inter-trough areas, and in Sam Ford and Clyde troughs (Figure 15). The unit is separated from overlying seabed units (Table 3) by a resistant unconformity that corresponds to the transverse ridges and depressions of inter-trough areas. The unit is tentatively correlated with the 'Quaternary' glacial to glacial marine successions of the adjacent coastal forelands, which date back to the Pliocene in places.

6.1.1 Character and distribution

The Cape Adair Sediments are present in all inter-trough areas (Figure 15), with thicknesses up to 75 m seaward of Cape Adair (Figure 16). The unit thins toward the shelf edge and reaches a seaward limit water depths of 250 – 400 m off Cape Aston (Figure 11a) and Cape Adair (Figure 16). The unit also thins to a limit on the upper walls of Buchan, Scott and Clyde troughs below water depths of 100 – 350 m (Figure 15), although a possible outlier is recognized on the outer southern wall of Scott Trough in depths of 350 – 500 m (Figure 12b). The unit consists of irregular reflectors of varying continuity that are mainly relatively flat-lying (Figures 10, 16). However, clinoform reflectors, suggestive of a prograding character, are recognized within Hecla and Griper Banks and its extension as a ridge along southern Scott Trough (Figure 13), as well as within transverse ridges seaward of Cape Adair where they locally underlie flat-lying reflectors (Figure 14a).

The surface of the Cape Adair Sediments is an unconformity that is inferred to correspond to the primarily transverse seabed relief of inter-trough areas north of Clyde Trough (Figure 4) and to record erosion above water depths of 250 – 300 m, presumably beneath an ice sheet. The unit thins beneath transverse depressions and in places has been completely removed (Figure 15). The unit is also absent over part of the inter-trough area seaward of Cape Aston (Figure 15) and the longitudinal relief of the shelf in the area is suggestive of glacial erosion. The possible outlier of the unit on the outer wall of Scott Trough (Figure 12b) suggests that its lower limit on the upper walls of Buchan, Scott and Clyde troughs may also reflect glacial erosion (e.g. Figure 12b).

The surface unconformity is overlain by seabed units that are generally <10 m thick in inter-trough areas. High resolution profiles show that where surficial units thin to <2 m the unconformity forms a subbottom horizon resistant to iceberg scour (Figure 10). Iceberg scours are incised only to the base of the thin surficial units, in contrast to greater scour depths in adjacent thicker surficial units (Figure 10). Similar associations of iceberg scour depths with the resistant unconformity surface are recognized in all inter-trough areas above water depths of ca. 150 m (see Baffin Shelf Drift subunit B).

The Cape Adair Sediments also extend across the floors of Sam Ford and Clyde troughs. In Sam Ford Trough, the unit is observed to extend continuously across the trough walls from adjacent inter-trough areas (Figure 8a), except along parts of the southern wall (Figure 15). The unit is up to 60 m thick, and consists of irregular weak reflectors (Figure 8). Cape Adair Sediments in Clyde Trough onlap the walls of the trough below depths of 150 – 250 m (Figure 15). The unit there is up to 100 m thick, and consists of strong irregular, relatively flat-lying reflectors (Figure 9).

6.1.2 Correlation with coastal forelands

The coastal forelands of Baffin Island (Figure 15) are underlain by up to 40 m of glacial deposits interlayered with marine sediments (Miller et al., 1977) that in places date back to the Pliocene (Feyling-Hanssen, 1985). The inter-trough areas of the shelf are physiographic extensions of the forelands and the Cape Adair Sediments in these areas are tentatively correlated with the foreland successions. The irregular reflectors of the Cape Adair Sediments (including inclined reflectors within some transverse ridges and Hecla and Griper Banks) are broadly compatible with glacial depositional styles. The Cape Adair Sediments within Sam Ford and Clyde troughs are at least partial correlatives and the extension of the unit into these two relatively shallow troughs is consistent with lesser long-term erosion than in the larger Scott and Buchan troughs.

6.2 Scott Trough Sediments

The name Scott Trough Sediments is an informal term proposed for mainly well stratified sediments that onlap bedrock depressions in Scott Trough and locally in Buchan Trough (Figures 7, 17). The unit is conformably overlain by younger seabed units. The unit may record a long period of marine deposition prior to, or rapid deposition during, the last glaciation to occupy the troughs.

6.2.1 Character and distribution

The Scott Trough Sediments onlap the walls of five bedrock basins in Scott Trough, in thicknesses up to 75 m (Figures 7b, 17b). A comparable succession onlaps a single basin in inner Buchan Trough, in thicknesses up to 50 m (Figures 7a, 17a). The unit primarily comprises flat-lying reflectors (Figure 18), consistent with marine deposition. Irregular unstratified intervals are present locally (Figure 18) and interpreted to result from mass failure along the steep basin walls (see Mass Failure).

The relationship between Scott Trough Sediments and Cape Adair Sediments is uncertain, as the latter are not present in the floors of Scott or Buchan troughs (Figure 15). The marine deposition recorded by Scott Trough Sediments is inferred to be at least partly (or entirely) younger than the long glacial depositional record attributed to Cape Adair Sediments.

The Scott Trough Sediments are conformably overlain by sediments of the Davis Strait Silt (Figure 18), a glacial marine unit that laterally inter-fingers with the ice-contact sediments of the Baffin Shelf Drift. The latter unit is not present on the floors of Scott or Buchan troughs where the Scott Trough Sediments occur (Figure 17), so that the relative age of the two units (Table 3) is not known.

6.2.2 Possible interpretations

The fiords of northeast Baffin Island contain thick sequences of stratified marine sediments (average thickness ca. 100 m: Gilbert, 1985), capped by Holocene sediments sampled in cores up to 11 m long (Syvitsky and Blakeney, 1983; Syvitski, 1984). Such sequences are recognized in Cambridge, Clark and Inugsuin fiords adjacent to the study area (Figure 15). Sediments beyond the reach of piston cores may record rapid glacial marine deposition during the last glaciation (Gilbert, 1985). Alternatively, they have been argued to record marine deposition prior to, and subsequently overridden by, the last glaciation, possibly spanning several glacial cycles (Andrews, 1990).

These alternatives also apply to the Scott Trough Sediments. The unit could represent glacial marine deposition prior to that recorded by conformably overlying Davis Strait Silt, in which case the unit could be partly correlative to Baffin Shelf Drift (Table 3). Alternatively, the unit could represent marine deposits that pre-date the Baffin Shelf Drift and were preserved during subsequent late Quaternary glaciation. The apparently conformable relationship with overlying sediments of the Davis Strait Silt, with no evidence of erosion or deformation, suggests continuous deposition and hence favours a glacial marine origin. The onlapping geometry of the unit is consistent with glacial marine turbidites deposited during rapid ice-margin sediment supply by underflows (Syvitski, 1989).

6.3 Baffin Shelf Drift

The name Baffin Shelf Drift was originally proposed for the southeast Baffin Shelf (Praeg et al., 1986), where it similarly describes unstratified sediments of irregular constructional geometry, interpreted to be of glacial ice-contact origin. On the northeast Baffin Shelf, the unit unconformably overlies either bedrock units or the Cape Adair Sediments and is overlain by (and locally interfingers with) the Davis Strait Silt.

6.3.1 Character and distribution

Two subunits of Baffin Shelf Drift are distinguished, A and B (Figure 19). Subunit A is characterized by generally incoherent acoustic reflections (lack of stratification but variable tone), and by an irregular to constructional geometry in which unit thickness varies independently of basal topography, in places forming mounds (Figure 20). The surface reflector commonly has small-scale relief of up to 8 m related to iceberg scours. Where the unit is unscoured a smooth to undulating surface is recognized, for example in the subsurface in Buchan Trough and Sam Ford Trough (e.g. Figure 20 a. and b). Subunit B is mapped in inter-trough areas where shallow scours indicate the unit is thin (<2 m) to discontinuous over the resistant Cape Adair Sediments (Figure 10). Bottom photographs (Figure 37) illustrate Baffin Shelf Drift where exposed at the seabed.

Baffin Shelf Drift forms the seabed across most of the shelf in the study area (Figure 19) and is recognized in the subsurface beneath Davis Strait Silt and Tiniktartuq Mud; it is discontinuous or absent above depths of ca. 100 m beneath Cape Aston Sand (Figure 21). The unit is recognized to depths of 300 – 400 m on the upper continental slope seaward of Cape Adair (Figure 21). It extends across the floors of Clyde and Sam Ford troughs, in water depths up to 320 m, and is present to at least this depth on the upper continental slope seaward and south of Clyde Trough, although its lower limit is unclear (Figure 22). The unit is absent on the walls of Scott Trough below depths of 300 – 400 m (Figure 21). Sediments similar in seismic character to the Baffin Shelf Drift overlie bedrock locally on the floor of Scott Trough, but are generally restricted to basin axes and are interpreted as mass failures (e.g. Figure 7b). The Baffin Shelf Drift is absent on parts of the floor of Buchan Trough (Figure 21), although it is present to water depths of ca. 850 m in outer Buchan Trough (Figure 21). A similar unit is recognized in depths of up to 1000 m to the north of the study area, off the entrance to Lancaster Sound (Praeg, 1986; unpublished data).

Baffin Shelf Drift subunit A is generally <10 m thick, but includes accumulations with a constructional geometry up to 25 m thick, and more than 50 m thick in Clyde and Sam Ford troughs (Figure 21). The constructional accumulations shown on Figure 21 include large and small individual mounds, and multiple mounds which may be separated by areas <10 m thick (see also Figure 20). Both areal and linear accumulations are recognized, primarily in association with inter-trough depressions or transverse troughs.

Areal accumulations composed of multiple mounds up to 25 m thick occur in inter-trough depressions seaward of Hecla and Griper Banks, and south of Sam Ford Trough (Figure 21). Thicknesses <2 m (facies B) occur on adjacent transverse ridges or banks (Figure 21; see also Figure 10). Areal accumulations also occur on the floor of Sam Ford and Buchan troughs (Figure 21). In outer Sam Ford Trough, an accumulation up to 50 m thick extends across the trough floor, thinning along the trough walls and thinning abruptly to seaward (Figure 8). In places it includes clinoform reflectors, suggestive of a progradational character or component (Figure 8b). In Buchan Trough, areal accumulations up to 30 m thick occur on the central and outer floor (Figure 21). The central accumulation flanks a bedrock high, and includes multiple mounds (Figure 20b).

Linear accumulations occur along the upper walls of Scott and Buchan troughs (Figure 21). In Scott Trough, an accumulation along the upper north wall in water depths of 150 – 400 m comprises up to 3 mounds, ranging up to 15 m in thickness. One or more mounds are recognized on successive profiles across the wall (e.g. Figure 21), but individual mounds cannot be correlated along the wall. The lower mound is approximately coincident with the lower limit of Baffin Shelf Drift, which increases in water depth from ca. 300 m in the inner trough to ca. 400 m in the outer trough (Figure 17b). On the south wall of the trough, a small accumulation up to 15 m thick is recognized in ca. 250 m water depth (Figure 21). In Buchan Trough, single mounds up to 25 m thick occur along parts of both walls (Figure 21), water depths of 230 – 350 m on the north wall and 350 – 450 m on the south wall.

Linear accumulations are present on the floor of Clyde Trough (Figure 21), where mounds >50 m thick occur along both sides of the trough floor in water depths of 200 – 300 m (Figures 22, 23). A broad mound up to 75 m thick is recognized across the inner floor of the trough (Figure 21), which locally includes inclined reflectors (Figure 9).

6.3.2 Glacial ice-contact origin

The generally incoherent, unstratified seismic character and irregular constructional geometry of Baffin Shelf Drift are consistent with a glacial ice-contact origin, as has been demonstrated for similar sediments prevalent throughout the Canadian eastern and Arctic offshore (e.g. King and Fader, 1986; Josenhans et al., 1986; Vilks et al., 1989; MacLean et al., 1989, 1992). The constructional geometry in particular indicates the agency of glacial ice, as other constructional agents, such as icebergs or sediment failure along slopes, are insufficient to account for either the geometry or distribution of the unit. Ice-contact sediment may include glacial till, ice-marginal dump material or ice-loaded or glacitectonized sediment, all deposited or remoulded in contact with grounded glacial ice (Syvitski and Praeg, 1989).

The term morainal bank has been proposed for subaqueous ice-contact accumulations (Powell, 1981). Morainal banks in Alaskan fiords form from sediment delivery to quasi-stable ice margins, the size of the bank primarily depending on the length of time an ice margin remains at one location, or fluctuates within a given area (Powell and Molnia, 1989). Constructional accumulations of Baffin Shelf Drift represent areas of enhanced sediment delivery and/or remoulding, and could record former ice margin positions. For example, linear accumulations on the floor of Clyde Trough (Figure 21) could record successive stable ice-margins during ice withdrawal from the trough, as suggested by Løken (1973). Linear accumulations on the walls of Scott and Buchan troughs (Figure 21) could result from deposition or remoulding along the lower grounding lines of ice shelves occupying the troughs (see Gilbert, 1982). Accumulations in Sam Ford and Buchan troughs and in inter-trough depressions (Figure 21) could be related to fluctuating ice margins and, where multiple mounds occur, may indicate successive ice-margin positions. The accumulation in Sam Ford Trough also contains inclined reflectors (Figure 8), suggestive of progressive accumulation along an advancing sediment source.

6.4 Davis Strait Silt

The name Davis Strait Silt is an informal term taken from the southeast Baffin Shelf (Praeg et al., 1986) to describe sediments with a mantling geometry, stratified where undisturbed, which locally interfinger with Baffin Shelf Drift and are interpreted as glacial marine sediment. The unit is conformably overlain by Tiniktartuq Mud (Table 3). Bottom photographs (Figure 38) illustrate Davis Strait Silt where exposed at the seafloor.

6.4.1 Character and distribution

Davis Strait Silt occurs in stratified and unstratified acoustic facies, corresponding to the presence or absence of iceberg scouring of the seabed (Figure 24). Facies A occurs where iceberg sours are absent or reduced in abundance. It is characterized by weak to strong reflectors (stratification), and by a mantling geometry in which the unit surface and internal reflectors are parallel to basal relief. Facies B is characterized by an irregular surface with up to 4 m relief related to iceberg scours and by a lack of acoustic stratification; it retains its mantling geometry, which serves to distinguish it from the unstratified Baffin Shelf Drift (Figure 24c). Disruption of acoustic stratification by iceberg scour has been documented for Davis Strait Silt on the southeast Baffin Shelf (Praeg et al., 1986).

Davis Strait Silt occurs at the seabed between Scott and Buchan troughs in water depths of 150 - 250 m. Within Scott and Buchan troughs, the unit extends across the walls below depths of ca. 250 – 550 m (Figure 19) and is continuous across their floors, beneath the Tinikturtuq Mud, to water depths of at least 850 m. The unit occurs in Clyde Trough below ca. 150 m depth (Figure 23) and extends northward towards outer Sam Ford Trough (Figure 19). However, it is not present at the seabed or in the subsurface between Clyde and Scott troughs, nor in Sam Ford trough (e.g. Figure 20a). The unit generally maintains thicknesses of 2 – 4 m, but thickens locally to ca. 7 m (e.g. Figure 24c).

Davis Strait Silt facies A interfingers with acoustically incoherent wedges or tongues of Baffin Shelf Drift at several locations in Buchan Trough (see Figure 17a). The interfingering relationship is most clearly defined in outer Buchan Trough (Figure 25) and demonstrates that the lower part of the Davis Strait Silt is stratigraphically correlative to Baffin Shelf Drift. Similar relationships have been recognized elsewhere offshore eastern and arctic Canada (King and Fader, 1986; Praeg et al.,, 1986; MacLean et al., 1989, 1992) as well as on the Norwegian Shelf (King et al., 1987).

In Clyde Trough, Davis Strait Silt thickens in proximity to a linear mound of Baffin Shelf Drift along the north side of the trough floor, but is absent across the mound (Figure 23). This abrupt change in thickness and sediment units may represent a lateral transition from Davis Strait Silt to Baffin Shelf Drift at a former ice margin position, analogous to the interfingering relationships observed in Buchan Trough. A similar lateral transition is recognized in outer Frobisher Bay on the southeast Baffin Shelf (Praeg et al., 1986). Abrupt lateral thinning of Davis Strait Silt is also recognized in a depression east of Cape Adair, where the unit thins from 7 m to the 3 m thickness more common across the shelf (Figure 24a). The upper margin of Davis Strait Silt in inter-trough areas or on the trough walls (generally facies B) also corresponds to a relatively abrupt reduction in thickness. These thickness variations across the study area may all represent lateral transitions to Baffin Shelf Drift.

6.4.2 Cored sediment

Piston core 80028-73 (2.08 m long) was collected on the south wall of Scott Trough in 432 m depth (Figure 26). No trigger weight core was recovered. High resolution seismic profiles show that 3 m of weakly stratified to unstratified sediment of Davis Strait Silt facies A overlies bedrock at the core site (Figure 27). The unstratified character of Facies A at the core site is atypical, as it has not been scoured by icebergs. The core consists largely of massive, olive gray to black, very poorly sorted sandy mud with gravel (coarse silt means); three narrow layered bands are present, the lower of which are clayey, and the upper one sandy (Figure 28).

The core was collected in an attempt to sample the bedrock underlying the site, and was successful in as much as the gravel fraction consists almost entirely of angular black shale, of late Cretaceous age, the abundance and friability of which suggests a nearby source on the trough walls (MacLean et al., 1981). Crystalline gravel clasts occur in minor amounts, and a single limestone clast is present (Figure 28). Both Precambrian crystalline rocks and Tertiary limestones have been recovered from the walls of Scott Trough (MacLean et al., 1981). The sand fraction in the core is dominated by black shale below 1.56 m, and by crystalline grains together with varying amounts of black shale above. Glauconite occurs throughout, in greater abundances above 1.56 m. Glauconite is abundant in borehole samples of Upper Cretaceous siltstones from Buchan Trough. The sediment composition thus demonstrates a strongly locally derived (autochthonous) character for the Davis Strait Silt at this locality.

The foraminiferal content of the core was estimated visually from subsamples (Figure 28). Most of the core is entirely barren; trace (1 – 2 individuals) numbers of single species occur in two samples, and low numbers (ca. 1/g) of 3 species occur in a sample from 75 – 78 cm. The species include C. laevigata, an early post-glacial indicator in Hudson Strait (G. Vilks, personal communication) and M. zaandami and C. reniforme, members of late glacial to deglacial assemblages in cores from the northeast Baffin Shelf (Osterman and Nelson, 1989. The general paucity of foraminifers in the core suggests a rigorous environment, or fast sedimentation rates.

6.4.3 Glacial marine origin

The mantling geometry of Davis Strait Silt, its relatively consistent thicknesses over long distances and occurrence in water depths of 150-850 m, along with its stratified character where undisturbed, all imply marine deposition under different conditions than prevail today (cf. Tiniktartuq Mud). These characteristics are consistent with a combination of widespread sediment sources and an absence of strong bottom current influence during deposition. Interfingering relationships with Baffin Shelf Drift in Buchan Trough suggest marine deposition adjacent to grounded ice margins. Proximity to former ice margin sediment sources may also be indicated by the abrupt lateral reductions in unit thickness observed in places. Interfingering relationships comparable to those observed in Buchan Trough are also recognized on the southeast Baffin Shelf and in Hudson Strait (Praeg et al., 1986; MacLean et al., 1992) and on the Nova Scotian and Norwegian continental margins (King and Fader, 1986; King et al., 1987) where they have been postulated to record the direct transition from grounded glacial ice to a glacial marine environment. However, the observation of such relationships in water depths of over 1000 m on the Scotian Slope suggests that, at least in places, they may simply reflect proximity to a glacial ice margin (Bonifay and Piper, 1988).

Sediments cored in Scott Trough are coarse-grained, and dominated by autochthonous lithologies, consistent with glacial erosion of the trough walls and proximal redeposition. It is not known if the cored sediment is typical of the unit. If it is, Davis Strait Silt in that area may primarily record proximal sedimentation along rapidly retreating ice margins, as proposed for glacial marine sediments in the St. Lawrence Estuary (Syvitski and Praeg, 1989). Alternatively, if the core record reflects local proximity to a glacial sediment source, other parts of the Davis Strait Silt sequence may have a more distal character related to deposition from suspended sediment plumes and ice-rafting. In Hudson Strait, ice proximal depositional environments represented in the lower part of glacial marine sequences commonly are transitional up-core to ice distal glacial marine environments, reflecting increasing distance from a retreating glacial ice margin (Vilks et al., 1989, MacLean et al., 1992).

6.5 Tiniktartuq Mud

The name Tiniktartuq Silt and Clay is an informal term proposed for a seabed unit that conformably overlies Davis Strait Silt on the southeast Baffin Shelf (Praeg et al., 1986). The informal name Tiniktartuq Mud (Piper et al., 1988, 1990) is used as a correlative on the northeast Baffin Shelf (Table 3) to describe a unit with a ponded geometry that records post-glacial deposition of hemipelagic mud in seabed depressions.

6.5.1 Character and distribution

Tiniktartuq Mud is characterized by low tone, weak or no reflectors on seismic profiles (Figure 25) and a ponded geometry in which the unit thins toward basin margins (Figure 20a, 25, 27). It is the only unit to readily afford penetration on echosounder profiles, indicating a fine-grained (muddy) composition; muddy seabed textures are also indicated by low reflectivity on sidescan imagery (Figure 23). The unit occurs on the floors of the transverse troughs, and in smaller bathymetric depressions in inter-trough areas (Figure 19). It generally occurs below the local limit of iceberg scour, and so has a smooth surface. It varies in thickness with locale, reaching a maximum of 7 m in inner Scott Trough, 5 m in Buchan Trough and inner Clyde Trough, and 4 m in Sam Ford Trough. Where present in inter-trough areas, it is up to 2 m thick. Bottom photographs (Figure 39) illustrate Tiniktartuq Mud where exposed at the seafloor.

The unit occurs in depths as shallow as 140 m in inter-trough depressions. It occurs below water depths of ca. 250 m in inner Clyde Trough and in outer Sam Ford Trough. In Buchan Trough it occurs below water depths of 500 – 600 m; it is absent above ca. 600 m depth in two locations on the floor of the trough. In Scott Trough the unit occurs below water depths of 550 – 600 m, except on the central part of the north wall where the upper limit falls to 700 – 750 m depth (Figure 26). Seismic profiles show a northward thinning wedge of Tiniktartuq Mud on the trough floor at this location, an atypical geometry (Figure 29). These observations suggest locally stronger current circulation within Scott Trough, possibly in response to the ridge extending from the north wall (Figure 26).

6.5.2 Core samples

Two piston cores from Tiniktartuq Mud in Scott Trough were studied by Jennings (1986). Core 76023-26 (1.44 m long) was collected on the south wall of Scott Trough in 615 m water depth, 185 m deeper than the site at core 80028-73 which sampled Davis Strait Silt (Figures 26, 27); no trigger weight core was recovered from either site. High resolution seismic profiles show that 1 – 2 m of Tiniktartuq Mud overlies Davis Strait Silt at the core site (Figure 27). Core 78029-24 (5.83 m long) was collected from the floor of inner Scott Trough in 830 m water depth (Figure 26). High resolution seismic profiles subsequently collected, as well as the echosounder profile recorded during core collection, show that the 7 m of Tiniktartuq Mud overlying Davis Strait Silt at the core site is dominated by an unstratified sediment lobe (Figure 30a). The lobe is inferred to result from *in situ* compression of Tiniktartuq Mud by mass failure on the adjacent steep slopes (see Mass Failure) and otherwise does not necessarily imply significant distortion of the sediment record at the core site.

Sediments in cores 76023-26 and 78029-24 consist of grayish-brown to olive gray massive to laminated mud, with sand and granules constituting up to 30% of the sediments in core 26 and up to 6% in core 24 (Figure 31). Gravel is scattered throughout the cores in low proportions, and includes carbonate clasts indicative of ice-rafting from distant sources, probably in west Greenland or the arctic archipelago (Jennings, 1986). The total carbonate content of the sand-mud fraction is 2.5 – 53.3% in core 26 and 6.3 – 14.8% in core 24, higher values corresponding to greater abundance of sand-size material (Figure 31), which also reflects distal ice-rafted sources (Jennings, 1986). Clay minerals interpreted as allochthonous are present in varying amounts.

The cores are interpreted to record deposition from suspension, including a significant allochthonous component, and from rafting by icebergs or sea ice (Jennings, 1986). The relatively finer textures of core 24 compared with core 26 partly reflect the location of the former in the greatest thickness of Tinikturtuq Mud in Scott Trough (Figure 30), while core 26 was collected on the wall of the trough near the limit of the unit (Figure 27). Coarse-grained components derived from ice-rafting therefore form a higher percentage of the sediments in core 26.

Radiocarbon dates on total organic matter, ‘corrected’ to equivalent shell ages using the empirical formula of Andrews et al. (1985b), indicate that both cores date from at least ca. 12 ka (Table 4). In core 24 a paleomagnetic inclination record substantiates the corrected laboratory chronology (Jennings, 1986). The basal age of the Tiniktartuq Mud at the core sites can be estimated by extrapolating interval sedimentation rates derived from the lower pair of dates in each core to the base of the unit measured from seismic profiles. This yields estimated ages for the base of Tiniktartuq Mud of 15 ka and 16 ka (Table 4). The 7 m thickness used for the core 24 extrapolation is that of undisturbed Tiniktartuq Mud (Figure 30a). These estimates assume no loss of sediment at the top of the cores; such loss is likely in piston cores and would result in younger age estimates. Deposition of the Tiniktartuq Mud in Scott Trough therefore dates from ca. 15 ka.

Core 26 contains abundant foraminiferal species which form three main zones, dominated respectively by C. reniforme, M. zaandami, and arenaceous species (Osterman, 1985; Osterman and Nelson, 1989). Core 24 contains low numbers (up to ca. 7/g) of benthic foraminiferal species which form zones qualitatively correlative to those in core 26 (Osterman and Nelson, 1989), but abundances are too low to quantitatively support such a correlation (Jennings, 1986).

Gravity core 81045-25C (1.6 m long) was collected south of Buchan Trough, off Cape Hunter, in a small depression in 146 m water depth (Figure 2b). No high resolution acoustic records are available from the site, but sidescan sonar imagery and sediment textures indicate the core was collected from Tiniktartuq Mud occupying the depression, similar to other occurrences of the unit in depressions east of Cape Adair (Figure 19). The core was examined by Cameron (1984). It consists of dark gray silty clay with 5 – 29% sand and up to 7% gravel, extremely poorly sorted and negatively (coarse) skewed. An upper 1.49 m of largely massive mud to sandy mud overlies a lower 0.11 m of laminated mud with no gravel. The upper interval contains benthic foraminiferal assemblages dominated by E. exclavatum, I. Helenae, I. Islandia and C. reniforme, and is interpreted to record hemipelagic sedimentation and ice-rafting. The lower interval contains a benthic foraminiferal assemblage dominated by H. obiculare and C. reniforme, which Cameron (1984) interpreted as indicative of brackish marginal marine conditions, possibly indicating proximity to a glacial ice-margin. This lower interval may represent Davis Strait Silt underlying Tiniktartuq Mud at the core site.

6.6 Cape Aston Sand

The name Cape Aston Sand is proposed for coarse-grained sediments overlying the Cape Adair Sediments or the Baffin Shelf Drift above water depths of 80 – 120 m (Figure 19). A core of the unit shows that it records deposition over the same period of time as the Tiniktartuq Mud (Table 3).

6.6.1 Character and distribution

Sandy sediments are indicated by increased seabed reflectivity and reduced seabed relief above depths of 80 – 120 m. Partial or overall reductions in tone (reflectivity) on sidescan sonar imagery suggest sandier textures (Figures 32, 33). This is substantiated by acoustic reflectivity data available on high resolution seismic profiles seaward of Cape Aston and the Clyde Foreland, which show that depths above ca. 100 m are characterized by an increase in R1 values (seabed reflectivity) to 30 – 50%, an increase in R2 values (first metre subbottom reflectivity) to 15 – 25%, and a reduction in variability about trend of both parameters. These values are similar to those recorded over seabed sands and gravels on the Scotian Shelf (Parrott et al., 1980). A distinct sand layer is not recognized on high resolution profiles (Figures 32, 33a) suggesting the sandy sediments are either thin (<1 m) or not separated from underlying sediments by a sharp impedance contrast. Bottom photographs (Figure 40) illustrate the Cape Aston Sand unit where exposed at the seafloor.

Bottom profiles show a reduction in seabed relief (to <2 m) in areas of Cape Aston Sand and sidescan imagery shows that this corresponds to reduced iceberg scour depths (and widths) in shallower water depths (Figures 32, 33). Shallower, narrower scours suggest a more resistant seabed or substrate; this is corroborated by a scour observed in the process of being formed just north of Clyde Trough (Figure 32). Larger scours (deeper and/or wider) however are observed in some places within areas of Cape Aston Sand, particularly seaward of Cape Aston (Figure 33).

Cape Aston Sand is underlain by Cape Adair Sediments in all areas north of Clyde Trough, and in part of the area south of Clyde Trough (Figure 15). Baffin Shelf Drift, which is mapped in depths below 80 – 120 m (Figure 32), may also be present beneath Cape Aston Sand in shallower depths (Figure 21). Adjacent occurrences of Baffin Shelf Drift generally consist of subunit B (<2 m thick) that overlie Cape Adair Sediments (Figure 19), which are resistant to iceberg scour (Figure 10). The resistant character of the seabed in areas of Cape Aston Sand may also reflect proximity to the seabed of the underlying Cape Adair Sediments (Figure 32). South of Clyde Trough, seaward of Cape Aston, the presence of often larger scours and irregular non-scour relief (e.g. Figure 33) may indicate that Baffin Shelf Drift is more common beneath Cape Aston Sand in that area.

6.6.2 Core sample

Vibrocore 78029-36 (0.93 m long) was collected from Cape Aston Sand in 98 m of water off Cape Aston (Figure 33). The core consists of sand (58 – 82%) with variable gravel (1 – 30%) and mud (5 – 33%); the sediments are poorly sorted, with fine to coarse sand means (Figure 33b). Visual examination shows that the sand is subangular to subrounded. Shell fragments are abundant in the coarse fraction. Four foraminiferal zones have been recognized, and correlated to zones in core 76023-26 on the south wall of Scott Trough (Osterman and Nelson, 1989). A radiocarbon date on shells of 11,770 ± 550 ka (GX-6280) was obtained from the lower zone, comparable to dates from Tiniktartuq Mud in Scott Trough (Table 4). Extrapolation of this date to the base of the core yields a basal age of 16.9 ka (Table 4). The extrapolation is based on a single date and is therefore of questionable accuracy, especially in view of the likelihood of intermittent sedimentation (Osterman and Nelson, 1989).

The core contains a record of coarse-grained deposition that is correlative in time to the fine-grained record of the Tiniktartuq Mud. Coarse-grained components in cores of Tiniktartuq Mud are derived from ice-rafting, which probably has also been a contributor to Cape Aston Sand. However, sedimentation rates in core 78029-36 appear to be as high as some in core 76023-26 from Tiniktartuq Mud in Scott Trough (Table 4), despite the absence of fine-grained components which constitute up to 70% of core 26. Assuming an equal contribution by ice-rafting across the shelf, this suggests additional sediment input. Erosion of older sediments in shallower depths, including the unconsolidated coastal forelands of Baffin Island, represents possible sources. The distinctly sandy character of sediments above water depths of 80 – 120 m may reflect a combination of their proximity to such sources, and stronger seabed currents which inhibit deposition of the fine-grained components that dilute sands in greater depths.

7. SEABED FEATURES

The seabed of the study area includes several features of interest, conditioned to varying degrees by the distribution of seabed sediment units (Figure 19). Mass failures are included here, although they are observed not only at seabed but at several levels in the subsurface of Scott and Buchan troughs. Iceberg scours have modified the seabed across most of the shelf. Scours have also influenced seabed sediment textures recorded in grab samples and observed from submersibles. Finally, evidence for natural seepage of petroleum from the seabed in Scott and Buchan troughs is summarized.

7.1 Mass Failure

A history of mass failure is recorded by acoustically unstratified lobes within Tiniktartuq Mud, Davis Strait Silt and Scott Trough Sediments in Scott Trough, and locally in Buchan Trough, both at seabed and in the subsurface.

Unstratified lobes are documented in the shallow subsurface of the Tiniktartuq Mud in Scott Trough (Figures 26, 30). The lobes lie on either side of the relatively level floors of steep-sided (generally >4º) bedrock basins, beneath a 1 – 2 m veneer of mud (Figure 30). The lobes are elongate in plan, although in places have coalesced at the base of the opposite walls (Figure 26). The lobes are characterized by a rough small-scale surface relief, expressed as hyperbolic reflections, and blunt distal terminations, elevated by ca. 1 m relative to the surface of adjacent weakly stratified sediments (Figure 30). The steep walls adjacent to the lobes are poorly resolved, but on oblique transects irregular unstratified sediment and bare bedrock are recognized (Figure 30). Undisturbed sequences of Davis Strait Silt and Tiniktartuq Mud overlie bedrock on the crest of inter-basin ridges (Figure 30b).

The lobes are interpreted as slide compression toes, generated by tensional failure of sediments along the steep basin walls. Similar features are recognized in sidewall failures in northeast Baffin fiords (Syvitski et al., 1987). The lobes have equivalent acoustic characteristics to features recognized in other areas and termed debris flows (Nardin et al., 1979; Prior et al., 1984). However, the geometry of the lobes in Scott Trough suggests they represent largely *in situ* compression of sediments on the basin floors by failure on the adjacent slopes. This is supported by the apparently undisturbed record of core 78029-24, which was collected from one of the lobes (Figure 30a). The core yielded vertically consistent radiocarbon dates, a plausible paleomagnetic inclination record as well as textural, mineralogical and foraminiferal similarities to changes in nearby cores (Jennings, 1986).

Lenticular unstratified lobes that record active displacement of sediment, probably as debris flows, are recognized in association with Davis Strait Silt in Scott Trough. In outer Scott Trough high resolution profiles show an unstratified lenticular lobe with surface hyperbolics below 710 m depth, adjacent to the southern wall of the trough (Figure 34). Tiniktartuq Mud is thin or absent in this area; the lobe overlies and partly truncates Davis Strait Silt. The adjacent wall is poorly resolved (Figure 34), but above 550 m depth Davis Strait Silt overlies bedrock. The relationships suggest Davis Strait Silt deposits have failed on the steep wall and have spread across and partly remolded sediments on the adjacent trough floor. Similar lenticular lobes are recognized beneath Tiniktartuq Mud in the inner-central trough (Figure 30b).

Unstratified intervals indicative of disturbance are also recognized within Scott Trough Sediments underlying Davis Strait Silt in Scott Trough (Figure 30). Similar features occur within Scott Trough Sediments, Davis Strait Silt and Tiniktartuq Mud in a basin in inner Buchan Trough.

The Scott – Buchan area is characterized by high levels of seismic activity (Basham et al., 1977) and this represents a likely mechanism for initiation of mass failures. The unstratified lobes within Tiniktartuq Mud in Scott Trough may represent a single event, or the cumulative compression of a series of slides on the adjacent steep walls. A history of failure is recorded by unstratified intervals within underlying Davis Strait Silt and Scott Trough Sediments.

7.2 Iceberg Scours

Iceberg scours are recognized from both sidescan sonar imagery and bottom profiles (on seismic and echosounder records) above water depths of ca. 300 m, and below these depths primarily from bottom profiles (Figure 35). Scours occur at the surfaces of glacial units (Baffin Shelf Drift and Davis Strait Silt facies B; (e.g. Figures 23, 24b), and in areas of Cape Aston Sand above water depths of ca. 100 m (Figures 32, 33); they are rare at the surface of Tiniktartuq Mud (e.g. Figure 23).

Scours up to 8 m deep are observed locally at the surface of Baffin Shelf Drift subunit A, but are typically of lesser relief (<4 m) both there and at the surface of Davis Strait Silt (facies B). In general, little difference in scour width or style is apparent within or between the two units on sidescan imagery. In Clyde Trough, a corrugated surface observed at the top of a constructional ridge of Baffin Shelf Drift is distinct from scours on adjacent Davis Strait Silt and could represent glacial sole markings (Figure 23). Shallow scours (<2 m) are present in areas of Baffin Shelf Drift subunit B, which is thin to discontinuous over the resistant surface of the Cape Adair Sediments (Figure 10). Shallow (<2 m) scours are ubiquitous above water depths of ca. 100 m in areas of Cape Aston Sand, and sidescan imagery shows they are generally also narrow features (Figures 32, 33). Gross physical properties of the seabed have therefore influenced scour character.

Scours are abundant across the majority of inter-trough areas, but are reduced in abundance or absent in inter-trough depressions and in Sam Ford and Clyde troughs (Figure 35). The lower limit of scour on the walls of Scott and Buchan troughs generally increases seaward from water depths of 300 – 400 m in the inner troughs to 500 – 600 m in the outer troughs, although scours are recognized to depths of ca. 600 m on a ridge in inner Buchan Trough. The lower depths of 300 – 400 m on the south wall of inner Scott Trough are corroborated by submersible observations (Grant et al., 1986). On the continental slope, bottom profiles indicate the lower limit of scours lies at 550-600 m water depth (e.g. Figure 22). This is confirmed by a short section of sidescan imagery from the slope between Scott and Buchan troughs showing scours at seabed to 600 m depth.

Iceberg scours have been observed to depths of 715 m on sidescan imagery across the southeast Baffin continental slope (Praeg et al., 1987). Modern iceberg drafts in the Baffin region do not generally exceed 300 m, so most scours below this depth are inferred to be relict from a period of greater iceberg drafts (Praeg et al., 1987). On the northeast Baffin Shelf, water depths <300 m correspond to the majority of the inter-trough areas (Figure 35), so that most scours in the study area may represent modern features that have largely obliterated or reworked older scour populations. The transverse ridges flanking Scott, Buchan, and Clyde troughs in water depths <100 – 200 m are well-known iceberg grounding lines (e.g. Løken, 1973). A grounded iceberg was observed in the study area in ca. 90 m depth (Figure 32).

7.3 Seabed Sediments

Grab samples, bottom photographs and submersible observations (Figure 2b) provide information on sediments at the immediate seabed. Muds and sands occur at seabed in areas underlain by post-glacial units (Tiniktartuq Mud and Cape Aston Sand), consistent with ongoing deposition. Areas underlain by glacial units (Baffin Shelf Drift and Davis Strait Silt) contain sediments of variable composition. Grab sample lithologies suggest a dominance of ice-rafted sources, although locally-derived lithologies are recognized in samples from the walls of Scott Trough. Local textural variability is recognized across iceberg scours at the surfaces of glacial units, and indicates a combination of deposition from ice-rafting, current modification, and reworking of underlying sediments.

The variability in seabed sediment textures in the Scott – Buchan portion of the study area, where most grab samples are available, is summarized in Figure 36. The lithologies of the gravel/granule fractions of selected grab samples are summarized in Table 5.

7.3.1 Muds

Samples consisting of >80% mud were recovered from areas of Tiniktartuq Mud on the floors of Scott and Buchan troughs, and locally in inter-trough areas (Figure 36). The sampled sediments are olive gray, often with a grayish-brown surface layer, and consist of equi-mixtures of silt and clay (silt/clay ratios 2:1 ro 1:2) with up to 10% sand and 2% gravel. In Scott and Buchan troughs the proportion of clay shows a trend to values >50% along the axes and toward the outer parts of the troughs (Figure 36).

Samples comprising <80% mud were recovered from the Tiniktartuq Mud near its margins in Scott Trough (up to 30% sand), and from some inter-trough occurrences (up to 50% sand and 25% gravel). The coarser textures reflect lower rates of sedimentation of fine-grained sediment and consequent concentration of ice-rafted components, as recorded in core 76023-26 from Tiniktartuq Mud on the wall of Scott Trough (Figure 31).

Bottom photographs from areas of Tiniktartuq Mud in Scott Trough and seaward of Cape Adair (Figure 39) show a smooth muddy seabed, locally disturbed by bioturbation; gravel is present in some photos from the inter-trough location.

7.3.2 Sands

Three samples consisting of 80% sand were recovered from Cape Aston Sand in water depths of 62 – 113 m, on either side of Scott Trough (Figure 36). Two other samples with 65% and 69% sand were recovered (Figure 36), in depths of 36 m and 75 m. Sand clasts are subangular to subrounded, as are gravel clasts which are commonly stained and encrusted by biota on one side, indicating exposure to currents.

Submersible observations along the inner wall of Scott Trough, on the northern flank of Hecla and Griper Banks (dive site 2, Figure 2b), showed sands and gravels above ca. 100 m water depth to the upper limit of the dive at 34 m, in association with strong seabed currents (Grant pers. comm., 1989). Two bottom photograph transects on Cape Aston Sand in 103 m water depth north of Clyde Trough show textures from sandy to sandy with gravel; lineations in some photos may represent sand ripples (Figure 40).

7.3.3 Variable textures

Samples consisting of varying proportions of mud (<80%), sand (<80%) and gravel (unstippled on Figure 36) were recovered from areas underlain by glacial units (Baffin Shelf Drift and Davis Strait Silt). No patterns are evident in the trends of sand or mud abundance across the study area. Several samples dominated by gravel (>50%) are noted on the outer south wall of Scott Trough (Figure 36) and submersible observations confirm the presence of extensive seabed gravel at this locality, often fine grained, but ranging up to boulder size (Grant et al., 1986). Gravel in these and other samples is subangular to subrounded, and generally stained and encrusted by biota on one side.

a) Local variability (iceberg scours)

Submersible observations show local variability in seabed textures across iceberg scours at the surfaces of glacial units. Dive site 1 was located in 130 – 140 m water depth in an area of scoured Baffin Shelf Drift north of inner Scott Trough (Figure 2b). Submersible video recordings indicate a pattern of relatively fine-grained sediments in the scour troughs and coarse-grained sediments in the scour berms. The berms include sandy and gravelly material, with the gravel (to boulder size) concentrated on the flanks of the berms, whereas the troughs contain soft sand and mud with occasional gravel clasts. The observed textural patterns indicate fine-grained deposition in scour troughs versus non-deposition or winnowing of berms under the influence of currents. The gravel in the troughs suggests a contribution from ice-rafting, although in places it may be derived from the berms where the greater abundance of gravel implies reworking of excavated material by bottom currents. It is also possible that the process of iceberg scouring results in a concentration of excavated (or older ice-rafted) clasts. Similar textural variability is recognized on bottom photo transects of scoured glacial units elsewhere in the study area. Iceberg scours are abundant at the surfaces of glacial units in inter-trough areas (Figure 35) and local textural variability is an important feature of the seabed.

b) Modern and relict components

The gravel/granule fractions of grab samples collected in 1980 in and adjacent to Scott Trough (Figure 36) were examined to determine the properties of crystalline and sedimentary clasts (Table 5). Most samples are dominated by crystalline clasts, with a lesser proporation (8 – 39%) of resistant sedimentary clasts, including carbonates. This includes samples from the Tiniktartuq Mud, the coarse fraction of which is inferred to derive from ice-rafting. The similarity of lithologies in samples from post-glacial units and those from seabed areas underlain by glacial units suggests that ice-rafting is also a principal source of coarse material at the seabed in the latter areas.

However, several grab samples from the walls of Scott Trough are dominated by or include distinctive sedimentary lithologies (Figure 36), including soft brown-black mudstone – sandstone, friable black shale and resistant light grey limestone (Table 5). These lithologies are interpreted to be derived from erosion of Cretaceous-Tertiary strata of the trough walls (MacLean et al., 1981) and the samples to represent glacial units (Davis Strait Silt or Baffin Shelf Drift), comparable to core 80028-73 from the Davis Strait Silt in Scott Trough in which the gravel fraction is dominated by black shale (Figure 28). The locally high abundances of soft sedimentary lithologies in samples of Davis Strait Silt or Baffin Shelf Drift from the walls of Scott Trough are interpreted to have been derived from erosion of sedimentary strata along the trough walls. One of the samples, which contains 92% soft mudstone clasts, was collected from outer Scott Trough, where a lobe of displaced Davis Strait Silt is recognized on acoustic records (Figure 34). The setting of the other samples is not clear; they could reflect local failures of glacial sediments on the trough walls, or alternately areas where an ice-rafted veneer is thin enough to be penetrated by grab samplers.

7.4 Hydrocarbon Seepage

Natural seepage of petroleum from the seabed was first indicated in the Scott Trough region by persistent surface oil slicks (Loncarevic and Falconer, 1977) and subsequently confirmed for both Scott and Buchan troughs by anomalous petroleum residue concentrations in sea-surface microlayer, water column, and surficial sediment samples (MacLean et al., 1981). The sedimentary strata underlying the troughs (Figure 3) were considered suitable source rocks (MacLean et al., 1981). Petroleum residue concentrations in surficial sediments in and between Scott and Buchan troughs were generally lowest in inter-trough areas and highest in the muds flooring the troughs, a pattern attributed to the greater adsorbing capacity of the finer grained sediments. However, anomalously high concentrations occurred locally, unrelated to water depth or surficial sediment textures. In Scott Trough these anomalous concentrations corresponded closely to water column anomalies and surface slick locations, and occurred over a basement high on the south wall flanked by Tertiary and older sedimentary strata (Figure 3). Seepage at the site was postulated to relate to updip migration of hydrocarbons along the contact with the basement rocks or within the sedimentary strata (MacLean et al., 1981).

Submersible observations at the Scott Trough seepage site (dive site 3, Fig. 2b) showed the presence of white `fuzzy slime` coating the seafloor, interpreted as bacterial growth associated with the hydrocarbon seepage (MacLean, 1982). Subsequent submersible observations in areas of the slime in 360 – 430 m water depths showed fissures extending into the seafloor through a surface layer of sediment that was weakly cemented into a resistant crust (Grant et al., 1986). A sample of the crust appeared to be composed of indurated bottom sediment held together by carbonate cement, and contained oil trapped in concave pits on the underside. The sample was collected in a shallow saucer-like depression 30 m across and 2 – 3 m deep, which Grant et al. (1986) suggested was a gas escape pockmark.

No sidescan sonar records are available from the depths of the dive site to identify possible pockmarks. Seismic profiles show that Davis Strait Silt facies A overlying bedrock in the area is essentially unstratified (Figure 27). The lack of stratification does not appear to be related to hydrocarbon content, as it is also noted where the unit overlies Precambrian bedrock. Acoustic masking attributable to hydrocarbon content is recognized within the Cretaceous sedimentary strata underlying the study area (MacLean et al., 1981). No seismic evidence for gas content, such as masking, bright spots or velocity pulldown, was recognized in the Quaternary sediments of the study area. Hydrocarbon seepage is primarily confined to the walls of Scott and Buchan troughs (MacLean et al., 1981), where Quaternary sediment cover is thinnest. Modification of seabed sediments in the form of indurated crusts, bacterial mats and pockmarks may be present along other parts of the trough walls.

8. QUATERNARY HISTORY OF THE NORTHEAST BAFFIN SHELF

The long-term morphologic and stratigraphic evolution of the northeast Baffin Shelf has included the erosion of the transverse troughs, the deposition of the Cape Adair Sediments in inter-trough areas (and in two of the transverse troughs) and their subsequent erosion in inter-trough areas. The late Quaternary history includes a major glaciation of the study area, followed by post-glacial sedimentation under the influence of currents and ice-rafting.

8.1 Long-term morpho-stratigraphic development

8.1.1 Erosion of troughs from the late Tertiary

The inter-island channels, fiords and troughs of the Canadian arctic archipelago have been postulated to record a late Tertiary fluvial drainage system (Fortier and Morley, 1956) subsequently exploited and modified by Quaternary glacial activity (Pelletier, 1966). A similar model has been proposed to account for the marginal and transverse troughs of the Labrador Shelf (Josenhans and Zevenhuizen, 1987). The troughs of the northeast shelf are compatible with such a model: the troughs are eroded into bedrock, primarily sedimentary strata of Upper Cretaceous to Oligocene age (MacLean et al., 1981, 1990) and contain direct evidence for glacial overdeepening in the form of enclosed depressions at the bedrock surface.

Results from ODP site 645 (Figure 1) suggest that the onset of glaciation in Baffin Bay dates back to late Pliocene time, ca. 3.5 Ma (Srivastava et al., 1987). Initial glacial erosion of the transverse troughs may thus date from the late Tertiary, while preceding fluvial erosion would have extended even farther back into the Tertiary. Sediments deposited at site 645 during the period 2.5 – 3.5 Ma contain a gravel fraction dominated by sedimentary clasts, especially black shale, while relatively coarse sediments (mean 25% sand) including similar clasts date back to late Miocene time, ca. 8.5 Ma (Srivastava et al., 1987). Such soft sedimentary lithologies do not presently occur to the west on Baffin Island, but are widespread beneath the continental shelf (Figure 3), include Upper Cretaceous black shales as recovered from core 80028-73 in Scott Trough (MacLean et al., 1981). Glacial erosion of the sedimentary strata of the northeast shelf between 3.5 – 2.5 Ma could account for the dominance of these lithologies at site 645. Prior fluvial erosion and delivery of coarse sediment to the shelf edge could account for the presence of coarse sediments including these lithologies as early as 8.5 Ma. Bedrock mapping on the southeast Baffin Shelf indicates extensive erosional beveling subsequent to early Eocene time (MacLean et al., 1982). Initial fluvial erosion of the submarine troughs on the northeast Baffin Shelf could also relate to this episode, possibly as early as Oligocene time (MacLean, 1985).

8.1.2 Glacial deposition from the Pliocene

The onset of glacial depositional styles on the northeast Baffin Shelf is recorded by the Cape Adair Sediments, which unconformably overlie bedrock units in inter-trough areas and in Clyde and Sam Ford troughs. The unit is inferred to be correlative to successions in the coastal forelands of Baffin Island, which contain evidence of glacial deposition since the Pliocene (Feyling-Hanssen, 1985). A reduction in sedimentary clasts, especially black shale, in the gravel fraction of sediments deposited at ODP site 645 subsequent to ca. 2.5 Ma (Srivastava et al., 1987) could also reflect the onset of a predominantly depositional regime on the shelf.

The coastal foreland successions of Baffin Island are attributed to cyclic marine deposition in response to repeated glaciations since the late Pliocene, primarily among the margins of outlet glaciers occupying the fiords and troughs (Miller et al., 1977; Mode et al., 1983). Sediments deposited at ODP site 645 subsequent to ca. 2.5 Ma contain lithofacies and oxygen isotope cycles that also suggest episodic glacial activity (Srivastava et al., 1987). The irregular stratification of the Cape Adair Sediments may record successive episodes of glacial occupation of the shelf.

Deposition of the Cape Adair Sediments in inter-trough areas may have commenced earlier than in the troughs. The lack of Cape Adair Sediments in Scott and Buchan troughs points to the probable co-existence of erosion in the troughs during deposition in inter-trough areas. Erosional conditions may have persisted in these two troughs throughout the Quaternary, or a depositional record similar to those in Sam Ford and Clyde troughs may have been subsequently removed by subsequent erosion. In either case, the depositional record in Sam Ford and Clyde troughs may be younger than the succession in inter-trough areas. Inclined reflectors in ridges bordering Buchan and Scott troughs may record glacial deposition along outlet glacier margins, although such a ridge is also present between Scott and Buchan troughs, seaward of Cape Adair. Deposition along outlet glacier margins, as well as along the leading margins of ice sheets, may both have contributed to Quaternary depositional styles on the shelf.

8.1.3 Later Quaternary erosion

At least one episode of glacial erosion of the shelf is recorded by the transverse depressions of inter-trough areas, and the associated resistant surface unconformity on Cape Adair Sediments. The surface unconformity is overlain by late Quaternary glacial sediments of Baffin Shelf Drift, interpreted to record the last glaciation of the shelf. Weathering zone contrasts on Baffin Island suggest that the last glaciation was more extensive than those preceding it (Andrews and Miller, 1976), possibly the most extensive for several hundred thousand years (Andrews, 1974). Glacial erosion of Cape Adair Sediments could therefore either significantly predate the last glaciation, or could have taken place after a long period of restricted or non-glacial conditions on the shelf.

The resistant character of the surface unconformity implies either consolidation of the Cape Adair Sediments themselves prior to erosion, or consolidation of the unconformity surface during or subsequent to erosion. Tertiary sedimentary strata underlying the shelf have a semi-consolidated character (MacLean et al., 1981, 1990), but it is not clear that even a long Quaternary period of non-deposition would be sufficient to result in lithification of the Cape Adair Sediments. Alternately, the unconformity surface could have been consolidated by glacial ice loading, or by a long period of exposure at the seabed.

8.2 Marine deposition in Scott and Buchan troughs

The Scott Trough Sediments may record relatively rapid glacial marine deposition during the last glaciation in Scott and Buchan troughs. The maximum thickness of the unit within elongate bedrock depressions (75 m in Scott Trough, 50 m in Buchan Trough) are much less than reported for sediments attributed to the last glaciation in the adjacent fiords (e.g. Gilbert, 1985). Alternatively, the Scott Trough Sediments could record marine deposition prior to the last glaciation, as proposed for sediments infilling the Baffin Island fiords (Andrews, 1990). In this case, the thickness of the unit would imply a relatively long period of deposition. Post-glacial marine sedimentation rates in core

78029-24 from Tiniktartuq Mud in Scott Trough are 40 cm/1000 yrs (Table 4). If a similar sedimentation rate were applicable to the Scott Trough Sediments (which underlie the core site - Fig. 30a) sediment deposits would represent deposition during up to 190,000 years in Scott Trough. Such a long period of deposition in the troughs could correspond to the long period of restricted glaciations prior to the last, proposed to explain the sharp break between weathering zones II and III on Baffin Island (Andrews and Miller, 1976; Andrews, 1974).

8.3 Late Quaternary glaciation

Late Quaternary glaciation of the continental shelf is recorded by ice-contact and glacial marine sediments of Baffin Shelf Drift and Davis Strait Silt. Widespread distribution of the Baffin Shelf Drift, to the shelf edge both in and between the transverse troughs (Fig. 21), implies extensive glacial ice. The presence of ice contact sediments to water depths of 850 m in outer Buchan Trough implies a massive outlet glacier extended from the adjacent fiords to fully occupy the trough. Outlet glaciers are also inferred to have extended to the shelf edge within the other transverse troughs based on the presence of Baffin Shelf Drift. The lack of Baffin Shelf Drift on the floor of Scott Trough below depths of 300-400 m, despite evidence for glacial erosion of the trough floor, may indicate that a rapid transition took place from a grounded ice stream to a floating ice shelf, during either the last or a prior glaciation.

Interfingering between the ice-contact sediments and glacial marine deposits of the Davis Strait Silt in Buchan Trough indicates that glacial units in the trough were at least partly emplaced during deglaciation. Possible interfingering relationships occur elsewhere on the shelf, and linear accumulations of ice-contact sediments in Clyde, Scott and Buchan troughs may record ice-marginal deposition during deglaciation. The sediment units thus suggest a record of deglaciation from a late Quaternary glacial maximum position at the shelf edge.

Estimates of the timing of deglaciation are available from radiocarbon dates on cores of post-glacial muds and sands overlying the glacial units (Table 4). Extrapolation of dates in cores 76023-26 and 78029-24 from the Tiniktartuq Mud in Scott Trough suggest that the base of the unit, and hence the top of the underlying Davis Strait Silt, dates from ca. 15 ka. A date of ca. 12 ka from vibrocore 78029-36, from the Cape Aston Sand, implies post-glacial deposition over a similar period, with an extrapolated age of 16.9 ka for the base of the core (Table 4). These age estimates therefore imply deglaciation of the continental shelf by ca. 15 ka

Tiniktartuq Mud conformably overlies Davis Strait Silt, suggesting that deposition was continuous between the two units. This is supported by the foraminiferal record of cores from sequences of Tiniktartuq Mud in cores 76023-26 and 78029-24 from Scott Trough, and of Cape Aston Sand in vibrocore 78029-36 from the Cape Aston area, which was interpreted to record a transition from late glacial to post-glacial oceanographic conditions subsequent to a glacial episode (Jennings, 1986; Osterman and Nelson, 1989). In addition, the cored sequence has been correlated to the upper part of cores from Baffin Bay (Jennings, 1986), in which correlative conditions were preceded by lithofacies interpreted to record glacial sediment delivery to the margins of Baffin Bay (Aksu, 1983). A glacial to post-glacial foraminiferal record may also be present in core 81045-25C seaward of Cape Adair (Cameron, 1984).

Deglaciation of the continental shelf from a late Foxe glacial maximum at the shelf edge is not consistent with accepted terrestrial reconstructions, which envisage restricted mid - to late Foxe glacial ice (Andrews and Miller, 1984; Andrews et al., 1984). Relative sea levels up to >80 m lower than present in the mid - to late Foxe have been proposed in these reconstructions (Andrews, 1980). No clear evidence for such a sea level lowstand is recognized in the sediments of the shelf. However, Cape Aston Sand above depths of 80-120m records sandy deposition during at least the last 12 ka.

Withdrawal of glacial ice from the shelf prior to ca. 15 ka is compatible with alternate reconstructions of late Foxe glacial ice extent (King, 1969; Hodgson and Haselton, 1974; Denton and Hughes, 1981). The continental shelf record suggests withdrawal of glacial ice by ca. 15 ka and retreat to the Cockburn moraines at the fiord heads by 8 – 9 ka. The offshore chronology is poorly constrained, however (Table 4), and additional dates are required to confirm the timing of events.

8.4 Post-glacial sedimentation

Sedimentation subsequent to deglaciation is recorded by Tiniktartuq Mud and Cape Aston Sand. Radiocarbon dates from cores of the units indicate that post-glacial conditions on the continental shelf have persisted since ca. 15 ka (Table 4). The record from cores in Scott Trough, and off Cape Aston, shows that `post-glacial` conditions have been influenced both by changing oceanographic conditions in Baffin Bay and by glacial fluctuations on Baffin Island (Jennings, 1986; Osterman andNelson, 1989). Thus higher sedimentation rates reflect increased sediment supply from the fiords during the formation of the Cockburn moraines at the fiord heads ca. 8 – 9 ka (Jennings, 1986), while foraminiferal assemblages indicate cold late glacial oceanographic conditions prior to ca. 8.4 ka (Osterman and Nelson, 1989). Jennings (1986) suggested that a coastal belt of shore-fast ice inhibited ice-rafting on the inner shelf. Foraminiferal assemblages indicate impingement of the warm West Greenland Current on the Baffin Shelf between 7 – 8.4 ka (Osterman and Nelson, 1989). Conditions similar to present have persisted since ca. 7 ka.

Ice-rafting, iceberg scouring and currents have been the fundamental post-glacial influences on shelf conditions. Ice-rafting has contributed coarse-grained material to the entire shelf, and probably supplied fine-grained material into suspension. Currents have provided continuous southern transport of suspended sediment and ice rafts, and have directly influenced the deposition of muds in basins and sands above water depths of 80 - 120 m. Currents, iceberg scouring and ice rafting together havepage generated highly variable seabed textures across the surfaces of glacial sequences.

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Table 1. Main acoustic systems used on the northeast Baffin Shelf.

Source	**Receiver**	**Tow Location**	**Power**	**Frequency** (kHz)	**Firing Rate** (sec)	**Maximum Observed Penetration**	**Vertical Resolution** (m)	**Horizontal Separation of Shots (@ 8 km/s)** (m)
air gun (Bolt)	6m NSRF hydrophone	at surface, 10-30m astern	0.5-1 litre chambers	0.08-1	2 - 3	500 msec	5 - 10	4 - 7
boomer (Huntec)	Internal and external hydrophones	≤200m depth, ≤500m astern	1000 J	0.8-10	0.75	50 msec	0.5-1	1 - 2
echosounder (Raytheon)	transducer	hull-mounted	-	12	1	20 msec (10 m)	<1	2
sidescan sonar (BIO)	transducer	≤200m depth, ≤500m astern	-	75	1	-	<0.1	2 (1500 m swath)

Table 2. Morphologic parameters of transverse troughs

TROUGH	WALL GRADIENTS	WIDTH• min. (km)	max. (km)	DEPTH min.* (m)	max. (m)	DEPTH TO BEDROCK min.* (m)	max. (m)	MAX. EROSION° (m)	BASIN RELIEF† (m)
Buchan	3-25°	26	36	535	760	540	775	650	75
Scott	3-25°	17	30	700	845	710	890	800	180
Sam Ford	0.5-2°	6	30	210	290	≤290	350	170	≥30**
Clyde	1-10°	16	30	240	320	≤340	460	350	≥100**

• at 200 m isobath
* excluding walls
° below adjacent bedrock surface
† limiting relief of bedrock surface basins
** minimum estimate due to lack of acoustic data in outer troughs

Table 3: Summary description of the recognized stratigraphy units

ACOUSTIC UNITS		ACOUSTIC CHARACTER THICKNESS (m)	STRATIFICATION	GEOMETRY	ICEBERG SCOUR ABUNDANCE	CORE LITHOLOGY	INTERPRETATION
CAPE ASTON SAND		≤1?	(low sidescan reflectivity)		ubiquitous	>65% sand	postglacial sand derived from ice rafting and reworking of shallower areas. Time equivalent of Tiniktartuq Mud.
TINIKTARTUQ MUD		≤7	weak	basinal	rare	>80% mud	postglacial hemipelagic mud containing minor ice-rafted components. Time equivalent of Cape Aston Sand.
DAVIS STRAIT SILT	A	≤7	weak to strong	mantling	absent	sandy mud with gravel (locally derived)	glacial marine sediment (ice-proximal in core sample, may include ice-distal elsewhere). At least in part, a time and facies equivalent of the Baffin Shelf Drift.
	B	≤4	absent	mantling	ubiquitous		
BAFFIN SHELF DRIFT	A	≤75 (typically ≤25)	typically absent	irregular to constructional	ubiquitous		glacial ice-contact sediments (may include till, ice-marginal dump material, ice-loaded sediment).
	B	≤2	absent	discontinuous over resistant unconformity on Cape Adair sediments	ubiquitous		
SCOTT TROUGH SEDIMENTS		≤75	weak to strong	onlapping			relict marine sediments (glacial marine turbidities or hemipelagic muds). Occurs in subsurface only.
CAPE ADAIR SEDIMENTS		≤100	weak to strong, irregular	variable (eroded)			irregularly stratified sediments tentatively correlated with glacial ice-contact/marine sequences of coastal forelands. Occurs in subsurface only.
BEDROCK		variably Precambrian crystalline basement and Cretaceous-Tertiary sedimentary strata					

Table 4. Radiocarbon dates used in this report, and derived sedimentation rates and extrapolated ages.

Core	Acoustic Unit	Depth (cm)	Lab #	POM* Date	Corrected Age° or Shell Date	Source	Sedimentation Rate• (cm/1000 yr)	Extrapolated Age†
76023-26 (piston core)	Tiniktartuq Mud	23-38	GX-8751	9480 ± 565	6868 ± 1100	Jennings (1986)	4.4	
		119-144	GX-6607	17,005 ± 720	11,759 ± 1100		20.7	15,000 @ 2 m (base of acoustic unit)
78029-24 (piston core)	Tiniktartuq Mud	270-280	GX-8753	9570 ± 370	6927 ± 1100		39.7	
		410-420	GX-8754	10,915 ± 600	7801 ± 1100		160.2	
		523-540	GX-9344	16,070 +1500 -1300	11,152 ± 1100		34.5	16,000 @ 7 m (base of acoustic unit)
78029-36 (vibrocore)	Cape Aston Sand	62-68	GX-6280		11,770 ± 550	Andrews et al. (1984)	5.5	16,900 @ 93 cm (base of core)

*Pre-treated Organic Matter
°Equivalent shell age estimated using empirical formula of Andrews et al. (1985)
•Calculated from core top or centre of preceding dated interval
†Extrapolated from centre of lowermost dated interval using adjacent sedimentation rate

Table 5. Lithology of gravel/granule fractions, selected 80028 grab samples

Grab #	**Depth** m	**Map** Unit	**Clasts** (#)	**Crystalline** %	**Sedimentary** %	**Lithology** (resistant clastics or carbonates unless indicated)
North of Scott Trough						
61	369	2B	97	82	18	
62	312	2B	33	64	36	
63	338	2B	221	85	15	
64	226	2B	37	63	37	
65	214	2B	17	71	29	
66	186	3	22	77	23	
67	125	1	257	88	12	
68	155	1	326	90	10	
70	128	2B	128	67	33	
71	198	3	18	72	28	
South of Scott Trough						
36	207	3	16	88	12	
Scott Trough walls						
27	680	2A	213	62	38	
30	547	2A	180	61	39	
*32	380	2A	25	28	72	72% black shale
*33	360	2A	224	38	62	57% soft brown-black mudstone
*34	275	2B	75	53	47	41% soft brown-black mudstone
35	197	1	142	92	8	
38	210	2B	33	90	10	
*44	732	2A	367	28	72	50% hard light gray-white carbonate 11% soft brown-black siltstone(?)
45	515	2A	264	63	37	
51	593	2A	42	88	12	
*52	638	2A	99	84	16	15% soft gray-brown mudstone
*54	174	1	402	93	7	3% soft gray & brown sandstones to siltstones
*56	690	2A	325	8	92	92% soft gray & brown mudstones
Scott Trough floor						
24	603	3	50	72	28	
28	713	3	17	76	24	
31	635	3	14	73	27	
40	585	3	28	71	29	
42	695	3	15	86	14	
43	703	3	10	80	20	
60	566	3	16	100	-	

* noted on Fig. 36

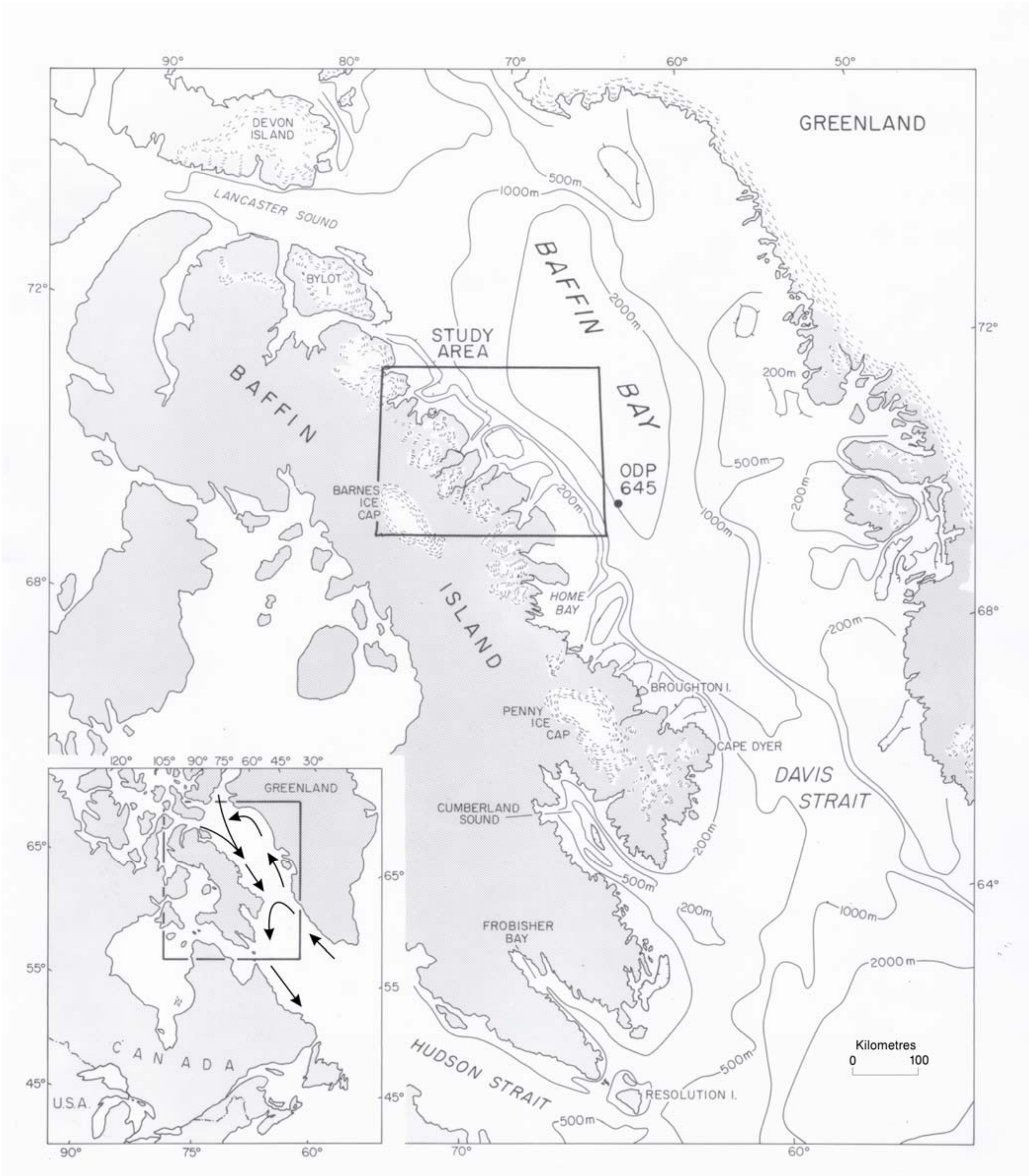


Figure 1. Index map showing generalized bathymetry and location of the study area on the Northeastern Baffin Island Shelf.

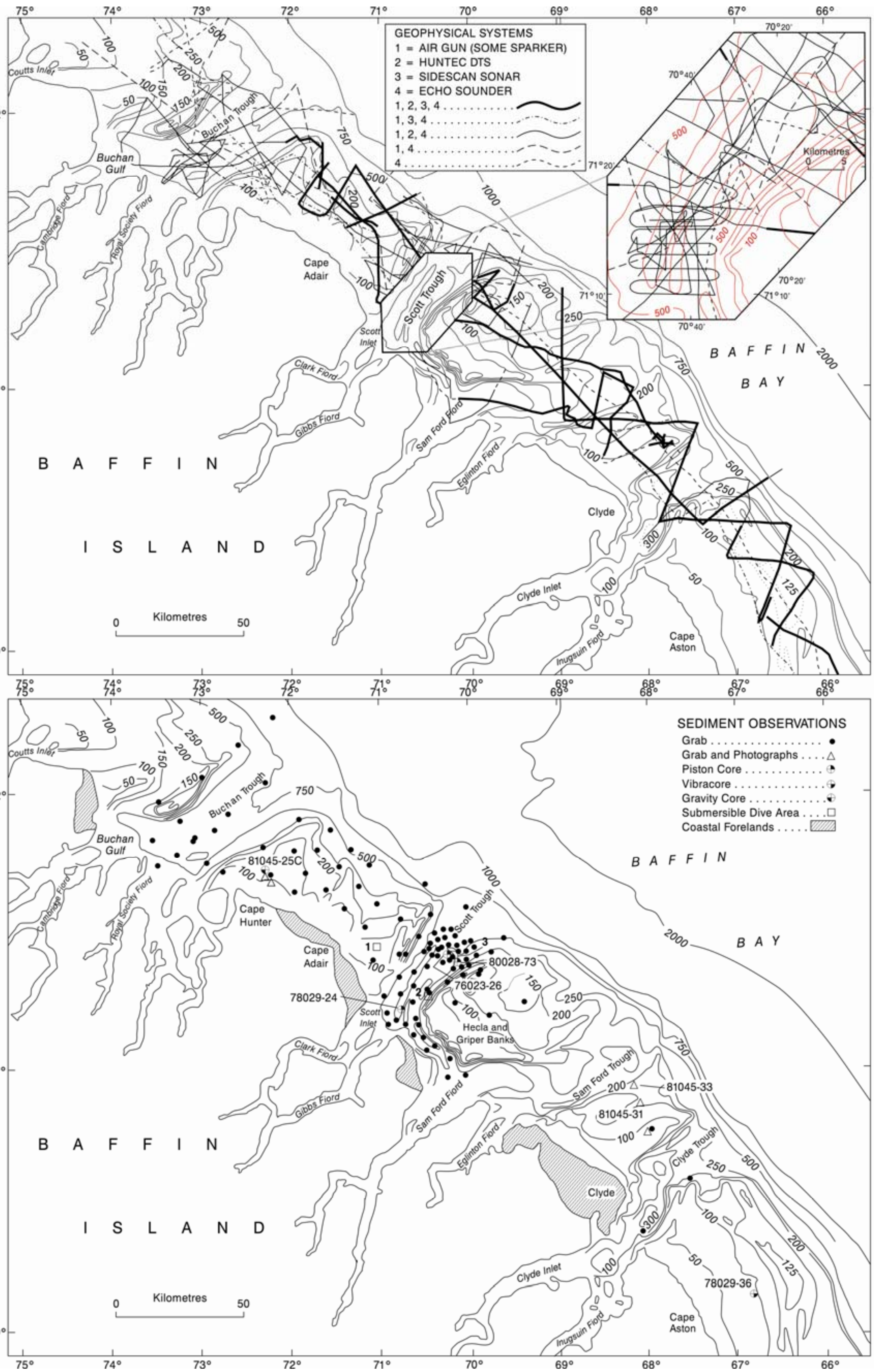


Figure 2. (a) Multiparameter survey tracks within the study area; (b) sample stations and submersible observation localities within the study area.

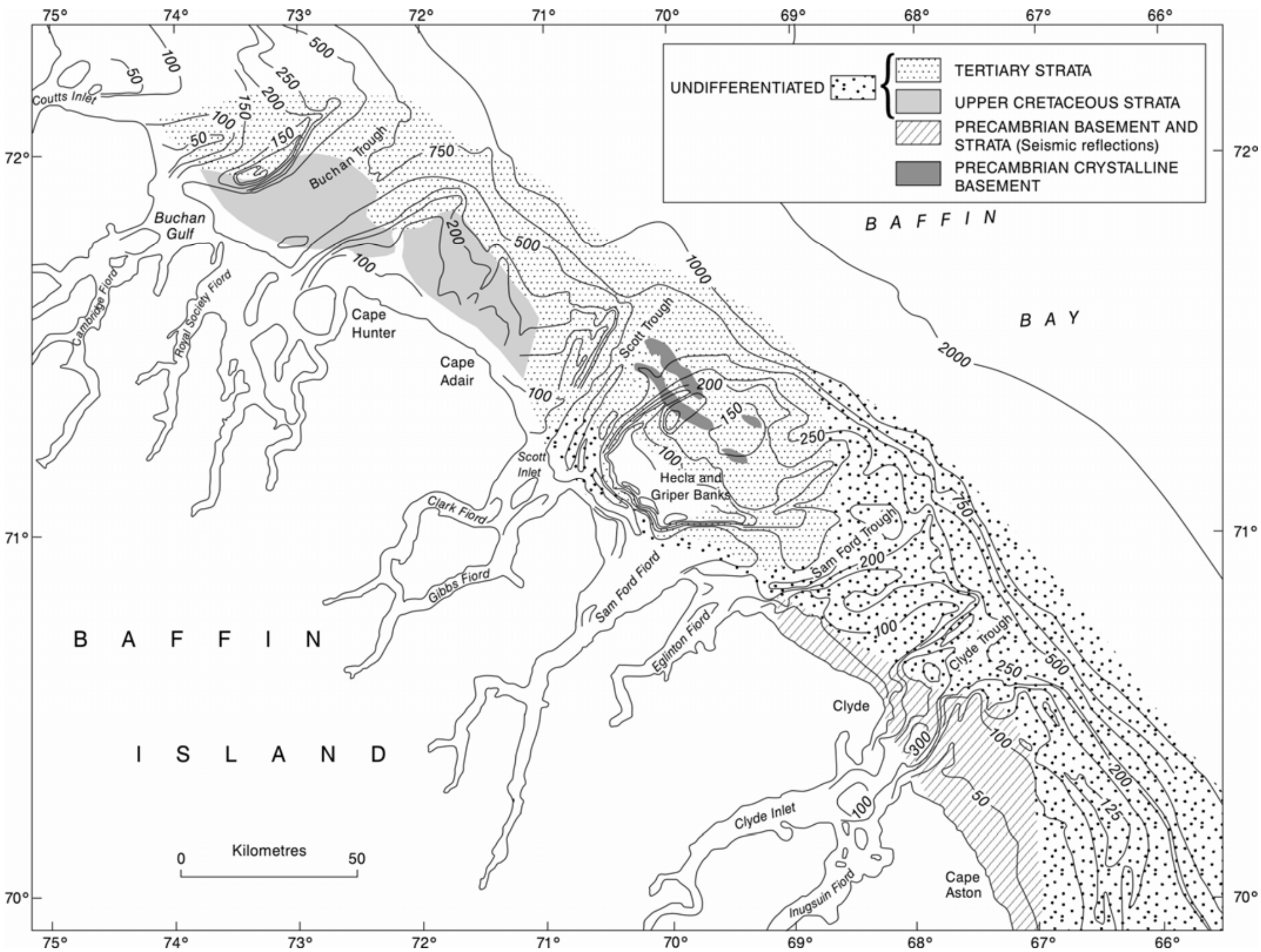


Figure 3. Bedrock geology of the study area (modified from MacLean et al., 1981).

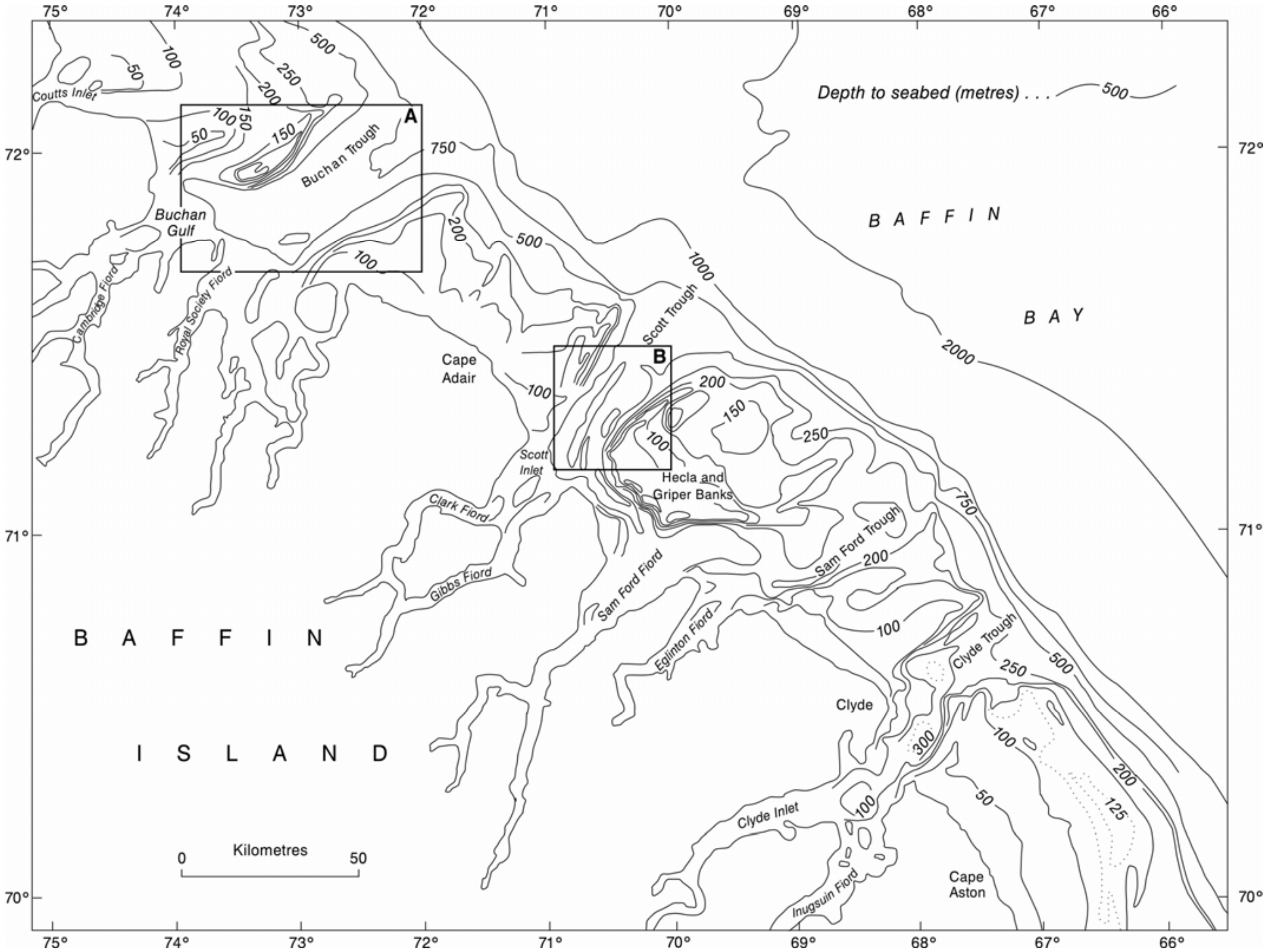


Figure 4. Bathymetry of the study area showing tranverse submarine troughs that extend across the shelf from the mouths of the fiords, and morphology of intertrough areas.

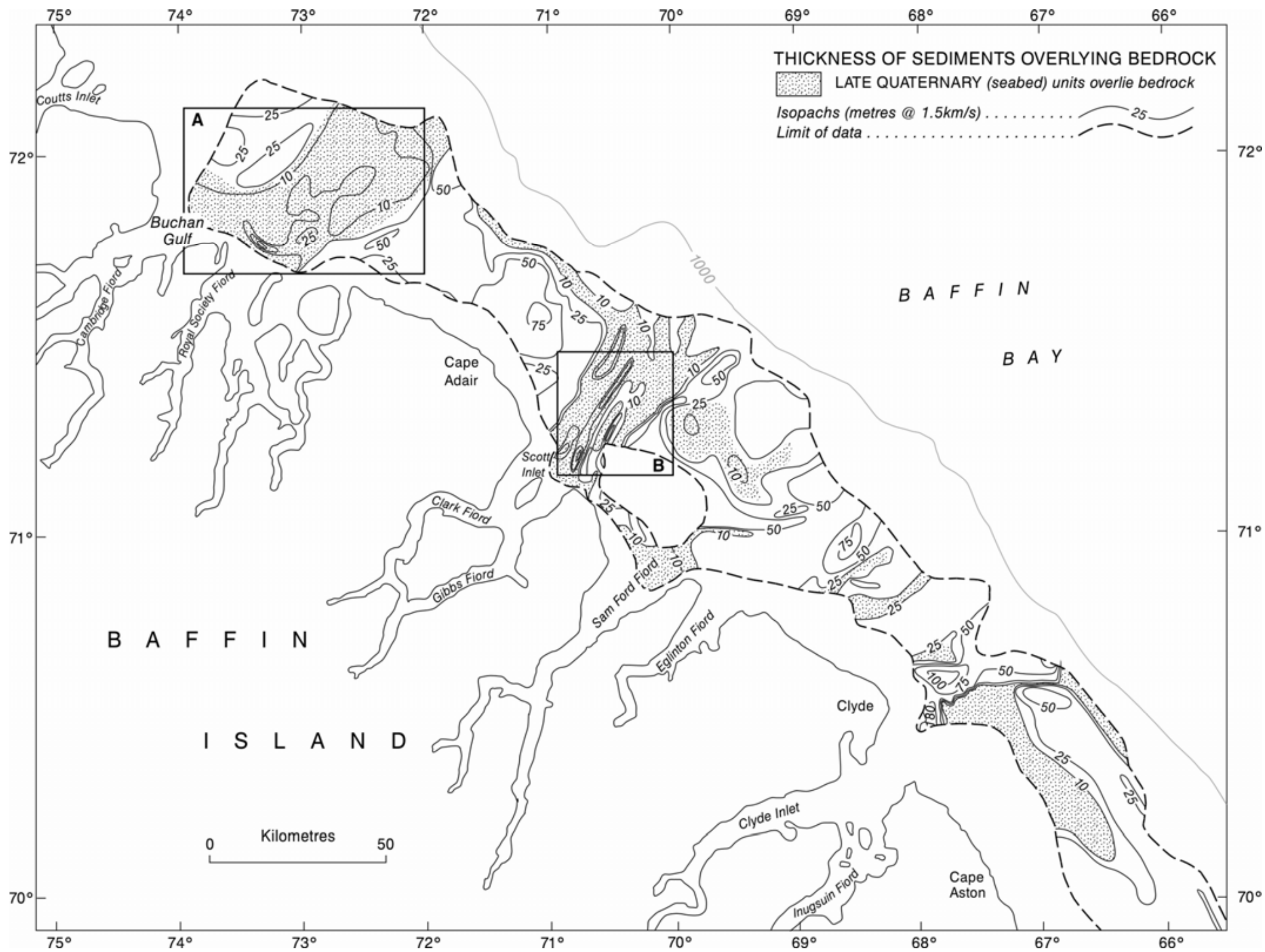


Figure 5. Isopach map of sediments overlying bedrock in the study area.

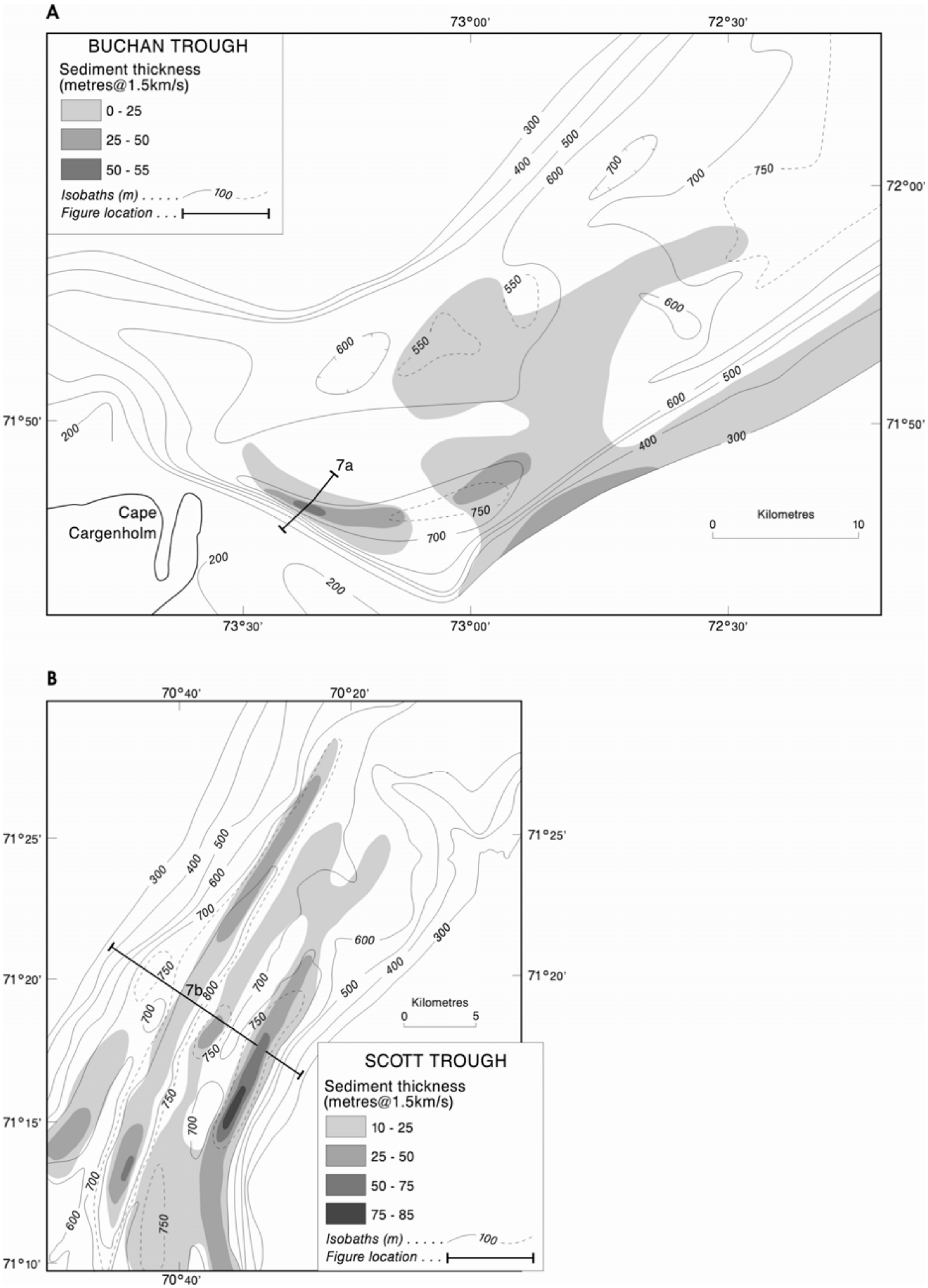
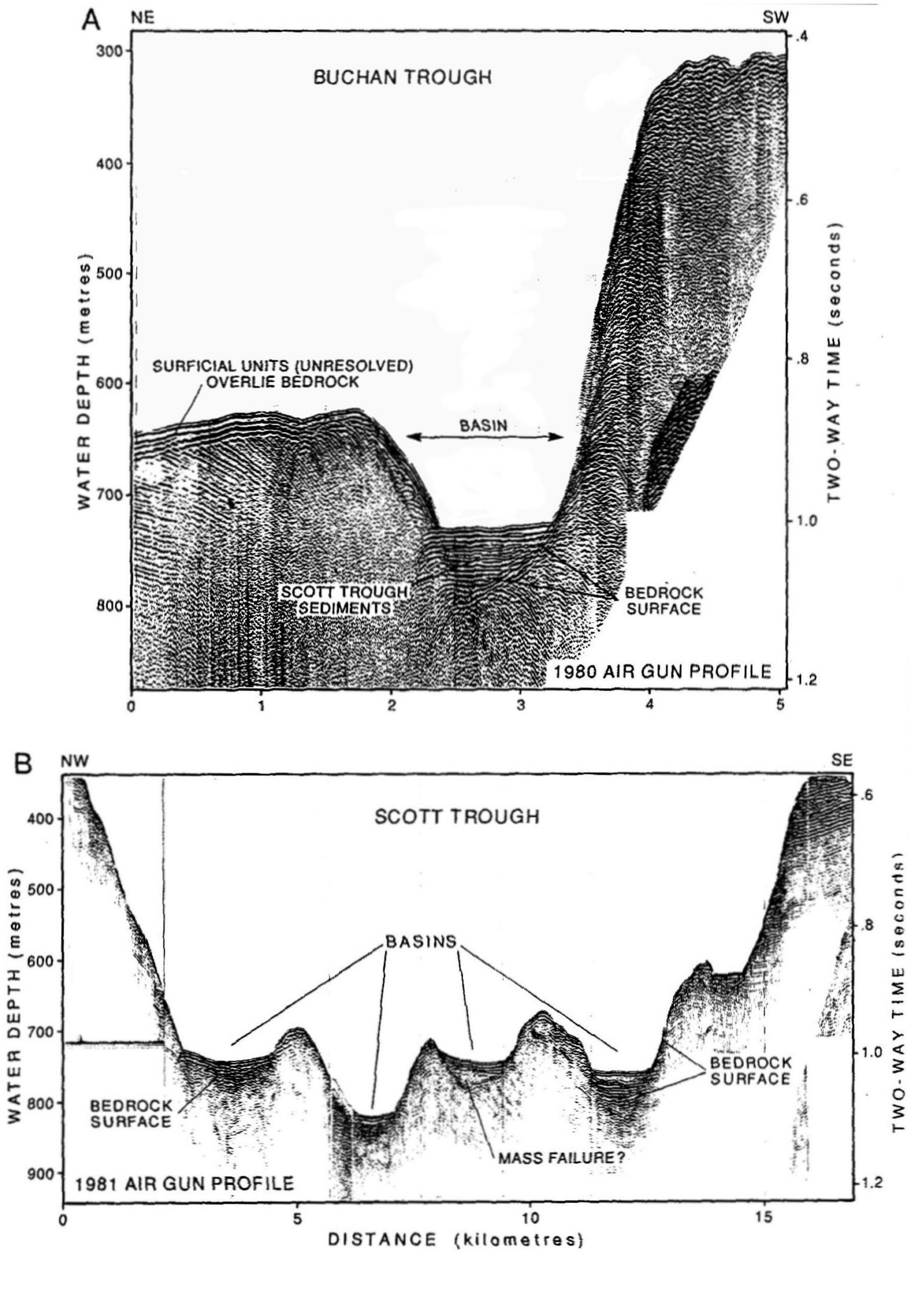


Figure 6. Bathymetry and sediment thicknesses in Buchan and Scott troughs.


A
NE
SW
BUCHAN TROUGH
SURFICIAL UNITS (UNRESOLVED) OVERLIE BEDROCK
BASIN
SCOTT TROUGH SEDIMENTS
BEDROCK SURFACE
1980 AIR GUN PROFILE
WATER DEPTH (metres)
TWO-WAY TIME (seconds)
300
400
500
600
700
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1.0
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0
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2
3
4
5
B
NW
SE
SCOTT TROUGH
BASINS
BEDROCK SURFACE
BEDROCK SURFACE
MASS FAILURE?
1981 AIR GUN PROFILE
WATER DEPTH (metres)
TWO-WAY TIME (seconds)
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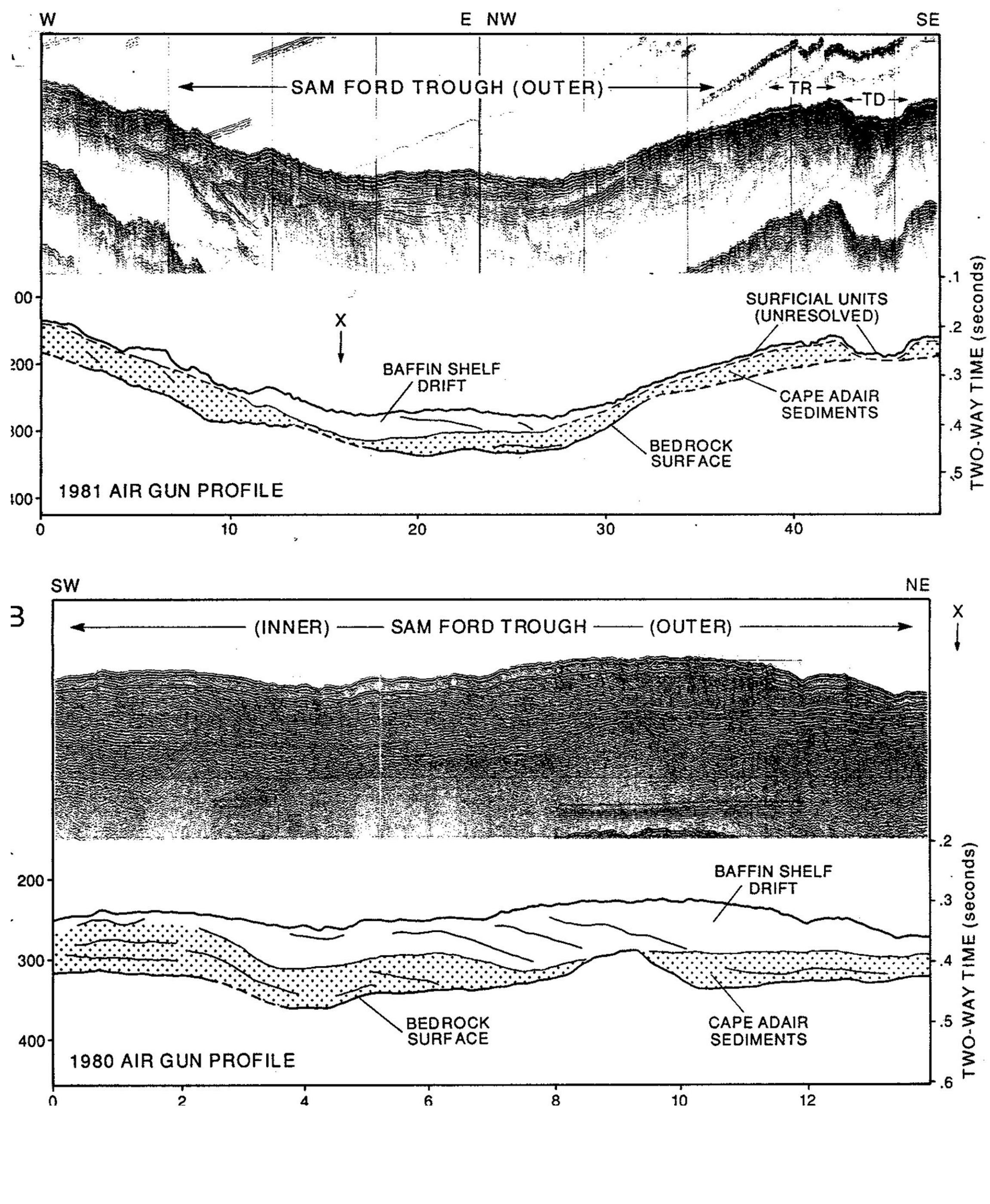
15
DISTANCE (kilometres)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SAM FORD TROUGH (OUTER)
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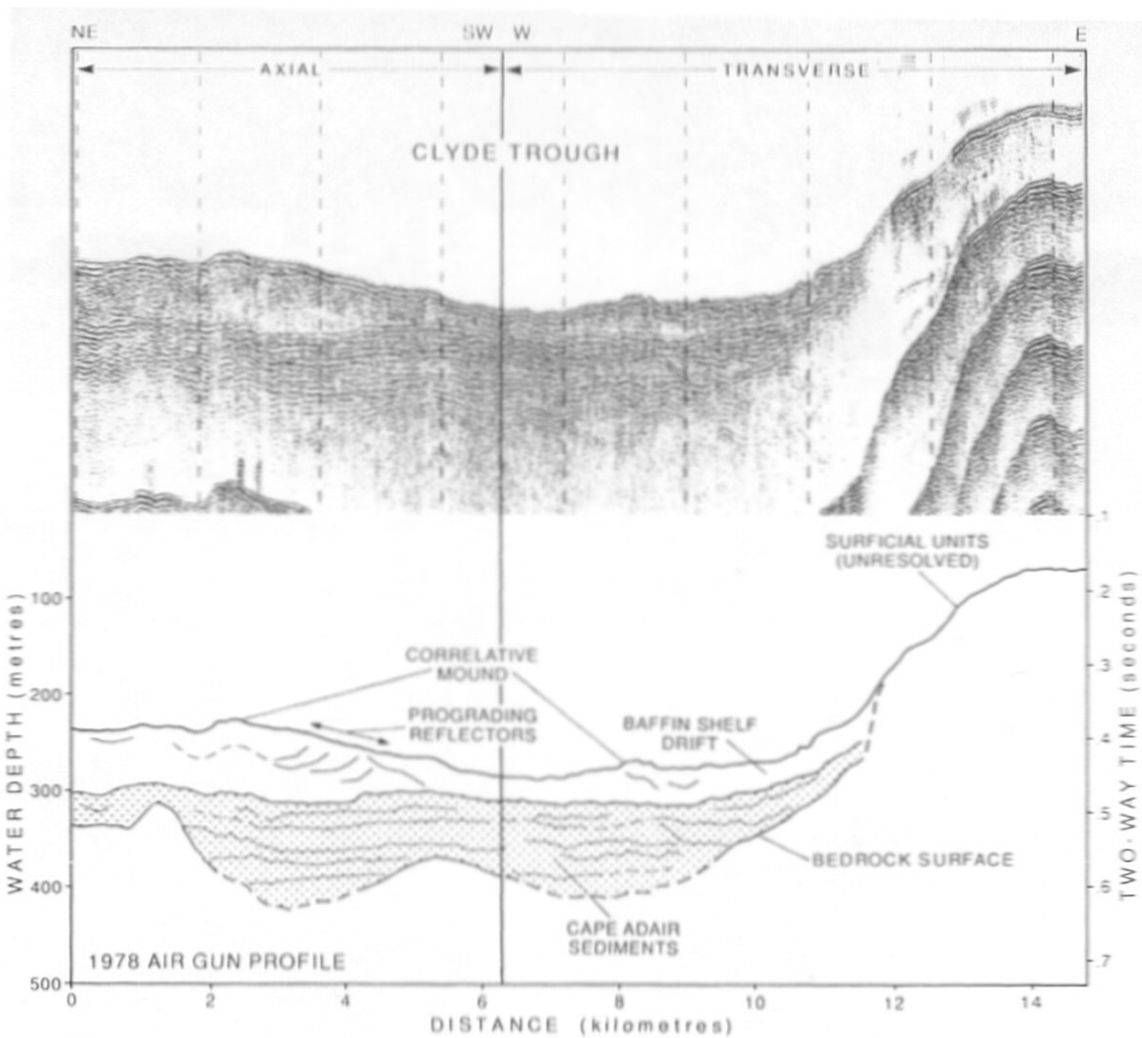
TD
X
SURFICIAL UNITS
(UNRESOLVED)
BAFFIN SHELF
DRIFT
CAPE ADAIR
SEDIMENTS
BEDROCK
SURFACE
1981 AIR GUN PROFILE
TWO-WAY TIME (seconds)
SW
NE
(INNER) SAM FORD TROUGH (OUTER)
X
BAFFIN SHELF
DRIFT
BEDROCK
SURFACE
CAPE ADAIR
SEDIMENTS
1980 AIR GUN PROFILE
TWO-WAY TIME (seconds)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TRANSVERSE
CLYDE TROUGH
SURFICIAL UNITS
(UNRESOLVED)
CORRELATIVE
MOUND
PROGRADING
REFLECTORS
BAFFIN SHELF
DRIFT
BEDROCK SURFACE
CAPE ADAIR
SEDIMENTS
1978 AIR GUN PROFILE
WATER DEPTH (metres)
TWO-WAY TIME (seconds)
DISTANCE (kilometres)
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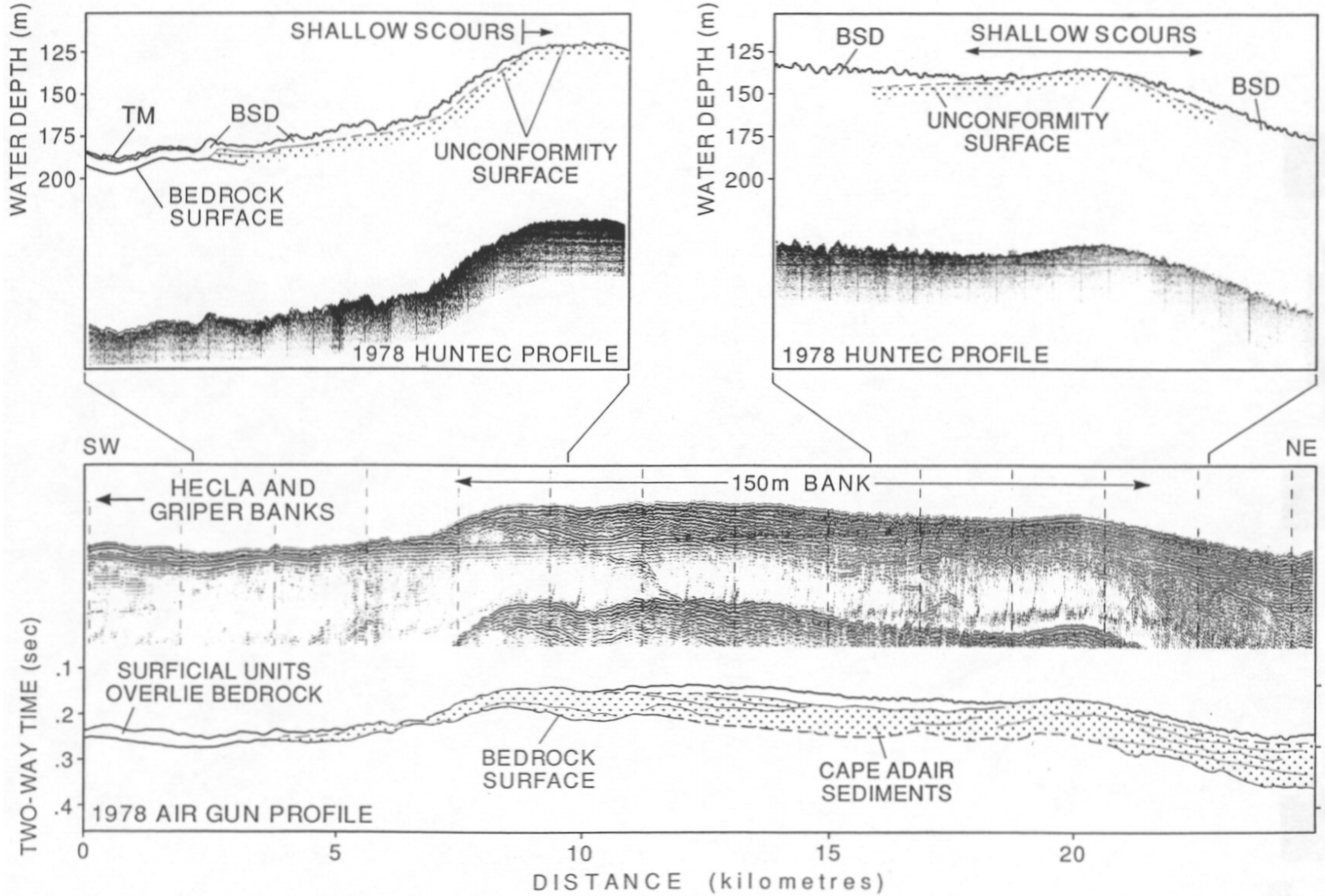
SHALLOW SCOURS
TM
BSD
UNCONFORMITY SURFACE
BEDROCK SURFACE
WATER DEPTH (m)
125
150
175
200
1978 HUNTEC PROFILE
BSD
SHALLOW SCOURS
BSD
UNCONFORMITY SURFACE
WATER DEPTH (m)
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1978 HUNTEC PROFILE
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HECLA AND GRIPER BANKS
150m BANK
SURFICIAL UNITS OVERLIE BEDROCK
BEDROCK SURFACE
CAPE ADAIR SEDIMENTS
1978 AIR GUN PROFILE
TWO-WAY TIME (sec)
.1
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WATER DEPTH (m)
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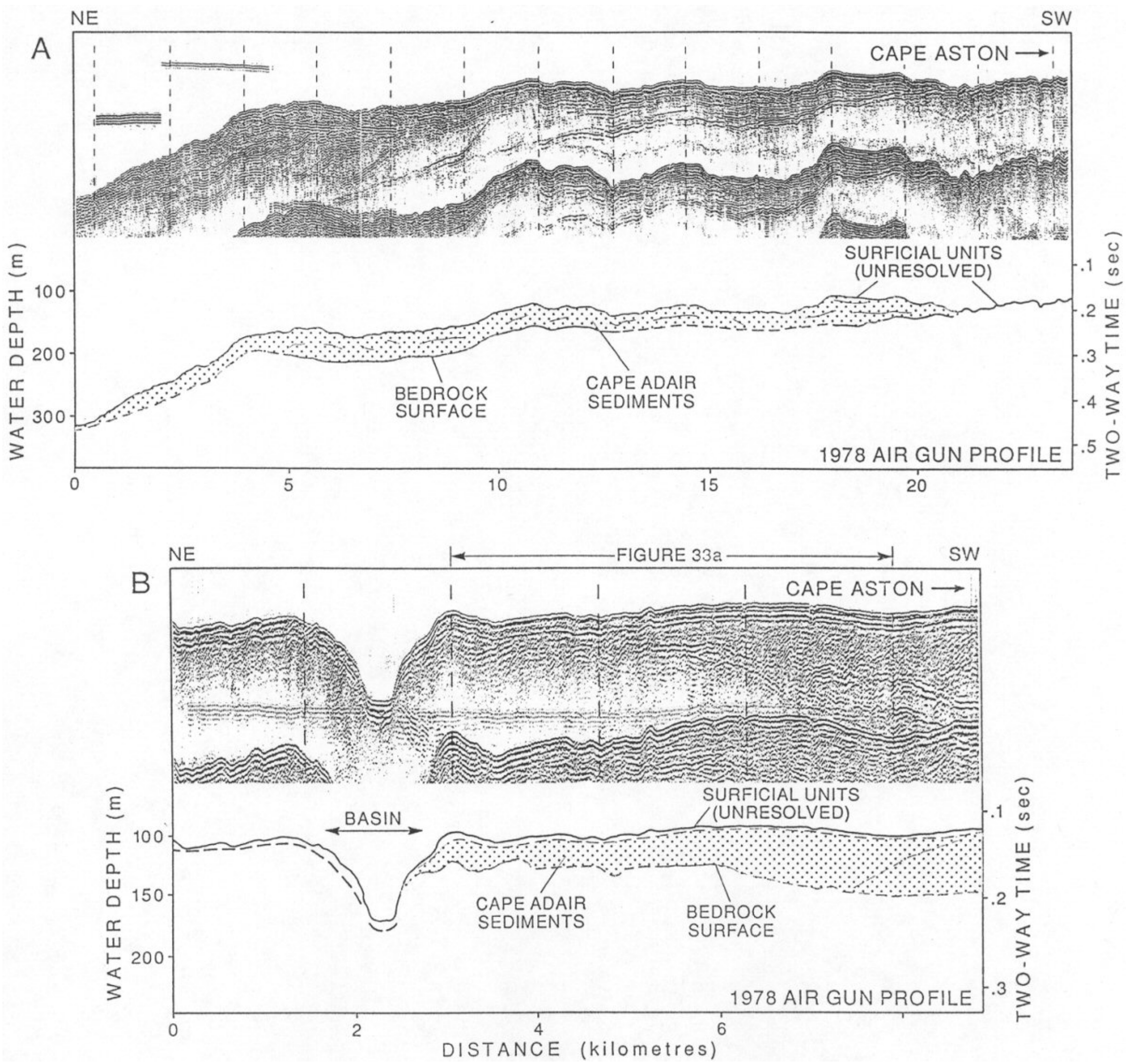
DISTANCE (kilometres)


A
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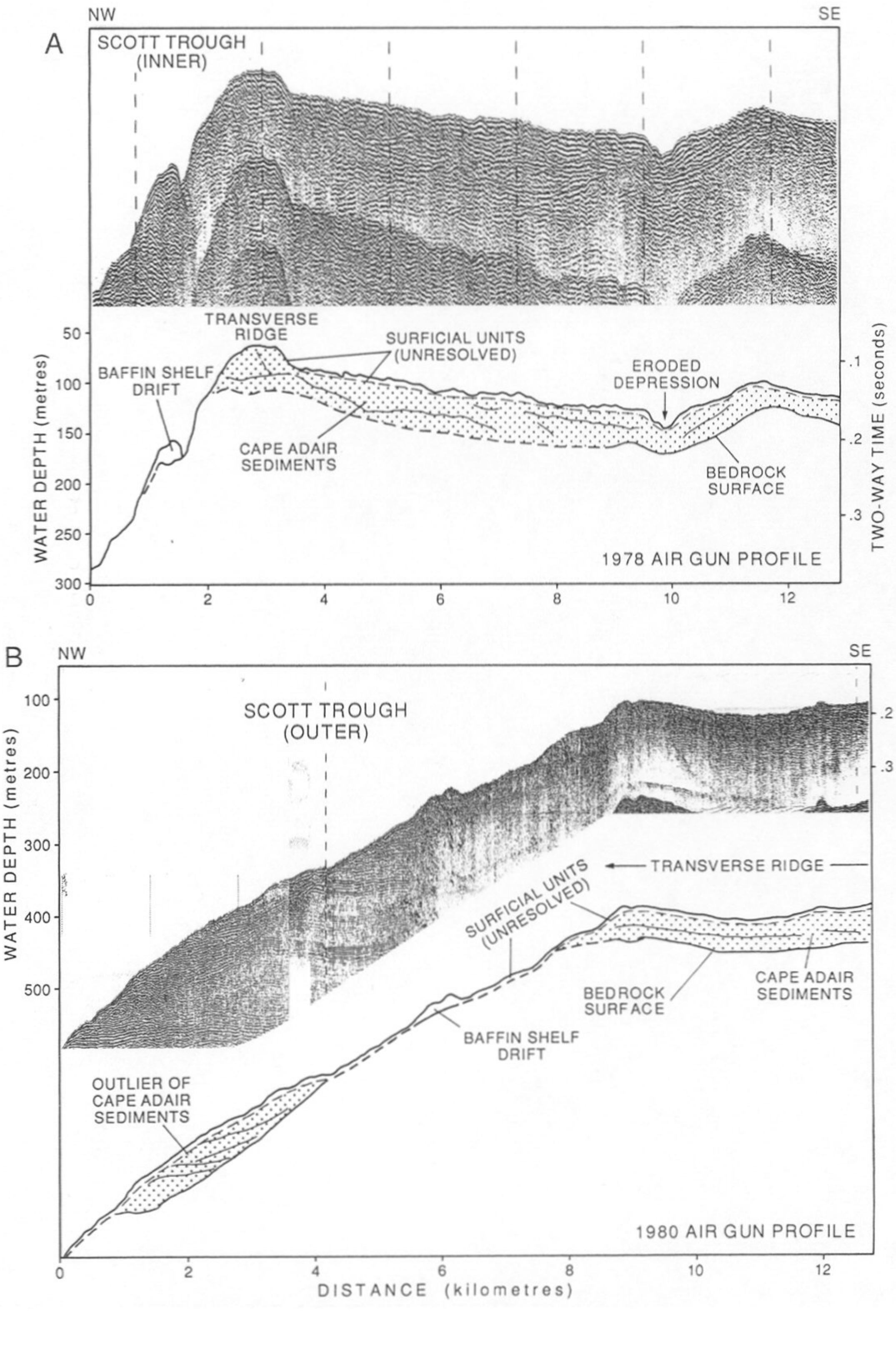
CAPE ASTON
SURFICIAL UNITS (UNRESOLVED)
BEDROCK SURFACE
CAPE ADAIR SEDIMENTS
1978 AIR GUN PROFILE
WATER DEPTH (m)
TWO-WAY TIME (sec)
B
FIGURE 33a
BASIN
DISTANCE (kilometres)



A
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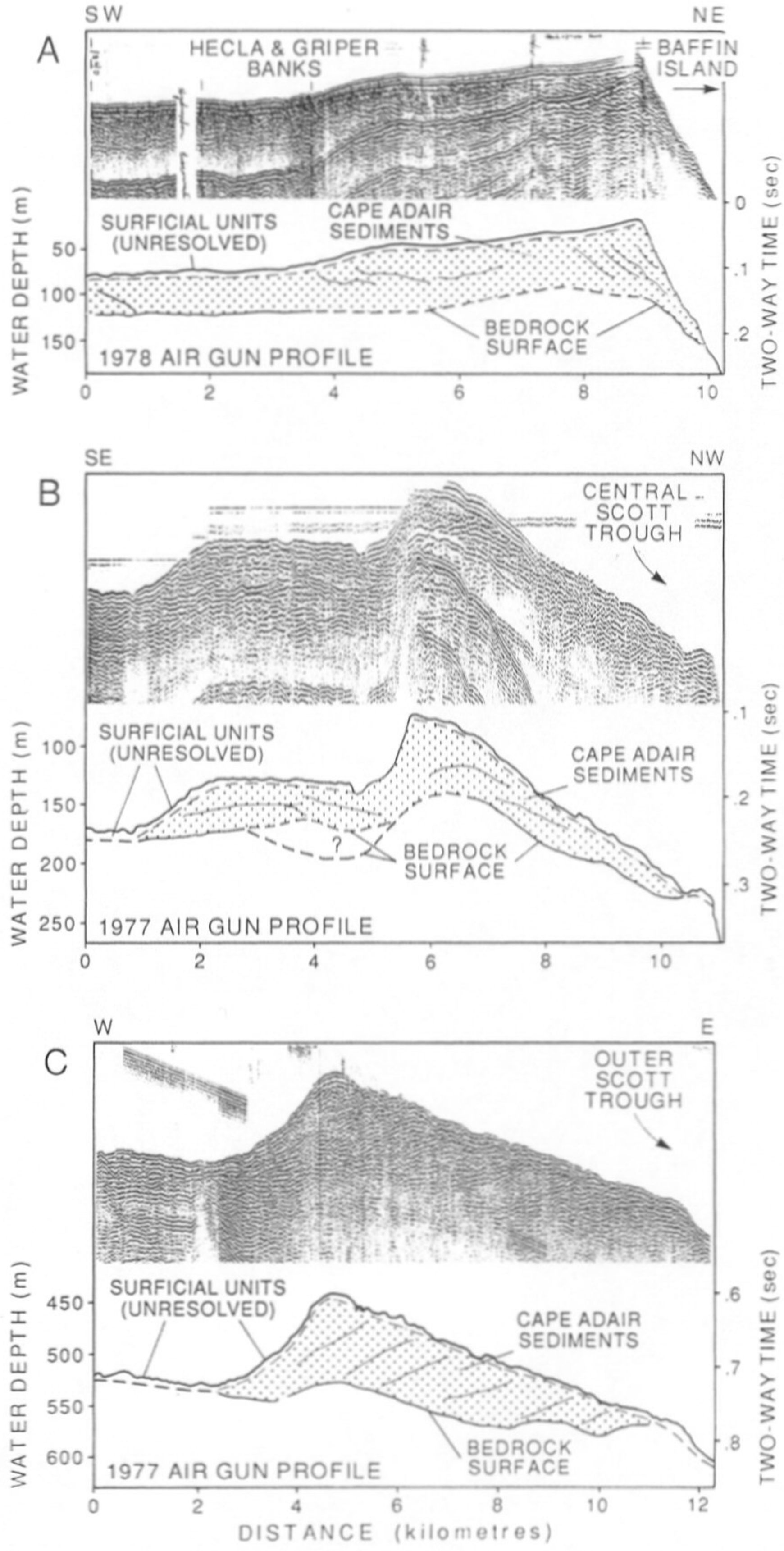
SCOTT TROUGH
(INNER)
TRANSVERSE RIDGE
SURFICIAL UNITS
(UNRESOLVED)
BAFFIN SHELF DRIFT
ERODED DEPRESSION
CAPE ADAIR SEDIMENTS
BEDROCK SURFACE
1978 AIR GUN PROFILE
WATER DEPTH (metres)
TWO-WAY TIME (seconds)
B
NW
SE
SCOTT TROUGH
(OUTER)
TRANSVERSE RIDGE
SURFICIAL UNITS
(UNRESOLVED)
BEDROCK SURFACE
CAPE ADAIR SEDIMENTS
BAFFIN SHELF DRIFT
OUTLIER OF CAPE ADAIR SEDIMENTS
1980 AIR GUN PROFILE
WATER DEPTH (metres)
TWO-WAY TIME (sec)
DISTANCE (kilometres)


SW
NE
A
HECLA & GRIPER
BANKS
BAFFIN
ISLAND
SURFICIAL UNITS
(UNRESOLVED)
CAPE ADAIR
SEDIMENTS
BEDROCK
SURFACE
1978 AIR GUN PROFILE
WATER DEPTH (m)
TWO-WAY TIME (sec)
SE
NW
B
CENTRAL
SCOTT
TROUGH
SURFICIAL UNITS
(UNRESOLVED)
CAPE ADAIR
SEDIMENTS
BEDROCK
SURFACE
1977 AIR GUN PROFILE
W
E
C
OUTER
SCOTT
TROUGH
SURFICIAL UNITS
(UNRESOLVED)
CAPE ADAIR
SEDIMENTS
BEDROCK
SURFACE
1977 AIR GUN PROFILE
DISTANCE (kilometres)

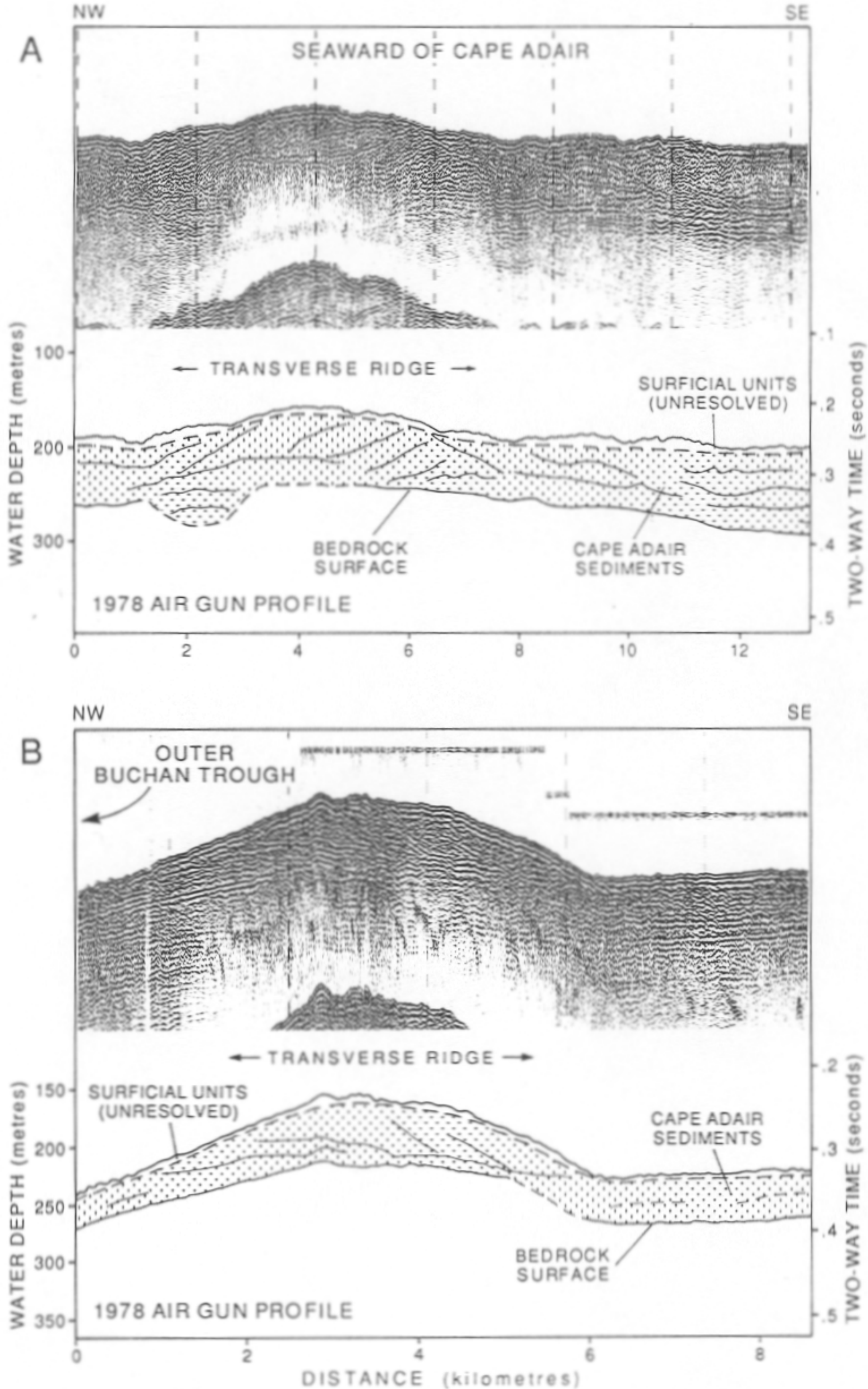


Figure 14. Single channel seismic reflection profiles and interpreted sections showing transverse ridges east of Cape Adair (see Figure 19 for location).

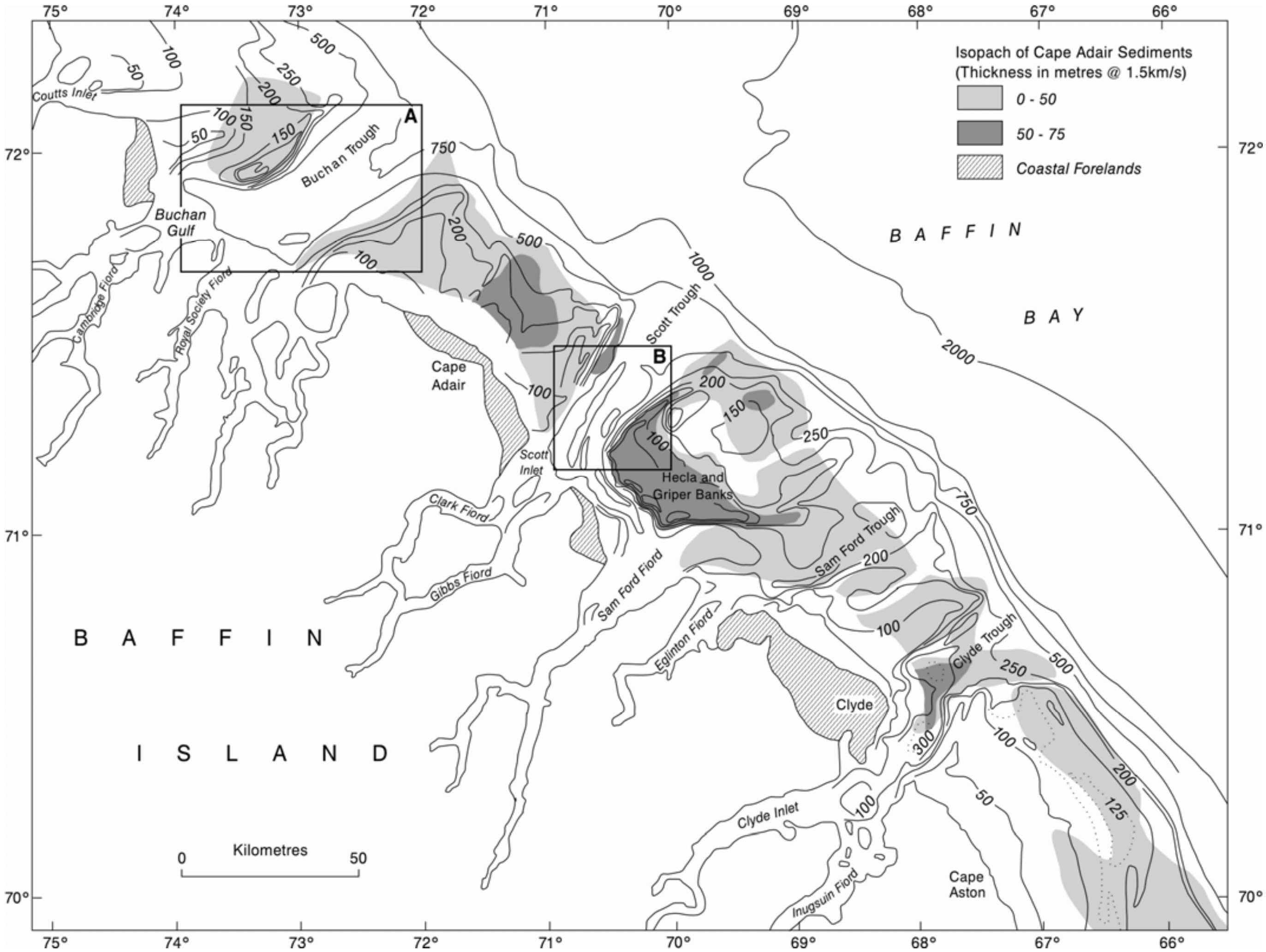
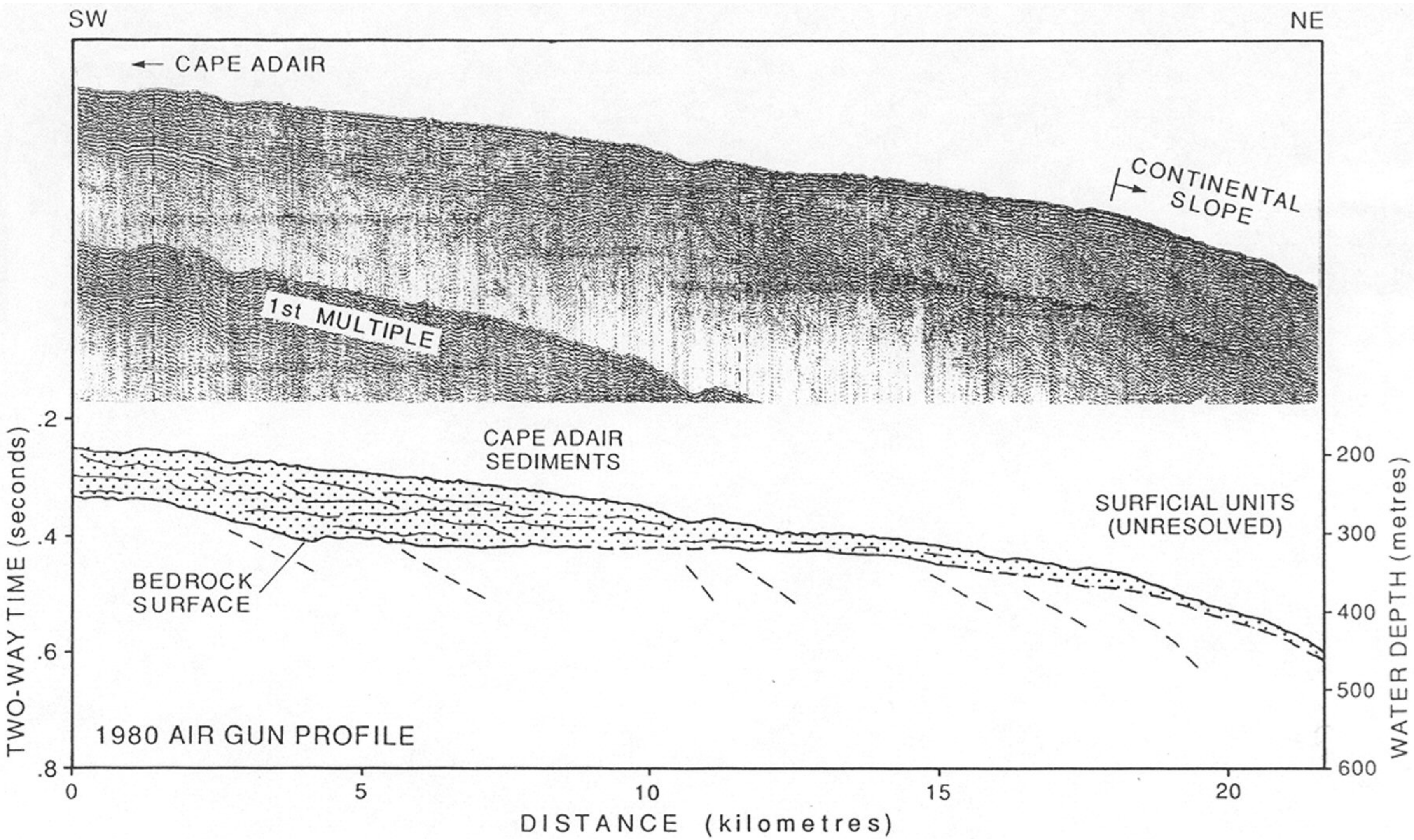


Figure 15. Map showing the subsurface distribution and thickness of Cape Adair Sediments in the study area.


SW
NE
← CAPE ADAIR
CONTINENTAL SLOPE
1st MULTIPLE
CAPE ADAIR SEDIMENTS
SURFICIAL UNITS (UNRESOLVED)
BEDROCK SURFACE
1980 AIR GUN PROFILE
TWO-WAY TIME (seconds)
.2
.4
.6
.8
WATER DEPTH (metres)
200
300
400
500
600
0
5
10
15
20
DISTANCE (kilometres)

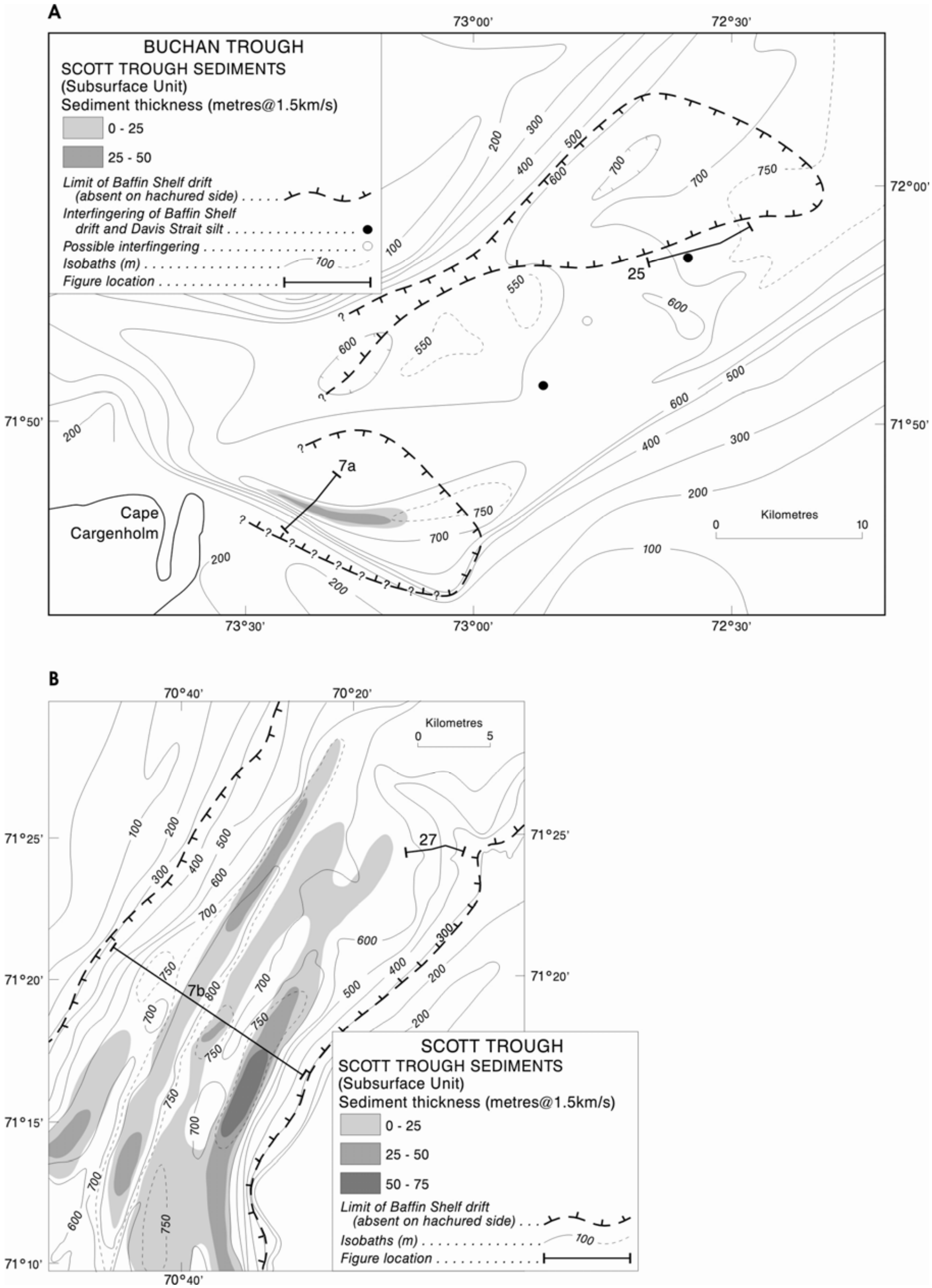
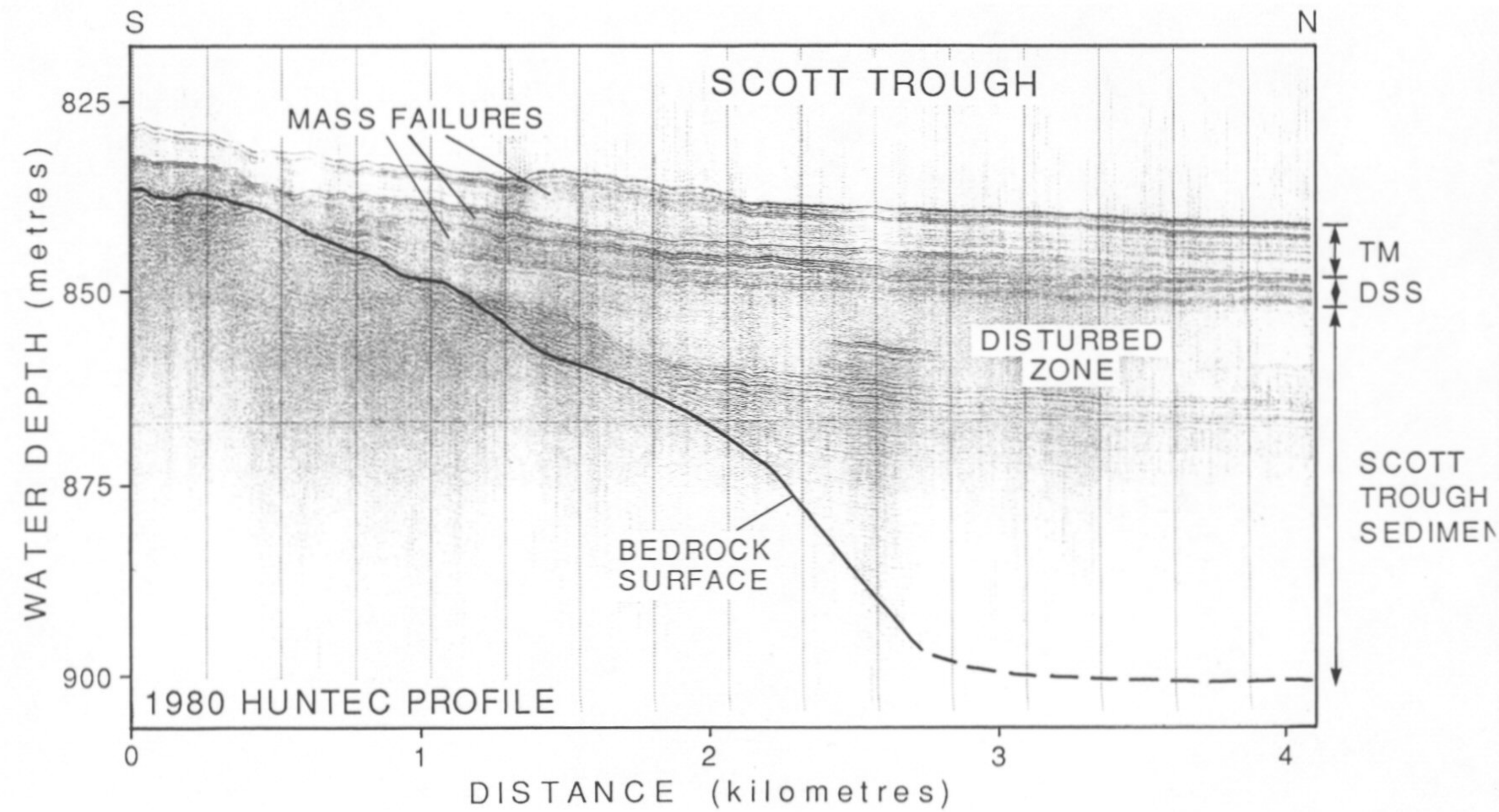


Figure 17. Map showing the subsurface distribution and thickness of Scott Trough Sediments in Scott and Buchan troughs.


S
N
SCOTT TROUGH
MASS FAILURES
825
850
875
900
WATER DEPTH (metres)
TM
DSS
DISTURBED ZONE
SCOTT TROUGH SEDIMEN
BEDROCK SURFACE
1980 HUNTEC PROFILE
0
1
2
3
4
DISTANCE (kilometres)

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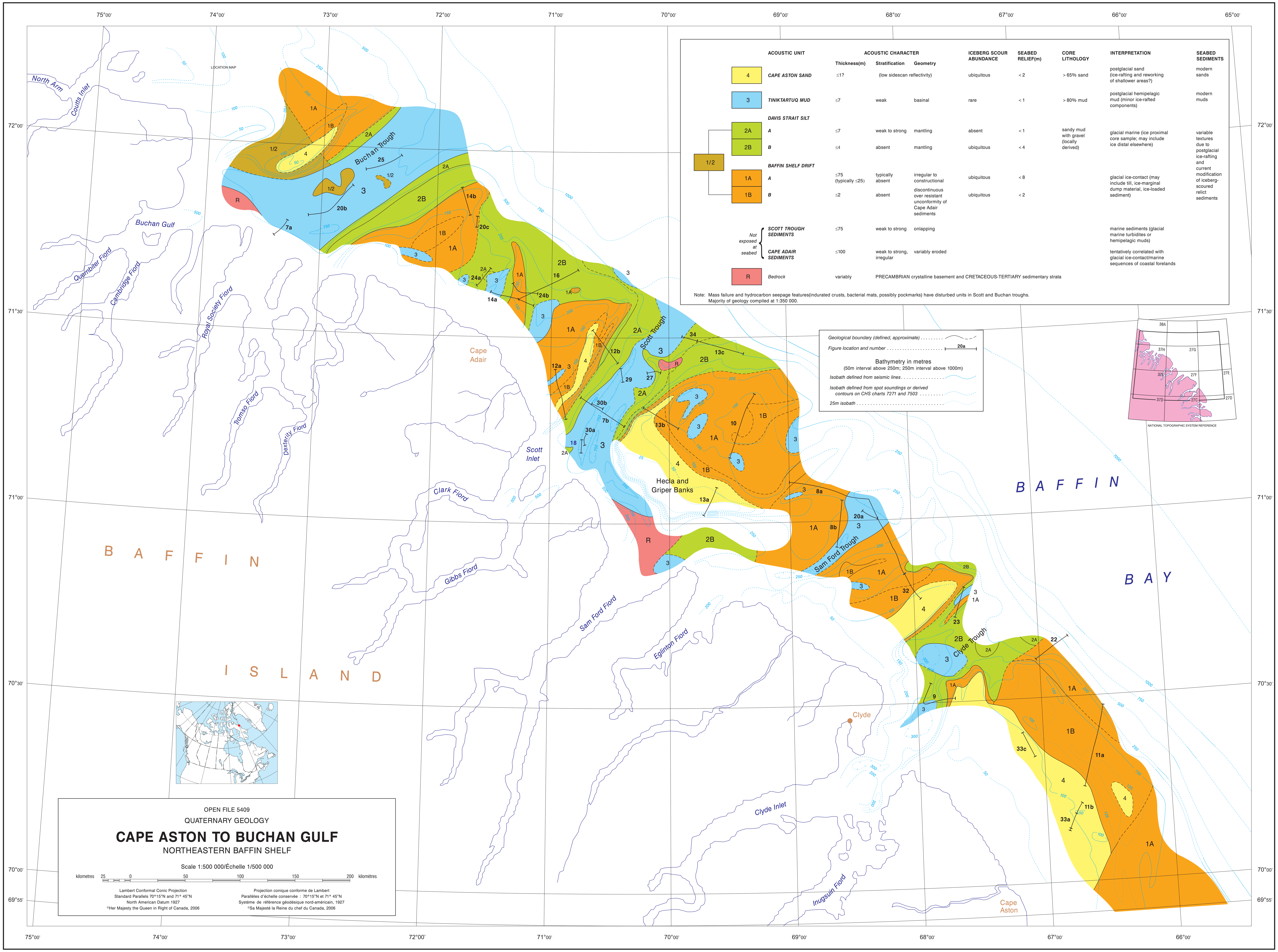
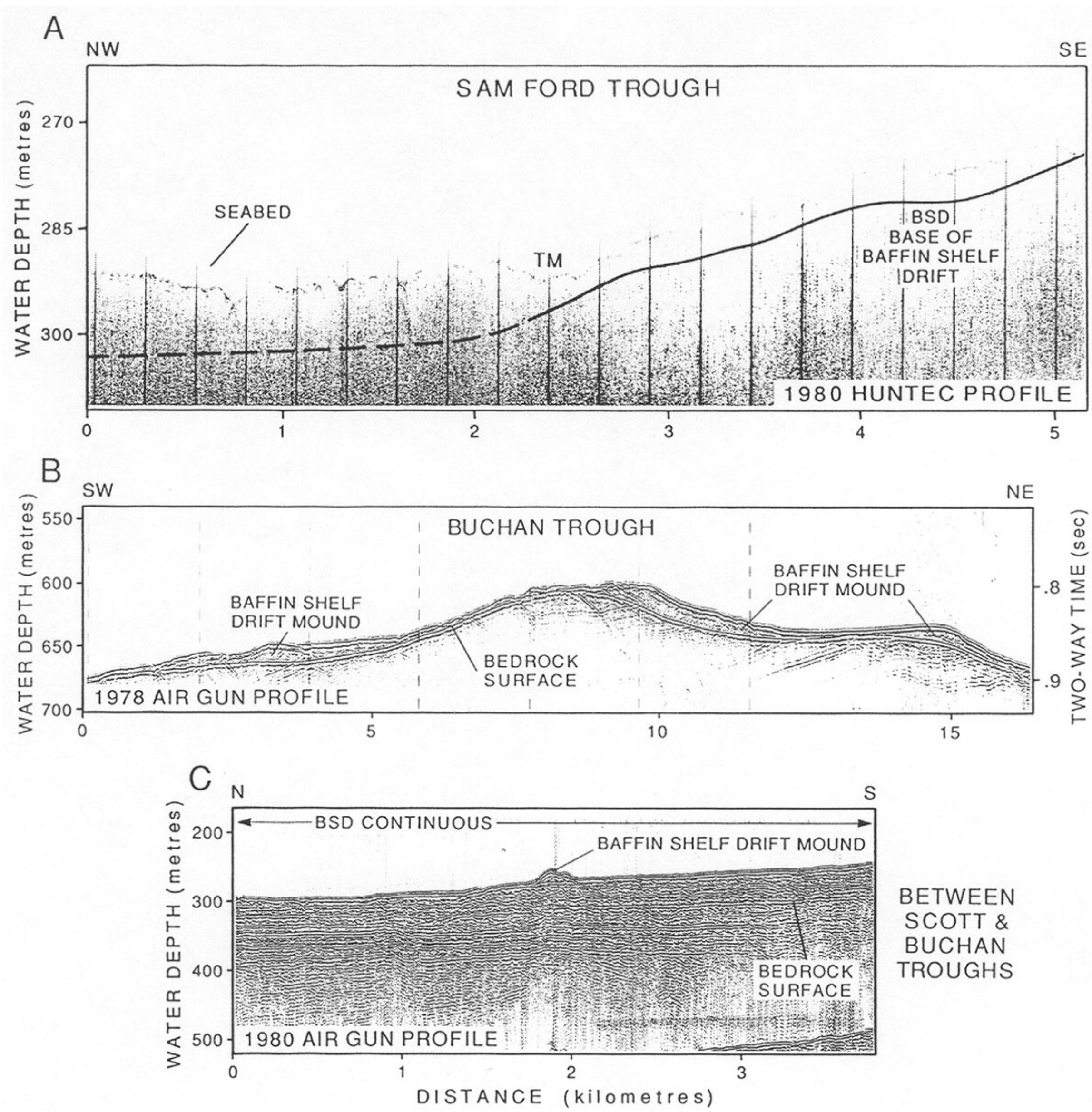
GEOLOGICAL SURVEY OF CANADA COMMISSION GÉOLOGIQUE DU CANADA



Canada


A
NW
SE
SAM FORD TROUGH
WATER DEPTH (metres)
270
285
300
SEABED
TM
BSD
BASE OF
BAFFIN SHELF
DRIFT
1980 HUNTEC PROFILE
0
1
2
3
4
5
B
SW
NE
BUCHAN TROUGH
WATER DEPTH (metres)
550
600
650
700
BAFFIN SHELF
DRIFT MOUND
BEDROCK
SURFACE
BAFFIN SHELF
DRIFT MOUND
1978 AIR GUN PROFILE
TWO-WAY TIME (sec)
.8
.9
0
5
10
15
C
N
S
BSD CONTINUOUS
BAFFIN SHELF DRIFT MOUND
WATER DEPTH (metres)
200
300
400
500
BEDROCK
SURFACE
1980 AIR GUN PROFILE
0
1
2
3
DISTANCE (kilometres)
BETWEEN
SCOTT &
BUCHAN
TROUGHS

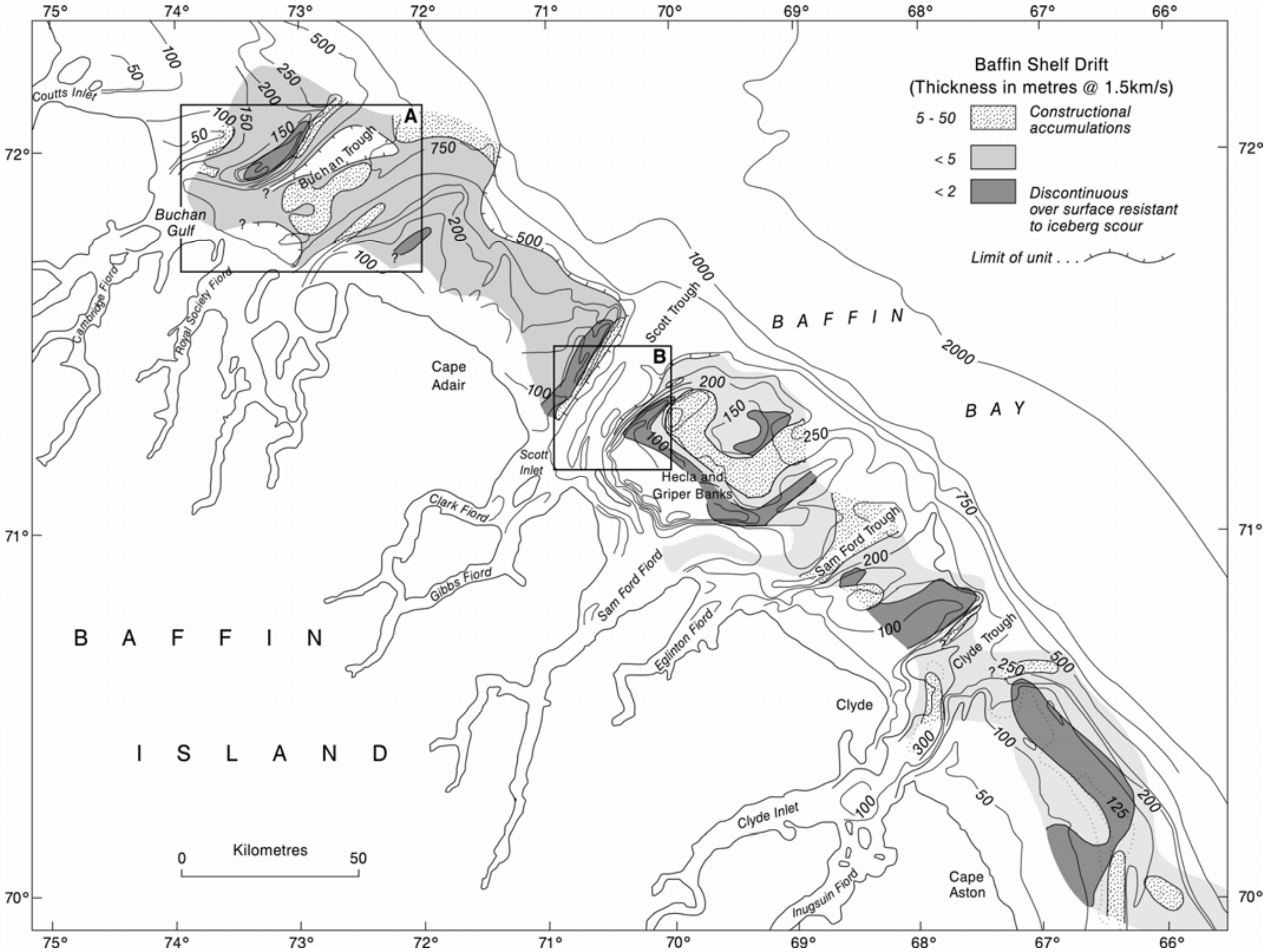
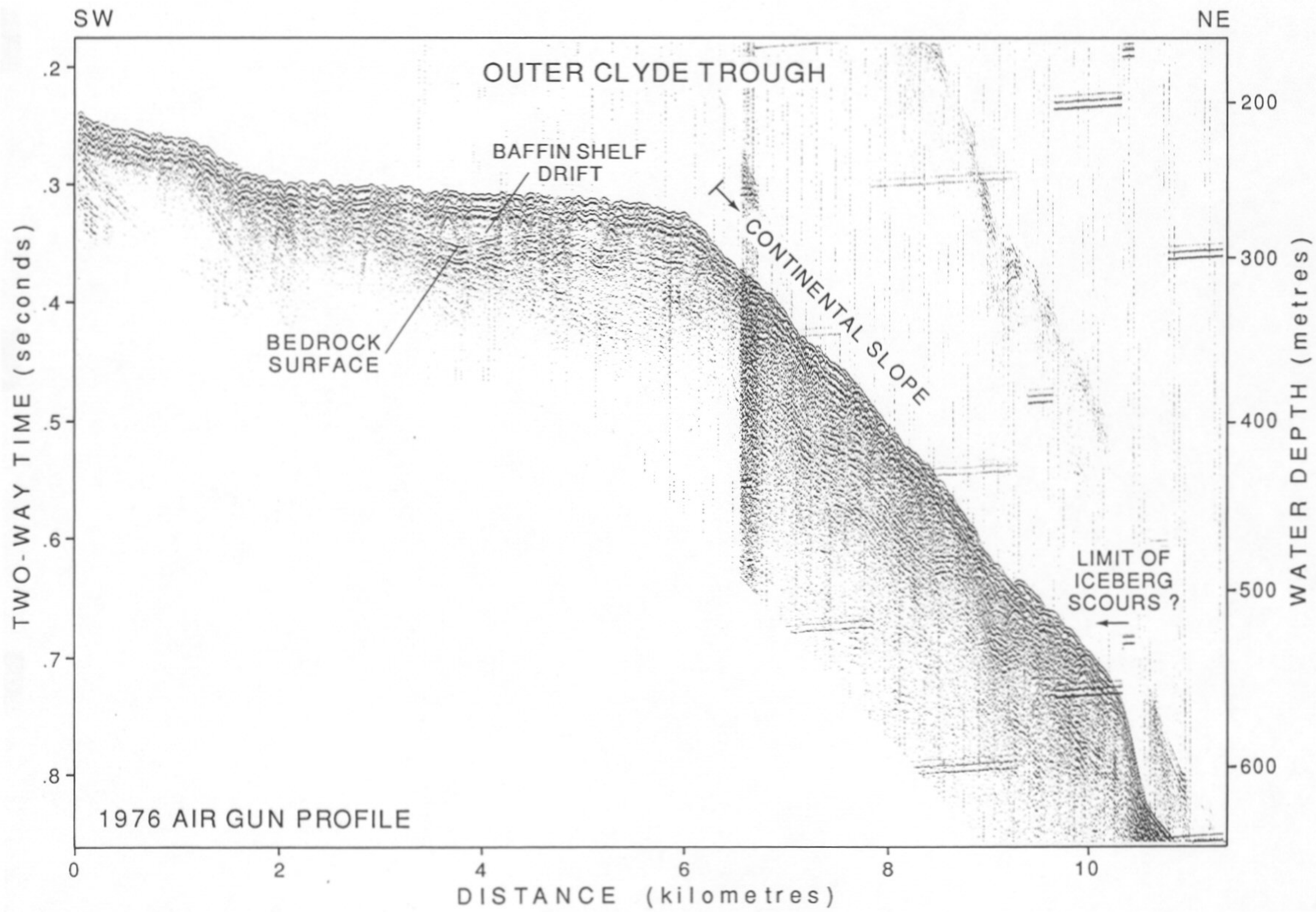
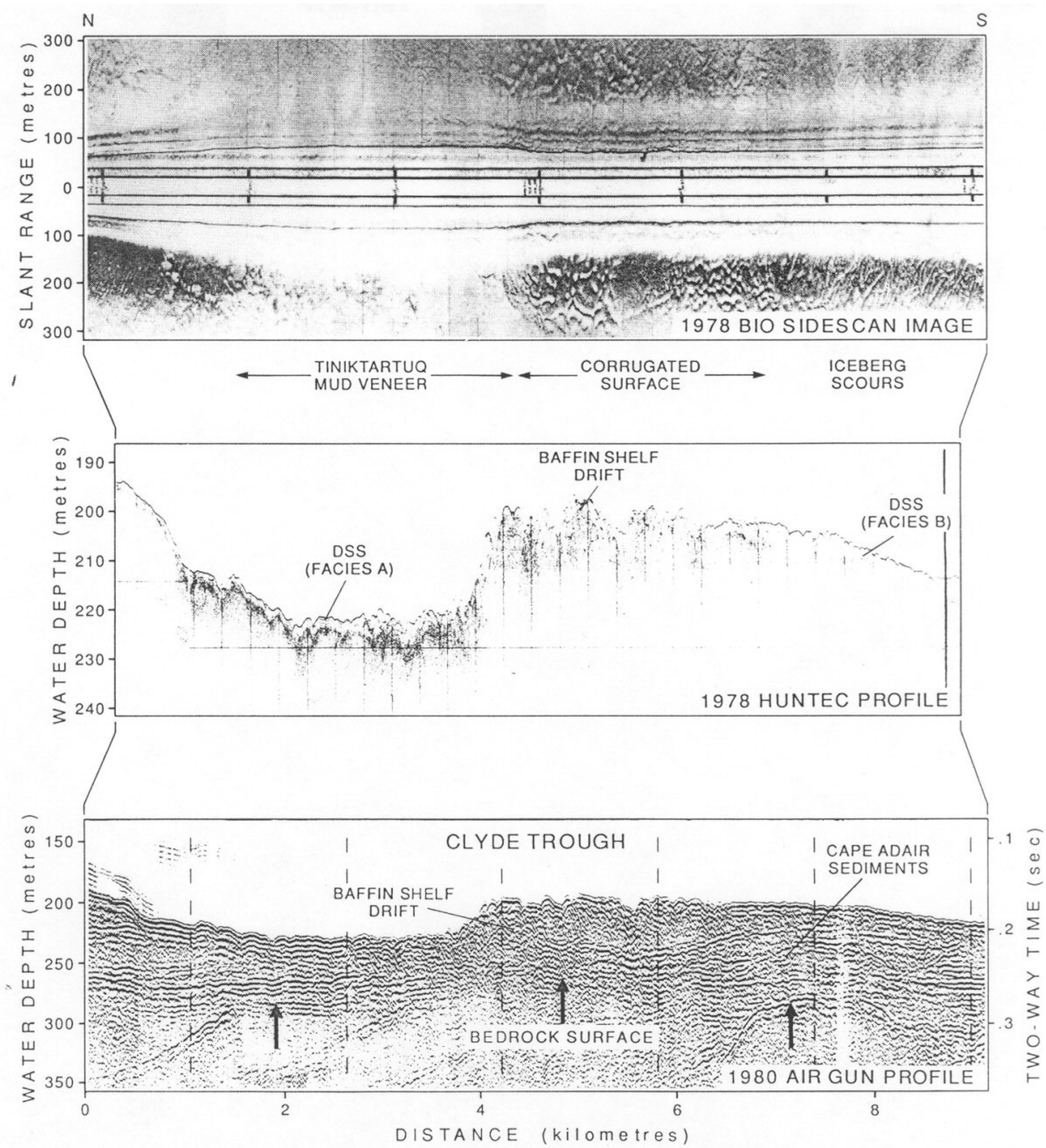
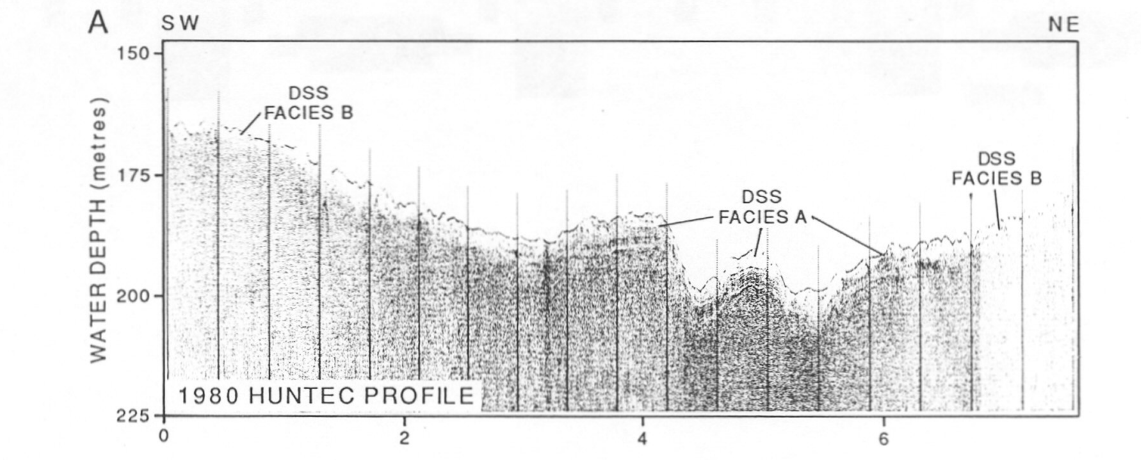
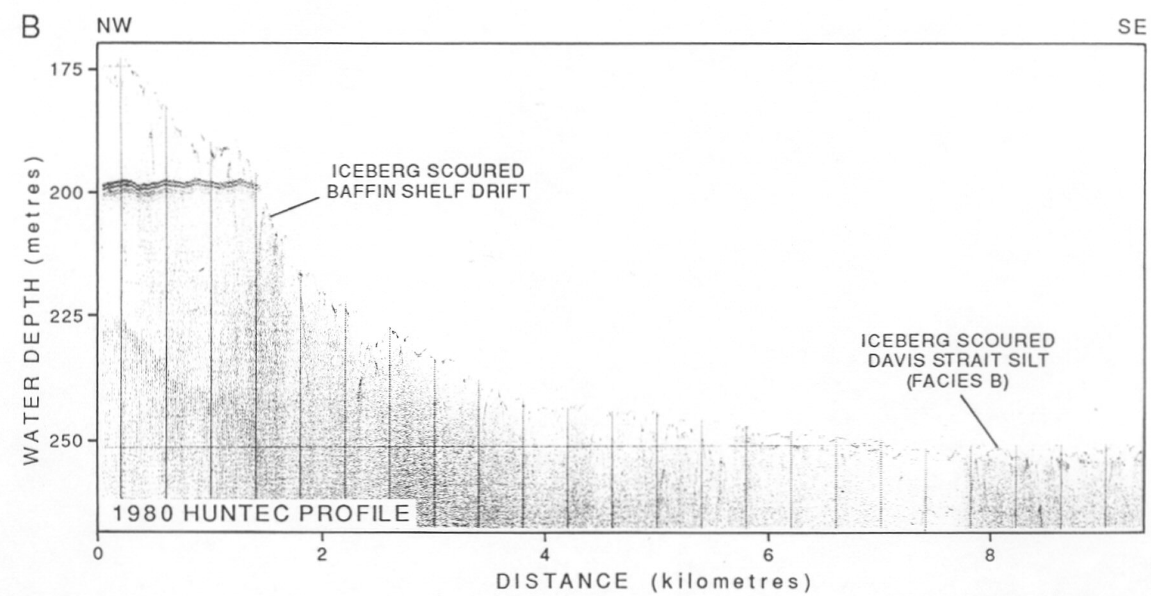


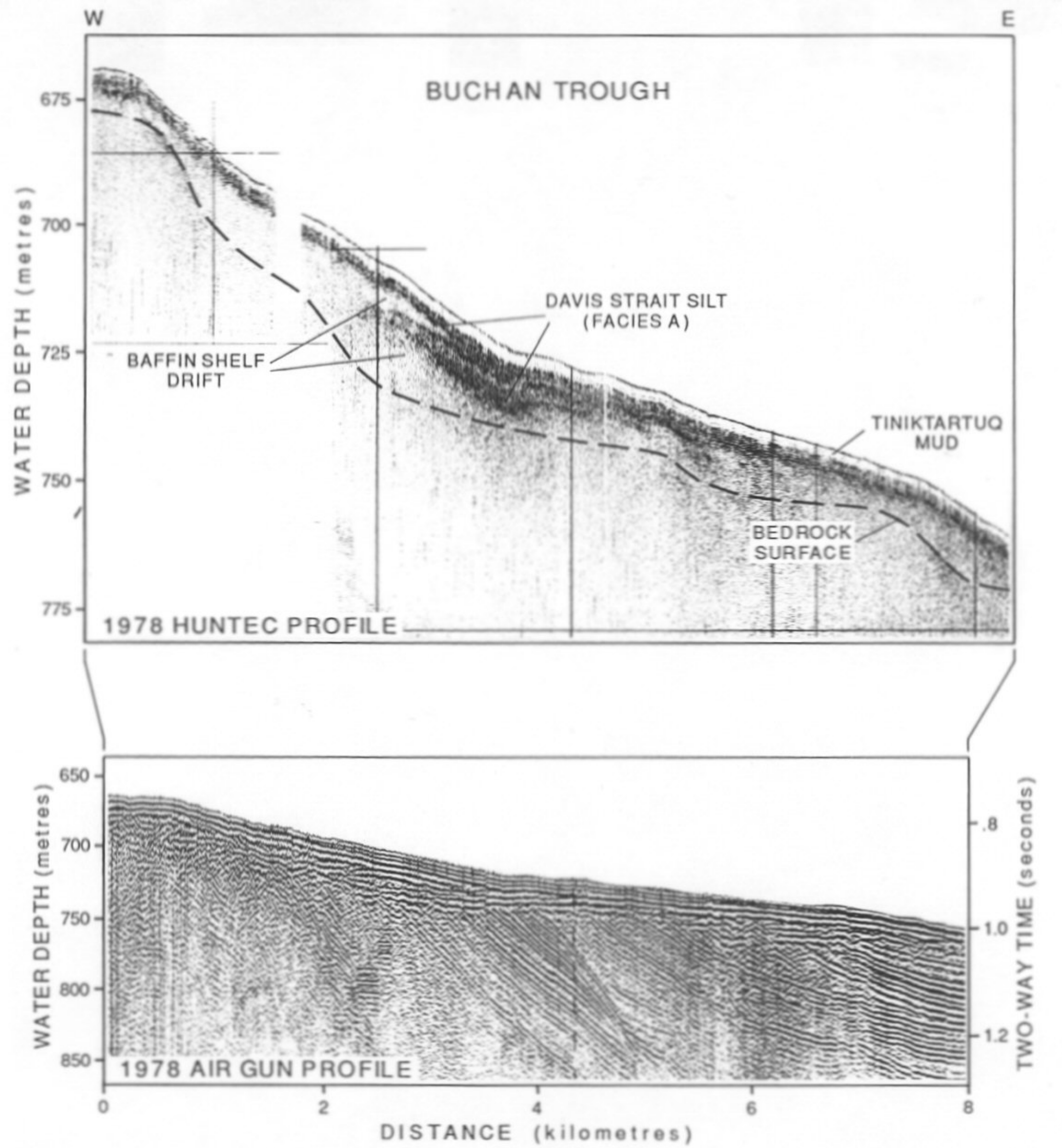
Figure 21. Map showing the distribution and thickness of Baffin Shelf Drift in the study area.

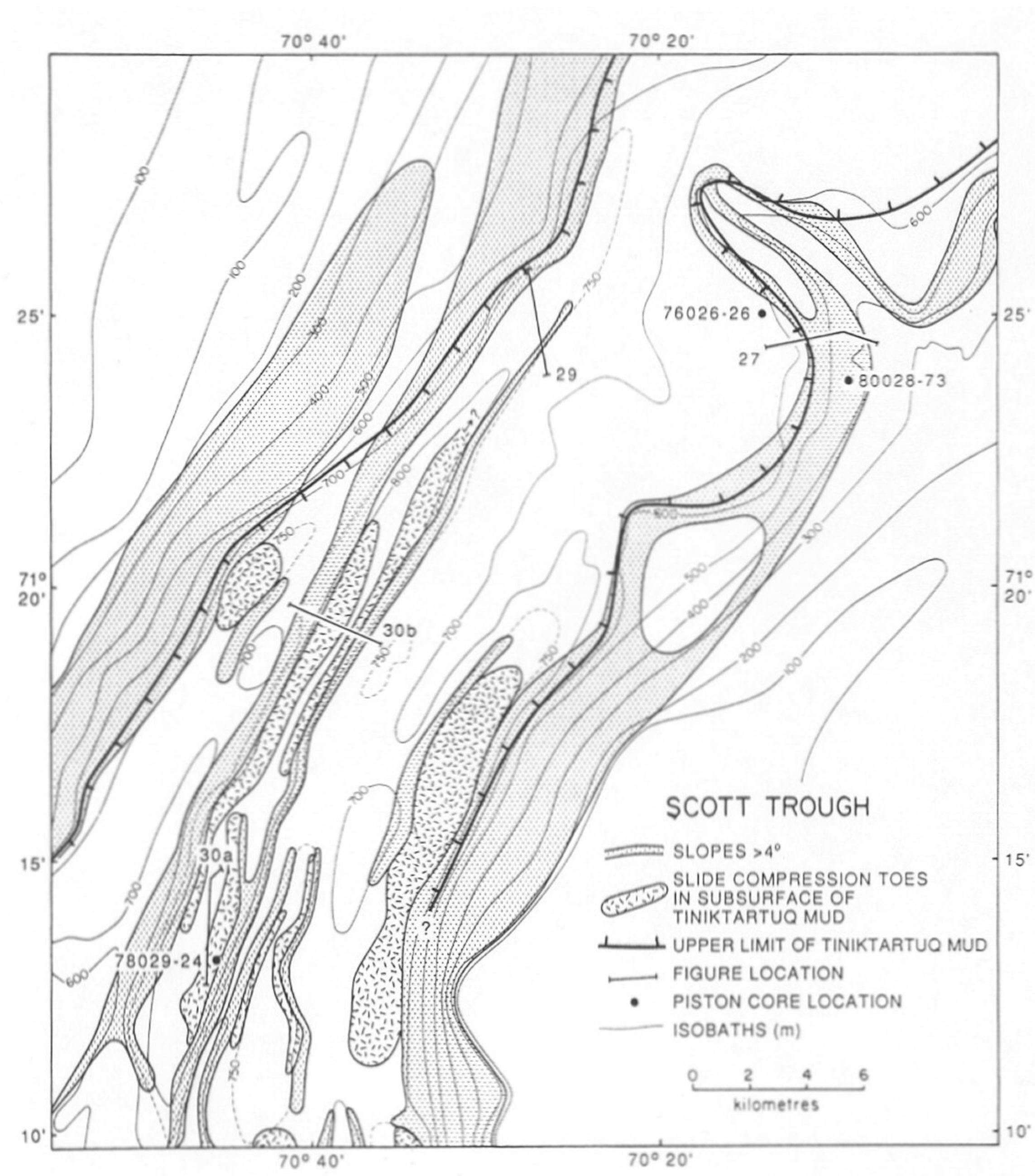

SW
NE
OUTER CLYDE TROUGH
BAFFIN SHELF DRIFT
BEDROCK SURFACE
CONTINENTAL SLOPE
LIMIT OF ICEBERG SCOURS ?
1976 AIR GUN PROFILE
TWO-WAY TIME (seconds)
.2
.3
.4
.5
.6
.7
.8
WATER DEPTH (metres)
200
300
400
500
600
0
2
4
6
8
10
DISTANCE (kilometres)

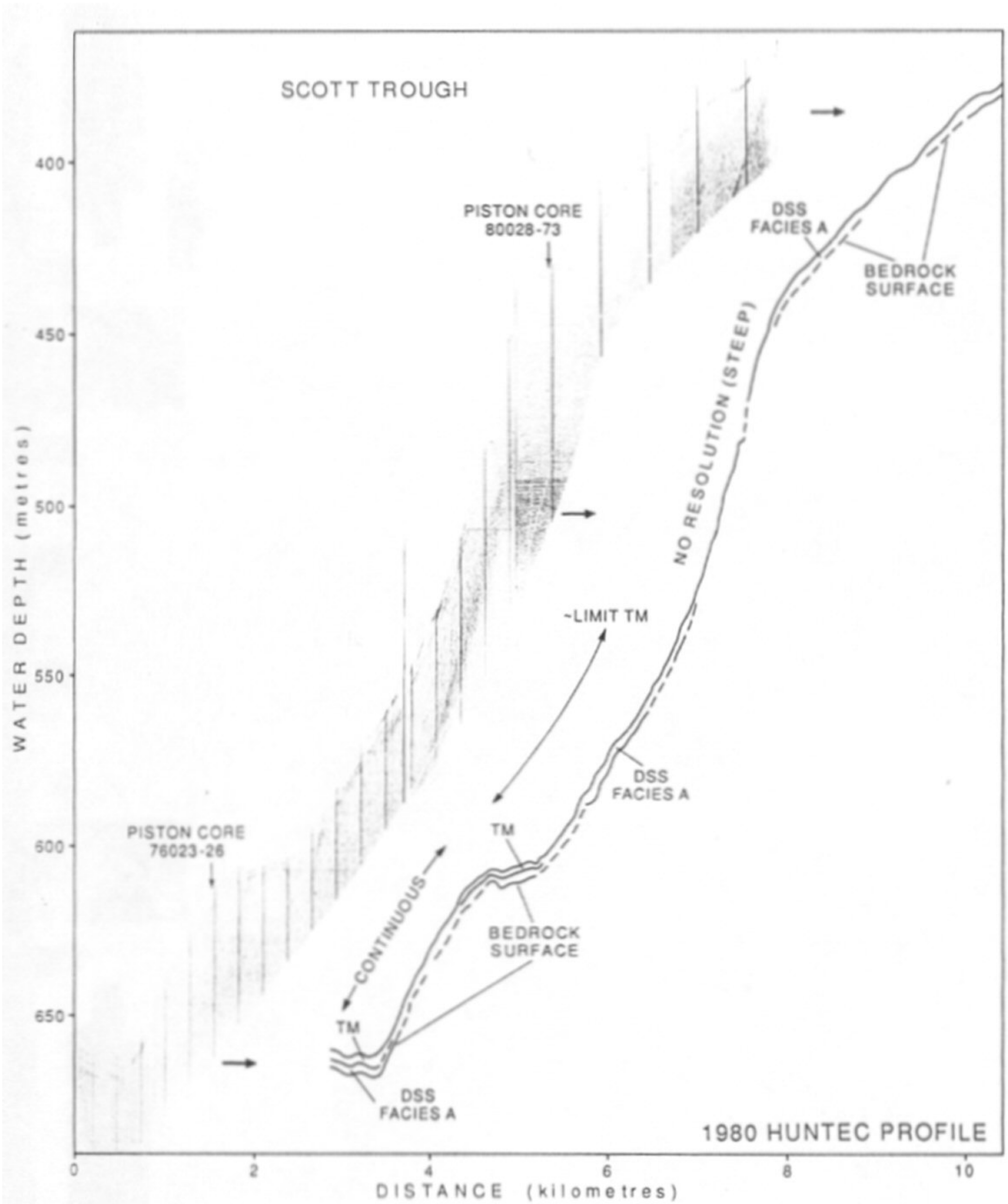

N
S
SLANT RANGE (metres)
1978 BIO SIDESCAN IMAGE
TINIKTARTUQ MUD VENEER
CORRUGATED SURFACE
ICEBERG SCOURS
WATER DEPTH (metres)
BAFFIN SHELF DRIFT
DSS (FACIES A)
DSS (FACIES B)
1978 HUNTEC PROFILE
CLYDE TROUGH
BAFFIN SHELF DRIFT
CAPE ADAIR SEDIMENTS
BEDROCK SURFACE
1980 AIR GUN PROFILE
TWO-WAY TIME (sec)
DISTANCE (kilometres)

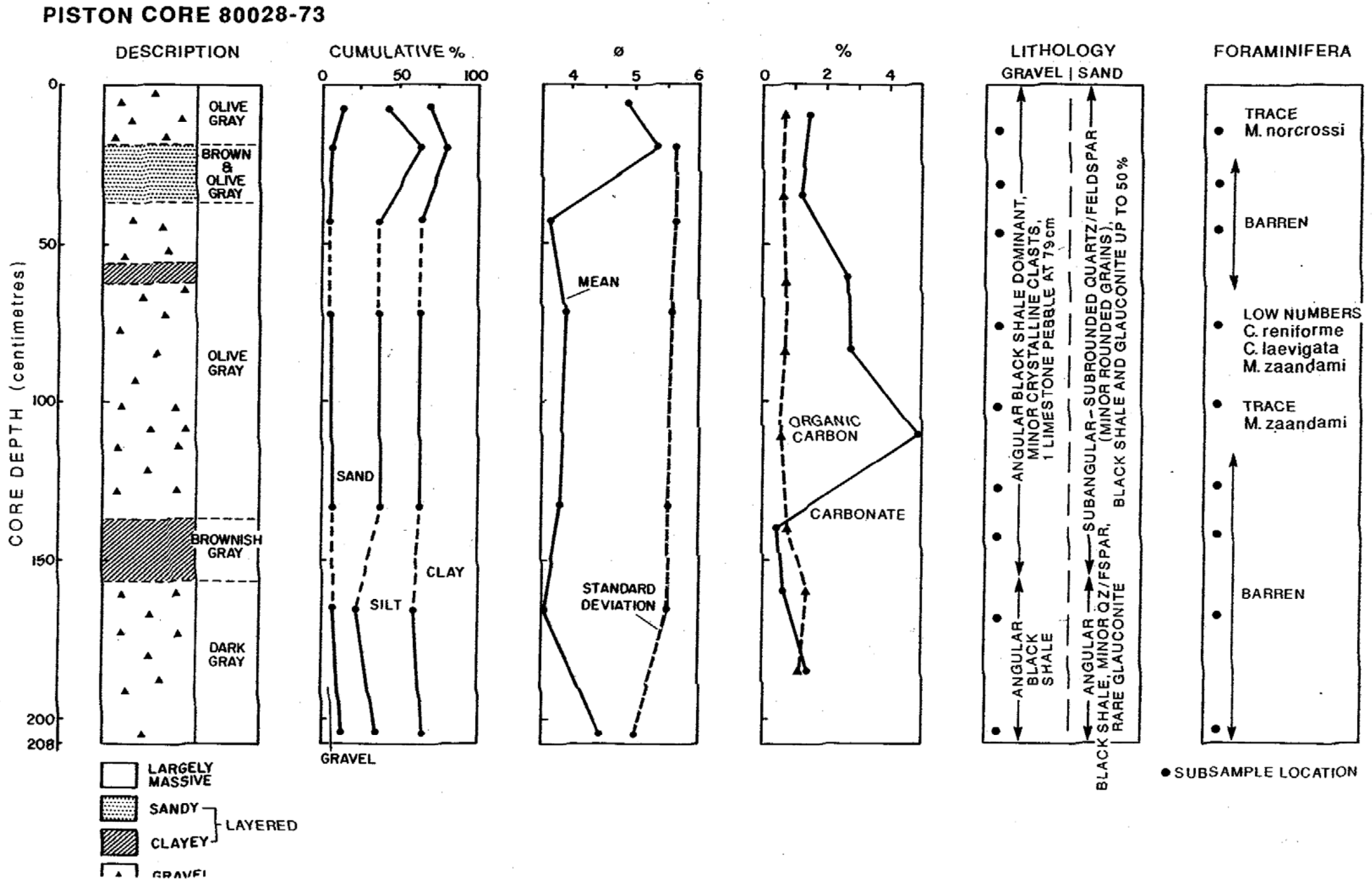

A
SW
NE
DSS
FACIES B
DSS
FACIES A
DSS
FACIES B
WATER DEPTH (metres)
150
175
200
225
1980 HUNTEC PROFILE
0
2
4
6


B
NW
SE
ICEBERG SCOURED
BAFFIN SHELF DRIFT
ICEBERG SCOURED
DAVIS STRAIT SILT
(FACIES B)
WATER DEPTH (metres)
175
200
225
250
1980 HUNTEC PROFILE
0
2
4
6
8
DISTANCE (kilometres)

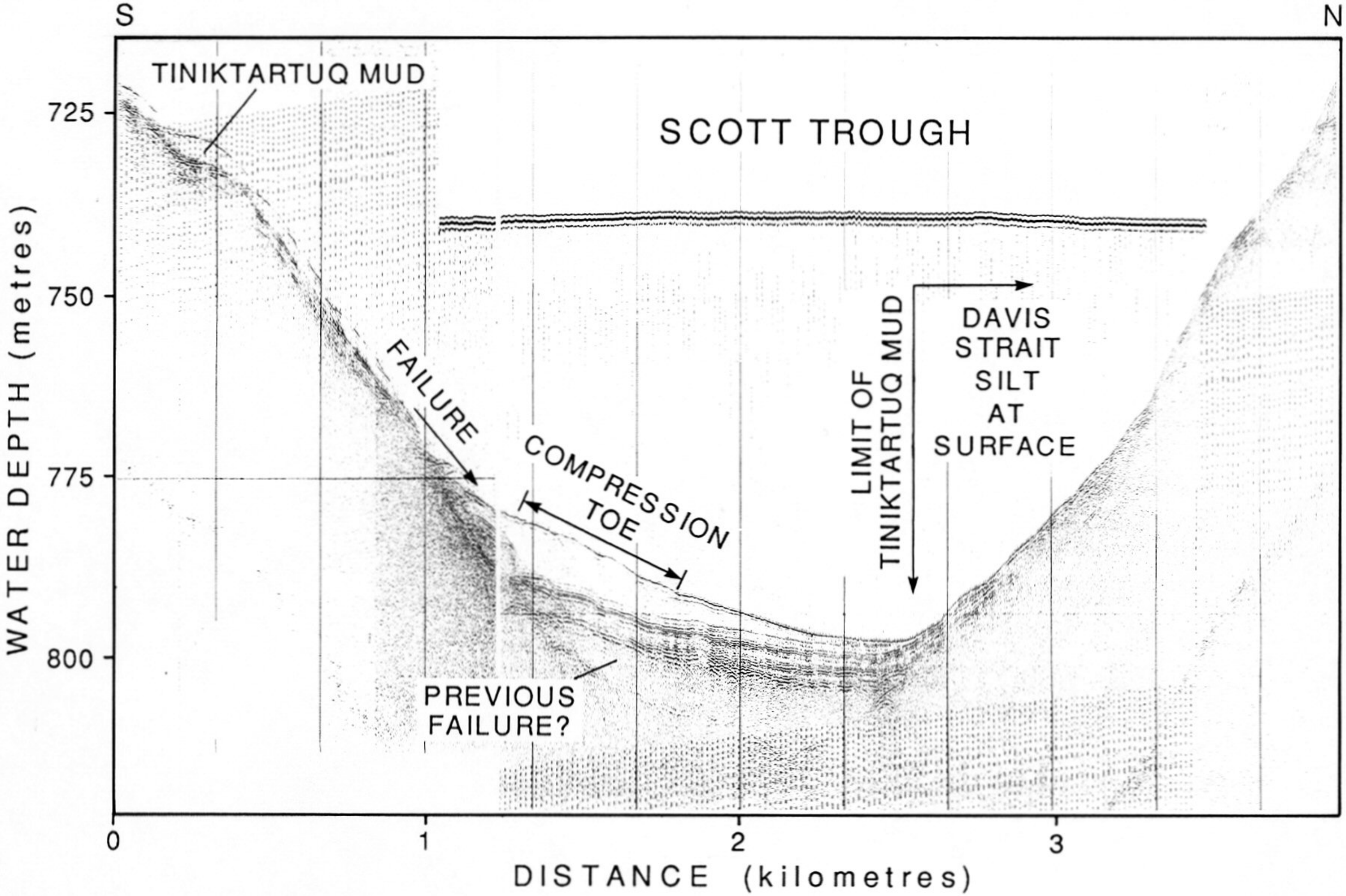

W
E
BUCHAN TROUGH
675
700
725
750
775
WATER DEPTH (metres)
DAVIS STRAIT SILT
(FACIES A)
BAFFIN SHELF
DRIFT
TINIKTARTUQ
MUD
BEDROCK
SURFACE
1978 HUNTEC PROFILE
650
700
750
800
850
WATER DEPTH (metres)
.8
1.0
1.2
TWO-WAY TIME (seconds)
1978 AIR GUN PROFILE
0
2
4
6
8
DISTANCE (kilometres)

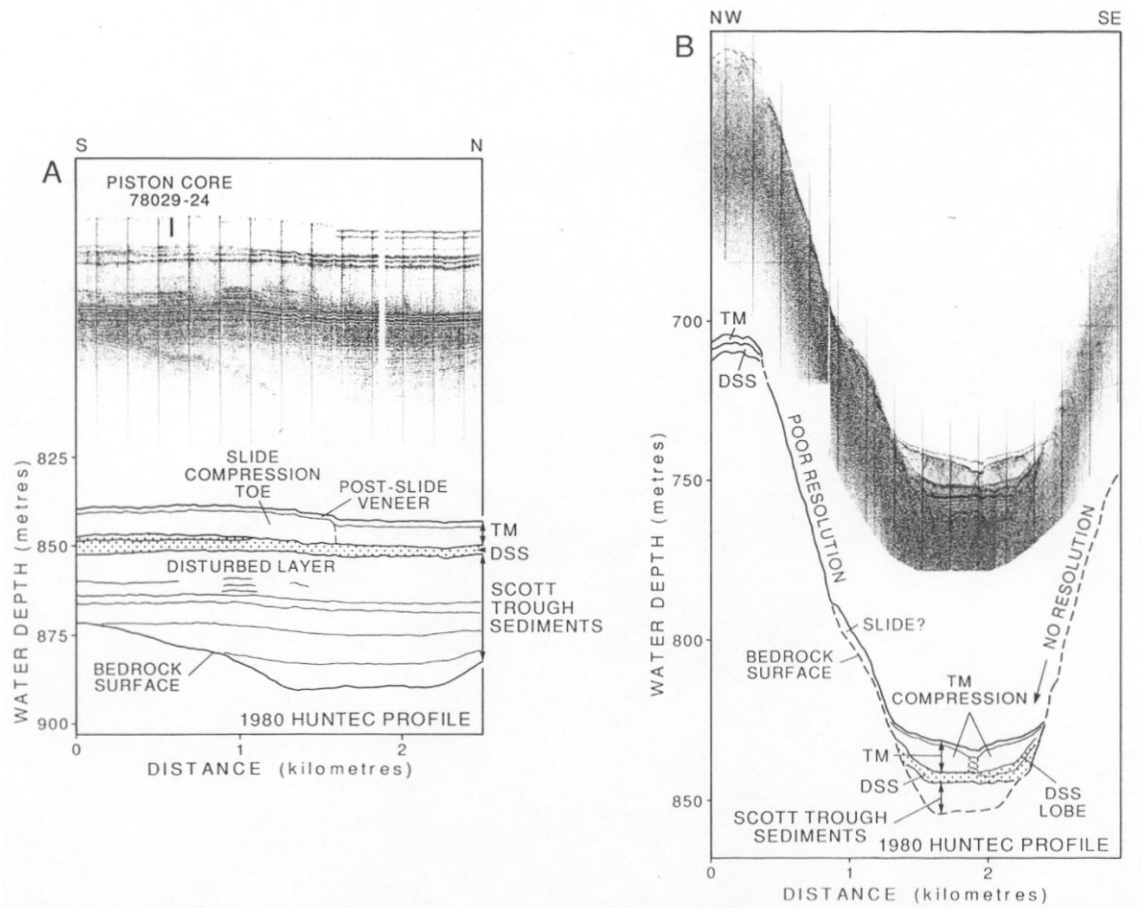

70° 40'
70° 20'
25'
71°
20'
15'
10'
SCOTT TROUGH
SLOPES >4°
SLIDE COMPRESSION TOES IN SUBSURFACE OF TINIKTARTUQ MUD
UPPER LIMIT OF TINIKTARTUQ MUD
FIGURE LOCATION
PISTON CORE LOCATION
ISOBATHS (m)
0 2 4 6
kilometres
76026-26
80028-73
78029-24
27
29
30a
30b
100
200
400
500
600
700
750
800

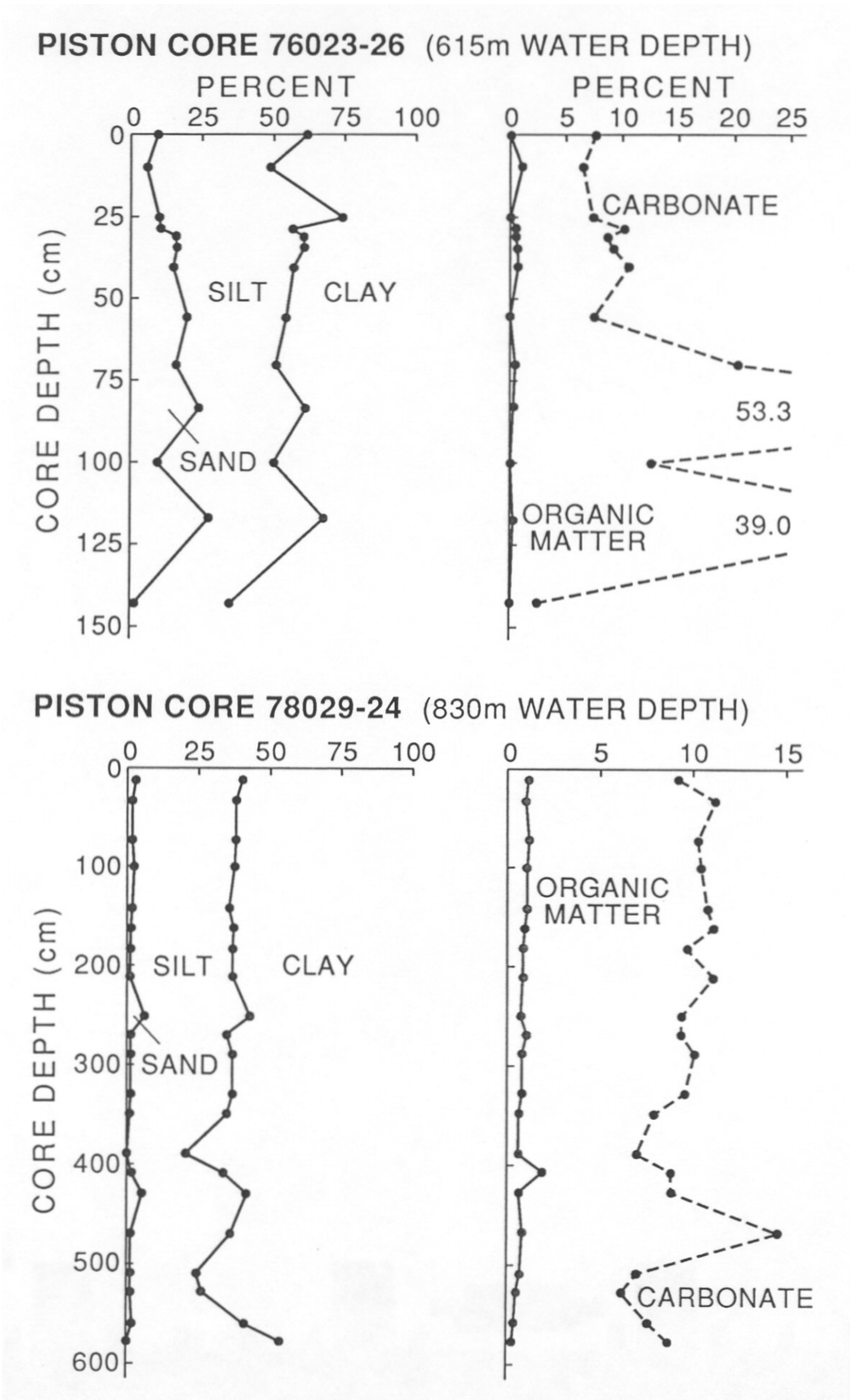

SCOTT TROUGH
PISTON CORE
80028-73
DSS
FACIES A
BEDROCK
SURFACE
NO RESOLUTION (STEEP)
~LIMIT TM
DSS
FACIES A
TM
PISTON CORE
76023-26
CONTINUOUS
BEDROCK
SURFACE
TM
DSS
FACIES A
1980 HUNTEC PROFILE
WATER DEPTH (metres)
400
450
500
550
600
650
DISTANCE (kilometres)
0
2
4
6
8
10



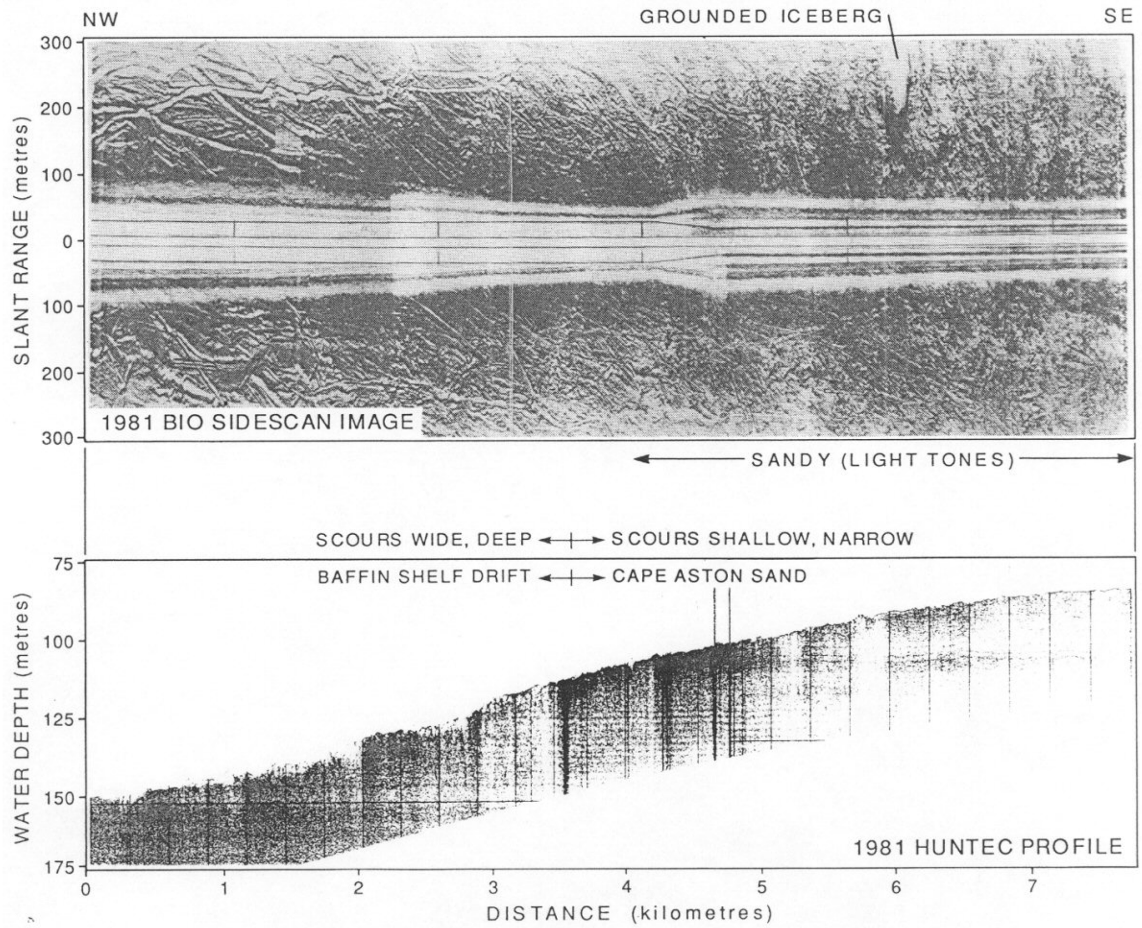
PISTON CORE 80028-73
DESCRIPTION
CUMULATIVE %
ø
%
LITHOLOGY
GRAVEL | SAND
FORAMINIFERA
CORE DEPTH (centimetres)
OLIVE GRAY
BROWN & OLIVE GRAY
OLIVE GRAY
BROWNISH GRAY
DARK GRAY
SAND
SILT
CLAY
GRAVEL
MEAN
STANDARD DEVIATION
ORGANIC CARBON
CARBONATE
ANGULAR BLACK SHALE DOMINANT, MINOR CRYSTALLINE CLASTS, 1 LIMESTONE PEBBLE AT 79cm
ANGULAR BLACK SHALE
SUBANGULAR–SUBROUNDED QUARTZ/FELDSPAR (MINOR ROUNDED GRAINS), BLACK SHALE AND GLAUCONITE UP TO 50 %
ANGULAR BLACK SHALE, MINOR QZ/FSPAR, RARE GLAUCONITE
TRACE M. norcrossi
BARREN
LOW NUMBERS C. reniforme C. laevigata M. zaandami
TRACE M. zaandami
BARREN
LARGELY MASSIVE
SANDY
CLAYEY
LAYERED
GRAVEL
● SUBSAMPLE LOCATION


S
N
TINIKTARTUQ MUD
SCOTT TROUGH
725
750
775
800
WATER DEPTH (metres)
FAILURE
COMPRESSION TOE
LIMIT OF TINIKTARTUQ MUD
DAVIS STRAIT SILT AT SURFACE
PREVIOUS FAILURE?
0
1
2
3
DISTANCE (kilometres)

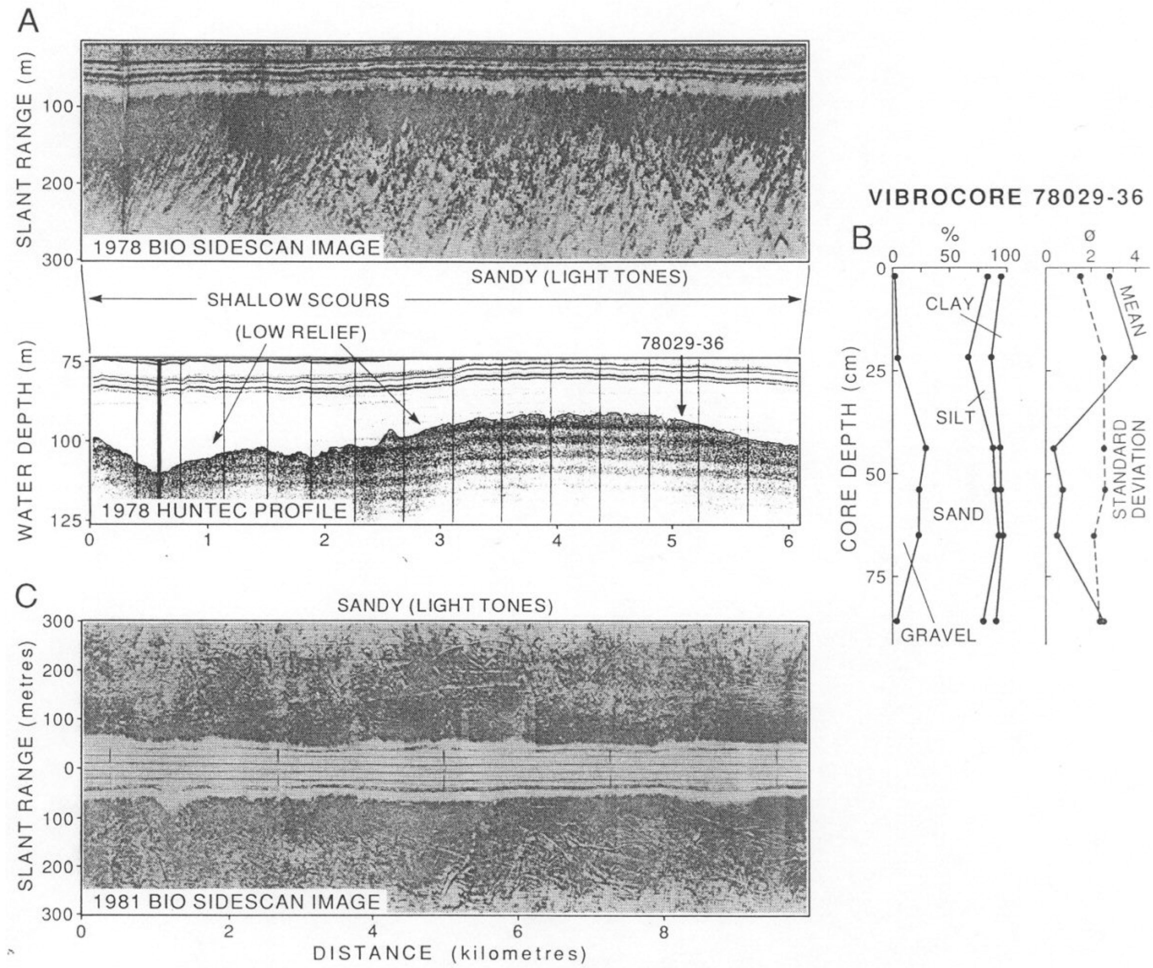

A
S
N
PISTON CORE
78029-24
SLIDE
COMPRESSION
TOE
POST-SLIDE
VENEER
TM
DSS
DISTURBED LAYER
SCOTT
TROUGH
SEDIMENTS
BEDROCK
SURFACE
1980 HUNTEC PROFILE
WATER DEPTH (metres)
825
850
875
900
0
1
2
DISTANCE (kilometres)
B
NW
SE
TM
DSS
POOR RESOLUTION
SLIDE?
BEDROCK
SURFACE
TM
COMPRESSION
NO RESOLUTION
TM
DSS
DSS
LOBE
SCOTT TROUGH
SEDIMENTS
1980 HUNTEC PROFILE
WATER DEPTH (metres)
700
750
800
850
0
1
2
DISTANCE (kilometres)

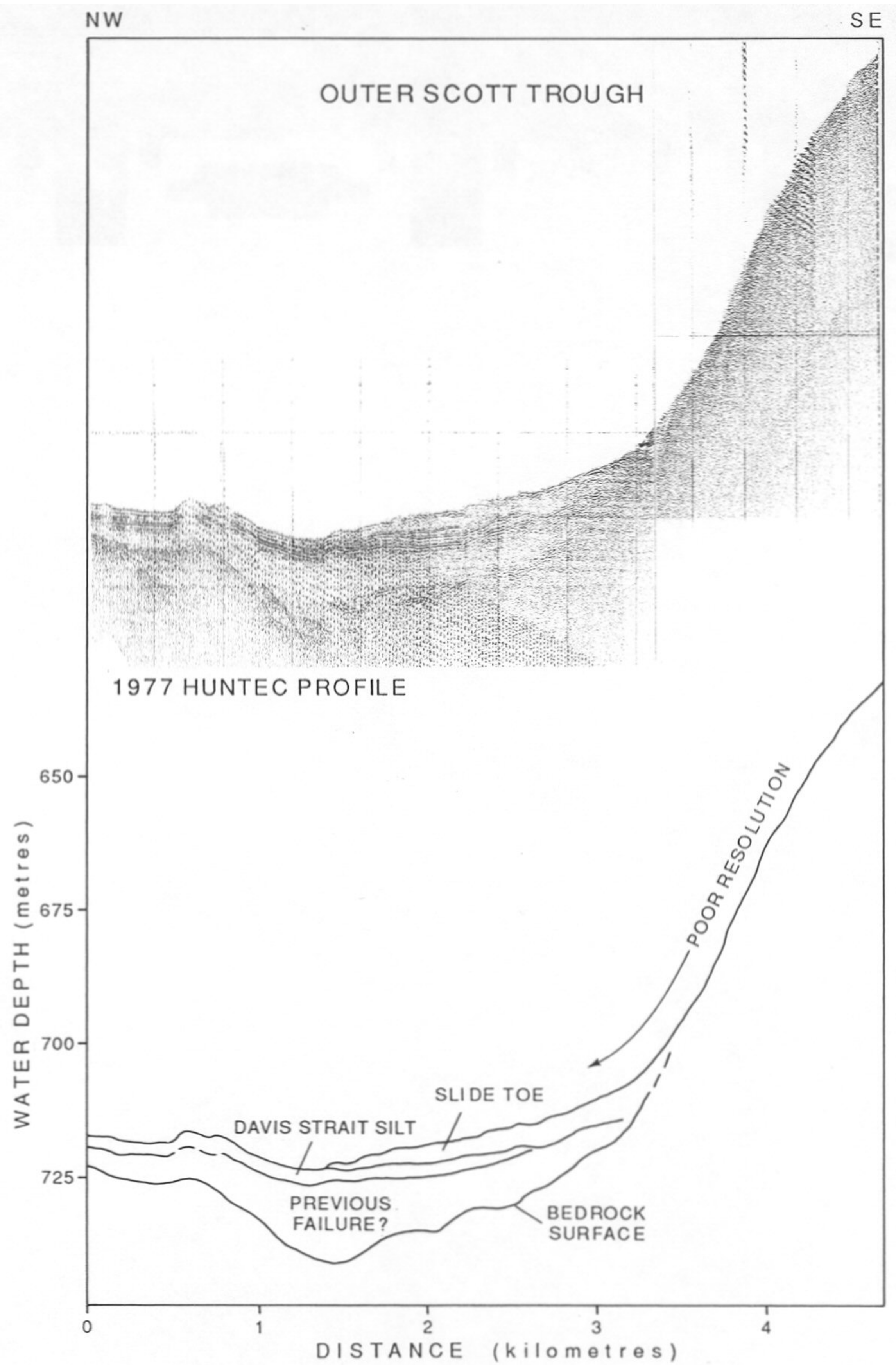


PISTON CORE 76023-26 (615m WATER DEPTH)
PERCENT
0
25
50
75
100
PERCENT
0
5
10
15
20
25
CORE DEPTH (cm)
0
25
50
75
100
125
150
SILT
CLAY
SAND
CARBONATE
ORGANIC MATTER
53.3
39.0
PISTON CORE 78029-24 (830m WATER DEPTH)
0
25
50
75
100
0
5
10
15
CORE DEPTH (cm)
0
100
200
300
400
500
600
SILT
CLAY
SAND
ORGANIC MATTER
CARBONATE



NW
GROUNDED ICEBERG
SE
300
200
100
0
100
200
300
SLANT RANGE (metres)
1981 BIO SIDESCAN IMAGE
SANDY (LIGHT TONES)
SCOURS WIDE, DEEP
SCOURS SHALLOW, NARROW
BAFFIN SHELF DRIFT
CAPE ASTON SAND
75
100
125
150
175
WATER DEPTH (metres)
1981 HUNTEC PROFILE
0
1
2
3
4
5
6
7
DISTANCE (kilometres)


A
SLANT RANGE (m)
100
200
300
1978 BIO SIDESCAN IMAGE
SANDY (LIGHT TONES)
SHALLOW SCOURS
(LOW RELIEF)
78029-36
WATER DEPTH (m)
75
100
125
1978 HUNTEC PROFILE
0 1 2 3 4 5 6
VIBROCORE 78029-36
B
%
0 50 100
ø
0 2 4
CORE DEPTH (cm)
0
25
50
75
CLAY
SILT
SAND
GRAVEL
MEAN
STANDARD DEVIATION
C
SANDY (LIGHT TONES)
SLANT RANGE (metres)
300
200
100
0
100
200
300
1981 BIO SIDESCAN IMAGE
0 2 4 6 8
DISTANCE (kilometres)


NW
SE
OUTER SCOTT TROUGH
1977 HUNTEC PROFILE
650
675
700
725
WATER DEPTH (metres)
POOR RESOLUTION
SLIDE TOE
DAVIS STRAIT SILT
PREVIOUS FAILURE?
BEDROCK SURFACE
0
1
2
3
4
DISTANCE (kilometres)

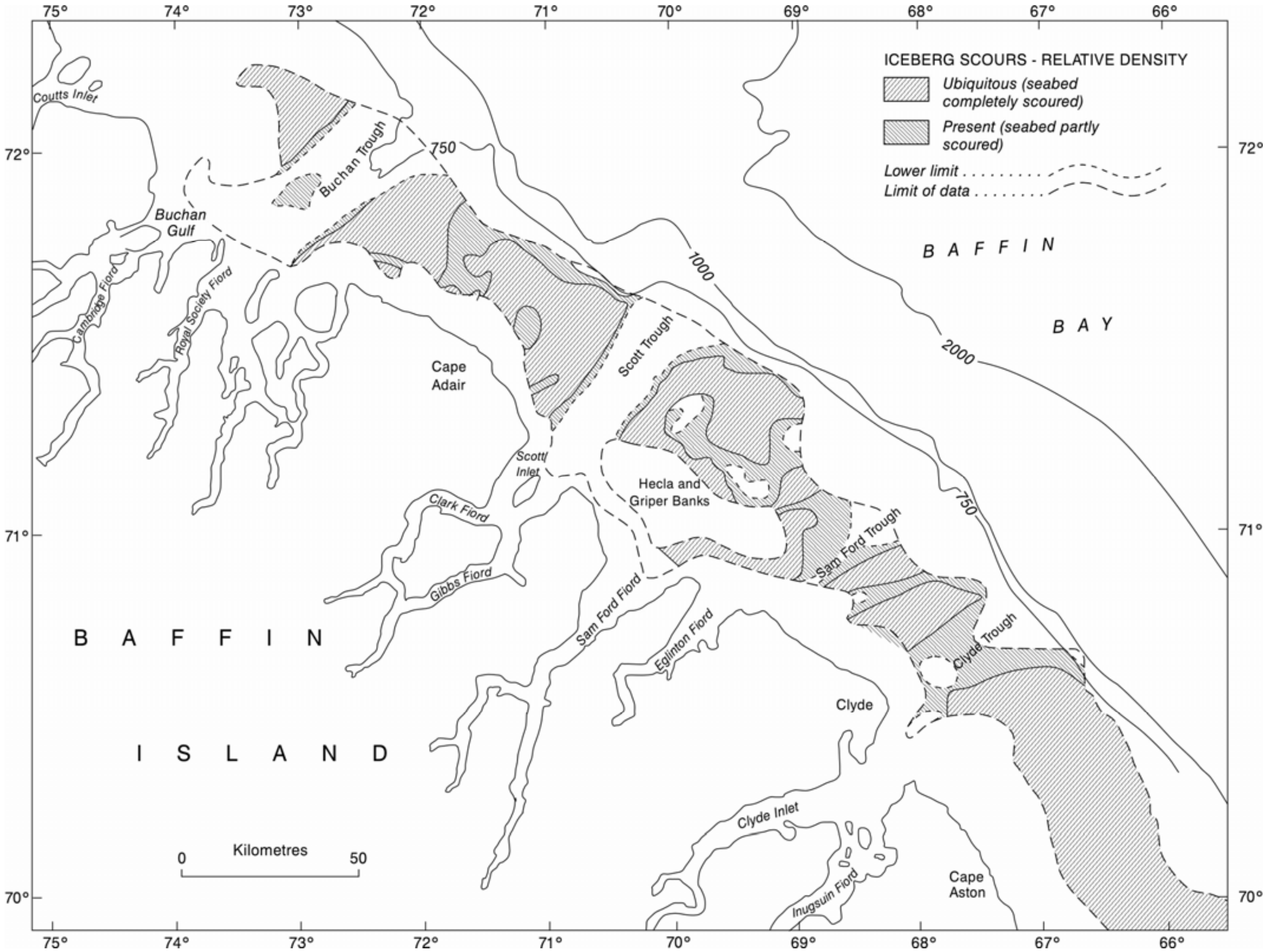
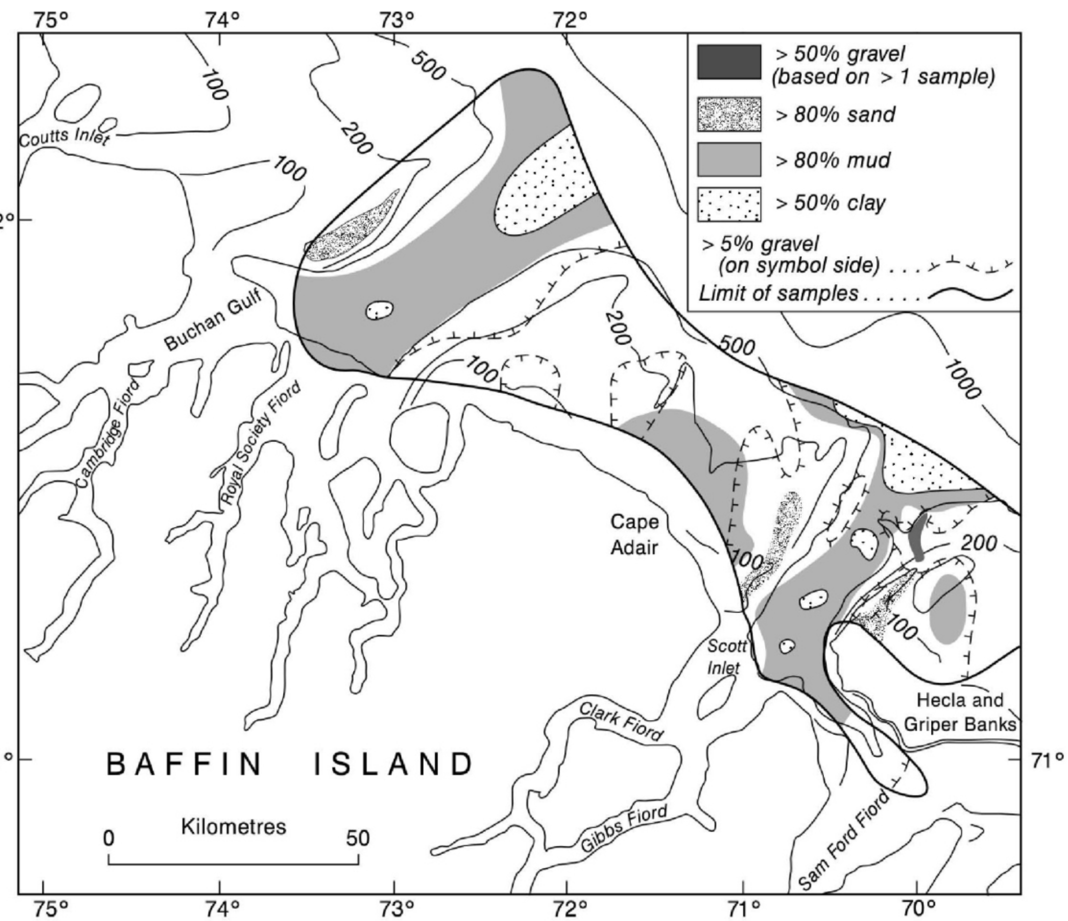
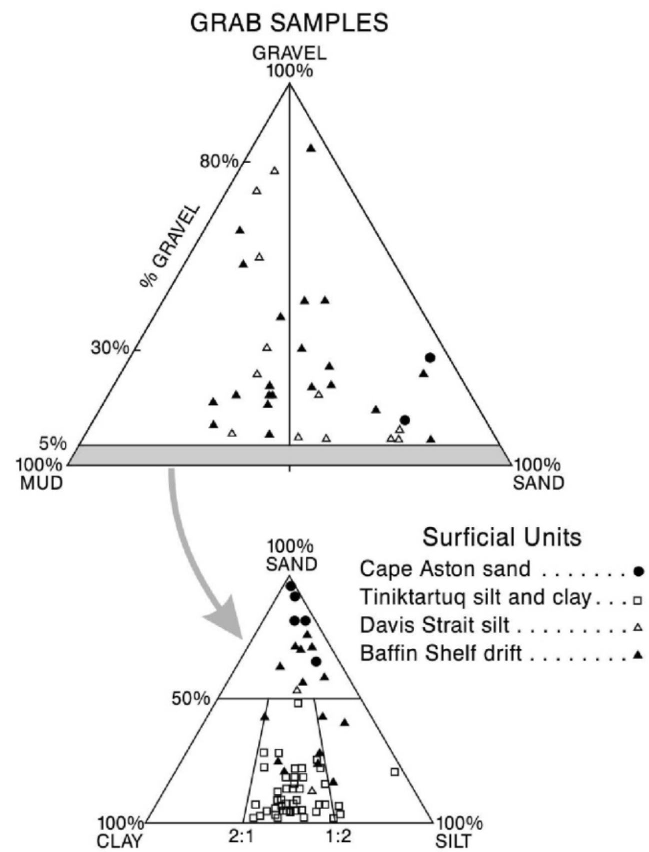


Figure 35. Map showing the distribution of iceberg scours in the study area.



> 50% gravel (based on > 1 sample)
> 80% sand
> 80% mud
> 50% clay
> 5% gravel (on symbol side)
Limit of samples
Coutts Inlet
Buchan Gulf
Cambridge Fiord
Royal Society Fiord
Cape Adair
Scott Inlet
Clark Fiord
Gibbs Fiord
Sam Ford Fiord
Hecla and Griper Banks
BAFFIN ISLAND
Kilometres
0
50
75°
74°
73°
72°
71°
70°



GRAB SAMPLES
GRAVEL 100%
% GRAVEL
80%
30%
5%
100% MUD
100% SAND
100% SAND
50%
100% CLAY
2:1
1:2
100% SILT
Surficial Units
Cape Aston sand
Tiniktartuq silt and clay
Davis Strait silt
Baffin Shelf drift

Figure 37. Bottom photographs (Expedition 81045 Station 33) illustrating areas of Baffin Shelf Drift.

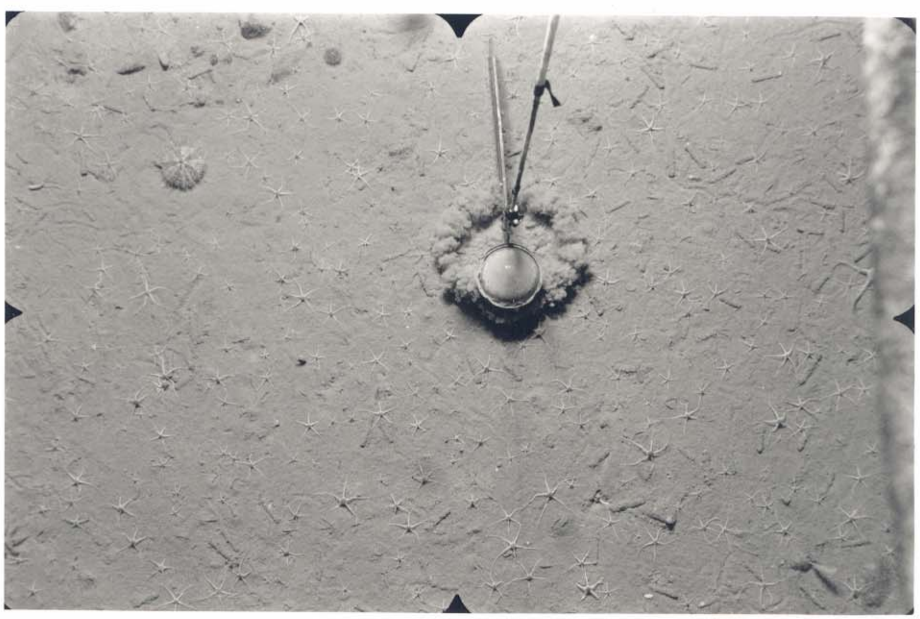


Figure 38. Bottom photographs (Expedition 81045, Station 31) illustrating areas of Davis Strait Silt.

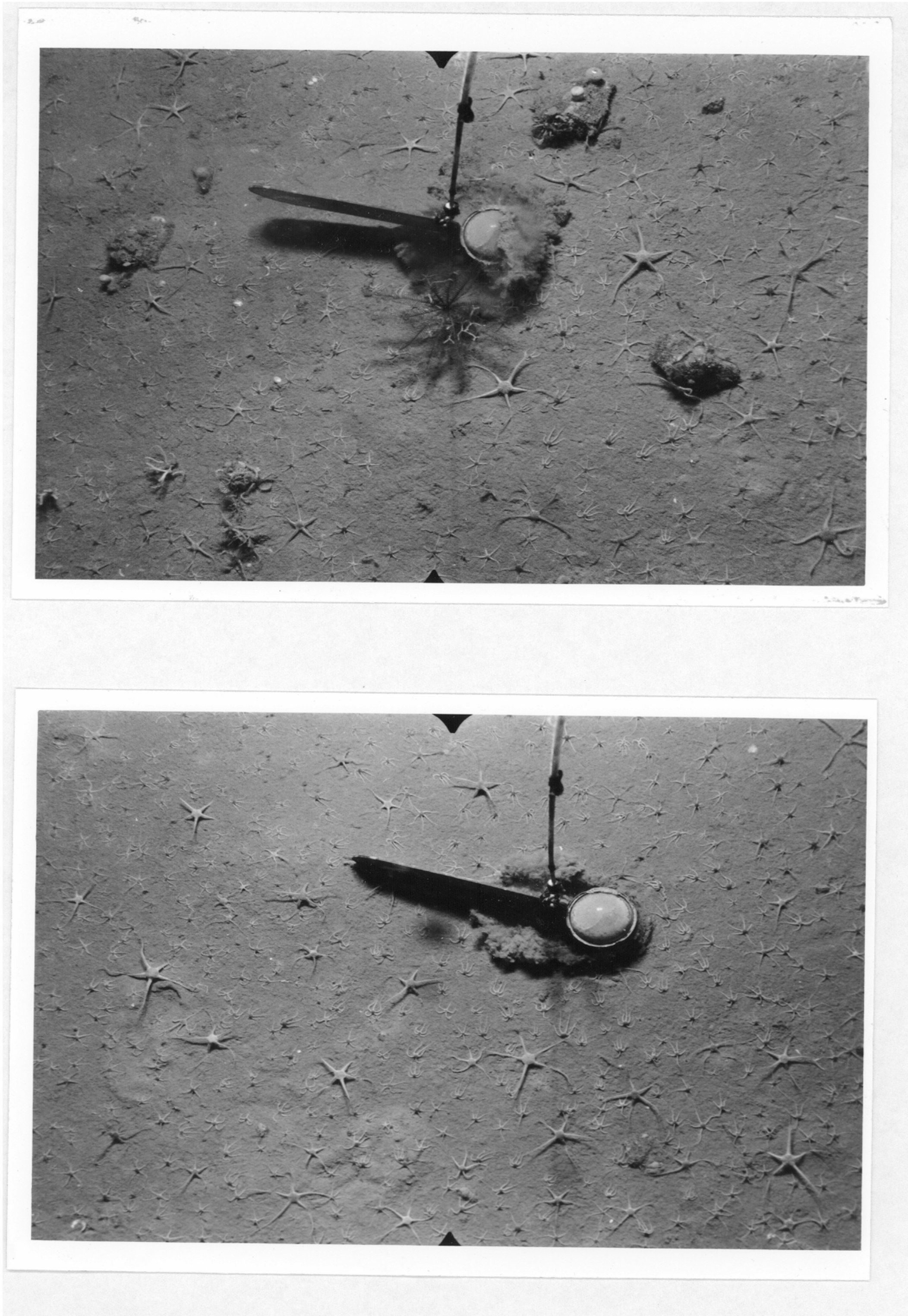


Figure 39. Bottom photographs (Expedition 81045, Station 24) illustrating areas of Tiniktartuq Mud.

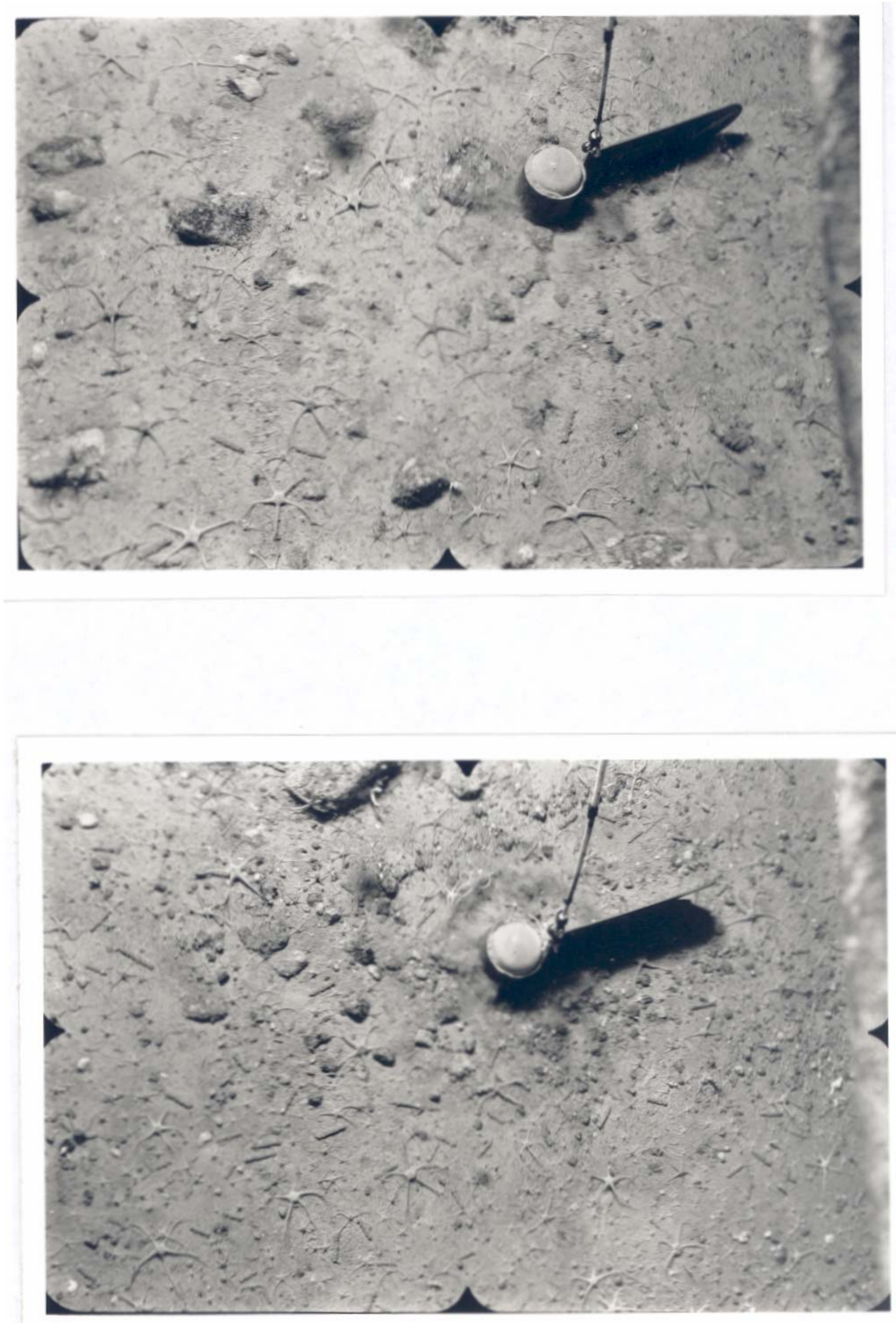


Figure 40. Bottom photographs (Expedition 81045, Station 27) illustrating areas of Cape Aston Sand.

APPENDIX 1

GRAB SAMPLE LOCATIONS AND GRAIN SIZE ANALYSES

MAP #	SAMPLE ID	DEPTH (m)	LATITUDE	LONGITUDE	GRAVEL %	SAND %	SILT %	CLAY %	MEAN %	STD. DEV. Ø	SKEWNESS
	77027-										
1	7	556	71°19.9'	70°22.1'	0	22	42	36	6.3	2.5	-0.1
2	11	640	71°25.4'	70°30.4'	>80%						
	78026-										
3	20	219	70°34.7'	67°30.7'	3	42	18	37			
4	31	853	71°40.4'	70°28.9'	1	7	34	59			
5	32	695	71°35.3'	70°02.5'	0	2	38	60			
6	33	631	71°29.0'	69°37.0'	10	27	33	29			
7	34	194	71°24.0'	69°14.1'	10	73	11	6			
					1	70	10	20	(duplicate analysis)		
8	35	122	71°15.0'	69°24.0'	6	71	17	6			
9	36	219	71°21.0'	69°53.6'	0	6	59	35			
10	37	667	71°26.6'	70°19.5'	1	18	45	36			
11	38	113	71°32.8'	70°46.5'	11	72	8	8			
12	39	130	71°23.8'	71°05.2'	<1	9	41	50			
13	40	713	71°18.5'	70°37.2'	0	3	44	53			
14	41	567	71°09.5'	70°31.2'	<1	9	48	43			
15	42	665	71°09.7'	70°53.9'	<1	13	47	40			
16	43	601	71°04.0'	70°28.0'	<1	13	42	45			
17	44	374	70°58.3'	70°03.2'	0	6	45	49			
					0	6	48	46	(duplicate analysis)		
18	47	541	71°16.5'	70°26.5'	<1	8	42	51			
19	48	62	71°25.2'	70°46.8'	2	96	1	2			
20	50	759	72°00.8'	71°33.9'	3	27	49	26			
21	51	832	72°08.4'	71°51.4'	<1	1	32	67			
22	52	841	72°15.3'	72°10.8'	1	6	63	31			
23	53	365	72°09.6'	72°34.1'	1	20	38	41			
24	54	100	72°03.0'	72°59.0'	3	79	10	8			
25	55	194	71°56.8'	73°27.5'	1	63	14	22			
26	56	627	71°55.4'	72°41.1'	3	18	41	38			
27	57	735	72°02.0'	72°15.2'	0	1	37	62			
28	58	322	71°54.1'	71°53.7'	16	24	34	25			
29	59	201	71°48.2'	72°17.9'	4	40	38	17			
30	60	36	71°43.0'	72°45.0'	28	69	2	2			
31	61	658	71°49.7'	73°03.7'	0	2	37	62			
32	62	287	71°44.4'	73°28.5'	<1	19	45	36			
	80028										
33	4*	386	71°45.0'	72°55.0'	16	36	31	17			
34	5	677	71°46.5'	73°16.5'	<1	4	50	46			
35	6	603	71°49.5'	73°04.0'	<1	7	60	33			
36	9	585	71°53.5'	73°14.0'	2	4	47	48			
37	10	627	71°52.7'	72°50.4'	<1	2	54	43			
38	11	220	71°47.5'	71°41.1'	55	15	21	9			
39	12	140	71°35.0'	71°23.2'	78	7	11	4			
40	13	283	71°33.7'	70°25.8'	1	77	17	5			
41	14	660	71°30.7'	70°12.4'	1	5	45	50			
42	15	493	71°28.2'	69°59.0'	53	12	22	14			
43	16	229	71°25.7'	69°45.6'	14	63	21	3			
44	17	250	71°24.9'	69°56.0'	21	35	27	18			
45	18	298	71°26.7'	69°57.0'	2	71	20	7			
46	19	351	71°25.9'	70°02.4'	62	7	14	17			
47	20	603	71°28.0'	72°03.8'	2	25	37	35			
48	21	594	71°27.4'	70°08.4'	3	10	44	43			
49	22	600	71°29.4'	70°09.8'	4	27	31	39			
50	23	653	71°28.9'	70°16.2'	2	18	40	41			
51	24	603	71°30.5'	70°17.0'	1	11	40	48			
52	25	590	71°29.8'	70°23.5'	39	28	16	17			
53	26	249	71°29.2'	70°34.0'	1	59	32	8			
54	27	680	71°27.9'	70°25.8'	18	36	19	27			
55	28	713	71°28.4'	70°20.5'	<1	7	46	47			
56	29	631	71°26.4'	70°20.3'	<1	5	43	52			
57	30	547	71°27.2'	70°13.5'	84	12	3	2			
58	31	635	71°25.3'	70°13.9'	<1	9	41	49			
59	32	380	71°25.7'	70°07.5'	6	80	8	6			
60	33	360	71°23.7'	70°07.4'	18	36	26	21			
61	34	275	71°24.0'	70°01.5'	43	36	10	11			
62	35	197	71°22.7'	70°00.4'	73	5	9	12			

APPENDIX 1

GRAB SAMPLE LOCATIONS AND GRAIN SIZE ANALYSES

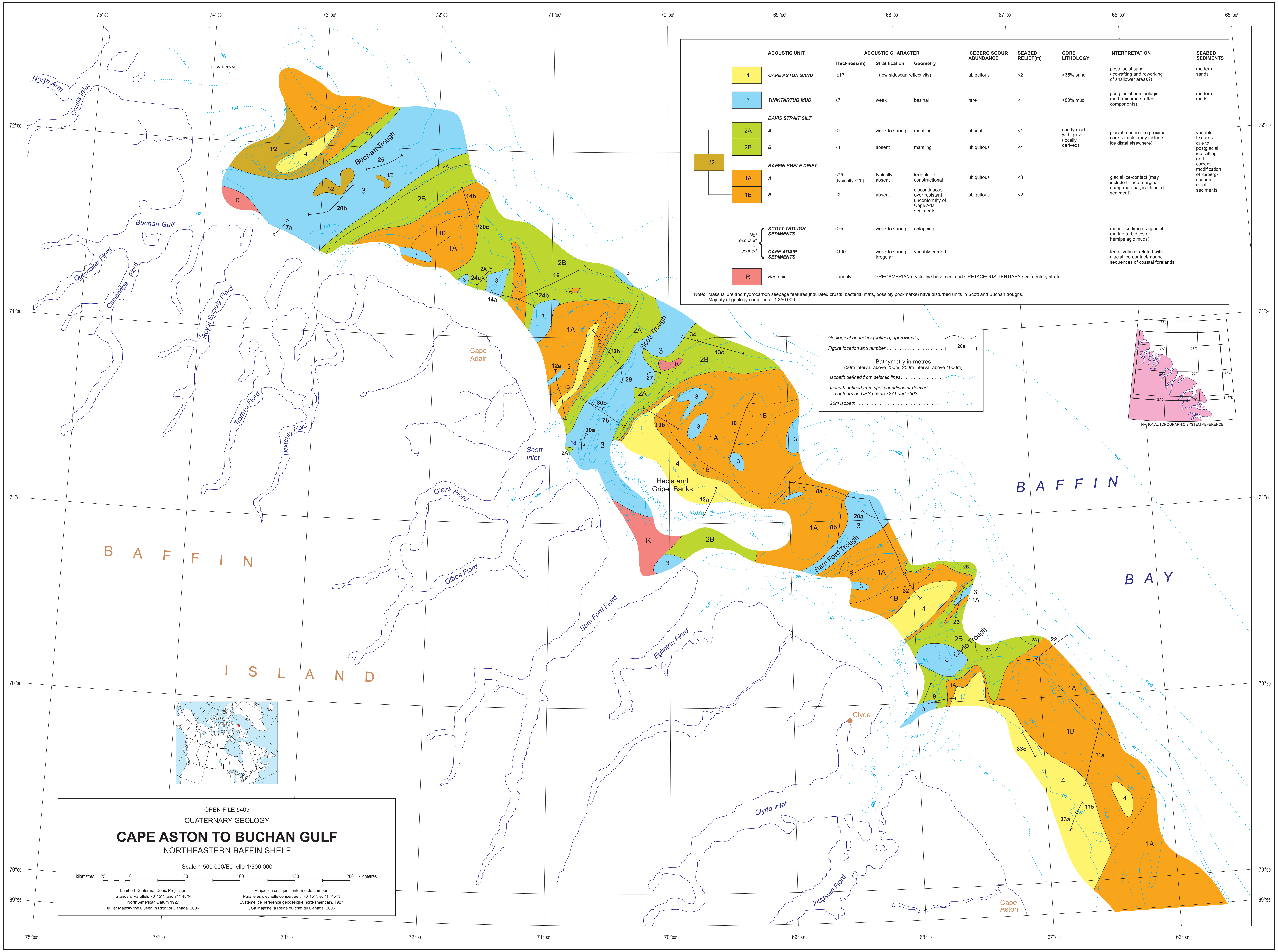
MAP #	SAMPLE ID	DEPTH (m)	LATITUDE	LONGITUDE	GRAVEL %	SAND %	SILT %	CLAY %	MEAN %	STD. DEV. Ø	SKEWNESS
63	36	207	71°21.4'	69°53.5'	<1	52	28	21			
64	37	113	71°20.6'	70°04.2'	1	93	5	1			
65	38	210	71°22.3'	70°05.5'	26	46	25	3			
66	39	252	71°21.9'	70°10.7'	1	71	16	12			
67	40	585	71°23.9'	70°13.5'	<1	13	45	42			
68	41	677	71°23.4'	70°18.1'	<1	5	44	51			
69	42	695	71°24.8'	70°21.9'	1	5	44	50			
70	43	703	71°25.0'	70°24.4'	<1	4	45	51			
71	44	732	71°26.5'	70°26.8'	18	28	22	32			
72	45	515	71°26.1'	70°30.8'	8	41	29	22			
73	48	223	71°25.1'	70°41.8'	<1	71	18	11			
74	50	475	71°12.5'	69°03.4'	<1	63	28	9			
75	51	593	71°16.3'	70°57.0'	1	16	44	40			
76	52	638	71°20.2'	70°47.1'	3	16	56	26			
77	53	722	71°22.6'	70°28.4'	<1	7	47	46			
78	54	174	71°19.0'	70°14.5'	18	47	31	4			
79	55	132	71°17.0'	70°03.7'	>80						
80	56	690	71°15.7'	70°30.1'	2	25	32	41			
81	59	713	71°11.0'	70°35.3'	<1	13	45	42			
82	60	566	71°04.8'	70°23.5'	1	15	55	29			
83	61	369	71°51.6'	71°32.9'	24	69	6	1			
84	62	312	71°47.3'	71°19.1'	21	49	26	4			
85	63	338	71°44.2'	71°06.4'	43	32	24	2			
86	64	226	71°40.0'	71°13.9'	31	29	40	0			
87	65	214	71°43.8'	71°27.0'	2	39	49	10			
88	66	186	71°39.1'	71°35.5'	1	20	78	2			
89	67	125	71°38.8'	71°56.5'	24	30	46	0			
90	68	155	71°42.9'	71°49.4'	7	48	30	14			
91	69	128	71°47.3'	71°56.9'	>80						
92	70	238	71°36.3'	71°01.5'	4	22	48	25			
93	71	198	71°31.1'	71°09.0'	25	3	44	28			
	81045-										
94	22	93	71°40.9'	72°12.5'	1	53	25	21	4.7	3.7	0.7
					1	46	34	19	4.9	3.3	0.6
95	23	102	71°41.8'	72°16.0'	7	55	19	18	3.7	4.1	0.7
					4	44	25	27	5.0	4.3	0.3
96	24	128	71°42.3'	72°13.0'	<1	22	45	33	6.4	3.4	0.0
					1	23	48	28	6.1	3.2	0.1
97	25	146	71°42.8'	72°14.5'	<1	28	45	26	5.9	3.3	0.2
					2	22	47	29	6.2	3.4	-0.1
98	26	198	71°48.0'	72°22.0'	31	38	13	19	2.5	5.1	0.6
					0.3	57	19	23	4.6	3.9	0.8
	81055-										
99	139	550	71°12.3'	70°54.5'	0	21	44	36	6.5	1.8	-1.0
100	140	730	71°14.8'	70°37.0'	0	3	67	30	6.9	1.3	-1.9
101	141	710	71°16.8'	70°46.0'	0	7	64	29	6.7	1.5	-1.5
102	142	800	71°21.3'	70°36.5'	0	1	67	32	7.1	1.1	-1.4
103	146*	75	71°14.0'	70°10.0'	0	65	26	8	4.2	2.1	0.4
104	147*	150	71°12.0'	69°47.0'	8	31	38	22	5.6	2.4	-0.6
105	148	386	71°24.7'	70°10.8'	20	45	27	9	4.3	2.8	0.0
106	149	732	71°09.8'	70°43.0'	0	5	52	43	7.0	1.5	-1.7
107	150	780	71°07.2'	70°38.0'	0	5	46	49	7.0	1.8	-2.3
108	151	760	71°07.0'	70°30.0'	0	3	56	40	7.2	1.2	-1.9
109	152	360	71°02.2'	70°13.0'	0	57	26	18	5.2	2.0	0.3
110	153	420	70°58.0'	70°14.9'	4	28	45	23	5.7	2.3	-1.0
111	157	128	71°26.5'	70°01.0'	gravity core 20 cm long:						
				9-12 cm depth:	6	34	28	33	5.1	2.9	-0.4
				core cutter:	1	37	29	33	4.5	2.9	-0.1
	82031-										
112	CA-9	610	71°48.8'	73°31.0'	0	<1	53	46	7.7	1.8	-0.1

* positions approximate

APPENDIX 2
CORE STATIONS

EXPEDITION	OLD STATION #	ED STATION #	TYPE	LENGTH (cm)	DEPTH (m)	LATITUDE	LONGITUDE	LAT_DEC	LONG_DEC
76023	26		piston core	144	615	70°25.0'	70°14.1'		
78029	24	3614	piston	583	832	71°13.2'	70°45.6'	71.22000	-70.76000
78029	36	3628	vibrocore	93	99	70°08.8'	66°48.7'	70.14667	-66.81167
80028	73	4761	piston	208	432	71°32.7'	70°09.2'	71.54500	-70.15333
81045	25C	5440	gravity	160	146	71°42.8'	72°14.5'	71.71333	-72.24167

Note: ED, the Exploration Database provides on-line information on Stations conducted by the Geological Survey of Canada
http://www.gsca.nrcan.gc.ca/ed/GSC/ed-f-menu.cgi



	ACOUSTIC UNIT	ACOUSTIC CHARACTER: Thickness(m)	Stratification	Geometry	ICEBERG SCOUR ABUNDANCE	SEABED RELIEF(m)	CORE LITHOLOGY	INTERPRETATION	SEABED SEDIMENTS
4	*CAPE ASTON SAND*	≤1?	(low sidescan reflectivity)		ubiquitous	<2	>65% sand	postglacial sand (ice-rafting and reworking of shallower areas?)	modern sands
3	*TINIKTARTUQ MUD*	≤7	weak	basinal	rare	<1	>80% mud	postglacial hemipelagic mud (minor ice-rafted components)	modern muds
	DAVIS STRAIT SILT								
2A (1/2)	*A*	≤7	weak to strong	mantling	absent	<1	sandy mud with gravel (locally derived)	glacial marine (ice proximal core sample; may include ice distal elsewhere)	variable textures due to postglacial ice-rafting and current modification of iceberg-scoured relict sediments
2B (1/2)	*B*	≤4	absent	mantling	ubiquitous	<4			
	BAFFIN SHELF DRIFT								
1A (1/2)	*A*	≤75 (typically ≤25)	typically absent	irregular to constructional	ubiquitous	<8		glacial ice-contact (may include till, ice-marginal dump material, ice-loaded sediment)	
1B (1/2)	*B*	≤2	absent	discontinuous over resistant unconformity of Cape Adair sediments	ubiquitous	<2			
Not exposed at seabed	*SCOTT TROUGH SEDIMENTS*	≤75	weak to strong	onlapping				marine sediments (glacial marine turbidites or hemipelagic muds)	
Not exposed at seabed	*CAPE ADAIR SEDIMENTS*	≤100	weak to strong, irregular	variably eroded				tentatively correlated with glacial ice-contact/marine sequences of coastal forelands	
R	*Bedrock*	variably	PRECAMBRIAN crystalline basement and CRETACEOUS-TERTIARY sedimentary strata						

Note: Mass failure and hydrocarbon seepage features(indurated crusts, bacterial mats, possibly pockmarks) have disturbed units in Scott and Buchan troughs. Majority of geology compiled at 1:350 000.

OPEN FILE 5409

QUATERNARY GEOLOGY

CAPE ASTON TO BUCHAN GULF

NORTHEASTERN BAFFIN SHELF

Scale 1:500 000/Échelle 1/500 000

kilometres 25 0 50 100 150 200 kilomètres

Lambert Conformal Conic Projection
Standard Parallels 70°15"N and 71° 45"N
North American Datum 1927

Projection conique conforme de Lambert
Parallèles d'échelle conservée : 70°15"N et 71° 45"N
Système de référence géodésique nord-américain, 1927

Canada