

Bedrock and surficial geology of Cumberland Sound, N.W.T.

Project 760015

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Abstract

The southwestern half and inner parts of Cumberland Sound are underlain by Precambrian rocks whereas the outer part is underlain by Ordovician carbonates which extend northwestward for 70 km. Cretaceous (Barremian-Cenomanian) semi-consolidated mudstones and siltstones underlie the northeastern half of Cumberland Sound. Palynomorph assemblages indicate deposition of the Cretaceous strata occurred in a nonmarine to marginal marine environment.

Cumberland Sound is a graben that appears to have been active subsequent to Barremian-Cenomanian time and possibly earlier.

The main accumulation of surficial sediments is in the outer half of the northeastern side of the sound. The sequence, 25-50 m thick, includes both unstratified and stratified sediments. Surficial sediments in southwestern and inner parts of the sound form a thin (<1-2 m) discontinuous cover over rough Precambrian rocks and comprise lag gravels and sands.

Résumé

La moitié sud-ouest et des parties intérieures du détroit de Cumberland sont formées de roches précambriennes, alors que la partie extérieure repose sur des carbonates de l'ordovicien qui s'étendent vers le nord-ouest sur une distance de 70 km. Des mudstone et des siltstone semi-consolidés du Crétacé (Barrémien-Cénomanien) se trouvent sous la moitié nord-est du détroit. Des assemblages palynomorphes indiquent que le dépôt des strates du Crétacé s'est fait dans un milieu variant de continental à marin marginal.

La détroit de Cumberland est un fossé qui semble avoir été actif après le Barrémien-Cénomanien et peut-être même avant.

La principale accumulation de sédiments superficiels se trouve dans la moitié extérieure, du côté nord-est du détroit. La séquence qui, à cet endroit, a une épaisseur de 25 à 50 m comprend des sédiments à la fois non stratifiés et stratifiés. Les sédiments superficiels des parties sud-ouest et intérieure du détroit forment une couverture discontinue (inférieure à 1 à 2 m) qui couvrent des roches rugueuses du Précambrien et comprend des résidus de déflexion graveleux et sableux.

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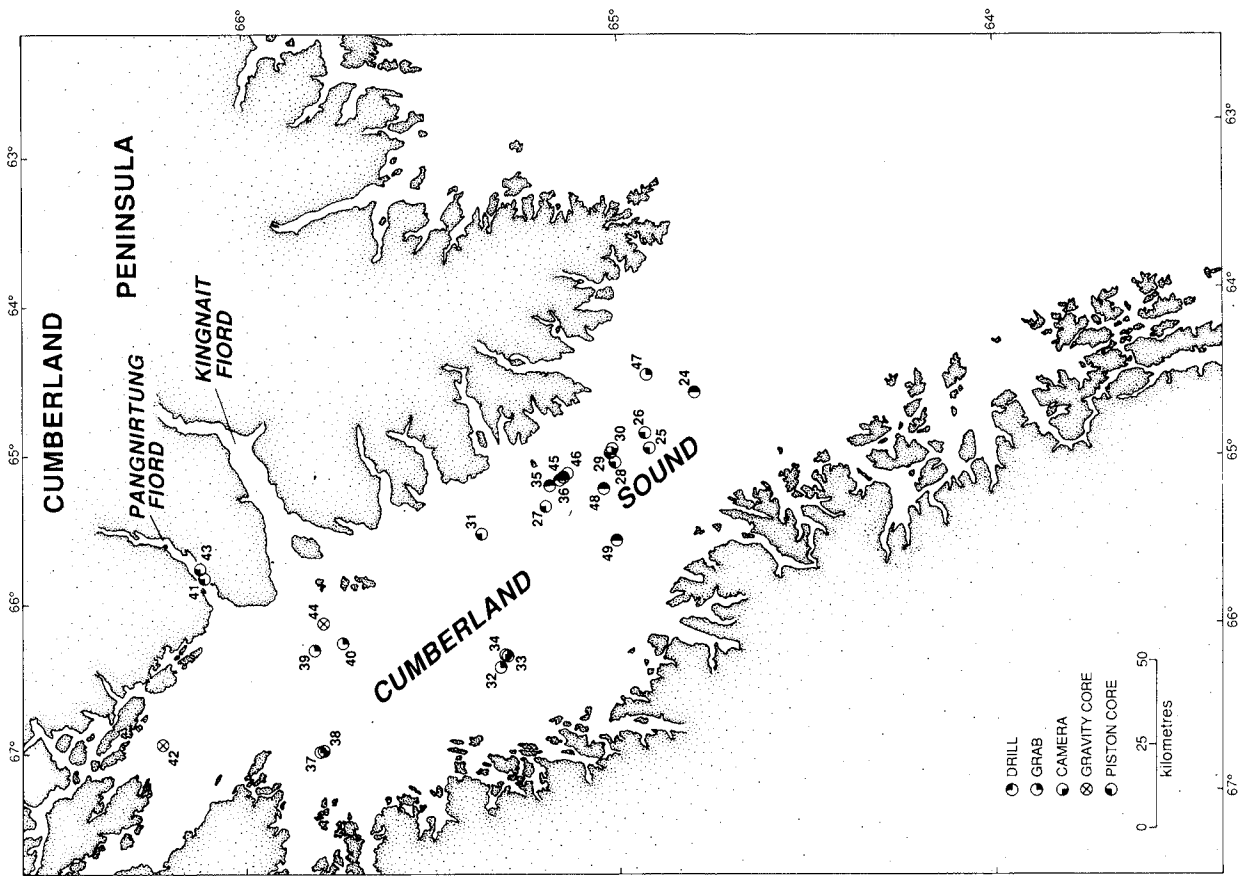


Figure 63.2. Sample station locations.

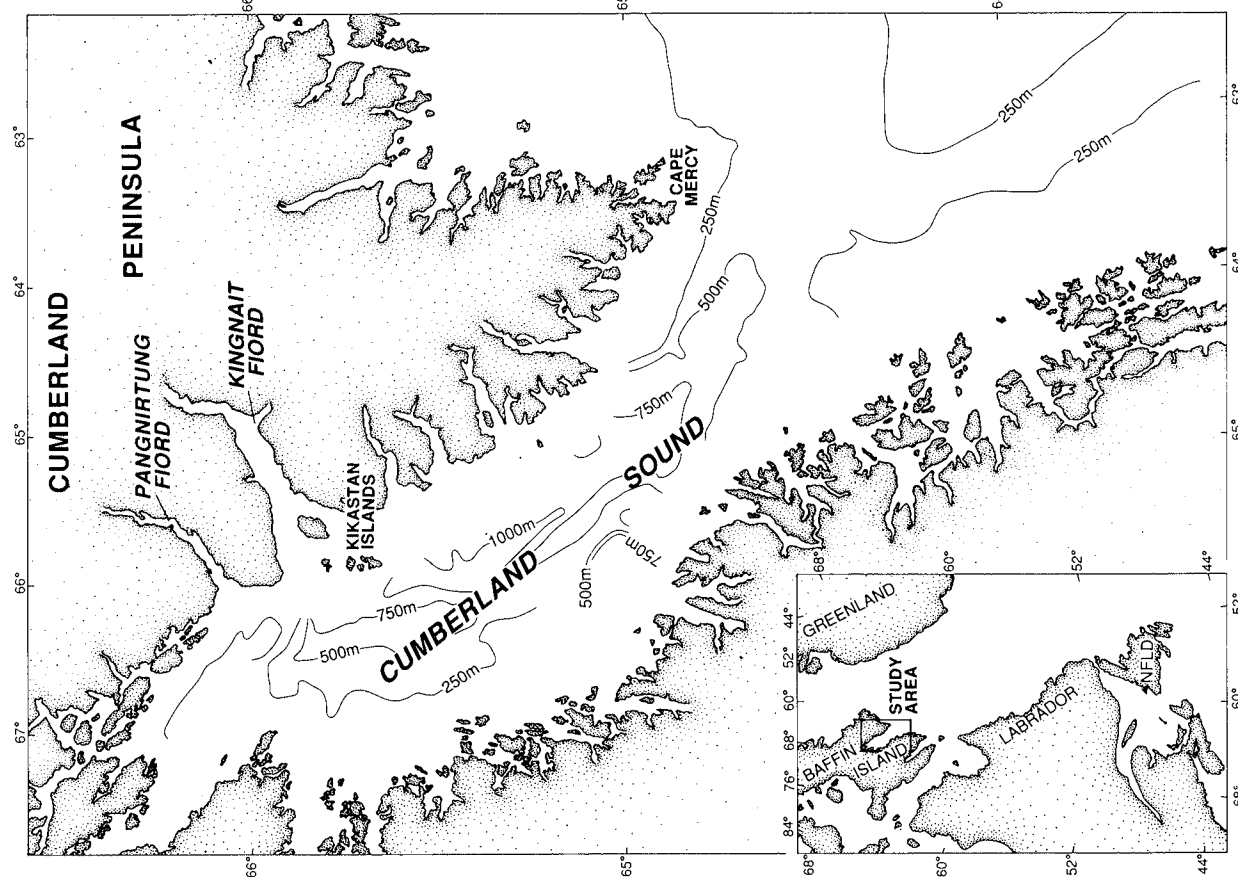


Figure 63.1. Generalized bathymetry in Cumberland Sound.

Introduction

The Cumberland Sound phase of CSS *Hudson* cruise 85-027 was carried out from 2 to 10 October 1985. The major objectives were to delineate the areal extent of the bedrock and surficial units and to obtain lithostratigraphic, biostratigraphic, and physical property data.

Cumberland Sound forms a major embayment, 280 km long by 70 km wide, in southeastern Baffin Island (Fig. 63.1). It is bounded by the Precambrian rocks of Cumberland

Peninsula to the north and Hall Peninsula to the south. The onshore topography ranges up to 1830 m with the highest elevation being on Cumberland Peninsula, which supports the Penny Ice Cap, several smaller ice caps, and numerous cirque and valley glaciers. The coast of Cumberland Sound is cut by deep fiords particularly along the southwest shore of Cumberland Peninsula. The largest of these fiords, Kingnait and Pangnirtung, are 83 km and 33 km long, respectively. There are numerous small islands and emergent rocks along the inner southwest margin and at the head of the sound (Canadian Hydrographic Chart 7051).

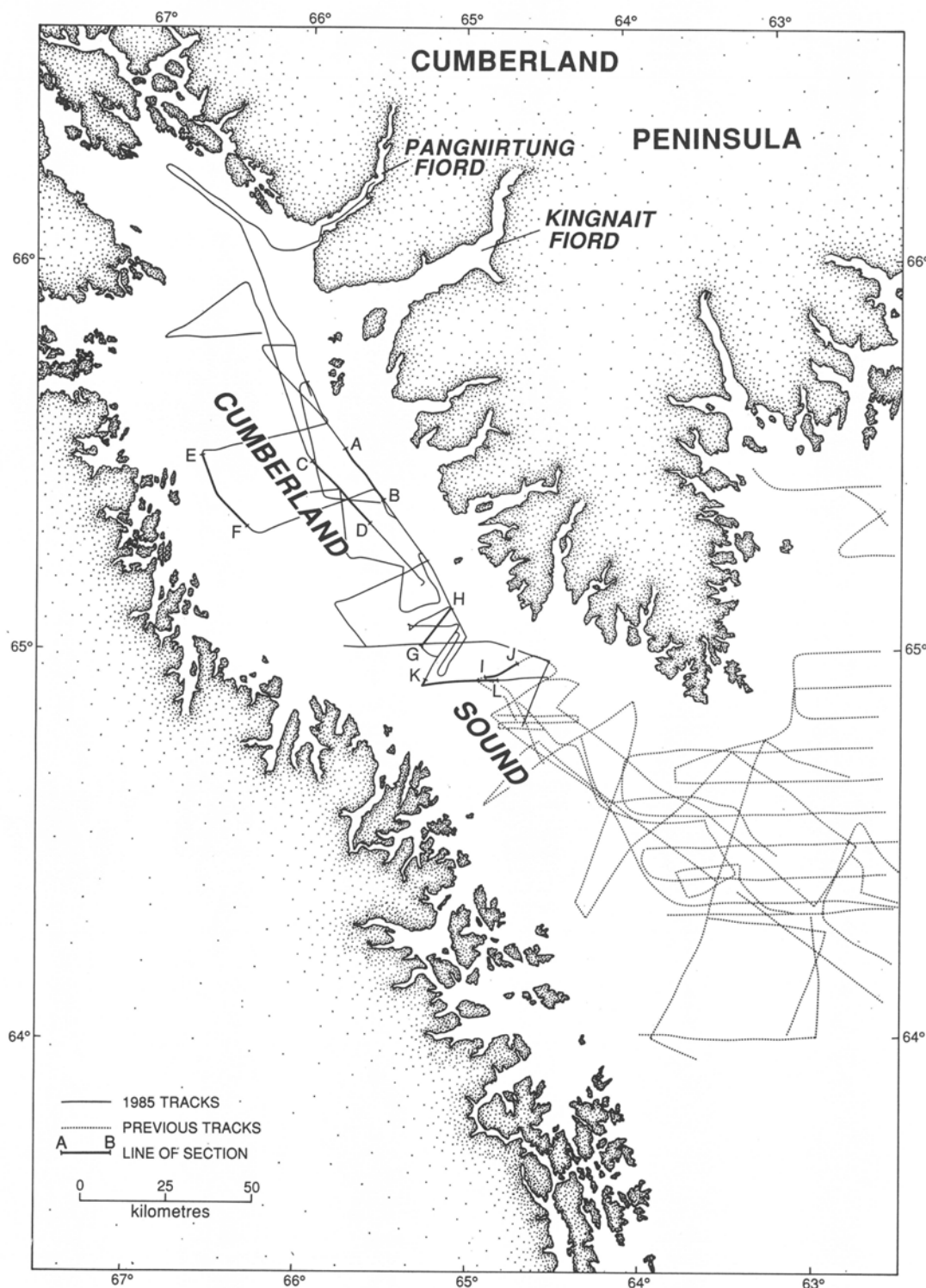


Figure 63.3. Survey tracks, cruise 85-027 and previous. Locations of profile sections are indicated.

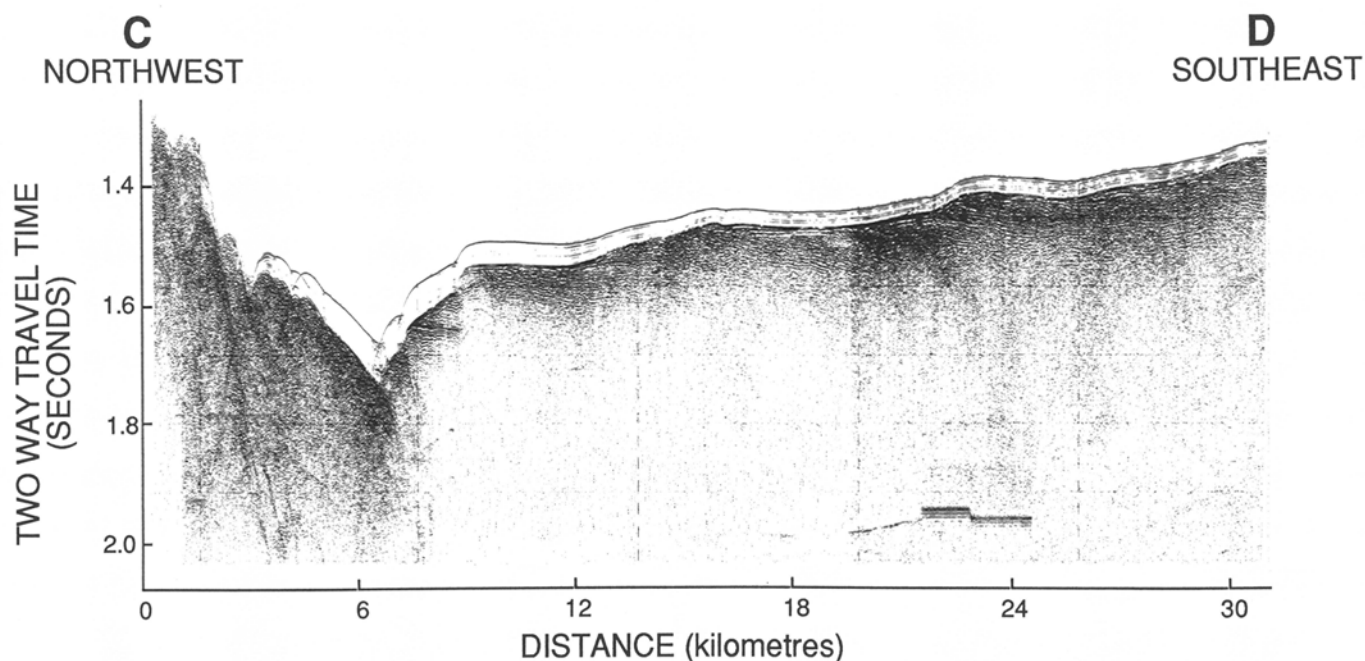


Figure 63.4. Section C-D: Seismic reflection profile illustrating gently dipping Cretaceous strata in probable fault contact with Precambrian rocks. A relict erosional "marginal channel" is developed at the contact. Up to 30 m of mainly stratified surficial sediments mantle the bedrock (see Fig. 63.3 for section location).

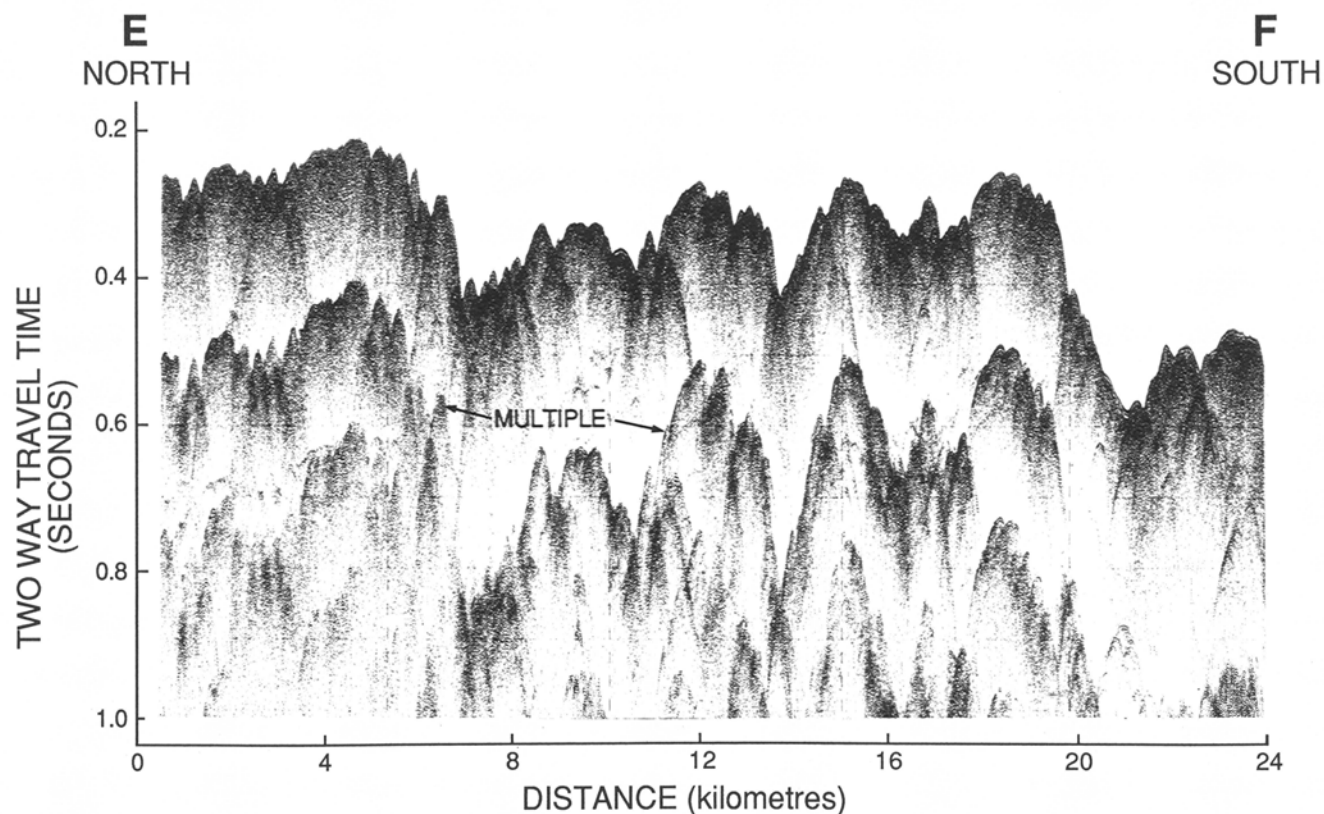


Figure 63.5. Section E-F: Seismic reflection profile across Precambrian rocks on the southwest side of Cumberland Sound; this illustrates the irregular topography associated with occurrences of these rocks and the absence of significant overburden (see Fig. 63.3 for section location).

Survey methods

The on board program included the collection of geophysical data and bedrock and sediment samples (Fig. 63.2, 63.3). Geophysical data were obtained using a single channel seismic reflection system (655 cm³ compressed air source), Hunttec high resolution deep tow seismic system, Bedford Institute of Oceanography sidescan, and Varian magnetometer. Bedrock cores in Cumberland Sound were obtained by means of the Bedford Institute of Oceanography rock core drill which can penetrate up to 9 m into the seafloor. Acoustic information was obtained using: a Nova Scotia Research Foundation 6 m hydrophone; a SE 30 m hydrophone; and Hunttec fitted with an internal hydrophone and a towed streamer. These systems provided good delineation of the near surface bedrock and overlying sediments. Such data were also the basis for locating drill sites. Surficial sediments were sampled principally by Benthos piston corer with 1360 kg head and by IKU clam shell sampler. UMEL cameras were used for seabottom photography at selected stations.

Navigational positioning was by the Bedford Institute navigational system BIONAV – which integrated data from rho-rho Loran C, Satellite Navigation, and log and gyro, and by radar.

Previous studies

Onshore

Precambrian metamorphic rocks form the onshore bedrock surrounding Cumberland Sound. The composition and distribution of these rocks have been reported by Riley (1960), Blackadar (1967), and Jackson and Taylor (1972).

Dyke et al. (1982) mapped the surficial materials of Cumberland Peninsula. The deposits include: till, felsenmere, raised marine deposits (mainly deltaic), lacustrine sediments, alluvium, and colluvium.

The land areas surrounding Cumberland Sound appear to have been glaciated at various times during the Quaternary: by the Laurentide ice sheet flowing eastward from Foxe Basin; by an expanded Penny Ice Cap; by local fiord and valley glaciers emanating from cirques (Dyke, 1977; Dyke et al., 1982); and possibly by local ice caps on Hall Peninsula (Miller, 1985b).

The late Foxe glacial maximum is marked by the Ranger Moraine which lies at the head of Cumberland Sound (Dyke, 1977; Miller, 1985b). It correlates with the Frobisher Bay Moraine of Hall Peninsula (Blake, 1966; Miller, 1985b).

Offshore

Aeromagnetometer surveys have shown that Cumberland Sound is a graben containing in excess of 8 km of sediments (Hood and Bower, 1975). Grant (1975), from seismic reflection and magnetometer data in the outer part of the sound, postulated the presence of Paleozoic-Mesozoic sedimentary rocks. MacLean and Williams (1983) on the basis of core material and seismic reflection data concluded that the stratigraphic section included

rocks of Aptian-Cenomanian age. MacLean et al. (1982) outlined the occurrence of Lower Cretaceous and lower Tertiary strata on the shelf seaward of Cumberland Sound.

Bathymetry

The general trend of bathymetric features is approximately parallel to the axis of Cumberland Sound (Fig. 63.1). Water depths are greatest in the northeastern half where they exceed 1100 m. The seafloor in that area is fairly smooth and consists of sedimentary rocks and unconsolidated sediments (Fig. 63.4). This contrasts with the highly irregular seafloor morphology in the southwestern and inner parts of the sound which are underlain by Precambrian metamorphic rocks (Fig. 63.5). The bathymetry is generally uncharted in a 15 km wide zone adjacent to the coast, thus the shoreward limit of deep water along the northeast side of the sound has been established only in a few localities which lie in the outer part. There the transition from deep to shallower depths is abrupt and spatial relationships suggest that a similar condition probably prevails along most of the northeast side of the sound. Though bathymetry on the southwest side of the sound is highly irregular, shallowing appears to be more gradual.

The lack of bathymetric data in the zone adjacent to the coast constrained the geological survey, particularly the definition of bedrock and surficial sediment boundaries and structural relationships on the northeast side.

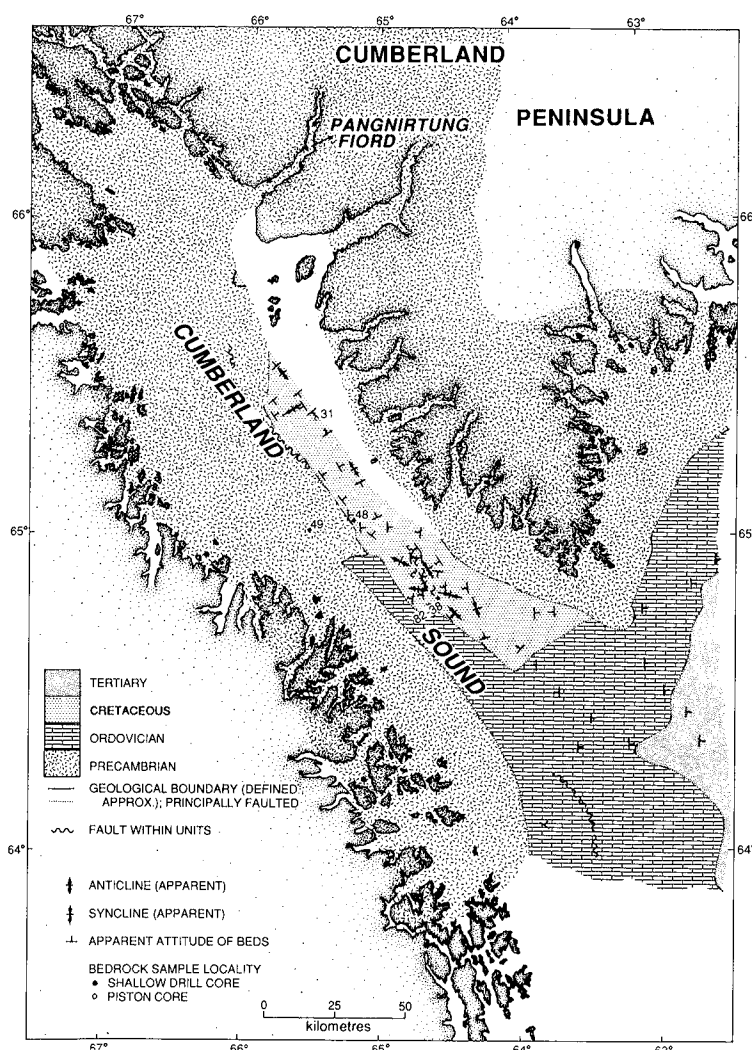


Figure 63.6

Bedrock geology of Cumberland Sound.

Bedrock geology

Precambrian metamorphic and granitic rocks that surround Cumberland Sound and form most of eastern Baffin Island (Riley, 1960; Blackadar, 1967; Jackson and Taylor, 1972) make up the bedrock beneath the southwestern half and inner part of the sound (Fig. 63.6). Seabed morphology across these areas is highly irregular (Fig. 63.5), a characteristic typical of Precambrian rocks on the inner part of the Baffin Island shelf. Where sampled at station 49 (Fig. 63.2, 63.6, Table 63.1), these rocks consisted of hornblende-pyroxene gneiss. Usually the Precambrian rocks in Cumberland Sound are either covered by less than 1-2 m of surficial sediments or are bare.

Sedimentary rocks interpreted to be Ordovician carbonates on the basis of their seismic character form the bedrock at the mouth of the sound. They extend northwestward in a 10-15 km wide band for 70 km along the southwest part of Cumberland Sound. They are in apparent fault contact with adjacent rocks (Fig. 63.7). Ordovician rocks underlie much of the southeast Baffin shelf between Cumberland Sound and Frobisher Bay and have been sampled at five localities (MacLean et al., 1977; MacLean and Falconer, 1979). These rocks are interpreted to extend northward along the shelf to the vicinity of Cape Dyer and possibly farther (Grant, 1975; MacLean et al., 1982).

Cretaceous (Barremian-Cenomanian) sedimentary rocks underlie the northeastern half of the sound. The age assignment is based mainly on spores and sparse dinoflagellates in samples from three localities (Fig. 63.2). The shallow drill core sample from station 48 (Fig. 63.6, 63.8, Table 63.1) consists of semi-consolidated mudstone and contains Barremian-Aptian palynomorphs. Lithologically it is similar to Aptian-Cenomanian sediments obtained 40 km to the southeast in core 82-034-38 (MacLean and Williams, 1983). Further confirmation of an early Cretaceous age was obtained at station 31 (Fig. 63.6, Table 63.1) where a benthos piston core cutter recovered black friable siltstone and mudstone. Palynomorphs in this core indicate that it is similar in age to the strata sampled at station 48, and suggest that these strata are terrestrial to marginal marine in origin. Throughout the area these rocks display a consistent acoustic signature, with penetration being substantially greater than that associated with the Paleozoic rocks.

The stratigraphic and structural characteristics of the Cretaceous rocks are illustrated in Figures 63.4, 63.7-63.9. The strata have been folded and faulted and extensively bevelled by erosion. In places (e.g. Fig. 63.4) a relict marginal channel exists at the contact between Precambrian and Cretaceous rocks. Boundary relations as seen on the seismic profiles suggest that these rocks are in fault contact. Low relief of Precambrian rocks adjacent to the contact (Fig. 63.4) suggests that they too have been faulted.

The Precambrian-Cretaceous contact on the northeast side of Cumberland Sound has not been established, as it lies in uncharted waters. In the outer part of the sound, where some soundings are available, the contact is coincidental with an abrupt transition from deep to shallow water. The narrow zone in which the transition must occur (both geologically and bathymetrically) along most of the northeast side of the sound suggests that the change is equally abrupt. This contact is interpreted to be a fault scarp.

Cumberland Sound thus appears to be a graben that has been active subsequent to Barremian-Cenomanian time. The presence of Ordovician rocks in Cumberland Sound suggests that pre-Barremian structural displacement may also have occurred. The post-Cenomanian faulting in the sound appears to be consistent with the time of rifting proposed in seafloor spreading models for northern Labrador Sea - Davis Strait - Baffin Bay (McMillan, 1973; Srivastava et al., 1981).

Table 63.1. Listing of samples from Cumberland Sound.

STATION NUMBER	SAMPLE TYPE	JULIAN DAY/TIME	LATITUDE	LONGITUDE	DEPTH (MTRS)	GEOGRAPHIC LOCATION	NOTES
24	DRILL	2751952	64 49.23N	64 37.03W	750	CUMBERLAND SOUND	BIO DRILL. NO SAMPLE.
24-G	GRAB/DRL	2751952	64 49.23N	64 37.03W	750	CUMBERLAND SOUND	GRAB SAMPLE TAKEN FROM THE LEG OF THE DRILL.
25	CORE	2752349	64 56.43N	64 57.78W	823	CUMBERLAND SOUND	PISTON CORE. LENGTH: 630 CM.
26	CORE	2760104	64 57.16N	64 52.19W	816	CUMBERLAND SOUND	PISTON CORE. LENGTH: 860 CM.
27	CORE	2761557	65 13.44N	65 21.22W	896	CUMBERLAND SOUND	PISTON CORE. LENGTH: 1150 CM.
28	CORE	2761744	65 01.88N	65 03.36W	850	CUMBERLAND SOUND	PISTON CORE. LENGTH: 1020 CM.
29	CORE	2761908	65 02.57N	64 59.51W	814	CUMBERLAND SOUND	PISTON CORE. LENGTH: 1140 CM.
30	CAMERA	2762015	65 02.36N	64 58.66W	823	CUMBERLAND SOUND	UMEL UNDERWATER CAMERA.
31	CORE	2772028	65 26.46N	65 30.82W	896	CUMBERLAND SOUND	PISTON CORE. LENGTH: 800 CM.
32	GRAB	2772305	65 19.98N	66 22.29W	350	CUMBERLAND SOUND	IKU GRAB.
33	GRAB	2780098	65 19.22N	66 17.13W	95	CUMBERLAND SOUND	IKU GRAB.
34	CAMERA	2780026	65 19.39N	66 16.81W	66	CUMBERLAND SOUND	UMEL UNDERWATER CAMERA.
35	DRILL	2781457	65 12.37N	65 12.06W	823	CUMBERLAND SOUND	BIO DRILL. NO SAMPLE.
35-G	GRAB/DRL	2781457	65 12.37N	65 12.06W	823	CUMBERLAND SOUND	GRAB SAMPLE TAKEN FROM THE LEG OF THE DRILL.
36	DRILL	2781908	65 10.32N	65 08.93W	845	CUMBERLAND SOUND	BIO DRILL. NO SAMPLE.
36-G	GRAB/DRL	2781908	65 10.32N	65 08.93W	845	CUMBERLAND SOUND	GRAB SAMPLE TAKEN FROM THE LEG OF THE DRILL.
37	GRAB	2791431	65 48.94N	66 58.01W	147	CUMBERLAND SOUND	IKU GRAB.
38	CAMERA	2791510	65 48.39N	66 55.67W		CUMBERLAND SOUND	UMEL UNDERWATER CAMERA.
39	GRAB	2791742	65 50.21N	66 16.21W	760	CUMBERLAND SOUND	IKU GRAB.
40	GRAB	2791903	65 45.57N	66 13.30W	680	CUMBERLAND SOUND	IKU GRAB.
41	CORE	2801453	66 08.31N	65 48.55W	165	PANGNIRTUNG FJORD	PISTON CORE. LENGTH: 930 CM.
42	CORE	2800829	66 14.36N	66 54.77W	310	CUMBERLAND SOUND	GRAVITY CORE. LENGTH: 151 CM.
43	CORE	2801649	66 08.28N	65 48.40W	165	PANGNIRTUNG FJORD	PISTON CORE. LENGTH: 600 CM.
44	CORE	2810422	65 48.75N	66 05.92W	1024	CUMBERLAND SOUND	GRAVITY CORE. LENGTH: 158 CM.
45	DRILL	2811446	65 10.79N	65 09.92W	845	CUMBERLAND SOUND	BIO DRILL. LENGTH: 24 CM. OF GNEISS.
45-G	GRAB/DRL	2811446	65 10.79N	65 09.92W	845	CUMBERLAND SOUND	GRAB SAMPLE TAKEN FROM THE LEG OF THE DRILL.
46	CORE	2812113	65 10.82N	65 09.93W	845	CUMBERLAND SOUND	PISTON CORE. LENGTH: 492 CM.
47	GRAB	2812341	64 56.82N	64 30.23W	475	CUMBERLAND SOUND	IKU GRAB.
48	DRILL	2831213	65 03.73N	65 12.98W	890	CUMBERLAND SOUND	BIO DRILL. LENGTH: 9 CM. MUDSTONE/SILTSTONE.
48-G	GRAB/DRL	2831213	65 03.73N	65 12.98W	890	CUMBERLAND SOUND	GRAB SAMPLE TAKEN FROM THE LEG OF THE DRILL.
49	DRILL	2831547	65 01.78N	65 32.98W	220	CUMBERLAND SOUND	BIO DRILL. LENGTH: 37 CM. OF GNEISS.
49-G	GRAB/DRL	2831547	65 01.78N	65 32.98W	220	CUMBERLAND SOUND	GRAB SAMPLE TAKEN FROM THE LEG OF THE DRILL.

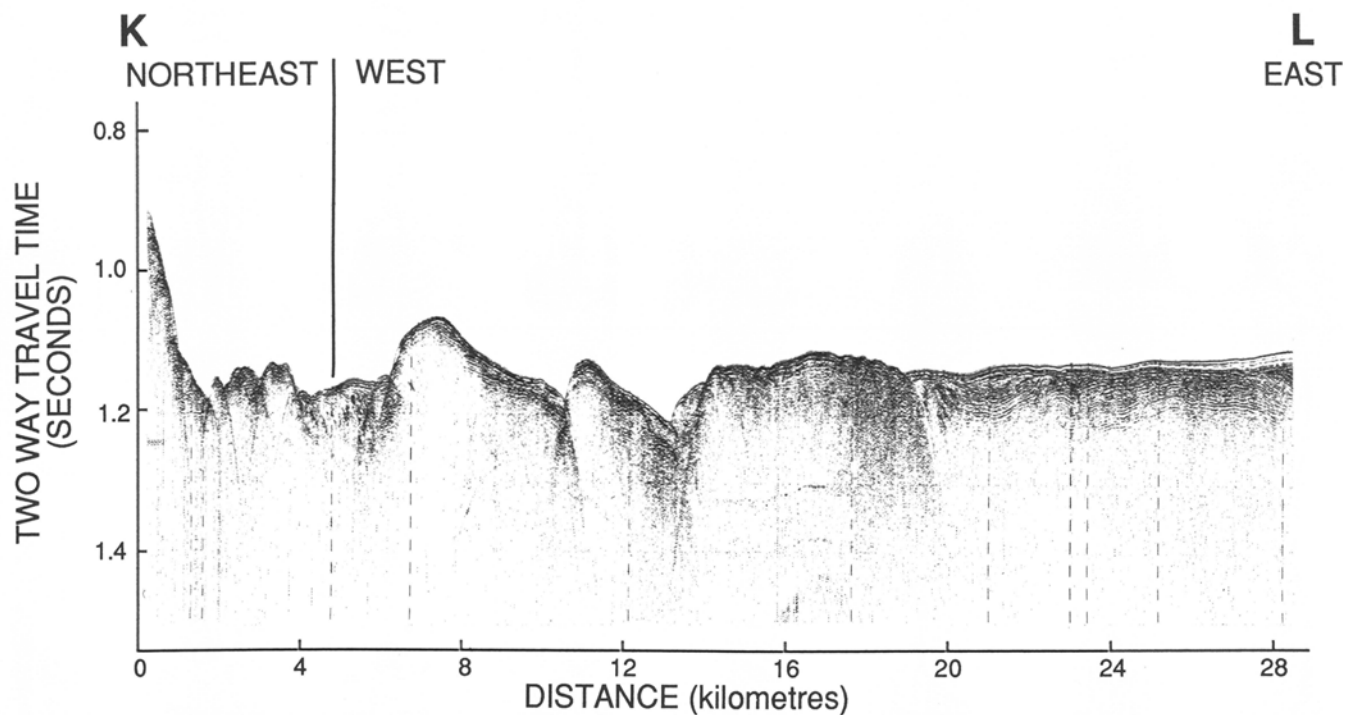


Figure 63.7. Section K-L: Seismic reflection profile west to east illustrating inferred Lower Paleozoic rocks in apparent fault contact with Precambrian and Cretaceous rocks, 4 km and 20 km respectively, along the section (see Fig. 63.3 for section location).

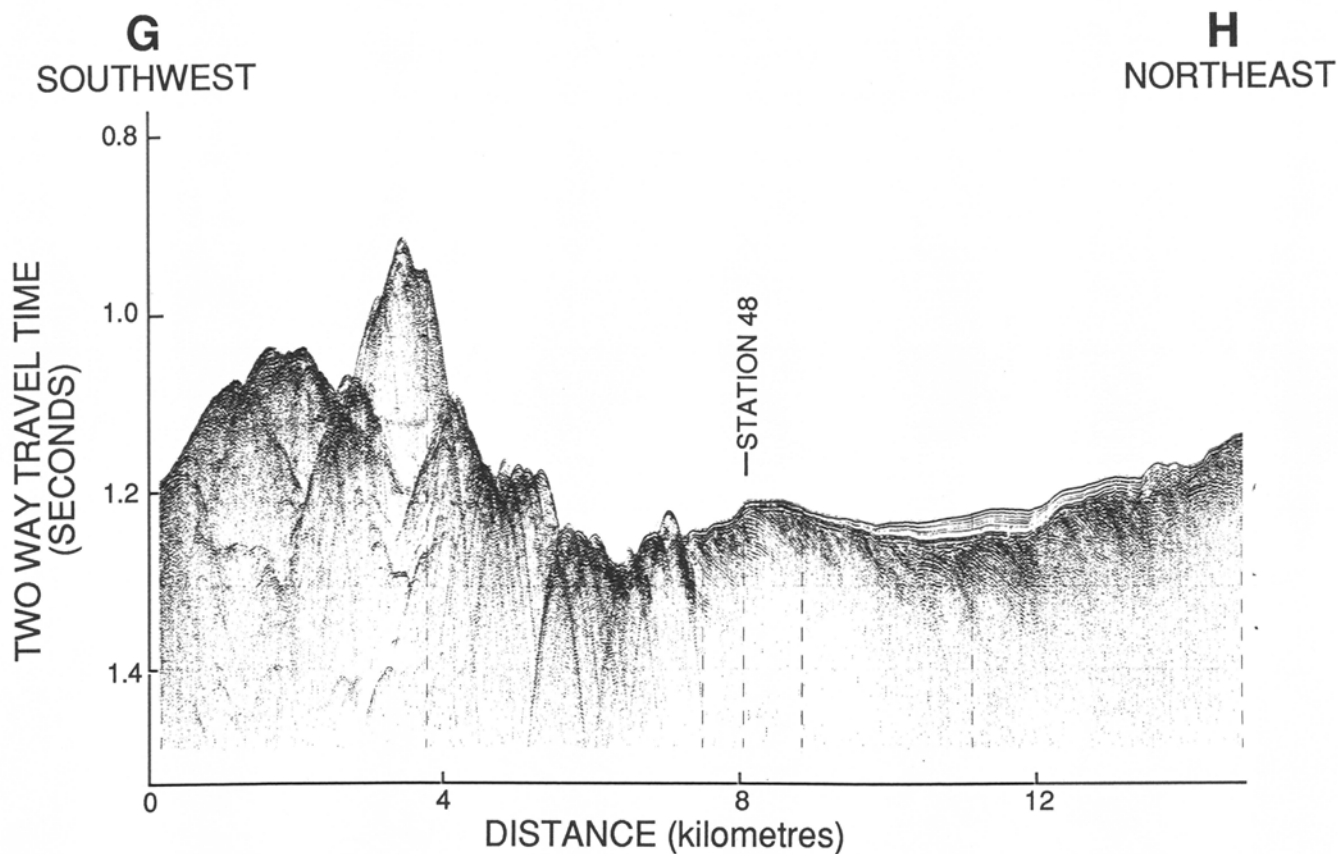


Figure 63.8. Section G-H: Seismic reflection profile illustrating: easterly dipping Cretaceous strata at bedrock sample locality, Station 48; the contact with Precambrian rocks at approximately 7 km; and the distribution of surficial sediments (see Fig. 63.3 for section location).

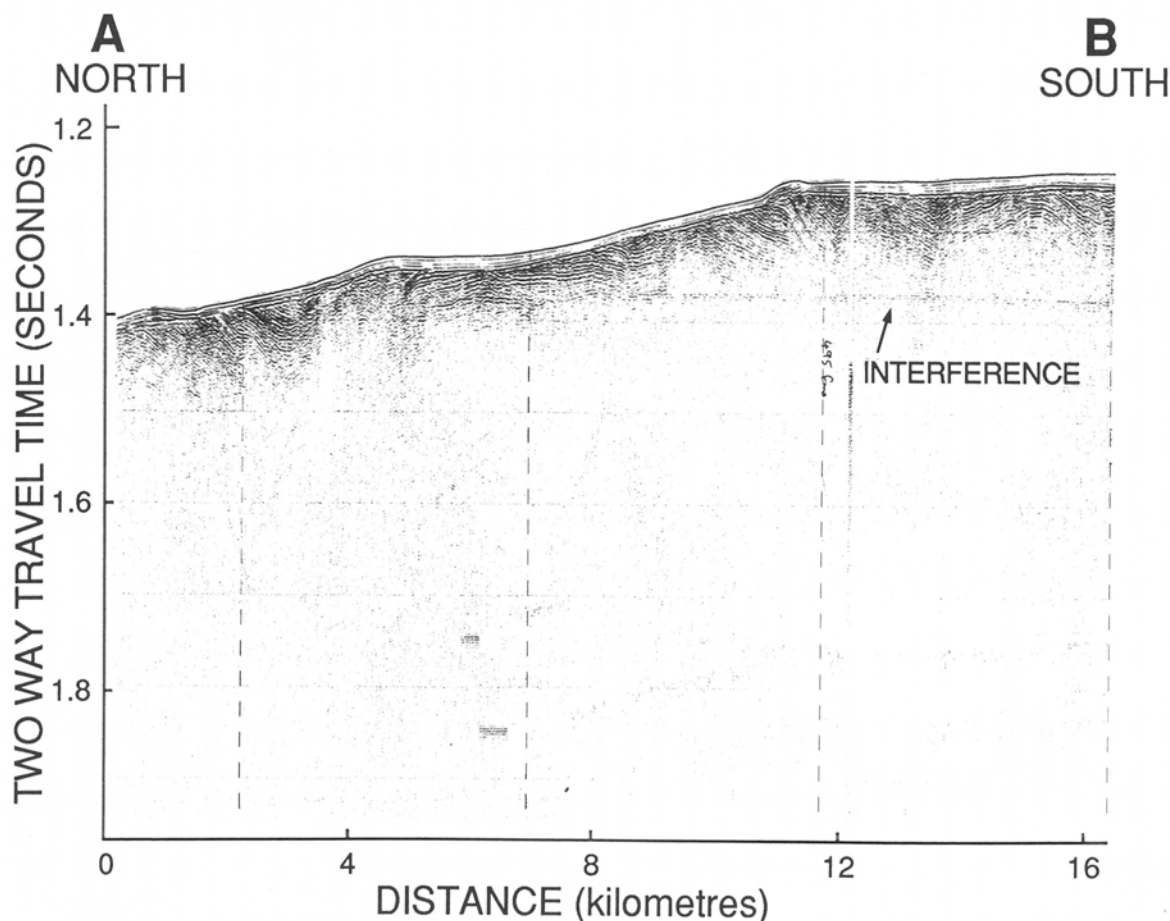


Figure 63.9. Section A-B: Seismic reflection profile northwest to southeast showing folding and possible faulting within Cretaceous rocks along the east side of Cumberland Sound, and erosional bevelling of the strata (see Fig. 63.3 for section location).

The sedimentary rocks on the continental shelf east of Cumberland Sound have been extensively bevelled by erosion subsequent to the early Eocene (MacLean et al., 1982). Similar bevelling of the Cretaceous beds in Cumberland Sound may relate to this event. Glacial erosion also presumably affected the seabed. To date no indication of Tertiary strata has been seen in Cumberland Sound; it appears either they were not deposited or they subsequently have been removed.

Surficial sediments

The main accumulation of unconsolidated sediments in Cumberland Sound occurs in the deeper northeast half (Fig. 63.4, 63.7, 63.8, 63.10). In the inner part of this area the unconsolidated sediments are generally underlain by Cretaceous strata. The surficial sediments are up to 30 m thick in this area and are up to 50 m thick in the outer part of the sound. Five units are recognized from acoustic profiles. The basal unit is unstratified and is interpreted as a till. It occurs in marginal areas and locally fills bedrock depressions and forms constructional features (Fig. 63.11). A second, acoustically stratified unit composed of black, very pebbly, sandy mud locally overlies the till and bedrock. These sediments are overlain by a basin wide unit that is poorly to well stratified and moderately transparent on seismic profiles. It may be a correlative of the Davis Strait Silt mapped on the southeast Baffin shelf (Praeg et al., 1986). Core data suggest that this unit includes unbioturbated black

and grey laminated mud with some sand beds overlain by bioturbated mud, sandy mud, and pebbles. The youngest unit in the basin sequence appears as a laminated basin fill sediment on high resolution seismic profiles. The unit is a correlative of the post-glacial marine Tiniktartuq Silt and Clay which occurs in the outer part of Cumberland Sound and on the Baffin shelf (Praeg et al., 1986) (Fig. 63.11). It consists of olive grey and sandy mud with indistinct banding.

Isolated patches of soft Quaternary sediments also are present: off Kingnait Fiord, 14 km northwest of the main body of sediments, locally in a small area at the head of the sound, and at another locality toward the southwest side (Fig. 63.10).

In the southwest and inner parts of Cumberland Sound surficial sediments mainly form a thin (<1-2 m) discontinuous cover over rough Precambrian bedrock (Fig. 63.5, 63.10). The seafloor sediments are mainly lag gravels and sands presumably formed by current modification of the underlying sediments. These commonly consist of mud, sand and gravel mixtures that appear to include till. Acoustic profiles show thicker, localized accumulations in some valley bottoms.

Cores of the surficial sediments were obtained at 10 localities and IKU grab samples at 6 others (Fig. 63.2, Table 63.1). Analyses of these samples should yield information on sediment textures, depositional environments, paleoceanographic and paleoclimatic conditions, geochronology, geotechnical, and related parameters.

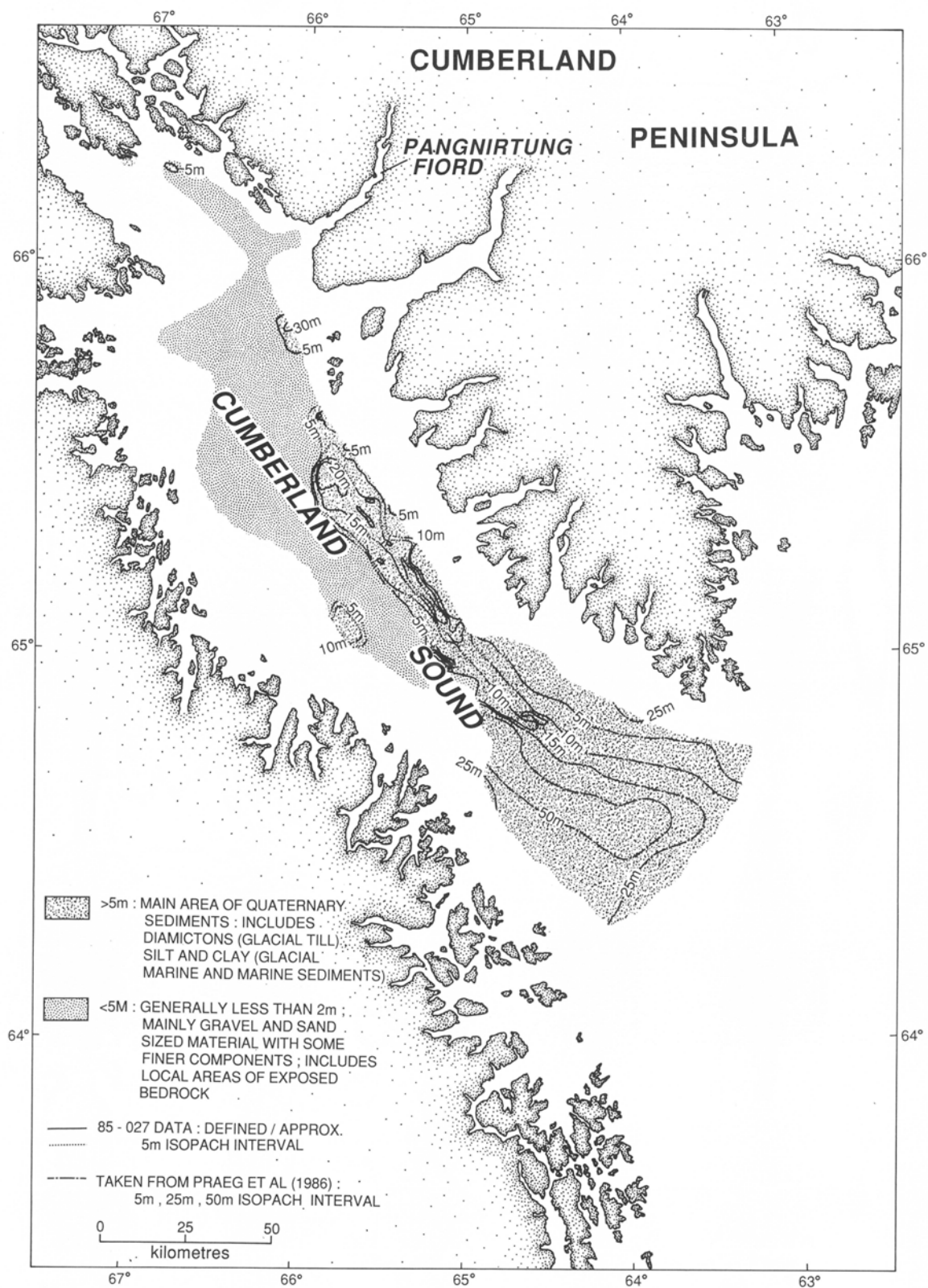


Figure 63.10. Isopach map of surficial sediments in Cumberland Sound.

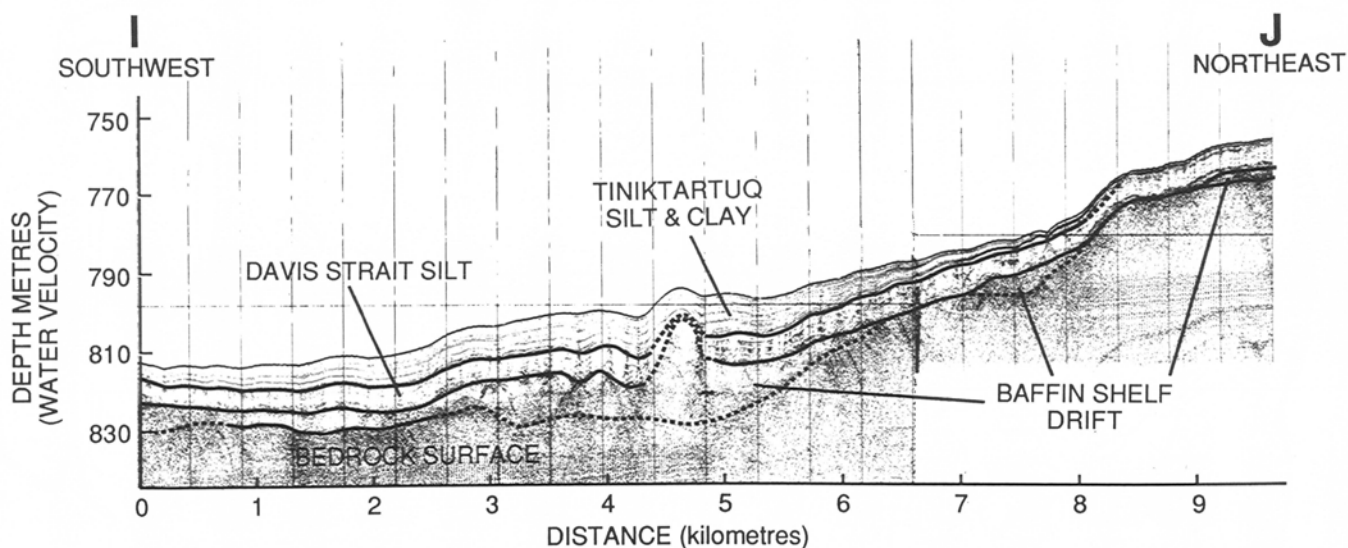


Figure 63.11. Section I-J: Huntec high resolution seismic reflection profile west to east in outer Cumberland Sound from Praeg et al. (1986); this illustrates glacial till of Baffin Shelf Drift which is overlain by Davis Strait Silt stratified glacial marine sediments and basin fill muds of the Tiniuktartuq Silt and Clay (see Fig. 63.3 for section location).

Acknowledgments

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