GEOLOGICAL INVESTIGATIONS OF BAFFIN ISLAND SHELF IN 1982

Project 760015

B. MacLean and G.L. Williams
Atlantic Geoscience Centre, Dartmouth

MacLean, B. and Williams, G.L., Geological investigations of Baffin Island shelf in 1982; in Current Research, Part B, Geological Survey of Canada, Paper 83-1B, p. 309-315, 1983.

Abstract

Marine geological and geophysical studies of the Baffin Island continental shelf, carried out from ***CSS Hudson*** *in 1982, were concerned primarily with the collection of bedrock samples. Biostratigraphic and lithostratigraphic analyses of the samples permitted identification of units previously only observed on seismic profiles.*

Palynological studies indicate the presence of Upper Cretaceous strata at Home Bay, and Lower Cretaceous strata off Padloping Island and in the outer part of Cumberland Sound. Cores obtained from Hudson Strait are lithologically similar to Lower Paleozoic rocks outcropping on Coats and Southampton islands in northern Hudson Bay.

Surficial sediment samples were taken to define correlations and depositional history of Quaternary sediments on the southeastern Baffin shelf.

Résumé

Des études géologiques et géophysiques marines du plateau continental de l'île Baffin, effectuées en 1982 à partir du ***CSS Hudson*** *ont porté surtout sur l'échantillonnage du socle rocheux. L'analyse biostratigraphique et lithostratigraphique des échantillons a permis d'identifier des unités qui, auparavant, avaient seulement été observées sur des profils sismiques.*

L'étude palynologique indique la présence de couches du Crétacé supérieur à Home Bay et du Crétacé inférieur au large de l'île Padloping et de la partie extérieure du détroit de Cumberland. Des carottes prélevées dans le détroit d'Hudson ont une lithologie semblable à celle des roches du Paléozoïque inférieur qui affleurent dans les îles Coats et Southampton dans le nord de la baie d'Hudson.

Des échantillons de sédiments de surface ont été prélevés afin de corréler les sédiments quaternaires de la partie sud-est du plateau de Baffin et de déterminer leur histoire stratigraphique.

Introduction

A program to extend geological knowledge of the Baffin Island shelf was undertaken from **CSS Hudson** between September 24 and October 18, 1982 (cruise 82-034). The prime objective of the cruise was the collection of bedrock samples for lithostratigraphic and biostratigraphic information for geological mapping. Surficial sediment sampling was also carried out on the southeastern Baffin shelf. The stations occupied and survey tracks are indicated in Figures 38.1 and 38.2. Satellite navigation and rho-rho Loran C (groundwave and skywave) systems and radar were used for navigational positioning.

The bedrock studies included collection of both samples and geophysical data. The sampling program was undertaken with a prototype version of the BIO underwater electric rock core drill extended to 10 m penetration capability to cope with the thick overburden found in this region. We were thus able to obtain samples beyond the reach of the regular 6 m drill. Most drill locations were selected on the basis of previously acquired data. All were resurveyed to ensure best possible site conditions. Drilling was hampered by mechanical and electrical problems with the drill, by the presence of gravel, and by the nature of the substrate.

Geophysical data were obtained using a conventional single channel seismic reflection system (655 cm^3 compressed air source), Huntec high resolution deep tow seismic system, and Varian magnetometer. Acoustic information from a Nova Scotia Research Foundation 6 m hydrophone in addition to that obtained with a SE 30 m hydrophone and the Huntec system proved very helpful in carrying out the drill site surveys.

Samples of sedimentary bedrock were recovered from Home Bay, Padloping Island, Cumberland Sound, and Hudson Strait areas (Fig. 38.1, Table 38.1). Preliminary results of laboratory studies are outlined for each of these areas.

Home Bay Area

Short cores of semiconsolidated sediments including mudstone, siltstone, and sandstone were recovered from two main localities 24 km apart (Stations 3, 8, 10). Figure 38.3 illustrates a seismic reflection profile across the station 8 and 10 locality. Station 3 in the northern part of the bay contained abundant dinoflagellates which show affinities with Bylot Island assemblages dated as Campanian. Station 8 and 10 in the southern part of the bay also contained dinoflagellates of Late Cretaceous age, possibly coeval with assemblages from station 3. Mudstone samples from station 8 (Figure 38.4) had a petroliferous odour and are organic rich. They appear to represent promising petroleum source rocks.

Bedrock samples recovered previously from the northeastern Baffin shelf included Upper Cretaceous (Campanian) marine strata from Buchan Trough and upper Eocene-lower Oligocene strata from Scott Trough, 425 km and 315 km north of Home Bay, respectively (MacLean et al., 1981; MacLean and Williams, 1980; Levy and MacLean, 1981).

Our highest priority for sampling on the cruise was Home Bay as it is the only area between Scott Trough and Padloping Island where overburden is thin enough to be penetrated by the drill. The acoustic stratigraphy also suggested that pre-Tertiary strata would be accessible.

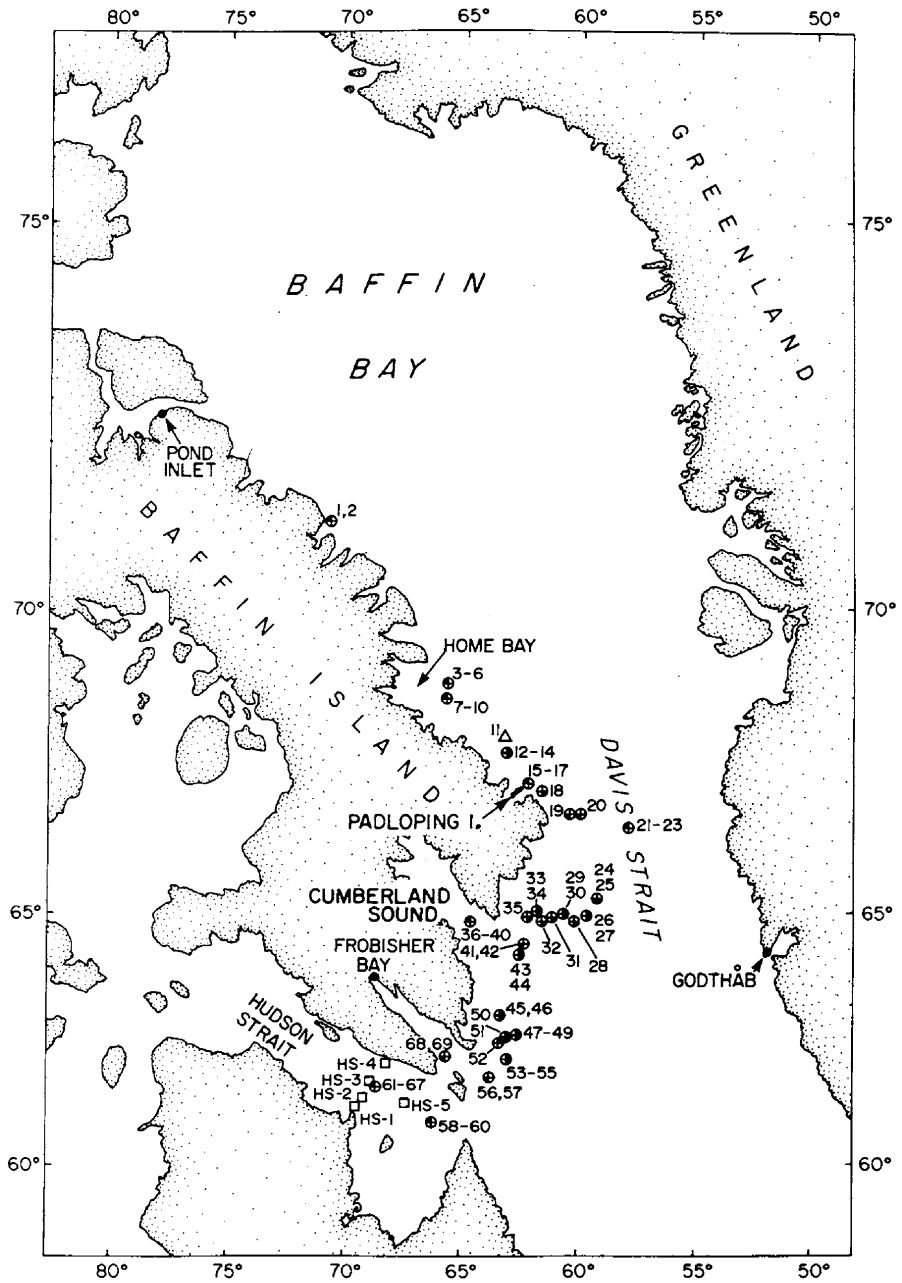

Figure 38.1. *Station locations – Cruise 82-034.*

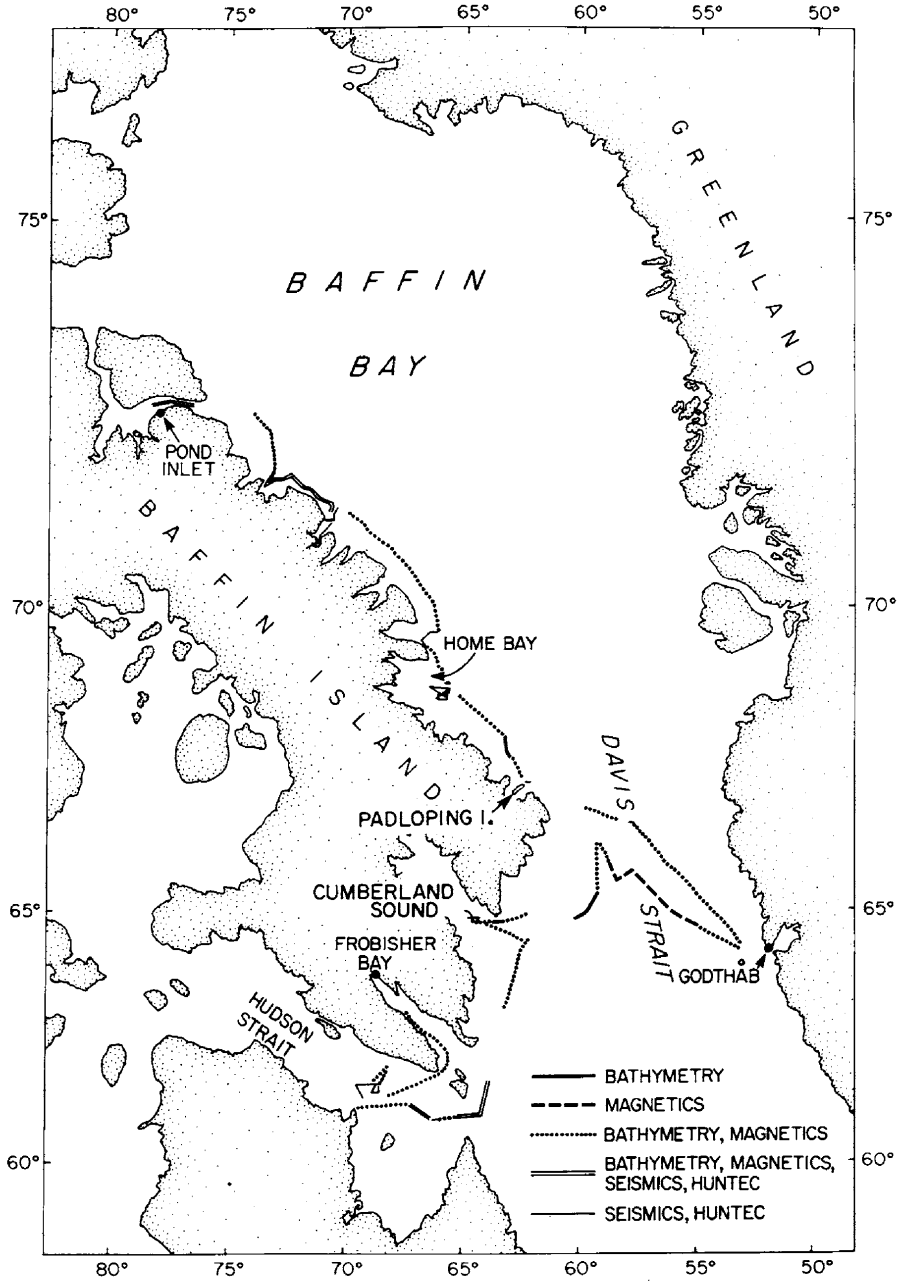

Figure 38.2. *Survey tracks – Cruise 82-034.*

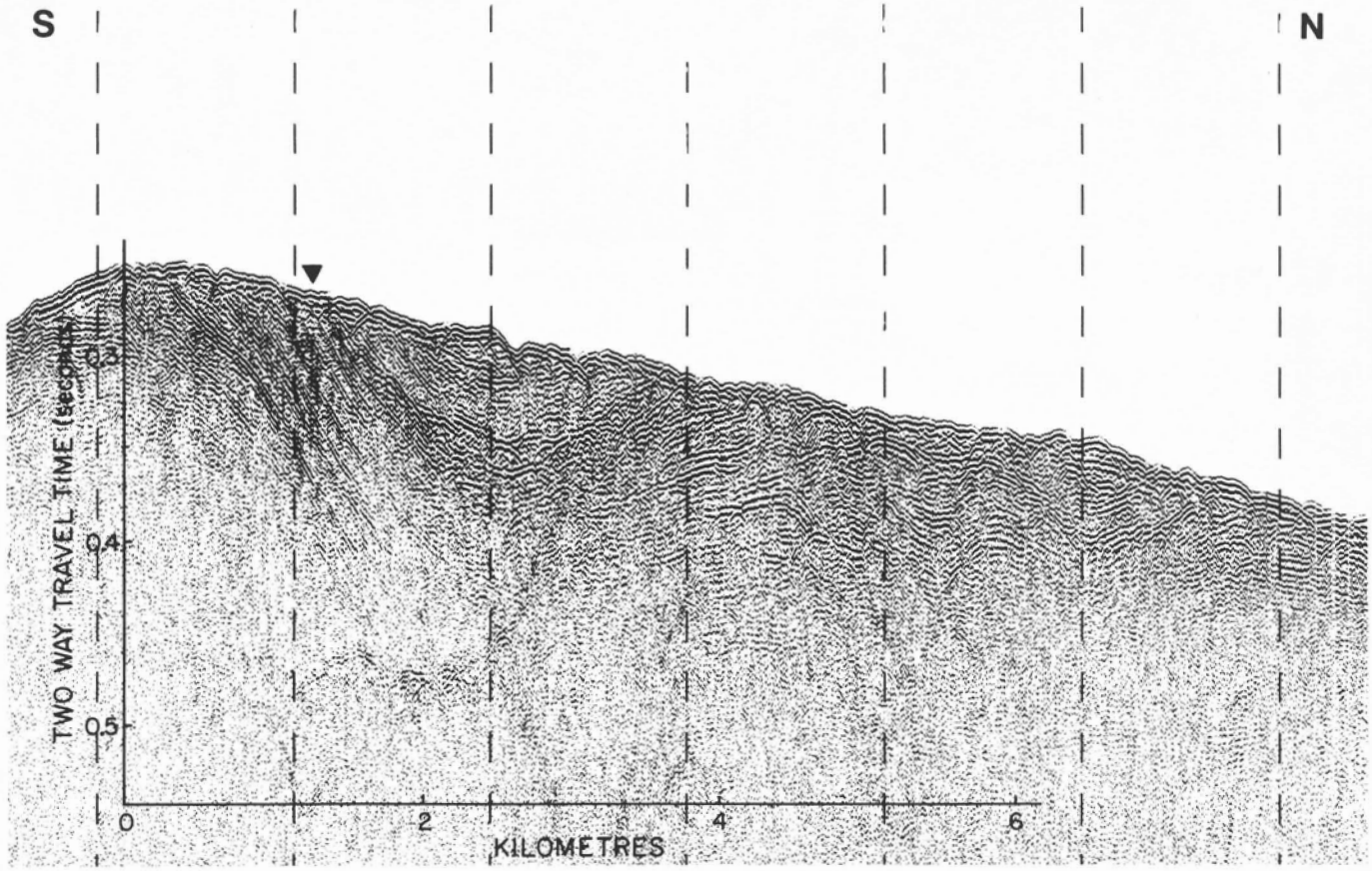

Figure 38.3. *Seismic reflection profile showing northward dipping Upper Cretaceous strata at sample locality in southern part of Home Bay. Solid triangle designates the station 8 and 10 locality (see Fig. 38.1 for location).*

Results from the 1982 Home Bay samples together with those obtained earlier from Buchan and Scott areas indicate that Upper Cretaceous marine strata occur extensively on the northeast shelf beneath a variable cover of Tertiary and Quaternary sediments. The existence of the natural submarine oil seep at Scott Trough and the apparent promising source rock characteristics of Upper Cretaceous strata at Home Bay suggest that the northeast Baffin shelf is a potential area for hydrocarbon resources.

Padloping Island Area

The single core (station 16) recovered from a locality 13 km northeast of Padloping Island (Fig. 38.1, 38.5) was of semiconsolidated fine grained clastic sediment containing coaly fragments. Palynological analyses of the sediment indicated a mixed Cretaceous spore assemblage with no dinoflagellates being seen. It is therefore believed that the sample represents nonmarine deposition. Coaly fragments processed separately contained rich spore assemblages with known Albian affinities (E.H. Davies, personal communication, 1983). Onshore coals of this age are unknown in the region although there are coals in the Bjarni Formation in Labrador Shelf wells (Umpleby, 1979). According to palynological studies referenced in Umpleby (1979), the Bjarni Formation is of Berremian-Aptian age. The only known outcrops of coal on Baffin Island other than those near Pond Inlet far distant to the north, are contained in sediments of Paleocene age underlying volcanic rocks on the coastal islands adjacent to station 16 (Clarke and Upton, 1971).

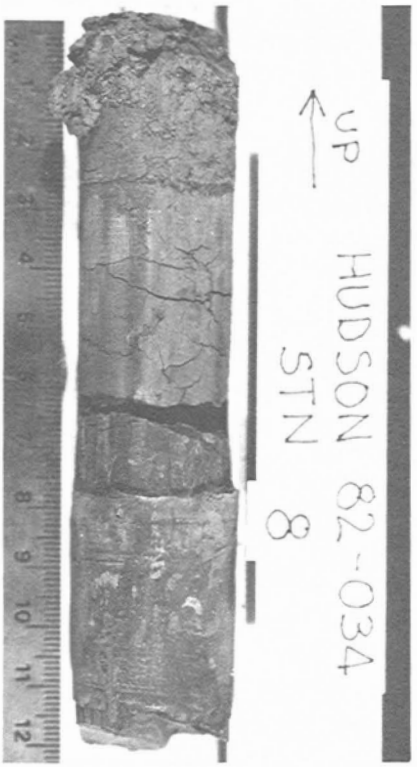

Figure 38.4. *A section of semiconsolidated Upper Cretaceous mudstone core recovered from southern Home Bay locality (station 8) illustrated in Figure 38.3.*

Table 38.1

Stn. no.	Time	Position	Depth (m)	Type and results
1	271/1637	71°15.3'N 70°41.4'W	752	Drill – No sample
2	271/2212	71°15.38'N 70°41.45'W	752	Drill – No sample
3	273/1606	68°52.0'N 65°39.6'W	659	Drill – Recovery: 19 siltstone core (bedrock) 3 cm gravel
4	273/1746	68°52.0'N 65°39.0'W	659	Drill – No Sample
5	273/2045	68°51.74'N 65°40.74'W	674	Drill – Recovery: gravel and small amount of bedrock as at stn. 3
6	273/2319	68°51.87'N 65°40.27'W	530	Drill – Recovery: gravel and small amount of bedrock as at stn. 3
7	274/1248	68°38.3'N 65°40.3'W	457	Drill – Recovery: 17 cm gravel
8	274/2035	68°38.8'N 65°40.2'W	460	Drill – Recovery: 15 cm bedrock (mudstone) 4 cm gravel
9	275/1052	68°38.8'N 65°42.5'W	461	Drill – Recovery: Few pebbles and a mud sample from legs
10	275/1548	68°38.2'N 65°42.0'W	460	Drill – Recovery: 17 cm bedrock (sandstone)
11	275/2300	68°00.0'N 63°13.0'W	795	CTD
12	276/0049	67°48.7'N 63°11.5'W	256	Camera
13	276/0120	67°45.6'N 63°11.0'W	230	Camera
14	275/0311	67°43.6'N 63°02.1'W	129	Van Veen grab
15	276/1310	67°15.5'N 62°11.1'W	274	Drill – No recovery
16	276/1652	67°15.6'N 62°11.3'W	368	Drill – Recovery: 6 cm bedrock (mudstone) 22 cm gravel
17	276/1830	67°15.3'N 62°11.0'W	366	Drill – Recovery: small amount of gravel
18	276/2105	67°08.0'N 61°36.0'W	156	Van Veen grab
19-1	277/0005	66°45.2'N 60°19.2'W	550	Gravity core
19-2	277/0025	66°45.2'N 60°19.2'W	550	Gravity core
20	277/0139	66°44.6'N 59°59.9'W	690	Gravity core
21	277/1205	66°30.38'N 57°53.08'W	569	Drill – Recovery: 14 cm bedrock (basalt) 5 cm gravel
22	277/1300	66°29.94'N 57°52.57'W	569	Drill
23	277/1423	66°30.28'N 57°52.75'W	564	Drill – Recovery: 15 cm gravel
24	282/0914	65°15.05'N 59°13.10'W	428	Gravity core
25	282/0940	65°15.36'N 59°12.6'W	428	Van Veen grab
26	282/1227	64°56.54'N 59°39.5'W	275	Camera
27	282/1325	64°56.67'N 59°39.74'W	377	IKU grab
28	282/1626	64°50.1'N 60°10.5'W	311	IKU grab
29	282/1811	64°59.8'N 60°41.2'W	288	Camera
30	282/1839	64°58.7'N 60°42.9'W	288	IKU grab
31	282/2005	64°55.0'N 61°08.0'W	265	IKU grab
32	282/2127	64°50.6'N 61°32.7'W	247	IKU grab
33	282/2301	65°01.0'N 61°46.0'W	275	Camera
34	282/2325	65°01.18'N 61°48.24'W	274	IKU grab
35	283/0044	64°55.18'N 62°09.48'W	275	IKU grab
36	283/1542	64°50.54'N 64°40.70'W	750	Drill – Mud sample from leg only
37	284/1127	64°48.9'N 64°34.4'W	724	Drill – No sample (lost flushing at 329 cm)
38	284/1157	64°48.99'N 64°34.9'W	724	Drill – Recovery 6 cm bedrock (mudstone)
39	284/1524	64°48.9'N 64°35.7'W	713	Drill – No sample
40	284/1747	64°48.9'N 64°35.7'W	720	Drill – No sample
41	284/2330	64°25.22'N 62°26.38'W	340	Piston core
42	285/0051	64°24.7'N 62°13.0'W	340	Piston core
43	285/0247	64°12.48'N 62°32.48'W	148	Camera
44	285/0305	64°12.6'N 62°32.4'W	148	Van Veen grab
45	285/1038	63°02.45'N 63°19.26'W	148	Van Veen grab
46	285/1048	63°02.06'N 63°19.29'W	148	Camera
47	285/1317	62°39.6'N 62°39.73'W	201	Camera
48	285/1336	62°39.38'N 62°40.16'W	201	IKU grab
49	285/1357	62°39.38'N 62°40.16'W	201	IKU grab
50	285/1457	62°36.90'N 63°02.65'W	214	Camera
51	285/1520	62°36.62'N 63°03.15'W	214	IKU grab
52	285/1607	62°31.72'N 63°15.54'W	220	Camera
53	285/1810	62°10.65'N 63°00.98'W	350	Camera
54	285/1825	62°10.45'N 63°01.91'W	350	IKU grab
55	285/1845	62°10.45'N 63°02.74'W	350	IKU grab
56	285/2055	61°51.01'N 63°39.3'W	523	Piston core
57	285/2200	61°46.75'N 63°49.7'W	512	Piston core
58	286/1901	60°53.24'N 66°11.81'W	690	Drill – No sample
59	286/2105	60°52.0'N 66°11.7'W	710	Drill – No sample
60	286/2232	60°52.83'N 66°12.02'W	710	Drill – No sample
61	288/1940	61°36.7'N 68°32.86'W	295	Drill – Recovery: fragments of core (limestone)
62	288/2045	61°36.8'N 68°33.26'W	295	Drill – No sample
63	288/2248	61°37.0'N 68°36.7'W	295	Drill – No sample
64	289/1220	61°37.79'N 68°41.86'W	293	Drill – No sample
65	289/1524	61°37.56'N 68°40.75'W	293	Drill – Recovery: 8 cm bedrock (limestone)
66	289/1612	61°37.52'N 68°41.02'W	293	Drill – Recovery: 50 cm bedrock (limestone)
67	289/1816	61°36.92'N 68°33.35'W	285	Drill – Recovery: 155 cm bedrock (limestone)
68	290/0734	62°13.3'N 65°40.2'W	311	Piston core
69	290/0905	62°14.9'N 65°35.0'W	315	Piston core

Current meter recovery locations:

HS 1	61°08.6'N 69°28.8'W	HS 4	62°00.5'N 68°09.7'W
HS 2	61°18.1'N 69°07.5'W	HS 5	61°12.3'N 67°22.1'W
HS 3	61°36.8'N 68°50.0'W		

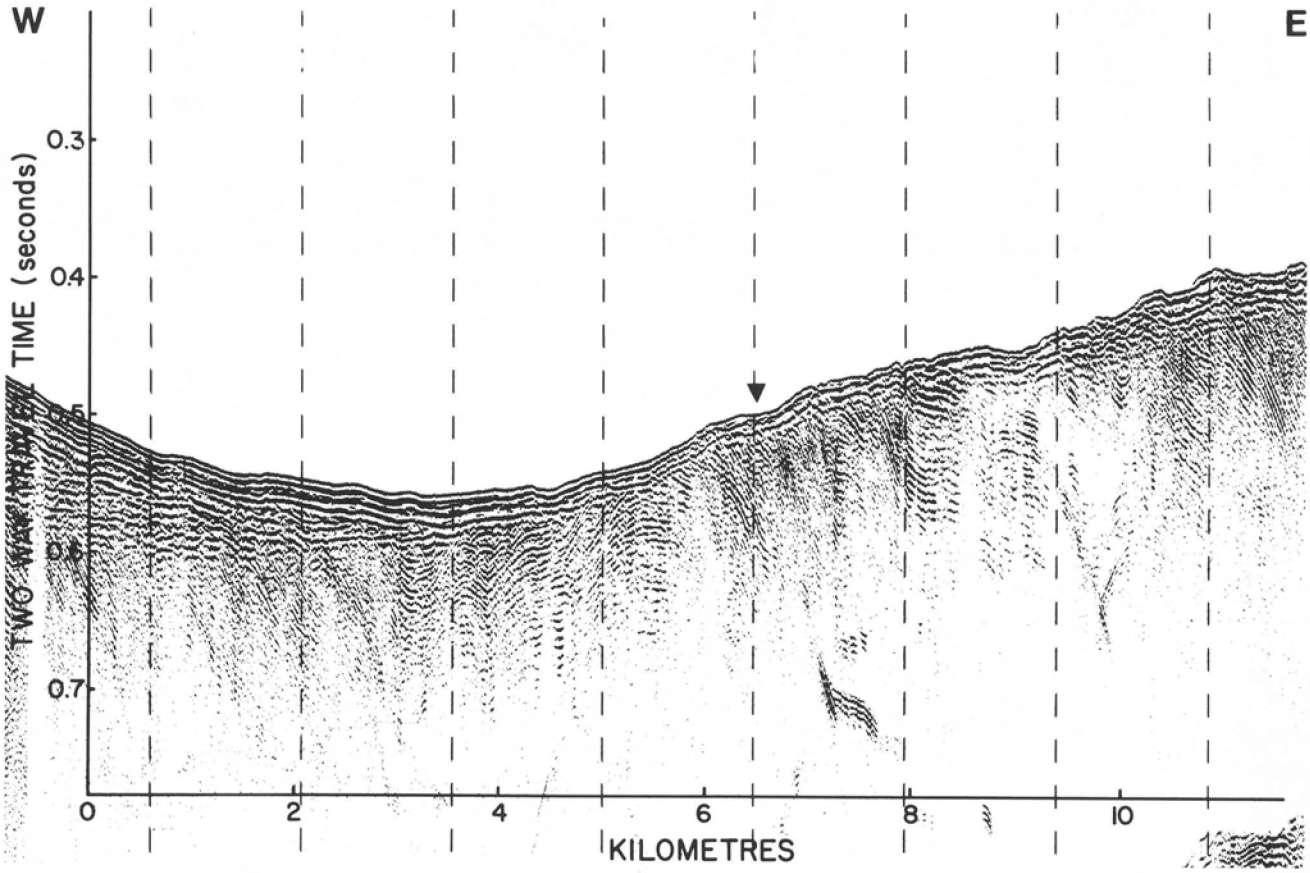

Figure 38.5. *Seismic reflection profile west to east across station 16 off Padloping Island.*

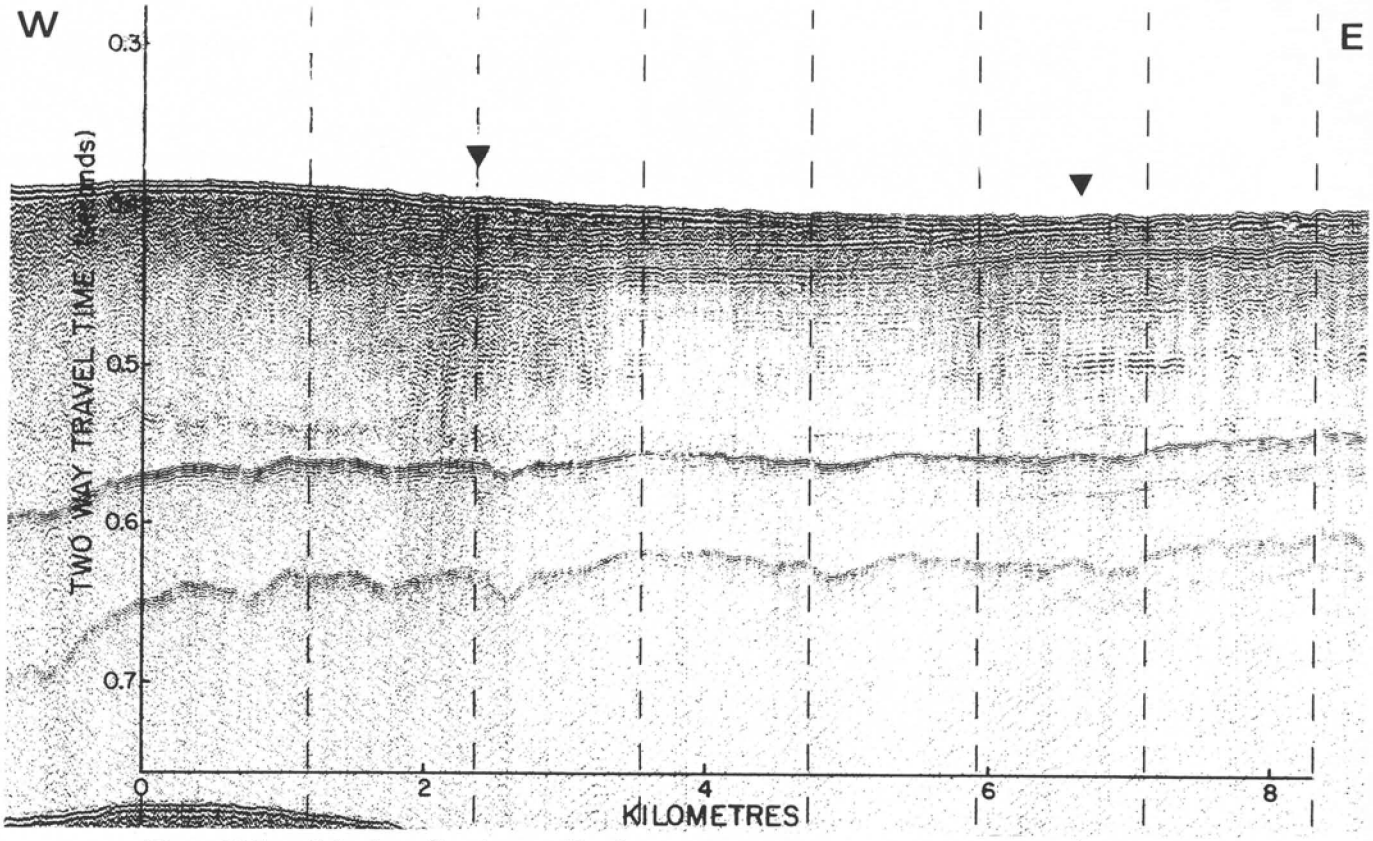

Figure 38.6. *Seismic reflection profile from west to east through sample localities in Hudson Strait, northeast of Cape Hopes Advance (see Fig. 38.1 for location). The profile lies approximately along strike of the strata which dip gently southward at this locality. Triangles indicate locations of stations 66 and 67 to the left and right, respectively.*

Figure 38.7. Section of core of massive limestone from Station 66 in Hudson Strait.

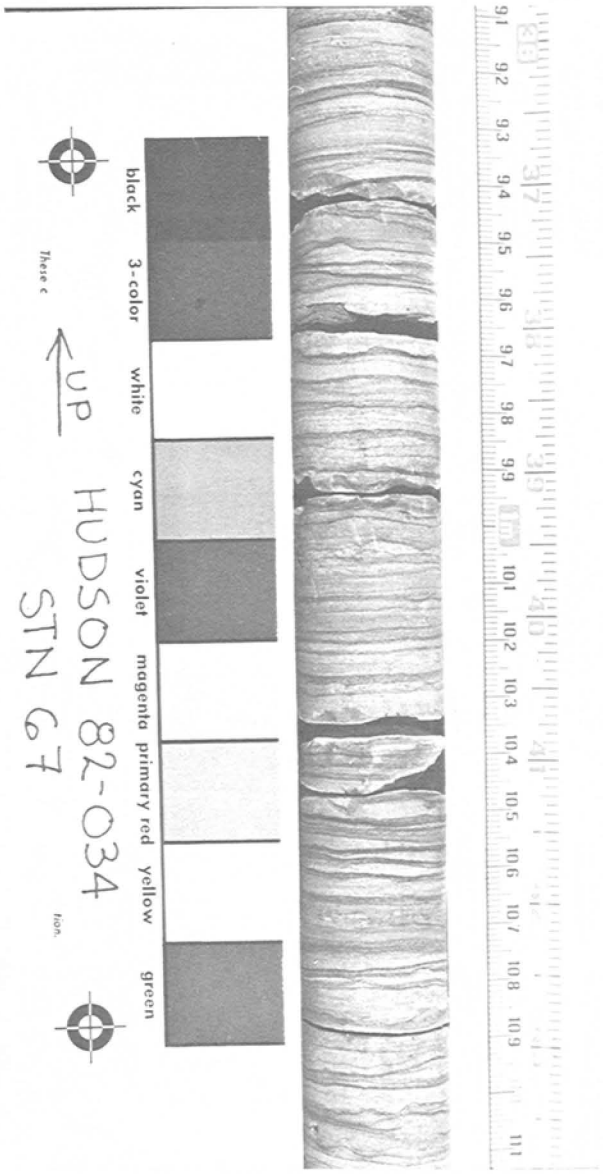

Figure 38.8. Section of core of finely laminated limestone from Station 67 in Hudson Strait.

Cumberland Sound

One short bedrock core of semiconsolidated mudstone was recovered from beneath 8 m of overburden in Cumberland Sound (station 38). The material has been assigned an Aptian-Cenomanian age on the basis of palynomorph assemblages. The core appears to be rich in organic matter, all of which is from a terrestrial source.

Strata underlying Cumberland Sound previously were considered by Grant (1975) to be of Paleozoic-Mesozoic age on the basis of acoustic resemblance to rocks in other east coast offshore areas. Middle-upper Ordovician strata subsequently identified on the adjacent shelf were also thought by MacLean et al. (1982) to be present in Cumberland Sound. The present age assignment indicates that Cretaceous strata are included in the Cumberland Sound succession. This suggests that the Cumberland Sound graben existed in the Cretaceous.

Hudson Strait

Two limestone cores, presumed to be of Early Paleozoic age, were recovered from two localities 4 km apart near the middle of Hudson Strait, northeast of Cape Hopes Advance (stations 66 and 67). Figure 38.6 illustrates a seismic reflection profile through the sample localities. One core was a massive limestone; the other was a finely laminated limestone (Fig. 38.7, 38.8). Paleontological studies of the material are as yet incomplete. Lithologically the samples appear similar to rocks included in the Upper Ordovician Red Head Rapids Formation, described by Heywood and Sanford (1976) from Coats and Southampton islands. These two islands lie 630 km to the west in the northern part of Hudson Bay. Sample and seismic reflection and magnetic data from cruise 82-034, geophysical data acquired by Grant and Manchester (1970), and data from the Premium Homestead Akpatok L-26 drillhole on Akpatok Island in Ungava Bay (Workum et al., 1976) indicate that lower Paleozoic rocks underlie much of eastern Hudson Strait and Ungava Bay.

Surficial Sediments

In addition to the bedrock investigation, surficial sediment samples were recovered using a piston corer and a large IKU clamshell sampler at several localities on the southeastern Baffin shelf. The samples were required for textural and paleontological study to clarify correlations, and to determine depositional environments. Sediments sampled included apparent glacial till, possible proglacial, and postglacial sediments.

Acknowledgments

We are grateful to Captain F.W. Mauger, Officers and Crew of **CSS Hudson** for their excellent co-operation and assistance in carrying out this program. We extend special thanks to F. Learning and D. Wilson of Geomarine Associates Ltd. and to all members of the scientific staff for their dedicated efforts and tremendous support. We are also grateful to A.C. Grant and R.F. Macnab for reviewing the manuscript.

References

Clarke, D.B. and Upton, B.G.J.
1971: Tertiary basalts of Baffin Island: field relations and tectonic setting; Canadian Journal of Earth Sciences, v. 8, p. 248-258.

Grant, A.C.
1975: Geophysical results from the continental margin off southern Baffin Island in Canada's Continental Margins and Offshore Petroleum Exploration, ed. C.J. Yorath, E.R. Parker, and D.J. Glass; Canadian Society of Petroleum Geologists, Memoir 4, p. 411-431.

Grant, A.C. and Manchester, K.S.
1970: Geophysical investigations in the Ungava Bay-Hudson Strait region of northern Canada; Canadian Journal of Earth Sciences, v. 7, p. 1062-1076.

Heywood, W.W. and Sanford, B.V.
1976: Geology of Southampton, Coats, and Mansel Islands, District of Keewatin, Northwest Territories; Geological Survey of Canada, Memoir 382, 35 p.

Levy, E.M. and MacLean, B.
1981: Natural hydrocarbon seepage at Scott Inlet and Buchan Gulf, Baffin Island shelf: 1980 update; in Current Research, Part A, Geological Survey of Canada, Paper 81-1A, p. 401-403.

MacLean, B. and Williams, G.L.
1980: Upper Cretaceous rocks in Baffin Bay; Geological Association of Canada, Program with Abstracts, v. 5, p. 69.

MacLean, B., Falconer, R.K.H., and Levy, E.M.
1981: Geological, geophysical and chemical evidence for natural seepage of petroleum off the northeast coast of Baffin Island; Bulletin of Canadian Petroleum Geology, v. 29, p. 75-95.

MacLean, B., Srivastava, S.P., and Haworth, R.T.
1982: Bedrock structures off Cumberland Sound, Baffin Island shelf: core sample and geophysical data; in Arctic Geology and Geophysics, ed. A.F. Embry and H.R. Balkwill; Canadian Society of Petroleum Geologists, Memoir 8, p. 279-295.

Umpleby, D.C.
1979: Geology of the Labrador Shelf; Geological Survey of Canada, Paper 79-13, 34 p.

Workum, R.H., Bolton, T.E., and Barnes, C.R.
1976: Ordovician geology of Akpatok Island, Ungava Bay, District of Franklin; Canadian Journal of Earth Sciences, v. 13, p. 157-178.