Report of
Atlantic Geoscience Centre Activities
in the Arctic Island Channels
During
CSS Baffin Cruise 87-027

by

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General Information:

BIO Cruise:	87-023
Vessel:	CSS Baffin
Responsible Agency:	Canadian Hydrographic Service
Hydrographer-in-charge:	M.G. Swim
Ship's Master:	Captain N. St. C. Norton
Area surveyed:	Wellington Channel - Lady Ann Strait - Norwegian Bay
AGC survey duration:	August 29 to September 28, 1987
AGC personnel:	Dan Praeg (AGC, party coordinator)
	Eric Clow (Earth and Ocean Research, air gun technician)
	Martin Uyesugi (Seakem Oceanography, Huntec technician)
	Steve Dunnill (PCSP, satellite technician)

Cruise Summary:

The Atlantic Geoscience Centre (AGC) participated in CSS Baffin cruise 87-027 in order to collect geological information on an opportunity basis during Canadian Hydrographic Service (CHS) operations in the Arctic island channels. This program was part of a series of AGC land- and ship-based expeditions to the channels since 1984 (BIO cruises 84-015, 85-027, 85-071, 85-100, 86-023, 86-027, 86-100 and 87-100), including two aboard Baffin (84-015 and 86-023), initiated as part of the Northern Oil and Gas Action Program. NOGAP objectives include determination of the regional character and depositional history of unconsolidated seabed sediments, with a view to identifying geological and geotechnical factors that may pose constraints to engineering development in the interisland channels. Three AGC personnel joined the cruise to collect geophysical records (single channel air gun/sparker and Huntec high resolution seismic reflection profiles, sidescan sonograms, 3.5 and 12 kHz acoustic profiles) and sediment samples (gravity cores and grabs); in addition, one Polar Continental Shelf Project staff member was loaned to the cruise to assist in the use of a weather satellite imaging system for ice data. CHS had 3 proposed survey areas, in order of priority: Barrow Strait south of Bathurst Island, Norwegian Bay/Belcher Channel, and the northeast Baffin Shelf.

The AGC party joined Baffin in Resolute on Aug. 29. The ship then proceeded west to the proposed Barrow Strait survey area, but helicopter reconnaissance showed heavy pack ice drifting east. This area was abandoned, and the ship proceeded toward Norwegian Bay via Wellington Channel. En route, AGC collected a 99 km geophysical line (Table 1) and a gravity core (Table 2) in western Wellington Channel (Figure 1). On arrival in northern Wellington Channel, ice reconnaissance data indicated that Belcher Channel was blocked by pack ice. The ship then returned south, and proceeded to Norwegian Bay via Lancaster and Jones Sounds. En route, AGC collected a 128 km geophysical line in Lady Ann Strait at the entrance to Jones Sound (Figure 1; Table 1).

Baffin entered Norwegian Bay through Hell Gate on the evening of Sept. 2, and remained until Sept. 22. During the 3 weeks of CHS operations, AGC was able to collect 1014 km of geophysical lines (Table 1) and occupy 42 sample stations (Table 2). These data provide extensive coverage of Norwegian Bay south of 77°30'N (Figure 2). Upon termination of the work in Norwegian Bay, Baffin left the area via Cardigan Strait and Jones Sound and steamed south for a crew change and new CHS work area at Nain, Labrador. The AGC party left the ship at Nain on Sept. 29.

Pattern of Operations:

The AGC program was carried out on an opportunity basis, and benefitted from cooperative interaction with CHS. The 2 geophysical lines (and 1 sample) collected en route to Norwegian Bay (Figure 1) involved additional time due to reduced speed and/or course alterations, which could be accommodated within the CHS time schedule. Once in Norwegian Bay a fairly regular pattern of operations was established: CHS would deploy the 6 launches at an 0800 way-point, and recover them at 2100; the ship was available at night, and was often available for at least part of the day. AGC generally collected geophysical records at night, and collected samples when possible during the day. The possible range of AGC operations was somewhat restricted by the intermittent nature of the time available, and the necessity of returning to CHS launch way-points; however, CHS moved their way-points across the bay as the survey progressed, and this extended the regional coverage.

This working pattern was interrupted on several occasions. During days 251-253 and 257-259 seas were too rough for launch work, so Baffin was used by CHS day and night to run closely spaced sounding lines. On the latter occasion ship's speed was reduced to 8 knots during darkness due to ice floes, and this opportunity was taken to run geophysical line L (Figure 1; Table 1) along a CHS sounding line. Extensive ice floes on day 256 precluded running a geophysical line that night. On day 264 AGC collected 2 geophysical lines (Q and R) during the day, as CHS had used the ship the previous night.

Baffin was used by AGC for 14 nights and part or all of 8 days while in Norwegian Bay, a total of approximately 190 hours. This reflects the generally favourable wind and ice conditions, and highlights the complementary nature of the AGC and CHS operations.

Ice Conditions:

This was an extremely good season for surveying in Norwegian Bay, which often remains ice-covered. On arrival Sept. 2, reconnaissance confirmed that Norwegian Bay was open but that Belcher

Channel was blocked by heavy pack ice. During the 3 weeks of the survey this ice in Belcher Channel moved in response to changing wind directions and strengths, often influencing geophysical surveys in western Norwegian Bay. From days 249 to 254 ice moved northeast out of Belcher Channel into Norwegian Bay west of Graham Island; the positions and orientations of parts of geophysical lines F, H, I and J (Figure 1) were dictated by the southern or eastern margins of this ice. On days 255 to 257 ice floes were blown southeast across Norwegian Bay towards Cardigan Strait; geophysical line K was collected in the ice-free southwestern corner of the bay on day 256, but no lines were run the next night due to ice. Southerly winds to gale force on days 257-259 cleared away most of these ice floes. However, on day 260 geophysical line M was turned north and west by a west-moving ice edge indicated by radar, although invisible in the darkness and mist, which in the morning was seen to be a narrow (<100 m) strip of ice floes, probably borne west with the tide.

The formation of sea ice was first noted in eastern Norwegian Bay on day 250 when geophysical line G ran harmlessly through nilus ice for much of the night. Nilus ice was observed forming around the edges of the pack ice in Belcher Channel and west of Graham Island on days 253-255, and on day 256 samples were collected through progressively more extensive nilus ice forming around the ice floes blown across the bay. This new ice was dispersed by southerly gales on days 257-258, but was observed to be reforming during operations in central and eastern Norwegian Bay on days 259-261. On days 262-264 geophysical lines O, P, Q and R were collected in eastern Norwegian Bay, first through nilus ice, and finally (day 264) through small pan ice which in places broke in sheets; the geophysical gear was closely tucked in astern of the ship, initially to minimize hydrophone noise but on day 264 to avoid abrasion. Norwegian Bay was still largely open on day 265 when Baffin left the area for crew-change in Nain, but ice reports indicate it was closed by day 272 (Sept. 29).

Satellite Imagery:

An APT satellite receiving system was installed on Baffin to obtain photographic imagery from high altitude (800-1000 km) American (NOAA 9 & 10) or Soviet (METEOR 2-14 & 2-15) weather satellites. This system was used in the Arctic in 1986 by CSS Hudson with great success to delineate the distribution of sea ice, and was a very valuable aid in planning cruise activities (MacLean, 1986). The system was loaned by the Polar Continental Shelf Project (PCSP), and their satellite technician in Resolute (Steve Dunnill) joined the ship to ensure the electromechanical integrity of the system and to support the collection of images. The system was installed in Baffin's plotting room, connected to the antenna on Monkey Island. Satellite passes were calculated using the program Graftrax II on a Corona PC microcomputer, which was very versatile and convenient.

On joining the ship, test runs showed the images were obscured by random noise (snow) and lineated by 60 Hz hum. The random noise was traced to a fault in the preamp/receiver/frequency synthesizer assembly. A spare receiver/synthesizer was obtained from PCSP at Resolute on Aug. 31, and this problem was resolved. The 60 Hz hum remained a problem throughout the cruise, although it did not ruin the images. Disconnecting the antenna cable stopped the hum, indicating an origin in the antenna/preamp or antenna cable. Several steps were taken to try to eliminate it: (1) ground shield of antenna cable repaired, (2) all short coax cables interconnecting the system replaced, (3)antenna DC power supply examined, no substantial ripple, (4) receiver regrounded, and (5) flourescent lights turned off. The hum may have been directly or indirectly related to a full ground fault reported in the ship.

The satellite images were made on Polaroid 665 positive/negative land pack film, and enlarged prints made from the negatives using a Kodak Daylab portable darkroom. The enlargements generally suffered from poor resolution and/or contrast, making it difficult to distinguish sea ice from the often extensive cloud cover, or to recognize sea ice distributions observed by visual reconnaissance within Norwegian Bay, even on clear days. The images were useful for regional ice distributions when the weather was clear, but the resolution was below that required for work within the bay. This was initially suspected to be due to poor use of the Daylab, and great care was given to focussing and development times, with little effect. The camera itself was re-focussed, which made a slight improvement. Subsequent to the cruise an enlargement was made from one of the negatives by the BIO photography department; this print was also of poor clarity, confirming that the problem was not with the Daylab. Comparison of the images collected by Hudson in 1986 with those obtained this year suggests a possible internal focussing problem with the system.

Navigation:

Prior to day 248 ship's navigation was primarily by radar ranges and/or bearings from adjacent land. Accuracy varied, from 100's of metres in Wellington Channel and Lady Ann Strait where the shorelines are steep, to up to 1000's of metres in Norwegian Bay where shorelines are generally low and inclined. Radar positions obtained during geophysical lines in Norwegian Bay on days 246 and 247 were subsequently adjusted, using a combination of ship's speed and comparison of bottom depths with soundings obtained by AGC and CHS.

Once in the Norwegian Bay area CHS established Siledas and Mini-Ranger navigation beacons along the shores. The Siledas system was available to AGC at night (when the launches were not using it), and allowed highly accurate (10's of metres) positioning of all night-time geophysical lines (and samples 22 and 23). 15 minute fixes and alter/course positions were recorded by bridge personnnel from a video monitor, set to lat/long mode. Subsequent to day 254 a second monitor was established in the afterlab to allow continuous monitoring of course and speed.

Day-time operations (most of the sampling and 2 geophysical lines) relied on radar positioning (100's to 1000's of metres accuracy). Sample sites chosen from the geophysical records were located by a combination of radar and depth positioning, although once on station an accurate (10's of metres) fix could often be obtained from CHS's Mini-Ranger System. Comparison of MRS fixes with proposed site locations indicates the radar and depth positioning was accurate to within 3 km, and generally within 1 km. Geophysical lines Q and R were collected during the day, but are accurate to within 100's of metres due to more precise radar bearings from the steeper shoreline of easternmost Norwegian Bay.

Sampling Operations:

Sediment samples (Figures 1,2; Table 2) were collected with either a Van Veen grab sampler or a Benthos gravity corer, deployed from Baffin's winch room. The corer was used preferentially; the grab was used if the corer failed, or if coarse-grained sediments were expected. Sample sites were chosen from the geophysical records, to examine a range of sediment types and seabed depths. The 12 kHz sounder was used during and between stations to record depth.

The gravity corer was 250 cm from cutter to fins, of which 225 cm was core liner. Five 40 lb weights were initially on the head, but this was increased to six after station 3 to try to increase penetration in the generally resistant sediments of Norwegian Bay. However, even in soft sediments apparent penetrations greatly exceeded core lengths (Table 2); the longest core obtained was 1.2 m, although apparent penetration at this station was 2.5 m. Cores up to 1.9 m were obtained from Baffin in 1986 (Praeg, 1986). It is possible that the spring-loaded one-way valve used this year presented too much resistance to the escaping water; smaller springs or a simple flap system would be useful improvements.

The corer was run out at medium speed until the metre block indicated it was 20-30 m from the seabed, and then at full speed. The grab was lowered at medium speed. As in 1986, the ship's winch often accelerated during payout, especially at higher speeds, producing a rhythmic grinding and jerky line feed. This could be resolved by stopping the winch and then resuming, but during the last 20-30 m of payout it was simply endured. The rythmic motion did not seem to affect the samples in any obvious way, but it sounded hard on the winch.

Geophysical Surveys:

Three main systems were available: (1) shallow air gun or sparker seismic reflection, (2) Huntec DTS high resolution seismic reflection and sidescan sonar, and (3) 3.5 kHz and 12kHz profiling. These systems were operated from Baffin's afterlab, just forward of the quarterdeck where the tow gear, winches and compressor were located; this was a very convenient working arrangement. The Huntec fish was towed directly astern, the air gun/sparker off to one side or the other, and the hydrophone(s) off the port or starboard boom(s). Deployment and recovery were accomplished with the help of one seaman (Seawatch) to run the A-frame, and took 5-10 minutes and 10-20 minutes, respectively. Geophysical lines (Figure 1) were generally run at 5.5 knots, the highest comfortable speed for Huntec, to maximize coverage; on days 262-264 lines Q and R were run at 6 knots due to time constraints. On day 254 a Siledas video monitor was set up in the afterlab to provide continuous readout of course and speed; a doppler speed indicator would have been very useful, especially for Huntec operations.

Acoustic information was recorded on 7 separate graphic recorders, and air gun/sparker and Huntec seismic information were also recorded on magnetic tape (Table 1). Time marks for the 5 EPC recorders were supplied from a +5V TTL fiducial box built for the cruise, which supplied 30 minute marks for the air gun/sparker recorders and 5 minute marks for the Huntec seismic and 3.5 kHz recorders. Time marks for the sidescan recorder were initially provided by a 2 minute contact closure in the systems console clock, but this quit midway through the cruise; 5 minute time marks were thereafter obtained from the Biodal clock in the ship's plotting room, which was also supplying the 12 kHz recorder.

The geophysical gear shared the quarterdeck with the ship's garbage, which became a close relationship at times. Garbage bags and boxes were piled up on the port side for days, burying the hydrophones, air gun hose and small winch, spilling into the compressor, and blocking passage to the port side. Some time was required each day to locate and free the gear, and the smell became offensive. The bags were slashed open and emptied over the side when no room was left, or on request, which provided temporary relief. These working conditions were unsanitary, and at times became hazardous, but there were no other provisions for garbage storage or disposal. Federal regulations tightly constrain the disposal of garbage on industry vessels or platforms working in Canadian waters; it would seem appropriate to take steps to ensure proper treatment of garbage on BIO vessels.

Air gun/sparker seismics

Air gun seismics were collected using one of two Bolt model 600B guns, with 270, 360 or 655 cm^3 chambers (14, 22 or 40 in^3; 14 and 22 with pulse shapers), fed by a RIX BI44 3-stage air compressor (1900 PSI). Firing rates varied with chamber size, from 2.0 sec with the 270 cm^3 to up to 5.0 sec with the 655 cm^3; the 360 cm^3 was used preferentially at a variety of firing rates (see below). An ORE Geopulse sparker towfish was set up as a back-up sound source in case of prolonged air gun problems, and was used on 2 occasions (lines E and F) with an Ignatron trigger at 450J and 2.0 sec firing. The air gun was towed ~30-40 m astern, more or less centered opposite the hydrophone(s); the sparker was towed ~10 m astern. Initially a single NSRF 6 m hydrophone was used to port, but on day 247 (line D) a second was streamed to starboard; the port hydrophone was filtered through a Khron-Hite filter with broadband (~70-2500 Hz) settings to an EPC4600 PGR (**record series A**), while the starboard hydrophone was filtered through the ORE Geopulse receiver with low frequency (~70-1000 Hz) settings and TVG to an EPC4100 PGR (**record series B**). Only the port hydrophone input was taped, on an HP3960 4-channel recorder at 3&3/4 speed initially and 1&7/8 speed after day 247; the recorder had 3 FM record boards, which may affect playback. Both records were collected at a 1 sec sweep speed.

On day 258 records were collected at 8 knots along a CHS sounding line (line L). In this case the air gun and sparker were both deployed, in an effort to use the sparker as a high resolution system. The sparker was used with a Spark-Gap trigger at 475J, firing at 3/4 sec, and was recorded through the starboard hydrophone and Geopulse receiver to the EPC4100. Little penetration was observed, partly due to the resistant seabed sediments.

Persistent problems were initially experienced with the air gun not firing due to formation of ice in the gun. Bringing the gun aboard and hosing it with hot water thawed it, but it would quickly refreeze. De-iciing fluid was added to the high pressure bottle, but was of little help. The gun could often be coaxed into firing by shooting high pressure down the line, and would then continue firing for some time at reduced pressure (1500-1700 PSI) with constant attention; it would not fire at high pressure, and would utimately fail. The gun had to be brought aboard and replaced with a fresh one during the first five lines. On day 247 the compressor was overhauled and the high pressure bottle emptied of several litres of oily water and gunk and cleaned with hot water. On day 255 a 2-gun system was established, T'd off the high pressure bottle. The compressor and bottle were cleaned again. A hot box (insulated and with work lamp) was constructed on the quarterdeck to store the gun(s) when not in use. These initiatives by Eric Clow, and his generally careful attention, greatly reduced gun failures or pressure problems. The 2-gun system was particularly useful, both to reduce down-time and to allow switching of gun sizes for reasons of data quality. Some problems were also experienced with gun failure due to rupturing of the air hose, which was of poor quality, and due to transmission of gunk down the line; the latter continued after the high pressure bottle had been cleaned, suggesting passage of lubricating fluid from the pressurizing stages.

The port hydrophone was damaged during deployment on day 259 when it tangled with the air gun and was pulled over the side. It was recovered on the gun, but was unusable due to damage at the severed lead-in cable. It was replaced with a spare NSRF 6 m hydrophone.

Record quality was very satisfactory (see Figures 3-6). The air gun problems above resulted in data gaps due to gun failure, and variations in paper speed due to changes in firing rate, but these were sporadic. The sparker data collected on lines E and F was comparable to the air gun data in the first 100-200 msec, but lacked in penetration (Figure 3). Little difference in quality or penetration was noted between the 3 air gun chamber sizes used. The broadband and low frequency records were generally similar as well, although one or the other was superior over some features. A problem of interest was a second outgoing pulse observed 40-60 msec after the initial shot, which often produced a second seabed trace (e.g. Figure 6). Second traces of subbottom echoes were rarely observed, suggesting the pulse was high frequency, possibly a second movement of the air gun shuttle. The pulse was observed with all 3 chambers, although the exact time of its appearance varied with the chamber, as well as with gun and hydrophone depths and configurations.

Huntec seismics and sidescan

Huntec seismics were collected using the AGC-3 deep tow fish with a 1000 J boomer source, an LC10 internal hydrophone, and a Benthos MESH 15/10P external (streamed) hydrophone. The fish was towed from a 50 HP Hydromac winch with 1100 m of 21 conductor cable. Input from the internal hydrophone was filtered through the Systems Console ASP to an EPC4100 PGR (**record series A**), and input from the external streamer was filtered through a Khron-Hite 3700R filter to an EPC4600 PGR (**record series B**); both returns were taped on an HP3960 4-channel recorder (Table 1). The system worked well, with only 5 hours lost on the first line due to a trigger problem. The quality of both the internal and external records was affected by harmonic resonant afterglow, or ringing (see Figures 7, 8). This was less pronounced on the internal record, and varied with the geology in that muddy or gravelly/sandy sediments tended not to ring while glacial sediments and bedrock reflectors did. On the external record everything rang, although the addition of a UDI variable gain amplifier on day 248 and variations in filter settings throughout the cruise made slight improvements. The external records were also lineated by 60 Hz hum from a full ground fault in the ship. Despite these problems geological information was generally clear, although resolution was reduced. Replay with different filters may improve some of these records.

Sidescan records (Table 1) were collected using Klein 50 kHz sidescan transducers on the Huntec fish, recorded on a Klein 421T 2-channel graphic recorder; a tape recorder was unavailable. Sidescan records were not collected outside of Norwegian Bay due to other system problems in Wellington Channel, and due to deep water in Lady Ann Strait, but were collected across much of the bay above 250-300 m. Maintaining the fish 50-70 m above the seabed for continuous collection of sidescan was very difficult due to the irregular and poorly charted nature of Norwegian Bay, and required constant attention to fish and bottom depths. After the winch developed problems on day 256, fewer sidescan records were collected. The records obtained are rather one-sided (Figures 9, 10), as the starboard transducer signal was very weak and only returned information when the fish was very close to the seabed (<30 m). Spare 100 kHz transducers were available, but these would have required very close approaches (<30 m) to an unpredictable seabed.

The Hydromac winch was a constant source of trouble. Numerous minor problems were experienced: the remote controls did not work; the rotation direction of the motor was reversed; the spooling mechanism did not work properly; the automatic brake was out of adjustment; there was no manual for any of this. On day 256 the winch failed during recovery; fortunately the fish had been raised to 7 m of water, and was recovered undamaged by grappling the tow fins. The problem was a pin in the directional control valve which had sheared off; it was not found, and although the winch was repaired, confidence in it was low. All of these winch problems (except the remotes) were overcome thanks to the talents of Martin Uyesugi and the resources of the ship's engineering department. However, a reliable winch with functioning remotes would have been better security for an expensive towfish.

3.5 and 12 kHz profiling

3.5 kHz records (Table 1) were collected using an ORE 10 kW transceiver and the ship's hull-mounted transducers (array of 9). A 3.5 kHz pollywog towfish and small hydraulic winch were available, but were not used. The data were recorded on an EPC1600S PGR, as the EPC4100 supplied did not work initially, and was later used for the air gun system. A 0.4 sec sweep and firing rate was used, as this seemed to result in crisper records. Midway through the cruise it was noticed that the bandwidth was centered on 4.5 kHz; this was changed to 3.5 kHz and record quality improved. The records provided subbottom information in areas of mud, and in other sediments locally. As the system was located in the afterlab it was used as the survey's echosounder, to compare bottom depths with the Huntec fish depth and to facilitate log-book keeping.

12 kHz records (Table 1) were collected using a Raytheon 106C-1 transceiver and the ship's hull-mounted transducers, recorded on a Raytheon UGR Line Scan Recorder. This system was mounted in the ship's plotting room. It was turned on during most geophysical lines, and during sampling operations. Records were marred by prominent interference from the 3.5 kHz system during geophysical lines, but provided corroborative information on the distribution of mud.

Data Curation:

Information on navigation, bathymetry (5 minute depths), geophysical surveys, and sampling operations were all recorded in log books during data collection. Geophysical records and tapes, and samples, were labelled according to standard AGC practice. In addition, navigations fixes, geophysical record and tape information, and sample information were entered into Dbase III databases on a Corona PC microcomputer, using a data-entry system currently being developed by AGC Data Section. This system had the advantage of reproducing repetitive information for each entry, thereby reducing the amount of retyping. However, (1) the system was fairly slow in moving to a new entry, or to a different branch of the system, and (2) there was no option to review previous entries or to make corrections once an entry had been made, except by leaving the system and accessing the database directly. These factors tended to offset the advantages of more rapid entry. A combination of direct access to Dbase with reproduction of repetitive information would be an ideal step.

Geological Results:

The geophysical records and sediment samples obtained in Norwegian Bay (Figure 2) provide information on bedrock geology, unconsolidated seabed sediments, and seabed features.

Geophysical records show that the bay is underlain by an acoustically broadly to closely stratified sequence indicative of gently deformed to flat-lying strata of sedimentary bedrock (Figure 3). Angular unconformities within this sequence (Figures 4,5) suggest division into at least 3 units, which probably include correlatives of both the Paleozoic sedimentary strata of Ellesmere Island/Grinnel Peninsula, and the Mesozoic sedimentary strata of Graham and Cornwall Islands. Most of the large-scale morphologic features of the bay have been carved into these units. This is demonstrated by truncated strata on slopes (Figures 3,4), which are common throughout the bay; steeper slopes are often separated by areas of gentler slope, resulting in a broadly 'stepped' appearance. Structural control on morphology may also be important for a few ridges and troughs on the eastern side of the bay (Figure 5), and in Belcher Channel.

Unconsolidated sediments in the bay are thin, generally less than 5 m (Figures 3,7), although thicker accumulations (up to 30 m) occur southwest of Graham Island (Figure 6), on the eastern side of the bay (Figure 5), and locally (Figure 4). The sediments are distinguished from the underlying bedrock by an angular unconformity; this is readily recognized from reflector truncations, but the unconformity surface itself is often poorly defined (Figures 6,7). Two main sediment types are recognized: (1) acoustically unstratified sediments with an irregular surface, which vary in thickness from less than 5 m to accumulations up to 30 m (Figures 5,6), and (2) overlying acoustically transparent (muddy) sediments with a smooth surface (Figure 8), which occur in deeper water both southeast and west of Graham Island, and in the southwest corner of the bay, in thicknesses up to 5 m, 2 m and 3 m respectively. Acoustically stratified sediments occur locally at the base of the mud west of Graham Island (<1 m thick), and at the foot of a steep slope southeast of Graham Island (<6 m thick). The two main sediment types resemble units interpreted as glacial drift and overlying post-glacial mud in other channels of the Arctic Archipelago (MacLean and Vilks, 1986; Sonnichsen and MacLean, in press).

Cores from these two sediment types have not been fully examined, but field observations (Table 2) indicate they are in marked contrast. Cores of the glacial sediments were generally short (<50 cm), and contained a grey to dark grey very stiff, sticky sediment which varied in texture but contained variable amounts of mud and sand with or without gravel. These cores were distinguished by the difficulty involved in washing or scraping the sticky sediment off the outside of the barrel. Cores of the post-glacial mud were up to 1.2 m long, and contained grey, soft mud with or without minor sand and gravel.

Sidescan records from depths above 50 m north of Cardigan Strait, and at depths of 250 m within the strait, show sand patches with bedforms (sand waves, megaripples) overlying a gravelly seabed (Figure 9). Seismic records suggest unstratified glacial sediments in the subsurface. Grab samples indicate that almost the entire seabed area from 30-300 m depth, including the trough running northwest from Cardiagan Strait, consists of brownish to olive green sand and/or gravel, sometimes visible as a thin (<10 cm) lag overlying sediments that contain mud (Figure 2; Table 2). Strong surface currents (up to 3 knots) are well-known in Cardigan Strait/Hell Gate, which is a polynya due to them (Sailing Directions Arctic Canada, 1982). The sample evidence indicates that bottom currents also affect the area, and have reworked a large part of the seabed. Olive green sediments are noted at the surface of many samples across the bay (Table 2), and may be a general indicator of the erosional or depositional influence of bottom currents.

Sidescan records show iceberg scours (Figure 10) at the top of the glacial sediments over much of Norwegian Bay above 200-300 m. Scours are generally 10-40 m wide and 1-5 m deep, and the troughs are often partly infilled by finer sediment. Above 100 m depth north of Cardigan Strait scours are generally shallower and infilled or overlain by sand patches. Above 50 m in this area distinctive narrow (1-5 m) scours are observed which may be of recent origin, but most of the scours observed are probably relict.

Recommendations:

(1) The APT satellite system problems should be resolved prior to the next field season. The system should also be tested on board ship prior to departure from BIO.

(2) Arrangements should be made for a more accomodating relationship between the geophysical gear and the ship's garbage on Baffin's quarterdeck. Steps should be taken to ensure proper storage and disposal of garbage on all BIO ships.

(3) Modifying or replacing the one-way valve system in the gravity corer should result in longer cores. Almost complete apparent penetrations observed in soft sediments suggest that a longer barrel could be used for these sites.

(4) The ship's winch could be examined for wear, and an attempt made to stop the rythmic grinding during payout.

(5) A doppler speed monitor in the afterlab would be very useful for geophysical surveys, especially for Huntec operations.

(6) The Huntec Hydromac winch had problems when it left for the field, and was of even more questionable reliability after it failed and the broken pin remained missing. The winch should be overhauled, the pin found or determined to be gone, and the remotes fixed.

(7) The starboard sidescan transducers should be repaired.

(8) The RIX BI44 compressor appeared to be passing lubricating fluid from the pressurizing stages into the bottle, and thence to the gun. This unit should be overhauled.

(9) The two-gun system T'd off the high pressure bottle was very useful, as was the hot box, and these should be available for future Arctic cruises.

Acknowledgements:

The success of this program reflects the influence of numerous individuals and groups. I wish to thank the Master, officers, crew and technicians of CSS Baffin for their cooperation during the survey operations; the Canadian Hydrographic Service staff, led by Bud Swim and John Ferguson, for their interest and support; the Polar Continental Shelf Project, for accomodations in Resolute and the loan of Steve Dunnill and the satellite imaging system; AGC Program Support for preparing the geophysical and sampling gear; Eric Clow and Martin Uyesugi for their energy, enthusiasm and interest in all phases of the program; the Northern Oil and Gas Action Program for financial support for this program; and Brian MacLean and Gary Sonnichsen for advice and encouragement, and for critically reading this manuscript.

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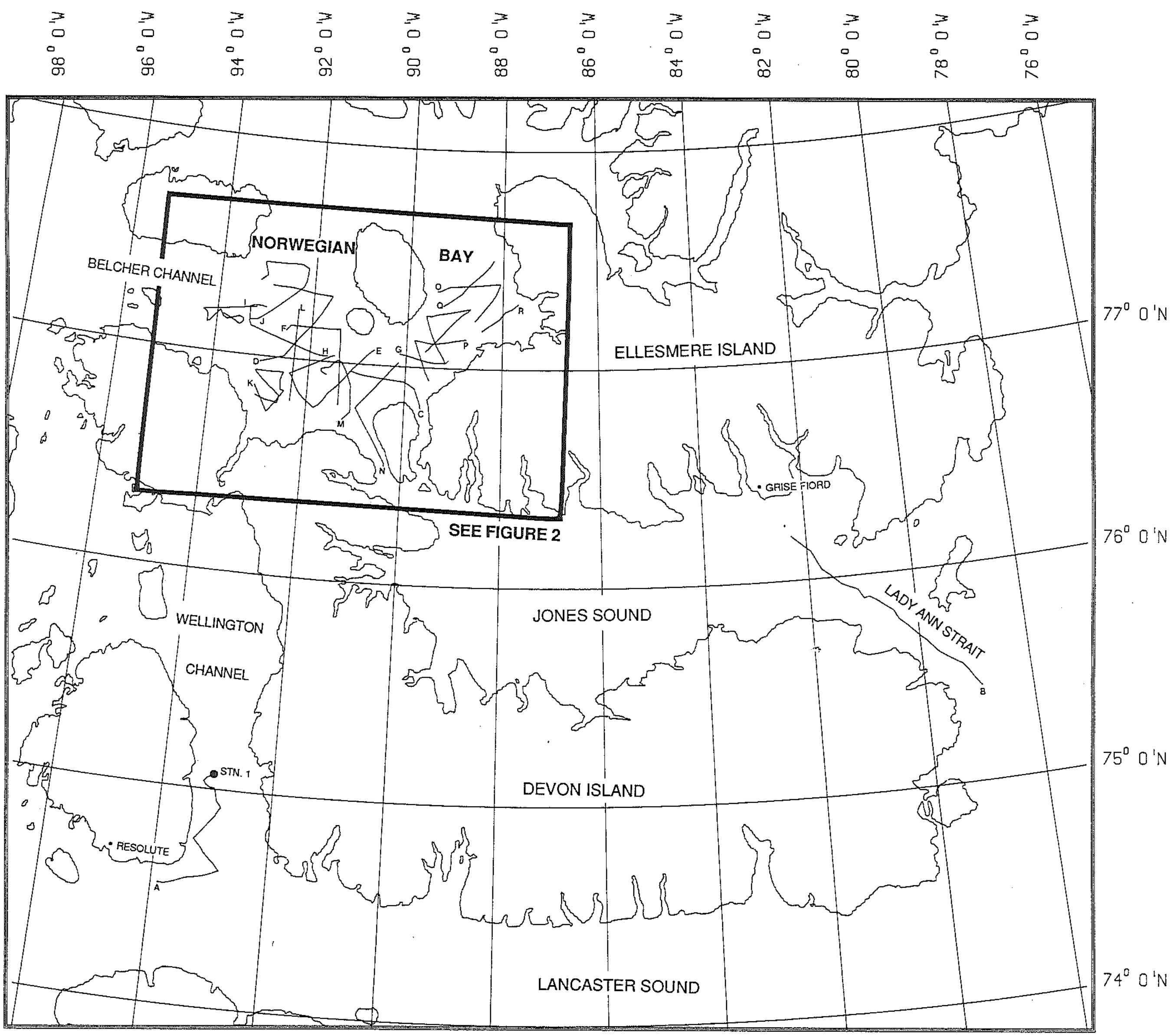

Figure 1 - Index map showing 87-027 geophysical lines A to R (see Table 1) and sample station 1. Sample stations in Norwegian Bay are indicated on Figure 2. For sample information see Table 2.

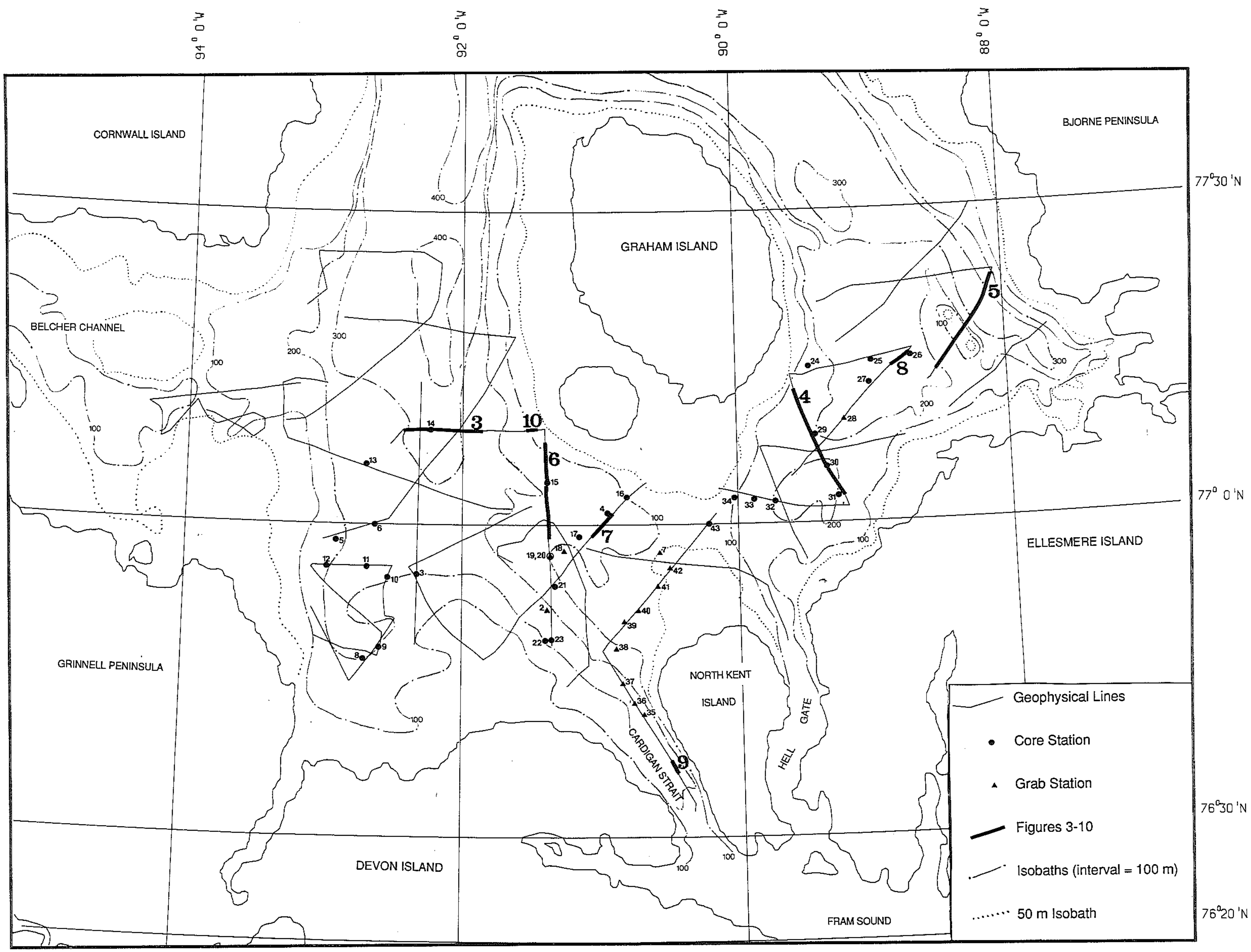

Figure 2 - 87-027 geophysical tracks and sample stations in Norwegian Bay. The locations of Figures 3-10 are indicated. For sample information see Table 2. Bathymetry is from CHS Chart 7950 (uncorrected for this survey).

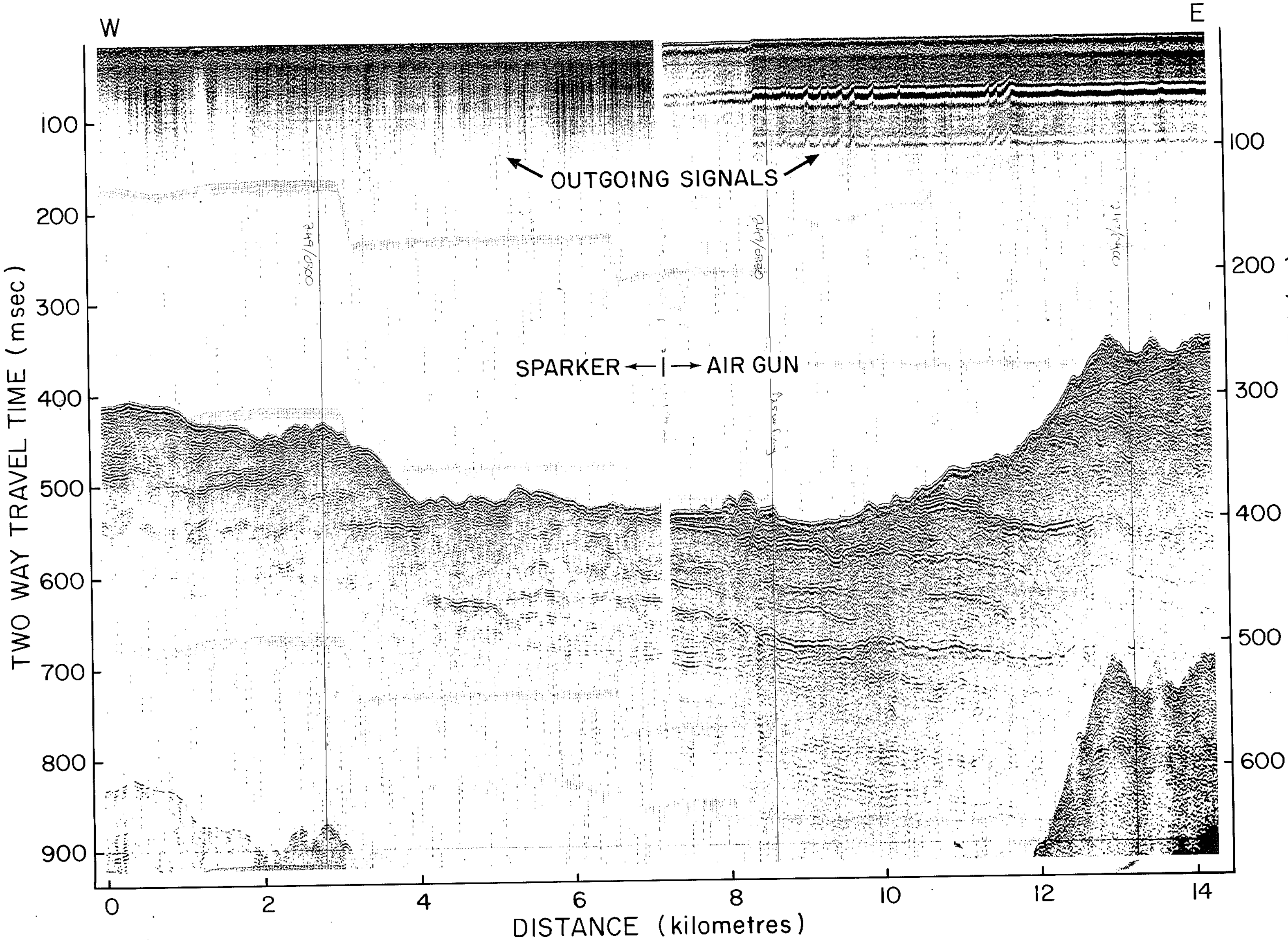

Figure 3 - Seismic reflection profile illustrating the transition from a 450J sparker source to a 360 cm^3 air gun source. The record shows gently deformed sedimentary strata underlying Norwegian Bay, with a thin cover of unconsolidated sediments. See Figure 2 for location.

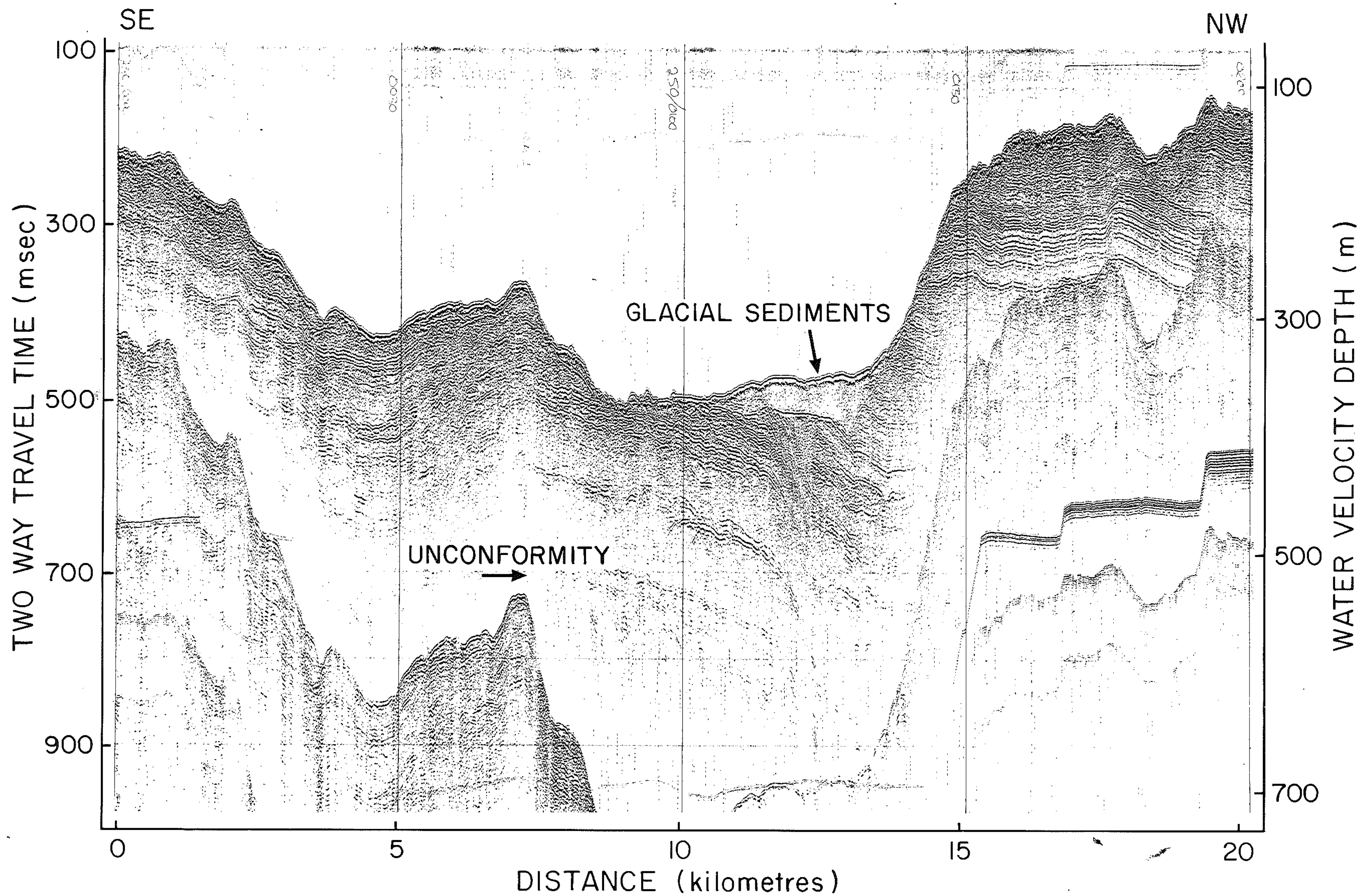

Figure 4 - 360 cm^3 air gun seismic reflection profile showing a lobe of glacial sediments occupying the floor of a trough, which has been eroded into the sedimentary strata of Norwegian Bay. Note the fault directly beneath the lobe, and the angular unconformity within the bedrock strata faintly visible from 8-13 km along the profile. See Figure 2 for location.

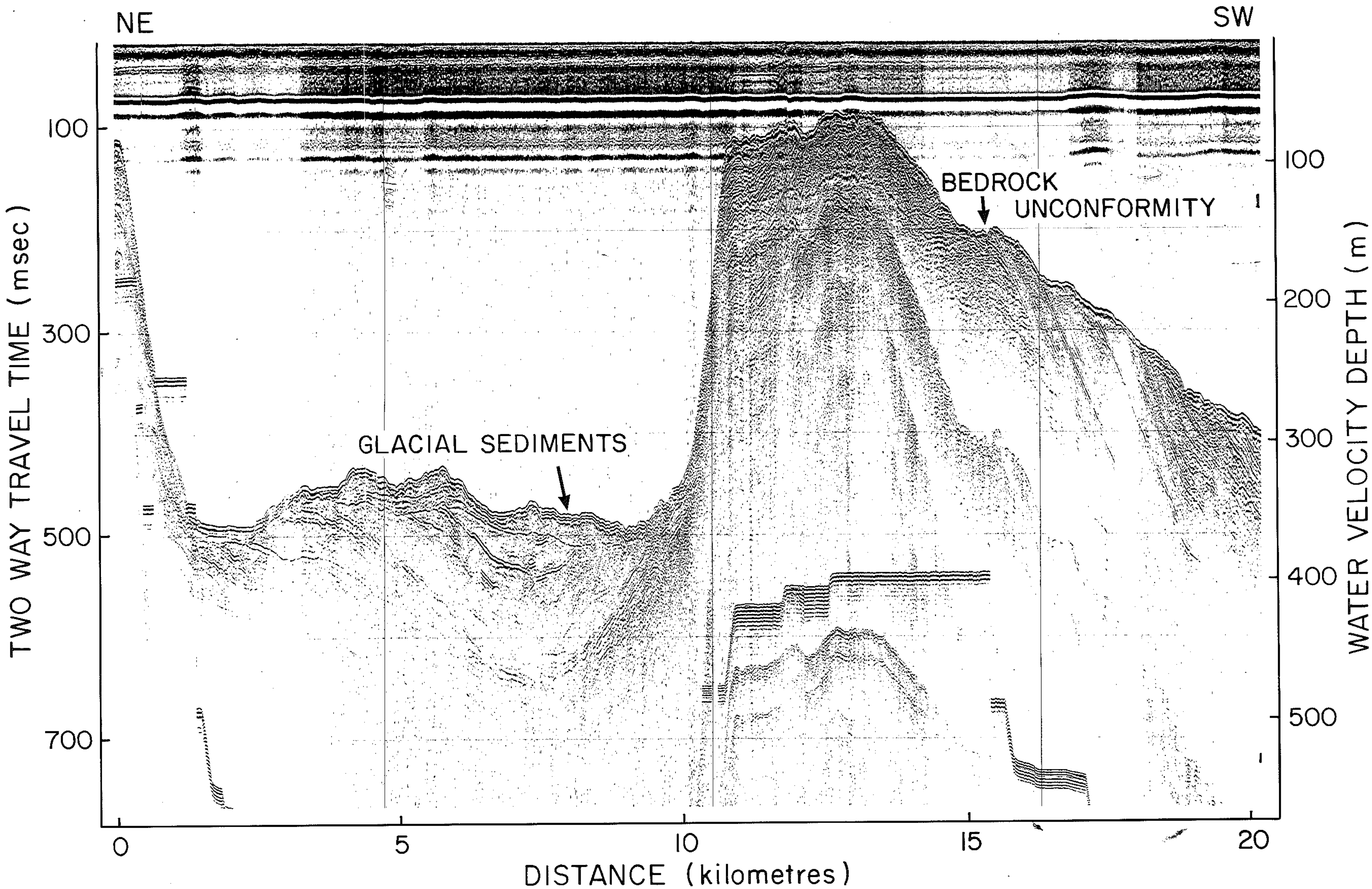

Figure 5 - 360 cm^3 air gun seismic reflection profile showing a ridge of older sedimentary strata (10-15 km along the profile) flanked by younger strata; an angular unconformity is visible on the southwest side of the ridge. Unconsolidated sediments up to 25 m thick overlie the bedrock strata from 2-10 km along the profile; high frequency records indicate a thin (<3 m) cover of mud across this interval. See Figure 2 for location.

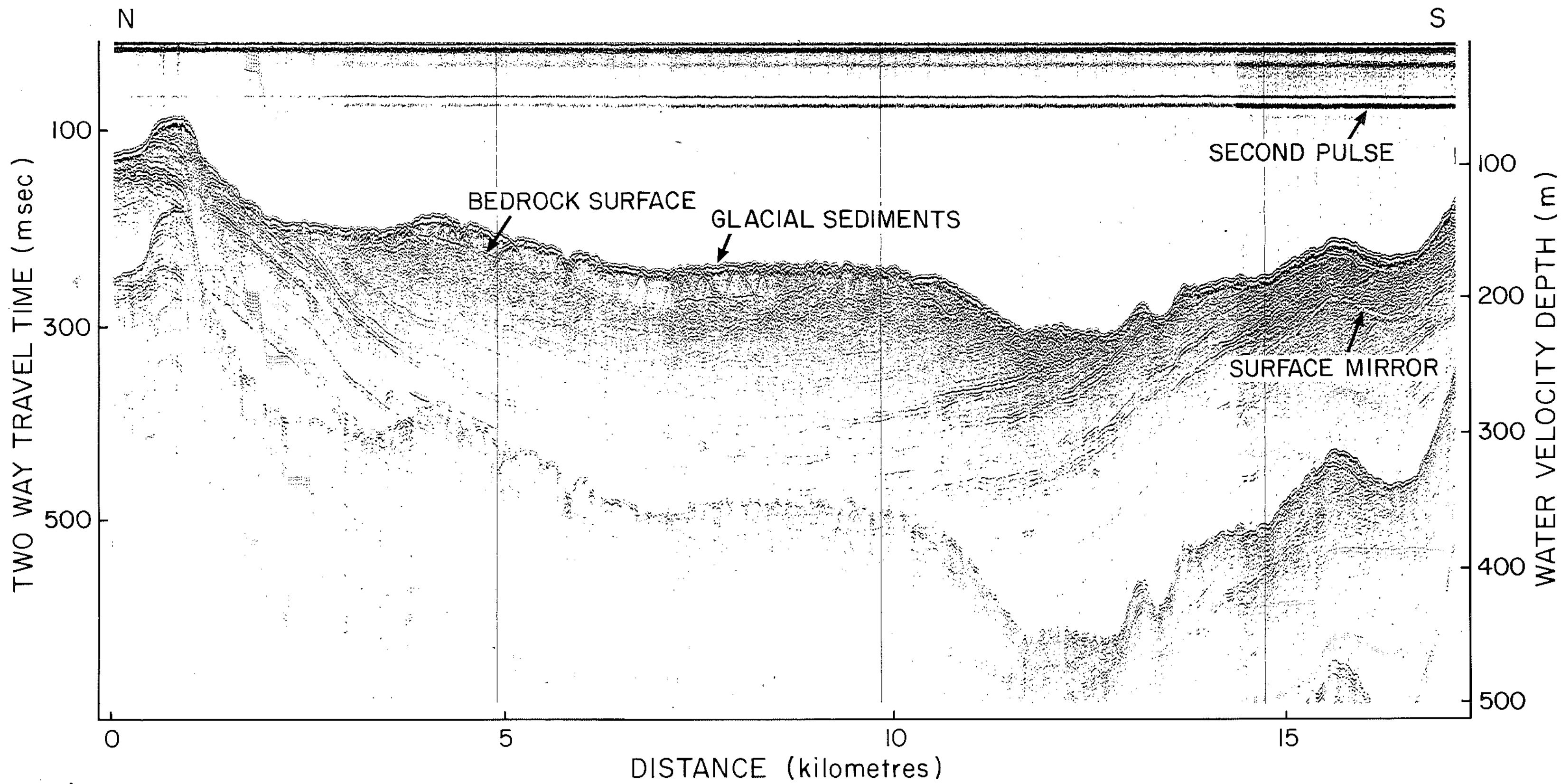

Figure 6 - 360 cm^3 air gun seismic reflection profile showing an accumulation of up to 30 m of glacial sediments overlying gently deformed sedimentary strata. Note the second outgoing pulse at the top of the record, and the second seabed trace visible from 15-17 km along the profile. See Figure 2 for location.

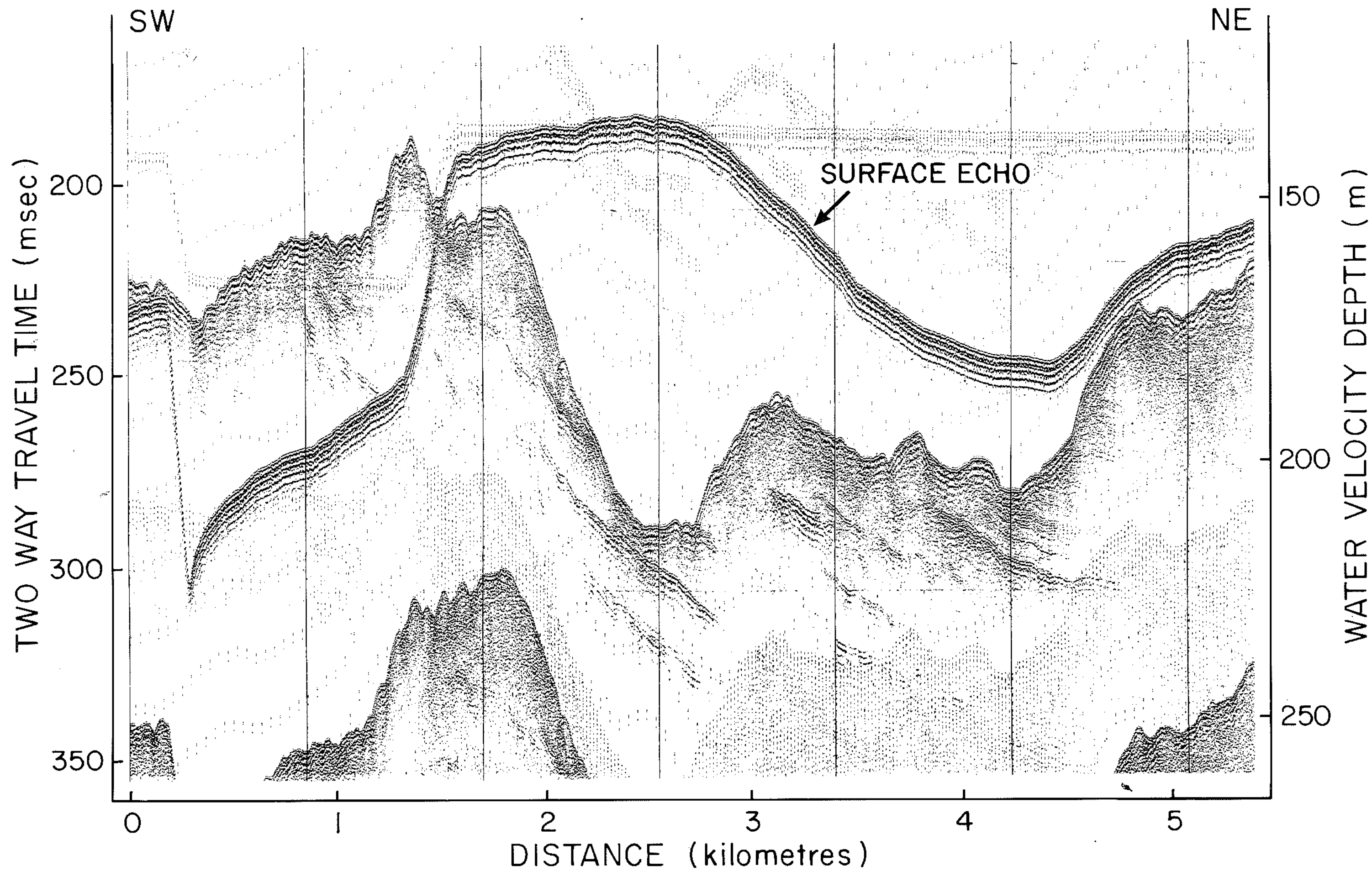

Figure 7 - Huntec high resolution seismic reflection profile (external hydrophone) showing dipping reflectors of sedimentary bedrock; the unconformity surface is not resolved, but reflector truncations suggest a generally thin cover of unconsolidated sediments, with a thicker (<15 m) accumulation locally at 3 km. Note the width of seabed and subbottom reflectors (ringing).

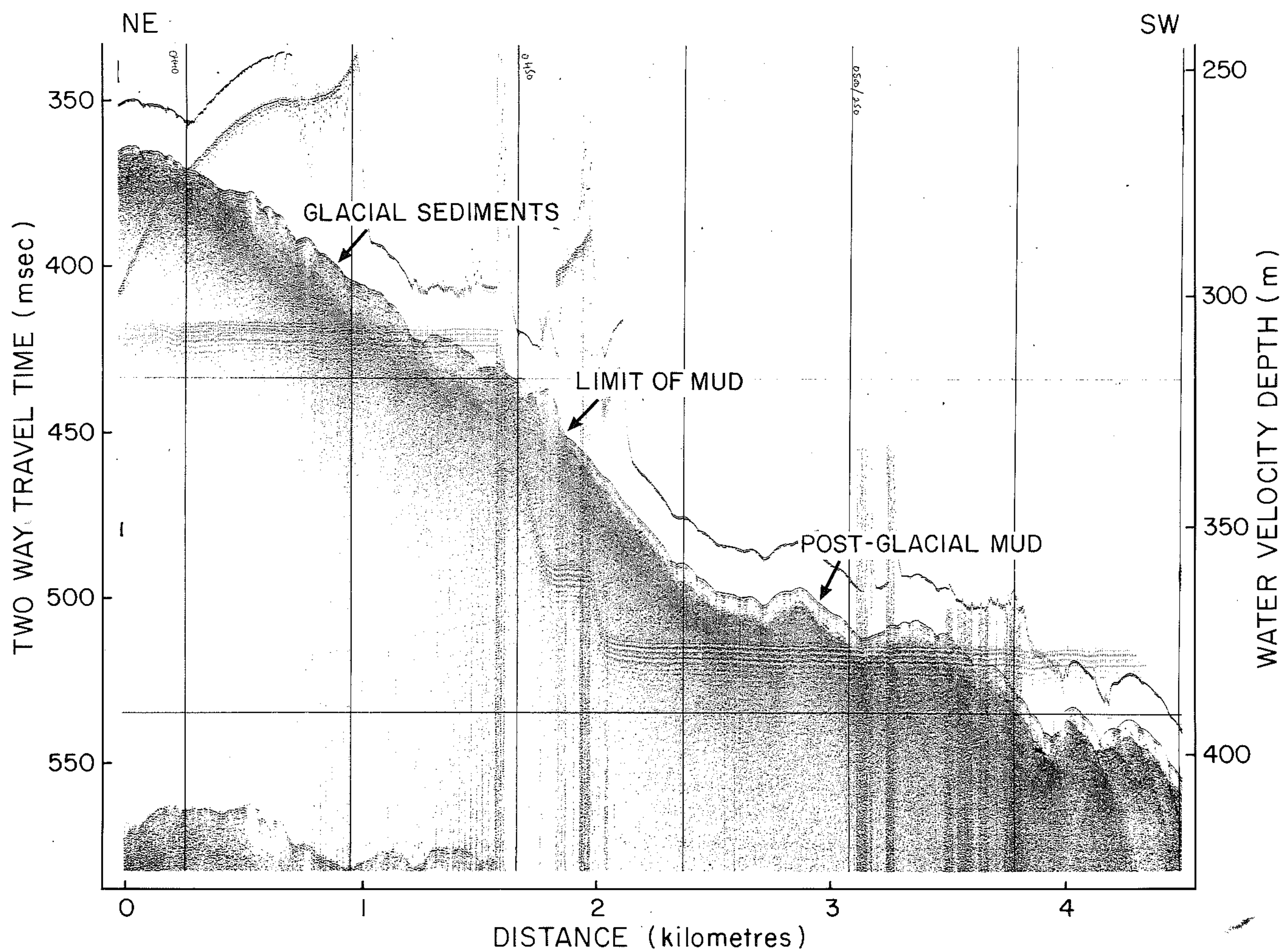

Figure 8 - Huntec high resolution seismic reflection profile (internal hydrophone) showing post-glacial mud at the seabed below 325 m. Note the ringing at the surface of the glacial sediments above 325 m.

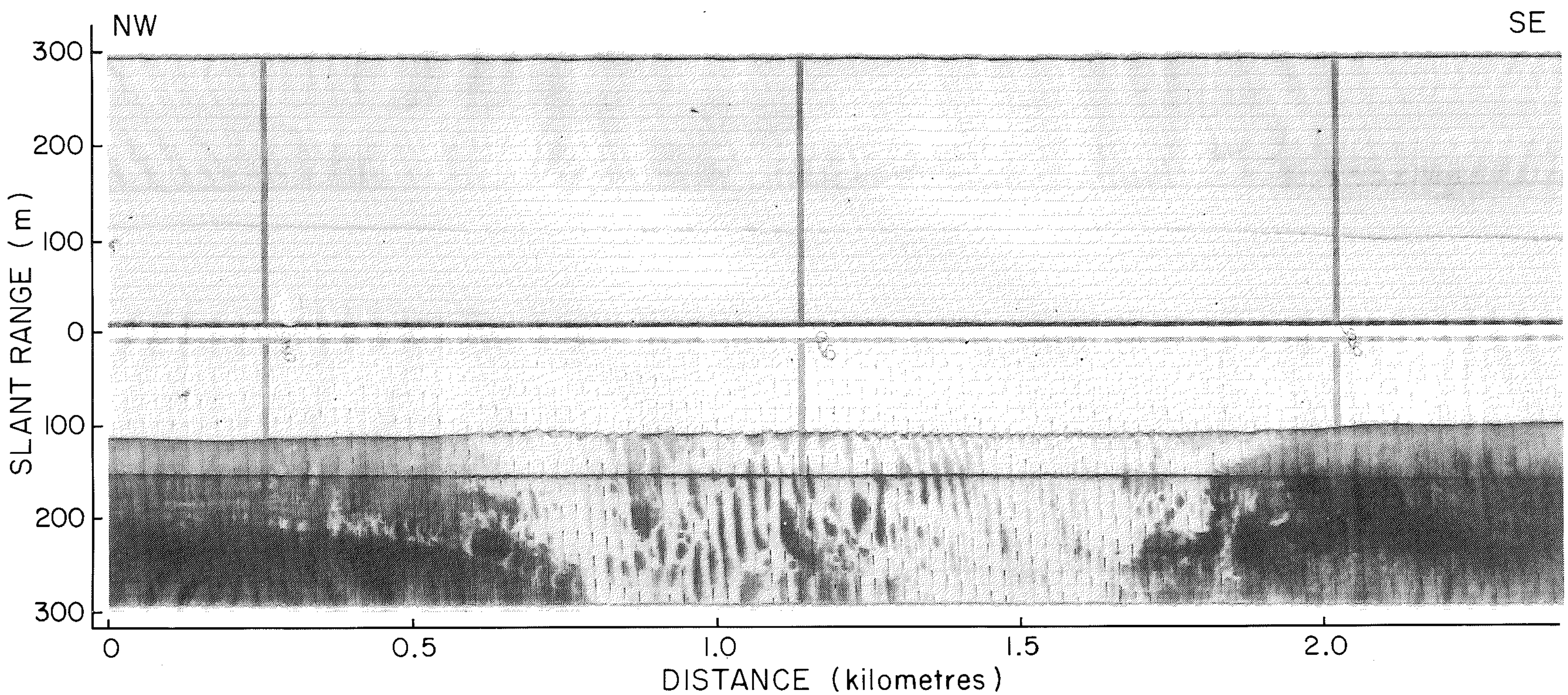

Figure 9 - Huntec 50 kHz sidescan sonogram showing sand (light tone) with linear bedforms overlying a gravel lag (dark tone) in approximately 240 m of water in Cardigan Strait. The starboard sidescan transducer was not functioning properly.

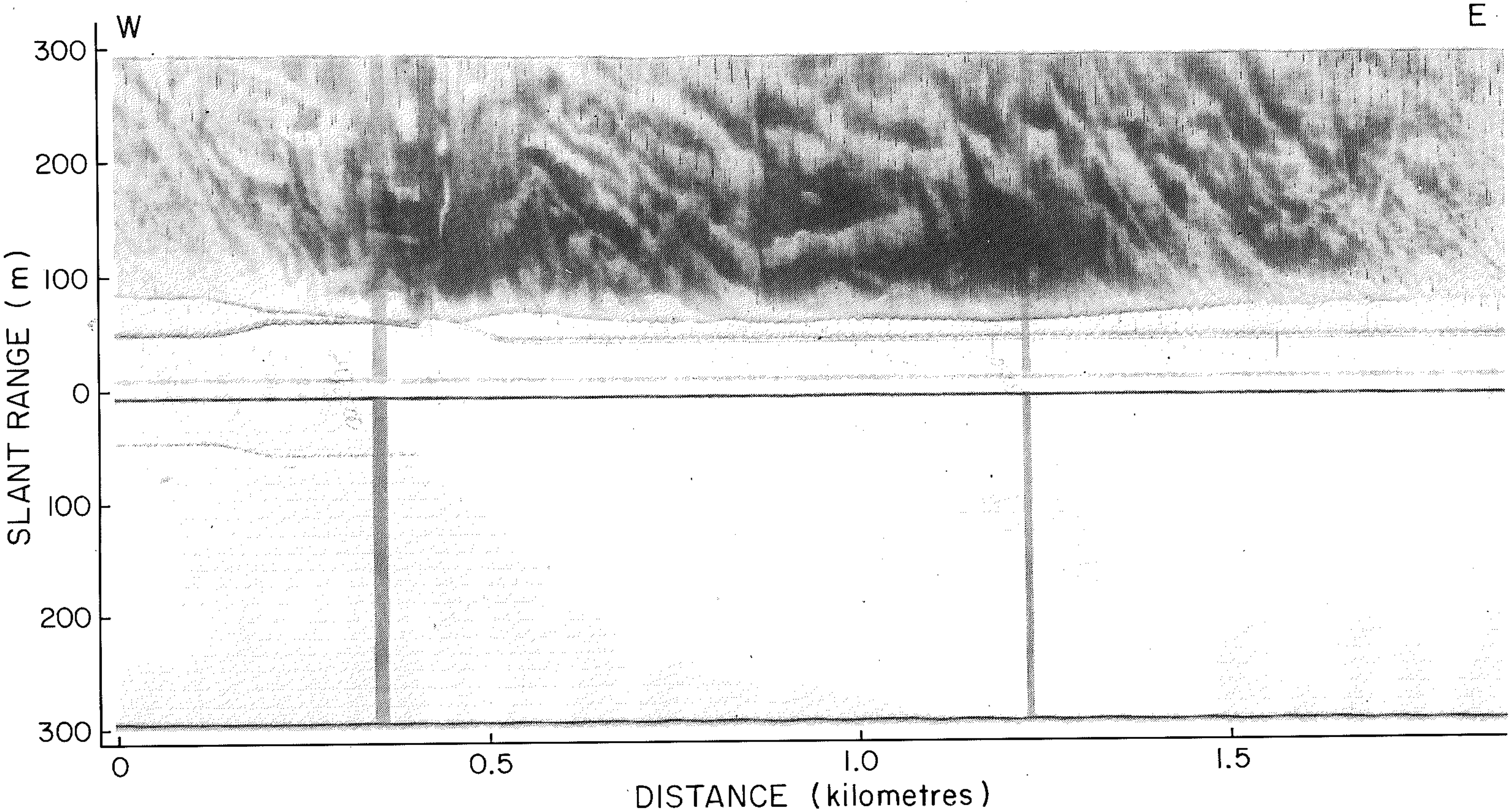

Figure 10 - Huntec 50 kHz sidescan sonogram showing iceberg scour lineations on the surface of glacial sediments in approximately 80-100 m of water in Norwegian Bay. The light tone of the scour troughs may partly reflect infilling by sandy sediments. The starboard sidescan transducer was not functioning properly.

TABLE 1
87027 GEOPHYSICAL SUMMARY

Line	Recording Interval	Air Gun/Sparker ROLL #	Air Gun/Sparker TAPE #	Huntec ROLL #	Seismics TAPE #	Huntec ROLL #	Sidescan INTERVAL	3.5 kHz ROLL #	12 kHz ROLL #	Distance Km
A	242/0200 242/1135	1	1-2	1(A,B)	1-2	-	-	1-2	1	99
B	244/2130 245/0900	2	3-4	2(A,B)	2-3	-	-	3	2	128
C	246/0123 246/0530	3	5-6	3(A,B)	4-5	1	All	4	3	44
D	247/0045 247/1000	4(A,B)	6-7	4(A,B)	5-7	2	0219-0730	4-5	3	83
E	248/0040 248/0930	5(A,B)	7-8	5(A,B)	7-10	3-4	0113-0920	5	3	90
F	249/0230 249/0900	6(A,B)	8-9	6(A,B)	10-12	5	0438-0912	6	4	68
G	249/2120 250/0800	7(A,B)	9-11	7(A,B)	12-15	6-8	2134-0100 0134-0355 0636-0801	7	4	105
H	251/0137 251/0730	8(A,B)	11-12	8(A,B)	15-17	9-10	All	8	4	61
I	254/0230 254/1020	9(A,B)	12-13	9(A,B)	17-19	11-13	All	9	5	73
J	255/0100 255/0830	10(A,B)	13-14	10(A,B)	19-20B	14-15	0114-0335 0652-0830	10	5	77
K	256/0030 256/0900	11(A,B)	14-15	11(A,B)	20B-22	16-18	All	11	6	89
L	258/0334 258/0640	12(A,B)	15-16	--	--	--	--	12	7	47
M	260/0357 260/0835	13(A,B)	16	12(A,B)	23-24	19	0509-0836	13	7	49
N	261/0320 261/0930	14(A,B)	16-17	13(A,B)	24-25	20-21	All	14	8	66
O	262/0306 262/0803	15(A,B)	18-19	14(A,B)	26-27	22	0705-0805	15	8	56
P	263/0215 263/0632	16(A,B)	19	15(A,B)	27-28	23	All	16	9	48
Q	264/1339 264/1645	17(A,B)	19-20	16(A,B)	28-29	--	--	17	9	35
R	264/1823 264/2020	17(A,B)	20	16(A,B)	29-30	24	1950-2026	17	9	24
										TOTAL= 1241 Km

87027 SAMPLE STATIONS

Station #	Day/Time GMT	Latitude Longitude	Depth (m)	Sample Type	Core App. Penet. (cm)	Core Length (cm)	Station Notes
1	2421210	75° 04.0' 93° 05.0'	209	CORE	170	80	*Target: mud, western Wellington Channel *Core top: olive green sticky mud (clay); 1 vial subsample *Core bottom: greyish brown gravelly sandy mud; 1 vial subsample
2	2491445	76° 51.85' 91° 23.38'	313	GRAB	--	--	*Target: thin glacial sed on slope/bedrock, 248/0637, 300m. *Grab attempted after gravity corer failed. *1st attempt empty. *2nd attempt 1/2 full of olive green cohesive muddy sand with some gravel (pebbles-cobbles, subangular-subrounded), pebbly surface lag (stained, encrusted). Larger gravel put in separate bag, including some unstained (subsurface) angular gravel.
3	2491605	76° 55.3' 92° 19.5'	206	CORE	30	15	*Target: thin glacial sed on slope/bedrock,248/0300-15, 200m. *Mud on one side of barrel for 2m - core fell over. *Core: mud, top few cms brownish, rest grey. Some gravel - pebbly sandy layer with shell frags visible through liner.
4	2502314	77° 01.17' 90° 57.07'	140	CORE	100?	25	*Target: thin glacial sed over bedrock, 248/0837, 150m. *Sed coated around lower 20cm of barrel, and on opposite sides of lower 100cm in a striped pattern - core may have fallen over. *Core & sed on barrel consist of a dark grey, stiff sticky sandy mud with a few granules. Coating on barrel hard to remove.
5	2542035	76° 58.5' 92° 54.5'	211	CORE	40	15	*Target: thin glacial sed, 247/0100, 240m. *Sed on barrel for 1m, but upper 60cm discontinuous and striped - core fell over. *Core split, then reassembled and put back in liner. *Core: 12cm olive green sandy mud with a few pebbles, worm tubes and rusty burrows, and cse sand lenses near the base, overlies 3cm greyish muddy cse sand.
6	2542123	77° 00.0' 92° 38.0'	215	CORE	145	60	*Target: accumulation of glacial sed, 247/0200, 220m. *Lower 50cm of sed on barrel greyish and gritty, upper 1m olive green and fine. *Core top: olive green slightly sandy mud. *Bottom: greyish gravelly muddy sand (med-cse).
7	2551908	76° 57.37' 90° 34.40'	92	GRAB	--	--	*Target: sand bedforms, 246/0415, 50m. *Grab attempted after gravity corer failed twice. *Small amount of olive green slightly muddy sand (med-fine) with pebbles (subangular-subrounded, stained). Worm tubes, 1/2 bivalve shell, and orange blob (anenome?).

87027 SAMPLE STATIONS (continued)

Station #	Day/Time GMT	Latitude Longitude	Depth (m)	Sample Type	Core App. Penet. (cm)	Core Length (cm)	Station Notes
8	2561420	76° 47.1' 92° 42'	184	CORE	190	95	*Target: thin mud/glacial sed, 256/0145, 190m. *Penetration to halfway up weights. *Core top: olive green mud (silty clay), 1 pebble. *Bottom: grey mud (silty clay), some sand.
9	2561503	76° 48.2' 92° 35.5'	142	CORE	110	45	*Target: iceberg scoured glacial sed, 256/0740, 150m. *Sed on barrel olive green mud at top grading down through brownish mud to stiff greyish gritty mud. *Core top: olive green sandy mud with gravel (encrusted) and shells. *Bottom: greyish sandy mud with granules.
10	2561559	76° 55.0' 92° 32'	215	CORE	150	85	*Target: mud?/stratified seds, 256/0345, 235m/ *Mud on barrel olive green at top grading to greyish in lower 50cm. *Core top: olive grey silty clay. *Bottom: brownish silty clay.
11	2561633	76° 56.0' 92° 41'	266	CORE	115	55	*Target: mud/glacial sed, 256/0430, >240m. *Wire wrapped around core head on recovery. *Sed on barrel mix of olive grey and green. *Core top: olive grey sandy mud. *Bottom: greyish sandy mud.
12	2561713	76° 56.0' 92° 58.5'	202	CORE	40	25	*Target: scoured strat(?) seds/bedrock, 256/0515, 200m. *Sed on barrel to weights (170cm) but on one side and striped above 40cm; sed olive green sandy mud to greyish cse sandy mud. *Core top: olive grey sandy mud. *Bottom: greyish sandy mud, coarser, stiffer.
13	2561830	77° 05.7' 92° 42'	266	CORE	165	30	*Target: strat(?) seds, 251/0420, 270m. *Sed on barrel olive grey to brownish sandy mud grading down to grey cse sandy mud near cutter. *Core top: olive grey to brownish sandy mud. *Bottom: grey sandy mud with gravel.
14	2561925	77° 09.0' 92° 14'	399	CORE	110	55	*Target: mud/bedrock, 249/0325, 390m. *Sed on barrel olive grey to grey silty mud. *Core top: olive grey slightly sandy mud. *Bottom: grey sticky clay.
15	2591502	77° 04.0' 91° 23'	169	CORE	60	40	*Target: glacial sed accumulation, 249/0615, 170m. *Mud on barrel grey, sticky, hard to wash off. Gravel fragments on cutter. *Core top: grey sandy mud, top few cms soft over stiffer. *Bottom: dark grey silty mud (fine sand?), stiff, sticky.

87027 SAMPLE STATIONS (continued)

Station #	Day/Time GMT	Latitude Longitude	Depth (m)	Sample Type	Core App. Penet. (cm)	Core Length (cm)	Station Notes
16	2591621	77° 02.63' 90° 48.22'	89	CORE	70	45	*Target: thin glacial sed/bedrock, 248/0900, 85m. *Sed on barrel grey to dark grey sandy mud, gravel fragments around cutter. *Core top: dark olive green gravelly muddy sand (granules + 1 pebble subrounded) (worm tube). *Bottom: dark grey sticky, stiff sandy mud.
17	2591714	76° 58.90' 91° 09.27'	160	CORE	30	12	*Target: thin glacial sed/bedrock, 248/0800, 140m. *Sed on barrel greyish muddy sand. *Core top: dark olive green slightly muddy sand (worm tube). *Bottom: greyish slightly muddy sand.
18	2591758	76° 57.52' 91° 15.83'	91	GRAB	--	--	*Target: sand&gravel?/bedrock, 248/0730, 90m. *Grab attempted after gravity corer failed twice. *Grab held open by rock in jaws, but full. Surface lag several cm's thick of gravel (pebbles-8cm cobbles, subangular-subrounded, stained and encrusted) with echinoderms, brittle stars, encrusting worm tubes and blue encrusting bryozoans(?), overlies subsurface olive green gravelly muddy sand. Surface and subsurface in separate bags.
19	2591819	76° 57.08' 91° 21.70'	95	CORE	60	10	*Target: sand&gravel?/bedrock, 249/0740, 100m. *No sed on lower 25cm of barrel, upper 35cm has brownish-red muddy veneer. *Core: 1cm brownish red consolidated friable sandstone with pebble and shell at surface, over 9cm olive green slightly muddy sand.
20	2591842	76° 57.08' 91° 21.70'	97	GRAB	--	--	*Target: as for Stn. 19. *1st attempt: jaws held open by cobble and pebble (angular, stained) encrusted with bryozoans, green sponge, and gelatinous bubble. Seabed side of cobble covered with brownish-red sandy material (see Stn. 19). *2nd attempt: jaws held open by cobble, small amount of greenish-grey slightly muddy sand with pebbles in grab.
21	2591909	76° 54.13' 91° 20.00'	139	CORE	0	0	*Target: thin glacial sed/bedrock, 249/0800. *1 attempt, empty.
22	2600215	76° 48.92' 91° 24.03'	233	CORE	?	7	*Target: lobe of glacial sed, 249/0855, 260m. *1st attempt: mud on one side of barrel for 150cm, but only 7cm core of olive green slightly muddy cse sand with gravel (stained) and shells. Put in bag. *2nd attempt: empty, veneer of cse sand on catcher. Dented leading edge of cutter.
23	2600241	76° 49.02' 91° 21.50'	259	CORE	0	0	*Target: as above, move back to station. *1 attempt - core empty. Veneer of brownish-green silty mud on parts of lower 60cm, cse sand veneer on catcher, few granules in liner. No time for grab.

87027 SAMPLE STATIONS (continued)

Station #	Day/Time GMT	Latitude Longitude	Depth (m)	Sample Type	Core App. Penet. (cm)	Core Length (cm)	Station Notes
24	2601440	77° 14.84' 89° 27.88'	175	CORE	150	25	*Target: thin glacial sed/bedrock, 250?0230, 165m. *Wire wrapped around core head on rcovery. *Sed on barrel on one side above 100cm. Sandy mud, with granules around the cutter; greenish grey, some brown on cutter. Difficult to wash off. *Core top: greenish grey gravelly sandy mud, soft. *Bottom: dark grey gravelly sand & mud, stiff, sticky.
25	2601535	77° 15.23' 89° 00.15'	314	CORE	30	20	*Target: glacial sed, 250/0345, 300m. *Sed on barrel for 130cm, but only on 2 sides above 30cm. *Core top: greenish brown sandy mud, soft. *Bottom: grey gravelly (granules) muddy sand (med-cse), sticky.
26	2601625	77° 15.61' 88° 42.61'	315	CORE	240	100	*Target: glacial sed near mud edge, 250/0445, 310m. *Mud to top of fins, light grey silty clay. *Core top: olive green soft silty clay. *Bottom: light grey soft silty clay.
27	2601658	77° 13.16' 89° 01.18'	366	CORE	250	120	*Target: mud (5m), 250/0600, 365 m. *Mud to top of core, greyish silty clay. *Core top: olive green soft silty clay. *Bottom: light grey soft silty clay.
28	2601752	77° 09.77' 89° 12.81'	253	GRAB	--	--	*Target: glacial sed, 250/0630, 245m. *Grab attempted after gravity corer failed. *Full grab- surface layer of olive green sandy mud (5cm) overlies grey-dark grey, stiff, sticky sandy mud. On washing out grab, stiff angular lumps of grey sed left on deck.
29	2601910	77° 08.33' 89° 25.81'	350	CORE	200	100	*Target: lobe of glacial sed, 250/0110, 340m. *Sed on barrel and weights greyish sandy mud, granules around cutter. Hard to wash off. *Core top: brownish veneer over light grey sandy mud (soft). *Bottom: dark grey sticky silty clay.
30	2602010	77° 05.24' 89° 20.94'	284	CORE	20	7	*Target: thin mud/strat?, 250/0030, 290m. *Sed (brownish muddy sand) on one side of barrel to top-corer fell over. *Core: brownish green muddy sand (stiff). Put in bag.
31	2602050	77° 02.51' 89° 16.10'	171	CORE	50	15	*Target: thin glacial sed/bedrock, 250/0000, 150m. *Sed on lower barrel brownish sandy mud with granules. *Core surface slanted, corer may have gone in at an angle. *Core top: stiff, sticky, brownish gravelly sandy mud (gravel mostly granules, sand to cse, in a <1cm surface layer). *Bottom: grey stiff, sticky sandy mud.

87027 SAMPLE STATIONS (continued)

Station #	Day/Time GMT	Latitude Longitude	Depth (m)	Sample Type	Core App. Penet. (cm)	Core Length (cm)	Station Notes
32	2602135	77° 02.08' 89° 43.83'	252	CORE	70	70	*Target: thin mud/?, 249/2230, 255m. *Sed (greyish sandy mud) on one side of barrel for 150cm - fell over. *Core top: olive green soft slightly sandy mud. *Bottom: grey soft slightly sandy silty clay.
33	2602210	77° 02.3' 89° 53'	153	CORE	70	50	*Target: glacial sed, 249/2200, 150m. *Sed on barrel for 95cm, but upper 25cm not on all sides-corer fell over. Green-grey sandy mud, sticky, hard to wash off *Core top: veneer of olive green muddy sand (1 pebble) over hard, dry brownish silty sed. *Bottom: dark grey sandy mud, sticky, stiff.
34	2602241	77° 02.47' 90° 01.63'	122	CORE	70	25	*Target: thin glacial sed, 249/2145, 130m. *Sed on barrel greenish-grey sandy mud. On outside of cutter a lump of very stiff, sticky grey silty mud. Not sure if in core, so put in plastic vial. Hard to scrape off cutter by hand, hard to wash remainder off cutter. *Core top: soft olive green sand & mud. *Bottom: Soft, sticky grey sandy mud.
35	2621640	76° 41.8' 90° 42.0'	237	GRAB	--	--	*Target: sand waves, Cardigan Strait, 261/0525, 225m. *1st attempt: gravel in jaws on recovery. 1 cobble and 5 pebbles (stained, encrusted, subangular). All bagged. *2nd attempt: gravel in jaws on recovery. 4 pebbles (stained, encrusted, subangular), a veneer of brownish sand on one side of one jaw, and sticky, stiff, grey sandy mud (with thin sand lag on one surface) in corner of one jaw. Sand, mud in plastic vials, put in bag with gravel.
36	2621715	76° 42.9' 90° 46.0'	244	GRAB	--	--	*Target: gravel lag, Cardigan Strait, 261/0525, 225m. *1st attempt: 1 large pebble (stained, encrusted, subangular) holding jaws open. *2nd attempt: gravel in jaws. 1 cobble and 8 pebbles (stained, encrusted, subangular-subrounded).
37	2621821	76° 44.8' 90° 51.0'	248	GRAB	--	--	*Target: sand bedforms, Cardigan Strait, 261/0545, 250m. *Pebble in jaws on recovery. Small sample of gravel (pebbles-cobbles, stained, encrusted, subangular-subrounded) with brownish sand on one face of one jaw. Sand put in vial, then in bag with gravel.
38	2621937	76° 48.07' 90° 53.78'	148	GRAB	--	--	*Target: scours (degraded?) on glacial sed, 261/0630,160m. *Grab attempted after gravity corer failed. *Small grab. Surface layer of gravel (granules-cobbles, stained, encrusted, subangular-subrounded) and cse sand overlies subsurface slightly muddy sand (med-cse). Surface and subsurface put in separate bags.

87027 SAMPLE STATIONS (continued)

Station #	Day/Time GMT	Latitude Longitude	Depth (m)	Sample Type	Core App. Penet. (cm)	Core Length (cm)	Station Notes
39	2622043	76° 50.75' 90° 49.93'	77	GRAB	--	--	*Target: scoured glacial sed/bedrock, 261/0645, 90m. *Grab attempted after gravity corer failed. *Gravel in jaws. Brownish sand (med-cse) and gravel (pebbles-cobbles, stained, encrusted, subangular-subrounded). Orange blob (anenome?), brittle stars, and worm tubes. Whole sample bagged.
40	2622107	76° 51.78' 90° 43.88'	64	GRAB	--	--	*Target: sand & gravel, 261/0715, 65m. *Pebble in jaws. Greenish-brown sand (med) and gravel (pebbles-cobbles, stained, encrusted, subangular-subrounded).
41	2622145	76° 54.15' 90° 35.38'	66	GRAB	--	--	*Target: ponded sand, 261/0745, 60m. *Grab attempted after gravity corer failed. *Grab closed, veneer of greenish-brown sand (med) with a few small pebbles on face of jaws. Whole sample scraped into plastic vial.
42	2622210	76° 55.90' 90° 30.07'	25	GRAB	--	--	*Target: sand & gravel, 261/0815, 27m. *Grab closed. Small sample of pretty mauve gravel (encrusted with reddish bryozoans?, stained, subangular-subrounded) and a small amount of greenish-brown sand. Shell fragments, brittle stars, echinoderms, and 1 piece of red seaweed. Sand in plastic vial, in bag with gravel.
43	2622250	77° 00.02' 90° 13.05'	91	CORE	90?	35	*Target: scoured glacial sed, 261/0910, 75m. *Sed on barrel for 90cm, but discontinuous. Dark grey sandy mud, sticky, hard to wash off. *Core top: hard, stiff dark grey sandy mud. *Bottom: less stiff, sticky dark grey sandy mud. *Core to mouth of cutter, had to be pushed up into liner.