REPORT OF FIELD ACTIVITIES

AGC PROGRAM # 87-100

A SMALL BOAT SURVEY OF THE LOUGHEED - KING CHRISTIAN - CAMERON ISLANDS REGION OF THE NORTHWESTERN CANADIAN ARCTIC USING OPEN WATER LEADS

by

G.V. SONNICHSEN
A. ATKINSON

GEOLOGICAL SURVEY OF CANADA OPEN FILE REPORT # 1903

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1.0 GENERAL INFORMATION

BIO CRUISE DESIGNATION	87-100
RESPONSIBLE AGENCY	Environmental Marine Geology, Atlantic Geoscience Centre, Geological Survey of Canada, Department of Energy, Mines and Resources
LOGISTICAL SUPPORT	Polar Continental Shelf Project Department of Energy, Mines, and Resources - contracted fixed and rotary wing aircraft, logistical support and accomodations in Resolute.
FINANCIAL SUPPORT	Northern Oil and Gas Action Program (NOGAP)
AREA OF OPERATIONS	Lougheed - King Christian - Cameron islands region, Canadian Arctic Archipelago
DURATION	July 1 to August 11, 1987

PERSONNEL

AGC	G. Sonnichsen	- Coordinator
	B. MacLean	(July 25 - Aug 6)
	T. Atkinson	- electronics tech
	F. Jodrey	- general tech
	A. Law	- electronics tech
	K. Robinson	- COSEP student

Contract:

Bradson Personnel	E. Wolter	- cook / technician
Associated Helicopters		
Pilots -	R. Bertram	- July 4 - 23
	R. Walker	- July 11 - 15
	K. Veroni	- July 15 - Aug 9
	J. Sawicki	- July 25 - Aug 9
Engineer -	T. Rooney	- July 4 - Aug 9

2.0 INTRODUCTION

Since 1984, the Atlantic Geoscience Centre (AGC) of the Geological Survey of Canada has undertaken a series of investigations of the Quaternary sediments of the Arctic Island Channels (AGC programs 84-015, 85-071, 85-100, 86-023, 86-027, 86-100 and 87-027) as part of the Northern Oil and Gas Action Program (NOGAP). Objectives are to determine the geological and geotechnical properties, and regional character and history of the unconsolidated sediments, and to identify geological constraints to future subsea engineering for production facilities and transportation of hydrocarbons in the inter-island channels.

In 1986, the ice - covered channels surrounding Lougheed Island were investigated using an experimental technique in which a 5 metre inflatable boat was transported by helicopter to open water leads to collect continuous seismic reflection profiles (see Sonnichsen and Vilks, 1987). Cores, grab samples and/or bottom photographs were also collected at four sites along the leads. This program obtained reconnaissance information in the channels south and west of Lougheed Island (Figure 1).

In 1987, the same technique, with modifications to both procedure and equipment, was used to collect reflection profiles (sparker, Datasonics Bubblepulser, and 12kHz) and bottom samples in the Lougheed - King Christian - Cameron islands region (Figure 2). This report describes the 1987 program and its results.

3.0 PROGRAM SUMMARY

Program personnel assembled at the Polar Continental Shelf Project base in Resolute on June 30. Organization, packing and transfer of personnel and equipment to the base camp on Lougheed Island by DC-3 and Twin Otter aircraft continued through until July 4. By July 6, the base camp was established (Figure 2), the boat and seismic equipment was ready, and the helicopter and crew had arrived.

Aerial reconnaissance of the surrounding channels was carried out on July 1 by Twin Otter aircraft and on July 4 and 5 by the project helicopter. Workable leads were found only in the first - year ice south and east of Lougheed Island.

Survey of Lead 1 to the south of Lougheed Island commenced on July 6th. The procedure was to survey each lead 2 or 3 times using a different seismic system on each transect. The different frequencies of these systems provided complementary data which facilitated discrimination of the sediment units. Space constraints in the boat did not allow simultaneous operation of the various systems. Stable ice conditions allowed fairly routine operations in 10 leads until July 27 when the first - year ice east of Lougheed Island began to break up. Leads became more chaotic and transient, often only lasting long enough to complete a single transect. Ice continued to deteriorate and fog conditions worsened, and by August 5 the area was unworkable.

Helicopter reconnaissance flights were then focussed west and southwest of Lougheed Island, but no workable leads were found in these areas of thick multi - year ice. Efforts were directed toward short leads which existed close to either the base camp or established fuel caches. On August 9, with all available leads surveyed and with no forseeable lead development occuring before the end of the season, the survey was terminated and the party broke camp. By August 11, all personnel and equipment were back in Resolute.

4.0 ICE AND LEAD CONDITIONS

In both 1986 and 1987, the distribution of good quality leads was directly related to the distribution of first - year ice. Multi-year and second - year ice is thicker and harder and tends not to crack. In areas with a mixture of old and young ice leads are usually restricted to the first- year matrix around old floes.

In 1986, the ice to the west and north of Lougheed Island did not fracture and remained a multiyear ice cover into 1987. To the south of Lougheed Island, the ice fractured but did not completely clear and a more heterogenous mixture of ice was seen in 1987. However, east and southeast of Lougheed Island the ice cover cleared in 1986 and large expanses of first year ice were seen in 1987. This was where all but two of the leads surveyed in 1987 were located.

Break - up in 1987 followed the same general trend as in 1986, with fracture to the east and southeast of Lougheed Island around July 27 and no fracture to the west. By this date surface melting had advanced enough that high winds were able to break the thinner first year ice sheet into big (500 to 2000 m across) and vast (2 to 10 km across) floes.

Leads seen in the summer months probably form as a result of wind strain on the landfast ice cover. They remain fairly stable while the ice is otherwise solid and immobile in the early summer. They progressively widen due to undercutting and melting along the edges. The leads surveyed prior to July 27 were generally between 2 and 25 metres, and the maximum length was 44 km. The leads remained fairly stable but with minor variations in lead width and occasional blockage by ice debris due to wind changes. Following break - up the leads became highly variable and mobile as winds moved and rotated the drifting ice floes. Open water expanses up to a kilometre wide would close in hours with a shift in wind direction.

5.0 WEATHER CONDITIONS

Relative to the harsh season experienced in 1986, the 1987 weather conditions in the high Arctic were much improved. Fog over the channels remained the typical condition, but temperatures were higher, and there was less precipitation and more sunshine than in 1986. This resulted in a greater percentage of workable days and generally better working conditions.

Eight days were lost to weather during the program. In the latter part of the program, high winds and snow became much more common and often forced a delay of survey operations.

6.0 LOCATION

In 1986 and 1987, the project base camp was established on the southern end of Lougheed Island at 77 09 N, 104 40 W (Figure 3). The area was chosen on the advice of D. Hodgson (Terrain Sciences) who had camped there previously. The camp site was on a raised sandy terrace between two streams. It formed an excellent runway long and dry enough to land a DC-3 aircraft and also provided a good substrate for pitching the tents.

The two streams provided potable but very silty water mainly suitable for laundry purposes. Clear drinking water was usually drawn from a frost wedge approximately 500 metres from camp. Both water supplies became increasingly marginal with diminishing snowmelt runoff but did manage to outlast the program.

7.0 SURVEY EQUIPMENT

7.1 HELICOPTER AND SUPPORT

The helicopter and crew were provided by Associated Helicopters (under subcontract to Okanagan Ltd.) through the Polar Continental Shelf Project. A Bell 206L LongRanger with floats was assigned by PCSP for the duration of the program. A Bell 206L-1 had originally been requested and would have been more appropriate because of its larger engine. The 206L was regularly run at close to maximum allowable engine temperatures, and this affected overall lift capacity. The helicopter was equipped with an Omega VLF navigation system and a VHF directional finder.

For most of the survey, the pilots worked on rotating schedules. This allowed round - the - clock surveying when ice and weather conditions were favourable.

7.2 BOAT EQUIPMENT

A 5 metre Zodiac inflatable boat with aluminum floorboards was used to collect the acoustic profiles. It was powered by a 15 horsepower Evinrude longshaft outboard motor. Half inch plywood was laid over the aluminum floor to separate the Geopulse power supply and generators from water and cold and to attach equipment during helicopter transport.

7.3 GEOPHYSICAL EQUPMENT

7.3.1 Sparker

An ORE Ferranti Geopulse subbottom profiling system was used with a Nova Scotia Research Foundation (NSRF) 20 tip sparker towfish, and an NSRF LT06 21 element tapered hydrophone array. The data were collected at a 1.0 second firing rate using a power level of 350 Joules.

The sparker and hydrophone were towed approximately adjacent to each other 15 metres astern of the Zodiac. A layer of fresh meltwater was often present in the leads; for reliable operation it was necessary to maintain the depth of the sparker towfish at or below this layer. The freshwater also impeded adequate grounding of the electronics, which manifested itself as noise on the seismic records. Efforts were made to eliminate the noise by towing a weighted 15 metre long, 2 cm wide grounding strap behind the boat.

The hydrophone signal was fed through the Geopulse receiver using a filter range of 180 to 1000 Hz. The data was displayed on an EPC model 1600S precision graphic recorder at a 0.5 second sweep. Optimum resolution was obtained using either the + or - print cycles rather than both together (+/-).

Power for the seismic system was supplied from a 3 Kw Honda EG-3000 portable generator. A 1500 W dummy load was required to stabilize the generator loading and improve voltage regulation. The system electronics were powered through a Sola 140 W microcomputer regulator: this was necessary to provide stable voltage to the EPC graphic recorder.

The unfiltered raw signal and the shot pulse were recorded on magnetic cassette tapes on a portable TEAC tape recorder.

7.3.2 Datasonics Bubblepulser

An early production version of a Datasonics Bubblepulser seismic system was evaluated during the program. This is a high efficiency profiling system which uses a magnetostrictive transducer designed to emulate a small air gun source. It has a fundamental source frequency of approximately 500 Hz. It has a high energy transfer which means that reasonable results may be obtained using a power level of only 20 Joules, which also means smaller components and greater portability.

Initial attempts to use this system were severely hampered by differences in the AC voltage supplied by the Honda EG-1000 generator and the input voltage required by the power supply. Most gas powered portable generators have an output voltage of 120 V RMS. The "Bubblepulser" power supply was designed to operate on an input voltage of 115 V. The result was continual fuse failure, a frustrating distraction while attempting to adjust gain levels and proceed with the survey. Several jury - rigged methods were used to adjust the supply voltage from the Honda generator which did not have an automatic voltage regulator and whose voltage could be lowered a small amount. After this, it was still necessary to keep an eye on the power supply fuse, but it didn't blow as often. Datasonics advises they have solved this problem by installing a bigger SCR (Silicon Controlled Rectifier). The ultimate solution however, is to install a transformer in the power supply that has an input voltage of 120 Volts RMS and an output of 600 Volts RMS instead of the present 115 Volt RMS input and 600 Volt RMS output. A 7 KVA variac (variable output voltage transformer) is on order and will be able to reduce the generator voltage to 115 Volts RMS and still provide adequate power to the system.

The Bubblepulser data was displayed on the EPC 1600S precision graphic recorder. Initial attempts were made to obtain a bottom record with the Bubblepulser while the boat was in deep water (> 200 m), but the weak signal did not allow adequate tracking or correction of system settings to produce an acceptable record. Once a suitable nearshore lead was chosen, the Bubblepulser began to produce good records. The signal attenuated in deeper water depths and was quite poor by approximately 300 m water depth.

The system is aptly named the " Bubblepulser" since it has a wide bubble pulse or outgoing pulse, similiar to that of an airgun. It also produces more ringing of the reflectors than the Geopulse sparker.

7.3.3 12 kHz profiler

Information on the distribution of fine- grained seabed sediments was provided by an Edo Western 1 KW 12 kHz echosounder which was mounted on an easily deployed transom mount developed by Program Support Subdivision. The sounder was triggered at a 1.0 second rate using a 0.5 to 1.0 millisecond outgoing pulse width by a Raytheon PTR transceiver. It could be powered by either the Honda 1000 W or 3000 W generator. The data was printed on the EPC 1600S graphic recorder.

The system was quite reliable and provided penetration of up to five metres in soft marine muds.

7.3.4 3.5 kHz

Original plans had included collection of high resolution data on the upper unconsolidated section using a 3.5 kHz source. However, the RTT system employed did not have sufficient power to provide an adequate signal in the water depths routinely encountered in the channels. Also the record was almost entirely wiped out by electrical interference from the outboard motor. The lack of an effective 3.5 system was a serious shortcoming to the overall program.

7.3.5 Sidescan Sonar

An EG&G 100 kHz sidescan sonar system was brought along but was not used because of the lack of suitable leads in water depths shallow enough for the 100 metre cable on the towfish. It was brought in the hope that a sufficiently large shore lead would develop to allow nearshore surveys of delta fronts.

7.4 NAVIGATION

The Omega navigation system and VHF directional homer in the helicopter were used for ice reconnaissance and lead relocation purposes. A Magnavox MX5102 satellite navigation receiver was used to determine seismic profile and sample station positions in the lead.

Positions for seismic profiles were taken at random waypoints when the boat was stopped long enough for a stationary fix. Other fixes obtained while actually transitting the lead were accepted or rejected depending on their agreement with the stationary fixes.

Lead positions based on the navigation are not completely uniform for each transect of the lead. This is assumed to be a result of incomplete navigation and minor errors in positioning rather than movement of the lead. This is substantiated by the similar bottom profiles on records collected on separated transects. The leads plotted in Fig 2 are based on composite and best - fit navigation from all transects of the lead. This has been done for simplicity and ease of interpretation.

7.5 COMMUNICATIONS

As in 1986, radio communications while working on the ice were problematic. Efforts to obtain a lightweight, mobile radio which was capable of contact between the helicopter on the ice and the boat were less than satisfactory. A marine band VHF radio was intended to provide routine communication between the helicopter and the boat but was found to have a severely limited range, probably as a result of a low efficiency antenna. Handheld air band radios were also used in the boat, and although communication from the boat to the helicopter was often garbled, they seem the best route for future short- range communications.

An SBX -11 HF radio was carried in the boat to provide communication between the boat and the helicopter, base camp, and PCSP. This was kept primarily for emergency use because of its size and the need for a large groundplane antenna to ensure a range in excess of 30 miles. It was also hard to maintain a constant radio watch in the base camp.

7.6 SEDIMENT SAMPLING EQUIPMENT

Sediment samples were collected from the lead edge at locations identified from the acoustic profiles. Grab samples were collected using a 10 kg Dietz-Lafonde sampler. Cores were collected with a 50 kg Benthos gravity corer fitted with a plastic liner that also served as a core barrel and a modified cutter and core catcher assembly.

An EG&G underwater camera modified for portable through - ice operations was used with mixed results. The flash assembly's power appeared to die very rapidly, often before bottom photos were collected.

A portable lightweight winch developed at BIO by Systems Engineering was used with a cantilevered tripod arrangement to lower the sampling equipment to the bottom. This was powered by a Honda EG3000 generator. Figure 4 shows the typical set -up for a gravity core from the lead edge.

Table 2 sumarizes the station data for the sediment samples collected in 1987.

8.0 SURVEY PROCEDURES

The seismic equipment, boat and two operators were transported to the leads in two helicopter flights. The inflated Zodiac was slung first with most of the seismic equipment attached (Figure 3). The remaining gear and the operators were brought on a subsequent flight. The pilot and helicopter would usually remain at the lead while the crew conducted the survey. At the end of a work shift, the two operators would be flown back to camp and a new pilot and crew would take their place. The length of a work shift varied with work and weather conditions. If ice and weather conditions were suitable work continued around the clock to take advantage of the 24 hour daylight.

The Geopulse sparker system was used most often as it was capable of providing good penetration with moderately high resolution, usually for the entire Quaternary section. The 12 kHz system was useful to determine the thickness and distribution of muddy sediments which were usually masked by the bubble pulse on the sparker profiles. Also, a Datasonics "Bubblepulser" surface-towed boomer system was tested as a possible light-weight, energy-efficient replacement for the Geopulse sparker. It was operated in three leads during the program.

Separate transects of the lead were required for each of the three systems because of space and power constraints in the Zodiac inflatable boat. The extent of geophysical surveys conducted in a lead depended on its quality (length, width, number of offsets, and amount of ice debris) and its distance from the base camp and established fuel caches. On 5 occasions only the Geopulse was operated as deteriorating ice conditions prevented a second transect of the lead.

Sixteen leads with a combined length of 280 km were surveyed in 1987 (Figure 2). A total of 310 line-kilometres of sparker, 225 km of 12 kHz profiles, and 43 km of Bubblepulser were collected (Table 2). The longest survey line was 44 km and the shortest was approximately 3 km.

Bottom samples were collected from 3 locations during the survey (Fig.3, Table 2). Two sites were chosen along Lead 2 based on the acoustic profiles. A marker had been placed on the lead edge for the first sample location. The second had to be located by the helicopter's Omega navigation system and landmarks; this was much less satisfactory and was only successful on the second attempt. A grab sample was first collected to determine the water depth at each site, followed by a gravity core. Then bottom photographs were attempted at the location.

9.0 GEOLOGICAL RESULTS

Subbottom penetrations on the sparker seismic profiles of up to 80 m (water velocity, 1500 m/s) show gently dipping to near horizontal strata of sedimentary bedrock, overlain by unconsolidated sediments ranging from less than 5 m (Figure 5) to at least 45m thick. Sediments are tentatively divided into two stratigraphic units on the basis of their acoustic character. The lowermost, which is both the most widespread and the thickest, rests directly on the underlying bedrock. This unit consists of unstratified sediments of variable thickness, with a typically hummocky and sometimes incised surface (Figure 6). This unit is interpreted to be glacial drift on the basis of its constructional character and similarity to marine sediments interpreted as glacial drift elsewhere (King and Fader, 1986; Josenhans et al.,1986; Praeg et al.,1986). The incised seabed relief is interpreted to be iceberg scours, which are probably relict considering the absence of icebergs in the area at present.

In some areas this lower unit has a smoother surface relief and a more transparent acoustic character. Sediments with similar character are observed in Austin Channel where they are interpreted as glacial drift on the basis of sample data (MacLean et al., in prep.). These variations in character may reflect changes in the sediment sources or depositional processes, e.g. ice loading, associated with the drift.

The 12 kHz acoustic profiles show that in places the lower unit is overlain by an acoustically unstratified, transparent unit with a smooth surface which is ponded in bathymetric depressions or draped over the underlying sediments.Thicknesses range from less than 1 m up to 5 m. Despite only localized appearances of the unit on the acoustic profiles, sediment sample data indicate this unit is regionally extensive. This disparity suggests the upper unit forms an extensive veneer thinner than the resolution of the acoustic systems used. The upper unit is interpreted to represent postglacial mud because of its stratigraphic position and its similarity to postglacial muds in other Canadian Arctic areas (Praeg et al.,1986). Also, acoustically and texturally similar muds identified in Jones Sound contain shells dated between 2610 ± 110 and 8410 ± 200 years BP (G. Vilks, 1986, pers. comm.).

10.0 RECOMMENDATIONS

1) Using leads in areas of permanent sea ice cover to collect continous seismic profiles has proven to be a laborious, but viable procedure. However, the existence of large expanses of first - year ice in the survey area is necessary for an acceptable quantity of workable leads. No survey should be planned until an accurate assessment of the regional ice distribution has been made. If the winter distribution shows a predominantly multiyear ice cover it is unlikely that the leads will be favourable in the summer.

2) Two Zodiacs operating in the lead together would allow collection of at least two systems simultaneously. This may be useful in rapidly changing ice conditions as it would ensure that all the data could be collected before the lead shifted or closed. Safety would become a major concern however with four men and a lot of equipment out on the ice at once. An attempt was made to have one crew collect samples while another collected seismic profiles about 20 km away on one ocassion during the program but the two team system seemed to use helicopter hours less efficiently.

3) The MX5102 satellite receiver was slow to lock or update on good quality passes. This often resulted in half hour delays or in the boat leaving the lead without having received a good position. This may have been the result of inefficient antenna operation or low power levels, but it should be looked at. A directional gyro may provide more accurate fixes while the boat is in motion. Also, more operator training may allow a more complete use of the system's options.

4) AGC should obtain a good quality portable 3.5 kHz system or equivalent that will work in deep water in a small boat. In two consecutive years, the 3.5 kHz systems taken to the field have proven worthless and this has resulted in a major data gap.

5) The EG&G underwater camera should have improvements to the flash power supply and undergo extensive tests before it is used again in the field.

11.0 ACKNOWLEDGMENTS

Financial support for this program was provided by the Northern Oil and Gas Action Program and is gratefully acknowledged.
T. Atkinson, F. Jodrey, and A. Law of Program Support should all be commended for carrying out a long and demanding program under uncomfortable and unpredictable conditions, as well as COSEP student Kevin Robinson and cook Erin Wolter for their excellent and enthusiastic support throughout the survey. Thanks to George Hobson, Barry Hough, and Jim Godden of the Polar Continental Shelf Project and their staff for great logistical support; and to our helicopter crew, Ross Bertram, Keith Veroni, Joe Sawicki, and Terry Rooney. Thanks also to Technical Field Support Services for providing our field equipment needs throughout the program. Special thanks to Brian MacLean for advice, guidance and encouragement, and to Dan Praeg and Anne Jennings for critical review.

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Praeg, D.B., MacLean, B., Hardy, I.A., and Mudie, P.J.,
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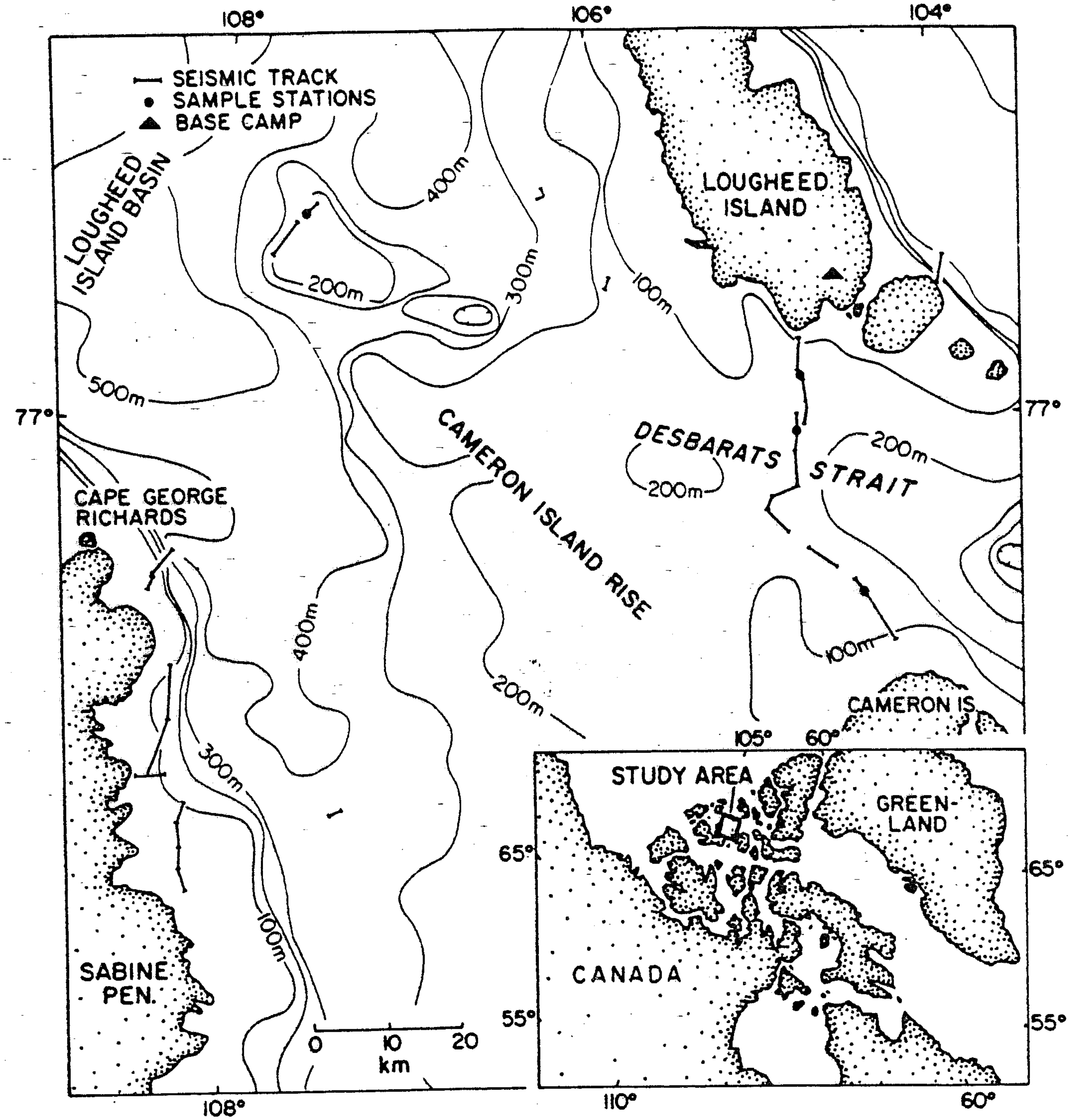

Figure 1

Index map of the 1986 survey area, showing locations of seismic tracks, sediment sample or bottom photograph stations, and base camp location. Isobaths from CHS Chart 7951.

TABLE 1 GEOPHYSICAL DATA

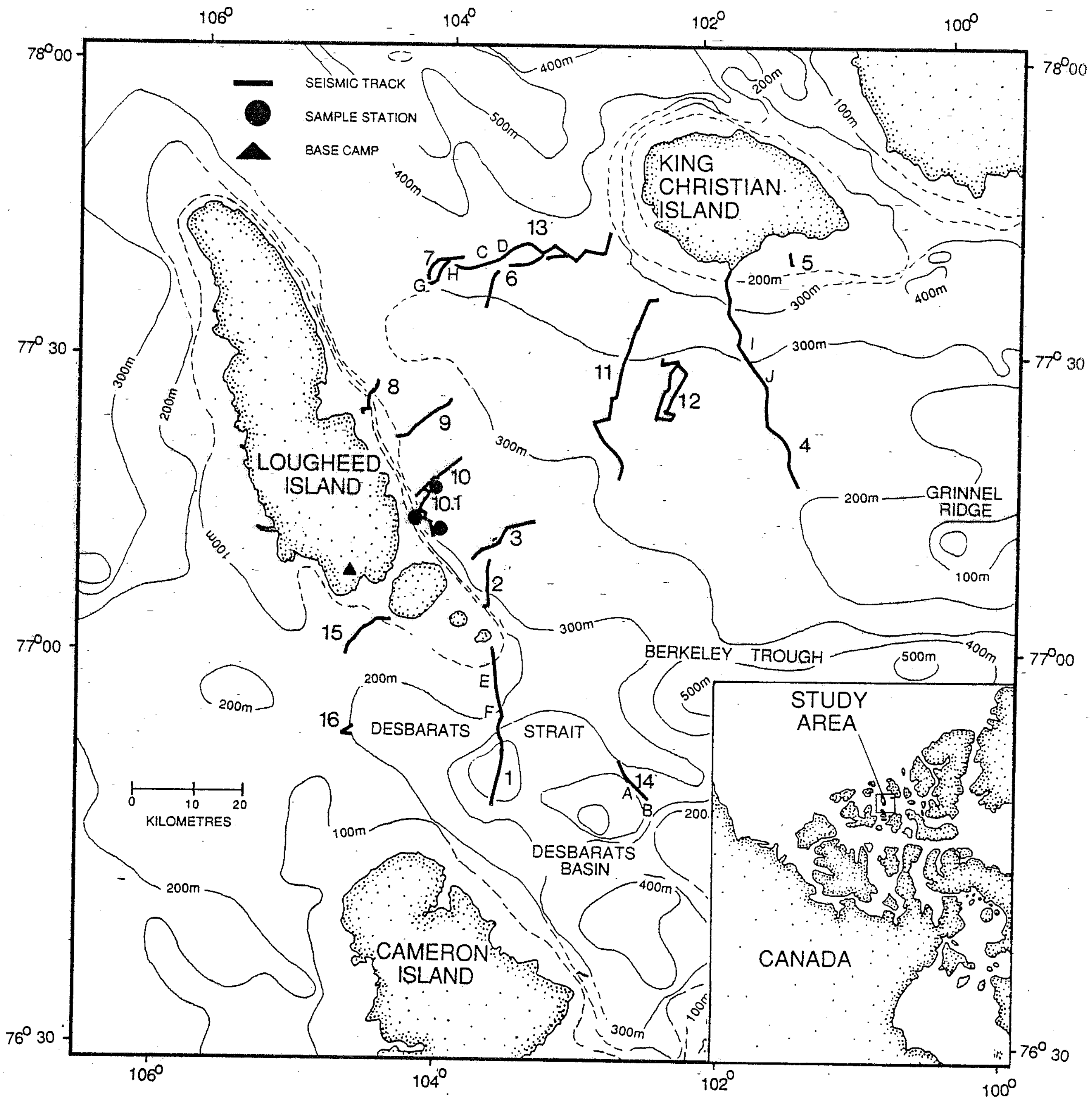

Figure 2
Index map of the 1987 survey area, showing locations of seismic tracks, sample stations, and base camp location. Isobaths from CHS Chart 7951. Table 1 summarizes the seismic data collected and Table 2 summarizes the sample data.

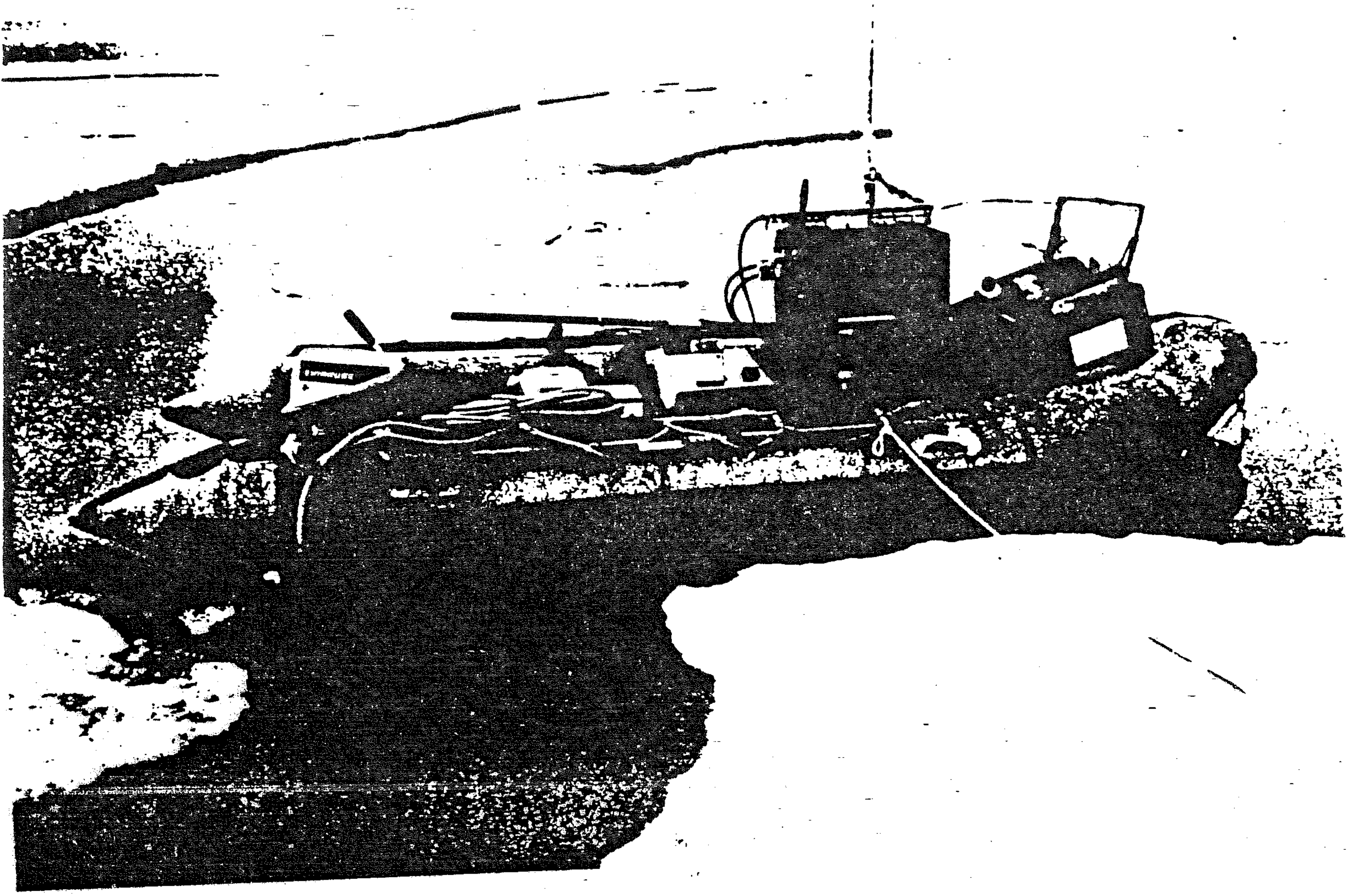

Figure 3
Five metre Zodiac inflatable boat equipped for sparker seismic profiling in one of sixteen leads surveyed in 1987. The majority of the boat equipment was left attached during transfer between survey leads by helicopter, to prevent major disassembly of the system and navigation electronics.

Figure 4
Photograph showing collection of a Benthos gravity core.The portable winch, powered by a Honda 3000 watt generator, is attached to the cantilevered tripod. Ice thicknesses at the lead edge were typically one to two metres.

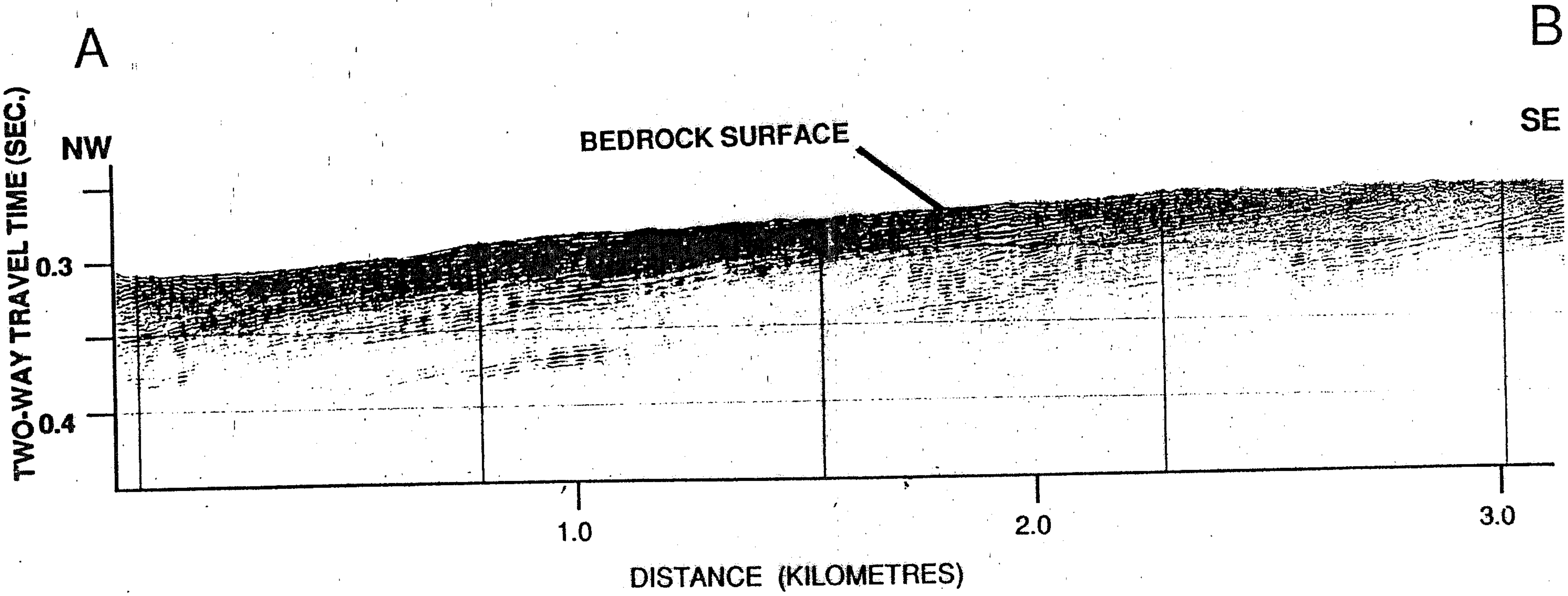

Figure 5
Geopulse sparker seismic reflection profile (A-B) showing gently dipping strata of sedimentary bedrock that are truncated at or near the seafloor. Unconsolidated sediments, if present, are too thin to be resolved by the Geopulse system (see Figure 2 for location).

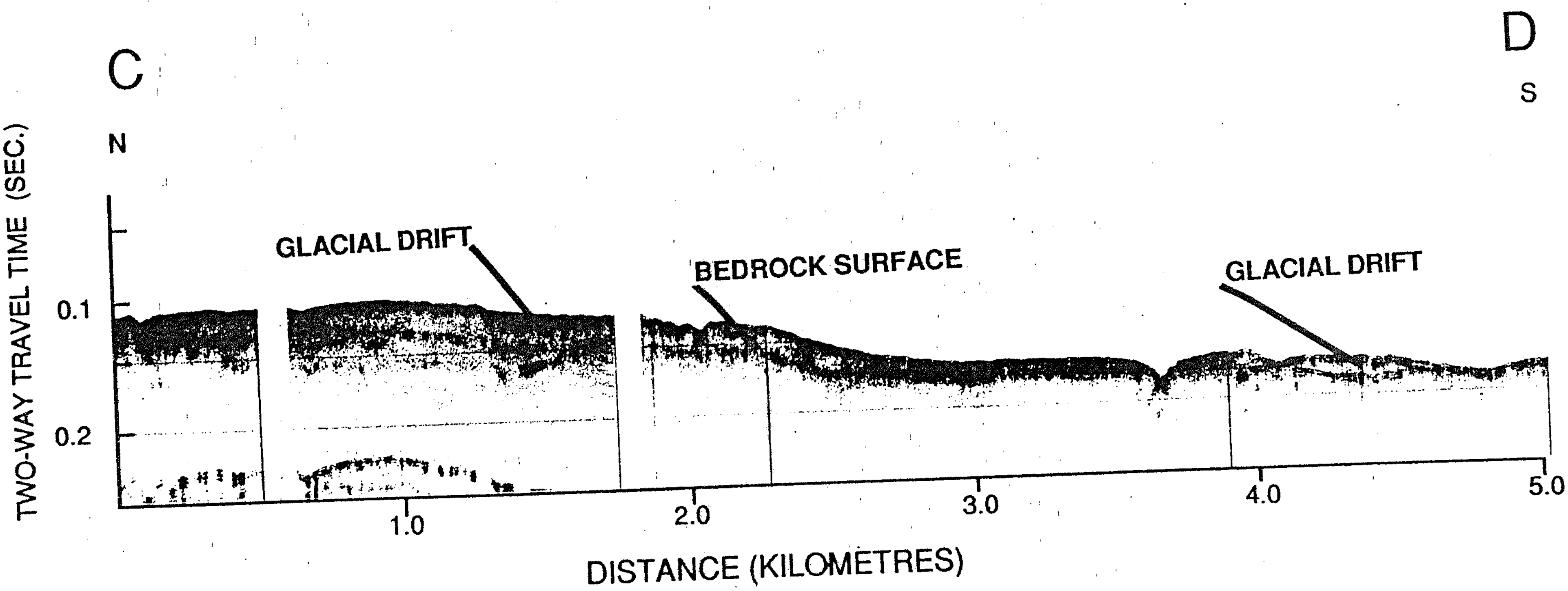

Figure 6
Geopulse sparker seismic reflection profile (C-D) showing up to 15 metres of unstratified sediment interpreted to be glacial drift, overlying an irregular bedrock surface.Note the seabed depressions at 0.1 , 2.1, and 3.8 kilometres. These are interpreted to be relict iceberg scour features. (See Figure 2 for location)

TABLE 1 GEOPHYSICAL DATA

LEAD	SYSTEM	ROLL #	START (JD/GMT)	STOP (JD/GMT)	TAPE #	LENGTH (KM)
1	SPARKER	1	188/ 0610	189/ 1005	1, 2	27
1	12 kHz	2	201/ 0625	201/ 1258		27
1	DATASONICS	3	202/ 0832	203/ 1239		27
2	SPARKER	4	189/ 2130	190/ 0011	3	13
2	12 kHz	5	196/ 1707	196/ 2037		13
3	SPARKER	6	190/ 0300	190/ 1728	4 - 6	15
3	12 kHz	7	190/ 2120	191/ 0058		15
4	SPARKER	8	191/ 2320	192/0724	7 - 13	44
4	12 kHz	9	193/ 0540	193/ 1436	14 - 23	44
5	SPARKER	10	195/ 0812	195/ 0930	24	3
6	SPARKER	11	197/ 0923	197/ 1133	25, 26	22
			197/ 1402	197/ 1539	27, 28	
			198/ 0611	198/ 1014	29, 30	
7	SPARKER	12	199/ 1727	199/ 1901	31, 32	8
7	12 kHz	13	200/ 2312	201/ 0044		8
8	SPARKER	12	199/ 2250	200/ 0121	33 - 35	7
8	12 kHz	13	200/ 1736	200/ 1854		7
9	SPARKER	14	204/ 1758	204/ 2053	36 - 40	16
			205/ 0012	205/ 0406		
9	DATASONICS	15	205/ 1934	206/ 0009		16
10	SPARKER	16	207/ 0152	207/ 0431	41 - 44	22
10	12 kHz	17	208/ 0800	208/ 1132		22
10.1	SPARKER	18	207/ 1932	207/ 2340	45 - 47	9
10.1	12kHz	19	208/ 0045	208/ 0441	48 - 51	9
11	SPARKER	20	208/ 2117	209/ 1452	52 - 66	40
11	12kHz	21	209/ 2120	209/ 2340		40
12	SPARKER	22	212/ 2338	213/ 0248	67 - 70	16
12	12kHz	23	212/ 1837	212/ 2242		24
13	SPARKER	24	216/ 0350	216/ 0937	71 - 81	34
13.1	SPARKER	25	217/ 0326	217/ 0425		7.3
14	SPARKER	26	218/ 0512	218/ 0901	82 - 84	9.5
	12kHz					9.5
15	SPARKER	27	218/ 2010	219/ 0041	85 - 88	11
15	SPARKER	28	218/ 2010	219/ 0041	REPLAYS	
	12kHz	29	219/ 0258	219/ 0512		
16	SPARKER	30	220/ 2132	220/ 2300	89	3.7

TABLE 2 BOTTOM SAMPLE DATA

SAMPLE #	DAY/TIME	LATITUDE	LONGITUDE	DEPTH	TYPE	LENGTH	TARGET	DESCRIPTION	SUBSAMPLES	WATER CONTENT
87-100-1	202/1912	77 10.18	103 40.04	340	GRAB		LEAD 2- LENTICULAR CONSTRUCTIONAL FEATURE	2 ATTEMPTS GREENISH - BROWN CLAY CLOSEST TO 5Y 5/2		
87-100-2	202/2000	77 10.18	103 40.04	339	CORE	53cm	AS ABOVE	GREEN-BROWN MUD ON TOP BOTTOM HAD SM. ANGULAR ICE CRYSTALS CATCHER MUD WAS PUT BACK IN THE CORE	87-100-2A CUTTER SAMPLE	# 4089
87-100-3	202/2044	77 10.18	103 40.04	339	CORE	29 cm	AS ABOVE	BOTTOM WAS GRITTY MUD W/ 1 PEBBLE AND GRANULES CATCHER SED WAS PUT BACK IN CORE BOTTOM		
87-100-4	202/2115	77 10.18	103 40.04	339	CAMERA					
87-100-5	203/0022	77 06.00	103 41.71	114	GRAB			DK-BRN-SLTY/SANDY MUD W/ BRITTLE STAR, BRYOZOAN &PINK FILAMENTOUS PLANT		
87-100-6	203/0110	77 06.00	103 41.71	114	CORE	35 cm		V. COHESIVE, COMPACTED DK GY SL. GRITTY MUD - CORE PROTUDED OUT OF CUTTER	87-100-6A CUTTER &CORE BOTTOM	# 4091
87-100-7	206/0025	77 08.87	103 40.18	345	grab		PONDED MARINE MUD	GREEN- BROWN MUD V. SL. GRITTY, NO CLASTS 5Y 4/2		
87-100-8	206/0046	77 08.87	103 40.18	345	CORE	109 CM	AS ABOVE	GREYISH BROWN MUD		# 5109