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GEOLOGICAL SURVEY
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CRUISE REPORT 88018 (F) PHASE 12
M. V. NAVICULA
NORTHEASTERN NORTHUMBERLAND STRAIT
SEPTEMBER 24–OCTOBER 4, 1988

D. Frobel

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Geological Survey of Canada
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1990

GENERAL INFORMATION

Cruise No:	88-018 (F), Phase 12
Vessel:	M. V. Navicula
Dates:	September 24 – October 4, 1988
Responsible Agency	Atlantic Geoscience Centre, Geological Survey of Canada Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada
Area	Northumberland Strait, Gulf of St. Lawrence off East Point , P.E.I. and along a possible electrical cable transmission route north of East Point on a line toward the Magdalen Islands.
Ships Captain:	Captain Niel Langille
Senior Scientist:	Dave Frobel
Scientific Staff:	K. Asprey AGC A. Atkinson AGC D. Beaver AGC W. Prime AGC

OBJECTIVES

Cruise 88018(F) was part of an inner-shelf mapping program initiated by the Atlantic Geoscience Centre and designed to collect geological and geophysical data in nearshore areas of the Atlantic Provinces. This leg (F) was one of 13 (Cruise 88018 legs A to H) undertaken by AGC during the 1988 field season using the vessel M.V. Navicula. A particular emphasis of the program was the collection of baseline information on the occurrence and distribution of offshore aggregates and minerals. Specific objectives of leg F were:

1. Northeastern Northumberland Strait - To map the surficial sediment and bedforms in the area of a large sand body east of East Point, identified by Kranck (1971). To determine the direction of sediment transport on this sand body from the interpretation of survey records. To collect seabed sediment samples to provide ground truth for the sidescan sonar and seismic data and to assess the construction aggregate potential of the sand.

2. North of East Point, P.E.I. - Within the range of the vessel, to map the distribution and thickness of surficial sediments along a potential electrical transmission cable route between the Magdalen Islands and Prince Edward Island. In the survey area, collect seabed sediment samples to provide ground truth for the sidescan sonar and seismic data.

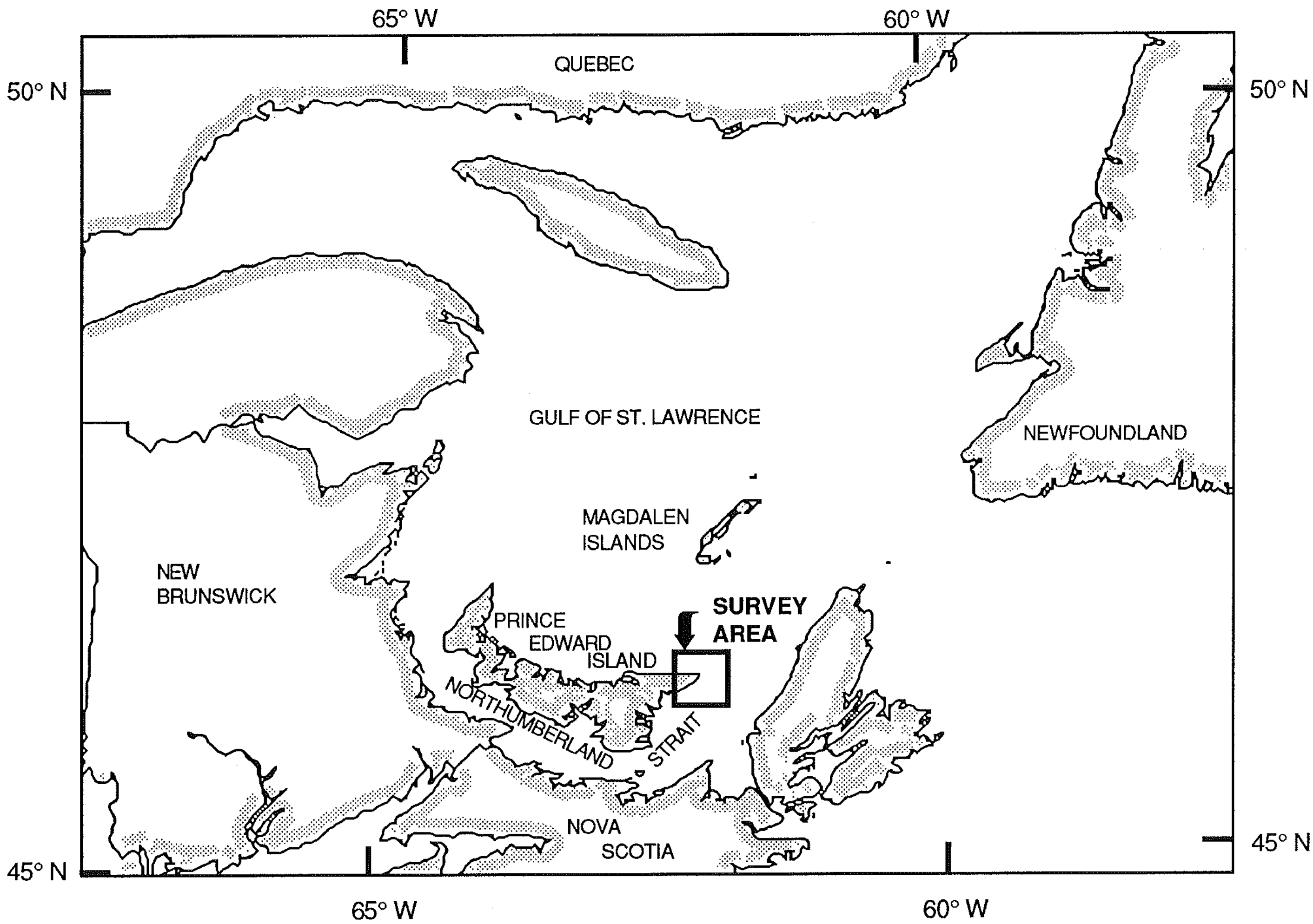


Figure 1: Survey area for Navicula cruise 88-018 (F) Phase 12

ORGANIZATION

All survey work was carried out on day trips from Souris, P.E.I. between September 25th and October 3rd 1988. Figure 1 shows the general location of the survey area.

SUMMARY OF OPERATIONS

September 24, (Day 268)
Frobel, Beaver and Prime travel in two AGC vehicles with scientific gear from Dartmouth, N.S. to Souris, P.E.I. Meet Atkinson in Souris.

September 25, (Day 269)
Set up of scientific gear on board Navicula. Cast off 1825 UT. Test gear and run line 1, parallel to shore between Souris and East Point. Return to Souris dock 2400 UT.

September 26, (Day 270)
Cast off 1100 UT. Running lines 2 to 7 off Souris and across sand body at East Point. 2300 UT.

September 27, (Day 271)
Cast off 1125 UT. Collect grab samples 1 to 41 between Souris and East Point and over sand body at East Point. 2200 UT. Asprey arrives in evening.

September 28, (Day 272)
Navicula taking on fuel and water. Wind and wave conditions deteriorating in Strait - too rough for survey work. Scientific staff plotting data. Beaver returns to Dartmouth with samples.

September 29, (Day 273)
Conditions too rough in Strait for survey work. Continue plotting data.

September 30, (Day 274)
Cast off 1115 UT Running lines 8, 9, and 10 north of East Point and line 11 across East Point sand body. 2315 UT.

October 1, (Day 275)
Cast off 1115 UT. Running lines 12 and 13 over East Point sand body. Leak in hydraulics line, return to Souris 1800 UT. Temporary repairs carried out.

October 2, (Day 276)
Cast off 1115. Running lines 14 to 19 to complete line coverage between Souris and East Point. 2400 UT.

October 3, (Day 277)
Cast off 1115. Collect grab samples 42 to 47 north of East Point and 48 to 86 east and south of East Point. 278/0200 UT.

October 4, (Day 278)
Secure scientific gear on Navicula for next AGC leg. Asprey, Frobel and Prime return to Dartmouth by government and private vehicle. Arrive BIO 1830 local. Atkinson remains in P.E.I.

SUMMARY OF ACCOMPLISHMENTS

Approximately 284 line kilometres (19 lines-see figure 2) of side scan sonar imagery, bathymetry and shallow seismic reflection data (see appendix) were collected on this cruise. In addition, a magnetometer was towed on all lines. Eighty-three van Veen grab samples were recovered(see figure 3).

TECHNICAL SUMMARY

Navigation
Navigation was provided by Loran-C with raw TDs (time delays) automatically logged every minute on a Corona personal computer in the lab, and every 10 minutes by the data technician on a chart on the bridge. The track plot in figure 2 is based on Loran-C data.

Bathymetry
Bathymetric data were obtained using the Elac 30 kHz echosounder permanently installed on the bridge of Navicula (see table 1 in the appendix). Depths were manually recorded every 10 minutes in the navigation log, during the survey, and later digitized at one minute intervals for use in figures 6 and 7.

Sidescan sonar
The Klein 100-Khz sidescan sonar system performed well throughout the cruise. Sidescan sonar data were recorded on a Klein wet-paper recorder and on magnetic tape (see table 2 in appendix). The sidescan sonar system was operated at a standard 100-m range (200-m swath) throughout the cruise. Scale lines on the records are nominally 15 m apart.

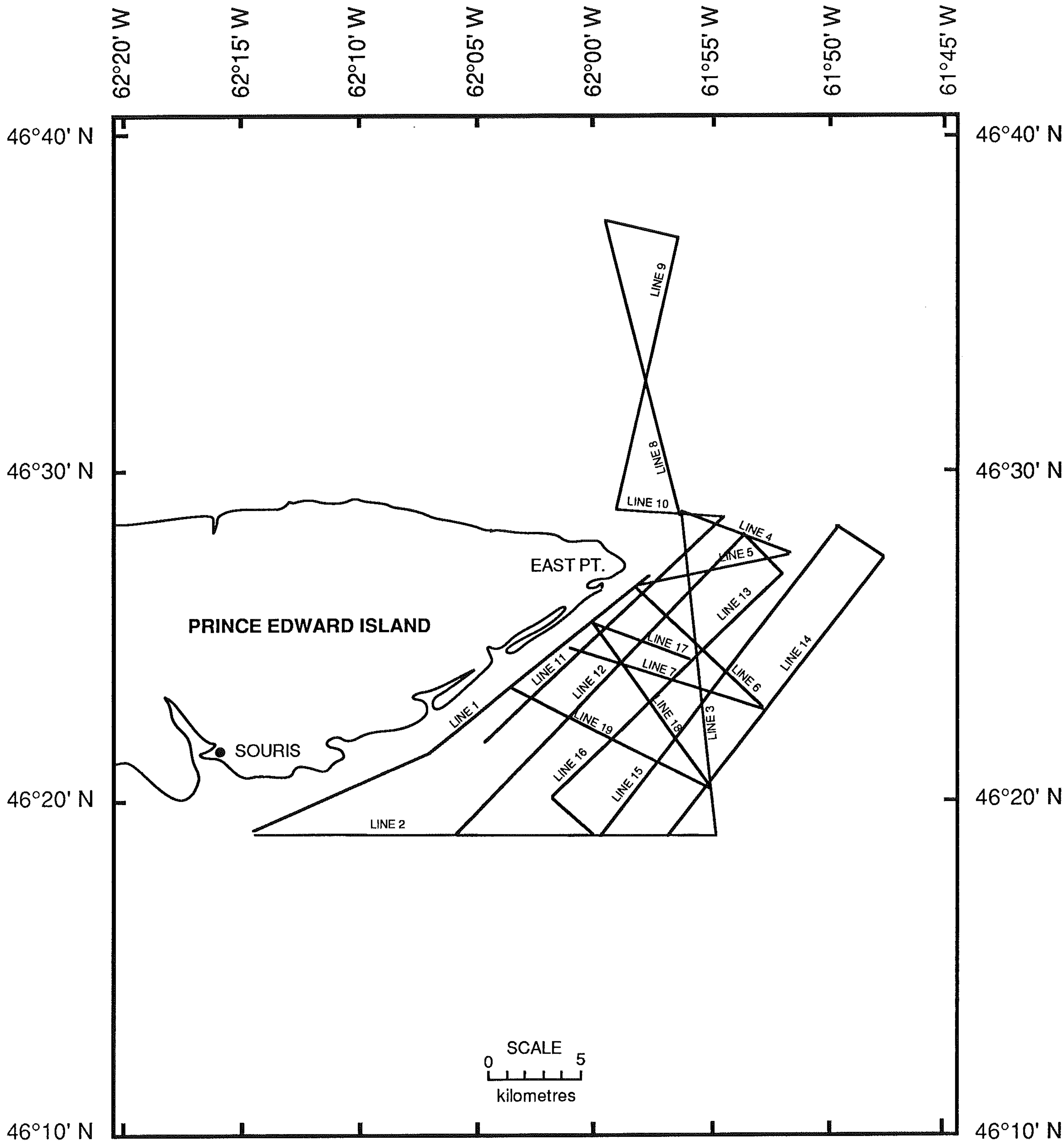


Figure 2: Track plot

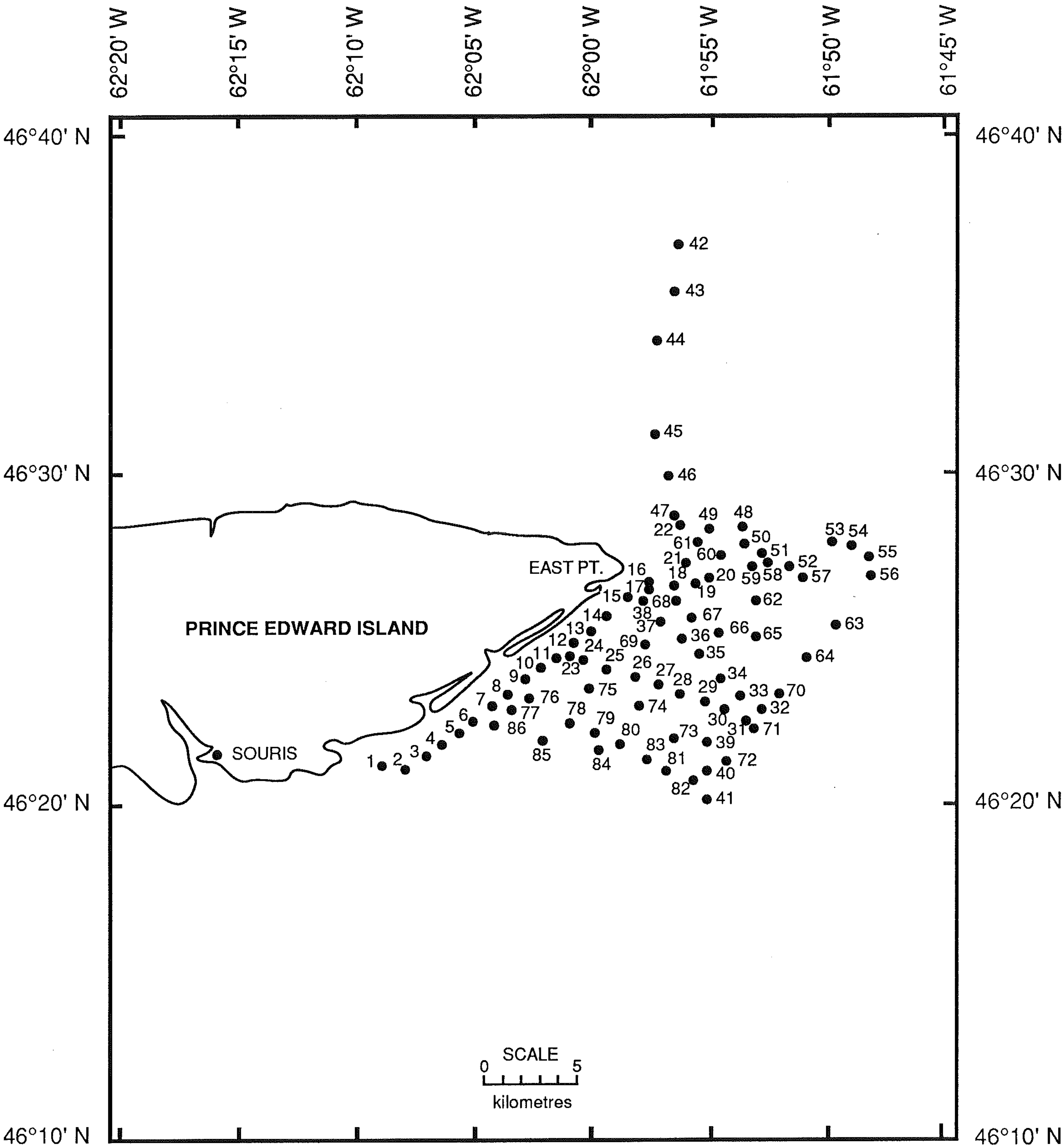


Figure 3: Grab sample locations

Some difficulty was encountered when rapid shallowing required a quick raising of the sidescan fish. It was almost impossible, from inside the lab where the winch control was located, to watch both the sidescan record and the sidescan cable. There was a danger of pulling the sidescan fish into the blocks. The situation would be improved if the sidescan recorder were moved under the lab window that looks out onto the deck.

Shallow seismic reflection systems

Shallow seismic data were obtained using (1) a Datasonic Bubble Pulser system and (2) an ORE Geopulse 5210A receiver, Nova Scotia Research Foundation Corporation (NSRFC) model LT06 streamer, and either multitip sparker or Huntec Sea-Lion sound sources (see tables in appendix).

The Datasonic system uses a 20-J coil vertically mounted in a housing on the underside of a surfboard. Surface wave noise was reduced in the record by towing the board just below the surface and the system was light enough to be deployed and recovered by hand. The equipment setup included a Datasonic model BPS-530 power supply, a model BPR-510 receiver and an EPC model 1600s recorder with a 190-ms sweep. Used throughout the cruise, this system was very reliable and produced excellent records. The system produced a wide bubble pulse, giving a vertical resolution of approximately 10 m.

The Huntec Sea-Lion is a boomer mounted in a housing designed to be towed down to a water depth of about 5m. The Sea-Lion in combination with an NSRF hydrophone eel produced excellent resolution (approximately 2 m) in shallow sub-buttom records. However this system demonstrated erratic towing behaviour, as it had in earlier phases of the Navicula program, and its use was limited.

The remainder of the time a 280-J 20-tip surface tow sparker was deployed in place of the Sea-Lion. The two systems could not be used together because there was only one power unit on the vessel. Although the sparker resolution (roughly 2-8 m) was not quite as good as the Sea-Lion, it demonstrated excellent penetration and produced good records.

Data from the Sea-Lion and sparker were displayed on an EPC model 4100 recorder, in most cases using a 250-ms sweep. All shallow seismic and sidescan records were marked with day and time at 2-minute intervals using a TSS 312B record annotator.

Magnetometer

A Barringer SM-123 nuclear-precession magnetometer was towed on all lines. The magnetometer data were recorded in analogue form at 10-s intervals on diskette using a Corona personal computer (see table in appendix).

Sampling

Seabed samples were collected using a van Veen grab sampler. Although the grab sampling program went smoothly, problems with the hydraulics on Navicula prevented the use of the Alpine gravity corer.

General comments

Navicula proved to be a convenient platform for this kind of nearshore survey work. The informality and close cooperation that resulted from working on a small vessel compensated for the problems associated with limited space. Except for the Huntec Sea-Lion, no problems were encountered while towing the various pieces of gear behind the vessel. The limited lab space was adequate. Noise levels in the lab, resulting from the need to keep the engine-room door open, remain a serious concern.

SCIENTIFIC RESULTS

Setting

The surficial sediments of the southern Gulf of St. Lawrence along the northeast shore of Prince Edward Island have been described as a thin veneer of lag deposit sand and gravel overlying reddish brown sandstone (Loring and Nota, 1973- see figure 4). This area is essentially nondepositional, with active reworking and redistribution in the coastal zone. The bathymetry is irregular, reflecting the presence of bedrock at or near the surface (see figure 5).

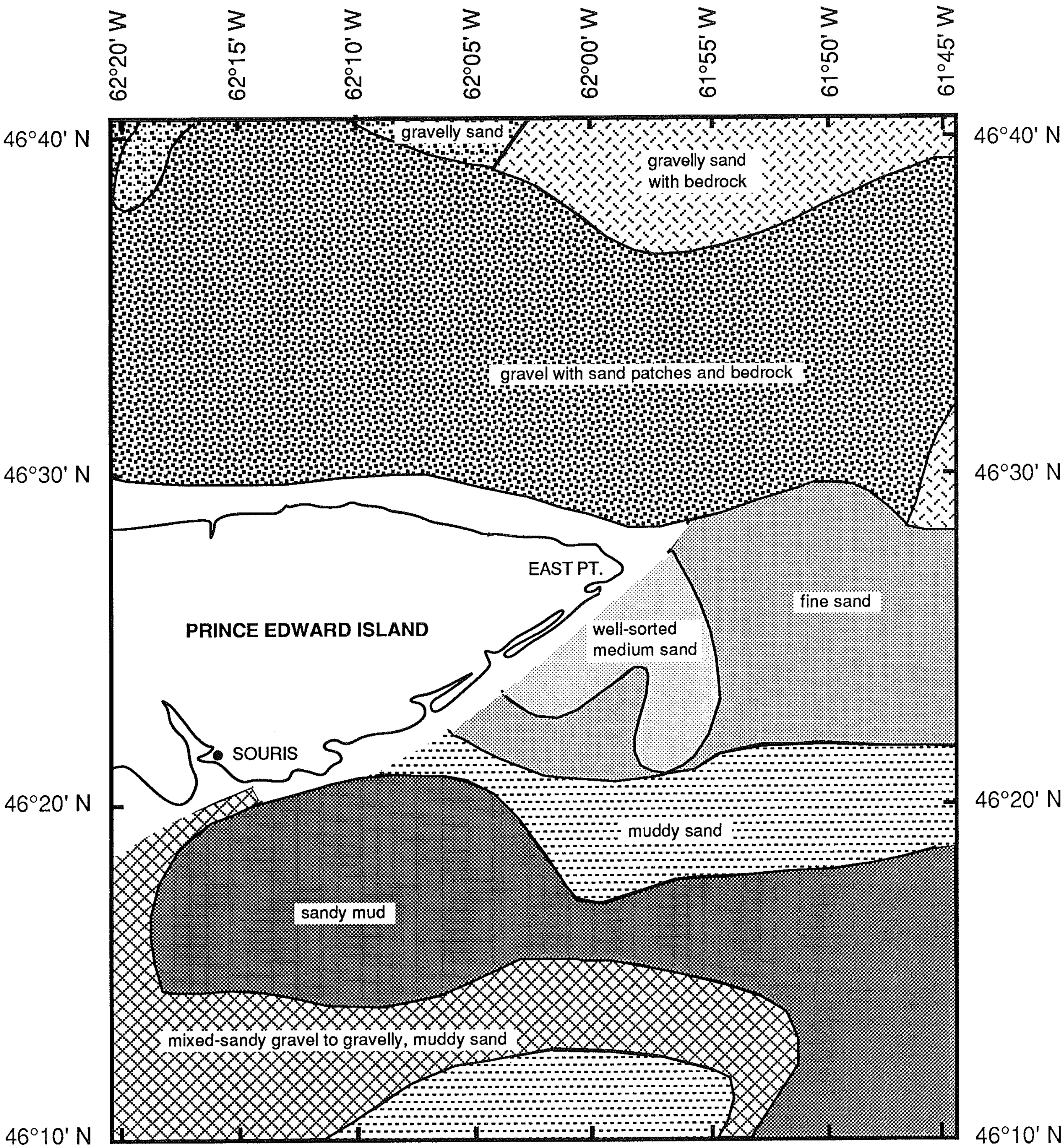


Figure 4: Surficial marine sediments around East Point, Prince Edward Island
- after Kranck, 1971 and Loring and Nota, 1973

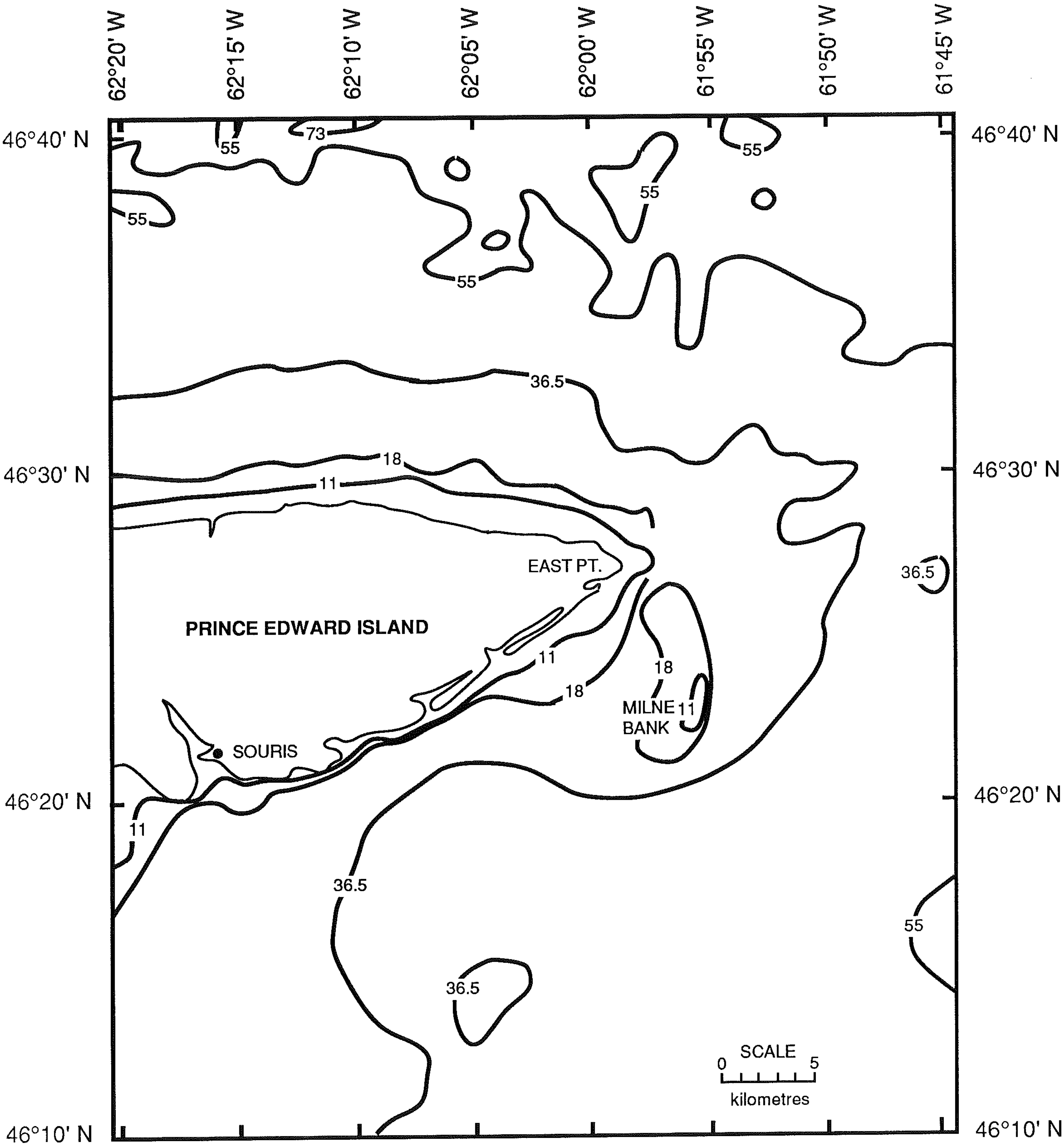


Figure 5: Bathymetry around East Point, Prince Edward Island - depth in metres

The north shore of P.E.I. is subject to the highest wave energy of the island and shoreline erosion rates of 1 to 2 metres/year have been measured (Owens, 1979). The northeast section of the coast is mostly low cliff of easily eroded sandstone and unconsolidated sediment. A coastal erosion study, carried out for the Prince Edward Island Department of Community and Cultural Affairs, (1988) shows annual erosion rates of up to 0.6 m (1.9 ft) along the shore west of East Point, based on a comparison of airphotos from the 1930's and 1980's. In this section, a strong west to east nearshore sediment transport system, moves material alongshore toward and past East Point where it is influenced by the strong tidal currents at the entrance to Northumberland Strait. This sediment then contributes to the sandy beaches southwest of East Point and to a large double-lobed body of well-sorted medium grained sand south of East Point (Owens, 1979; Kranck, 1971). The outer lobe of this sand body is topped by Milne Bank. The airphoto study shows low erosion rates at the coast south of East Point, generally less than 0.1m/yr,. with some areas having deposition rates of over 1 m/yr. Away from the offshore sand body, the sediments in this part of Northumberland Strait become finer, ranging through fine sand, muddy sand to sandy mud (see figure 4).

MILNE BANK AREA

Bathymetry

At the eastern entrance to Northumberland Strait, off East Point, a double-lobed sand body rises above the surrounding seabed. It has a width of about 3 kilometres at East Point and extends south for approximately 11 kilometres to a point where the width has increased to about 13 kilometres and the two north-south trending lobes are separated by a well defined trough (see figures 6 and 7).

The slope of the outer edge of the sand body is variable. Near East Point, the northern edge of the sand body shows a moderate change in slope dropping from 20 to 24 metres over a distance of approximately 350 metres. Away from here, the outer edge is generally steeper. At the northeast corner, the depth change increases to 8 metres over a distance of 250 metres. Along the eastern margin, the top of the slope starts at depths between 13 and 18 metres and the base is at 22 to 31 metres and the incline is variable. The steepest slopes are found on the southeastern side of the outer lobe with depths falling from around 14 metres at the top edge to 30 metres at the base over a distance of about 150 metres. The southern face is also steep along the western edge of the outer lobe the slopes become much gentler and lacks the sharp shoulder and well defined face of the outer slopes. This gentler slope is part of the trough that separates the two lobes of the sand body.

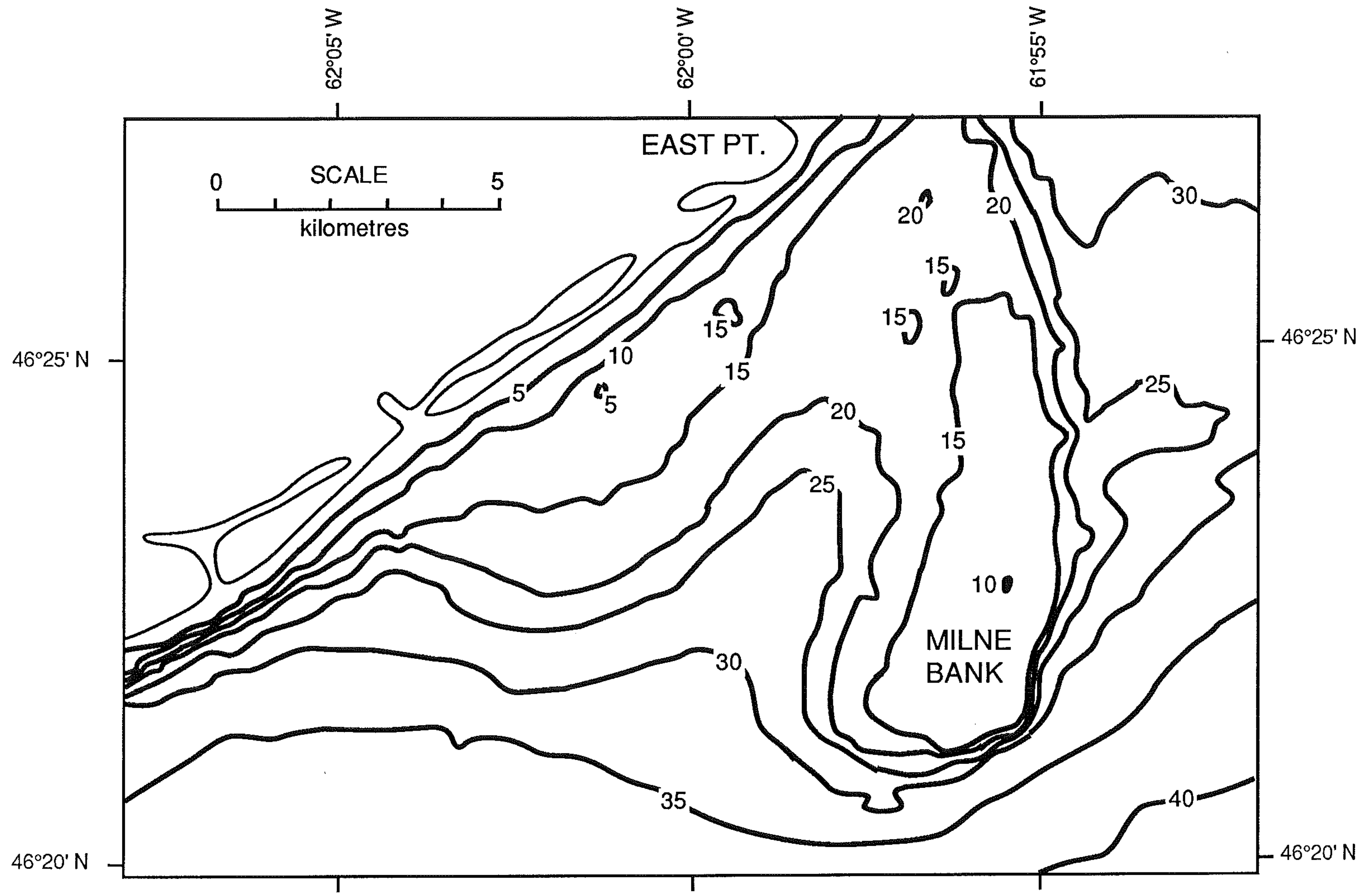


Figure 6: Bathymetry around Milne Bank - depth in metres

At the north end, this central trough exists as a narrow (less than 1 kilometre), north-south oriented channel at the base of the inner slope at East Point. At a point about 3.4 kilometres farther south the channel broadens to over 2 kilometres and has a water depth at its base of just under 20 metres. The trough widens to over 5 kilometres and has a depth of over 30 metres at the southern end of the sand body between the two lobes.

The nearshore, western lobe, is not as sharply defined as the eastern lobe. Eastward from East Point the bottom slopes evenly to a depth of about 19 - 20 metres to the trough that separates the two lobes. South from East Point, the even nearshore slope levels off at about 10 - 12 metres depth forming the top of the inner lobe and in some places a second break in slope occurs at 17 - 18 metres depth before the slope increases to form the side of broad central trough. At its southern end the inner lobe has a width of more than 3 kilometres.

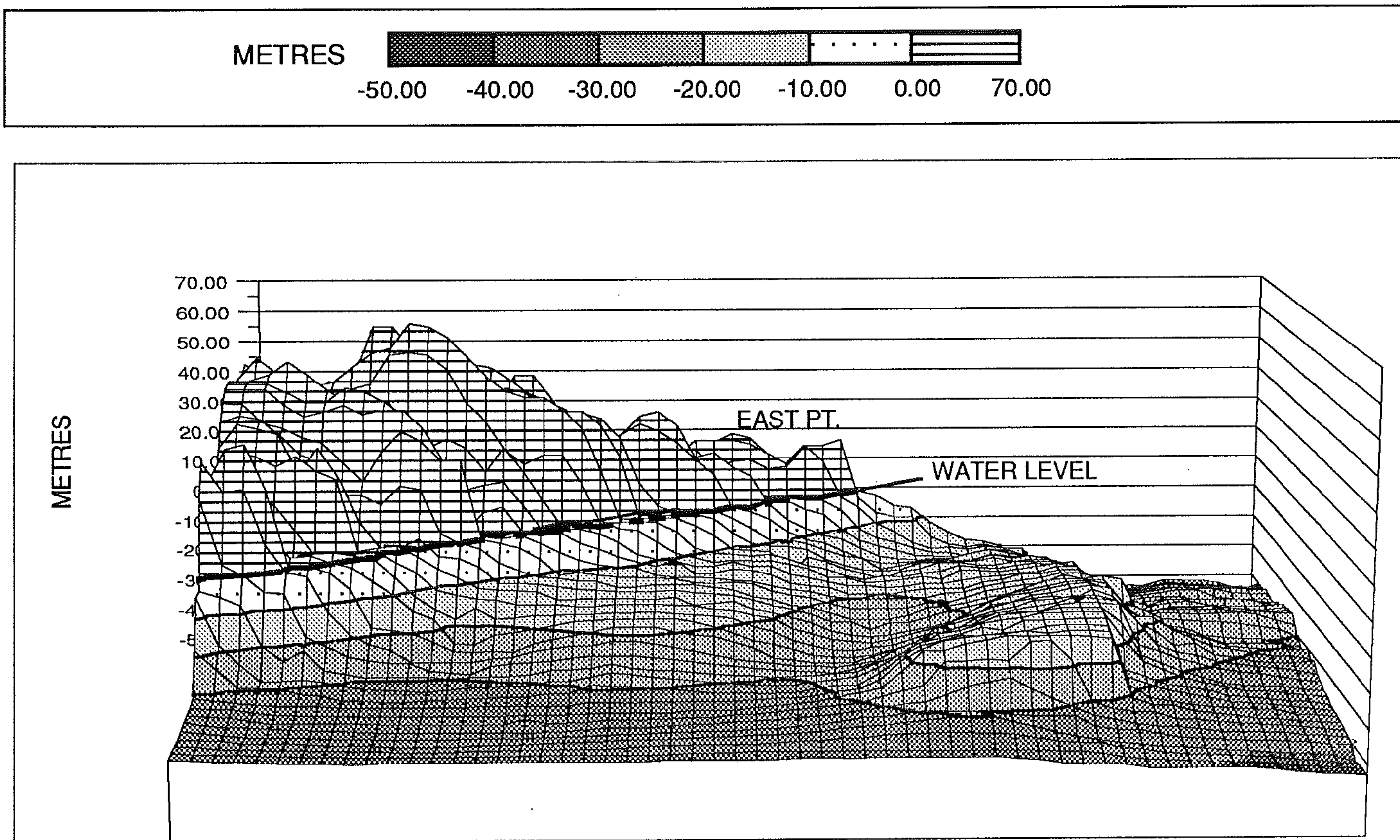


Figure 7: Shaded, 3-D surface graph of the East Point sand body. The area covered is the same as figure 6. View from south to north. Shading below water level at 10 m intervals.

Sediments

Most of the surface of the sand body is covered with well-sorted medium grained sand which often contains sand dollars and shell fragments. On the south and southeast sections of the sand body the sediment becomes finer and moving off the body in these directions the sediments change through fine sand, muddy fine sand to silty mud and mud. Grab samples from two areas of the sand body included small pebbles with the sand. The nearshore samples from the southern half of the western lobe ranged from fine sand with pebbles (#76 - figure3) in the south to medium sand with pebbles (#12 - figure 3) further north. The largest pebbles measured were 8 cm in length and most were composed of the local bedrock - a red-brown sandstone. Two samples (# 16 and #17 - figure 3) from an area 1.5 kilometres southeast of East Point also included pebbles.

Surficial Features

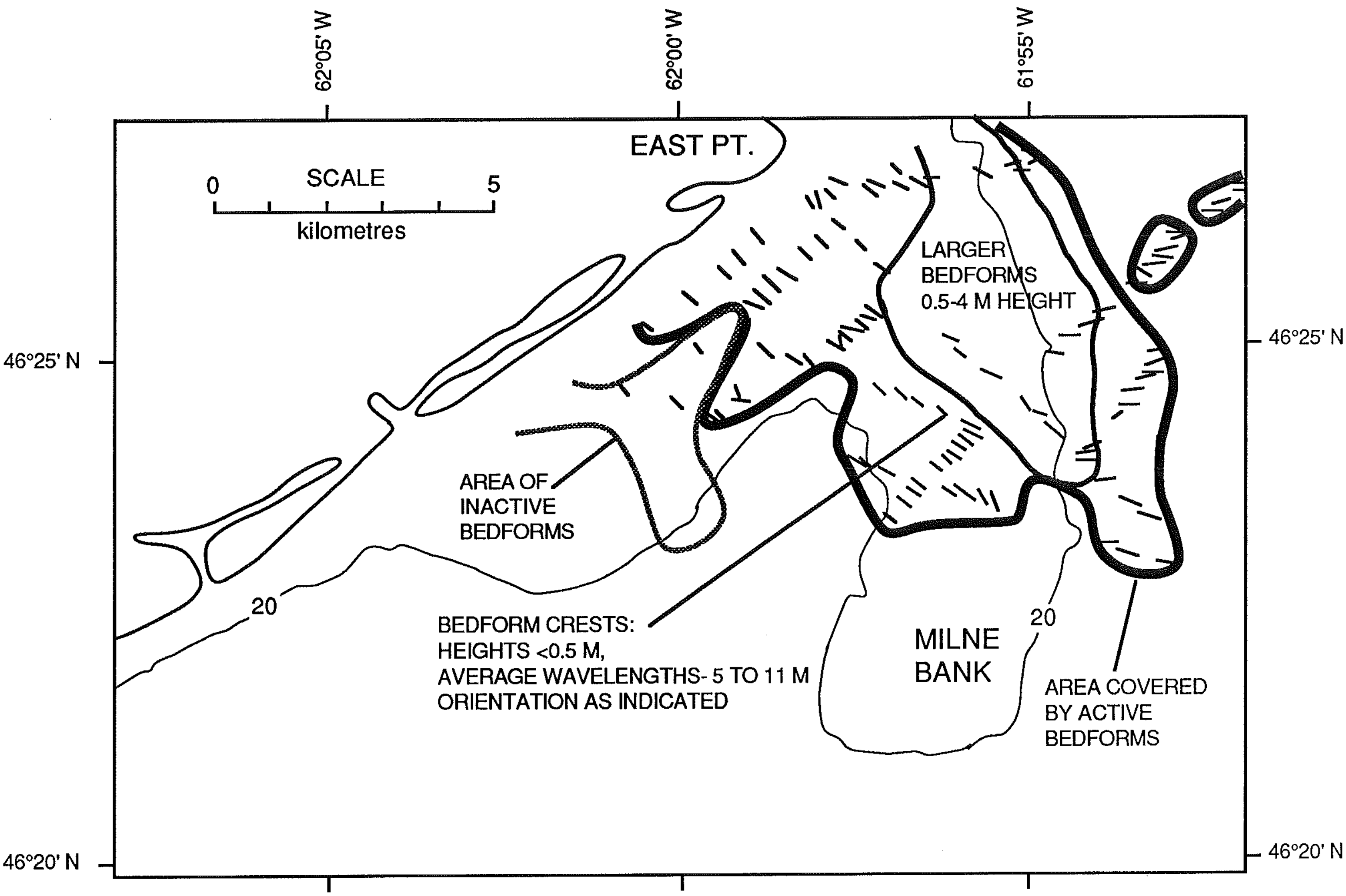


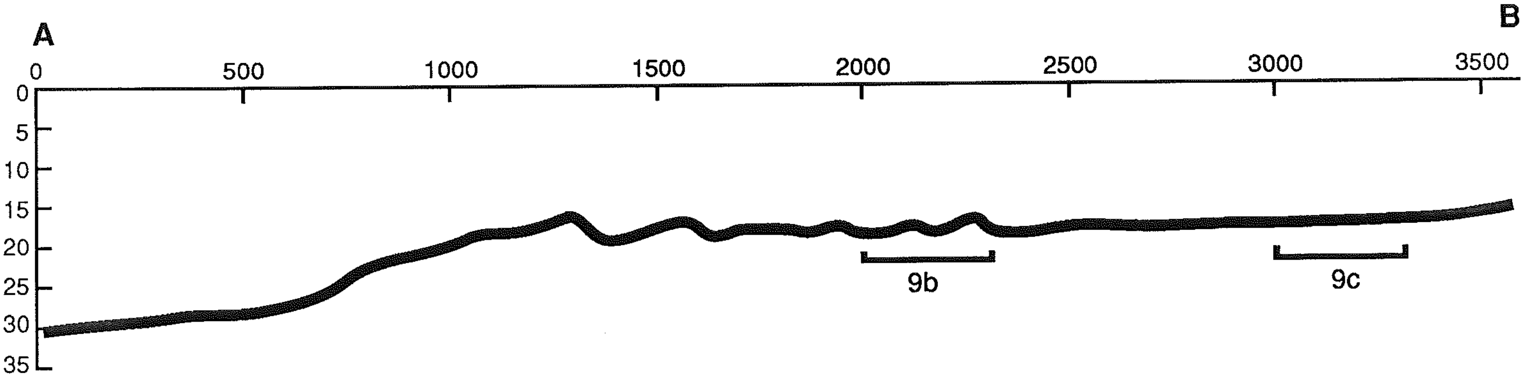
Figure8: Sediment surface features - the 20 metre bathymetric contour roughly outlines the edge of the sand body.

The identification of bottom features and bedforms is somewhat determined by the equipment and recorder settings used during this survey. The northern half of the sand hill (see figure 8) has an almost complete cover of active bedforms. Many of these are less than 0.4 - 0.5 m in height, which makes their profile difficult to separate from the surface traces and wave noise of the sounder and seismic records. However, on sidescan records (see figure 9) these low amplitude sand ripples can be easily identified and their wavelengths, crest orientations and distribution determined These small bedforms cover most of the northern half of the sand body. Wavelengths are typically 5 - 11 metres and the orientation of the crests indicate currents flowing parallel or sub-parallel to the shoreline.

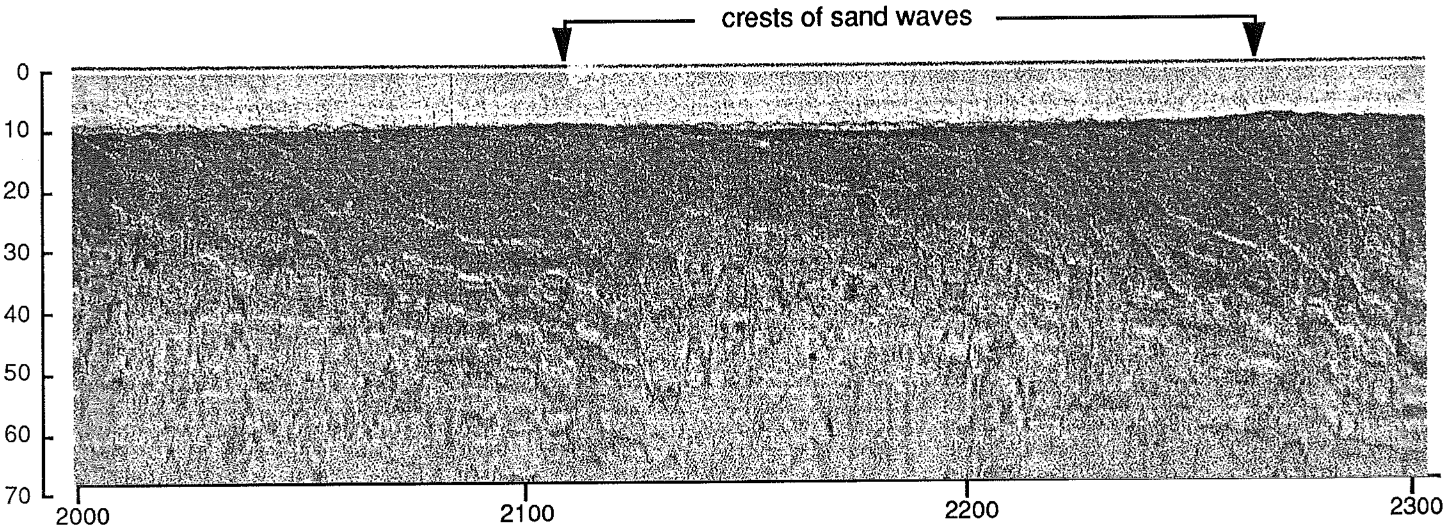
Bedforms, large enough to be seen in profile on the sounder and seismic records are also present in the survey area along the top and eastern slope of the outer lobe of the sand body. These bedforms range in height from 0.5 to 4.0 metres but average between 1 and 2 metres and have wavelengths of tens of metres. A more accurate determination of wavelength is difficult to obtain because these larger bedforms have wavelengths that are of the same order as the range setting (100 m) of the sidescan records. The longest wavelength that could be measured with any accuracy from the sidescan records was 59 metres for 1 metre high sand waves (Amos and King, 1984) on the eastern slope of the outer lobe of the sand body. Often the smaller bedforms can be seen, on sidescan records, superimposed on these larger ones (figure 9).

Figure 10 is the trace of a sounder record showing bedforms of varying wavelength along a line that starts north of the sand body, off East Point, and runs south parallel to the shoreline. The location of this line is shown on figure 11. The largest bedforms on this section are the sand waves (Amos and King, 1984) at the north edge of the sand body that have heights up to 2.9 metres and wavelengths of less than 407 metres. Generally, the bedforms decrease in size north to the south from typical values of 2 metres height and maximum wavelengths of 296 metres to heights of about 1 metre and maximum wavelengths of 115 metres. South of the 3800 m point on figure 10, where these bedforms can easily be identified, there are smaller megaripples (Amos and King, 1984) of less than 0.5 metres height and wavelengths of about 7 - 8 metres. The decreasing size to the south and the asymmetry of the larger bedforms indicate a strong north to south current.

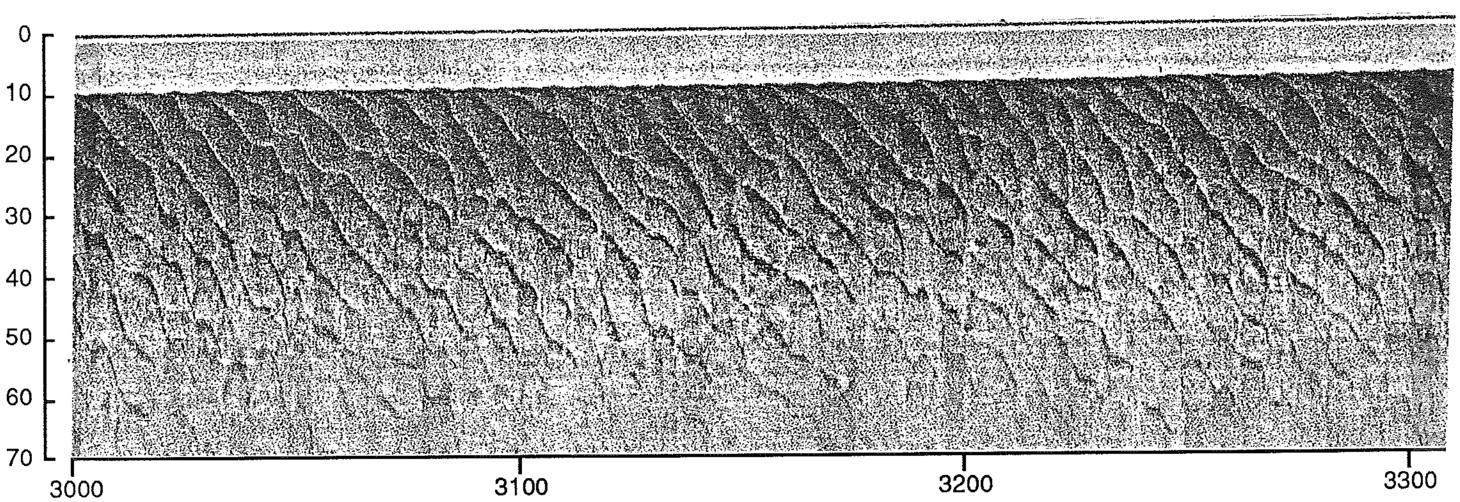
To the south of the area of active bedforms (figure 8) on the western lobe there is an area of broad low sand ridges with relief of 0.5 - 2.0 metres. The widths of these 7 ridges are difficult to determine accurately but values range from about one hundred metres to several hundred metres. These ridges have dimensions similar to the sand waves to the north and, although only two measurements of their orientation were possible, it appears that these ridges are also oriented in the same direction as the active bedforms. However they differ significantly in profile, being flat-topped, and lack the sharp crests of the bedforms in other parts of the survey area. These ridges are interpreted as inactive bedforms that have undergone some erosion.



9a: Seabed trace from the northeast corner of the sand body showing sand waves - largest is 2.4 m in height

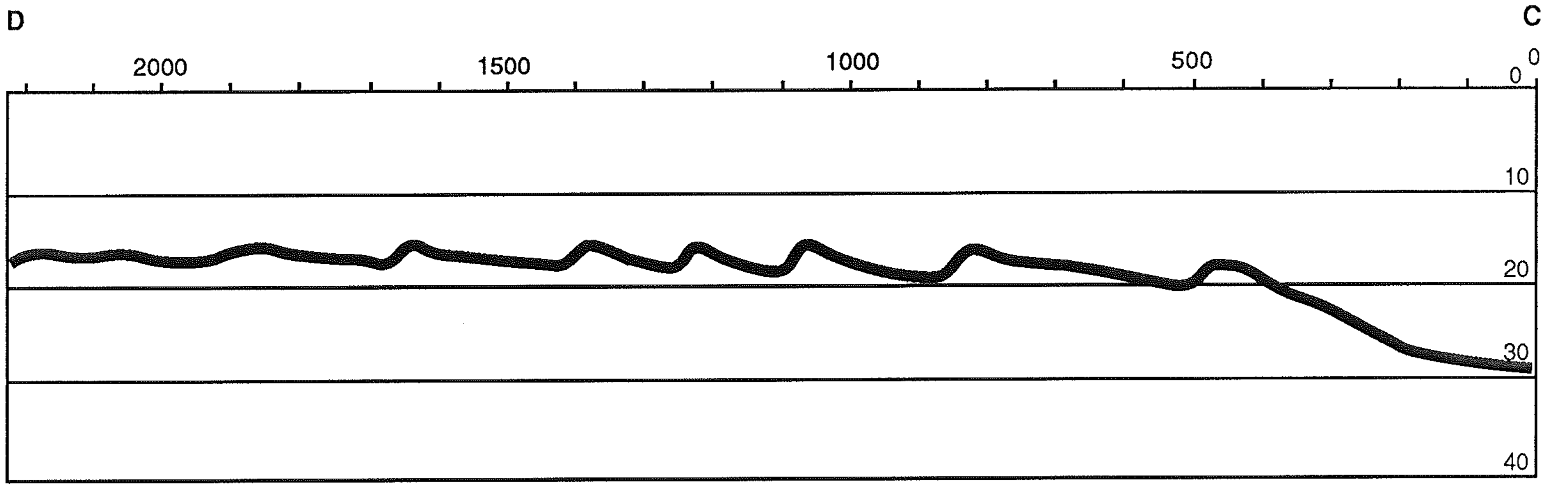


9b: Starboard channel of sidescan record showing megaripples superimposed on sand waves

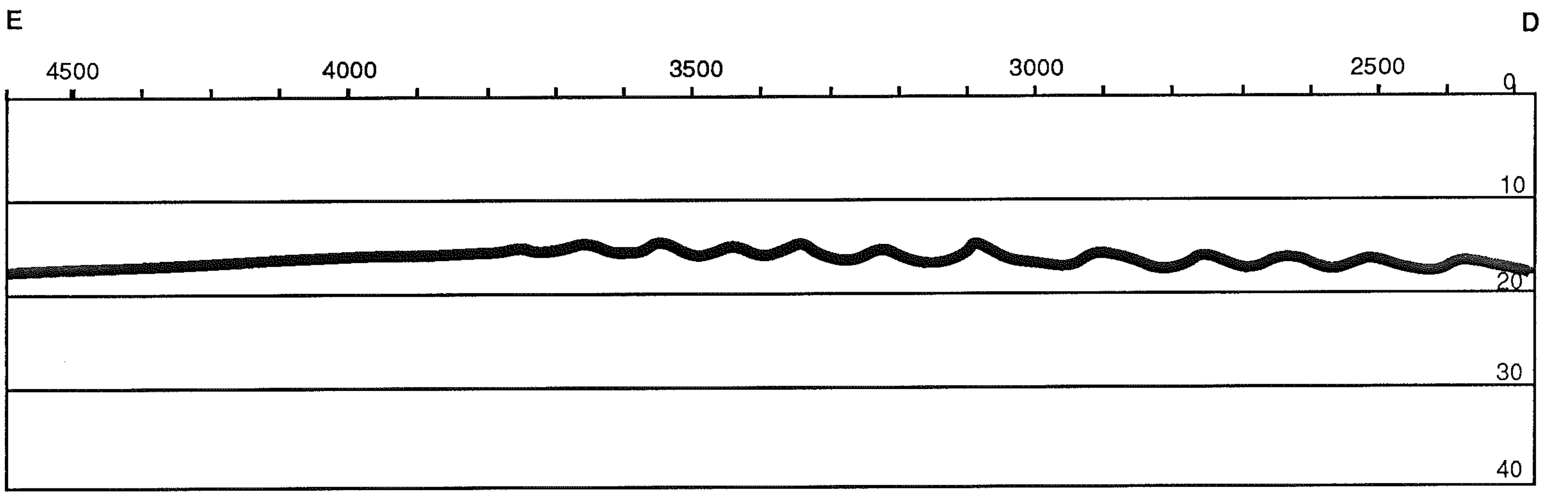


9c: Starboard channel of sidescan record showing megaripples- wavelengths 7 - 13 metres.

Figure 9: A sample of bedforms seen on sounder and sidescan records. All distances in metres.
See figure 11 for location of section A-B



10a: Bedforms up to 2.9 metres in height and maximum wavelength of about 400 metres.



10b: Bedforms up to 1.9 metres in height and wavelengths less than 185 metres.

Figure 10: Bedforms on a line parallel to the shore at the north edge of the sand body. Distances and depths in metres. See figure 11 for location of section C - E.

Sub-bottom

Kranck (1971) describes this sand body as a large deposit of well sorted medium-grained sand resulting from the present erosion and transport of material from the north shore of the island. This deposit of Egmont sand sits on a well developed post Pleistocene terrace of Buctouche sand and gravel which is a lag deposit created during post glacial transgression of the sea. These formations overlie bedrock.

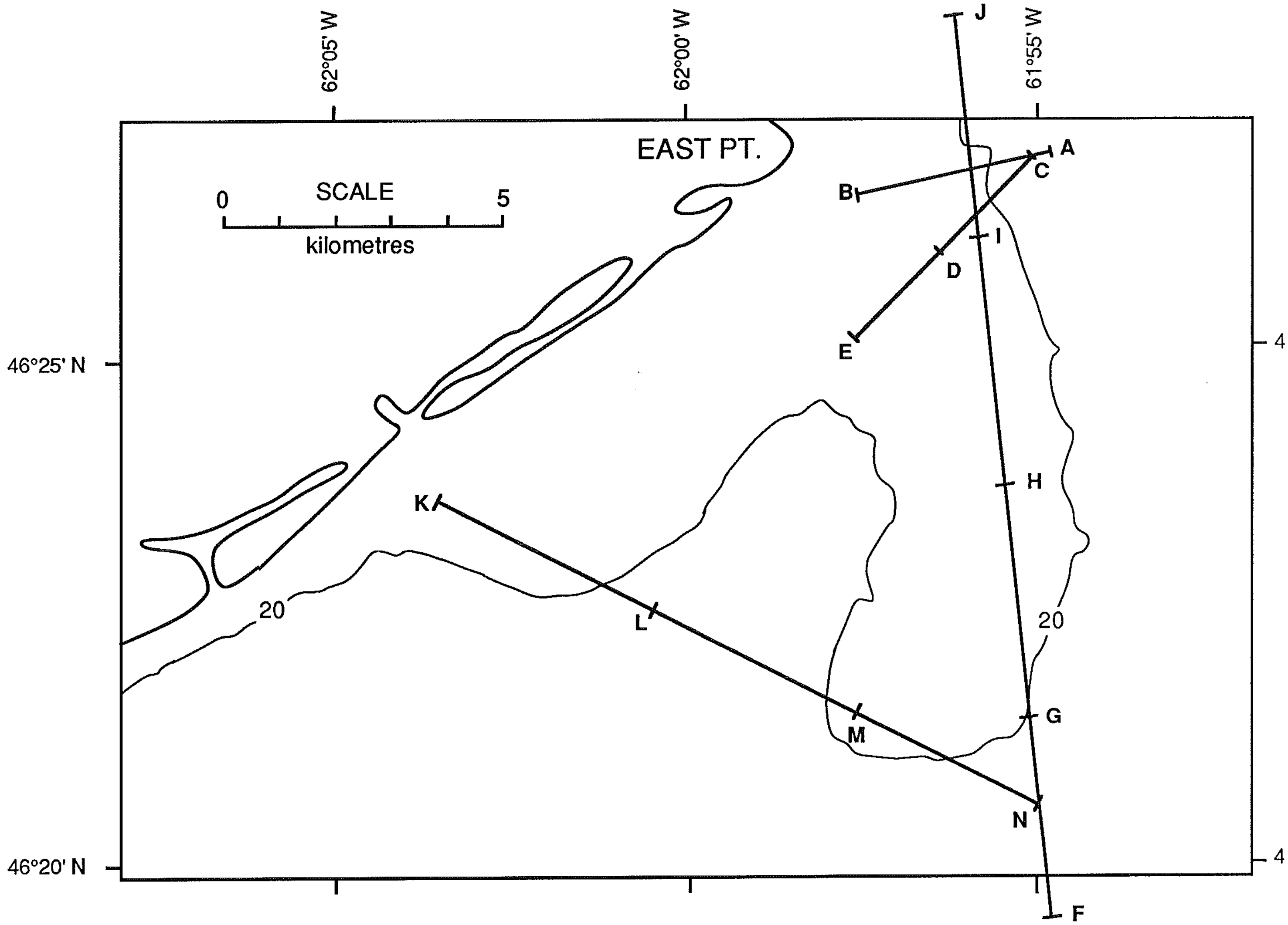


Figure 11: Locations of sections in figures 9, 10, 12 and 13. The 20 metre bathymetric contour roughly outlines the edge of the sand body.

Figures 12 and 13 are interpreted profiles, combining Bubble Pusler and Sea-Lion or sparker records of sections F - J (line 3) and K - N (line 19). F - J runs south to north along the axis of the eastern lobe and K - N runs northwest to southeast across the southern end of the sand body (figure 11).

On the seismic records of these two lines there is a highly irregular seismic reflector that has relief of up to 20 m and is buried 12 - 52 m below the seabed, 41 -76 m below water level. This reflector is marked with a heavier line in figures 12 and 13. A preliminary examination of the rest of the seismic records indicates that this surface can be seen under most of the sand body and probably represents the lag surface described by Kranck (1971).

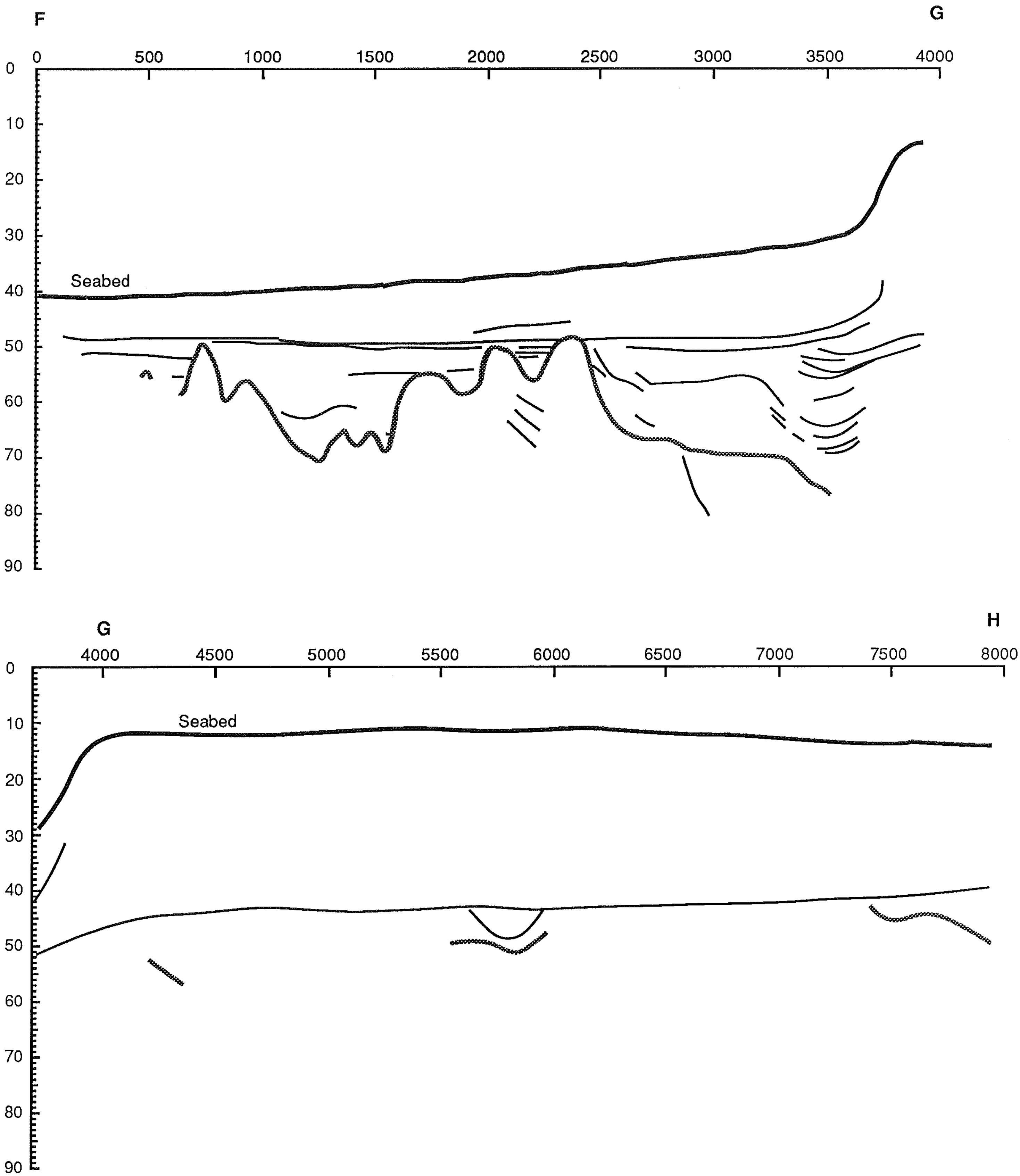
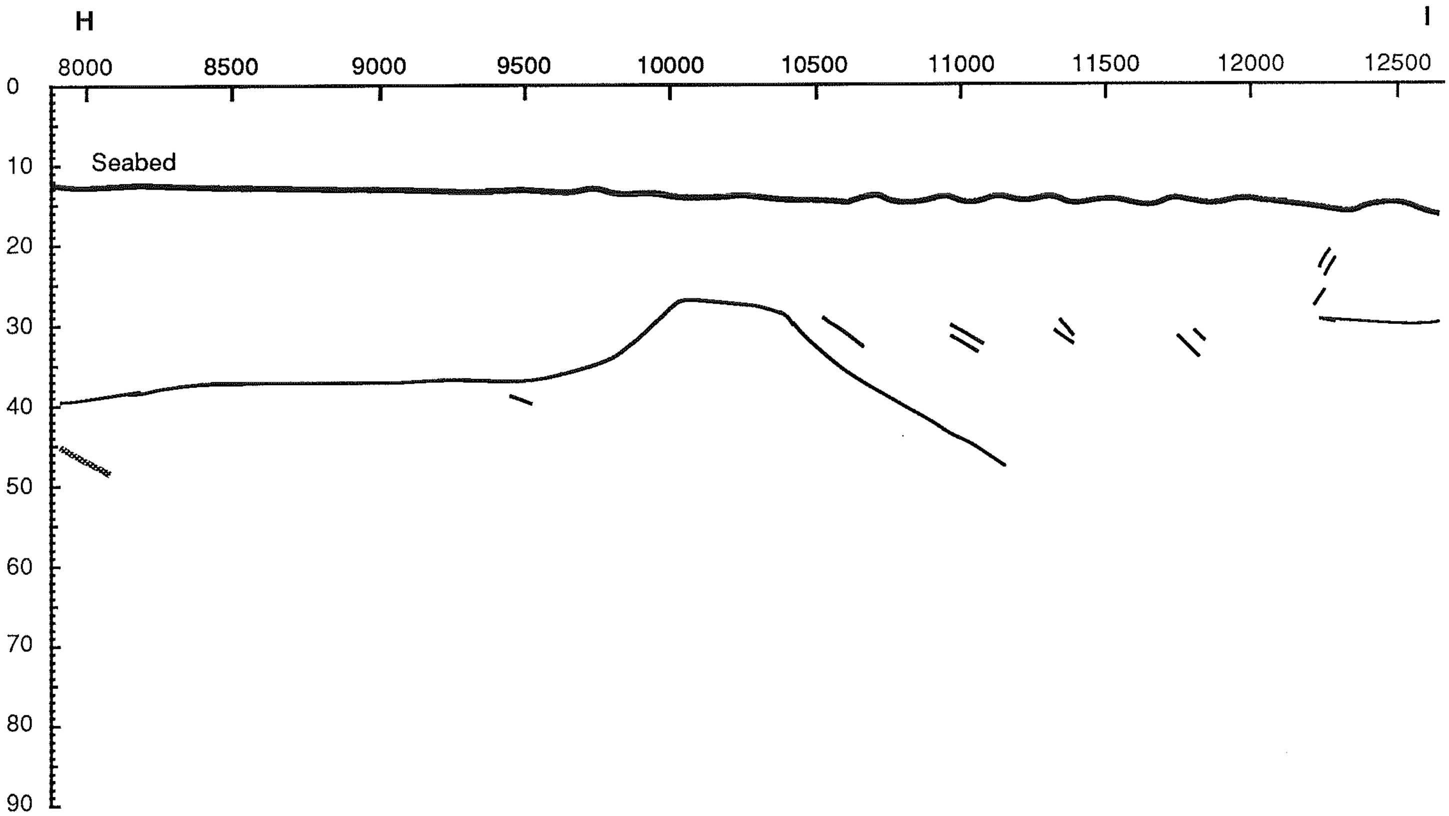


Figure 12 -part1: Interpreted seismic profile of part of a line running along axis of the eastern lobe of the sand hill. Profile continued on next page. All depths and distances in metres. For section location see figure11.



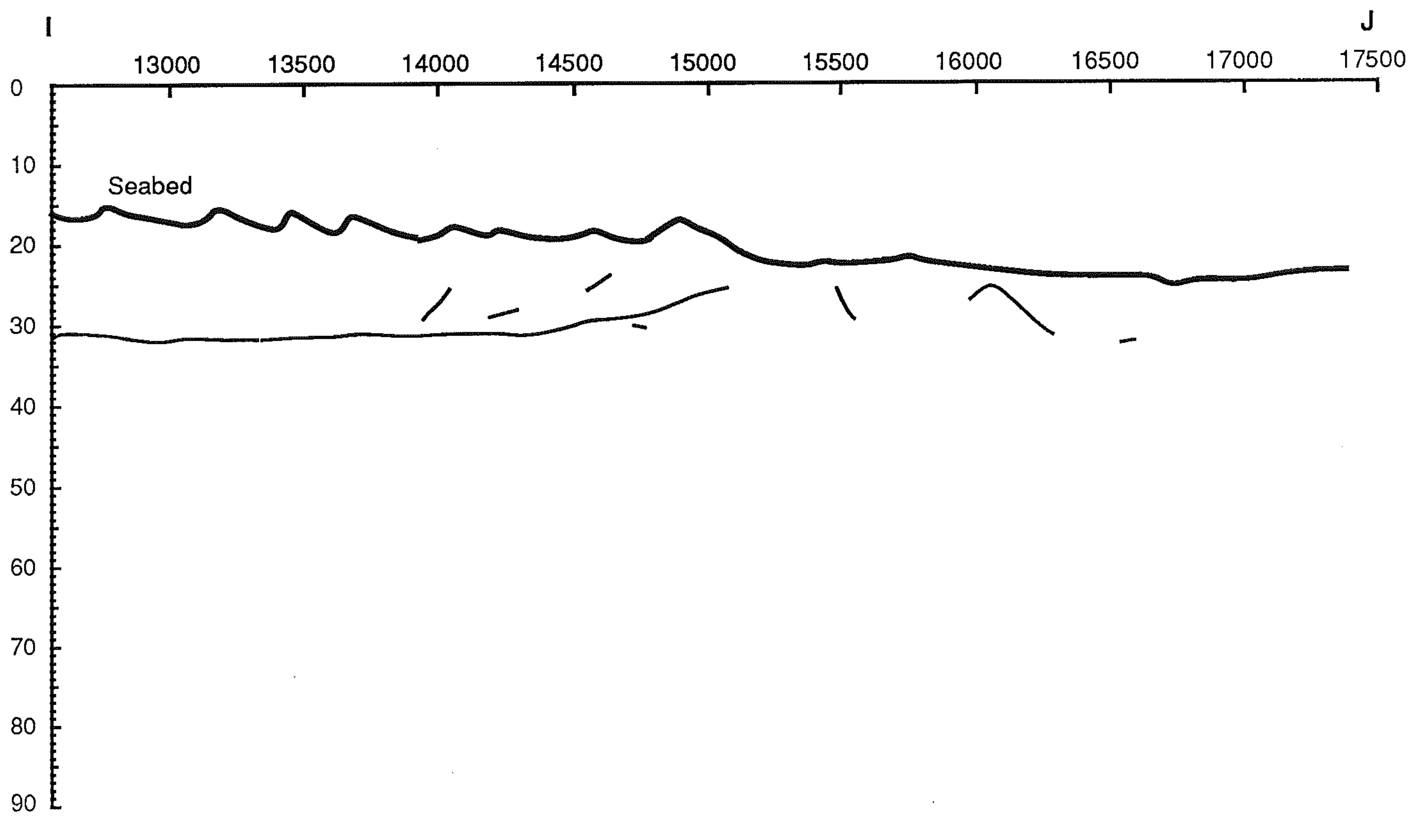


Figure 12 -part 2: Interpreted seismic profile of part of a line running along axis of the eastern lobe of the sand body. All depths and distances in metres. For section location see figure11.

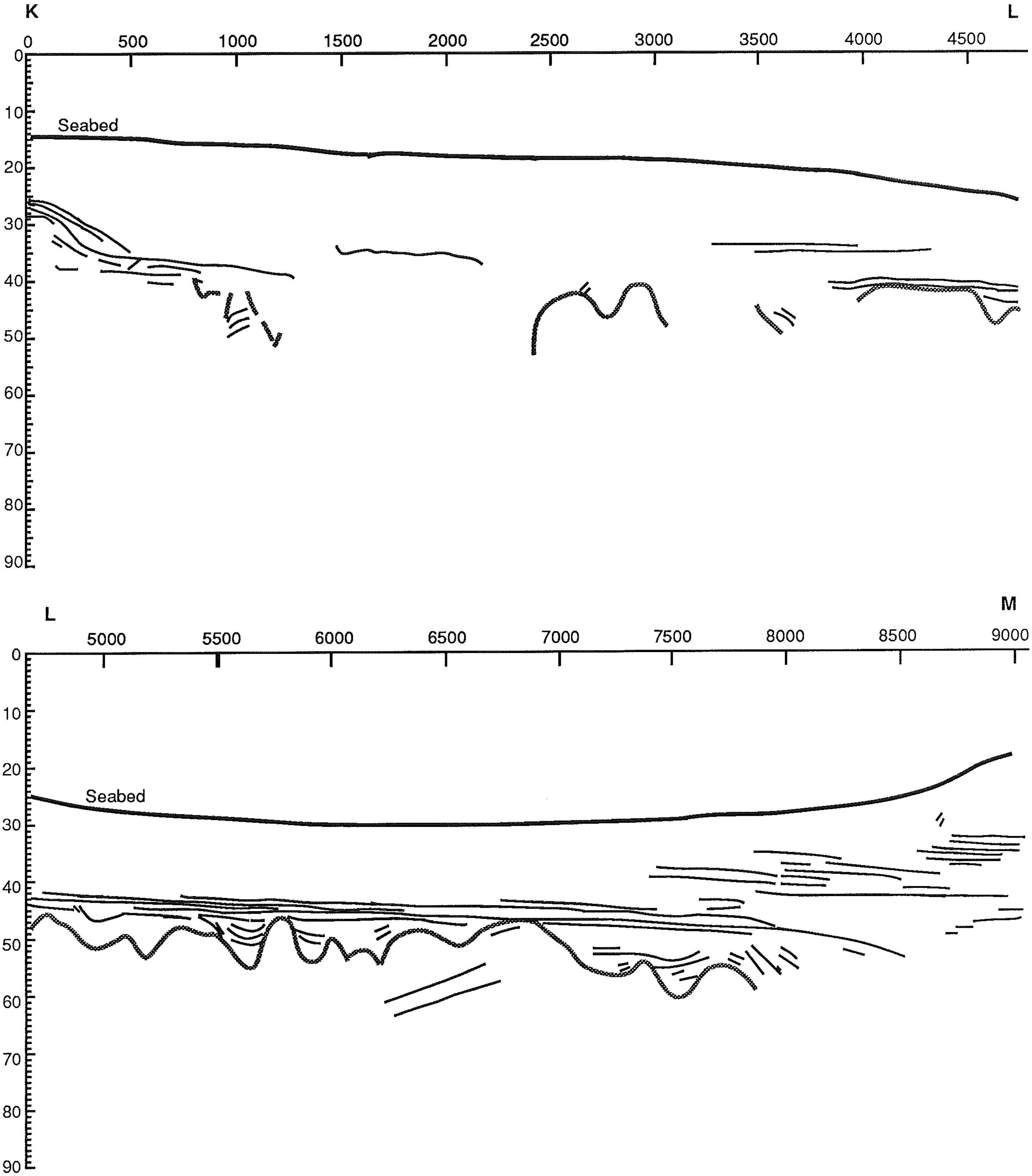


Figure 13 -part 1: Interpreted seismic profile of part of a line running across the southern end of the sand hill. Profile continued on next page. All depths and distances in metres. For section location see figure11.

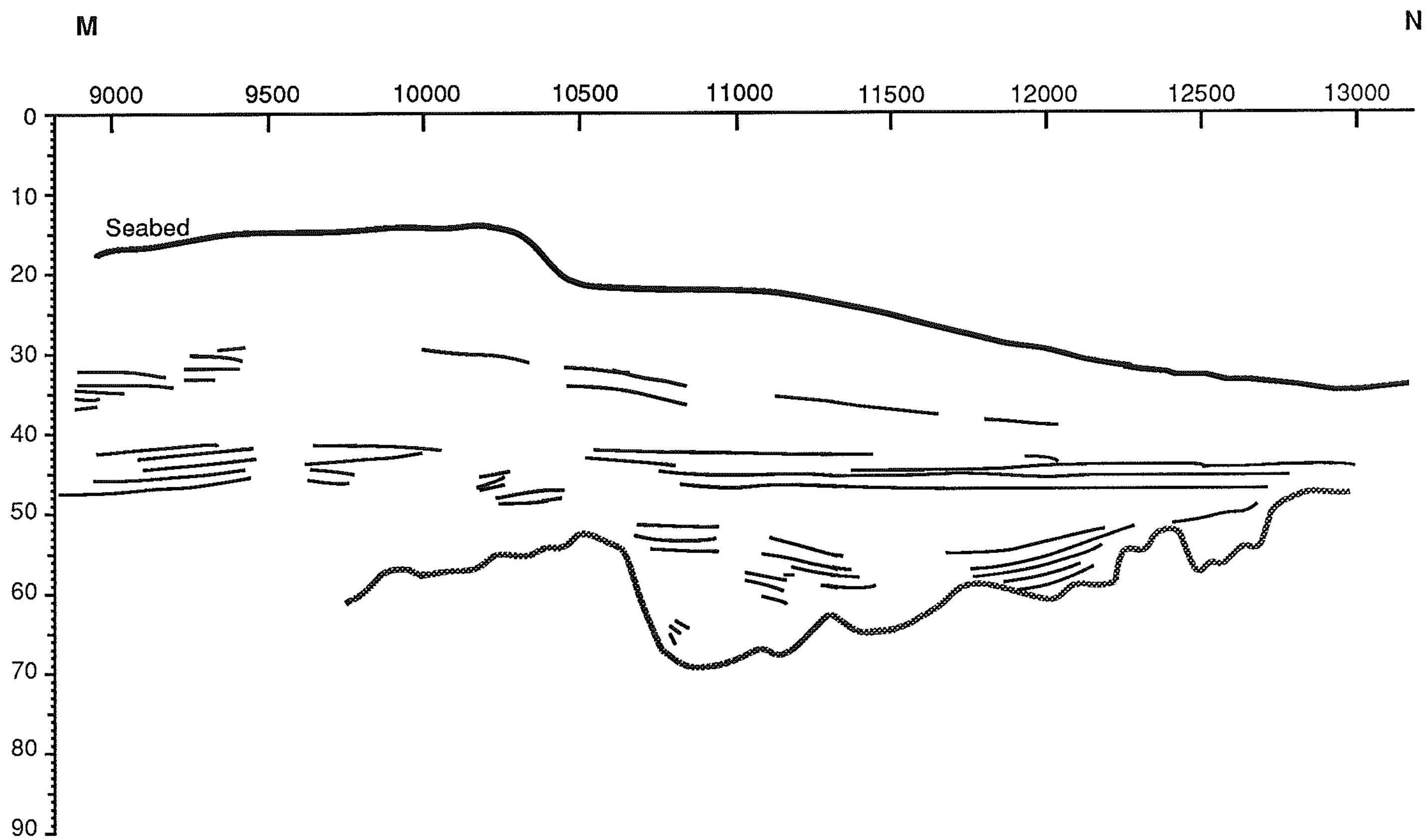


Figure 13 -part 2: Interpreted seismic profile of part of a line running across the southern end of the sand hill. All depths and distances in metres. For section location see figure11.

Below this irregular surface some discontinous reflectors can be seen but many more can be identified above this level. These reflectors indicate infilling of the depressions and a general blanketing by almost flat lying beds above the highest level of the lag surface

CONCLUSIONS FOR MILNE BANK AREA

The distribution of surficial sediments around the sand body off East Point, as determined by the visual examination of the grab samples from this survey, agrees well with that mapped by Kranck (1971). The sand body is covered by well sorted medium grained sand. This material fines to the south and southeast of the sand body. Along the west side closer to shore the sand contained some small pebbles and in other areas the sand ranged up to coarse in size. The suitability of this material for construction aggregate requires further sediment size analysis of the samples.

Bedforms cover most of the northern half of the sand body and extend down the northeastern slope of the outer lobe. The largest ones are found along the north edge and along the outer slope and these diminish in size to the south. Although there is considerable variability, in general, the bedform crests are oriented perpendicular to the shoreline and the larger ones show an asymmetry of profile indicating formation by currents from the northeast.

SURVEY NORTH OF EAST POINT

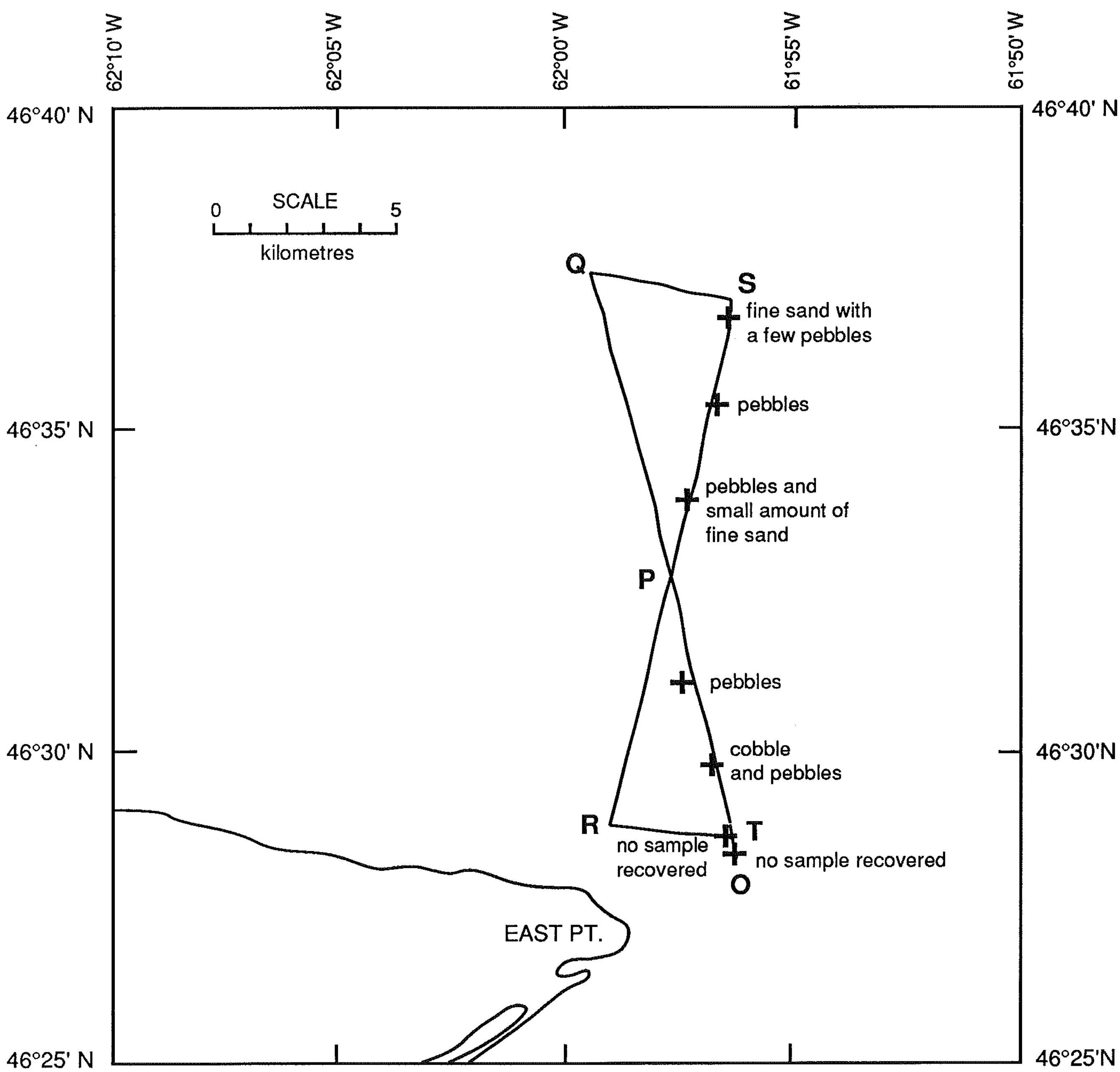


Figure 14: Track lines, sample locations and descriptions for area surveyed north of East Point.

Two onshore/offshore lines and two short east/west connecting lines were run north of East Point as a preliminary investigation of seabed conditions at the southern end of a possible electrical transmission cable route from the Magdalen Islands to Prince Edward Island (see figure 14). In addition, grab sampling was carried out at seven stations in the area. The coverage started about 2.5 kilometres north of East Point in water depths of 17 to 25 metres and extended approximately 16 kilometres north to water depths of 58 to 67 metres.

Features

Figure 15 shows bathymetric profiles along the survey lines. The depth increases in three irregular steps offshore from East Point. The first step drops from the nearshore end of the survey lines at about 20 metres to a depth of about 35 to 37 metres. The next step lies between 35 and 50 metres and the last, which is the flattest, lies between 50 and 55 metres depth near the outer end of the lines.

The sidescan sonar records show much of the area surveyed to be exposed bedrock (up to 30%) or bedrock with gravel (up to 5%) while in other areas the surface is covered with coarse material up to boulder size (up to 35%) (see figures 15 and 16). Sand was only sampled at the outer end of line R-S. The surface material could not be determined for the remaining sections of the lines. In the bedrock areas the seabed is irregular but relief, generally, only varies by a metre or two. Greater variation in the seabed can be found outside or between the bedrock areas where depressions of varying widths and depths occur. These range from steep-sided gullies of 5 metres depth and 250 metres width to broad low depressions of 6 to 7 metres relief and one kilometre width.

The seismic records show a number of subsurface features interpreted to be of buried channels, most of which have a maximum depth of 10 metres below the seabed and are often associated with depressions in the seabed (see figure 15).

Conclusions

A number of cable laying problems can be expected at the southern end of a route between the Magdalen Islands and East Point, Prince Edward Island These include the presence of bedrock, coarse surficial materials, up to boulder in size, and irregular relief.

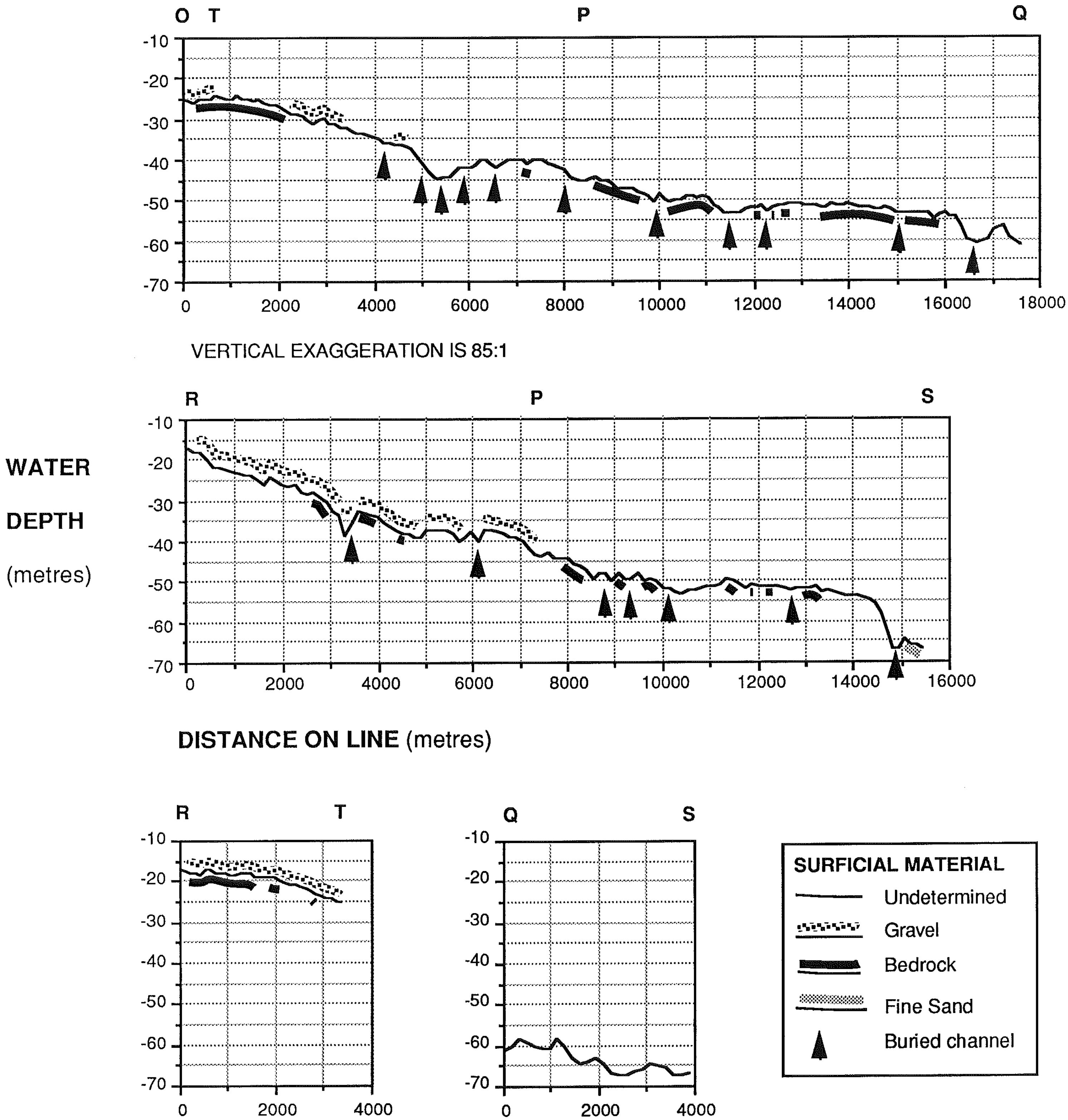


Figure 15: Bathymetry and surficial materials along the survey lines north of East Point.
For location of sections see figure 14.

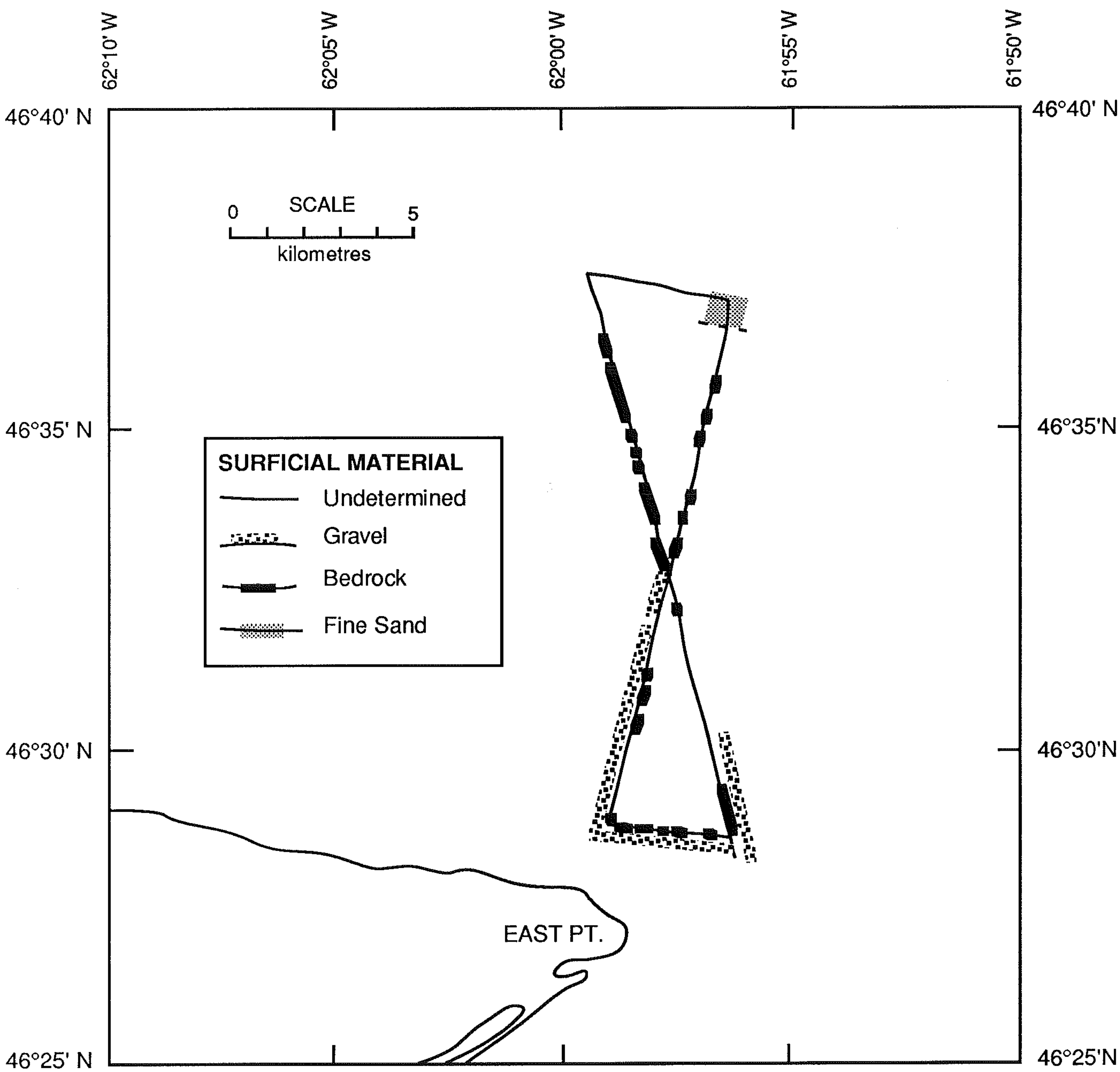


Figure 16: Distribution of surficial material along survey lines north of East Point.

ACKNOWLEDGEMENTS

The positive attitude, cooperation, and seamanship of the Navicula crew contributed greatly to the success of the cruise. The long hours and the small size of the vessel put an unusual strain on all onboard. The technical support and positive attitude of Ken Asprey, Darrel Beaver, Tony Atkinson and Wayne Prime during the cruise were greatly appreciated. John Shaw and John Zevenhuizen kindly read and commented on a draft of the report.

LIST OF CHARTS

All charts published by the Canadian Hydrographic Service, Department of Fisheries and Oceans, Ottawa.

4023 Northumberland Strait: Gulf of St. Lawrence (Nov. 28, 1986 edition); compiled by the Canadian Hydrographic Service from Canadian and British Admiralty surveys; scale 1:300,000 at latitude 46° 30' N.

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APPENDIX

TABLE 1

BATHYMETRIC RECORDS 88018(F) PHASE 12

ROLL NUMBER	START DAY/TIME	STOP DAY/TIME	LINE NUMBERS	GEOGRAPHIC LOCATION	FREQUENCY	RECORDER	NOTES
001	269/1853	270/1120	1	EAST PEI	30 KHZ	ELAC	
002	270/1140	270/1920	2-5	EAST PEI	30 KHZ	ELAC	
003	270/1925	270/2155	6,7	EAST PEI	30 KHZ	ELAC	
004	271/1200	271/2028		EAST PEI	30 KHZ	ELAC	GRABS 1-41
005	274/1310	276/1310	8-14	EAST PEI	30 KHZ	ELAC	
006	276/1320	276/2317	14-19	EAST PEI	30 KHZ	ELAC	
007	277/1342	277/1916		EAST PEI	30 KHZ	ELAC	GRABS 42-61
008	277/1937	278/0106		EAST PEI	30 KHZ	ELAC	GRABS 62-86

TABLE 2

SEISMIC RECORDS 88018(F) PHASE 12

ROLL NUMBER	START DAY/TIME	STOP DAY/TIME	HYDROPHONE	LINE NUMBERS	GEOGRAPHIC LOCATION	RECORDER	SYSTEM/ SOUND SOURCE
001	269/1832	269/2230	EXTERNAL EEL	1	EAST PEI	EPC 1000	BUBBLE-PULSER
002	270/1128	270/2156	EXTERNAL EEL	2-7	EAST PEI	EPC 1000	BUBBLE-PULSER
003	274/1304	274/2222	EXTERNAL EEL	8-11	EAST PEI	EPC 1000	BUBBLE-PULSER
004	275/1154	275/1632	EXTERNAL EEL	12,13	EAST PEI	EPC 1000	BUBBLE-PULSER
005	276/1241	276/2314	EXTERNAL EEL	14-19	EAST PEI	EPC 1000	BUBBLE-PULSER
001	270/1128	270/1430	NSRF EEL	2	EAST PEI	EPC 4100	GEOPULSE/SEA-LION
002	270/1509	270/2156	NSRF EEL	3-7	EAST PEI	EPC 4100	GEOPULSE/SEA-LION
003	274/1252	274/1540	NSRF EEL	8	EAST PEI	EPC 4100	GEOPULSE/SEA-LION
004	274/1616	274/2222	NSRF EEL	9-11	EAST PEI	EPC 4100	GEOPULSE/SEA-LION
005	275/1316	275/1632	NSRF EEL	12,13	EAST PEI	EPC 4100	GEOPULSE/SEA-LION
001	269/1838	269/2230	NSRF EEL	1	EAST PEI	EPC 4100	GEOPULSE/SPARKER
002	276/1241	276/1544	NSRF EEL	14,15	EAST PEI	EPC 4100	GEOPULSE/SPARKER
003	276/1556	276/2314	NSRF EEL	15-19	EAST PEI	EPC 4100	GEOPULSE/SPARKER

TABLE 3

MAGNETOMETER RECORDS 88018(F) PHASE 12

ROLL NUMBER	START DAY/TIME	STOP DAY/TIME	LINE NUMBERS	GEOGRAPHIC LOCATION	INSTRUMENT	RECORDER
001	269/1930	276/1750	1-19	EAST PEI	BARRINGER SM-123	HP7155

TABLE 4

SIDESCAN TAPES 88018(F) PHASE 12

TAPE NUMBERS	START DAY/TIME	STOP DAY/TIME	LINE NUMBERS	GEOGRAPHIC LOCATION	CHANNEL INFO	SIDESCAN SYSTEM
001	269/1847	269/2000	1	EAST PEI	PORT-FM STBD-FM REF-FM VOICE-DR	100-KHZ KLEIN
002	269/2000	270/1430	1,2	EAST PEI	PORT-FM STBD-FM REF-FM VOICE-DR	100-KHZ KLEIN
003	270/1430	270/1740	2-4	EAST PEI	PORT-FM STBD-FM REF-FM VOICE-DR	100-KHZ KLEIN
004	270/1741	270/2100	4-7	EAST PEI	PORT-FM STBD-FM REF-FM VOICE-DR	100-KHZ KLEIN
005	270/2100	274/1815	7-10	EAST PEI	PORT-FM STBD-FM REF-FM VOICE-DR	100-KHZ KLEIN
006	274/1510	274/1815	8,10	EAST PEI	PORT-FM STBD-FM REF-FM VOICE-DR	100-KHZ KLEIN
007	274/1819	274/2126	10,11	EAST PEI	PORT-FM STBD-FM REF-FM VOICE-DR	100-KHZ KLEIN
008	274/2130	275/1415	11,12	EAST PEI	PORT-FM STBD-FM REF-FM VOICE-DR	100-KHZ KLEIN
009	275/1420	276/1337	12-14	EAST PEI	PORT-FM STBD-FM REF-FM VOICE-DR	100-KHZ KLEIN
010	276/1337	276/1647	14,15	EAST PEI	PORT-FM STBD-FM REF-FM VOICE-DR	100-KHZ KLEIN
011	276/1648	276/1958	15,16	EAST PEI	PORT-FM STBD-FM REF-FM VOICE-DR	100-KHZ KLEIN
012	276/2000	276/2305	17-19	EAST PEI	PORT-FM STBD-FM REF-FM VOICE-DR	100-KHZ KLEIN
013	276/2310	276/2315	19	EAST PEI	PORT-FM STBD-FM REF-FM VOICE-DR	100-KHZ KLEIN

TABLE 5

SIDESCAN RECORDS 88018(F) PHASE 12

ROLL NUMBERS	START DAY/TIME	STOP DAY/TIME	LINE NUMBERS	GEOGRAPHIC LOCATION	RECORDER	SIDESCAN SYSTEM
001	269/1900	269/2027	1	EAST PEI	KLEIN 401	100-KHZ KLEIN
002	269/2030	269/2330	1	EAST PEI	KLEIN 401	100-KHZ KLEIN
003	270/1140	270/1440	2	EAST PEI	KLEIN 401	100-KHZ KLEIN
004	270/1445	270/1838	2-4	EAST PEI	KLEIN 401	100-KHZ KLEIN
005	270/1840	270/2017	4-6	EAST PEI	KLEIN 401	100-KHZ KLEIN
006	270/2020	270/2156	6,7	EAST PEI	KLEIN 401	100-KHZ KLEIN
007	274/1252	274/1500	8	EAST PEI	KLEIN 401	100-KHZ KLEIN
008	274/1510	274/2046	8-11	EAST PEI	KLEIN 401	100-KHZ KLEIN
009	274/2057	274/2220	11	EAST PEI	KLEIN 401	100-KHZ KLEIN
010	275/1154	275/1540	12	EAST PEI	KLEIN 401	100-KHZ KLEIN
011	275/1542	275/1636	13	EAST PEI	KLEIN 401	100-KHZ KLEIN
012	276/1250	276/1646	14,15	EAST PEI	KLEIN 401	100-KHZ KLEIN
013	276/1720	276/2252	15-19	EAST PEI	KLEIN 401	100-KHZ KLEIN
014	276/2252	276/2315	19	EAST PEI	KLEIN 401	100-KHZ KLEIN

TABLE 6

GRAB SAMPLES 88018(F) PHASE 12

SAMPLE NUMBER	SAMPLER TYPE	JULIAN DAY/TIME	LATITUDE LONGITUDE	DEPTH (M)	NO. OF ATTEMPTS	NO. OF SUB-SAMPLES	SEISMIC TIME	GEOGRAPHIC LOCATION	NOTES
001	VAN VEEN	271/1200	46°21.26'N 62°08.78'W	28	1	2	269/2000	EAST PEI	RED-BROWN SILTY MUD WITH WORMS AND BLACK ORGANIC STREAKS
002	VAN VEEN	271/1210	46°21.19'N 62°07.80'W	33	1	2	269/2010	EAST PEI	RED-BROWN SILTY MUD
003	VAN VEEN	271/1220	46°21.58'N 62°06.92'W	33	1	2	269/2022	EAST PEI	RED-BROWN SILTY MUD
004	VAN VEEN	271/1231	46°21.91'N 62°06.28'W	31.5	1	2	269/2030	EAST PEI	RED-BROWN SILTY MUD
005	VAN VEEN	271/1238	46°22.28'N 62°02.57'W	29.5	1	2	269/2040	EAST PEI	RED-BROWN SILTY MUD
006	VAN VEEN	271/1247	46°22.56'N 62°04.91'W	28.5	1	2	269/2050	EAST PEI	RED-BROWN FINE SAND

TABLE 6 (continued)

GRAB SAMPLES

007	VAN VEEN	271/1256	46°23.00'N 62°04.81'W	24.5	2	2	269/2100	EAST PEI	RED-BROWN FINE-MEDIUM SAND WITH SHELL FRAGMENTS
008	VAN VEEN	271/1307	46°23.38'N 62°03.57'W	16.6	2	1	269/2110	EAST PEI	MEDIUM SAND WITH PEBBLES UP TO 8x3x0.5CM -ANGULAR TO SUBROUNDED- MOSTLY RED SANDSTONE AND A FEW QUARTZ
009	VAN VEEN	271/1316	46°23.81'N 62°02.81'W	13.5	1	2	269/2120	EAST PEI	RED-BROWN MEDIUM SAND WITH A FEW ANGULAR PEBBLES, SAND DOLLARS AND WORMS
010	VAN VEEN	271/1324	46°24.14'N 62°02.19'W	13	1	2	269/2130	EAST PEI	RED-BROWN MEDIUM-COARSE SAND WITH SAND DOLLARS
011	VAN VEEN	271/1338	46°24.38'N 62°01.50'W	12.5	1	2	269/2140	EAST PEI	RED-BROWN MEDIUM SAND WITH SAND DOLLARS
012	VAN VEEN	271/1346	46°24.88'N 62°00.81'W	13.5	1	2	269/2150	EAST PEI	RED-BROWN MEDIUM SAND WITH A FEW ROUNDED FINE PEBBLES
013	VAN VEEN	271/1354	46°25.23'N 62°00.05'W	13	2	2	269/2200	EAST PEI	RED-BROWN MEDIUM TO COARSE SAND
014	VAN VEEN	271/1403	46°25.69'N 61°59.37'W	12.3	1	2	269/2210	EAST PEI	BROWN MEDIUM SAND WITH A FEW SAND DOLLARS AND MANY SHELL FRAGMENTS
015	VAN VEEN	271/1412	46°26.22'N 61°58.42'W	14	2	2	269/2220	EAST PEI	BROWN MEDIUM SAND WITH SAND DOLLARS AND SHELL FRAGMENTS

TABLE 6 (continued)

GRAB SAMPLES

016	VAN VEEN	271/1420	46°26.65'N 61°57.52'W	18	2	2	269/2230	EAST PEI	BROWN MEDIUM SAND TO GRAVELLY SAND WITH PEBBLES UP TO 3.5 CM
017	VAN VEEN	271/1433	46°26.43'N 61°57.52'W	19.2	1	2	270/1920	EAST PEI	BROWN MEDIUM SAND WITH A FEW FINE PEBBLES AND SAND DOLLARS
018	VAN VEEN	271/1443	46°26.54'N 61°56.52'W	20.0	1	2	270/1910	EAST PEI	RED BROWN MEDIUM SAND
019	VAN VEEN	271/1450	46°26.65'N 61°55.60'W	18.5	1	2	270/1900	EAST PEI	BROWN MEDIUM TO COARSE SAND
020	VAN VEEN	271/1532	46°26.79'N 61°54.94'W	30	2	2	270/1850	EAST PEI	BROWN FINE SAND WITH MANY SAND DOLLARS
021	VAN VEEN	271/1546	46°27.29'N 61°55.97'W	21.5	2	2	270/1650	EAST PEI	BROWN MEDIUM SAND
022	VAN VEEN	271/1558	46°28.38'N 61°56.27'W	27	3	0	270/1700	EAST PEI	NO SAMPLE
023	VAN VEEN	271/1647	46°24.47'N 62°01.02'W	14	2	2	270/2155	EAST PEI	MEDIUM SAND WITH PEBBLES UP TO 2 CM
024	VAN VEEN	271/1703	46°24.33'N 62°00.33'W	14	1	2	270/2150	EAST PEI	BROWN MEDIUM SANDWITH MANY SAND DOLLARS
025	VAN VEEN	271/1712	46°24.08'N 61°59.38'W	17	1	2	270/2140	EAST PEI	BROWN MEDIUM SAND WITH MANY SAND DOLLARS
026	VAN VEEN	271/1720	46°23.81'N 61°58.20'W	25	3	1	270/2130	EAST PEI	SMALL SAMPLE OF BROWN MEDIUM SAND WITH MANY SAND DOLLARS
027	VAN VEEN	271/1732	46°23.60'N 61°57.18'W	24.5	3	1	270/2120	EAST PEI	BROWN MEDIUM SAND WITH SAND DOLLARS

TABLE 6 (continued)

GRAB SAMPLES

028	VAN VEEN	271/1744	46°23.32'N 61°56.18'W	16.5	3	2	270/2110	EAST PEI	BROWN MEDIUM SAND WITH SAND DOLLARS
029	VAN VEEN	271/1802	46°22.92'W 61°55.18'W	12	2	2	270/2100	EAST PEI	BROWN MEDIUM SAND
030	VAN VEEN	271/1802	46°22.92'N 61°54.38'W	18	3	2	270/2050	EAST PEI	BROWN MEDIUM SAND WITH SAND DOLLARS
031	VAN VEEN	271/1812	46°22.61'N 61°53.48'W	18	1	2	270/2040	EAST PEI	BROWN MEDIUM SAND
032	VAN VEEN	271/1819	46°22.88'N 61°52.78'W	31.5	2	1	270/2030	EAST PEI	BROWN MEDIUM SAND WITH SAND DOLLARS
033	VAN VEEN	271/1838	46°23.32'N 61°53.70'W	24.5	1	2	270/2020	EAST PEI	BROWN MEDIUM SAND AND A SAND DOLLAR
034	VAN VEEN	271/1849	46°23.82'N 51°54.48'W	13	2	2	270/2010	EAST PEI	BROWN MEDIUM SAND
035	VAN VEEN	271/1903	46°24.45'N 61°55.32'W	13.5	1	1	270/2000	EAST PEI	BROWN MEDIUM SAND
036	VAN VEEN	271/1915	46°24.94'N 61°56.12'W	15.5	1	2	270/1950	EAST PEI	BROWN MEDIUM SAND
037	VAN VEEN	271/1927	46°25.52'N 61°55.32'W	16	1	2	270/1940	EAST PEI	BROWN MEDIUM SAND LARGE SAMPLE
038	VAN VEEN	271/1937	46°26.10'N 61°57.82'W	19	1	2	270/1930	EAST PEI	BROWN MEDIUM SAND
039	VAN VEEN	271/2007	46°21.94'N 61°55.18'W	9.5	2	2	270/1550	EAST PEI	BROWN FINE TO MEDIUM SAND WITH SAND DOLLARS
040	VAN VEEN	271/2017	46°21.11'N 61°55.09'W	31.5	2	2	270/1540	EAST PEI	MUDDY FINE SAND WITH NUMEROUS SHELL FRAGMENTS
041	VAN VEEN	271/2028	46°20.25'N 61°54.98'W	38	1	2	270/1530	EAST PEI	RED BROWN MUD WITH BRITTLE STARS

TABLE 6 (continued)

GRAB SAMPLES

042	VAN VEEN	277/1342	46°36.80'N 61°56.50'W	65	3	2	274/1610	EAST PEI	FINE SAND WITH A FEW FLAT PEBBLES UP TO 3 CM IN DIAMETER AND LOTS OF SHELLS
043	VAN VEEN	277/1404	46°35.40'N 61°56.75'W	52	2	1	274/1630	EAST PEI	3 ANGULAR PEBBLES UP TO 8 CM IN DIAMETER
044	VAN VEEN	277/1421	46°33.90'N 61°57.35'W	52	3	1	274/1650	EAST PEI	GRAVEL AND FINE SAND, PEBBLES UP TO 10 CM IN DIAMETER
045	VAN VEEN	277/1504	46°31.10'N 61°57.40'W	44	2	1	274/1400	EAST PEI	4 ANGULAR PEBBLES, GRANITIC AND SANDSTONE
046	VAN VEEN	277/1528	46°29.80'N 61°56.50'W	24	3	1	274/1340	EAST PEI	4 PEBBLES, 1 COBBLE = 12X10X8 CM ALL WITH PINK RED COATING
047	VAN VEEN	277/1544	46°28.65'N 61°56.50'W	24	3	0		EAST PEI	NO SAMPLE
048	VAN VEEN	277/1600	46°28.30'N 61°53.65'W	30.5	3	1	274/1910	EAST PEI	PEBBLES AND COBBLES = 5 ROCK PIECES UP TO 12 CM IN DIAMETER
049	VAN VEEN	277/1627	46°28.25'N 61°55.08'W	27	3	0	270/1720	EAST PEI	NO SAMPLE
050	VAN VEEN	277/1639	46°27.81'N 61°53.58'W	35.5	2	1	270/1740	EAST PEI	20 - 30 PEBBLES UP TO 10 CM IN DIAMETER
051	VAN VEEN	277/1647	46°27.53'N 61°52.81'W	36	3	1	270/1750	EAST PEI	APPROX-IMATELY 8 PEBBLES
052	VAN VEEN	277/1701	46°27.17'N 61°.5158'W	32.5	2	2	270/1805	EAST PEI	RED-BROWN FINE TO MEDIUM SAND
053	VAN VEEN	277/1717	46°27.83'N 61°49.78'W	37.5	3	1	276/1540	EAST PEI	MEDIUM SAND WITH A FEW ANGULAR PEBBLES

TABLE 6 (continued)

GRAB SAMPLES

054	VAN VEEN	277/1728	46°27.83'N 61°48.98'W	35	2	2	276/1530	EAST PEI	MEDIUM TO COARSE PEBBLEY SAND WITH SAND DOLLARS
055	VAN VEEN	277/1736	46°27.39'N 61°48.25'W	35	1	2	276/1520	EAST PEI	MEDIUM
056	VAN VEEN	277/1744	46°26.79'N 61°48.12'W	35.5	1	2	276/1500	EAST PEI	MEDIUM TO COARSE SAND
057	VAN VEEN	277/1802	46°26.77'N 61°50.98'W	32	3	2	276/1600	EAST PEI	RED BROWN GRAVELLY SAND
058	VAN VEEN	277/1820	46°27.28'N 61°52.58'W	35.5	1	2	270/1820	EAST PEI	RED BROWN MEDIUM SAND
059	VAN VEEN	277/1820	46°27.20'N 61°53.20'W	34	3	1	270/1830	EAST PEI	MOSTLY SAND DOLLARS AND VERY SMALL AMOUNT OF FINE SAND
060	VAN VEEN	277/1901	46°27.46'N 61°54.50'W	34	3	1	275/1510	EAST PEI	PEBBLES, COBBLES AND SMALL AMOUNT OF FINE SAND
061	VAN VEEN	277/1916	46°27.82'N 61°55.50'W	24	3	1	274/1940	EAST PEI	RED SANDSTONE PEBBLES
062	VAN VEEN	277/1937	46°26.10'N 61°52.98'W	30	2	2	275/1600	EAST PEI	FINE SAND WITH A FEW PEBBLES
063	VAN VEEN	277/1956	46°25.43'N 61°49.48'W	31.5	1	2	276/1440	EAST PEI	RED-BROWN MEDIUM SAND
064	VAN VEEN	277/2009	46°24.43'N 61°5082'W	27.5	1	2	276/1420	EAST PEI	LARGE SAMPLE OF MEDIUM SAND
065	VAN VEEN	277/2023	46°25.08'N 61°53.01'W	27.5	02	2	276/1630	EAST PEI	MEDIUM SAND AND SAND DOLLARS
066	VAN VEEN	277/2035	46°25.10'N 61°54.57'W	18	2	2	275/1620	EAST PEI	RED-BROWN MEDIUM SAND
067	VAN VEEN	277/2046	46°25.64'N 61°55.73'W	16	1	2	270/1630	EAST PEI	LARGE SAMPLE OF MEDIUM SAND
068	VAN VEEN	277/2054	46°26.08'N 61°56.42'W	18	1	2	275/1430	EAST PEI	LARGE SAMPLE OF RED-BROWN MEDIUM SAND
069	VAN VEEN	277/21111	46°24.82'N 61°57.72'W	20	1	2	276/2010	EAST PEI	LARGE SAMPLE OF MEDIUM SAND

TABLE 6 (continued)

GRAB SAMPLES

070	VAN VEEN	277/2141	46°23.41'N 61°51.97'W	30	2	2	276/1400	EAST PEI	RED-BROWN MEDIUM SAND
071	VAN VEEN	277/2154	46°22.38'N 61°53.11'W	32.5	1	2	276/1340	EAST PEI	MUDDY FINE SAND
072	VAN VEEN	277/2206	46°21.38'N 61°54.22'W	34	3	1	276/1340	EAST PEI	MUDDY FINE SAND
073	VAN VEEN	277/2225	46°22.10'N 61°56.45'W	14.5	1	2	276/1720	EAST PEI	FINE SAND
074	VAN VEEN	277/2237	46°23.01'N 61°57.88'W	28	2	2	276/1930	EAST PEI	FINE SAND
075	VAN VEEN	277/2253	46°23.53'N 62°00.08'W	19	1	2	275/1320	EAST PEI	FINE SAND
076	VAN VEEN	277/2307	46°23.28'N 62°02.65'W	14.5	3	2	274/2150	EAST PEI	FINE SAND WITH SMALL PEBBLES
077	VAN VEEN	277/2316	46°22.88'N 62°03.37'W	24.5	1	2	274/220	EAST PEI	SANDY MUD
078	VAN VEEN	277/2329	46°22.48'N 62°00.90'W	24	2	2	274/2200	EAST PEI	MUDDY FINE SAND
079	VAN VEEN	277/2340	46°22.19'N 61°59.78'W	29.5	2	2	276/2240	EAST PEI	SILTY MUD
080	VAN VEEN	277/2348	46°21.88'N 61°58.78'W	30	4	1	276/2230	EAST PEI	MUDDY SAND WITH LOTS OF SHELLS
081	VAN VEEN	278/0007	46°21.12'N 61°56.70'W	23.5	2	2	276/2210	EAST PEI	RED-BROWN FINE SAND
082	VAN VEEN	278/0015	46°20.82'N 61°55.68'W	30	2	2	276/2200	EAST PEI	FINE SAND WITH LOTS OF SHELL FRAGMENTS AND SAND DOLLARS
083	VAN VEEN	278/0027	46°21.08'N 61°57.62'W	28	2	2	276/1740	EAST PEI	FINE SAND WITH MANY SAND DOLLARS
084	VAN VEEN	278/0043	46°21.72'N 61°59.65'W	31	1	2	276/1910	EAST PEI	MUDDY FINE SAND
085	VAN VEEN	278/0055	46°22.00'N 68°02.80'W	28.5	1	2	275/1250	EAST PEI	MUDDY FINE SAND
086	VAN VEEN	278/0106	46°22.45'N 62°04.10'W	29	1	2	274/2210	EAST PEI	MUDDY FINE SAND