GRANULAR RESOURCE POTENTIAL
WESTERN BEAUFORT (YUKON) SHELF

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for:
Department of Indian and Northern Affairs

July, 1986

OVERVIEW OF GRANULAR RESOURCES POTENTIAL FOR THE WESTERN BEAUFORT (YUKON) CONTINENTAL SHELF

SUBMITTED TO:

Indian and Northern Affairs Canada
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D.S.S. Contract Number: OST85-00374
EOR Project Number: 85-37

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SUMMARY

An investigation of the potential granular resource base of the western Beaufort (Yukon) continental shelf was undertaken on behalf of the Department of Indian and Northern Affairs by Earth & Ocean Research Ltd. The study was carried out from February through April, 1986. The area of interest extends from the northern Yukon coast to the shelf edge at approximately 80 meters water depth, and from 139°W longitude to the Alaska / Yukon border at 141°W longitude. These boundaries enclose an area of approximately 5000 Km.^{2}.

The data set consisted of 240 grab samples, 18 piston cores, 2 boreholes, and 2770 line Km. of high resolution seismic data. Additionally, selected echo sounder profiles were examined from a data base of 14055 line Km.

Since ground truthing data is very limited, no proven granular deposits have been identified within the study area. There are, however, significant probable and prospective deposits. The probable resource base seaward of the 10 meter contour is estimated as 556-842 million cubic meters. This is increased by 444 to 740 million cubic meters if the area shoreward of the 10 meter contour is included. This resource is localized in large drowned alluvial fans adjacent the coast that extend seaward to the 18 to 22 meter isobath. Also included in this base is a reserve consisting of a group of high relief shoals situated on the east central shelf adjacent the shelf edge in approximately 46-48 meters of water. These shoals may be remnants of a locally restricted stratal outcrop or may be morainal in nature.

Prospective resources are estimated to be an additional 328 million cubic meters. The prospective deposits occur primarily in shoals located on the Middle shelf. The shoals are interpreted as stamukhi shoals[1] both presently active and relict. The source of coarse sediment is thought to be primarily ice rafting with concentration on the shoals through subsequent winnowing. Limited borehole coverage indicates that there is no source of coarse grained material within the underlying strata.

The Outer Shelf zone, with an area of 1400 million square meters, is considered prospective but is not included in the above estimate due to conflicts between seismic and borehole data and grab samples. Based on seafloor morphology only, much of this area may be morainal or sub glacial in origin.

Lack of sample analyses limits estimates of resource quality to a very general statement that the alluvial fan material and material on the eastern edge of the Middle Shelf is expected of be of high quality while the remainder of the deposits will likely be prone to high percentages of fines.

1. Stamukhi Shoals: Linear, shore parallel shoals developed at the boundary of the shore fast ice and the winter ice pack by the grounding effects of the ice pack as it is driven along shore by the Arctic Gyre. (Reimnitz and Maurer, 1978).

1. INTRODUCTION

On behalf of the Department of Indian and Northern Affairs Canada, a study of granular resources on the Western Beaufort (Yukon) continental shelf was undertaken by Earth & Ocean Research Ltd. The investigation is part of a regional program undertaken by DIAND, to systematically define the sand and gravel deposits in the Beaufort Sea region. The study was conducted during the months of February and March, 1986 and consisted of the interpretation and integration of previously collected bathymetric, geophysical, and geological data.

The intent of the investigation is to provide an overview of the granular resource base of this area. This overview will assist in planning of future exploration studies to delineate granular materials for use in onshore or offshore construction by industry and government.

The area of concern extends from the Yukon coast northwards to the shelf edge at approximately the 80 meter contour, and westward from the eastern end of Herschel Island at approximately 139° W to the Yukon / Alaska boundary at 141° W. (Figure 1). These boundaries enclose an area of approximately 5000 Km^2. Within these boundaries the proven, probable, and prospective resources are to be defined in terms of location, areal extent, thickness, volume and quality.

2. DATA BASE

A summary of the data base by source is presented as Table 1. Prior to the field investigations of 1984-1985, sample, bathymetric, and geophysical data were extremely sparse within this area. Bathymetric data, as presented on Canadian Hydrographic Service (CHS) Chart 7601 consisted of a few widely spaced lines with non systematic coverage. A total of 53 grab samples and 4 piston cores had been taken from within the site boundaries by the Geological Survey of Canada (GSC). Grain size and other analyses have been performed on these samples and are presented in Pelletier (1975), Vilks, Wagner and Pelletier (1979), and Pelletier (1985). A single geotechnical borehole, Natsek 4, was drilled in 1978, and textural descriptions and test results are presented by McClelland Engineers Ltd.(1979).

A significant increase in the data base occurred in 1984 when a combined hydrographic and geophysical survey was conducted from the M.V. Banksland by the CHS and the GSC. This survey yielded 14055 Km. of heave compensated echo sounder data, 820 Km. of 10 in^3 airgun, 50 Khz. sidescan and 3.5 Khz profiler data, 14 piston cores to a maximum 1.5 meter penetration, and 187 Shipek grab samples. The results of the hydrographic survey are presented in McGladrey (1984) and resulted in the preparation of CHS field sheet WA10167. A preliminary interpretation of the geophysical and geological data is presented in Meagher (1985).

The 1984 GSC geophysical program was not completed due to ice conditions and in 1985 an additional 1950 Km. of 10 in^3 airgun, 3.5 Khz profiler and EG&G boomer data were collected from the M.V. Tully by Geomarine Associates. No sediment samples were collected during this program. Approximately half of this volume was collected from within the area of the present study, the remainder covers an area to the north and east. The field operations are reported in Fehr(1986).

Also during the 1985 field season, a geotechnical borehole (GSC-1), was drilled from the M.V. Broderick on the outer shelf (EBA Engineering Consultants Ltd. 1986). This borehole, located at 70°08'23.91"N, 140°28'17.86"W, was drilled to a sub-seafloor depth of 52.6 meters. Additionally a number of boreholes were drilled for industry, on the Alaskan shelf. Five of these are located near the site and reference is made to field notes of these borings.

These latest data sets are presently being interpreted by various workers and integrated with previous data to arrive at an understanding of the shallow geologic framework, history, and present day processes. The sidescan data is being examined for ice scour and other seabed transport information (Shearer, in preparation), the 1985 geophysical data is being examined and integrated with the 1984 data to arrive at a geologic synthesis, (Lewis and Meagher, in preparation), the CHS bathymetric data is being computer analysed to display surface trends, (Challenger Surveys, in preparation), and the GSC-1 borehole results are being examined by the Geological Survey of Canada to furnish information on age, environment and geotechnical properties of the shelf sediments in that locale (Hill, in preparation). In addition, an engineering hazards survey report over the Edlok wellsite has been prepared by MacGregor Geosciences Ltd. To the extent that the results of these reports are available and relevant to this study, they have been incorporated.

TABLE 1

SUMMARY OF SOURCE DATA

Source	Grab samples	Piston Cores	Boreholes	Echo Sounder Line Km.	Microprofiler Line Km.	Boomer Line Km.	Airgun Line Km.	References
CSS Hudson 1970 GSC SS Parizeau 1970-'72 GSC Helicopter 1970-'75 GSC	53	4						Pelletier (1975) Pelletier et al (1979) Pelletier (1985) BIO Database
MV Supplier V 1978 Canmar			Natsek 4					McClelland Engineers (1979)
MV Banksland 1984								
CHS	66	-		14055	-	-	-	McGladrey (1984)
AGC	121	14		-	820	-	820	Meagher (1985)
MV Tully 1985								
AGC	-	-		-	1016	525	1163	Fehr (1986)
MV Broderick 1985								
GSC			GSC-1					EBA Engineering (1985)
Industry			Belcher 726 Belcher 768 Lyon 705 Lyon 771 Lyon 815	-				J. Brigham Grette (pers. comm.)

3.GEOLOGIC SETTING

3.1 PHYSIOGRAPHY and BATHYMETRY

A contoured bathymetry of the Yukon Shelf is presented as Enclosure 2, Figure 2, taken from Meagher (1984). The contoured map is based on CHS field sheet WA 10167. The Yukon Shelf is a shallow submerged plain that has a regional slope of 1:833 to the north. The surface slopes north in the coastal and mid shelf regions and trends increasingly to the northeast as the shelf edge is approached. The shelf is bounded to the east by the Mackenzie Trough and to the north by the Beaufort Sea. The transition from the shelf to the slope is abrupt and occurs at approximately 80 meters water depth. The shelf edge is noticeably regular with no prominences or incisions, possibly the result of horizontal planation by glacier ice restricted to the trough during the Wisconsin Glaciation (Lewis and Meagher, 1986).

The major physiographic subregions of the Yukon Shelf, as defined by the present study are shown in Figure 3 and are described below. The feature names are informal and are used in order to facilitate description.

Two ridges dominate the shelf morphology. The Inshore Ridge is narrow and slightly arcuate and lies 8 to 13 Km. offshore from and subparallel to the coast. It extends from a point due west of the northern tip of Herschel Island to within 7 Km. of the Alaska Yukon boundary. It is approximately enclosed by the 24 meter contour and has a minimum water depth of 15.2 meters. As defined by the 24 meter contour, it is 60 Km. long and 4 Km. wide. The topography of the ridge is fairly regular with the axial profile rising gently to a minimum depth at the approximate center of the feature.

The Offshore Ridge is a larger feature and occupies the outer north facing shelf from the 50 meter contour to the shelf edge. It extends to the west onto the Alaskan shelf. Within the study area the ridge is 66Km. in length and 14-18 Km. wide. The axis of the ridge is situated near its southern flank where minimum water depths of 37 meters are recorded. A narrow linear spur ridge extends from its northeast corner in a northeast direction to the shelf break.

The topography the Outer Ridge is irregular with numerous linear to sinuous shoals of one to several meters local relief developed on its surface. These superimposed shoals form a second ridge complex referred to as the "Natsek Ridge". The Natsek Ridge is subparallel to the axis of the Offshore Ridge and is located near its southern edge. It is narrow and linear and displays a branching pattern reminiscent of dendritic drainage. This pattern, not readily apparent on the plan view of the contoured bathymetry, is obvious on the 3-D perspective display prepared by Challenger Surveys and Services (Challenger Surveys and Services Ltd., 1986). The display depicts four or five "tributary" ridges that coalesce with the trunk ridge at their eastern ends. The ridges die out to the west and do not appear to extend beyond the Alaska-Yukon boundary.

Numerous shoals of lesser extent are scattered over the shelf although generally concentrated immediately north of the Inner Ridge. There are noticeably fewer shoals in the mid shelf area. These deeper shoals are thought to be relict stamukhi shoals developed as the sea encroached across

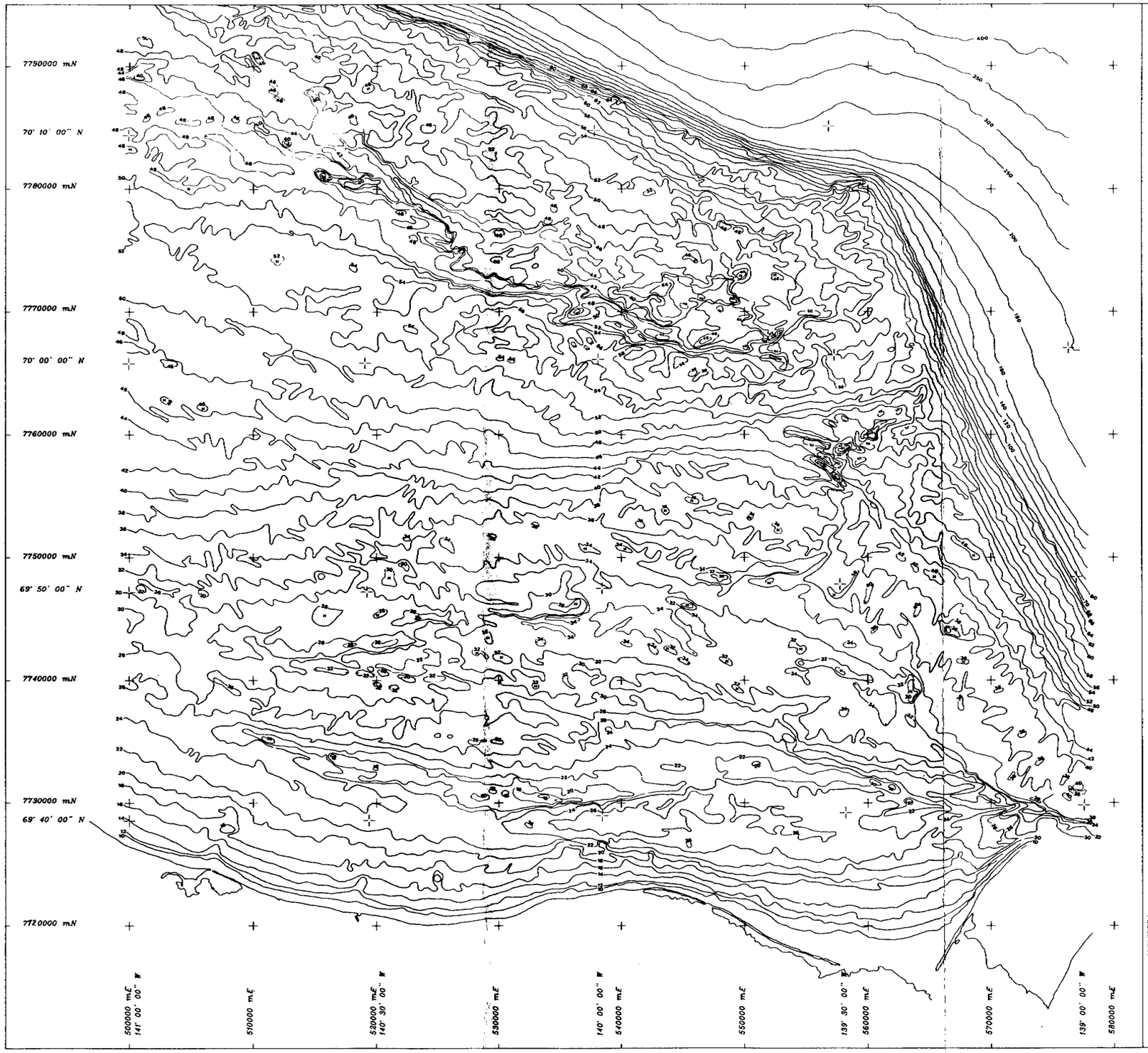
the coastal plain. An exception to this is a group of shoals situated near the Mackenzie Trough shelf edge and south of the Offshore Trough. These shoals, which exhibit significantly higher relief and slope may represent a limited exposure of coarse, resistent material lying between Units L and M or are possibly morainal deposits.

Bathymetric troughs are situated inshore from the ridges. The Outer Trough is broad and flat bottomed with small mounds of 2 to 5 meters elevation scattered over its floor. The trough parallels the Outer Ridge and descends to the east on a uniform gradient of 1 meter in 6500 meters (0.009^{o}). The trough is open to the Mackenzie Trough where it is abruptly truncated to form a hanging valley. Maximum depth within the trough is 58 meters.

The Outer Trough is an erosional landform with older strata exposed in the trough and younger strata on the ridge. The Outer Ridge is in part a remnant of the pre-trough shelf and also shows evidence of subsequent outbuilding possibly related to transgression (see Section 3.2).

The Inshore Trough is a smaller feature than the Offshore Trough. It is virtually enclosed by the 24 meter contour and has a maximum depth of 27 meters. The trough is 36 Km. long and 6 Km. wide at its widest point. The Inshore ridge is interpreted as a stamukhi shoal feature constructed by the scour action of the winter ice pack as it rotates against the shore fast ice (Reimnitz and Maurer, 1978). Evidence suggests that the stamukhi shoal developed on an older shoal feature.

The contours are highly crenulated over much of the shelf and are most severely contorted between approximately 40 meters and 20 meters depth. The disruption is due to scouring of the seafloor by pack ice. Scours and scour berms of several meters are observed.



LEGEND

H Bathimetric high

NOTE: CONTOURS IN METERS
BATHYMETRY CONTOURED FROM CHS FIELD SHEET NO. WA 10167

from Meagher, 1985

NEAR SURFACE GEOLOGY - YUKON COAST			
BATHYMETRY			
ENCLOSURE: 3	DATE: MAY/85	SCALE: 1:100000	
PROJECTION: **Mercator**			
PROJECT: 84-35	DRN. BY:	CKD. BY:	
EARTH & OCEAN RESEARCH LTD. 22 WADDELL AVE, DARTMOUTH, NOVA SCOTIA B3B 1K3			

FIGURE: 2

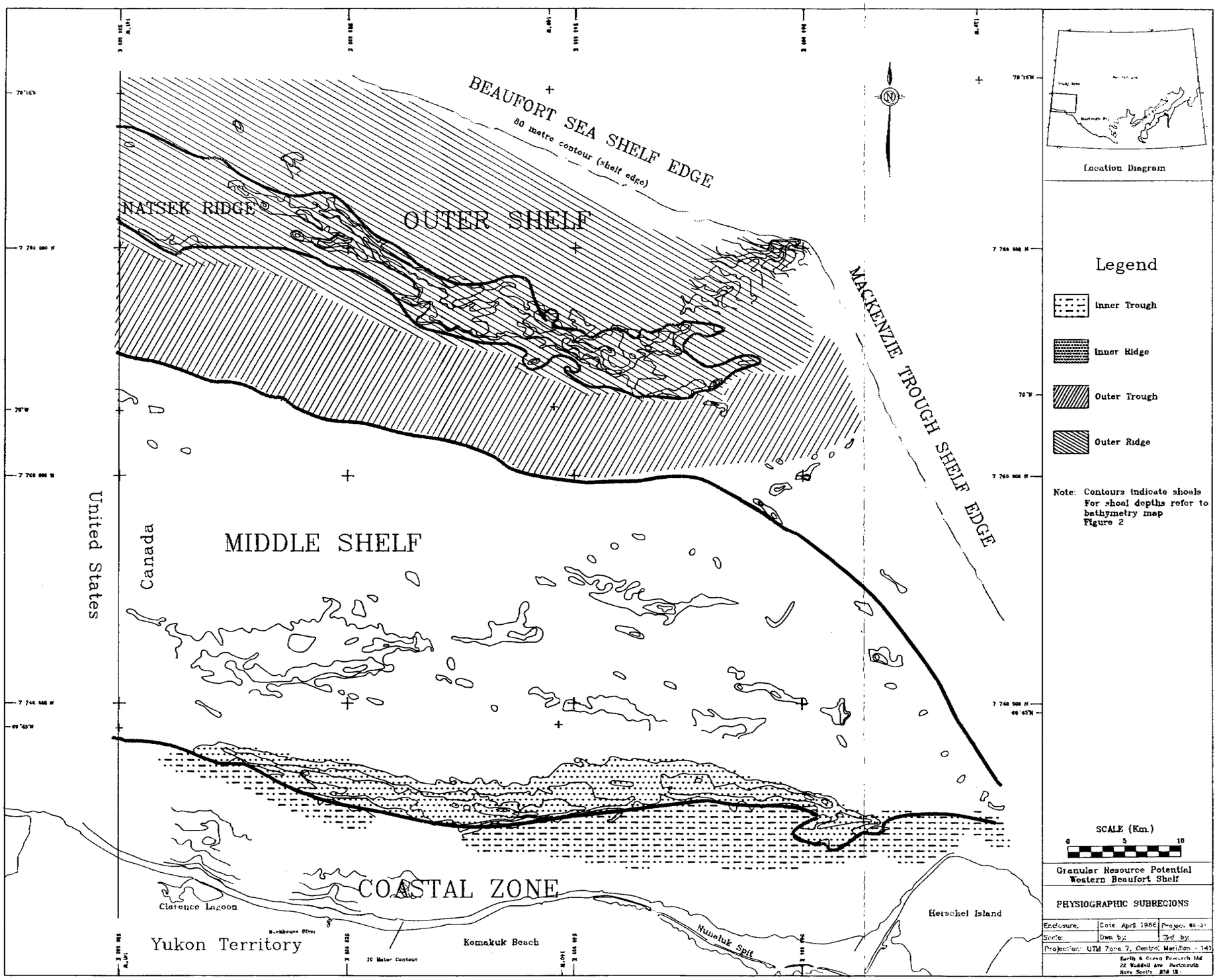

BEAUFORT SEA SHELF EDGE
80 metre contour (shelf edge)
NATSEK RIDGE
OUTER SHELF
MACKENZIE TROUGH SHELF EDGE
MIDDLE SHELF
United States
Canada
COASTAL ZONE
Clarence Lagoon
Yukon Territory
Komakuk Beach
Nunaluk Spit
Herschel Island
10 Meter Contour
Location Diagram
Legend
Inner Trough
Inner Ridge
Outer Trough
Outer Ridge
Note: Contours indicate shoals
For shoal depths refer to
bathymetry map
Figure 2
SCALE (Km.)
0 5 10
Granular Resource Potential
Western Beaufort Shelf
PHYSIOGRAPHIC SUBREGIONS
Enclosure
Date: April 1986
Scale:
Dwn by:
Chd. by:
Projection: UTM Zone 7, Central Meridian - 141

FIGURE 3

3.2 SURFICIAL SEISMO-STRATIGRAPHY

The surficial geology of the study site is displayed in Enclosure 3 and Figure 4. The boundaries are seismo-stratigraphic although the increase in the textural information over the Meagher (1985) report allows some lithologic constraints on the seismic units. A composite profile of Lines 51, 41 and 52 is presented as Figure 5 and shows the general shallow stratigraphy from the shoreline to the shelf edge.

A total of 11 seismo stratigraphic units are identified within the shallow sequence and eight are exposed on the shelf. These have not been given formal names and are presently identified as Units G through R (Meagher, 1985, Lewis and Meagher, 1986). They are separated by surfaces described as Horizons 7 through 16 from oldest to youngest. Table 2 shows the relationship of the Horizons to Units referred to in the text.

Dating of the sequence has not been carried out. Unit R, a drowned alluvial fan sequence, underlies Buckland glacial deposits on land. The Buckland event is considered to be early to middle Quaternary in age (Rampton 1982). Unit R is apparently contemporaneous with Unit L offshore. Age dating on boreholes on the Alaskan shelf yields a date of 125000 yrs at 9 meters sub seafloor (P.Hill, pers. comm.). This is tentatively correlated to strata lying between Horizons 9 and 12 on the Yukon Shelf and suggests an early Wisconsin age for Unit L.

The surficial geology describes a history of numerous peneplanations followed by marine incursions over a surface that has remained at shelf depths since the early to mid Tertiary. Sea level has advanced and retreated across the shelf, subaerially exposing it on several occasions.

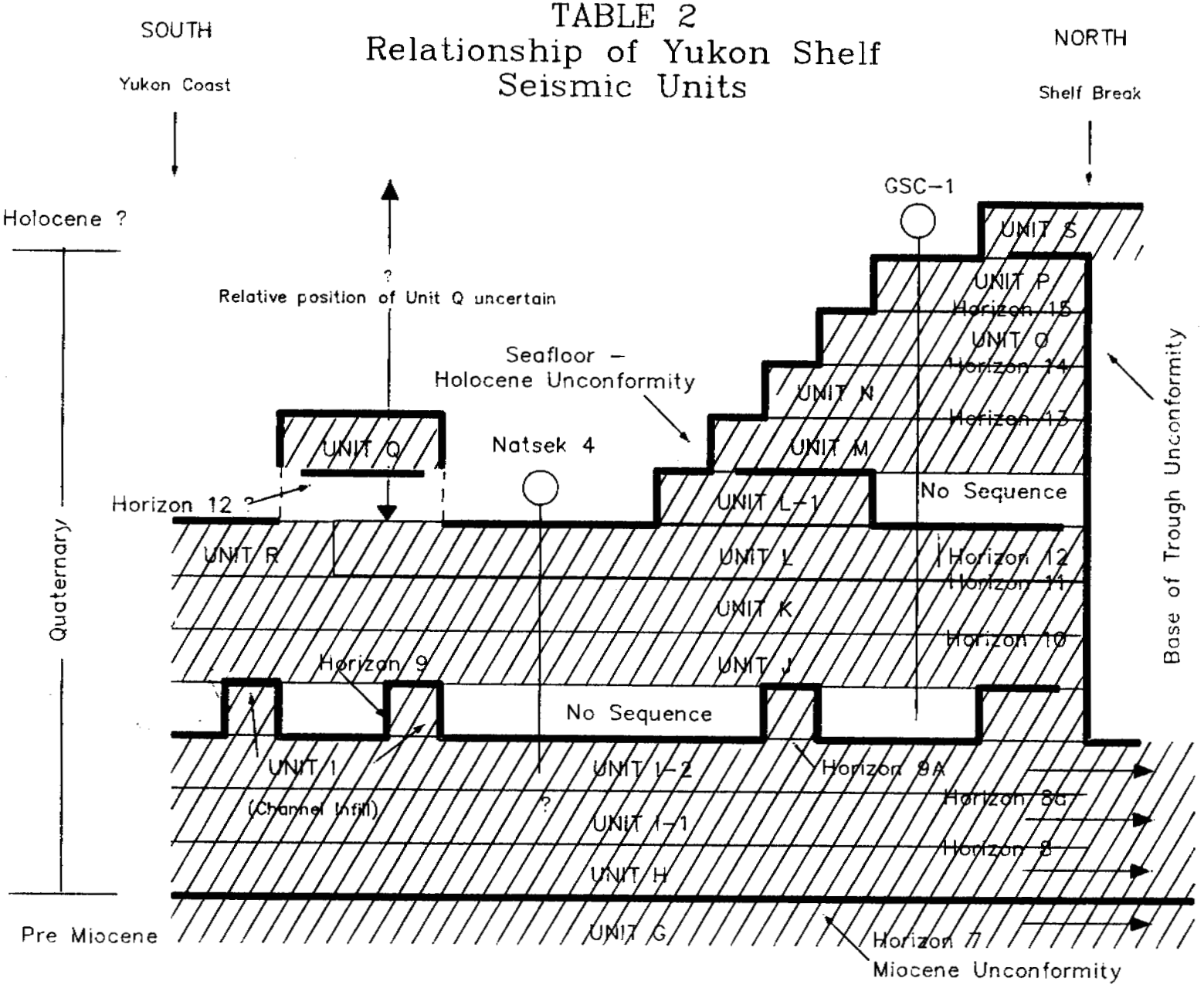
The present seafloor is an erosion surface with progressively younger strata outcropping to seaward. Recent deposition is minimal and thought to be restricted to the coastal zone (Lewis and Meagher, 1986). The stratigraphic boundaries are coast parallel, terminate abruptly against the Mackenzie Trough and predate the most recent excavation of that feature.

The sequences dip shallowly and regularly towards the shelf edge. As the shelf edge is approached, the slope of deeper units becomes more pronounced producing an increasingly thicker wedge of younger sediments that reaches a maximum at the shelf break. This seaward thickening sequence is truncated abruptly by a shelf edge unconformity and indicates that the shelf has undergone significant retreat since deposition of the youngest strata. The truncated shelf strata are unconformably overlain by well stratified sediments of the Mackenzie Trough sequence. On the surficial seismo stratigraphy map these strata are referred to as Unit S.

The strata form a predominantly fine grained clastic wedge laid down under shelf, coastal, subaerial and glacial environments. It is deposited on a Miocene unconformity that is sporadically observed in the seismic data and is identified as Horizon 7. Persistent to sporadically observed unconformities identified as Horizons 8, 9, and 11 are not exposed at the seafloor and record periods of peneplanation and minor channel incision.

The shallowest of these, Horizon 11, is of interest to this study as

TABLE 2
Relationship of Yukon Shelf Seismic Units



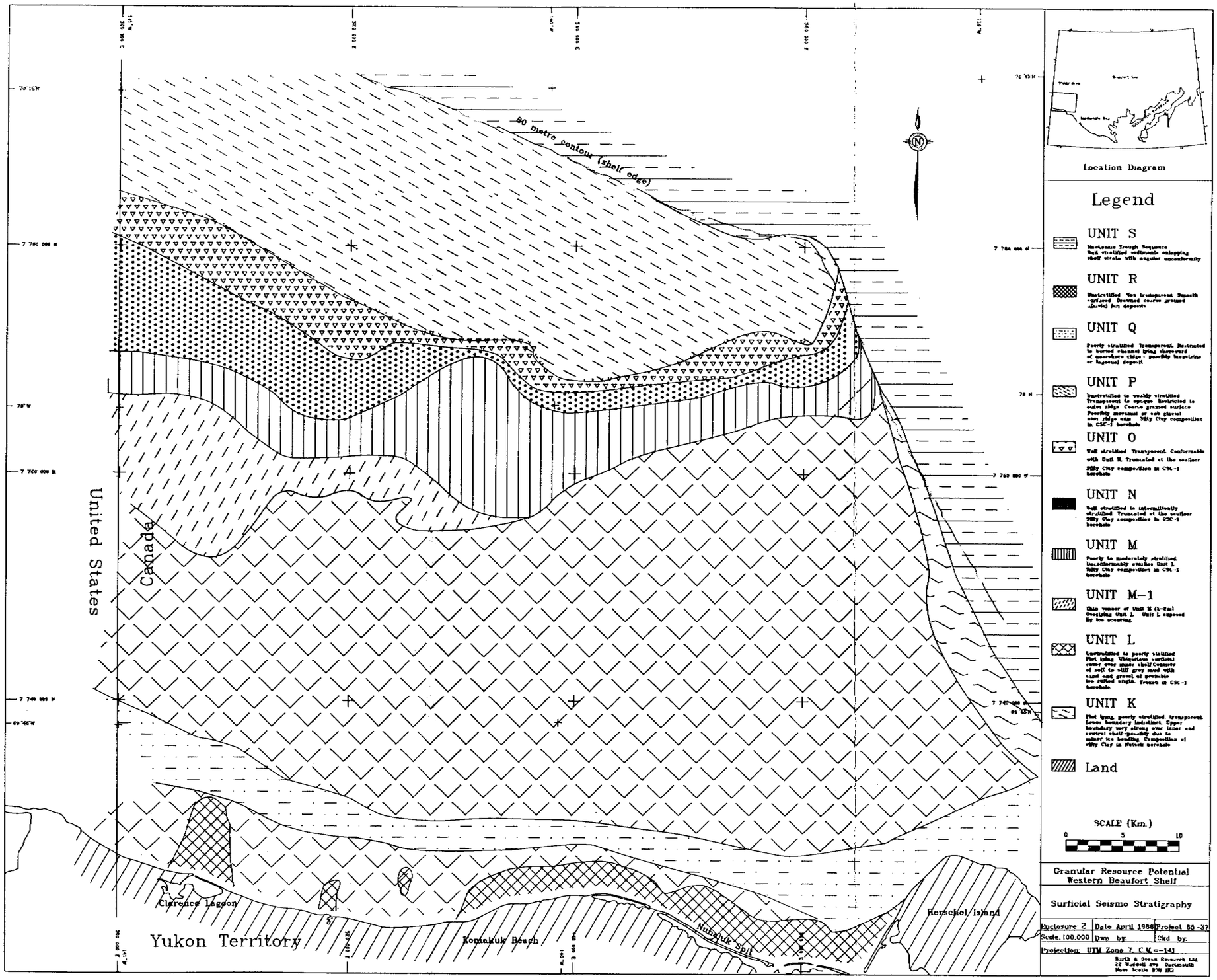
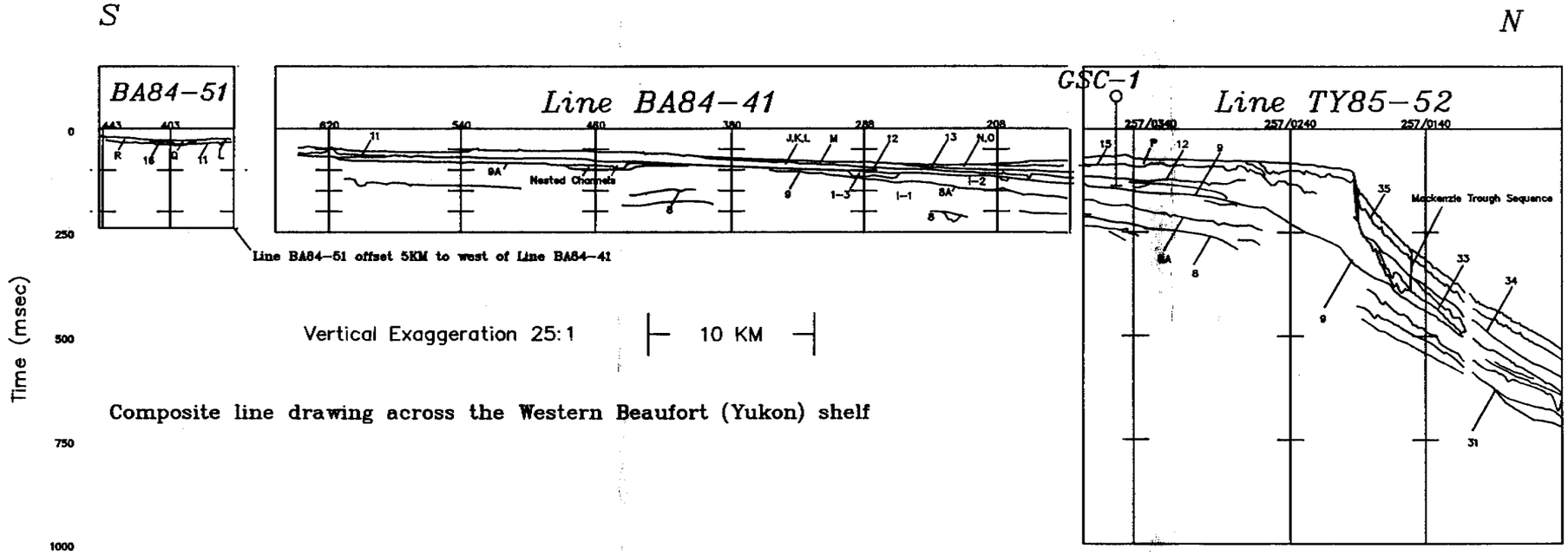

80 metre contour (shelf edge)
United States
Canada
Yukon Territory
Clarence Lagoon
Komakuk Beach
Nuvuk Spit
Herschel Island
Location Diagram
Legend
UNIT S
Mackenzie Trough Sequence
Well stratified sediments onlapping shelf strata with angular unconformity
UNIT R
Unstratified to transparent. Smooth surfaced. Drowned coarse grained alluvial fan deposit
UNIT Q
Poorly stratified Transparent. Restricted to buried channel lying shoreward of nearshore ridge. Possibly lacustrine or lagoonal deposit
UNIT P
Unstratified to weakly stratified Transparent to opaque. Restricted to outer ridge. Coarse grained surface. Possibly morainal or ice glacial over ridge axis. Silty Clay composition in CSC-1 borehole
UNIT O
Well stratified Transparent. Conformable with Unit N. Truncated at the seafloor. Silty Clay composition in CSC-1 borehole
UNIT N
Well stratified to intermittently stratified. Truncated at the seafloor. Silty Clay composition in CSC-1 borehole
UNIT M
Poorly to moderately stratified. Unconformably overlies Unit L. Silty Clay composition in CSC-1 borehole
UNIT M-1
Thin veneer of Unit M (1-2m) Overlying Unit L. Unit L exposed by ice scouring.
UNIT L
Unstratified to poorly stratified Flat lying. Ubiquitous surficial cover over inner shelf. Consists of soft to stiff grey mud with sand and gravel of probable ice rafted origin. Present in CSC-1 borehole.
UNIT K
Flat lying, poorly stratified transparent. Lower boundary indistinct. Upper boundary very strong over inner and central shelf - possibly due to minor ice bonding. Composition of silty Clay in Mobil borehole
Land
SCALE (Km.)
0 5 10
Granular Resource Potential
Western Beaufort Shelf
Surficial Seismo Stratigraphy
Enclosure 2 | Date April 1988 | Project 85-37
Scale 100,000 | Dwn by: | Ckd by:
Projection: UTM Zone 7, C.M. = -141
Earth & Ocean Research Ltd
22 Waddell Ave Dartmouth
Nova Scotia B3B 1K3

FIGURE 4



Composite line drawing across the Western Beaufort (Yukon) shelf

FIGURE 5

it represents the base event underlying the exposed sequences on the inner shelf. The structure and isopach for the horizon are presented as Figures 6 and 7. The surface forms a good acoustic horizon within a limited area confined to the inner to middle shelf. Texturally the over and underlying strata are similar and consist of marine silty clays. Ice veins associated with the horizon in the Natsek borehole suggest that ice content determines the strength of the acoustic signature. The occurrence of the ice may be associated with pore water salinity variations due to sub aerial exposure of the inner shelf.

The surface is regular and slopes gently from the shoreline. The nearshore ridge and trough features observed on the bathymetry are also observed on this surface in a subdued form. The thickness of overlying sediments increases over the ridge indicating that while the ridge existed prior to the deposition of Unit L, the surficial cover, it has been subsequently enlarged. This relationship is observed over many of the shoals examined on the middle shelf and suggests that the shoals on Horizon 11 may have acted as loci for the development of stamukhi shoals as the sea level encroached across the shelf during the Holocene. As the sealevel rose the older stamukhi shoals were abandoned and now occur as remnant high areas on the middle shelf.

Overlying Horizon 11 at the coastline, an unstratified sequence that is largely opaque to 3.5 Khz energy occurs. The unit is observed in the areas fronting the larger rivers entering the Beaufort Sea; the Firth, Malcolm and Backhouse, the rivers flowing into the Clarence Lagoon, and an unnamed river, here referred to by an asterisk (*), situated between Komakuk Beach and Backhouse River. This sequence, termed Unit R, forms arcuate to linear elevated areas that rest on Horizon 11 and appear to be contemporaneous with Unit L. The unit is onlapped at its seaward edges by transparent ponded strata of Unit Q.

From their alignment with the alluvial fans onshore, their acoustic signature, and coarse grained nature (see section 3.3), these deposits are interpreted to be the drowned seaward edges of the onshore gravel rich alluvial fans that were initiated in early Wisconsin or older time.

Seaward of Unit R, Unit L is exposed over most of the inner to middle shelf areas. Landward of the Inshore Ridge it is covered by ponded, stratified lacustrine or lagoonal sediments, Unit Q. The unit is unstratified to weakly stratified, translucent to opaque to profiler energy, and highly scoured. It is composed predominantly of marine silty clay with minor admixtures of sand and gravel that are locally concentrated possibly by winnowing and ice processes.

An isolated remnant is observed above Unit L but below Horizon 12. It is located in the northeast corner of the shelf south of the Offshore Trough. It is not observed elsewhere and is presumed to have been excavated by the erosion event that formed Horizon 12. The unit, referred to as Unit L-1, is observed on line BA-84-126 (Figure 7A) but its occurrence is not recorded on adjacent and crossing lines due in part to reduced data quality. For this reason it is not mapped on the surficial geology map. The unit is exposed at the seafloor over its southern extent where it is formed into steep sided linear ridges and troughs.

Seaward of Unit L, erosion of the offshore trough exposes the transparent, well stratified sequences, Units M, N, and O at the seafloor. These sequences conformably overly Unit L and dip at a shallow angle to the shelf edge where they are truncated. The GSC-1 borehole penetrates these units and records their lithologies as uniform marine silty clay throughout.

Unit P occupies the outer ridge and extends to the shelf edge. Structure and isopach maps of the surface, identified as Horizon 15, on which the sequence rests are displayed in Figures 8 and 9. The surface displays a morphology that is suggestive of an ancient buried strand line with river channels and offshore bars. This surface is exposed at the seafloor in two areas, indicated on the maps.

The seismic character of Unit P varies from unstratified and translucent over the crest of the Natsek Ridge to stratified and transparent seaward of this feature. The offshore stratified sequence rests on the shoreward unstratified section and indicates that Unit P in fact consists of two distinct depositional sequences. Seismic resolution is not adequate to define this boundary between the sequences across the region and consequently the entire outer shelf sequence above Horizon 15 is included in Unit P. The stratification patterns indicate both steeply dipping foresets of a prograding bar or delta and less steeply dipping reflectors of a ponded depositional sequence (Figure 10).

Isolated remnants of still younger strata occupy the outer shelf at its northeast extremity. These deposits are stratified and conformable and dip to the shelf edge or are ponded on the underlying topography of Horizon 15 Their limited extent and lack of seismic coverage in this area precludes mapping of these units at present.

The sequence is overlaid with angular unconformity at the shelf edge by well stratified sediments of the Mackenzie Trough sequence, Unit S.

The GSC-1 borehole records the texture of Unit P as silty clay. The borehole is located between two forks of the Natsek Ridge and does not therefore sample this feature. The textural nature of the ridge may differ from the borehole results. The seismics and grab samples suggest that this texture may vary laterally and be coarser in places.

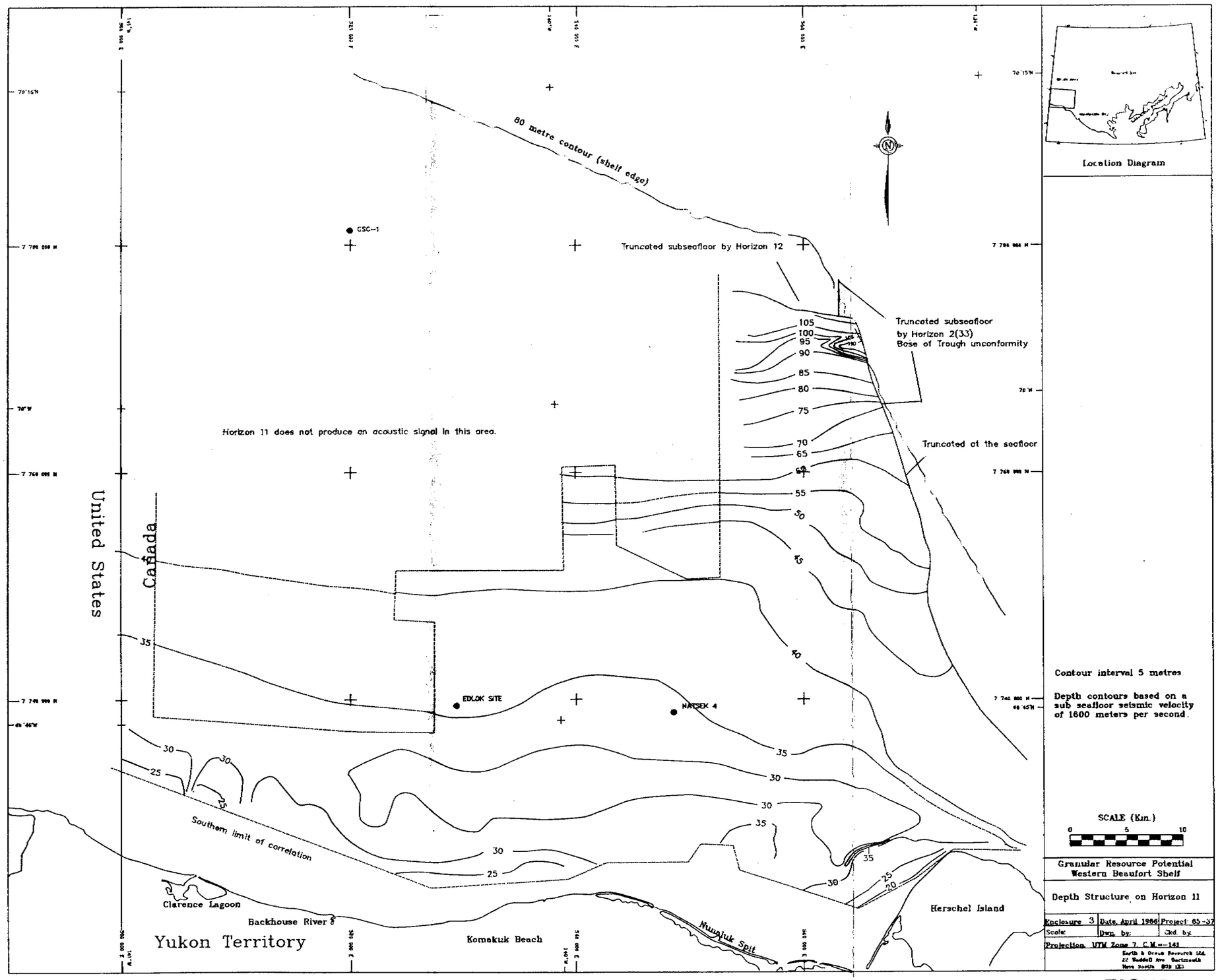
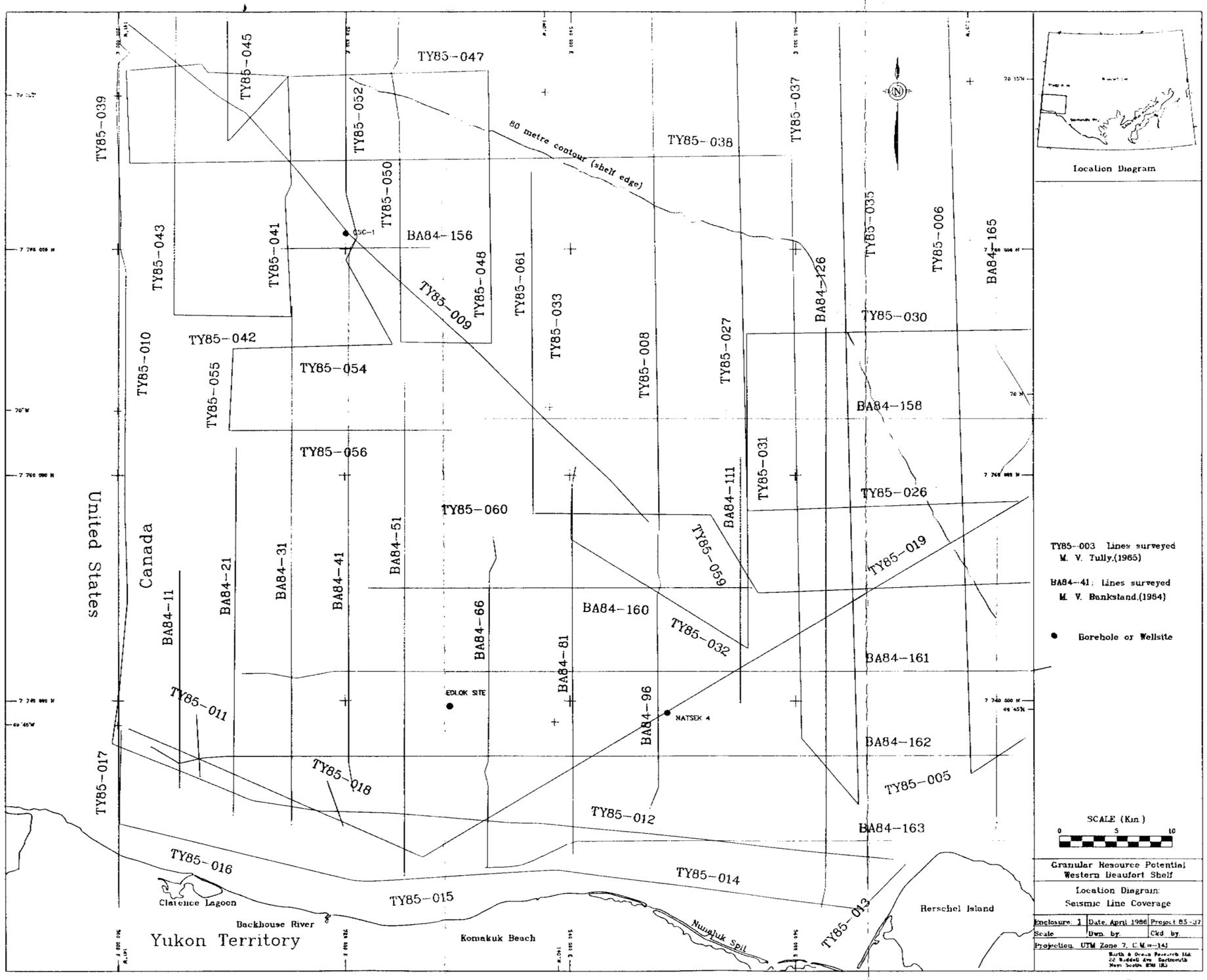

80 metre contour (shelf edge)
GSC--1
Truncated subseafloor by Horizon 12
Truncated subseafloor
by Horizon 2(33)
Base of Trough unconformity
Truncated at the seafloor
Horizon 11 does not produce an acoustic signal in this area.
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
United States
Canada
EDLOK SITE
NATSEK 4
Southern limit of correlation
Clarence Lagoon
Backhouse River
Yukon Territory
Komakuk Beach
Nunaluk Spit
Herschel Island
70°15'N
70°N
69°45'W
Location Diagram
Contour interval 5 metres
Depth contours based on a sub seafloor seismic velocity of 1600 meters per second.
SCALE (Km.)
0 5 10
Granular Resource Potential
Western Beaufort Shelf
Depth Structure on Horizon 11
Enclosure 3
Date: April 1986
Project: 65-37
Scale:
Dwn. by:
Ckd. by:
Projection: UTM Zone 7, C.M. -- 141
Earth & Ocean Research Ltd.
Dartmouth Nova Scotia

FIGURE 6


TY85-045
TY85-047
TY85-039
TY85-052
80 metre contour (shelf edge)
TY85-038
TY85-037
TY85-050
TY85-043
TY85-041
OSC-1
BA84-156
TY85-048
TY85-009
TY85-061
TY85-033
TY85-035
TY85-006
BA84-165
BA84-126
TY85-030
TY85-042
TY85-010
TY85-054
TY85-055
TY85-008
TY85-027
BA84-158
TY85-056
TY85-031
TY85-026
TY85-060
BA84-111
TY85-059
TY85-019
BA84-51
BA84-21
BA84-31
BA84-41
BA84-11
BA84-66
BA84-160
TY85-032
BA84-81
BA84-96
EDLOK SITE
NATSEK 4
BA84-161
TY85-011
BA84-162
TY85-017
TY85-018
TY85-005
TY85-012
BA84-163
TY85-016
TY85-014
TY85-015
TY85-013
Clarence Lagoon
Backhouse River
Yukon Territory
Komakuk Beach
Nunaluk Spit
Herschel Island
United States
Canada
Location Diagram
TY85-003 Lines surveyed M. V. Tully.(1985)
BA84-41: Lines surveyed M. V. Bankstand.(1984)
Borehole or Wellsite
SCALE (Km)
0
5
10
Granular Resource Potential Western Beaufort Shelf
Location Diagram: Seismic Line Coverage
Enclosure: 1
Date: April 1986
Project 85-37
Scale
Dwn. by
Ckd by
Projection: UTM Zone 7, C.M.=-141
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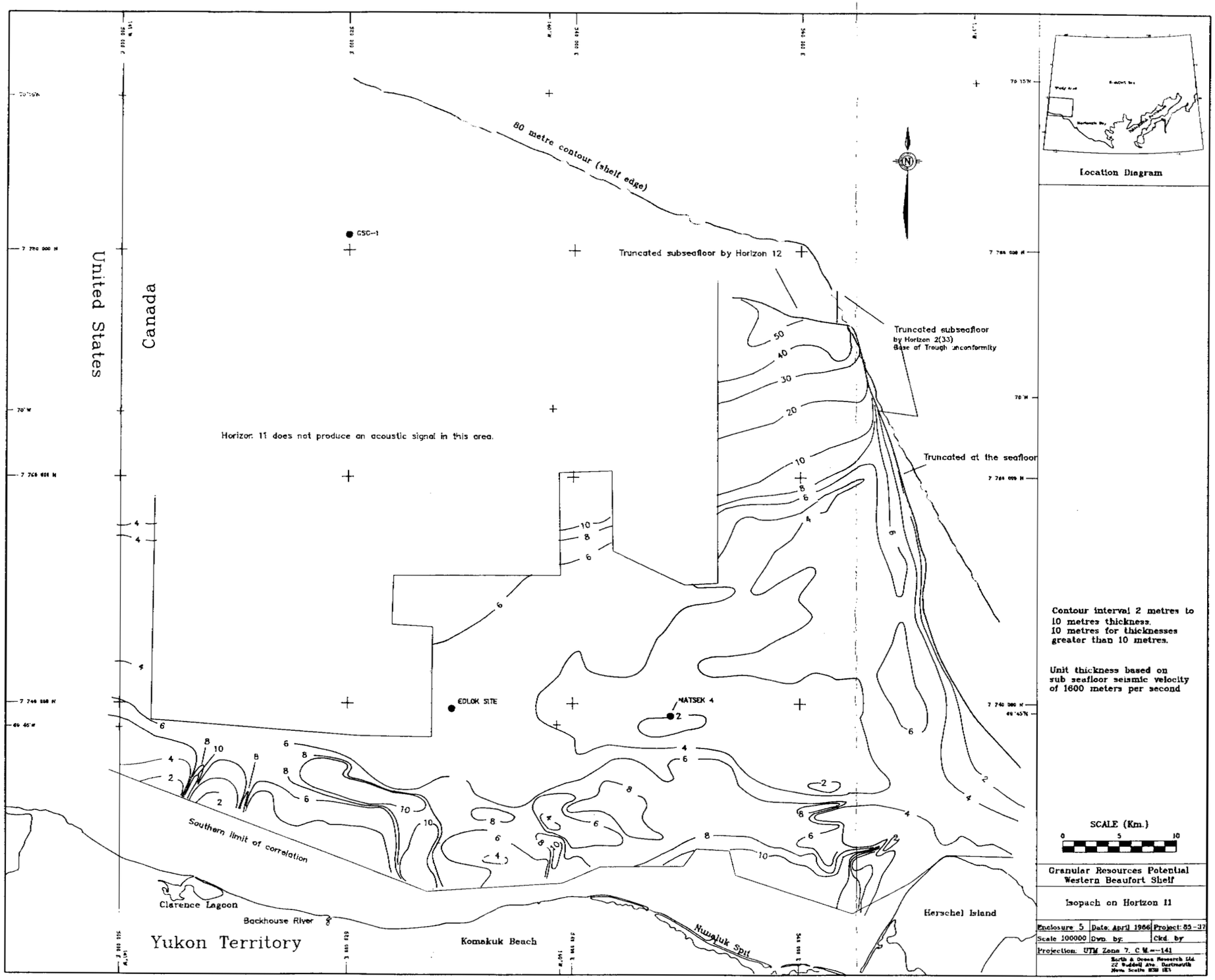
22 Waddell Ave Dartmouth
Nova Scotia B2W 1K1

FIGURE 1


80 metre contour (shelf edge)
GSC–1
Truncated subseafloor by Horizon 12
Truncated subseafloor
by Horizon 2(33)
Base of Trough Unconformity
Truncated at the seafloor
Horizon 11 does not produce an acoustic signal in this area.
EDLOK SITE
MATSEK 4
Southern limit of correlation
Clarence Lagoon
Backhouse River
Komakuk Beach
Nunaluk Spit
Herschel Island
Yukon Territory
United States
Canada
Location Diagram
Contour interval 2 metres to 10 metres thickness.
10 metres for thicknesses greater than 10 metres.
Unit thickness based on sub seafloor seismic velocity of 1600 meters per second
SCALE (Km.)
0 5 10
Granular Resources Potential
Western Beaufort Shelf
Isopach on Horizon 11
Enclosure 5 | Date: April 1986 | Project: 85-37
Scale 100000 | Dwn. by: | Ckd. by
Projection: UTM Zone 7, C.M. –141
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Nova Scotia B3B 1R5

FIGURE 7

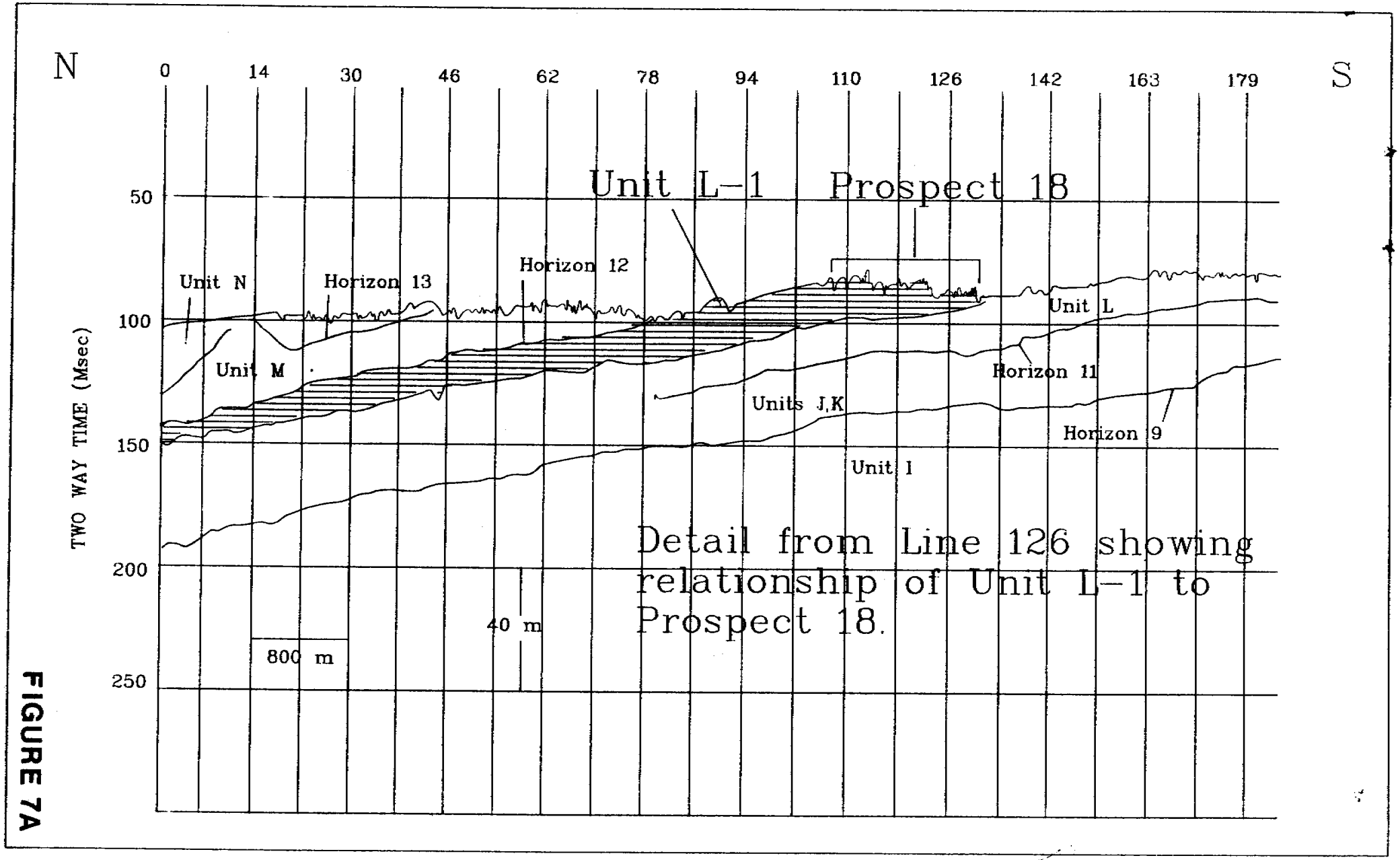
N
S
0
14
30
46
62
78
94
110
126
142
163
179
50
100
150
200
250
TWO WAY TIME (Msec)
Unit L-1 Prospect 18
Unit N
Horizon 13
Horizon 12
Unit L
Unit M
Horizon 11
Units J,K
Horizon 9
Unit I
800 m
40 m
Detail from Line 126 showing relationship of Unit L-1 to Prospect 18.

FIGURE 7A


80 metre contour (shelf edge)
Horizon 15 truncated at seafloor
CSC-1
EDLOK SITE
NATSEK 4
United States
Canada
Yukon Territory
Clarence Lagoon
Komakuk Beach
Nunaluk Spit
Herschel Island
Location Diagram
Contour interval 10 metres
Depths based on a seismic velocity of 1600 m/sec.
SCALE (Km.)
0 5 10
Granular Resource Potential
Western Beaufort Shelf
Depth Structure on Horizon 15
Enclosure 6
Date, April 1986
Project: 85-37
Scale 100,000
Dwn by:
Chkd. by
Projection: UTM Zone 7, C.M.=-141
Earth & Ocean Research Ltd.
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Nova Scotia, B3B 1X1

FIGURE 8

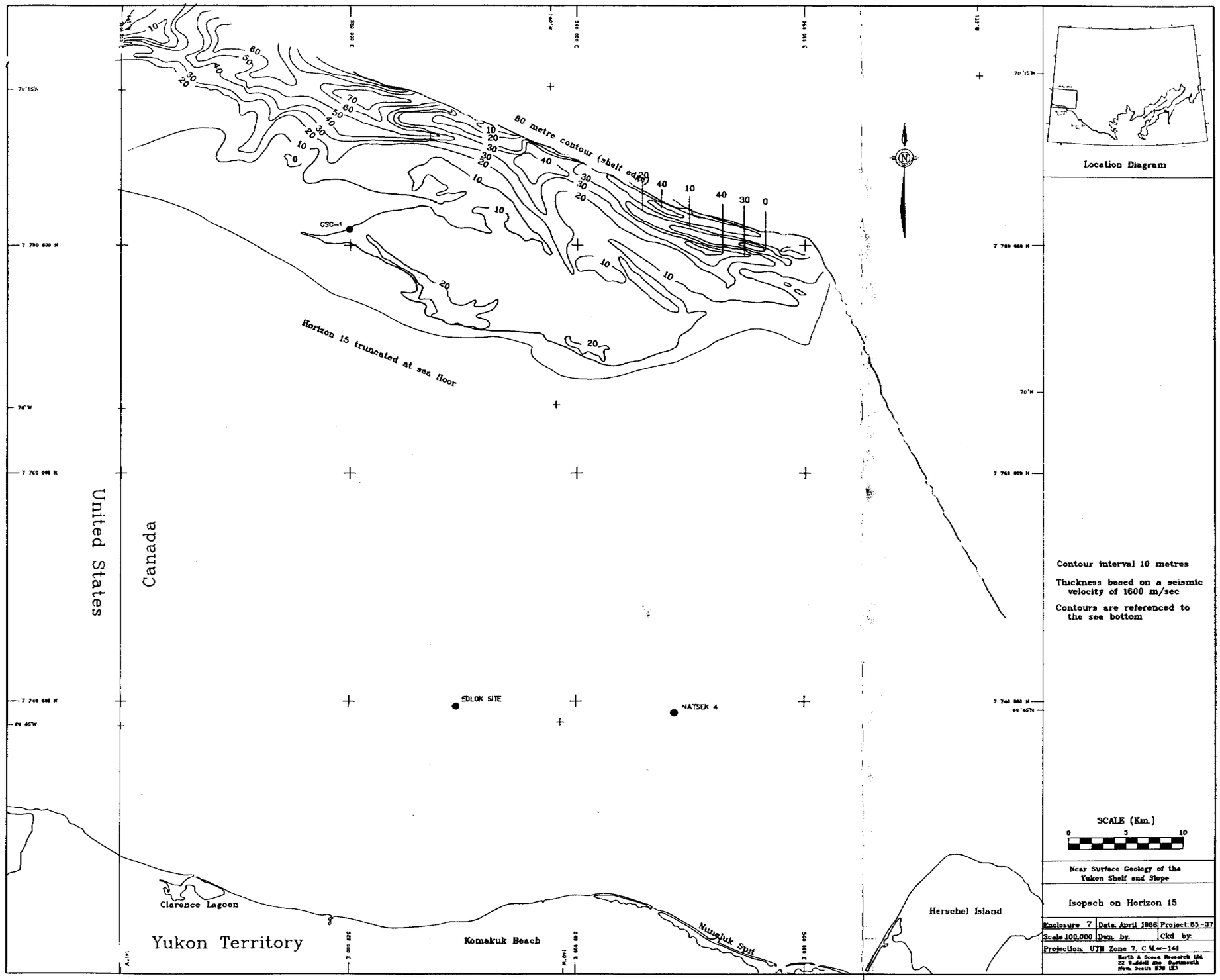

80 metre contour (shelf edge)
Horizon 15 truncated at sea floor
CSC-1
EDLOK SITE
NATSEK 4
United States
Canada
Yukon Territory
Clarence Lagoon
Komakuk Beach
Nunaluk Spit
Herschel Island
Location Diagram
Contour interval 10 metres
Thickness based on a seismic velocity of 1600 m/sec
Contours are referenced to the sea bottom
SCALE (Km.)
0 5 10
Near Surface Geology of the Yukon Shelf and Slope
Isopach on Horizon 15
Enclosure 7 | Date: April 1986 | Project: 85-37
Scale 100,000 | Dwn. by: | Ckd by:
Projection: UTM Zone 7, C.M.=-141
Earth & Ocean Research Ltd.
22 Waddell Ave. Dartmouth
Nova Scotia B3B 1K1

FIGURE 9

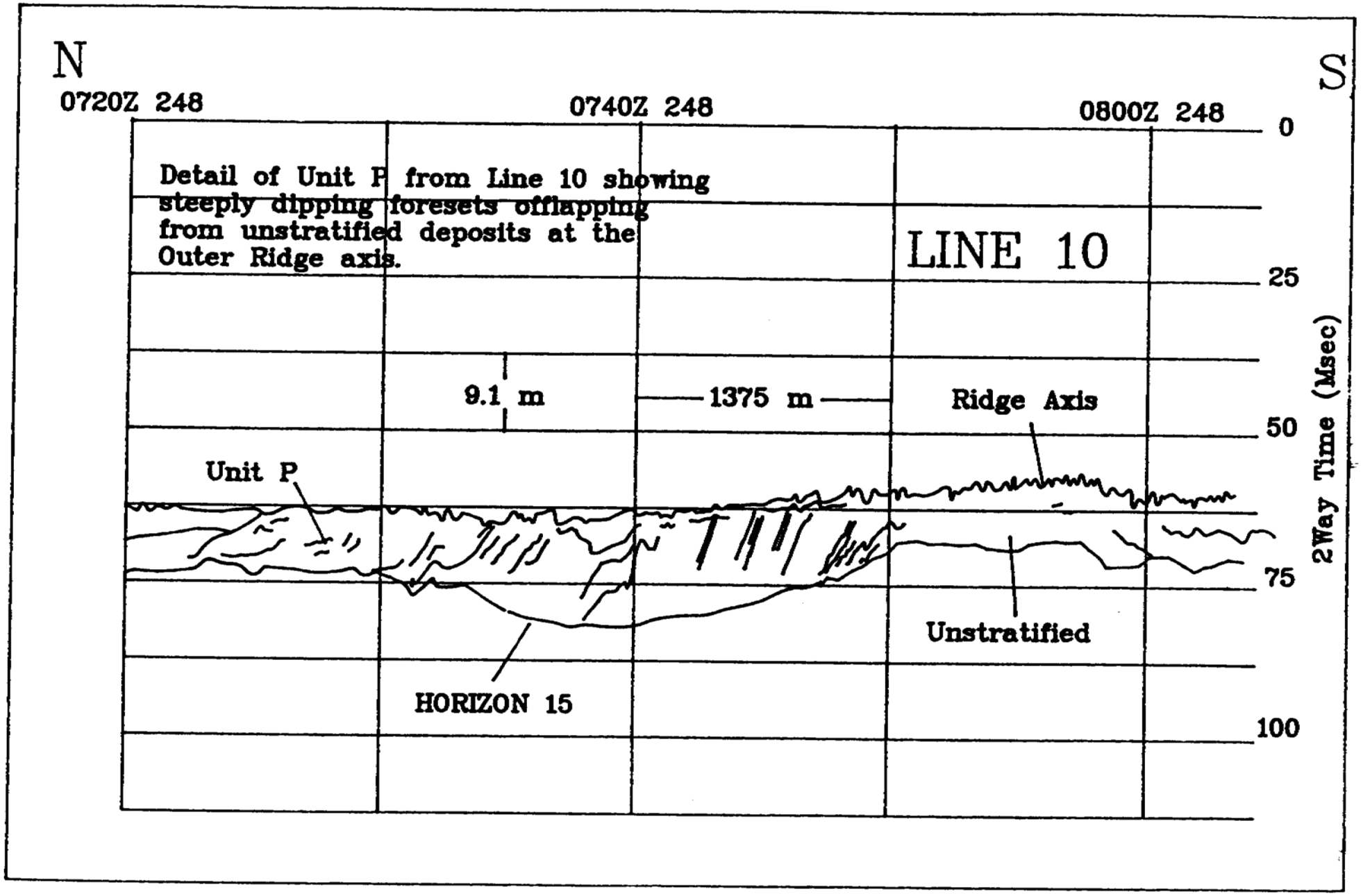

N
S
0720Z 248
0740Z 248
0800Z 248
0
25
50
75
100
2Way Time (Msec)
Detail of Unit P from Line 10 showing steeply dipping foresets offlapping from unstratified deposits at the Outer Ridge axis.
LINE 10
9.1 m
1375 m
Ridge Axis
Unit P
Unstratified
HORIZON 15

FIGURE 10

3.3 SURFICIAL COVER

A total of 240 grab samples, 18 piston cores and 2 boreholes have been collected from within the study area with an additional five boreholes located just beyond the bounds of the site on the Alaskan Beaufort Shelf. The distribution of these samples is displayed in Enclosure 8 and in reduced form as Figure 11. Number designations and descriptions of the samples are also presented adjacent to the symbols indicating sample location and type. Tables A-3.1, A-3.2, and A-3.3, (Appendix 3), present the sample data in tabular form. The sample coverage extends over the entire shelf area but is of uneven density. North of approximately 69°55'N, samples are primarily limited to those collected pre-1984. These are more or less regularly spaced on a 10 Km. grid. South of 69°55'N, the concentration of samples increases and includes samples taken by the CHS in 1984 for shoal examination, samples and piston cores taken by the GSC during that same time period, and pre-1984 samples and cores. The Natsek borehole is located on the Middle Shelf area and the GSC-1 borehole is located on the Outer Shelf.

Of the grab sample data set, only the pre-1984 samples have been lab tested for grain size and other properties. Twenty nine of these analyses have been retrieved from the Bedford Instute of Oceanography data base and are included in this report in Table A-3.3 (Appendix 3) and on Figure 11, (Enclosure 8). For the remainder of the pre-1984 samples, textural parameters have been taken from maps presented in Pelletier (1985). Several of these samples are not identified by sample number. It should also be noted that the sample identification of pre-1984 samples is as received from the BIO data base and may refer to sample number, sampling station or seive analysis number, the distinction between them being unclear.

The remaining samples included in Tables A-3.1 and A-3.2 (Appendix 3), and presented on Figure 11 (Enclosure 8), have received a visual classification only. These descriptions have been made by a number of field workers and are non standard. Thus one worker's "muddy gravel" may be another's "gravelly mud". Additionally, textural nomenclature is variable between agencies. Where the CHS field worker describes a sample as "fine grey mud" the GSC field worker may describe the same sediment type as "soft grey mud" or "stiff grey mud". The imprecision of description and variability of nomenclature between agencies limits the precision to which textural boundaries can be drawn. Standardization through laboratory size analyses of the visually described samples will solve this problem.

The absence of actual weight percentage data for most samples also degrades the analysis of aggregate quality.

Distribution of bottom sediment types is presented in Figure 12, taken from Pelletier (1985), while the percentages of gravel, sand, silt and clay are presented in Appendix 1 as Figures A-1.1, A-1.2, A-1.3 and A-1.4. The data collected in 1984 suggests some revision of these maps is required; however, the lack of size analyses for 1984 sediment samples does not permit modification of these quantitative boundaries at present.

Based on Pelletier's (1985) data, the inner shelf is dominated by a silty clay facies with a composition of 40-60% clay, 20-40% silt, and typically less than 20% total sand and gravel. Isolated patches of clayey

silt and gravelly clayey silt are scattered through the region. Zones of sand and gravel have been identified on the inner shelf, based on visual analyses of the 1984 sample data and sidescan data from 1984 and 1985 surveys. These qualitative boundaries, which are significantly modified from Pelletier's 1985 maps, are outlined on the map of Granular Resources (Enclosure 9 and Figure 14) and this figure should be referred to for sand and gravel distribution.

Based on Pelletier's sample data, sidescan data from the 1984 and 1985 surveys and to a lesser extent, the 1984 sample data, the outer shelf area is dominated by a sand and gravel facies. Most of the samples contain from 40-60% gravel, 20-40% sand and from 20-50% silt and clay. A few samples are almost pure sand and gravel, with less than 5% silt and clay.

High gravel concentrations, as interpreted from side scan sonograms, are restricted to a narrow zone that runs the length of the Mackenzie Trough shelf edge (Mr. Jim Shearer, pers comm.). This zone, is presented on the Granular Resources Map (Figure 14, Enclosure 9). The zone lies between the 40 and 64 meter contours in the south and occurs in progressively deeper water depths to the north. At its northern extent on the northeastern edge of the Yukon shelf the zone occurs from approximately 50 meters water depth to the shelf break at 80 meters.

The sidescan data also indicate extensive areas that are dominated by sand ripples and megaripples. Sand ripples are observed within the eastern and central parts of the Outer Trough while megaripples occur in a narrow linear zone sandwiched between the eastern edge of the gravel zone and the Mackenzie Trough shelf break at 80 meters depth.

This study considers all areas where significant portion of sand and gravel-sized particles occur in the samples. While materials with a significant percentage of fines are not considered suitable borrow materials, they can not be overlooked at this time. Considerably more data is needed to delineate proven deposits of the required quality, and similarly to reject unsuitable materials.

3.3.1 Provenance

The relation between locale, bathymetry, stratigraphy and sample texture is not straightforward and indicates that distribution is controlled by several independant mechanisms.

The coastline west of Komakuk Beach and extending almost to Clarence Lagoon is dominated by fine grained lacustrine sediments. The shoreline is fronted by coastal cliffs of approximately 9 meters height (Rampton, 1982). Coastal retreat through thermal niching or retrogressive thaw flow slides is presently active. Studies on the Alaskan North Slope (Reimnitz et al,1985), indicate that coastal retreat for coastlines composed of similar fine grained material averages 5.4 meters / year and locally reaches 18 meters / year. Coastal retreat of the fine grained areas fronting the Yukon coast should be, therefore, a major contributor to the offshore sediment budget.

Deposits of fine grained Holocene material are not directly observed within the study area, however, and microprofiler data indicate erosion of

the shelf strata. Figure 13, a section of microprofiler record from Line 41 of the 1984 survey shows reflectors of Unit M truncated at the seafloor with no overlying cover. This section is located on the middle shelf, and is observed in all areas where the surficial deposits are stratified i.e. Units M, N, and O on the Middle Shelf and Unit S on the upper slope. Although the substrate shoreward of this, (Unit L) lacks reflectors and truncation of strata at the seafloor is not observed, it may be assumed that this observation holds for this area as well. This suggests that fine grained deposits are likely derived from in situ reworking of the underlying strata, which from the limited number of boreholes are also seen to be uniformly composed of silts and clays.

The possibility cannot be ruled out, however, that some of the influx of material eroded from the coast and brought in from river discharge may be deposited on the inner and middle shelf where it is thoroughly mixed with the older sediment of Unit L through ice scouring. It is noted that the shoreline composition is reflected in the offshore sediment composition of Unit L. Highly scoured fine grained mud with nearly even proportions of silt and clay are ubiquitous offshore from the fines dominated coastline.

From the density of scour marks on the seafloor it is presumed that scouring of the seafloor by ice is the primary mechanism for reworking and redistribution of these materials.

The influx of sediment from onshore may be restricted to the innermost shelf adjacent the shoreline. Alternately, and perhaps more plausibly, current velocities over the shelf may be sufficiently high that the fine grained sediments eroded from the coast bypass the shelf completely and are deposited in the Mackenzie Trough and Beaufort Sea. The truncation of strata both on the shelf and on the upper slope and the occurrence of gravel lags and megaripples along the shelf edge, tends to support this theory.

The gravels and sands of the Coastal Zone are relict and were deposited as alluvial fans at a time of lower sealevel (see section 4.1). They are presently being reworked into marine landforms of baymouth bars, islands and spits, and are also being transported offshore a minimal distance where they form a thin veneer of coarse material on top of fine grained lacustrine or lagoonal material which occupies the Inshore Trough.

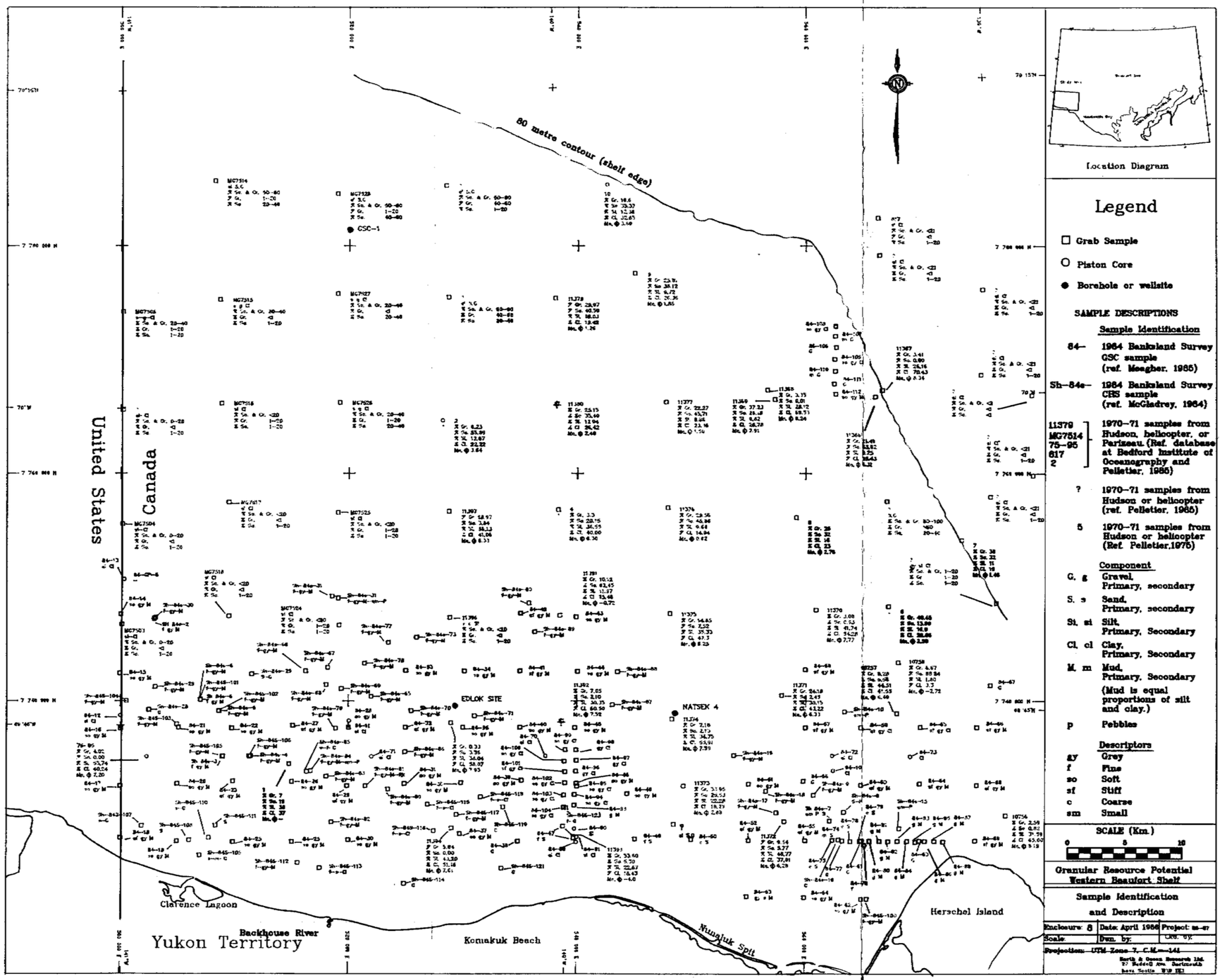
The coarse grained sediments of the Middle Shelf are generally, though not always, located on shoals. Most shoal areas within the study area are, however, composed of fine grained sediments similar to the surrounding sediments and the existence of the shoals is in most cases not thought to be due to their more resistant nature as coarse grained deposits. The sands and gravels are unevenly distributed over the Middle Shelf and where they occur are generally in a bimodal distribution with mud. From all borehole and core data, there appears to be little source in the underlying strata for the coarse fraction , except in the alluvial fans. From these observations it would seem that the likely source for the sands and gravels over most of the Middle Shelf is ice rafting with subsequent concentration through winnowing on the tops of shoals.

This mechanism is postulated on a larger scale on the Outer Shelf where a surficial veneer of coarse material is ubiquitous. Again borehole and

seismic evidence indicates that the sub bottom strata are sand and gravel poor and therefore not likely sources. The coincidence of the coarse concentrations to the Outer Shelf suggest that this fraction is or was transported to the shelf from offshore, possibly at a time of lower sealevel when access by ice was restricted to the 40-50 meter isobath.

It is also possible that the coarse material represents a substrate that was not sampled by the boreholes. Ongoing studies being conducted by EBA Engineering Ltd., and Challenger Surveys, on the morphologic features on the shelf, indicate that the Natsek Ridge surface is strongly reminisent of an esker landform (Paul Ruffel, pers comm).

These two interpretations result in significantly different appraisals of the granular resource base and must be resolved before a valid assessment of this zone can be made.


80 metre contour (shelf edge)
United States
Canada
Yukon Territory
EDLOK SITE
NATSEK 4
Clarence Lagoon
Backhouse River
Komakuk Beach
Nunaluk Spit
Herschel Island
Location Diagram
Legend
Grab Sample
Piston Core
Borehole or wellsite
SAMPLE DESCRIPTIONS
Sample Identification
84– 1984 Bankisland Survey GSC sample (ref. Meagher, 1985)
Sh–84e– 1984 Bankisland Survey CHS sample (ref. McGladrey, 1964)
11379 MG7514 75–95 617 2 1970–71 samples from Hudson, helicopter, or Parizeau. (Ref. database at Bedford Institute of Oceanography and Pelletier, 1985)
? 1970–71 samples from Hudson or helicopter (ref. Pelletier, 1965)
5 1970–71 samples from Hudson or helicopter (Ref. Pelletier, 1975)
Component
G, g Gravel, Primary, secondary
S, s Sand, Primary, secondary
Si, si Silt, Primary, Secondary
Cl, cl Clay, Primary, Secondary
M, m Mud, Primary, Secondary
(Mud is equal proportions of silt and clay.)
p Pebbles
Descriptors
gy Grey
f Fine
so Soft
sf Stiff
c Coarse
sm Small
SCALE (Km.)
0 5 10
Granular Resource Potential Western Beaufort Shelf
Sample Identification and Description
Enclosure: 8
Date: April 1986
Project: 86-87
Scale:
Dwn. by:
Chkd. by:
Projection: UTM Zone 7, C.M.—141
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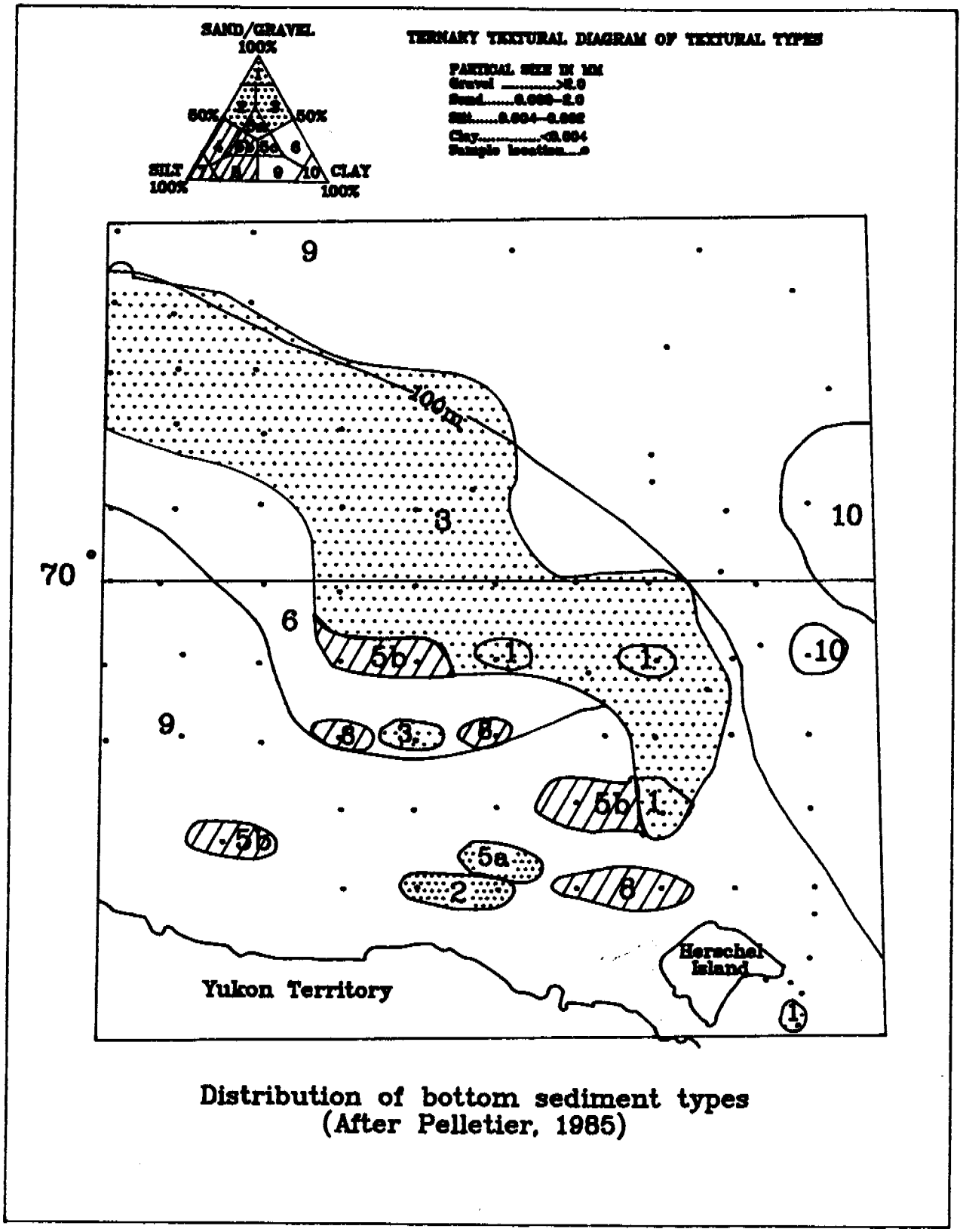
Nova Scotia B3B 1E1

FIGURE 11



Distribution of bottom sediment types
(After Pelletier, 1985)

FIGURE 12

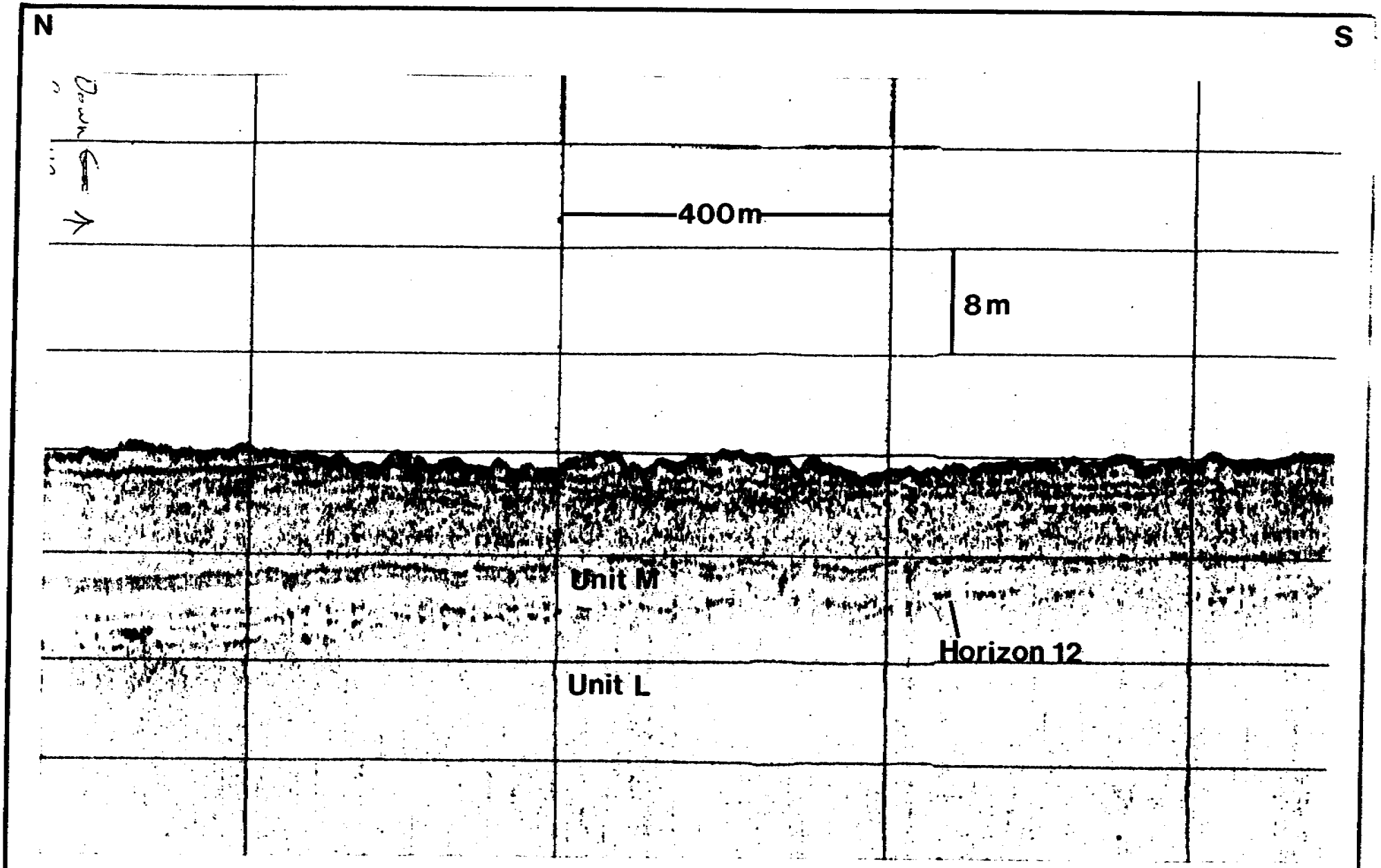


FIGURE: 13

Microprofiler Record of Middle Shelf Area showing Absence of Recent Sediment Deposits

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E O R

4. GRANULAR RESOURCES

GENERAL

Table 3 summarizes the granular resource potential as identified from this study and Figure 14 (Enclosure 9) present the data in map form. The description of potential aggregate concentration is subdivided into three geographic zones : a Coastal Zone where coarse aggregate deposits are drowned extensions of onshore deposits, a Middle Shelf zone dominated by lag deposits localized on shoals and an Outer Shelf zone where a combination of outcrops of coarse material and concentrations of ice rafted detritus are the likely sources of coarse material.

There are no "proven" resources within the study area. Given the conflicting nature of the cores, boreholes, and seismics against the grab sample data, it is obvious that the grab samples can not be taken as representative of the substrate to any depth greater than a few centimeters. There are several areas, mostly within the Coastal Zone, in which the various data sources corroborate each other and indicate substantial concentrations of coarse material. While the areal extent of these deposits are reasonably well ascertained, the thickness of the deposits are best estimates. These prospects are considered "probable".

The Middle Shelf is dominated by fine grained facies and the coarse material distribution, while in places localized on bathymetric highs, is apparently random with no unique correlation to topography or stratigraphy observed.

On the Outer Shelf the limited data coverage and conflict between the borehole and seismic data with the grab samples and side scan data limits the designation of the area to "prospective" although grab samples and sidescan data indicate high concentrations of sand and gravel.

The following subsections describe the "probable" or "prospective" deposits within the three areas. The deposits are identified as "prospects" and are indicated on the Granular Resource map (Figure 14). While the entire Outer Shelf is identified as "prospective", specific areas are highlighted in the basis of likely topography (prominant shoals), seismics or topography plus samples in order to narrow the search areas to some degree. This is done while recognizing that a unique relationship between shoal areas and coarse materials is not established from this study for the Outer Shelf area.

TABLE 3

SUMMARY OF GRANULAR RESOURCE POTENTIAL ON THE WESTERN (YUKON) CONTINENTAL SHELF

ZONE	PROSPECT	AREA (m^2) * 1 million	AV. THICKNESS (m)	PROVEN (m^3) * 1 million	PROBABLE (m^3) * 1 million	PROSPECTIVE (m^3) * 1 million	CONFIDENCE
Coastal	1 (10m-20m)	71.35	6-10		428-713.5		High
	1 (10m-0m)	73.99	6-10		444-740		High
	1A	74.65	-				Moderate
	2	2.4	2.5		6.0		High
	3	2.9	2.0		5.8		High
	4	25.1	2.0		50.2		High
Middle Shelf							
	5	13.0	2.0			26.0	Moderate
	6	1.8	1.5			2.7	Moderate
	7	—	—				Low
	8	6.5	—				Low
	9	2.9	2.0			5.8	Low
	10	1.1	2.0			2.2	Low
	11	3.4	1.0			3.4	Low
	12	4.0	0.5			2.0	Low
	13	1.0	0.5			0.5	Low
	14	11.0	0.8			8.8	Low
	15	2.7	0.7			1.9	Low

TABLE 3 (CONT)

Outer Shelf						
	16	3.0	2.0		6.0	Moderate
	17	---	---			
	18	16.7	4.0	66.0		High
	19	31.7	8.5		269.5	Moderate
TOTALS		275.2		556.0-841.5	328.8	

NOTE: The general outer shelf zone (Prospect 20), is not included in the above summation pending additional information on the nature and thickness of the coarse grained substrate. It is, however, prospective, and includes an area of 1400 million square meters.

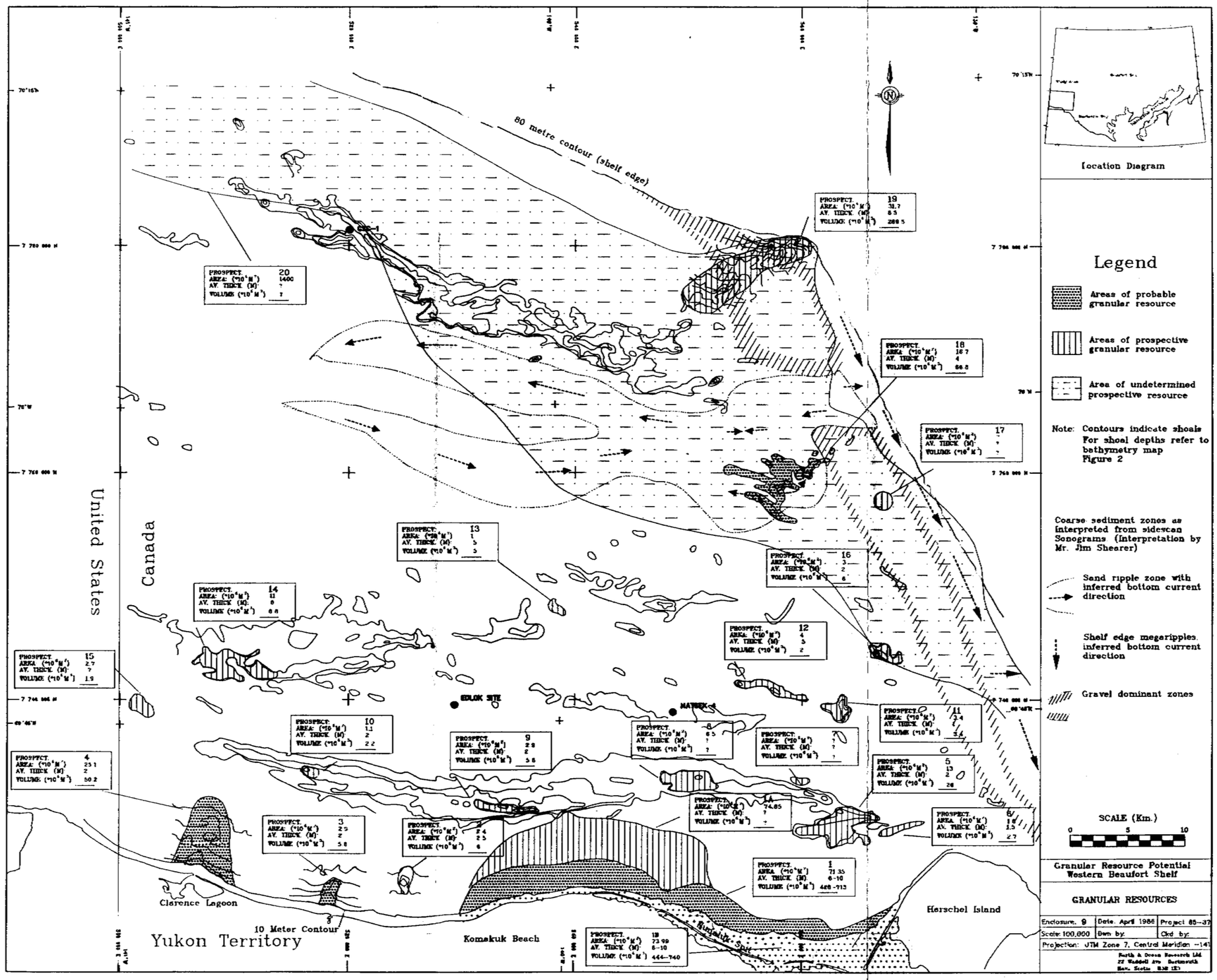
80 metre contour (shelf edge)
United States
Canada
Yukon Territory
Clarence Lagoon
10 Meter Contour
Komakuk Beach
Herschel Island
EDLOK SITE
NATKEK-1
PROSPECT 19 AREA (*10³M²) 38.7 AV. THICK (M) 8.5 VOLUME (*10³M³) 288.5
PROSPECT 20 AREA (*10³M²) 1400 AV. THICK (M) ? VOLUME (*10³M³) ?
PROSPECT 18 AREA (*10³M²) 16.7 AV. THICK (M) 4 VOLUME (*10³M³) 66.8
PROSPECT 17 AREA (*10³M²) ? AV. THICK (M) ? VOLUME (*10³M³) ?
PROSPECT 13 AREA (*10³M²) 1 AV. THICK (M) 5 VOLUME (*10³M³) 5
PROSPECT 16 AREA (*10³M²) 3 AV. THICK (M) 2 VOLUME (*10³M³) 6
PROSPECT 14 AREA (*10³M²) 11 AV. THICK (M) 6 VOLUME (*10³M³) 66
PROSPECT 12 AREA (*10³M²) 4 AV. THICK (M) 5 VOLUME (*10³M³) 2
PROSPECT 15 AREA (*10³M²) 2.7 AV. THICK (M) ? VOLUME (*10³M³) 1.9
PROSPECT 10 AREA (*10³M²) 11 AV. THICK (M) 2 VOLUME (*10³M³) 22
PROSPECT 9 AREA (*10³M²) 29 AV. THICK (M) 2 VOLUME (*10³M³) 58
PROSPECT 8 AREA (*10³M²) 65 AV. THICK (M) ? VOLUME (*10³M³) ?
PROSPECT 7 AREA (*10³M²) ? AV. THICK (M) ? VOLUME (*10³M³) ?
PROSPECT 11 AREA (*10³M²) 3.4 AV. THICK (M) ? VOLUME (*10³M³) 34
PROSPECT 4 AREA (*10³M²) 25.1 AV. THICK (M) 2 VOLUME (*10³M³) 50.2
PROSPECT 5 AREA (*10³M²) 13 AV. THICK (M) 2 VOLUME (*10³M³) 26
PROSPECT 3 AREA (*10³M²) 29 AV. THICK (M) 2 VOLUME (*10³M³) 58
PROSPECT 2 AREA (*10³M²) 24 AV. THICK (M) 25 VOLUME (*10³M³) 6
PROSPECT 6 AREA (*10³M²) 16 AV. THICK (M) 1.5 VOLUME (*10³M³) 27
PROSPECT 1 AREA (*10³M²) 79.35 AV. THICK (M) 6-10 VOLUME (*10³M³) 468-713
PROSPECT 18 AREA (*10³M²) 73.99 AV. THICK (M) 6-10 VOLUME (*10³M³) 444-740
Location Diagram
Legend
Areas of probable granular resource
Areas of prospective granular resource
Area of undetermined prospective resource
Note: Contours indicate shoals For shoal depths refer to bathymetry map Figure 2
Coarse sediment zones as interpreted from sidescan Sonograms (Interpretation by Mr. Jim Shearer)
Sand ripple zone with inferred bottom current direction
Shelf edge megaripples. inferred bottom current direction
Gravel dominant zones
SCALE (Km.)
0 5 10
Granular Resource Potential Western Beaufort Shelf
GRANULAR RESOURCES
Enclosure 9 | Date April 1986 | Project 85-37
Scale 1:00,000 | Dwn by: | Chkd by:
Projection: UTM Zone 7, Central Meridian -141
North & Ocean Research Ltd 27 Waddell Ave Dartmouth Nova Scotia B3B 1E1

FIGURE 14

4.1 COASTAL ZONE

Prospect 1: Malcolm and Firth River Alluvial Fans

The Malcolm and Firth Rivers are major drainage systems that begin in the British Mountains and flow north across the Yukon Coastal Plain to empty into the Beaufort Sea west of Herschel Island. They form large terraced alluvial fans that coalesce at their distal edges. The Malcolm River fan, more so than the Firth, has extended the shoreline seaward in a broad arc. The fans are composed predominantly of "stratified poorly sorted pebbly gravels with many cobbles and few boulders (Rampton 1982).

At the shoreline these alluvial sands and gravels are being actively reworked into beach and spit deposits that extend from Komakuk Beach at the western edge of the Malcolm River fan to Herschel Island. The spits are composed predominantly of fine pebbly gravel to coarse sand, are up to 150 meters wide and may be up to 8 meters thick (Rampton 1982). The spits and bars are generally 1 to 2.5 meters above sea level. Longshore movement of sand and gravel, mainly from coastal erosion has caused recent extension of most spits and is presently continuing (McDonald and Lewis, 1973). Longshore drift is from west to east along the Malcolm and Firth River coastlines and north to south along the west coast of Herschel Island (Pelletier, 1985). This transport pattern has resulted in spits attached to the shore at their western ends along the Malcolm River coast and a spit extending southwards from the southwest tip of Herschel Island. The pattern also indicates a sediment sink within the embayment north of the Firth River between the Malcolm River and Herschel Island.

Bathymetry, seismic profiles and bottom grab samples indicate that the coarse facies of the Malcolm River fan extends seaward of the shoreline and lies exposed at the seafloor to a maximum depth of 20 meters. As alluvial fans are primarily terrestrial deposits except in areas of high coastal topography (Friedman and Sanders, 1978), this indicates that the fan deposits were laid down at a time of lower sealevel and have been subsequently drowned. Rampton (1982), notes that the alluvial fans in this area are probably early to middle Quaternary in age as their distal edges are overlain by Buckland glacial deposits of probable early Wisconsinan age.

Bathymetric profiles crossing seaward of the Malcolm River fan show an abrupt rise to a smooth surfaced terrace that contrasts sharply with the rugged, ice scoured microrelief of the surrounding seafloor (Figure 15). This boundary is well defined and is displayed in Figure 5 as Horizon 16. The boundary is arcuate, bulging to seaward, and parallels the coastline shape of the Malcolm River fan. A single grab sample, SH-84s-121, is collected within this morphologic entity, and is described as "gravel". The smooth seafloor profiles exhibited by the bathymetric and high resolution seismic sources is the result of the resistance of coarse sediments to deep scouring combined with the rapid recovery of the non cohesive coarse sediments after disturbance.

High resolution data indicate that to seaward the surface forms a shallow shelf covered with a thin veneer of transparent, scoured sediments before descending to form the floor of the near shore trough.

A lower extent for the coarse material of this unit cannot be firmly established from the data at hand. Core 84-89 (Figure A-2.1, Appendix 2), penetrated the unit to 89 cm without encountering the lower limit and it is felt that the base lies significantly deeper. The shallowest horizon identified beneath the unit, Horizon 11, is poorly defined in this area. The isopach on this horizon indicates that the unit thickens shoreward and is 6 to 10 meters thick at the shoreward limit of seismic coverage beneath the offshore Malcolm River fan (Enclosure 5, Figure 7). The lack of strong or continuous acoustic horizons above Horizon 11 does not preclude variations in texture within the sequence. Rampton notes, however, that in the area of the alluvial fans onshore "6 to 15 meters of gravel commonly overlies bedrock, especially... west of Firth River" (Rampton, 1982). It is therefore possible and likely that Horizon 11, extrapolated shoreward as a flat, slightly inclined plane represents the base of the deposit. This provides a tentative base for determining the volume of coarse grained sediment lying between the seaward boundary of the exposure and the 10 meter isobath. The area enclosed by the boundary and the 10 meter isobath measures 71.35 million square metres and, assuming a 6 meter thick section we arrive at 428 million cubic metres of coarse grained material. A 10 meter thick section yields 713.5 million cubic metres.

The prospect can, with reasonable confidence, be extended from the 10 meter contour to shoreline. This results in an additional area of 73.99 million square meters. If we again assume a minimum of 6 meters and a maximum of 10 meters for the thickness of the deposit, volumes of 444 and 740 million cubic meters, respectively, are computed. This additional area is outlined as Prospect 1B on the Granular Resources map.

Prospect 1A

The zone lying to seaward of the drowned Malcolm River fan, (Prospect 1A), is defined by eight grab samples and three cores. The zone forms a crescent shaped apron around the perimeter of the fan. The grab samples range in visual description from fine sand to coarse sand to gravel. A single sample has been analysed. Sample 11393 is strongly bimodal and consists of 54% gravel, only 5% sand, and 41% silt and clay.

Three piston cores, 84-89, 84-90, 84-91, (Appendix 2, Figures A-2.1, A-2.2, and A-2.3) are taken from within the zone and do not support an extensive sand and gravel zone as inferred from the grab samples. Cores 90 and 91 show virtually no sand but rather lagoonal or lacustrine type fine grained deposits. Core 84-89, the southernmost core, is taken at the boundary of Prospects 1 and 1A. This core encounters sand beneath 10 centimeters of laminated, organic rich silt and clay. The sand coarsens downsection to gravel at 69 centimeters and gravel is encountered to the depth of penetration at 89 centimeters. From its position beneath the "lagoonal" material this sand is interpreted to be part of the Malcolm River Fan deposit (Prospect 1) and distinct from the sands of Prospect 1A which overlie the "lagoonal" material.

The seismics corroborate the core descriptions. Prospect 1A lies within the inshore trough, a bathymetric depression sub-parallel to the shoreline (see Section 3.1). The seismics show that this depression is

partially filled with transparent well to poorly stratified ponded sediments (Unit Q). It seems likely then that the sand and gravel "apron" seaward of the drowned Malcolm River fan is a thin and patchy veneer reworked from the fan in recent times, and overlaid on the fine grained sediments of Unit Q.

This interpretation indicates that Prospect 1A is not a highly prospective area for high grade aggregate deposits. The area for Prospect 1A measured 74.65 million square metres. The volume cannot be estimated without further testing as there appears, from the limited data at hand to be of neglible thickness.

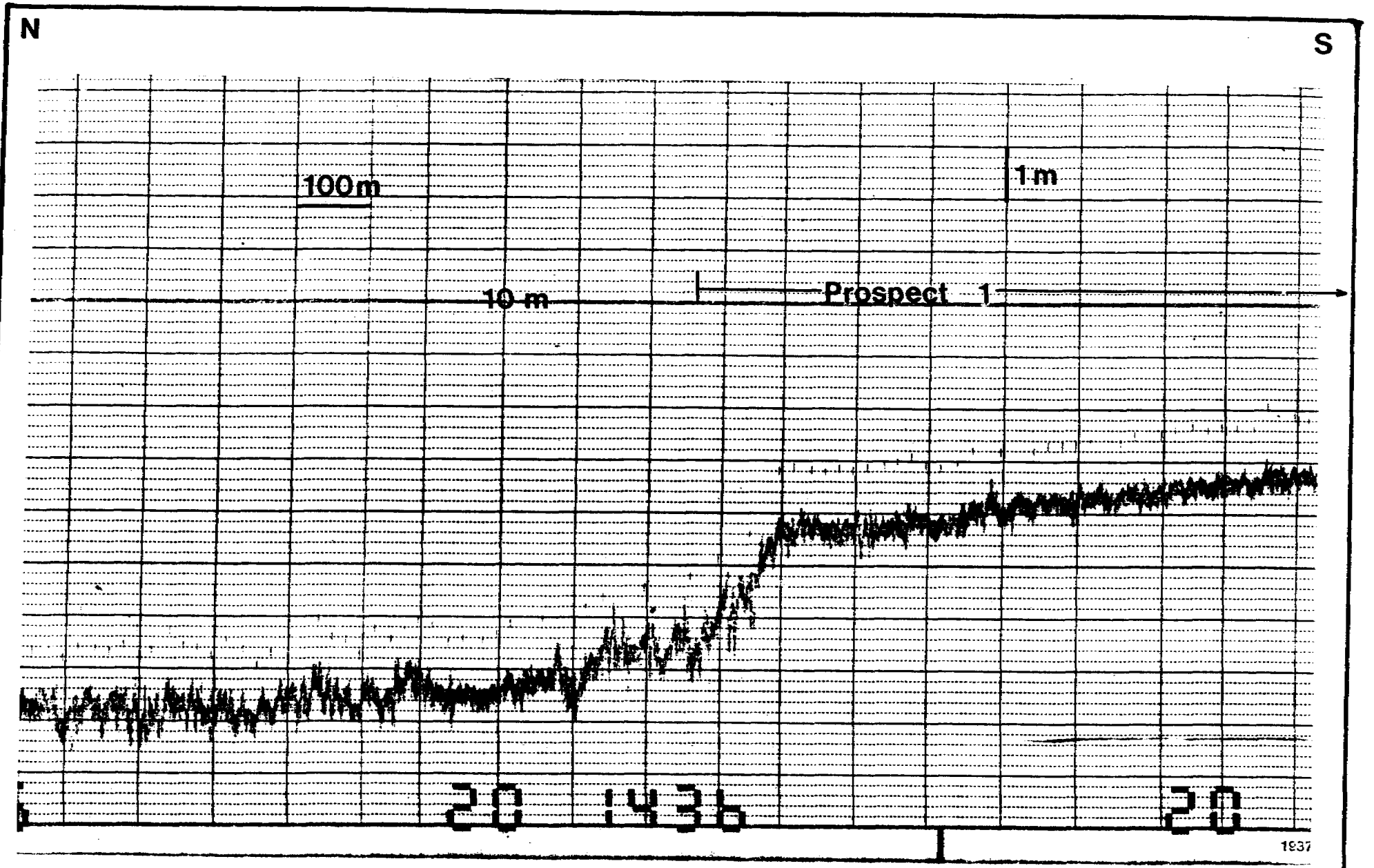

FIGURE: 15

Bathymetry Profile Across Prospect 1

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EOR

Prospects 2 and 3: * and Backhouse River Alluvial Fans

Directly offshore from the * River and the Backhouse River, 6 Km. to the west, the bathymetric contours bulge seaward to form narrow ridges. The 16 and 18 meter contours are extended seawards off of the * River while north of the Backhouse River the 12 to 16 meter contours are affected.

Figures 16, 17 and 18 are bathymetric, boomer, and 3.5 KHz. profiles across the * River Prospect. Due to the recording scales the three records are quite dissimilar in appearance but each yields useful information. The bathymetric profile depicts a conical feature with a local elevation of 2-3 meters. The boomer record displays the abrupt transition to a smooth, unscoured surface across the shoal while the 3.5 KHz. profile displays a subsurface reflector, Horizon 11, as the possible base of the feature.

A grab sample, (Sh-84s-114), taken on the shoal north of the * River is described as "gravel". No grab samples are recovered from the ridge north of the Backhouse River, however, bathymetric profiles display a similar transition to a smooth crest (Figure 19).

The Backhouse and * Rivers occupy linear, narrow valleys partially cut into bedrock and filled with terraces of fluvial gravel and fine sand. The offshore ridges are interpreted as seaward extensions of these deposits. That the 10 meter contour is unaffected by the deposits suggests that they may be remnants partially or wholly cut off from the shoreline.

Extending the boundary of the Backhouse River deposit into the 10 meter contour yields an area of 2.9 million square metres. The * River deposit is left as a shoal unattached to the coast and measuring 2.4 million square metres. The thickness of the deposits is conjectural. Two seismic lines extend over the * River shoal. Horizon 11 is the shallowest horizon observed and occurs at 5 meters depth. Assuming that this represents the base of the deposit, an average thickness of 2.5 metres is assumed, yielding a volume of 6 million cubic metres.

Seismic coverage does not extend over the Backhouse River shoal and the thickness of 4 meters over Horizon 11 is extrapolated to the shoal. This thickness yields a volume of 5.8 million cubic metres. It should be re-emphasized, however, that the position of Horizon 11 is tenuous due to poor seismic returns in this area.

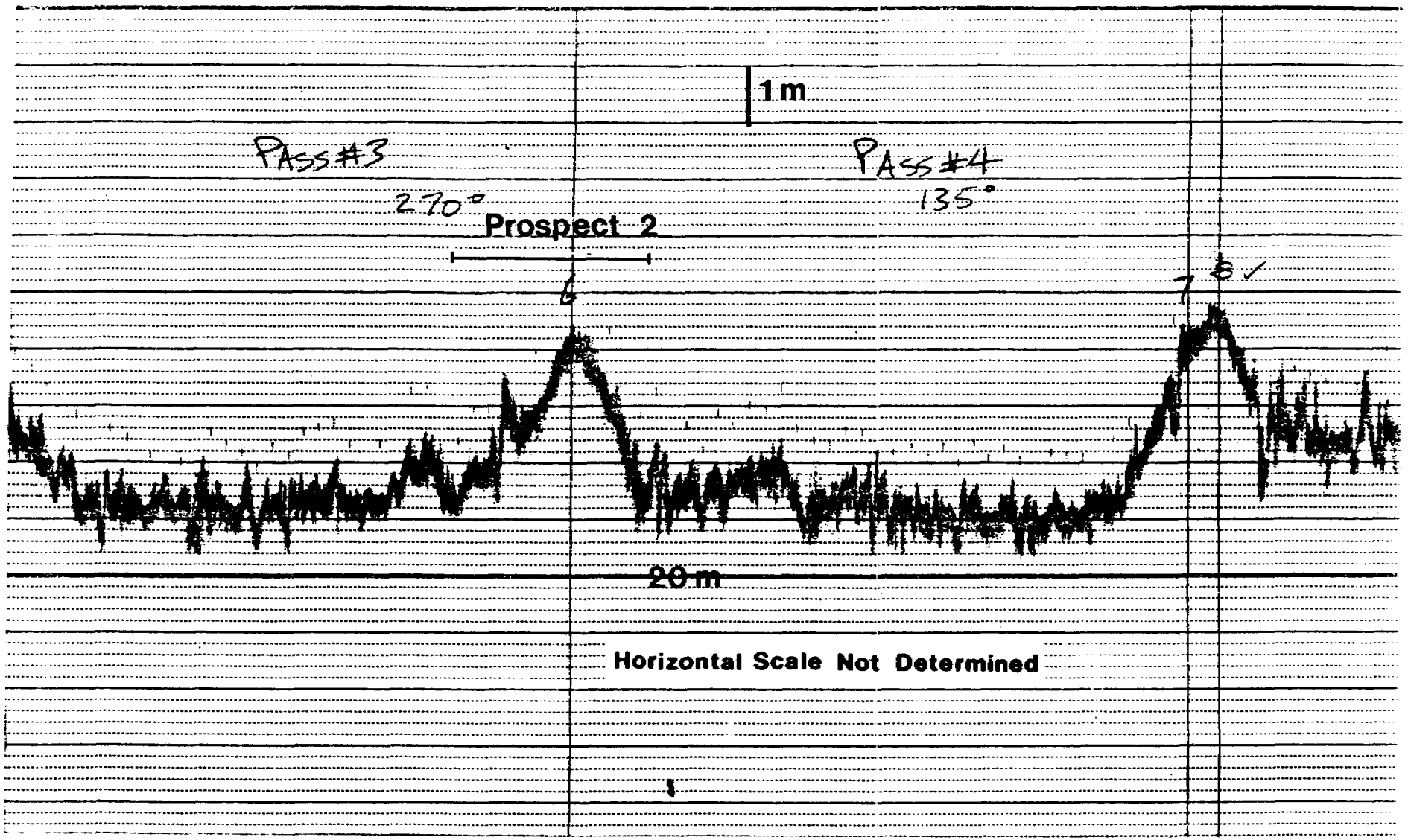

FIGURE: 16

Bathymetry Profile Across Prospect 2

EARTH & OCEAN RESEARCH LTD.

E O R

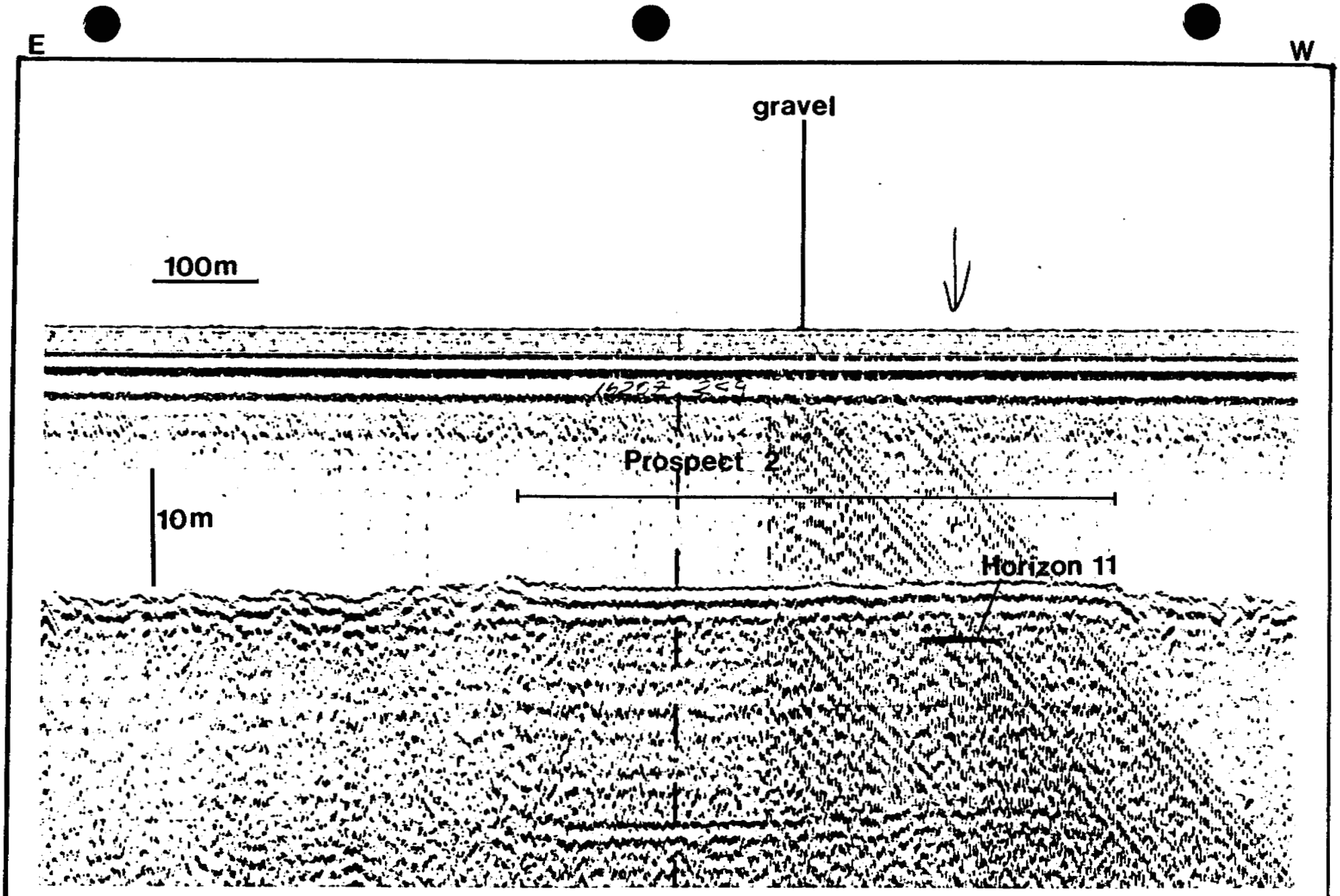

FIGURE: 17

Boomer Profile Across Prospect 2

EARTH & OCEAN RESEARCH LTD.

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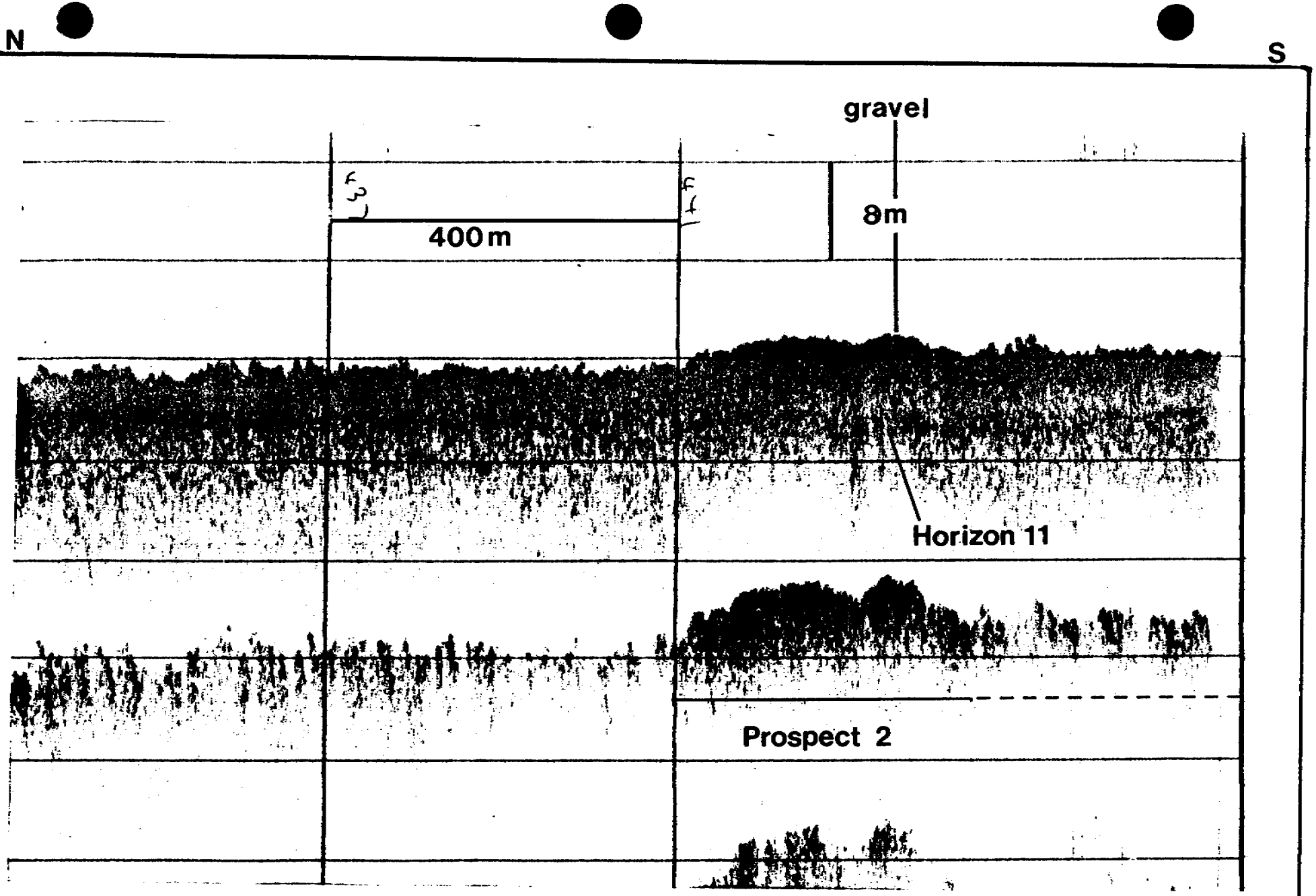

FIGURE: 18

Microprofiler Profile Across Prospect 2

EARTH & OCEAN RESEARCH LTD.

E&OR

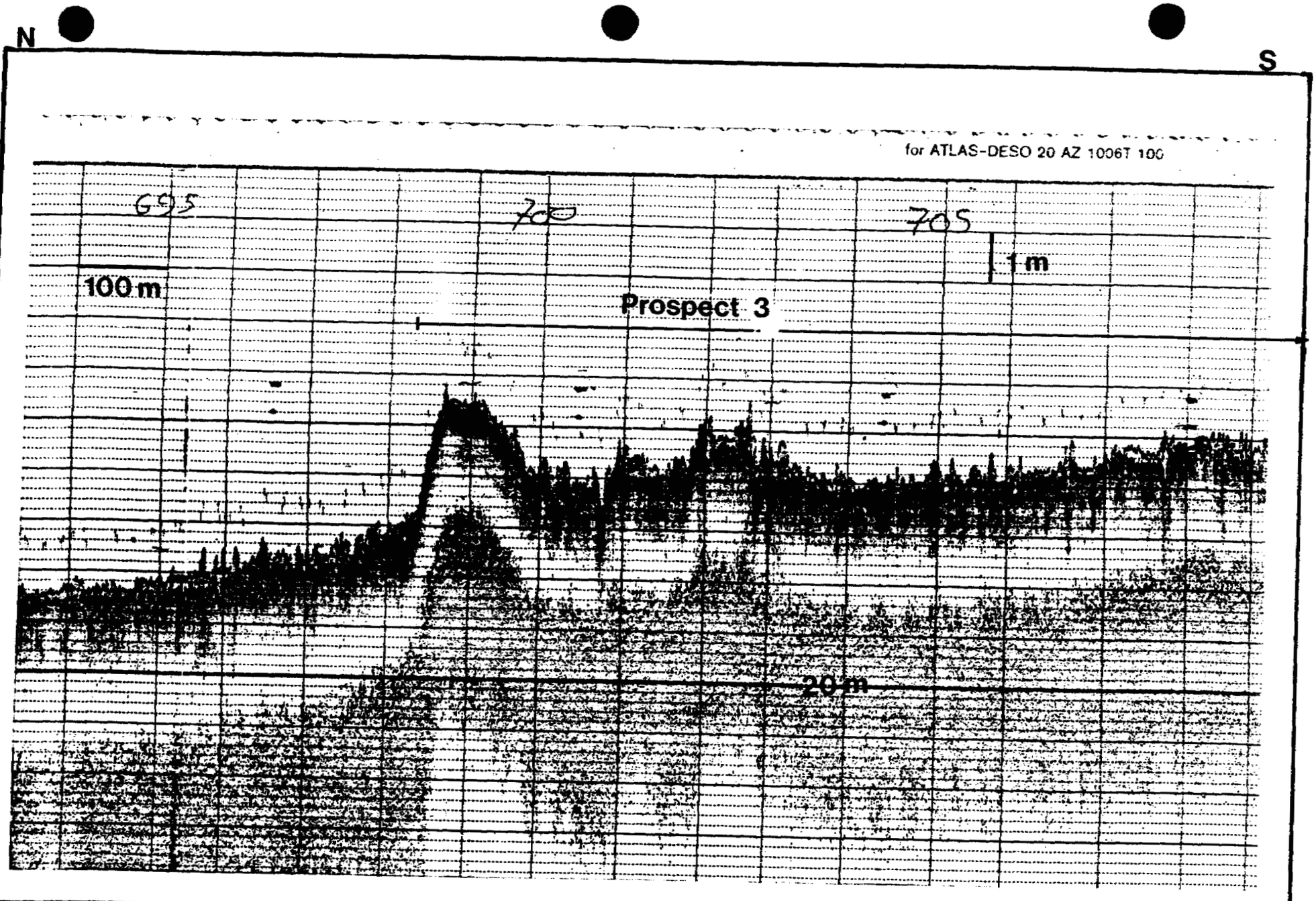

FIGURE: 19

Bathymetry Profile Across Prospect 3

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Prospect 4: Clarence Lagoon Alluvial Fan

A much larger bathymetric high is located offshore from, and is apparently associated with, the river systems that flow into the Clarence Lagoon. This lagoon acts as a debouchement point for numerous rivers, chief among them the Clarence River, and Craig Creek. The rivers combine to form an extensive alluvial fan-delta plain composed predominantly of fluvial gravels. A baymouth bar is anchored on the eastern end of and virtually encloses the lagoon, indicating an east to west longshore drift.

Offshore, the bathymetric contours extend seaward to form a broad ridge aligned in a north - south direction. The ridge is connected to the shoreline and extends to the 20 - 22 meter isobath. East-west oriented boomer records and north - south bathymetric profiles indicate that it is smooth crested (Figures 20 and 21). Six grab samples were retrieved on and around the shoal. Two of these, (84-19 and 84-25), located on the flanks of the shoal, are described as "soft grey mud". Four samples (SH-84s-108, 109, 110, and 111), scattered about the length of the shoal, are described as "sand", "sandy gravel", or "sandy muddy gravel".

The bathymetric data, combined with the grab samples allow delineation of the extent of the coarse grained deposit as 25.1 million square metres. The seismics are, however, again ambiguous, and the lower limit cannot be reliably estimated. As the shoal has a local relief of about 2 meters, we assume this as a minimum thickness. This figure yields a minimum volume of 50.2 million cubic metres of coarse grained material.

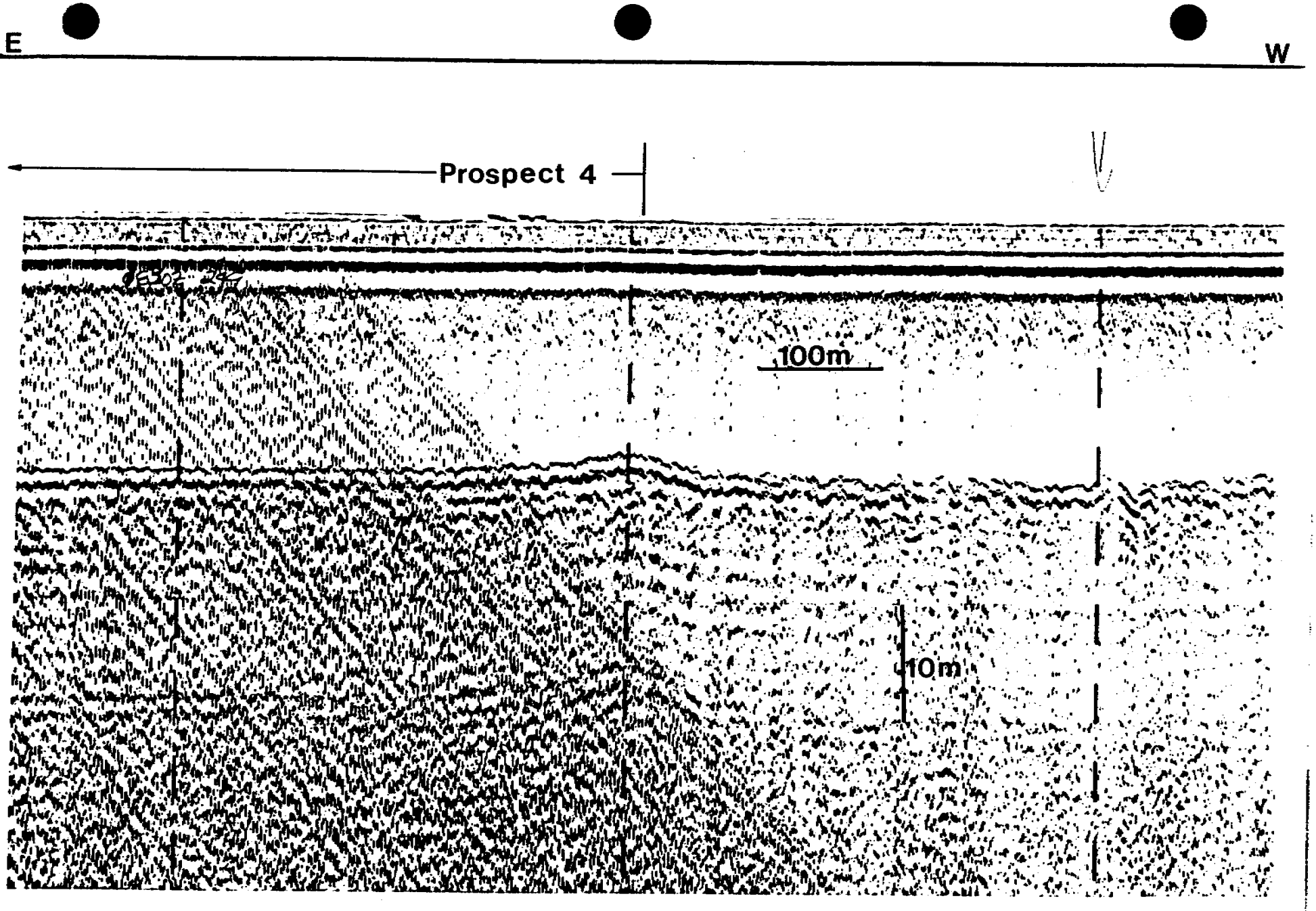

FIGURE: 20

Boomer Profile Across Prospect 4

EARTH & OCEAN RESEARCH LTD.

EOR

Clarence Lagoon

10?

10-30

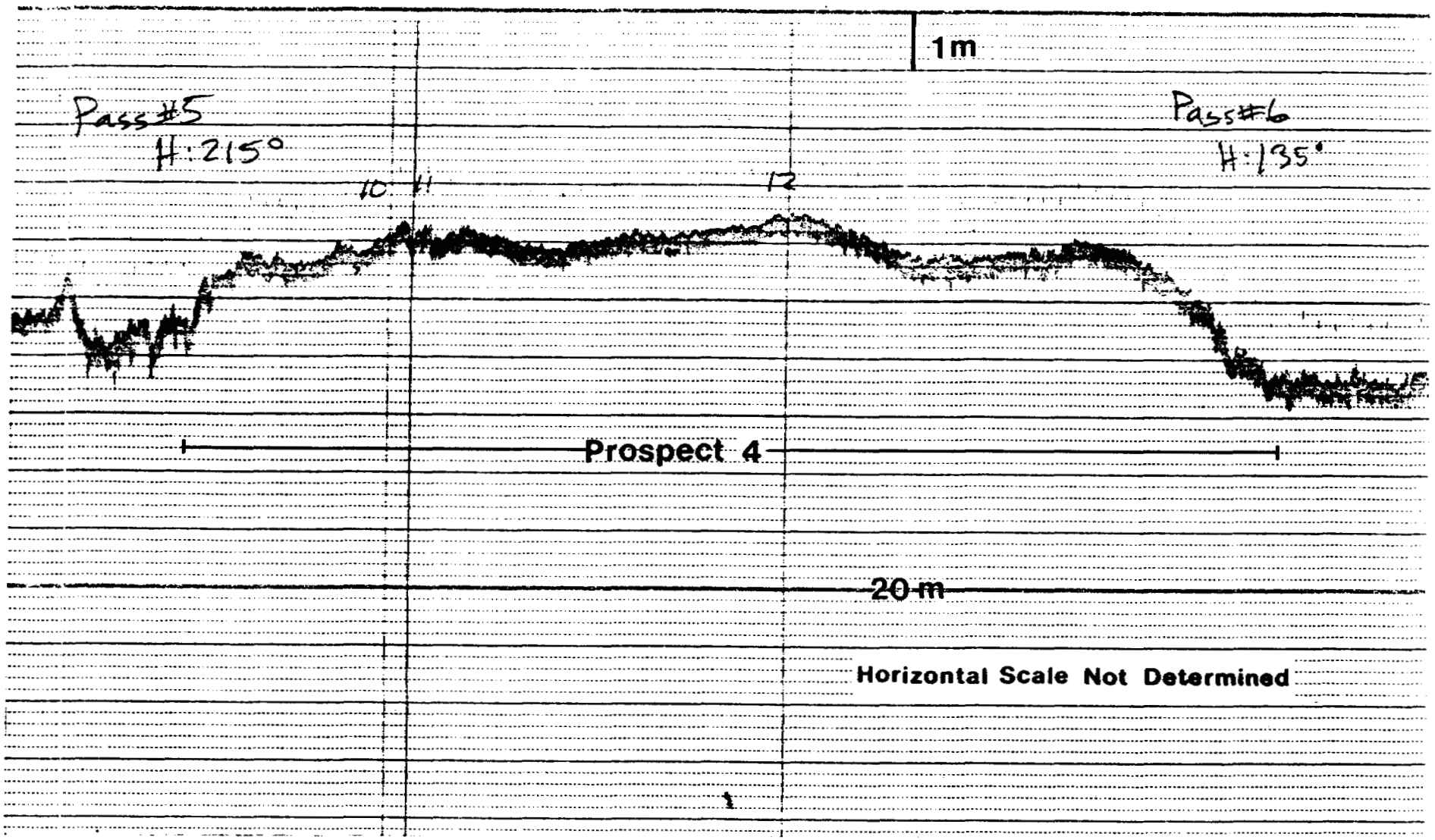

FIGURE: 21

Bathymetry Profile Across Prospect '4

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3.2 MIDDLE SHELF ZONE

Six prospective sites are identified on the Nearshore Ridge and an additional five are scattered over the Middle Shelf area seaward of the ridge.

Prospect 5

Prospect 5 is a shoal located 7 Km. due west of the north tip of Herschel Island. The zone is situated in approximately 22 to 26 meters of water and comprises the eastern end of the Nearshore Ridge described in Section 3.1. It is notable, however, that this shoal is offset slightly from the main ridge and may be a separate feature. Eight grab samples define the zone and are visually described as coarse sands to gravels. No size analyses have been conducted on these samples. A short core, 84-74, (Appendix 2, Figure A-2.4), located at the edge of the shoal penetrated 7 cm of coarse, muddy sand into 11 cm of silt. A number of bathymetry and 3.5 Khz profiles across the shoal are presented in Figures 22 to 26. Figures 22 and 23 cross the crest of the shoal from north to south. They depict a steep sided plateau with greater relief on the north flank. The shoal in Figure 22 is flat topped with reduced scour micro-relief on the top and flanks. A bathymetry profile (Figure 24) crosses the southern flank in an east - west direction and displays a more subdued local relief.

On the microprofiler records (Figures 25 and 26) the shoal is seen to rest on stratigraphic Unit L. Horizon 11 is the shallowest coherent sub seafloor reflector and occurs at 6-7 meters depth below the crest of the shoal. As this reflector underlies Unit L in fine grained areas surrounding the shoal, it is not expected that it represents the base of coarse sediments. The base may be defined by the lower extent of the dark surface return which is noticeably thicker beneath the shoal. Referring to Figure 25 it appears that this imprecise lower limit forms a flat slightly inclined surface that, beneath the crest of the shoal is 4.5 meters below seafloor and thins to near zero away from the crest on either side. The zero edge coincides with the 24 meter contour and by tracing the 24 meter contour we find that it does enclose all of the coarse grained samples and excludes fine grained samples taken in proximity to them.

Using the 24 meter isobath and the grab sample distribution to define the feature an area of 13 million square metres is determined for the shoal. If an average thickness of 2 meters is assumed, this results in a volume of 26 million cubic metres.

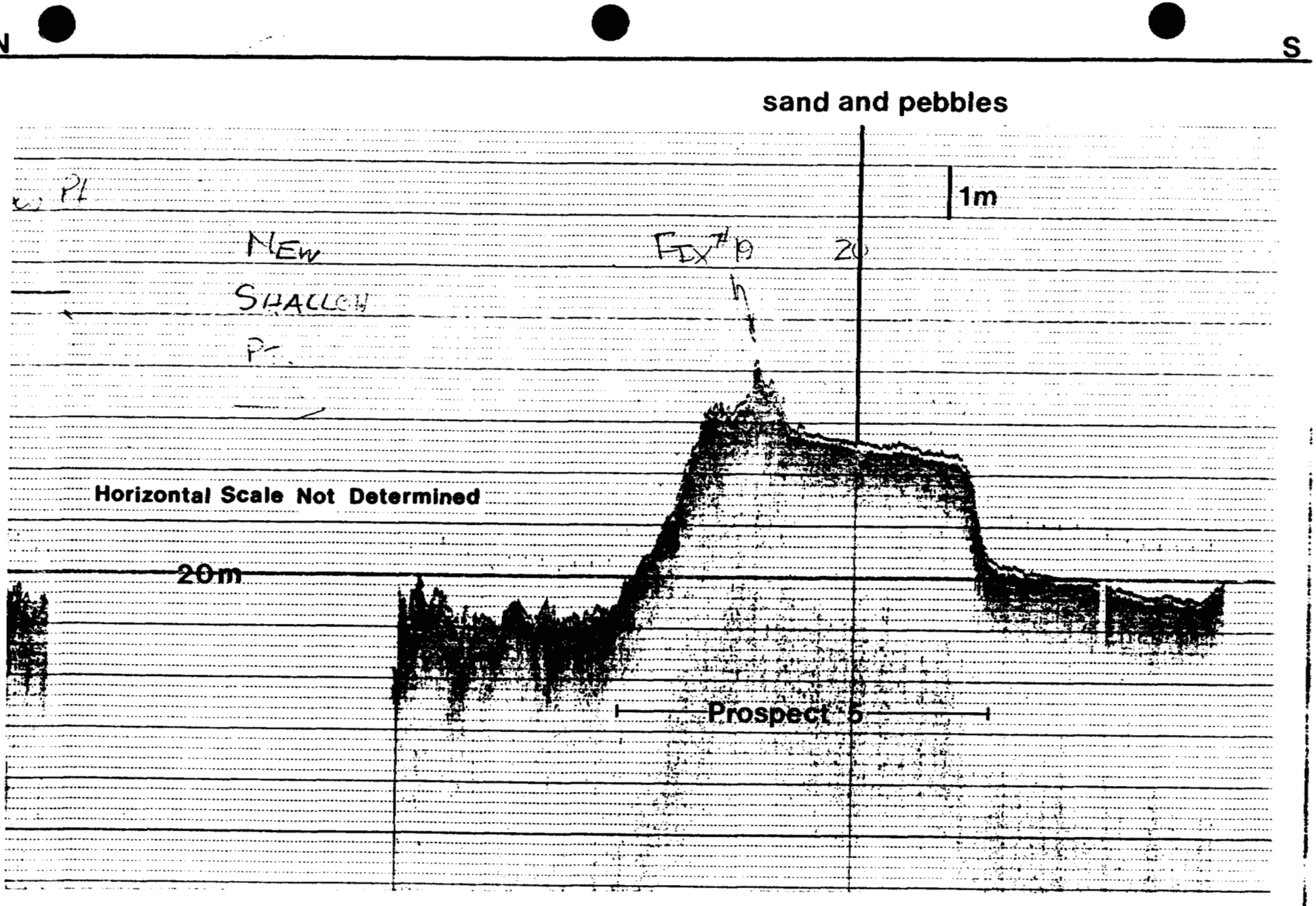

FIGURE: 22

Bathymetry Profile Across Prospect 5

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EOR

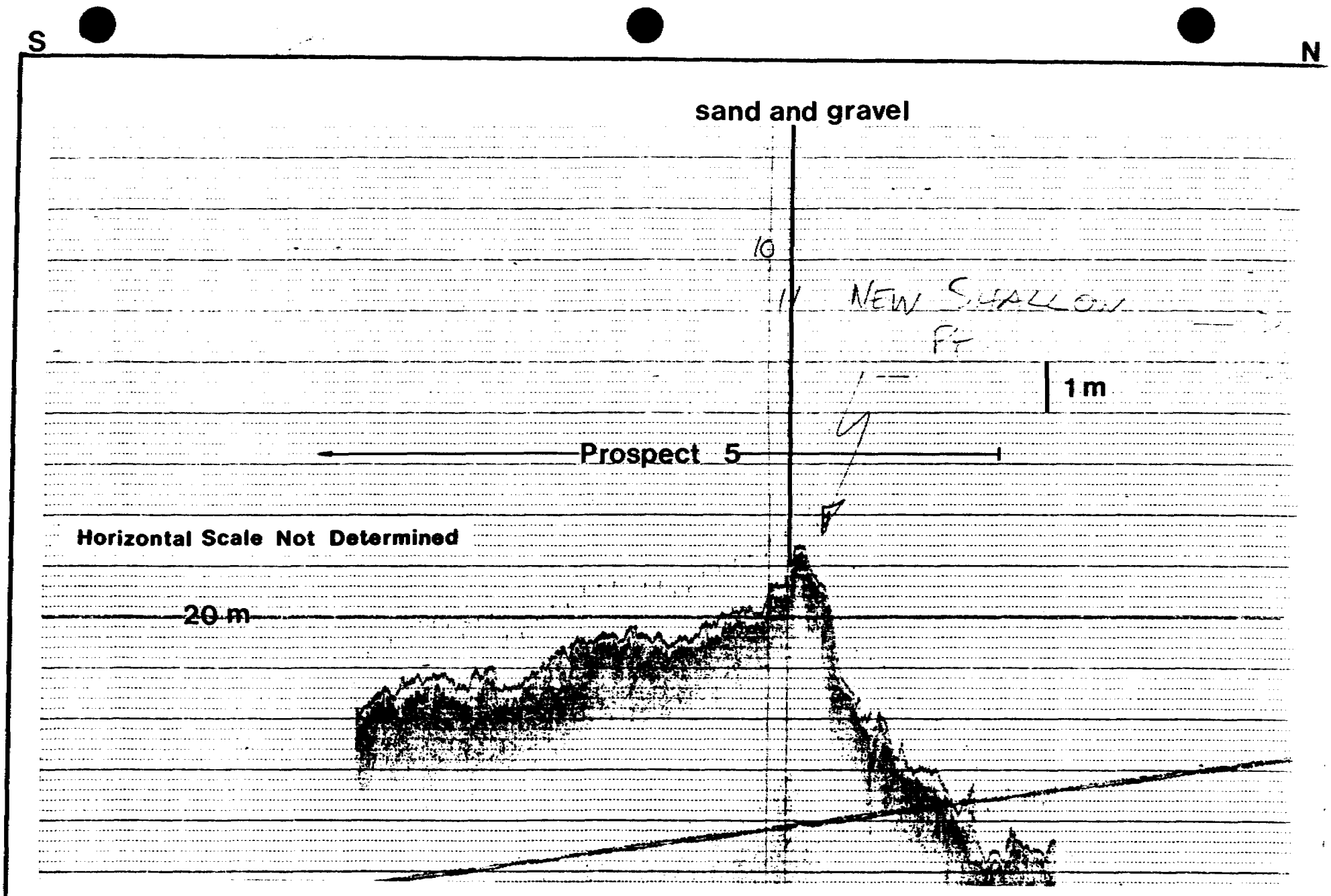

FIGURE: 23

Bathymetry Profile Across Prospect 5

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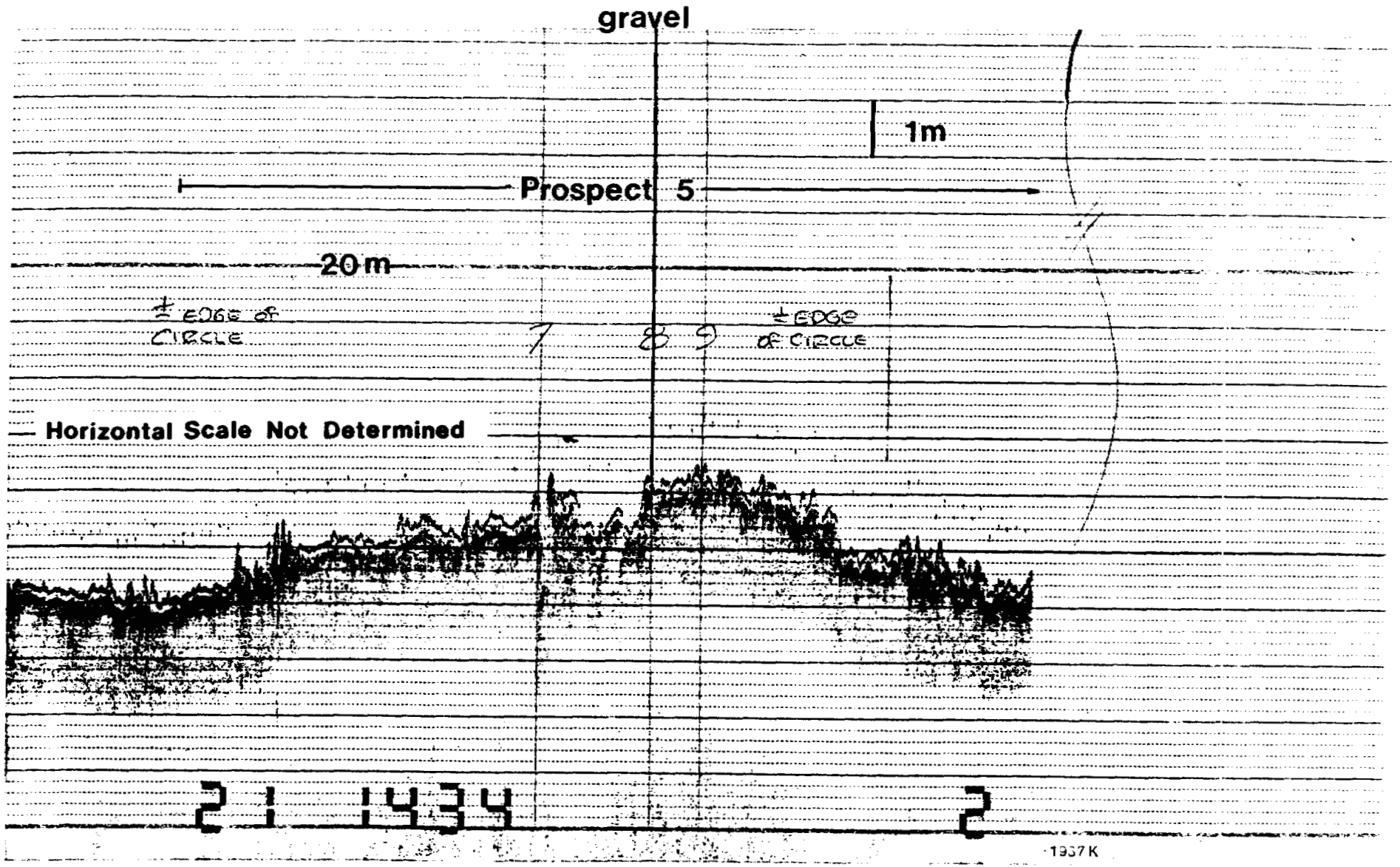

FIGURE: 24

Bathymetry Profile Across Prospect 5

EARTH & OCEAN RESEARCH LTD.

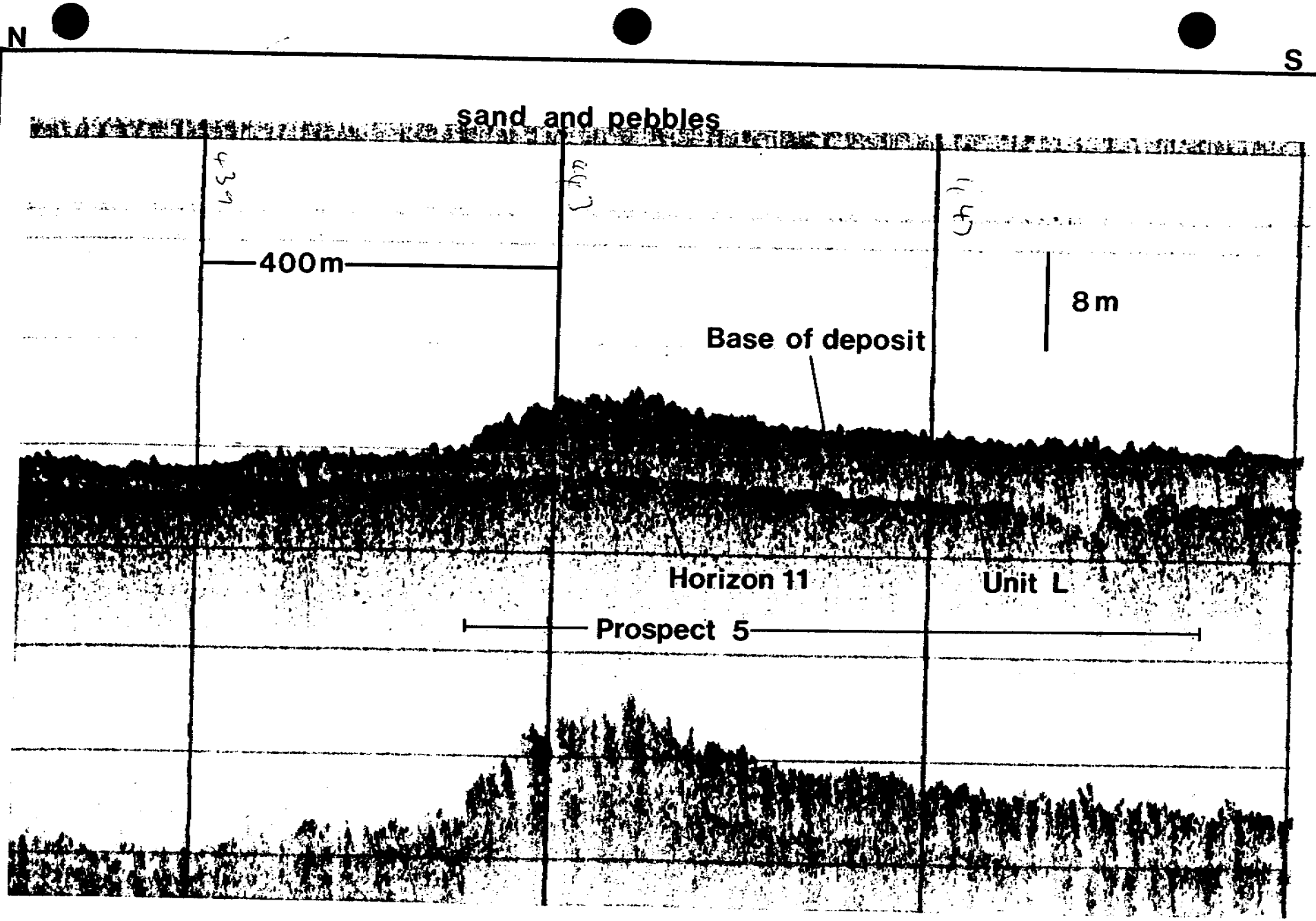

FIGURE:25

Microprofiler Profile Across Prospect 5

EARTH & OCEAN RESEARCH LTD.

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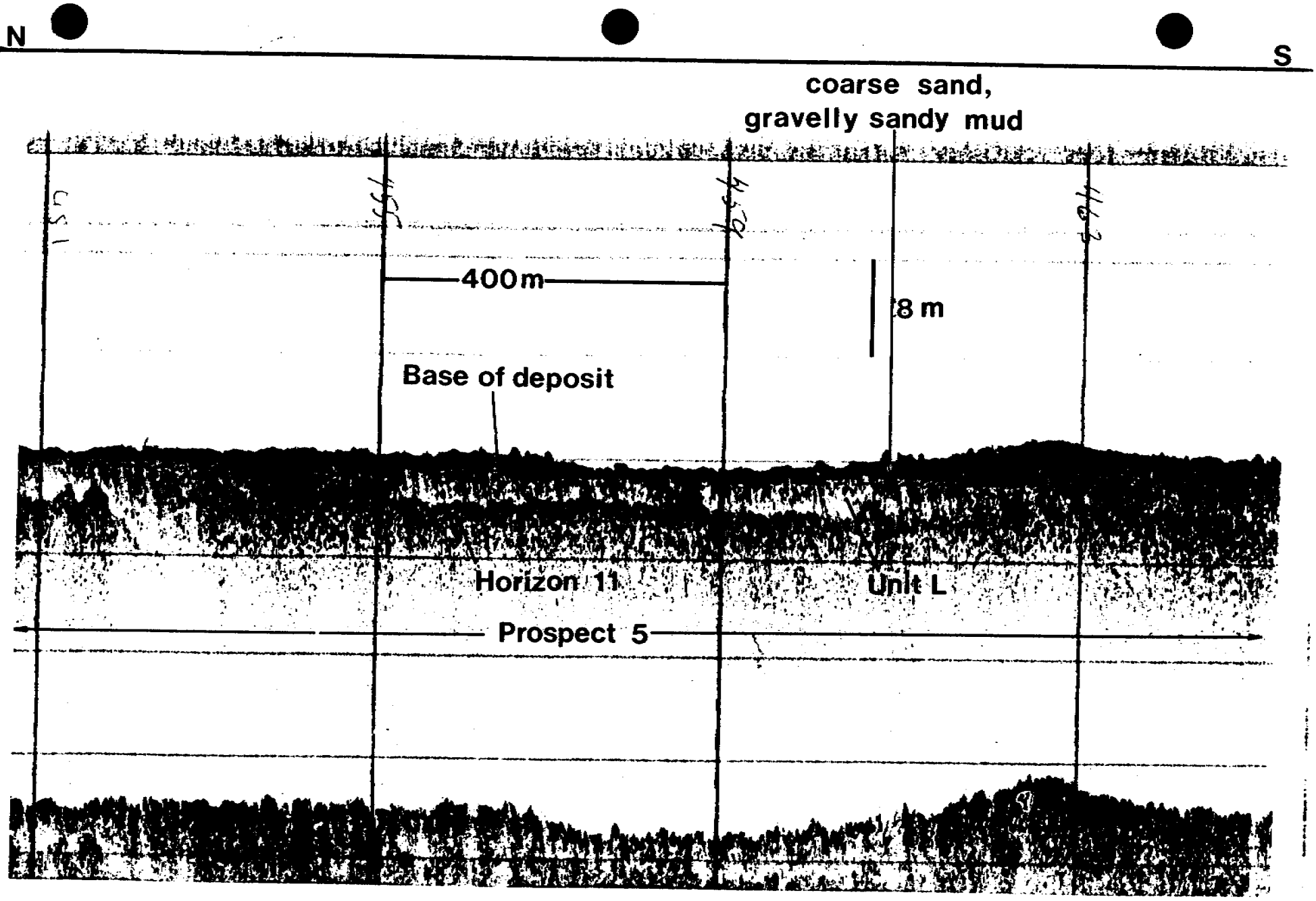

FIGURE: 26

Microprofiler Profile Across Prospect 5

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Prospect 6

Offset approximately 1 Km. to the east of Prospect 5 a second shoal of possible coarse material is noted. The shoal has local relief of about 3 meters and rises from the 24 meter contour to a minimum depth of 20.7 meters. A single sample, SH-84s-15, (Figure 27), is located on the feature and is visually described as "small pebbles". The similarity and proximity to the larger shoal suggest that they are part of the same feature; a sand and gravel remnant resting on the finer grained Unit L.

The area of this shoal is 1.8 million square metres and assuming an average thickness of 1.5 meters a volume of 2.7 million cubic metres is obtained.

Prospect 7

Three and one half Km. north-northeast of Prospect 5 a single grab sample with a description of "gravel" is recorded. The sample is taken from the north flank of the inner ridge and is not localized on a shoal. With no bathymetric trends or seismic evidence to constrain this area a boundary is not attempted and the feature is located by a circle on the prospects map.

Prospect 8

Prospect 8 is situated on the crest of the nearshore ridge, 7 Km west of Prospect 7 and 5 Km. south of the Natsek 4 borehole. Grab sample # 11373, taken from this locale, contains 34% gravel, 26% sand and 40% silt and clay, and is therefore considered of low quality. Samples along the axis of the ridge to the east and west, as well as off the ridge to the north and south, are uniformly identified as muds. Line 96 from the 1984 survey passes over the shoal in proximity to the location of sample #11373. A section of the profile where it crosses the crest of the ridge is shown in Figure 28. Figure 28 shows 4 to 6 metres of unstratified, acoustically transparent sediment on a flat-lying reflector, Horizon 11. The seafloor is highly scoured and the bottom return is slightly diffuse. These observations indicate a soft substrate with little coarse material present. The coarse fraction is thought to be either disseminated throughout the unit or exists as a very thin lag at the seafloor. Because of these uncertainties, no thickness is applied to the prospect. The 22 m contour outlines the potential target area. This area is 6.5 million square metres.

Prospect 9.

Prospect 9 is located on the axis of the nearshore ridge at the ridge's shallowest point, which is measured as 15.5 m. A grab sample from this locale is described as "gravel". Other samples to the east and west along the shoal, and on the flanks to the north and south, are fine-grained and restrict the potential coarse deposit to the area approximately enclosed by the 18 m contour.

Figure 29 presents a microprofiler record across the western end of the feature. It depicts a 10 m thickness of Unit L on Horizon 11. The

profiler record is excessively dark due to high gain settings, and consequently any boundaries are obscured. The first multiple, however, may be helpful. Here, under diminished energy, the diffuse, opaque unit is restricted to the southern (right hand) shoal, while the more northern part of the shoal is acoustically transparent. The thickness of the opaque zone is 4 meters at its greatest and may indicate that a maximum of 4 m of coarse material occurs at this location.

The area enclosed by the 18 m contour is 2.9 million square metres, and assuming that the average thickness for the coarse deposit is 2 metres, a volume of 5.8 million cubic metres is calculated.

Prospect 10.

Prospect 10 is located near the western edge of the nearshore ridge. Bathymetric profiles across the prospect are presented in Figures 30 and 31. These profiles depict an uneven surface, elevated 3 to 5 metres above the surrounding seabed, to a minimum of 18 m water depth. The scour-induced micro-relief is much reduced on this feature.

Two grab samples from the shoal are described as "very fine gravel", and "fine grey mud with small pebbles". Samples of fine grained material around these samples constrain the extent of the deposit. The shoal is situated on the western end of the Inner Ridge which for the greater part is sampled as fine mud. Because of this it cannot be assumed that the height of the shoal is the thickness of the coarse material. Microprofiler lines are not run over the feature and an alternate lower limit is conjectured to be similar to that of Prospect 9, i.e. 4 meters. An approximate maximum area, based on limits imposed by the grab samples and topography is 1.1 million square meters. The assumption of an average thickness of 2 m. yields an estimate of 2.2 million cubic meters.

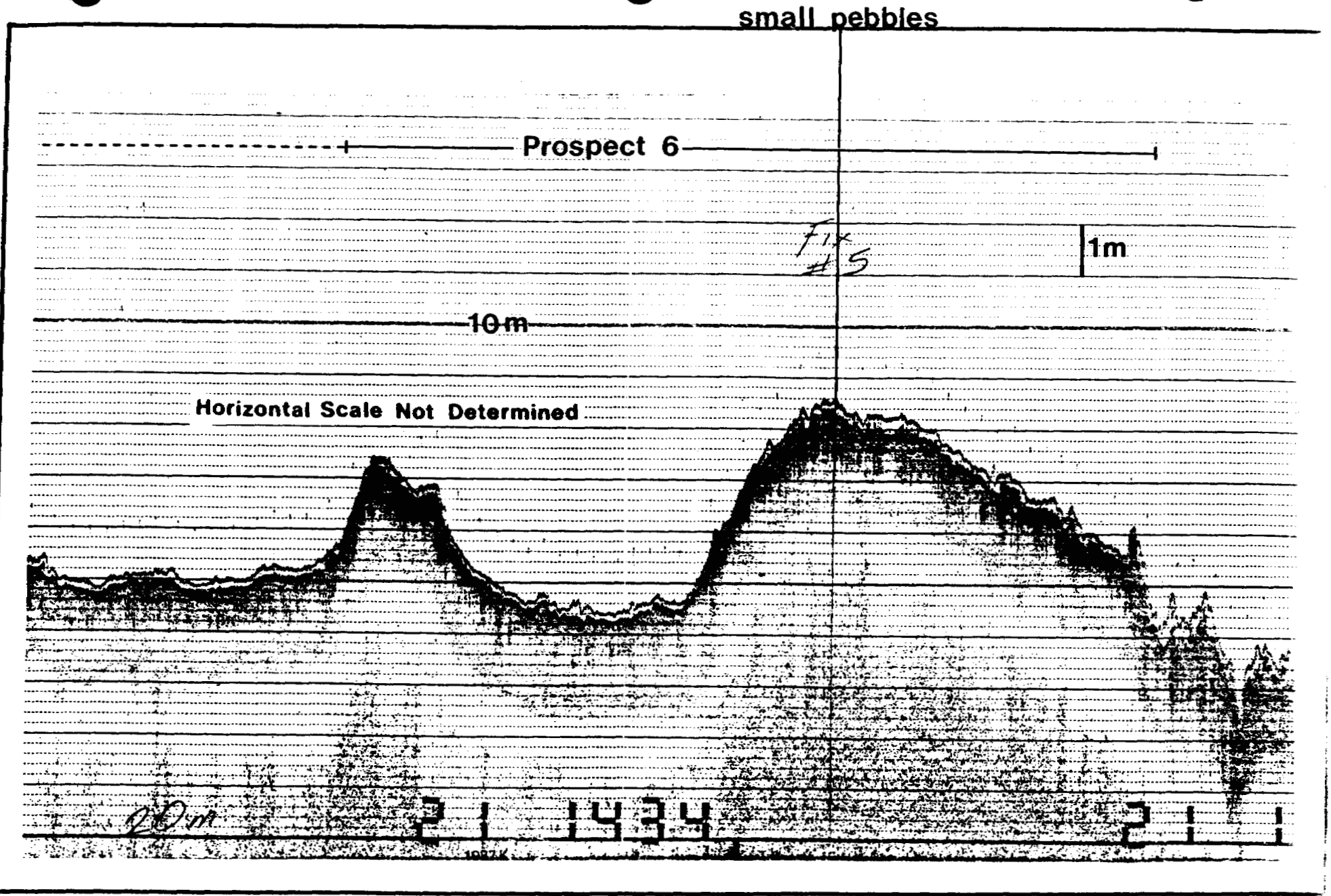

FIGURE: 27

Bathymetry Profile Across Prospect 6

EARTH & OCEAN RESEARCH LTD.

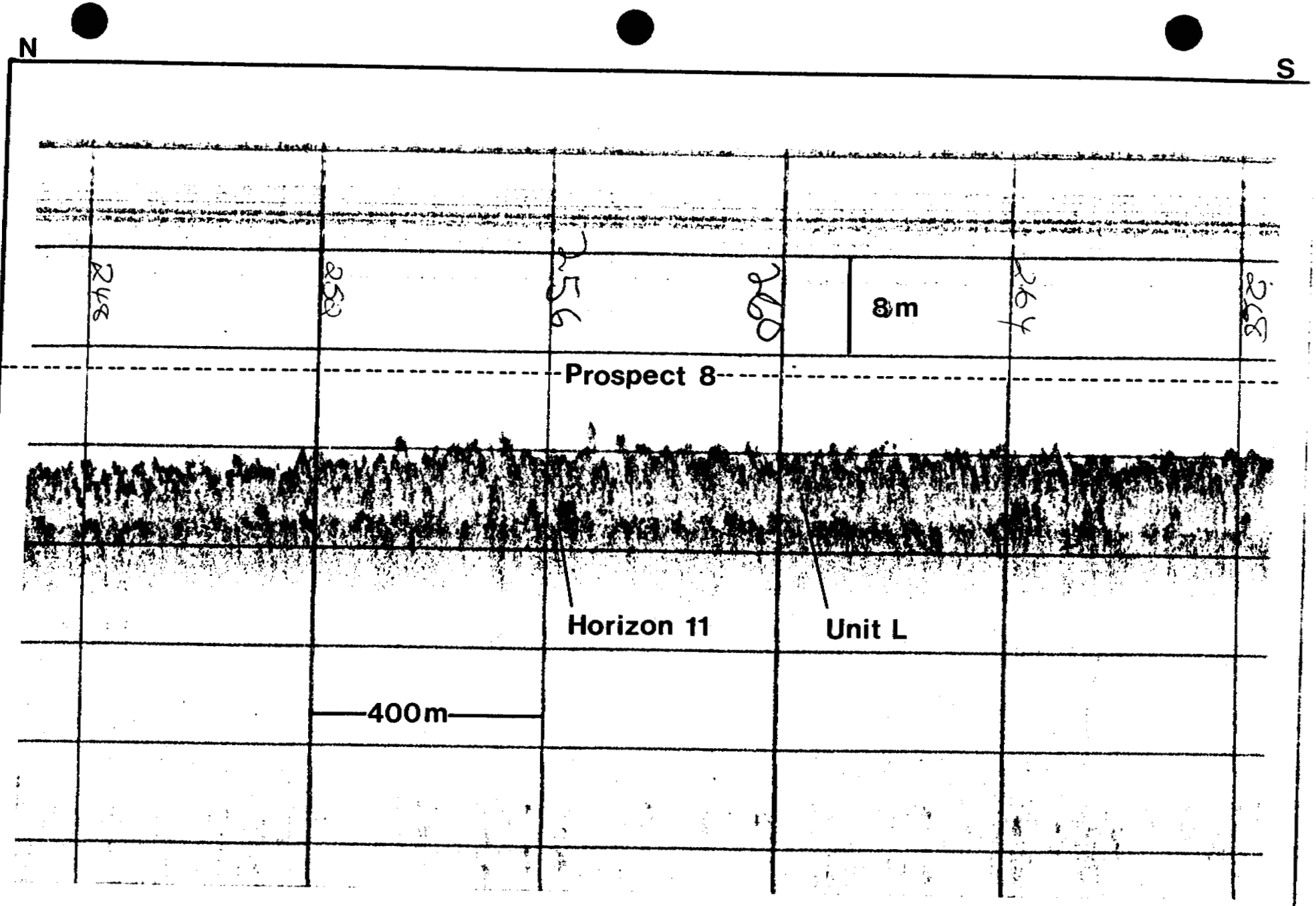

FIGURE: 28

Microprofiler Profile Across Prospect 8

EARTH & OCEAN RESEARCH LTD.

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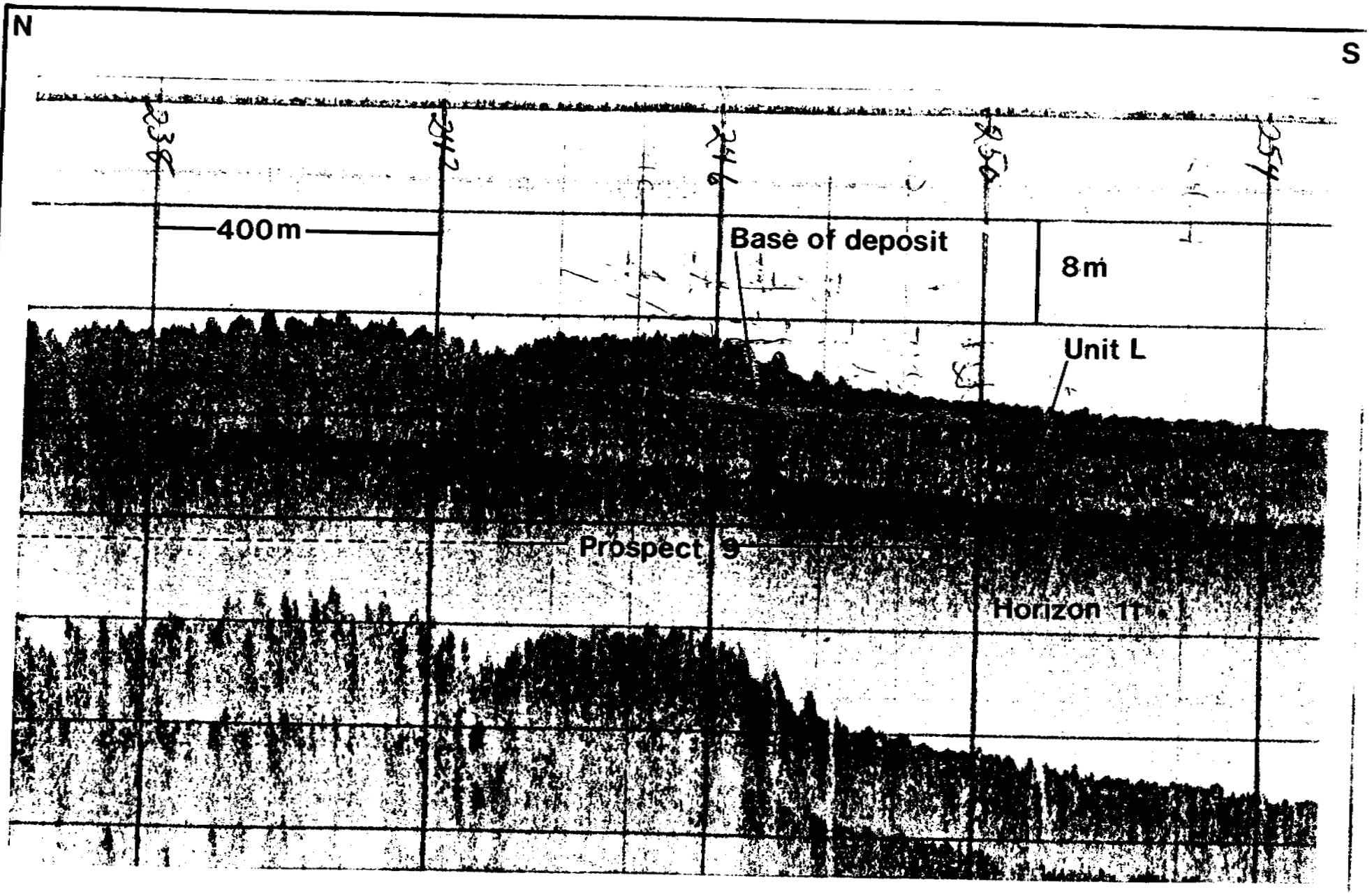

FIGURE:29

Microprofiler Profile Across Prospect 9

EARTH & OCEAN RESEARCH LTD.

E O R

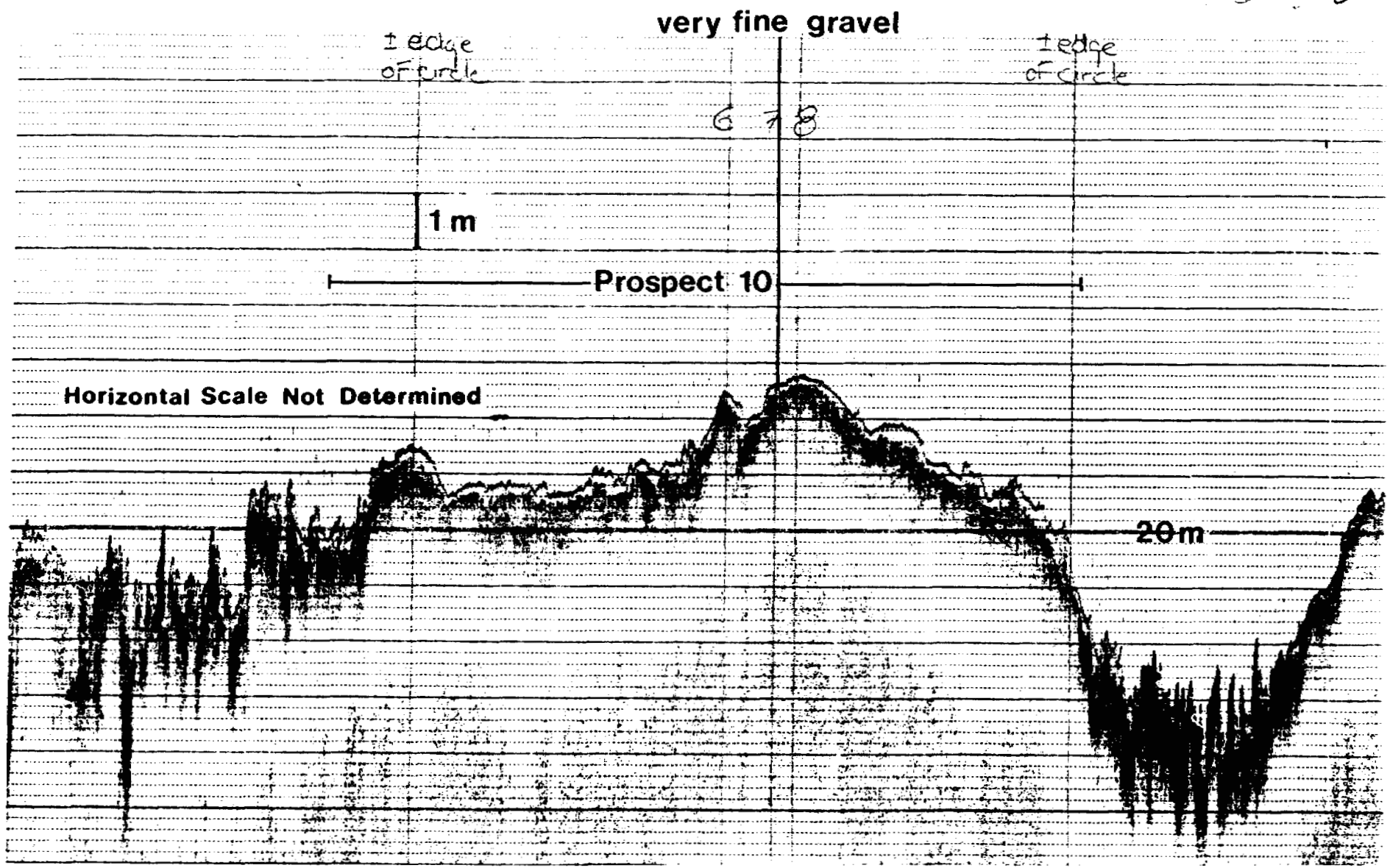

FIGURE: 30

Bathymetry Profile Across Prospect 10

EARTH & OCEAN RESEARCH LTD.

E O R

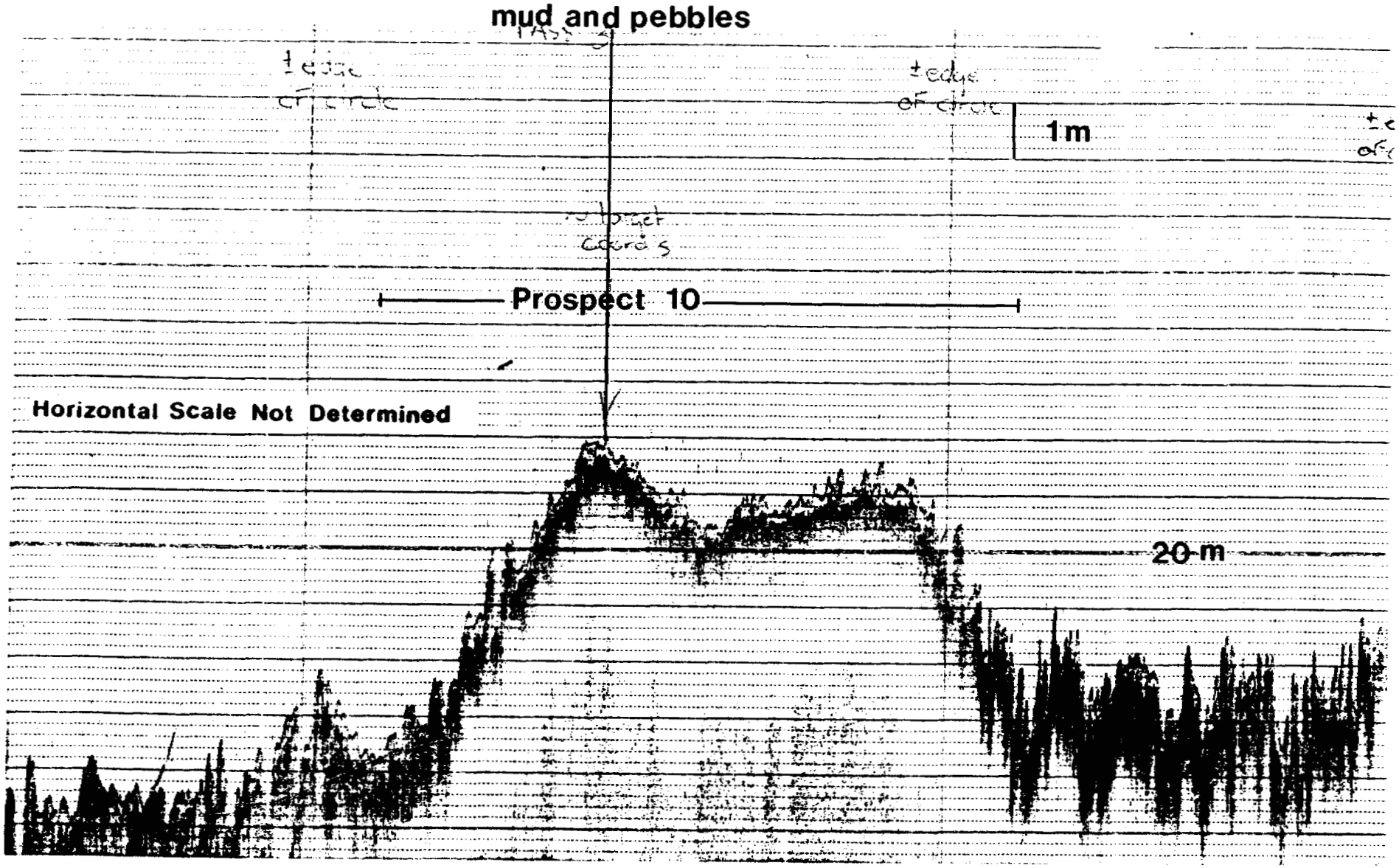

FIGURE: 31

Bathymetry Profile Across Prospect 10

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Prospect 11

To the north of Prospect 7 and some 6 Km. distant is another shoal area that is possibly coarse grained. A single grab sample, Sh-84s-10 , is described as "small pebbles". The shoal is enclosed by the 32 meter contour and attains a minimum depth of 28.4 meters. The bathymetric profile across the feature, however, shows a rugged scour micro-relief suggestive of fine grained material and therefore, the small pebbles may not be representative of the seafloor composition.

Figure 32 is a microprofiler record across the west edge of the shoal. It shows a scoured, unstratified sequence typical of Unit L resting on the slightly domed surface of Horizon 11. The seafloor return is opaque to about 2 meters depth and this may reflect a coarse sediment lag.

The shoal, as defined by the 32 meter contour, measures 3.4 million square meters. If an average thickness of 1 meter is assumed, a volume of 3.4 million cubic meters is calculated.

Prospect 12

Twelve Km. due west of Prospect 11, Prospect 12 is identified. A grab sample taken from this feature (sample # 11371), contains 24% gravel, 3% sand, and 73% silt and clay. It is therefore considered a poor quality prospect. The shoal is linear in an east - west direction, enclosed by the 32 meter contour and has a minimum depth of 30 meters. It measures 4 million square meters in area. A microprofiler line crossing the western edge of Prospect 12 is presented in Figure 33. It is similar to Figure 32 and shows typical scoured Unit L strata on a slightly bowed Horizon 11. The thickness of the opaque seafloor return is only about 1 meter and this is perhaps the thickness of the coarse lag. Assuming 0.5 meters as an average thickness, a prospective volume of 2 million cubic meters is calculated.

Prospect 13

Prospect 13 is located in the north central portion of the Middle Shelf. Grab sample #11391, from this location, contains 10% gravel, 62% sand, and 28% silt and clay. The mean phi is -0.72 indicating a coarse sand deposit. The sample is situated on a small rise of about one meter relief and is nearly enclosed by the 34 meter contour. There are no profiler lines in the area and an average thickness of 0.5 meters is assumed based on relief alone. The area for the deposit, as measured within the 34 meter contour is 1 million square meters and a total volume of 0.5 million cubic meters of potential coarse sediment is calculated.

Prospects 14 and 15

The remaining prospective deposits on the Middle Shelf are subject to even lower confidence levels. Prospect 14 is located at the western end of a large ridge feature to the eastnortheast of Prospect 15 . A grab sample at this site (sample # SH-84s-25) is described as "sand and gravel". The echo sounder profile at the site, however, depicts a highly scoured

seafloor (scour depth of 2+ meters), suggesting a high fines content (Figure 34). Samples taken to the east on the same ridge are uniformly described as "fine grey mud". There is, therefore, little evidence to support a gravel deposit at this locale.

A maximum area of 11 million square meters is calculated by assuming that the deposit is restricted to the shoal, and limited by the surrounding fine grained sediments. The shoal height is 1.6 meters and based on an average thickness of 0.8 meters a volume of 8.8 million cubic meters is arrived at.

Prospect 15, located near the western boundary in 26 meters of water is not appreciably elevated relative to the surrounding seafloor, (minimum height 24.6 m), and is noticeably scoured, suggesting a fine grained texture (Figure 35). Grab sample # SH-84s-28, retrieved from this location, is visually described as "gravel". There are no microprofiler lines across the site. It is conjectured that the gravel is a minor constituent in an otherwise fine grained deposit. An area of 2.7 million square meters is calculated using the 26 meter contour. Assuming an average thickness of 0.7 meters a volume of 1.9 million cubic meters is calculated.

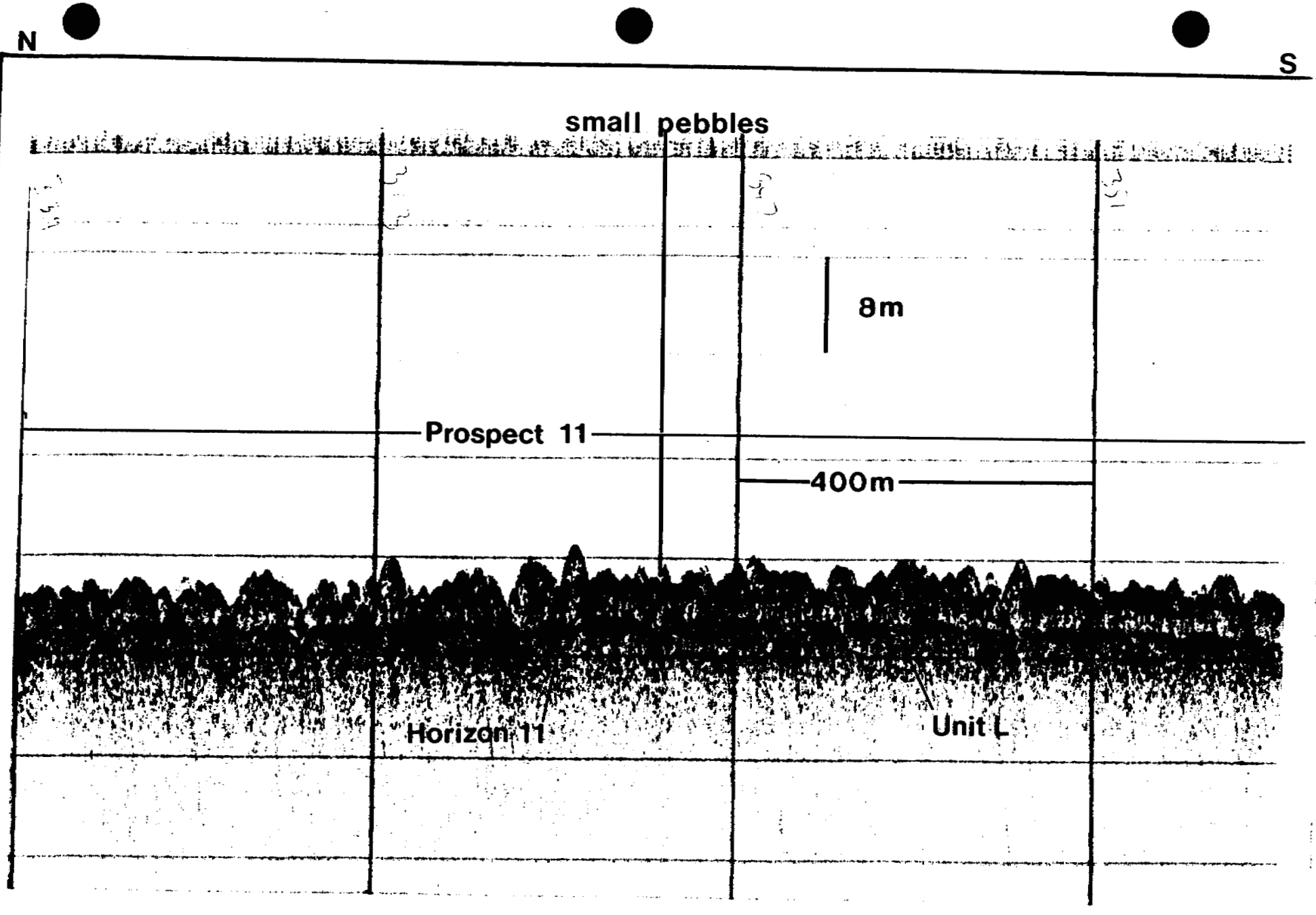

FIGURE: 32

Microprofiler Profile Across Prospect 11

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E O R

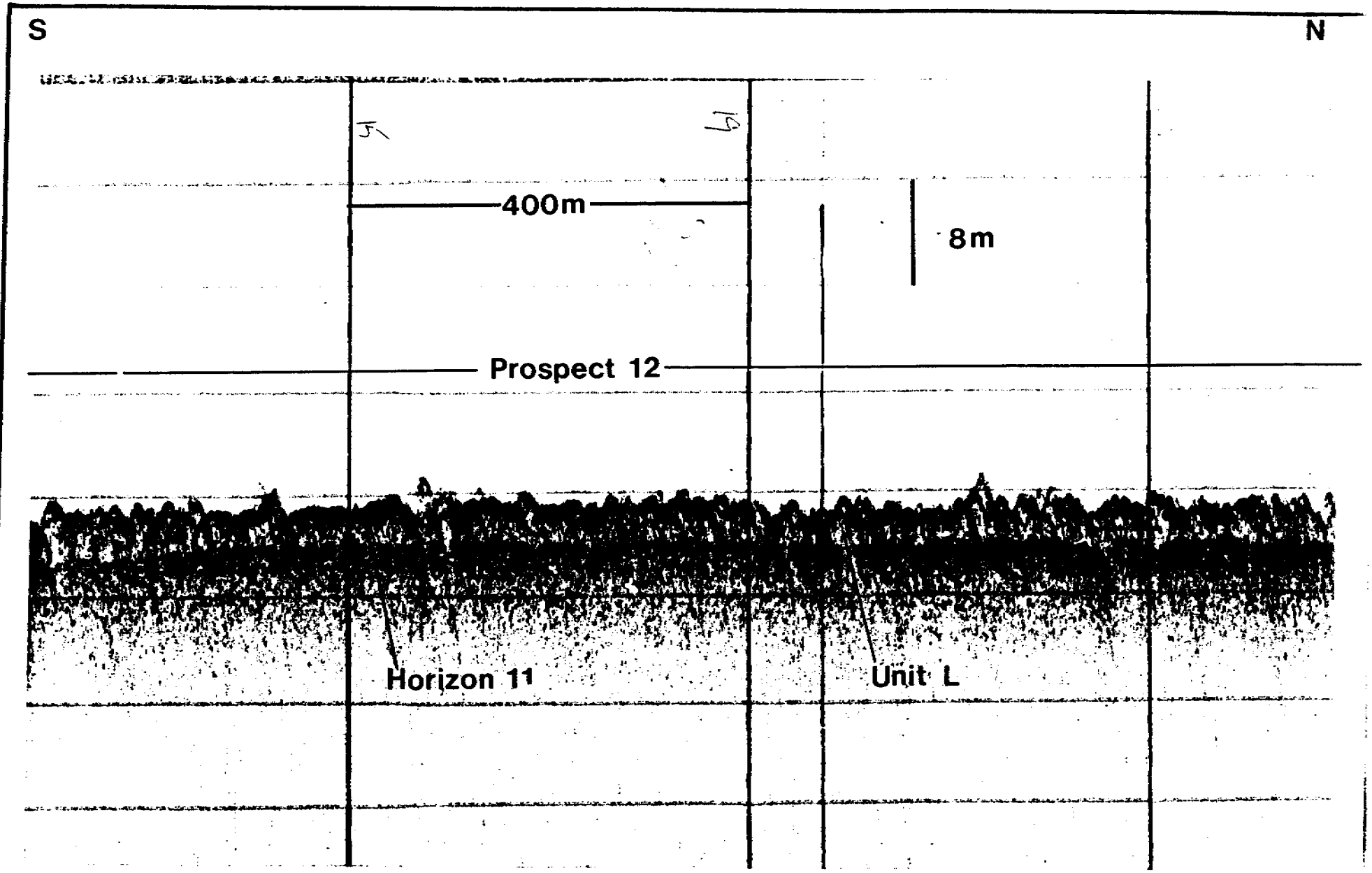

FIGURE: 33

Microprofiler Profile Across Prospect 12

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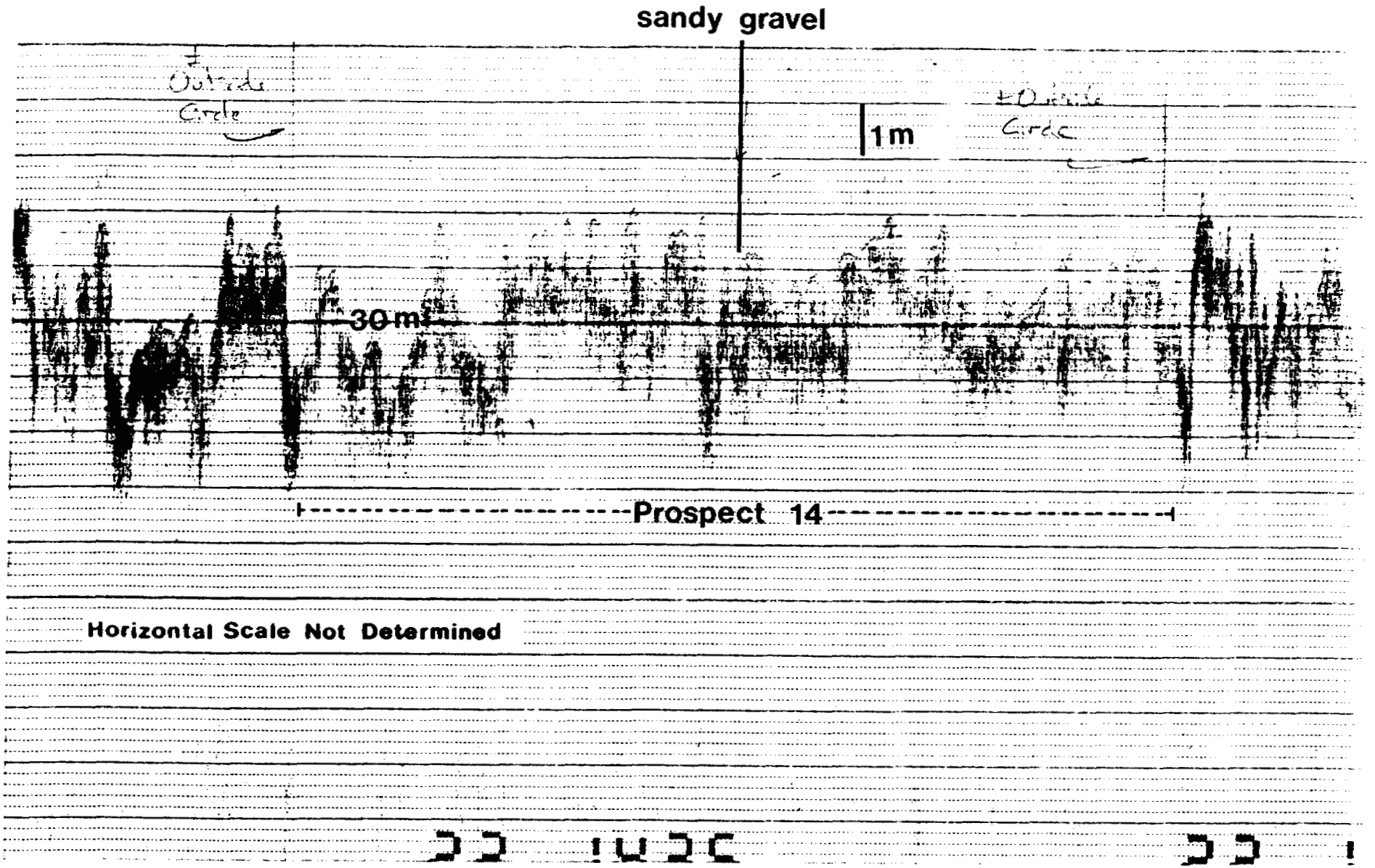

FIGURE:34

Bathymetry Profile Across Prospect 14

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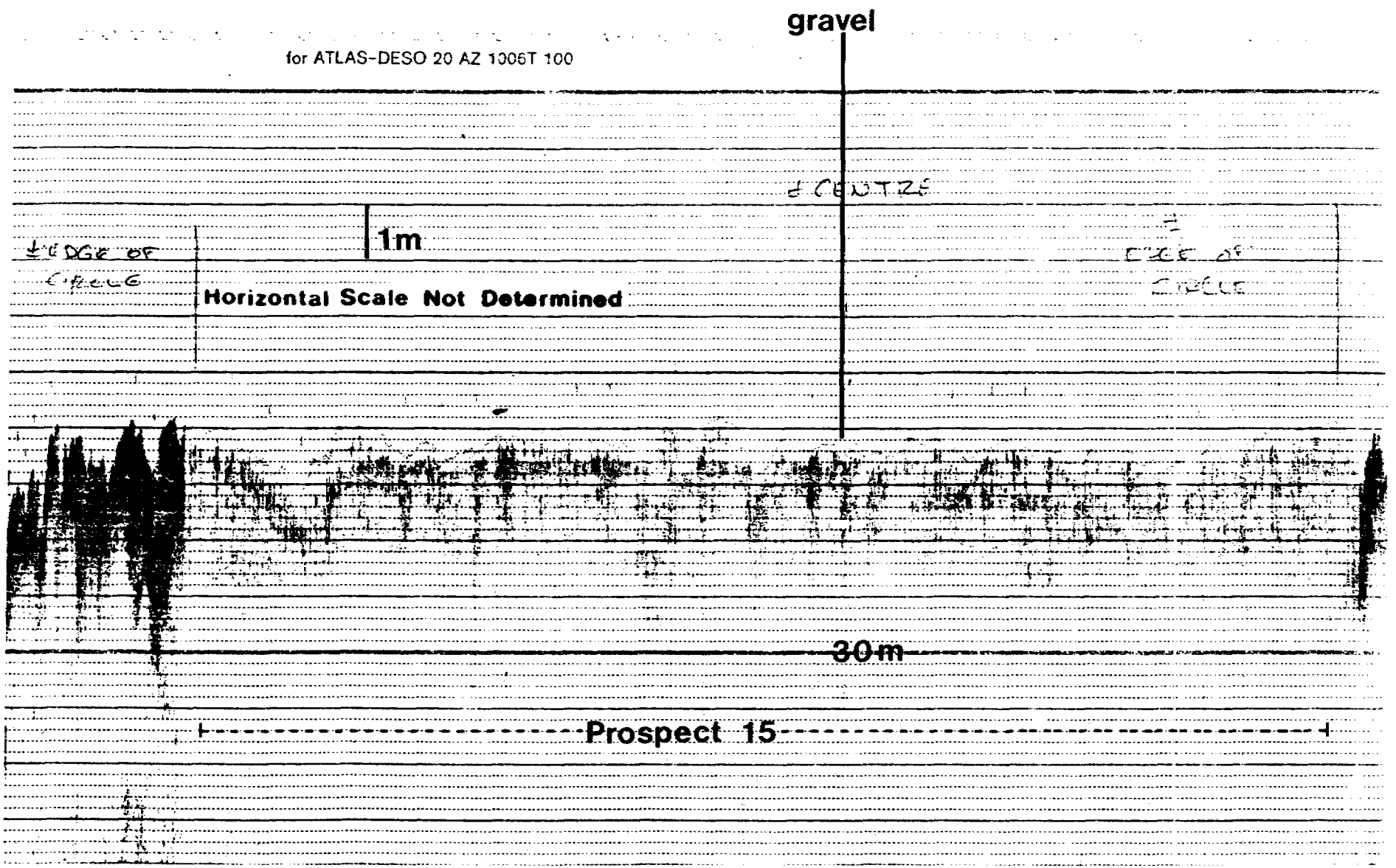

FIGURE:35

Bathymetry Profile Across Prospect 15

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4.3 OUTER SHELF ZONE

A number of questions must be resolved before a confident assessment of the outer shelf area as an aggregate resource can be made. Significant volumes of sand and gravel are predicted from the grab sample and sidescan data, however, this conclusion is contradicted by borehole and geophysical data.

The borehole GSC-1 is located on the axis of the Outer Ridge in proximity to, but not on, the Natsek Ridge. The borehole, drilled in 47 meters of water and to a sub seafloor depth of 52.6 meters, encountered silt and clay throughout with only traces of sand and gravel present. The borehole penetrated to within a few meters of Horizon 9 and sampled Units L, M, N, O, and P, i.e., virtually all of the seismo-stratigraphic units exposed on the shelf. The amounts of sand and gravel present are insufficient to produce a significant lag deposit through winnowing which is considered the most likely origin for potential granular deposits.

The geophysical data also contradict an in situ provenance for the sands and gravels. From the airgun and profiler data a surficial seismo-stratigraphy is developed that is based on distinct differences in the acoustic signatures of the substrates. These differences should correlate with changes in stratal properties, including grain size, and the textural changes in the surficial cover should coincide with seismic unit boundaries. Referring to Figures 4 and 14, it is seen that this is not the case, as the sand and gravel dominant cover crosses the surficial stratigraphic boundaries. Coarse grained samples are equally common on the eastern portion of the transparent, closely banded strata of Units M, N, and O as on the diffuse and unstratified strata of Unit P. As Units M, N, and O are seen to be truncated at the seafloor, this also suggests that the coarse material is a veneer with a thickness below the resolution of the microprofiler.

There may well exist local coarse grained units exposed on the shelf which are not sampled by the sparse borehole control. These units may act as sources for the sands and gravels which are then distributed by bottom current action over the fine grained units. The Natsek Ridge and Unit L-1 are two possible sources. Bottom current activity in the form of sand ripples and megaripples is noted along the Mackenzie Trough shelf edge and within the Offshore Trough by Shearer. These areas are outlined on the Granular Resources Map, (Figure 14, Enclosure 9). The megaripple patterns indicate that one current regime is active at the shelf edge and travels from north to south, and the sand ripple pattern describes a second current regime that forms an elongated east-west gyre contained completely within the Offshore Trough. These strong currents may be sufficient to erode and redistribute coarse sediments from as yet unidentified sources on the shelf.

That the coarse unit, particularly the gravel zone as defined by sidescan, parallels the trend of the shelf edge to a significant degree also suggests, as an alternative to a lag origin, an offshore source whose incursion onto the shelf is in some manner restricted to present day water depths greater than 40 to 50 meters. Pelletier (1985), suggests an ice rafting mechanism for the emplacement of the coarse sediments in the area west of Herschel Island, and this mechanism may apply at least to the outer

shelf region. Dinter (1985), invokes ice rafting to explain the gravel deposits situated on the outer Alaskan shelf and in support of this sites the abundance of clasts whose lithologies are exotic to the Alaska mainland and common to the Canadian Arctic Islands (the dolomite facies of Rodeik, 1979). He notes that the sand and gravel deposits are largely restricted to areas below 44 meters depth and postulates that this value approximates sea level or minimum depth of iceberg grounding when the source of sediment supply dwindled.

The entire outer shelf is typed as prospective and is identified on the Granular Resources map as Prospect 20. A number of smaller zones are identified as deserving of a higher priority in future investigations.

Prospect 16

This prospect is located on the southern boundary of the Outer Shelf. The prospect is a shoal on which a grab sample (Sample #10758) recovered 88% sand, 7% gravel and only 5% silt and clay. Figure 36 is a bathymetric profile across the feature. The shoal has a minimum depth of 33 meters and is enclosed by the 40 meter contour. Most of the shoal, however, lies between 36 and 40 meters depth. The surface of the shoal is scoured to a slightly lesser degree than the surrounding seafloor. The area of the shoal is measured as 3 million square meters. A volume of 6 million cubic meters is arrived at by assuming an average thickness of 2 meters for the deposit.

Prospect 17

Prospect 17 is located 12Km. due north of Prospect 16. It does not occur on a shoal and is included as a prospect on the basis of the very high gravel content recorded in a single grab sample. A percentage of >60% gravel and 20-40% sand is noted. An area and volume have not been calculated for this deposit and it is identified on the prospects map with a circle.

Prospect 18

This prospect lies 7 Km. to the west of Prospect 17. The prospect is a grouping of linear shoals and depressions of high relief. The shoal is part of or rests on the outcrop of Unit L-1. As noted in Section 3.2 Unit L-1 is poorly defined by the seismics but is considered to be of limited extent. The shoals may alternatively be relict moraine deposits lying on the surface of Unit L-1. They occur near the edge of the Mackenzie Trough and due north of the western limit of glaciation on land (Rampton 1982). They may therefore represent lateral or end moraine deposits. A separating boundary between the shoals and Unit L-1 is not observed on the seismics but this may be due to a lack of penetration through the coarse sediments by the microprofiler energy.

A grab sample on one of the shoals (Sample # 818), is described as "clayey sand and gravel" with 50-80% sand and gravel. Figures 37, 38, and 39, are bathymetric profiles across three of the shoals. They depict

features of high relief and in places near vertical walls. Scouring on the shoals is noticeably lesser than the off shoal areas. Figure 40 is a section of microprofiler line 111 that crosses the western edge of the shoal. The profile shows an unstratified unit with a strong seafloor return suggestive of a hard bottom.

The data indicate a high probability of finding coarse material and the shoals are typed as probable deposits. The combined area of the shoals is 16.7 million square meters as approximately enclosed by the 46 to 48 meter contours. A minimum depth of 34 meters is recorded, however the local elevation Is generally 8 meters or less.

A lower limit is not observed on the seismics. If we assume the base of the shoal as the base of deposit, and an average thickness of 4 meters, a volume of 66 million cubic meters results.

Prospect 19

A final area for special consideration is identified at the extreme northeast corner of the shelf. No samples have been taken from this site, however it lies within the gravel dominant zone as defined by sidescan and its anomalous morphology is noteworthy. The prospect consists of a narrow linear ridge that protrudes from the Natsek Ridge northeastwards to the shelf edge. A microprofiler line over the feature (Figure 41), shows a remnant, slightly stratified deposit perched within a bowl shaped depression. Penetration is noticeably reduced across the center of the feature suggesting a harder seafloor.

The anomalous topography may indicate a coarser, more resistant material than the surrounding seabed. The feature measures approximately 31.7 million square meters in area. It has a maximum thickness in Figure 41 of 17 meters. Assuming an average thickness of 8.5 meters for the unit we obtain a volume of 269.5 million cubic meters.

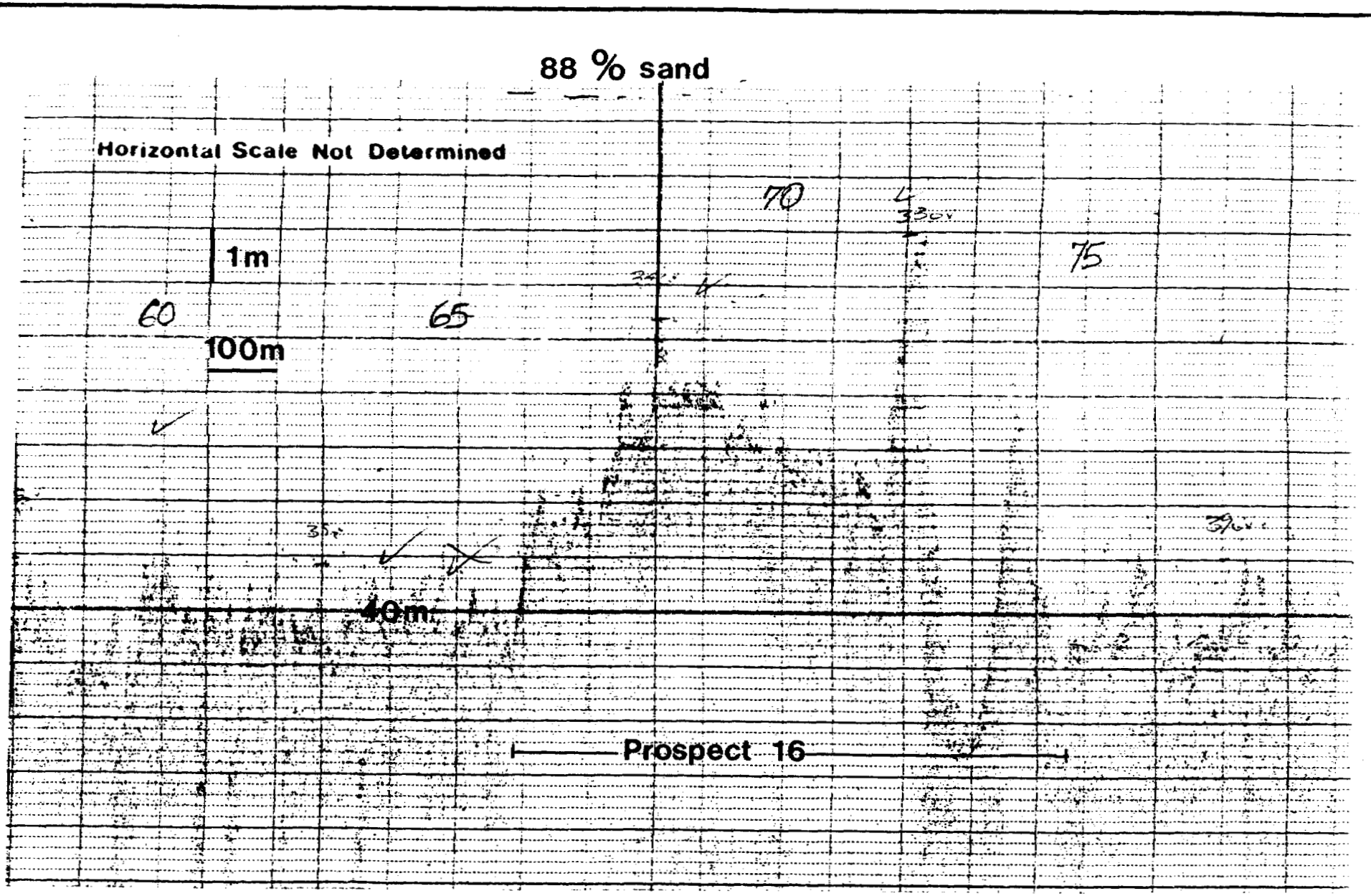

FIGURE:36

Bathymetry Profile Across Prospect 16

EARTH & OCEAN RESEARCH LTD.

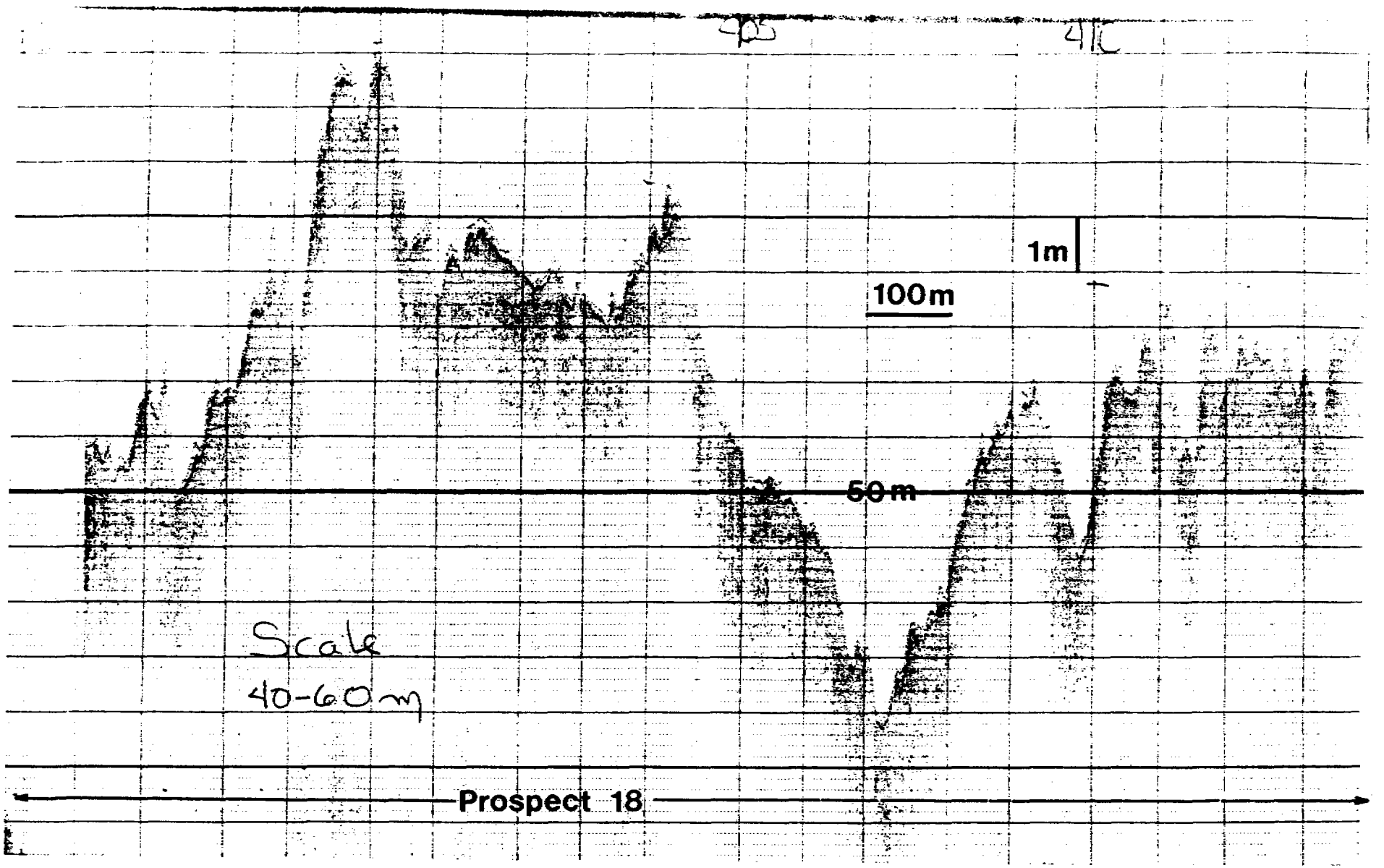

FIGURE: 37

Bathymetry Profile Across Prospect 18

EARTH & OCEAN RESEARCH LTD.

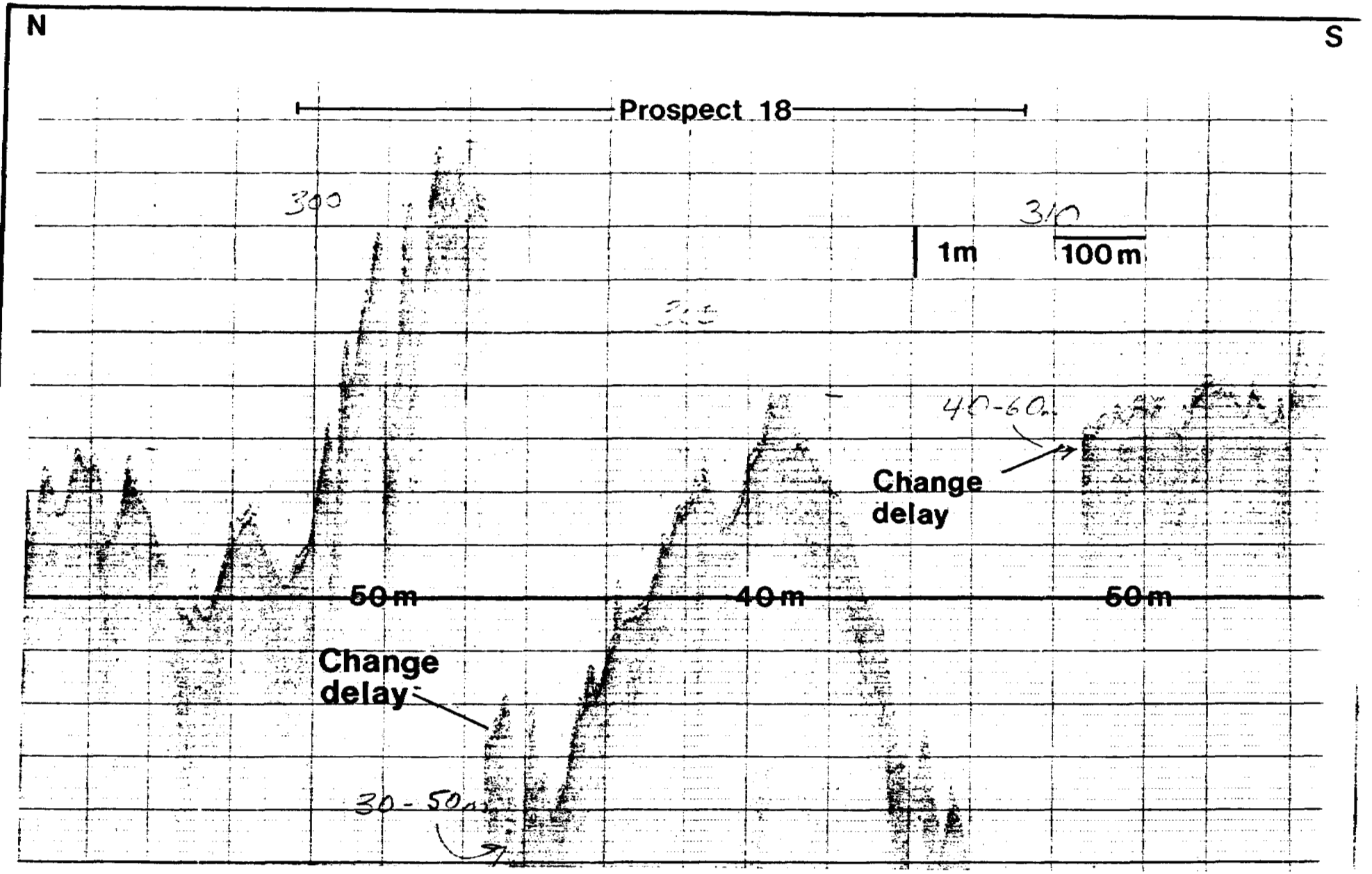

FIGURE:38

Bathymetry Profile Across Prospect 18

EARTH & OCEAN RESEARCH LTD.

EOR

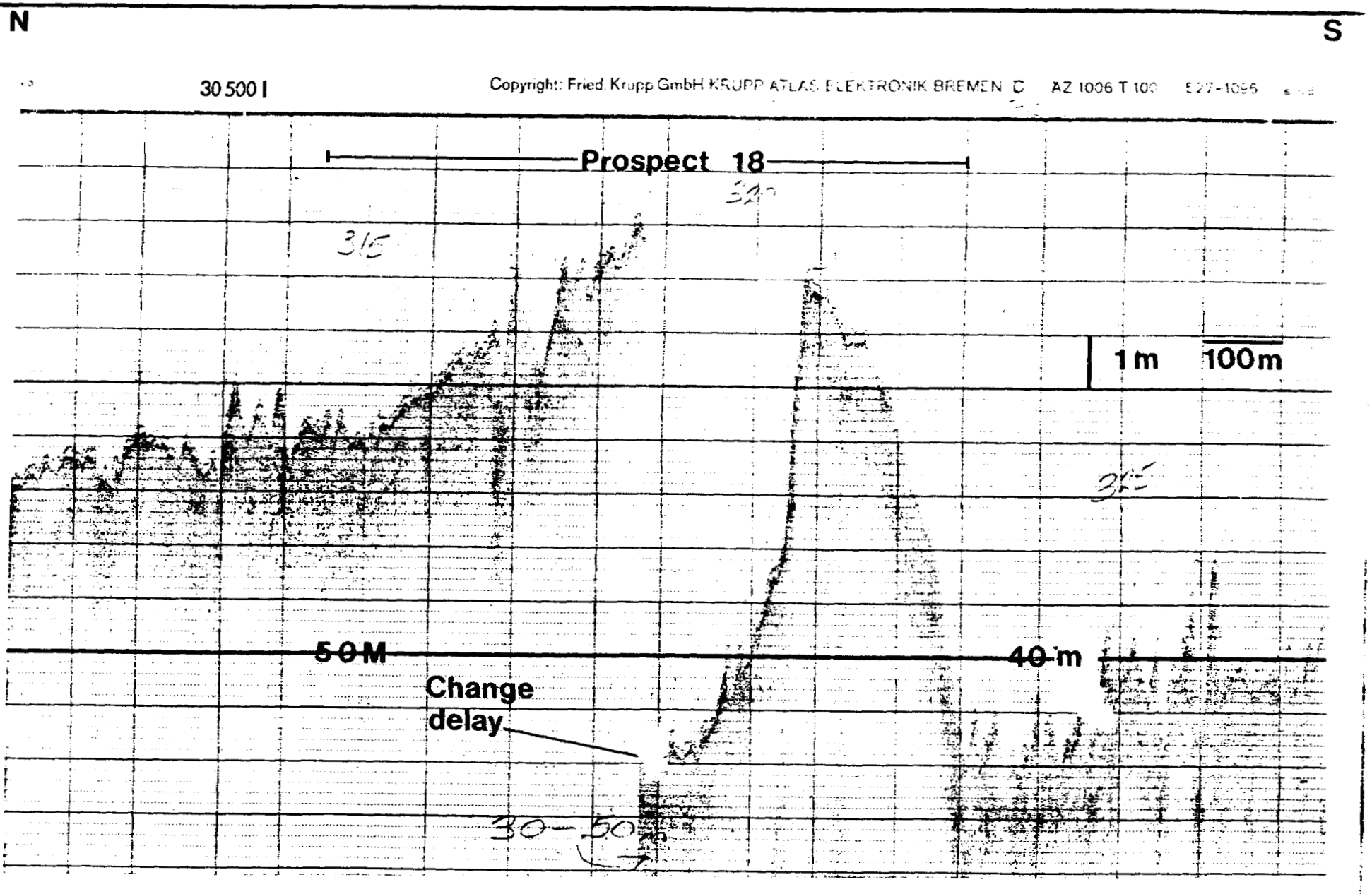

FIGURE:39

Bathymetry Profile Across Prospect 18

EARTH & OCEAN RESEARCH LTD.

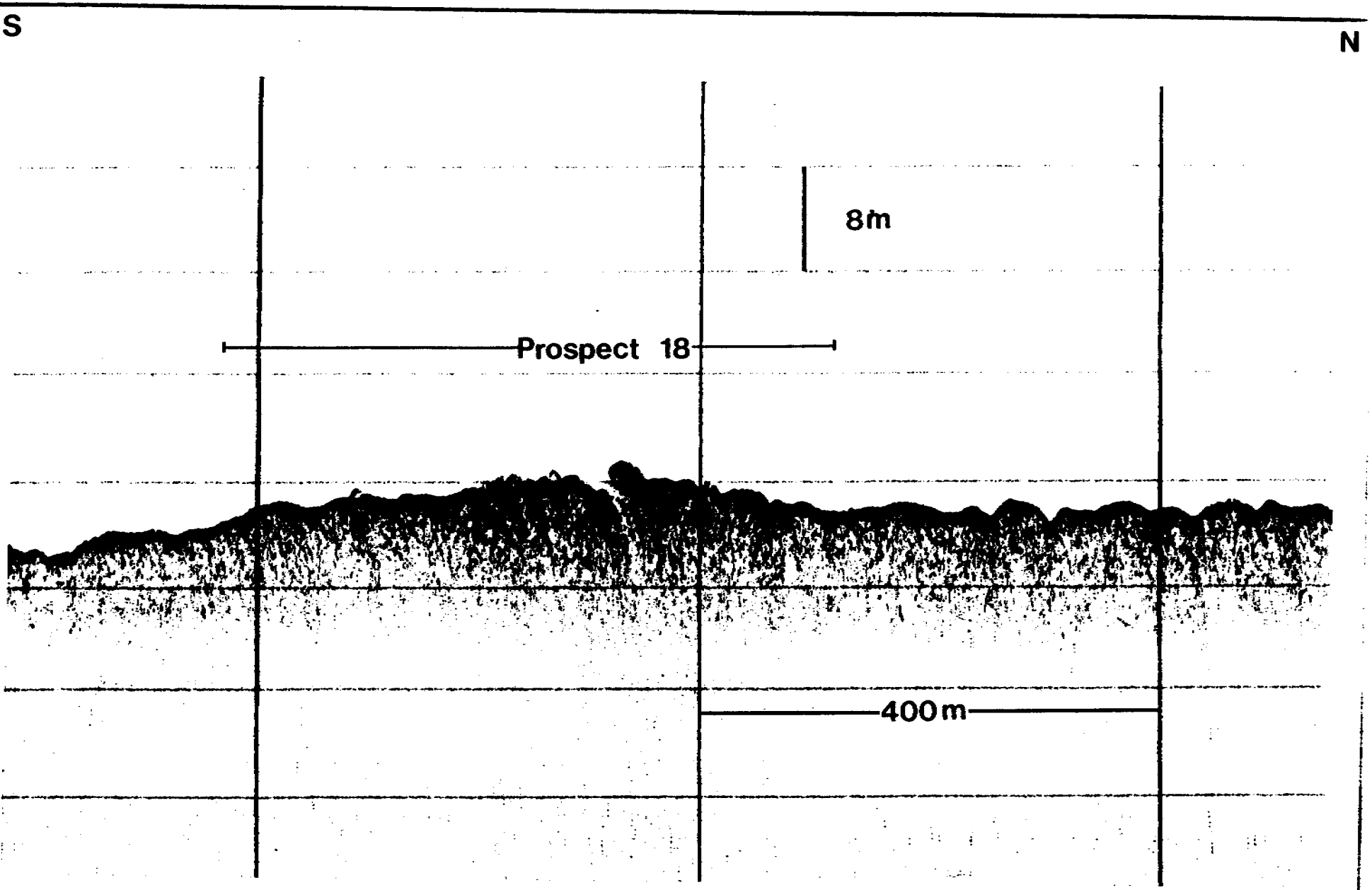

FIGURE: 40

Microprofiler Profile Across Prospect 18

EARTH & OCEAN RESEARCH LTD.

EOR

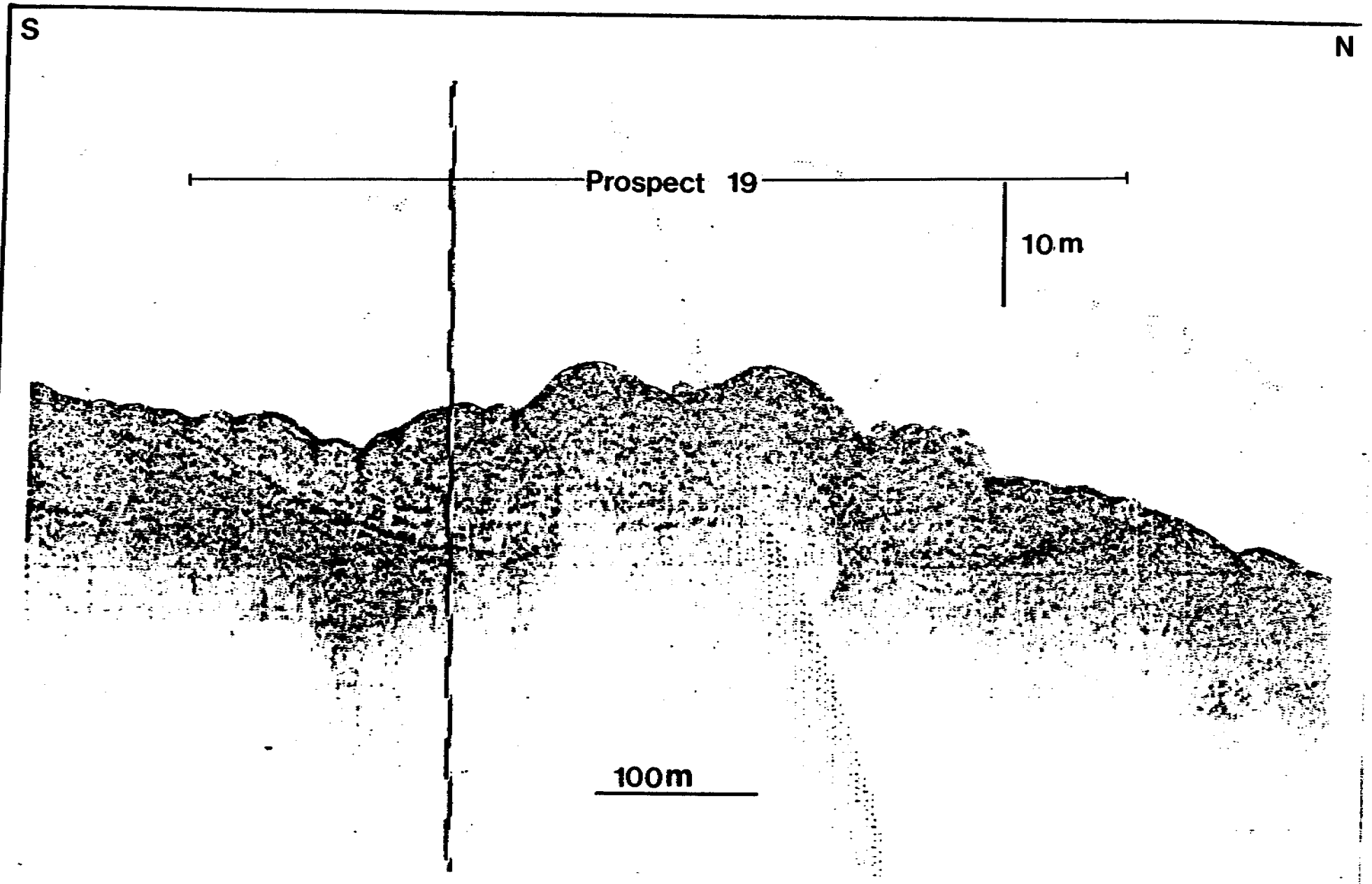

FIGURE: 41

Microprofiler Profile Across Prospect 19

EARTH & OCEAN RESEARCH LTD.

5. CONCLUSIONS

From a study of the sample, bathymetric, and geophysical data available on the Yukon Shelf the following conclusions are drawn:

-There are no proven deposits of coarse material within the study area due primarily to a lack of borehole control

-Probable areas include four drowned alluvial fan deposits adjacent the coastline and a grouping of shoals of possibly resistant substrate or morainal material situated on the east central edge of the shelf.

-The total volume of material identified as probable resource from the 10 meter isobath to the shelf edge is 557 to 842 million cubic meters.

-An additional 444 to 740 million cubic meters of probable resource is calculated for the area lying between the 10 meter isobath and the shoreline.

-Prospective areas include a number of shoals on the Middle Shelf and virtually the entire Outer Shelf from the 40-50 meter isobath to the shelf edge.

-This latter area is not satisfactorily resolved from the data at hand and it is possible that the coarse grained deposit may be a surficial veneer of only a few centimeters over most of the area.

-The prospective areas, exclusive of the general area of the Outer Shelf represents a total volume of 329 million cubic meters.

-The Outer Shelf zone has an area of 1400 million square meters but no thickness is attributed to the deposit at this time.

-The quality of the granular material requires more extensive analyses of the grab samples. From the data at hand it appears that the quality in terms of grain size and sorting will be highest on the drowned alluvial fan deposits and the possible moraine deposit on the east central shelf edge, and elsewhere will be deteriorated by high admixtures of fine grained material.

6. Recommendations

There is sufficient bathmetric data over the study area to delineate potential resource sites to the next level of confidence. The seismic grid should be increased to the concentration of the bathymetric grid over specific sites in future studies. Borehole information is the limiting factor in assessing the quantity and quality of the deposits. Additional refinement will also be achieved through seive analyses of the grab samples obtained during the 1984 survey.

A borehole program concentrated on the "probable" prospects will have the best chance of success. A borehole program on the outer shelf area, and designed particularly to sample the Natsek Ridge, will shed light on the apparent conflict between the samples and other data.

The synthesis of the interpretations of other workers may modify and should strengthen the interpretation within this report. Of particular import is the work being undertaken by Challenger Surveys and EBA Engineering on the detailed morphologic forms on the shelf and that by James Shearer on the seafloor textures and microrelief.

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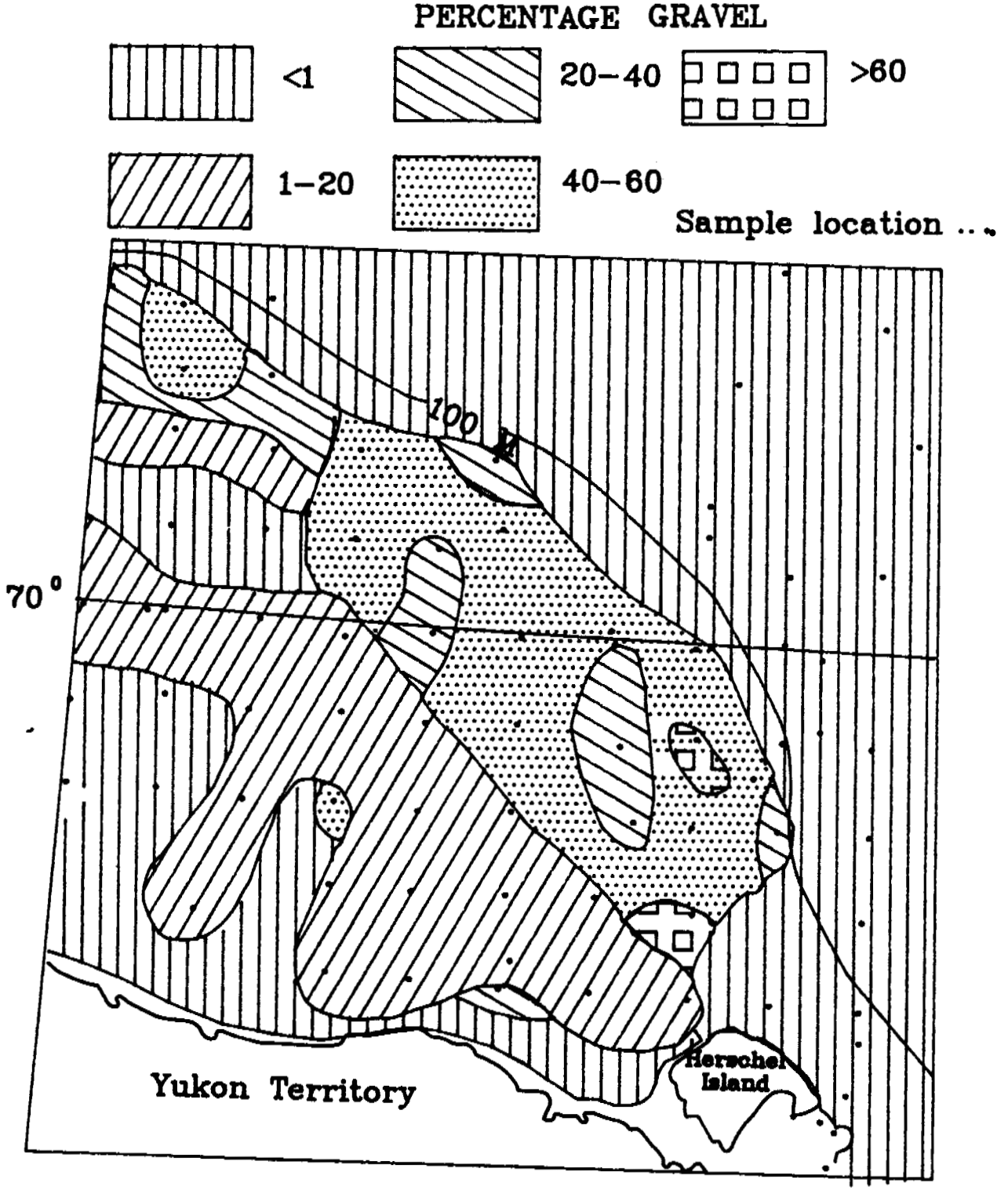
APPENDICES

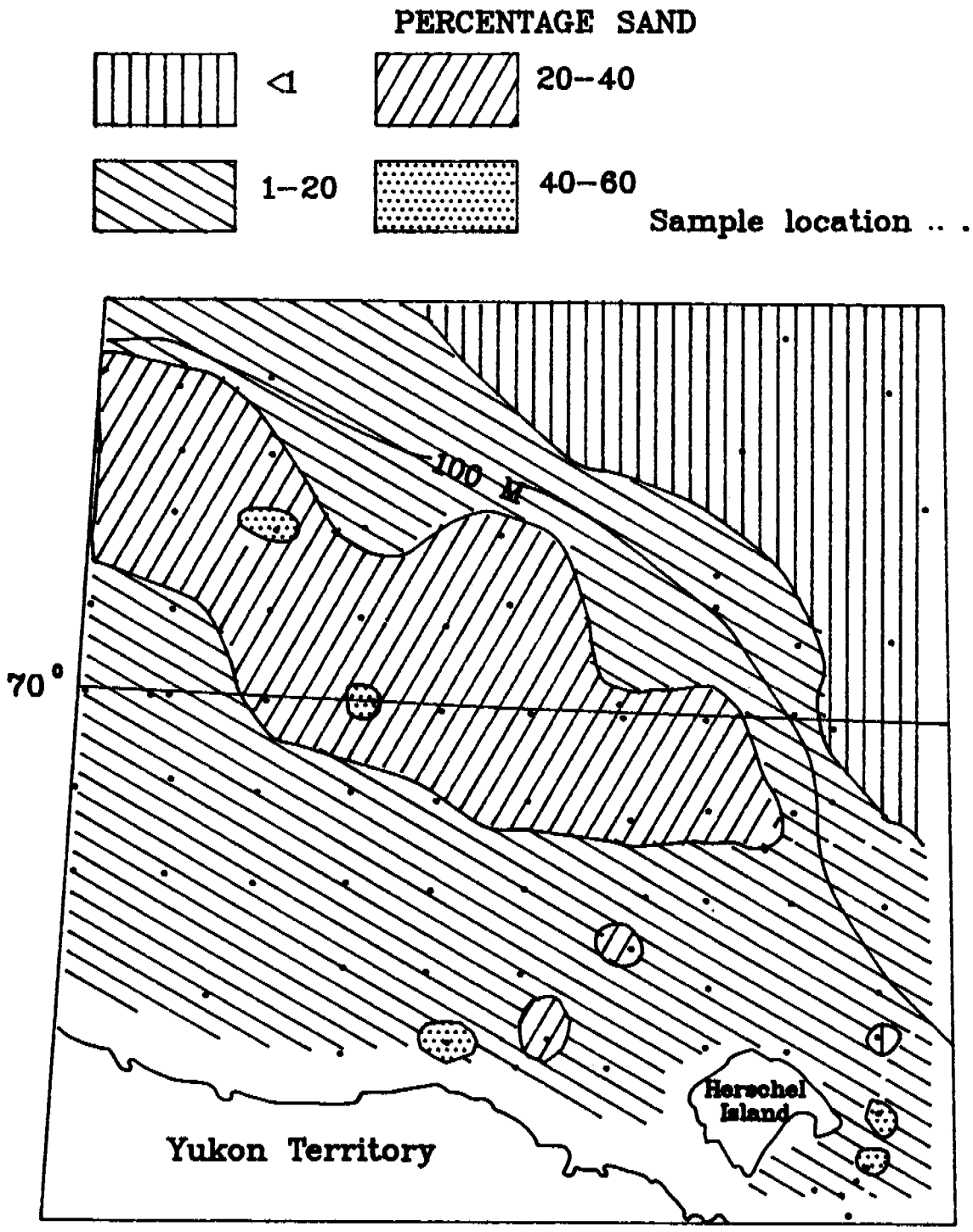
APPENDIX 1

Distribution of Surficial Cover on the Western Beaufort (Yukon) Shelf.



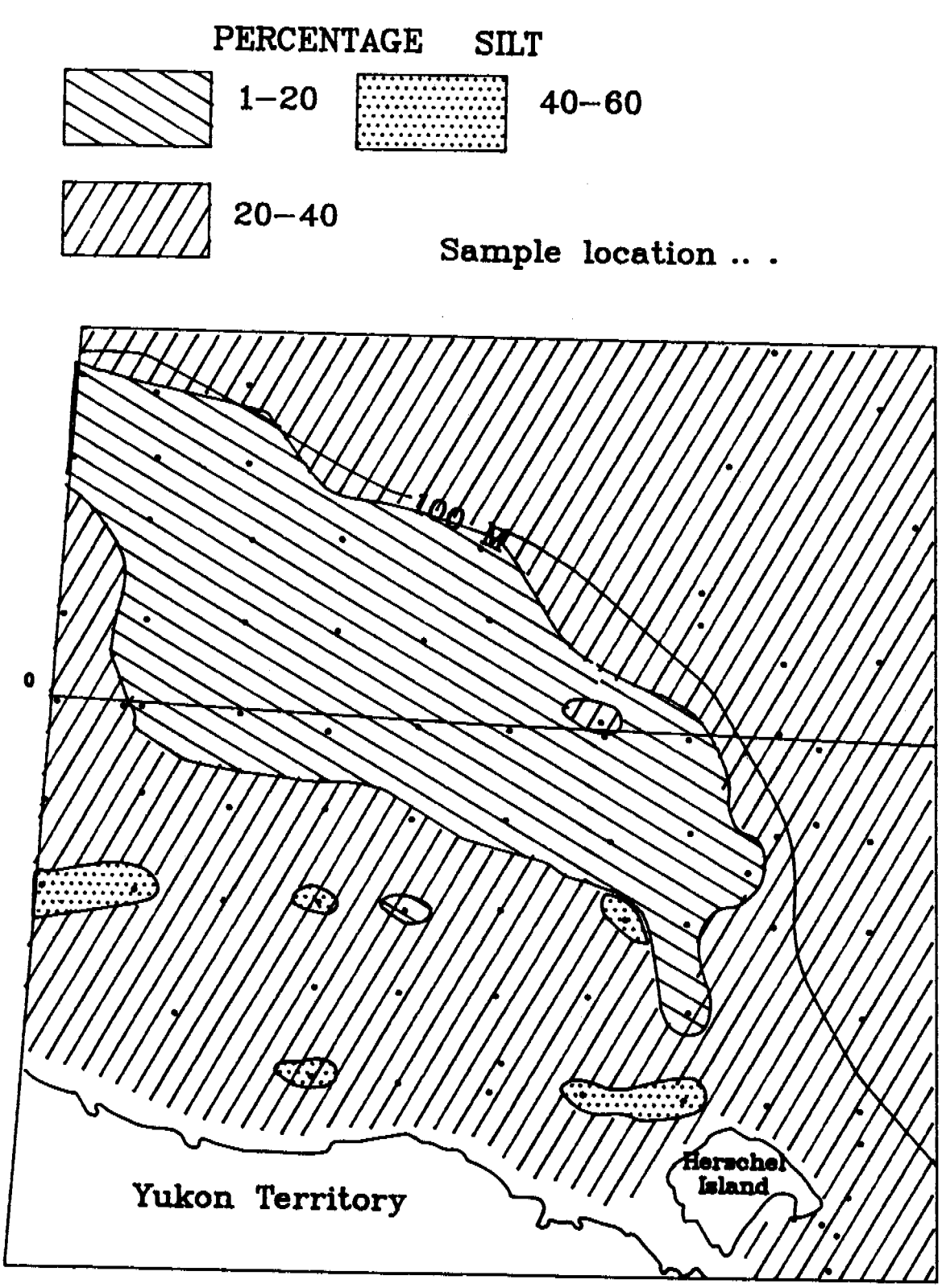
Distribution of Gravel
(After Pelletier, 1985)

FIGURE A–1. 1



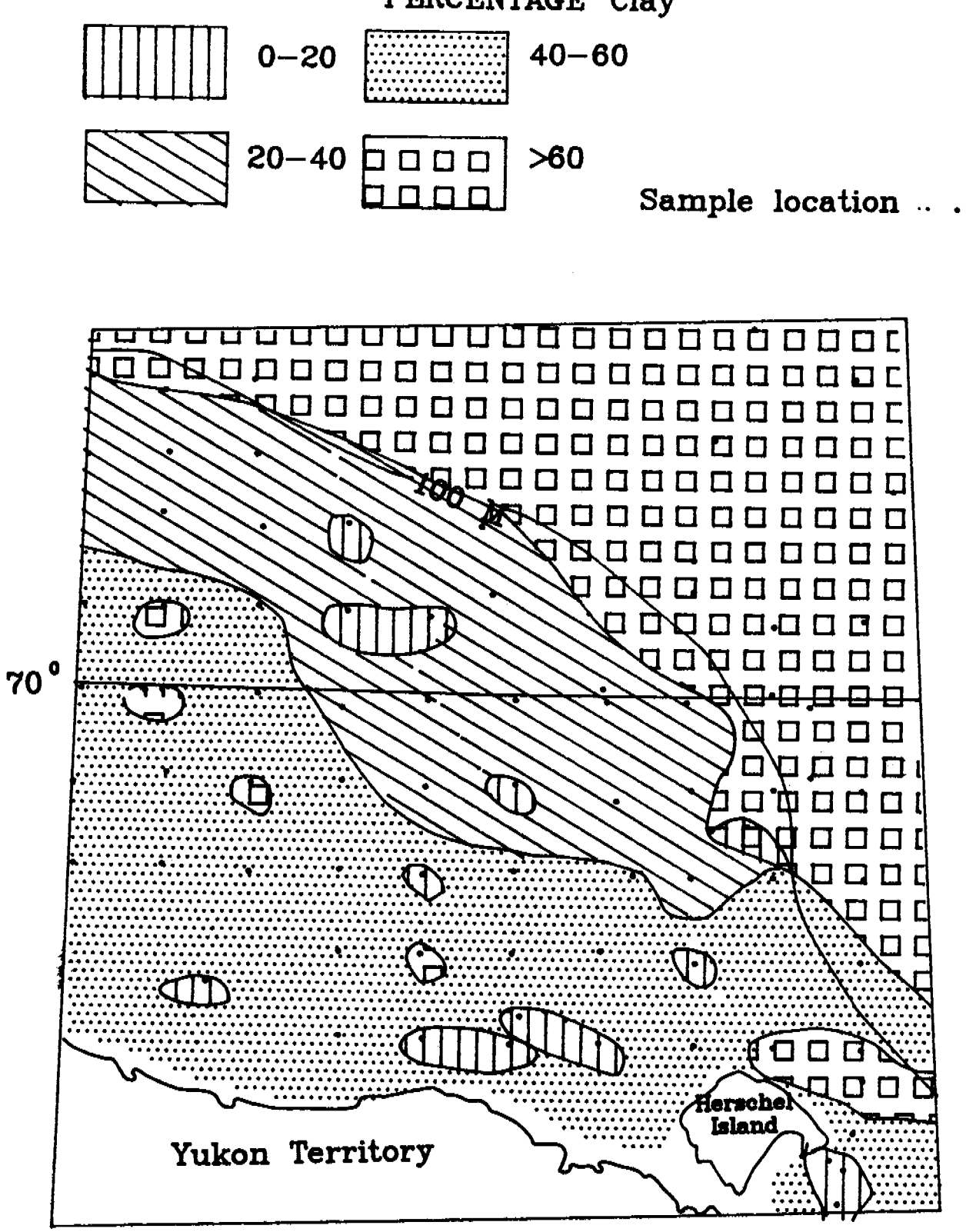
Distribution of Sand
(After Pelletier, 1985)

FIGURE A-1.2



Distribution of Silt
(After Pelletier, 1985)

FIGURE A–1.3



Distribution of Clay
(After Pelletier, 1985)

FIGURE A–1.4

LEGEND: Core Description


PARALLEL LAMINAE


DEFORMED BED OR LAMINAE


GRADED BED - SHARP BASAL CONTACT


DETRITAL ORGANIC MATERIAL

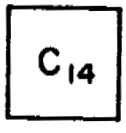

PEAT


BIOTURBATION


SHELLS

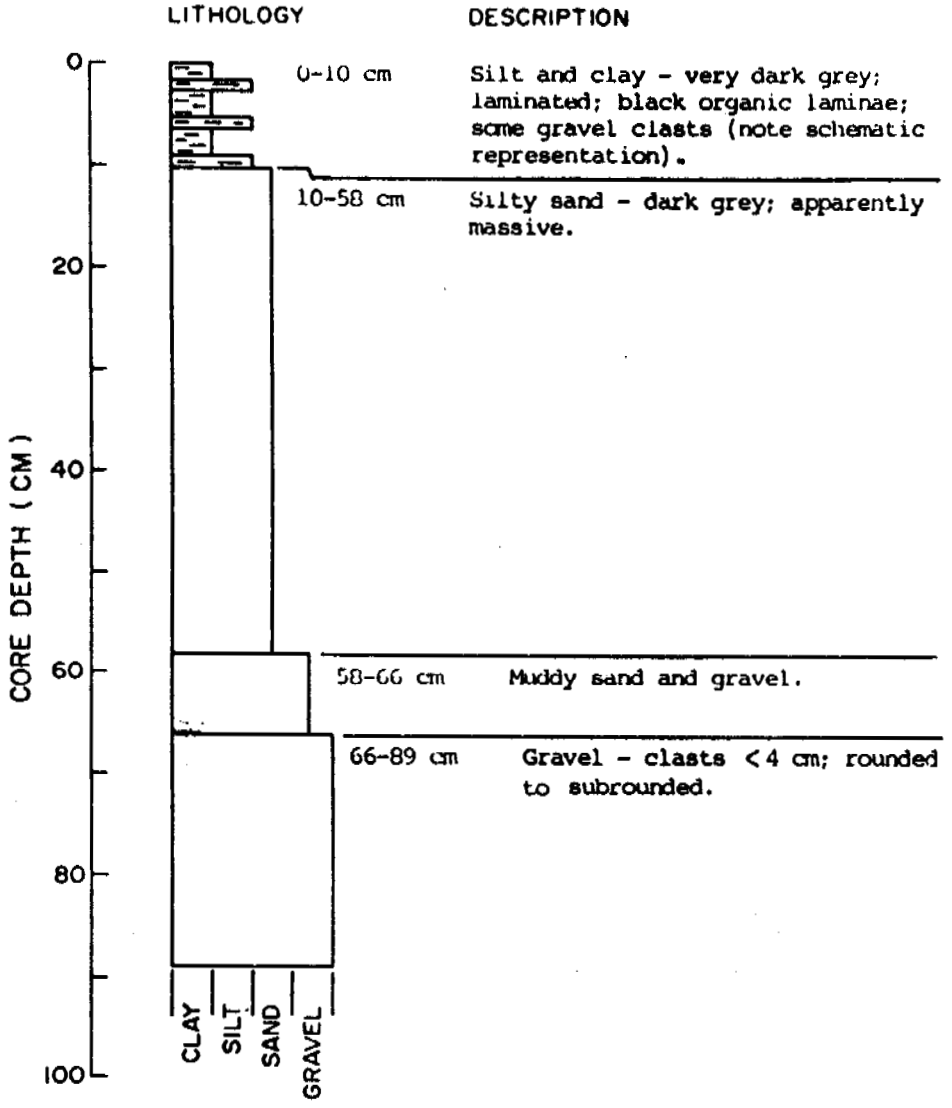

DROPSTONE

ATTERBERG TESTS



CARBON 14 SAMPLE

BKSLD - 84 - 89
SAMPLE RECORD



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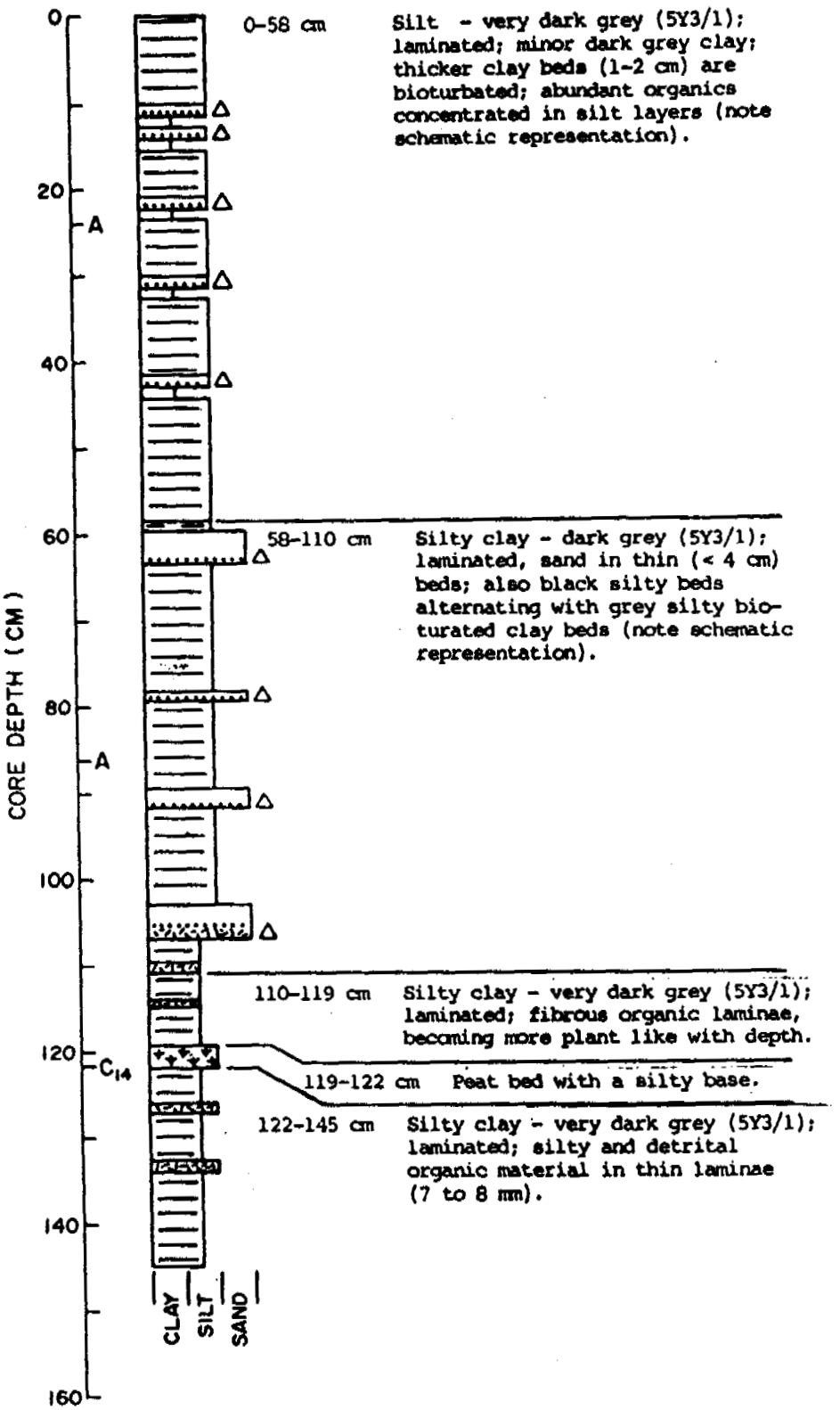
Core 84-89, Visual Description

FIGURE: A-2.1

BKSLD - 84 - 90
SAMPLE RECORD



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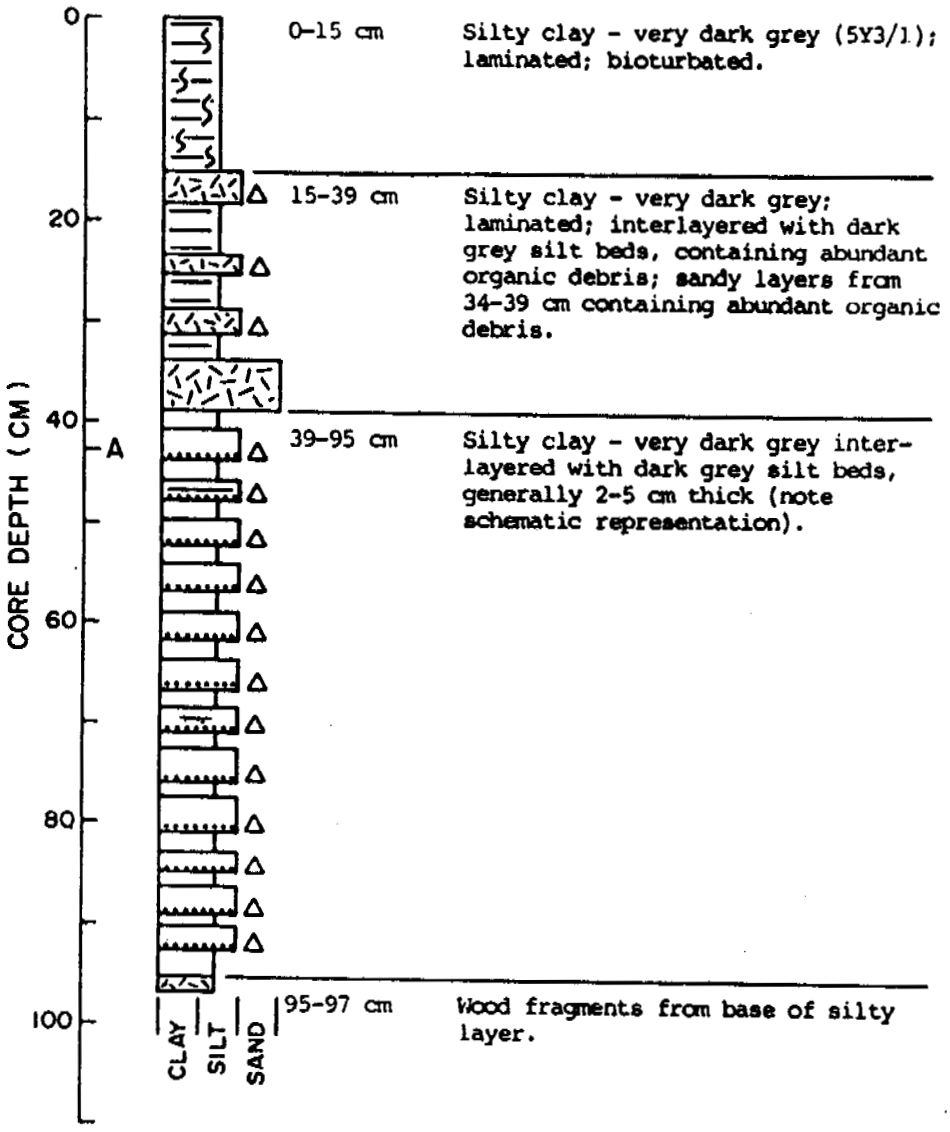
Core 84-90, Visual Description

FIGURE: A-2.2

BKSLD - 84 - 91
SAMPLE RECORD



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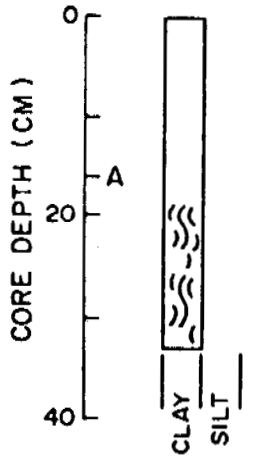
Core 84-91, Visual Description

FIGURE: A-2.3

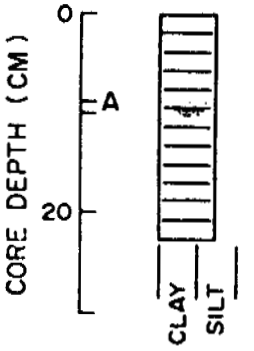
BKSLD - 84 - 10
SAMPLE RECORD

LITHOLOGY	DESCRIPTION	SAMPLE INFORMATION
0-33 cm	Clay - dark grey (5Y3.5/1); deformed black laminae.	



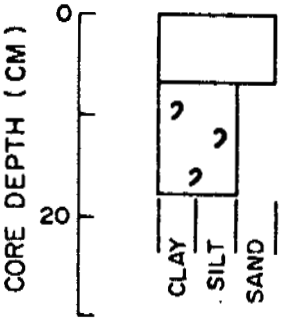
BKSLD - 84-72

0-23 cm	Silty clay - very dark grey; laminated; black silt laminae.	



BKSLD - 84 - 74

0-7 cm	Muddy sand - coarse; very stiff.	
7-18 cm	Silt - very dark grey; small shells.	



EARTH & OCEAN RESEARCH LTD.

Core 84-74, Visual Description

FIGURE: A-2.4

APPENDIX 3

Sample Data

Table A-3.1

Samples from the geophysical component of the 1984 MV Banksland survey

Sample No.	Latitude Deg Min Sec	Longitude Deg Min Sec	East.*	North.*	Sample Type	Results **
84-GP 5	69 51 52.1 N	-140 59 35.5 W	500262	7750585	CORE	no descr.
84-10	69 42 20.9 N	-139 23 8.1 W	562489	7733716	CORE	Cl
84-11	69 44 49.6 N	-140 28 50.3 W	520065	7737580	CORE	si Cl
84-12	69 45 25.4 N	-141 0 2.3 W	499975	7738604	CORE	si Cl
84-13	69 51 51.1 N	-140 59 37.6 W	500239	7750554	CORE	si Cl
84-14	69 50 12.9 N	-141 0 2.0 W	499979	7747511	GRAB	so gy M
84-15	69 47 25.2 N	-141 0 8.9 W	499905	7742315	GRAB	so gy M
84-16	69 44 48.3 N	-141 0 3.2 W	499966	7737454	GRAB	so gy M
84-17	69 42 5.6 N	-141 0 3.5 W	499962	7732415	GRAB	so gy M
84-18	69 39 37.5 N	-141 0 1.2 W	499987	7727827	GRAB	sf gy M
84-19	69 39 27.9 N	-140 52 18.1 W	504978	7727536	GRAB	so gy M
84-20	69 42 11.6 N	-140 52 15.5 W	504995	7732606	GRAB	so gy M
84-21	69 44 50.6 N	-140 52 6.3 W	505084	7737533	GRAB	so gy M
84-22	69 44 48.3 N	-140 44 46.3 W	509806	7737475	GRAB	so gy M
84-23	69 42 18.0 N	-140 44 38.0 W	509914	7732821	GRAB	sf gy M
84-24	69 39 25.2 N	-140 44 39.2 W	509924	7727467	GRAB	so gy M
84-25	69 39 24.6 N	-140 36 44.0 W	515046	7727475	GRAB	so gy M
84-26	69 42 16.3 N	-140 36 43.2 W	515021	7732795	GRAB	so gy M
84-27	69 44 55.0 N	-140 36 34.2 W	515086	7737710	GRAB	sf gy M
84-28	69 44 48.2 N	-140 28 56.9 W	519995	7737537	GRAB	so gy M
84-29	69 42 2.7 N	-140 29 12.3 W	519873	7732410	GRAB	sf gy M
84-30	69 39 28.6 N	-140 29 3.7 W	520005	7727635	GRAB	so gy M
84-31	69 42 7.2 N	-140 21 20.6 W	524944	7732597	GRAB	so gy M
84-32	69 44 47.5 N	-140 21 10.0 W	525006	7737563	GRAB	sf gy M
84-33	69 47 29.0 N	-140 21 1.4 W	525045	7742568	GRAB	so gy M
84-34	69 47 25.5 N	-140 13 3.2 W	530167	7742517	GRAB	so gy M
84-35	69 44 45.7 N	-140 13 21.2 W	530037	7737565	GRAB	so gy M
84-36	69 42 7.9 N	-140 13 41.2 W	529885	7732675	GRAB	so gy M
84-37	69 39 42.4 N	-140 13 52.5 W	529820	7728166	GRAB	so gy M
84-38	69 39 19.0 N	-140 6 4.8 W	534870	7727511	GRAB	G
84-39	69 42 11.9 N	-140 5 29.0 W	535176	7732873	GRAB	so gy M
84-40	69 44 43.5 N	-140 5 36.3 W	535028	7737568	GRAB	sy go M
84-41	69 47 23.9 N	-140 5 31.5 W	535005	7742535	GRAB	sf gy M
84-42	69 50 7.2 N	-140 5 20.9 W	535043	7747597	GRAB	sf gy M
84-43	69 49 54.3 N	-139 57 47.0 W	539900	7747274	GRAB	so gy M
84-44	69 47 19.8 N	-139 57 42.0 W	540035	7742490	GRAB	so gy M
84-45	69 44 39.7 N	-139 58 11.6 W	539802	7737524	GRAB	so gy M
84-46	69 41 52.7 N	-139 58 0.6 W	540008	7732353	GRAB	so gy M
84-47	69 39 25.2 N	-139 58 34.4 W	539721	7727780	GRAB	f S
84-48	69 39 19.7 N	-139 50 16.3 W	545091	7727704	GRAB	f S
84-49	69 41 28.8 N	-139 51 14.9 W	544385	7731692	GRAB	so gy M
84-50	69 39 15.1 N	-139 42 39.2 W	550020	7727661	GRAB	c S
84-51	69 41 49.1 N	-139 34 45.0 W	555020	7732545	GRAB	so gy M
84-52	69 39 8.3 N	-139 34 53.2 W	555047	7727561	GRAB	sf gy M
84-53	69 36 29.2 N	-139 35 9.5 W	554986	7722632	GRAB	gy S M

Table 1 (cont.)

Sample No.	Latitude Deg Min Sec	Longitude Deg Min Sec	East.*	North.*	Sample Type	Results **
84-54	69 36 22.7 N	-139 27 30.2 W	559951	7722551	GRAB	so gy M
84-55	69 39 3.9 N	-139 27 12.7 W	560014	7727547	GRAB	sf gy M
84-56	69 41 53.2 N	-139 27 15.1 W	559855	7732788	GRAB	G
84-57	69 44 24.7 N	-139 26 50.0 W	560006	7737488	GRAB	sf gy M
84-58	69 47 10.8 N	-139 26 39.1 W	559992	7742635	GRAB	sf gy M
84-59	69 44 21.1 N	-139 19 12.6 W	564918	7737505	GRAB	sf gy Cl
84-60	69 41 38.0 N	-139 19 25.0 W	564923	7732452	GRAB	sf gy M
84-61	69 38 56.9 N	-139 19 31.4 W	564991	7727462	GRAB	G
84-62	69 36 13.5 N	-139 19 44.2 W	564992	7722397	GRAB	so gy M
84-63	69 38 54.8 N	-139 11 46.4 W	570005	7727539	GRAB	G
84-64	69 41 38.0 N	-139 11 30.5 W	570027	7732597	GRAB	sf gy M
84-65	69 44 18.0 N	-139 11 14.7 W	570050	7737556	GRAB	sf gy Cl
84-66	69 44 12.5 N	-139 3 32.6 W	575014	7737539	GRAB	sf gy M
84-67	69 46 11.0 N	-139 1 29.9 W	576212	7741251	GRAB	G
84-68	69 41 28.7 N	-139 3 48.9 W	575000	7732461	GRAB	sf gy M
84-69	69 38 50.6 N	-139 4 16.2 W	574861	7727556	GRAB	so gy M
84-70	69 43 19.6 N	-140 2 7.1 W	537314	7735003	CORE	si Cl
84-71	69 43 24.4 N	-140 25 45.2 W	522076	7734958	CORE	si Cl
84-72	69 43 3.4 N	-139 23 17.9 W	562348	7735029	CORE	si Cl
84-73	69 42 55.4 N	-139 12 41.7 W	569191	7734972	CORE	no descr.
84-74	69 39 1.6 N	-139 23 27.0 W	562448	7727538	CORE	m S
84-75	69 39 3.0 N	-139 23 27.8 W	562438	7727581	GRAB	c S
84-76	69 38 58.5 N	-139 18 59.6 W	565333	7727521	CORE	no descr.
84-77	69 39 0.2 N	-139 22 6.1 W	563321	7727519	GRAB	G
84-78	69 38 58.4 N	-139 21 1.0 W	564024	7727481	GRAB	c S
84-79	69 38 58.6 N	-139 19 42.8 W	564867	7727509	GRAB	c S
84-80	69 38 57.6 N	-139 18 25.1 W	565705	7727503	GRAB	G M
84-81	69 38 56.9 N	-139 17 5.4 W	566565	7727505	GRAB	G M
84-82	69 38 55.5 N	-139 15 56.7 W	567307	7727481	GRAB	G M
84-83	69 38 55.2 N	-139 14 41.9 W	568113	7727496	GRAB	G M
84-84	69 38 54.5 N	-139 13 25.2 W	568940	7727498	GRAB	G M
84-85	69 38 51.2 N	-139 12 18.3 W	569664	7727417	GRAB	G M
84-86	69 38 53.2 N	-139 11 3.3 W	570471	7727503	GRAB	G M
84-87	69 38 52.5 N	-139 9 47.2 W	571292	7727504	GRAB	G M
84-88	69 38 50.5 N	-139 8 34.2 W	572081	7727466	GRAB	G M
84-89	69 39 12.7 N	-139 58 11.6 W	539973	7727395	CORE	no descr.
84-90	69 39 50.8 N	-139 58 23.0 W	539830	7728574	CORE	no descr.
84-91	69 39 27.0 N	-139 58 7.4 W	540011	7727841	CORE	no descr.
84-92	69 40 36.9 N	-139 58 9.4 W	539953	7730006	CORE	no descr.
84-93	69 40 57.6 N	-139 58 24.2 W	539782	7730642	GRAB	G M
84-94	69 41 28.4 N	-139 58 20.6 W	539805	7731598	GRAB	so gy Cl
84-95	69 42 0.4 N	-139 58 5.2 W	539954	7732591	GRAB	so gy Cl
84-96	69 42 34.4 N	-139 58 6.4 W	539923	7733646	GRAB	gy Cl
84-97	69 43 5.4 N	-139 58 2.2 W	539952	7734607	GRAB	gy Cl
84-98	69 43 35.5 N	-139 58 3.9 W	539918	7735539	GRAB	gy Cl
84-99	69 43 36.8 N	-139 59 30.6 W	538986	7735561	GRAB	so gy Cl
84-100	69 43 3.4 N	-139 59 40.9 W	538893	7734527	GRAB	so gy Cl
84-101	69 42 33.2 N	-139 59 34.7 W	538975	7733593	GRAB	sf gy Cl

Table A-3.1 (cont.)

Sample No.	Latitude Deg Min Sec	Longitude Deg Min Sec	East.*	North.*	Sample Type	Results **
84-102	69 42 1.9 N	-139 59 37.6 W	538960	7732623	GRAB	so gy Cl
84-103	69 41 27.5 N	-139 59 46.3 W	538883	7731554	GRAB	so gy Cl
84-104	69 40 52.7 N	-139 59 47.9 W	538884	7730475	GRAB	so gy Cl
84-105	70 3 20.8 N	-139 21 19.7 W	562602	7772764	CORE	no descr.
84-106	70 2 22.0 N	-139 21 18.0 W	562669	7770941	GRAB	G
84-107	70 2 53.8 N	-139 21 23.7 W	562582	7771926	GRAB	M G
84-108	70 3 23.0 N	-139 21 19.4 W	562603	7772830	GRAB	so gy Cl
84-109	70 1 47.7 N	-139 21 32.3 W	562546	7769877	GRAB	so gy Cl
84-110	70 1 13.9 N	-139 21 30.7 W	562592	7768829	GRAB	M G
84-111	70 0 38.6 N	-139 21 41.7 W	562505	7767733	GRAB	G
84-112	70 0 9.5 N	-139 21 30.5 W	562648	7766834	GRAB	so gy M

* Eastings and northings in meters calculated using Zone 7, Central Meridian = -141
** Abbreviations after Folk (1964)

Abbreviations:

Component

G,g	Gravel, primary, secondary
S,s	Sand, primary, secondary
Si,si	Silt, primary, secondary
Cl,cl	Clay, primary, secondary
M,m	Mud, primary, secondary
	(Mud is equal proportions of silt and clay)
P	Pebbles

Descriptors

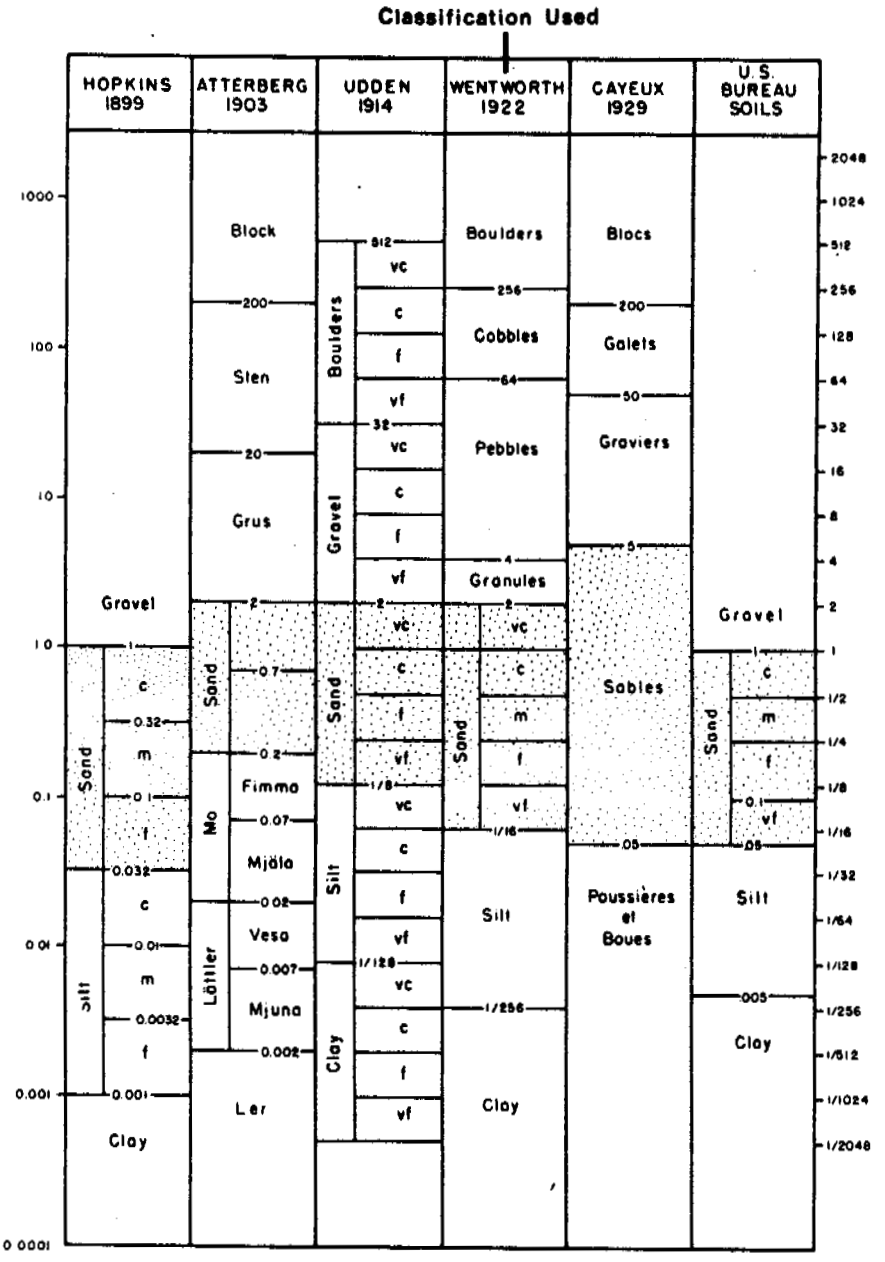
gy	Grey
f	Fine
so	Soft
sf	Stiff
c	Coarse
sm	Small

Secondary component is included in description if greater than 20% by weight.

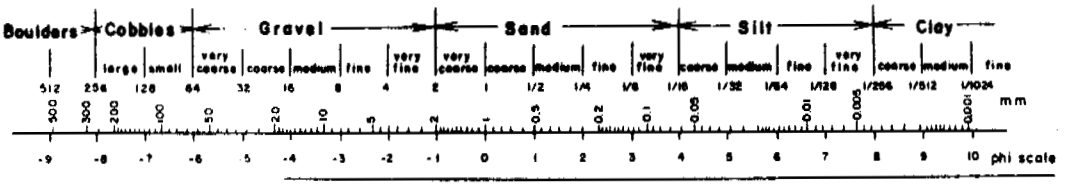
Table A-3.2

Samples from the hydrographic component of the 1984 MV Banksland survey

Sample No.	Latitude Deg Min Sec	Longitude Deg Min Sec	East.*	North.*	Sample Type	Results* Sample Description
Sh-84s-2	69 50 0.4 N	-140 55 28.4 W	502903	7747125	GRAB	f gy M
Sh-84s-3	69 43 28.9 N	-140 46 2.6 W	508996	7735014	GRAB	f gy M
Sh-84s-4	69 43 28.8 N	-140 42 18.2 W	511407	7735019	GRAB	f gy M
Sh-84s-5	69 45 38.3 N	-140 46 32.6 W	508659	7739019	GRAB	f gy M
Sh-84s-6	69 46 10.2 N	-140 49 6.3 W	507008	7740002	GRAB	f gy M
Sh-84s-7	69 39 58.7 N	-139 23 49.4 W	562160	7729300	GRAB	sm P S
Sh-84s-8	69 40 22.8 N	-139 21 49.2 W	563435	7730079	GRAB	S P
Sh-84s-9.1	69 41 13.1 N	-139 25 54.3 W	560756	7731568	GRAB	f gy M
Sh-84s-10	69 45 9.0 N	-139 21 21.4 W	563496	7738950	GRAB	sm P
Sh-84s-15	69 39 32.0 N	-139 14 24.7 W	568266	7728640	GRAB	sm P
Sh-84s-16	69 39 4.5 N	-139 22 41.1 W	562940	7727642	GRAB	G
Sh-84s-17	69 40 25.7 N	-139 31 3.1 W	557469	7730018	GRAB	f gy M
Sh-84s-18	69 41 27.8 N	-139 32 23.7 W	556555	7731919	GRAB	f gy M
Sh-84s-19	69 43 10.8 N	-139 36 40.3 W	553722	7735046	GRAB	f gy M
Sh-84s-25	69 47 22.4 N	-140 42 5.3 W	511510	7742257	GRAB	S G
Sh-84s-28	69 45 41.8 N	-140 56 12.2 W	502443	7739115	GRAB	G
Sh-84s-28.1	69 45 42.4 N	-140 56 11.1 W	502455	7739131	GRAB	G
Sh-84s-29	69 46 47.2 N	-140 55 19.2 W	503009	7741140	GRAB	f gy M
Sh-84s-30	69 50 3.7 N	-140 55 18.3 W	503011	7747227	GRAB	g gy M
Sh-84s-31.1	69 51 1.9 N	-140 31 7.2 W	518505	7749100	GRAB	f gy M
Sh-84s-31.3	69 50 56.2 N	-140 30 17.2 W	519041	7748930	GRAB	f gy M sm P
Sh-84s-65	69 46 16.7 N	-140 25 47.2 W	522005	7740295	GRAB	f gy M
Sh-84s-66	69 47 31.1 N	-140 34 46.7 W	516206	7742555	GRAB	f gy M
Sh-84s-67	69 47 39.8 N	-140 31 44.9 W	518151	7742838	GRAB	f gy M
Sh-84s-68	69 46 51.2 N	-140 32 0.1 W	518000	7741332	GRAB	f gy M
Sh-84s-69	69 46 39.8 N	-140 29 54.4 W	519349	7740990	GRAB	f gy M
Sh-84s-70	69 45 35.1 N	-140 20 21.3 W	525512	7739043	GRAB	f gy M
Sh-84s-71	69 45 18.4 N	-140 11 46.4 W	531042	7738591	GRAB	f gy M
Sh-84s-73	69 49 3.6 N	-140 19 34.5 W	525943	7745507	GRAB	f gy M
Sh-84s-77	69 48 49.6 N	-140 23 24.0 W	523493	7745049	GRAB	f gy M
Sh-84s-78	69 47 51.1 N	-140 26 40.7 W	521405	7743216	GRAB	f gy M
Sh-84s-79	69 44 46.7 N	-140 30 43.0 W	518857	7737482	GRAB	f gy M
Sh-84s-80	69 41 52.5 N	-140 23 33.8 W	523516	7732127	GRAB	f gy M
Sh-84s-81	69 42 2.5 N	-140 26 41.1 W	521499	7732418	GRAB	f gy M Rk
Sh-84s-82	69 40 20.4 N	-140 31 23.0 W	518492	7729228	GRAB	f gy M
Sh-84s-83	69 42 30.8 N	-140 32 4.0 W	518019	7733264	GRAB	f gy M
Sh-84s-84	69 42 44.8 N	-140 34 43.4 W	516303	7733686	GRAB	f gy M sm P
Sh-84s-85	69 42 46.5 N	-140 34 10.3 W	516658	7733740	GRAB	v f G
Sh-84s-86	69 43 38.1 N	-140 21 14.7 W	524978	7735414	GRAB	f gy M
Sh-84s-87	69 45 44.3 N	-139 53 5.7 W	543048	7739582	GRAB	f gy M



Three types of representative grade scales. The scales of Hopkins and Atterberg are geometric, decimal, and cyclic. Udden's scale, later adopted by Wentworth and since accepted by the Lane Committee, is geometric but noncyclic and nondecimal. The scales of the Bureau of Soils (U.S. Dept. of Agriculture) and of Cayeux are nonregular. The diagram illustrates the diverse meanings of the size terms and need for standardization. Note the variations in the limits of sand (stippled).



Relation between Wentworth-Lane class limits and phi scale.

(from Pettijohn, 1975)

FIGURE A-3.1

Table A-3.2 (cont.)

Sample No.	Latitude Deg Min Sec	Longitude Deg Min Sec	East.*	North.*	Sample Type	Results **
Sh-84s-88	69 47 17.7 N	-139 52 19.0 W	543496	7742486	GRAB	f gy M
Sh-84s-89	69 49 14.6 N	-140 3 25.9 W	536297	7745986	GRAB	f gy M
Sh-84s-90	69 50 36.7 N	-140 4 9.6 W	535791	7748520	GRAB	f gy M
Sh-84s-100	69 36 15.5 N	-139 19 0.7 W	565459	7722472	GRAB	f gy M
Sh-84s-101	69 46 11.1 N	-140 49 7.9 W	506990	7740031	GRAB	f gy M
Sh-84s-102	69 45 39.1 N	-140 46 34.6 W	508638	7739044	GRAB	f gy M
Sh-84s-103	69 45 0.6 N	-140 52 22.1 W	504913	7737843	GRAB	f gy M
Sh-84s-104	69 46 7.9 N	-140 59 17.1 W	500459	7739922	GRAB	f gy M
Sh-84s-105	69 43 30.2 N	-140 45 58.7 W	509039	7735052	GRAB	f gy M
Sh-84s-106	69 43 29.2 N	-140 42 25.3 W	511331	7735033	GRAB	f gy M
Sh-84s-107	69 40 12.6 N	-140 57 8.3 W	501850	7728917	GRAB	f gy M
Sh-84s-108	69 39 31.8 N	-140 50 39.1 W	506045	7727659	GRAB	S
Sh-84s-109	69 38 48.5 N	-140 49 14.0 W	506966	7726319	GRAB	s m G
Sh-84s-110	69 39 38.8 N	-140 47 56.7 W	507794	7727881	GRAB	s G
Sh-84s-111	69 40 12.7 N	-140 47 0.1 W	508401	7728932	GRAB	S
Sh-84s-112	69 38 25.8 N	-140 35 58.7 W	515545	7725657	GRAB	f gy M
Sh-84s-113	69 38 11.2 N	-140 32 59.9 W	517500	7725220	GRAB	f s Cl
Sh-84s-114	69 37 23.8 N	-140 21 29.8 W	524938	7723818	GRAB	G
Sh-84s-115	69 41 8.9 N	-140 18 12.8 W	526985	7730813	GRAB	f s Cl
Sh-84s-116	69 39 53.1 N	-140 17 27.4 W	527500	7728471	GRAB	f s Cl
Sh-84s-117	69 40 38.8 N	-140 14 18.1 W	529522	7729910	GRAB	f gy M
Sh-84s-118	69 41 28.1 N	-140 11 1.7 W	531616	7731464	GRAB	f s Cl
Sh-84s-119	69 40 57.6 N	-140 8 1.9 W	533564	7730548	GRAB	G
Sh-84s-121	69 38 4.3 N	-140 8 19.9 W	533447	7725177	GRAB	G
Sh-84s-122	69 40 51.7 N	-139 59 31.1 W	539075	7730448	GRAB	S
Sh-84s-123	69 38 25.0 N	-139 54 48.4 W	542189	7725958	GRAB	f G

* Eastings and northings calculated using Zone 7, Central Meridian = -141.
** Abbreviations as given in Folk (1964).

Abbreviations:

Component

G,g	Gravel, primary, secondary
S,s	Sand, primary, secondary
Si,si	Silt, primary, secondary
Cl,cl	Clay, primary, secondary
M,m	Mud, primary, secondary
	(Mud is equal proportions of silt and clay)
P	Pebbles

Descriptors

gy	Grey
f	Fine
so	Soft
st	Stiff
c	Course
sm	Small

TABLE A-3.3

Samples from the Yukon shelf that were obtained prior to 1984.

Sample No.*	Latitude Deg	Min	Sec	Longitude Deg	Min	Sec	East.**	North.**	Sample Type	% Composition Gravel	Sand	Silt	Clay	Mean (PHI)
10756	69	40	0.0	-139	0	0.0	577552	7729794	GRAB	2.59	0.82	31.59	65.00	8.1
10757	69	45	0.0	-139	14	18.0	568045	7738799	GRAB	8.28	5.56	44.51	41.55	6.4
10758	69	45	0.0	-139	14	18.0	568045	7738799	GRAB	6.67	88.24	1.80	3.30	-2.7
10	70	10	18.0	-139	52	36.0	542525	7785235	CORE	19.6	35.37	12.38	32,65	3.6
2	69	59	16.8	-140	15	44.4	528175	7764530	CORE	9.23	55.89	12,67	22.22	3.6
75-95	69	43	0.0	-140	43	0.0	510962	7734126	CORE	4.02	0.00	55.74	40.24	7.2
11366	70	0	0.0	-139	16	0.0	566159	7766638	GRAB	21.41	43.92	9.25	25.43	4.3
11367	70	0	18.0	-139	15	0.0	566779	7767214	GRAB	3.41	0.00	26.16	70.43	8.3
11368	70	0	27.0	-139	31	0.0	556598	7767223	GRAB	3.35	0.01	28.12	68.53	8.2
11369	70	0	0.0	-139	30	0.0	557254	7766402	GRAB	37.23	26.18	9.82	26.78	2.9
11370	69	50	0.0	-139	25	0.0	560917	7747901	GRAB	3.08	0.93	41,74	54.28	7.7
11371	69	45	6.0	-139	30	0.0	557894	7738715	GRAB	24.18	2.45	30.15	43.22	6.3
11372	69	40	0.0	-139	30	0.0	558168	7729239	GRAB	9.54	5.77	46.77	37,91	6.2
11373	69	40	0.0	-139	45	0.0	548474	7729021	GRAB	33,95	25,53	22.28	18,25	2.8
11374	69	45	0.0	-139	45	0.0	548284	7738312	GRAB	7.18	2.13	34.75	55.91	7.5
11375	69	50	0.0	-139	45	0.0	548094	7747604	GRAB	14.85	7.52	35.33	42.30	6.2
11376	69	55	0.0	-139	45	0.0	547903	7756895	GRAB	29.56	45.86	9.64	14.94	0.6
11377	70	0	0.0	-139	45	0.0	547713	7766187	GRAB	22.27	45.71	8.66	23.36	1.5
11378	70	6	6.0	-139	40	0.0	550646	7777590	GRAB	25.81	38.12	9.72	26.36	1.8
11379	70	5	0.0	-140	0	0.0	538019	7775303	GRAB	29.97	40.59	10.03	19.42	1.2
11380	70	0	0.0	-140	0	0.0	538171	7766011	GRAB	25.15	35.49	12.94	26,42	2.4
4	69	55	0.0	-140	0	0.0	538324	7756718	GRAB	3.30	20.15	36.55	40.00	6.3
11391	69	50	0.0	-140	0	0.0	538476	7747426	GRAB	10.12	62.45	11.97	15.46	-0.7
11392	69	45	0.0	-140	0	0.0	538628	7738134	GRAB	7.05	2.10	30.35	60.50	7.52
11393	69	40	0.0	-140	0	0.0	538780	7728842	GRAB	53.60	5.30	22,67	18.43	4.00
11394	69	40	0.0	-140	15	0.0	529086	7728703	GRAB	5.64	0.00	43.20	51.16	7.61
3	69	45	0.0	-140	15	0.0	528972	7737996	GRAB	0.33	3.56	38.04	58.07	7.91
11396	69	30	0.0	-140	15	0.0	529314	7710118	GRAB	3.01	0.49	51.19	45.31	7.41
11397	69	55	0.0	-140	15	0.0	528743	7756581	GRAB	48.97	3.84	36.13	41.06	6.33
1	69	43	00.0	-140	37	00.0	514831	7734147	GRAB	6.64	18.83	37.95	36.57	5.94
69050-815	69	43	0.0	-140	37	0.0	514831	7734147	CORE	s g M ***				
69050-817	70	08	24.0	-139	15	54.0	565778	7782248	GRAB	si Cl				
75-MG7504	69	54	36.0	-141	00	00.0	500000	7746739	GRAB	si Cl				
75-MG7505	70	00	00.0	-141	00	00.0	500000	7765698	GRAB	si Cl				
75-MG7506	70	04	36.0	-141	00	00.0	500000	7774248	GRAB	s g Cl				
75-MG7514	70	10	30.0	-140	46	00.0	508832	7785231	GRAB	S,G				
75-MG7515	70	04	48.0	-140	45	36.0	509126	7774637	GRAB	g Cl				
75-MG7516	70	00	00.0	-140	45	18.0	509352	7765717	GRAB	si Cl				
75-MG7517	69	55	24.0	-140	44	48.0	509706	7757168	GRAB	si Cl				
75-MG7518	69	50	18.0	-140	44	00.0	510258	7747691	GRAB	si Cl				
75-MG7524	69	49	54.0	-140	30	00.0	506413	7746934	GRAB	si Cl				
75-MG7525	69	54	54.0	-140	30	00.0	519164	7756297	GRAB	si Cl				

Table A-3.3 (cont.)

Sample No.	Latitude Deg Min Sec	Longitude Deg Min Sec	East.*	North.*	Sample Type	% Composition Gravel	Sand	Silt	Clay	Mean (PHI)
75-MG7526	70 00 00.0	-140 30 06.0	519023	7765775	GRAB	s	g	Cl		
75-MG7527	70 05 12.0	-140 30 36.0	518627	7775438	GRAB	s	g	Cl		
75-MG7528	70 09 36.0	-140 30 06.0	518877	7783619	GRAB	cl	S,G			

* Sample numbers may refer to field sample number, sampling station number, or laboratory (size analysis) test number.

** Eastings and northings calculated using Zone 7, Central Meridian = -141

*** Abbreviations as given in Folk (1964).

Abbreviations:

Component

G,g	Gravel, primary, secondary
S,s	Sand, primary, secondary
Si,si	Silt, primary, secondary
Cl,cl	Clay, primary, secondary
M,m	Mud, primary, secondary
	(Mud is equal proportions of silt and clay)
P	Pebbles

Descriptors

gy	Grey
f	Fine
so	Soft
st	Stiff
c	Coarse
sm	Small

Secondary component is included in description if greater than 20% by weight.

Phi units= $\log^{-2}$ of the mean grain diameter. e.g.: 0.25mm dia = 2 Phi
0.5mm dia = 1 Phi
1mm dia = 0 Phi
2mm dia = -1 Phi
4mm dia = -2 Phi

TY85-039
TY85-045
TY85-047
TY85-052
TY85-038
TY85-037
TY85-050
TY85-043
TY85-041
GSC-1
BA84-156
TY85-048
TY85-009
TY85-061
TY85-033
TY85-035
TY85-006
BA84-165
BA84-126
TY85-030
TY85-042
TY85-010
TY85-055
TY85-054
TY85-008
TY85-027
BA84-158
TY85-056
TY85-031
BA84-111
TY85-060
TY85-026
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TY85-019
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BA84-31
BA84-41
BA84-66
BA84-81
BA84-160
TY85-032
BA84-161
EDLOK SITE
BA84-96
NATSEK 4
TY85-011
TY85-017
TY85-018
BA84-162
TY85-005
TY85-012
BA84-163
TY85-016
TY85-014
TY85-015
TY85-013
Herschel Island
Clarence Lagoon
Backhouse River
Yukon Territory
Komakuk Beach
Nunaluk Spit
80 metre contour (shelf edge)
United States
Canada
70°15'N
70°W
7 780 000 N
7 760 000 N
7 740 000 N
69°45'W
500 000 E
520 000 E
540 000 E
560 000 E
141°W
140°W
139°W
70°N
69°45'N

Location Diagram

TY85-003: Lines surveyed
M. V. Tully,(1985)

BA84-41: Lines surveyed
M. V. Banksland,(1984)

● Borehole or Wellsite

SCALE (Km.)
0 5 10

Granular Resource Potential
Western Beaufort Shelf

Location Diagram:
Seismic Line Coverage

Enclosure: 1	Date: April 1986	Project: 85-37
Scale: 100000	Dwn. by:	Ckd. by:
Projection: UTM Zone 7, C.M.=-141		

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22 Waddell Ave., Dartmouth
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7790000 mN

70° 10' 00" N

7780000 mN

7770000 mN

70° 00' 00" N

7760000 mN

7750000 mN

69° 50' 00" N

7740000 mN

7730000 mN

69° 40' 00" N

7720000 mN

500000 mE
141° 00' 00" W

510000 mE

520000 mE
140° 30' 00" W

530000 mE

140° 00' 00" W
540000 mE

550000 mE

139° 30' 00" W
560000 mE

570000 mE

139° 00' 00" W
580000 mE

NOTE: CONTOURS IN METERS
BATHYMETRY CONTOURED FROM CHS FIELD SHEET NO. WA 10167

NEAR SURFACE GEOLOGY - YUKON COAST

BATHYMETRY

ENCLOSURE: **2**	DATE: MAY/85	SCALE: 1:100000
PROJECTION: **Mercator**		
PROJECT: 84-35	DRN. BY:	CKD. BY:

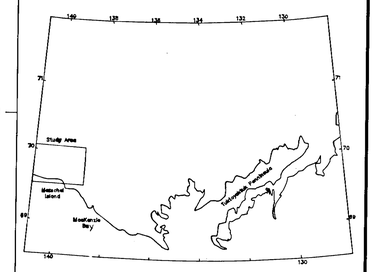
EARTH & OCEAN RESEARCH LTD.
22 WADDELL AVE., DARTMOUTH,
NOVA SCOTIA B3B 1K3

500 000 E
520 000 E
540 000 E
560 000 E
141°W
140°W
139°W
70°15'N
70°N
69°45'N
7 780 000 N
7 760 000 N
7 740 000 N

80 metre contour (shelf edge)

United States
Canada

Clarence Lagoon
Yukon Territory
Komakuk Beach
Nunaluk Spit
Herschel Island



Location Diagram

Legend

UNIT S
Mackenzie Trough Sequence
Well stratified sediments onlapping shelf strata with angular unconformity

UNIT R
Unstratified. Non transparent. Smooth surfaced. Drowned coarse grained alluvial fan deposits

UNIT Q
Poorly stratified. Transparent. Restricted to buried channel lying shoreward of nearshore ridge– possibly lacustrine or lagoonal deposit

UNIT P
Unstratified to weakly stratified Transparent to opeque. Restricted to outer ridge. Coarse grained surface. Poss bly morsinal or sub glacial
Over ridge axis

UNIT O
Well stratified. Transparent. Conformable with Unit N. Truncated at the seafloor.
Silty Clay composition in GSC–1 borehole

UNIT N
Well stratified to intermittently stratified. Truncated at the seafloor Silty Clay composition in GSC–1 borehole.

UNIT M
Poorly to moderately stratified. Unconformably overlies Unit L Silty Clay composition in GSC–1 borehole.

UNIT M–1
Thin veneer of Unit M (1–2m) Overlying Unit L. Unit L exposed By ice scouring.

UNIT L
Unstratified to poorly stratified Flat lying Ubiquitous surficial cover over inner shelf.Consists of soft to stiff grey mud with sand and gravel of probable ice rafted origin.

UNIT K
Flat lying, poorly stratified, transparent. Lower boundery indistinct. Upper boundary very strong over inner and central shelf–possibly due to minor ice bonding. Composition of silty Clay in Natsek borehole.

Land

SCALE (Km.)
0 5 10

Granular Resource Potential Western Beaufort Shelf

Surficial Seismo Stratigraphy

Enclosure: 3	Date: April 1986	Project 85–37
Scale: 100,000	Dwn. by:	Ckd. by:
Projection: UTM Zone 7, C.M.=–141		

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141°W
500 000 E
520 000 E
140°W
540 000 E
560 000 E
139°W
70°15'N
7 780 000 N
70°W
7 760 000 N
7 740 000 N
69°45'W
70°N
69°45'N

United States

Canada

80 meter contour (shelf edge)

GSC-1

Truncated subseafloor by Horizon 12

Truncated subseafloor
by Horizon 2(33)
Base of Trough unconformity

Truncated at the seafloor

Horizon 11 does not produce an acoustic signal in this area.

EDLOK SITE

NATSEK 4

Southern limit of correlation

Clarence Lagoon

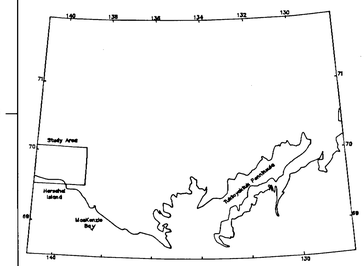
Backhouse River

Yukon Territory

Komakuk Beach

Nunaluk Spit

Herschel Island



Location Diagram

Contour interval 2 metres to
10 metres thickness,
10 metres for thicknesses
greater than 10 metres.

Unit thickness based on
sub seafloor seismic velocity
of 1600 meters per second

SCALE (Km.)
0 5 10

Granular Resources Potential
Western Beaufort Shelf

Isopach on Horizon 11

Enclosure: 5	Date: April 1986	Project: 85-37
Scale: 100000	Dwn. by:	Ckd. by:
Projection: UTM Zone 7, C.M.=-141		

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80 metre contour (shelf edge)

Horizon 15 truncated at sea floor

GSC-1

EDLOK SITE

NATSEK 4

United States

Canada

Yukon Territory

Clarence Lagoon

Komakuk Beach

Nunaluk Spit

Herschel Island

141°W

500 000 E

520 000 E

140°W

540 000 E

560 000 E

139°W

70°15'N

70°W

69°45'W

69°45'N

7 780 000 N

7 760 000 N

7 740 000 N

70°N

Location Diagram

Contour interval 10 metres

Depths based on a seismic velocity of 1600 m/sec.

SCALE (Km.)

0 5 10

Granular Resource Potential
Western Beaufort Shelf

Depth Structure on Horizon 15

Enclosure: 6	Date: April 1986	Project: 85-37
Scale:100,000	Dwn. by:	Ckd. by:
Projection: UTM Zone 7, C.M.=-141		

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80 metre contour (shelf edge)

GSC-1

EDLOK SITE

NATSEK 4

Horizon 15 truncated at sea floor

Clarence Lagoon

Yukon Territory

Komakuk Beach

Nunaluk Spit

Herschel Island

United States

Canada

141°W

140°W

139°W

520 000 E

540 000 E

560 000 E

7 780 000 N

7 760 000 N

7 740 000 N

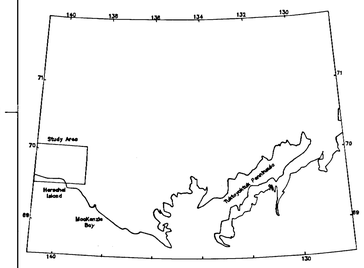
70°15'N

70°W

69°45'W

69°45'N

70°N



Location Diagram

Contour interval 10 metres

Thickness based on a seismic velocity of 1600 m/sec

Contours are referenced to the sea bottom

SCALE (Km.)

0 5 10

Near Surface Geology of the Yukon Shelf and Slope

Isopach on Horizon 15

Enclosure: 7	Date: April 1986	Project: 85-37
Scale: 100,000	Dwn. by:	Ckd. by:
Projection: UTM Zone 7, C.M.=-141		

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141°W
500 000 E
520 000 E
140°W
540 000 E
560 000 E
139°W
70°15'N
7 780 000 N
7 760 000 N
7 740 000 N
70°W
69°45'W
70°N
69°45'N

United States
Canada
Yukon Territory

80 metre contour (shelf edge)

MG7514
cl S,G
% Sa. & Gr. 50–80
% Gr. 1–20
% Sa. 20–40

MG7528
cl S,G
% Sa. & Gr. 50–80
% Gr. 1–20
% Sa. 40–60

GSC–1

?
cl S,G
% Sa. & Gr. 50–80
% Gr. 40–60
% Sa. 1–20

10
% Gr. 19.6
% Sa. 35.37
% Si. 12.38
% Cl. 32.65
Mn. Φ 3.69

817
si Cl
% Sa. & Gr. <21
% Gr. <1
% Sa. 1–20

?
si Cl
% Sa. & Gr. <21
% Gr. <1
% Sa. 1–20

9
% Gr. 25.81
% Sa. 38.12
% Si. 9.72
% Cl. 26.36
Mn. Φ 1.86

MG7515
s g Cl
% Sa. & Gr. 20–40
% Gr. <1
% Sa. 1–20

MG7527
s g Cl
% Sa. & Gr. 20–40
% Gr. <1
% Sa. 20–40

?
cl S,G
% Sa. & Gr. 50–80
% Gr. 40–60
% Sa. 20–40

11379
% Gr. 29.97
% Sa. 40.59
% Si. 10.03
% Cl. 19.42
Mn. Φ 1.26

MG7506
s–g–Cl
% Sa. & Gr. 20–40
% Gr. 1–20
% Sa. 1–20

84–108
so gy Cl

84–107
m G

84–106
G

84–109
so gy Cl

84–110
m G

84–111
G

84–112
so gy M

11367
% Gr. 3.41
% Sa. 0.00
% Si. 26.16
% Cl. 70.43
Mn. Φ 8.34

?
si Cl
% Sa. & Gr. <21
% Gr. <1
% Sa. 1–20

?
si Cl
% Sa. & Gr. <2
% Gr. <1
% Sa. <1

11368
% Gr. 3.35
% Sa. 0.01
% Si. 28.12
% Cl. 68.53
Mn. Φ 8.24

11377
% Gr. 22.27
% Sa. 45.71
% Si. 8.66
% Cl. 23.36
Mn. Φ 1.50

11369
% Gr. 37.23
% Sa. 26.18
% Si. 9.82
% Cl. 26.78
Mn. Φ 2.91

11366
% Gr. 21.41
% Sa. 43.92
% Si. 9.25
% Cl. 25.43
Mn. Φ 4.31

?
si Cl'
% Sa. & Gr. <21
% Gr. <1
% Sa. 1–20

?
si Cl
% Sa. & Gr. 0–20
% Gr. <1
% Sa. 1–20

MG7516
si Cl
% Sa. & Gr. <20
% Gr. 1–20
% Sa. 1–20

MG7526
s g Cl
% Sa. & Gr. 20–40
% Gr. 1–20
% Sa. 20–40

2
% Gr. 9.23
% Sa. 55.89
% Si. 12.67
% Cl. 22.22
Mn. Φ 3.64

11380
% Gr. 25.15
% Sa. 35.49
% Si. 12.94
% Cl. 26.42
Mn. Φ 2.48

MG7517
si Cl
% Sa. & Gr. <20
% Gr. <1
% Sa. 1–20

MG7525
si Cl
% Sa. & Gr. <20
% Gr. 1–20
% Sa. 1–20

11397
% Gr. 18.97
% Sa. 3.84
% Si. 36.13
% Cl. 41.06
Mn. Φ 6.33

4
% Gr. 3.3
% Sa. 20.15
% Si. 36.55
% Cl. 40.00
Mn. Φ 6.30

11376
% Gr. 29.56
% Sa. 45.86
% Si. 9.64
% Cl. 14.94
Mn. Φ 0.62

8
% Gr. 28
% Sa. 32
% Si. 16
% Cl. 23
Mn. Φ 2.76

?
S,G
% Sa. & Gr. 80–100
% Gr. >60
% Sa. 20–40

7
% Gr. 38
% Sa. 32
% Si. 11
% Cl. 19
Mn. Φ 1.46

?
gy si Cl
% Sa. & Gr. 1–20
% Gr. 1–20
% Sa. 1–20

MG7518
si Cl
% Sa. & Gr. <20
% Gr. <1
% Sa. 1–20

MG7524
si Cl
% Sa. & Gr. <20
% Gr. 1–20
% Sa. 1–20

11391
% Gr. 10.12
% Sa. 62.45
% Si. 11.97
% Cl. 15.46
Mn. Φ –0.72

11396
s c Si
% Sa. & Gr. <20
% Gr. <1
% Sa. 1–20

11375
% Gr. 14.85
% Sa. 7.52
% Si. 35.33
% Cl. 42.3
Mn. Φ 6.25

11370
% Gr. 3.08
% Sa. 0.93
% Si. 41.74
% Cl. 54.28
Mn. Φ 7.77

6
% Gr. 40.45
% Sa. 13.99
% Si. 16.9
% Cl. 28.66
Mn. Φ 2.58

MG7503
si–Cl
% Sa. & Gr. 0–20
% Gr. <1
% Sa. 1–20

11392
% Gr. 7.05
% Sa. 2.10
% Si. 30.35
% Cl. 60.50
Mn. Φ 7.52

11371
% Gr. 24.18
% Sa. 2.45
% Si. 30.15
% Cl. 43.22
Mn. Φ 6.33

10757
% Gr. 8.28
% Sa. 5.56
% Si. 44.51
% Cl. 41.55
Mn. Φ 6.49

10758
% Gr. 6.67
% Sa. 88.24
% Si. 1.80
% Cl. 3.3
Mn. Φ –2.72

EDLOK SITE

NATSEK 4

11374
% Gr. 7.18
% Sa. 2.13
% Si. 34.75
% Cl. 55.91
Mn. Φ 7.59

11373
% Gr. 33.95
% Sa. 25.53
% Si. 22.28
% Cl. 18.25
Mn. Φ 2.88

?
si S,G

84–50
c S

3
% Gr. 0.33
% Sa. 3.56
% Si. 38.04
% Cl. 58.07
Mn. Φ 7.93

1
% Gr. 7
% Sa. 19
% Si. 38
% Cl. 37
Mn. Φ –

75–95
% Gr. 4.02
% Sa. 0.00
% Si. 55.74
% Cl. 40.24
Mn. Φ 7.20

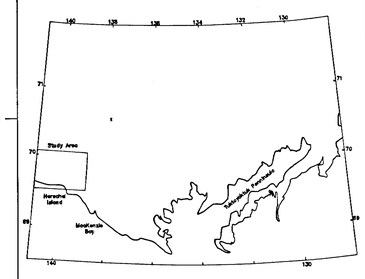
11372
% Gr. 9.54
% Sa. 5.77
% Si. 46.77
% Cl. 37.91
Mn. Φ 6.28

11394
% Gr. 5.64
% Sa. 0.00
% Si. 43.20
% Cl. 51.16
Mn. Φ 7.61

11393
% Gr. 53.60
% Sa. 5.30
% Si. 22.67
% Cl. 18.43
Mn. Φ –4.0

10756
% Gr. 2.59
% Sa. 0.82
% Si. 31.59
% Cl. 65.00
Mn. Φ 8.19

Clarence Lagoon
Backhouse River
Komakuk Beach
Nunaluk Spit
Herschel Island



Location Diagram

Legend

- Grab Sample
- Piston Core
- Borehole or wellsite

SAMPLE DESCRIPTIONS

Sample Identification

84–	1984 Banksland Survey GSC sample (ref. Meagher, 1985)
Sh–84s–	1984 Banksland Survey CHS sample (ref. McGladrey 1984)
11379, MG7514, 75–95, 817	1970–71 samples from Hudson, helicopter, or Parizeau. (Ref. database at Bedford Institute of Oceanography and Pelletier, 1985)
?	1970–71 samples from Hudson or helicopter (ref. Pelletier, 1985)
5	1970–71 samples from Hudson or helicopter (Ref. Pelletier,1975)

Component

G, g	Gravel, Primary, secondary
S, s	Sand, Primary, secondary
Si, si	Silt, Primary, Secondary
Cl, cl	Clay, Primary, Secondary
M, m	Mud, Primary, Secondary (Mud is equal proportions of silt and clay.)
p	Pebbles

Descriptors

gy	Grey
f	Fine
so	Soft
sf	Stiff
c	Coarse
sm	Small

SCALE (Km.)

0 5 10

Granular Resource Potential
Western Beaufort Shelf

Sample Identification and Description

Enclosure: 8	Date: April 1986	Project: 85–37
Scale:100,000	Dwn. by:	Ckd. by:
Projection: UTM Zone 7, C.M.=–141		

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141°W
500 000 E
520 000 E
140°W
540 000 E
560 000 E
139°W
70°15'N
7 780 000 N
70°W
7 760 000 N
7 740 000 N
69°45'W

United States

Canada

80 metre contour (shelf edge)

PROSPECT: 19
AREA: (*10⁶M²) 31.7
AV. THICK. (M): 8.5
VOLUME (*10⁶M³) 269.5

PROSPECT: 20
AREA: (*10⁶M²) 1400
AV. THICK. (M): ?
VOLUME (*10⁶M³) ?

PROSPECT: 18
AREA: (*10⁶M²) 16.7
AV. THICK. (M): 4
VOLUME (*10⁶M³) 66.8

PROSPECT: 17
AREA: (*10⁶M²) ?
AV. THICK. (M): ?
VOLUME (*10⁶M³) ?

PROSPECT: 13
AREA: (*10⁶M²) 1
AV. THICK. (M): .5
VOLUME (*10⁶M³) .5

PROSPECT: 16
AREA: (*10⁶M²) 3
AV. THICK. (M): 2
VOLUME (*10⁶M³) 6

PROSPECT: 14
AREA: (*10⁶M²) 11
AV. THICK. (M): .8
VOLUME (*10⁶M³) 8.8

PROSPECT: 12
AREA: (*10⁶M²) 4
AV. THICK. (M): .5
VOLUME (*10⁶M³) 2

PROSPECT: 15
AREA: (*10⁶M²) 2.7
AV. THICK. (M): .7
VOLUME (*10⁶M³) 1.9

PROSPECT: 10
AREA: (*10⁶M²) 1.1
AV. THICK. (M): 2
VOLUME (*10⁶M³) 2.2

PROSPECT: 9
AREA: (*10⁶M²) 2.9
AV. THICK. (M): 2
VOLUME (*10⁶M³) 5.8

PROSPECT: 8
AREA: (*10⁶M²) 6.5
AV. THICK. (M): ?
VOLUME (*10⁶M³) ?

PROSPECT: 7
AREA: (*10⁶M²) ?
AV. THICK. (M): ?
VOLUME (*10⁶M³) ?

PROSPECT: 11
AREA: (*10⁶M²) 3.4
AV. THICK. (M): 1
VOLUME (*10⁶M³) 3.4

PROSPECT: 4
AREA: (*10⁶M²) 25.1
AV. THICK. (M): 2
VOLUME (*10⁶M³) 50.2

PROSPECT: 5
AREA: (*10⁶M²) 13
AV. THICK. (M): 2
VOLUME (*10⁶M³) 26

PROSPECT: 1A
AREA: (*10⁶M²) 74.65
AV. THICK. (M): ?
VOLUME (*10⁶M³) ?

PROSPECT: 6
AREA: (*10⁶M²) 1.8
AV. THICK. (M): 1.5
VOLUME (*10⁶M³) 2.7

PROSPECT: 3
AREA: (*10⁶M²) 2.9
AV. THICK. (M): 2
VOLUME (*10⁶M³) 5.8

PROSPECT: 2
AREA: (*10⁶M²) 2.4
AV. THICK. (M): 2.5
VOLUME (*10⁶M³) 6

PROSPECT: 1
AREA: (*10⁶M²) 71.35
AV. THICK. (M): 6–10
VOLUME (*10⁶M³) 428–713

Clarence Lagoon

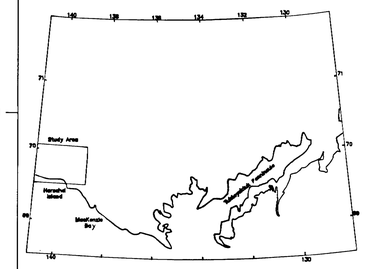
10 Meter Contour

Yukon Territory

Komakuk Beach

Nunaluk Spit

Herschel Island



Location Diagram

Legend

- Areas of probable granular resource
- Areas of prospective granular resource
- Area of undetermined prospective resource

Note: Contours indicate shoals
For shoal depths refer to bathymetry map Figure 2

Coarse sediment zones as Interpreted from sidescan Sonograms. (Interpretation by Mr. Jim Shearer)

- Sand ripple zone with inferred bottom current direction
- Shelf edge megaripples, inferred bottom current direction
- Gravel dominant zones

SCALE (Km.)
0 5 10

Granular Resource Potential
Western Beaufort Shelf

GRANULAR RESOURCES

Enclosure: 9	Date: April 1986	Project: 85–37
Scale: 100,000	Dwn by:	Ckd. by:
Projection: UTM Zone 7, Central Meridian –141		

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Nova Scotia B3B 1K3