BEAUFORT SEA GEOPHYSICAL SURVEY;

SCOPING STUDY

Dobrocky Seatech Ltd.

PREAMBLE

This unedited open file report presents the results of a feasibility study for conducting shallow water geophysical surveys in the Canadian Beaufort Sea. The study focuses principally on suitable vessels and appropriate high resolution marine seismic profiling equipment for operating in water depths less than 10 m. The report will be of value to other government, industry or university researchers who need to conduct survey work in Arctic coastal waters.

This study was carried out under contract by Dobrocky Seatech Limited as part of the Northern Oil and Gas Action Program (NOGAP) Project D.1: Beaufort Sea Coastal Zone Geotechnics. This Open File has not been edited by the Geological Survey of Canada and opinions or ideas presented herein are not necessarily those of the Geological Survey of Canada.

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Final Report

Beaufort Sea Geophysical Survey; Scoping Study

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SUMMARY

The report summarizes a feasibility study for conducting shallow-water geophysical surveys in the Canadian Beaufort Sea. Nearshore geophysical surveys have been conducted on a routine basis in the Alaskan Beaufort Sea for over ten years and we have relied heavily on the previous operating experience of U.S.G.S. in our study. The study focused principally on suitable vessels and appropriate equipment.

The Canadian Beaufort Sea poses a number of special problems that influence vessel suitability, including rudimentary logistical support and seasonal development of sea ice. Our survey suggests that a single-screw, shallow-draft displacement type vessel is most suitable for remote operations in the Beaufort Sea. Vessel size of 12 to 23 m (50 - 75 ft) appears optimum; smaller vessels may be suitable if appropriately configured. An appropriately equipped vessel should be capable of self-contained support for two to three weeks in remote areas and be capable of riding-out storm events. Experience of the U.S.G.S. personnel with the 13 m (43 ft) KARLUK indicates that even a smaller vessel is capable of meeting the specifications. Unfortunately, there is a very limited supply of this type of vessel in the Canadian Beaufort Sea. Only one vessel is available for the 1985 season and it is of marginal suitability (13 m but with very limited cabin space and accommodation).

It is possible to run the following equipment on a vessel in this size range: survey echo-sounder, side-scan sonar, sub-bottom profiler and high resolution seismic system. For shallow-water operations, a through-the-hull transducer is used for the echo-sounder, the side-scan fish is towed off a boom suspended from the bow, the sub-bottom profiler is operated over the side (or can be incorporated in the side-scan fish) and

the high resolution seismic system, with associated streamer, is towed aft. Approximately 5 m (15 linear ft) of bench space is required for recording systems. Two separate auxiliary generators are required to power this equipment. Specific equipment recommendations are provided within the main body of the report.

It is unlikely that a vessel in the 13 to 23 m size range could support either an air or water gun system because of the size of the associated compressors and pumps. As a result, boomers or small sparkers are more appropriate for this type of survey.

SPECIAL NOTE

This report was originally prepared in June 1985 over a three-week period. A revised edition of the report was prepared in July 1986 to include several vessels not previously available during 1985. Vessel and equipment lease rates were <u>not</u> updated in the 1986 revision, and, therefore, may be dated; in fact, many of the lease rates are likely to be lower than quoted as a result of increased competition in the lease market.

A similar ship-of-opportunity survey completed for DFO in early 1986 is included as Appendix 5 and summarizes larger ships available in the Beaufort Sea.

TABLE OF CONTENTS

TABLE OF CONTENTS

Continued

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES

(continued)

1.0 INTRODUCTION

This study involved a technical and cost evaluation of a geological and geophysical survey program in the Canadian Beaufort Sea coastal zone, and was conducted under contract to the Atlantic Geoscience Centre, through contract No. DSS 13SC.23420-5-M582.

1.1 STATEMENT OF THE PROBLEM

Recent oil discoveries in the Canadian Beaufort Sea indicate that oil production from offshore wells may be feasible within the next ten years. Many of the development scenarios require that oil be moved on shore through subsea pipelines, and piped overland to southern Canada for further processing from the pipeline landfall locations. Engineering design criteria require that geophysical surveys and geological surveys be conducted in the shallow areas where the pipeline may cross the shore. In addition, numerous of the development scenarios indicate that aggregate materials for offshore construction may be supplied from nearshore sediment sources. These development concerns, coupled with a poor understanding of the nearshore sediment dynamics (Harper and Penland, 1982) necessitate that nearshore geophysical surveys be conducted in the Canadian Beaufort Sea.

At the present time there is little shallow-water geophysical information because most of the offshore geophysical work has been done from larger vessels, which ordinarily have draft restrictions, preventing survey work in water depths of less than 10 m. The extensive shallow water area (<10 m) of the Beaufort Sea (estimated to be approximately 8,000 km^2 or 15% of the total Beaufort Shelf area) requires a special approach be taken to nearshore surveying.

1.2 OBJECTIVES

The overall goal of this study was to recommend a strategy for conducting nearshore geophysical surveys in the Canadian Beaufort Sea. Specific objectives included:

1. The evaluation of suitable geophysical equipment for operating in the nearshore areas of the Canadian Beaufort Sea;

2. Evaluation and identification of suitable vessels for conducting nearshore geophysical surveys; and

3. The evaluation of equipment deployment strategies for conducting the geophysical surveys in a timely and efficient manner.

1.3 SCOPE OF STUDY

The recommendations that this report provides are based on a review of existing published and unpublished information on geophysical survey work in the Canadian and Alaskan Beaufort Seas, interviews with researchers who have conducted similar surveys in the Beaufort Sea, a review of existing vessel capabilities and availabilities in the Canadian Beaufort Sea and a review of geophysical equipment, including operating constraints, success in previous similar projects, and suitability for future work.

The review of vessels and geophysical equipment is included in Sections 2.0 and 3.0 and Section 4.0 (Strategies and Recommendations) includes a professional review and assessment of most suitable survey programs for nearshore geophysical and geological studies. Available vessel specifications (Appendix 1) and geophysical equipment specifications (Appendix 3) are included as far as possible.

The study was conducted over a three week period (24 May to 10 June, 1985) with a revised report prepared 1 August 1986. A similar report prepared for IOS in January 1986 is included as an Appendix.

2.0 VESSELS

2.1 OPERATING CONSTRAINTS

There are a number of important operating constraints in the Beaufort Sea which will dictate vessel suitability. Important constraints considered and discussed in this report include:

- Sea ice
- Wave climate
- Water depth
- Harbours (supply bases and anchorages)
- Horizontal control (limitations of benchmark positions on navigation).

These environmental and logistical factors provide important constraints for small vessel operation the Beaufort Sea.

2.1.1 Sea Ice

The presence of sea ice during even open water months provides an important operating constraint to vessel type in the Beaufort Sea. The distribution of the pack ice edge is indicated in Figures 2.1 - 2.4 although smaller ice floes, growlers and brash ice may occur within the nearshore zone even during the open water season. As the figures indicate, the maximum operation season is limited to three months. Sea ice will influence the selection of survey vessels in the following respects:

(1) Collisions with ice could damage the structural integrity of the hull;

(2) Operations in and around ice could damage the propeller or rudders, thereby affecting control of the vessel.

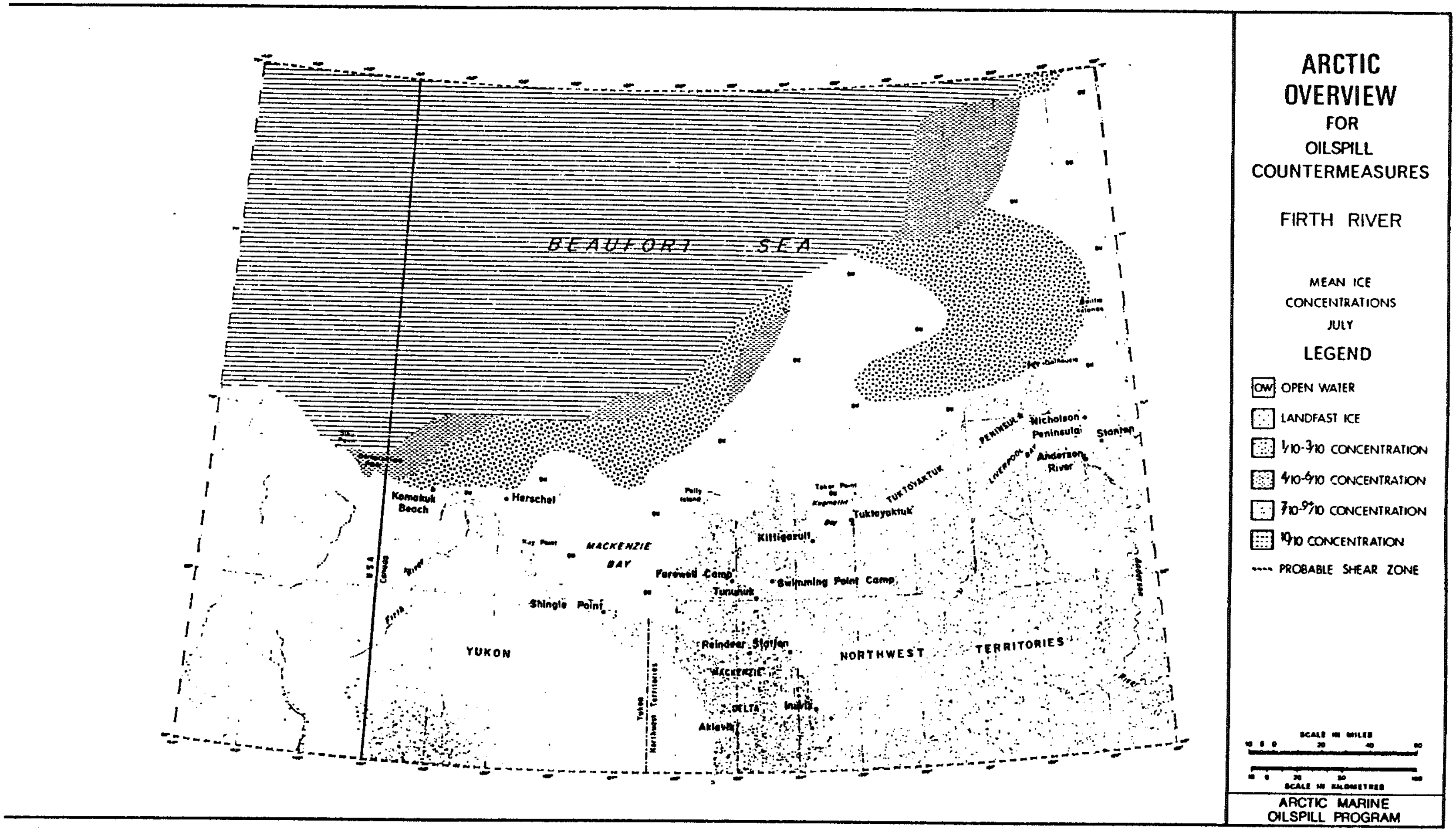


Figure 2.1 Mean ice concentrations in the Beaufort Sea during July.

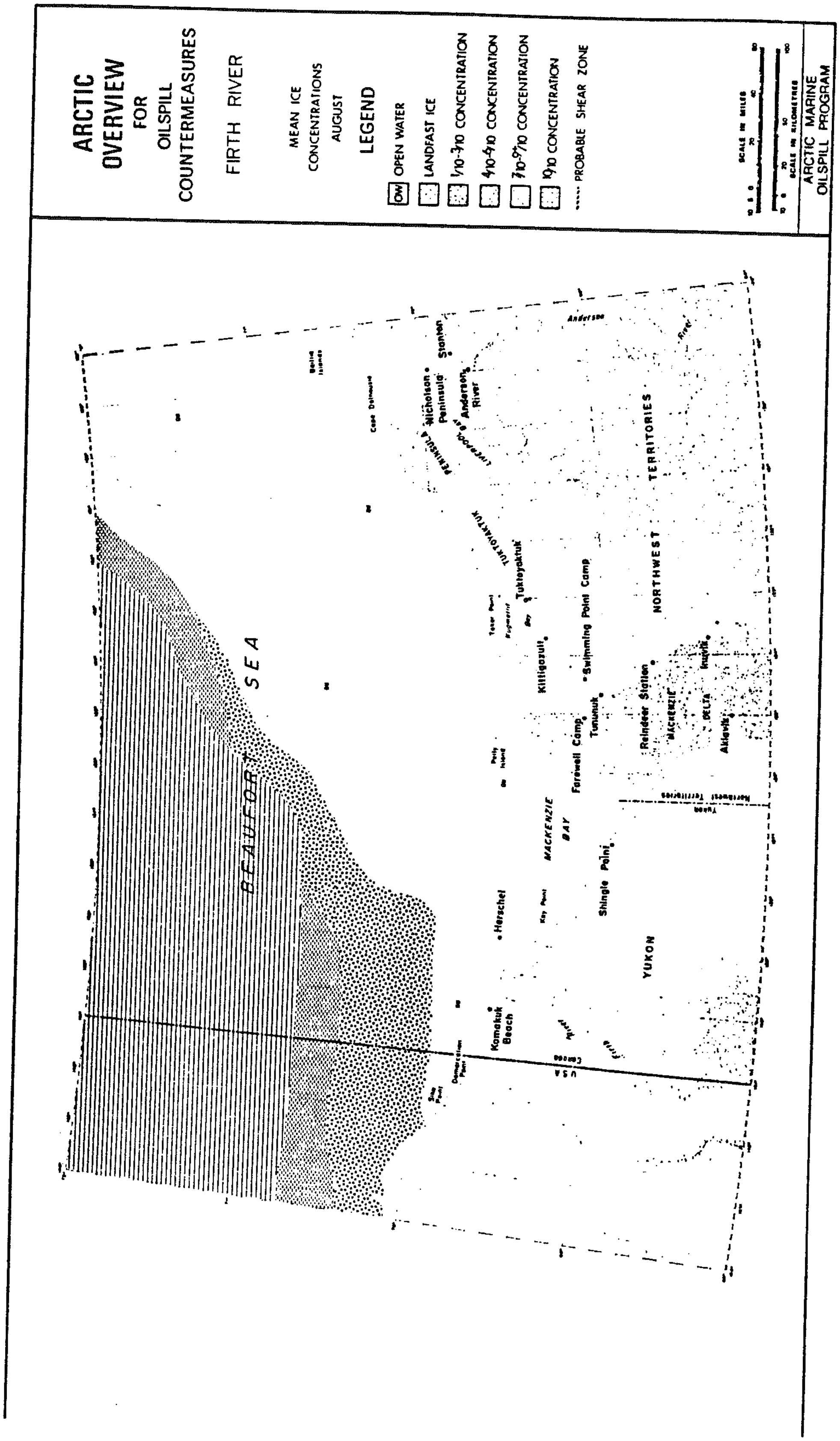


Figure 2.2 Mean ice concentrations in the Beaufort Sea during August.

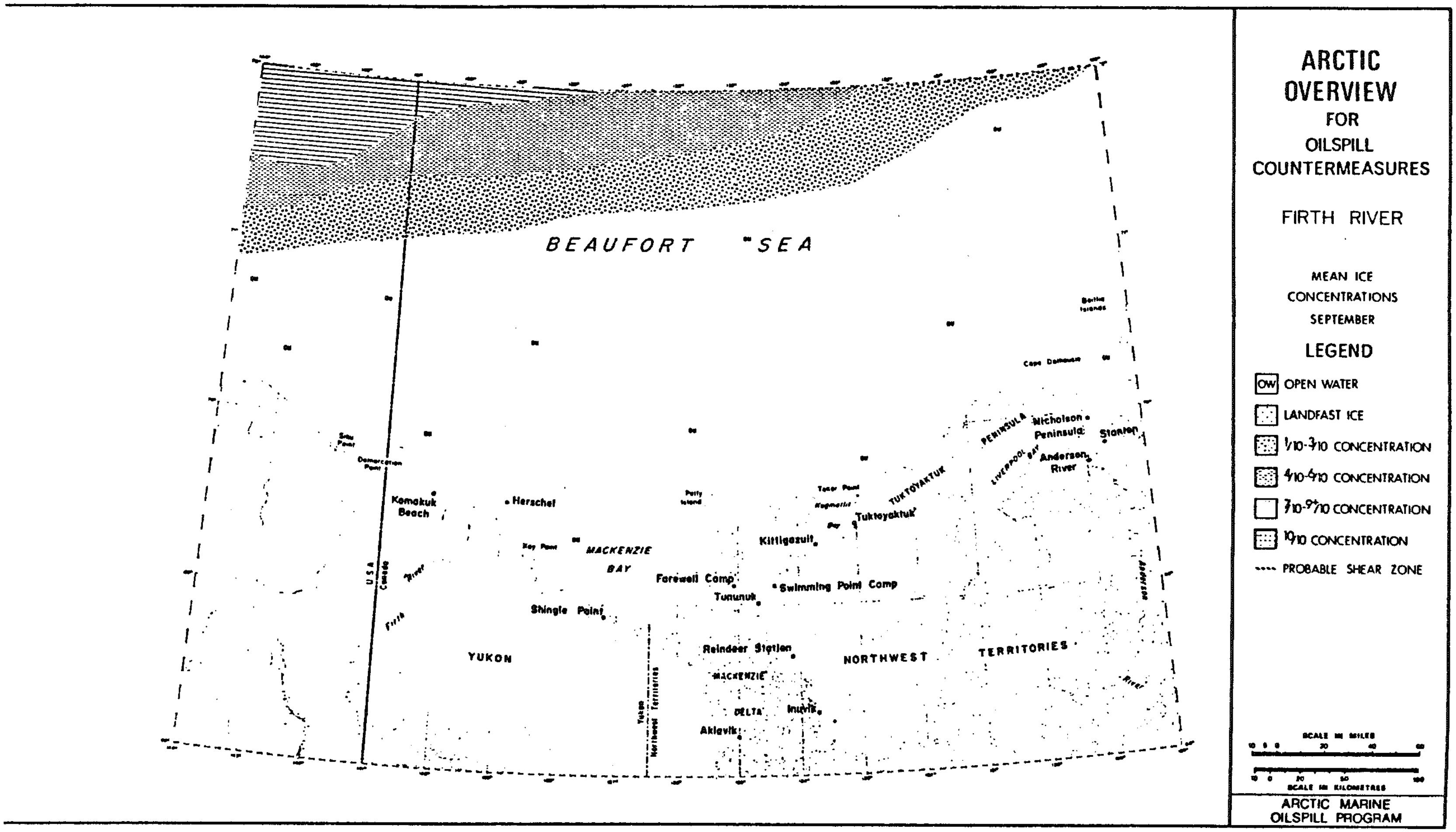


Figure 2.3 Mean ice concentrations in the Beaufort Sea during September.

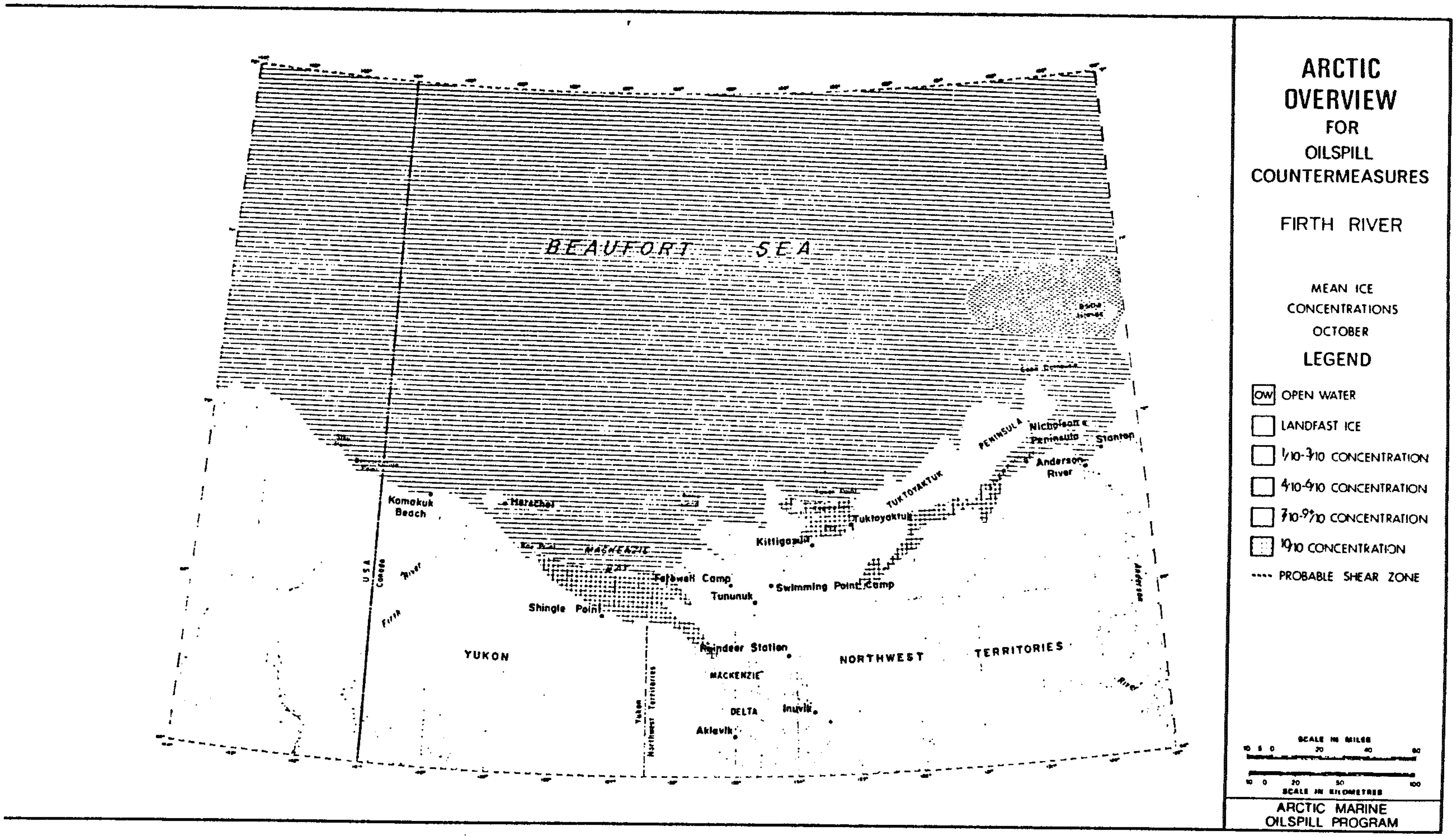


Figure 2.4 Mean ice concentrations in the Beaufort Sea during October.

In addition, the presence of small ice pieces and ice cakes will influence survey grid patterns and also potential anchorages.

Discussions with U.S.G.S. personnel (E. Reimnitz, pers. comm., 1985) indicate that a single screw vessel is much less susceptible to ice damage because of partial protection provided by the keel. Discussions with other Alaskan Beaufort Sea operators (B. Koplan, pers. comm., 1985) indicate that dual propellers are susceptible to ice damage and performance of these vessels is often reduced because of damaged propellers or rudders. Several vessels operating in the Alaskan Beaufort Sea nearshore area have had special ice cages manufactured to help prevent damage to the props and rudders (D. Wilson, pers. comm., 1985).

To date, there have been no reported sinkings of small vessels due to collisions with pieces of ice. In fact, simple avoidance of ice pieces is comparatively easy and ice has caused minimal damage on board vessels operating routinely in the Beaufort Sea. Reimnitz (pers. comm., 1985) notes that the potential for impact damage from ice is much greater for faster moving vessels (i.e., twin engine vessels) than for a single screw vessels, as speeds for single screw vessels are usually in the range of 8 - 10 knots.

An additional problem of vessel operation related to ice is with cooling systems. Flow-through cooling systems may be subject to frazzle ice buildup when operating in below freezing temperatures. This process, in conjuction with clogging of the water intake systems by brash ice, has not proven to be a major problem in Beaufort Sea operations but has occurred sporadically. The alternative is to use a vessel with keel cooling, however, external keel coolers then are vulnerable to ice damage. Flow-through water systems for engine cooling appear to be superior provided that intakes are accessible for cleaning.

2.1.2 Wave Climate

The wave climate in the Canadian Beaufort Sea is comparatively mild, as indicated in Table 2.1. Of particular significance is that most waves (60%) are less than 1 m in height and that severe storm waves (greater than 2 m in height) occur less than 5% of the time. Moderate storm waves (1 to 2 m) occur approximately 35% of the time. Given these constraints, most vessels are capable of operating up to 60% of the time with little to no problem and during the remaining 40% of the time would operate under reduced efficiency, weather out the storms or seek safe harbour in anchorages (see Section 2.1.4). As indicated in Figure 2.5, the dominant wave approach directions are from easterly quadrants, however, these are usually smaller waves. Storm waves typically originate from the northwest requiring protection from the northwestly wave approach.

Given these wave characteristics, most vessels in the range of 40 to 50 feet would be capable of operating safely throughout most of the open water season in the Beaufort Sea. The exception occurs during the very infrequent (5%) severe storm periods when wave heights may exceed 2 m. E. Reimnitz (pers. comm., 1985) indicated that the RV KARLUK has weathered severe storms with wave heights in excess of 2 m in the Chukchi Sea. Dobrocky Seatech Ltd. has similar operating experience with their 42 foot research vessel, the RV SEATECH II.

2.1.3 Nearshore Bathymetry

Nearshore bathymetry will provide an additional operating constraint in the Beaufort Sea and requirements of the project state that the vessel should be shallow draft. This is particularly important in the Mackenzie River delta area where extensive areas have water depths less than 2 m (Figure 2.6). In the delta area, there are an estimated 6,000 km^2 of water depths less than 2 m. In other areas of the Beaufort Sea shallow water depths will pose minimum problems in doing nearshore research, except in some of the major embayments along the Tuktoyaktuk Peninsula and in Liverpool Bay. Other potential draft problems include uncharted or poorly charted shoals and abandoned exploration islands offshore.

Table 2.1 Wave Height Frequency Of Occurrence in The Canadian Beaufort Sea (after Baird and Hall, 1980)

Wave Height Class		Frequency of Occurrence During Open-Water Season	
(ft)	(m)		
0 - 1	0 - 0.3	12%	60%
1 - 2	0.3 - 0.6	26%	
2 - 3	0.6 - 0.9	22%	
3 - 4	0.9 - 1.2	17%	35%
4 - 5	1.2 - 1.5	12%	
5 - 6	1.5 - 1.8	6%	
6 - 7	1.8 - 2.1	3%	5%
> 7	> 2.1	2%	

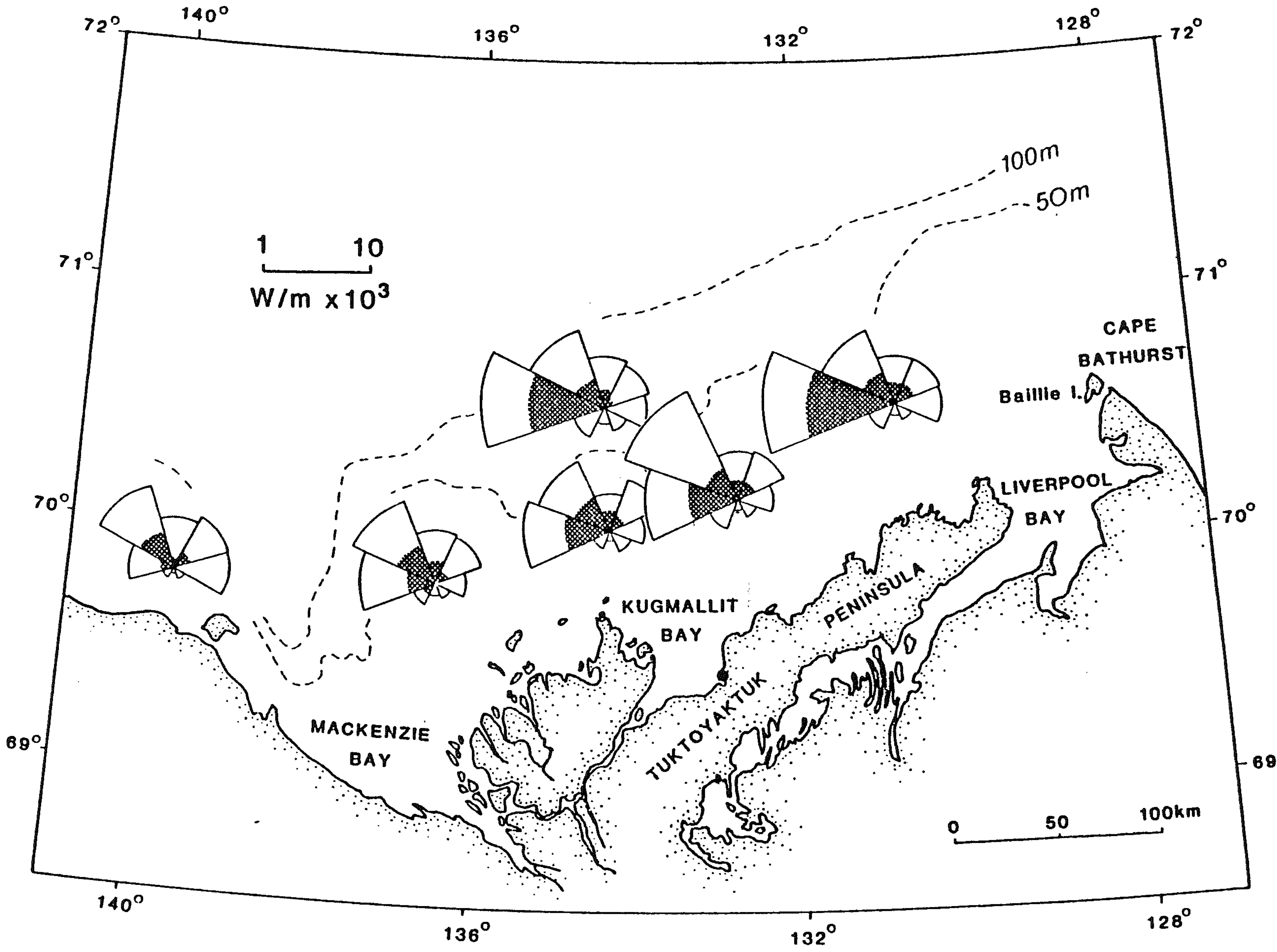


Figure 2.5 Wave power roses computed form hindcast wave data (Baird and Hall, 1980). Roses indicate dominant wave approach directions; shaded areas indicate power component related to waves greater than 2 m (from Harper and Penland, 1982).

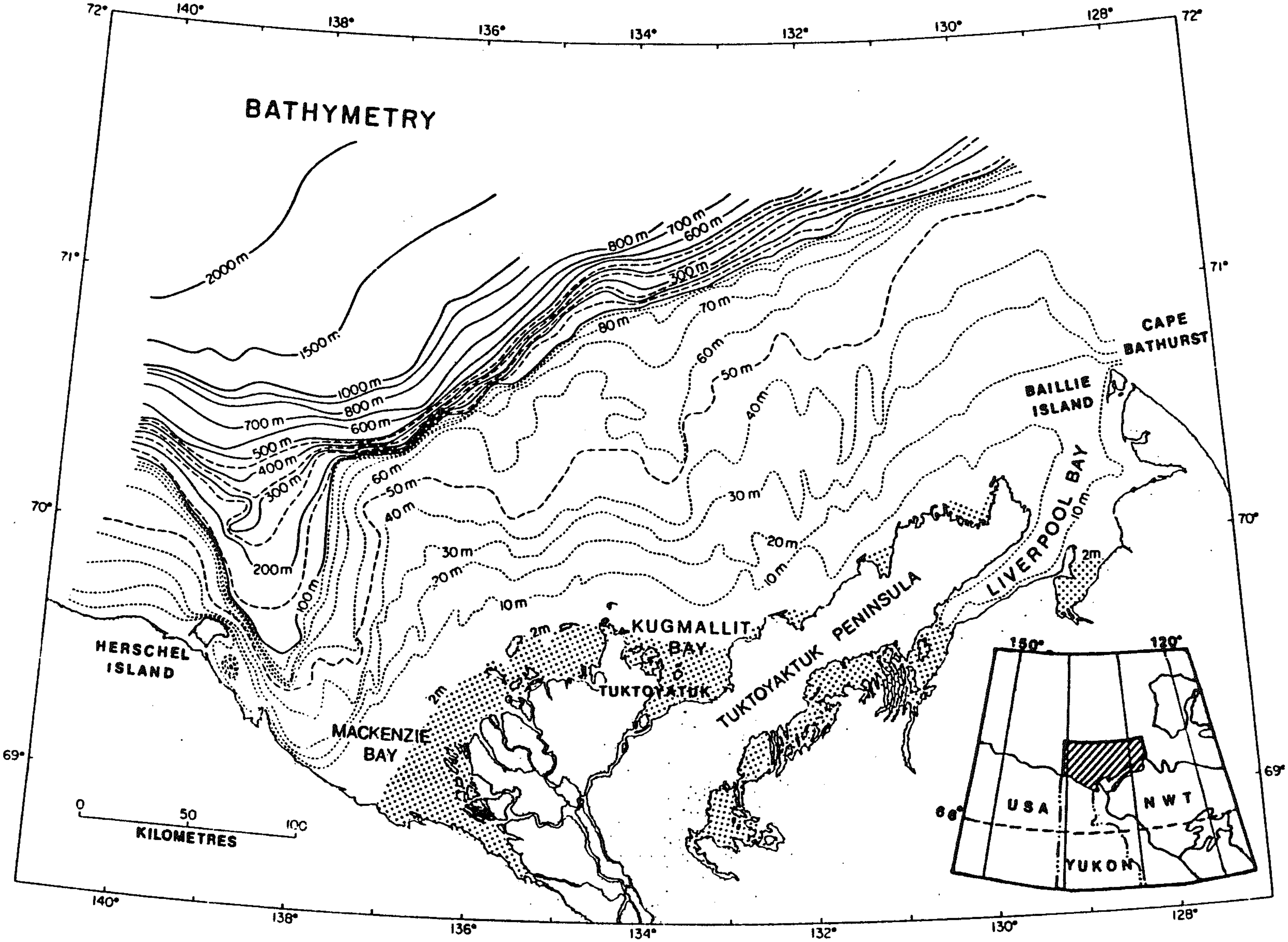


Figure 2.6 Bathymetry in the Beaufort Sea. The shaded portions indicate the approximate areas of water depths less than 2 m.

The shallow water area of the Mackenzie delta dictates that vessels used for nearshore surveying must be of shallow draft, preferably 1 m or less. In addition, the vessel must be configured in such a way to accept grounding on an occasional basis. E. Reimnitz (pers. comm., 1985) of the U.S. Geological Survey indicates that grounding of their research vessel is a common occurrence and must be anticipated in conducting such nearshore surveys. In addition, Reimnitz points out that when anchoring off the coast, not in a protected anchorage, it is important to have the vessel anchored as closely as possible to shore to minimize the potential collision with ice blocks; the deeper blocks normally ground offshore. Reimnitz advised that the RV KARLUK frequently anchors in water depths of 1-1/2 to 2 m to avoid being hit by large pieces of floating ice.

2.1.4 Harbours: Supply Bases, Anchorages

Summer sea conditions for the Canadian Beaufort, as outlined in section 2.1.1 and 2.1.2 indicate the periodic need for safe anchorages, particularly with small vessels at shallow draft. Possible anchorage are identified in Figure 2.7.

Between Demarcation Point and Kugmallit Bay, protection may be found at the following:

- Demarcation Bay (provisional, in U.S.)
- Komakuk Beach (provisional, exposed anchorage)
- Workboat Passage
- Thetis Bay (Pauline Cove)
- Kay Point (provisional, shallow, uncharted inlet)
- Shingle Pt (Escape Reef)
- Garry Island (provisional, shallow when east winds predominant)
- Pelly Island
- Pullen Island
- Hansen Harbour
- Masen Bay
- Numerous offshore exploration islands (provisional, shelter uncertain)

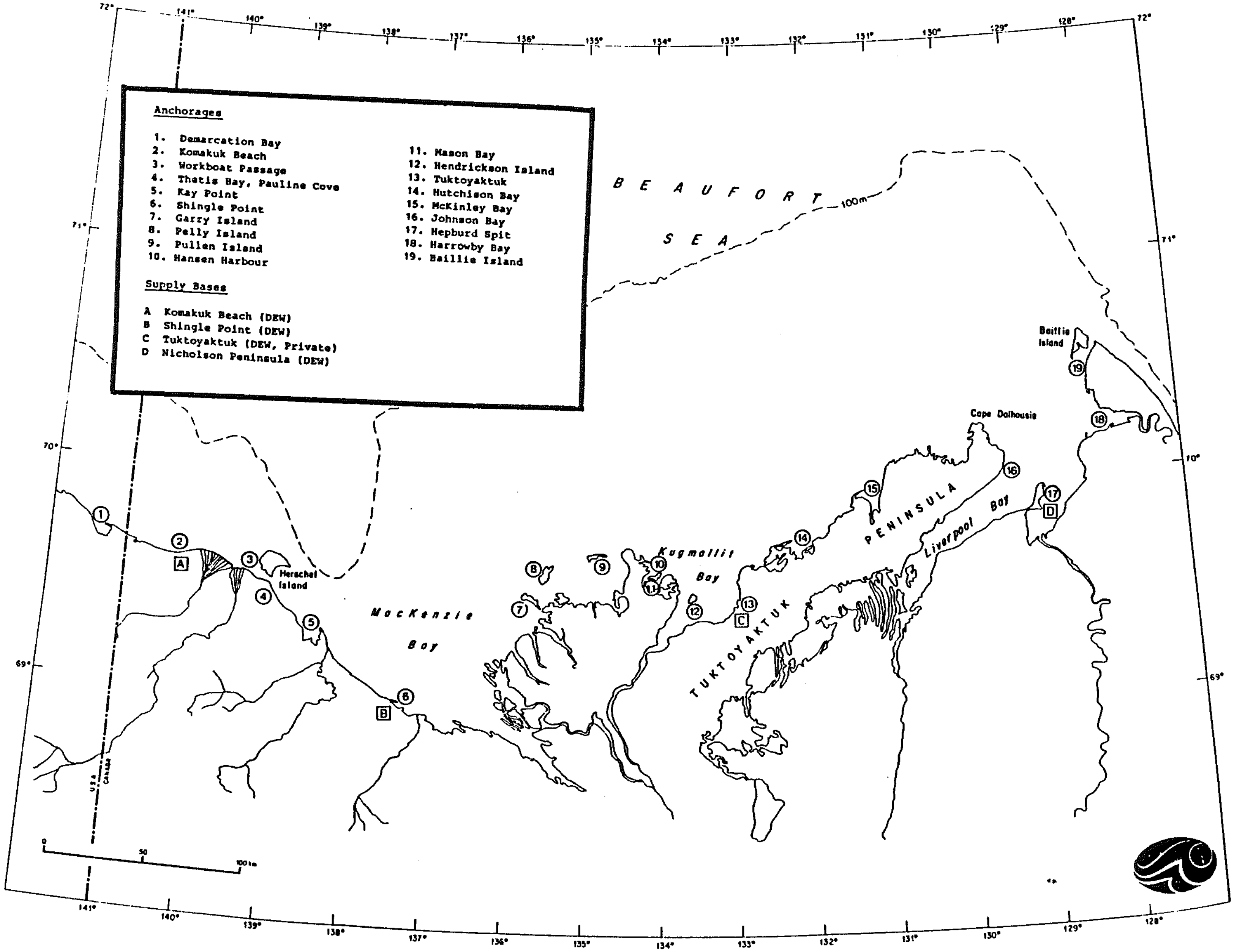


Figure 2.7 Location of Beaufort Sea anchorages and supply bases.

In the area of Kugmallit Bay access to Tuktoyaktuk Harbour becomes feasible, where complete harbour facilities are available. In addition, protection may be found in the immediate vicinity of Hendrickson Island.

From Tuktoyaktuk to Cape Bathurst (Baillie Islands) the following protection is afforded:

- Hutchison Bay
- McKinley Bay
- Russell Inlet
- Cape Dalhousie (provisional, protection and charting unknown)
- Johnson Bay
- Baillie Islands
- Harrowby Bay (Liverpool Bay)
- Hepburn Spit (Liverpool Bay)

Details for the above anchorages are included as Appendix 2.

Supplies

Dew Line Sites

Fuel and provisions can be landed at DEW Line sites; however, assistance in moving materials to the shore are not routinely available. In general, provisions cannot be obtained at these sites. DEW Line stations are located at Komakuk Beach, Shingle Point, Tuktoyaktuk and Nicholson Peninsula.

Private

Supplies of diesel fuel may be obtained through prior arrangement with Arctic Transportation Ltd. or Northern Transportation Company Ltd.

Water may be taken on in Tuktoyaktuk Harbour and replenished at shore points along the Beaufort coast.

Food supplies can be airfreighted to Tuktoyaktuk and transferred to vessel at remote locations using Twin Otter resupply flights.

2.1.5 Horizontal Position Control

Monumented benchmark placement between Demarcation Point on the west and Cape Dalhousie to the east consist of 96 individual positions, with an average spacing of 9 to 13 km. The exceptions are placements at the northwest entrance to Workboat Passage, where a gap of 16.2 km between bench marks occurs at Thetis Bay, where there is an 18.9 km, gap and a gap of 43.2 km in the southwest shore of the entrance to Shallow Bay.

Benchmark coverage in the vicinity of Liverpool Bay is limited to four useable stations between Dalhousie Pt. in the north and proceeding southward on the west shore ending at 70°N 129° 30' W. These are situated at approximately 12 km intervals. There are two useable stations located on the Nicholson Peninsula with eight located on and around the Baillie Islands. Coverage for Liverpool Bay is very limited, as may be readily seen on the accompanying field sheets (Appendix 4).

2.2 PREVIOUS OPERATING EXPERIENCE AND VESSELS

Dobrocky Seatech Ltd. conducted a brief telephone survey and literature review on previous vessel experience in the Beaufort Sea. During this review, we contacted individuals with experience in shallow water geophysical surveys from both the Alaskan Beaufort Sea as well as the Canadian Beaufort Sea. The principal source of information was obtained from the U.S. Geological Survey personnel who have conducted nearshore geophysical research in the Alaskan Beaufort Sea since 1971. Other operators and scientists that have conducted similar nearshore surveys in Alaska were also contacted. Individuals are listed in Table 2.2.

Table 2.2 Contacts for Beaufort Sea Vessel Experience

Individual	Affiliation	Vessel	Notes
E. Reimnitz	U.S.G.S. Menlo Park, CA	KARLUK	has conducted surveys since 1972
D. Wilson	Dobrocky Seatech Alaska Anchorage, AK	D.W. HOOD	managed research vessel in Beaufort Sea for five years
B. Kopplin	Ocean Research Ltd. Prudhoe Bay, AK	ANNIKA MARIE	vessel experience in Beaufort Sea since 1978; owner/operator since 1981
L. Toilmil	Harding Lawson Assoc. Novato, CA	VARIOUS	vessel experience in Alaskan arctic since 1976; numerous geophysical surveys; owner/operator of small vessel
J. Hunter	EMR Ottawa, Ontario	J. ROSS MACKAY	conducted shallow seismic for last three years
D. MacWatt	Beaufort Sea Environmental Services Inuvik, N.W.T.	SEQUEL	owner of 42' research vessel; offshore experience since 1978
D. Tetrault	Arctic Offshore Ltd. Hay River, N.W.T.	M.T. PILOT II	
V. Steen	Tuktoyaktuk, N.W.T.	PRESSURE RIDGE	owner/operator

2.2.1 RV KARLUK

The RV KARLUK has been operated in the Beaufort Sea by the U.S. Geological Survey since 1973. The boat is 42 feet in length, has a 3 foot draft and is a converted fishing vessel (design displacement 18 tons; actual displacement 25 tons). The vessel is a single screw displacement hull, capable of approximately 9 knots cruising speed. Detailed specifications on the vessel are included in Appendix 1. The vessel includes two auxiliary generators, one 15 kilowatt generator and one 5 kilowatt generator. It sleeps four and ordinarily goes out for cruises from 10 days to two weeks.

The RV KARLUK has proven to be extremely suitable for conducting nearshore geophysical surveys in the Alaskan Beaufort Sea. The heavy displacement hull allows extra supplies and full backup replacement parts to be carried on board the vessel (e.g., major engine components, propellor, shaft, diving compressor, range-range navigation stations with batteries, etc.). The cruising range is approximately 1,000 miles or 2 1/2 weeks, averaging fuel consumption of about 50 gallons (U.S.) per day. The vessel operates from Prudhoe Bay or other remote ports and requires no additional support while conducting surveys. Range-range navigation stations (Del Norte Trisponder system) are set up on existing bench marks to provide navigation control. These shore stations are established using the launch of the KARLUK and typically operate from 5 to 7 days.

Accommodation on board the vessel for four allows 12 hour work days with the KARLUK returning to safe anchorage each night. Where no convenient anchorage located near the survey area, the KARLUK would be anchored close to the open coast if weather conditions permit.

Discussions with E. Reimnitz (pers. comm., 1985) indicate that the KARLUK is a near ideal vessel for conducting nearshore geophysical surveys in the Beaufort Sea. In particular, the vessel can operate as a self-contained unit because of its large carrying capacity and fuel capacity. The configuration of the vessel makes it less vulnerable to damage from either ice or grounding. Comparatively frequent grounding of the vessel during survey activities has not proven to be a problem as the shallow draft permits easy refloating of the vessel. The mast/boom system for lifting and handling materials over the side has proven to be extremely flexible in a wide range of situations and has an operating capacity of up to 2000 lb. The vessel is extremely seaworthy having weathered 60 plus knot winds with virtually unrestricted fetches in the Chukchi Sea.

The one improvement suggested by Dr. Reimnitz is possibly having an additional 5 feet of vessel length to allow transport and operation of all scientific gear on the vessel; this would include a vibracore, seismic reflection unit, subbottom profiler, skiff and other geophysical/ oceanographic equipment. With the present configuration all this equipment may be carried on deck but not operated at the same time. The additional length in the hull would allow materials to be stored and operated without significant off-loading and redistribution problems.

A number of unique equipment configurations exist on board the KARLUK. For example, the KARLUK carries two auxiliary generators, one 15 kW and one 5 KW generator which powers the boomer system; this power source must be kept separate because of the surging load caused by the booming electronics. The other auxiliary generator provides power to the electronics gear as well as to the freezer compartment on the vessel and also includes an auxiliary hydraulic system that is capable of turning the main shaft in an emergency. Surprisingly, the mast boom system of the KARLUK is somewhat unique (although a common feature in fish boats) as it provides sufficient lifting capacity for all operations on board the vessel (the boom extends out over the stern) and the associated mast gives a high point for positioning of the radar and crows nest, which is often required when navigating in constricted channels.

The KARLUK carries a hard skiff (aluminum) that is carried on deck during transit and surveying. U.S.G.S. feels that the hard skiff offers several advantages over an inflatable tender, including:

1) the skiff is drier and clothing stays dry,
2) the aluminum skiff is light and can be easily handled either on board the vessel or pulled on shore,
3) the greater carrying capacity of the aluminum boat versus an inflatable,
4) inflatables typically do not wear as well in the Arctic and cost considerably more than a comparably sized aluminum skiff. An aluminum skiff typically lasts one to two seasons.

The skiff also plays an important role during grounding. The skiff may be launched to conduct a bathymetric survey around the vessel (the skiff is equipped with a flasher type sounder system) to assist with refloating. Also the skiff may be used to push the bow of the KARLUK around as the stern section of the vessel is usually the portion which grounds.

The RV KARLUK is configured with an inside head which consists of a "port-a-potty" type toilet. While the vessel is operating in the Beaufort Sea, under the direction of Dr. Reimnitz, the "bucket and chuck it" technique is used instead of the head, allowing the head to be used as a wet locker for foul weather gear or for diving gear. While the vessel is operating in the Chuckchi Sea, under the direction of Dr. Larry Philips, the "port-a-potty" is reinstalled in the interior of the vessel which improves the moral of the crew, but at the sacrifice of usable space.

Dr. Reimnitz provided several additional comments on vessel suitability in the Beaufort Sea which are of interest. In particular the use of a twin engine, twin screwed survey vessel, which provides an additional factor of safety because of the extra engine was discussed at length. However, Dr. Reimnitz indicated in the 12 years of research conducted from the KARLUK they have never had a major engine breakdown and that a well maintained single screw vessel has less operating problems than a twin screw vessel. As an example, he sites one of the charter vessel operators in the Beaufort Sea that has a twin screw vessel capable of cruising at 15 knots but frequently has to cruise at 10 knots due to propellor damage or shaft damage. Dr. Reimnitz also noted that planing hulls had less storage space and do not perform well in heavier seas.

A critical aspect of any shallow water survey operation is the attitude of the vessel captain. In particular the skipper must be confident in his vessel and not afraid of proceeding in shallow water. Grounding must be anticipated and expected on a routine basis while conducting this type of survey. This factor has apparently been an important part of the successful operation of the U.S.G.S. vessel KARLUK.

2.2.2 Other Vessels

Other vessel operators and/or users from the Alaskan Beaufort Sea were contacted regarding vessel performance and configurations for conducting similar shallow water geophysical surveys. They are listed in Table 2.2. In general many of the comments support those summarized for RV KARLUK, however, several other points warrant emphasizing.

1) Shore-Camps

Shore-camps were generally regarded unfavourably for most work in the Alaskan Beaufort Sea. The reason for this was that they usually significantly complicate the logistics and increase overall program size. In particular a field cook is normally required and regularly scheduled meals are required. Such meal scheduling can frequently interfere with survey operations. The view of experienced operators in the Beaufort was that shore camps were not a reasonable alternative and that they significantly complicated logistics.

2) Remote Provisioning

Several aspects of remote provisioning are important particularly refueling and re-provisioning of stores. These have been accomplished on the Alaskan Beaufort Sea with minimal problems, typically by Twin Otter aircraft landing on beaches and leaving provisions for later pick-up. Drums of fuel can be towed to the vessel by floating them in the water, towing them to the vessel and lifting them aboard.

iii) Size

- defined as available deck space (5 m approx.), bench space (3 linear m), accommodation (4 - 5 people)

iv) Minimum Equipment

- defined as deck gear (anchor winch, lifting boom and winch, davits); portable fuel pumps, safety equipment and navigating instruments (see Section 2.2.2)

v) Engines and Auxillaries

- diesel (well-maintained with hydraulics and independent batteries); two auxiallary generators (minimum 5 kW output).

See Table 2.3 for vessels meeting or approach these criteria. Specifications for each vessel are included as Appendix 1.

Table 2.3 Existing Vessels

VESSEL	COMPANY	LOA	DRAFT	DAY RATE	COMMENTS
CANADIAN VESSELS					
M.T. PILOT II	Arctic Offshore Ltd.	74'	3'5"	$9500/day dry/crew	Refitted as survey vessel 1979, operation in 1985 uncertain, proven Beaufort Sea vessel since 1979.
SEQUEL	Beaufort Environmental Support Services	42'	5'5"	$1750/day wet/crew	Low cost, marginal suitability for survey work due to cabin limitation; hold has been used for alternative lab space and accommodation; only portable generators.
PRESSURE RIDGE	Double Echo Marine Services	45'	6'	$1800/day dry/crew	Availability uncertain; no generators, poorly equipped, no specifications supplied.
J. ROSS MACKAY	GSC/EMR	43'	4'	N/A	River boat, accommodation limited; seaworthiness questionable for offshore operation; portable generators only.
HERSCHEL	Beaufort Environmental Support Services	52'	4.6'	$2200/day dry	Present configuration of vessel not suitable (2 berths - no boom or A-frame) but owners indicate willingness to modify; has been used for summer work in Beaufort Sea.
NEAKOOLIK	Beaufort Environmental Support Services	49'	3'	N/A	Very limited accommodation & cabin but could be accommodated with container for specialized operations.
U.S. VESSELS					
KARLUK	U.S.G.S.	42'	3'5"	N/A	Ideal survey vessel; proven; outfitted specifically for shallow water geophysical surveys.
R.V. HOOD	Kinnetics Laboratories	32'	33"	$3200(US)/ day dry/crew	General geological and oceanographic support vessel; proven; has operated with four people and gear up for one month; size limits extended geophysical surveying capabilities.
R.V. ANNIKA MARIE	Ocean Research Services	43'	3'5"	$3600(US)/ day dry	All around survey vessel with proven Beaufort Sea record; has conducted nearshore geophysical surveys for up to three week periods.

3.0 GEOPHYSICS

3.1 OPERATING CONSTRAINTS

The problem associated with the use of reflection seismic techniques to delineate geological structure in shallow inshore waters such as found in the Beaufort Sea are more varied than those techniques used further offshore. Apart from possible geological, navigational and logistical differences, the main technical difficulties arise from the two adjacent reflecting boundaries: the sea surface and the seafloor. These boundaries tend to trap acoustic energy resulting in multiple echoes of large amplitude (multiples) coincident with energy reflected from geologic boundaries below the seafloor. Because of the relative amplitude of the reflected energy, the useful but weaker energy reflected from the deeper structure is invariably masked by the seafloor multiples. This inevitably limits the data window of seismic profiling systems (for observing seismic structure and events) to the time interval between the outgoing acoustic pressure pulse and the arrival of the first multiple. In inshore regions, except perhaps for estuarine environments, this situation is exacerbated because of the acoustic properties of the sediments. These tend to be "hard" and therefore reflect rather than transmit sound energy. This phenomenon not only reduces energy transmitted into the seafloor but increases the amount reflected back into the water column.

In attempting to review the performance of commercially available seismic and profiling systems for use in shallow water, it is necessary first to consider the technical requirements and then to catalogue the expected performance of available systems in order to find the best compromise. In addition systems that have been used in similar operations in the past should be appraised for their cost/effectiveness.

The specific area that this study addresses is the coastline of the Canadian Arctic and the water depths of interest range for 5 m to 15 m. The penetration requirements cover two regions: the upper 15 m of the seafloor and the zone that extends from 15 to 75 m. These two requirements suggest that two separate systems may be required. Thus the range of equipment under review must include shallow profiling using "narrowband" sonar systems and "broadband" impulsive type sources that are usually termed shallow seismic systems.

3.2 SOME THEORETICAL ASPECTS OF SHALLOW SEISMIC PROFILING

3.2.1 The Effect of the Sea Surface Boundary

1) On a Towed Source

The two boundaries mentioned above affect the pressure signature received from a source/detector combination in two fundamental ways. Initially, the sea surface, if assumed to be acoustically smooth, forms a perfect "soft" acoustic reflector behind any source of energy that may be towed in the water. This "soft" reflector has a plane wave reflection coefficient of -1 which indicates that if the towed sound source is omnidirectional, a second "image source" will develop which will produce a pressure impulse similar in form to the original source pulse but inverted and delayed. The length of the delay is equal to the difference in travel time for a plane wave travelling in any direction to pass between the actual and image source at the speed of sound in the water. Since this delay will be a function of angle, then the source/image combination will have directional properties. Assuming a perfect reflecting surface, the resulting downward going pressure impulse will be the sum of the source and image impulses. It will be of longer duration than the original impulse and have a modified spectral content with a reduced bandwidth characteristic.

2) On a Detector

Reflected acoustic energy is detected after its journey through the earth by a pressure sensitive transducer that produces a signal (voltage) proportional to instantaneous pressure. In general, transducers or hydrophones are omnidirectional and therefore react in a similar manner to reflected energy. Thus, a pressure wave from below the seafloor will first be detected on its upward journey (direct) and then again after being reflected from the sea surface. The receiving hydrophone will superimpose the delayed and inverted reflected signature on the direct arrival to produce a receiving system with directional and bandlimited properties similar to that discussed for the source.

Thus, a seismic system comprising of a source and detector will have a response determined by the system geometry. The actual voltage received from a hydrophone will be the convolution of this response with the basic source pressure signature. Unless steps are taken to modify the reflecting characteristics of the boundary, the resulting overall system response will effectively lengthen a source pressure pulse which implies less resolution capabilities but with an increase in energy over certain frequency bands due to reinforcement of in-phase components.

3.2.2 Modification to the Reflecting Boundaries

The suggestion is made above that the source amplitude can be increased, albeit at the expense of resolution, by utilising the surface reflector and that directional properties, which may offer some advantages in seismic profiling, may result. However, the use of the surface as a reflector in this manner will be limited to cases where variations in the properties of the reflector do not significantly affect the overall response or to cases where its effect is removed from the time window of interest by physical separation. This latter case is, in reality the deep towed situation. The alternative to using the sea surface as a reflector when in a shallow tow situation is to modify the reflector itself or to lessen its effect. This can be accomplished by fixed, passive reflectors, shading of transducers and in using arrays of detectors rather than single elements.

3.2.3 The Effect of the Seafloor

In seismic profiling, the seafloor represents the first reflector that contains useful geological information. Subsequent layering, formations and individual objects such as boulders are also targets of interest from which information is required. The physics of the situation is such that target energy, particularly from the seafloor is not destroyed after being detected by the hydrophone but reflected from the water surface down towards the seafloor. This twice reflected energy, although less than the initial impulse energy, acts as a second source and is in turn reflected form the seafloor and detected a second time by the hydrophones. This process continues, involving the sea surface, the seafloor and subsequent reflectors until the energy level has decreased to below the detection threshold. The effect of these multiple reflections is to mask useful reflection data from deeper target horizons. In shallow water, where the separation between the seafloor and the sea surface is small, this effect limits the performance of seismic systems to a particular depth equal to the water depth, unless the deeper target reflectors produce a relatively large reflected signal that is shot to shot coherent. On the other hand, if the water depth is very shallow to the point that the pulse length is of the same order as the water layer, a conditions exists where the initial and multiple energy merges. In the limit, this "low frequency" condition may be beneficial for deep penetration in that the water layer becomes a perfect match for acoustic energy of a particular wavelength and the multiple effect vanishes. In reality, however, natural topography is constantly changing so that a seismic system to utilize this effect fully would have to be capable of adapting to these changes.

3.2.4 Penetration and Resolution

With any seismic system a compromise has to be reached between penetration and resolution. This results from the fact that sound absorption processes in the earth are frequency dependent. Thus, acoustic impulses with a predominant high frequency content will have limited penetration when compared with a predominantly low frequency source. However, high frequency sources imply short pulse durations in the vertical direction; a requirement for resolving closely spaced targets or layers. However, for detailed surveys, particularly where the geology is complex, resolution in the horizontal, or areal direction is very important. This implies an increasing sampling or firing rate which, in terms of overall energy requirements, can place a further constraint on penetration by limiting source amplitude.

3.2.5 Types of Sources

The types of systems that can be considered for shallow water seismic profiling fall into two categories. Impulsive types, which ideally produce a single negative or positive pressure impulse usually by the discharge of stored energy, and transducer types which involve the sinusoidal excitation of a piezo-electric transducer which converts electrical to acoustic energy.

Impulsive sources can involve the sudden release of stored electrical, mechanical, hydraulic, pneumatic or chemical energy and produce an impulse that is generally omnidirectional. These sources are non-reversible meaning that they operate only as generators of acoustic energy. Detection of the seismic signatures must be done separately by towing a single or an array of hydrophones.

Transducer type sources are narrow bandwidth generators which can also act as detectors. These transducers are usually excited electrically using pulsed sine waves with fundamental frequencies from 1 to 12 kHz and with pulse lengths form 0.1 to 10 milliseconds depending on range and resolution requirements. These types of sources tend not to generate as high a source pressure level as the impulsive sources and are generally used in areas of softer sediments such as silts and clays. As the transducers are reversible, the source and receiver are the same assembly and the different electrical signals are separated electronically. In shallow water work, however, this can cause problems due to the finite time required for the outgoing energy to dissipate. If echoes from targets arrive before this energy is dissipated then data will be masked. To reduce this problem, a separate receiving transducer assembly can be used.

In terms of the requirements for this project an impulsive type source would be required for the deeper (15-70 m) seismic profiling and possibly a transducer type system for sub-bottom operation up to 10 m penetration.

3.3 POSSIBLE SEISMIC SYSTEMS FOR USE IN SHALLOW WATER

a) For Sub-bottom Operation up to 10 m Penetration

Two possible modes of transducer operation can be considered here: (a) operation with the transducer mounted in a fixed position over the side of the vessel, or (b) in a towed vehicle which could also house a sidescan sonar system if required. Commercially available profilers include: (1) the Ferranti O.R.E. 136A sub-bottom profiler which can operate over a frequency range of 1 kHz to 12 kHz but is often operated at 3.5 kHz, (2) a Klein 3.5 kHz profiler and (3) a Datasonics DFS 2100 profiler (see Appendix 3 for specifications). The Ferranti O.R.E. system consists of four transducers which can be operated in a separate mode with two transducers acting as transmitters, and two as receivers. This improves the performance in shallow water. The O.R.E. 140 system includes a two fish weighing 150 kg, a Model 140 transceiver and a separate graphic recorder. The weight of the fish means that a small hand winch is necessary for launching over the side of a ship. Ferranti O.R.E. 160 sidescan transducers can be added to the fish and a 160 tranceiver used to collect dual channel data. A second, two channel graphic recorder would be required to display the sidescan sonograms. Alternatively a three channel EPC recorder could produce a combined sidescan and profile record. No records are available showing the performance of the Ferranti O.R.E. Profiler in shallow water with hard bottoms; however, Figure 3.1 is a rather poor display of the system operating in deeper water with a slow firing rate. Penetration of several metres can be seen and optimised display procedures would improve on this. It is not known if the O.R.E. system has been used in the Canadian Beaufort Sea, but U.S.G.S. have used the system sucessfully in the Alaskan Beaufort Sea.

The Datasonics DFS-2100 system is similar to the O.R.E. but has dual frequency operation with frequencies selectable between 3.5 Hz and 200 Hz. Figure 3.2 shows typical output over a range of sediment types. The higher frequency unit could be used for suspended sediment studies and as a high resolution echo sounder. A sidescan system is not normally available with the Datasonics DFS-2100.

Both the above systems could be used in a fixed, over-the-side mount in which case water depth information could be extracted.

The Klein 3.5 kHz profiling system is designed for use as part of a combined sidescan and shallow profiling system which has been used in the Arctic regions for several years. This unit comprises a single transducer and probably has less power capability than the O.R.E. system. Recent studies by the U.S.G.S. have shown that good data can be obtained from the Alaskan Beaufort Sea in shallow water as shown in Figure 3.3 but on harder sediments (Figure 3.4) the penetration is limited. However, again it is felt that better display techniques would improve the record. Figure 3.3 and 3.4 also show the problem that could occur in very shallow water where the outgoing pulse could contaminate the seafloor echoes.

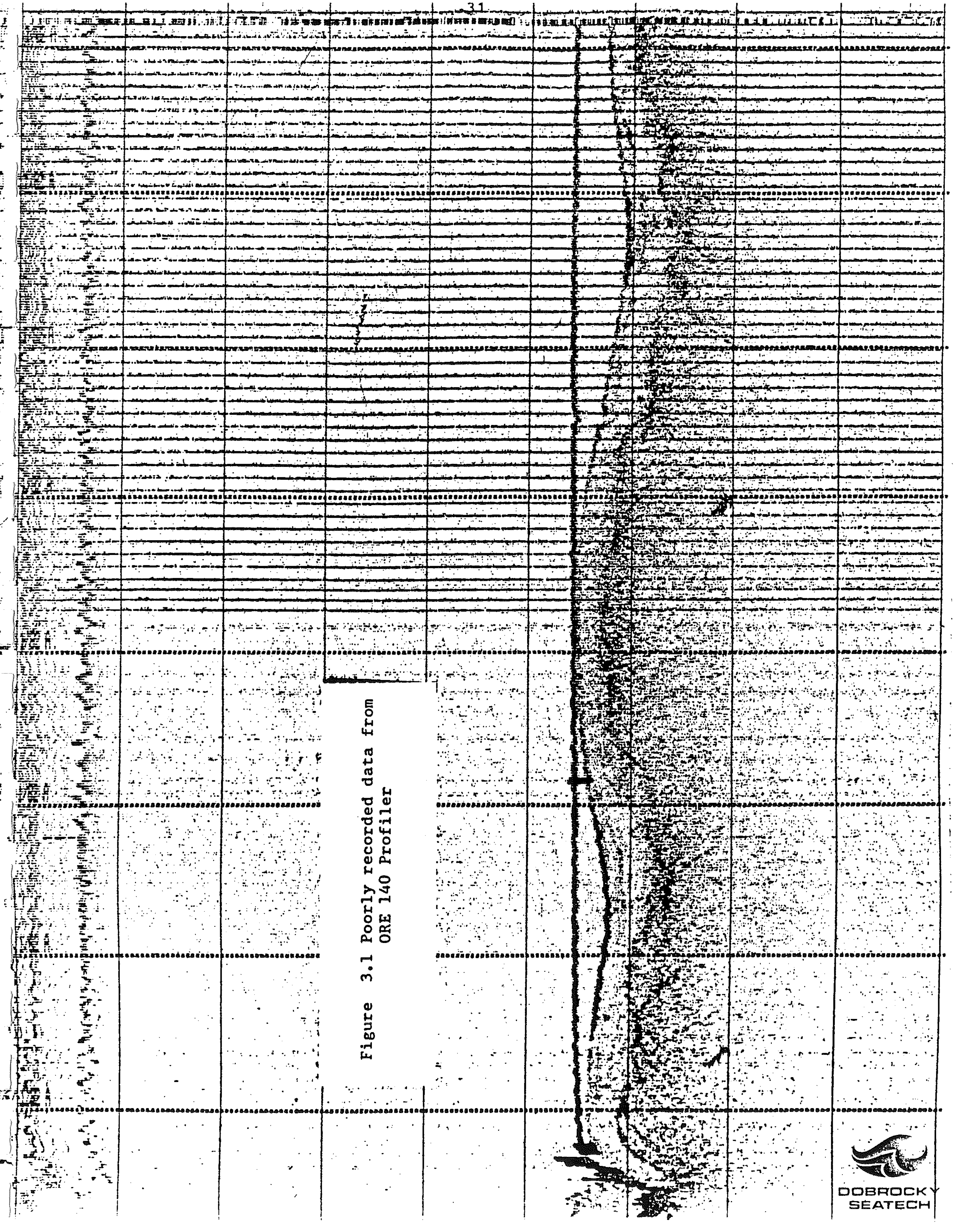


Figure 3.1 Poorly recorded data from ORE 140 Profiler

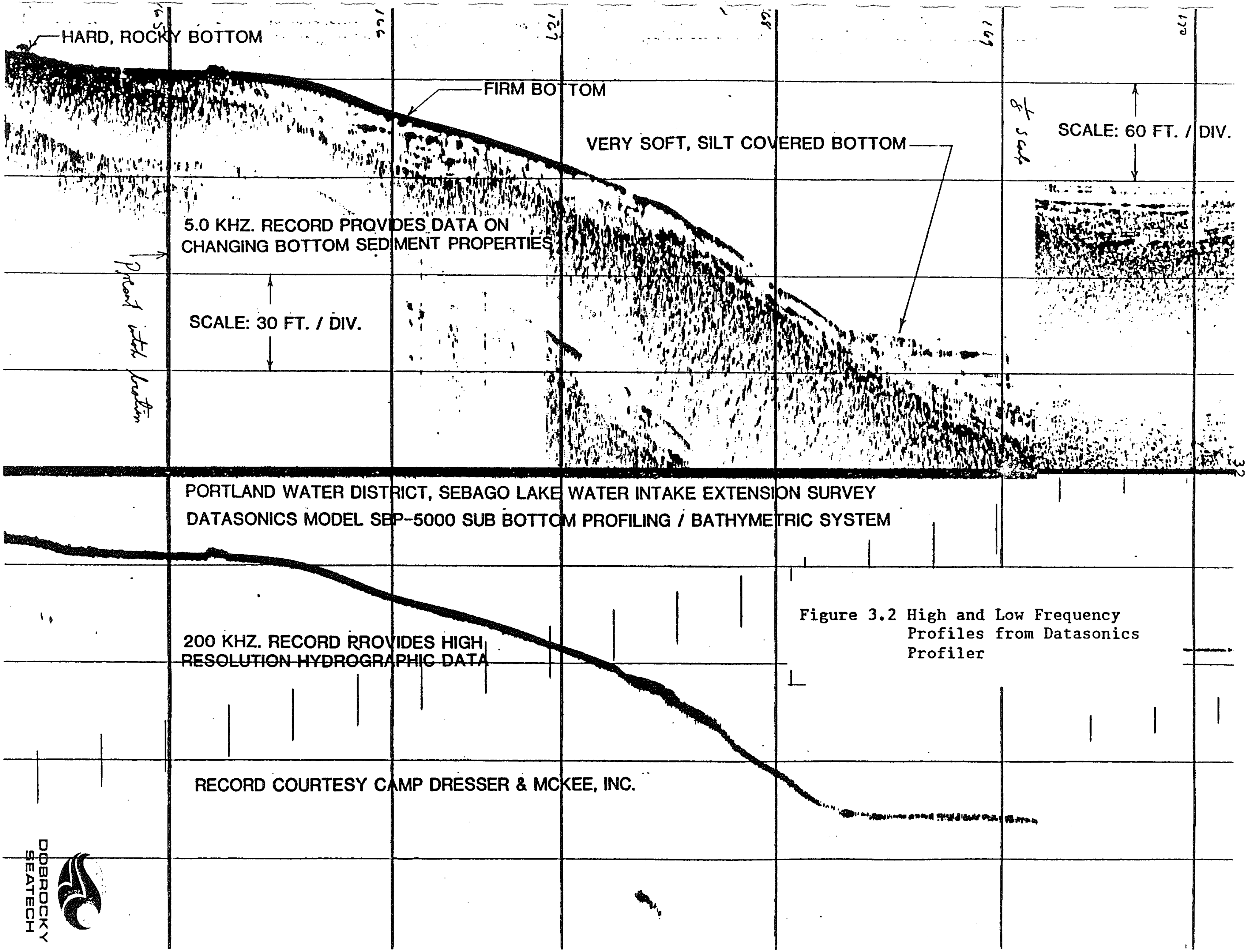


Figure 3.2 High and Low Frequency Profiles from Datasonics Profiler

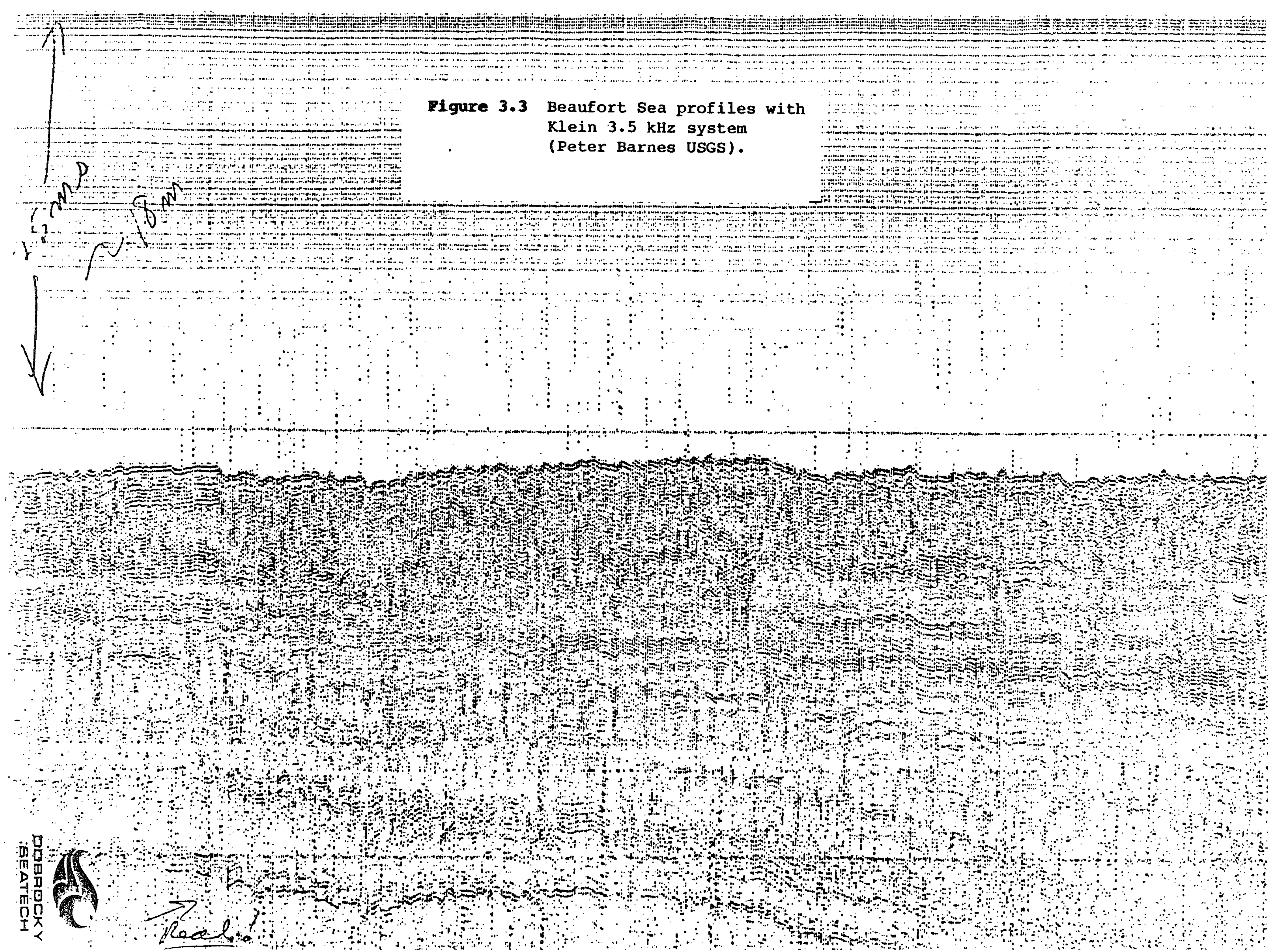


Figure 3.3 Beaufort Sea profiles with Klein 3.5 kHz system (Peter Barnes USGS).

Real!

DOBROCKY SEATECH

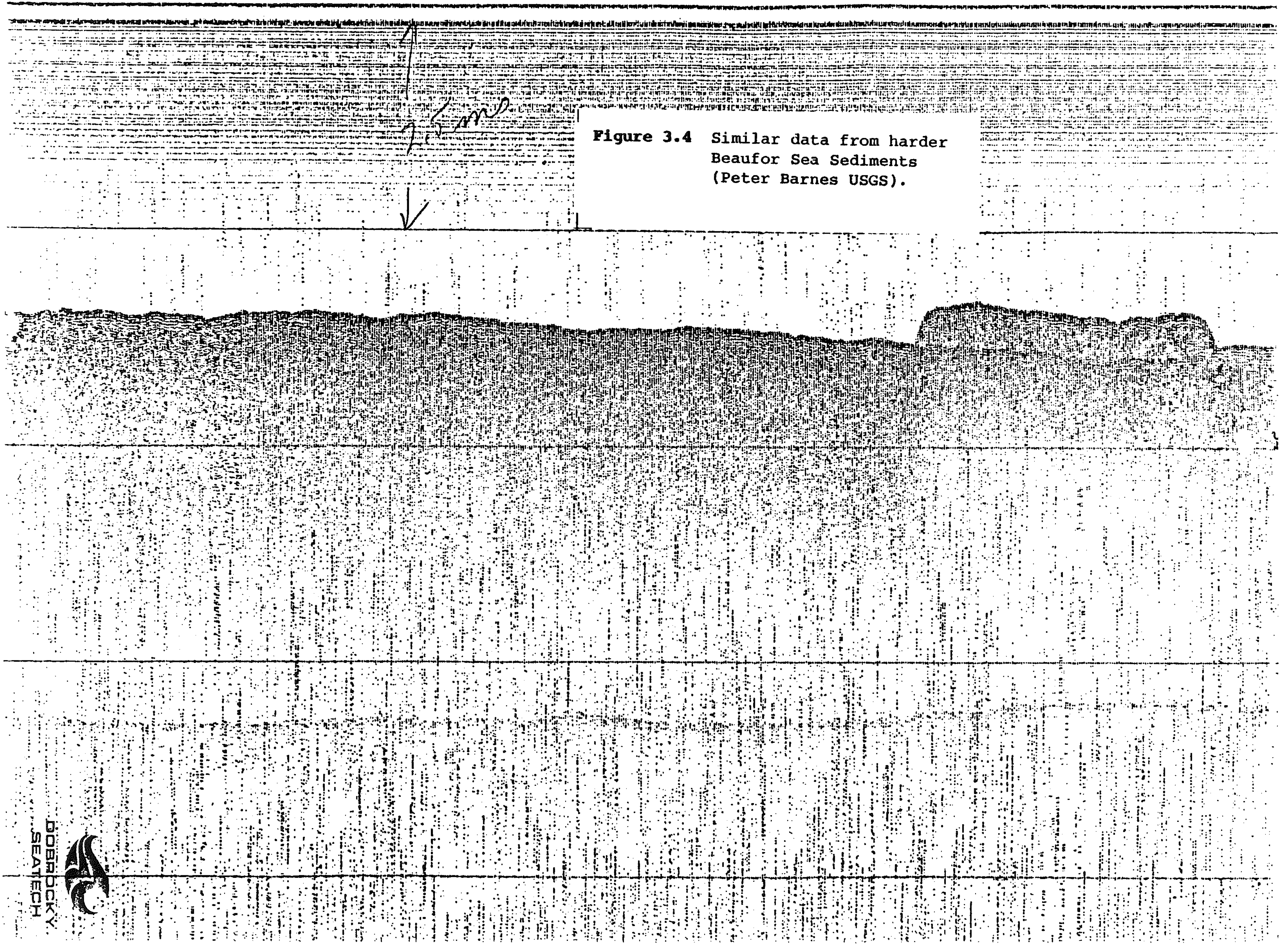


Figure 3.4 Similar data from harder Beaufor Sea Sediments (Peter Barnes USGS).

b) For Deeper Penetration

Several different types of systems can be considered here. There are the electrodynamic "Boomer" type systems which produce a near ideal positive pressure pulse with a fundamental bandwidth of approximately 1 kHz to 5 kHz, electrical "sparker" type systems using single or multi-tip arrays, the more powerful "mechanical" systems which include small air guns and water guns and finally, the Flexichoc system. Some of these systems have been used in the Arctic, however, as with the profilers, little shallow water data are available. All these systems require a detecting system which invariably involves a shallow towed seismic ministreamer positioned to minimize noise from wave action, ship generated sources and turbulance. Several of the Boomer and Sparker systems have been reviewed in a recent report by Borden Chapman of Bedford Institute of Oceanography and technical extracts from the report are included herein.

The boomer and sparker systems offer the highest resolution but have lower penetrating capabilities. They could be considered as covering the intermediate regime with possible penetration up to 75 m in soft sediments but probably no more than 25 m in hard sediments such as sands and gravels. On the other hand the large "seismic" sources such as the air and water guns and the Miniflexichoc have greater power and have the capability to penetrate sands and gravels much deeper. These larger systems would have a lower firing rate than the boomer or multi-tip sparker indicating that horizontal resolution would not be as detailed. For all these systems the surficial sediment is important. If a "softer" surface layer covers a harder unit then often greater penetration is obtained. This may apply in this case in the very shallow regions particularly with the larger sources.

The fact that water depth is between 1 and 15 m indicates that any system would have to be deployed near or on the surface rather than towed at depth and adjusted as water depth changes. Thus a catamaran type sled or buoyed support system would be required.

3.3.1 Boomers

Several Boomer systems are available for lease or purchase. These include one Canadian system and two from the U.S.A.

a) The Huntec Boomer

A recent development by Huntec '70 Ltd. of Toronto is the Hydrosonde Sea Otter system comprising a catamaran supported boomer, ship-based power supply and storage units, and a Benthos ministreamer or "Exorcist" hydrophone system for very shallow operation. Examples of recent test results are given in Figures 3.5 and 3.6 and further details are provided in Appendix 3. Unfortunately, results of the "Exorcist" hydrophone system are not available but it is expected to produce an improvement in very shallow operation by reducing direct interference and by reducing the surface multiple.

b) The Ferranti O.R.E. Geopulse Boomer

This system has been in use for at least a year and has been well accepted in industry. It comprises a catamaran supported boomer, a power supply and a receiving unit consisting of a 20 element hydrophone array, line amplifier, TVG/AGC amplifier and EPC recorder. Figure 3.7 is an example of a graphic record from the Arctic collected in water depths of 50 m. Figure 3.8a is from the aforementioned BIO report and Figure 3.8b was provided by Ferranti O.R.E. Figure 3.8a includes a swell filter option which has potential in removing the effects of swell from the records and Figure 3.8b shows the exceptional performance of the system in very shallow water. The technical specification of the boomer is similar to that of the Huntec boomer, however, the amplifier/receiver appears to have some useful features.

c) The E.G. & G. Uniboom System

These system which are reviewed in the Chapman report have been used commerically for almost twenty years. Like the other two systems they comprise a sound source, energy source and receiving array with some signal

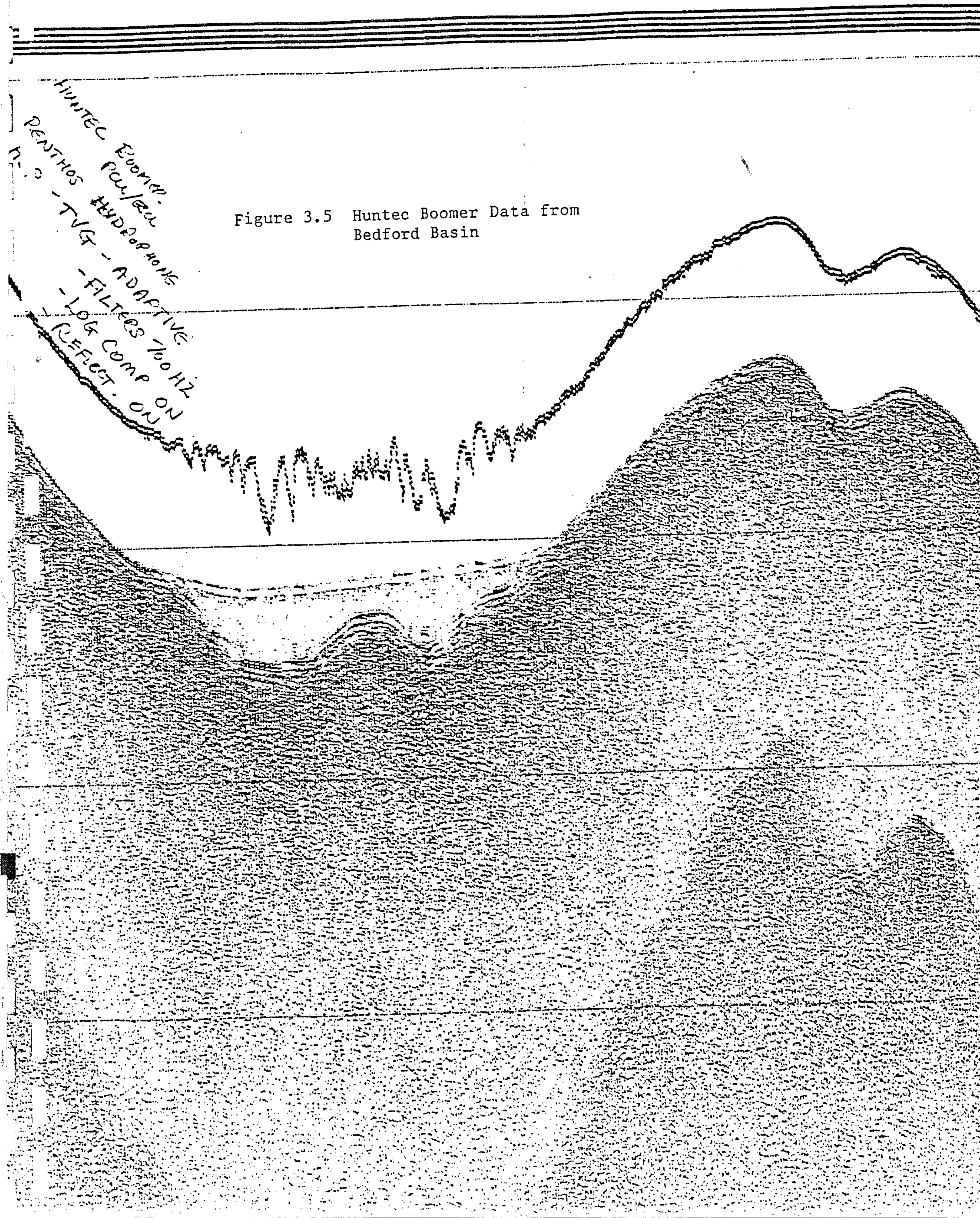
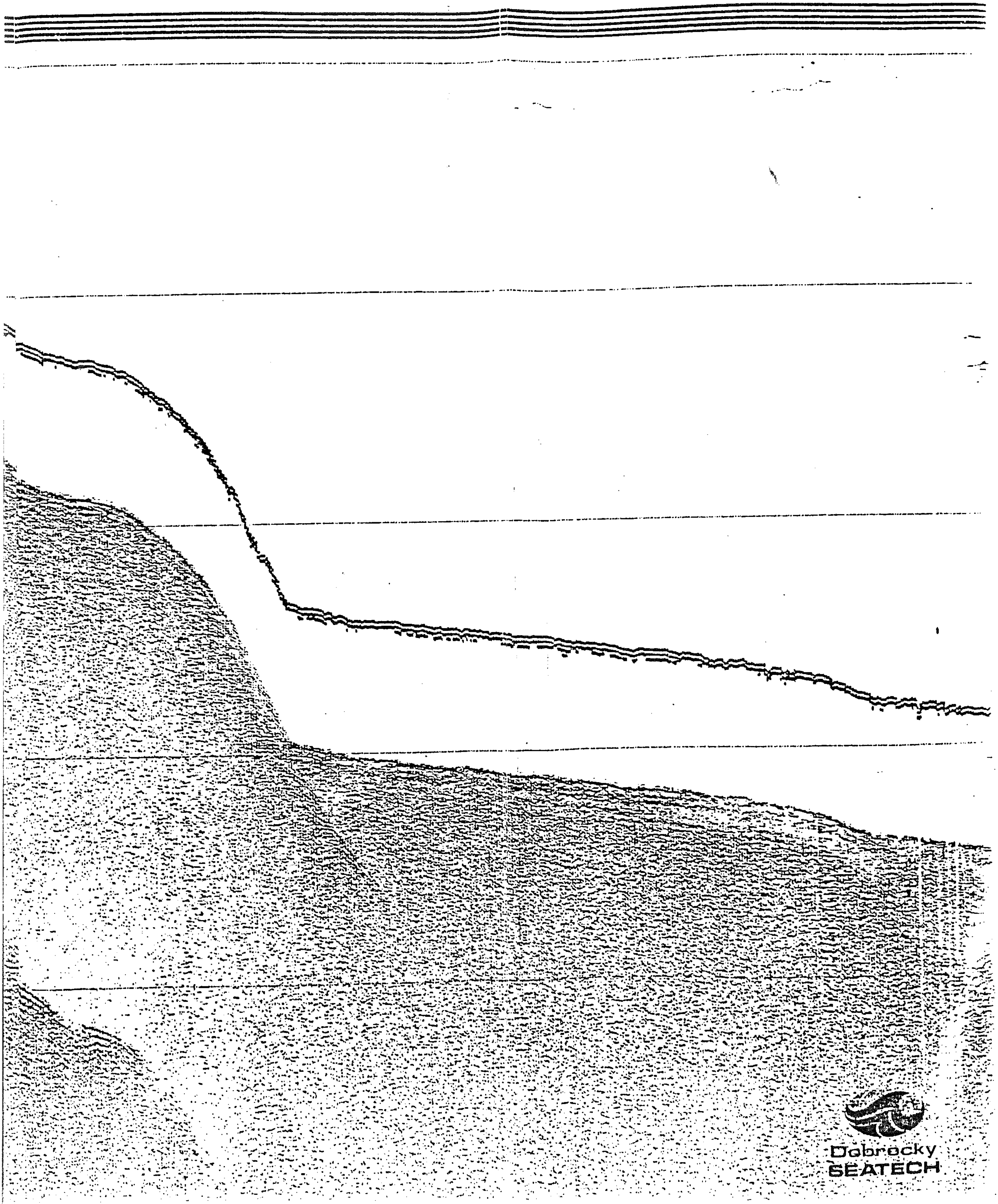


Figure 3.5 Huntec Boomer Data from Bedford Basin



Dobrocky
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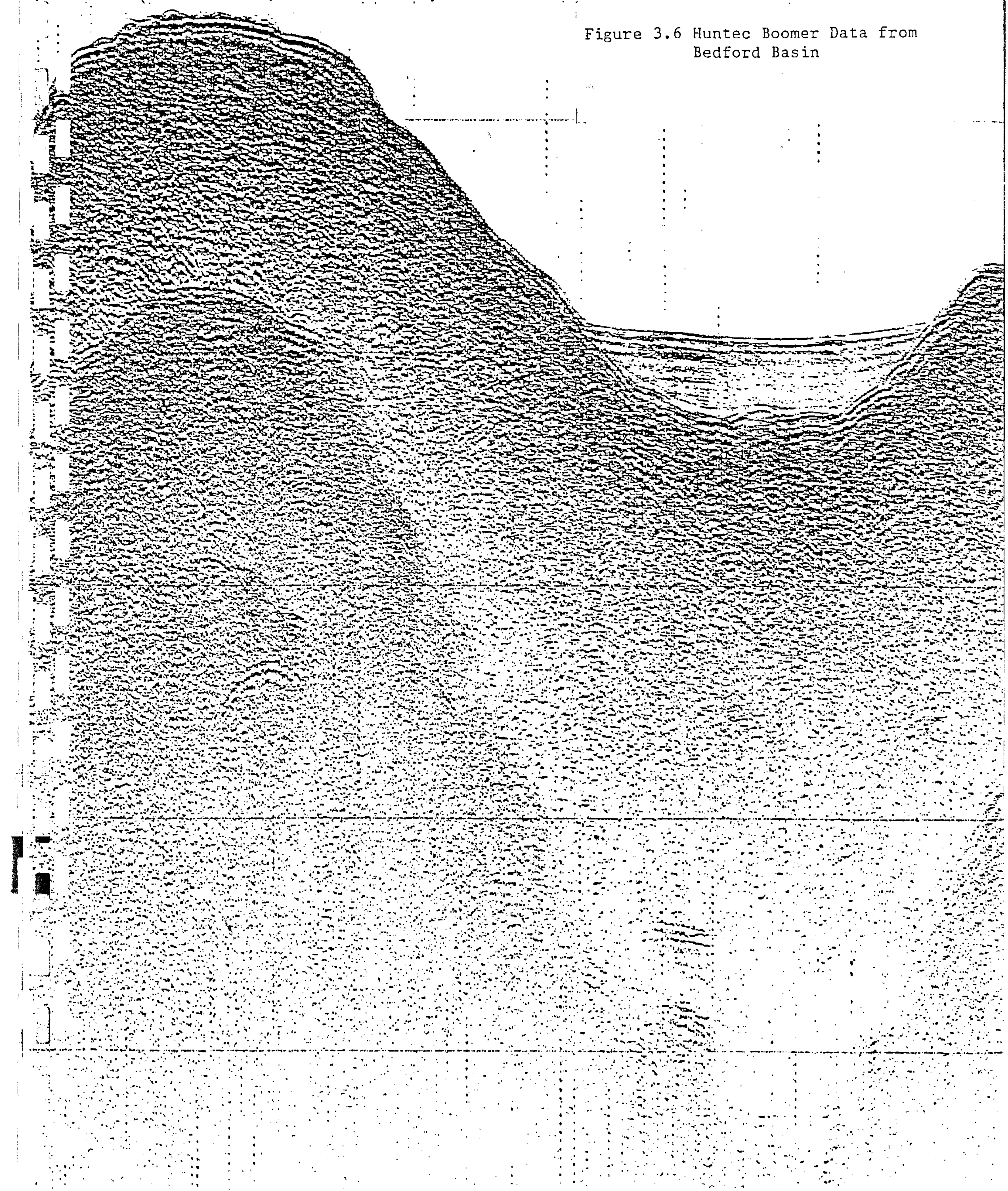
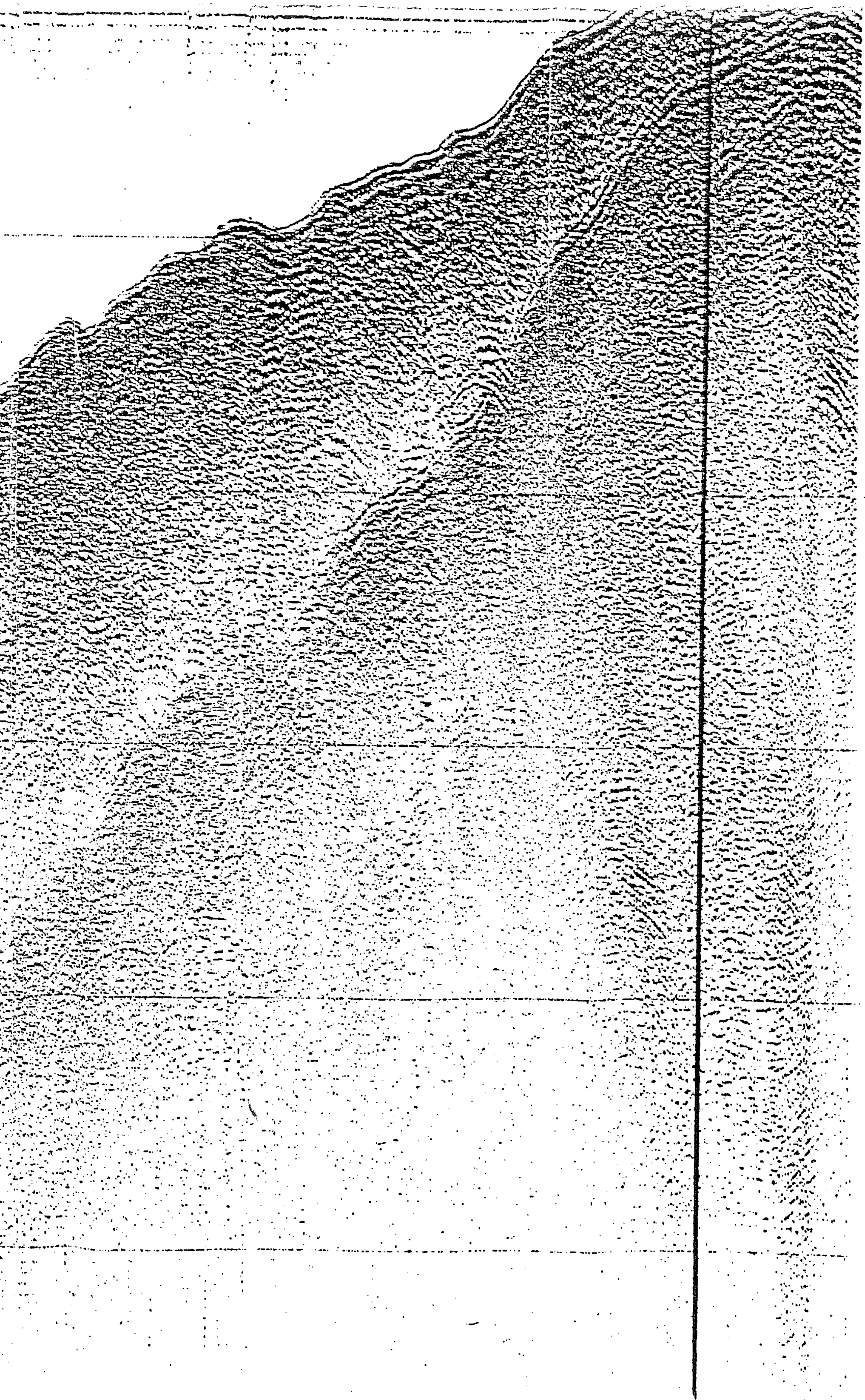


Figure 3.6 Huntec Boomer Data from Bedford Basin



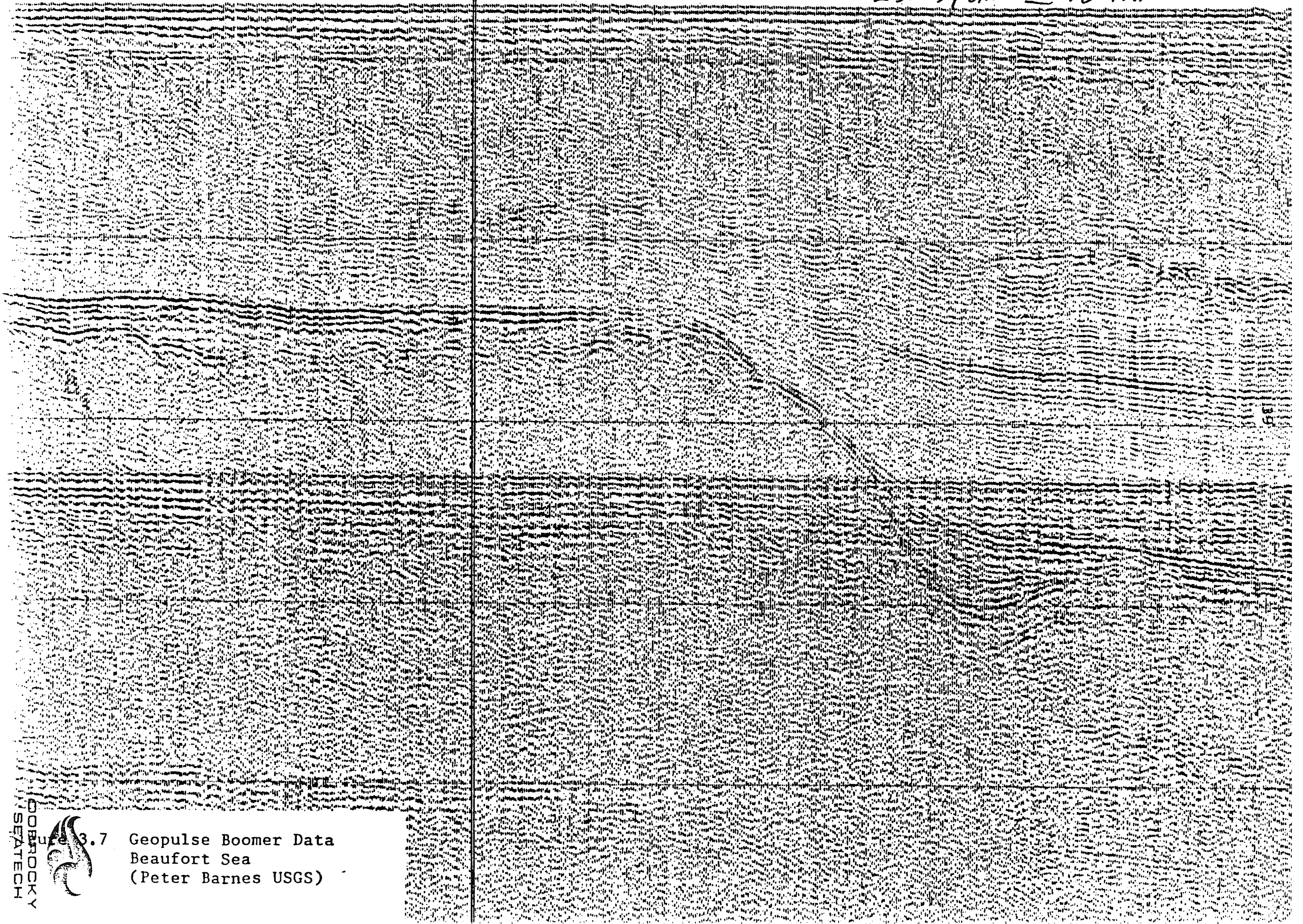
15-20

Dobrocky
SEATECH

50m water dept

EPC 3200 Rcd.

25ms/div ≃ 18.7m



ure 3.7 Geopulse Boomer Data
Beaufort Sea
(Peter Barnes USGS)

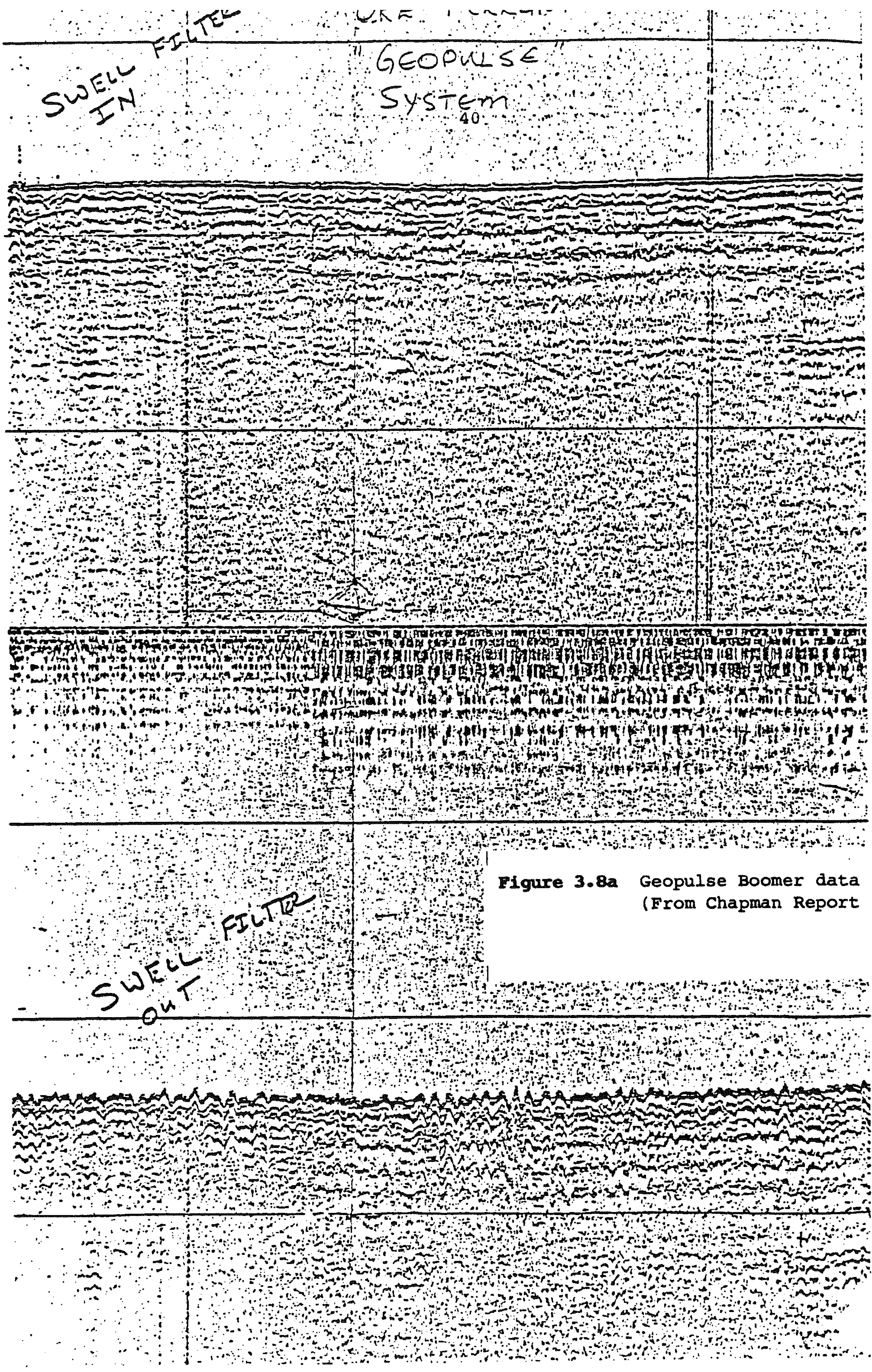
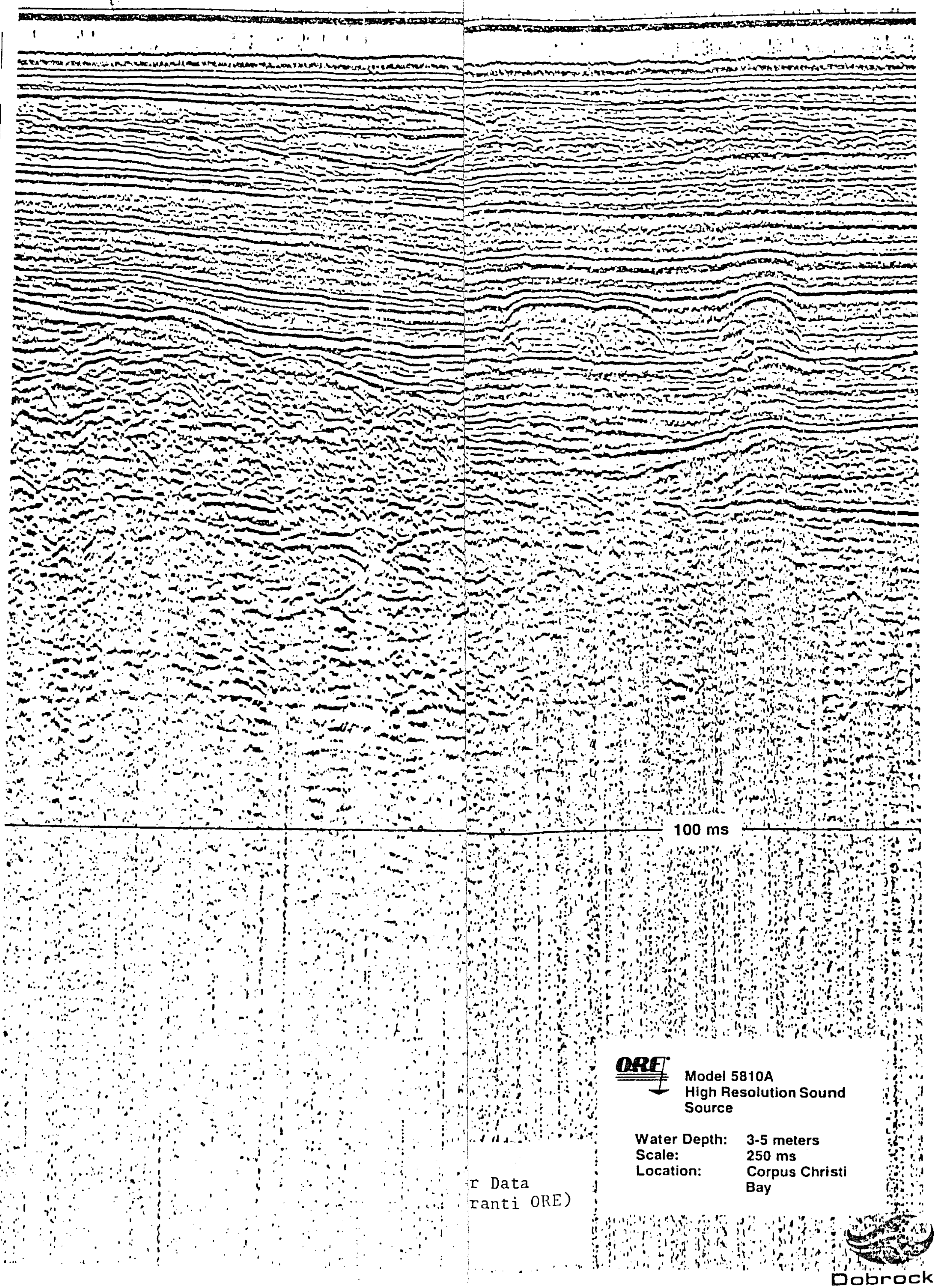


Figure 3.8a Geopulse Boomer data (From Chapman Report - BIO).



r Data
ranti ORE)

Dobrocky
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processing and a graphic recorder. The "sub tow" version of the system is capable of being towed approximately 20 m deep but would offer no advantages over a catamaran system in shallow water. This system can also be used with a multi-tipped spark array which is a useful feature. No examples of Uniboom records are available but they are expected to be similar to the Huntec and Geopulse data.

3.3.2 Shallow Sparkers

Commercially available sparkers are also discussed in the Chapman report. Like the boomers they can be configured in a variety of ways but for shallow work would be towed very close to the surface. Under normal open sea conditions when salinity levels are normal, they are very reliable, however, in brackish water they can cause problems. The advantage of sparkers is that power levels can be varied over a wide range. Whereas boomers are generally limited to 1,000 Joules electrical input power (less for high repetition rate firing) power levels can exceed 10,000 Joules if required, bring sparkers up to seismic source regime.

Figure 3.9 is an expanded replay of an N.S.R.F. spark array from data recorded in the Beaufort Sea. The repetition in this example is 1/4 second and because of the horizontal expansion, great detail can be seen. In some cases detail can be seen down to 30 m below the sea bed. This data was obtained from a system towed in water depths around 50 m deep with the source towed close to the seafloor with an input energy level of between 200 and 400 Joules.

Recent brush tip sparker developments have improved acoustic pulse waveform from large sparker arrays at these low power levels. Figures 3.10a, b & c are three examples of profiles using various combinations of energy source receiver with a line tip (or Brush) type array. Although various firing rates, sweep and paper feed rates have been used, this ensemble of sparker profiles suggests that several equipment combinations can produce good data and that differences that do exist may, in most cases, be geological and operator dependent. Figures 3.11a and 3.11b are two examples of a higher powered brush tip sparker using EG&G multi-tip array at approximately

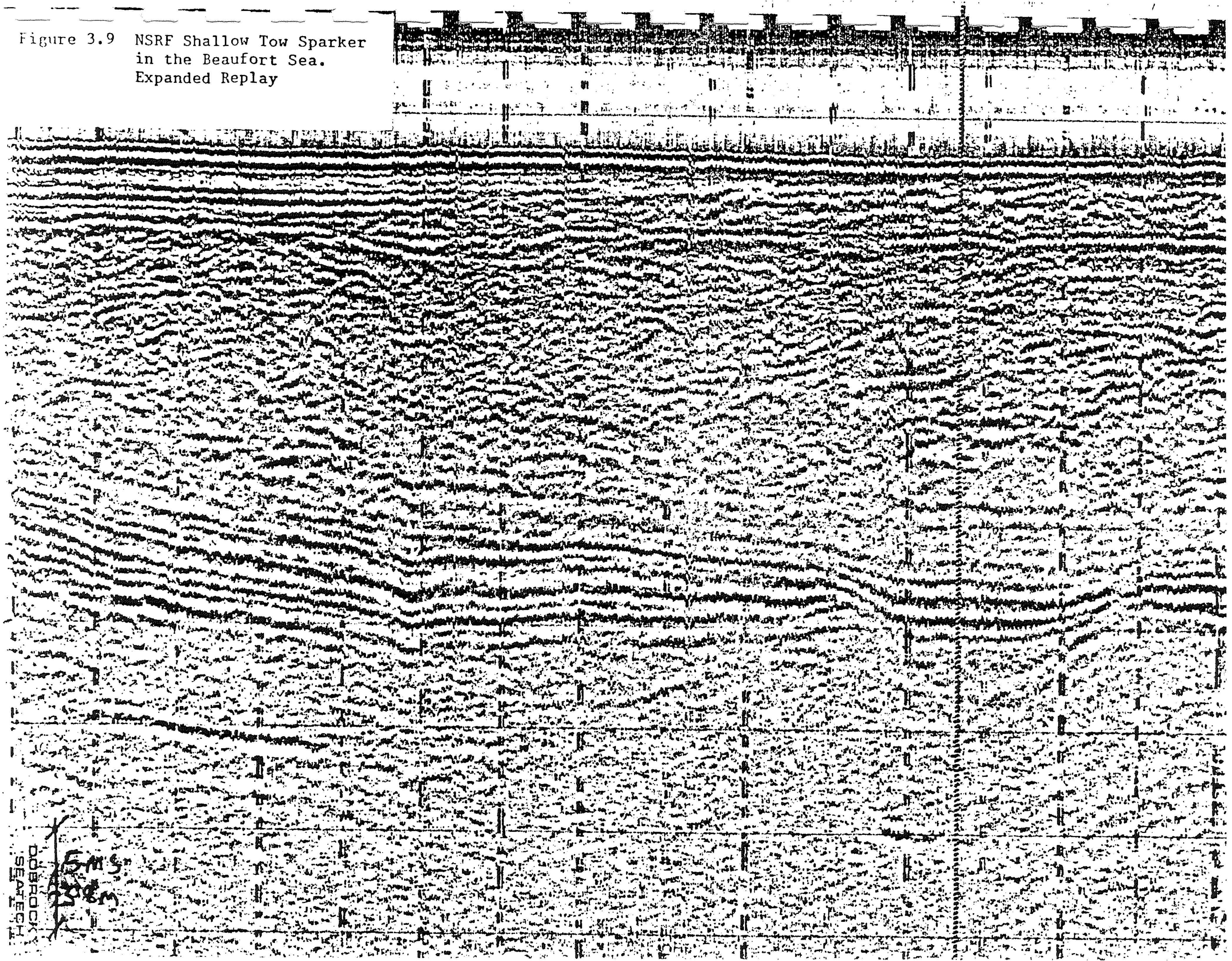

Figure 3.9 NSRF Shallow Tow Sparker in the Beaufort Sea. Expanded Replay

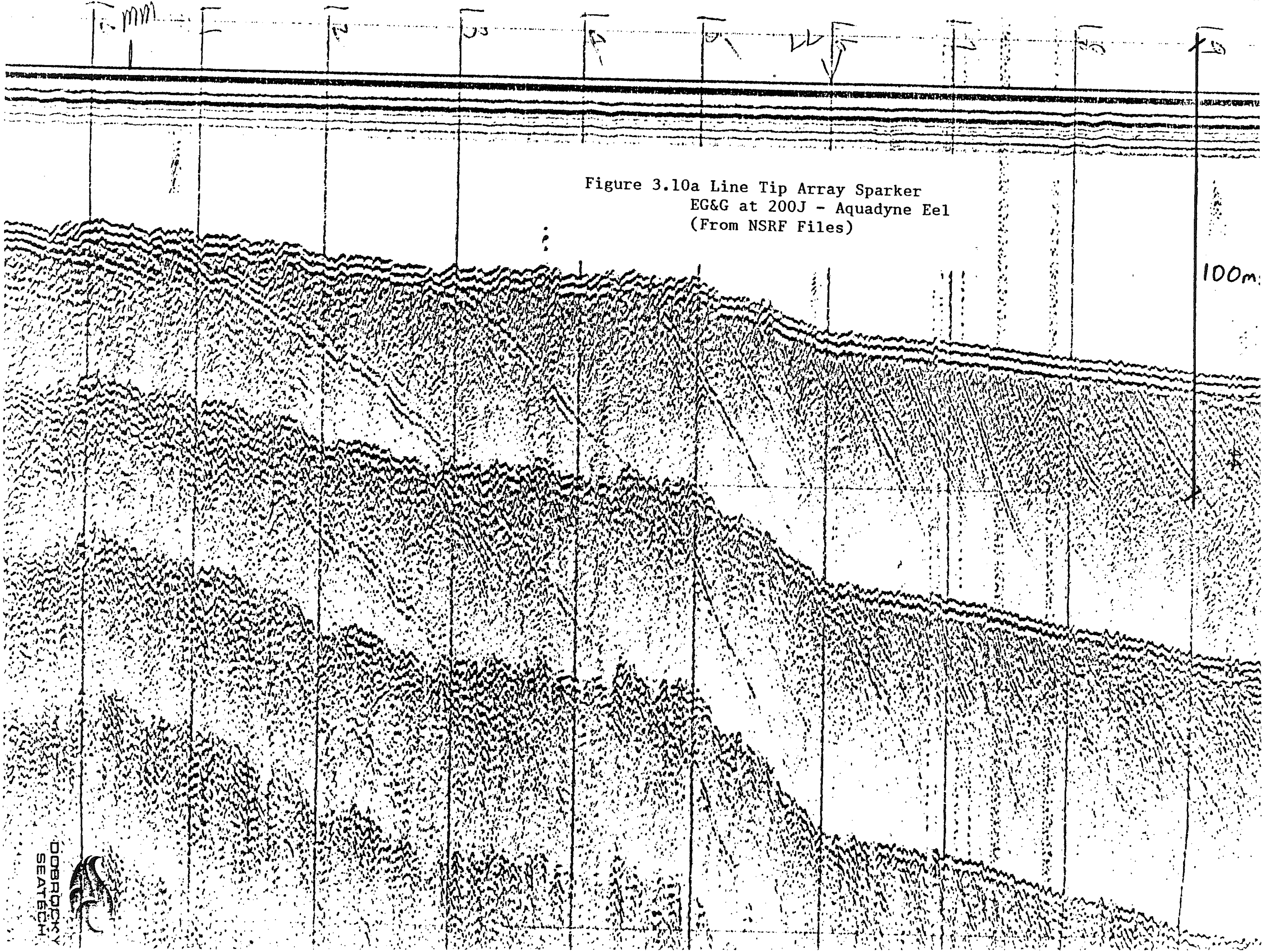

Figure 3.10a Line Tip Array Sparker
EG&G at 200J - Aquadyne Eel
(From NSRF Files)

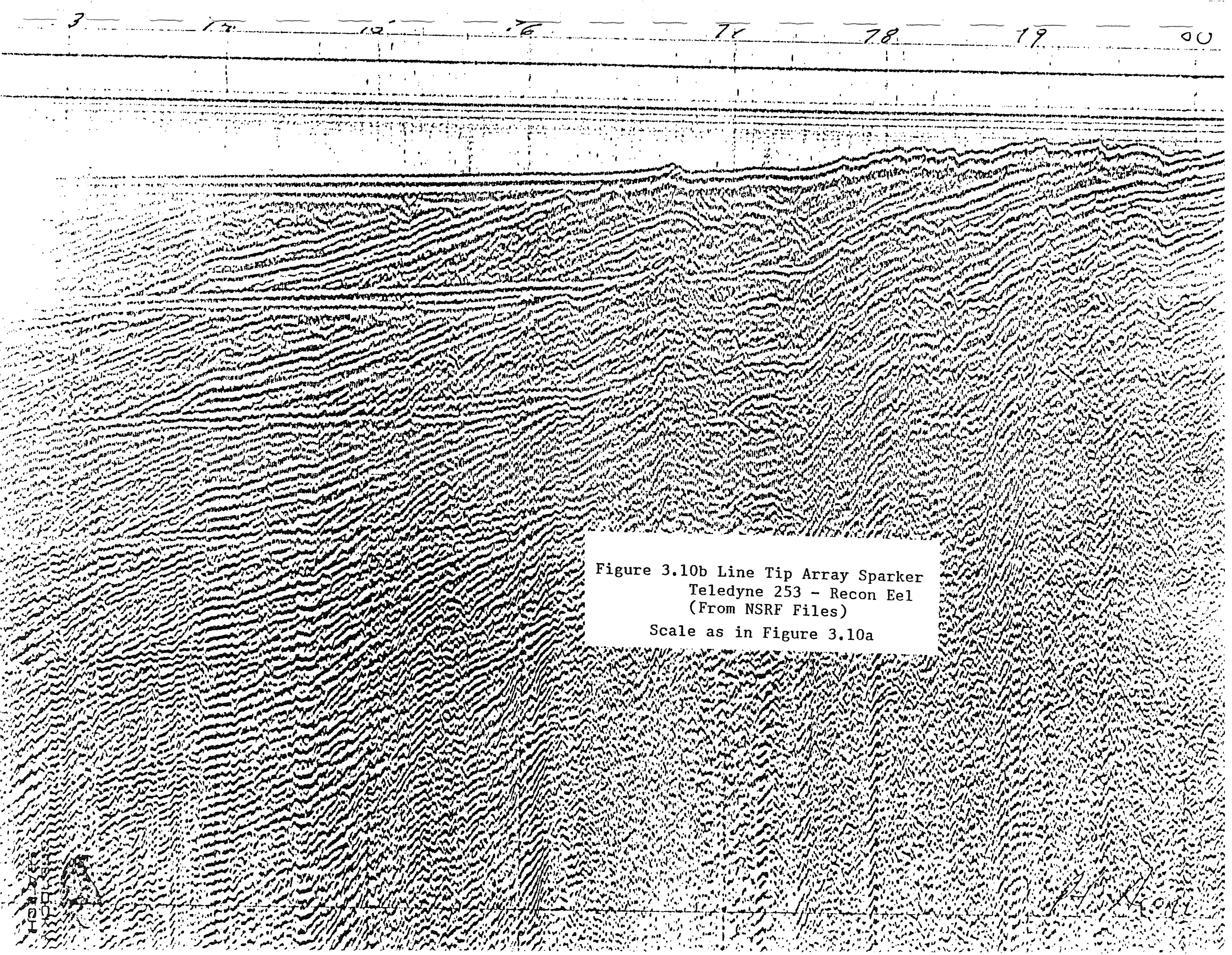

Figure 3.10b Line Tip Array Sparker
Teledyne 253 - Recon Eel
(From NSRF Files)
Scale as in Figure 3.10a

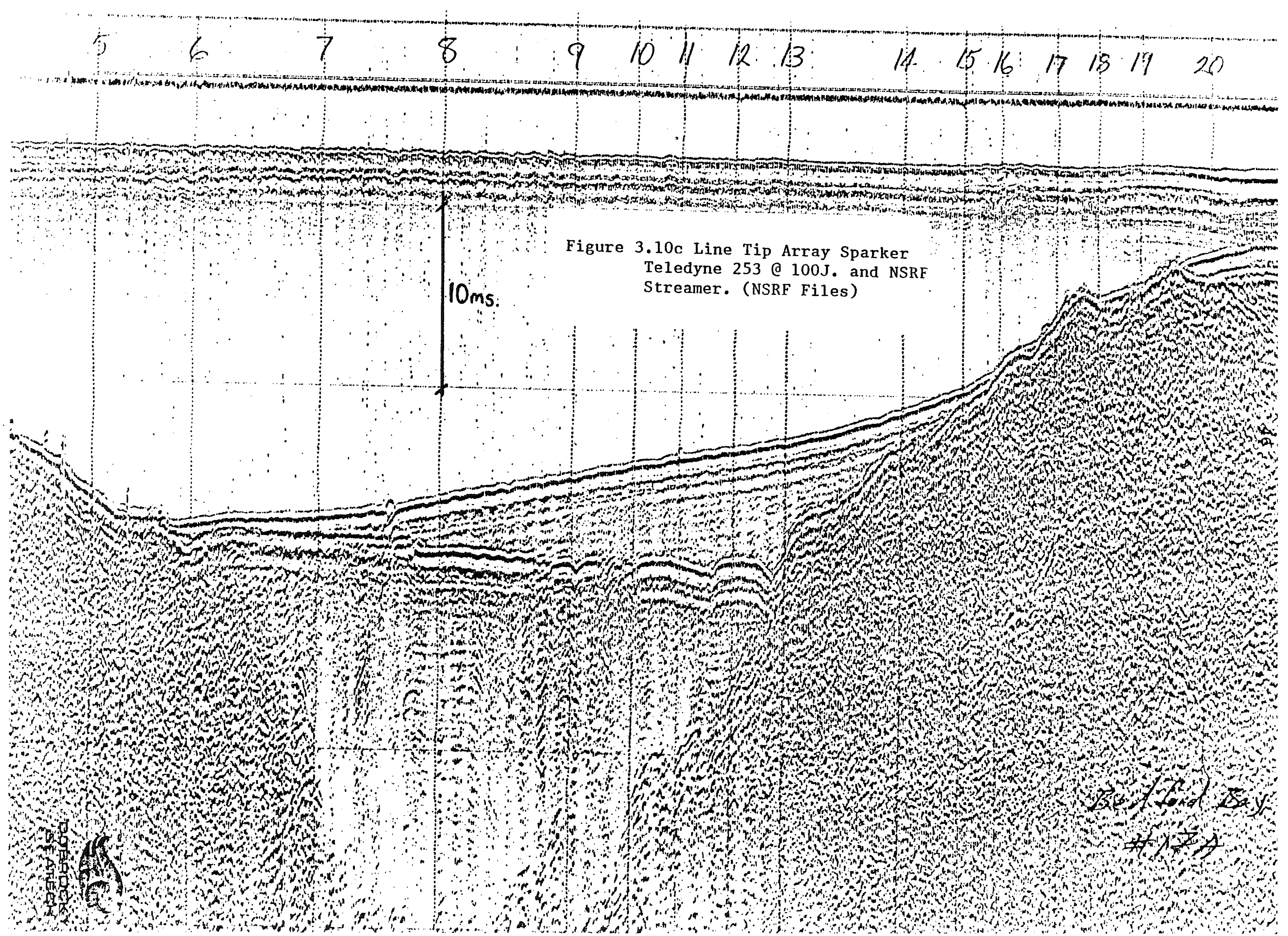

Figure 3.10c Line Tip Array Sparker Teledyne 253 @ 100J. and NSRF Streamer. (NSRF Files)

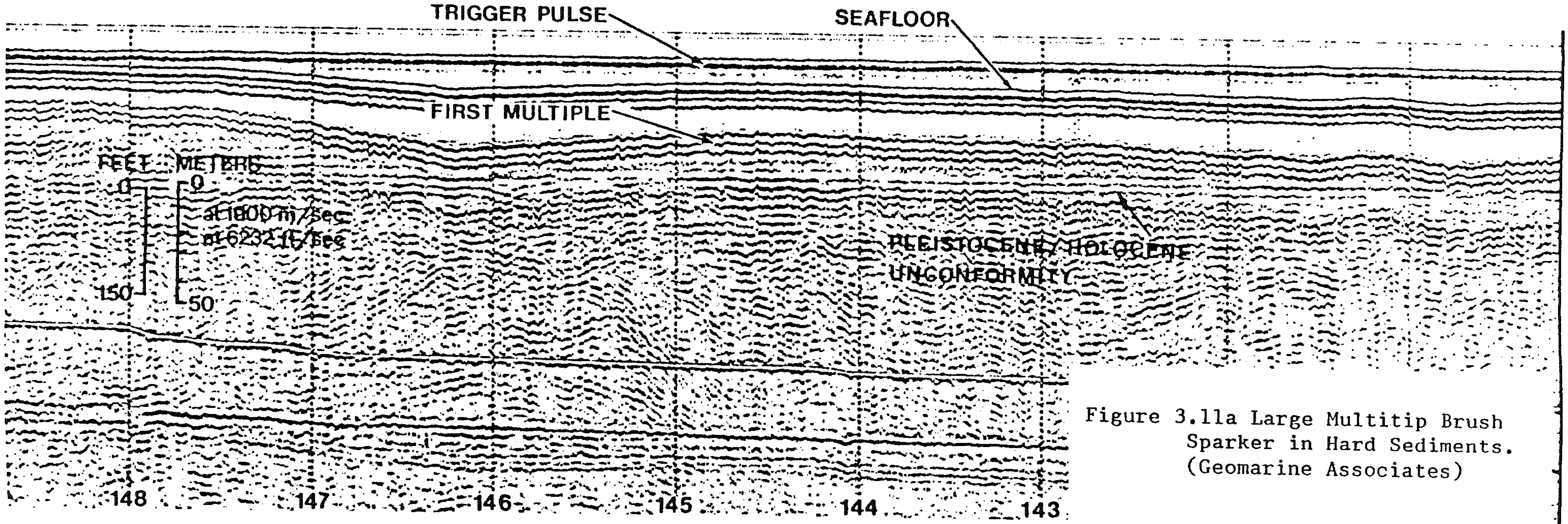

Figure 3.11a Large Multitip Brush Sparker in Hard Sediments. (Geomarine Associates)

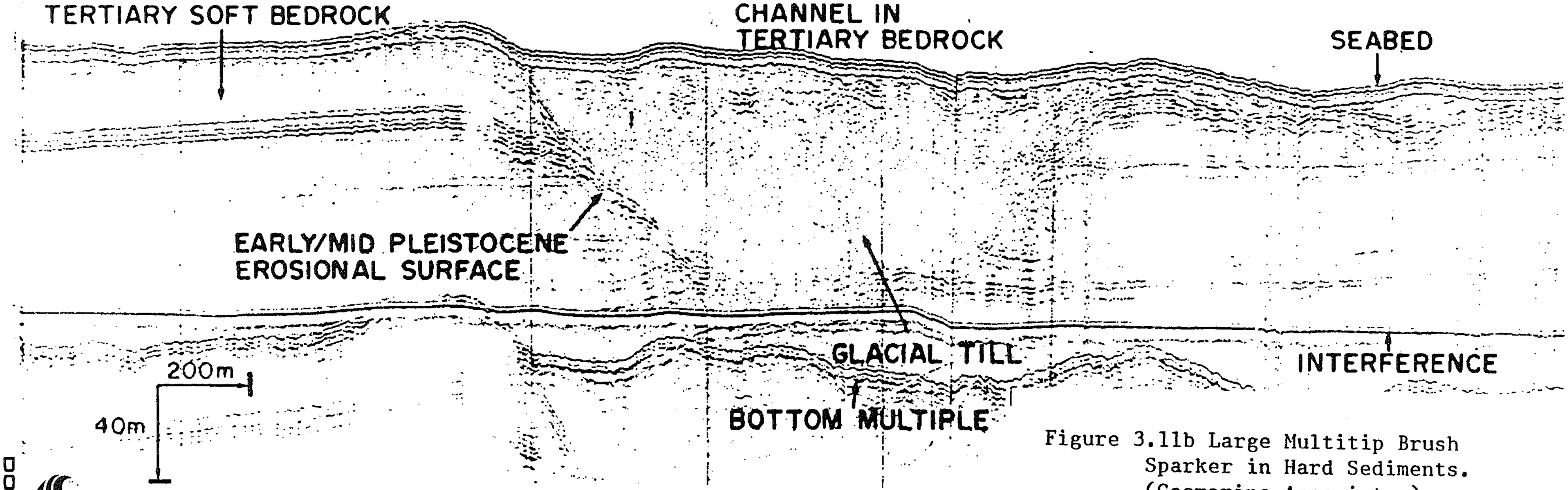

Figure 3.11b Large Multitip Brush Sparker in Hard Sediments. (Geomarine Associates)

1000 Joules. In the shallow water case (Figure 3.11a) the seafloor is composed of dense, hard packed sand and in both cases the rather long pulse length can be observed. Penetration up to 100 m can be seen.

3.3.3 Seismic Sources

The higher powered seismic sources that could be used for deep penetration include air guns, water guns and the Miniflexichoc source as well as the larger sparker arrays mentioned above. Of these sources only the air gun has been used in the Arctic - with very good results. The water gun is a recently available system which is gaining interest.

a) The Small Airgun Array

The air gun system has been used for high resolution profiling for many years and has generally involved 5 cubic inch and 10 cubic inch guns often with wave shape kits to improve performance. Figure 3.12 is a profile from the Beaufort Sea obtained with a 2 x 10 cubic inch array at a one second firing rate. The tow depth of the gun was approximately one meter and the ministreamer was very shallow. Penetration up to 0.3 seconds can occasionally be seen and resolution is about two metres.

b) The Water Gun

The water gun is a new development and has undergone recent trials in the Strait of Georgia. Its performance in these trials was impressive from a technical viewpoint and one outstanding feature was the amount of energy above 1 kHz. However, there has been some doubt expressed about the reliability of the gun over extended periods. Unfortunately the trials were not able to confirm this due to their limited duration. Figure 3.13 is an example of single channel data collected with a short ministreamer.

c) The Miniflexichoc

The Miniflexichoc system consists of dual hydraulically operated pistons which are separated against the ambient water pressure prior to release.

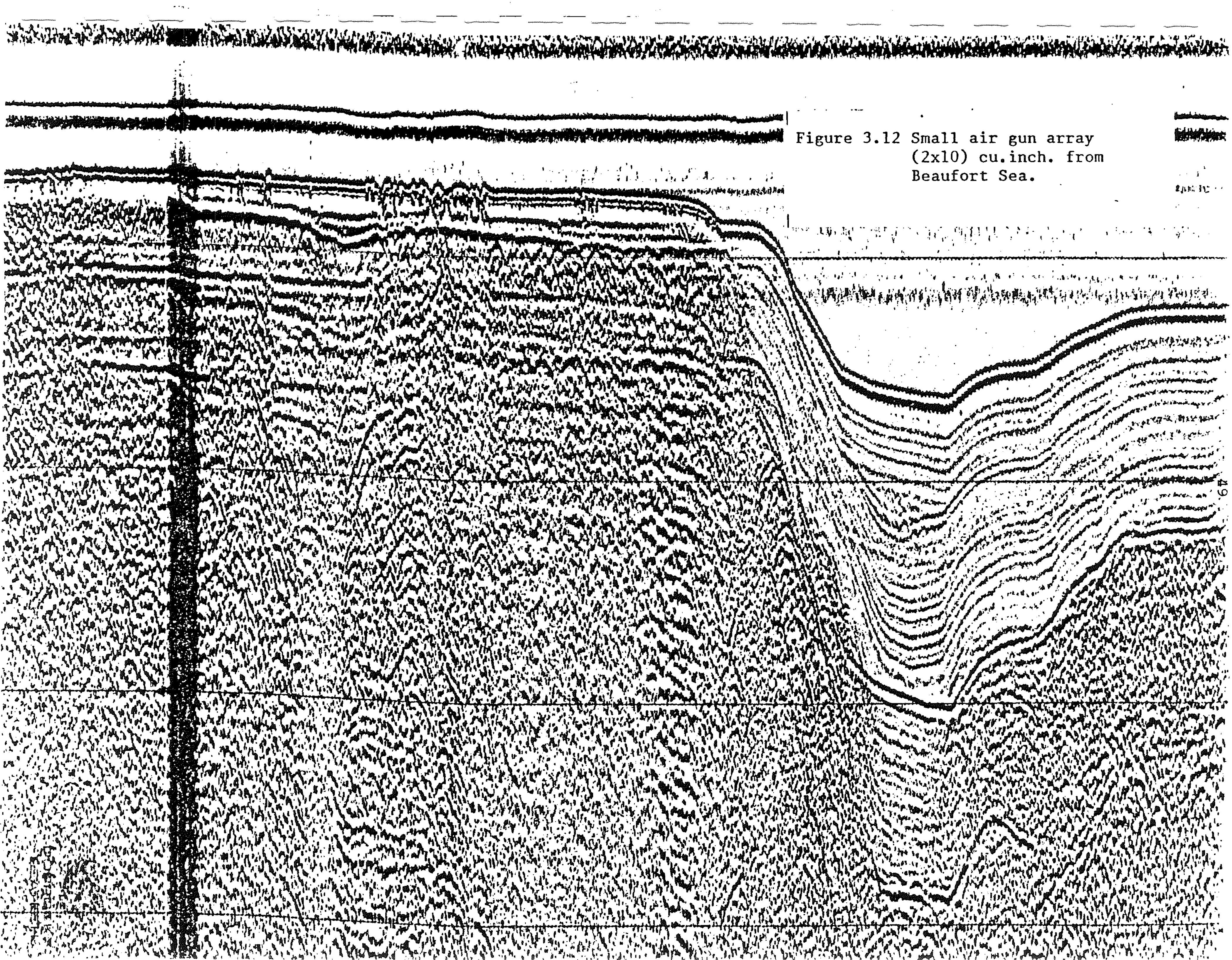

Figure 3.12 Small air gun array (2x10) cu.inch. from Beaufort Sea.

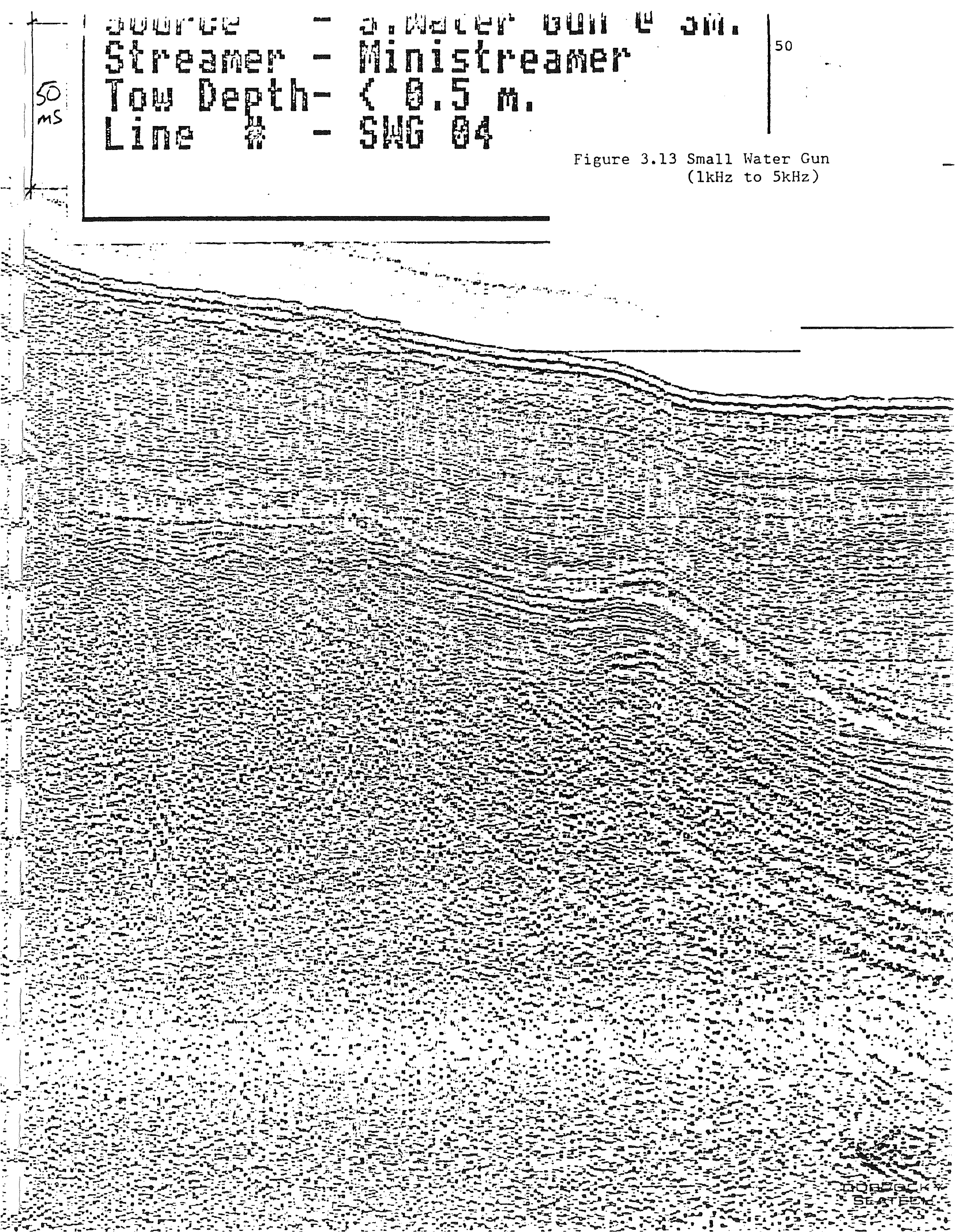

Figure 3.13 Small Water Gun (1kHz to 5kHz)

This source, which has been in commercial operation for many years and has been used in surveys in the deeper water areas of the Beaufort Sea, has a good reputation for quality performance and reliable operation. Figure 3.14 is an example of processed multichannel seismic data and Figure 3.15 of single channel data.

d) Large Sparker Arrays

As mentioned earlier a large sparker array could be used for the deeper work. However it is felt that the pulse shape would not be capable of providing the resolution requirements for this project and is not dealt with in detail.

3.4 SIDE-SCAN SYSTEMS

Four possible systems are considered herein of which three are discussed in reasonable detail. It was mentioned earlier that a side-scan combined with a profiler may be useful and two of the systems discussed took this configuration into consideration. Because of vessel size limitations, an over-the-side, short tow operation is considered rather than a deep tow operation which would involve a large winch and power pack.

3.4.1 The Klein 3 Channel Side-scan/Profiler

This system has been used extensively over recent years and has a good track record for resolution, and ease of operation. Two frequencies, 100 kHz and 500 kHz, are available and true scale and slant range correction can be implemented provided ship's speed information can be entered directly from the navigation. The recording system is self contained with a three channel graphic recorder and signal processer combined. The tow fish can support either an altimeter or a 3.5 kHz sub-bottom profiler, both of which can provide signals to the slant range correcting system.

Fig10: MINIFLEXICHOC PROCESSED SECTION
FOUNDATION PURPOSES

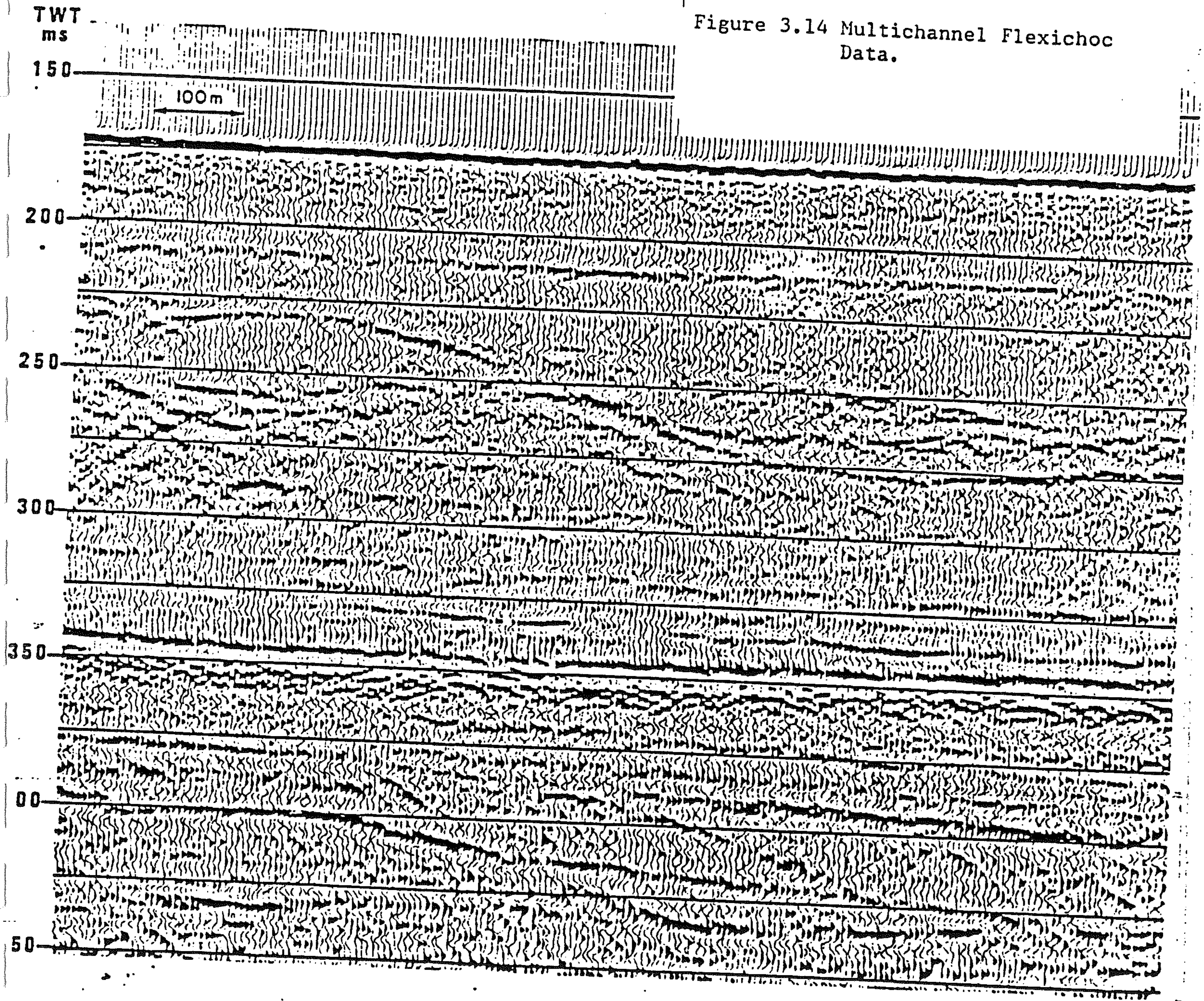

Figure 3.14 Multichannel Flexichoc Data.

SOURCE

MINIFLEXICHOC FHC 50

IMMERSION DEPTH : 1 m

DISTANCE BETWEEN SHOTS : 6.25 m

RECORDER

HR 6300 DIGITAL RECORDER

SAMPLING RATE : 1/4 ms

FILTERS : 32-1280 Hz

STREAMER

AMG 12 TRACES

TRACE INTERVAL : 12.5 m

IMMERSION DEPTH : 2-3

PROCESSING

CGG PROCESSING

-STACK 1200%

DOBROC Y
SEATEC

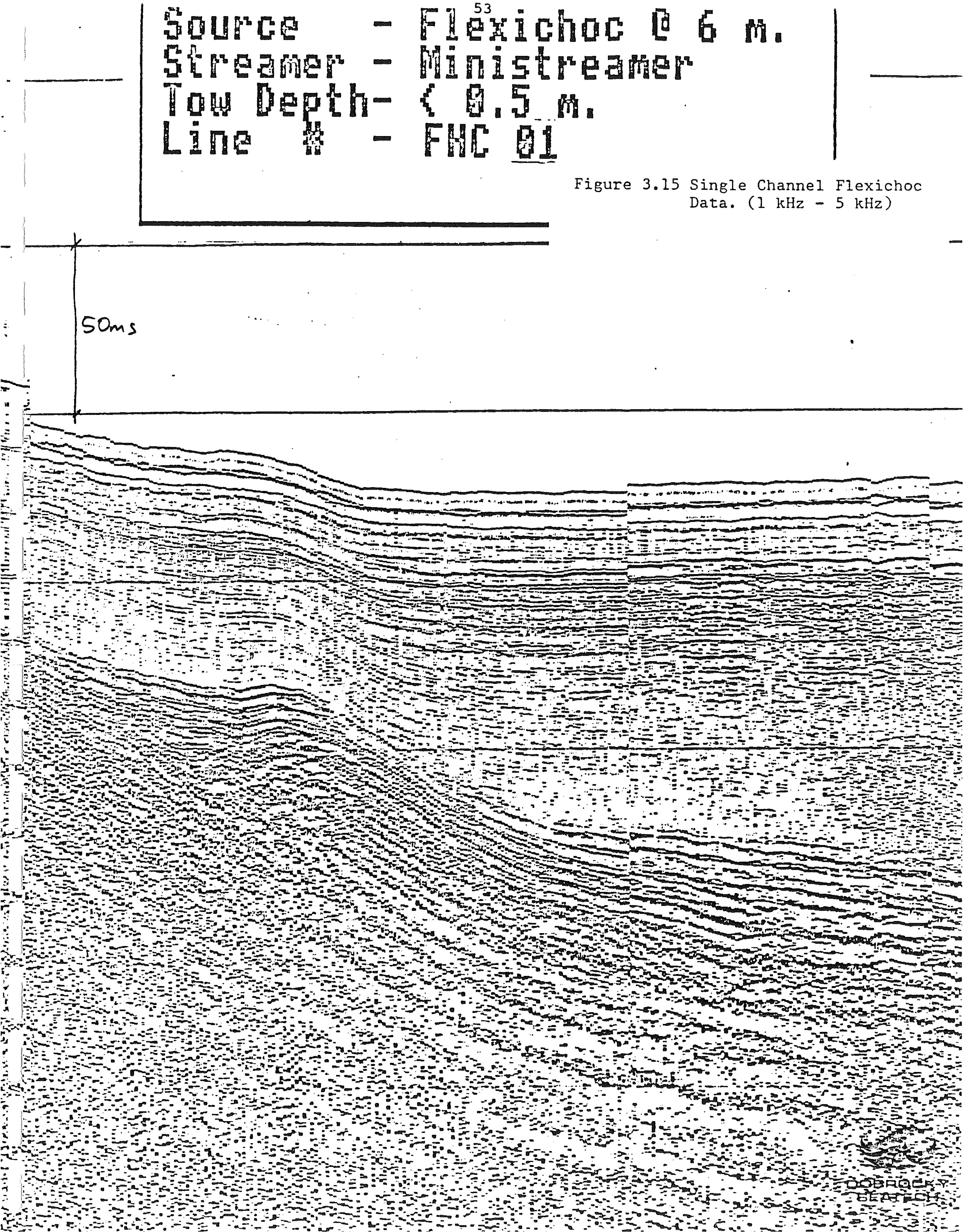

Figure 3.15 Single Channel Flexichoc Data. (1 kHz - 5 kHz)

3.4.2 The Ferranti O.R.E. 136A Fish with Side-scan

This is basically a profiler with a 100 kHz side-scan system added. Because of this, it is heavier but can be used from a small boat. Without the profiler the smaller, more easily manageable Model 159 side-scan fish is available. The shipboard units are not integrated and a separate graphic recorder is required. A three-channel EPC recorder would be of great value in this case. Again this system has been widely used and recent developments have included a slant range correction system.

3.4.3 The E.G. & G. Model 260 Side-scan Sonar

This system is a self-contained two-channel recorder/processor with an operating frquency of 105 kHz. This fish unit does not have profiling capacity but can be used from a small boat. The system also has a good track record and has complete water column removal and scale correcting capabilities.

3.4.4 The Waverlev Side-scan System

This is a U.K. system which has been in use with the Royal Navy for several years. It has a complete slant range and scale correction and can be presented to any scale on replay. The sonogram data can also be presented as a coloured T.V. image for detailed analysis. Unfortunately, no detailed information is available at the time of writing.

3.5 ECHO SOUNDING

There are two possible options to the collection of bathymetric data in shallow water - a hydrographic standard echo sounder such as the Honeywell Elac LAZ 4700 or the Altas Deso range of sounders or the better quality small boat sonars such as the Raytheon JRC sonar, Furuno and the Ross 801 sounder. One improvement to all sounding systems for hydrographic purposes is the use of a heave compensation system. Unfortunately, these systems are often more expensive than the sonar themselves.

3.6 EQUIPMENT AVAILABILITY AND RATES

The rates and availability given below are those current as of 9th June 1985. As with any leasing agreement, any quotes are subject to availability and summer is the busiest season for marine surveys. In addition the lease rates are often quoted with a one month minimum duration and from a supplier's viewpoint, a longer term lease is more attractive. Another point of note is that all leased equipment would entail transporation costs and equipment leased from outside the country would necessarily involve more expense as well as duty payments on entry into Canada.

3.6.1 Profiling and Side-scan System

a) Ferranti O.R.E. 136A Fish and 160B Side-scan System

Comprising 1) 136A fish with 4 x 137 transducers
2) 159 side-scan components
3) Hand winch and 50 m cable
4) 140 transceiver
5) 160B transceiver
6) EPC 3 channel recorder
System lease $670/Cdn./day
System with slant range processor $1,458/day
(Items 1 - 5 available from O.R.E., Falmouth, Mass. U.S.A.
Item 6 available form EPC, Danvers, Mass. U.S.A.)

b) Klein Sidescan and 3.5 kHz Profiler

Available on lease from McQuest, Burlington, Ontario. (Prices in Canadian dollars unless stated otherwise.)

Consisting:	1) 531 recorder, spare boards, power supply.	Lease $6,825/month	Cost $47,760 USD
	2) 100 kHz tow fish and spare board.	Lease $2,600/month	Cost $14,610 USD
	3) 500 kHz tow fish and spare board.	Lease $3,100/month	Cost $18,720 USD
	4) 3.5 kHz sub-bottom profiler	Lease $2,500/month	Cost $14,820 USD
	5) 100 kHz altimeter (Alternative to Item 4)	Lease $870/month	Cost $3,990 USD
	6) 100 m cable	Lease $460/month	Cost $2,506 USD
	7) K-Maps 606 slant range processor	Lease $6,650/month	Cost $23,734 USD
	500 kHz fish and 3.5 kHz profiler		
	Totals	Lease $19,535/month	Cost $107,540 USD

c) <u>DataSonics DFS 2100 Profiler (no side-scan)</u>

Available from DataSonics, Cataumet, Mass. U.S.A.

Consisting:	1) SPB 5000 Profilier Transceiver	Lease	Cost $19,500 USD
	2) Model TTV-120 Towed Transducer (no side-scan)		Cost $8,850 USD
	Totals:	$6,000/month	Cost $28,350 USD

3.6.2 Boomer Systems

a) Huntec SeaOtter Boomer

Consisting: 1) SeaOtter Catamaran Assembly with 4425-1 Seismic Source and new preamplifier.

2) Streamer Hydrophone

3) Exorcist Hydrophone

4) Power Control Unit

5) Energy Storage Unit

The rental rate is $365.00 per day, or $10,100.00 per month.

b) O.R.E. Geopulse

Consisting:	1)	Power Supply with Discharge Unit	Cost $14,175 USD
	2)	Catamaran with Towing/Steering Lines	Cost $3,465 USD
	3)	Geopulse Acoustic Source	Cost $7,665 USD
	4)	50 m Power Cable	Cost $1,536 USD
	5)	Geopulse Receiver with gain, TVG, AGC, bottom track, key program	Cost $7,875 USD
	6)	EPC 1600 Graphic Recorder	Cost $9,000 USD
	7)	50 m Hydrophone Assembly with Model 5110A 20-Element Hydrophone	Cost $7,768 USD
	8)	Full Spares	Cost $10,184 USD
			Total Cost $61,931 USD

Lease rates either:

i) One per cent per day - $619 USD which is equivalent to $836 Canadian per day.

ii) Twenty per cent per month - $12,386 USD which is equivalent to $16,712 Canadian per month.

c) E.G. & G. Uniboom (Quotation from T. Thompson)

Consisting:	1)	Model 230-1 Sound Source/Catamaran	Cost $12,900 USD
		Spares	Cost $4,300 USD
	2)	Model 234 Energy Source	Cost $11,800 USD
	3)	Model 265 Hydrophone Array	* N/A
	4)	Model 3700 Band Pass Amplifier	* N/A
	Total Cost		$29,000 USD

equivalent to $39,150 CAD

* These could be available locally.

3.6.3 Shallow Sparker

a) Nova Scotia Research Foundation

Consisting:

1)	Teledyne High Research Foundation	Cost $21,500
2)	NSRFC Multielectrode Sparker with replaceable assemblies	Cost $1,000
3)	High Voltage and Trigger Connecting Cables	Cost $1,800
4)	NSRF Hydrophone Array with pre-amplifier	Cost $7,600
5)	NSRF Signal Processor and Source Key Generator	Cost $20,000

Total: Lease $690/day + $600 set-up; Total Cost $51,900

Lease rates are not available.

b) Seatronix, Houston, TX

Consisting:

1)	E.G. & G. Multi Electode Sparkarray	Lease $27.00 per day
2)	E.G. & G. 233A Capacitor Bank	Lease $40.80 per day
3)	E.G. & G. 231 Trigger Bank	Lease $54.00 per day
4)	E.G. & G. 232A Power Supply	Lease $46.00 per day

Total Lease Rates $7,000/month CAD

Uniboom is not available from this source. Prices FOB Houston.

c) M.K. Services, Missisauga, Ontario
Sold in Canada by ROMOR Equipment Ltd.

Consisting: (E.G. & G. Equivalents)

1)	BB1 Energy Discharge Unit	Cost $12,000
2)	BB2 Capacitor Charging Unit	Cost $10,500

3)	BB3 Energy Storage Unit	Cost $10,500
4)	Field Spares for BB1 and BB2	Cost $10.750
5)	Field Spares for BB3	Cost $1,250
		Total Cost $45,000

Delivery is about three weeks and prices quoted are FOB Halifax.

d) Geomarine Associates, Halifax, Nova Scotia

Consisting: (E.G. & G. Equipment)

1)	E.G. & G. 231 Trigger Bank 1000J	Lease $62 per day
2)	E.G. & G. 232A Power Supply	Lease $53 per day
3)	Multi Electrode Sparker and Cable	Lease $30 per day
4)	NSRF Ministreamer	Lease $40 per day
5)	TVG and Swell Filter	Lease $85 per day
6)	12 kw 220 V 3 Phase Generator	Lease $47 per day

Total $316/day or $9,827/month, FOB Halifax

3.6.4 Seismic Sources

a) Dalhousie University (Larry Meyer)

Consisting:	1)	One gun system	Lease $300 per day
	2)	Two gun system	Lease $350 per day

One gun system $9,300/month

Two gun system $10,850/month

Either system includes pump, compressor, hose bundle, shotbox, etc. FOB Halifax.

b) Maizes Consulting, Bragg Creek, Alberta

Consisting:	1)	Bolt 600B airgun	Lease $250 per week
	2)	Selection of small chambers	Lease $125 per week
	3)	Airgun Spares	Lease $400 per week

b) As Above

Consisting:	1) Honeywell LAZ 4700 Hydrographic Sounder (available October)	Cost $20,000

c) Local Supplier

Consisting:	1) Raytheon JRC Small Boat Sonar Model JFF 760	Cost $2,800

d) McElhanney Surveys Ltd.

Consisting:		
Either	1) Raytheon 731 Shallow water echo sounder	Lease $500/month
or	2) Ross 801 Echo Sounder	Lease $1,200/month

A summary of the costs of all the lease and purchase items mentioned above is given in Table 3.1.

Table 3.1 Summary of Equipment Costs

			Canadian	Dollars
Item	Equipment	Source	Lease/mo	Purchase
	Sidescan and Profiling			
1	Ferranti O.R.E. 100 kHz SS & 3.5	O.R.E. - Falmouth	$13,808	$ 69,444
2	Klein 500 kHz side-scan/3.5 kHz	McQuest	19,535	145,179
3	SPB 5000 & TTV-120 Profiler	Datasonics	7,425	36,929
	Boomers			
5	Huntec SeaOtter System	Huntec 70	10,100	
6	Geopulse System	Ferranti/O.R.E.	16,712	61,931
7	Uniboom without Streamer	T. Thompson		39,150
	Small Sparkers			
10	Brush type 800J	NSRF	20,700	51,900
11	E.G.& G Multi Electrode 1000J	Seatronics	7,000	
12	E.G.& G Equiv. No spark array	M.K. Services		45,000
13	E.G.& G System 1000J or more	Geomarine	9,827	
	Seismic Sources			
15	EESI Water Guns - One Gun	Dalhousie	9,300	
16	- Two Guns	Dalhousie	10,850	
17	Air guns - One Gun	Ed. Maizes	8,392	
18	- Two Guns	Ed. Maizes	14,400	
19	Miniflexichoc	Geoterrex		
	Echo Sounders			
25	Honeywell LAZ 721	R.C. Marine		13,500
	with Digitiser			25,000
26	Raytheon JFF 760	Local		2,800
27	Ross 801	McElhanney	1,200	
28	Raytheon 731	McElhanney	500	
30	EPC 4800 3 channel Recorder (inc. spares) 5 - 6 weeks			16,500

Above rates do not include Transportation, Duties, F.S. Tax, Prov. Sales Tax or Brokerage Fees.

* Includes operator @ $440/day.

4.0 RECOMMENDATIONS AND STRATEGIES

4.1 VESSEL RECOMMENDATIONS

Previous experience with vessel operations in this type of shallow water survey indicates that a properly configured 13 m (42 ft) shallow draft survey vessel can accommodate all the required geophysical equipment. This vessel length appears to be the minimum capable of supporting a shallow water geophysical survey. Maximum vessel length is not critical to operations although draft and charter costs typically increase with vessel length. We have therefore selected 23 m (75 ft) as an upper limit for vessel length. Maximum draft has been specified at 1.8 m.

A single screw, displacement type hull is recommended over a planing or semi-planing type hull. The single screw type hull is less susceptible to damage from grounding or from ice collisions, important considerations in conducting shallow water surveys. A displacement type hull also offers additional space for storage of spares, provisions, fuel and equipment and as a general rule, is more seaworthy than planing type hulls (e.g. river boats, crew boats). The additional security of an extra engine has not proven to be a significant advantage in Beaufort Sea operations.

At least one auxiliary generator, possibly supporting a back-up hydraulics system, is required of minimum 7 kw capacity. A second, completely independent power capability is required for the boomer/sparker system as it is not possible to filter power surges, which could damage other electrical components; it is preferable that this system by permanently installed aboard the vessel but portable deck units can be used.

Some type of over-the-side boom or A-frame with an hydraulic winch/capstan will be required for raising and lowering the launch, deploying and recovering equipment and raising fuel drums from the water to the deck. Both A-frames and mast/boom systems have been used with the latter providing greater flexibility in positioning equipment on deck and over-the-side. Side davits may be required for light lifting tasks (e.g., bottom grab sampling). A temporary bow-sprit is required for towing the side-scan fish.

Table 2.3 summarizes vessel characteristics in the Canadian and Alaskan Beaufort Seas. At the present time, there are no vessels currently available in the Canadian Beaufort Sea that meet the above-mentioned criteria. The M.T. PILOT II is not in operation this year; the SEQUEL is of marginal suitability (limited cabin and accommodation space, no auxiliary generators), and is under long-term charter to Fisheries and Oceans; the PRESSURE RIDGE is of very questionable seaworthiness and not recommended and HERSCHEL is potentially useful.

The HERSCHEL is potentially a useful vessel but would require the following modifications:

(1) increase in berths from two to four,

(2) addition of mast and/or A-frame,

(3) addition of winches for lifting.

The lack of storage space due to the twin engine configuration represents the most potentially serious drawbacks to the use of the HERSCHEL.

4.2 EQUIPMENT RECOMMENDATIONS

The selection of the most appropriate suite of equipment to operate successfully within the operating constraints of this project is very much a factor of the type of vessels available. The smaller profiling systems such as the Klein combined side-scan and 3.5 kHz system may operate from displacement vessel with a draft of less than 1 m, providing sufficient covered space exists for the electronic equipment and outside space for a small generator. An O.R.E. profiler, with greater penetration capability, would require a small davit or boom. It has been suggested by one arctic operator that in very shallow water it is best to use the side-scan/ profiler from the bow in order to prevent any shadowing by the boat. The echo sounder requirement could be fulfilled by a small boat system. Providing daily bar checks were undertaken, sufficient accuracy could be attained. However, if digitized and heave compensated profiles are required, then a hydrographic standard sounder would be required.

The larger profiling systems, which are of the impulsive type, need a separate large prime power source of one type or another. Any sparker or boomer would require a separate electrical generator of sufficient capacity to provide the maximum demand on a continuous basis. The weight of such a generator could be in the range 100 - 1000 kg, depending on the power required. If sufficient room exists for two generators and extra dry space for the additional equipment then these systems may still operate from a small boat.

However, the air gun system would require a suitable compressor and the water gun would require a hydraulic pump and a small air compressor. The Flexichoc, which has been used in shallow water coal surveys off Nova Scotia, requires an air compressor. These support systems could weigh over one tonne and together with the other systems would require a larger vessel.

Of the boomers, the Huntec system, although a recent development, has merit both in terms of price and theoretical resolution capabilities. As mentioned earlier, the receiving configuration plays a very large part in the acquisition of good data and the directional qualities of the "Exorcist" hydrophone may be an asset in very shallow water. The Ferranti O.R.E. Geopulse system is costly although it has been a production item for two years and has produced good data in water depths less than 2 m in the Beaufort Sea. The signal receiving and processing system of the Geopulse boomer is well thought of and could be used with any of the other systems, including the brush tip sparkers.

Of the small sparkers the NSRF system has had more exposure in the Arctic and the results shown in this report verify that it is basically a good, reliable system for shallow work.

Of the seismic systems the airgun and Flexichoc are known to be reliable if well maintained but need the heavier supporting systems. Of the three sources, the Flexichoc and water gun should give the best resolution because of the higher bandwidths, however, rental and operating costs may be the major factor in selecting a seismic system. Finally, there is the possibility that the bandwidth of the water gun may be sufficient to dispense with any other profiling system apart from the 3.5 kHz profiler used on the side-scan for slant range correction. As far as is known, no attempts have been made to run a water gun very shallow, but such a trial may be very interesting particularly if coupled with a shallow towed ministreamer and the Huntec "Exorcist" hydrophone system. In addition, the water gun is the more transportable in terms of size and number of packages.

In summary, several additional factors may result in improved data. The synchronization of all firing times and the implementation of receiving windows controlled by a master firing unit may remove asynchronous interference between systems. In addition, automatic annotation of records would leave the operators with more time to run the instruments. Tape recording of all data and timing signals would allow for replay and data manipulation later, and horizontally expanded seismic profiles would present the data in a more useful format, particularly if a time varied gain system is used to process the seismic signals prior to recording and display.

Finally, the best data from any seismic system will be obtained only if all the individual system components are compatible and are operating in their optimum manner for the particular geological scenario. This applies to sources, receiver, layout geometry, signal processing and recording equipment settings, etc. If any one of the above are not operating correctly, then data quality will suffer and although some improvement may be expected on playback, the highest quality data will not be obtained.

4.3 STRATEGIES

Survey vessels in the 13 m to 23 m range should provide an adequate working platform for conducting shallow-water geophysical surveys. A variety of commercially available equipment components can be used to collect required geophysical data. In some cases, the combining of sensors will simplify deployment configerations (e.g., side-scan sonar and sub-bottom profiler; sub-bottom profiler and echo-sounder).

Surveying in the Mackenzie River delta may require a completely different survey approach in that substantial areas of the delta (6,000 km^2) have water depths less than 2 m (Figure 2.5). Vessels of the jet-boat type (length 10 m; draft 0.6 m) may prove suitable, although the geophysical equipment has practical limitations. Some type of over the ice survey approach may be more suitable for these areas.

Horizontal survey control may provide a significant constraint to survey patterns. In general, a range-range navigation system (e.g., Del Norte Trisponder; Motorola Miniranger) will provide adequate control for nearshore surveys. Bench mark "gaps" exist near western Herschel Island, Shallow Bay and in Liverpool Bay and will require intermediate survey points to be established if a range-range navigation system is to be used.

Because most bench marks are near the coast, working close to the base line (i.e., near the coast) may be a problem that requires the addition of intermediate stations. Set-up and take down of shore-stations is time consuming and may require up to 0.5 day per station.

The alternative to range-range navigation is a more sophisticated over-the-horizon system. These systems are very expensive and require a dedicated operator on board the vessel. However, it may be possible to "buy in" to an existing navigation net, thereby reducing the costs. The addition of a dedicated navigator and the greater space required by over-the-horizon receiver systems may necessitate the use of larger vessels.

In summary, past performance of similar geophysical survey programs in the Alaskan Beaufort Sea indicate the following are appropriate for conducting shallow-water geophysical surveys in the Canadian Beaufort Sea:

- a single screw displacement-type hull; maximum draft less than 2 m and preferably about 1 m; minimum length of 13 m (42');
- the use of a range-range positioning equipment for horizontal control;
- the use of conventional, off-the-shelf geophysical instrumentation including echo sounder; sub-bottom profiler; shallow seismic; and side-scan sonar. A combined echo-sounder/profiler or side-scan/profiler will simplify operations;
- three people are required to operate the instrumentation while an additional person serves as the skipper/engineer;
- the vessel is self-contained and capable of supporting all operations for up to a two week period.

Special problems that may be encountered in the Canadian Beaufort Sea include: (1) extensive areas of the Mackenzie River delta with water depths under 2 m and (2) bench mark gaps in areas of Herschel Island, Shallow Bay and Liverpool Bay. The former problem may necessitate the use of very shallow draft survey vessels or over-the-ice systems. The latter problem may require use of expensive over-the-horizon positioning systems or the establishment of intermediate bench marks.

5.0 REFERENCES

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Vessel Specifications

ANNIKA MARIE
HERSCHEL
R.W. HOOD
J. ROSS MACKAY
KARLUK
NEAKOOLIK
M.T. PILOT II
PRESSURE RIDGE
SEQUEL

Appendix 1

2-450 SURVEY VESSEL SPECIFICATIONS

NAME: RV ANNIKA MARIE

COMPANY: OCEAN RESEARCH SERVICES **CONTACT PERSON:** BILL KOPPLIN

SIZE: L.O.A. 43' BEAM 14'6" DRAFT 3'6"

DECK SPACE APPROX 15' AFT
CABIN SPACE APPROX 20'
BENCH SPACE APPROX 3'×5'

SPEED: 15 - 16 Kn / 10 Kn CRUISE

DECK GEAR: WINCHES SMALL 2000 lb w CABLE
HYDRAULICS YES
A-FRAME/BOOMS A-FRAME, HEAVY DUTY w HYDRAULICS
DAVITS/ROLLERS SIDE DAVIT
OTHER DECK LIGHTS

ENGINE: TYPE DIESEL H.P. 218 ×2
SINGLE/TWIN TWIN
FUEL CAPACITY UNKNOWN CONSUMPTION
RANGE POWER
COOLING FLOW THROUGH (FRAZEL, FEATHERS CAN BLOCK STRAINERS. NOT BIG PROBLEM
GENERATOR YES TYPE NO.

ACCOMODATION: TYPE FOC'SLE CAPACITY 4
GALLEY KEROSENE
HEATING KEROSENE

NAVIGATION EQUIPMENT: RADAR YES SOUNDER ROSS, SITEX
OTHER SATNAV, LORAN, SITEX 767C, SSB, VHF, CB

SAFETY GEAR: 6 MAN INFLATABLE

LAUNCHES: 12' ZODIAC w 6 HP (EXTRA)

COSTS: CHARTER 3600 / DAY WET/DRY DRY
CREW OH EXTRA FOOD NO / FW EXTRA

AVAILABILITY: CHARTER VESSEL, TRAVEL TO CANADA POSSIBLE LOCATION PRUDHOE BAY

SPECS. SENT: YES DATE 27 MAY 85

COMMENTS: FIBERGLASS; OPERATED FROM PRUDHOE BAY SINCE 1982.

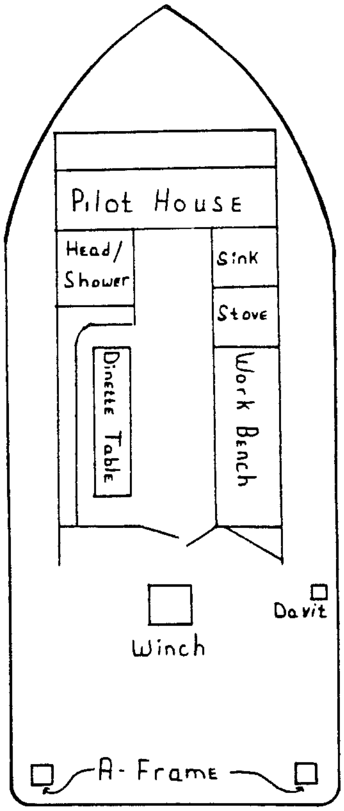
OCEANIC RESEARCH SERVICES, INC.

THE R/V ANNIKA MARIE

AVAILABLE FOR SUMMER HIRE in Prudhoe Bay, Alaska. Fully equipped, complete with experienced crew. Qualified technicians available.

Capabilities include:

- ***Oceanographic studies, including deployment and recovery of instrument packages***
- ***Biological studies using trawls, grabs, nets and scuba diving techniques***
- ***Geophysical surveys using side-scan sonar, bathymetry and sediment samples recovery***
- ***Archaeological surveys***
- ***Salvage***



The R/V Annika Marie, berthed at Prudhoe Bay, is available for exploration and research service this summer in Arctic waters. Especially retrofitted for North Slope projects, the vessel is capable of providing support for all types of research conducted in the area. The ship is 43 feet in length, draws 3'6" of water, and cruises at 15 knots.

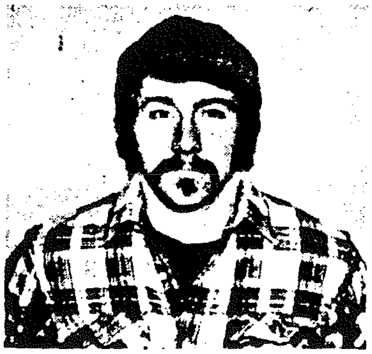
The full array of electronic systems includes a satellite navigation system, a single side band radio for off-shore work, a 36-mile radar, a precision recording fathometer, and other navigational equipment. The hydraulic system includes a movable A-frame, winch, capstan and hydraulic-driven 10 KW generator.

The stern working area is approximately 12' by 15.' A removable transom section facilitates diving, heavy mooring installation and instrument package placement. Interior cabinetry includes a seven-foot map/work bench with large storage cabinets beneath. The ship readily accommodates three to four scientists and gear and is capable of working 24 hours a day.

(See reverse side for specifications.)

SKIPPER, WILLIAM KOPPLIN

William Kopplin, owner of the R/V Annika Marie, is a graduate of Clatsop College, Oregon, and holds degrees in Oceanographic Technology and Marine Technology. He has been performing Northwest and Alaskan coastal technical research since 1973. Kopplin has coordinated projects in Southeast Alaska, the Gulf of Alaska, the Bering Sea and the Beaufort Sea, and two winters of ice diving experience in Prudhoe Bay. Last summer the Annika Marie was under contract for oil exploration purposes in the Prudhoe Bay area.



For further information and references, write, cable or call:

OCEANIC RESEARCH SERVICES, INC.
Box 192, Ester, Alaska 99725

Phone: 907/479-5426
Cable: Fairbanks

THE R/V ANNIKA MARIE

Specifications

Hull	Built by Delta Marine, hand laid and pressed fire retardant fiberglass. Length 43', beam 14'6", draft 3'6".
Power	Twin 653 GMC diesel engines, 218 HP each. Rebuilt 1982. Cruise at 15 knots, top speed 18 knots. Fresh water cooled with wet exhaust. 2:1 Borg-Warner reduction gear. Engine room insulated for sound.
Electrical	12 volt system, dual battery banks. 10 KW Lima generator with micropressor, 110/220 volt.
Hydraulic System	A-frame off stern, 3,000 lb. capacity, Rowe winch with 1,000', ¼" cable, 6" capstan mounted on winch. Hydraulic steering.
Freshwater System	200 gallon pressurized system, hot water heater, shower in head.
Electronics	Decca Radar, Model 110, 36 mile with variable range ring, Magnavox 4102 satellite navigator, Loran, Sitex 767C, single side band radio, Hygain 55 channel VHF, CB radio, Ross precision fathometer with paper graph, Sitex flashing fathometer, intercom system, AM-FM cassette player.
Safety Equipment	Engine-driven 1½" Jabsco bilge pump with four separate bilge compartments, battery-driven bilge pump with alarm, survival suits, life jackets, 8-man survival life raft, flare kit, EPIRB (emergency locating beacon), four fire extinguishers, 12-volt search light.
Main Cabin	Starboard side has galley with sink, diesel stove and reefer. Seven-foot work bench with storage cabinets below. Portside has dinette table and seats. Forward is wheelhouse with steering and electronics. Below wheelhouse are four bunks, with two extra bunks optional.
Deck	Work area is approximately 12' by 15'. A-frame is 10' wide and 12' high. A-frame comes back on deck and behind winch to facilitate bringing gear and nets on board. The transom is removable for operations over the stern. Davit on starboard side can be swung into any position. Stern wash-down pump for clean-up. Quartz lights mounted on cabin for night work. Six-man Avon inflatable boat with 15 HP outboard.
Auxiliary Gear	Dry suit, hooka compressor with hose, scuba equipment.

OCEANIC RESEARCH SERVICES, INC.

Box 192
Ester, Alaska 99725

William Kopplin, Owner

(907) 479-5426
Cable: Fairbanks
Owners and Lessee of
R/V Annika Marie Berthed
in Prudhoe Bay, Alaska

RATE SCHEDULE

Price includes skipper.

	Daily	Weekly
R/V Annika Marie 43'	$3,800.00	$3,600.00 per day
Standby Time	$1,900.00	$1,800.00 per day

The above rates include all maintenance, hull insurance and skipper. A day is considered 12 hours. Over that time, clients will be charged at $47.00 per hour for the skipper.

If desired, a deck hand is available at $275.00 per day for a 12-hour day. Time over 12 hours will be charged at $35.00 per hour.

The contractor will provide food, fuel, fresh water and the contractor's own liability insurance. Room and board, if not provided by the contractor, will be billed at $125.00 per day per crew member.

Discounts apply for contracts over 30 working days.

2-450 SURVEY VESSEL SPECIFICATIONS

NAME: THE HERSCHEL

COMPANY: BEAUFORT ENV. SUPPORT SERVICES **CONTACT PERSON:** DON MACWATT

SIZE: L.O.A. 52' BEAM 16' DRAFT 4.6'

DECK SPACE GOOD
CABIN SPACE ADEQUATE
BENCH SPACE UNKNOWN

STEEL HULL

SPEED: 9.5 KNOTS (DISPLACEMENT HULL)

DECK GEAR: WINCHES NOT INSTALLED, BUT OWNER WILLING
HYDRAULICS YES
A-FRAME/BOOMS NOT INSTALLED, BUT OWNER WILLING
DAVITS/ROLLERS NONE
OTHER STEEL - EASILY MODIFIED
MOON POOL!

ENGINE: TYPE GM H.P. 871
SINGLE/TWIN TWIN
FUEL CAPACITY CONSUMPTION
RANGE POWER 110/220 VAC
COOLING KEEL
GENERATOR ONAN TYPE 8 or 9 KW NO. 1
ADDITIONAL GENERATOR PREVIOUSLY INSTALLED ON BOARD

ACCOMODATION: TYPE FOCSLE CAPACITY 2 BERTHS PRESENT; COULD INSTALL 2 ADDITIONAL IN FOREPEAK
GALLEY DICKINSON
HEATING DICKINSON

NAVIGATION EQUIPMENT: RADAR YES SOUNDER YES
OTHER VHF, SSB

SAFETY GEAR: UNKNOWN

LAUNCHES: NOT SUPPLIED - COULD BE SUPPLIED AS EXTRA (12' ALUMINUM)

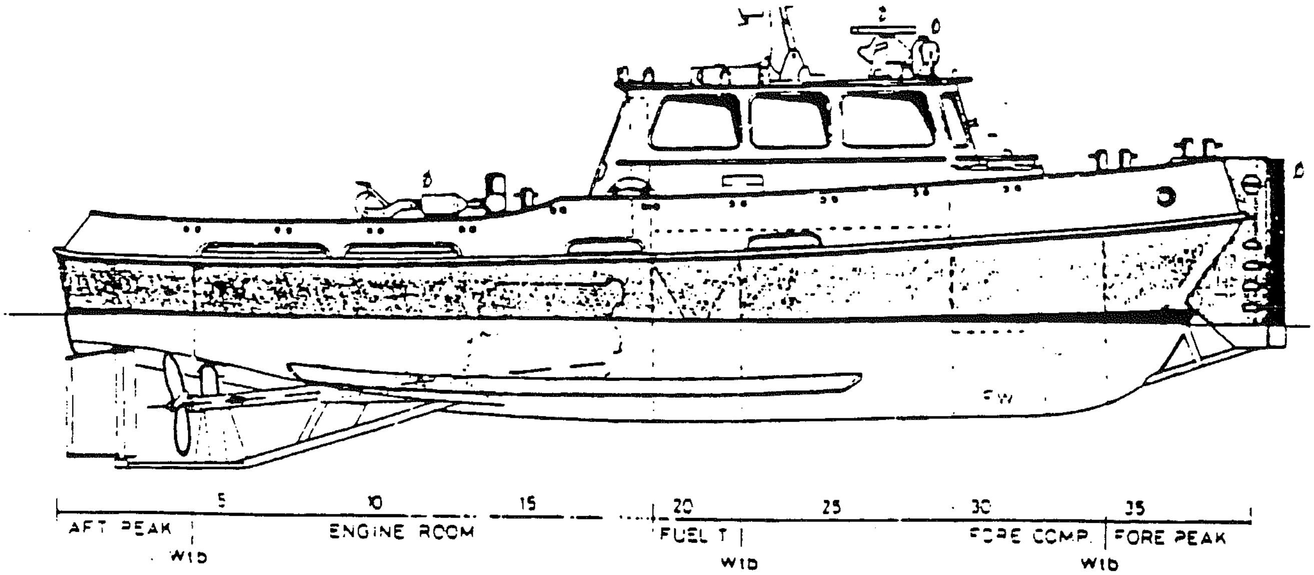
COSTS: CHARTER $2,200/day [✓ WET]/DRY
CREW NOT INCLUDED FOOD NOT SPECIFIED

AVAILABILITY: LOCATION TUKTOYAKTUK

SPECS. SENT: ATTACHED DATE 8/86

COMMENTS: VESSEL IS NOT PRESENTLY SUITABLE BUT MODIFICATIONS ARE POSSIBLE & OWNER WILLING TO MAKE THESE (e.g. A-FRAME, WINCHES, MAST, BERTHS) - MOON POOL IS UNIQUE! STEEL CONSTRUCTION IS SOLID AND PERMITS EASY MODIFICATIONS.

BEAUFORT ENVIRONMENTAL SUPPORT SERVICES LTD.



VESSEL #4

Name:	"<u>THE HERSCHEL</u>" formerly "<u>F-15</u>"
Length:	52'
Beam:	16'
Draught:	4.6'
Power:	Twin 871 G.M.
Speed:	9.5 Knots
Hull Type:	Displacement - Round Chines
Hull Material:	Steel
Year Built:	1975
Navigational Equipment:	Radar; Steel Boat Compass; Sounders VHF

Features: 24V Electrical System and Diesel Generator Set; Engine Rubber Mounted; Moon Pool; Survey Table; Ice Props; Towing Bit; Large After Deck.

"THE HERSCHEL" is a very stable small tug type work boat. It was originally built as a survey boat and is suitably equipped to continue this function. It has worked in the Beaufort since 1979 in dredging operations and has proved to be sturdy and reliable in a range of uses and weather conditions.

2-450 SURVEY VESSEL SPECIFICATIONS

NAME: R. W. HOOD

COMPANY: KINETICS LABORATORIES **CONTACT PERSON:** PAT KINNEY

SIZE: L.O.A. 32' BEAM 15' DRAFT 33"

DECK SPACE
CABIN SPACE
BENCH SPACE

SPEED: 8 knots

DECK GEAR: WINCHES 2000 16
HYDRAULICS FULL
A-FRAME/BOOMS ARTICULATED, 8' [illegible] TALL, [illegible]
DAVITS/ROLLERS
OTHER BOOM w POWER HEAD

ENGINE: TYPE DIESEL H.P.
SINGLE/TWIN SINGLE
FUEL CAPACITY CONSUMPTION 6-10 GAL/HR
RANGE POWER
COOLING KEEL
GENERATOR AUX OFF ENGINE TYPE HONDA NO. 1

ACCOMODATION: TYPE FO'C'SLE, CABIN, HOLD CAPACITY 6
GALLEY DIESEL
HEATING DIESEL

NAVIGATION EQUIPMENT: RADAR YES SOUNDER YES. FISHFINDER TYPE
OTHER SAT NAV, VHF, SSB.

SAFETY GEAR: SURVIVAL SUITS, 6 PACK

LAUNCHES: MK III, SUZUKI w BOAT

COSTS: CHARTER 3200 w CAPTAIN WET/DRY DRY
CREW FOOD EXTRA
WATER EXTRA

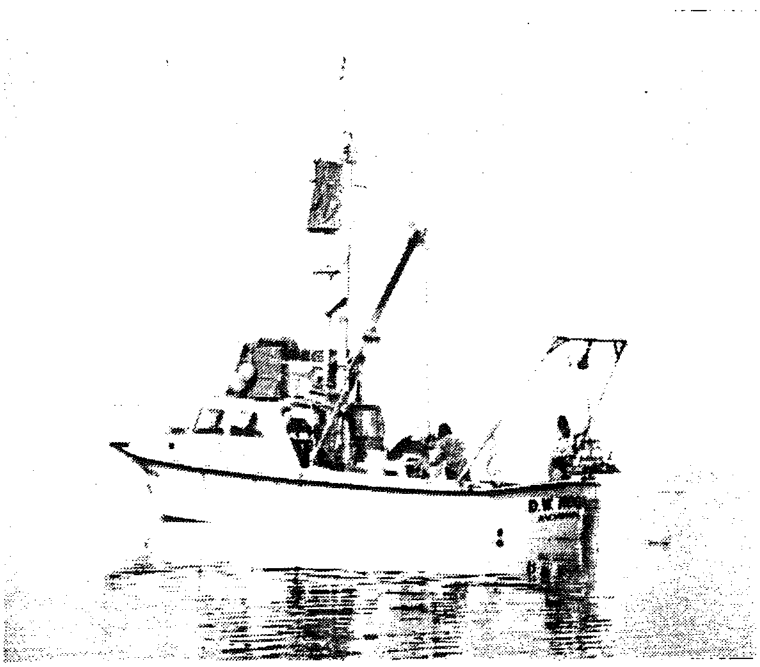
AVAILABILITY: LOCATION PRUDHOE BAY

SPECS. SENT: YES DATE

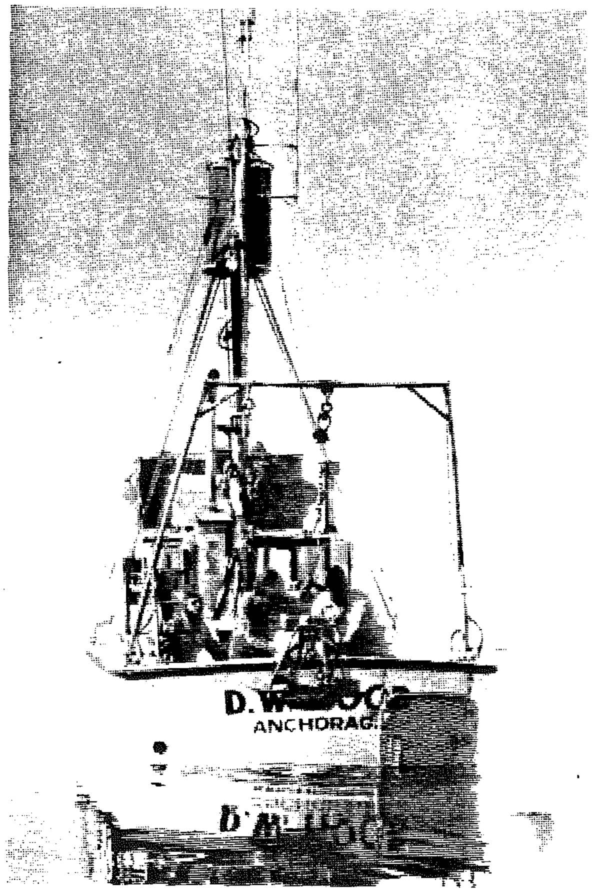
COMMENTS: OMEGA OK; SIDE SCAN, SUB BOTTOM
4 PEOPLE ON BOARD 1 MOS CHUKCHI, 12-
14 hr DAY MAX. SMALL FW TANK.

OCEANOGRAPHIC SURVEY VESSEL

KINNETIC LABORATORIES, INC., oceanographic and environmental consultants, will again have available for the summer season (beginning in July) a working vessel equipped for oceanographic surveys in the Beaufort/Chukchi Sea nearshore areas. By special arrangement, this vessel can also be available for other Alaskan waters. This Bristol Bay 32-foot shallow draft (33 inch) design vessel was custom outfitted in Seattle for oceanographic work in the Arctic. Full electronics, including precision navigation equipment, can be provided. A high capacity hydraulic system (winches, gypsy, A-frame, and powered boom) are featured. Working spaces are set up to accommodate: 1) geophysical work (side-scan sonar, precision bathymetry, high resolution seismic, sediment sampling); 2) biological operations (underwater color TV, benthic and nekton sampling gear, diving operations); 3) chemical/ physical operations (mooring installations, water quality sampling, STD probe systems); and 4) other similar oceanographic operations. This vessel, D.W. HOOD, has facilities for a 4 - 6 man crew and sufficient endurance for 24-hour operations.



The D.W. HOOD is ideally suited for work in the adverse conditions common to the North Slope. During its first season (1980), the vessel operated successfully off Harrison Bay and seaward off the Midway-Stockton Island complex, including 20 days of continuous operation. Tasks accomplished at those times included trawling, benthic sampling, sediment coring, fish surveys, SCUBA diving, drogue studies, water quality sampling, and mooring installations. Often, as during the five days off the island complex, the boat operated in ice coverage conditions of up to five-eighths and in heavy wind chop while deploying several 700 lb. quadrapods containing precision oceanographic equipment. In 1981, 38 days were spent in the Chukchi Sea collecting baseline physical oceano graphic data (currents, tides, winds, and water quality) for NOAA/BLM.



OCEANOGRAPHIC SURVEY VESSEL

HULL: Commercial T-33; fire retardant fiberglass; tunnel drive; 3" rub rail; 32' LOA, 11'4" beam, 2'9" draft, unladen displacement-11,000 lb., freeboard forward-4'8", freeboard aft-3'.

POWER: Volvo TAMD 60B diesel; Twin Disk 506, 2/1 reduction; dry stack; keel cooled; Vickers hydraulic pump-12.5 GPM; Carnitti diesel outboard-16HP (auxiliary power).

FUEL: Diesel, 480 gal. welded aluminum; twin Racor filters. Range, 1300 Nmi at 3.5 Knots, 800 Nmi at 12 Knots.

ELECTRICAL:
Twin 12VDC, 205 amp hour electrical systems; 24 VDC option; 5.5 Kw, 110/220 VAC main drive Autogenerator.

STEERING: Three station Capilano 250 hydraulics; pipe bridge with canvas dodger and transom steering stations.

RIGGING: Lifting eyes; towing point; towing bit; boom; hydraulic A-frame; bow roller platform; dive platform; Kolstrand hydraulic 1200 and 2,000 lb. anchor winches and gypsy; protected crow's nest with wheel house communications.

SAFETY: Hydraulic bilge pump; electrical bilge pumps, bilge and fire alarms; automatic Halon fire extinguisher system; three collision bulkheads and water tight hatches; emergency steering system; emergency diesel power; six Imperial survival suits; Zodiac tender with outboards and arctic survival gear; EPIRB, emergency locator beacon.

OPERATIONS:
90 GPM washdown, 12V search lights; U.S.C.G. specified lights and horn; bow platform; dive platform; dry suit SCUBA equipment; air compressor when desired.

NAVIGATION:
Ritchey compass; Raytheon 2800 radar; SBX-11, SSB (port.); Northern N825 SSB-radiotelephone; Motorola VHF radio; Ratheon DE 750 LED depth indicator; Sitex HE-32 precision recording fathometer; weather station; chart table and storage; Motorola Miniranger III system when desired.

ACCOMMODATION:
Five day endurance with four personnel (4 bunks - 2 more optional); forced air heat; Dickerson oil stove; 100 gal. water; heated shower; head; galley; refrigerator/freezer.

SUPPORT: Shore-side expediting accomplished in modular living accommodations with radios and telephone. Resupply and recrew using shore camps, aircraft, or support boats.

2-450 SURVEY VESSEL SPECIFICATIONS

NAME: J. Ross Mackay

COMPANY: GSC/EMR CONTACT PERSON: Jim Hunter

SIZE: L.O.A. 43' BEAM DRAFT 4'

DECK SPACE 14' work space

CABIN SPACE Pilot House w Lab Aft

BENCH SPACE —

SPEED: 17 kn / 10 kn cruise

DECK GEAR: WINCHES Mounts available / no permanent

HYDRAULICS Nil

A-FRAME/BOOMS A-Frame but NO WINCHES

DAVITS/ROLLERS Movable Davits

OTHER

ENGINE: TYPE GM Diesel H.P.

SINGLE/TWIN Twin

FUEL CAPACITY 150-300 gal CONSUMPTION UNKNOWN

RANGE YES POWER

COOLING UNKNOWN

GENERATOR Portable TYPE 4 kw NO. 1

ACCOMODATION: TYPE NA CAPACITY Sleeps 4

GALLEY Yes

HEATING Diesel Furnace

NAVIGATION EQUIPMENT: RADAR (1) SOUNDER (1)

OTHER Nil

SAFETY GEAR: N/A

LAUNCHES: Zodiac

COSTS: CHARTER N/A WET/DRY N/A

CREW N/A FOOD N/A

AVAILABILITY: Available to AGC w approved operator LOCATION Inuvik

SPECS. SENT: No DATE 29 May/1985

COMMENTS: ~~See attached~~ working range limited. Owner recommends no use offshore and not more than 1 hr from safe harbour.

2-450 SURVEY VESSEL SPECIFICATIONS

NAME: KARLUK

COMPANY: USGS CONTACT PERSON: E. REIMNITZ

SIZE: L.O.A. 42' BEAM 15' DRAFT 3'

DECK SPACE ~ 25'
CABIN SPACE ~ 15'
BENCH SPACE

SPEED: 9 Knots

DECK GEAR: WINCHES ON MAST
HYDRAULICS FULL. 2 SYSTEMS
A-FRAME/BOOMS BOOM FROM MAST
DAVITS/ROLLERS
OTHER

ENGINE: TYPE GM H.P. 12-71
SINGLE/TWIN SINGLE
FUEL CAPACITY 960 GAL CONSUMPTION 50 GAL/DAY AV.
RANGE 2.5 wks / 1000 mi. POWER 15 KW / 5 KW
COOLING
GENERATOR 110 V TYPE NO. 2

ACCOMODATION: TYPE CAPACITY 4
GALLEY DIESEL STOVE
HEATING DIESEL STOVE

NAVIGATION EQUIPMENT: RADAR YES SOUNDER YES. RECORDING.
OTHER GYRO COMPASS

SAFETY GEAR: 6 MAN INFLATABLE w DOUBLE BOTTOM, AIR MATTRESS. FLOATER SUITS

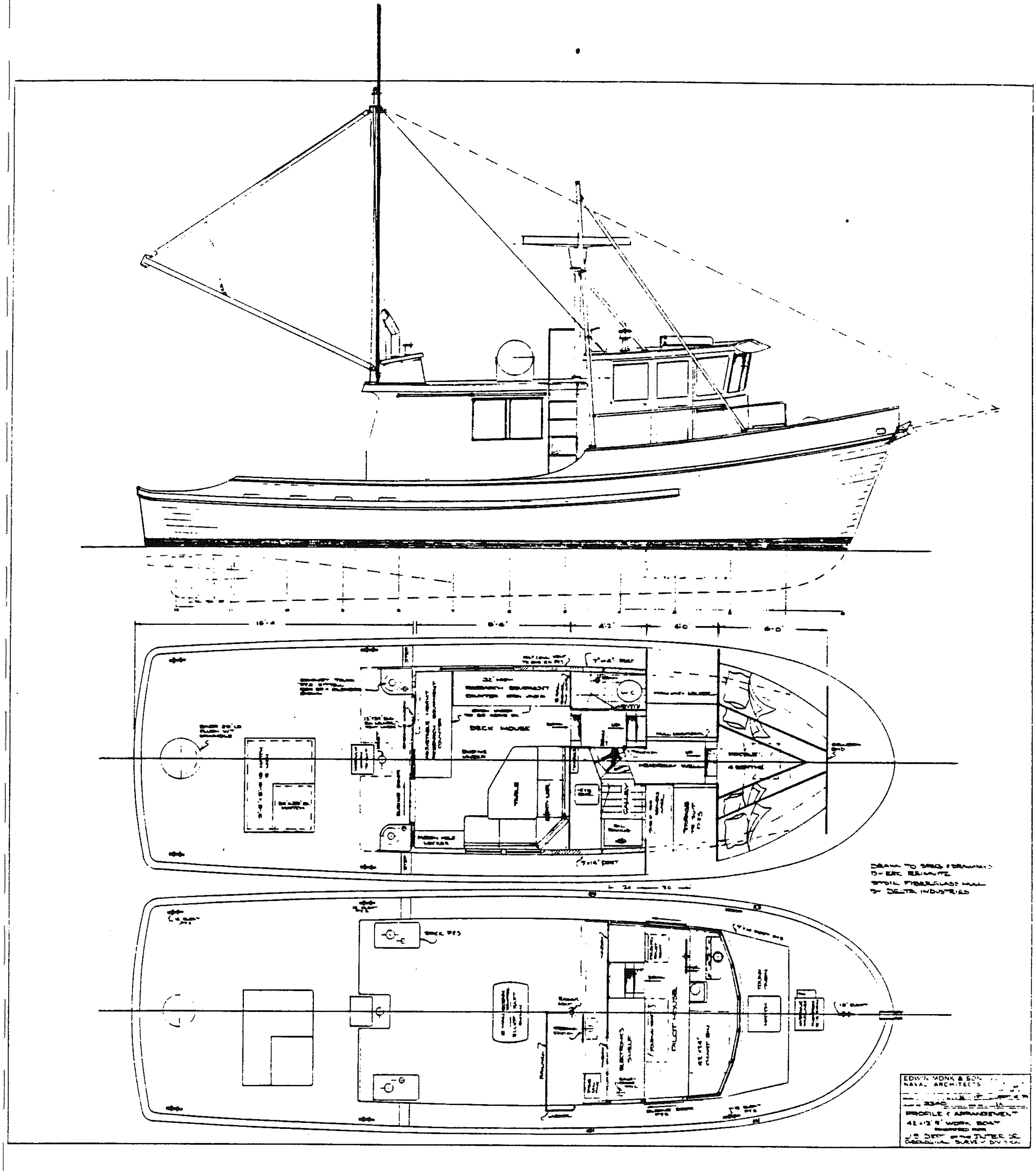
LAUNCHES: YES. HARD.

COSTS: CHARTER NOT APPLICABLE WET/DRY
CREW FOOD

AVAILABILITY: NOT APPLICABLE LOCATION NOME. PRUDHOE BAY

SPECS. SENT: YES DATE 30 MAY, 1985

COMMENTS:

15'-4"
9'-6"
4'-2"
4'-0"
6'-0"
32" HIGH
RESEARCH EQUIPMENT
DECK HOUSE
TABLE
GALLEY
W.C.
4 BERTHS
PILOT HOUSE
ELECTRONICS SHELF
HATCH
DRAWN TO SPEC & DRAWINGS
BY ERIC REINHITZ
STOCK FIBERGLASS HULL
BY DELTA INDUSTRIES
EDWIN MONK & SON
NAVAL ARCHITECTS
3340
PROFILE & ARRANGEMENT
42'-3" WORK BOAT
U.S. DEPT OF THE INTERIOR
GEOLOGICAL SURVEY

R/V KARLUK

SPECIFICATIONS

HULL: Length: 42' (13 m)
Beam: 13.75' (4.2 m)
Draft: 3.5' (1.1m)
Displacement: 23 tons

SPEED: Cruise - 8 knots
Maximum - 9 knots

FUEL: 1000 gallons
DFA or No. 2 diesel

DUAL CONTROL STATIONS: Fly bridge/Pilot House

RANGE: 1000 nautical miles

WATER: 150 gallons fresh water
seawater deck washdown

ENDURANCE: 14 days

PROPULSION: GMC 8V71 diesel engine, direct tunnel drive
and emergency hydraulic drive from 15 KW generator.

TENDER: 16' aluminum skiff with 25 HP outboard and flasher depth sounder.

FIRE PROTECTION: Automatic Fiquench Halon 1301 Engine Room system
5 hand extinguishers/smoke alarm
Seawater pump off main engine

EQUIPMENT

WINCH - 5000 lb capacity, 500' cable

LIFE RAFT - 6-man arctic YFC

AIR COMPRESSOR - 3.0 CFM at 2200 PSI

DEPTH SOUNDER - Simrad Partner 0-400m

ELECTRICAL: 120-240V, 60 Hz-1Ø, 7.5 KW
220-440V, 60Hz-3Ø, 15 KW or
380V, 50Hz-3Ø, 12 KW
24 V DC. 200 AH
12V DC, 400 AH

RADIOS: Motorola 24-channel
(Duplex SSB)
Konel 16-channel VHF
Aircraft Radio (all channels)
40-channel CB radio
2 EPIRBS - raft and tender

NAVIGATION: RADAR-Decca mod. 916,
48 mile range
SATNAV - Magnavox mod. 1242
Gyrocompass-Sperry mod. 37,
with autopilot
Sextant - Plath
Range/range system - Del Norte Trisponder,
±3 m accuracy to 30 km, with 4 self-contained
shore stations

POTENTIAL SCIENTIFIC EQUIPMENT

Fathometer: Raytheon RTT 1000 with 3.5/7kHz subbottom profiler and narrow beam transducer

High resolution seismic system: EG&G Model 234 Uniboom with EPC 1900 recorder and Del Norte filters

Side-scanning sonar: EG&G Model 259-3 with an EG&G Model 272 tow fish

Complete SCUBA equipment including hardwire communication system

Kiel vibracorer

Underway bottom sampler

Van Veen bottom grab sampler

Beckman RS-5 Temperature/Salinity sensor

Hydroproducts transmissometer

Hydroproducts underwater television system

Helleinger - underwater location marking system

2-450 SURVEY VESSEL SPECIFICATIONS

NAME: NUAKOOLIK

COMPANY: BEAUFORT ENV. SUPPORT SERVICES **CONTACT PERSON:** DON MAC WATT

SIZE: L.O.A. 49' BEAM 14' DRAFT 3'

DECK SPACE APPROX 30' x 14'
CABIN SPACE MINIMAL BUT V. LARGE HOLD
BENCH SPACE NONE
STEEL HULL

SPEED: 10 KNOTS

DECK GEAR: WINCHES NONE
HYDRAULICS COULD BE ADDED
A-FRAME/BOOMS CARGO MAST; ELECTRIC WINCHE
DAVITS/ROLLERS STERN ROLLER
OTHER TOWING BIT

ENGINE: TYPE GM H.P. 453
SINGLE/[✓ TWIN]
FUEL CAPACITY UNKNOWN CONSUMPTION UNKNOWN
RANGE UNKNOWN POWER 24VDC
COOLING UNKNOWN
GENERATOR NONE TYPE NO.

ACCOMODATION: TYPE NO BERTHS CAPACITY NONE
GALLEY "MINI GALLEY"
HEATING ?

NAVIGATION EQUIPMENT: RADAR 24 MILE RADAR SOUNDER YES
OTHER VHF; SSB

SAFETY GEAR: UNKNOWN

LAUNCHES: COULD BE SUPPLIED

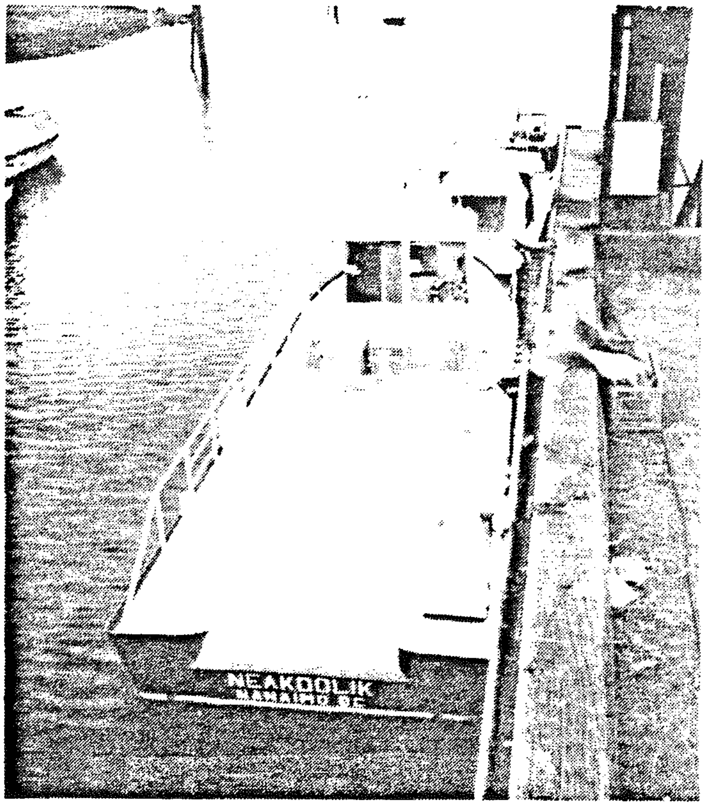
COSTS: CHARTER WET/DRY
CREW FOOD

AVAILABILITY: 1987 LOCATION TUK

SPECS. SENT: YES, ATTACHED DATE 8/86

COMMENTS: DECK CONFIGURATION LIKE MINIATURE SUPPLY VESSEL; V. LARGE-AFT DECK SUITABLE FOR PLACING CONTAINER ON BOARD.

BEAUFORT ENVIRONMENTAL SUPPORT SERVICES LTD.



VESSEL #2

Name:	"NEAKOOLIK"
Length:	49'
Beam:	14'
Draught:	3'
Power:	Twin 453 G.M.
Speed:	10 Knots
Hull Type:	Shallow Displacement - Semi Tunnels
Hull Material:	Steel
Year Built:	1981
Navigational Equipment:	24 Mile Radar; Depth Sounder; VHF Electronic Compass

Features: Large After Deck with Roller Style Transom and Towing Bit; Cargo Mast/Boom and Electric Winch; Day Cabin with Mini-Galley; Large Cargo Hold.

This vessel was designed as a self contained oilspill response work boat for the variety of coast types and weather conditions in the near shore Beaufort region. The principal features incorporated in the design were:

- Capability of operating in shallow water but with good sea keeping qualities.
- A large after deck and hold for oilspill response duties.
- Capable of towing.

The NEAKOOLIK has been proven equal to the task in all areas and has adequately performed its duties in the Beaufort since 1981.

2-450 SURVEY VESSEL SPECIFICATIONS

NAME: M.T. Pilot II

COMPANY: Arctic Offshore Limited   CONTACT PERSON: Don Tetrault

SIZE: L.O.A. 74'   BEAM 15'   DRAFT 3.5'

DECK SPACE ✓
CABIN SPACE ✓
BENCH SPACE ✓

SPEED:

DECK GEAR: WINCHES Swann Windless
HYDRAULICS UNKNOWN
A-FRAME/BOOMS NONE
DAVITS/ROLLERS UNKNOW
OTHER Towing Bit

ENGINE: TYPE GM 671   H.P. 480
SINGLE/TWIN Twin
FUEL CAPACITY 2420 gal   CONSUMPTION
RANGE 3400 mi   POWER 110/220V
COOLING
GENERATOR 2 30 kvA/12.5 kva   TYPE Bedford Duatz   NO. 1/1

ACCOMODATION: TYPE Cabin   CAPACITY 12 berths
GALLEY Galley/Mess
HEATING Yes

NAVIGATION EQUIPMENT: RADAR 2 Deccas   SOUNDER Echo
OTHER SSB, Gyro Compass, Magnetic Compass

SAFETY GEAR: 6 man inflatable w 12 hp outboard,
16 man Inflatable life raft

LAUNCHES:

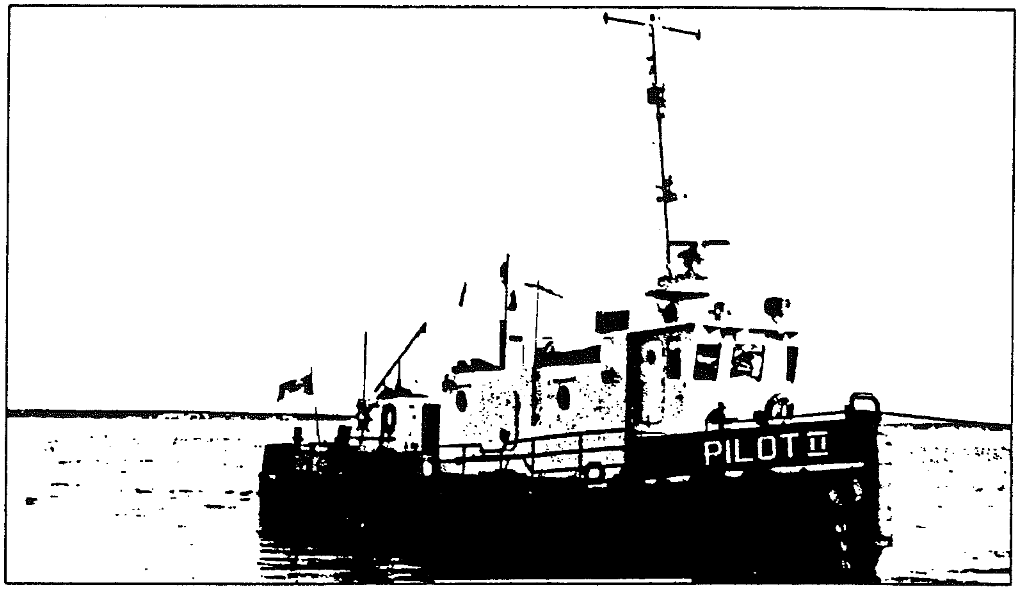
COSTS: CHARTER 9500/day   WET/DRY DRY
CREW   FOOD

AVAILABILITY: UNAVAILABE SUMMER 1985   LOCATION MAY RIVER, N.W.T.

SPECS. SENT: YES   DATE

COMMENTS:

Arctic Offshore Limited
Serving The Offshore Marine Needs In Canada



M.T. Pilot II

Standby Survey Tug

BUILT	Rebuilt 1979
FLAG	Canadian
YARD	Northern Arc Shipyards, Hay River, N.W.T.
REGISTERED TONNAGE	Gross 68.02 Net 19.74
SPEED	12 Knots
RANGE	3400 Miles
BOLLARD PULL	5 Ton
LENGTH O.A.	22.5 m (74')
BREADTH MOULDED	4.57 m (15')
DRAFT SUMMER	1.09 m (3.5')
FUEL CAPACITY	2420 Gals.
FRESH WATER CAPACITY	660 Gals.
CLASS	Arctic Class E
OFFICIAL NUMBER	177559
CALL SIGN	CZ-9898

PROPULSION

Two 671 Detroit Diesel engines producing a total of 480 B.H.P..

Two fixed pitch propellers driven through Twin Disc 521 reversible reduction gear box.

Two rudders controlled by a Wagner Steering System giving excellent maneuverability.

AUXILIARIES

One Bedford generating plant providing 30 K.V.A. at 220/110 Volt.

One Duatz generating plant providing 12.5 K.V.A. at 220/110 Volt.

SAFETY

1 6-man rubber Raft with 12 H.P. Outboard Motor.

1 16-man Inflatable Life Raft.

7 Survival Suits.

ACCOMMODATION

12 berths in 6 cabins.

1 Galley - Mess room.

DECK MACHINERY

One Swann Windlass with Chain plus 2 x 250 lb. Admiralty Anchors.

Cruciform Towing Bit.

2 Control Stations Wheelhouse Port and Starboard.

1 Control Station Aft.

NAVIGATION EQUIPMENT

1 Motorolla S.S.B. Radio.

2 Decca Radars.

1 Compass Gyro and Magnetic.

1 Echo Sounder.

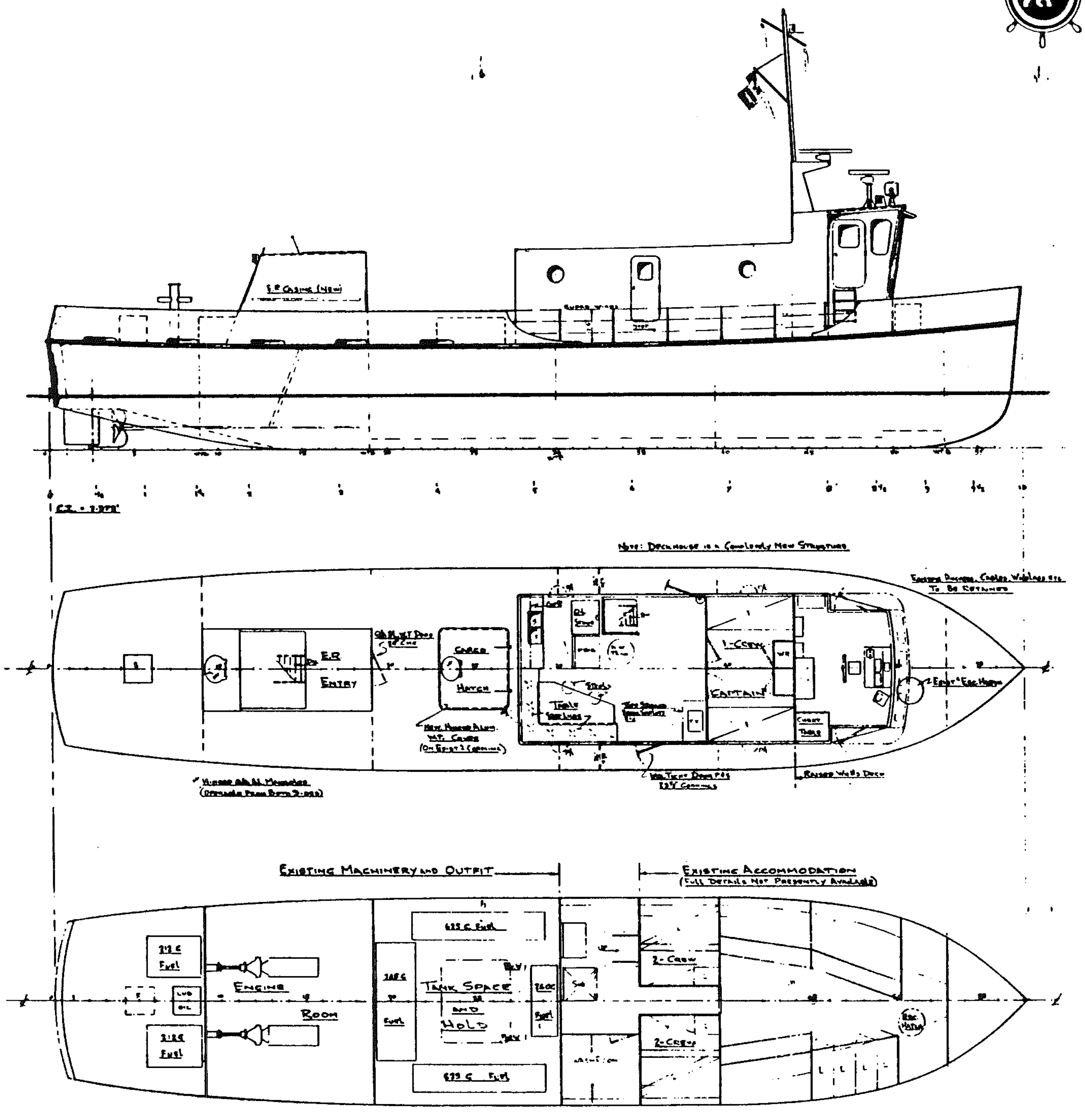
2 Search Lights.

Arctic Offshore Limited

Serving The Offshore Marine Needs In Canada

STANDBY SURVEY TUG

LENGTH O.A. .... 22.5 m (74′)
BREADTH MOULDED .... 4.57 m (15′)
DRAFT SUMMER .... 1.09 m (3.5′)



Arctic Offshore Limited

CORPORATE PROFILE

ARCTIC OFFSHORE LIMITED is a wholly Canadian corporation which owns and operates a fleet of ice-class tugs/supply vessels and supply barges currently deployed in support of petroleum resource development activities in the Beaufort Sea.

Originally constituted by thirty-three Canadian businessmen in August of 1969, the corporation commissioned the construction of its first ship, the M. V. "Norweta".

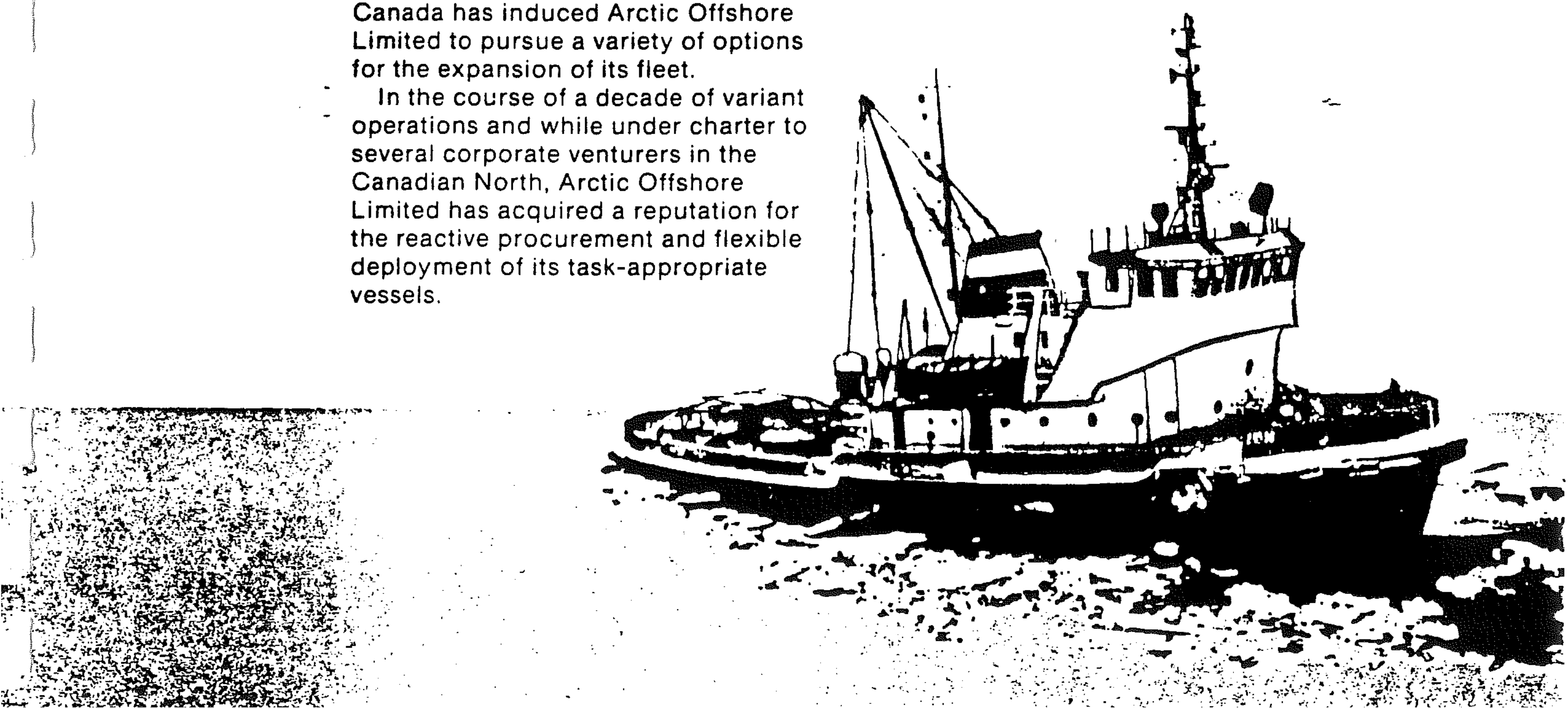
From the time of the M. V. "Norweta's" first assignment in the Beaufort Sea to the present, Arctic Offshore Limited has chartered its rapidly expanding fleet to various petrochemical companies engaged in hydrocarbon resource exploitation activities in Canada's far North.

Arctic Offshore Limited while federally incorporated, is also registered under the Companies Ordinance of the Northwest Territories and the Corporations Registration Acts of both Nova Scotia and Newfoundland and is in the process of establishing a corporate presence in Halifax and St. John's so that it may better accommodate the marine support requirements of East Coast project operators.

Arctic Offshore Limited maintains a staff of marine officers each of whom is fully qualified to assume responsibility for the largest vessels operating world wide and, more particularly, in Canada's frontier oil exploration areas. Most of the company's masters hold a Foreign Going Master Certificate; each chief engineer is qualified under a Chief's Combined Certificate. In view of the critical connection between the reliability of the service Arctic Offshore provides and the quality of the personnel which it engages to manage its vessels, the support of operational staff in periodic training programmes has always been a firmly entrenched component of corporate policy.

The intensification of petroleum resource development in Maritime Canada has induced Arctic Offshore Limited to pursue a variety of options for the expansion of its fleet.

In the course of a decade of variant operations and while under charter to several corporate venturers in the Canadian North, Arctic Offshore Limited has acquired a reputation for the reactive procurement and flexible deployment of its task-appropriate vessels.



BEAUFORT
ENVIRONMEN

2-450 SURVEY VESSEL SPECIFICATIONS

NAME: 'Sequel'

COMPANY: Beaufort Environmental Support Services
CONTACT PERSON: Don MacWatt

SIZE: L.O.A. 42' BEAM 14' DRAFT 5.5'

DECK SPACE Moderate
CABIN SPACE Adequate
BENCH SPACE Adequate

SPEED: 8 Knots

DECK GEAR: WINCHES Variable Speed Hydraulic
HYDRAULICS Gurdies
A-FRAME/BOOMS W. Coast w stabilizers
DAVITS/ROLLERS Stern
OTHER

ENGINE: TYPE GM 471 H.P.
SINGLE/TWIN Single
FUEL CAPACITY 700 gal CONSUMPTION 2.8 gal/hr
RANGE 2200 nm POWER 110 V
COOLING Keel
GENERATOR Yamaha 110 V TYPE 4.8 kw NO. 1

ACCOMODATION: TYPE Focsle, Hold, Cabin CAPACITY 5
GALLEY Full
HEATING Oil

NAVIGATION EQUIPMENT: RADAR 24 mile SOUNDER Depth recorder
OTHER VHF, SSB, Loran C, Compass

SAFETY GEAR: Complete

LAUNCHES: 14' Lund Aluminum (New outboard recommended)

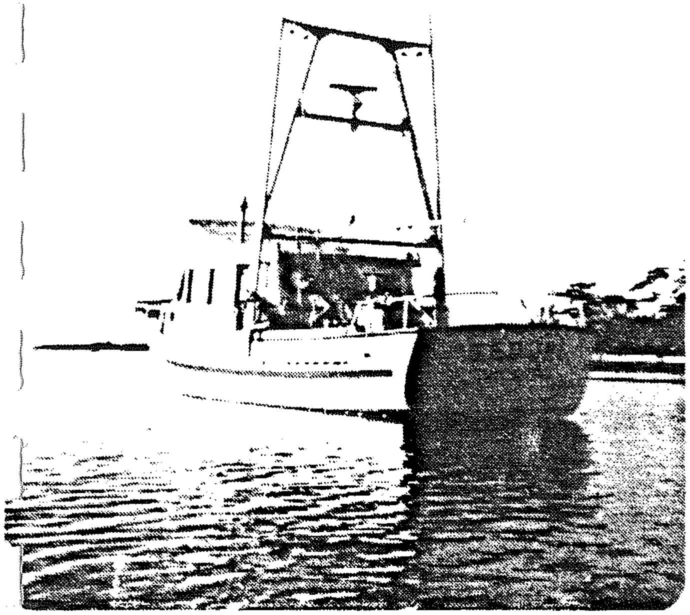
COSTS: CHARTER 1750/day WET/DRY Wet
CREW 1 (included in cost) FOOD Not supplied

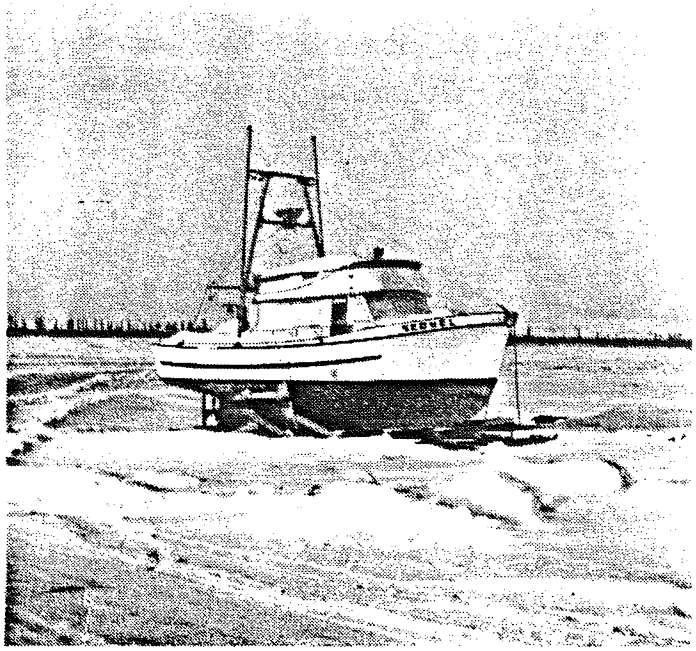
AVAILABILITY: Aug. 15 - Sept. 15/85 LOCATION Tuk

SPECS. SENT: ✓ DATE ~~24/5/85~~

COMMENTS: Don may be reached Eskimo Inn (to June 2) Gulf base to June 10th. Satnav recommended general positioning

BEAUFORT ENVIRONMENTAL SUPPORT SERVICES LTD.





VESSEL #1

Name:	"SEQUEL"
Length:	42'
Beam:	14'
Draught:	5.5'
Power:	471 G.M.
Speed:	8 Knots
Hull Type:	Displacement - West Coast Type
Hull Material:	Wood with Gum Wood Sheathing
Year Built:	1974
Navigational Equipment:	24 Mile Radar; Depth Sounder and Recorder; VHF; SSB; LORAN C; Standard Compass.

Features: Stabilizers; A-Frame W/Boom; Variable Speed Hydraulic Winch; Hydraulic Gurdies; Accommodation for Four; Full Galley.

This vessel has completed four seasons in the Southern Beaufort employed on many environmental and geotechnical surveys. It has navigated the waters between Herschel Island and Bailie Island providing economical and versatile support for smaller marine projects.

Anchorage Descriptions

Appendix 2

Komakuk Beach

Anchorage can be obtained between 0.5 and 1 mile off Komakuk Beach in about 12 m (39 ft) with good holding. The anchorage is unprotected and when there is no ice offshore, onshore winds can create a heavy swell and breakers along the beach. An alternative anchorage can be found in Thetis Bay on Herschel Island, 25 miles east.

Thetis Bay (Pauline Cove)

Anchorage in depths of 7 to 11 m (23 to 36 ft) can be found in Thetis Bay, on the SE side of the island; it is exposed to winds between east and south and offers little protection from drifting ice. In 1976 and 1977, offshore drilling ships used this anchorage as a fitting-out base.

Pauline Cove, in the northeast part of Thetis Bay, has the abandoned settlement of Herschel situated on its south side on a low spit known as Simpson Point. Small vessels can obtain anchorage in Pauline Cove in depths of about 5 m (16 ft), soft mud, but the holding ground is not very good and the cove is exposed to the southwest.

Shingle Pt.

Anchorage for vessels drawing about 1.5 m (5 ft) can be found south of Shingle Point. The anchorage can be approached from the east between the mainland and Escape Reef, a narrow sand bank whick is reported to be about 1.2 m (4 ft) dry at normal water levels.

Hansen Harbour, Mason Bay

Hansen Harbour, situated seven miles southeast of North Head, is suitable only for boats. Reindeer Islands, to the north, have elevations of about 15 m (49 ft).

Mason Bay, situated 12 miles south-southeast of North Head, has depths inside of 24 m (79 ft) but its entrance channels on both sides of Hadwen Island are suitable only for boats. Wallace Bay, on the northwest side of Mason Bay, is unsounded.

Tuktoyaktuk Harbour

Tuktoyaktuk Harbour, relatively deep and sheltered, is the best harbour between Herschel Island to the west and Cape Bathurst to the east.

Anchorages affording good shelter with good holding ground in mud can be obtained in several places in Tuktoyaktuk Harbour. The one most frequently used is in that part of the harbour bounded by Tuktoyaktuk Island, Fort Ross Islands and Ptarmigan Point.

A T-shaped Public wharf, situated at the hamlet and close north of the Hudson's Bay Company store, has a width of 15 m (50 ft) across the outer end and a depth of 2.1 m (7 ft) alongside this face.

Hutchison Bay

Anchorage has been obtained close south of Warren Point in a depth of 2.4 m (8 ft) with mud bottom and good holding ground. The anchorage offers shelter from west winds, and small craft have safely ridden out winds of hurricane force.

McKinley Bay

McKinley Bay, which has general depths between 3.4 and 6 m (11 and 20 ft) is bordered on its east side by a 9-mile-long sand spit drying 1 m (3 ft). Anchorage in 3.7 m (12 ft), mud bottom with good holding, can be found one mile east of Atkinson Point, south of the sand spit.

In strong east winds, sheltered anchorage with good holding ground can be found in the east part of McKinley Bay, one mile off the sand spit, in depths of 4 to 6 m (13 to 20 ft). Drilling support bases in this bay may provide logistical support.

Johnson Bay

Between Johnson Bay and an unnamed point 20 miles southwest, the water close inshore is relatively deep and parts of the coastline give good radar responses.

Anchorage for small craft can be found in a small bay southwest of the above-mentioned unnamed point. The anchorage has good holding gound of stiff mud in 7.3 m (24 ft) of water and is sheltered by a sand spit to the northeast.

Baillie Islands - Snowgoose Passage

Anchorage for shallow-draught vessels, with shelter from any wind, can be obtained in the vicinity of Snowgoose Passage by shifting berth, but there is no single sheltered anchorage from all winds. Good holding ground may be found in a depth of 3.7 m (12 ft), mud bottom, on the east side of the sand spit that extends south from the southwest end of the large Baillie Island. The survey ship RICHARDSON has ridden out several westerly gales in this anchorage; the recommended approach is from the southwest.

Anchorage in 2.1 m (7 ft) of water can be obtained 0.1 mile offshore in the shelter of the hook at the northwest end of the sand spit that extends northwest from Cape Bathurst. Water sweeps over the low points of this spit in a gale. Entrance to this anchorage from the east should be made around the north end of the spit that extends northwest from Cape Bathurst; as this end of Snowgoose Passage is reported to be silting, depths in this entrance are likely to be less than charted.

Harrowby Bay

Harrowby Bay is entered between an unnamed point five miles south of Cy Peck Inlet and Ikpisugyuk Point, seven miles farther south-southwest. Its south shore is swampy, rising to elevations of about 45 m (148 ft) 4 miles inland. Old Horton Channel, at the head of Harrowby Bay, has depths of about 1 m (3 ft) for a distance of ten miles from the entrance.

North Star Harbour, a narrow inlet on the north side of Harrowby Bay, offers good protection for small craft.

Hepburn Spit

Anchorage can be obtained close off the outer spit of Hepburn Spit in a depth of 5 m (16 ft). The survey ship RICHARDSON found anchorage with good holding ground and shelter from westerly gales in the inner harbour.

Geophysical Equipment Specifications

Appendix 3

Bench Mark Locations
(unattached)

Appendix 4

Large Vessel Survey

Appendix 5

SURVEY OF SHIPS FOR THE RECOVERY OF CURRENT METER MOORINGS IN THE BEAUFORT SEA, SUMMER 1986

by

Tamás Juhász

OCEANETIC MEASUREMENT LIMITED
3212 Carman St., Victoria, British Columbia

Submitted to:

Dr. H. Melling
Frozen Sea Research Group, Ocean Physics
Institute of Ocean Sciences, Sidney, British Columbia

January, 1986

TABLE OF CONTENTS

LIST OF FIGURES

APPENDICES

ACKNOWLEDGEMENTS

I would like to thank Mr. M. Craton and Mr. H. Elliot, both of the Ship's Division of the the Institute of Ocean Sciences for their help in finding information on chartering agencies.

Similarily, the input of Mr. B. Lake, Mr. C. de Jong and Mr. S. Moorehouse of the Ocean Physics Division at Institute of Ocean Scieces was very informative and much appreciated.

NOTICE

The information presented in this report was complied by Mr. T. Juhász of OCEANETIC MEASUREMENT LTD., in the capacity of a consultant on mooring operations for the Ice Motion Experiemnt. OCEANETIC was under contract to the Department of Supply and Services to provide technical and consulting support, reference number VIC-85-2938-1 / 5-1940.

The Scientific Authority is:

Dr. H. Melling
Project Head, Ice Motion Experiment
Frozen Sea Research Group, Ocean Physics
Institute of Ocean Sciences
Sidney, British Columbia

SURVEY OF SHIPS FOR THE RECOVERY OF CURRENT METER MOORINGS IN THE BEAUFORT SEA, SUMMER 1986

1.0 INTRODUCTION

The Frozen Sea Research Group, Ocean Physics Division of the Institute of Ocean Sciences initiated the Ice Motion Experiment, in the spring of 1985, to gather data over a 1 year period. Under the direction of Dr. H. Melling, a field party deployed 14 current meter moorings, 2 tide gauge moorings, 4 ice drift stations and 2 meteorological stations, employing a completely aircraft based operation. The ice drift and meteorological stations have since been recovered and the tide gauge moorings will be recovered by aircraft, consequently these sites are of no concern for the purposes of the ship survey.

Of direct concern, is the recovery of the current meter moorings and the choice of a logistic base to accomplish this, ie., aircraft based "through-ice" or ship based in "open water". Accessibility to the area is limited by the unpredictable ice conditions that vary each year. Basically, either ice free water, or a durable ice cover is required to allow recovery of the moorings, that is; for ship based operations, ice free water is preferred, conversely, for aircraft based operations, ice that is sufficiently thick and smooth to allow unincumbered landings is preferred. It is likely that only a portion of the moorings can be recovered by either of the two alternatives, necessitating employment of both to increase the probability of a successful recovery of all the moorings.

A ship based operation, given that favourable conditions prevail, has the potential of being the more convenient, efficient and cost-effective alternative of the two logistic bases. Consequently, OCEANETIC MEASUREMENT LTD., was retained on contract by the Institute of Ocean Sciences to conduct a survey of vessels, available in the Beaufort Sea in the summer of 1986, suitable for the current meter mooring recoveries. The survey progressed through a series of steps;

- telephone contact with operators of charter vessels,
- collection of specifications on prospective vessels through the mail.,
- completing standarzied "ship data summary sheets" on "suitable" vessels,

- categorizing them into groups that relate to requirement/cost based scenarios, and selecting the preferred ship in each group.

For the information of possible users of the material in this report, please be advised that this survey was very project specific and only ships that were deemed suitable for this particular operation were considered. A selection was made, during the initial step, rejecting ships that were obviously inadequate or "over-kill" for the task. Some of the rejected ships are presented in section 4.0, Scope of Survey, and on "ship data summary sheets", simply because information on them was readily available. Unavoidably, the selection was influenced by the judgement of the interviewer, and based on his previous experiences in this type of operation. The survey was conducted by Mr. Tamás Juhász of Oceanetic Measurement Ltd.

This report is a summary of OCEANETIC's findings and recommendations. Supplementary to this report 15 separate "ship data summary sheets", with attached specifications, provided by the operators, of the 20 ships that were considered "suitable", (some data sheets represent sister ships), were submitted to the scientific authority.

Please refer to Figure 1 for the positions of the current meter moorings.

2.0 ASSUMPTIONS BASIC TO THE SURVEY

A number of assumptions regarding recovery operations and consequently pertinent to the ship survey were made. These are as follows:

(1) - operations will be based in Tuktoyaktuk.

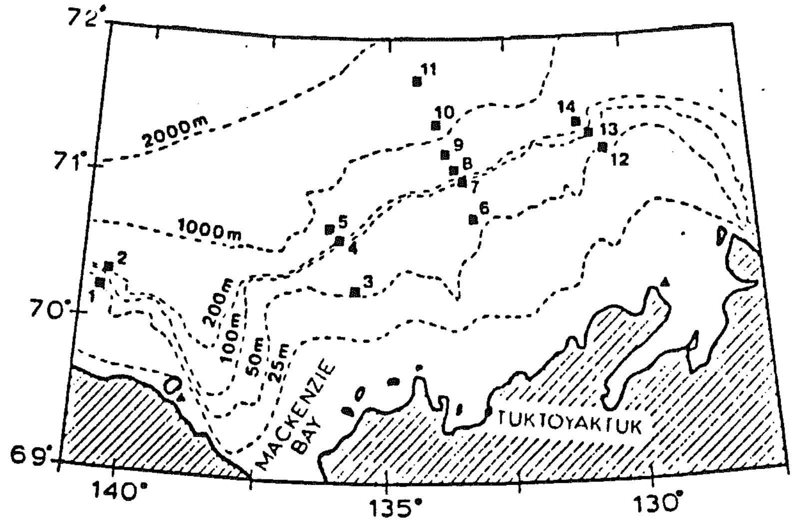
(2) - the entire mooring program will be recovered by ship except for the 2 near-shore tide gauge sites.

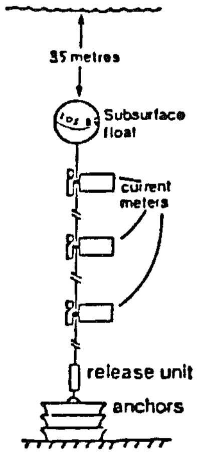
(3) - there is no intention to service and redeploy any of the moorings.

(4) - the moorings are in ideal condition; on station, intact, free to surface upon release and acoustic releases are functioning as expected, ie., searching and alternate recovery methods are not anticipated.

(5) - other data collection operations are not being conducted, ie., CTD survey etc.

OCEAN CURRENT STUDY: April 1985 to April 1986





The Institute of Ocean Sciences, Sidney, B.C. (Department of Fisheries and Oceans, Canada) has deployed 14 moorings in the southern Beaufort Sea as part of a study of ocean currents and ice drift. The moorings are entirely sub-surface with the shallowest float at 35m depth. Mishap may allow a mooring to surface, in which case orange steel or plastic floats up to 30" in diameter will be visible at the surface. These floats are well marked with an address, telephone number and in most cases a serial number.

Should you notice any stray floats with our markings, please call collect to one of the numbers listed below. If you bring floats aboard, please bring ALL the attached synthetic rope, as scientific instruments are attached to it.

For information, call:

	Work	Home
Humfrey Melling	(604) 656-8252	(604) 386-0366
Syd Moorhouse	(604) 656-8281	(604) 479-5723
Ron Cooke	(604) 656-8292	(604) 656-6628

Location of moorings are:

1.	70° 10.5'N	140° 41.2'W	8.	71° 03.3'N	133° 31.8'W
2.	70° 16.7'N	140° 33.6'W	9.	71° 10.2'N	133° 41.2'W
3.	70° 12.8'N	135° 34.1'W	10.	71° 22.8'N	133° 53.2'W
4.	70° 34.9'N	135° 58.3'W	11.	71° 41.3'N	134° 18.5'W
5.	70° 36.8'N	136° 04.5'W	12.	71° 11.5'N	130° 23.1 W
6.	70° 42.9'N	133° 07.0'W	13.	71° 18.3'N	130° 42.0'W
7.	70° 58.9'N	133° 22.1'W	14.	71° 22.1'N	130° 53.5'W

Figure 1.

(6) - the probable length of the recovery cruise would be 11 days, based on:

- it is possible, in ideal conditions, to recover one transect line per day, (a likely scenario as evidenced in past open water experiences); therefore there are 4 productive work days.
- for every productive day, there will be one day expended in non-productive activity, i.e., travel time and standby due to weather or equipment failure; therefore there are 4 non-productive work days.
- there is an additional 1 day mobilization and 2 days demobilization at either end of the cruise, ie., for loading and unloading in Tuktoyaktuk.

(7) - the vessel crew and the survey party will work a minimum of 12 hour work-days.

(8) - ship based recovery is not feasible in conditions of greater than 5/10 ice cover.

(9) - ideal conditions will prevail, ie., it will be possible to travel from site to site without detours around ice flows, and the total round trip is estimated at 640 nm., or 2.6 days travel in a vessel that cruises at 10 kts., (this travel time is hidden in the 8 days at sea, mentioned above).

It should be noted at this point that a concurrent statistical study of ice conditions in the Beaufort Sea, indicates that September is the most favourable month, with respect to ice cover at the mooring sites, for ship based operations.

3.0 CRITERIA DEFINING THE SUITABLE VESSEL

Considering the scope of the project and having established the above assumptions, the capabilities that a "suitable vessel" would require, could be defined. The ship that could do the job must have these characteristics:

- meet the requirements as outlined in the Shipping Safety Control Zones Order, Arctic Shipping Pollution Prevention Regulations and Arctic Waters Pollution Prevention Regulations pursuant the Arctic Waters Pollution Prevention Act, for the zone of intended operations, ie., Zone 12, during the proposed period of operation, ie., August through September. This implies a minimum Type E, Hometrade II, ice strengthened and preferrably better than Type B, Hometrade I, if the reguirement to enter Zone 4, to the north arises.

Please refer to Appendix A for a map of the Shipping Safety Control Zones and Table of Ship Classifications, and note that the moorings are all in Zone 12.

- with respect to size; the ship must have sufficient deck space to allow working with, and storage of the recovered hardware, buoys and lines, similarily, enclosed space is required to work with, and store the recovered instruments. The amount of space must be such that no requirement exists to return to base and off-load equipment part way through the cruise.

- with respect to operational capabilities and deck equipment; the ship must have either existing "over-the-side" lifting supports, ie., crane, davit or A-frame, and winches that can lift a minmum of 500 lbs, or the possibilty of mounting a portable system supplied by the recovery team. In addition, the ship should be able to dispatch a small work boat and possibily accommodate a helicopter, if needed, however, the latter two capabilities are secondary to the basic requierment of being able to recover moorings.

- with respect to accomodation; the ship must be able to accomodate a recovery team of, a minimum of 2, and maximum of 4, members and their equipment.

- with respect to range and speed; the ship must be able to cover a minimum of twice the 640 nm., round trip distance from Tuktoyaktuk to all the sites and back, with fuel to spare for contingencies and without refuelling. Ideally the ship will be capable of a speed of 10 kn., or more, and be able to "overnight" at sea, travelling to the next transect line during non-working hours.

- with respect to navigation aids and ice information capability; the ship will have a full compliment of suitable navigation and communication aids, ie., depth sounder, radio, gyro compass, self positioning systems (Loran C and/or Satellite Nav.), radar, DF systems, etc., with adequate back-up systems. In addition, the vessel will preferrably be able to receive updated ice information from satellite or ice facsimile.

- with respect to experience and attitude; the vessel operator should be able to demonstrate that the ship and crew have past experience in navigating throughout the survey area and are willing to contribute to the work during the recovery, mobilization, and demobilization operations.

- with respect to availability and cost; the ship should be available on a "spot charter" basis, with a reasonable minumum charter period, during the optimum time frame, as defined by the previously mentioned statistical study. In order for cost to remain in step with those of the airborne operations, approximately $150,000, the ship should cost less than $13,500 per day "all found", or increased capability, that would tend to reduce charter length, should come along with higher cost.

All the vessels selected as "suitable" satisfy the above characteristics to varying degrees.

4.0 SCOPE OF SURVEY - ALL OPERATORS AND VESSELS SURVEYED

Operators	Vessels
* Department of Fisheries, CND.	CSS John P Tully
* Department of Transport, CND.	CCGS Nahidik CCGS Martha Black CCGS Camsell
* Puget Sound Tug & Barge Co., Seattle, Washington, USA.	Arctic Salvor
* Northern Transportation Ltd., Edmonton, Alberta, CND.	MV Banksland MV Frank Broderick
* Crowley Maritime Ltd., Anchoage, Alaska, USA.	3 unnamed pusher tugs
* Arctic Transportation Ltd., Calgary, Alberta, CND.	Beaufort Sea Explorer Arctic Sounder Arctic Hooper Arctic Taglu
* Ocean Research Services Inc., Ester, Alaska, USA.	Anika Marie
* Arctic Lighterage Inc., Anchorage, Alaska, USA.	Avik Nanuk III
* Kodiac Marine Inc., Anchorage, Alaska, USA.	Arctic Fox Arctic Bear
* Sy-Tech Research Ltd., Sidney, British Columbia, CND.	unnamed survey craft
* Arctic Offshore Ltd., Hay River, NWT, CDN.	MT Pilot II also MT Toga Norweta MT Duga MT Gordon Gill
* BeauDril Ltd., Calgary, Alberta, CDN.	MV Terry Fox MV Miscaroo MV Ikaluk MV Kalvik
* Coastal Marine Ltd., Inuvik, NWT, CDN.	no show
* Beluga Transportation Inuvik, NWT, CDN.	no show
* Jacobson Terminals Inc., Seattle, Washington, USA.	no show
* Sause Bros., Ocean Towing Seattle, Washington, USA.	no show
* Marine Logistics Corp., Seattle, Washington, USA.	no show
* Foss Launch $ Tug Co., Seattle, Washington, USA.	no show
* Faustug Marine Corp., Seattle, Washington, USA.	no show

5.0 "SUITABLE VESSEL" GROUPINGS

		Ice Condition Scenarios		
		0/10-2/10	2/10-5/10	5/10 +
Cost Scenarios	$0-$10K	Nahidik Norweta *Pilot II*	*J.P.Tully*	*Martha Black*
	$10K-$20K	Crowley tug (3) *Arctic Sounder* Arctic Salvor	Toga Duga *Beau. Sea Exp.* Gordon Gill	Arctic Hooper *Arctic Taglu*
	$20K +	*Banksland*		

NB -(1) A vessel suitable for a more adverse ice condition scenario may be employed for work in less ice covered waters.

(2) Ice condition scenario headings are qualitative and are meant to indicate increasing ice cover in 3 stages between 0 cover to 5/10 cover.

(3) It is deemed advisable that shipboard recoveries not be conducted in waters with greater than 5/10 ice cover, however, this is not to say that it is not possible to do so.

(4) The perferred vessel in each ice/cost scenario is highlighted by italics, (in some categories the choice is obvious), leaving 7 "suitable" vessels for the purposes of cost forecasting.

(5) For comparitive purposes please refer to Appendix B which contains the findings of a previous ship survey conducted by Ship's Division at I.O.S.

(6) For detailed information on the 7 preferred vessels, the reader will have to refer to the "ship data summary sheets", Appendix C.

6.0 COST FORECAST FOR CHARTER

The proposed cost forcast for the charter of each of the preferred vessels identified above, over the assumed 11 day duration required to complete all recoveries, is presented:

MT Pilot II	@	$10,800/day	(all found)	=	$118,800
J.P.Tully	@	$ 7,000/day	app. user fee	=	$ 77,000
Martha Black	@	?	user fee	=	*
Arctic Sounder	@	$14,500/day	(+fuel)	=	$159,500 +
Beau. Sea Exp.	@	$15,000/day	(+fuel)	=	$165,000 +
Arctic Taglu	@	$17,500/day	(+fuel)	=	$192,500 +
MV Banksland	@	$19,000/day	(+fuel)	=	$209,000 +

* Information is pending reply from Canadian Coast Guard Regional Director.

7.0 NOTES ON AVAILABILITY

Assuming that the problems of cost and capability have been adequately adressed, an attempt will be made to summarize a number of obstacles, relating to availability, involved in chartering vessels in the Beaufort Sea, as observed from the information gathered. Government operated vessels will not be dealt with in this section.

- vessel operators accept business on a first come basis and require a letter of intent to reserve ship time while contractual arrangements are ironed out.
- vessels are usually booked as early as possible by the users allowing for charters to extend into the season as schedules begin to slip.
- vessel operators are not as willing or capable of accommodating small spot charters in the beginning of the season as near the end, once they have made their operations money.
- many operators have minimum charter lengths and it is not worth their effort to mobilize ship and crew for a charter under this minimum, ie., the Banksland requires a 30 day charter.
- short charter customers are advised to charter collectively.
- all operators require reasonable notice prior to a charter for scheduling purposes, (varying notice times were mentioned).

8.0 RECOMMENDATIONS AND COMMENTS

Upon conclusion of this survey and review of the information that has been collected, the following applies:

(1) the development of ice conditions for the summer of 1986 in the Beaufort Sea will have to be closely monitored to help make the decision on which logistic base should receive emphasis.

(2) to maximize all chances of recovery, an initial aircraft based recovery attempt in the spring should be carried out.

(3) if possible, use of the J.P. Tully should be secured, given that she is operating in the Beaufort during the summer of 1986; this being the most cost effective strategy.

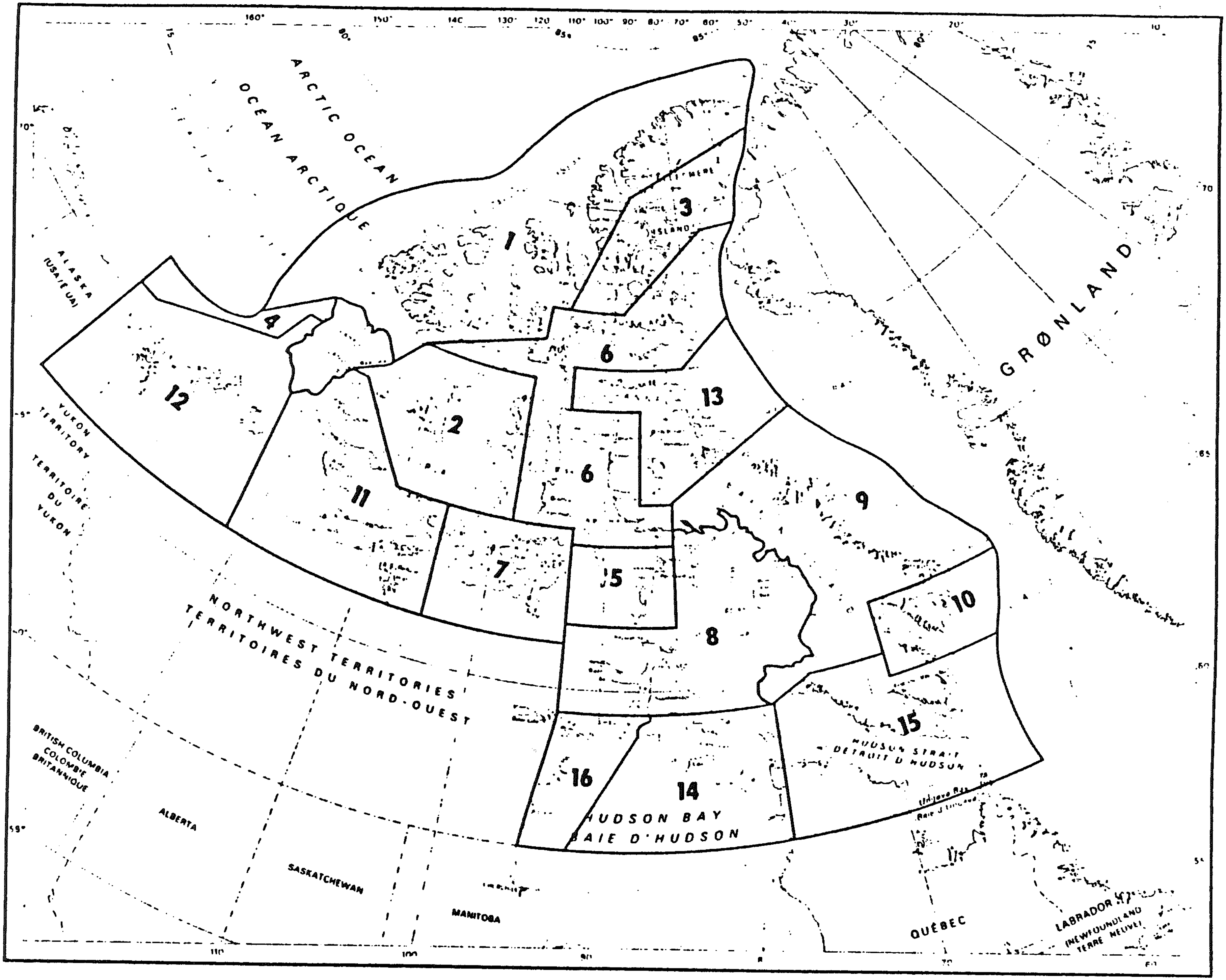
(4) the next most attractive strategy is to make use of the Canadian Coast Guard ships as "ships of opportunity" and attempt to overlap I.O.S. operations with theirs, such that a minimum, if any, "user fee" is incurred. This implies greater flexibility on the part of the recovery team(s) in order to meet and utilize Coast Guard ships, when, where and if they are operating in the areas of interest. Generally, these ships, specifically the Nahidik and the Martha Black, arrive in the Beaufort Sea in July. They spend July and August tending navigation aids and escorting "sea-lifts" to local communities throughout the Beaufort Sea and toward Banks Island. Late August and early September they escort the "sea-lift" into Cambridge and Spence Bays, returning to the Beaufort Sea by mid to late September. They are under orders to return at this point and indications are that extensive operations that would slow the ships' return are not welcome, however they are open to accommodating simple operations such as mooring recoveries. This represents 4 potential chances for recovery by shipboard operations; at the beginning and end of the season, onboard either or both of 2 "ships of opportunity". This strategy should be examined in the light of forthcoming information from the Canadian Coast Guard Regional Director's office, in response to a letter requesting their assistance, sent as part of the ship survey.

(5) the least attractive strategy, in terms of cost is the charter of a dedicated, private sector vessel. The cheapest alternative being the MT Pilot II or the Norweta at an estimated $118,000 for the completion of all mooring recoveries. These vessels can be employed only in the least severe ice conditions and their availability is doubtful, ie., at the time this survey was conducted, both ships were already booked by a client, tentatively through June and July, 1986, with anticipated extensions of their charter.

Developnig ice conditions would have to be monitored closely, in order to make the selection of an appropriate ship. A finely tuned cost/benefit analysis weighing capabilities against requirements would have to performed for each potential and/or available, "suitable" ship.
If this route is chosen, a ship should be booked as early as possible, allowing for contingencies in case the ice conditions for 1986 prove to be untenable.

(6) the last alternative strategy would be the use of a combination of dedicated charter vessel and "ship of opportunity". For example, the opportunistic use of Coast Guard vessels at the beginning and end of the season combined with the charter of a dedicted vessel to cover the mid-season. The complexity of this may make this stratgy unworkable, not to mention the probable high cost.

APPENDIX A



SHIPPING SAFETY CONTROL ZONES
ZONES DE CONTRÔLE DE LA SECURITÉ DE LA NAVIGATION

SCHEDULE VIII

TABLE

	Column I	Column II	Column III	Column IV	Column V	Column VI	Column VII	Column VIII	Column IX	Column X	Column XI	Column XII	Column XIII	Column XIV	Column XV	Column XVI	Column XVII
Item	Category	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10	Zone 11	Zone 12	Zone 13	Zone 14	Zone 15	Zone 16
1	Arctic Class 10	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year
2	Arctic Class 8	Jul 1 to Oct 15	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year
3	Arctic Class 7	Aug 1 to Sept 30	Aug 1 to Nov 30	Jul 1 to Dec 31	Jul 1 to Dec. 15	Jul 1 to Dec. 15	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year
4	Arctic Class 6	Aug 15 to Sept 15	Aug 1 to Oct 31	Jul 15 to Nov 30	Jul 15 to Nov 30	Aug 1 to Oct 15	Jul 15 to Feb 28	Jul 1 to Mar 31	Jul 1 to Mar 31	All Year	All Year	Jul 1 to Mar 31	All Year	All Year	All Year	All Year	All Year
5	Arctic Class 4	Aug 15 to Sept 15	Aug 15 to Oct 15	Jul 15 to Oct 31	Jul 15 to Nov 15	Aug 15 to Sept. 30	Jul 20 to Dec 31	Jul 15 to Jan 15	Jul 15 to Jan 15	Jul 10 to Mar 31	Jul 10 to Feb 28	Jul 5 to Jan 15	June 1 to Jan 31	June 1 to Feb 15	June 15 to Feb 15	June 15 to Mar 15	June 1 to Feb 15
6	Arctic Class 3	Aug 20 to Sept 15	Aug 20 to Sept 10	Jul 25 to Oct 15	Jul 20 to Nov 5	Aug 20 to Sept 25	Aug 1 to Nov 30	Jul 20 to Dec 15	Jul 20 to Dec 31	Jul 20 to Jan 20	Jul 15 to Jan 25	Jul 5 to Dec 15	June 10 to Dec 31	June 10 to Dec 31	June 20 to Jan 10	June 20 to Jan 31	June 5 to Jan 10
7	Arctic Class 2	No Entry	No Entry	Aug 15 to Sept 30	Aug 1 to Oct 31	No Entry	Aug 15 to Nov 20	Aug 1 to Nov 20	Aug 1 to Nov 30	Aug 1 to Dec 20	Jul 25 to Dec 20	Jul 10 to Nov 20	June 15 to Dec 5	June 25 to Nov 15	June 25 to Dec 10	June 25 to Dec 20	June 10 to Dec 10
8	Arctic Class 1A	No Entry	No Entry	Aug 20 to Sept 15	Aug 20 to Sept 30	No Entry	Aug 25 to Oct 31	Aug 10 to Nov 5	Aug 10 to Nov 20	Aug 10 to Dec 10	Aug 1 to Dec 10	Jul 15 to Nov 10	Jul 1 to Nov 10	Jul 15 to Oct 31	Jul 1 to Nov 30	Jul 1 to Dec 10	June 20 to Nov 30
9	Arctic Class 1	No Entry	No Entry	No Entry	No Entry	No Entry	Aug 25 to Sept 30	Aug 10 to Oct 15	Aug 10 to Oct 31	Aug 10 to Oct 31	Aug 1 to Oct 31	Jul 15 to Oct 20	Jul 1 to Oct 31	Jul 15 to Oct 15	Jul 1 to Nov 30	Jul 1 to Nov 30	June 20 to Nov 15
10	Type A	No Entry	No Entry	Aug 20 to Sept 10	Aug. 20 to Sept 20	No Entry	Aug 15 to Oct. 15	Aug 1 to Oct 25	Aug 1 to Nov 10	Aug 1 to Nov 20	Jul 25 to Nov 20	Jul 10 to Oct 31	June 15 to Nov 10	June 25 to Oct 22	June 25 to Nov 30	June 25 to Dec 5	June 20 to Nov 20
11	Type B	No Entry	No Entry	Aug 20 to Sept. 5	Aug. 20 to Sept 15	No Entry	Aug 25 to Sept 30	Aug 10 to Oct. 15	Aug 10 to Oct. 31	Aug 10 to Oct 31	Aug 1 to Oct 31	Jul 15 to Oct 20	Jul 1 to Oct 25	Jul 15 to Oct 15	Jul 1 to Nov 30	Jul 1 to Nov 30	June 20 to Nov 10
12	Type C	No Entry	No Entry	No Entry	No Entry	No Entry	Aug 25 to Sept. 25	Aug 10 to Oct 10	Aug 10 to Oct 25	Aug 10 to Oct. 25	Aug 1 to Oct 25	Jul 15 to Oct 15	Jul 1 to Oct 25	Jul. 15 to Oct. 10	Jul 1 to Nov 25	Jul 1 to Nov 25	June 25 to Nov 10
13	Type D	No Entry	No Entry	No Entry	No Entry	No Entry	No Entry	Aug 10 to Oct. 5	Aug 15 to Oct. 20	Aug 15 to Oct 20	Aug 5 to Oct 20	Jul 15 to Oct 10	Jul 1 to Oct 20	Jul. 30 to Sept 30	Jul 10 to Nov 10	Jul 5 to Nov 10	Jul 1 to Oct 31
14	Type E	No Entry	No Entry	No Entry	No Entry	No Entry	No Entry	Aug 10 to Sept. 30	Aug 20 to Oct. 20	Aug 20 to Oct 15	Aug. 10 to Oct 20	Jul 15 to Sept. 30	Jul 1 to Oct. 20	Aug 15 to Sept 20	Jul 20 to Oct 31	Jul 20 to Nov 5	Jul 1 to Oct 31

APPENDIX B

SHIP SURVEY

Beaufor Sea Current Meters

Following is a list of Companies which have indicated they have vessels available and capable for the current meter recover program in the Beaufort Sea during the Summer of 1986.

1. Nortran Offshore Ltd:
    - M. V. Banksland Surveryor; Length 180 ft., is idealy suited for part or all of the recovery program, depending on ice conditions. Although she has very little ice breaking capacity (2-3 inches), she has heavy ice belt protection. She can accommodate a helicopter (5000 lb) and carries an aluminum work launch. Vessel particulars enclosed. Price $19,000 per day.
    - M.V. Frank Broderic: Length 296 ft., idealy suited for part or all of the recovery program, depending on ice conditions. She also has heavy ice belt protection. She can accommodate a helicopter (10,000 lb). Vessel particulars enclosed. Price $35,000 day.

2. Arctic Transportation Ltd.: Have various anchor handling and supply boats available. They are Ice Class A vessels. These vessels will need a portable workshop/storage facility supplied, and also an 'A' frame or equivalent fitted if overhead stopping of the mooring wire is required during recovery. Particulars included. Price $17,500-$20,000 per day.

3. BeauDril (Gulf Oil Ltd.): Have four Ice-breaking,anchor-handling, towing and supply vessels. These are Ice- Class 4 vessels. They have deck equipment and work-shop/storage space available for the recovery program. Charter cost $30,000 per day. Particulars included.

<u>Note:</u> The above vessel availabilty is subject to prior charter.

(cont'd)

4. I.O.S. Vessel M.V. J.P.Tully: Idealy suited for all or part of the recovery program. She meets all requirements for deck machinery ans work-shop?storage space. Operating costs Aprox. $7,000 Day. Ice class 1A

5. Arctic Offshore Ltd.: Sending brochures of vessel particulars with charter costs.

6. Dome Petroleum Ltd. (Canadian Marine Drilling) Awaiting brochures with various vessel particulars and prices. Previous conversations with Dome have indicated a possible substancial reduction in costs, depending on usefullness of data received and availability to this company.

APPENDIX C

Vessel Name: Arctic Salvor

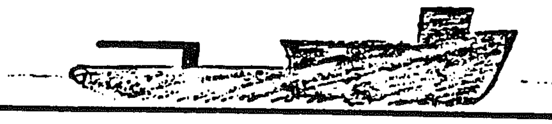
Charter Ship Survey : Beaufort Sea 1986
Oceanetic Measurement Ltd.

Date: Dec 10 85

Operator: Puget Sound Tug + Barge Co (Crowley Maritime)
Crowley Maritime Plaza
P.O. Box 2287, Seattle Washington 98111

Contact Person: Bob Ziegler
206-583-8100

Type: Supply / anchor handling tug converted to salvage vessel



Specifications

Length	213'
Beam	54'
Draft	10'
Speed	assume adequate + comparable speed ie. 2250 HP (2 engines)
Range	98 000 gals - consumption ?
Ice Class	ice sheathing ?
Helicopter	4000 lbs helicopter capability
Work Boat	21' with outboard
Lifting	35T crane, 2 Skagit 150T winches, stern roller
Accomodations	Vessel crew 8 survey crew 17
Work Space	work shop space
Deck Space	very large aft deck ample space
Availability	-escorts Crowley operations in/around Prudhoe Bay -available after Crowley fleet is out of Beaufort Sea
Nav. Aids	
Experience	-operating as arctic salvage vessel since 1980

Spot Charter Rate + Conditions: $12000/day U.S. travelling or $10400/day standby and operations rate.

Comments: - expensive
- availability severely limited ie. only after their own operations are complete.

Vessel Name: Camsell

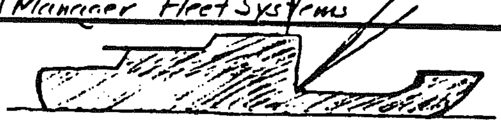
Charter Ship Survey : Beaufort Sea 1986
Oceanetic Measurement Ltd.

Date: Nov 12 85

Operator: Department of Transport
C.C.G. Victoria

Contact Person: Larry Slaght. 388-0279
M Turner Regional Manager Fleet Systems

Type: Ice breaker, Supply, Buoy Tender



Specifications

Length	223'
Beam	48'
Draft	16'
Speed	11 kn
Range	12000 miles
Ice Class	E (Home Trade 1) Zone 12 Jul. 1 to Oct. 20
Helicopter	yes (size ?)
Work Boat	yes. (size ?) probably whaler or zodiac
Lifting	3, 6, 10, + 20 ton cranes (4) and derricks (3).
Accomodations Work Space Deck Space	all adequate
Availability	- 2-3 wk beginning of season + 1 wk near the end.
Nav. Aids	- standard DOT
Experience	- in service since 1959 in Western Arctic.

Spot Charter Rate + Conditions - nominal user pay policy

Comments: - decommissioned
- for comparison only

Vessel Name: "Martha L. Black" 1100
or "George R. Pearkes"

Charter Ship Survey : Beaufort Sea 1986
Oceanetic Measurement Ltd.

Date: Nov. 12 85

Operator: Department of Transport
C. C. G , Victoria.

Contact Person: Larry Slaght 388-0279
M. Turner Regional Manager Fleet Systems

Type: 1100 Series, Ice
Breaker, Supply, Buoy Tender

Specifications

Length	272'
Beam	52'
Draft	19'
Speed	15 kn.
Range	?
Ice Class	Light Ice Breaker
Helicopter	yes (size ?)
Work Boat	yes life boat, size, whaler, zodiac.
Lifting	20T forward derricks (2)
Accomodations	all adequate
Work Space	
Deck Space	
Availability	Replaces Camsell 1985
Nav. Aids	- standard DOT
Experience	- new ship.

Spot Charter Rate + Conditions - nominal user pay policy

Comments: - ideally suited if available.

Vessel Name: Nahidlik

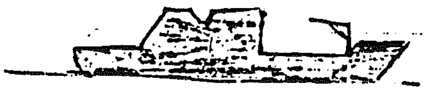
Charter Ship Survey : Beaufort Sea 1986
Oceanetic Measurement Ltd.

Date: Nov 12 85

Operator: Department of Transport
C. C. G. Hay River

Contact Person: Larry Slaght 388-0279
M. Turner Regional Manager Fleet Systems

Type: Buoy Tender + Supply Vessel



Specifications

Length	175'
Beam	50'
Draft	6½"
Speed	14 kn
Range	Mackenzie River + Western Arctic Ocean.
Ice Class	Home Trade Class II Zone 12 July 1. - Oct. 20
Helicopter	yes (size ?)
Work Boat	yes
Lifting	2 × 3¾ T cranes aft.
Accomodations	18 persons
Work Space Deck Space	adequate
Availability -	in the Beaufort July and Sep (not Aug.)
Nav. Aids	
Experience	- in operation since 1974

Spot Charter Rate + Conditions - nominal user pay policy

Comments: - used by Geoscientists extensively (Steve Blascoe)

Vessel Name: John P Tully

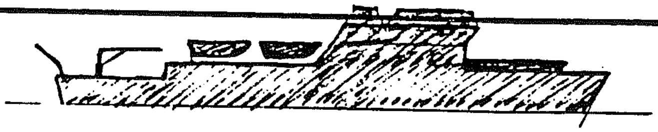
Charter Ship Survey : Beaufort Sea 1986
Oceanetic Measurement Ltd.

Date: Nov 8 85

Operator: D.F.O
1.O.S.
Sidney, BC

Contact Person: A. Fitch 656-8246

Type: - Survey Vessel
- aft deck work



Specifications

Length	226'
Beam	46'
Draft	14.8'
Speed	12 - 14 knots
Range	12000 nm
Ice Class	Lloyds 100 A1 Ice Class 1A. Zone 12 Jul.1 - Nov.10
Helicopter	9000 lb helicopter.
Work Boat	
Lifting	1 10T. crane /@ 20', 3x 2T. "A" frames
Accomodations	15 scientific + crew.
Work Space	2 scientific laboratories
Deck Space	large open aft deck space.
Availability	- ?
Nav. Aids	Sat. Nav., Loran C, Omega, radars, gyros, doppler log
Experience	new.

Spot Charter Rate + Conditions: N/A - user fee or operating cost $7000/day.

Comments: - ideally suited if available.

Vessel Name: Arctic Hooper also Arctic Taglu.

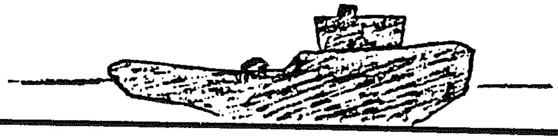
Charter Ship Survey : Beaufort Sea 1986
Oceanetic Measurement Ltd.

Date: Dec 10 85

Operator: Arctic Transportation.
Suite 1900 Esso Plaza East Tower.
425 - 1st St. W
Calgary, Alberta T2P 3L8

Contact Person: J. Wainwright
403 - ~~264-9972~~ 234-7526

Type: pusher / towing tugs.



Specifications

Length	111'
Beam	34'
Draft	13 ½'
Speed	13 knts
Range	220.8 m³ capacity 8.46 tonnes/day @ 13 knts.
Ice Class	Ice Class 1 Type A Zone 12 June 15 - Nov 10
Helicopter	no ice strengthened
Work Boat	no.
Lifting	towing winch (25T), stern roller, mooring capstans
Accomodations	9 single berth cabins + 1 spare cabin
Work Space	no lab space -(except accomodations)
Deck Space	suitable aft deck space
Availability	not committed as of Dec 85.
Nav. Aids	2 radars, 2 sounders, gyro, Loran C.
Experience	operating since 1976

Spot Charter Rate + Conditions: 17 500 / day + fuel.

Comments: -suitable except for accomodation, work space and lifting capability.

Vessel Name: Arctic Sounder

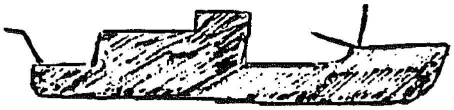
Charter Ship Survey : Beaufort Sea 1986
Oceanetic Measurement Ltd.

Date: Dec 4 85

Operator: Arctic Transportation Ltd.
Suite 1900, Esso Plaza, East Tower
425 1st St. S.W.
Calgary Alberta T2P 3L8

Contact Person: John Wainwright
403 - 234 - 7524

Type: Survey/Seismic/Research
Vessel.



Specifications

Length	180'
Beam	32'
Draft	11'
Speed	11 knots.
Range	147.6 m^3 fuel consumption 4.2 tonnes/day @ 11 knots. ÷6500m.
Ice Class	Home Trade I Type E Zone 12 Jul. 1. to Oct. 20.
Helicopter	no
Work Boat	20'
Lifting	5T stern "A" frame, hinged boom forward, hydrographic booms midships
Accomodations	22 berths.-crew (14) + survey party (8)
Work Space	7 laboratory spaces.
Deck Space	- 76 ft^2 well deck, 48 ft^2 aft deck
Availability	subject to availability. not yet committed Dec. 85
Nav. Aids	2 radars, depth sounder, gyro, Loran, DF, Sat. Nav.
Experience	

Spot Charter Rate + Conditions: $14500.00/day + fuel delivery/redelivery Tuk

Comments: - very suitable vessel
- availability on a short spot charter is difficult.
- lifting capability limited.

Vessel Name: Beaufort Sea Explorer

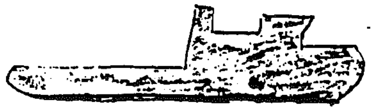
Charter Ship Survey : Beaufort Sea 1986
Oceanetic Measurement Ltd.

Date: Dec 3 85

Operator: Arctic Transportation Ltd.
Suite 1900, Esso Plaza, East Tower
425 - 1st St. S.W.
Calgary Alberta T2P 3L8

Contact Person: John Wainwright
403-234-7524

Type: pusher / towing tug.
anchor handling



Specifications

Length	118'
Beam	36'
Draft	8'
Speed	2 Cat D399 @ 2250 HP total (assume adequate)
Range	172.8 m³ fuel consumption ? (assume adequate).
Ice Class	Home Trade II Type E Zone 12 Jul 1 - Oct 20 - ice strengthened bow.
Helicopter	no
Work Boat	no (or life boat).
Lifting	anchor handling winch + stern roller.
Accomodations	12 berths - (9 crew, 3 survey party)
Work Space	enclosed deck. no real lab. space
Deck Space	ample stern deck area
Availability	- not yet committed Dec. 85.
Nav. Aids	2 radar, sounder, DF, gyro, Sat. Nav.
Experience	operating in area 1971

Spot Charter Rate + Conditions - \$15000/day + fuel delivery-redelivery / Tuk.

Comments: - lifting capability not versatile - bring own A frame + winch.
- accomodations will have to double as work space.

Vessel Name: M.V. Frank Broderick

Charter Ship Survey : Beaufort Sea 1986
Oceanetic Measurement Ltd.

Date:

Operator: Northern Transportation Ltd
9945 108 St
Edmonton Alb. T5K 2G9

Contact Person: Harry Amos 403-423-9201

Type: Seismographic survey

Specifications

Length	292'
Beam	42'
Draft	10'
Speed	13¼ knot
Range	9540 nm.
Ice Class	Lloyds 100A1 (2-3" ice breaking capability) Home Trade 1 Zone 12 Jul 1. to Nov. 10
Helicopter	10,000 lbs capacity.
Work Boat	yes
Lifting	1 crane forward capacity ?
Accomodations	27 survey staff + 19 crew
Work Space	2 laboratory spaces (upper deck)
Deck Space	- large main deck, small aft deck - "moon pool"
Availability	
Nav. Aids	Loran C, Decca Sat Nav., radar, gyro, echo sounder
Experience	

Spot Charter Rate + Conditions: $35,000.00/day + fuel + accomodation.

Comments:
- too large
- too expensive

Vessel Name: M.V. Banksland

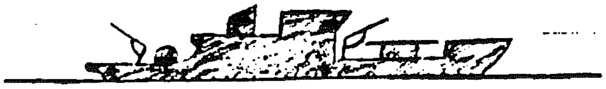
Charter Ship Survey : Beaufort Sea 1986
Oceanetic Measurement Ltd.

Date: Nov 12 85

Operator: Northern Transportation Ltd
9945 108 St
Edmonton, Alb. T5K 2G9

Contact Person: Harry Amos 403-423-9201

Type: Seismic survey
vessel



Specifications

Length	180'
Beam	27'
Draft	9'
Speed	11 knots
Range	2700 nm
Ice Class	Lloyds 100 A1 (breaking capacity 2-3° of ice.) Home Trade 1 Zone12 Jul 1. - Nov. 10.
Helicopter	5000 lbs capacity
Work Boat	27' work launch. (- hydrographic launch)
Lifting	2×1T cranes, 5T winch + "A" frame aft, 1×5T crane forward
Accomodations	20 scientific staff + 12 crew.
Work Space	2 science labs
Deck Space	- large well deck - "moon pool" (5'×5')
Availability	- not yet commited requires 30days total charter time for mobilization.
Nav. Aids	Decca Sat-Nav., radar, sperry gyro, Apelco echo sounder., 2 Marconi radios
Experience	

Spot Charter Rate + Conditions
$19,000.00 / day + fuel extra + $41/day/man accomodation
- requires total charter time (all users) min. 30 days.

Comments:
- well suited
- expensive
- will have to find other users to total 30days time.

Vessel Name: Norweta

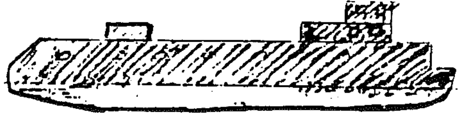
Charter Ship Survey : Beaufort Sea 1986
Oceanetic Measurement Ltd.

Date: Nov. 8 85

Operator: Arctic Offshore Ltd
17th Fl. Mackenzie Pl , P.O. Box 1155
Hay River, NWT
XOE ORO

Contact Person: Capt. D. Tetrault

Type: - Standby Survey Vessel
-"odd-ball" looks like converted ferry



Specifications

Length	103'
Beam	25'
Draft	4½" (summer)
Speed	11 kn
Range	2000 nm
Ice Class	CSI Class E Zone 12 Jul.1 - Oct. 20
Helicopter	no
Work Boat	16' launch on boat deck out board motor
Lifting	work boat davit, davit forward with anchor windlass
Accomodations	21 berths / 11 cabins (for crew and scientists)
Work Space	Instrument Rm on boat deck
Deck Space	-small uncovered deck space bow+stern on main deck. -ample deck space on boat deck
Availability	-available on spot charter. - on charter 86 Jun-Jul Esso -after mid July.
Nav. Aids	- Decca Radar.
Experience	

Spot Charter Rate + Conditions: 10 800.00 / day all found Tuk. includes fuel, water, lubes, meals.

Comments: - marginally suitable - cost attractive.
-bring along own nav. aids.
-have to recover off bow deck and handle

Vessel Name: MT Pilot II

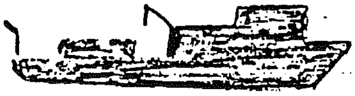
Charter Ship Survey : Beaufort Sea 1986
Oceanetic Measurement Ltd.

Date: Nov 29 85

Operator: Arctic Offshore Ltd
17th Fl Mackenzie Pl. P.O. Box 1155
Hay River, N.W.T
X0E 0R0

Contact Person: Capt. D Tetrault.

Type: Stand by Survey Tug
NB. under modification



Specifications

Length	74'	⟹	84'
Beam	15'	⟹	23'
Draft	3½'	⟹	6'
Speed	12 knots.		
Range	2420 gals = ?		
Ice Class	Arctic Class E		July 1 – Oct. 20 Zone 12 (Home Trade II)
Helicopter	no		
Work Boat	zodiac rubber raft + outboard		
Lifting	anchor windlass	⟹	(2 cranes aft + articulated Hiab midships)
Accomodations	12 berths	⟹	16 berths
Work Space	none	⟹	13½' x 10½'
Deck Space	aft deck space and space along main deck each side	⟹	27' x 14½'
Availability	- available late July (on charter with Esso Jun - July 86)		
Nav. Aids	- Ice Facsimilie machine available, 2 radars, sounder, gyro		
Experience	- many years - no fears of approaching broken ice pack - rebuilt and operating since 1979		

Spot Charter Rate + Conditions: $10,800.00 all found.

Comments:
- very suitable in new configuration. (rebuilt for 1986 season)
- the price is right.
- may require a mid cruise return to base to free up deck space

Vessel Name: (3 Sister vessels) unnamed

Charter Ship Survey : Beaufort Sea 1986
Oceanetic Measurement Ltd.

Date:

Operator: Crowley Maritime Alaska Ltd
Anchorage, Alaska. USA

Contact Person: Steve Petersen 907-267-3302

Type: Pusher Tugs.

?

Specifications

Length	66 ft.
Beam	
Draft	shallow draft ?
Speed	8-9 kts. 1100 hp.
Range	600 + nm. "not a limitation".
Ice Class	not ice class but additional bow strengthened.
Helicopter	none.
Work Boat	?
Lifting	none.
Accomodations	5 crew - 2 additional is possible
Work Space	- limited
Deck Space	- open aft deck.
Availability	-available in Sept. (July - Aug in Prudhoe Bay). -operating period July 1 - Oct end.
Nav. Aids	Loran C, sat nav.
Experience	- operating since 1978

Spot Charter Rate + Conditions: $12000.00 U.S. all found / day or willing to quote on hourly basis.

Comments: - marginally suitable - does not compare well with other vessels.

Vessel Name: Anika Marie

Charter Ship Survey : Beaufort Sea 1986
Oceanetic Measurement Ltd.

Date: Nov 12 85

Operator: Ocean Research Services Inc.
Ester Alaska

based in Prudhoe Bay

Contact Person: David Stone 819-997-0045
(past user)

Type: converted fishing boat.

Specifications

Length	43'
Beam	?
Draft	3½'
Speed	15 kn
Range	550 gals. fuel @ 15gal./hr @ 15knot @ 8gal./hr @ 8knot.
Ice Class	none (steel hull)
Helicopter	no
Work Boat	dinghy
Lifting	"A" frame, winch and capstan capacity ?
Accomodations	
Work Space	?
Deck Space	12' x 15' aft deck
Availability	
Nav. Aids	Decca radar, Magnavox Sat. Nav., depth sounder (Ross)
Experience	- bowhead whale survey Env. Can. see attached

Spot Charter Rate + Conditions $3600.00 US / day + fuel

Comments: not suitable

Vessel Name: M.T. Toga also M.T. Duga

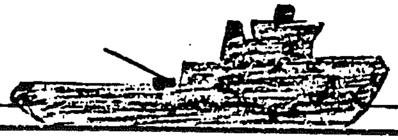
Charter Ship Survey : Beaufort Sea 1986
Oceanetic Measurement Ltd.

Date: Dec. 10, 85

Operator: Arctic Offshore Ltd.
17th Fl. Mackenzie Pl. P.O. Box 1155
Hay River N.W.T.
XOE ORO

Contact Person: Capt. D. Tetrault
403 874-2260.

Type: Supply Tug/
anchor handling



Specifications

Length	111'
Beam	33'
Draft	13½'
Speed	13 knots
Range	5500 nm.
Ice Class	1A1 C Tug Zone 12 Jul1-Nov. 10 Zone 4 Aug20-Sep3
Helicopter	no
Work Boat	zodiak + outboard
Lifting	towing/anchor handling winch, small crane midship, stern roller, 5T tuggerwinc
Accomodations	10 berths, 8 cabins (probably occuppied by crew)
Work Space	covered deck space, limited inside space
Deck Space	large aft deck
Availability	available on spot charter, not yet committed as of Dec. 85,
Nav. Aids	Sat. Nav., sounder, D.F., gyro, 2 radar,
Experience	since 1977 in Beaufort

Spot Charter Rate + Conditions $17,500/day + fuel + lubes + accomodation.

Comments: - questionable accomodations and inside work space

Vessel Name: M. T. Gordon Gill

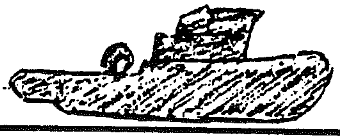
Charter Ship Survey : Beaufort Sea 1986
Oceanetic Measurement Ltd.

Date: Dec 10 85

Operator: Arctic Offshore Ltd.
17 th Fl. Mackenzie Pl.
Box 1155 Hay R. NWT
XOE ORO

Contact Person: Don Tetrault
403 874 2260

Type: Ice Breaking / Anchor Handling Tug.



Specifications

Length	60'
Beam	28'
Draft	6'
Speed	12 kn.
Range	7000 gal. fuel / consumption ?
Ice Class	1A1 Tug. - pollution "A" Zone 12 June 15 - Nov 10
Helicopter	no
Work Boat	Lucas rubber lifeboat
Lifting	anchor handling winch, small boat davit
Accomodations	5 berths in 4 cabins. (may be suitable for 1 person survey crew).
Work Space	limited
Deck Space	small aft deck
Availability	- committed to Canmar Jun. and part July. available on spot charter after.
Nav. Aids	1 radar, sounder, gyro.
Experience	- in Beaufort since 1983

Spot Charter Rate + Conditions -$13,500/day + food + fuel + lubes.

Comments: - marginally useful - consider for heavy ice cover ops.
- accomodation, work space + lift capability very limited.