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Report

Beaufort Sea Coastal Morphology Study

by

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Beaufort Sea Coastal Morphology Study.

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This Open File report presents the results and descriptive background from a field survey conducted along the Beaufort Sea coast in 1986. The survey aimed to establish new sites for monitoring coastal change and to remeasure sites where surveys had been carried out in earlier years. The report contains measured surveys of 40 cliff and beach profiles from the U.S. border to Cape Dalhousie, and calculations of retreat rates at 7 sites.

This study was carried out under contract by Dobrocky Seatech Ltd. as part of the Northern Oil and Gas Action Program (NOGAP) Project D.1: Beaufort Sea Coastal Zone Geotechnics. The report was completed by R.D. Gillie. The report has not been edited by the Geological Survey of Canada and statements contained herein do not necessarily reflect the views or policies of the Government of Canada.

P.R. Hill
Scientific Authority

SUMMARY

This report presents the results of the 1986 Beaufort Sea coastal morphology survey which was conducted from July 13 to July 27, 1986. The field research was undertaken as the continuation of a coastal surveying program which was initiated in 1984.

Coastal surveys included a total of 40 beach profiles at 10 sites and 137 measurements of cliff erosion position at 12 sites. Included in the 1986 survey for the first time were an additional 20 beach profiles at 4 new sites and 33 cliff erosion measurements at 5 new sites.

Plotted and tabulated results of the beach profile surveys are presented for all 40 profiles. Determination of beach profile changes is presented for five profiles at King Point. For the other profiles, the arbitrary nature of distance and elevation datums needs to be resolved for the pre-1986 data before the determination of beach profile changes can be made.

Comparison of the 1986 cliff erosion measurements with data surveyed previously was completed. Computed rates of cliff erosion are similar to those determined for earlier periods.

Two field survey note books containing bench mark and other on site information and a complete set of reduced (prior to computer entry and tidal corrections) beach profile data sheets are archived with the Atlantic Geoscience Centre, Dartmouth, Nova Scotia.

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The following persons and organizations contributed significantly to the activities carried out under this project.

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   Kevin MacKillop, Scientific Authority, Field Geologist
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2. Polar Continental Shelf Project
   Jim Gooden, Manager
   Support Staff at P.C.S.P.

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1.0 INTRODUCTION

In 1984, the Geological Survey of Canada initiated a coastal surveying program in the Canadian Beaufort Sea (Forbes and Frobel, 1985). The need for information on coastal geology and processes in the Beaufort Sea has increased rapidly as a result of anticipated shorebased development to support offshore exploration and production. Sites for port facilities and shore pipeline crossings will be required. In addition, park planning and the Inuvialuit land claim settlement developments also require coastal geology and process information. As a continuation of this research, a field program was conducted for approximately two weeks during the 1986 field season. This report is a description of the data collected and analyzed as part of the 1986 Beaufort Sea Coastal Morphology Study.

The objectives of the 1986 program, as defined in the Work Statement, were as follows:

1) Collect beach profile and sediment data at representative sites to supplement existing information,
2) Resurvey monumented cliff sections to determine erosion rates, and
3) Make observations and sample coastal sections which have received little attention to date.

The Work Statement also outlines that the report will include:

1) Erosional rates of cliff retreat,
2) Description of beach deposits and coastal morphology encountered during the surveys,
3) Profiles illustrating beach/shoreface morphology,
4) Determination of beach and cliff stability using comparisons of data collected during 1976 and 1984. This data will be provided to the contractor by the Scientific Authority, and
5) Determination of the important coastal processes on the evolution of coastal morphology at each site. This will be based on the above data and on observations made during the field program.

2.0 FIELD TECHNIQUES

The Work Statement provided by the Scientific Authority defined the survey objectives, the general field techniques to be used and the location of the beach profile and cliff section sites. The role of the contractor was to provide experience in the use of these survey techniques and in the observation and interpretation of coastal morphology, sediments and processes in the Beaufort Sea coastal environment.

All surveying equipment was provided by the Scientific Authority. This included not only field instruments but also vertical air photos, topographic sheets and hydrographic charts. Previous field survey notes were used to assist in the re-location of existing survey sites. All photographs (slides) were taken, logged and retained by the Scientific Authority. All sediment samples were collected at the discretion of the Scientific Authority and retained for further analysis.

2.1 Field Study Logistics

The 1986 Beaufort Sea coastal morphology survey was conducted from July 13 to July 27, 1986. Coastal surveys included a total of 40 beach profiles at 10 sites and 137 measurements of cliff erosion position at 12 sites. Included in the 1986 survey for the first time were 20 beach profiles at 4 new sites and 33 cliff erosion measurements at 5 new sites.

A summary of survey locations is presented in Table 2.1 and illustrated in Figure 2.1. In some cases, both beach profiles and cliff surveys were conducted at the same geographic site. This is the case for Toker Point, North Head, Ellice Island, King Point and Kay Point (see Table 2.1). In addition, at Toker Point and Ellice Island some beach survey lines are also included as cliff survey lines.

A log of daily survey activities is presented in Appendix 1. Appendix 1 also contains information on the field technique used for either cliff surveys or beach surveys. In some cases, beach profiles were re-surveyed at a later date by what was considered to be the more accurate method. Only data from the later survey has been used for this report. This is discussed further in section 2.4.

Appendix 2 presents an additional summary of cliff erosion survey activities. Appendix 2 is divided into new survey sites and previous survey sites and provides further information on the survey personnel involved and the field techniques used.

TABLE 2.1 1986 Beach and Cliff Survey Locations

Key	Cliff Locations (Lines)	Beach Locations (Lines)
1		Cape Dalhousie (1)
2		Point Atkinson (3)
3	Toker Point (4)	Toker Point (8)
4		Tuktoyaktuk (3)
5	North Head (6)	North Head (3)
6	Hooper Island Site 1 (15) Site 2 (10) Site 3 (13) Site 4 (7)	
7	Pelly Island, Site 3a (4)	
8	Gary Island (4)	
9	Ellice Island (8)	Ellice Island (4)
10	Tent Island (10)	
11	King Point (5)	King Point (5)
12	Kay Point (12)	Kay Point Spit (11)
13		Stokes Point (1)
14		Komakuk Beach (1)

Note: (1) At Toker Point and Ellice Island some beach survey lines are also included as cliff survey lines.

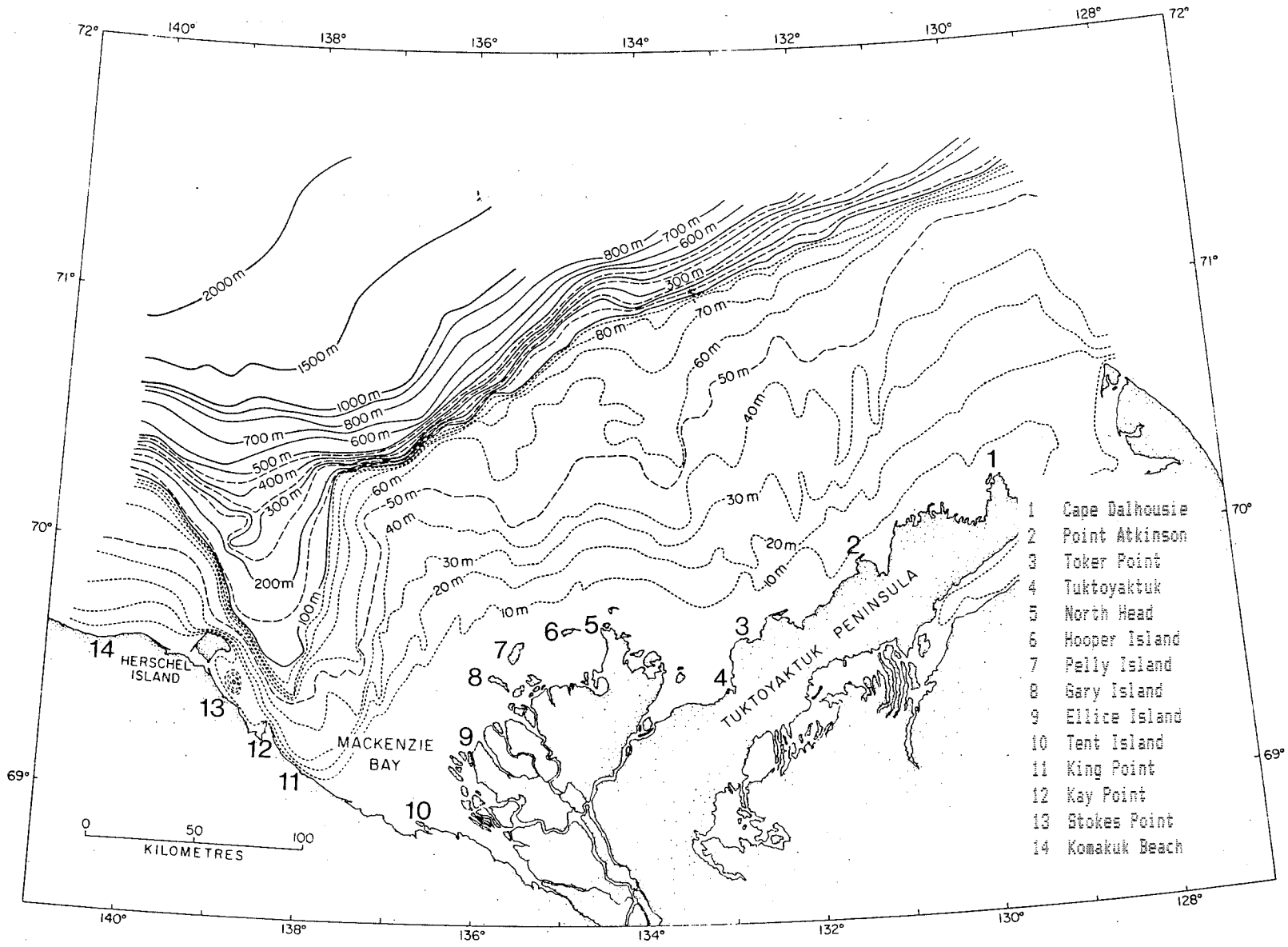


Figure 2.1 - Location of 1986 Beach and Cliff Survey Sites

Field survey work was conducted from a base facility at the Polar Continental Shelf Project in Tuktoyaktuk. Two Bell 206 helicopters, one equiped with floats, were available for use on a shared basis with other researchers at P.C.S.P. A typical day of field work comprised the survey party of three personnel being flown to a particular site with the helicopter either remaining at the site or returning to Tuktoyaktuk, depending upon time, distance and weather criteria. Downtime, because of bad weather conditions or conflicting demands for helicopter use, amounted to three of the total of fourteen days in the field. This equates to 21% of the total field survey time. Downtime was spent at P.C.S.P. performing preliminary reduction of the field data.

2.2 Locating Previous Benchmarks

The process of locating and defining previously installed benchmarks relied upon the information contained in copies of field notes made during previous surveys and brought into the field by the Scientific Authority. The Scientific Authority had also been briefed by the personnel who had conducted the previous surveys, but no personnel from previous surveys were present in the field for this survey. In some cases descriptions of previously installed benchmarks were insufficiently defined and extra time was spent searching for possible benchmark locations.

Over the years different objects have been used for benchmarks, including steel pipes, wooden dowels and wooden stakes. These are usually not identifed with any distinguishing marks so that possible confusion may result with other survey markers which have been placed by other organisations as activities in the Beaufort Sea have increased. In addition some benchmarks had either been removed intentionally or were lost through accident or natural forces. For example, at Cape Dalhousie the previously installed benchmark could not be located near the navigation tower. At Atkinson Point the survey lines, which consisted of a line of 1/2 to 3/4 inch diameter steel pipes, were located but it was not clear from survey notes which was the benchmark pipe for elevation and distance references. At Komakuk Beach no evidence of the previous benchmark could be found and a new benchmark was established. Further information of site specific problems relating to the location of previous benchmarks is provided in Appendix 7 (Bench Mark Descriptions).

2.3 Installation of New Benchmarks

The selection of new survey sites was done to provide a more comprehensive coverage of the Beaufort Sea coast and to obtain data at sites of potential industrial development, such as North Head.

For the new sites an attempt was made to provide better documentation of survey benchmarks with more complete descriptions and sketch maps and to install more easily identified benchmarks. Specifically, the following procedures were used. New bench marks were installed using either reinforcing rod (1/2 inch diameter) or 2 x 2 inch wood stakes. To identify the bench marks in the field a Canada Geodetic Survey aluminum cap was fixed to the top of each reinforcing rod benchmark. The aluminum caps are approximately 7 cm in diameter and were individually identified with a Roman numeral (I, II, III, IV, etc) chiseled into the top surface. In the case of 2 x 2 inch wood stakes benchmarks the stakes were individualy identified with indelible marker pens. Bright orange survey flagging tape was also attached for easy observation from a distance.

Occasional problems were encountered attempting to install benchmarks at the time of year (mid-July). Frozen ground at shallow depths in areas of vegetative ground cover precluded the use of wood stakes and the reinforcing rods could not always be driven into the frozen substrate as deep as was desireable. On exposed ground (beaches and sand dunes) the active layer had thawed deep enough to allow wood stakes to be driven into the loose substrate.

In addition to the detailed descriptions of benchmarks in Appendix 7, two field survey note books completed by the contractor are provided in a separate file box appendix and descriptions of benchmark types, location sketches and locations on air photos were also made and retained by the Scientific Authority.

2.4 Beach Surveys

Field techniques used to survey beaches included two different methods. The method of choice was the use of a survey level on a tripod, a stadia rod to determine elevation differences and a fiberglass tape to determine distance. The second choice was the use of what are commonly known as Emery poles and a tape measure (Emery, 1961). In some cases, beach profiles originally surveyed using the Emery poles method were later resurveyed with a survey level (see Appendix 1).

Survey line orientation was determined by taking the magnetic bearing with a Brunton compass or lensmatic compass. Both provided approximately one degree of resolution and an estimated accuracy of two degrees. In order to provide a stable and level surface the compass was read while mounted on a short wood stake.

A reference water level and time were also taken for subsequent tidal correction of the elevation data to mean sea level.

2.5 Cliff Surveys

Cliff erosion surveys at new sites employed the use of a Brunton compass to determine the magnetic bearing of the survey baseline and the line of distance measurement to the cliff edge. In addition to the primary benchmark for each a line an additional stake was usually placed about 30 m seaward to assist with future measurement orientation. Distance to the cliff edge was measured by fiberglass tape. In some cases the distance to lower breaks in slope, such as multiple cliff faces, were also measured in addition to the upper cliff edge. More detailed measurements of slope element distance and angle were made at the North Head cliff profile sections (Appendix 6). Observations of cliff face stratigraphy and cliff erosion processes were also made at North Head.

2.6 Preliminary Reduction of Field Data

Each evening upon return to the base facility data collected during the day of field activities was reviewed and reduced from field measurements to elevation and distance measurements relative to the survey benchmark. By doing this any possible field survey inconsistences could be detected.

3.0 BEACH SURVEYS

3.1 Beach Profile Sites

The location of beach profile sites are listed in Table 2.1 and shown on Figure 2.1. Previously surveyed sites that were re-surveyed in 1986 included Cape Dalhousie (1 profile), Point Atkinson (3 profiles), Tuktoyaktuk (3 profiles), King Point (5 profiles), Kay Point (11 profiles), Stokes Point (1 profile) and Komakuk Beach (1 profile). However, in the case of Cape Dalhousie, 1 profile at Tuktoyaktuk and Komakuk Beach, the previously installed benchmarks were not found and new benchmarks were installed. Therefore, the new profiles at these sites cannot be directly related to the previous profiles.

New beach profiles were established at Toker Point (8 profiles), North Head (3 profiles) and Ellice Island (4 profiles).

3.2 Beach Deposits and Coastal Morphology

This section presents detailed observations of beach sediments and morphology made at each of the sites visited. Comments on significant coastal processes have also been included.

CAPE DALHOUSIE

The single beach profile comprised a relativley large, vegetated dune deposit with a wide (300 m), windswept sand flat towards the waterline. The sand flat appeared to normally be supra-tidal although driftwood at the base of the dune suggests episodic inundation by storm surges. At the time of the survey heavy 10/10 ice cover was still present off the northeast Tuktoyaktuk Peninsula except for a 200 m wide shore lead and in the vicinity of bays.

ATKINSON POINT

The three beach profiles surveyed across the sand spits at this site were all very low and wide with very little relief. The surface of the beach does not appear to rise more than about 1 m above mean sea level. No vegetated dunes or driftwood is present on the beach extending across from the open sea to the lagoon. The sand sediments on the surface may be transported at times by strong winds but appear to be largely present as a result of storm surge overwash processes.

TOKER POINT

Eight beach profiles were surveyed in the vicinity of Toker Point. In general, the wider beaches are located near the major inlets or as spits, while narrower beaches front low tundra cliff which is eroding. The predominant sediment type is sand with accumulations of gravel to boulder size materials being locally significant but not generally affecting the generally low slope to the beaches. Intertidal ridge and runnel bar systems and sub-tidal, multiple parallel, bar systems are common.

As a point of interest, the inlet a Toker Point was about 60 m in width with a maximum channel depth greater than 2 m when visited in 1986. On July 16 the two small lagoon entrances either side of Toker Point were closed by barrier bars with ponded water at a higher elevation than the sea level at the time.

Profile 1: This profile is located on the seward side of the northeast barrier of Tininerk Bay. The beach has a broad nearshore zone and on the day of the survey (July 15) many pieces of ice were grounded offshore. The profile originates on the northerly of two sand dunes. The backshore is covered with lag gravel over sand.

Profile 2: This profile is backed by a 1 m high cliff of high organic content material. The cliff face consists of slumped peat material. The top of the cliff is vegetated but there are also wave-thrown deposits of sand and wood 5 to 10 m back of the cliff edge. In addition, two distinct storm surge deposited log lines are present about 200 to 300 m back of the beach. Below the low cliff in-situ peat deposits outcrop in the inter-tidal zone. Lag gravels up to boulder size are also present in the inter-tidal zone. Swash bars or ridge and runnel bar systems are present in the lower inter-tidal zone. At the time of survey there were two swash bars with about 0.15 m relief. Grounded ice was present at the waterline. The sub-tidal portion of the beach appears to have a relatively low slope.

Profile 3: This profile terminates on a low sand dune deposit. The beach to the north is a barrier spit with a wind deflated backshore surface of gravel sediments with overwash lobes projecting into a lagoon. Some ridge and runnel features are located near high tide on the profile.

Profile 4: This profile is located on the spit to the southeast of Toker Point. Most of the spit elevation is quite low and devoid of vegetation and driftwood suggesting frequent overwash by waves. However, at the profile location there are some small (less than 0.3 m high) vegetated sand dunes and driftwood debris. Multiple, parallel, longshore bars are present in the sub-tidal zone which were causing waves of 0.5 m height to break at the time of the survey. Beyond profile 4 the more distal portion of the spit is very low in elevation.

Profile 5: The profile on the more distal portion of the spit southeast of Toker Point is very low in elevation with no driftwood deposits. At the time of the survey rafted pieces of peat were strewn over the surface. The profile line terminates on the seaward side of the spit in an area of cuspate shoreline features with wavelengths of approximately 50 m. In the sub-tidal zone crescentic bar systems were also present.

Profile 9: This profile is located approximately 100 m to the east of the entrance to the lagoon at Toker Point. The supra-tidal area landward of the profile comprised vegetated mounds covered with dune grass. A sand dune (1.5 m height) is present between the profile and the lagoon entrance to the west. Peat is exposed on the lower foreshore and at the waterline. Two very distinct log lines are present on the east side of Toker Point lagoon.

Profile 10: This profile originates on a 5 m high sand dune curving for 500 m behind a wide (200 m) supra-tidal sand flat. The lower foreshore has welded ridge and runnel bar systems. At least two parallel, longshore sub-tidal bar systems are present beyond the profile survey depth. The nearshore zone is low gradient.

Profile 11: The landward portion of the profile consists of tundra covered with some wind blown sand. The backshore is composed of sand with minor gravel. A longshore bar is located approximately 100 m offshore at a depth of less than 0.5 m.

TUKTOYAKTUK

Three beach profiles were surveyed in the vicinity of the Village of Tuktoyaktuk. Regarding the two profiles south of the school, the benchmark for the one designated Zone2/Line1 in previous years could not be found and was assumed to have been destroyed. A new benchmark was established.

The two beach profiles south of the school are composed of a mix of sand and gravel sediments. Sand and gravel overwash lobes are encroaching onto the tundra and lagoon backshore areas.

In front of the school, an attempt has been made to control the severe erosion by using a continuous 2 m diameter black fibre tube filled with sand. However, at the ends of the tube, outflanking of the coastal protection has occurred and erosion continues to be severe.

The beach profile at the cemetary consists of an eroding 5 m high cliff composed of mixed sand and gravel with layers of mud. Erosion of the cliff is occurring in the form of debris slides and block falls.

NORTH HEAD

Profile A: Located at the proximal end of a spit the profile consists of a ponded (?) lagoon, a backshore with washover lobes, a large quantity of driftwood logs and a low gradient nearshore zone with multiple, parallel longshore bars. Foreshore sediments are mixed sand and gravel.

Profile 4: This profile is located in the middle of a short (500 m) barrier beach on an otherwise cliffed section of eroding coastline. Prominent overwash lobes extend into a ponded water and marsh area.

Profile 8: The profile originates on a remnant of tundra surrounded by wind blown sand on a supra-tidal flat. In-situ mud and peat is exposed at the shoreline indicating the erosional nature of the local coast. Sand and gravel beach sediments are underlain by peat deposits resulting in a spongy nature to the beach surface.

ELLICE ISLAND

Four of the eight cliff erosion sites on Ellice Island were also surveyed as beach profiles. The four beach profiles are ranges +500, 1,250, 000 and -500. The backshore is fronted by an eroding cliff composed of low relief, vegetated, modern delta deposits approximately 1 to 1.5 m elevation above mean sea level. The low gradient intertidal zone extends up to 300 m from the cliff base. Intertidal sediments are muddy sands overlying high organic deltaic deposits resulting in a spongy feel to the surface.

KING POINT

At King Point five of the seventeen beach profiles established in 1985 (Gillie, 1985) were re-surveyed in 1986. The most apparent change was the presence of a newly formed berm of gravel deposited over ground previously covered by driftwood. The berm was most extensive along the southeast portion of the barrier spit which is the portion of the spit which is prograding most rapidly. At the northwest end of the spit near beach profile line +1,400 there were several (six) overwash channels through the barrier. Each channel was 2-5 m wide and 0.5 m deep. The channels had not been present at the end of the 1985 field season (September 16, 1985).

KAY POINT SPIT

Eleven beach profiles were surveyed at Kay Point spit comprising five profiles in Zone 9, five profiles in Zone 25 and one isolated profile believed to be Zone 37 (?). Within Zone 9 and Zone 25 each beach profile is spaced approximately 20 m apart. The profiles are characterised by similar sediments and morphology. The line of

characterised by similar sediments and morphology. The line of the profile at Zone 37 (?) extends over a new recurve at the distal end of the spit. On the day of the survey (July 24, 1986) approximately 25 dead Beluga whales were found beached on both the seaward and lagoon side of the distal half of the spit.

STOKES POINT

The one beach profile is composed of mixed sand and gravel with a steep foreshore and step. Overwash lobes extend into the low level marsh deposits and lagoon behind the profile. On the day of the survey (July 18, 1986) the beach was eroding. Wind swell from the northeast was causing sediment transport away from the spit apex towards both the east and west as viewed from the heliocopter. The surfzone was 3 to 4 wavelengths in width with breaking waves of 0.5 m height.

KOMAKUK BEACH

Since no sign of the previous benchmark was found, a new benchmark was established approximately 100 m west of the road leading to the west end of the runway.

On the date of the survey it was apparent that no wave action had been present on the beach to this point in the season. Pieces of ice and ice melt holes were prominent everywhere on the beach. The beach is composed of mixed sand and gravel sediments backed by an eroding cliff approximately 5-6 m high. Wave thrown gravel deposits are present on top of the cliff.

3.3 1986 Survey Data Results

A total of 40 beach profiles were surveyed at 10 different locations (see Table 2.1 and Figure 2.1). In order for the beach profile data to be displayed in a consistent format a number of data reduction procedures were applied.

In the field the profile is surveyed relative to an installed benchmark with an elevation reference being taken as the sea level at the time of the survey. The first data reduction procedure comprises defining the benchmark for each profile with a distance of 0.0 m and and an elevation of 0.00 m. Distances landward of the benchmark are then defined as negative and distances seaward as positive. Similarily, elevations below the benchmark ground level elevation are defined as negative and elevations above as positive.

At this stage the data has been reduced by hand and entered onto a "Beach Profile Data Sheet" showing each survey point, elevation and distance relative to the benchmark ground level and a

morphologic features, benchmark measurements, and lagoon or shoreline water levels. The Beach Profile Data Sheets for this survey are contained in a separate appendix along with field survey books.

The next data reduction procedure involves entering the elevation and distance data into the computer. Finally, elevation corrections are applied to reduce the data to mean sea level. The elevation corrections are based upon predicted tide heights derived from the Canadian Hydrographic Service Tide Tables. Tuktoyaktuk was used as the primary port and corrections were applied for secondary port locations near the beach survey locations. The tidal elevation correction applied to each beach profile is contained in Appendix 3A. Only in the case of the King Point profiles was this procedure different. For the King Point data elevation corrections were based upon the detailed mean sea level determination made in 1985, which related all King Point benchmarks to mean sea level.

The 1986 beach profile data is presented in plotted form in Appendix 3B and tabulated form in Appendix 3C. Distance is shown as relative to the benchmark location (- landward, + seaward). Elevations are shown relative to mean sea level. All of the plotted data is displayed at the same scale for conformity. The vertical exaggeration is approximately 60 X.

3.4 Beach Profile Changes

With the exception of the five beach profiles at King Point, the pre-1986 beach profile data cannot presently be compared to the 1986 survey data collected in this survey. The reason for this is the arbitrary nature of distance and elevation datums which have been used to represent the pre-1986 data supplied by the Scientific Authority. For example, the 1984 beach profile data provided on the diskette from the Atlantic Geoscience Centre comes with the following notes on the diskette:

> "All surveys are nominally related to mean water level; however, appropriate corrections have not been made in all cases. Therefore, the datum should be treated as an arbitrary local value with some caution."

An attempt has been made by the contractor to compare 1984 and 1986 data, however the choice of the appropriate benchmark to use at such locations as Kay Point spit and Atkinson Point needs to be defined before the problem can be resolved.

Another problem is present for the beach profiles where benchmarks were not found and had to be re-established. This is the case for Cape Dalhousie, one profile at Tuktoyaktuk and Komakuk Beach.

Regarding the beach profile changes at King Point (Appendix 3D), all profiles show the additional presence of a berm on the 1986 profiles. There has been little change in the backshore zones of all profiles which is to be expected since this zone has not been subjected to wave action. An apparent discrepancy is present on profile 000 which suggests an increase in the backshore elevation by about 0.2 to 0.3 m. This is not considered to be real and instead is thought to be due to a possible survey error from incorrect line orientation.

4.1 Cliff Study Sites

A total of 137 measurements of cliff erosion position were made at 12 locations. This included 33 cliff erosion measurements at 5 new sites in 1986. Previous sites re-surveyed included Hooper Island, Pelly Island, Gary Island and Kay Point. The new sites included Toker Point, North Head, Ellice Island, Tent Island and King Point. These locations are shown in Figure 2.1 and supplementary data on cliff survey operations is contained in Appendix 2.

4.2 Cliff Morphology and Stratigraphy

This section presents observations of cliff morphology, stratigraphy and erosion processes made while conducting the cliff erosion measurements. Emphasis is on describing new sites in 1986 since field time did not allow for more than cliff erosion measurements at sites established in previous years. Table 2.1 indicates the personnel involved in the survey of each site.

TOKER POINT

Cliff erosion sites to the southeast of Toker Point comprise lines 6, 7 and 8. Massive ice layers and ice-rich sediments cause undermining of the cliff face when thawing occurs at the cliff base. Erosion in the form of block falls result. Along this section of shoreline there is a gradual change from ice-rich sediments in the northwest to ice-poor sediments in the southeast. Sediment texture also changes from fines (clay, silt and high organics) to silty sands.

At line 6 the cliff height is 1.2 m and is composed of ice-rich, silty organic material.

At line 7 the cliff height is 3.8 m with thick ice/snow drift at the base of the cliff.

At line 8 the cliff height is 1.8 to 2.5 m. The material is silty sand to sand with organic rich layers. Some massive ice (1 m thick) layers occur along the section.

At line 11, located to the southwest of Toker Point and approximately 200 m north of the navigation tower, the cliff is about 2 m in height and is composed high organic content material.

NORTH HEAD

At North Head 6 lines were established. Detailed cliff face cross-sections showing morphology and stratigraphy are present in Appendix 6.

At line 1 ice-wedge polygons intersect the cliff edge at various angles resulting in variable distances to the cliff edge from the measurement stake. The cliff edge is eroded further back at the location of ice-wedges. Sediments are predominantly silts. Active cliff base erosion was indicated by a vertical scarp backing the beach.

At line 2 massive ice is exposed in the lower portion of the cliff section. Cliff sediments are composed of fine sand to silty sand with no visible gravel. The beach foreshore is composed of a cobble lag.

At line 3 the cliff top edge distance varies +/- 5 m either side of the surveyed distance due to small thaw failures and the position of ice-wedges. Mud flows occur at the base of the cliff. A large snowdrift extends for 200 m to the southwest of the surveyed line. The beach at the base of the cliff comprises promontories every 200 m composed of gravel to boulder lag deposits. The nearshore zone is low gradient with three, parallel longshore bar systems.

At line 5 the surveyed distance intersects the cliff edge at an active retrogressive thaw failure with a mudflow at the base. The cliff edge to the west-southwest is 10 m further to seaward.

Line 6 is located across a former lake bed with an elevation of about 5 m above sea level. Cliff face debris flows have buried snow and ice drifts at the base of the cliff.

Line 7 has a cliff height of approximately 30 m. The cliff edge is straight except for variations of up to 5 m associated with ice-wedge polygons and cliff headwall slumps. Minor ice occurs in the upper section of the cliff. Cliff sediments are predominantly fine sand with minor gravel. There are no apparent retrogressive thaw failure features. Most of the top half of the cliff slopes at greater than 70 degrees, while the lower half consists of debris slides at a slope of about 45 degrees. Mud flows extend onto a predominantly sandy beach with gravel patches. The nearshore is low gradient with multiple parallel bars.

ELLICE ISLAND

Eight cliff erosion lines were established at Ellice Island extending along the coast for a distance of approximately 2 km. Ellice Island is a very low elevation, supra-tidal deltaic flat composed of high organic content sediments. The cliff section material is also high in organic content. The same material

material is also high in organic content. The same material outcrops on the beach about mid-tide level resulting in a hummocky topography. It is quite likely that the organic material underlies the total width of the inter-tidal zone with a relatively thin layer of surficial mud and sand. Erosion of the low cliff (height of about 1 m) produces very little material which would be capable of forming beach deposits.

At least to 100 m landward of the cliff edge, the grass surface is covered with recent silt sediments either deposited by river flood waters or storm surges. There is also grass debris in branches of small willow or birch trees to a height of 0.7 m above the ground. Individual logs are scattered on the surface. Some tree trunks with roots suggest deposition by flood waters in that the root portion is grounded with the trunk directed seaward.

TENT ISLAND

Ten cliff erosion lines were established on Tent Island extending a distance of approximately 1.5 km along the coastline. Shoreline erosion appears to be very rapid along this coast. A new Navigation Aid tower was recently established approximately 100 m back of the existing shoreline. The foundations and remains of the previous tower were visible approximately 20 m seaward of the shoreline. For the purpose of shoreline erosion measurements the top of the cliff edge is a more easily defined feature than the position of the waterline.

The island surface consists of very low elevation, very flat vegetated terrain. The cliff height is about 1.5 m maximum and quite crenulate in plan outline. The cliff material is high organic content with some fine sediments. One of the processes of cliff erosion is associated with small block failures which are initiated by cracks along the top of the cliff edge. No depositional beach exists apart from thick layers of organic detritus. The intertidal zone is also composed of eroding organic and fine sediments.

Various driftwood lines are present within 10 m of the cliff edge. Isolated large driftwood tree trunks with roots lie 200 to 300 m back of the cliff edge indicating major river flooding and/or storm surge events.

KING POINT

Five cliff erosion survey lines were established behind the cliffs at King Point, immediately northwest of King Point spit. The stratigraphy and morphology of these cliffs has been documented in other studies. With regard to cliff erosion measurements at King Point, at line 2 the survey line strikes the cliff near the headwall of a stabilized retrogressive thaw failure which lies above a lower active retrogressive thaw failure.

4.3 1986 Cliff Data Results

The complete results for the 1986 cliff erosion survey are presented in Appendix 4. New sites surveyed for the first time in 1986 include Toker Point, North Head, Ellice Island, Tent Island and King Point. Previously established sites which were re-surveyed in 1986 include Hooper Island (4 sites), Pelly Island, Gary Island and Kay Point.

The survey measurements presented in Appendix 4 are normally the horizontal distance from the benchmark to the cliff edge. The bearing of the surveyed line is also shown. In some cases, the distance to a lower, secondary cliff edge is also shown. Distance to the waterline was also measured where appropriate.

Over 90% of the previously established benchmarks were located and re-surveyed. In other cases, the benchmarks were not found, having been pulled out or lost to rapid coastal erosion. Where existing benchmark stakes were found within 10 m of the present cliff edge, and in danger of being lost to erosion, a decision was made to relocate these stakes landward. In all cases the stakes were moved 10 m and the resulting new distance to the cliff edge has been noted in Appendix 4.

4.4 Cliff Erosion Rates

A major objective of the 1986 field program was to resurvey cliff erosion sites which had been previously surveyed in 1984 and earlier years (Forbes and Frobel, 1985). The tabulated data for the resulting cliff erosion rates in 1986 are presented in Appendix 5. The cliff distance change (erosion) between 1984 and 1986 is usually shown. In addition, at Kay Point, a comparison of 1976 to 1986 changes is also presented.

The tabulated data include a list of the stakes or benchmarks at each site, the total number of available measurements (n), the total of the distance changes for the site (Sigma x), the mean change (Sigma x / n) and the mean yearly average. The sample and population variations ($\pm$ standard error) are also presented.

A summary of the cliff erosion rates for the period 1984 to 1986 is presented in Table 4.1. In general, the calculated rates of erosion are similar to those presented in Table 9.2 of Forbes and Frobel (1985). In this respect, the shorter term rates (2 years) determined from 1984 to 1986 changes are similar to the longer term rates determined for 1976 to 1984 (8 years), although one would expect more variation with shorter term rate determinations.

TABLE 4.1 Summary of Cliff Erosion Rates

Site	n	Mean Erosion Rate (m/a) 1985-1986	1984-1986
Kay Point	10	1.5 (±1.5)	
Gary Island	38		1.2 (±0.9)
Pelly Island Site 3a	4		2.1 (±0.9)
Hooper Island Site 1	15		0.6 (±0.3)
Site 2	10		1.8 (±0.7)
Site 3	13		1.1 (±0.5)
Site 4	6		2.7 (±2.3)

5.0 CONCLUSIONS

In 1984, the Geological Survey of Canada initiated a coastal surveying program in the Canadian Beaufort Sea. As a continuation of this field research, a two week program was conducted in July of 1986 with the objectives of (i) collecting beach profile and sediment data at representative sites, (ii) resurveying monumented cliff sections to determine erosion rates and (iii) making observations at coastal sections which had received little attention to date. All of these objectives were achieved.

A total of 40 beach profiles were surveyed at 10 sites. For comparison, 20 of the beach profiles were at new sites which had not previously been surveyed. In addition, three profiles at previously established sites were re-monumented because of lost benchmarks. At present, comparisons of the 1986 beach profile data to data collected previously is limited to the five profiles at King Point. For the other profiles the arbitrary nature of distance and elevation datums for the pre-1986 data needs to be resolved before profile comparisons can be made.

A total of 137 measurements of cliff erosion positions were made at 12 sites. This included 33 measurements at five new sites. Comparison of the 1986 data with data surveyed previously was successful. Computed rates of cliff erosion are similar to those determined for earlier periods.

6.0 REFERENCES

Emery, K.O., 1961. A simple method of measuring beach profiles. Limnology and Oceanography, volume 6, pp. 90-93.

Forbes, D.L. and D. Frobel, 1985. Coastal erosion and sedimentation in the Canadian Beaufort Sea. In Current Research, Part B, Geological Survey of Canada, Paper 85-1B, pp. 69-80.

Gillie, R.D., 1985. King Point Coastal Zone Sediment Transport Study. Report by Dobrocky Seatech Ltd., Sidney, B.C. Geological Survey of Canada, Open File 1260, 105 pp.

LOG OF 1986 SURVEY ACTIVITIES

APPENDIX 1

BEAUFORT SEA COASTAL MORPHOLOGY STUDY

LOG OF 1986 SURVEY ACTIVITIES

Date	Location	Range	Cliff Surveys		Beach Surveys	
			Tape	Tape and Hand Level	Tape and Emery Poles	Tape, Rod, Survey Level
July 13	Tent Island	000	X			
"	"	100	X			
"	"	200	X			
"	"	300	X			
"	"	400	X			
"	"	500	X			
July 13	Ellice Island	000	X			
"	"	100	X			
"	"	200	X			
"	"	300	X			
"	"	400	X			
"	"	500	X			
July 14	King Point	-200				X
"	"	000				X
"	"	200				X
"	"	600				X
"	"	1,400				X
July 14	King Point	1	X			
"	"	2	X			
"	"	3	X			
"	"	4	X			
"	"	5	X			

APPENDIX 1 (continued)

BEAUFORT SEA COASTAL MORPHOLOGY STUDY

LOG OF 1986 SURVEY ACTIVITIES

Date	Location	Range	Cliff Surveys		Beach Surveys	
			Tape	Tape and Hand Level	Tape and Emery Poles	Tape, Rod, Survey Level
July 15	Tuktoyaktuk	Z2/L1(*)			X	
"	"	Z2/L2(*)			X	
"	"	3 Cemetery(*)			X	X
July 15	Toker Point	1				X
"	"	2				X
"	"	3(*)			X	
July 16	Toker Point	4(*)			X	
"	"	5(*)			X	
"	"	6	X			
"	"	7	X			
"	"	8	X			
"	"	9(*)			X	
July 17	Atkinson Pt.	1 (Z1/L2)			X	X
"	"	2 (Z3/L1)				X
"	"	3 (Z3/L2)				X
July 17	Cape Dalhousie	1				X
July 17	Toker Point	10(*)				X
"	"	11(*)	X			X

APPENDIX 1 (continued)

BEAUFORT SEA COASTAL MORPHOLOGY STUDY

LOG OF 1986 SURVEY ACTIVITIES

Date	Location	Range	Cliff Surveys		Beach Surveys	
			Tape	Tape and Hand Level	Tape and Emery Poles	Tape, Rod, Survey Level
July 18	Komakuk Beach	1	X		X	
July 18	Stokes Point	1			X	
July 19	Tuktoyaktuk	Z2/L1			X	X
"	"	Z2/L2			X	X
"	"	3 (Cemetery)			X	X
July 20	Toker Point	4				X
"	"	5				X
"	"	9				X
"	"	10				X
"	"	11				X
"	"	3				X
July 21	No survey work conducted.					
July 22	North Head	A				X
"	"	1		X		
"	"	2		X		
"	"	3		X		
"	"	4				X
"	"	5		X		
"	"	6		X		
July 23	North Head	7		X		
"	"	8				X

APPENDIX 1 (continued)

BEAUFORT SEA COASTAL MORPHOLOGY STUDY

LOG OF 1986 SURVEY ACTIVITIES

Date	Location	Range	Cliff Surveys		Beach Surveys	
			Tape	Tape and Hand Level	Tape and Emery Poles	Tape, Rod, Survey Level
July 23	Ellice Island	1,250		X		X
"	"	500		X		X
"	"	000		X		X
"	"	-500		X		X
July 24	Kay Point Spit	Z9/L1				X
"	"	Z9/L2				X
"	"	Z9/L3				X
"	"	Z9/L4				X
"	"	Z9/L5				X
"	"	Z25/L1				X
"	"	Z25/L2				X
"	"	Z25/L3				X
"	"	Z25/L4				X
"	"	Z25/L5				X
"	"	Z37				X
July 25	Tent Island	750		X		
"	"	1,000		X		
"	"	1,250		X		
"	"	1,500		X		
July 25	Gary Island	41 stakes		X		
July 25	Pelly Island	Site 3, 4 stakes		X		

APPENDIX 1 (continued)

BEAUFORT SEA COASTAL MORPHOLOGY STUDY

LOG OF 1986 SURVEY ACTIVITIES

Date	Location	Range	Cliff Surveys		Beach Surveys	
			Tape	Tape and Hand Level	Tape and Emery Poles	Tape, Rod, Survey Level
July 26	No survey work conducted.					
July 27	Hooper Island	Site 1, 15 stakes		X		
"	"	Site 2, 11 stakes		X		
"	"	Site 3, 13 stakes		X		
"	"	Site 4, 7 stakes		X		
July 20	Kay Point	12 stakes		X (Surveyed by Scott Dallimore)		

Notes:

1. (*) Indicates re-surveyed at a later date by more accurate technique. Only data from later survey has been reduced for profile representative profile.

SUMMARY OF 1986 CLIFF EROSION SURVEY ACTIVITIES

APPENDIX 2

SUMMARY OF 1986 CLIFF EROSION SURVEY ACTIVITIES

(I) Survey of New Sites

Site	N	Survey Date	Survey Personnel	Comments
(1) Tent Island	10	July 13, 25	Gillie, MacKillop, Milne	All horizontal taped distances.
(2) Ellice Island	8	July 13, 23	Gillie, MacKillop, Milne	Six lines horizontal tape distance only, four lines include beach profiles.
(3) King Point	5	July 14	Gillie, MacKillop, Milne	All horizontal taped distances
(4) Toker Point	4	July 16, 20	Gillie, MacKillop, Milne	Three lines horizontal tape distance, are with beach profile.
(5) North Head	6	July 22, 23	Gillie, MacKillop, Milne	All lines tape and hand level profiles.

APPENDIX 2 (continued)

SUMMARY OF 1986 CLIFF EROSION SURVEY ACTIVITIES

(II) Re-survey of Previous Sites (All horizontal taped distances)

	Site	N	Survey Date	Survey Personnel	Comments
(1)	Kay Point	12	July 20	Dallimore	Polygon zone, as defined by Peter Lewis, just south of spit.
(2)	Garry Island	41	July 25	Gillie, MacKillop, Milne	
(3)	Pelly Island, Site 3a	4	July 25	Gillie, MacKillop, Milne	Also searched for stakes at two sites on southwest cliff, but none found.
(4)	Hooper Island, Site 1	15	July 27	MacKillop, Milne	
	Hooper Island, Site 2	10	July 27	MacKillop, Milne	
	Hooper Island, Site 3	13	July 27	MacKillop, Milne	
	Hooper Island Site 4	7	July 27	MacKillop, Milne	

1986 BEACH PROFILE DATA

APPENDIX 3A - ELEVATION CORRECTIONS

APPENDIX 3B - PLOTTED DATA

APPENDIX 3C - TABULATED DATA

APPENDIX 3D - BEACH PROFILE CHANGES, KING POINT, 1985-1986

APPENDIX 3A - ELEVATION CORRECTIONS

APPENDIX 3A: Elevation Corrections Applied to 1986 Beach Profile Data to Reduce to Mean Sea Level

NOTES:

(1) Relative Surveyed Water Level (Column 3)
- The local sea level elevation at the time of the survey is represented as 0.00 m in every case.
- The lagoon water level, when available for measurement, is represented relative to the sea level.
- Differences in height between the two are due to tidal changes over the time duration of the survey line and/or are an indication of relative survey measurement accucacy.
- Times are local (MDT).

(2) Predicted Tide Heights (Column 4)
- These were derived from the CHS Tide Tables based upon the time of the survey. Corrections were applied for MST and secondary port locations.

APPENDIX 3A: Elevation Corrections Applied to 1986 Beach Profile Data to Reduce to Mean Sea Level

Location Profile	B.M. Estab. (19__)	Relative Surveyed Water Level (Lagoon, Sea) (Date, Time)	Predicted Tide Height (m)	Correction to Mean Sea Level (m)
King Point				
-200	1985	14/07,		+1.48
000	1985	14/07,		+1.52
+200	1985	14/07,		+1.20
+600	1985	14/07,		+1.63
+1,400	1985	14/07,		+1.36
(Note: Corrections for King Point where derived in 1985 from local tide gauge records and have been applied to the 1986 data.)				
Toker Point				
1	1986	____,0.00 15/07,14:20	+0.5	+0.1
2	1986	____,0.00 15/07,15:50	+0.5	+0.1
3	1986	____,0.00 20/07,16:30	+0.6	+0.2
4	1986	-0.06,0.00 20/07,10:55	+0.35	-0.05
5	1986	-0.04,0.00 20/07,11:35	+0.35	-0.05
9	1986	____,0.00 20/07,12:50	+0.50	+0.10

APPENDIX 3A: Elevation Corrections Applied to 1986 Beach Profile Data to Reduce to Mean Sea Level (Continued)

Location Profile	B.M. Estab. (19__)	Relative Surveyed Water Level (Lagoon, Sea) (Date, Time)	Predicted Tide Height (m)	Correction to Mean Sea Level (m)
Toker Point				
10	1986	_____,0.00 20/07,14:45	+0.55	+0.15
11	1986	_____,0.00 20/07,15:30	+0.60	+0.20
Ellice Island				
+500	1986	_____,0.00 23/07,15:10	+0.30	+0.10
+1,250	1986	_____,0.00 23/07,16:33	+0.35	+0.15
000	1986	_____,0.00 23/07,17:31	+0.40	+0.20
-500	1986	_____,0.00 23/07,18:10	+0.40	+0.20
Tuktoyaktuk				
1 (Z2/L1)	1986	_____,0.00 19/07,14:45	+0.65	+0.35
2 (Z2/L2)	1986/ 1984	_____,0.00 19/07,14:15	+0.65	+0.35
3 (?)	1986/ 1984	_____,0.00 15/07,11:48	+0.60	+0.30

APPENDIX 3A: Elevation Corrections Applied to 1986 Beach Profile Data to Reduce to Mean Sea Level (Continued)

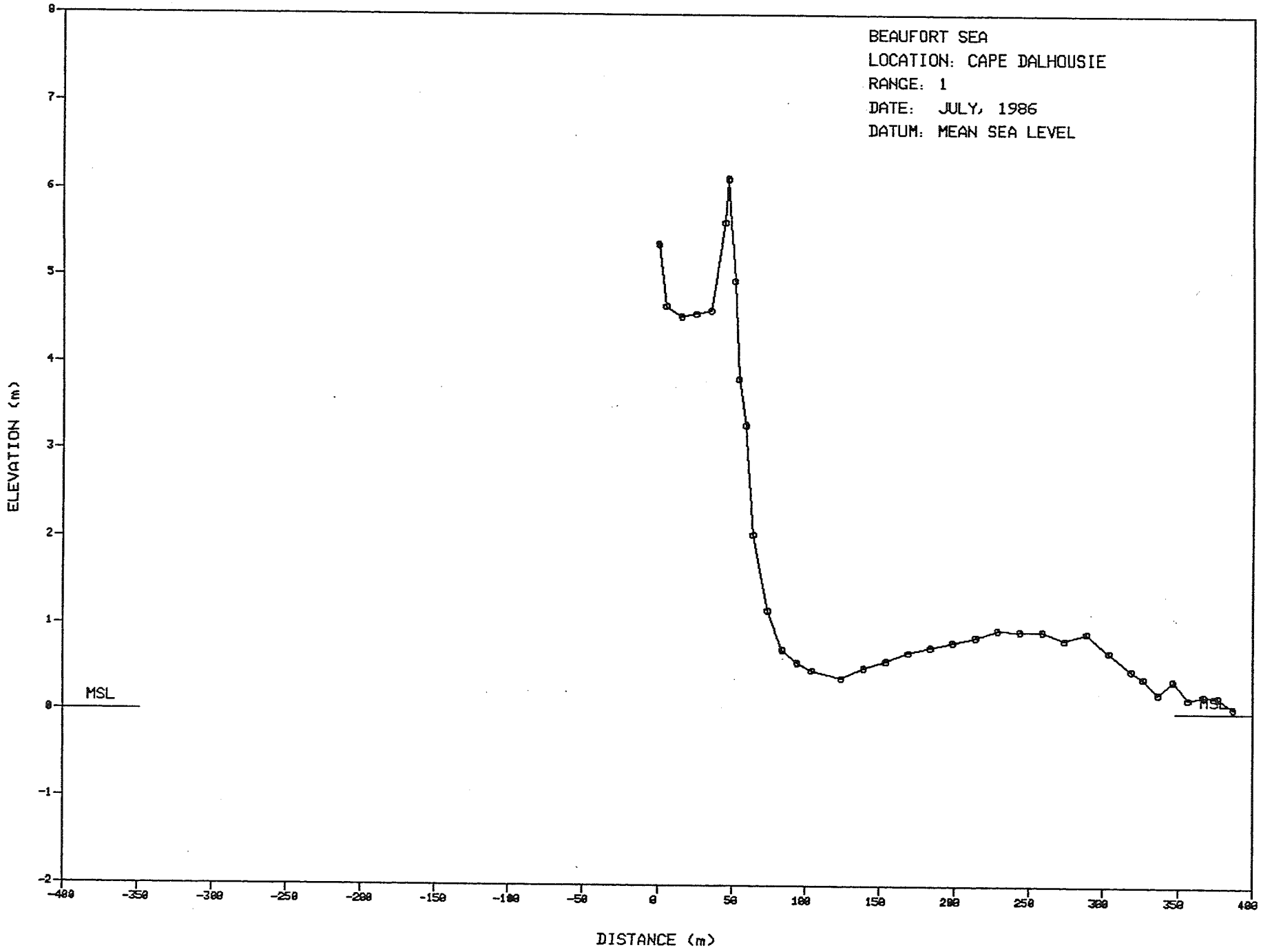
Location Profile	B.M. Estab. (19__)	Relative Surveyed Water Level (Lagoon, Sea) (Date, Time)	Predicted Tide Height (m)	Correction to Mean Sea Level (m)
Kay Point				
Z9/L1	----	0.00,0.00 24/07,17:15	+0.60	+0.30
Z9/L2	----	0.00,0.00 24/07,17:22	+0.60	+0.30
Z9/L3	----	-0.04,0.00 24/07,12:50	+0.45	+0.15
Z9/L4	----	-0.04,0.00 24/07,17:30	+0.60	+0.30
Z9/L5	----	-0.03,0.00 24/07,17:40	+0.60	+0.30
Z25/L1	----	-0.02,0.00 24/07,15:30	+0.55	+0.25
Z25/L2	----	-0.02,0.00 24/07,15:20	+0.55	+0.25
Z25/L3	----	-0.08,0.00 24/07,14:10	+0.50	+0.20
Z25/L4	----	-0.04,0.00 24/07,15:00	+0.55	+0.25
Z25/L5	----	-0.02,0.00 24/07,14:50	+0.55	+0.25
Z37	----	+0.03,0.00 24/07,16:20	+0.55	+0.25
Komakuk Beach	1986	_____,0.00 18/07,13:14	+0.60	+0.20

APPENDIX 3A: Elevation Corrections Applied to 1986 Beach Profile Data to Reduce to Mean Sea Level (Continued)

Location Profile	B.M. Estab. (19__)	Relative Surveyed Water Level (Lagoon, Sea) (Date, Time)	Predicted Tide Height (m)	Correction to Mean Sea Level (m)
Atkinson Point				
1 (Z1/L2)	----	-0.04,0.00 17/07,10:32	+0.55	+0.15
2 (Z3/L1)	----	+0.05,0.00 17/07,10:50	+0.60	+0.20
3 (Z3/L2)	----	+0.06,0.00 17/07,13:00	+0.55	+0.15
North Head				
A	1986	_____,0.00 22/07,16:45	+0.50	+0.20
4	1986	_____,0.00 22/07,20:22	+0.45	+0.15
8	1986	_____,0.00 23/07,10:00	+0.40	+0.10
Cape Dalhousie				
1	1986	_____,0.00 17/07,14:48	+0.90	+0.40
Stokes Point				
1	-----	_____,0.00 18/07,16:15	+0.50	+0.10

APPENDIX 3B - PLOTTED DATA

Cape Dalhousie
Atkinson Point, Range 1 (Z1/L2)
Atkinson Point, Range 2 (Z3/L1)
Atkinson Point, Range 3 (Z3/L2)
Toker Point, Range 1
Toker Point, Range 2
Toker Point, Range 3
Toker Point, Range 4
Toker Point, Range 5
Toker Point, Range 9
Toker Point, Range 10
Toker Point, Range 11
Tuktoyaktuk, Zone 2 / Line 1
Tuktoyaktuk, Zone 2 / Line 2
Tuktoyaktuk, Zone 3 (Cemetary)
North Head, Range A
North Head, Range 4
North Head, Range 8
Ellice Island, Range + 500
Ellice Island, Range +1,250
Ellice Island, Range 000
Ellice Island, Range - 500
King Point, Range -200
King Point, Range 000
King Point, Range +200
King Point, Range +600
King Point, Range +1,400
Kay Point, Z9 / Line 1
Kay Point, Z9 / Line 2
Kay Point, Z9 / Line 3
Kay Point, Z9 / Line 4
Kay Point, Z9 / Line 5
Kay Point, Z25 / Line 1
Kay Point, Z25 / Line 2
Kay Point, Z25 / Line 3
Kay Point, Z25 / Line 4
Kay Point, Z25 / Line 5
Kay Point, Z37
Stokes Point
Komakuk Beach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MSL
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7
6
5
4
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0
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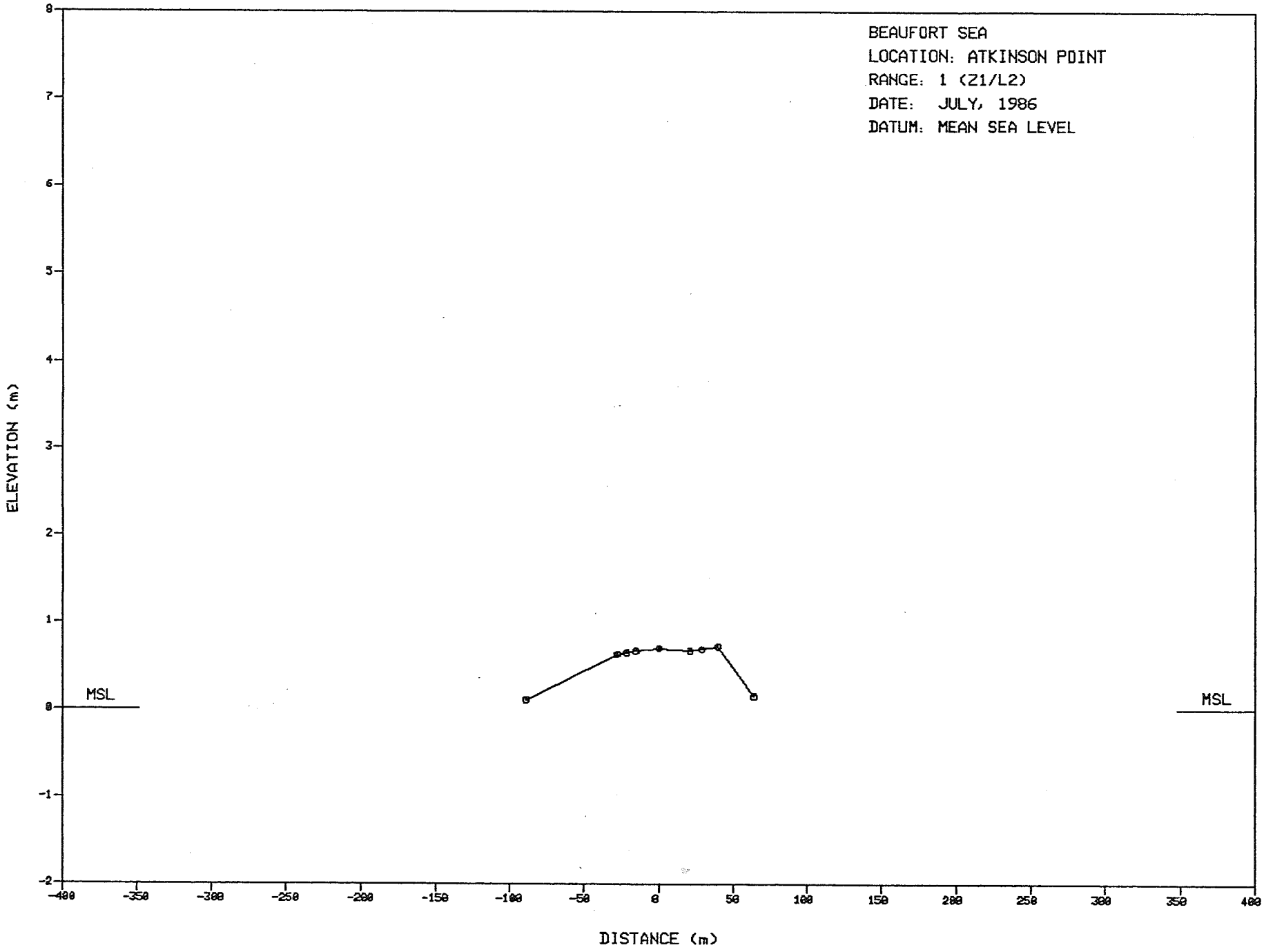
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DISTANCE (m)
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MSL
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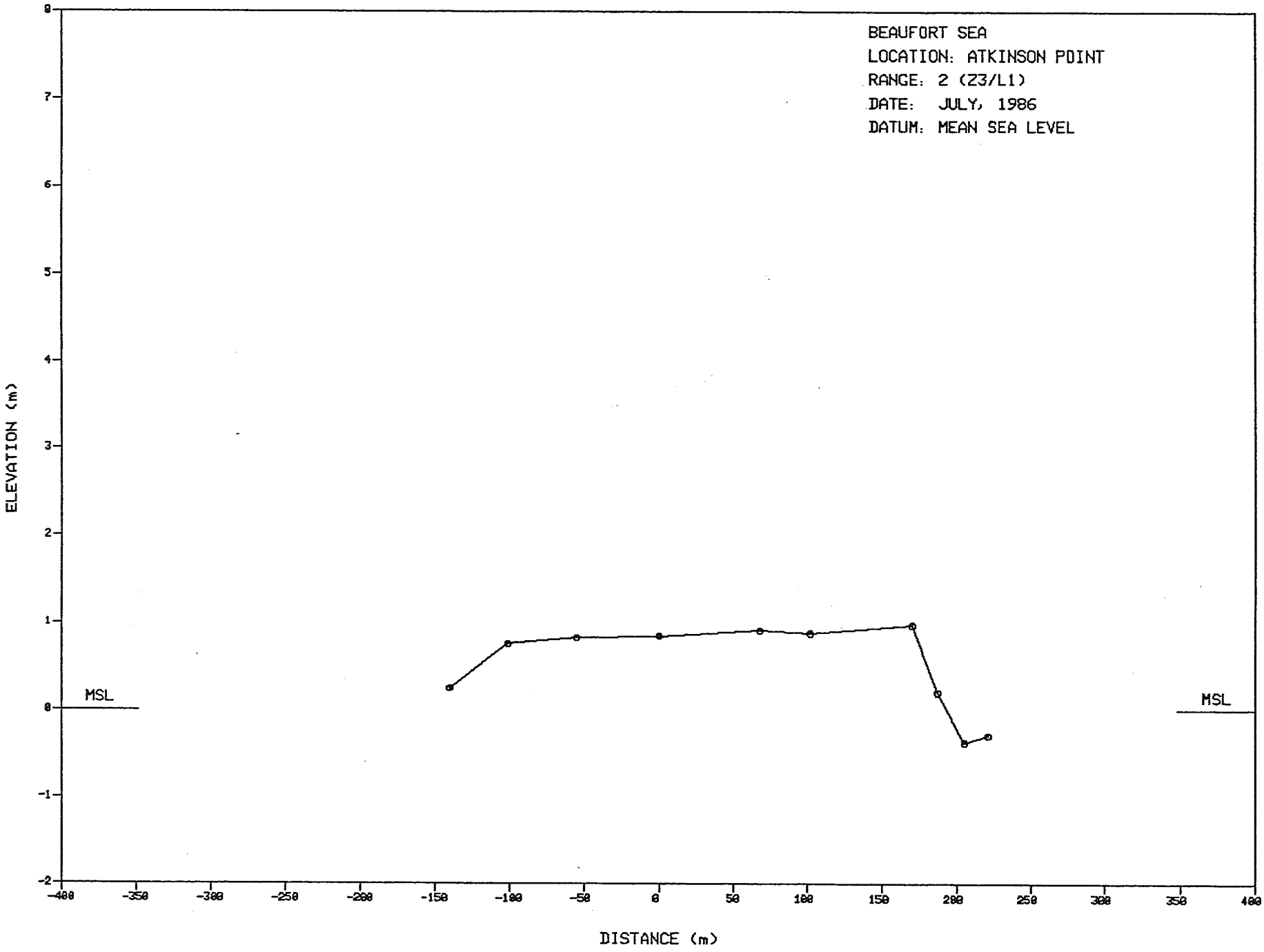
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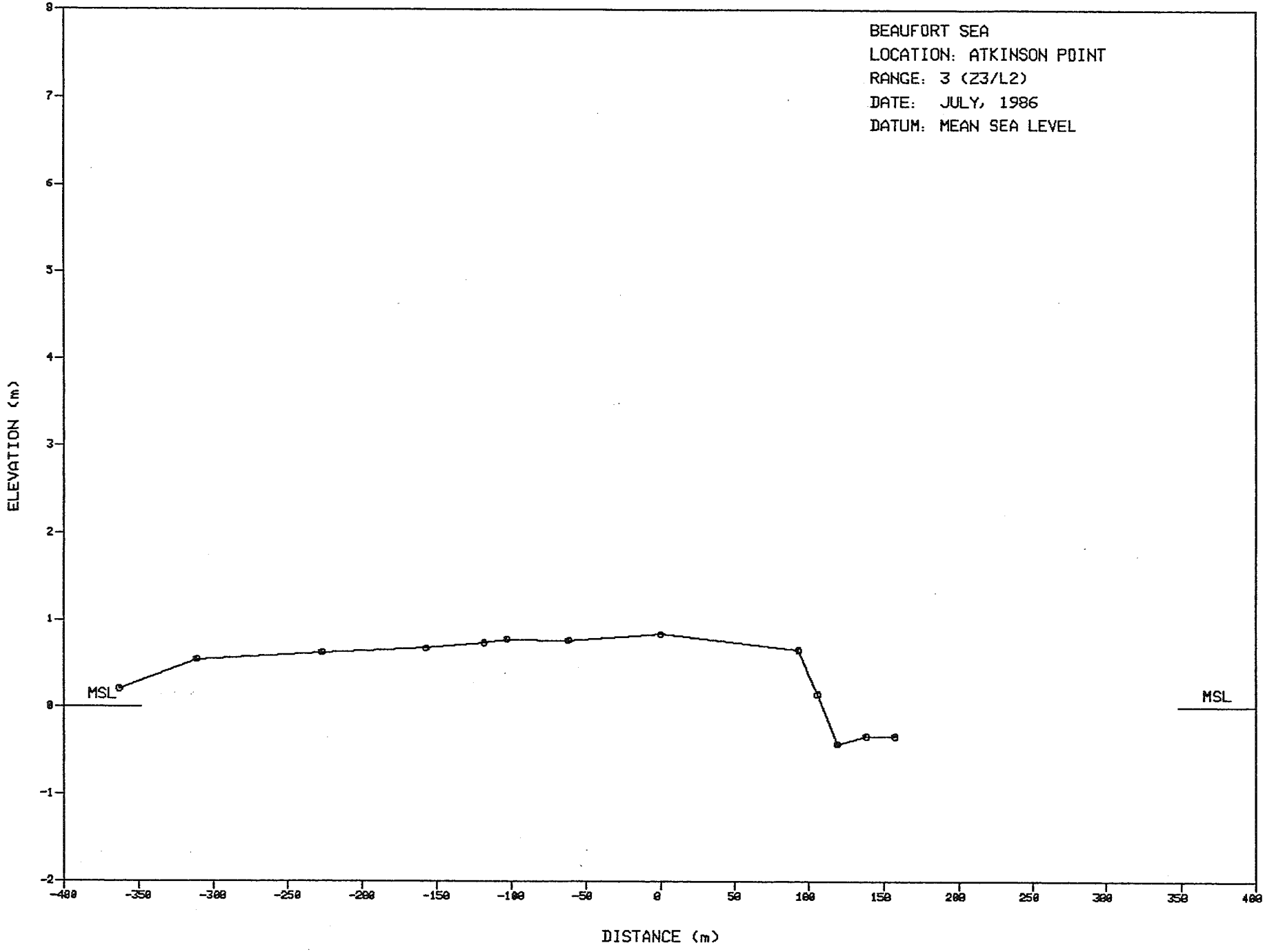
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DISTANCE (m)
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MSL
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4
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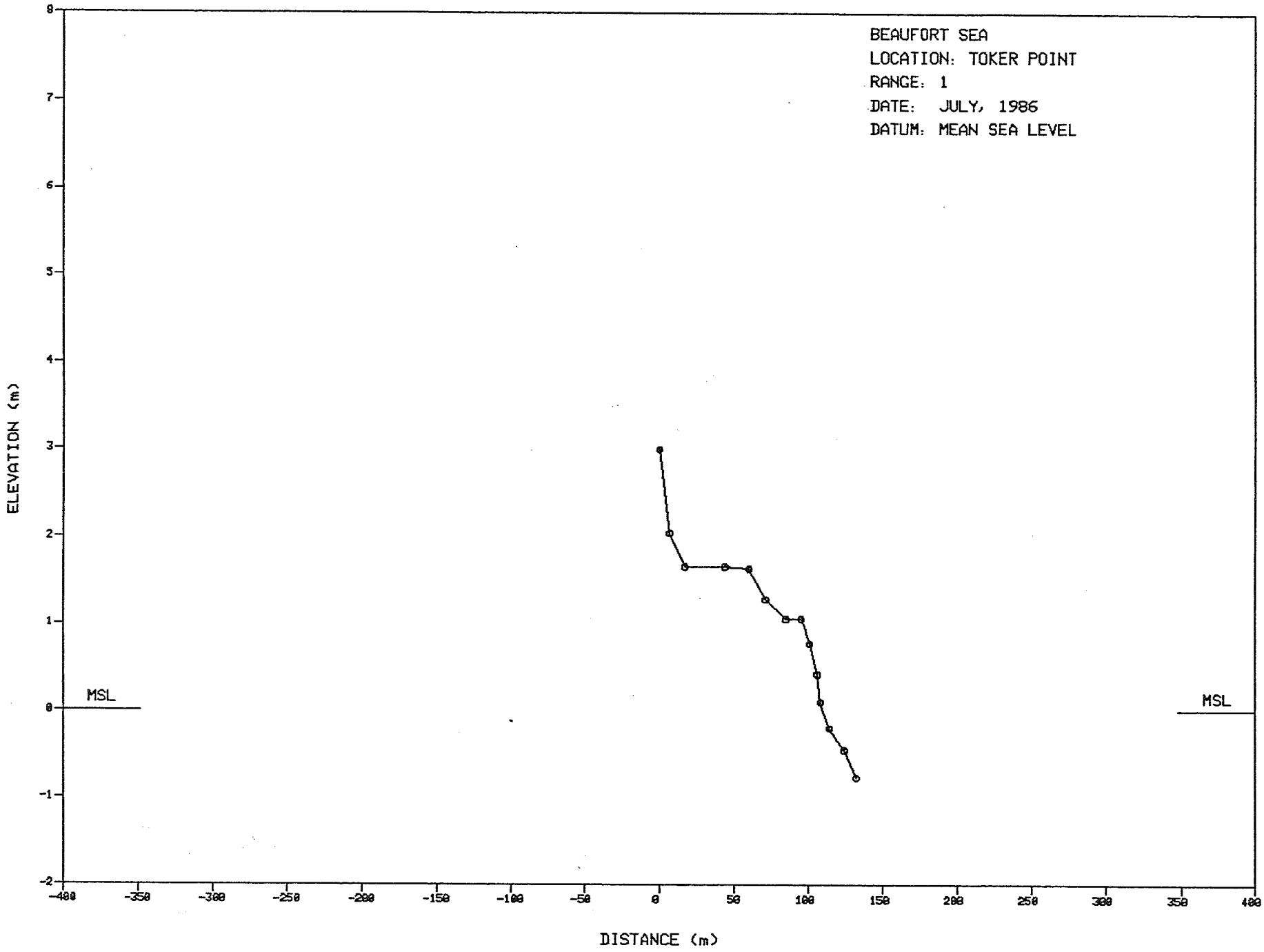
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RANGE: 1
DATE: JULY, 1986
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MSL
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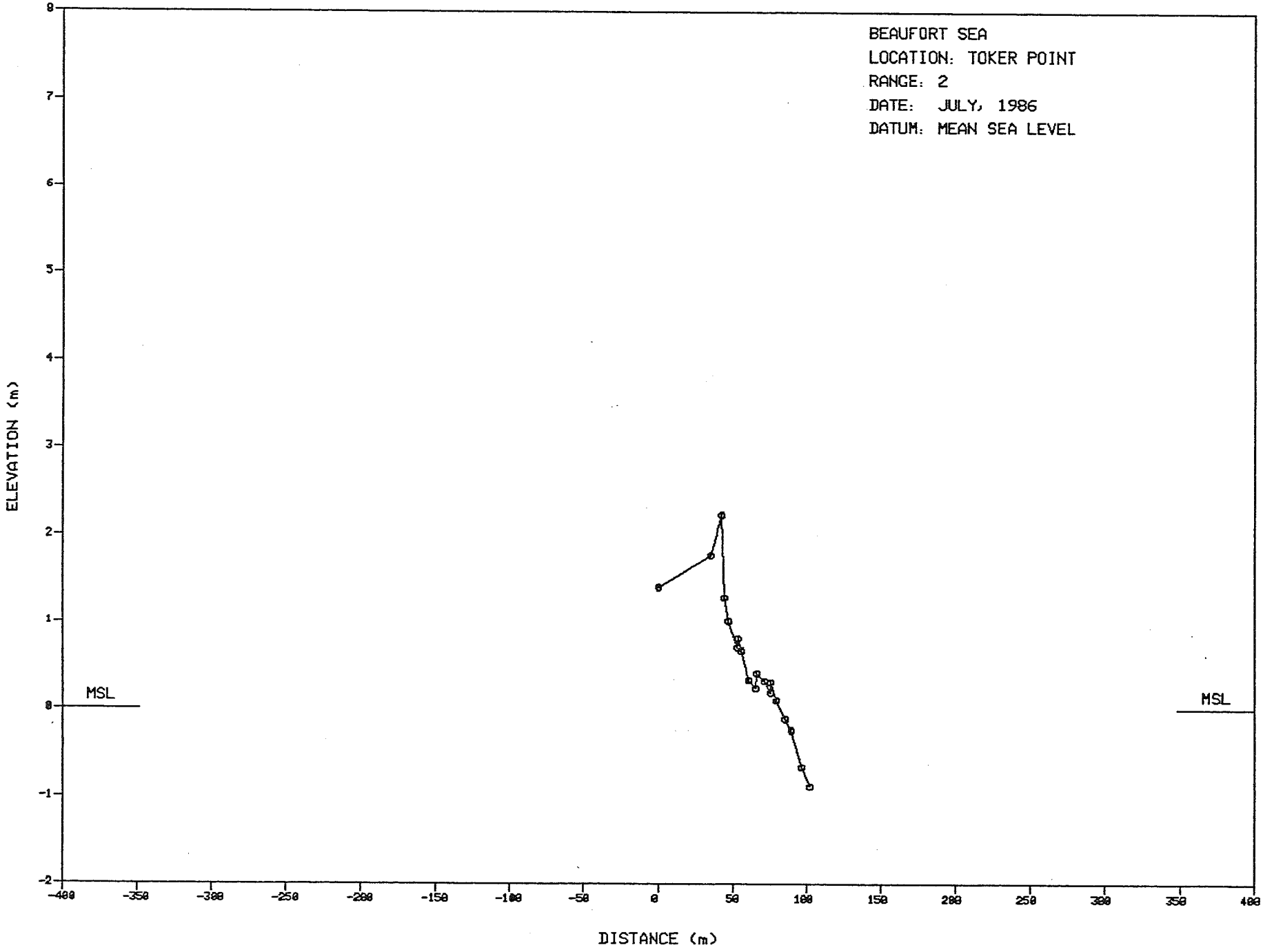
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RANGE: 2
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
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6
5
4
3
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1
0
-1
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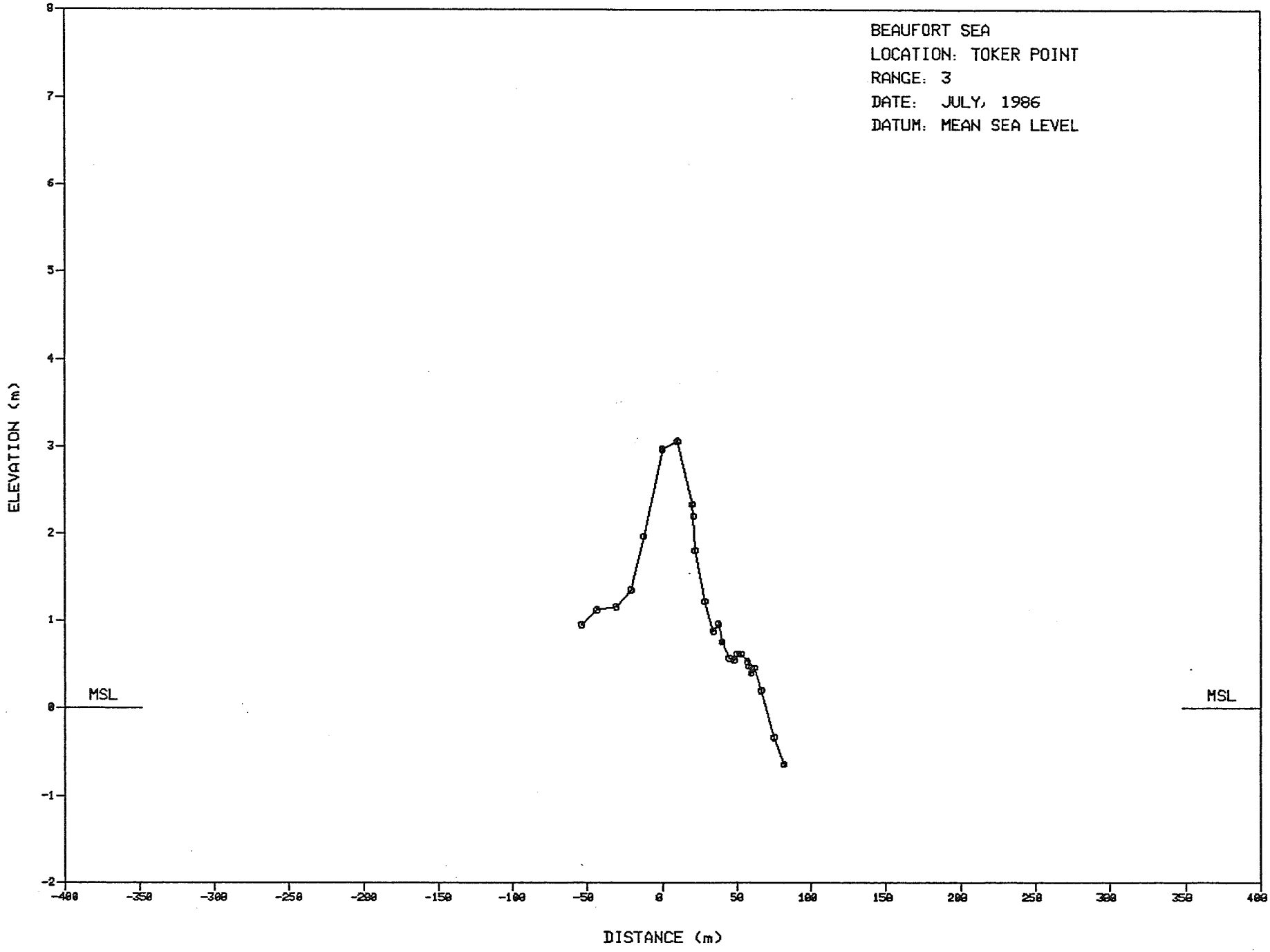
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RANGE: 3
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
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1
0
-1
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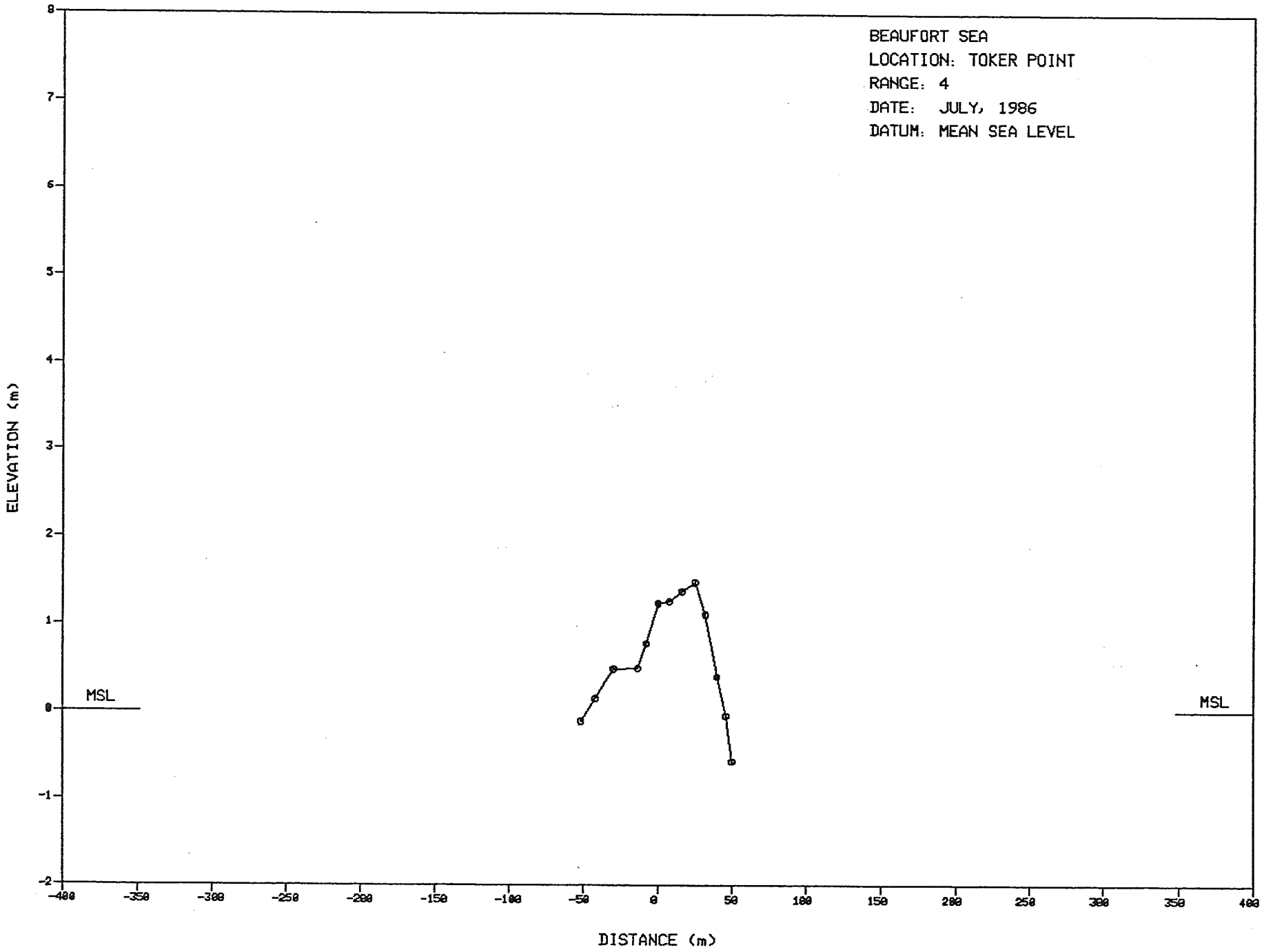
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RANGE: 4
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
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5
4
3
2
1
0
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-2
MSL
MSL
-400
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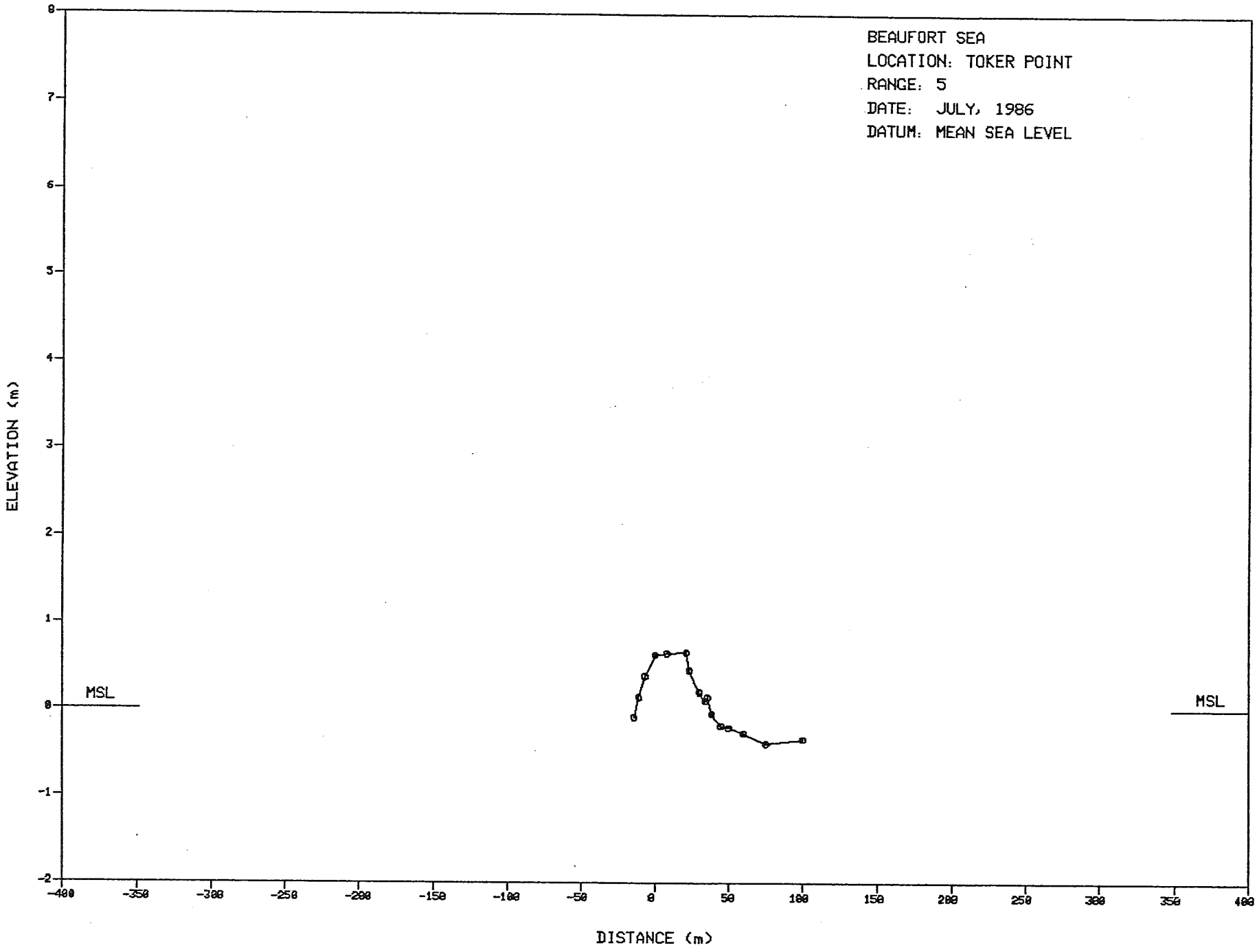
350
400
DISTANCE (m)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RANGE: 5
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
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DISTANCE (m)
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MSL
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7
6
5
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-150
-100
-50
0
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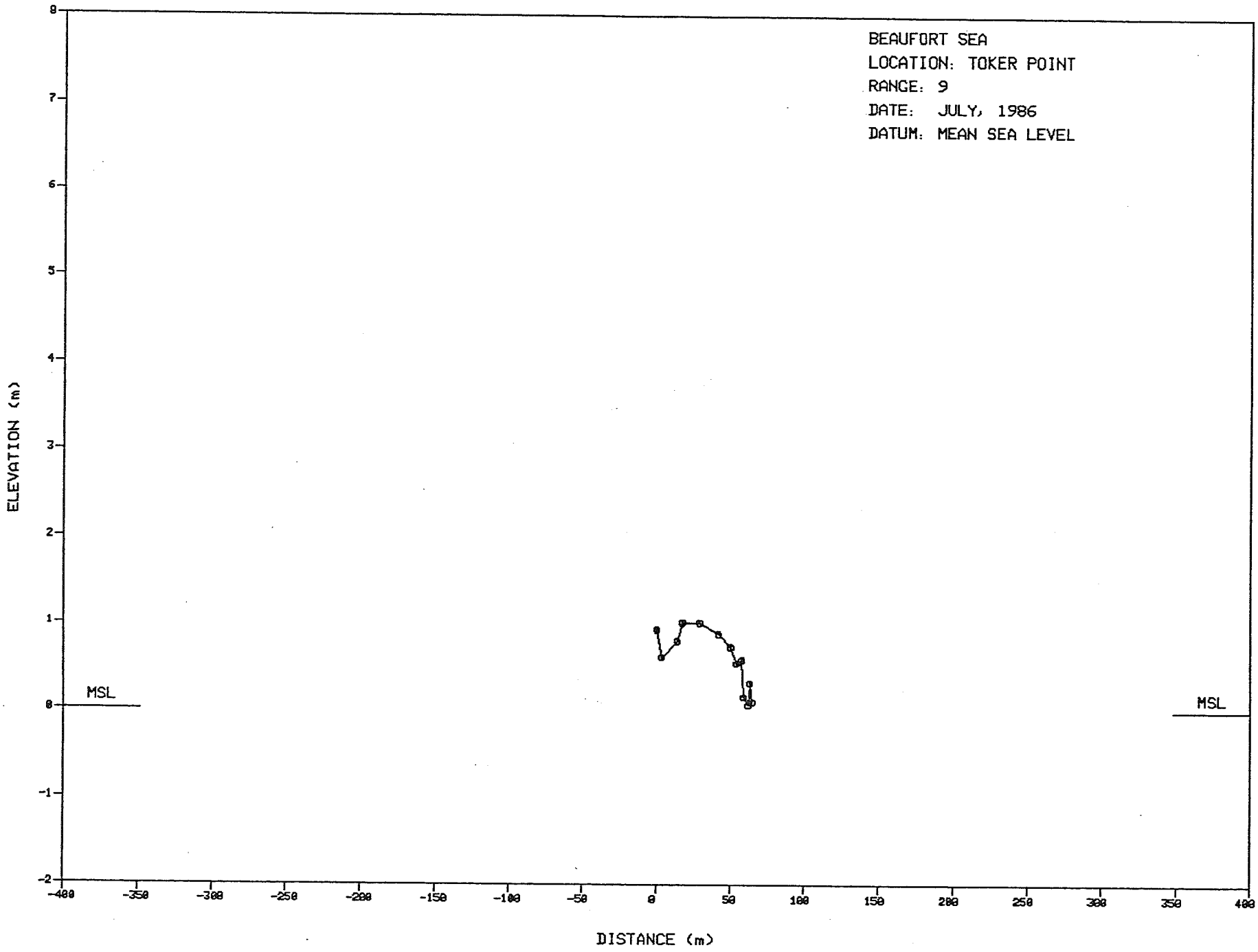
100
150
200
250
300
350
400


BEAUFORT SEA
LOCATION: TOKER POINT
RANGE: 9
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
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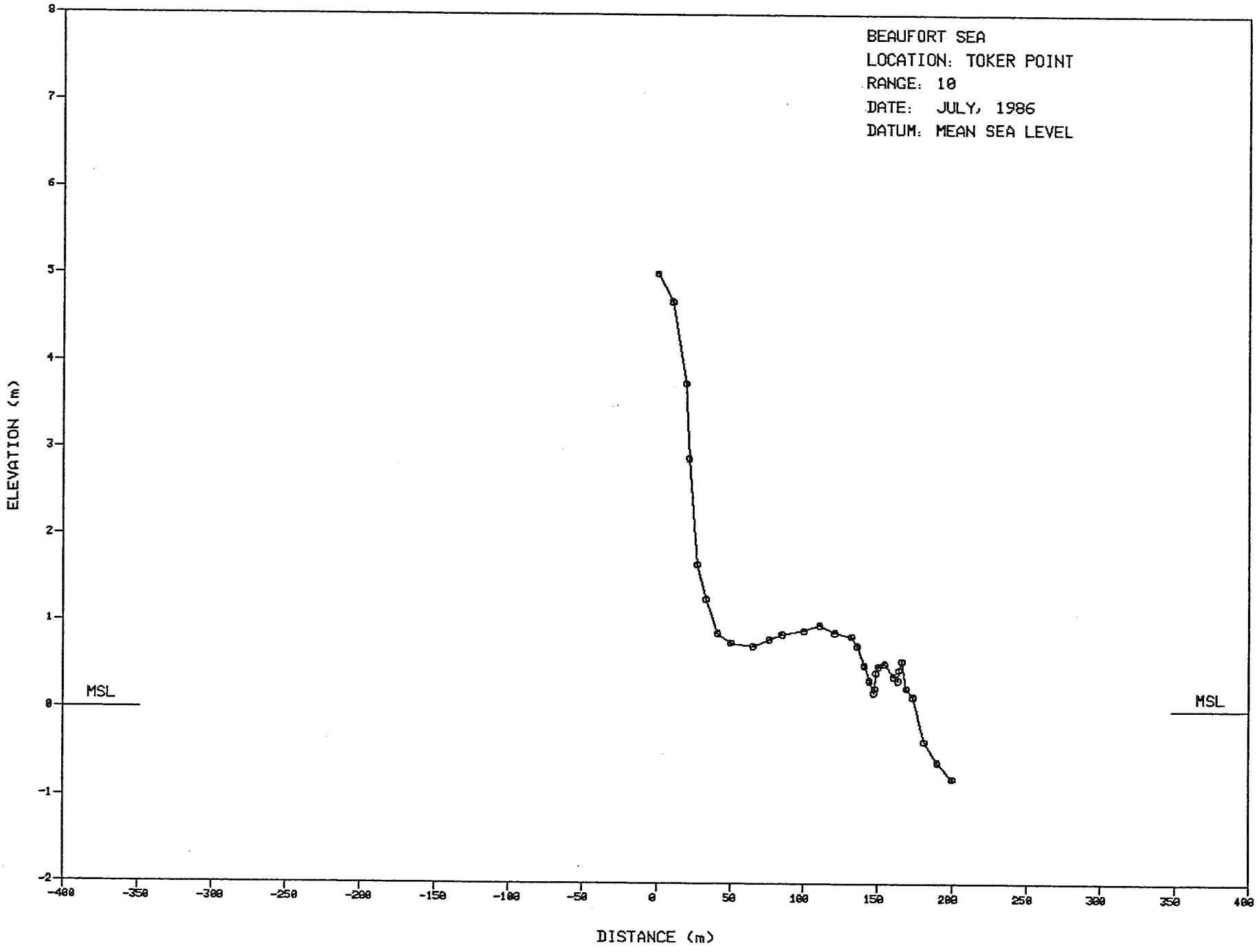
200
250
300
350
400


BEAUFORT SEA
LOCATION: TOKER POINT
RANGE: 10
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
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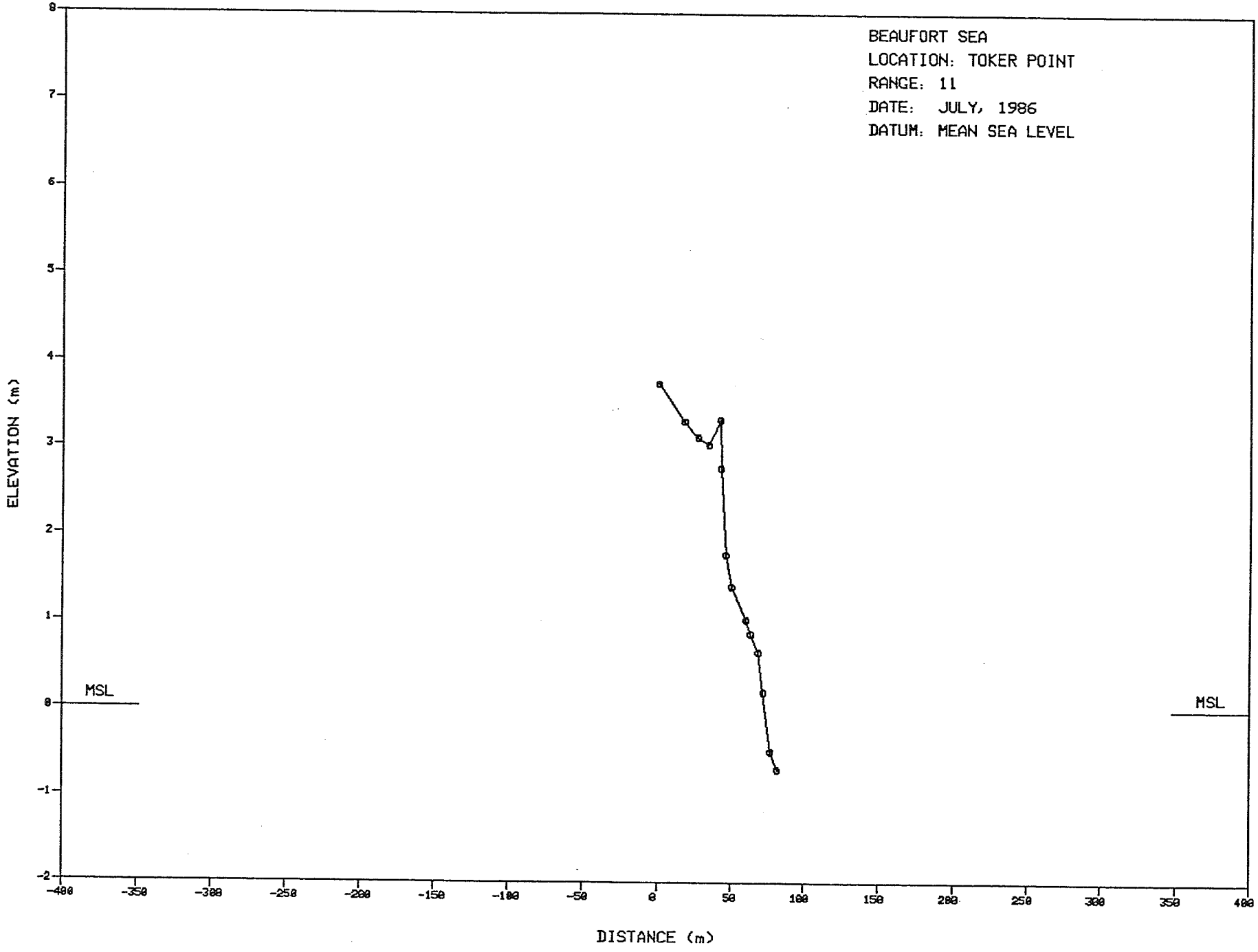
200
250
300
350
400


BEAUFORT SEA
LOCATION: TOKER POINT
RANGE: 11
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
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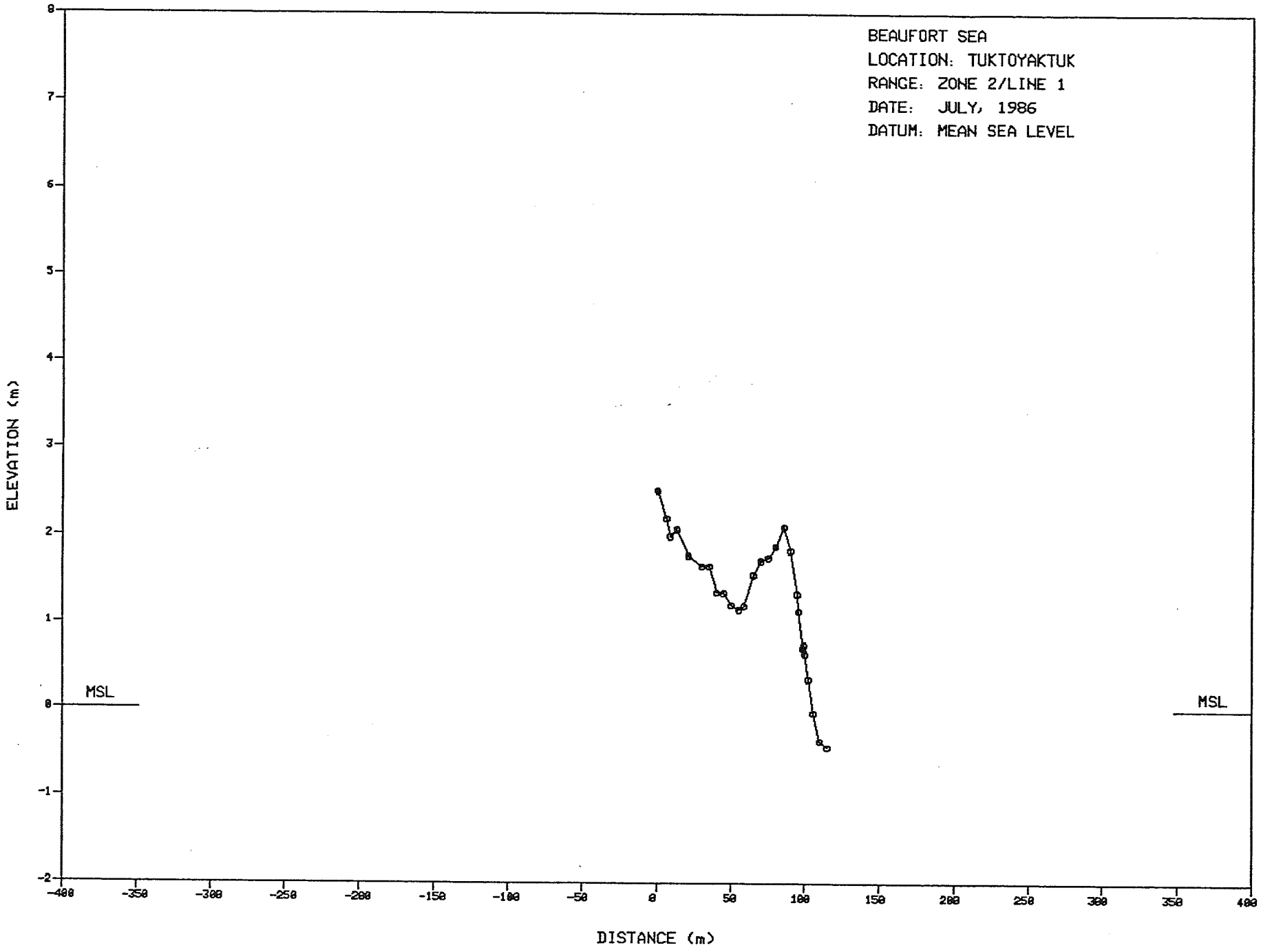
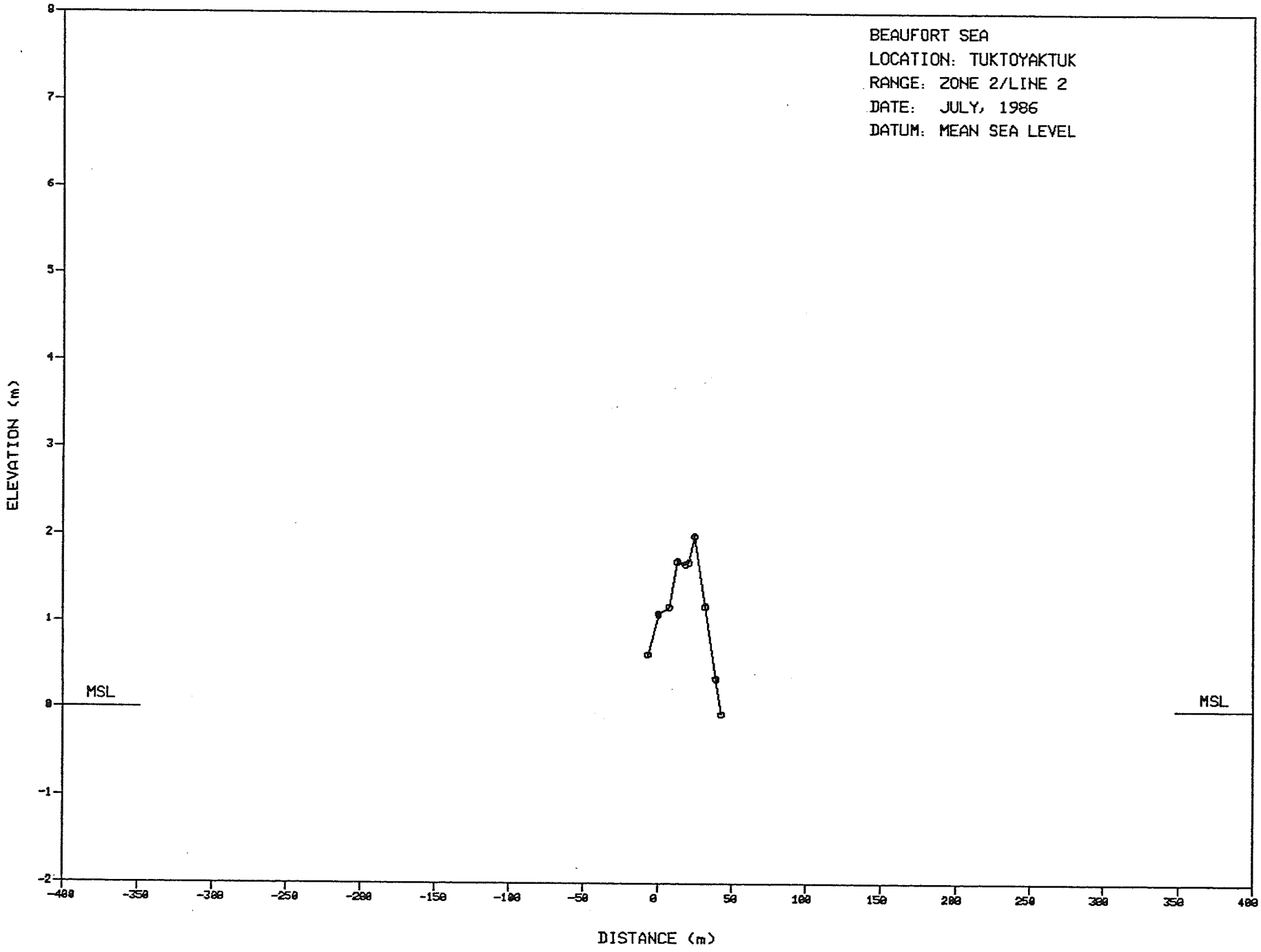
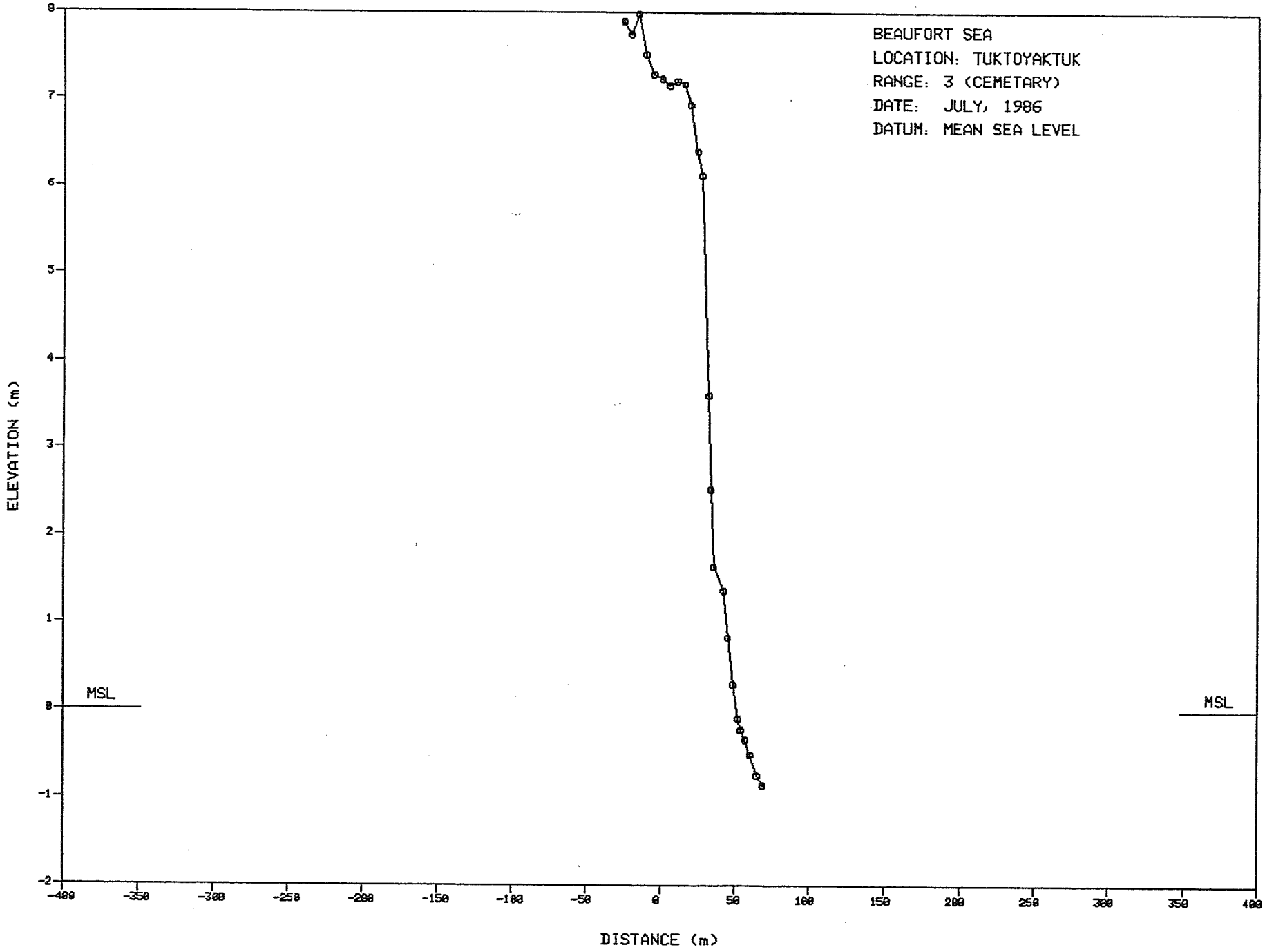
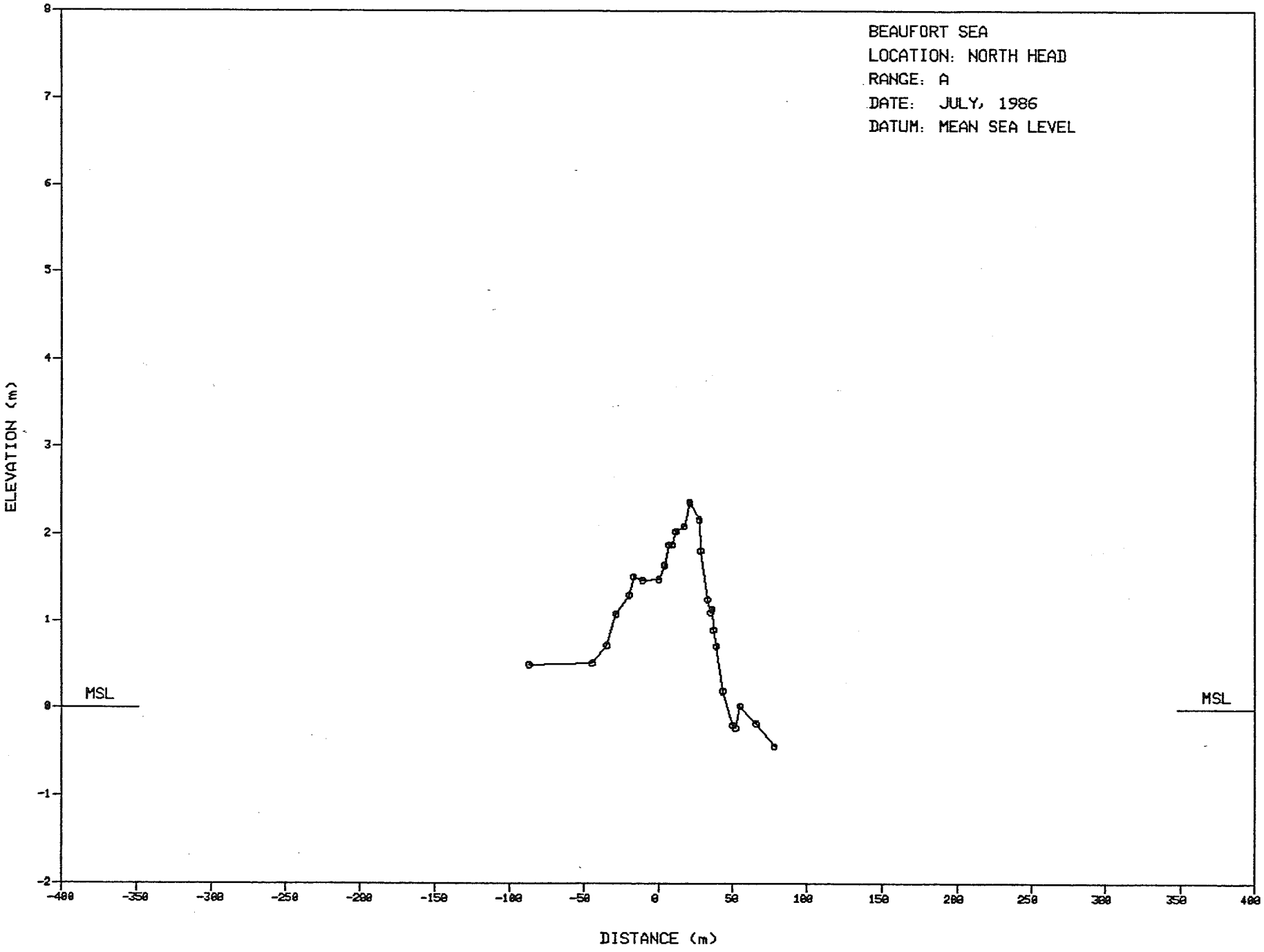
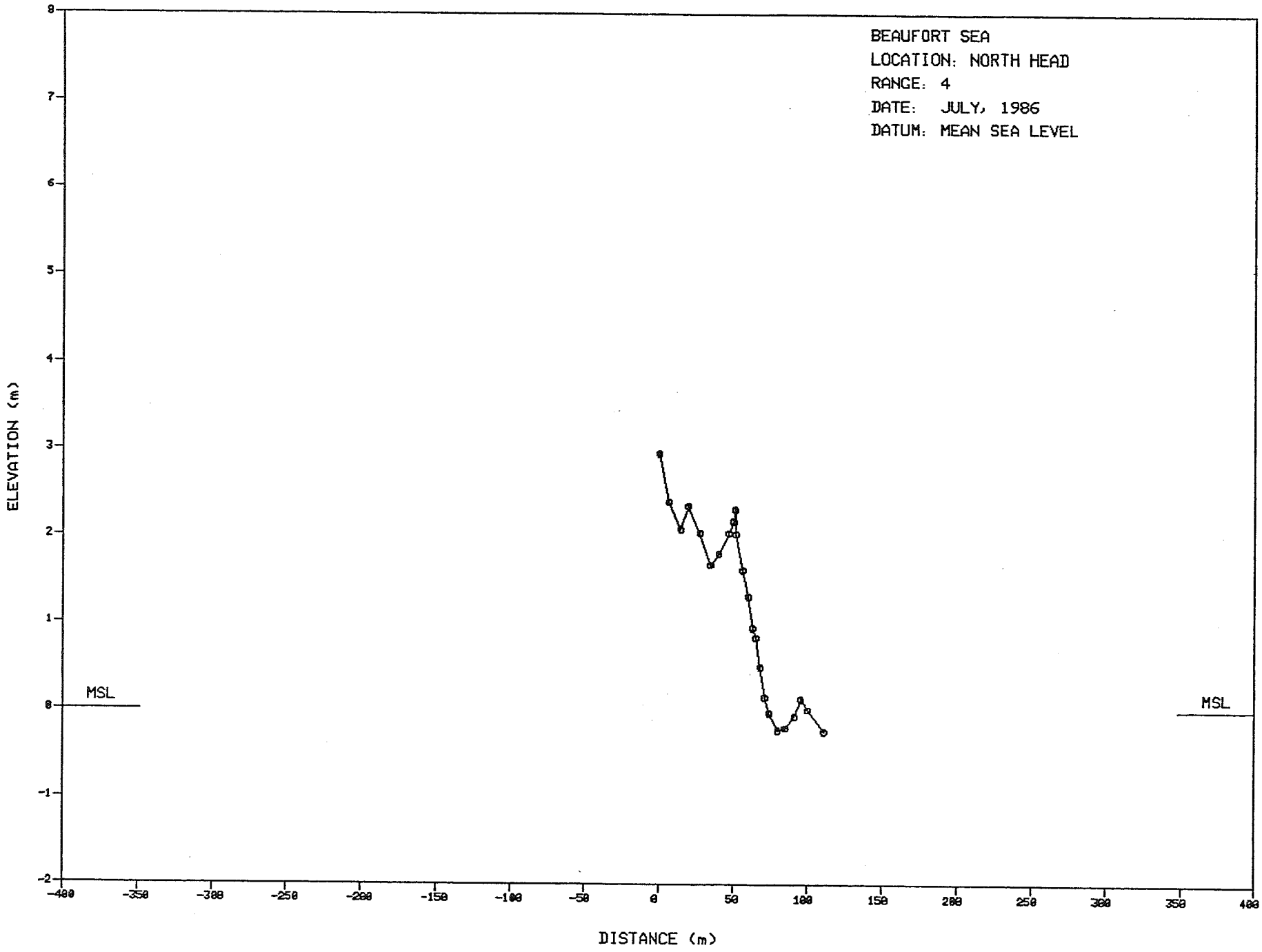
300
350
400

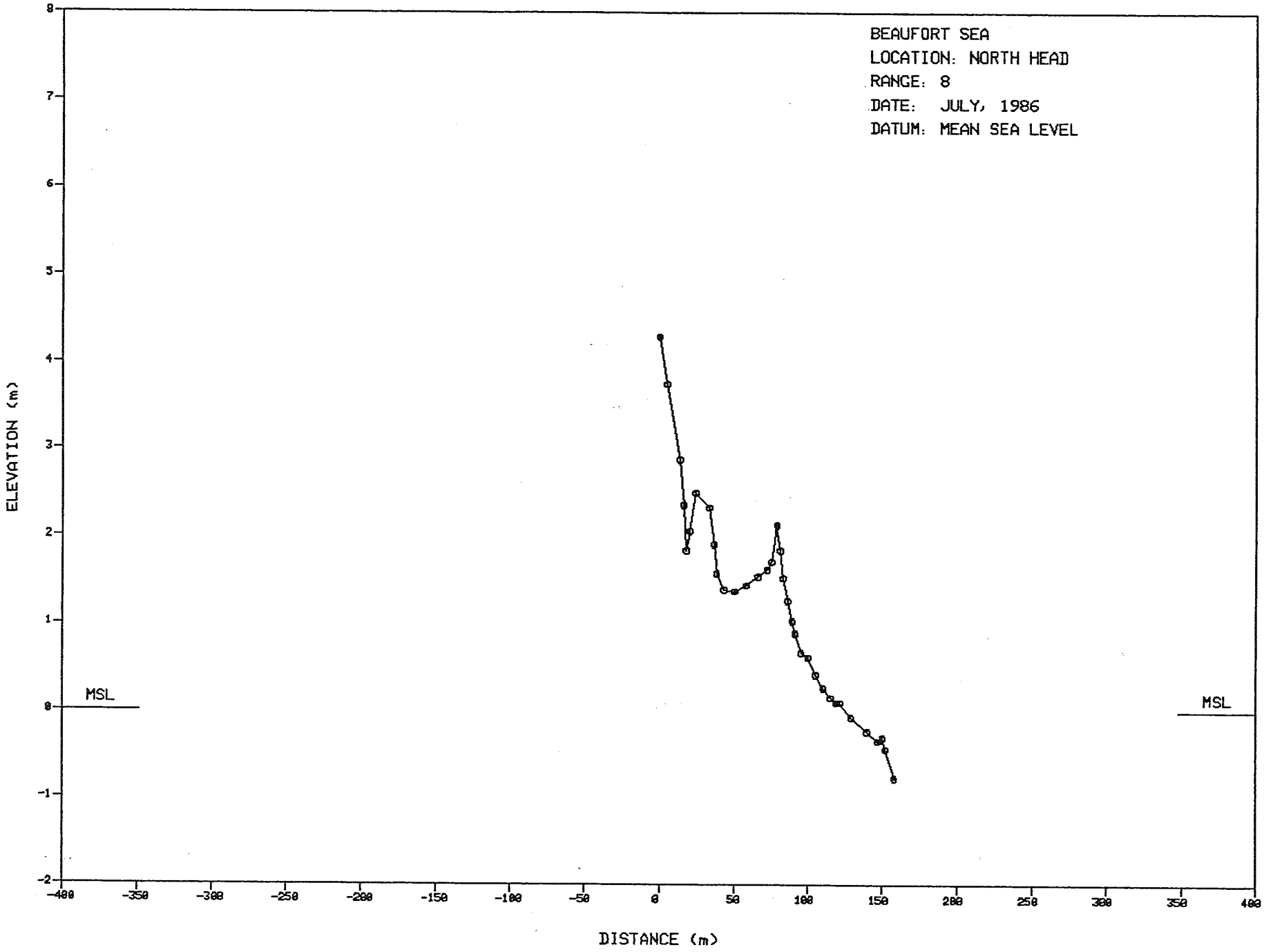

BEAUFORT SEA
LOCATION: TUKTOYAKTUK
RANGE: ZONE 2/LINE 1
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
8
7
6
5
4
3
2
1
0
-1
-2
MSL
MSL
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
DISTANCE (m)

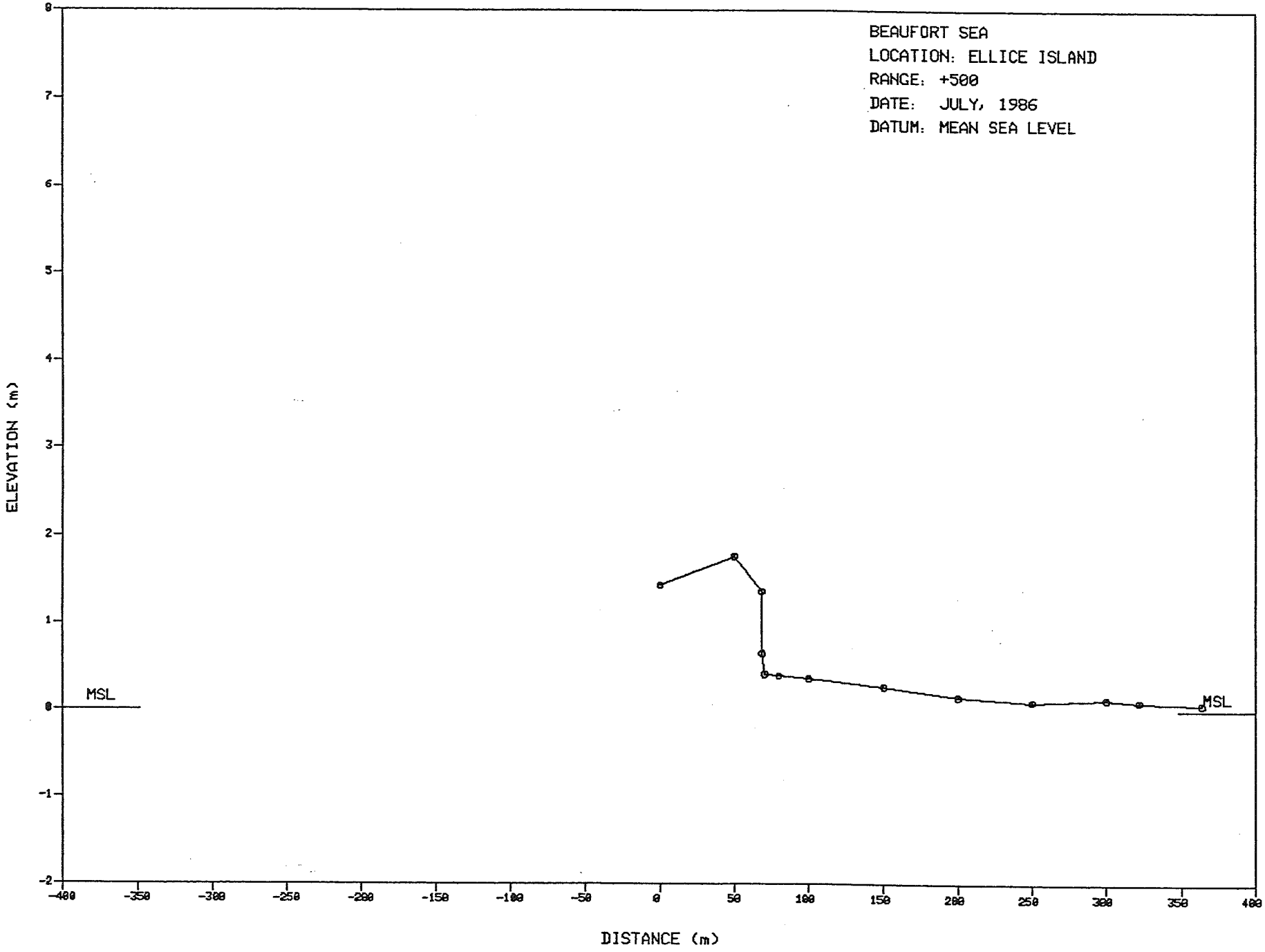

BEAUFORT SEA
LOCATION: TUKTOYAKTUK
RANGE: ZONE 2/LINE 2
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
8
7
6
5
4
3
2
1
0
-1
-2
MSL
MSL
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
DISTANCE (m)

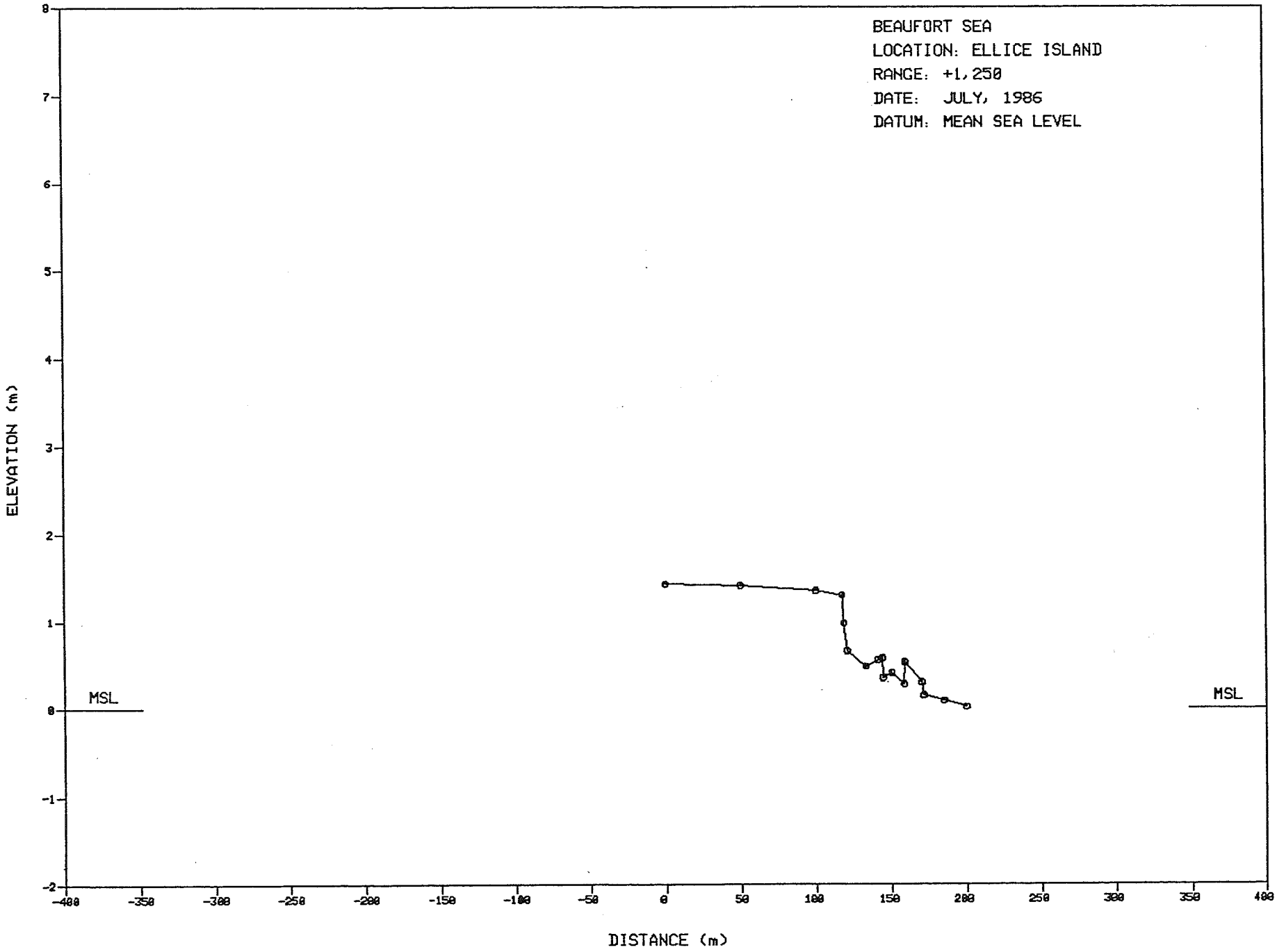

BEAUFORT SEA
LOCATION: TUKTOYAKTUK
RANGE: 3 (CEMETARY)
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
MSL
MSL
ELEVATION (m)
DISTANCE (m)
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400

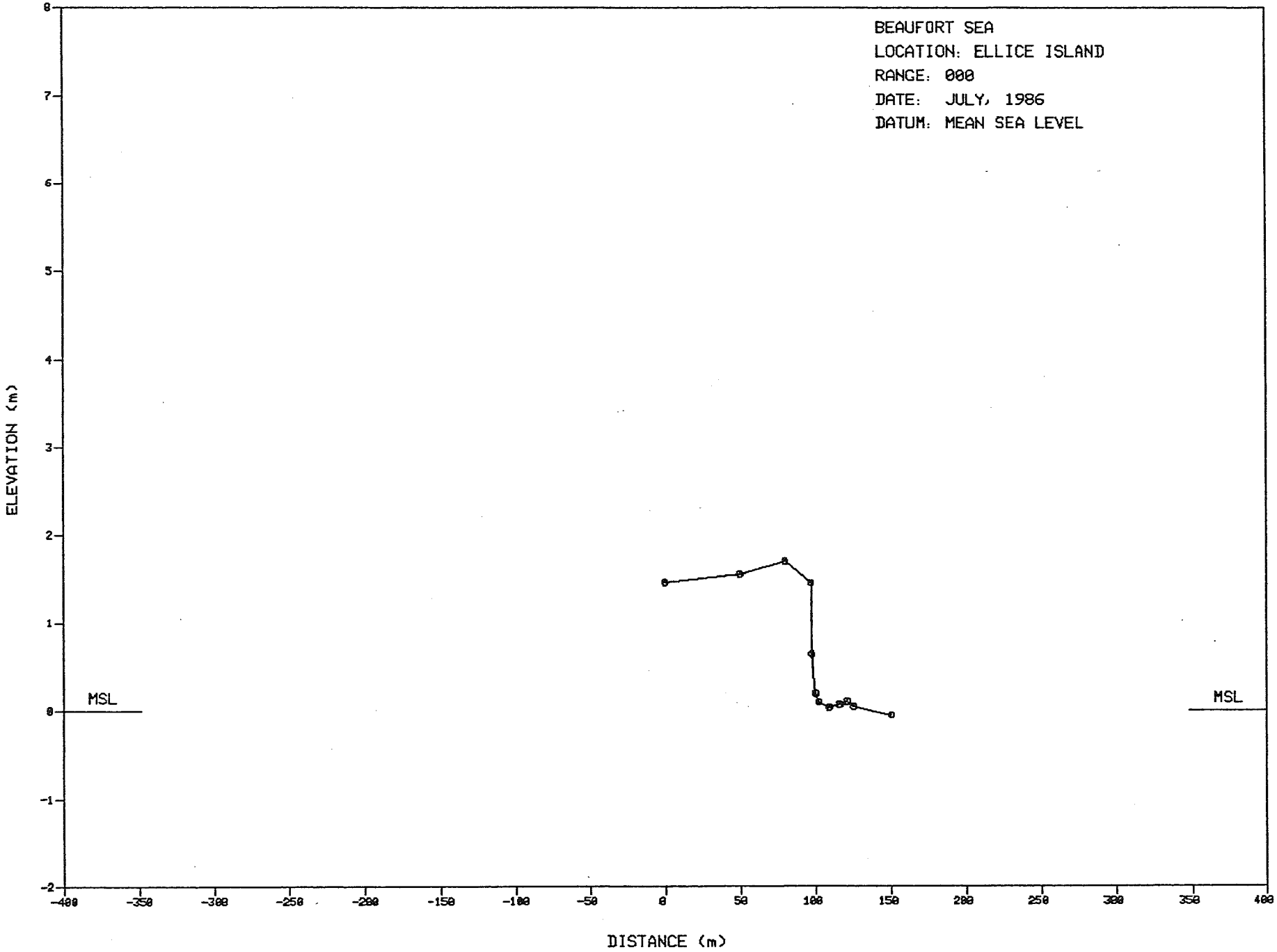

BEAUFORT SEA
LOCATION: NORTH HEAD
RANGE: A
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
MSL
MSL
ELEVATION (m)
DISTANCE (m)
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400

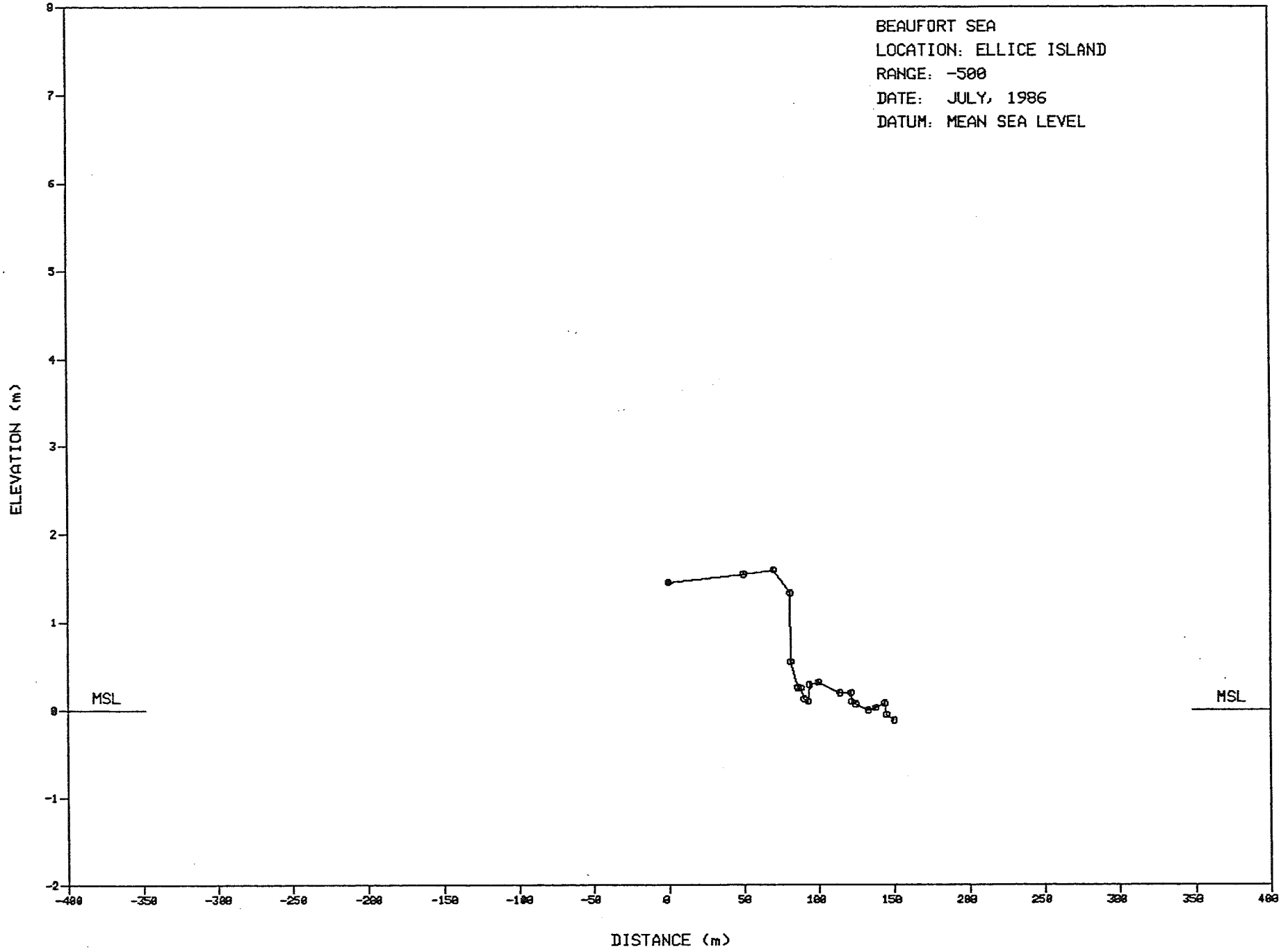

BEAUFORT SEA
LOCATION: NORTH HEAD
RANGE: 4
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
8
7
6
5
4
3
2
1
0
-1
-2
MSL
MSL
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
DISTANCE (m)

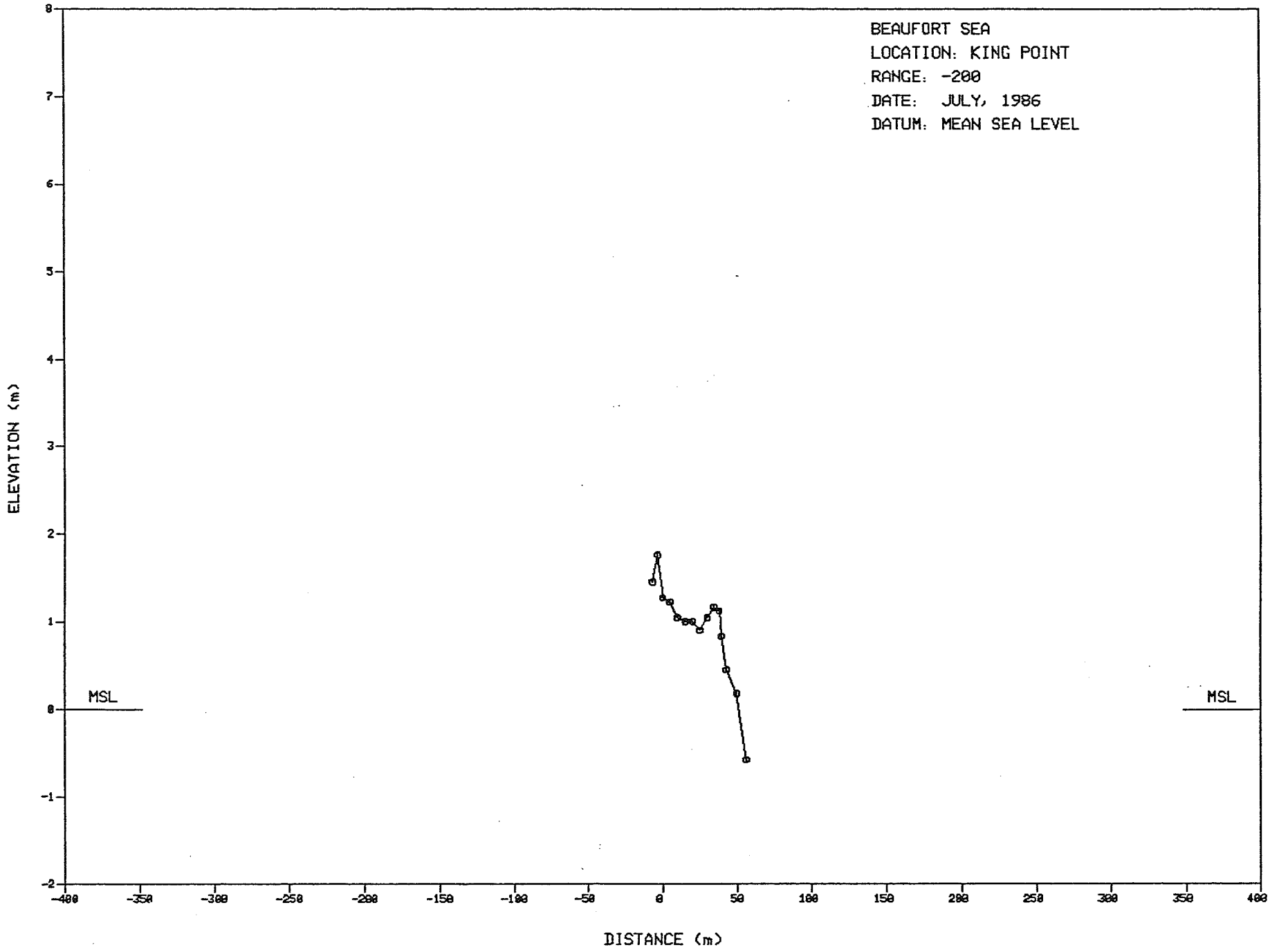

BEAUFORT SEA
LOCATION: NORTH HEAD
RANGE: 8
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400

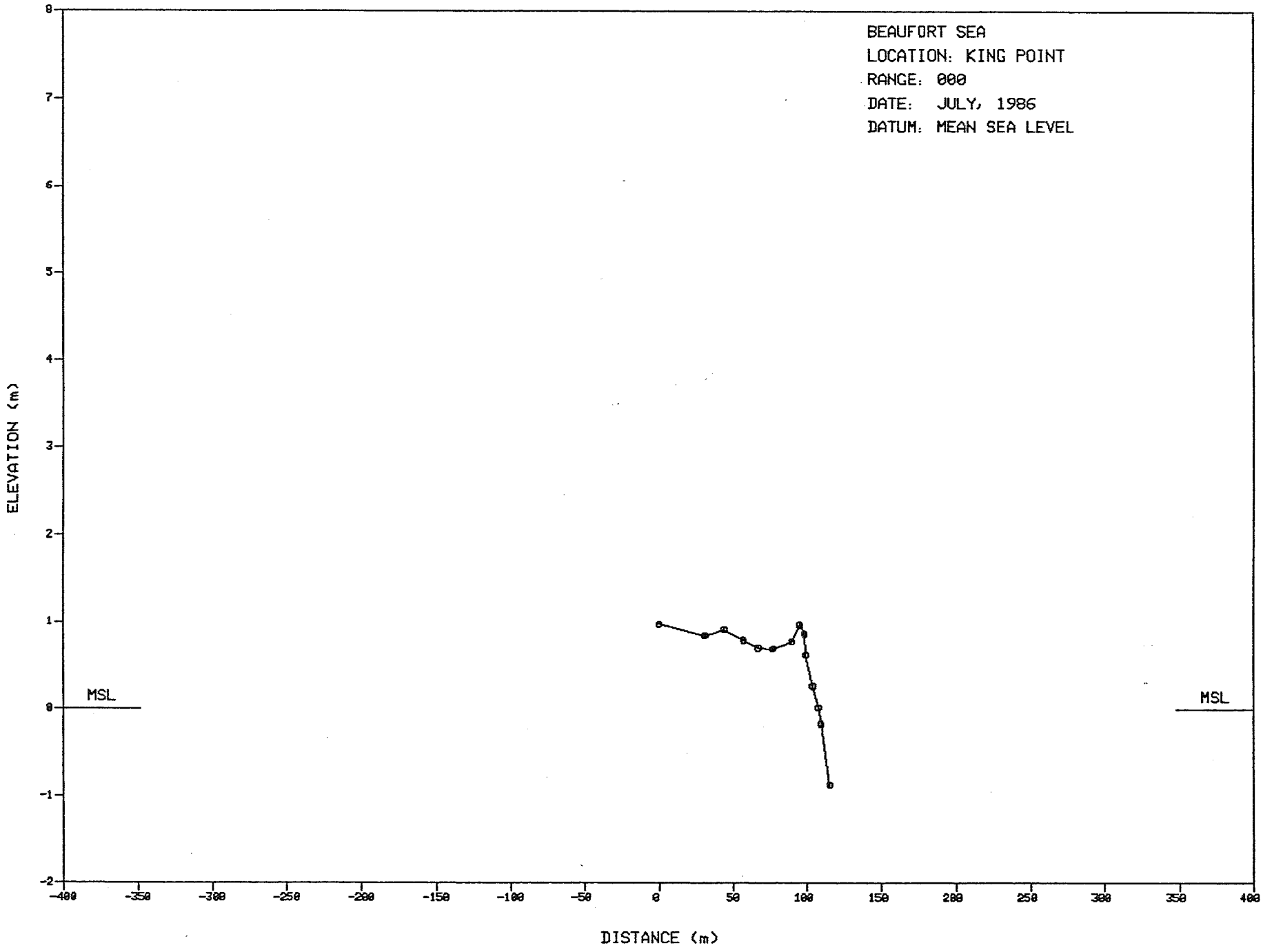

BEAUFORT SEA
LOCATION: ELLICE ISLAND
RANGE: +500
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400

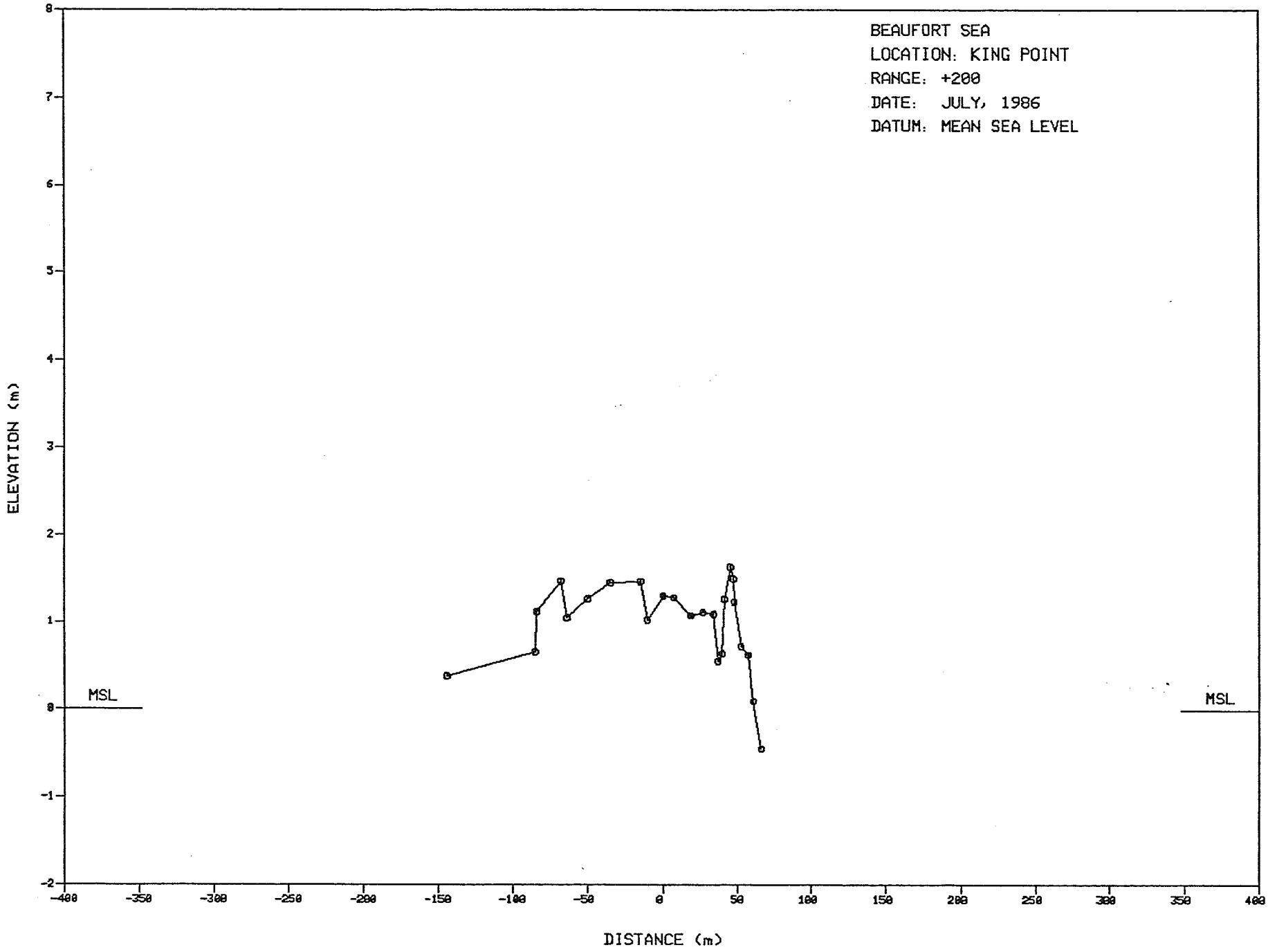

BEAUFORT SEA
LOCATION: ELLICE ISLAND
RANGE: +1,250
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400

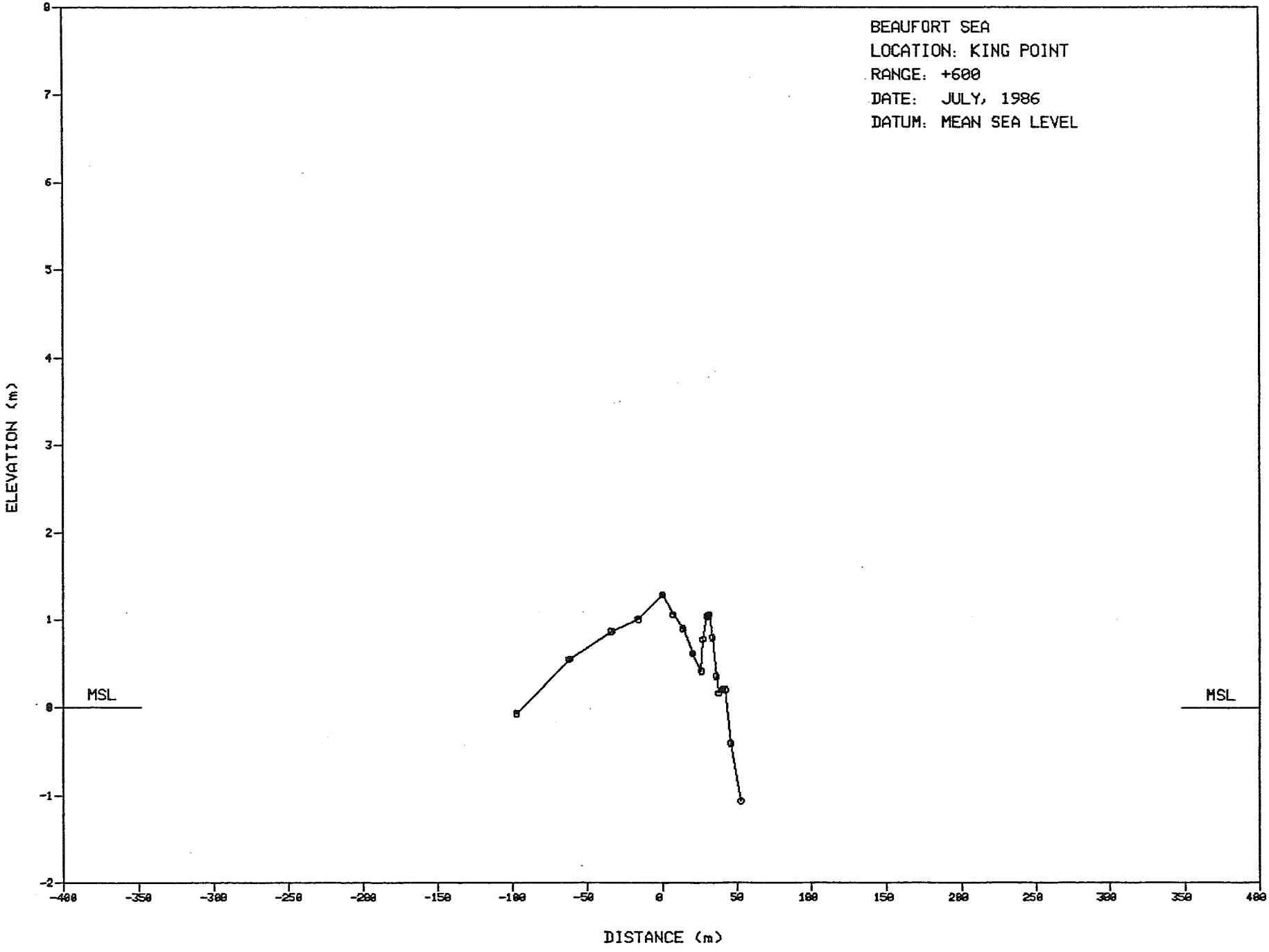

BEAUFORT SEA
LOCATION: ELLICE ISLAND
RANGE: 000
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400

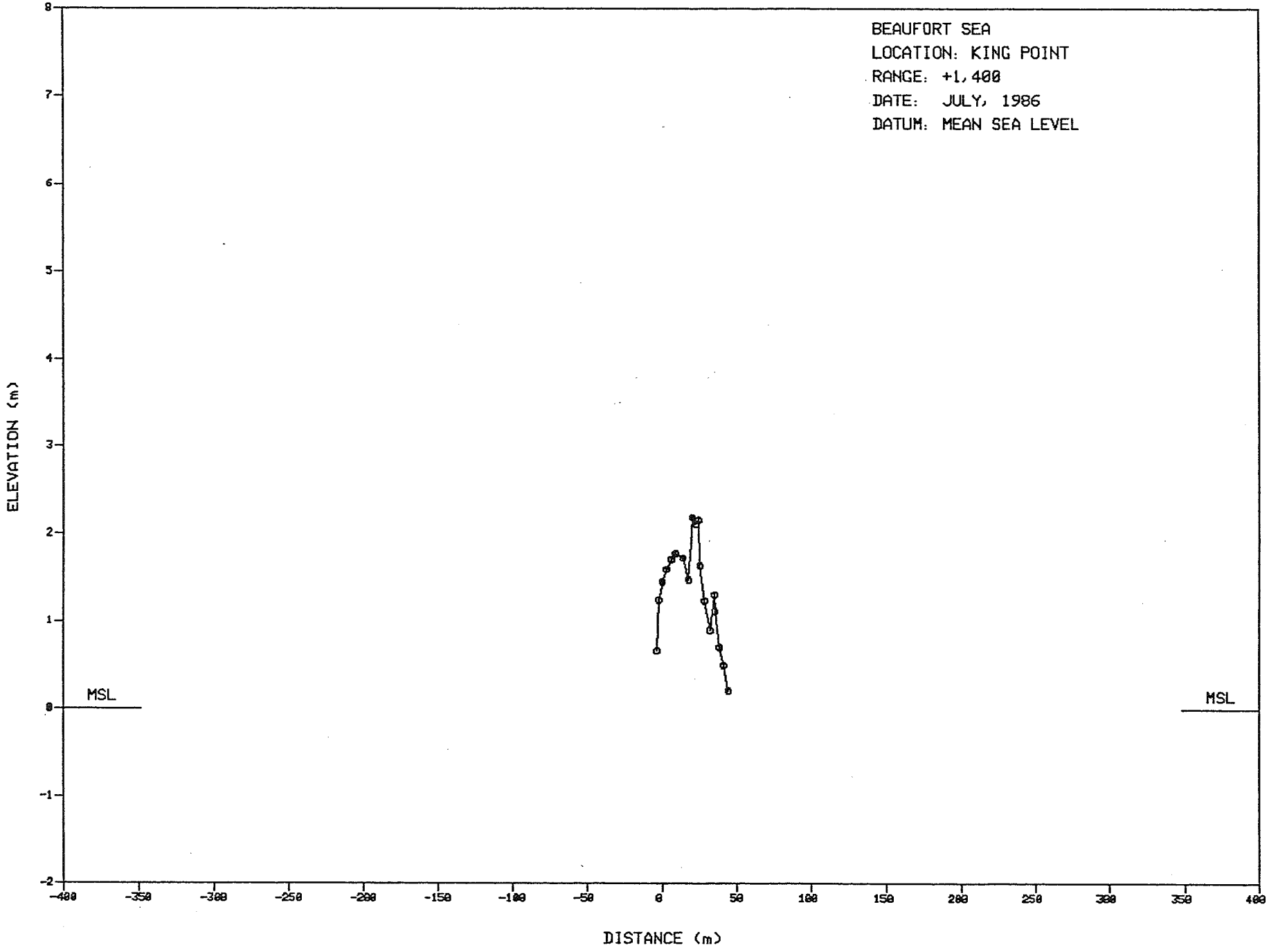

BEAUFORT SEA
LOCATION: ELLICE ISLAND
RANGE: -500
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400

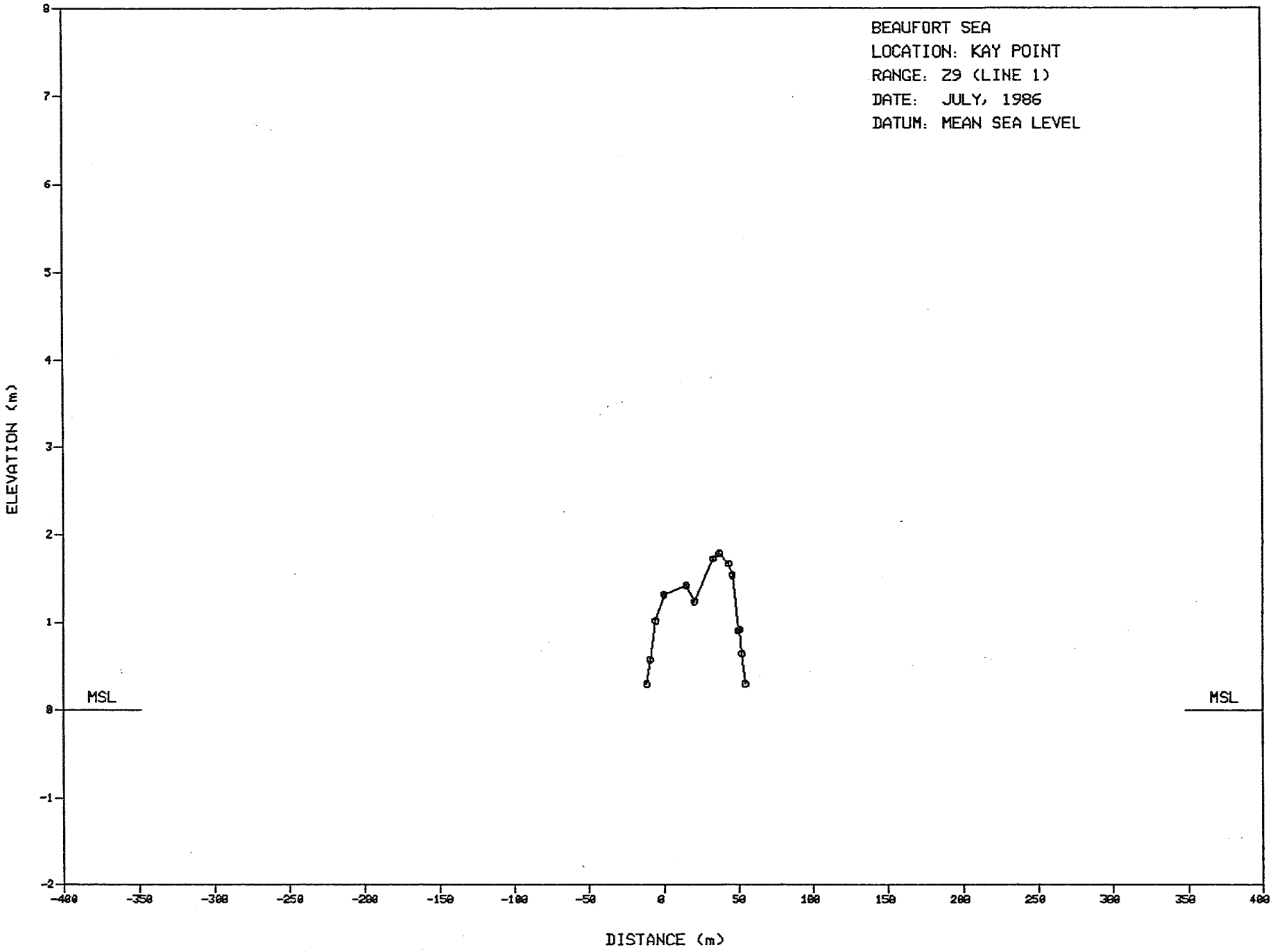

BEAUFORT SEA
LOCATION: KING POINT
RANGE: -200
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
8
7
6
5
4
3
2
1
0
-1
-2
MSL
MSL
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
DISTANCE (m)

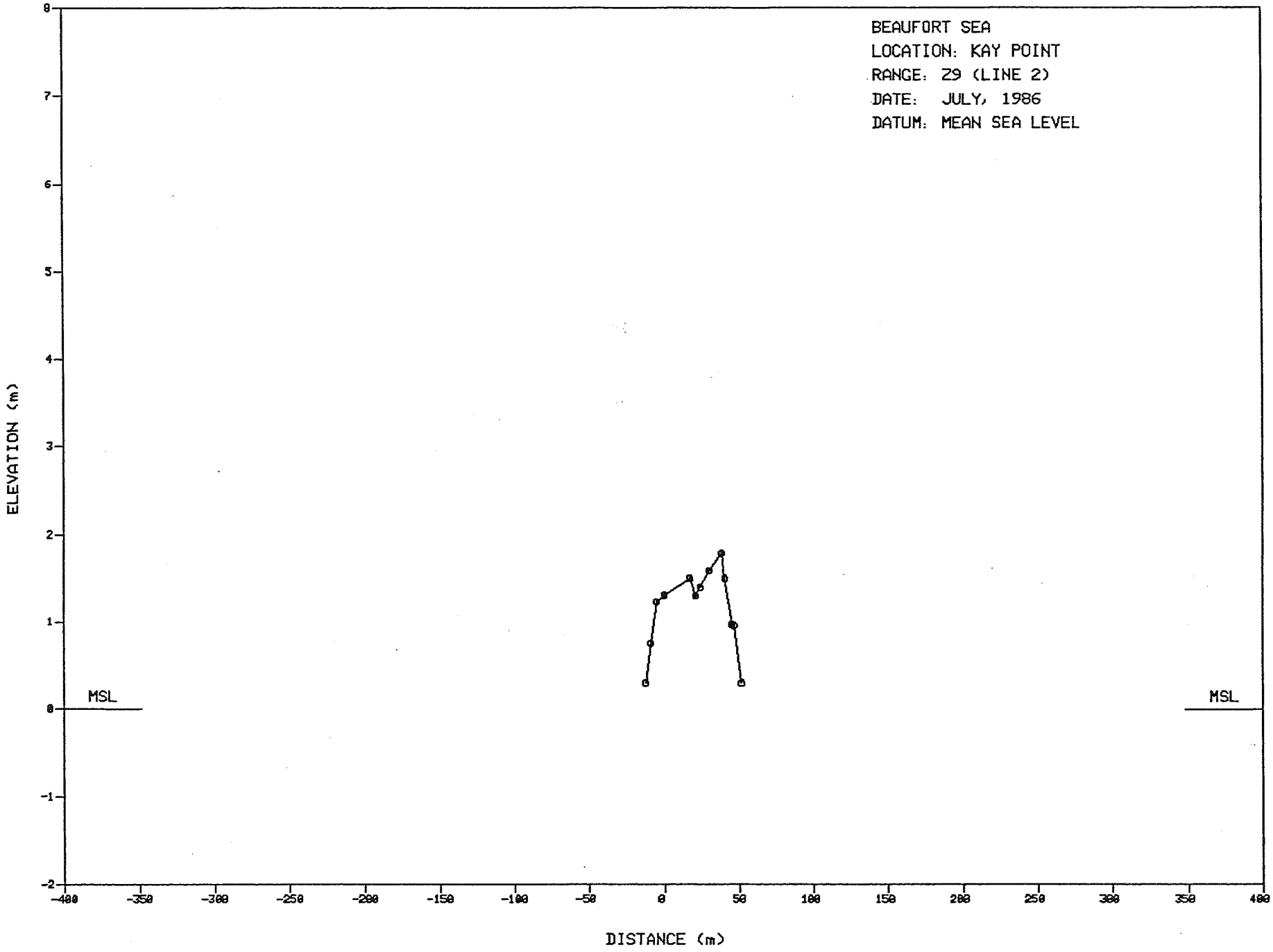

BEAUFORT SEA
LOCATION: KING POINT
RANGE: 000
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400

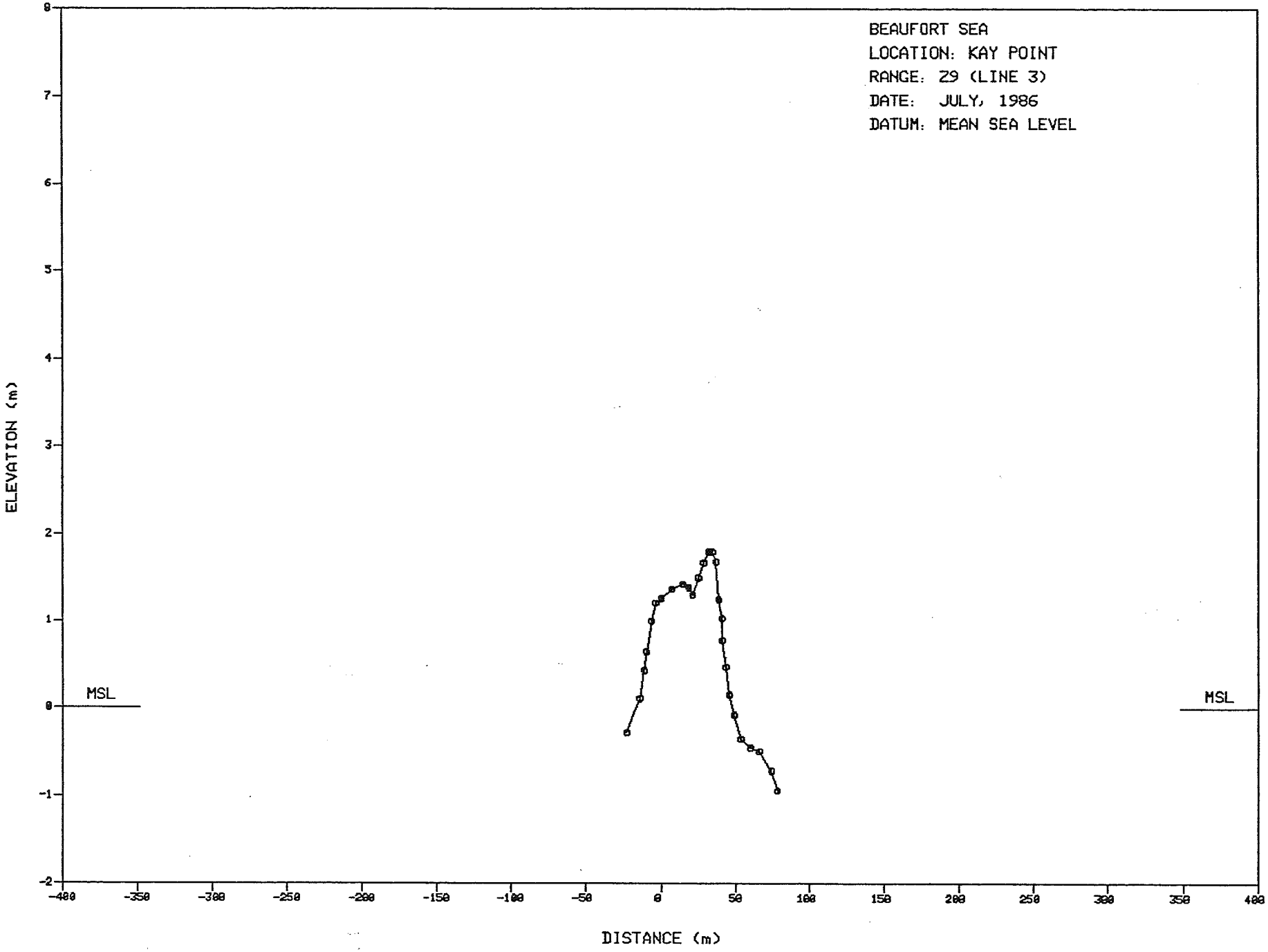

BEAUFORT SEA
LOCATION: KING POINT
RANGE: +200
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400

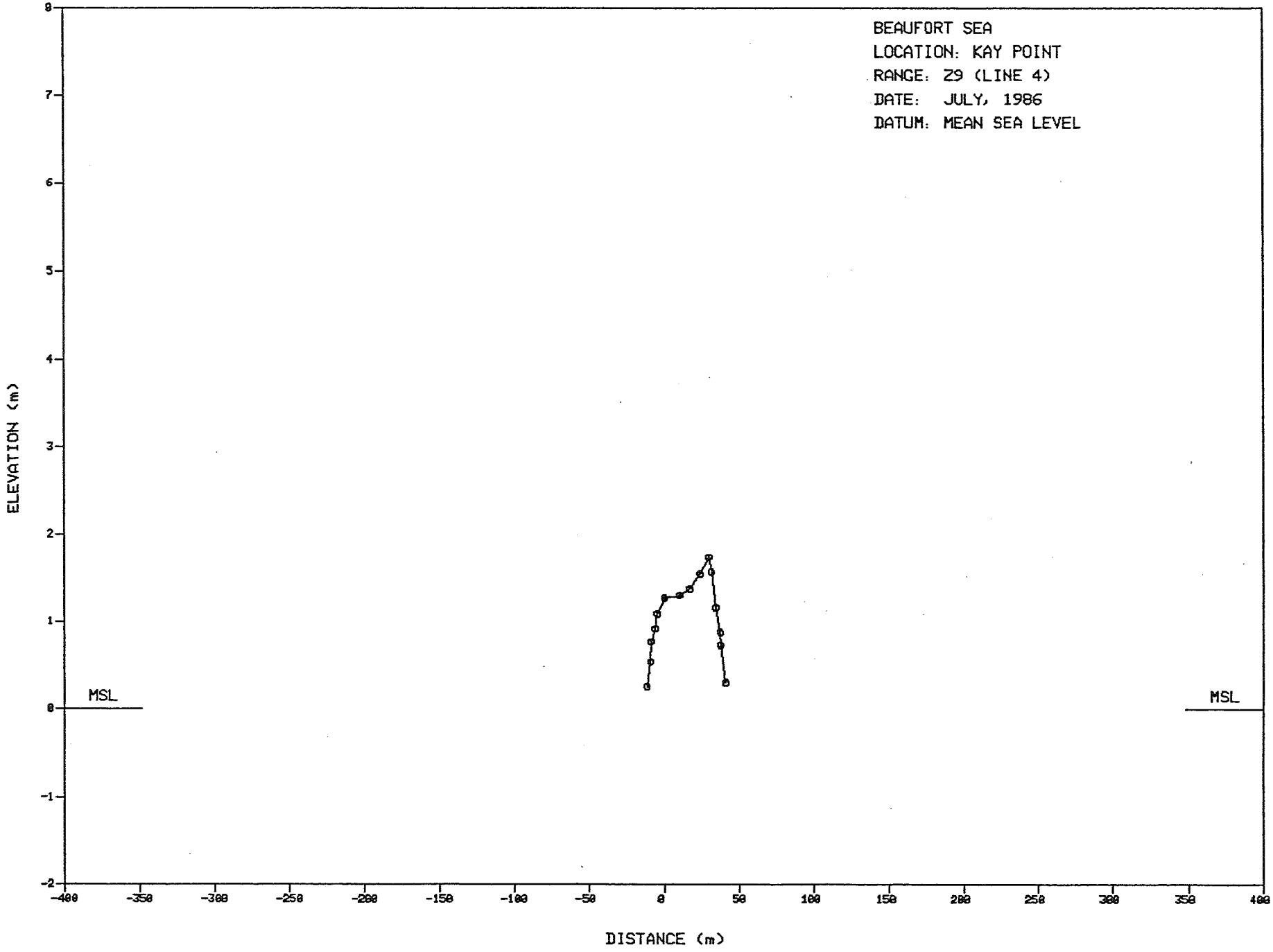

BEAUFORT SEA
LOCATION: KING POINT
RANGE: +600
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400

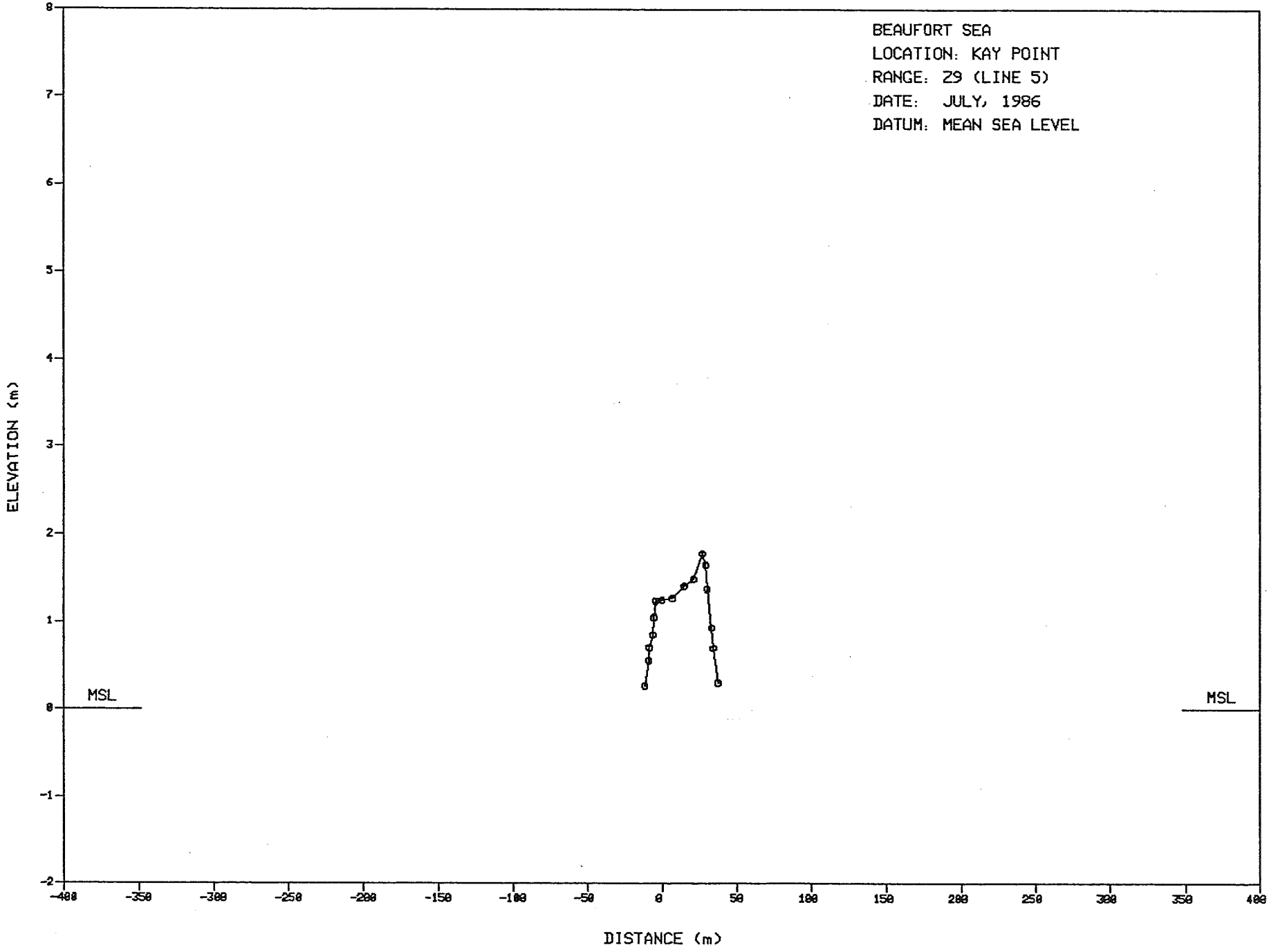

BEAUFORT SEA
LOCATION: KING POINT
RANGE: +1,400
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400

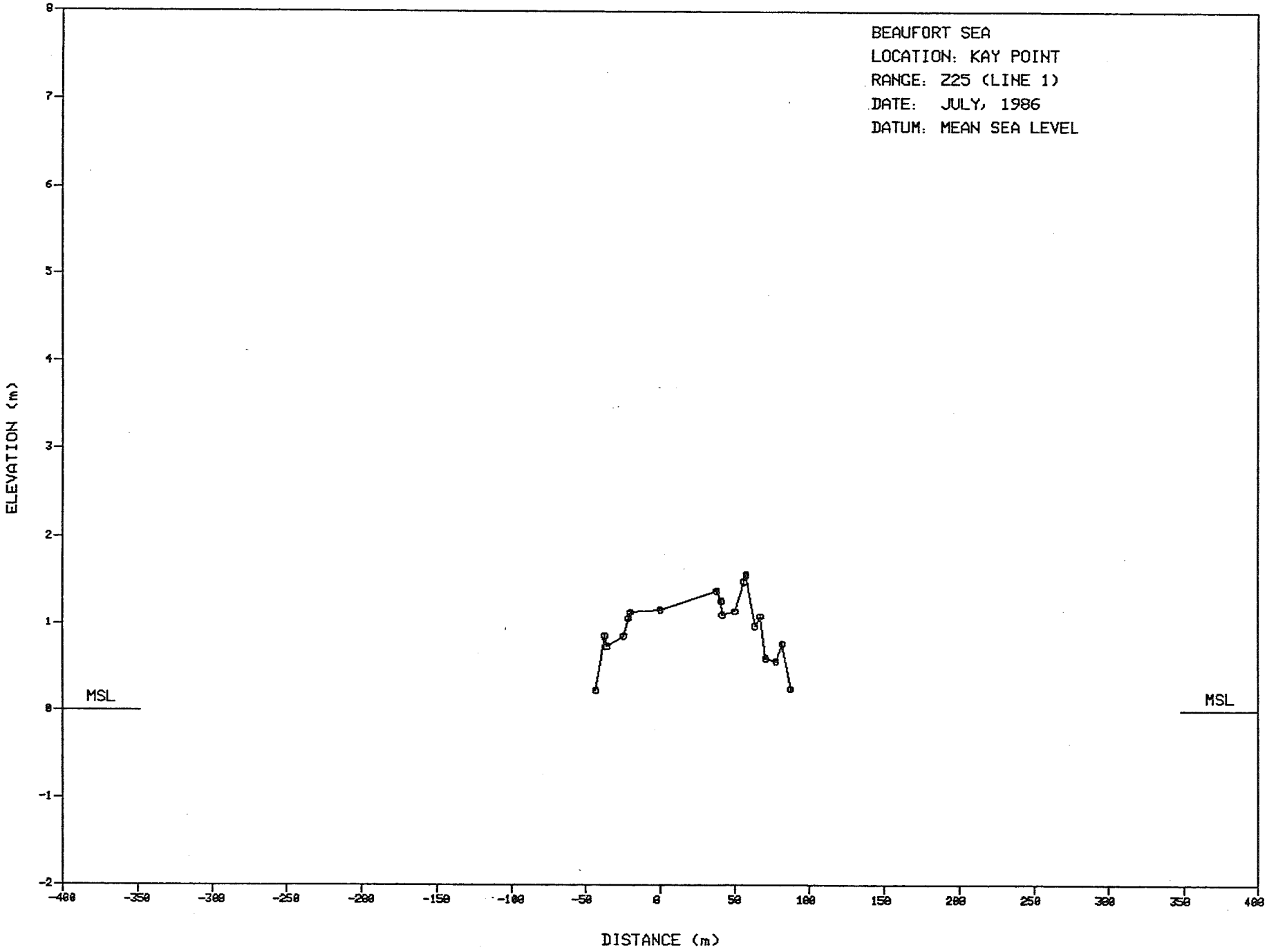

BEAUFORT SEA
LOCATION: KAY POINT
RANGE: Z9 (LINE 1)
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
8
7
6
5
4
3
2
1
0
-1
-2
MSL
MSL
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
DISTANCE (m)

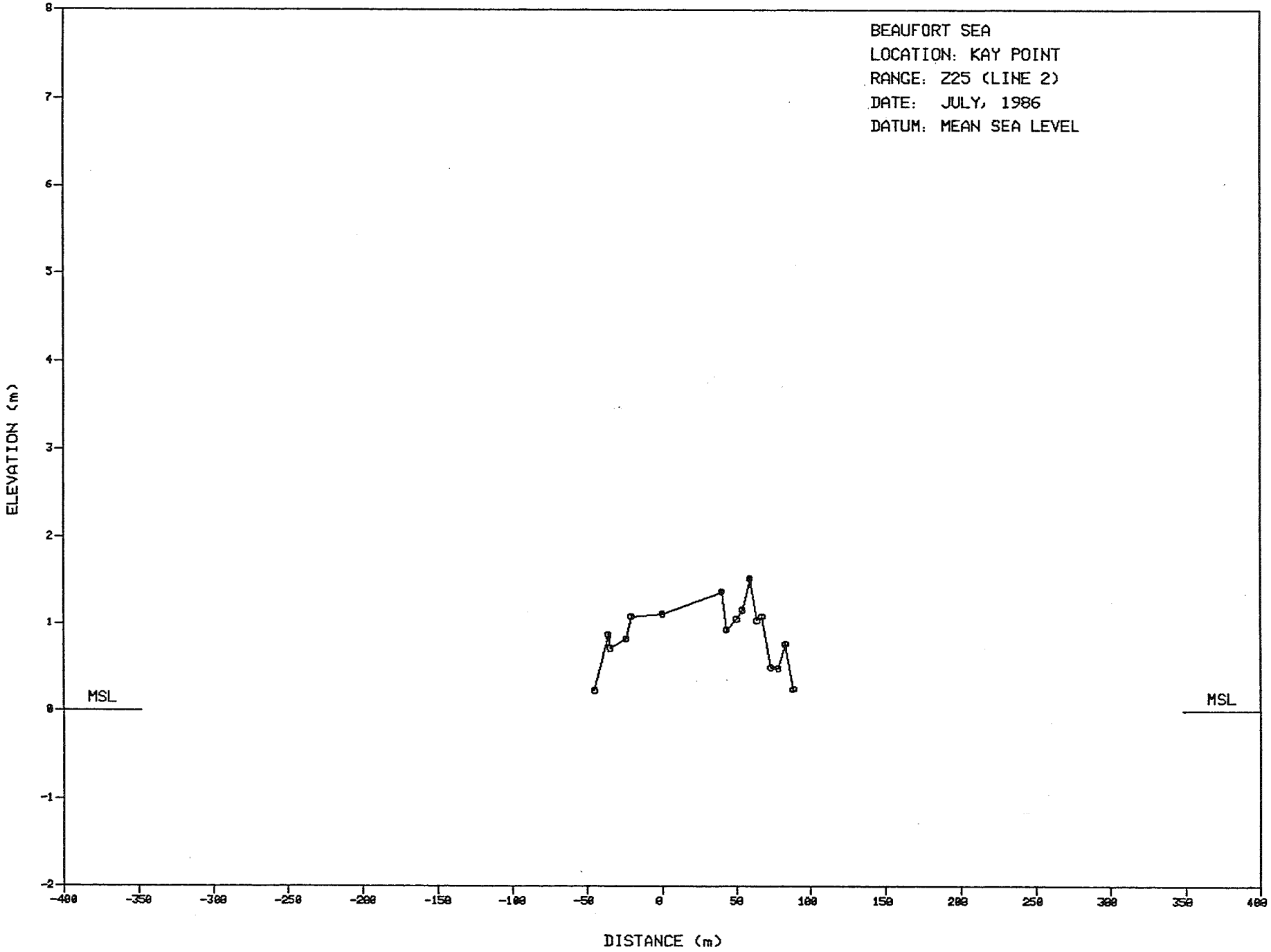

BEAUFORT SEA
LOCATION: KAY POINT
RANGE: Z9 (LINE 2)
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
8
7
6
5
4
3
2
1
0
-1
-2
MSL
MSL
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
DISTANCE (m)

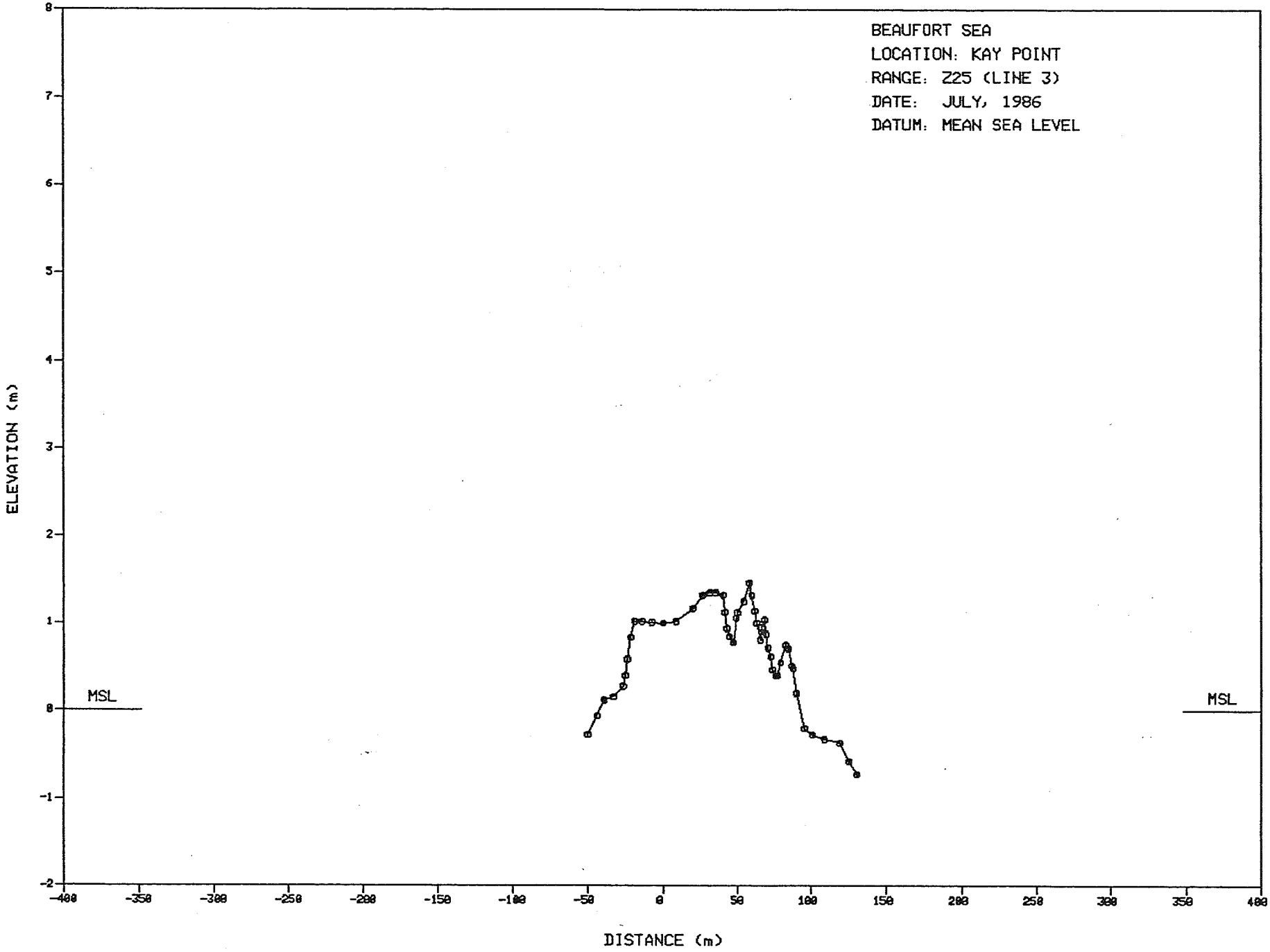

BEAUFORT SEA
LOCATION: KAY POINT
RANGE: Z9 (LINE 3)
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400

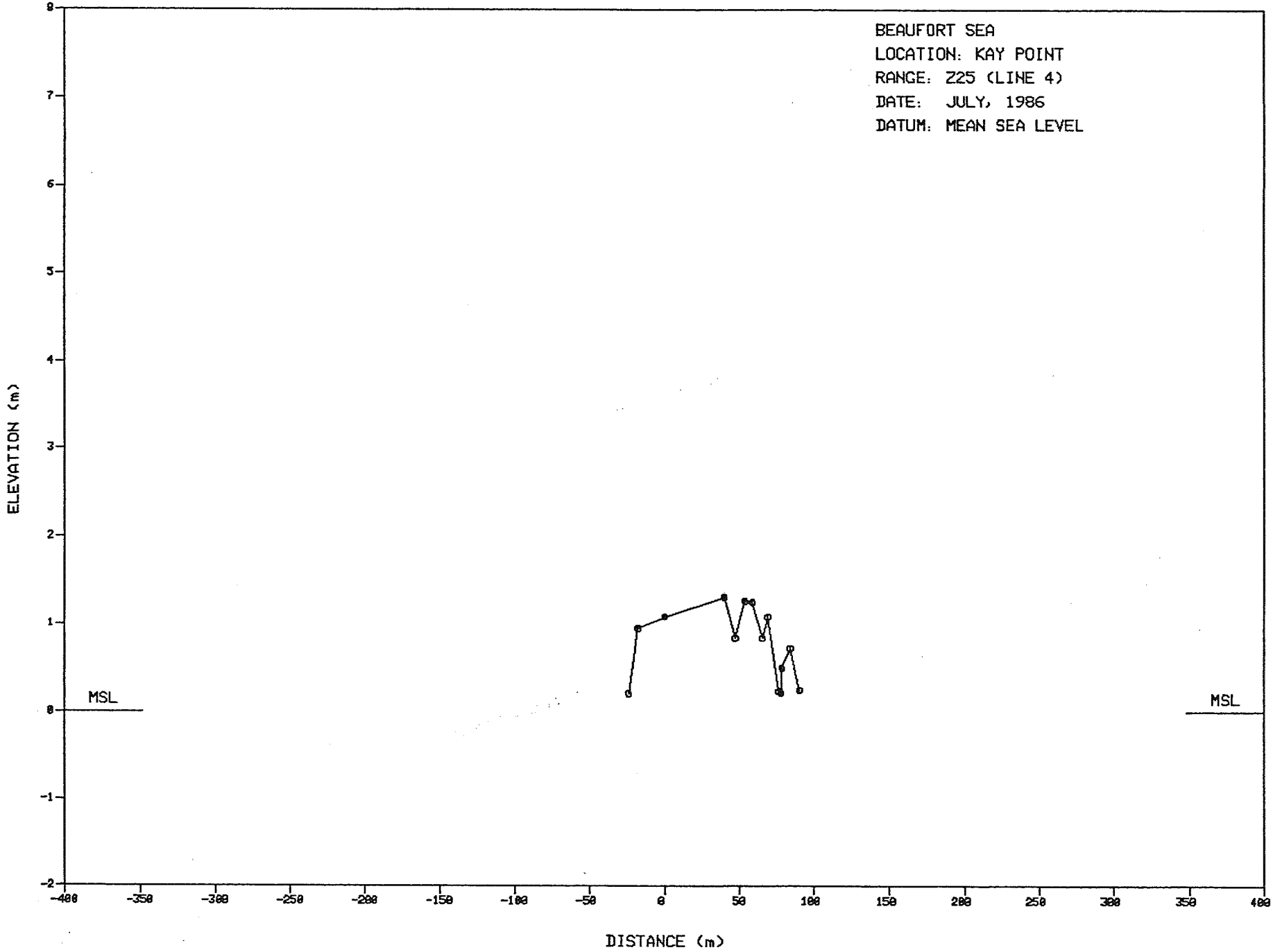

BEAUFORT SEA
LOCATION: KAY POINT
RANGE: Z9 (LINE 4)
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
8
7
6
5
4
3
2
1
0
-1
-2
MSL
MSL
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
DISTANCE (m)

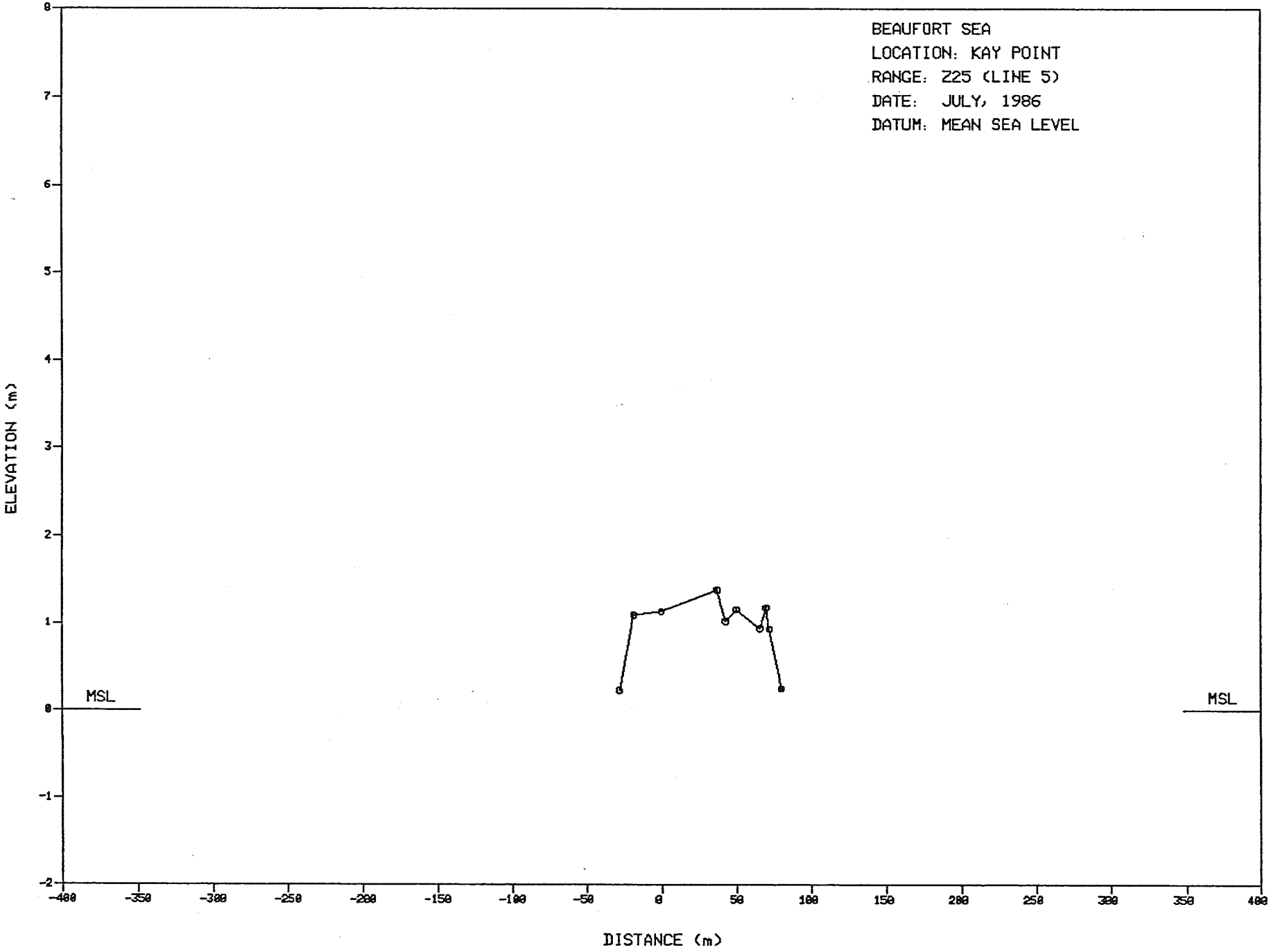

BEAUFORT SEA
LOCATION: KAY POINT
RANGE: Z9 (LINE 5)
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
8
7
6
5
4
3
2
1
0
-1
-2
MSL
MSL
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
DISTANCE (m)

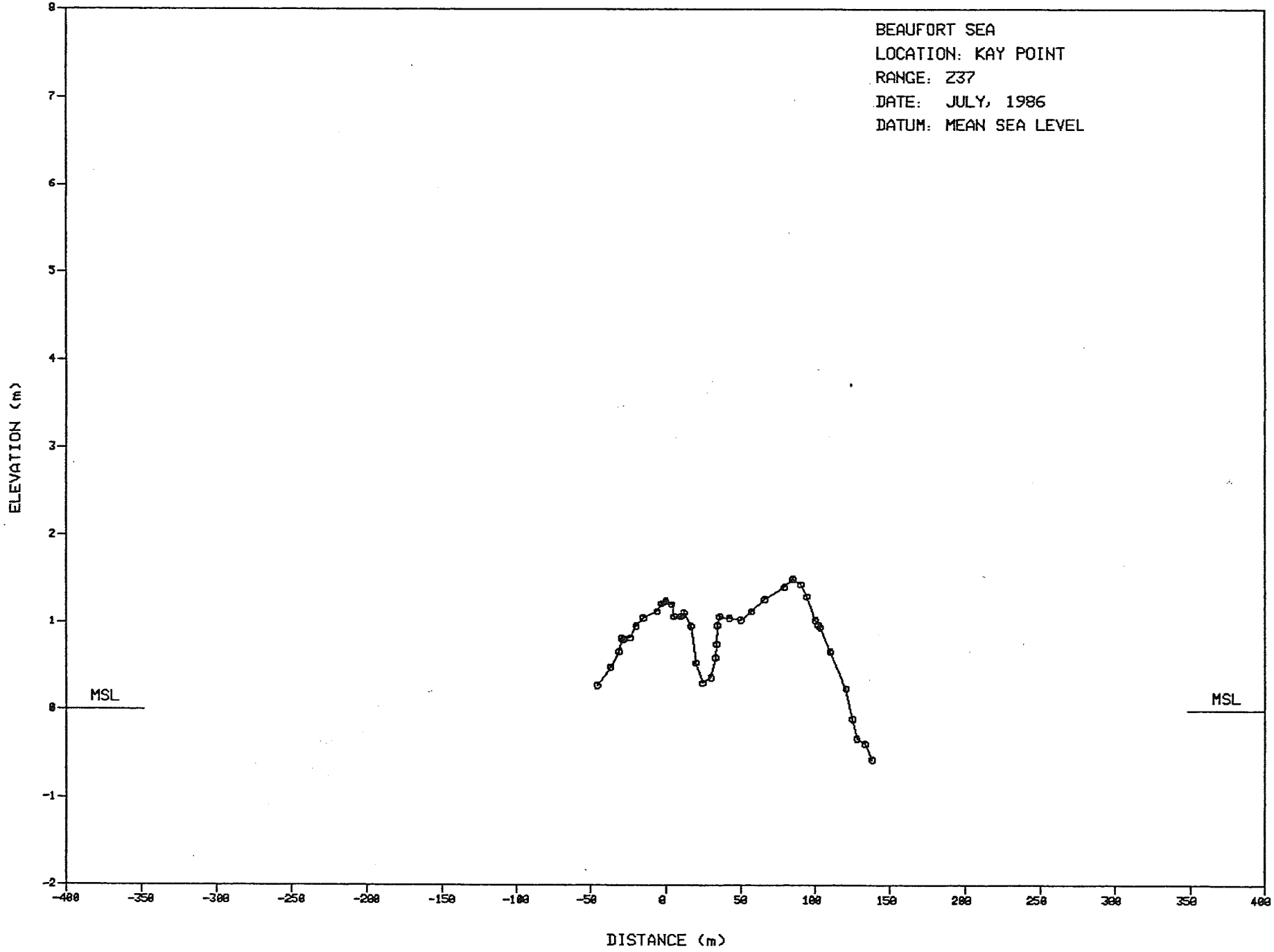

BEAUFORT SEA
LOCATION: KAY POINT
RANGE: Z25 (LINE 1)
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
8
7
6
5
4
3
2
1
0
-1
-2
MSL
MSL
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
DISTANCE (m)

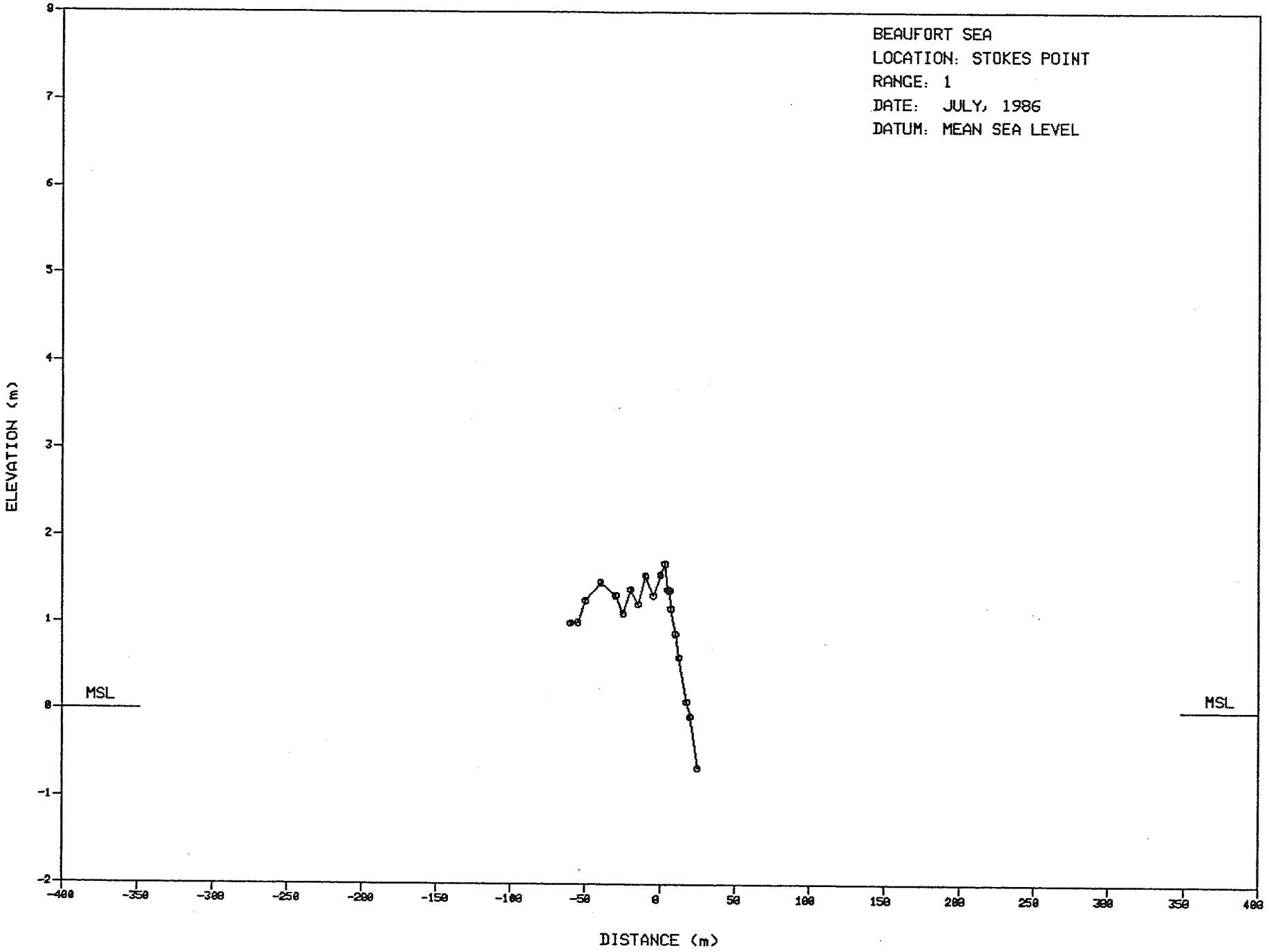

BEAUFORT SEA
LOCATION: KAY POINT
RANGE: Z25 (LINE 2)
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400

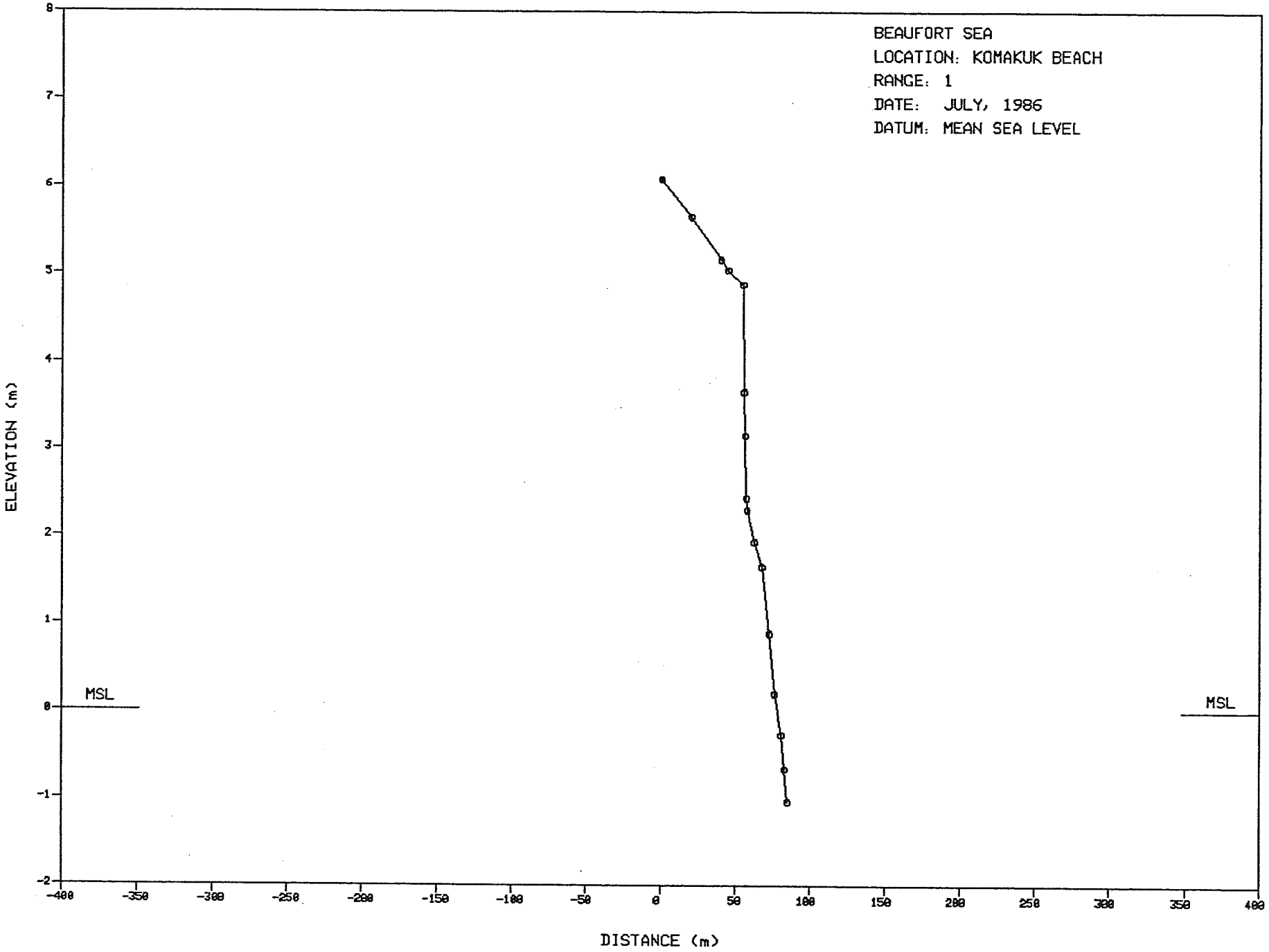

BEAUFORT SEA
LOCATION: KAY POINT
RANGE: Z25 (LINE 3)
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
8
7
6
5
4
3
2
1
0
-1
-2
MSL
MSL
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
DISTANCE (m)


BEAUFORT SEA
LOCATION: KAY POINT
RANGE: Z25 (LINE 4)
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
8
7
6
5
4
3
2
1
0
-1
-2
MSL
MSL
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
DISTANCE (m)


BEAUFORT SEA
LOCATION: KAY POINT
RANGE: Z25 (LINE 5)
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400


BEAUFORT SEA
LOCATION: KAY POINT
RANGE: Z37
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
8
7
6
5
4
3
2
1
0
-1
-2
MSL
MSL
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
DISTANCE (m)


BEAUFORT SEA
LOCATION: STOKES POINT
RANGE: 1
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400


BEAUFORT SEA
LOCATION: KOMAKUK BEACH
RANGE: 1
DATE: JULY, 1986
DATUM: MEAN SEA LEVEL
ELEVATION (m)
DISTANCE (m)
MSL
MSL
8
7
6
5
4
3
2
1
0
-1
-2
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400

APPENDIX 3C - TABULATED DATA

Cape Dalhousie
Atkinson Point, Range 1 (Z1/L2)
Atkinson Point, Range 2 (Z3/L1)
Atkinson Point, Range 3 (Z3/L2)
Toker Point, Range 1
Toker Point, Range 2
Toker Point, Range 3
Toker Point, Range 4
Toker Point, Range 5
Toker Point, Range 9
Toker Point, Range 10
Toker Point, Range 11
Tuktoyaktuk, Zone 2 / Line 1
Tuktoyaktuk, Zone 2 / Line 2
Tuktoyaktuk, Zone 3 (Cemetary)
North Head, Range A
North Head, Range 4
North Head, Range 8
Ellice Island, Range + 500
Ellice Island, Range +1,250
Ellice Island, Range 000
Ellice Island, Range - 500
King Point, Range -200
King Point, Range 000
King Point, Range +200
King Point, Range +600
King Point, Range +1,400
Kay Point, Z9 / Line 1
Kay Point, Z9 / Line 2
Kay Point, Z9 / Line 3
Kay Point, Z9 / Line 4
Kay Point, Z9 / Line 5
Kay Point, Z25 / Line 1
Kay Point, Z25 / Line 2
Kay Point, Z25 / Line 3
Kay Point, Z25 / Line 4
Kay Point, Z25 / Line 5
Kay Point, Z37
Stokes Point
Komakuk Beach

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: CAPE DALHOUSIE
RANGE: 1
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
0.00	5.37
5.00	4.66
15.00	4.54
25.00	4.57
35.00	4.61
45.00	5.62
47.10	6.12
51.10	4.95
53.80	3.82
58.80	3.29
63.80	2.04
73.80	1.17
83.80	0.72
93.80	0.57
103.80	0.48
123.80	0.39
138.80	0.51
153.80	0.59
168.80	0.69
183.80	0.75
198.80	0.81
213.80	0.87
228.80	0.95
243.80	0.94
258.80	0.94
273.80	0.84
288.80	0.92
303.80	0.70
318.80	0.49
326.80	0.40
336.80	0.22
346.80	0.37
356.80	0.16
366.80	0.20
376.80	0.19
386.80	0.06

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: ATKINSON POINT
RANGE: 1 (Z1/L2)
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-89.00	0.11
-27.90	0.63
-21.90	0.65
-15.40	0.67
0.00	0.70
20.90	0.67
28.70	0.69
39.60	0.72
64.00	0.15

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: ATKINSON POINT
RANGE: 2 (Z3/L1)
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-140.00	0.25
-101.00	0.76
-55.00	0.83
0.00	0.85
68.00	0.91
102.00	0.88
170.00	0.97
187.00	0.20
205.00	-0.37
221.00	-0.29

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: ATKINSON POINT
RANGE: 3 (Z3/L2)
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-363.00	0.21
-311.00	0.55
-227.00	0.63
-157.00	0.68
-118.00	0.74
-103.00	0.78
-62.00	0.77
0.00	0.84
93.00	0.66
106.00	0.15
119.00	-0.42
138.00	-0.33
157.00	-0.33

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: TOKER POINT
RANGE: 1
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
0.00	3.00
7.00	2.04
17.00	1.65
44.00	1.65
60.00	1.63
71.00	1.28
85.00	1.05
95.00	1.05
101.00	0.77
106.00	0.42
108.00	0.10
114.00	-0.20
124.00	-0.45
132.00	-0.77

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: TOKER POINT
RANGE: 2
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
0.00	1.40
35.00	1.77
42.30	2.23
44.10	1.28
47.00	1.01
52.80	0.71
53.30	0.81
55.50	0.67
60.40	0.33
65.30	0.24
66.00	0.41
71.00	0.32
75.00	0.19
75.00	0.31
79.00	0.10
85.00	-0.11
89.00	-0.24
96.00	-0.66
102.00	-0.88

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: TOKER POINT
RANGE: 3
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-53.80	0.95
-43.50	1.12
-30.80	1.16
-20.80	1.35
-12.40	1.97
0.00	2.98
10.10	3.07
20.00	2.34
20.90	2.20
22.00	1.81
28.30	1.22
34.00	0.88
37.40	0.96
40.00	0.76
45.00	0.57
48.30	0.55
50.00	0.62
53.00	0.62
57.00	0.53
58.10	0.48
59.50	0.40
61.90	0.46
66.40	0.20
75.00	-0.33
82.00	-0.64

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: TOKER POINT
RANGE: 4
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-51.80	-0.11
-42.20	0.15
-29.90	0.49
-13.50	0.50
-8.00	0.78
0.00	1.24
7.50	1.26
16.00	1.38
25.00	1.48
32.00	1.11
40.00	0.40
46.00	-0.05
50.00	-0.57

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: TOKER POINT
RANGE: 5
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-14.40	-0.09
-11.30	0.14
-7.00	0.38
0.00	0.63
8.00	0.65
21.30	0.66
23.50	0.45
30.00	0.20
34.00	0.10
35.60	0.14
38.50	-0.05
45.00	-0.19
50.00	-0.21
60.00	-0.27
75.00	-0.39
100.00	-0.34

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: TOKER POINT
RANGE: 9
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
0.00	0.94
3.30	0.62
13.80	0.81
17.20	1.02
29.00	1.02
42.00	0.89
50.00	0.74
54.00	0.55
57.50	0.59
58.70	0.16
62.00	0.07
62.90	0.32
64.60	0.10

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: TOKER POINT
RANGE: 10
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
0.00	5.02
10.00	4.70
19.20	3.76
21.70	2.90
27.00	1.67
33.00	1.27
41.00	0.88
50.00	0.77
65.00	0.73
76.00	0.81
85.00	0.87
100.00	0.91
110.70	0.97
121.00	0.89
132.00	0.85
136.00	0.74
141.00	0.51
144.20	0.34
147.00	0.20
147.70	0.25
148.50	0.43
150.00	0.50
154.30	0.53
160.60	0.38
163.40	0.34
164.20	0.46
166.00	0.56
169.00	0.25
173.40	0.15
181.00	-0.36
190.00	-0.60
200.00	-0.79

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: TOKER POINT
RANGE: 11
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
0.00	3.75
17.50	3.31
26.80	3.13
34.00	3.05
42.00	3.33
42.60	2.77
46.00	1.78
50.00	1.41
60.00	1.03
63.30	0.87
68.60	0.66
72.00	0.20
77.00	-0.48
82.00	-0.69

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: TUKTOYAKTUK
RANGE: ZONE 2/LINE 1
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
0.00	2.52
6.00	2.20
8.50	2.00
13.00	2.08
21.00	1.78
30.00	1.66
35.00	1.66
40.00	1.36
45.00	1.35
50.00	1.21
55.00	1.16
58.60	1.20
65.00	1.56
70.00	1.72
75.00	1.76
80.00	1.89
85.70	2.11
90.00	1.84
94.60	1.34
95.60	1.14
98.60	0.71
99.40	0.75
100.00	0.65
102.40	0.35
106.00	-0.04
110.00	-0.36
115.00	-0.43

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: TUKTOYAKTUK
RANGE: ZONE 2/LINE 2
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-7.10	0.63
0.00	1.10
7.30	1.18
12.90	1.71
18.10	1.68
20.90	1.70
24.50	2.00
31.90	1.19
39.10	0.35
42.90	-0.06

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: TUKTOYAKTUK
RANGE: 3 (CEMETARY)
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-25.70	7.90
-20.70	7.75
-15.70	7.98
-10.70	7.52
-5.70	7.29
0.00	7.24
5.00	7.16
10.00	7.21
15.00	7.18
19.10	6.94
24.10	6.41
27.20	6.13
31.90	3.62
33.50	2.54
35.40	1.65
42.30	1.38
45.20	0.84
48.70	0.30
52.20	-0.09
54.20	-0.22
56.90	-0.33
60.40	-0.50
65.00	-0.74
68.80	-0.85

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: NORTH HEAD
RANGE: A
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-87.00	0.50
-45.00	0.52
-35.00	0.73
-29.00	1.09
-20.00	1.31
-17.00	1.52
-11.00	1.48
0.00	1.49
4.00	1.65
7.00	1.89
9.00	1.89
11.40	2.04
17.00	2.10
21.00	2.37
27.50	2.17
28.30	1.82
33.00	1.26
35.00	1.11
36.00	1.15
37.00	0.91
39.00	0.72
43.40	0.20
50.00	-0.19
52.00	-0.22
55.00	0.03
66.00	-0.17
78.00	-0.43

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: NORTH HEAD
RANGE: 4
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
0.00	2.96
6.40	2.40
14.30	2.08
19.40	2.35
27.40	2.04
34.20	1.67
40.00	1.80
46.90	2.04
50.00	2.17
51.10	2.31
51.60	2.03
56.00	1.61
60.00	1.31
63.00	0.95
65.00	0.84
68.00	0.50
70.90	0.15
74.00	-0.03
80.00	-0.23
85.00	-0.20
91.00	-0.07
95.00	0.13
100.00	0.01
110.90	-0.24

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: NORTH HEAD
RANGE: 8
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
0.00	4.29
5.00	3.75
13.30	2.88
15.70	2.36
17.40	1.84
20.00	2.06
24.00	2.50
33.00	2.33
36.00	1.91
38.00	1.57
43.00	1.39
50.00	1.37
58.00	1.44
66.00	1.54
72.00	1.62
75.00	1.71
78.60	2.13
81.00	1.84
83.00	1.52
86.00	1.26
89.00	1.03
91.00	0.89
95.00	0.67
100.00	0.62
105.00	0.42
110.00	0.27
115.00	0.16
119.00	0.10
121.70	0.10
129.00	-0.07
140.00	-0.23
147.00	-0.34
150.00	-0.30
152.00	-0.43
158.00	-0.77

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: ELLICE ISLAND
RANGE: +500
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
0.00	1.43
50.00	1.76
68.40	1.36
68.60	0.65
70.30	0.41
80.00	0.39
100.00	0.36
150.00	0.27
200.00	0.15
250.00	0.10
300.00	0.13
322.00	0.10
364.00	0.07

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: ELLICE ISLAND
RANGE: +1,250
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
0.00	1.43
50.00	1.41
100.00	1.35
117.40	1.30
118.50	0.98
120.80	0.66
133.00	0.48
141.00	0.56
143.90	0.58
144.30	0.35
150.00	0.41
158.40	0.28
158.70	0.53
170.00	0.30
171.40	0.15
185.00	0.09
200.00	0.02

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: ELLICE ISLAND
RANGE: 000
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
0.00	1.46
50.00	1.55
80.00	1.70
97.00	1.45
97.40	0.65
100.00	0.20
102.20	0.10
109.00	0.04
115.50	0.07
120.70	0.11
125.00	0.05
150.00	-0.05

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: ELLICE ISLAND
RANGE: -500
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
0.00	1.45
50.00	1.54
70.00	1.59
81.10	1.33
81.40	0.55
86.00	0.26
88.00	0.25
90.20	0.13
93.00	0.10
93.80	0.29
100.00	0.32
114.00	0.20
121.50	0.20
121.90	0.10
125.00	0.07
133.00	0.00
138.00	0.03
144.00	0.08
145.00	-0.05
150.00	-0.11

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: KING POINT
RANGE: -200
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-6.80	1.66
-3.50	1.97
0.00	1.48
5.00	1.43
10.00	1.25
15.00	1.21
20.00	1.21
25.00	1.11
30.00	1.25
34.20	1.37
38.00	1.33
39.50	1.04
43.00	0.66
49.70	0.39
55.80	-0.37

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: KING POINT
RANGE: 000
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
0.00	1.52
31.00	1.39
44.00	1.46
57.00	1.34
67.00	1.25
77.00	1.24
89.70	1.32
95.00	1.51
98.30	1.41
99.40	1.17
104.00	0.81
107.60	0.56
109.50	0.37
115.30	-0.33

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: KING POINT
RANGE: +200
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-144.00	0.27
-85.00	0.55
-84.00	1.01
-68.00	1.36
-64.00	0.94
-50.00	1.16
-35.00	1.35
-15.00	1.36
-10.50	0.92
0.00	1.20
7.10	1.18
18.70	0.97
26.90	1.01
33.80	0.99
36.70	0.45
39.70	0.54
41.40	1.16
45.40	1.53
47.30	1.39
47.90	1.13
52.40	0.62
57.20	0.52
60.90	-0.01
66.10	-0.55

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: KING POINT
RANGE: +600
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-97.00	0.27
-62.00	0.89
-34.00	1.21
-16.00	1.35
0.00	1.63
7.20	1.40
13.80	1.24
20.30	0.96
26.10	0.76
27.20	1.12
30.00	1.38
31.50	1.40
33.50	1.14
36.10	0.70
37.70	0.51
40.30	0.55
42.30	0.55
45.90	-0.06
52.70	-0.72

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: KING POINT
RANGE: +1,400
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-3.60	0.57
-2.50	1.15
0.00	1.36
3.00	1.50
6.00	1.61
8.90	1.68
13.80	1.63
17.60	1.38
20.30	2.09
22.80	2.01
24.50	2.06
25.40	1.54
28.40	1.14
32.20	0.80
35.00	1.21
35.40	1.02
38.40	0.61
41.40	0.40
44.40	0.21

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: KAY POINT
RANGE: Z9 (LINE 1)
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-11.20	0.30
-9.00	0.58
-5.50	1.02
0.00	1.32
15.00	1.42
20.50	1.24
33.00	1.73
37.10	1.79
43.60	1.67
45.90	1.54
50.00	0.91
51.00	0.92
52.20	0.65
54.50	0.30

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: KAY POINT
RANGE: Z9 (LINE 2)
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-12.40	0.30
-9.20	0.76
-5.20	1.23
0.00	1.31
17.00	1.50
20.80	1.30
24.10	1.40
30.00	1.59
38.30	1.79
40.50	1.50
45.20	0.97
46.70	0.96
51.60	0.30

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: KAY POINT
RANGE: Z9 (LINE 3)
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-23.00	-0.28
-14.10	0.11
-11.30	0.43
-9.80	0.65
-6.50	1.00
-3.80	1.21
0.00	1.26
7.10	1.37
14.40	1.43
18.20	1.39
21.00	1.31
25.00	1.50
28.60	1.68
32.00	1.80
34.20	1.80
36.60	1.69
38.50	1.25
40.90	1.03
41.10	0.78
43.50	0.47
45.80	0.15
49.00	-0.08
53.20	-0.35
60.00	-0.45
66.00	-0.49
74.00	-0.71
78.00	-0.94

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: KAY POINT
RANGE: Z9 (LINE 4)
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-11.80	0.26
-9.30	0.54
-9.00	0.77
-6.20	0.92
-4.90	1.09
0.00	1.27
10.00	1.30
16.80	1.38
24.00	1.55
29.60	1.74
31.50	1.57
34.20	1.16
37.30	0.88
37.50	0.73
41.00	0.30

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: KAY POINT
RANGE: Z9 (LINE 5)
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-11.80	0.27
-9.20	0.56
-8.70	0.71
-6.40	0.85
-5.50	1.05
-4.40	1.24
0.00	1.25
7.00	1.27
14.70	1.41
21.30	1.49
27.20	1.78
29.40	1.65
30.20	1.38
33.30	0.93
34.30	0.70
37.50	0.30

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: KAY POINT
RANGE: Z25 (LINE 1)
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-43.40	0.23
-37.20	0.86
-35.60	0.74
-24.60	0.86
-21.50	1.06
-20.00	1.13
0.00	1.16
37.80	1.38
41.00	1.26
41.70	1.10
50.00	1.14
55.80	1.48
57.60	1.56
63.60	0.97
67.00	1.08
70.70	0.60
77.40	0.57
81.80	0.77
87.20	0.25

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: KAY POINT
RANGE: Z25 (LINE 2)
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-45.30	0.23
-36.00	0.87
-34.70	0.72
-24.20	0.83
-20.90	1.08
0.00	1.11
40.00	1.37
43.30	0.93
50.00	1.05
53.70	1.16
59.00	1.52
64.00	1.04
67.00	1.08
73.00	0.50
78.00	0.49
82.90	0.77
88.10	0.25

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: KAY POINT
RANGE: Z25 (LINE 3)
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-50.00	-0.27
-44.00	-0.06
-39.50	0.12
-33.00	0.16
-26.80	0.28
-25.20	0.40
-23.80	0.59
-21.70	0.84
-19.10	1.02
-14.10	1.02
-7.70	1.01
0.00	1.00
8.40	1.02
19.90	1.17
26.50	1.32
31.20	1.35
35.10	1.35
40.20	1.32
41.70	1.13
43.00	0.94
44.60	0.85
47.20	0.78
49.20	1.06
50.00	1.12
54.30	1.25
58.00	1.46
59.50	1.32
61.70	1.14
63.00	1.00
65.60	0.81
66.30	0.95
68.40	1.04
69.40	0.88
70.70	0.72

DISTANCE	ELEVATION
72.70	0.62
73.70	0.47
76.00	0.40
76.90	0.40
79.20	0.55
82.90	0.75
84.60	0.71
86.80	0.51
87.70	0.48
89.80	0.20
95.50	-0.20
101.00	-0.27
108.80	-0.32
118.90	-0.36
125.20	-0.57
130.50	-0.72

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: KAY POINT
RANGE: Z25 (LINE 4)
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-24.20	0.21
-18.00	0.95
0.00	1.08
40.00	1.31
47.30	0.84
53.60	1.26
58.80	1.25
65.60	0.84
69.30	1.08
76.50	0.24
78.00	0.22
78.60	0.50
84.00	0.72
90.30	0.25

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: KAY POINT
RANGE: Z25 (LINE 5)
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-28.20	0.23
-18.50	1.09
0.00	1.13
37.10	1.38
43.00	1.02
50.00	1.15
65.80	0.94
69.70	1.17
72.00	0.93
80.00	0.25

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: KAY POINT
RANGE: Z37
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-45.70	0.28
-36.70	0.49
-31.10	0.67
-29.50	0.82
-27.90	0.81
-23.80	0.83
-19.80	0.96
-14.90	1.05
-6.00	1.13
-3.00	1.22
0.00	1.25
4.00	1.21
5.50	1.07
10.00	1.07
11.90	1.11
16.70	0.96
20.00	0.54
24.50	0.31
30.00	0.37
33.00	0.60
33.80	0.76
34.30	0.97
35.70	1.07
42.50	1.05
50.00	1.03
57.00	1.13
66.00	1.27
79.00	1.41
85.00	1.50
90.00	1.44
94.00	1.30
100.00	1.03
101.70	0.98
103.20	0.95
110.00	0.67
120.50	0.25
125.00	-0.10
127.80	-0.32
133.20	-0.38
138.00	-0.56

BEAUFORT SEA COASTAL MORPHOLOGY

LOCATION: STOKES POINT
RANGE: 1
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

BEACH

DISTANCE	ELEVATION
-60.00	1.00
-55.00	1.01
-50.00	1.26
-40.00	1.47
-30.00	1.32
-25.00	1.11
-20.00	1.39
-15.00	1.22
-10.00	1.55
-5.00	1.32
0.00	1.56
3.10	1.69
5.00	1.39
6.00	1.38
7.00	1.17
10.00	0.88
12.40	0.61
17.40	0.10
19.90	-0.07
24.90	-0.66

BEAUFORT SEA COASTAL MORPHOLOGY

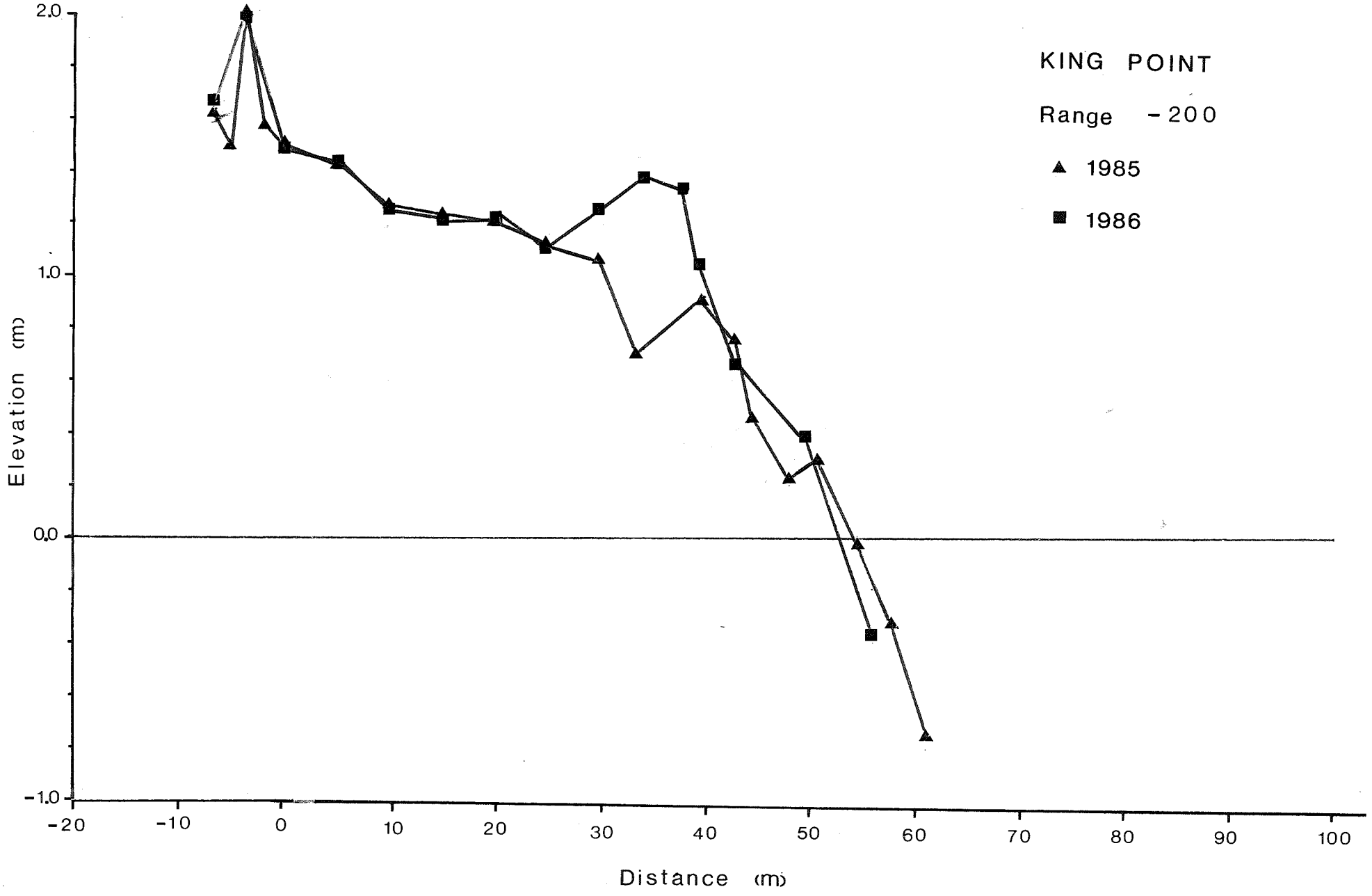
LOCATION: KOMAKUK BEACH
RANGE: 1
DATE: JULY, 1986
VERTICAL DATUM: MEAN SEA LEVEL
BENCH MARK

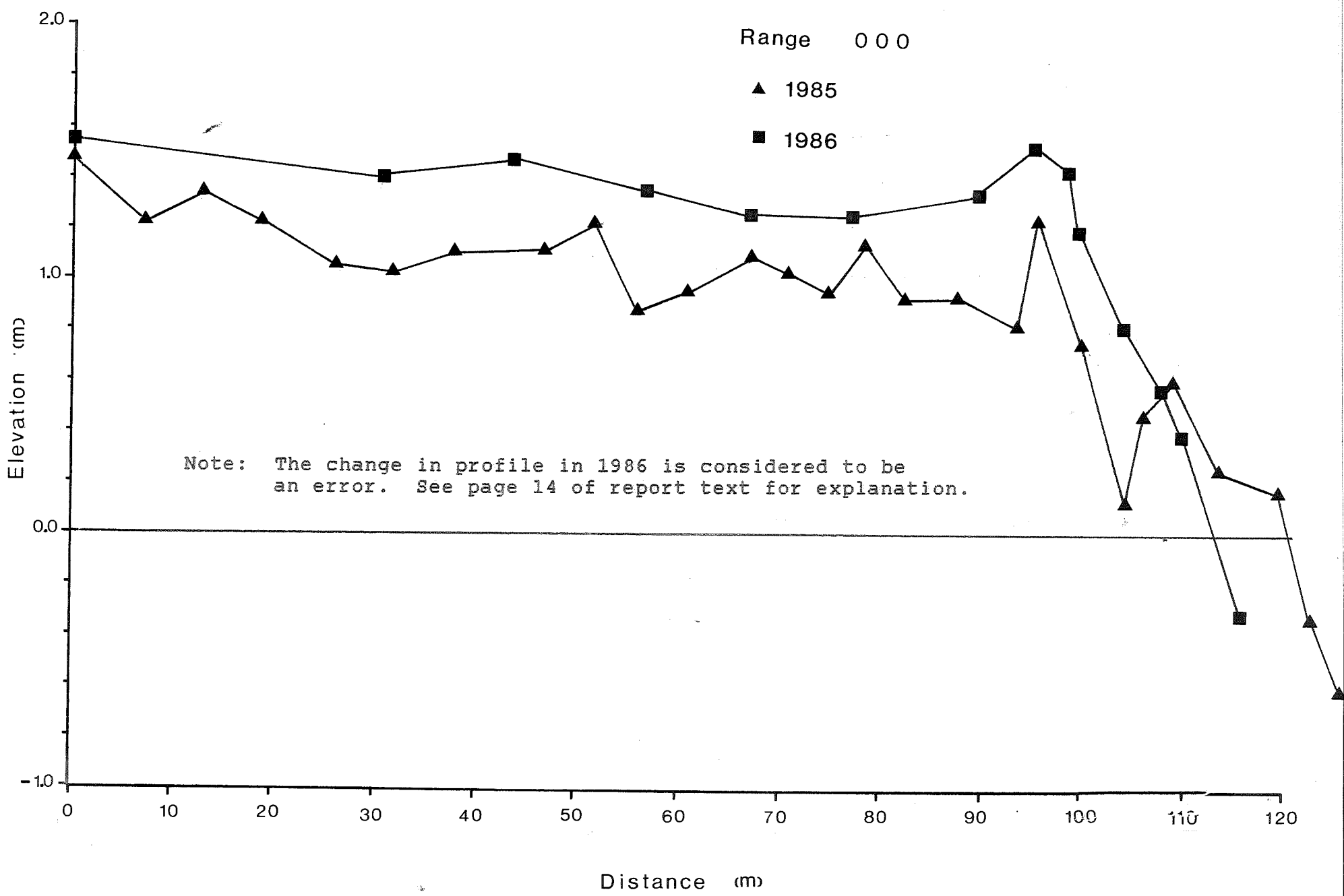
BEACH

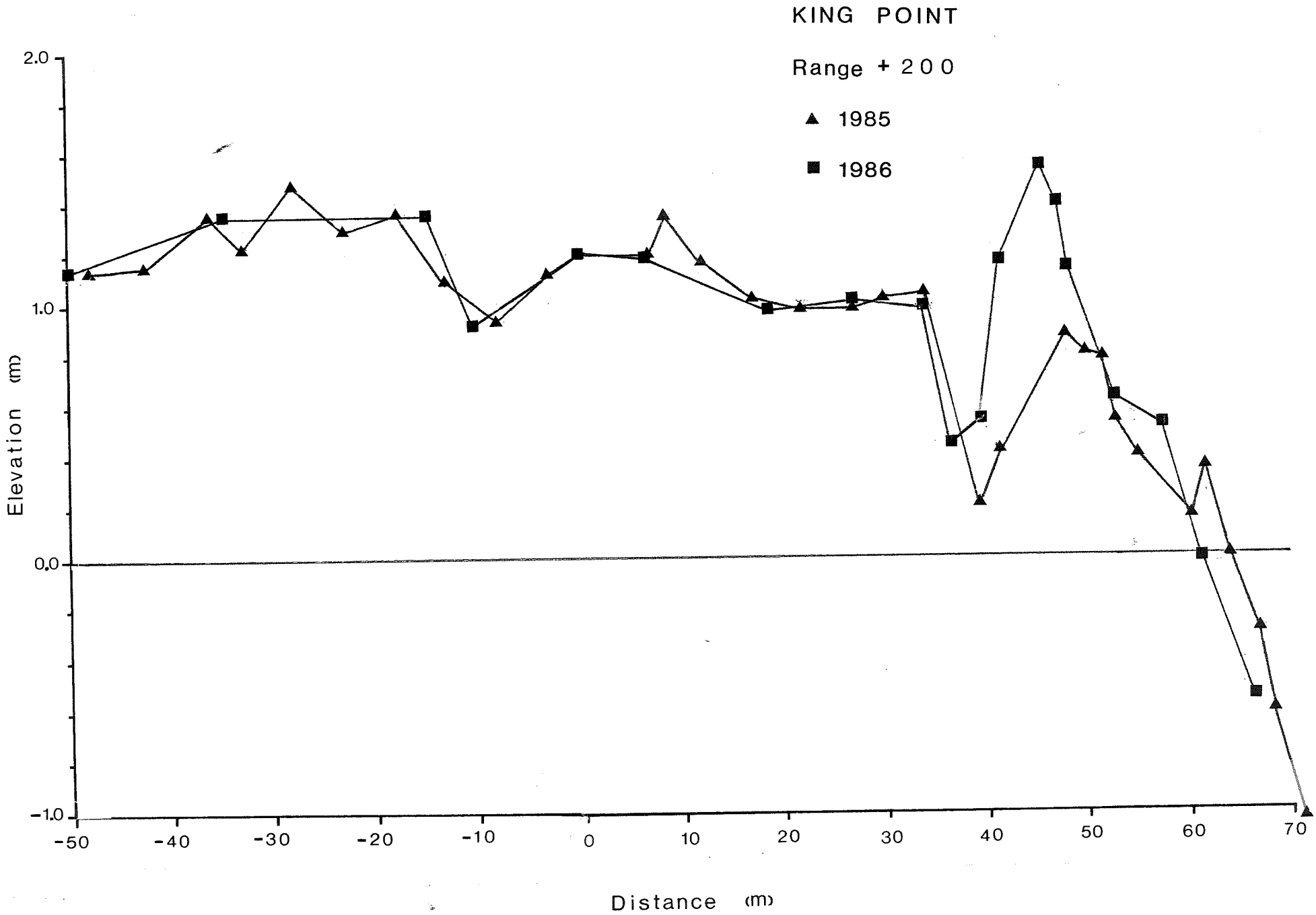
DISTANCE	ELEVATION
0.00	6.08
20.00	5.65
40.00	5.16
45.00	5.04
54.50	4.88
55.40	3.66
56.20	3.16
56.90	2.44
57.70	2.30
62.70	1.94
67.70	1.65
72.70	0.89
76.10	0.20
81.10	-0.27
83.10	-0.66
85.10	-1.04

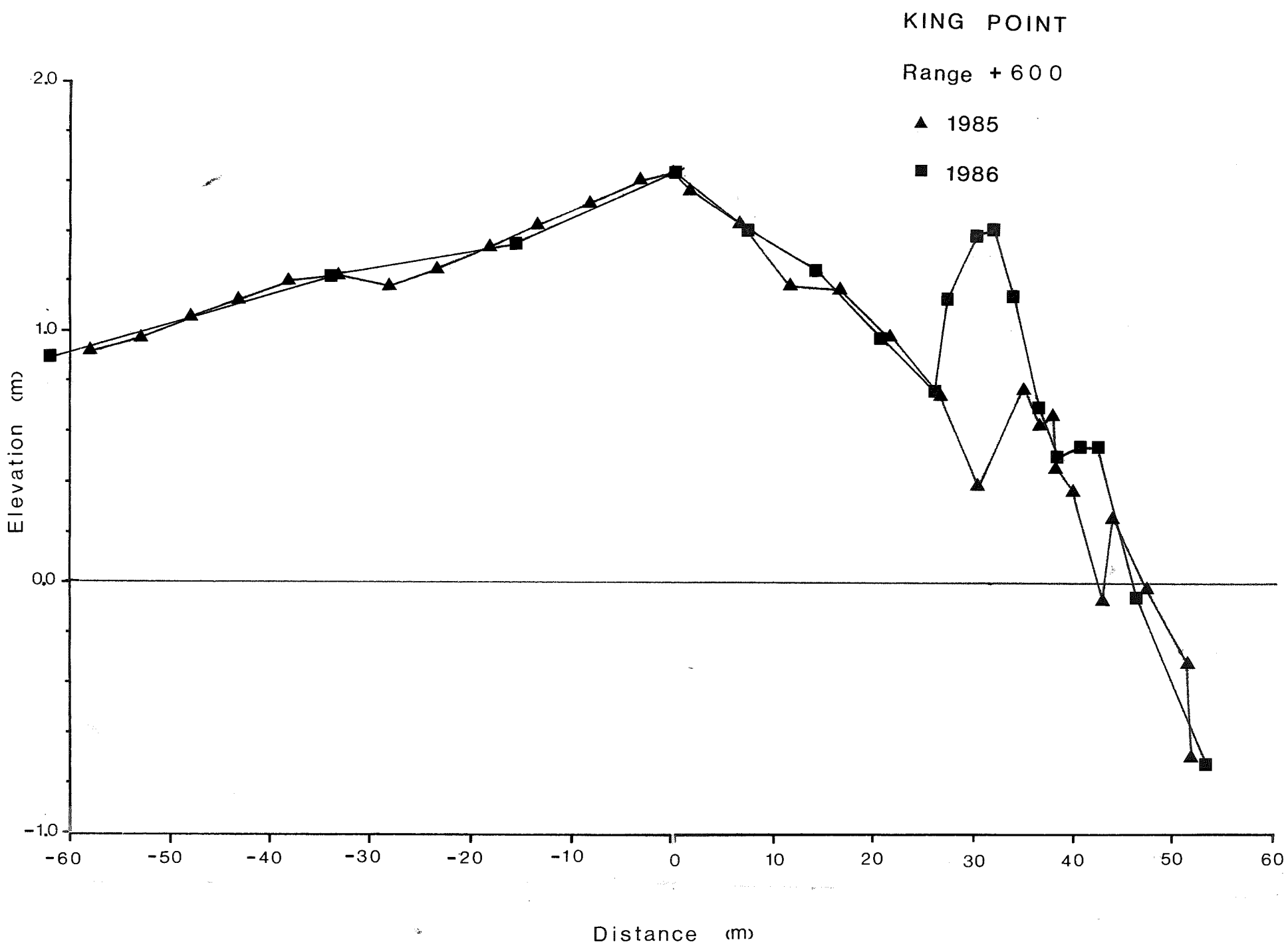
APPENDIX 3D - BEACH PROFILE CHANGES, KING POINT, 1985-1986

King Point, Range -200
King Point, Range 000
King Point, Range +200
King Point, Range +600
King Point, Range +1,400


KING POINT
Range -200
1985
1986
2.0
1.0
0.0
-1.0
Elevation (m)
-20
-10
0
10
20
30
40
50
60
70
80
90
100
Distance (m)


KING POINT
Range 000
1985
1986
2.0
1.0
0.0
-1.0
Elevation (m)
Note: The change in profile in 1986 is considered to be an error. See page 14 of report text for explanation.
0
10
20
30
40
50
60
70
80
90
100
110
120
Distance (m)


KING POINT
Range + 200
1985
1986
2.0
1.0
0.0
-1.0
Elevation (m)
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
Distance (m)


KING POINT
Range +600
1985
1986
2.0
1.0
0.0
-1.0
Elevation (m)
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
Distance (m)

1986 CLIFF SURVEY MEASUREMENTS

Tent Island
Ellice Island
King Point
Toker Point
North Head
Kay Point
Garry Island
Pelly Island, Site 3a
Hooper Island, Site 1
Hooper Island, Site 2
Hooper Island, Site 3
Hooper Island, Site 4

Tent Island Cliff Survey
July 13, 25, 1986

STAKE I.D.	DISTANCE (m) TUNDRA CLIFF	WATERLINE	COMMENTS
0(BMI)	169.5	185	
100	232	240	
200	200,229	253	
300	231.7	256	
400	221.7	231	
500(BMII)	233.2	250	
750	201	219	Bearing 5^{o} mN
1,000	106	134	Bearing 5^{o} mN
1,250	130	147	Bearing 355^{o} mN
1,500	132	156	Bearing 330^{o} mN

Ellice Island Cliff Survey
July 13,23, 1986

STABLE I.D.	DISTANCE (m)	COMMENTS
0(BMI)	96.9	Bearing 70° mN
100	79.2	Bearing 70° mN
200	104.0	Bearing 70° mN
300	104.8	Bearing 70° mN
400	91.5	Bearing 70° mN
500(BMI)	68.7	Bearing 70° mN
-500	81.1	Bearing 70° mN
+1,250	117.4	Bearing 70° mN

King Point Cliff Survey
July 14, 1986

STAKE I.D.	DISTANCE (m)	COMMENTS
BM1	69.4	Bearing 0^{o} mN
BM2	84.5	Bearing 0^{o} mN. Distance to stabilized headwall.
BM3	66.5	Bearing 0^{o} mN. Distance to stabilized headwall.
	219.0	Distance to active cliff
BM4	156.6	Bearing 352^{o} mN
BM5	76	Bearing 357^{o} mN

Toker Point Cliff Survey
July 16,20, 1986

STAKE I.D.	DISTANCE (m) CLIFF TOP	WATERLINE	COMMENTS
6	74.6	84.6	Bearing 0^{o} mN. Cliff height 1.2 m
7	58	--	Bearing 17^{o} mN. Cliff height 3.8 m
8	57	72	Bearing 15^{o} mN. Cliff height 1.8 to 2.5 m
11	42.5	--	Bearing 320^{o} mN.

North Head Cliff Survey
July 22,23, 1986

STAKE I.D.	DISTANCE (m)	COMMENTS
1	39.7	Bearing 325^{o} mN
2	31.4, 59.7	Bearing 302^{o} mN
3	40.5	Bearing 302^{o} mN
5	59.9, 83.5	Bearing 310^{o} mN
6	53.2	Bearing 278^{o} mN
7	36.4	Bearing 264^{o} mN

Kay Point Cliff Survey
July 20, 1986

Polygon Zone - as defined by Peter Lewis

STAKE I.D.	DISTANCE (m)	COMMENTS
1A-5	--	Unable to find. Missing?
6	4.5	
7	--	
8	9.3	
9	13.4	
10	8.3	
11	14.4	
12	10.0	
13	6.1	
14	--	
15	11.0	
16	15.8	
17	--	
18	21.3	
19	29.3	Questionable measurement.
20	30.4	
21	--	

Garry Island Cliff Survey
July 25, 1986

Located on northwest end of Island along west-facing coast.

STAKE I.D.	DISTANCE (m)	COMMENTS
217 (382)	15.0	Bearing 263° mN
4 (383)	16.5	Bearing 263° mN
216 (384)	22.8	
215 (385)	21.3	
214 (386)	5.6	
213 (388)	18.3	
212 (389)	21.8	
209 (394)	11.6	
208 ( )	--	Not found
207 (395)	10.9	
206 (397)	19.2	Questionable measurement
398	15.7	Stabilized headwall
399	18.6	Stabilized headwall
203 (400)	7.0	Active headwall
202 (401)	16.3	
402	3.3	
403	14.5	
404	15.1	
405	7.6	Set back to 17.6 m
406	10.5	
407	10.4	
408	11.8	
409	11.8	
410	13.2	
411	13.0	
412	10.9	4 m high cliff, polygon cracks
413	9.4	Set back to 19.4 m
414	--	Not found
415	8.3	Set back to 18.3 m
416	6.3	Set back to 16.3 m
417	7.0	Set back to 17.0 m
418	--	Not found
419	9.0	Set back to 19.0 m
420	10.9	Set back to 20.9 m
421	16.5	
422	--	Not found
423	12.4	
424	12.9	
425	18.9	
426	16.6	
427	13.2	
428	14.8	
429	22.7	
430	19.4	10 m high cliff
431	24.8	

Pelly Island Cliff Survey
July 25, 1986

Site #3a

STAKE I.D.	DISTANCE (m)	COMMENTS
143	16.3	
144	9.3	
145	8.6	Set back to 13.6 m
146	--	Not found
147	1.9	Set back to 11.9 m

Hooper Island Cliff Survey
July 27, 1986

Site 1

STAKE I.D.	DISTANCE (m)	COMMENTS
53	15.3	
54	15.0	
55	13.8	
56	13.7	
57	13.1	
58	13.3	
59	14.0	
60	16.4	
61	16.0	
62	15.7	
63	14.3	
64	12.9	
65	13.0	
66	14.3	
67	13.7	

Hooper Island Cliff Survey (Continued)
July 27, 1986

Site 2

STAKE I.D	DISTANCE (m)	COMMENTS
68	17.8	
69	14.3	
70	13.8	
71	--	Pulled out
72	11.0	
73	11.6	
74	10.6	
75	17.7	
76	--	Missing
77	11.5	
78	17.2	
79	--	Missing
80	6.8	Moved back 10 m to 16.8 m
81	8.1	Moved back 10 m to 18.1 m

Hooper Island Cliff Survey (Continued)
July 27, 1986

Site 3

STAKE I.D.	DISTANCE (m)	COMMENTS
83	5.4	Moved back 10 m to 15.4 m
84	15.5	
85	15.1	
86	18.3	
87	18.7	
88	15.1	
89	17.7	
90	15.6	
91	17.4	
92	14.9	
93	13.6	
94	10.5	
95	13.5	
96	--	Missing
97	--	Missing

Hooper Island Cliff Survey (Continued)
July 27, 1986

Site 4

STAKE I.D.	DISTANCE (m)	COMMENTS
98	--	Missing
99	--	Missing
100(*)	6.7	Moved back 10 m to 16.7 m
101	11.7	Moved back 10 m to 21.7 m
102	13.2	
103	17.3	
104	--	Not present
105	19.8	Questionable measurement
106	14.1	
107	15.4	
108-112	--	Missing

(*) Stake 100 is located at edge of retrogressive thaw failure.

CLIFF EROSION RATES

Kay Point
Gary Island
Pelly Island, Site 3a
Hooper Island, Site 1
Hooper Island, Site 2
Hooper Island, Site 3
Hooper Island, Site 4

Kay Point Cliff Erosion Rates

Polygon Zone - as defined by Peter Lewis

STAKE I.D.	EROSION (m) 1984/1985	1985/1986	1976/1984
1A-5	--	--	--
6	-1.0	-1.3	-19.7
7	--	--	--
8	-0.1	-2.0	-14.0
9	-0.7	-5.3	-4.9
10	-1.0	-1.0	-13.1
11	-0.3	-1.6	-8.2
12	-0.2	-1.7	-10.4
13	-2.8	-0.8	-10.9
14	--	--	--
15	0.0	-0.5	-11.3
16	-0.2	-1.1	-8.2
17	--	--	--
18	0.0	0.0	-7.1
19	--	--	-3.1
20	--	--	-1.0
21	--	--	-2.6
	Σx = 6.3	Σx = 15.3	Σx = 114.5
	n = 10	n = 10	n = 13
	$\bar{x}$ = 0.6 m/a	$\bar{x}$ = 1.5 m/a	$\bar{x}$ = 8.8/8 = 1.1 m/a
	σ_{n-1} = 0.9	σ_{n-1} = 1.5	σ_{n-1} = 5.2/8 = 0.7
	σ_n = 0.8	σ_n = 1.4	σ_n = 5.0/8 = 0.6

Gary Island Cliff Erosion Rate

STAKE I.D.	EROSION (m) 1984-1986		
382	-4.7		
383	-1.6		
384	0.0		
385	+0.2	(?)	Assumed to be no change.
386	+0.1	(?)	Assumed to be no change.
388	-0.3		
389	-0.1		
394	-0.2		
395	-1.5		
397	+6.8	(?)	Not included in statistics.
398	--		
399	--		
400	-1.8		
401	-3.7		
402	-2.9		
403	-2.1		
404	-1.4		
405	-3.6		
406	-3.7		
407	-4.5		
408	-1.5		
409	-2.4		
410	-2.8		
411	-2.5		
412	-3.0		
413	-3.0		
415	-2.0		
416	-2.6		
417	-3.1		
419	-8.1		
420	-6.6		
421	-2.3		
423	-1.7		
424	-3.1		
425	-2.2		
426	-0.8		
427	-2.3		
428	-5.1		
429	-1.9		
430	-2.3		
431	-2.2		

$\Sigma \bar{x} = 93.6$

$n = 38$

$\bar{x} = 2.5/2 = 1.2$ m/a

$\sigma_{n-1} = 1.7/2 = 0.9$

$\sigma_n = 1.7/2 = 0.9$

Pelly Island Cliff Erosion Rates

STAKE I.D.	EROSION (m) 1984-1986
143	-3.1
144	-2.2
145	-5.3
146	--
147	-6.0

Σx = 16.6

n = 4

$\bar{x}$ = 4.2/2 = 2.1 m/a

σ_{n-1} = 1.8/2 = 0.9

σ_n = 1.6/2 = 0.8

Hooper Island Cliff Erosion Rates

Site 1

STAKE I.D.	EROSION (m) 1984-1986
53	-0.1
54	-0.9
55	-1.3
56	-1.6
57	-1.2
58	-1.5
59	-2.1
60	-1.0
61	-1.8
62	-0.7
63	-1.6
64	-1.2
65	-0.3
66	-1.1
67	-0.2

$\Sigma x = 16.6$

$n = 15$

$\bar{x} = 1.1/2 = 0.6$ m/a

$\sigma_{n-1} = 0.6/2 = 0.3$

$\sigma_n = 0.6/2 = 0.3$

Hooper Island Cliff Erosion Rates (Continued)

Site 2

STAKE I.D.	EROSION (m) 1984-1986
68	-5.0
69	-3.7
70	-5.1
71	--
72	--
73	-4.8
74	-2.0
75	-3.4
76	--
77	-4.3
78	-1.5
79	--
80	-3.9
81	-2.0

$\Sigma x = 35.7$

$n = 10$

$\bar{x} = 3.6/2 = 1.8$ m/a

$\sigma_{n-1} = 1.3/2 = 0.7$

$\sigma_n = 1.3/2 = 0.7$

Hooper Island Cliff Erosion Rates (Continued)

Site 3

STAKE I.D.	EROSION (m) 1984-1986
83	-3.8
84	-2.9
85	-2.6
86	-1.1
87	-2.3
88	-3.7
89	-0.3
90	-2.5
91	-2.8
92	-1.5
93	-0.9
94	-2.4
95	-1.9
96	--
97	--

$\Sigma x = 28.7$

$n = 13$

$\bar{x} = 2.2/2 = 1.1$ m/a

$\sigma_{n-1} = 1.0/2 = 0.5$

$\sigma_n = 1.0/2 = 0.5$

Hooper Island Cliff Erosion Rates (Continued)

Site 4

STAKE I.D.	EROSION (m) 1984-1986
98	--
99	--
100	-9.6
101	-3.3
102	-3.9
103	-12.3
104	--
105	?
106	-1.0
107	-1.5
108-112	--

$\Sigma x = 31.6$

$n = 6$

$\bar{x} = 5.3/2 = 2.7$ m/a

$\sigma_{n-1} = 4.6/2 = 2.3$

$\sigma_n = 4.2/2 = 2.1$

NORTH HEAD CLIFF PROFILE SECTIONS

Range 1
Range 2
Range 3
Range 5
Range 6
Range 7

North Head Cliff Profile Sections

(i) Bench marks were installed for the purpose of cliff erosion measurements at North Head on July 22 and 23, 1986.

(ii) Due to the recent interest in this area it was deemed appropriate to also make measurements of the nature of the cliff slope morphology in addition to the normal horizontal distance to the cliff edge.

(iii) Field data collection consisted of slope facet measurements on the cliff between the bench mark and the water line. The slant range (distance) of each facet was measured by tape to 0.1 m resolution. The angle of each slope facet was measured by Abney level to 1 degree resolution.

(iv) In addition, general observations of slope facet stratigraphy and surface erosion processes were also made.

(v) Data reduction comprised determining the vertical height and horizontal distance of each slope facet from the field measurements and the subsequent elevation relative to the water line at the time of the survey and distance relative to the bench mark.

(vi) Slope morphology data are presented in the following tables and cliff section drawings.

North Head Cliff Profile Data

RANGE NO.	SURVEY POINT	FIELD MEASUREMENT R(m)	O	DY	DX	ELE(m)	DIST(m)	COMMENTS
1	1	--	--	--	--	8.7	0.0	B.M.
	2	39.7	0	0.0	39.7	8.7	39.7	Cliff Edge
	3	5.4	-33	2.9	4.5	5.8	44.2	
	4	15.6	-12	3.2	15.3	2.6	59.5	Veg. surface
	5	--	--	1.3	1.1	1.3	60.6	Active erosion
	6	15.0	-5	1.3	14.9	0.0	75.5	Water line
2	1	--	--	--	--	15.4	0.0	B.M.
	2	31.4	1	-0.5	31.4	15.9	31.4	
	3	8.2	-24	3.3	7.5	12.6	38.9	
	4	20.9	-6	2.2	20.8	10.4	59.7	
	5	13.2	-45	9.3	9.3	1.1	69.0	
	6	12	-5	1.1	12.0	0.0	81.0	Water line
	7	15	-1	0.3	15.0	-0.3	96.0	
3	1	--	--	--	--	15.1	0.0	B.M.
	2	40.5	-1.5	1.1	40.5	14.0	40.5	
	3	17.6	-47	12.9	12.0	1.1	52.5	
	4	8.0	-8	1.1	7.9	0.0	60.4	Water line
5	1	--	--	--	--	15.2	0.0	B.M.
	2	60	-3	3.1	59.9	12.1	59.9	
	3	16.8	-31	8.7	14.4	3.4	74.3	
	4	9.2	-1.2	0.2	9.2	3.2	83.5	
	5	4.6	-30	2.3	4.0	0.9	87.5	
	6	17.9	-3	0.9	17.9	0.0	105.4	Water line
6	1	--	--	--	--	5.9	0.0	B.M.
	2	53.2	0	0	53.2	5.9	53.2	
	3	5.4	-46	3.9	3.8	2.0	57.0	
	4	19.3	-6	2.0	19.2	0.0	76.2	Water line
7	1	--	--	--	--	18.0	0.0	B.M.
	2	36.4	+0.5	-0.3	36.4	18.3	36.4	
	3	23.5	-43	16.0	17.2	2.3	53.6	
	4	13.5	-10	2.3	13.3	0.0	66.9	Water line

NOTE: R: Slant range of slope facet
O: Angle of slope facet
DY: Slope facet distance
DX: Slope facet height

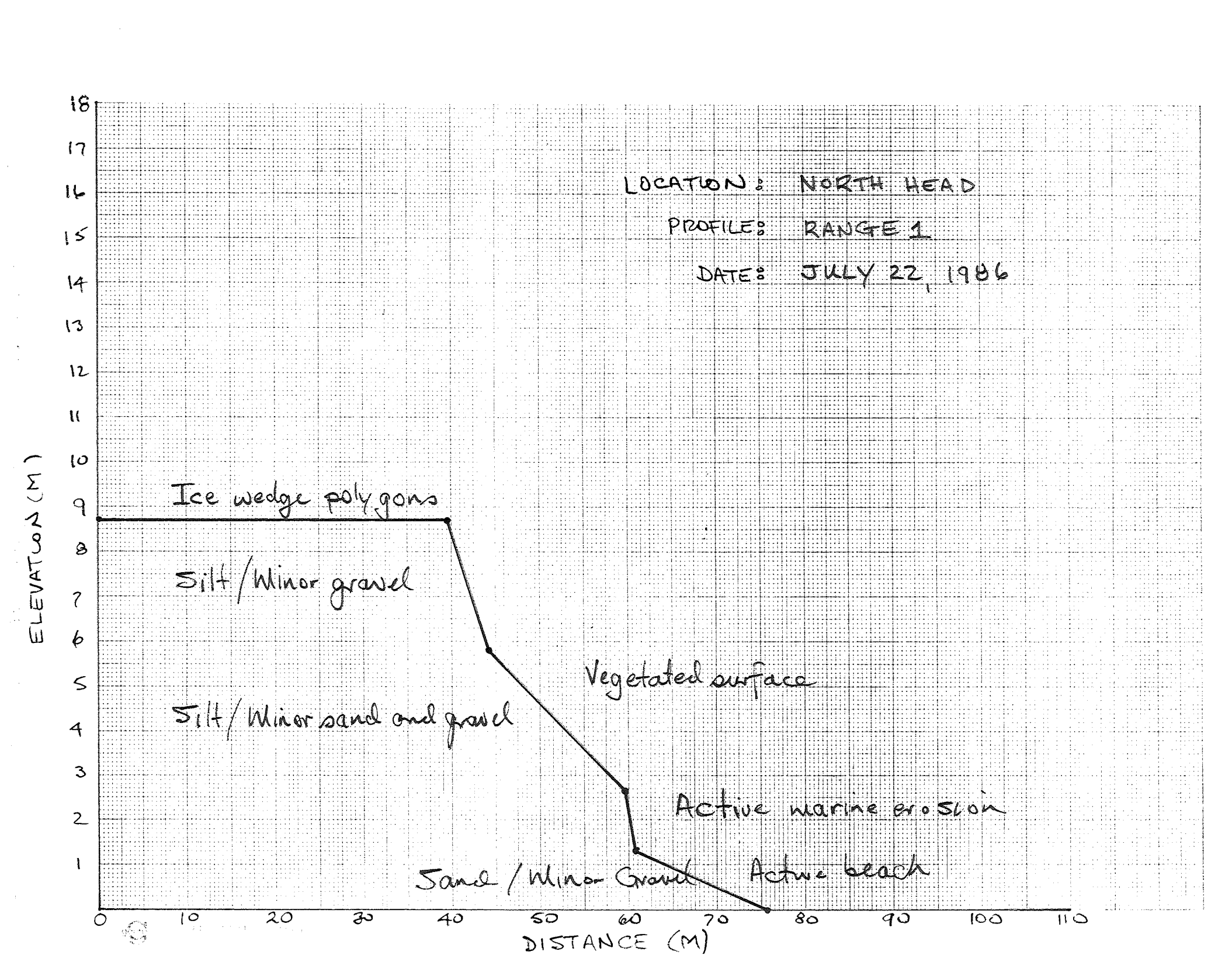
North Head

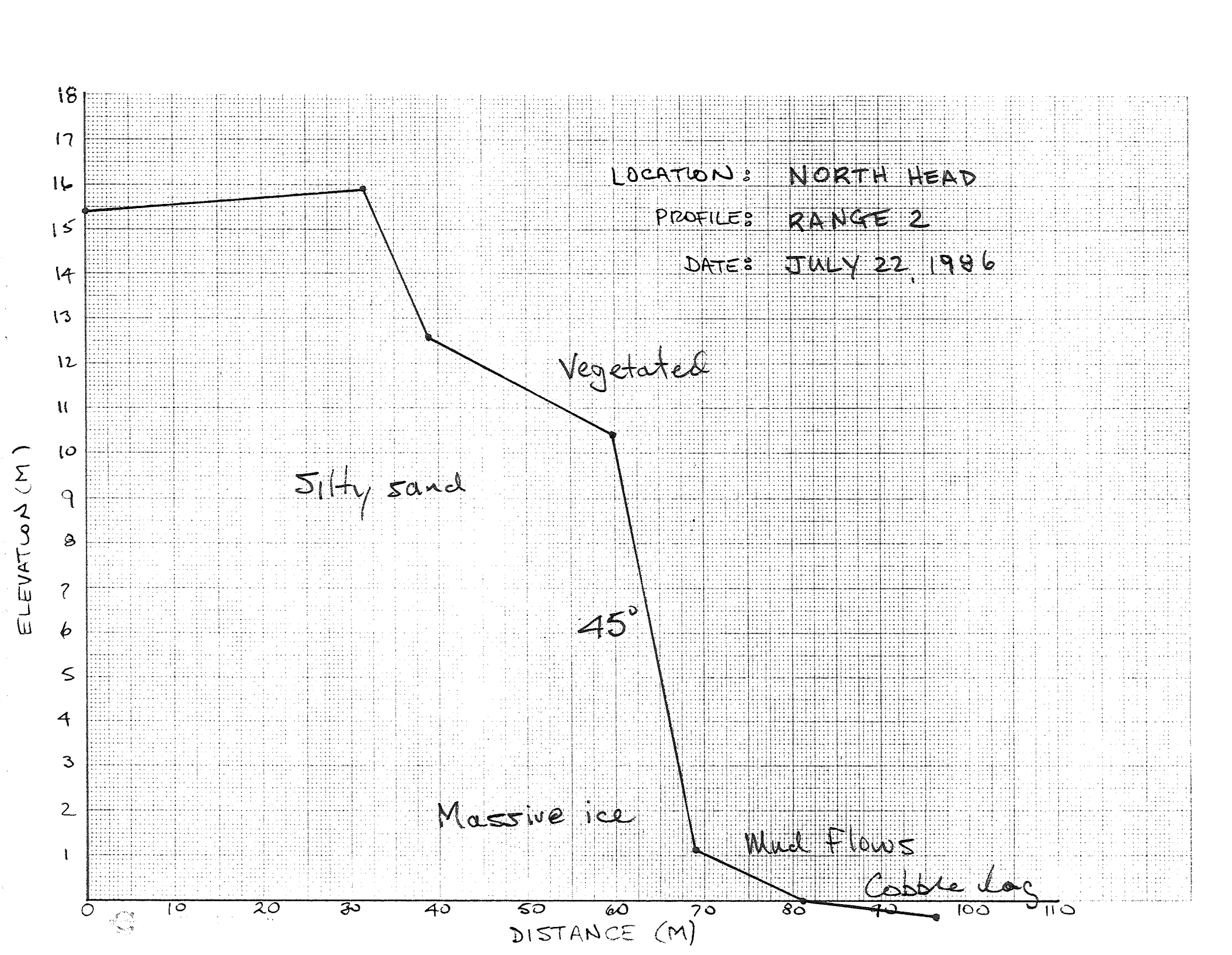
BM	DESCRIPTION
A	- Installed on July 22, 1986. - Located on east side of North Head on proximal end of beach spit approximately 100 m ENE of base of tundra slope. - B.M. is 2" x 2" wood stake painted and labelled "North Head BMA". - Survey line bearing is 330 MN.
1	- Installed on July 22, 1986. - Located on tundra surface approximately 150 m WSW of proximal end of beach spit to ENE, and 40 m from cliff edge. - B.M. is steel R-bar with aluminum GSC cap labelled "I". - Survey line bearing is 325 MN. Bearing lines up with west cliff of Pullen Island.
2	- Installed on July 22, 1986. - Located approximately 700 m WSW of B.M. 1 at 31 m from cliff edge. - B.M. is steel R-bar with aluminum GSC cap labelled "II". - Survey line bearing 302 MN.
3	- Installed on July 22, 1986. - located approximately 500 m ENE of pocket beach and 41 m from cliff edge. - B.M. is steel R-bar with aluminum GSC cap labelled "III". - Survey line bearing 302 MN.
4	- Installed on July 22, 1986. - Located in middle of short (500 m long) beach. B.M. placed on tundra surface behind log line. - B.M. is steel R-bar with aluminum GSC cap labelled "IV". - Survey line bearing 305 MN.
5	- Installed on July 22, 1986. - Located approximately 250 m WSW of small beach approximately 60 m from cliff edge. - B.M. is steel R-bar with aluminum GSC cap labelled "V". - Survey line bearing 310 MN.

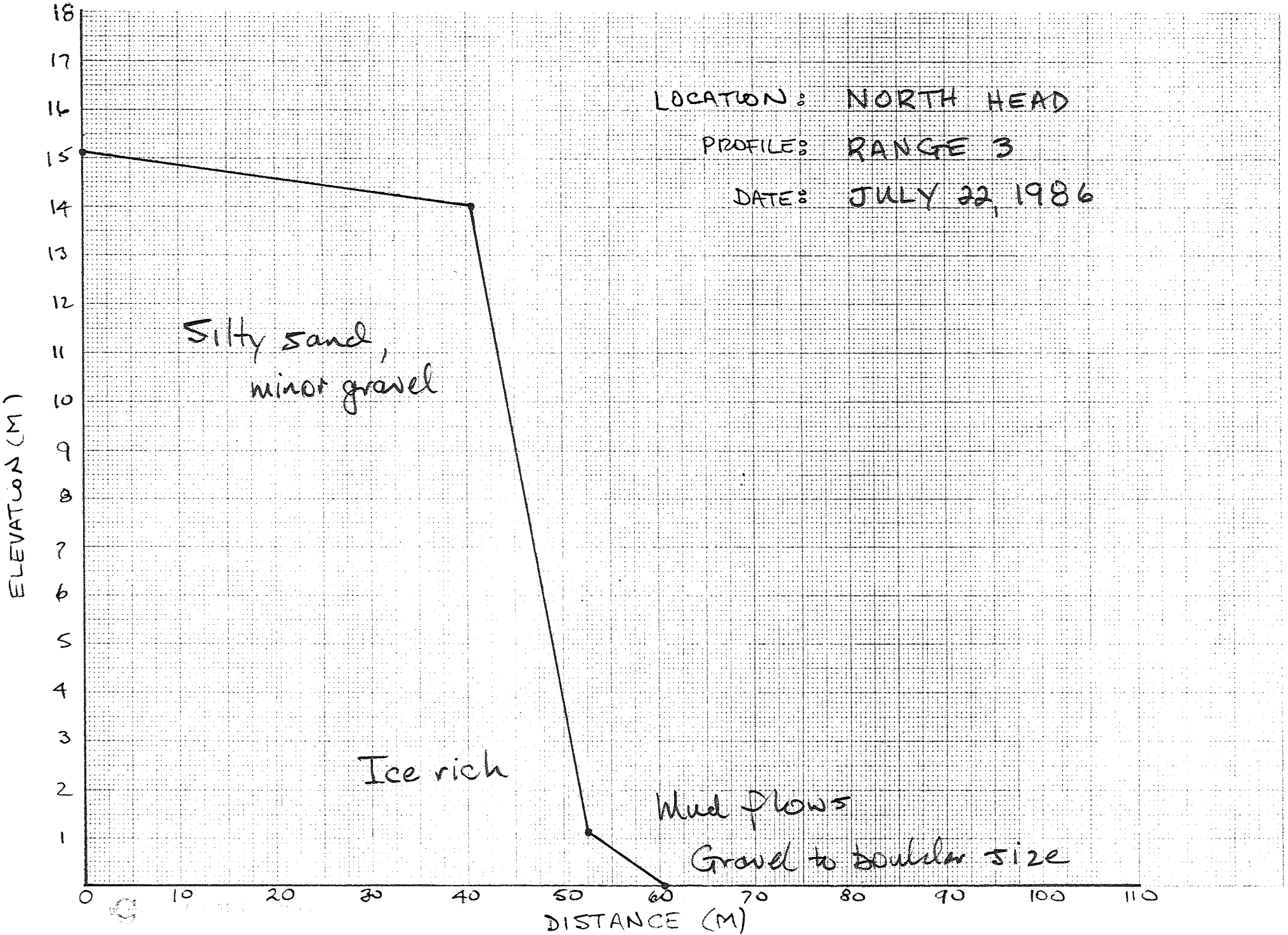
6 - Installed July 22, 1986.
- Located approximately 700 m to WSW of B.M. 5 at WSW end of tundra flat on former lake bed approximately 53 m from cliff edge.
- B.M. is steel R-bar with aluminum GSC cap labelled "IV" (?).
- Survey line bearing 278 MN.

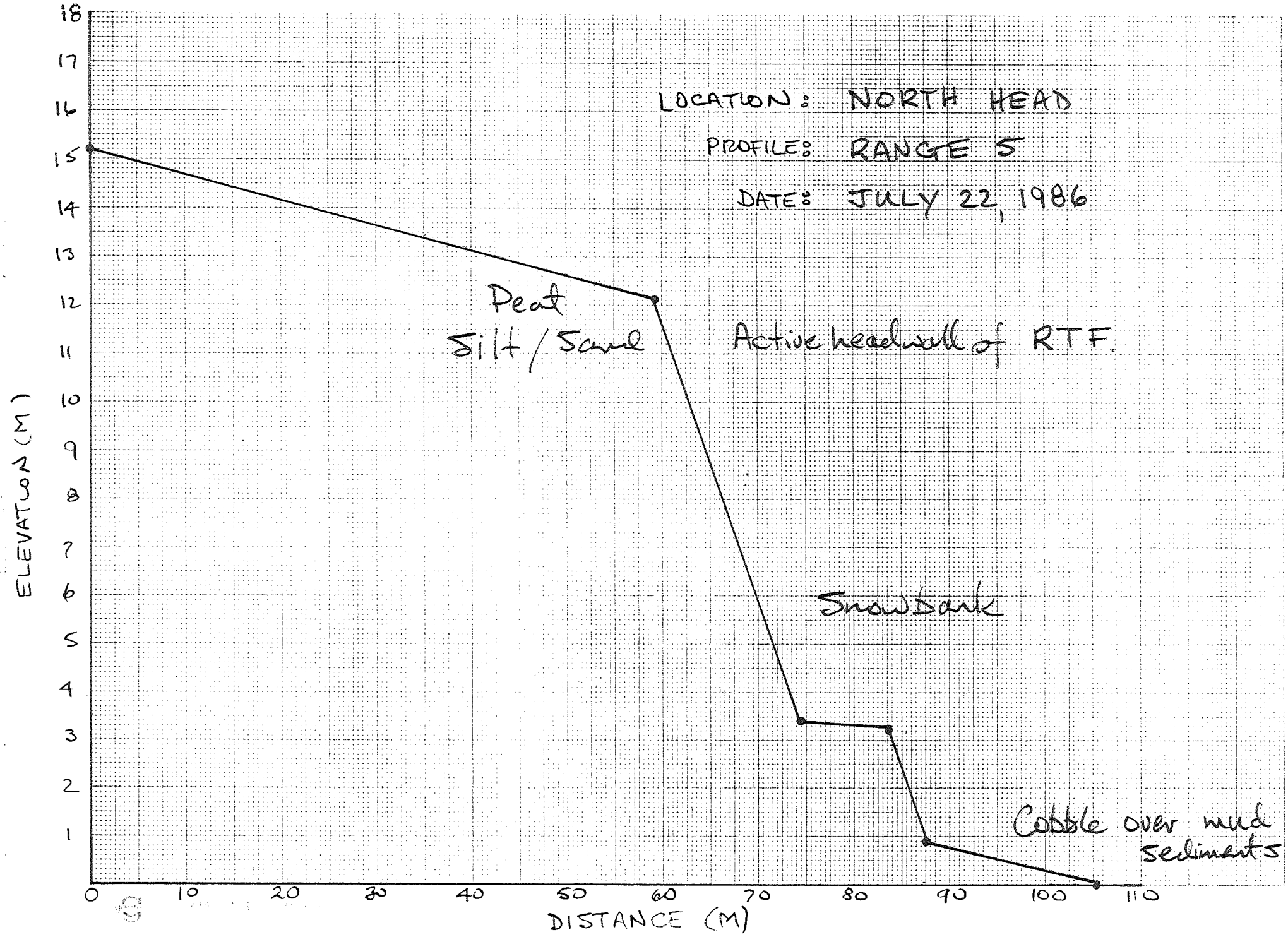
7 - Installed July 23, 1986.
- Located on tundra on SW end of North Head approximately 36 m from cliff edge.
- B.M. is steel R-bar with aluminum GSC cap labelled "I".
- Survey line bearing is 264 MN.

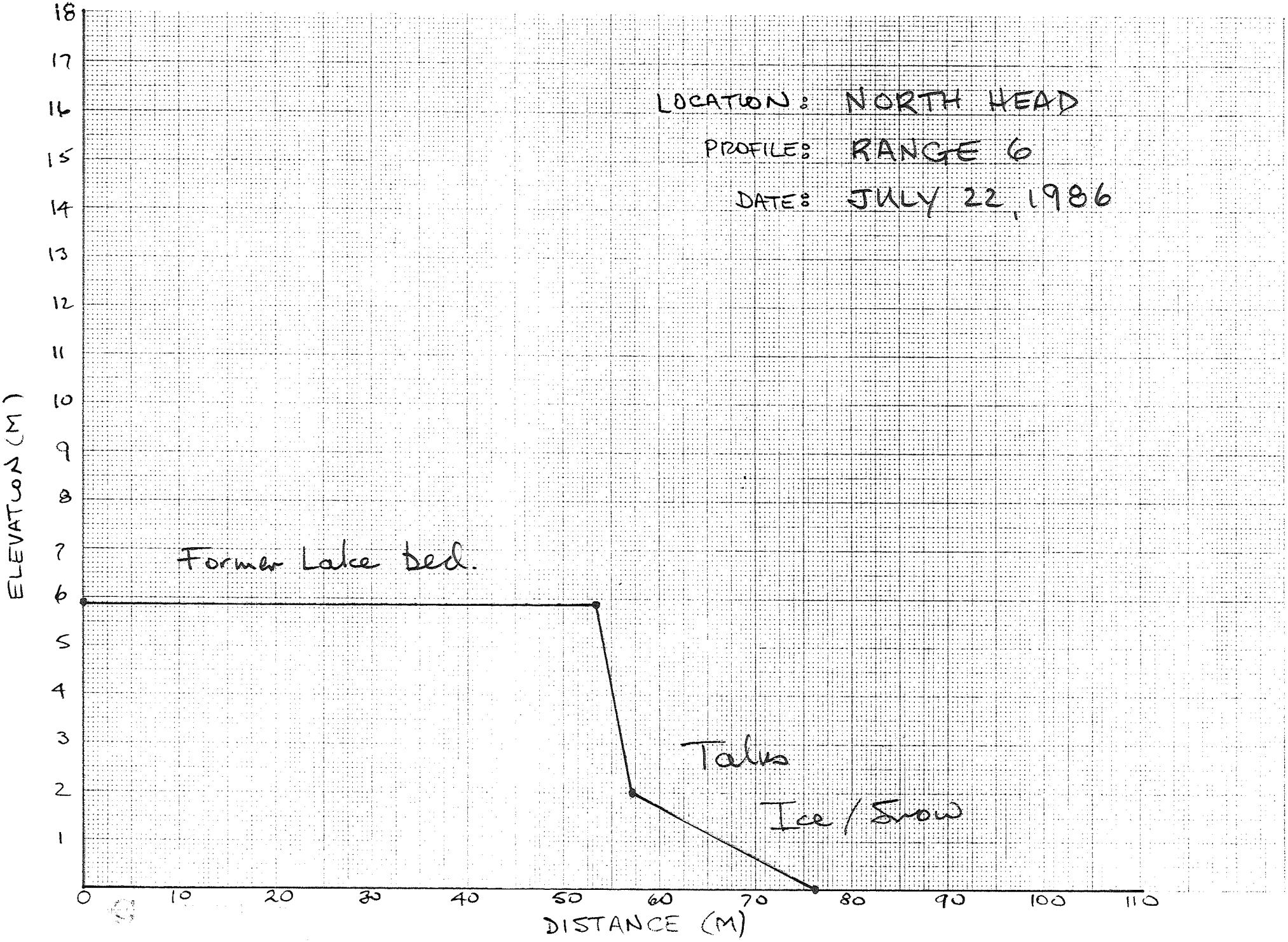
8 - Installed July 23, 1986.
- Located on top of tundra remnant surrounded by dune deposit on supra tidal flat at SW end of North Head.
- B.M. is 2" x 2" wood stake.
- Survey line bearing is 260 MN.

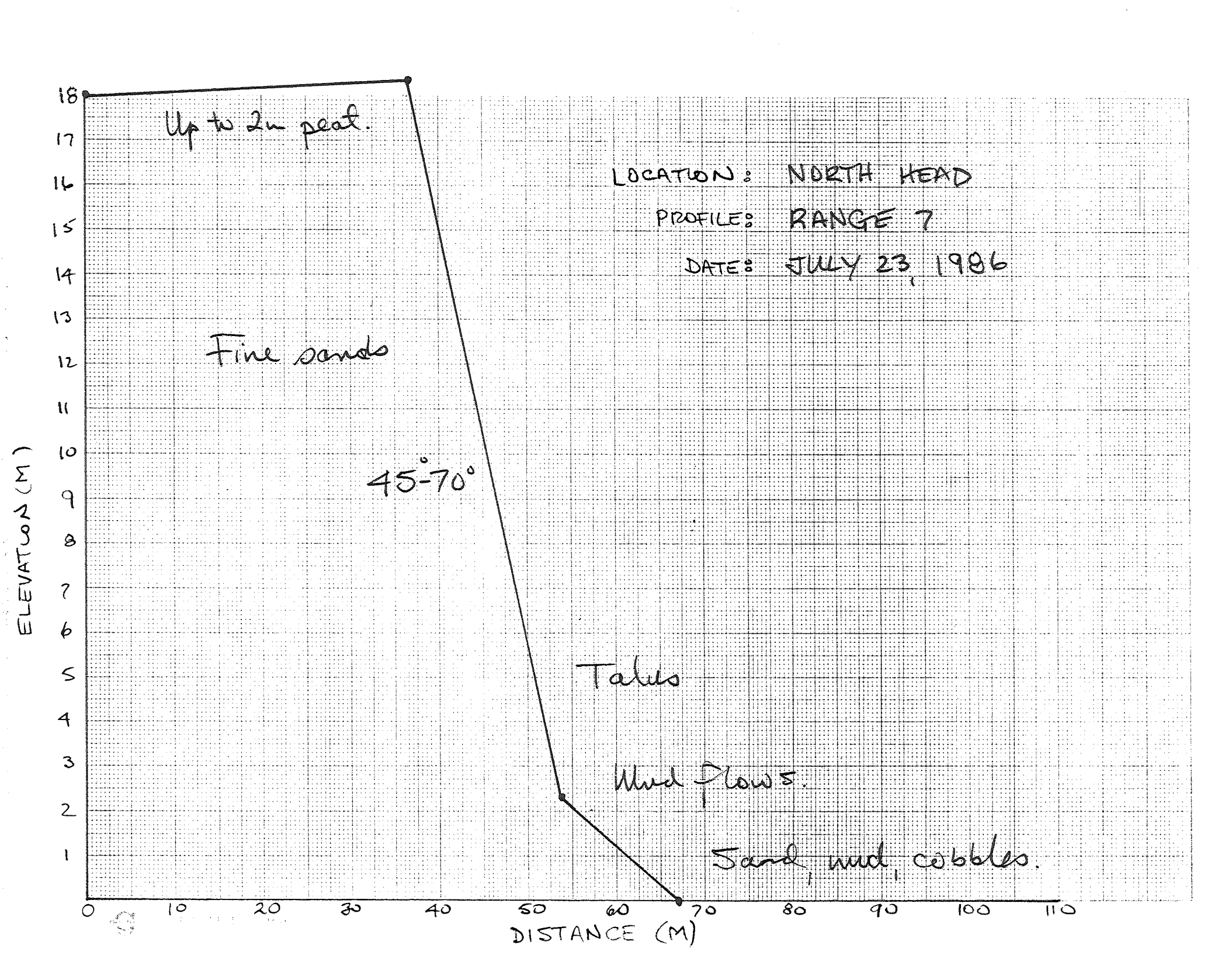

LOCATION: NORTH HEAD
PROFILE: RANGE 1
DATE: JULY 22, 1986
ELEVATION (M)
DISTANCE (M)
Ice wedge polygons
Silt / Minor gravel
Silt / Minor sand and gravel
Vegetated surface
Active marine erosion
Sand / Minor Gravel
Active beach


LOCATION: NORTH HEAD
PROFILE: RANGE 2
DATE: JULY 22, 1986
Vegetated
Silty sand
45°
Massive ice
Mud Flows
Cobble lag
ELEVATION (M)
DISTANCE (M)
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
10
20
30
40
50
60
70
80
90
100
110


LOCATION: NORTH HEAD
PROFILE: RANGE 3
DATE: JULY 22, 1986
Silty sand, minor gravel
Ice rich
Mud flows
Gravel to boulder size
ELEVATION (M)
DISTANCE (M)
0
10
20
30
40
50
60
70
80
90
100
110
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18


LOCATION: NORTH HEAD
PROFILE: RANGE 5
DATE: JULY 22, 1986
Peat
Silt / Sand
Active headwall of RTF.
Snowbank
Cobble over mud sediments
ELEVATION (M)
DISTANCE (M)
0
10
20
30
40
50
60
70
80
90
100
110
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18


LOCATION: NORTH HEAD
PROFILE: RANGE 6
DATE: JULY 22, 1986
ELEVATION (M)
DISTANCE (M)
Former Lake bed.
Talus
Ice / Snow
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
10
20
30
40
50
60
70
80
90
100
110


LOCATION: NORTH HEAD
PROFILE: RANGE 7
DATE: JULY 23, 1986
Up to 2m peat.
Fine sands
45-70°
Talus
Mud flows.
Sand, mud, cobbles.
ELEVATION (M)
DISTANCE (M)
0
10
20
30
40
50
60
70
80
90
100
110
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

BENCH MARK DESCRIPTIONS

For new bench marks installed in 1986
and for King Point Spit (installed 1985).

Toker Point

B.M.	DESCRIPTION
1	- Installed on July 15, 1986. - Located on northeast barrier spit of Tininerk Bay on more northerly of two sand dunes about 200 m apart. - BM is 2" x 2" wood stake painted orange. - Survey line bearing is 263 MN.
2	- Installed on July 15, 1986. - Located immediately north of Tininerk Bay. - BM is set about 40 m back of low (1 m) tundra cliff. - BM is 2" x 2" wood stake and steel R-bar. - Survey line bearing is 275 MN.
3	- Installed July 15, 1986. - Located approximately 1,500 m south of navigation beacon on top of sand dune. - BM is 2" x 2" wood stake (?). - Survey line bearing is 298 MN.
4	- Installed July 16, 1986. - Located on spit to SE of Toker Point appoximately 1,000 m from proximal end and 500 m from distal end. - BM is 2" x 2" wood stake on low (0.3 m) vegetated sand dunes. - Survey line bearing is 7 MN.
5	- Installed July 16, 1986. - Located on spit SE of Toker Point approximately 500 m from proximal end. - BM is 2" x 2" wood stake. - Survey line bearing approximately 0 to 5 MN.
6	- Installed July 16, 1986. - Located to east of Toker Point, approximately 500 m west of tundra cliff/spit junction. - BM is 2" x 2" painted wood stake on top of 1 m high hummock 75 m back of cliff top. - Survey line bearing is 0 MN.
7	- Installed July 16, 1986. - Located 150 m north of lake to the east of Toker Point. - BM is 2" x 2" wood stake with steel R-bar. - Survey line bearing is 17 MN.

8
- Installed July 16, 1986.
- Located approximately 1,000 m to east of inlet.
- BM is 2" x 2" stake and steel R-bar.
- Survey line bearing is 15 MN.

9
- Installed July 16, 1986.
- Located 100 m to east of inlet at Toker Point.
- BM is 2" x 2" wood stake, 70 m back of inundated tundra.
- Survey line bearing is 334 MN.

10
- Installed July 17, 1986.
- Located approximately 1,000 m to the southwest of Toker Point inlet entrace and 1,000 m to northeast of navigation tower.
- BM on top of 5 m high sand dune approximately 200 m back of waterline.
- BM is 2" x 2" wood stake.
- Survey line bearing is 312 MN.

11
- Installed July 17, 1986.
- Located approximately 200 m north of navigation tower. BM set 60 m back from cliff on top of small tundra hummock.
- BM is 2" x 2" wood stake and steel R-bar with aluminum cap.
- Survey line bearing is 320 MN.

Ellice Island

- The cliff erosion and beach profile survey lines were located north of a small stream on the west side of Ellice Island.
- Bench marks BM I 000, 100, 200, 300, 400 and BM II 500 were installed on July 13, 1986 when a cliff erosion survey was conducted.
- On July 23, 1986 the site was re-visited and additional benchmarks were installed at 1250 and -500. These two bench marks and the bench marks at 000 and 500 were then used to conduct a beach profile survey.
- In addition to the baseline benchmarks described above, an additional set of wood stakes was placed approximately 30 m seaward of each baseline bench mark to indicate the survey line bearing.
- The baseline extends on a line bearing 340 mN. Each survey line is perpendicular to the baseline running seaward at a bearing of 70 mN. The baseline is located approximately from 70 to 100 m back of the low cliff shoreline.
- The bench mark descriptions are as follows:

B. M.		DESCRIPTION	SURVEY LINE BEARING (mN)
BM I	000	Steel R-bar, aluminum GSC cap	70
	100	Wood stake	70
	200	Wood stake	70
	300	Steel R-bar	70
	400	Steel R-bar	70
BM II	500	Steel R-bar	70
	1250		70
	-500	Steel R-bar, 2" x 2" wood stake	70

Tent Island

- Cliff erosion survey lines were located at the northwest corner of Tent Island.
- Bench marks BM I 000, 100, 200, 300, 400 and BM II 500 are located on a baseline bearing 52 mN from BM I which is located at the northwest end of the baseline approximately 132 m from a navigation tower beacon. The distance of 100 m between each beach mark was determined by tape measure.
- Additional bench marks 750, 1000, 1250 and 1500 are located on a southeast extension of the BM I to BM II baseline at a bearing of between 95 to 60 mN. The approximate distance of 250 m between each bench mark was paced off on foot.
- Bench mark descriptions are as follows:

B. M.		DESCRIPTION	SURVEY LINE BEARING (mN)
BM I	000	Steel R-bar, aluminum GSC cap	322
	100	2" x 4" wood stake	322
	200	Wood post, 5 cm diameter	322
	300	Wood post, 5 cm diameter	322
	400	Wood post, 5 cm diameter	322
BM II	500	Steel R-bar, aluminum GSC cap	322
	750	Steel R-bar	5
	1000	Steel R-bar	5
	1250	Steel R-bar	355
	1500	Steel R-bar	330

King Point

Beach Profile Bench Marks

- Beach profile bench marks were installed in August, 1985 (see Gillie, 1985) and found to be in good condition and easily identified on July 14, 1986.

- Beach profile lines re-surveyed in 1986 include -200, 000, 200, 600 and 1400 extending from the southeast to the northwest along the beach.

- All beach profile bench marks are 5 x 5 cm wood stakes extending approximately 0.60 to 0.90 m above the ground, with the exception of B.M. 000 which is a steel pin driven into a short post buried in the ground.

- Survey line bearings are as follows:

B.M.	SURVEY LINE BEARING (MN)
-200	342
000	20
200	20
600	20
1400	20

King Point

Cliff Survey Bench Marks

- Cliff erosion survey bench marks were established to the northwest of the beach.

- B.M. descriptions are as follows:

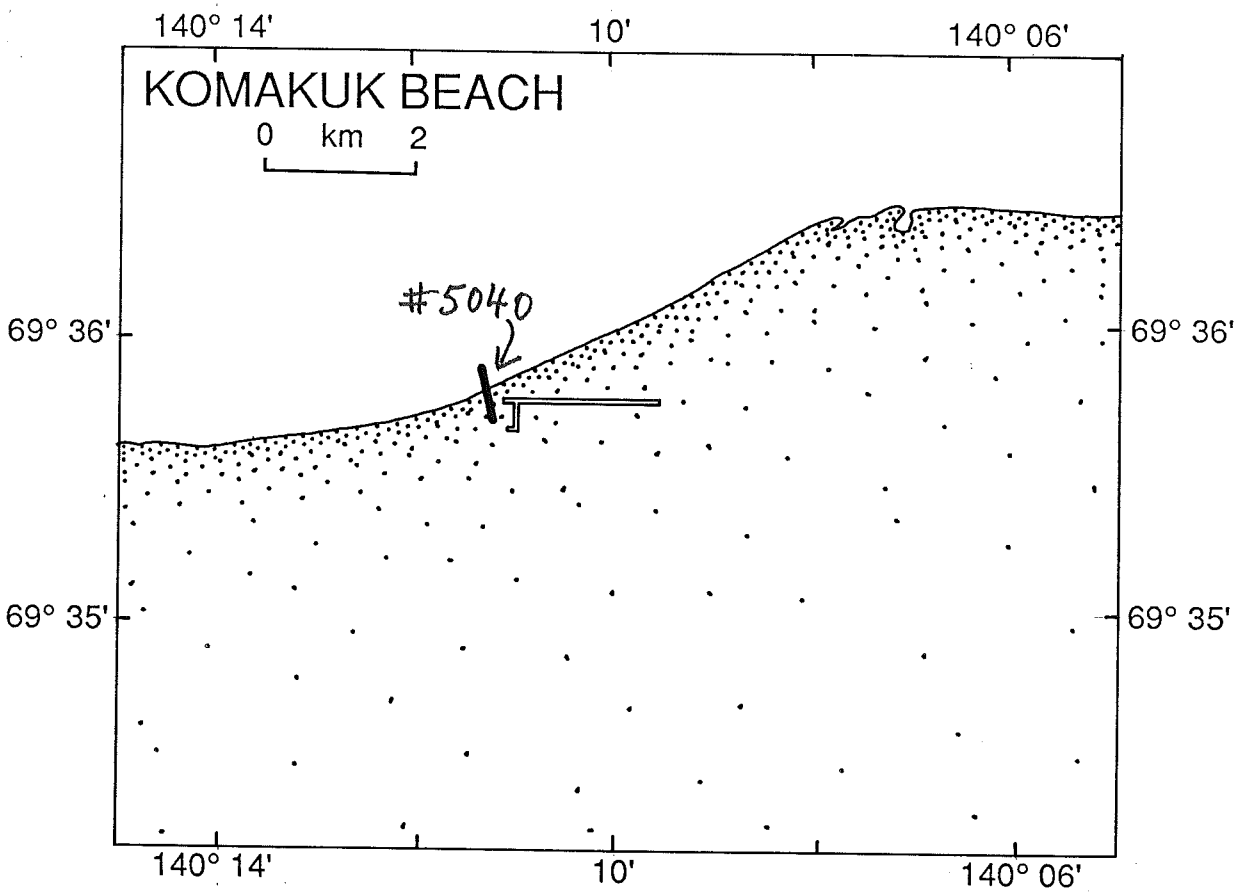
B.M.	DESCRIPTION	SURVEY LINE BEARING (MN)
1	Located approximately 100 m SW of log cabin ruins. Steel R-bar with aluminum GSC cap and 5 x 5 cm stake.	0
2	Located approximately 200 m to the west of B.M.1. Steel R-bar and 5 x 5 m stake.	0
3	Located approximately 200 m to the west of B.M.2. Steel R-bar and 5 x 5 cm stake.	0
4	Located to west of B.M.3. Steel R-bar and 5 x 5 cm stake.	352
5	Located to west of B.M.4. Steel R-bar and 5 x 5 cm stake.	357

Other Locations

B. M.	DESCRIPTION
Cape Dalhousie	- The previously installed benchmark could not be found near the navigation tower as the directions indicated. - A new benchmark consisting of a 2 x 2 inch wood stake ,labelled GSC BM #1 (1986), was installed 5 m to seaward of the tower. - A steel R-bar with a GSC aluminum cap was also driven in. - The height of the 2 x 2 stake was 0.36 m and the height of the R-bar was 0.07 m above the local ground surface. - The survey line bears 158 mN.
Atkinson Point	- Line 1 (also known as zone1/line2, and 5191 ?) is the most southwest profile surveyed. - It consisted of a line of 1/2 to 3/4 inch diameter steel pipes across the barrier spit approximately 500 m south of the navigation beacon. - Based upon D. Forbes notes of 1984, rods #9 to #3 still appear to be present. - A 2 x 2 wood stake was driven in at rod #9(?) to represent the reference benchmark for the horizontal distance of 0.0 m. - Lines 2 and 3 are located approximately 1 km to the northeast of the navigation tower. - These lines are also referred to as 5193, and zone3/line1 and zone3/line2, respectively. - The two survey lines are about 500 m apart. - The more southerly of the two profiles is a line of four 1/2 inch diameter steel pipes. - A 2 x 2 inch wood stake was installed beside the most landward pipe to indicate the horizontal distance of 0.0 m. - The more northerly of the two profiles comprises a line of three bent 1/2 inch steel pipes on the landward side of the barrier spit. - The most landward pipe is located in the lagoon at a water depth of 0.2 - 0.3 m. - The middle of the three pipes was used as the distance reference of 0.0 m.

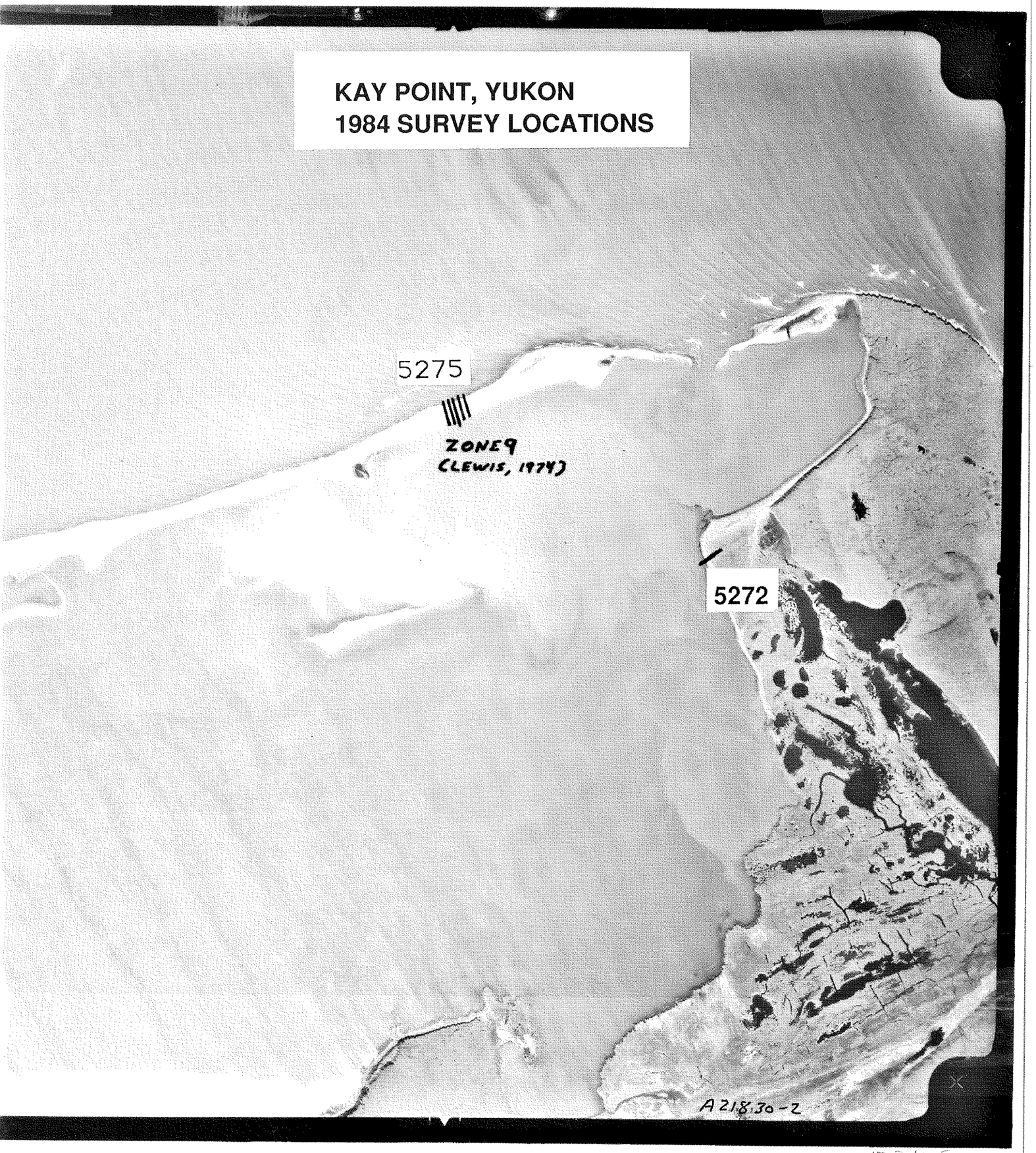
B. M.	DESCRIPTION
Kay Point Spit	- The five profile lines in Zone 9 were taken to be near the distal end or terminus of Kay Point Spit. - The five profile lines in Zone 25 were further north, toward the proximal end of the spit. - The profile line tentatively identified as Zone 37 was taken to be a wood tetrapod with a line of 2 steel pipes and 6 wood dowels bearing 218 mN. - The line extends over a new recurve at its proximal end.
Stokes Point	- The survey line was located approximately at the centre of the airstrip and seaward of a large garage or hanger. - The benchmark was identified as a steel pipe. - A 2 x 2 inch wood stake was placed beside the pipe to aid location in the event of burial of the pipe by overwash deposits. - The profile line was surveyed at a bearing of 40 mN.
Komakuk Beach	- No evidence of the previous benchmark was found at either end of the air strip. - A decision was made to establish a new benchmark approximately 100 m west of a road leading to the west end of the air strip. - The benchmark was set approximately 60 landward of the cliff edge. - The benchmark was a steel R-bar and 2 x 2 inch wood stake, at heights of 0.62 m and 0.87 m, respectively. - The survey line bears from the benchmark at 295 mN toward the cliff edge.

SURVEY PROFILE LOCATIONS ON AIR PHOTOGRAPHS

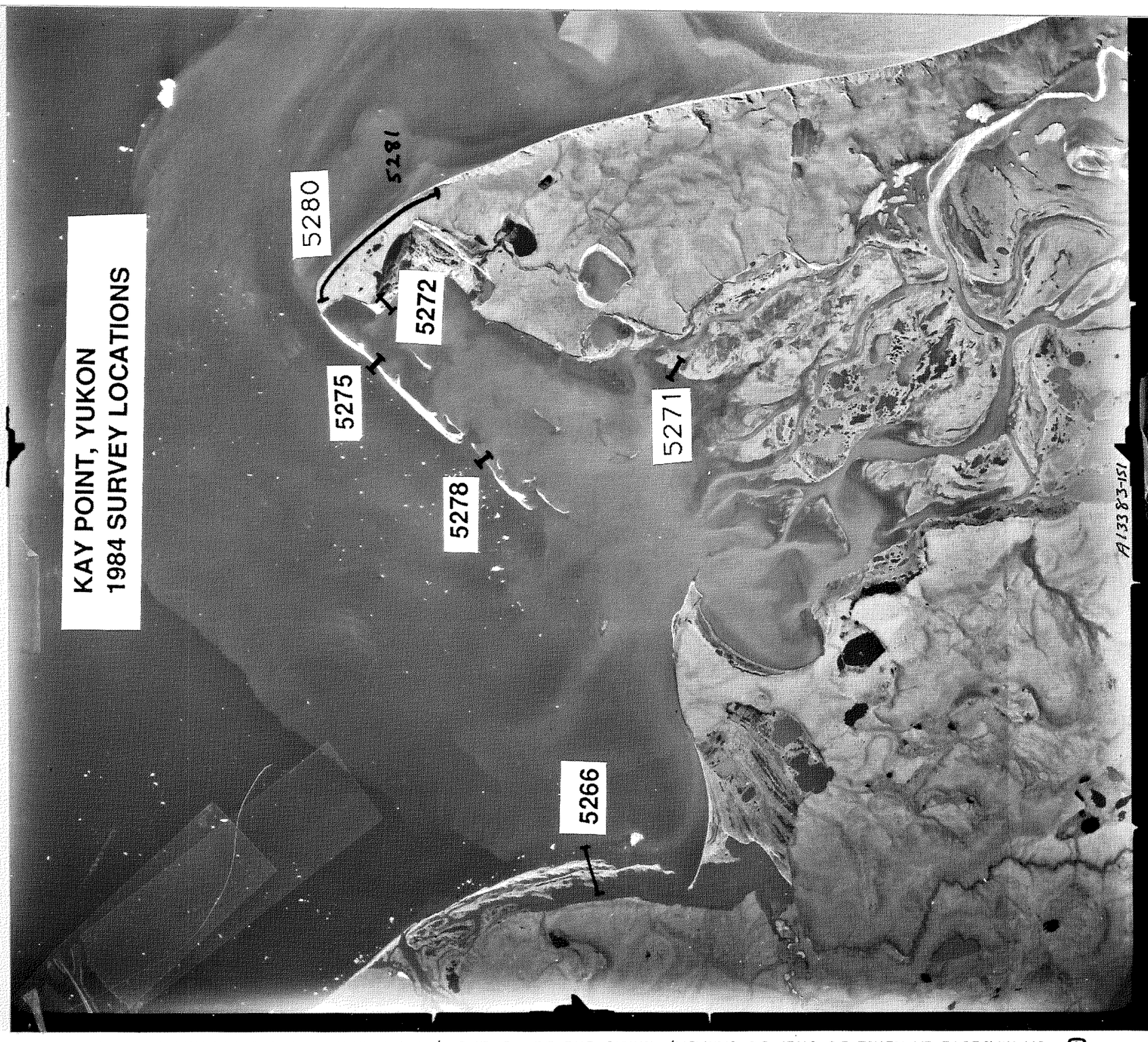

140° 14'
10'
140° 06'
KOMAKUK BEACH
0 km 2
#5040
69° 36'
69° 35'
140° 14'
10'
140° 06'


A21826-223
5278
ZONE 25
(LEWIS, 1974)

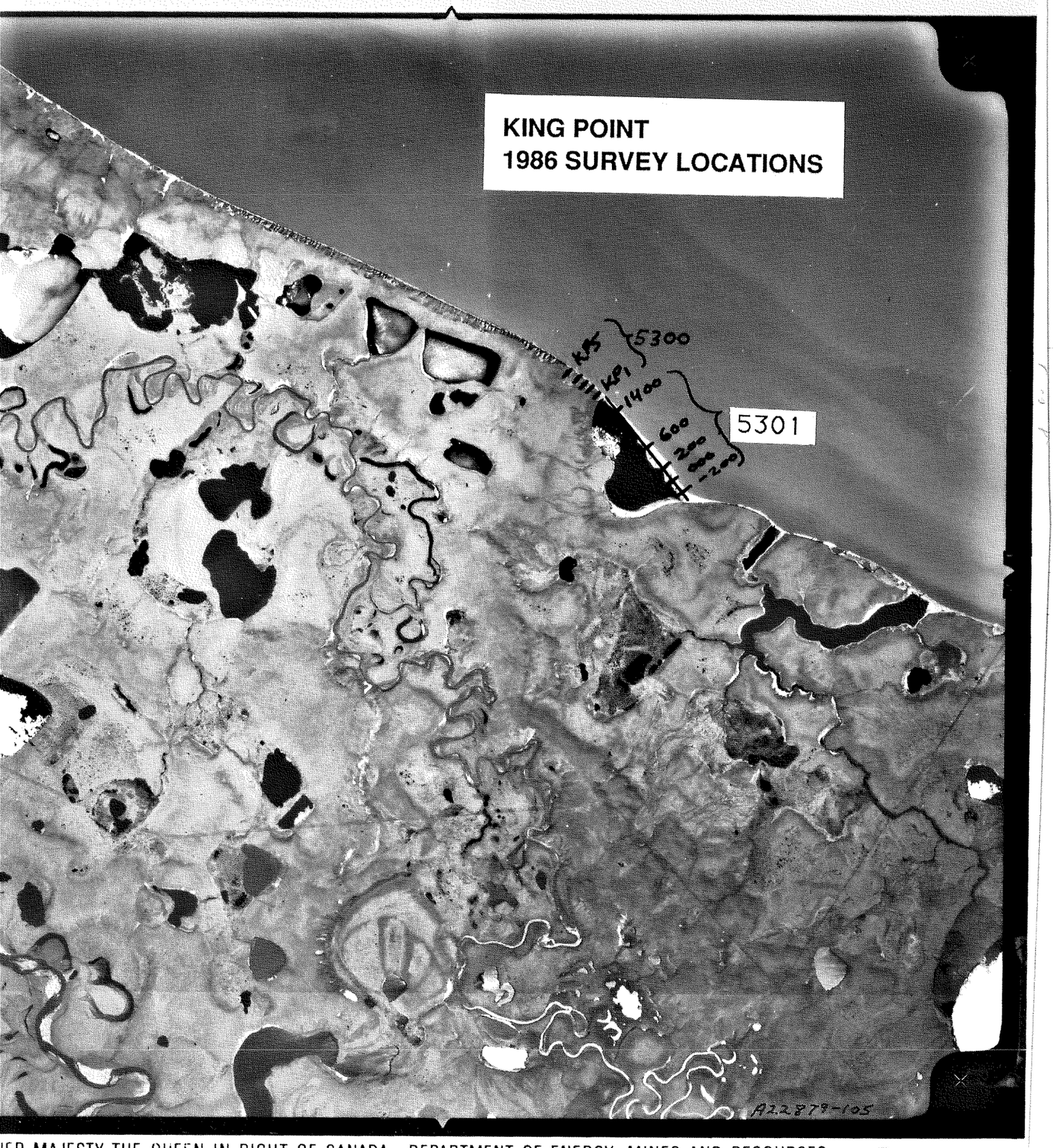
KAY POINT, YUKON
1984 SURVEY LOCATIONS



112 D/6 E



© SA MAJESTE LA REINE DU CHEF DU CANADA, MINISTERE DE L'ENERGIE, DES MINES ET DES RESSOURCES. T



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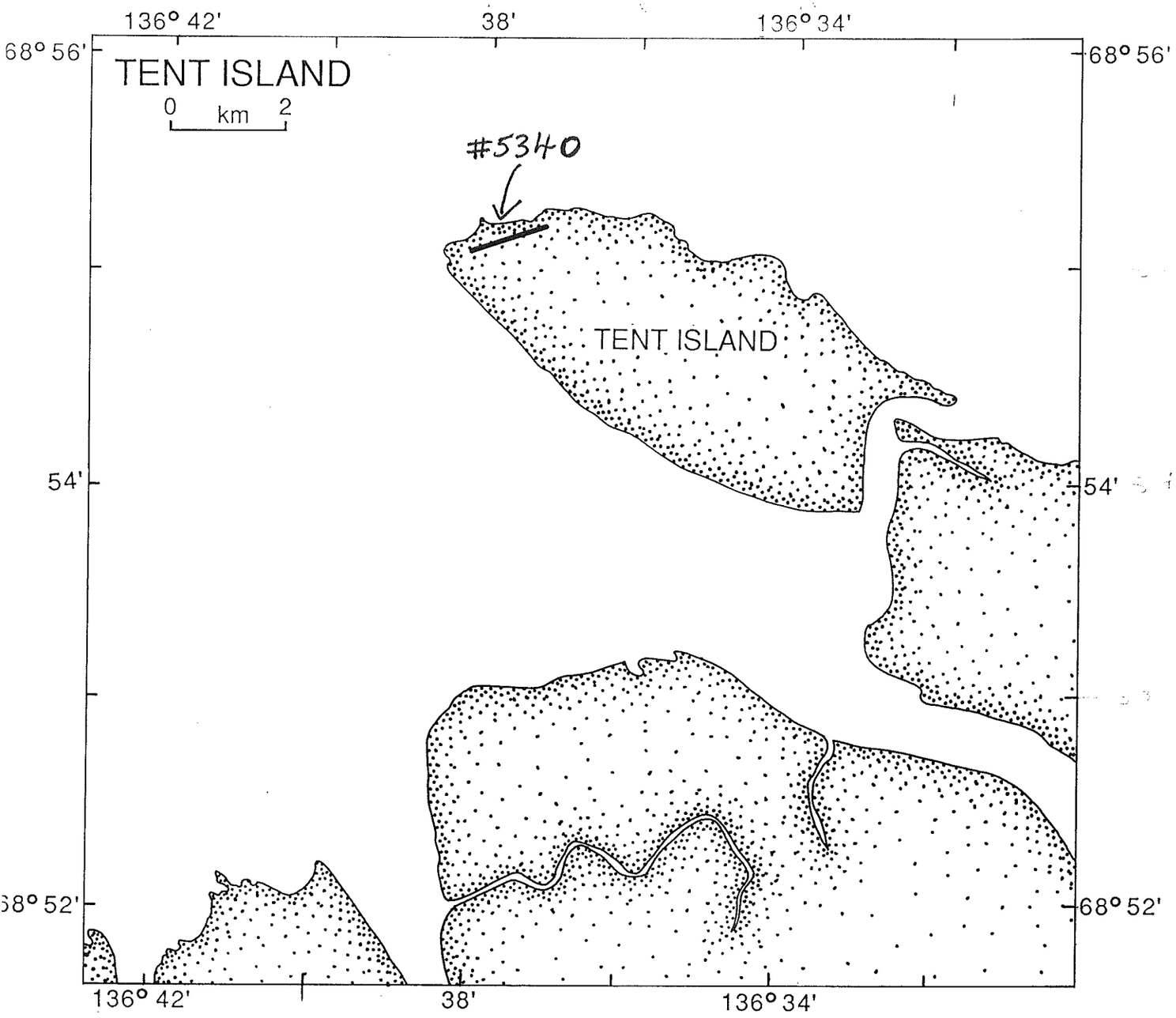
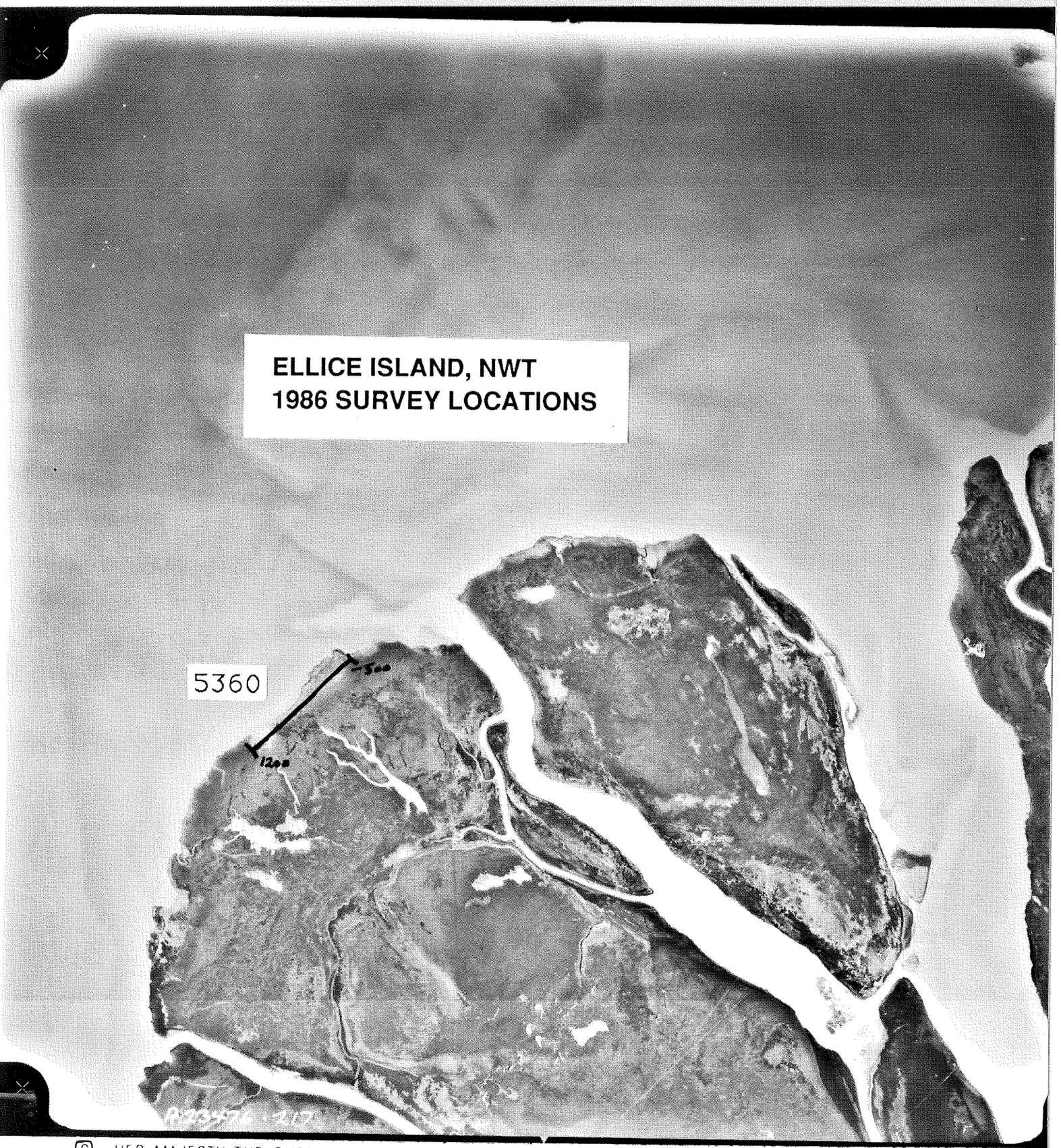
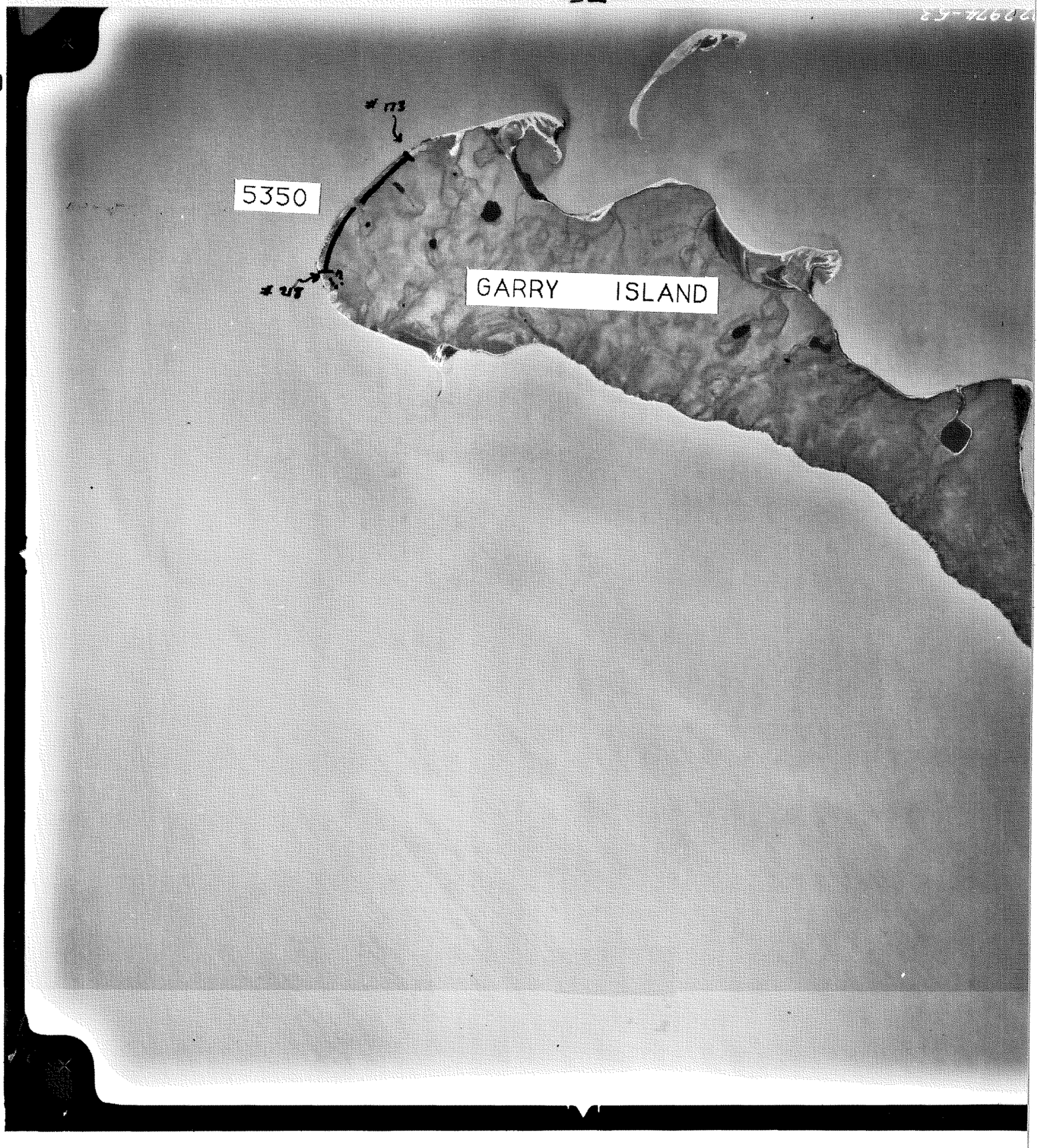
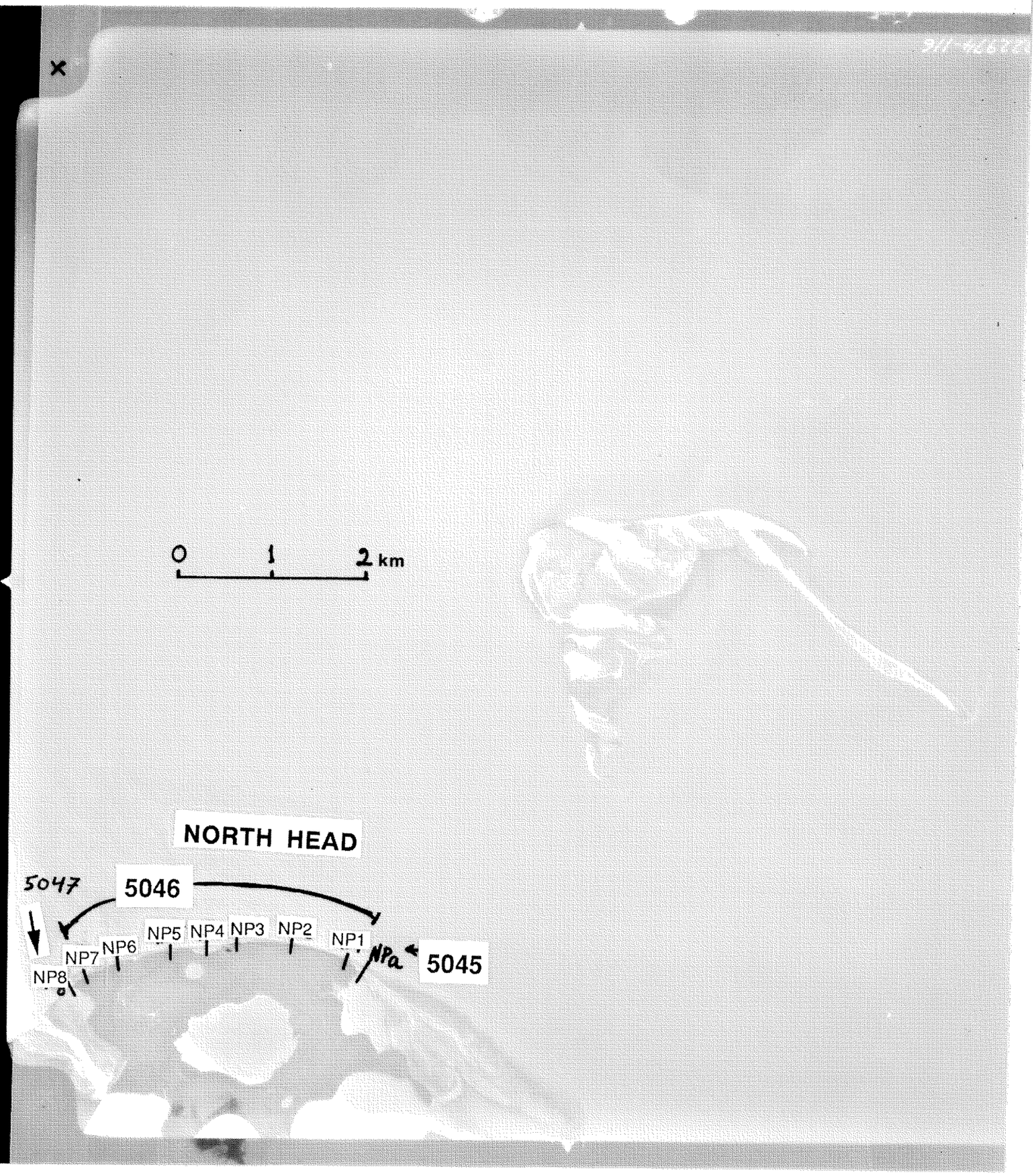
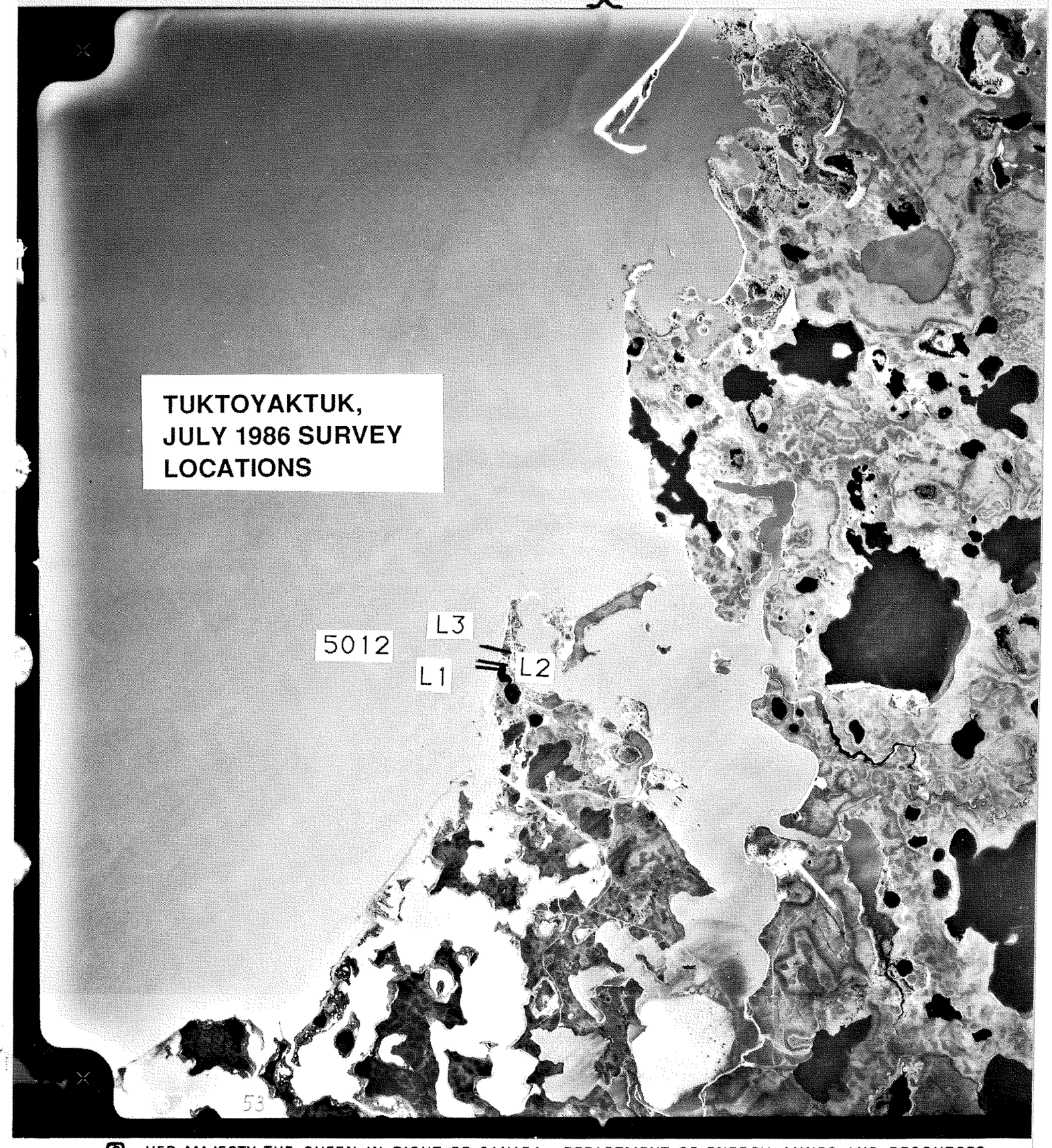

136° 42'
38'
136° 34'
68° 56'
68° 56'
TENT ISLAND
0 km 2
#5340
TENT ISLAND
54'
54'
68° 52'
68° 52'
136° 42'
38'
136° 34'



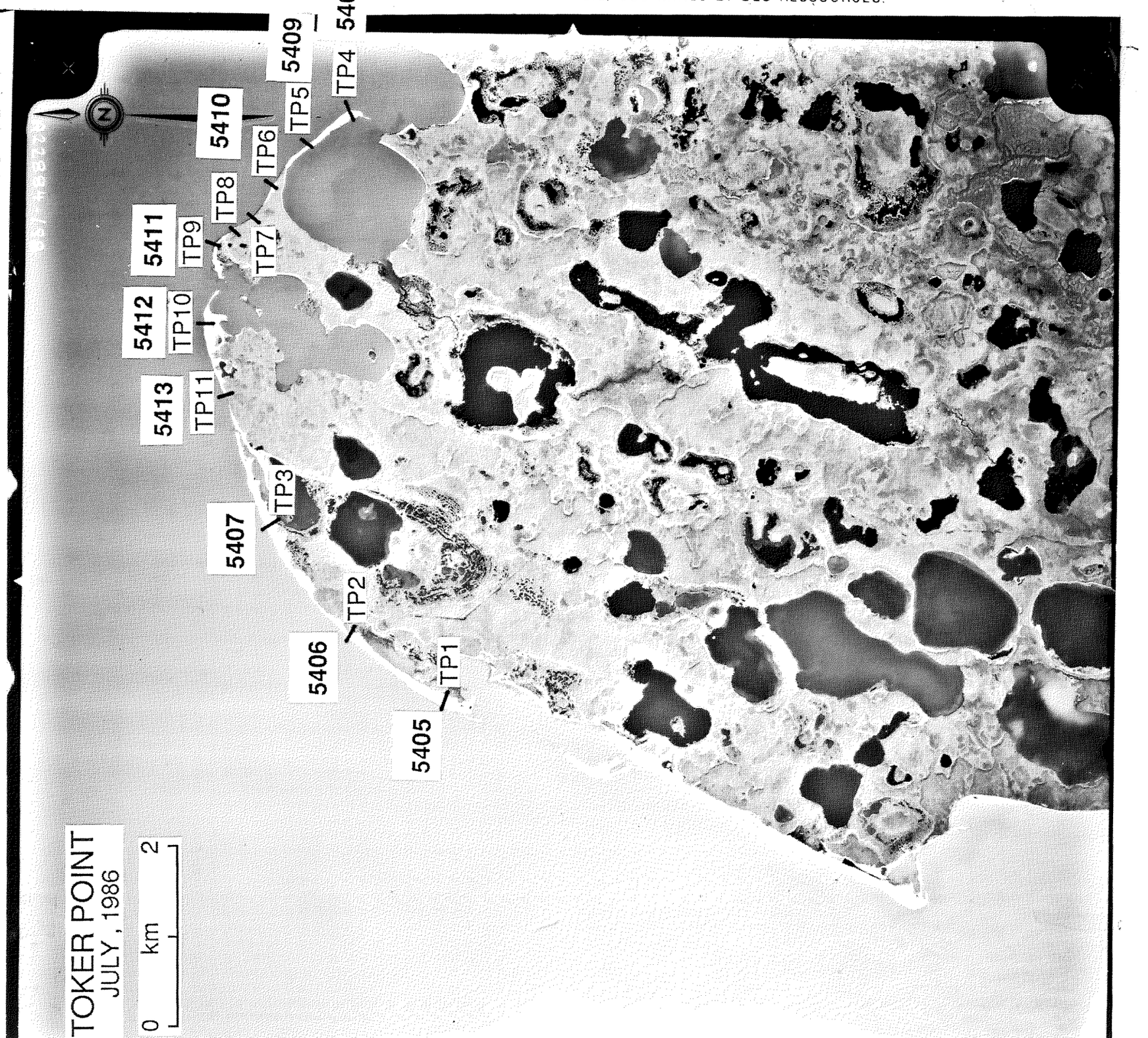


HOOPER ISLAND, NWT
1986 SURVEY LOCATIONS





SA MAJESTE LA REINE DU CHEF DU A, MINISTERE DE L'ENERGIE, DES MINES ET DES RESSOURCES.




ATKINSON POINT
JULY 19, 1986
0 km 2
N
5193
2
1
5191
1

Cape Dalhousie