RECENT ICEBERG GROUNDINGS AND SCOURS ON THE GRAND BANKS OF NEWFOUNDLAND

SUBMITTED TO:

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EXECUTIVE SUMMARY

Iceberg keel-dragging along the seabed of the Grand Banks of Newfoundland has implications for burial depths of pipelines and wellheads. Obviously, burial depth should exceed the expected depth of scours and prior knowledge of the rate of scouring is essential for determining the probability that icebergs will scour in the area of concern.

This study was conducted to determine the recent rate of scouring on the Grand Banks. Analysis of the iceberg drift track data sets collected by Mobil Oil, Petro-Canada and Husky Oil East Coast Project from 1983 to 1989 indicates that a total of 27 large icebergs experienced 44 definite groundings in water depths from 72 to 150m. The derived scour rate for definite groundings is 0.020 scours/100 square kilometers-year. Multiple groundings account for 27 of the 44 groundings (61%), and these occurred in progressively shallower water. Twenty-one of the 44 groundings occurred in water depths of 100m and greater. Definite groundings were defined to occur when 24 hours of stationarity was observed in water depths less than 200m. The scour rate derived from this analysis should be considered as a minimum because possible groundings were noted for other icebergs in the iceberg drift track data sets. Possible groundings were identified from the same data sets in a related study in which 21 possible groundings were identified for 20 icebergs. Based on the 44 definite groundings and the 21 possible groundings, a more realistic rate of scouring can be calculated to be 0.030 scours/100 square kilometers-year for the 1983 to 1989 period.

This information is relevant for the Hibernia area and should be of interest to companies planning to install pipelines and wellheads. The depths and widths of recent scours left on the seabed by the identified icebergs can now be measured through sonar surveys because the location of each scour scour track or grounded position has been identified.

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ACKNOWLEDGEMENTS

This project was funded by the UNSOLICITED PROPOSAL FUND and the Atlantic Geosciences Centre. Husky Oil East Coast Operations kindly provided iceberg data, and the Canada Newfoundland Offshore Petroleum Board provided access to additional iceberg data collected by Mobil Oil and Petro-Canada. These data sets form the basis of this report. Dr. M. Lewis and Mr. G. Sonnichen at AGC provided important discussions and suggestions, and directions regarding the use of in-house facilities. Mr. G. Fader provided side-scan sonar records of one surveyed scour and Dr. S.D. Smith provided data on one grounding. Information on ocean currents was provided by Dr. B. Petrie. Mr. L.R. Prather, T. Murphy and F. Leafloor of Husky Oil kindly supported the project. The author wishes to say THANK YOU FOR ALL YOUR SUPPORT.

SUMMARY

Atlantic Geosciences Centre (AGC) is presently engaged in studies of the regional distribution of iceberg scours, and the frequency and extent of sediment deformation by iceberg scouring on the eastern Canadian continental margin, including the northern Grand Banks of Newfoundland. This study complements the AGC study by providing information leading to case histories of iceberg groundings under known conditions for later comparison with and interpretation of the general population of iceberg scours on the seabed. Such examples of groundings in which (1) the iceberg, (2) the environmental conditions and (3) the seabed disruption are all known are extremely rare (possibly only 1 or 2 other cases are known for the Grand Banks). Yet such case histories form the basis for interpreting or calibrating the vast majority of scour marks observable on the seabed of the Bank at present. This study has identified (1) and (2) for 44 recent grounding events by 27 icebergs; the seabed disruptions (3 above) require mapping in future survey as was done successfully by Husky Oil under the authors direction for one inferred 1988 iceberg grounding. Another more recent scouring event, identified in this study, was mapped by AGC in May, 1989. In addition to providing a knowledge of scour case histories, this study reveals the environmental circumstances and the proportion (hence probability) of iceberg groundings on the Grand Banks. Such probabilities are helpful parameters for constraining estimates of the frequency of iceberg scouring on the Grand Banks as a function of the flux of icebergs during the iceberg season which commences in February or March and ends in June.

1. INTRODUCTION

The Atlantic Geosciences Centre (AGC) has identified seabed scouring as a topic for research. Surveys on the Grand Banks have disclosed an inferred record of former iceberg scouring events on the seabed in the form of furrows and pits (iceberg scours). It was considered essential to augment this record by documenting new scours related to observed iceberg groundings. In addition, it was considered important to gather as much information as possible concerning the icebergs themselves and their drift tracks prior to and after grounding as well as information on wind conditions and current conditions associated with incursions of icebergs onto the Grand Banks. The ability to document actual cases of groundings has been limited in the past by a severe lack of an extensive data base of relevant iceberg drift tracks. Fortunately, unique iceberg drift data sets have become available, thanks to efforts by oil companies drilling for oil on the Grand Banks in the period 1983 to 1989. Mobil Oil collected and documented iceberg drift tracks in 1983 and 1984 and Petro-Canada tracked and documented icebergs in 1984 and 1985. Husky Oil East Coast Operations collected and thoroughly documented iceberg drift tracks during the period 1983 to 1989. The Husky data set consists of 454 drift tracks, data summaries and wind data. In addition, the data sets provide information on the advance and retreat of packice as documented by ice reconnaissance flights. In 1988, the occurrence of an iceberg grounding documented by Husky Oil came to the attention of AGC, and AGC subsequently participated in a scour survey conducted by Husky Oil. The new inferred scour on the seabed was readily

documented by side-scan sonar and it was considered prudent by AGC to attempt to identify more new scours by searching through existing iceberg drift data sets. It was known at the time, that other icebergs in the data sets had experienced extensive periods of zero drift. Consequently, AGC contracted the author to conduct a search through the available iceberg drift data sets with a view to identifying as many grounding/scouring events as possible. There was also a requirement to document wind conditions associated with scouring events and to infer the probability of occurrence of grounding as a function of iceberg population. Information on currents close to icebergs were generally not available as measurements were usually only made at well sites and drilling locations. This report documents the iceberg groundings inferred from stationarity of large icebergs on the Grand Banks extracted from the iceberg drift track data sets. A similar approach was taken by El Tahan et al (1985) in documenting grounded icebergs in the vicinity of drill rigs off Labrador. In this study, criteria are established for assessing free drift, keel dragging and grounding. Data search procedures are presented along with the results of the search. A total of 27 icebergs are inferred to have grounded a total of 44 times, partly through multiple groundings in progressively shallower water depths. Information on iceberg population is used to reach conclusions regarding the percentage of icebergs which transgress onto the Grand Banks and the rate of scouring. The case histories of new scours presented in this report can be used for later comparison with and interpretation of the annual generation

of scours on the seabed of the Grand Banks.

2. THE DATA BASE

Part of the data base used in this study was collected by Husky Oil East Coast Operations during 1984 to 1988 inclusively. Husky Oil collected the data set while drilling on the Grand Banks and kindly agreed to make the data available to AGC as part of a co-operative scour survey project conducted in July, 1988. Husky Oil also collected iceberg data in 1989 on behalf of Texaco Canada Ltd. The data are described in sections 2.2 to 2.8. In addition to the Husky Oil data, iceberg drift data collected by Petro-Canada and Mobil Oil in 1983, 1984 and 1985 is included. These data are described in section 2.9 and 2.10.

2.1 Husky Oil operations area and periods of operation.

Drilling operations were conducted by Husky Oil on the Grand Banks of Newfoundland (Fig. 2.1). Attempts were made to drill on a year-round basis but owing to the presence of packice and icebergs and requirements for refits, operations were interrupted during some of the packice seasons (March and April) and occasionally by icebergs. Drill site occupancy period for the first six months of each year are presented in Tables 2.1 and 2.2.

1984: Drilling proceeded uninterrupted from Feb. 25 to June 12 which indicates that surveillance for icebergs and packice was ongoing through the period.

1985: In 1985, there was a disruption in drilling operations due to packice from early February to April 20 with a few days of rig-on-site at the end of March. Despite the absence of rigs, it

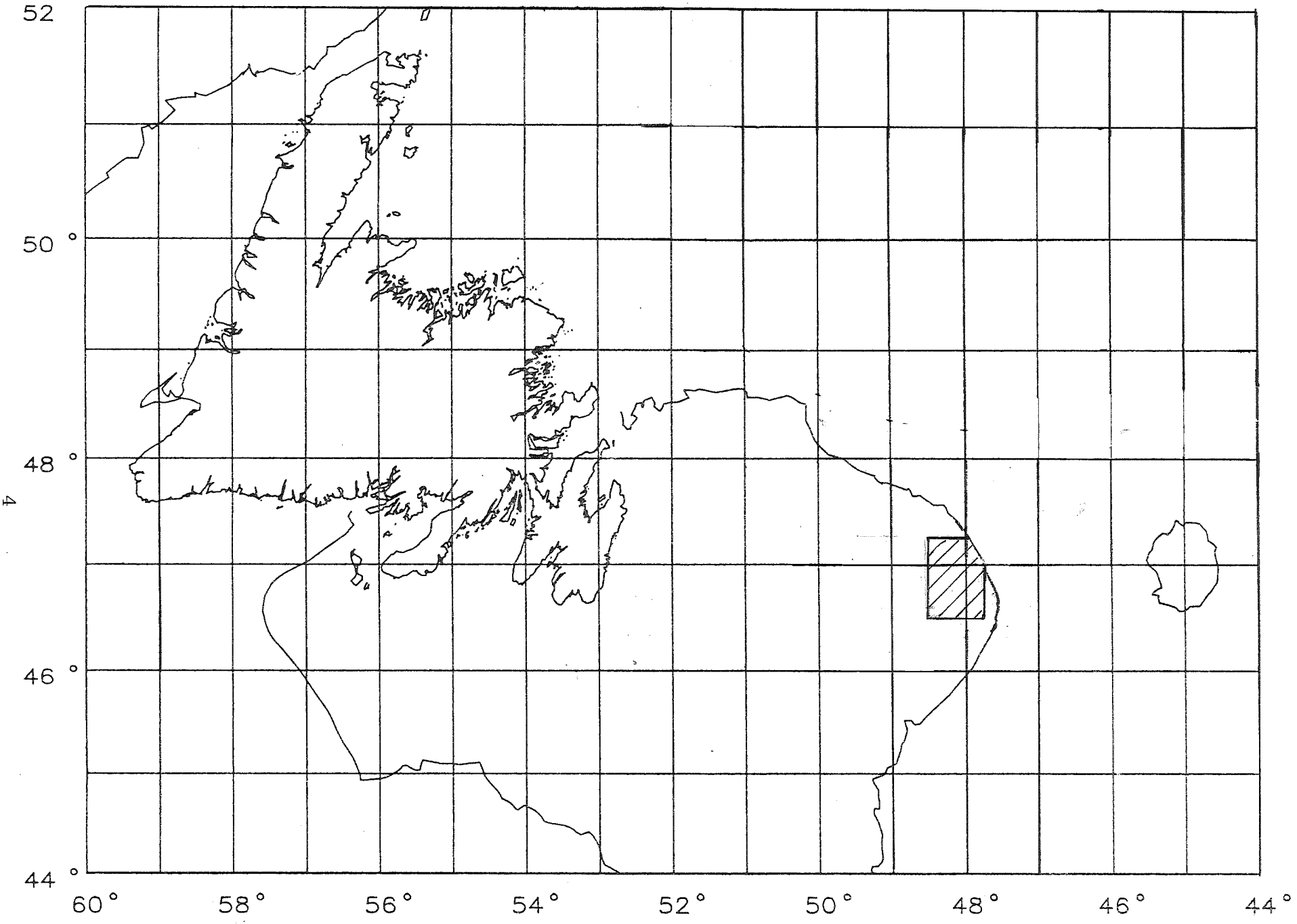


Figure 2.1 Husky Bow Valley Area of Drilling Activity Offshore Newfoundland, 1983 to 1987

TABLE 2.1 Husky Bow Valley East Coast Project wellsite listing (1984 to 1987)

Wellsite Name	Wellsite Co-ordinates	Rig Name	Observation Period(s) Covered	
			Start Time (GMT)	End Time (GMT)
Voyager J-18	46°27'32.50"N 48°17'00.49"W	Sedco 706	0300 Feb.25/84	0300 Jun.12/84
Archer K-19	46°38'43.17"N 48°02'18.42"W	Bow Drill 3	1200 Jun.25/84	0600 Dec.16/84
Whiterose N-22	46°51'47.99"N 48°03'56.51"W	Sedco 706	1500 Jun.26/84	1800 Jan.05/85
Conquest K-09	47°08'34.68"N 48°15'45.08"W	Bow Drill 2	1200 Nov.12/84 0300 Apr.21/85 1500 May 30/85	1500 Feb.02/85 0600 May 28/85 2100 Jul.26/85
North Ben Nevis P-93	46°42'48.10"N 48°28'34.24"W	Bow Drill 3	1800 Dec.16/84 1500 Mar.27/85 1200 Apr.21/85	1800 Feb.03/85 2100 Mar.31/85 1500 Nov.01/85
Panther P-52	47°01'53.37"N 47°37'43.83"W	Sedco 706	2100 Jan.05/85	1800 Jan.25/85
Whiterose J-49	46°48'31.30"N 48°06'27.51"W	Bow Drill 2	0300 Jul.27/85	0900 Dec.12/85
Panther P-52 re-entry	47°01'53.37"N 47°37'43.80"W	Bow Drill 3	0000 Nov.03/85	0000 Jan.31/86
Whiterose L-61	46°50'34.12"N 48°10'28.34"W	Bow Drill 2	1200 Dec.12/85 0300 Mar.04/86 1500 Mar.21/86	0300 Feb.17/86 1200 Mar.15/86 1800 Mar.31/86
North Ben Nevis M-61	46°40'53.57"N 48°25'18.60"W	Sedco 710	1500 Jan.09/86	2100 Mar.31/86
Fortune G-57	46°36'18.90"N 48°08'02.21"W	Bow Drill 3	2100 Feb.04/86 1800 Mar.01/86	0300 Feb.14/86 1500 Sep.09/86
Whiterose L-61 re-entry	46°50'34.12"N 48°10'28.34"W	Bow Drill 2	0000 Sep.10/86	1200 Oct.04/86
Golconda C-64	46°53'11.62"N 47°39'56.54"W	Bow Drill 3	0600 Oct.05/86	0600 Feb.02/87
Bonne Bay C-73	46°32'10.74"N 48°11'30.51"W	Bow Drill 3	0000 Feb.03/87 0000 Mar.16/87 1800 Jun.18/87	1500 Feb.27/87 1200 Apr.23/87 0000 Jul.18/87
North Ben Nevis M-61 re-entry	46°40'53.57"N 48°25'18.60"W	Bow Drill 3	0900 Jul.18/87	0300 Aug.18/87

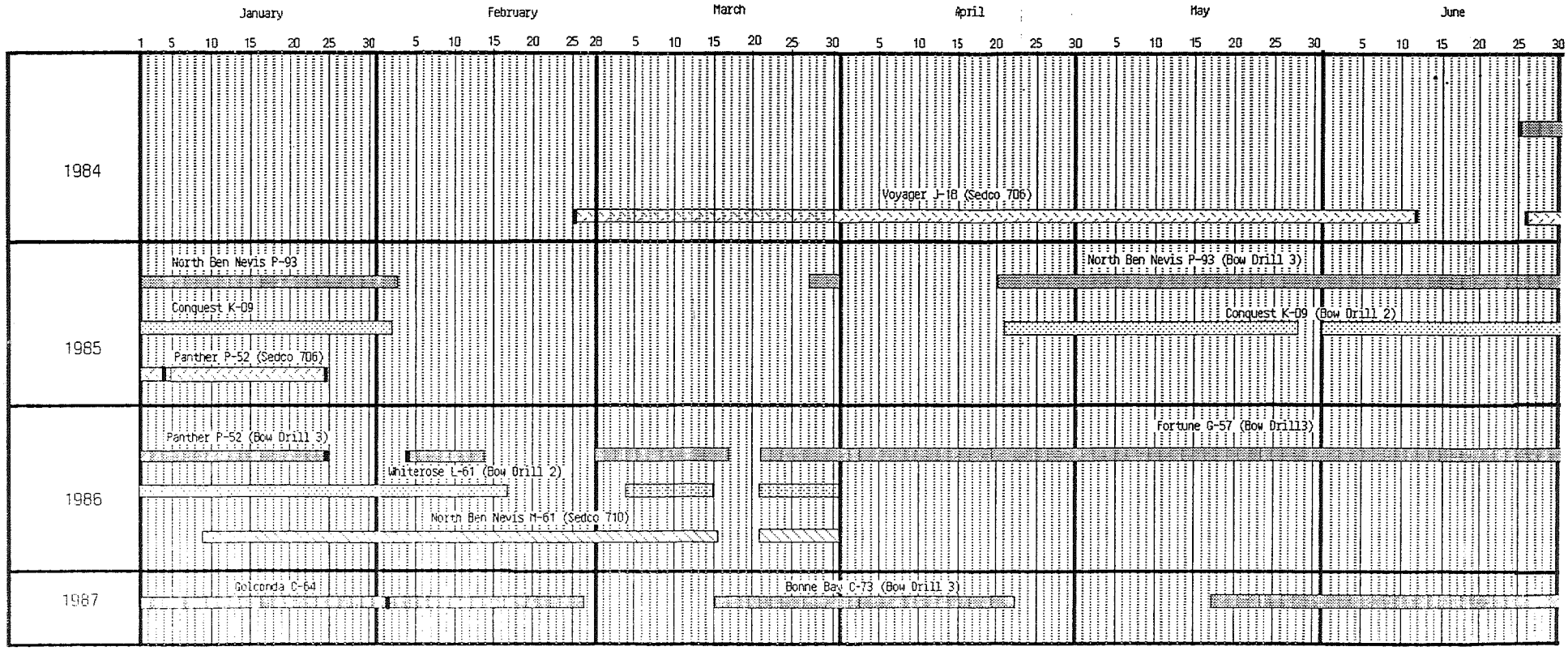


TABLE 2.2 Summary of Husky Bow Valley East Coast Project wellsite occupancy for January to July (1984 to 1987)

is obvious from the ice reconnaissance maps in Appendix B that a serious effort was made to monitor icebergs and five grounded icebergs were monitored by Husky Oil. One iceberg was monitored by the Bedford Institute of Oceanography, and one was monitored by Petro-Canada.

1986: During early 1986, drilling proceeded at three locations with few interruptions. During April and May, drilling proceeded uninterrupted and no icebergs were inferred to be grounded.

1987: In 1987, drilling operations were interrupted from April 22 to May 17. The main packice remained inshore and ice reconnaissance maps indicate very few icebergs were monitored and one was inferred to be grounded.

1988: Drilling was interrupted from February 23 to April 20, but vigilant monitoring of icebergs was undertaken, especially during April when four icebergs were inferred to be grounded.

1989: Drilling operations continued basically uninterrupted except for time lost when iceberg 001 grounded. A total of 2 icebergs were observed to be grounded in March.

Discussions with Mr. Tom Murphy of Husky Oil (personal comm., 1989) indicate that 4 levels of surveillance were used to ensure a high level of confidence that all bergs were detected and tracked in the north-west quadrant out to about 100 nm from the northern-most rig operating on the Grand Banks. The first level of surveillance was provided by Side-Looking Aperture Radar (SLAR) observations made by Atmospheric Environment Service (AES) ice flights. Husky had direct access to AES's computer and was able to plot AES-detected icebergs within 1 hour of data being logged on the AES computer. This information on the large-

scale distribution of icebergs was used as a guide in the deployment of radar-equipped aircraft from St. John's. SLAR-equipped aircraft were used during 1984 and 1985, and Litton search radars were used thereafter. The site-specific iceberg surveillance constituted the second level of surveillance and the flights flown in the period are listed in Table 6.1. Flights were made as often as every second day. Since the general drift of icebergs is from the north-west, most ice reconnaissance flights were concentrated in the north to west quadrant out to a distance of about 100 nautical miles. The third level of surveillance was provided by supply vessels conducting ice sweeps or standing by selected bergs or towing. The final level of surveillance was provided by radar surveillance from the drill rigs which allowed continuous coverage. All iceberg and packice data were collected and analyzed in Husky's ice data management office in St. John's and Husky had confidence that all icebergs in the north to west quadrant were detected. Radar surveillance and ice sweeps by supply vessels plus aerial ice reconnaissance also ensured a 100% confidence level that all icebergs within 30 nautical miles were being tracked.

2.2 Sample iceberg data

Iceberg data were collected by Husky Oil supply vessels and aircraft ice reconnaissance and by radar from the rigs. The data consists of:

* individual iceberg data listings (see sample data listing Table 2.3)

* individual drift track plots (see sample plot Fig. 2.2)

* collective drift track plots (see sample plot Fig. 2.3)

* summary of tracked icebergs (sample is presented in Table 2.4)

Individual iceberg data listings provide tracking information for each iceberg and includes for each observation the following information:

* Date of observation

* Time of observation (Local Time)

* Range of iceberg from wellsite (n.mi.)

* Bearing of iceberg from wellsite (°True)

* Latitude of iceberg position (deg. min)

* Longitude of iceberg position (deg. min)

* Radio call sign of data source, see listing of call signs (Table 2.5) for individual vessel names or sources.

* Rig T-time at time of iceberg position (hours) (This is the time required for a rig to pull up and be underway from a drilling situation)

* Drift speed of iceberg (knots)

* Course to which iceberg was drifting (°True)

* Elapsed time from start of observation for this iceberg in hours (E.T.)

* Elapsed distance or length of iceberg's trajectory in n.mi. (E.D.)

* Maximum Detection Range (MDR); i.e., the maximum range (in n. mi.) at which the iceberg was detected and its position recorded.

* Number of observations of iceberg position recorded.

* Whether the iceberg was being towed at the time of observation, indicated [T] if towed by synthetic line; [P] if propwashed; [N] if being towed with a net; [c] if deflected by water cannon or [O] if another method was used. Note that these indicators do not necessarily mark the exact start and end

BERG 013 (Page 1)

Whiterose E-09 (Bow Drill 3)
(46 48.44′ N 48 1.38′ W)

Note: Iceberg dimensions are in meters and the mass is given in tonnes

Iceberg Dimensions: Size = B Shape = BBB
Length = M16 Width = M08 Height = M03
Draft = C19 Mass = 1152

M = measured, C = calculated
BBB = bergy bit

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (Kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
16/04/88	1433	86.7	290.0	47 18.1	50 1.0	GPCD	19							
18/04/88	0056	85.0	293.9	47 22.8	49 55.5	VCBQ	19	0.18	039	34.4	6.0			
20/04/88	0955	86.5	289.5	47 17.3	50 1.0	VCBQ	19	0.12	215	91.4	12.7			
20/04/88	1900	87.8	289.9	47 18.3	50 2.6	VXJK	19	0.16	313	100.5	14.2			
25/04/88	1255	81.9	290.9	47 17.7	49 53.7	GPCD	19	0.05	096	214.4	20.3			
27/04/88	0300	77.5	291.9	47 17.3	49 47.0	VXJK	19	0.12	095	252.5	24.9			
27/04/88	1245	76.6	291.5	47 16.5	49 46.0	VCYS	19	0.11	140	262.2	25.9			
28/04/88	1346	71.7	289.4	47 12.3	49 40.6	GSLA	22	0.22	139	287.2	31.5			
28/04/88	2000	72.9	289.8	47 13.1	49 42.0	VXJK	22	0.20	310	293.5	32.7			
28/04/88	2046	72.8	289.8	47 13.1	49 41.9	VXJK	22	0.09	090	294.2	32.8			
28/04/88	2200	72.8	289.8	47 13.1	49 41.9	VXJK	22	0.00	000	295.5	32.8			
29/04/88	0000	72.9	289.8	47 13.1	49 42.0	VXJK	22	0.03	270	297.5	32.8			
29/04/88	0400	72.9	289.8	47 13.1	49 42.0	VXJK	22	0.00	000	301.5	32.8			
29/04/88	0700	72.9	289.8	47 13.1	49 42.0	VXJK	22	0.00	000	304.5	32.8			
29/04/88	0800	72.8	289.8	47 13.1	49 41.9	VXJK	22	0.07	090	305.5	32.9			
29/04/88	1200	72.8	289.8	47 13.1	49 41.9	VXJK	22	0.00	000	309.5	32.9			
29/04/88	1600	72.8	289.8	47 13.1	49 41.9	VXJK	22	0.01	025	313.5	32.9			
30/04/88	0400	72.8	289.8	47 13.1	49 41.9	VXJK	22	0.00	205	325.5	33.0			
30/04/88	0800	73.4	288.0	47 11.1	49 43.8	VXJK	22	0.60	213	329.5	35.4			
30/04/88	1000	73.3	287.7	47 10.7	49 43.8	VXJK	22	0.20	181	331.5	35.8			
30/04/88	2350	75.2	284.9	47 7.8	49 47.8	VXJK	22	0.29	224	345.3	39.8			
01/05/88	0900	75.4	284.6	47 7.5	49 48.3	VXJK	22	0.05	229	354.5	40.2			
01/05/88	1105	75.4	284.6	47 7.5	49 48.3	VXJK	22	0.00	000	356.5	40.2			
01/05/88	2245	75.3	284.7	47 7.5	49 48.2	VCYQ	22	0.01	090	368.2	40.3			
02/05/88	1343	75.6	284.7	47 7.6	49 48.6	VXJK	22	0.02	290	383.2	40.6			
02/05/88	1600	75.3	284.7	47 7.5	49 48.2	VCYQ	22	0.13	110	385.5	40.9			
03/05/88	0440	75.2	284.6	47 7.4	49 48.0	VCYS	22	0.01	126	398.1	41.0			
03/05/88	1545	76.5	284.2	47 7.2	49 50.0	VCYQ	22	0.12	262	409.2	42.4			
03/05/88	1900	77.1	283.4	47 6.3	49 51.2	VCYQ	22	0.38	223	412.5	43.6			
03/05/88	2000	78.2	283.2	47 6.3	49 52.9	VCYQ	22	1.16	270	413.5	44.8			
03/05/88	2130	79.2	283.0	47 6.3	49 54.4	VCYQ	22	0.68	270	415.0	45.8			
03/05/88	2300	79.8	283.0	47 6.4	49 55.3	VCYQ	22	0.41	279	416.5	46.4			
04/05/88	0000	80.1	282.7	47 6.1	49 55.8	VCYQ	22	0.46	229	417.5	46.9			
06/05/88	0916	87.2	286.5	47 13.2	50 4.0	GPCD	20	0.16	322	474.7	55.9			
06/05/88	1000	86.6	286.7	47 13.3	50 3.1	CCG	20	0.85	081	475.5	56.5			

TABLE 2.3 Sample of individual iceberg drift track listing by Husky Oil

Figure 2.2
Sample of site-specific target plot

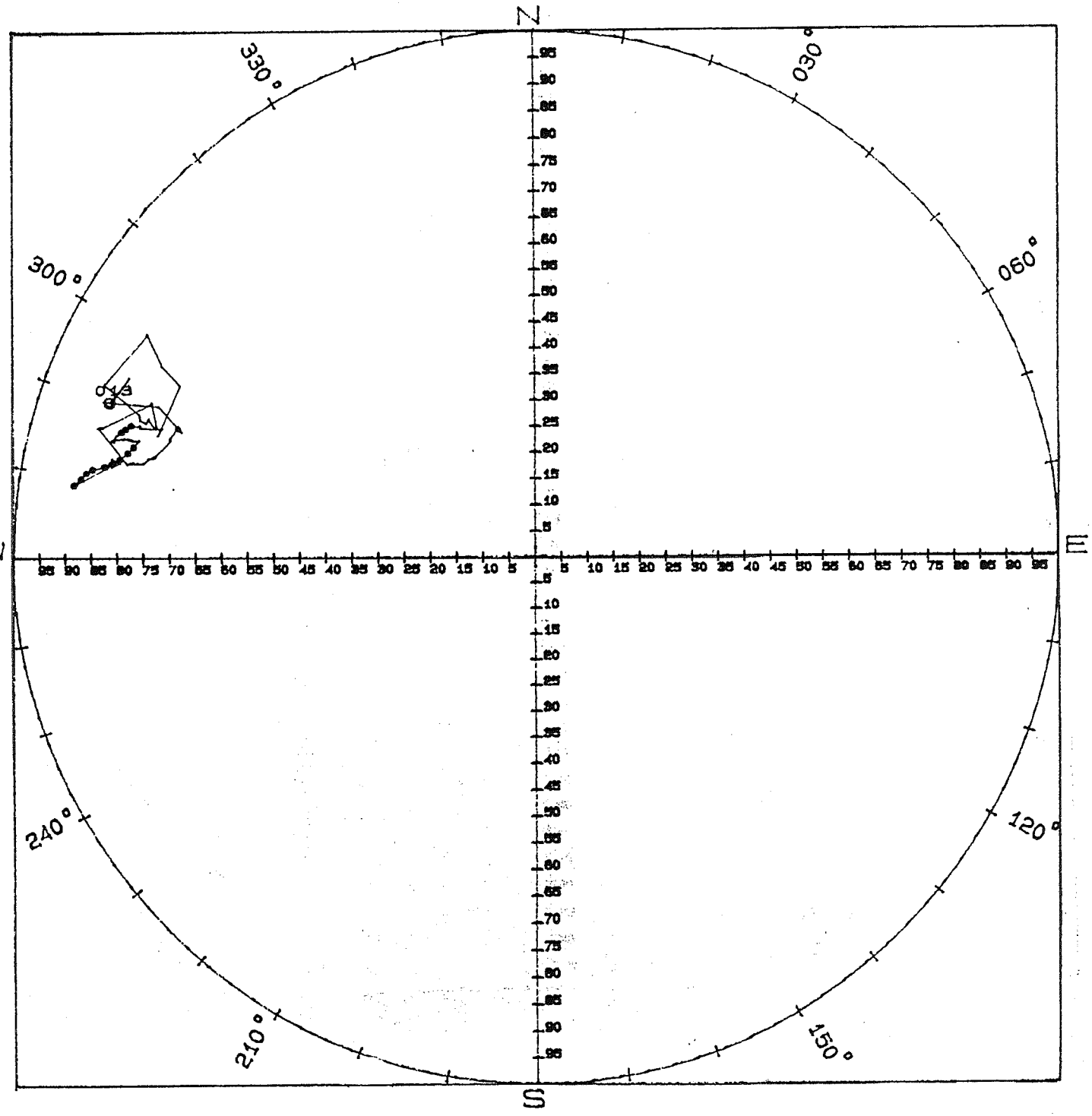


Figure 2.3

Sample of collective site-specific target plot

SURROUNDING Area w.r.t.
Whiterose E-09
(Bow Drill 3)
46 48' 26.24" N
48 1' 22.65" W

From 1332 L April 02, 1988
to 1844 L June 17, 1988
(76 days, 5.20 hours)

18 Icebergs Tracked.
717 Observations.
6 Targets Towed.
1 Target Deflected.

Radius = 130.0 n. mi.
Tic Interval = 10.0 n. mi.

Whiterose E-09 is at
the Center of Plot.

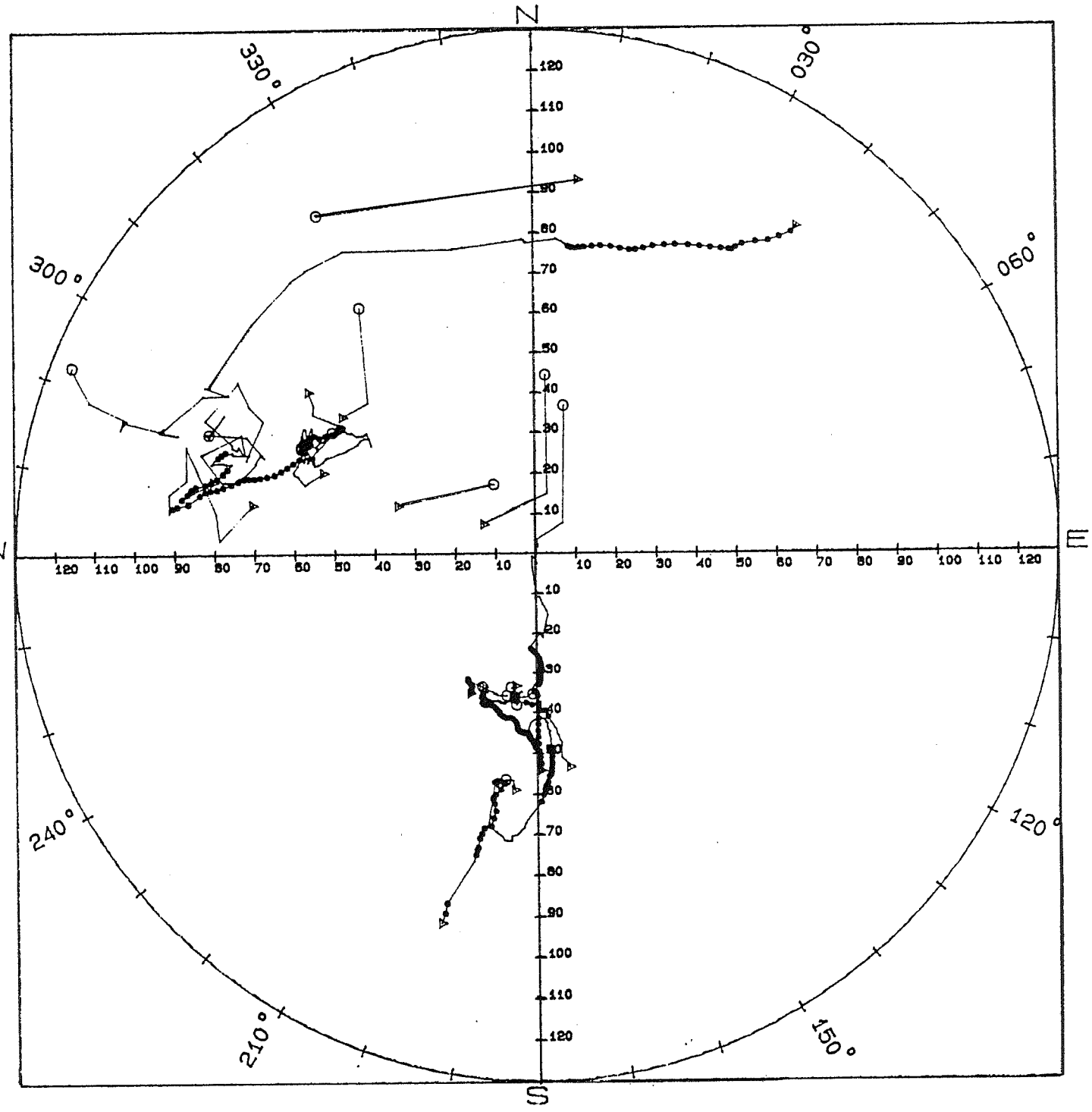


TABLE 2.4 Sample of summary of icebergs tracked by Husky Oil

Date	Time	Berg	Start Position		Iceberg Parameters (metric units)							Speed (knots)				Elapsed	Elapsed	#	Berg
yymmdd	Local	Ident	Latitude Deg Min	Longitude Deg Min	Size	Shape	Length (m)	Width (m)	Height (m)	Draft (m)	Mass (tonnes)	Min	Max	Mean	Made Good	Time (hours)	Distance (nm)	Obs	De-flected
Voyager J-18 (Sedco 706)																			
840326	2028	1	46 36.5	47 15.9	LB	DDK	E75	E45	E18	C59	64,881	.3	1.0	.8	.6	18.3	123.3	103	
840401	1920	2	46 53.1	47 04.0								1.0	1.1	.7	.7	9.2	6.2	10	
840401	2230	3	46 36.6	47 02.7								.1	1.4	.9	.5	6.0	5.4	7	
840324	O747	4	46 50.0	47 35.2	MB	WDG	M100	M31	M16	C61	116,540	.0	2.3	1.0	.4	102.7	99.6	73	Yes
840402	1900	6	47 35.0	47 50.5	SB	DDK	M32	M3	M11	C49	23,825							1	
840403	2010	7	47 39.5	47 48.7	MB	PNC	E100	E50	E30	C69	267,000							1	
840403	O954	8	46 22.0	47 19.6														1	
840403	O630	9	46 17.8	47 07.4														1	
840403	1154	10	46 14.5	46 48.2														1	
840403	O830	11	47 19.3	48 39.5														1	Yes
840404	1130	12	47 37.2	48 09.0								1.5	1.5	1.5	1.5	4.0	6.2	2	
840404	1530	13	47 31.2	47 07.2														1	
840403	1930	15	47 12.5	47 50.5	SB	TAB	M120	M100	M9	C79	384,480	.4	2.3	1.2	.7	22.0	21.4	16	Yes

LEGEND: MB = medium berg, LB = large berg, SB = small berg, DDK = drydock berg, WDG = wedge shaped berg, PNC = pinnacled berg, TAB = tabular berg, E = estimated, M = measured and C = calculated

Table 2.5 Alphabetical Listing of Call Signs and Data Sources

AES	Atmospheric Environment Service
CCGS	Canadian Coast Guard Ships
GPCD	Atlantic Airways King Air B200 Aircraft
IIP	International Ice Patrol
QKK	Sealand Helicopter
SLE	Sealand Helicopter
VO2329	M/V Triumph Sea
VCBQ	M/V Arctic Shiko
VCYQ	M/V Maersk Placentia
VCYS	M/V Maersk Gabarus
VOGF	M/V Acadian Gale
VSBC4	MODU Bow Drill 3
VXJG	M/V Maersk Bonavista
VXJK	Maersk Chignecto

All else are ships of opportunity

times of tows, as observations of an iceberg's position may not have been made at these start and end times.

* Tow heading (°T)

* Tow force applied by the vessel shown in tonnes, calculated by the percentage of power used (i.e. 100% pitch = 135 tonnes bollard pull) represented as E135.

Underneath each complete listing of iceberg observations is a summary giving the date, time, range and bearing of the iceberg's closest-point-of-approach (CPA), the minimum, maximum and mean drift speeds (in knots) of the iceberg, and the total number of observations or positions recorded for that iceberg. Where only one observation was made for a given iceberg, speed calculations are not applicable and are therefore not printed. Iceberg dimensions at the top of Table 2.3 are given in meters.

2.3 Sample wind data

Wind data were collected onboard each rig and reported to Husky Oil base in St. John's on an hourly basis. Winds were measured by anemometer situated some 75m above the waterline. At the end of each well, wind data were compiled as shown in Table 2.6. The data acquisition starts when the rig is on location. In the case of April 1988, the rig was off location until April 20 but wind data are needed for the drift and grounding of iceberg 001/1988 on April 12 and 13. Therefore, wind data were extracted from Surface Analysis plots compiled for April, 1988 by the Maritime Weather Centre. These data are presented in Table 2.7. Both sources of wind data are utilized in describing wind conditions

DAY/HOUR MATRIX OF SELECTED HOURLY DATA FOR
Whiterose E-09 - MAY 1988

WIND SPEED/DIRECTION (kts/!T)

TYPE OF ANEMOMETER: WEATHER MEASURE W102

ELEV. 76.2 m
46-48-26 N 48-01-23 W

DAY	TIME (GMT) 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	26	26	29	36	42	40	38	33	34	30	34	20	25	09	07	12	11	08	12	10	08	04	04	05
	ENE	ENE	ENE	E	E	E	E	E	E	E	E	E	SE	S	SSW	WSW	WSW	WSW	SW	SW	WSW	WSW	SW	SW
2	04	05	05	05	03	06	07	07	10	15	19	22	23	25	30	28	30	28	26	24	25	25	27	30
	SW	W	W	NW	NW	N	N	NNE	NNE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
3	31	27	30	27	27	27	26	23	25	22	23	20	20	23	26	24	33	32	35	35	37	37	36	23
	NE	NE	NE	NE	NE	NE	NE	ENE	ENE	ENE	ENE	ENE	ENE	ENE	E	ENE	E	E	E	E	E	E	E	ESE
4	16	20	36	37	32	25	26	31	26	20	11	09	17	16	26	31	27	23	23	25	27	25	28	28
	ESE	ESE	E	E	ESE	ESE	ESE	SSE	SSE	S	SSW	S	SSW	S	S	S	SSW	SSW	SSW	SW	SW	SSW	SSW	SSW
5	25	25	22	24	23	19	18	17	13	13	14	11	10	10	15	17	25	31	31	33	32	31	30	27
	SSW	SSW	SSW	SSW	SSW	SW	SW	SW	SW	W	WNW	NW	NW	N	N	N	N	N	N	N	N	N	N	N
6	25	25	24	23	22	15	16	15	12	13	12	13	12	12	18	20	27	27	28	29	31	28	28	3
	N	N	N	N	NNW	NNW	NNW	NW	WNW	W	W	WSW	SW	SW	SSW	SSW	SSW	SSW	SW	SSW	SW	SW	SW	SW
7	31	29	29	29	30	28	25	25	25	27	26	27	29	31	29	31	30	30	31	32	31	28	31	31
	SW	SW	SW	SW	SW	SW	SW	SW	SW	SSW	SSW	SSW	SSW	SSW	SSW	SSW	SSW	SSW	SSW	SSW	SSW	SSW	SSW	SSW
8	30	31	32	29	30	30	32	28	17	00	12	12	12	10	10	09	12	12	11	14	12	14	18	17
	SSW	S	S	S	S	S	S	SSE	SE	C	S	S	SW	SW	SW	SW	SW	W	NNW	NNE	NNE	NNE	NE	NE
9	21	13	20	17	19	22	19	17	19	18	17	14	12	06	03	02	04	02	11	12	13	12	12	09
	NE	NE	NE	NE	NE	NE	NE	NE	ENE	ENE	E	E	E	E	E	ESE	SSE	SSE	SSW	SW	SW	SW	SW	SW
10	08	07	11	06	08	08	09	07	11	05	18	10	20	19	19	16	16	14	20	19	22	27	30	29
	SW	SSW	SW	SW	SW	SSW	S	S	SSE	SE	SSE	SE	ESE	SSE	S	S	SSW	SSW	SW	SSW	SSW	SSW	SSW	SSW
11	32	32	30	33	31	30	34	34	36	38	40	38	36	29	30	31	28	30	25	27	26	28	26	28
	SSW	SSW	S	S	S	S	S	S	S	S	S	S	S	SSW	SSW	SSW	SSW	SW	SW	SW	SW	SW	SW	SW
12	28	25	26	26	24	27	22	23	20	20	20	22	21	18	18	21	16	18	15	17	15	14	15	16
	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	W	W	W	W	WSW	WSW	WSW	WSW	WSW	WSW
13	15	17	15	14	17	19	20	20	19	21	22	18	17	15	12	11	25	21	20	15	10	07	03	02
	W	W	W	W	W	W	W	W	W	W	W	W	NW	NW	NNW	NW	WNW	WNW	NW	NW	N	NNW	N	N
14	03	04	06	10	11	11	11	09	04	06	06	04	03	05	03	04	07	07	04	08	10	09	11	14
	SW	WSW	SW	SW	SW	WSW	W	WSW	WNW	N	NE	S	ENE	ENE	E	SSE	S	SSW	SSW	SSW	SW	SW	SW	W
15	11	11	11	10	09	12	08	08	11	11	13	11	13	13	16	15	21	21	24	21	19	23	21	20
	WSW	SW	SW	SW	SW	SW	SW	SW	SW	SW	WSW	SW	SW	SW	SSW	SSW	SSW	SSW	SSW	SSW	WSW	WNW	NW	NW

TABLE 2.6 Sample of wind data from Husky Oil drill rigs

DAY/HOUR MATRIX OF SELECTED HOURLY DATA FOR
Whiterose E-09 - APRIL 1988

WIND SPEED/DIRECTION (kts/!T)

TYPE OF ANEMOMETER: WEATHER MEASURE W102

ELEV. 76.2 m
46-48-26 N 48-01-23 W

TIME (GMT)

DAY	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
16	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
17	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
18	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
19	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
20	M	M	M	M	M	M	15	15	13	14	17	13	12	09	13	14	11	11	12	14	20	20	20	22
	M	M	M	M	M	M	N	N	NNE	NNE	NE	NE	NE	NE	NE	NE	ENE	ENE	ENE	E	E	E	E	E
21	19	20	20	14	20	25	30	40	35	30	25	29	20	20	17	13	15	16	14	14	20	17	23	2.
	ESE	ESE	ESE	ESE	ESE	ESE	ESE	E	ESE	ESE	SE	SSE	S	WSW	WSW	SW	SW	SW	SW	SW	SSW	SW	SW	SW
22	21	20	20	21	24	24	25	20	21	20	19	12	13	07	13	12	09	08	13	08	16	17	36	32
	SW	SW	SW	SW	SW	SW	WSW	SW	WSW	SW	SW	SW	SW	SW	SSW	S	S	SE	E	ESE	E	ESE	E	ESE
23	09	30	30	29	25	20	18	20	17	22	23	22	21	18	11	14	14	15	13	07	07	07	09	09
	ESE	ESE	SSE	S	S	SSW	SSW	S	SSW	WSW	WSW	WSW	WSW	SW	SW	SW	SSW	SW	SW	SW	SW	SSW	SW	SW
24	08	10	08	07	10	13	18	20	24	21	20	22	25	27	25	26	27	30	33	31	31	28	28	27
	WSW	W	W	WSW	SW	SW	WSW	WSW	WSW	WSW	WSW	WNW	WNW	WNW	WNW	WNW	WNW	WNW	WNW	WNW	NW	WNW	W	WNW
25	23	22	19	16	15	14	12	11	07	07	09	13	08	06	18	23	29	30	30	35	40	35	30	34
	NW	WNW	W	W	WSW	SW	WSW	SW	SW	S	SSE	SSE	SE	SE	E	E	E	E	E	E	E	E	ESE	SSE
26	32	31	32	31	34	36	32	37	38	35	35	34	32	28	28	27	28	25	21	23	26	25	28	27
	S	SSW	SSW	SSW	SSW	SSW	SSW	SSW	SSW	SSW	SSW	SSW	SSW	SW	SW	SW	SW	SW	WSW	WSW	W	W	W	W
27	30	32	36	31	34	34	35	31	24	24	26	23	22	21	20	18	15	13	12	12	11	10	13	12
	W	W	W	W	W	WNW	WNW	NW	NW	W	WNW	W	W	W	W	WNW	WNW	W	WSW	WSW	SW	SW	SSW	SW
28	13	13	13	16	16	13	12	09	05	03	02	04	05	07	07	09	13	06	07	06	02	06	12	15
	SW	SW	SSW	SW	SW	SW	SW	SW	SW	SW	SSW	SSW	E	E	ESE	E	E	ESE	E	E	E	NNW	N	N
29	20	13	07	08	09	10	10	12	12	12	12	11	14	10	16	12	09	07	11	07	09	08	07	0
	N	N	N	NW	NW	NNW	NNW	NW	NNW	NW	NNW	NNW	N	NNW	N	N	NNW	NNW	W	NNW	N	N	NNE	N
30	06	07	07	07	07	09	09	11	12	13	14	13	13	16	19	20	23	23	25	27	28	30	27	26
	NE	NE	ENE	ENE	ENE	ENE	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E

TABLE 2.6 Sample of wind data from Husky Oil drill rigs (continued)

TABLE 2.7 April, 1988 winds derived from Surface Analysis

April	Wind speed (kts)	From
1	02	S. E.
2	20	N
3	20	N
4	15	NNW
5	30	W
6	15	N
7	20	NNW
8	10	NE
9	10	NE
10	10	NE
11	25	ENE
12	35	NE
13	25	NNW
14	10	SSW
15	10	NE
16	20	N
17	10	NE
18	15	E
19	15	NNE
20	10	NE
21	15	SW
22	25	SW
23	20	WSW
24	20	WNW
25	15	SE
26	30	SSW
27	22	W
28	10	E
29	15	N
30	10	E

Source: Surface Analysis maps prepared by Maritime Weather Service

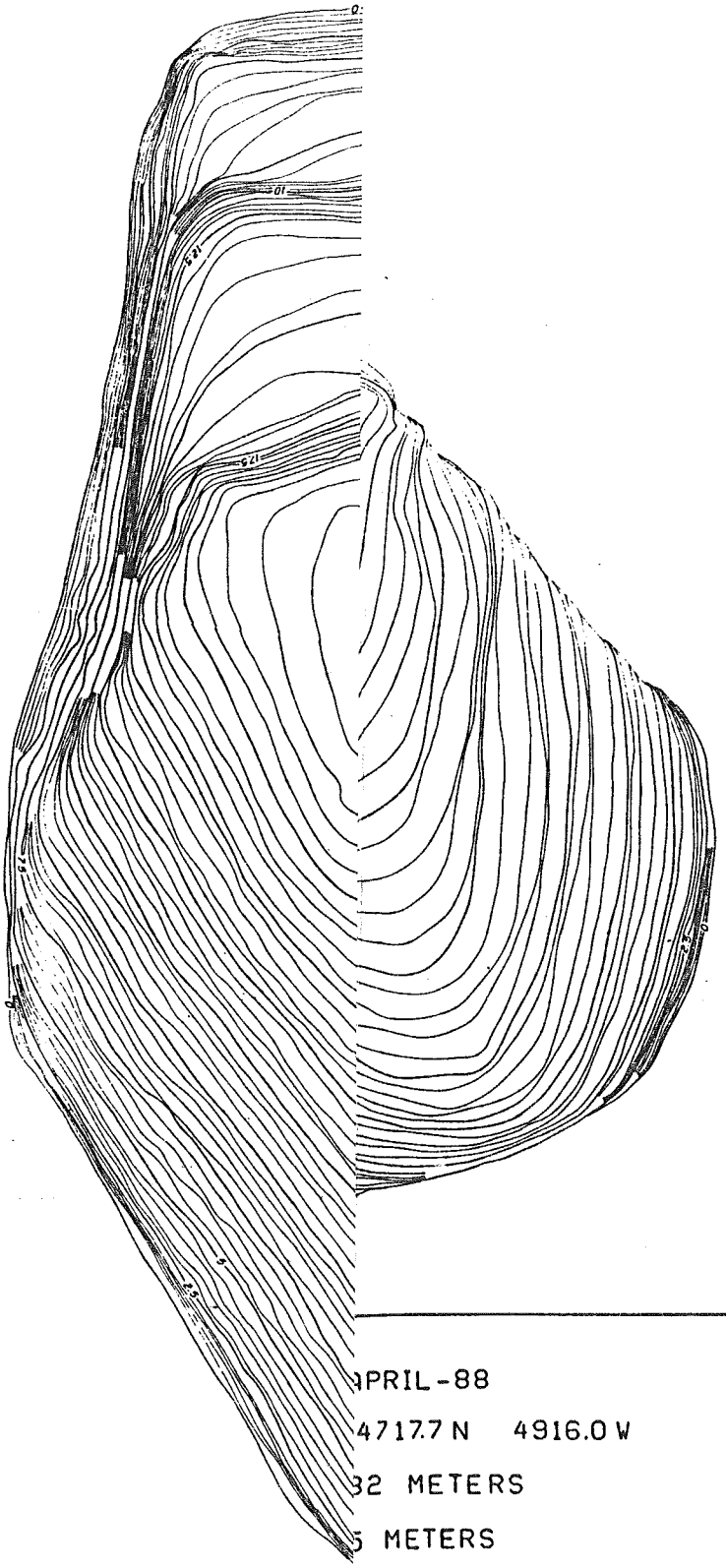
associated with grounding events detailed in the Report Appendix and summarized in section 5. Winds at the rigs are considered to be relevant to drift of icebergs owing to the large scales of wind/weather systems.

2.4 Sample iceberg sail contour derived from a stereophotograph

Most of the observed icebergs were not stereophotographed, but in 1988, three of the four grounded icebergs were documented by stereo camera flown by Atlantic Airways. A sample stereoplot of the topside contour of iceberg 013/1988 is presented in Fig. 2.4. Maximum water line length and width are computed along with maximum sail height and the volume of ice contained in the sail of the berg. In this case, the volume was 138252 cubic meters, which provides a basis for an estimate of the total volume and mass of the iceberg.

2.5 Sample ice reconnaissance map

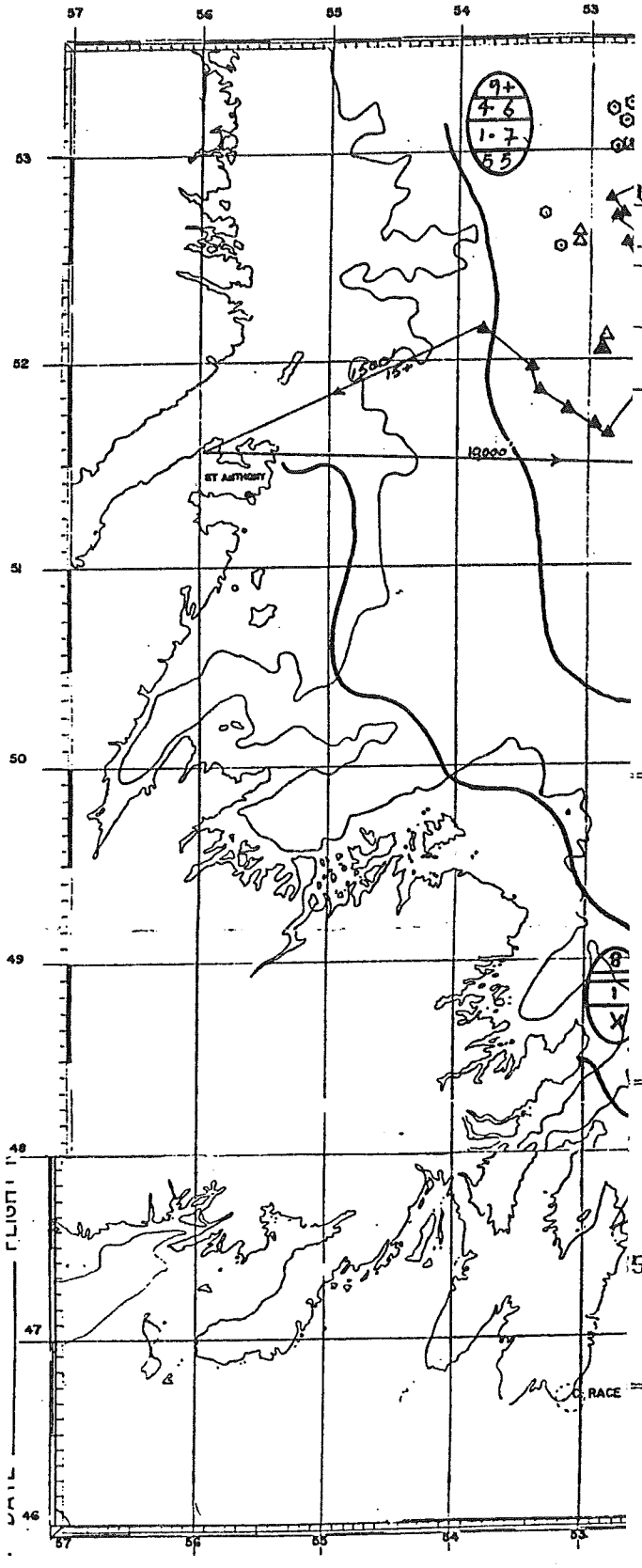
Ice reconnaissance flights were flown in the Grand Banks area by Atlantic Airways on charter to oil companies drilling on the Grand Banks to locate icebergs and packice. A sample ice reconnaissance map is presented in Fig. 2.5 showing a total of 68 identified icebergs and the extent of the packice. A Litton V-3 search radar was in use at the time for detection of icebergs, packice and targets. More recently a Litton V-5 search radar has been in general use. Prior to the advent of search radar in 1986, Side Looking Aperture Radar (SLAR) was in general use. Ice reconnaissance maps assist in assessing the population of icebergs from which grounded icebergs originate. Another source of information on iceberg counts is provided by the International



APRIL-88
4717.7 N 4916.0 W
32 METERS
5 METERS
5 METERS
ER VOLUME 138,252 CUBIC METERS

map of iceberg sail derived from a stereophotograph

23 Feb 188



WAYS LIMITED

TA SHEET

PEX14a

LOG NO: 5446

COPILOT: Cal Blackwood

RADAR OP: Ken Ludlow

▲ POSITIONED ONTOP	X GROWLERS
⚠ RADAR POSITIONED	POSITIONED ICE E
△ EST. POSITION	RADAR ICE EDGE
⚠ NO. OF BERGS	EST. ICE EDGE
BERGY BIT	STRIPS &/OR PATC

337 from Sedco 710

ICE RECONNAI

PAGE 1 OF 2 REPORT No: PEX

Figure 2.5 Sample ice reconnaissance map

Ice Patrol. Ice reconnaissance data are discussed in section 6 and the available ice reconnaissance maps are presented in Appendix B for the flight listing in Table 6.1.

2.6 Percentage exceedance parameters

Sample exceedance values of iceberg parameters such as length and width and sail height, keel draft and mass were calculated by Husky for the 1984 to 1987 data base (Table 2.8). For present purposes, the main parameter of interest is draft. A total of 243 observations, measurements or estimates of iceberg drafts were made by Husky between February 1984 and November 1987. Iceberg draft was very occasionally measured by sonar and sometimes inferred by the water depth at grounding locations. When the length, width and sail height were known, the draft was calculated according to a formula developed for Husky by its contractors. Iceberg widths, lengths and heights were measured by a sextant and range technique and 243 length measurements, 236 width measurements and 240 height measurements were made. The draft exceedance data is referenced in considerations of percentage of iceberg population which could potentially ground on the Grand Banks.

2.7 Current data

Current data were collected in the vicinity of rigs, generally far removed from iceberg locations. Owing to the fact that coherence in currents is limited to a few miles in the Grand Banks area, currents at the rig bear no relationship to currents at iceberg locations. As a result no data base exists for currents at iceberg locations.

LENGTH (m)	%	WIDTH (m)	%	HEIGHT (m)	%	DRAFT (m)	%	MASS (tonnes)	%
70	33.74	42	35.59	18	36.25	57	37.86	86348	34.91
70	33.74	42	35.59	18	36.25	58	37.04	89712	34.48
70	33.74	45	34.75	18	36.25	58	37.04	90686	34.05
70	33.74	45	34.75	19	35.83	59	34.98	91955	33.62
70	33.74	50	30.08	20	29.17	59	34.98	93450	33.19
70	33.74	50	30.08	20	29.17	59	34.98	94874	32.76
70	33.74	50	30.08	20	29.17	59	34.98	102753	32.33
70	33.74	50	30.08	20	29.17	59	34.98	103019	31.90
70	33.74	50	30.08	20	29.17	60	34.16	103680	31.47
70	33.74	50	30.08	20	29.17	60	34.16	104604	31.03
70	33.74	50	30.08	20	29.17	61	31.69	104842	30.60
71	33.33	50	30.08	20	29.17	61	31.69	116540	30.17
72	32.92	50	30.08	20	29.17	61	31.69	120150	29.74
75	31.28	50	30.08	20	29.17	61	31.69	120417	29.31
75	31.28	50	30.08	20	29.17	61	31.69	122462	28.88
75	31.28	53	29.24	20	29.17	61	31.69	130614	28.45
75	31.28	53	29.24	20	29.17	62	31.28	133500	28.02
78	30.86	54	28.39	20	29.17	63	30.86	140527	27.59
79	30.45	54	28.39	20	29.17	64	29.22	149520	26.72
80	29.63	55	27.97	20	29.17	64	29.22	149520	26.72
80	29.63	57	27.54	21	27.92	64	29.22	162750	26.29
82	29.22	58	25.42	21	27.92	64	29.22	165868	25.86
83	27.98	58	25.42	21	27.92	65	26.75	170773	25.43
83	27.98	58	25.42	23	26.25	65	26.75	178178	25.00
83	27.98	58	25.42	23	26.25	65	26.75	180791	24.57
85	27.57	58	25.42	23	26.25	65	26.75	181560	24.14
86	26.75	59	24.58	23	26.25	65	26.75	187897	23.71
86	26.75	59	24.58	24	23.75	65	26.75	197972	23.28
90	25.51	60	22.88	24	23.75	67	24.69	207594	22.84
90	25.51	60	22.88	24	23.75	67	24.69	212096	22.41
90	25.51	60	22.88	24	23.75	67	24.69	221802	21.98
91	24.69	60	22.88	24	23.75	67	24.69	233536	21.55
91	24.69	61	22.46	24	23.75	67	24.69	234859	21.12
92	24.28	62	22.03	25	20.00	68	23.46	244914	20.69
93	23.87	63	21.61	25	20.00	68	23.46	245886	20.26
95	23.46	65	19.92	25	20.00	68	23.46	253650	19.83
96	23.05	65	19.92	25	20.00	69	21.81	267000	19.40
97	22.63	65	19.92	25	20.00	69	21.81	280430	18.97
98	22.22	65	19.92	25	20.00	69	21.81	284310	18.53
100	18.11	66	19.49	25	20.00	69	21.81	286082	18.10
100	18.11	67	18.64	25	20.00	71	20.99	305494	17.67
100	18.11	67	18.64	25	20.00	71	20.99	310446	17.24
100	18.11	70	16.10	26	19.17	72	19.75	333660	16.81
100	18.11	70	16.10	26	19.17	72	19.75	349005	16.38
100	18.11	70	16.10	28	18.75	72	19.75	360983	15.95
100	18.11	70	16.10	30	13.75	73	17.28	373800	15.09
100	18.11	70	16.10	30	13.75	73	17.28	373800	15.09
100	18.11	70	16.10	30	13.75	73	17.28	384480	14.66
100	18.11	74	15.68	30	13.75	73	17.28	389350	14.22
103	17.70	75	15.25	30	13.75	73	17.28	392490	13.79

TABLE 2.8 Percentage exceedance values of iceberg parameters

LENGTH (m)	%	WIDTH (m)	%	HEIGHT (m)	%	DRAFT (m)	%	MASS (tonnes)	%
104	17.28	76	14.83	30	13.75	73	17.28	423640	13.36
105	16.87	78	14.41	30	13.75	74	16.46	472910	12.93
107	16.46	80	13.14	30	13.75	74	16.46	488868	12.50
109	16.05	80	13.14	30	13.75	75	16.05	512640	12.07
111	15.64	80	13.14	30	13.75	76	15.64	553224	11.64
112	14.81	81	12.71	30	13.75	77	15.23	609375	11.21
112	14.81	84	12.29	30	13.75	78	13.99	619381	10.78
118	13.99	85	11.86	32	13.33	78	13.99	672840	10.34
118	13.99	87	11.44	33	12.92	78	13.99	673837	9.91
120	13.17	88	11.02	34	12.08	79	13.58	700608	9.48
120	13.17	90	10.17	34	12.08	80	12.76	712000	9.05
122	12.76	90	10.17	35	10.00	80	12.76	781776	8.62
123	12.35	92	9.32	35	10.00	82	11.93	824283	8.19
124	11.93	92	9.32	35	10.00	82	11.93	888431	7.76
125	11.11	94	8.90	35	10.00	83	11.52	950360	7.33
125	11.11	100	6.78	35	10.00	85	10.70	1133490	6.90
130	9.88	100	6.78	36	9.58	85	10.70	1241870	6.47
130	9.88	100	6.78	37	8.75	86	10.29	1281867	6.03
130	9.88	100	6.78	37	8.75	87	9.88	1401750	5.60
132	9.47	100	6.78	39	7.92	89	9.47	1601897	5.17
133	9.05	104	6.36	39	7.92	90	8.64	1650701	4.74
138	8.64	105	5.51	40	7.50	90	8.64	1672488	4.31
150	8.23	105	5.51	41	7.08	91	8.23	1734005	3.88
155	7.82	111	5.08	42	6.67	94	7.00	1734966	3.45
157	7.41	112	4.66	43	6.25	94	7.00	2200561	3.02
166	7.00	115	4.24	45	5.00	94	7.00	2329564	2.59
174	6.58	120	2.97	45	5.00	95	6.58	2374164	2.16
175	5.76	120	2.97	45	5.00	96	6.17	2700000	1.72
175	5.76	120	2.97	46	4.58	97	5.76	3115000	1.29
184	4.94	123	2.12	48	3.75	98	5.35	3237299	0.86
184	4.94	123	2.12	48	3.75	100	4.53	3272694	0.43
189	4.53	126	1.69	50	2.92	100	4.53	4060724	0.00
190	4.12	137	1.27	50	2.92	101	4.12		
196	3.70	145	0.85	55	2.50	102	2.88		
200	2.88	150	0.42	57	2.08	102	2.88		
200	2.88	152	0.00	64	1.67	102	2.88		
203	2.47			70	1.25	103	2.47		
219	2.06			83	0.83	104	2.06		
228	1.65			95	0.42	106	1.65		
238	1.23			100	0.00	113	1.23		
248	0.82					116	0.82		
260	0.41					127	0.41		
360	0.00					162	0.00		

TABLE 2.8 Percentage exceedance values of iceberg parameters (continued)

2.8 Summary of Husky Oil iceberg data

The data in Husky Oil's data base are catalogued in Table 2.9 by well name. A total of 513 icebergs were tracked from 1984 through 1988 and of these 63 were duplicates. This leaves 450 individual drift tracks. In 1989, 4 additional tracks were included, which means that the total number of icebergs tracked is 454. It should be noted, that the number of tracked icebergs is not the total number of icebergs observed in the Grand Banks area. Many more were observed by airborne radar (refer Section 6) and more still were reported by the International Ice Patrol. The above data bases are considered in estimating percentage population of grounded icebergs in section 7.

2.9 Petro Canada iceberg data

Petro Canada conducted drilling operations on the Grand Banks during 1984 and 1985 and collected data on winds, iceberg positions and iceberg dimensions. The wind data format is identical to the format used by Husky Oil. The wind data are presented in Appendix C. The iceberg drift data collected by Petro Canada in 1985 was logged as indicated in Table 2.10 and Fig. 2.6. In 1984 the iceberg drift data were logged as shown in Table 2.11 and Fig. 2.7. The iceberg drift data are presented in the Report Appendix for grounded icebergs.

2.10 Mobil Oil iceberg data

Mobil Oil conducted drilling operations on the Grand Banks during 1983 and 1984 and collected data on winds, iceberg positions and iceberg dimensions. A sample wind data plot is presented in Fig. 2.8 and the selected wind data set is presented in Appendix C. A

TABLE 2.9 Summary of icebergs tracked by Husky oil (1984 to 1989)

Well Name	Year	# of tracked icebergs
Springdale M-29	1989	4*
Whiterose E-09	1988	8
Bonne Bay C-73	1987	37
Golconda C-64	1986	5
Fortune G-57	1986	21
N. Ben Nevis M-61	1986	9
Whiterose 1-61	1986	1
Panther P-52	1986	1
Whiterose J-49	1985	8
N. Ben Nevis P-93	1985	153
Conquest K-09	1984	133
Whiterose N-22	1984	8
Archer K-18	1984	7
Voyager J-18	1984	112

* The total count of icebergs tracked by Husky Oil in 1989 on behalf of Texaco Canada is not available, but it is known that at least 4 icebergs were tracked.

WEST BEN NEVIS B-75
46 34.0 N 48 26.1 W
1985

Iceberg : P509 page 1

Characteristics :

Size	Shape	Length	Width	Height	Draft	Mass
		0	0	0	0	0

Summary of the Iceberg Track

Time tracked : 102.3 hrs.
Total Distance : 1.0 nm.
Net Displacement : 0.0 nm.

Position Observations : 9

Time (GMT)	Date (GMT)	Range (nm)	Bear (deg)	Speed (knots)	Dir (deg)	Status	Towhead (deg)	Tension (tons)
0000	20 Apr	56.7	339	0.0	0			
0600	20 Apr	56.7	339	0.0	269			
0000	21 Apr	56.7	339	0.0	89			
0030	21 Apr	56.7	339	.4	75			
0600	21 Apr	56.7	339	0.0	255			
0615	21 Apr	56.7	339	.9	75			
0000	22 Apr	56.7	339	0.0	255			
0100	22 Apr	56.7	339	0.0	164			
0615	24 Apr	56.7	339	0.0	344			

TABLE 2.10 Sample of individual iceberg drift track listing by Petro-Canada in 1985

WEST BEN NEVIS B-75
46 34.0 N 48 26.1 W

OBSERVED TRACK PLOT & SUMMARY FOR ICEBERG : P509

Observed from : 0000 20 Apr 85 to : 0615 24 Apr 85 (GMT)
Hours Tracked : 102 hrs # of Observations : 9
Distance tracked : .98 nm. Net Displacement : 1.1 nm
Closest Approach : 56.7 nm. 339° at 0100 22 Apr 85

Iceberg track : ———— Tow operations : ----------
Scale : 60 nm

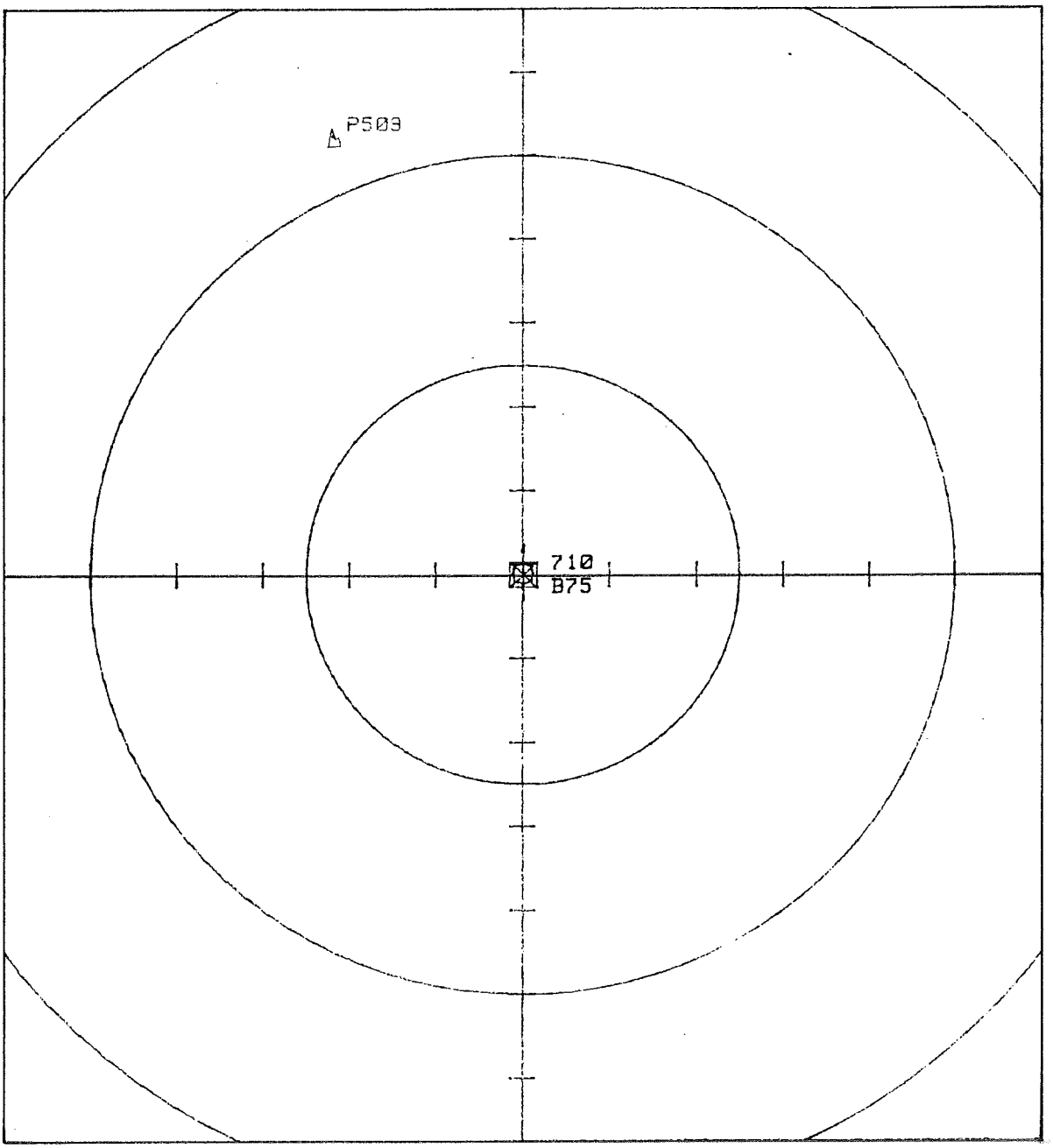


Figure 2.6 Typical Petro-Canada iceberg drift track plot, 1985

Day	Hour	Bearing (°T)	Range (nm)	Drift speed (kn)	Towards (°T)	
12	0700	69.0		0.00	0.0	R
12	0800	68.0		0.00	0.0	R
12	0900	70.0		0.43	176.0	R
12	1000	71.0	8.00	0.07	193.0	R
12	1100	73.0	8.90	0.13	179.9	R
112	0075	75.0	8.70	0.32	182.1	
112	1300	77.0	8.70	0.03	166.0	R
112	1400	79.0	8.80	0.32	149.9	R
112	1500	81.0	8.80	0.31	170.0	R
112	1600	79.0	9.10	0.43	33.8	R
112	1700	81.0	8.90	0.37	202.9	R
112	1800	80.0	8.90	0.16	350.5	R
112	1900	80.0	8.90	0.00	0.0	R
112	2000	81.0	8.90	0.16	170.5	R
112	2100	82.0	8.80	0.18	204.4	R
112	2200	83.0	8.60	0.25	223.3	R
112	2300	84.0	8.50	0.33	237.9	R
113	0000	86.0	8.09	0.41	221.0	R
113	0100	88.0	7.90	0.34	312.9	R
113	0200	91.0	7.70	0.56	224.6	R
113	0400	98.0	7.50	0.53	219.1	
113	0500	97.0		0.32	299.7	
113	0600	96.0		0.61	286.9	R
113	0700	94.0	7.10	0.23	135.9	R
113	0800	94.0	7.00	0.13	274.0	R
113	0900	92.0	6.90	0.22	236.0	R
113	1100	85.0	6.80	0.38	21.0	R
113	1200	84.0	6.80	0.14	38.0	R
113	1300	82	6.20	0.38	24.0	
113	1400	81	6.20	0.00	0.0	
113	1500	80	6.50	0.32	60.0	
113	1640	80	6.60	0.06	80.0	
113	1800	81	6.00	0.31	97.0	
113	1900	81	6.20	0.20	81.0	
113	2000	83	6.20	0.50	173.0	
113	0000	85	6.40	0.32	137.0	
113	0100	87	6.60	0.44	121.0	

TABLE 2.11 Sample of individual iceberg drift track listing by Petro-Canada in 1984

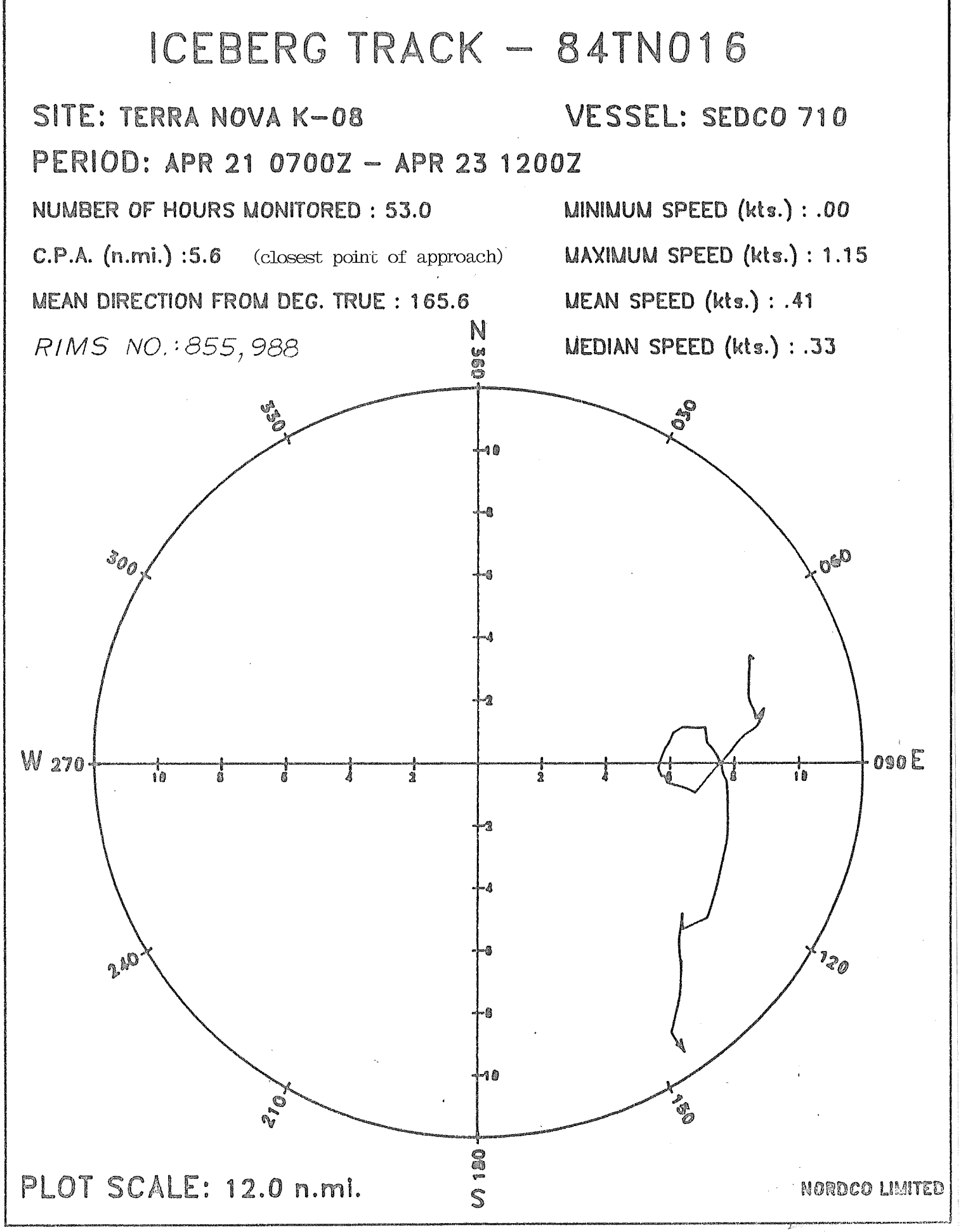


Figure 2.7 Typical Petro-Canada iceberg drift track plot 1984

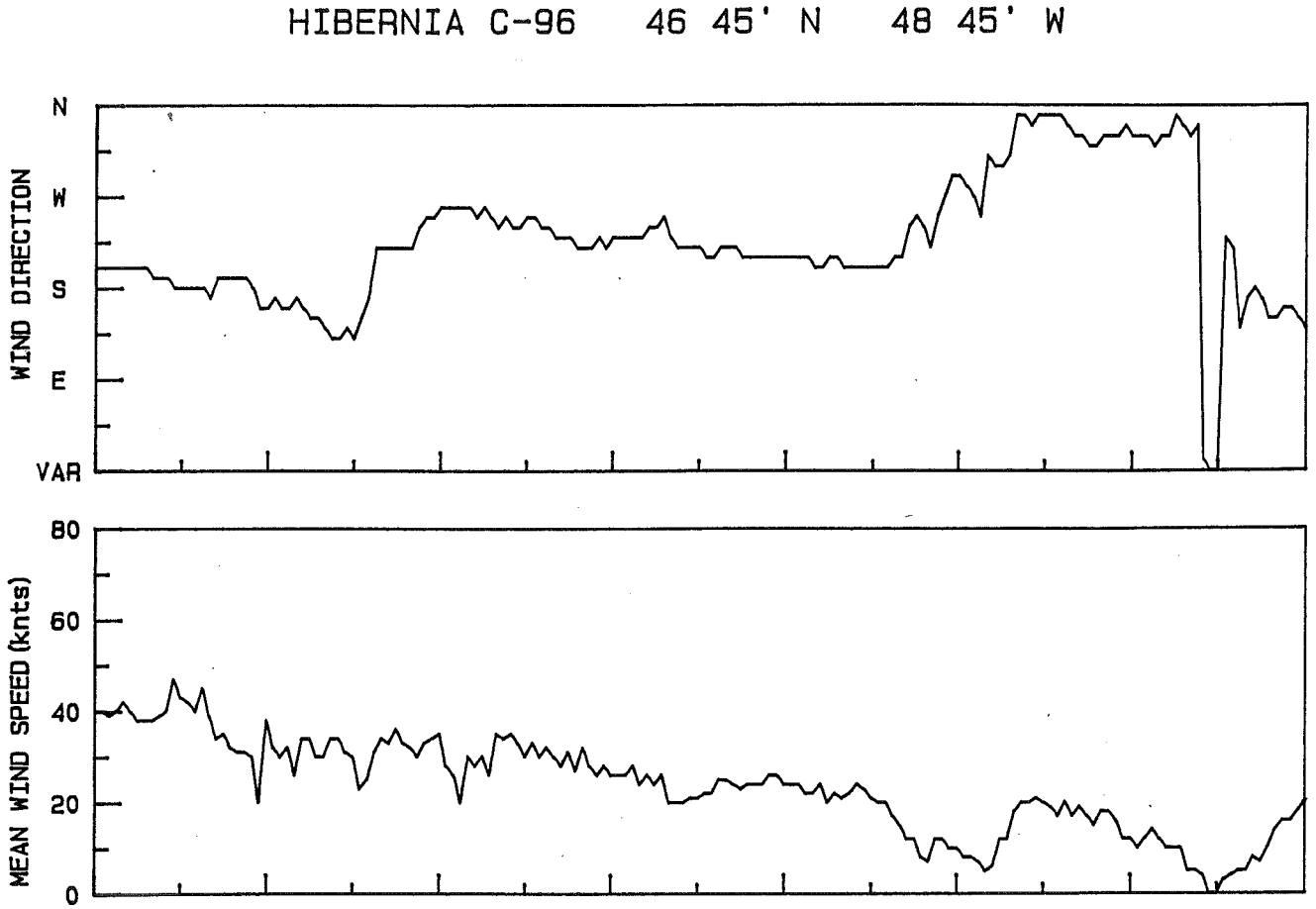


Figure 2.8 Sample of Mobil Oil wind data

typical "long range berg plot" is presented in Table 2.12. This form of logging of iceberg positions and dimensions was used by Mobil in 1984. In 1983 the iceberg data were logged in the format shown in Table 2.13. For each grounded iceberg, positions were extracted from the logs and combined as shown for example for iceberg 095/1983 in Table A18. The drift data are presented in the Report Appendix.

3. CRITERIA

Criteria for grounding of icebergs have been investigated previously by El Tahan (1985) in a report for the Environmental Studies Research Funds. Velocity histories and drift tracks of 100 icebergs off Labrador were used to reach conclusions regarding grounding definitions, and stationary icebergs were identified to be either positively grounded or probably grounded depending on duration of stationarity. Stationarity beyond a period of 24 hours was taken to indicate positive grounding while stationarity from 6 to 24 hours indicate probable grounding. Periods of stationarity below 6 hours were taken to indicate no grounding. Three states of iceberg motion are recognized in this study; namely, freedrift, keel dragging and grounding. Free drift is defined as drift at mean drift speed for the iceberg prior to and(or) after grounding. Mean drift speeds are presented for some tracked iceberg in the data file in the data summary in Appendix A. Keel dragging is defined as occurring when the indicated drift speeds in the individual drift track sets are very low, less than 0.05 knots. Grounding is evidenced by virtually zero drift for at least 12 hours or by very limited

LONG RANGE BERG LOG

BERG NO. ____ RIG NAME W. Venture RIG LOCATION C-96 DATE 15-5/84

DATE / TIME	LATITUDE	LONGITUDE	RANGE	BEARING	SOURCE	NOTES
19:45/15/5	47° 32.74	48° 42.17	47.2	002	Ravensturm	
23:45/15	47° 33	48 41.6	47.5	002	"	seems to be grounded
02:45	47° 33	48 41.6	47.5	002	"	"
05:45	47 33	48 41.6	47.5	002	"	
0845/16	47 36.0	48 40.5	50.9	003	"	BERG BREAKING UP.
1145/16	47 35.6	4841.0	50.1	003	"	
1500/16	47 35.6	4841.0	50.1	003	"	BERG GROUNDED.

		est. or measured
HEIGHT	50	E
LENGTH	100	E
WIDTH	75	E
MASS	1,340,000	E
DRAFT	90	E

SCALE: 1 SQUARE = ____ METRES

NOTES AND COMMENTS

1500 - RAVENSTURM INSTRUCTED TO PROCEED ON ICE SWEEP LEAVING BERG AREA.

TABLE 2.12 Sample of Mobil Oil iceberg drift data in 1984

Table 2.13 Sample of Mobil Oil iceberg drift data in 1983

Yr Mo Dy Hr	Cons Num	Lat	Long	Days On	Src	Typ	Siz	Len Wid Ht Dft	Code	Sp.Codes 1 2 3	Day 01 am pm	Day 02 am pm	Day 03 am pm	Day 04 am pm
83 07 08 09	726	47,50.8	48,12.0	09	2	3	1				0706 1004	1004 1004	0904 0904	1204 1205
83 07 08 09	727	48,28.0	47,04.8	08	2	3	2				0405 0502	0502 0502	0603 0902	1202 1202
83 07 08 09	731	48,45.0	47,32.8	07	2	3	2				0405 0502	0502 0502	0603 0902	1202 1202
83 07 08 09	733	47,23.0	45,40.0	06	3	8					0405 0502	0502 0502	0603 0902	1202 1202
83 07 08 09	734	47,49.8	47,04.8	03	3	4					0503 0901	1102 0902	0704 1002	1202 1202
83 07 09 09	726	47,56.0	47,54.0	10	2	3	1				1104 0903	0402 0304	1203 1203	0000
83 07 09 09	727	48,35.9	46,50.9	09	2	3	2				0901 0501	0204 3605	1102 1102	0000 0000
83 07 09 09	731	48,53.0	47,10.9	08	2	3	2				0901 0501	0204 3605	1102 1102	0000 0000
83 07 09 09	733	47,30.9	45,2 .0	07	3	8					0901 0501	0204 3605	1102 1102	0000 0000
83 07 09 09	734	47,55.0	46,51.9	04	3	4					1902 1701	0205 3605	1102 1102	0000 0000
83 07 10 09	726	47,53.0	47,44.0	11	2	3	1				0404 0205	3605 0205	0103 0103	0105 0102
83 07 10 09	734	47,49.9	46,58.0	05	4						3502 3504	0105 0205	0103 0103	0105 0105
83 07 11 09	735	48,07.0	47,42.0	00	3	8	3	100 300 70			0408 3607	3608 3608	3606 3604	3602 0000
83 07 12 09	735	48,13.0	47,15.0	00	3	8	3	100 300 70			0504 0304	3605 3606	3604 3604	0303 0403
83 07 13 09	735	48,19.8	46,45.0	01	3	8	3	100 300 70			0407 0107	0107 3607	3605 3605	3604 3604
83 07 13 09	736	50,10.0	50,41.0	01	3	3	2				3504 3604	3604 3604	3603 3603	3602 3602
83 07 14 09	735	48,35.9	46,49.9	02	3	8	3	100 300 70			3405 3406	3606 3406	3605 3604	0000 0901
83 07 15 09	735	48,51.9	46,57.0	03	3	8	3	100 300 70			3307 3505	3605 0104	0403 0403	3506 3507
83 07 16 09	735	49,12.0	47,06.9	04	3	3	3				3407 3505	3605 3407	0305 0305	0405 0405
83 07 17 09	735	49,35.9	47,12.0	05	3	3	3				3607 3608	3607 0506	0307 0407	1205 1205
83 07 18 09	735	49,55.0	47,17.9	06	3	3	3				0408 0607	0707 0407	1005 1105	0706 3604
83 07 19 09	735	50,06.9	47,00.0	07	3	3					0507 0406	0503 0304	0106 0106	0306 0306
83 07 20 09	735	50,17.6	46,12.5	08	3	3					1602 0203	0204 0104	3307 3307	3305 3305
83 07 21 09	000	, .	, .								3003 3303	3607 0208	0309 0408	0407 1002
83 07 22 09	000	, .	, .								3602 3407	0307 0507	0507 1006	1002 3303
83 07 23 09	000	, .	, .								3608 0210	0407 0505	0404 0404	0404 0404
83 07 25 09	000	, .	, .								3401 3407	0211 0208	0207 0207	1104 1104
83 07 26 09	000	, .	, .								3610 0506	1203 1603	1405 1202	1003 1003
83 07 27 09	000	, .	, .								0503 1303	1802 0000	0000 0503	0405 0406
83 07 28 09	000	, .	, .								2204 1805	1802 1002	0705 0707	0804 0804

apparent displacements in water depths less than 200m. In some cases, the drift prior to or after grounding is not known and the date of grounding may not be known. The actual date of departure from grounded positions of some of the icebergs is also not known. The above criteria are used in the interpretation of free drift, keel dragging and grounding of icebergs in the iceberg data sets.

4. DATA SEARCH PROCEDURE

The search for grounded icebergs was done manually at Husky's offices and at the offices of the Canada Newfoundland Offshore Petroleum Board (CNOPB) in St. John's Newfoundland. Some of the iceberg data is stored on magnetic tape, but the majority of grounded icebergs inferred in this study are not included on the data tape.

Search procedure:

The search for grounded icebergs consisted of the following sequential steps:

1. Scan iceberg data summaries and identify icebergs with low and zero drift speeds.
2. Access well history reports for icebergs identified in step 1, and extract drift track listings, drift track plots and wind data for each.
3. Search through individual iceberg data listing and identify icebergs with low or zero speeds for periods greater than 12 hours.
4. Prepare list of identified low speed or 0 speed icebergs, eliminating those with drafts less than 60m and in water depths greater than 200m at the locations of low or zero drift speed.
5. Extricate individual site specific target plots for each iceberg identified in step 4 (if available).
6. Extricate summary site specific target plots (if available).

7. Extricate wind data from environmental well history reports or from Surface Analysis of winds and atmospheric pressure fields

8. Prepare plots of iceberg drift for periods prior to, during and after low speed or no speed events.

9. Based on the plots prepared in step 8 and the individual iceberg listings, assign status of the drift as free drift, keel dragging or grounded for each segment of the drift record.

10. Prepare listing of grounded icebergs (Table 5.1), listings of grounding events (Table 5.2) and area plots of iceberg grounding locations (Fig. 5.1 and 5.2).

5. RESULTS

During the various data searches at Husky Oil and CNOPB offices in St. John's, available iceberg drift data from 1983 to 1989 were reviewed and candidate icebergs for keel dragging/scouring and grounding were selected for closer scrutiny at AGC. A total of 29 candidate icebergs drift tracks were selected and these are analyzed for purposes of identifying inferred groundings and scour locations on the Grand Banks. The criteria defined in section 3 were applied to the drift track of each candidate iceberg. The segments of each drift track inferred as free drift, keel dragging or grounding were identified. The results are summarized below, and the analysis of the 29 selected drift tracks is presented in the Report Appendix.

The primary result of the search through 29 candidate icebergs is that 27 have been inferred as grounding at 44 loctions. The remaining candidates were rejected because some of the criteria were not met. The iceberg data are summarixed in Table 5.1 and the 44 inferred grounding events are summarized in Table 5.2 and detailed in the Report Appendix. The positions of all groundings are plotted in Figs. 5.1 and 5.2 Husky data yielded 23 inferred groundings by 12 icebergs, and 21 groundings by 15 icebergs were inferred from Petro-Canada and Mobil data. Overall, a total of 44 definite groundings are inferred for 27 large icebergs on the Grand Banks of Newfoundland during the period 1983 to 1989.

TABLE 5.1 Summary of 27 icebergs grounded on the Grand Banks during 1983 to 1989.

Berg#/year	Iceberg Length(m)	Width(m)	Sail Ht(m)	Draft (m)	Grounded depth(m)*	Mass(mil. tonnes)	Type of berg
001/1989	162	100	46	117	112	2.0	Pinnacle
004/1989	283	91	38	104	100	4.0	Wedged
001/1988	287	114	40	125	125	1.9	Drydock
005/1988	112	105	18	90	100	0.4	Drydock
013/1988	182	125	25	80	84	1.0	Drydock
015/1988	185	137	34	100	100	0.9	Drydock
028/1987	166	81	21	85	80	0.8	Spherical
002/1985	133	59	35	118	118	0.5	Pinnacle
004/1985	132	123	30	115	115	1.7	Tabular
014/1985	360	90	42	108	108	4.0	Spherical
BIO002/1985	224	137	24	135	130	2.0	Blocky
019/1985	196	123	46	100	95	3.2	N/A
026/1985	120	100	30	122	120	1.0	Spherical
061/1985	N/A	N/A	N/A	N/A	125	N/A	N/A
014/1984	N/A	N/A	N/A	81	79	N/A	N/A
015/1984	100	78	33	92	90	1.0	Tabular
028/1984	N/A	N/A	N/A	70	74	N/A	N/A
036/1984	N/A	N/A	N/A	77	75	N/A	N/A
037/1984	75	50	22	92	90	0.2	Pinnacle
050/1984	100	70	22	115	106	0.3	Pinnacle
1381/1984	90	23	24	92	90	0.1	N/A
095/1983	180	100	15	95	93	1.4	N/A
104/1983	210	162	42	155	149	N/A	N/A
135/1983	Medium berg			140	137	N/A	N/A
241/1983	Large berg			106	104	N/A	N/A
292/1983	N/A	N/A	N/A	110	108	N/A	N/A
649/1983	N/A	N/A	N/A	97	86	N/A	N/A

Note: N/A implies that the data are not available.
* Indicates depth at the first grounding site.

TABLE 5.2 Summary of 44 definite groundings on the Grand Banks during 1983 to 1989.

Berg#/Year Drift, drag or grounding	Period of Grounding Hour/Day/Month	Days Aground Min.	 Max.	Lat. (°-')	Long. (°-')	Water depth (m)
001/1989						
FD, Dragging						
G1	2200/10/13 to 0407/24/04	45	45	46-40.2	48-08.3	112
004/1989						
G1	1750/12/03 to 16/03	3	44	46-44.4	48-27.4	100
001/1988						
FD						
G1	1705/12/04 to 0400/13/04	1/2	3	46-50.3	48-01.2	125
FD						
G2	1620/16/04 to 0800/20/04	3 1/2	-	46-10.0 - 46-12.2	48-09.8- 48-10.1	104
FD						
G3	1551/20/04 to 0800/21/04	1/2	-	46-13.6	48-07.3	106
Dragging						
G4	1600/22/04 to 0400/29/04	7 1/2	-	46-12.6	48-10.3	104
Dragging, FD						
005/1988						
Unknown drift						
G1	1900/14/04 to 1010/20/04	6	-	47-18.5	49-15.9	100
FD						
G2	1230/21/04 to 0500/22/04	3/4	-	47-11.8	49-24.5	95
FD						
G3	2040/22/04 to 0000/25/04	2	8	47-12.3	49-22.7	95
Dragging						
G4	1935/01/05 to 0800/02/05	1	4	47-12.2	49-26.2	88

TABLE 5.2 Continued

Berg#/Year Drift, drag or grounding	Period of Grounding Hour/Day/Year	Days Aground Min.	Max.	Lat. (°–')	Long. (°–')	Water depth (m)
013/1988						
FD & dragging						
G1	2046/28/04 to 0400/30/04	1	–	47–13.1	49–42.0	84
FD						
G2	2330/30/04 to 0440/03/05	2	–	47–07.5	49–48.3	78
FD						
015/1988						
Dragging						
G1	1406/27/04 to 1215/04/05	7	–	47–21.0	50–31.5	100
FD						
G2	0900/06/05 to 1050/24/05	17	–	47–18.6	50–18.1	90
FD & dragging						
G3	2200/31/05 to 2310/05/06	5	–	47–29.9	50–01.0	86
FD						
028/1987						
G1	1100/09/03 to 0800/10/03	1	7	47–19.5	49–42.8	80
FD						
G2	0600/19/03 to 0405/22/03	3	4	47–23.5	50–02.9	80
FD						
002/1985						
G1	——/02/04 to ——/17/04	15	–	47–18.0	48–41.5	118
004/1985						
G1	1430/04/04 to 1430/24/04	20	–	47–26.5– 47–27.5	48–55.0– 48–56.0	115
FD						
014/1985						
FD						
G1	0100/16/04 to 0730/18/04	2	–	47–05.4	51–13.9	108
BIO002/1985						
G1	1700/30/04 to ——/02/05	2	–	47–45.0	50–49.9	130

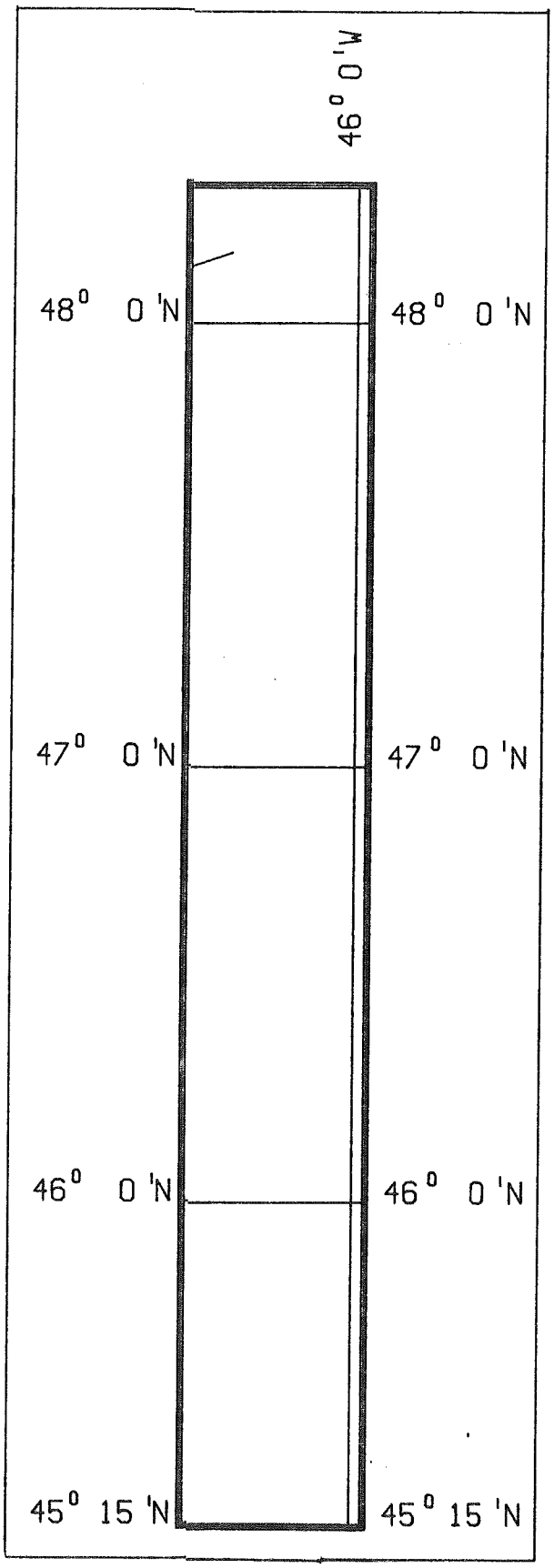
TABLE 5.2 Continued

Berg#/Year Drift, drag or grounding	Period of Grounding Hour/Day/Month	Days Aground Min.	 Max.	Lat. (°-')	Long. (°-')	Water depth (m)
019/1985						
G1	2030/28/04 to 0015/07/05	9	17	47-41.0	49-47.5	95
FD						
G2	2130/16/05 to 1130/07/06	22	-	47-25.5	49-45.8	88
026/1985						
G1	——/31/05 to ——/06/06	6	-	45-58.6	48-05.0	120
061/1985						
FD frm NE						
G1	1720/26/05 to 1720/27/05	1	-	46-10.8	47-58.0	125
014/1984						
G1	0700/21/04 to 1800/26/05	5	-	46-13.5	48-41.6	79
015/1984						
G1	0700/21/04 to 1600/26/04	5	5	46-19.3	48-32.7	90
FD						
Dragging						
G2	0900/30/04 to 1400/07/05	7	7	46-20.8	48-45.3	72
Dragging						
G3	0500/07/05 to 0000/09/05	2	2	46-20.8	48-44.8	72
FD						
028/1984						
FD& dragging						
G1	0900/25/04 to 1800/26/04	1	1	46-29.7	48-46.3	74
036/1984						
FD or dragging						
G1	——/24/04 to ——/06/05	12	12	46-27.8	48-43.0	75
FD						
037/1984						
G1	0830/18/04 to 1130/19/04	1	-	46-40.8	48-36.3	90
050/1984						
G1	2248/30/04 to 1435/04/05	3	-	47-06.5	48-40.0	106

TABLE 5.2 Continued

Berg#/Year Drift, drag or grounding	Period of Grounding Hour/Day/Month	Days Aground Min.	 Max.	Lat. (°-')	Long. (°-')	Water depth (m)
1381/1984						
G1	1145/26/05 to 1145/30/05	4	-	47-29.8	49-35.4	90
095/1983						
FD						
G1	0900/21/02 to 0900/23/02	2	2	47-18.7	49-18.7	93
Dragging						
G2	0900/25/02 to 0900/23/03	26	26	47-15.0	49-16.7	90
Dragging						
G3	0900/25/03 to 0900/01/04	7	7	47-13.0	49-16.7	86
104/1983						
FD						
G1	0900/11/03 to 0900/18/03	7	7	47-35.8	49-08.0	149
Dragging						
G2	0900/19/03 to 0900/10/04	22	-	47-34.8	49-08.0	149
135/1983						
FD& dragging						
G1	0900/10/04 to 0900/11/04	1	-	47-00.0	48-02.6	137
241/1983						
G1	0900/19/04 to 0900/21/04	2	-	46-45.6	48-21.9	104
292/1983						
G1	0900/22/04 to 0900/23/04	1	1	47-00.9	48-35.9	108
Dragging						
G2	0900/24/04 to 0900/25/04	1	-	46-58.0	48-34.8	106
649/1983						
Dragging						
G1	0900/30/05 to 0900/02/06	3	3	47-06.9	48-43.0	86

* Total number of grounded icebergs is 27 and the total number of inferred groundings is 44.
* 17 icebergs had single groundings.
* 10 icebergs had multiple groundings and account for 27 groundings.
* In column 1, FD = Free drift, G = grounding numbered sequentially and a - indicates a lack of information.
* In column 2, time is local Newfoundland time.


46° 0 'W
48° 0 'N
48° 0 'N
47° 0 'N
47° 0 'N
46° 0 'N
46° 0 'N
45° 15 'N
45° 15 'N

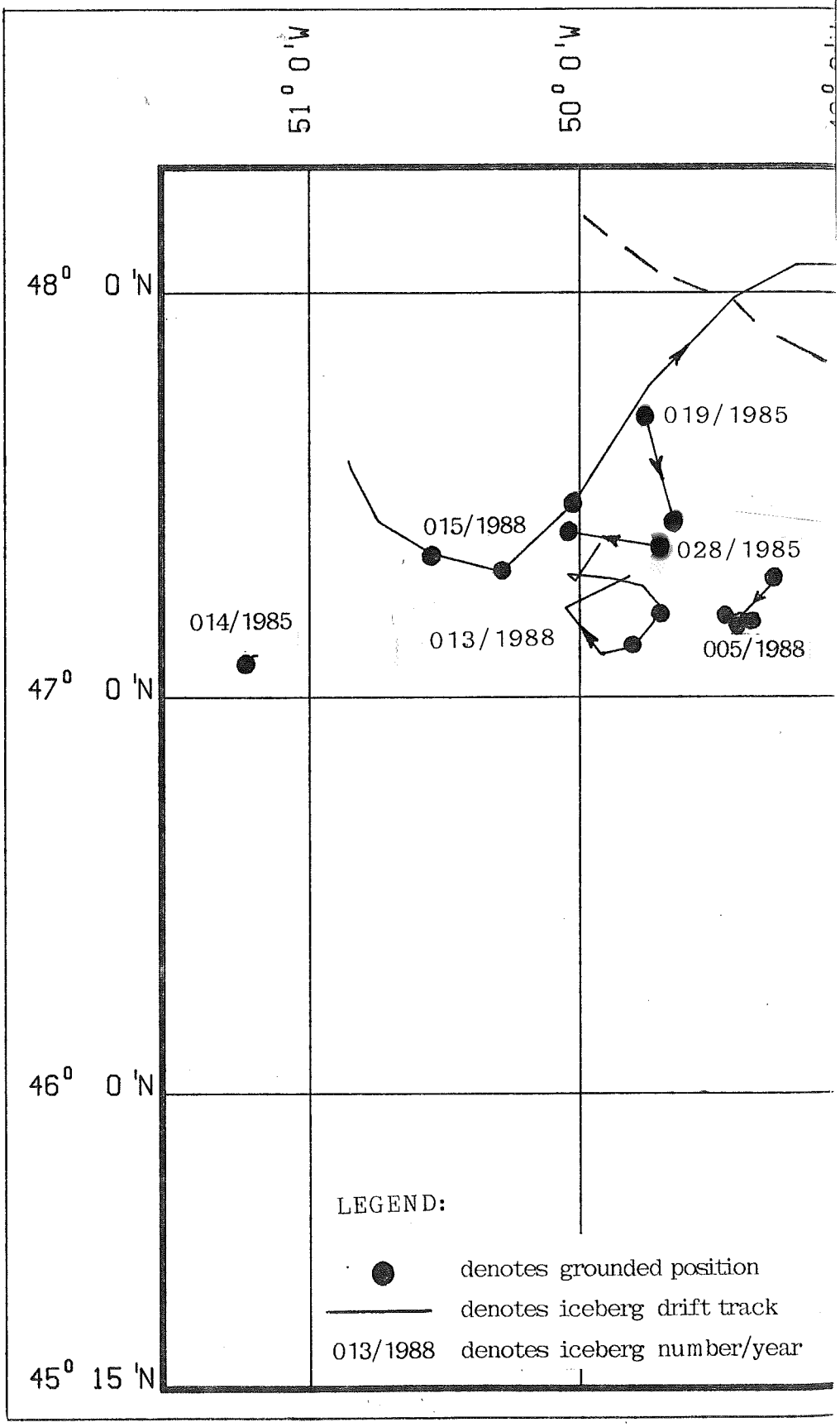
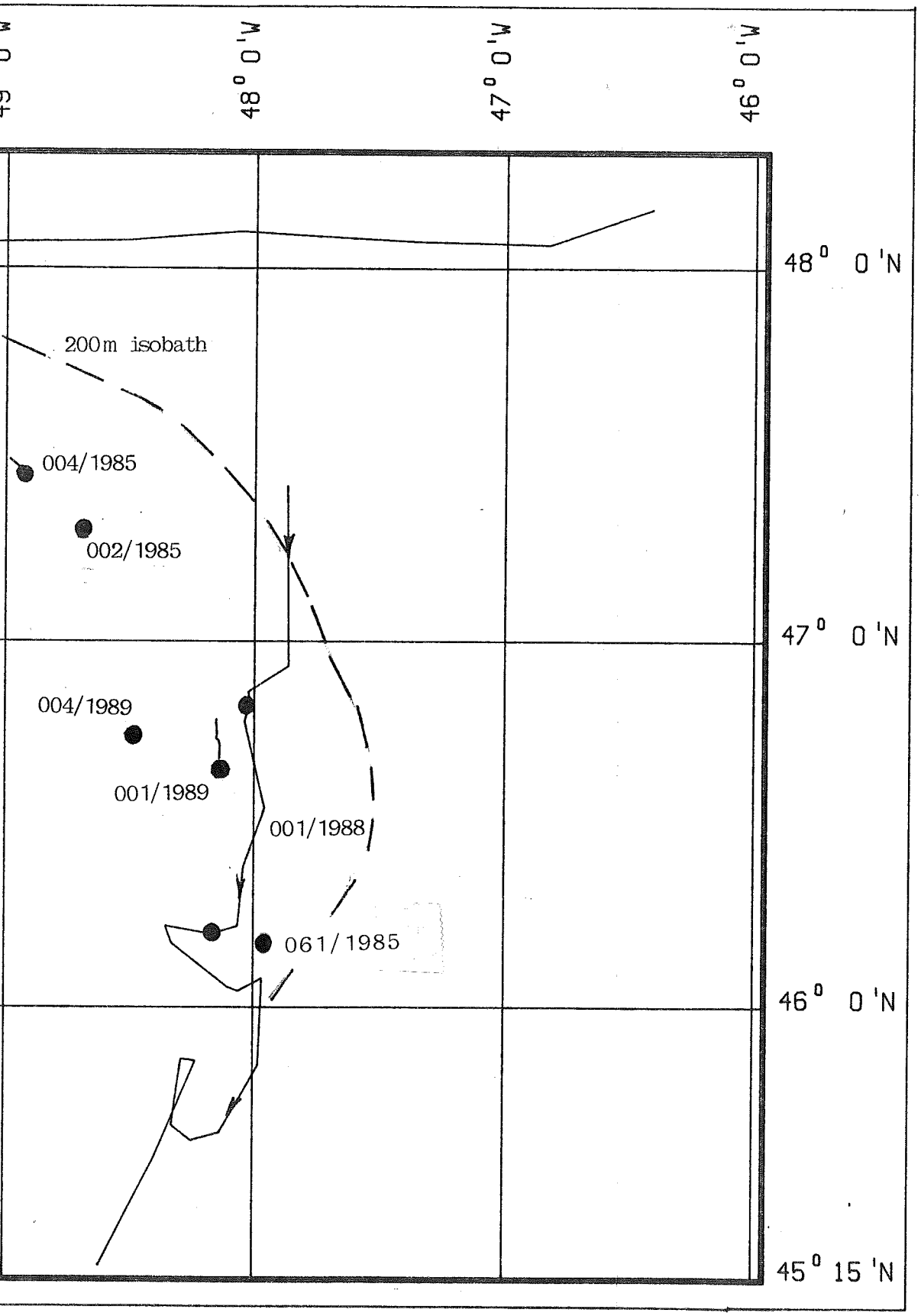


Figure 5.1 Drift tracks of 12 grounde



icebergs tracked by Husky Oil in the period 1984 to 1989

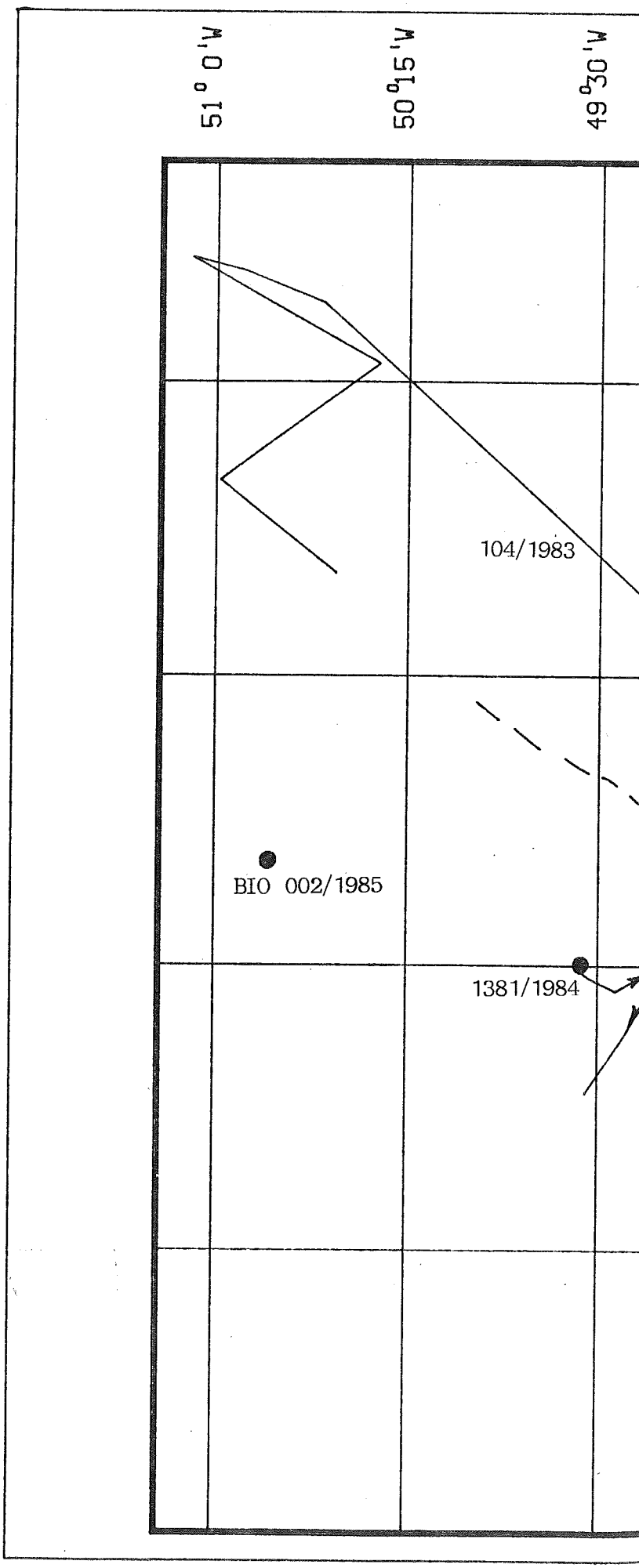
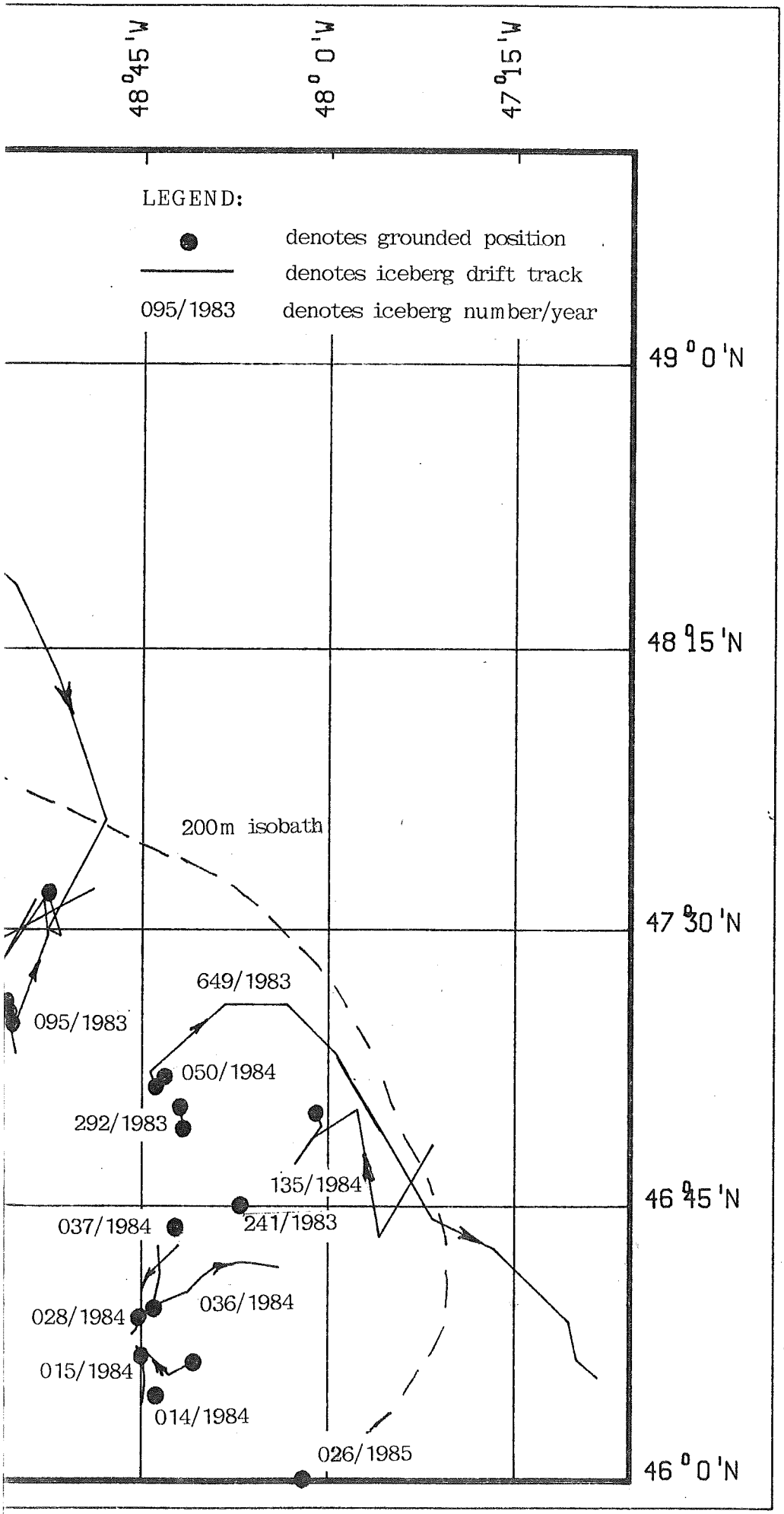


Figure 5.2 Drift tracks of 15 grounded icebergs tracke



d by Mobil Oil in 1984 and 1983 and by Petro-Canada in 1985 and 1984

Groundings can be summarized as follows:

* 44 groundings are inferred for 27 icebergs
* 17 of the 27 grounded icebergs experienced single groundings
* 10 of the 27 grounded icebergs experienced multiple groundings
* multiple groundings account for 27 of the 44 inferred groundings
* multiple groundings occurred in progressively shallower water depths
* icebergs grounded a minimum of once and a maximum of 4 times
* maximum grounding duration - 45 days
* minimum grounding duration - half a day
* all groundings occurred between 68m and 149m water depth
* the earliest grounding occurred Feb. 21; the latest on May 31.
* Annually, the inferred groundings are distributed as follows:

1989	2	icebergs	& 2	groundings
1988	4	"	& 13	"
1987	1	"	& 2	"
1986	0	"	& 0	"
1985	7	"	& 8	"
1984	7	"	& 9	"
1983	6	"	& 10	"
TOTAL	27	icebergs	& 44	groundings

Dates of first observation of icebergs in the vicinity of the Grand Banks

* 1989 - March 9
* 1988 - April 2
* 1987 - February 24
* 1986 - March 15
* 1985 - April 2
* 1984 - March 26
* 1983 - February 21

5.1 Tides

Although the exact times of lift-off of bergs from their inferred grounding positions are not known, the indicated times in Table 5.2 have been taken as the actual lift-off times. The idea of looking at tides as an agent for terminating groundings stems from a desire to determine whether current-forcing due to tidal currents or the additional buoyancy available at the peak of the tide causes the lift-off from grounded positions (although the tidal range is only about 30cm). Tides were plotted at the Bedford Institute and were referenced to determine the state of the tide at the time of lift-off for the first 9 icebergs in Table 5.2. It might be expected that lift-off would occur at the peak of the tide, when the bouyancy is greatest, but it should be noted that tidal currents are basically non-existent at that point. Therefore, at the peaks of tides, tidal currents do not assist in dislodging bergs from their grounded positions. Examination of the state of the tides at lift-off indicates that the majority of lift-offs were associated with a rising tide and a minority occurred on a falling tide or at a low tide. This suggests that tidal currents contribute to forcing bergs away from grounded positions and that the additional buoyancy at the peak of the tides is less important. This may have implications regarding keel dragging and scouring by bergs after grounding. As far as the influence of tides on the groundings is concerned, it is found that bergs can ground at any point on the tide. Of course, a berg is more likely to ground solidly if grounding occurs at the peak of the tide. When the water level drops, there is greater opportunity for the berg to seat itself into the

seabed. When a berg grounds at low tide, it is expected that lift-off and drift away from the grounded position occurs more readily on subsequent rising tides. For icebergs such as berg 001/1989 which probably had about 5m of excess draft at the grounding location, the tidal changes could only become significant after considerable berg deterioration and draft reduction.

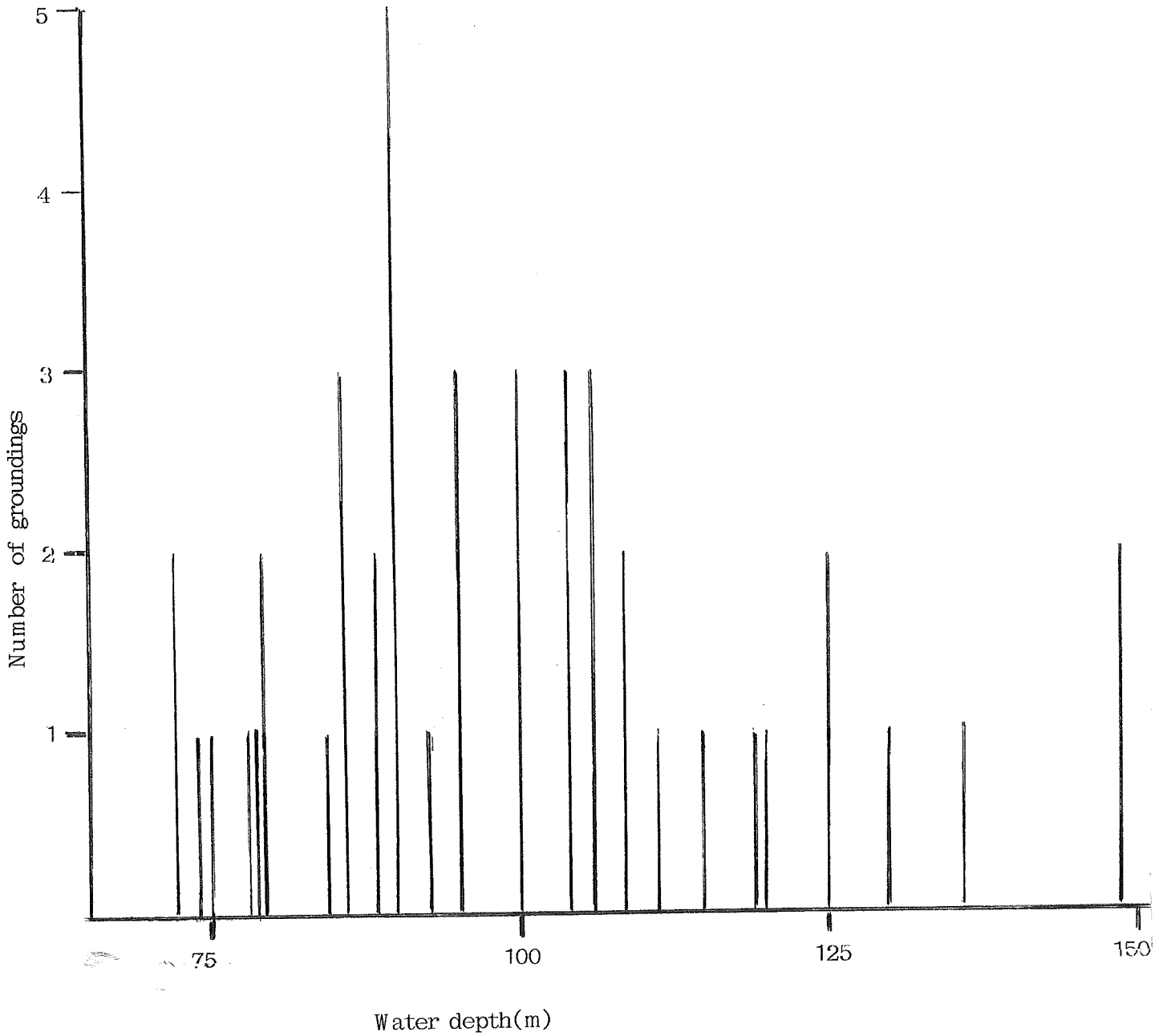
5.2 Multiple groundings and draft reduction

Of the 27 large icebergs listed in Table 5.2, 17 had a single inferred grounding and the remaining 10 bergs experienced multiple groundings. The multiple groundings account for 61%; ie 27 of the 44 inferred groundings. In each multiple grounding sequence, each berg grounded in progressively shallower water (refer Table 5.2), which is to be expected. A grounded berg tends to lose mass by wave activity and calving of growlers by splitting and by rolling: all of these activities result in the general reduction of a bergs draft. It is therefore expected that any groundings subsequent to the previous grounding will occur in progressively shallower water depths. It is considered unlikely, but not impossible, for a berg to ground in water depths greater than the previous grounding. The rate of loss of draft can be inferred from the present data set because the times and water depths of multiple groundings are known. The rate of loss of draft varies from 0.2m/day for berg 095/1983 which was grounded for 35 days in February and March 1983, to a rate of 3m per day inferred for berg 013/1988 which grounded during April, 1988. The average rate of loss of draft was 1m/day.

5.3 Iceberg draft and grounding distribution with depth

Grounding depths of the 27 bergs, which grounded 44 times, varied from a maximum of 149m to a minimum of 74m. The distribution with depth is shown in Fig. 5.3. Twenty-one of the groundings occurred in depths of 100m and greater. All 44 groundings had occurred in water depth of 74m and greater.

Figure 5.3 Grounding distribution with water depth



6. AERIAL ICE RECONNAISSANCE

Aerial reconnaissance flights were flown on a regular basis by Atlantic Airways to monitor the presence of packice and icebergs in the Grand Banks area. A typical ice reconnaissance map for March 10, 1989 is presented in Fig. 6.1; Fig. 6.2 shows the corresponding ice report, indicating the presence of about 90 icebergs and packice north of and on the Grand Banks on the 11th of March, 1989. It can be seen that the majority of the icebergs were staged near the packice edge inside the 200m isobath at the time. It is obvious from reviewing ice reconnaissance maps in Appendix B, that many more icebergs existed than were included in the trajectory data base. Air reconnaissance maps were therefore reviewed in order to develop a better understanding of the iceberg population from which grounded icebergs originated. Unfortunately, ice reconnaissance maps for 1986 and 1983 could not be found. The maximum number of icebergs seen on each flight in 1984, 1985, 1987 and 1988 has been tabulated in Table 6.1 The maximum (about 600) was observed in April 1984. On some flights, no icebergs were observed. Icebergs reported by ice reconnaissance maps, presented in Appendix B, are discussed below with reference to Tables 6.1 and 6.2.

1984: In 1984, a maximum of about 600 icebergs were reported (on April 3). This concentrated batch of icebergs dispersed quickly and by May 12, only 14 icebergs were logged on the ice reconnaissance maps. In 1984, Husky tracked icebergs on the northeastern Grand Banks while the International Iceberg Patrol (IIP) reported 2202 icebergs crossing south of 48°N. Although

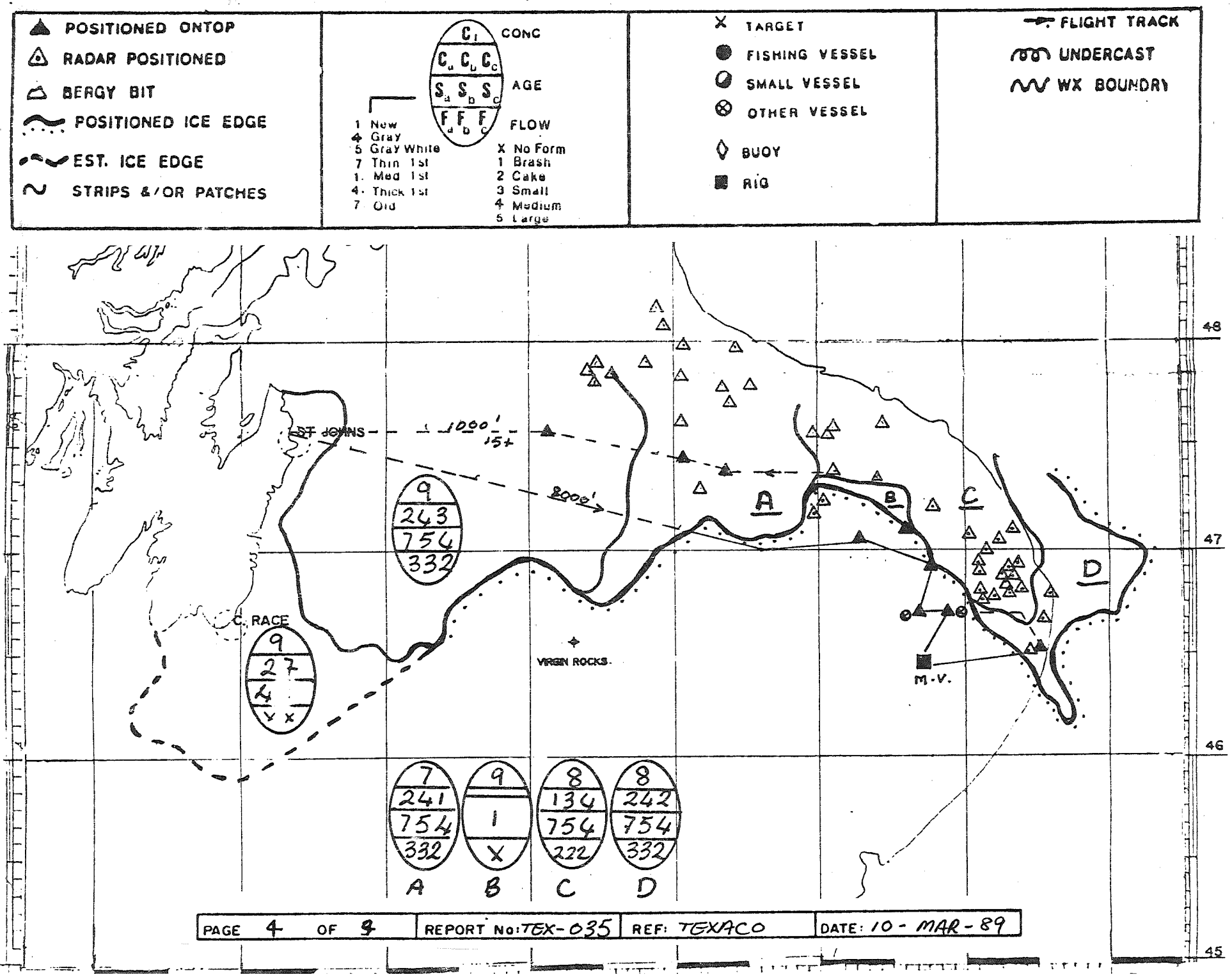


Figure 6.1 Ice reconnaissance map for March 10, 1989

Figure 6.2 Husky Oil Daily Ice Report 0800L March 11, 1989

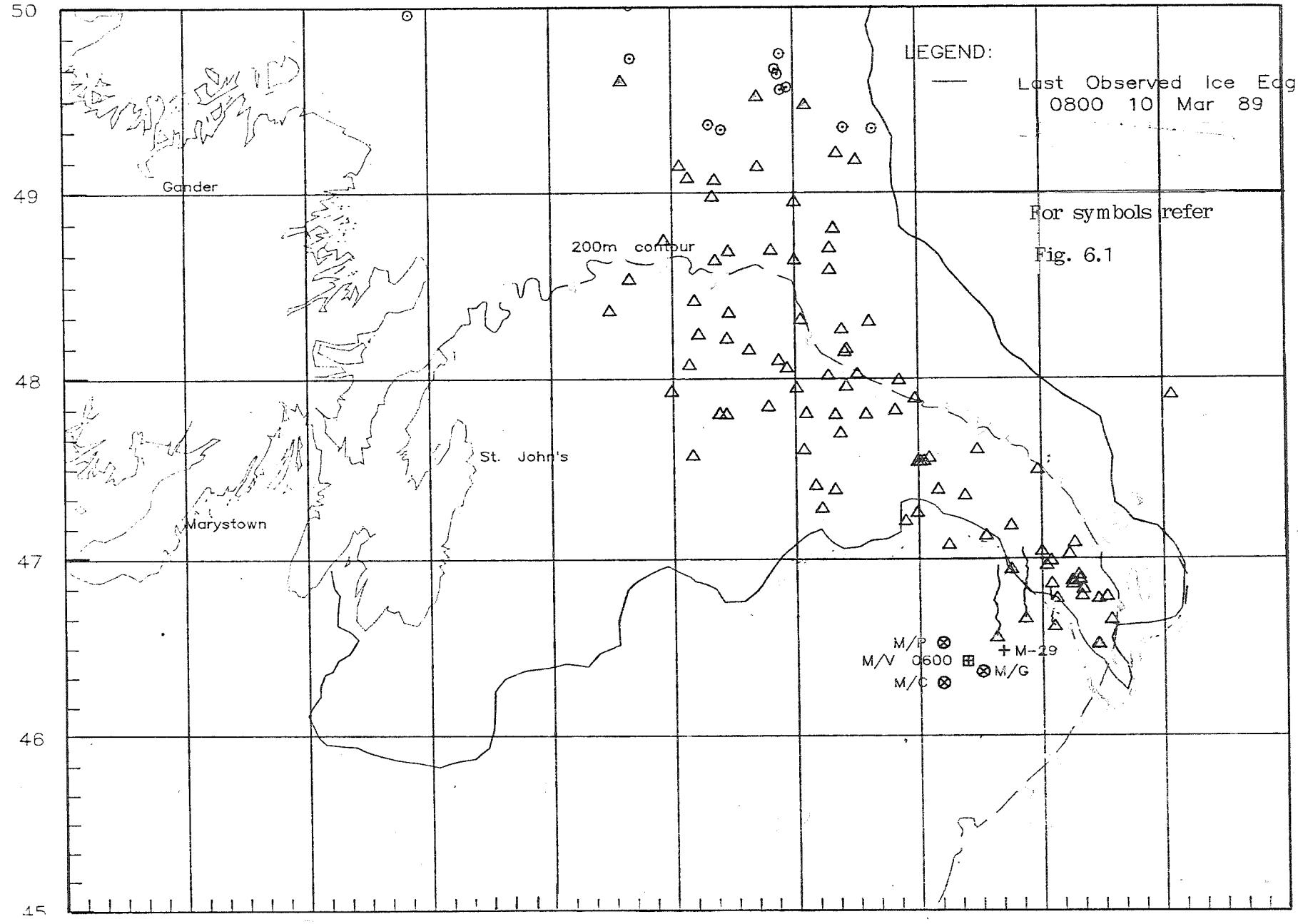


TABLE 6.1 Summary of icebergs reported by ice reconnaissance

1984		1985		1987		1988	
Day	# of bergs	Day	# of bergs	Day	# of bergs	Day	# of bergs
Ap. 2	400-600	Ap. 1	17	Feb. 27	7	Ma. 23	68
Ap. 5	306	Ap. 6	30	Ma. 12	5	" 28	60
Ap. 6	524	Ap. 9	19	Ma. 23	2	Ap. 2	11
Ap. 19	180	Ap. 15	37	Ap. 8	0	" 4	20
Ap. 21	65	Ap. 23	29	" 12	5	" 6	47
Ap. 23	43	May 13	76	" 13	10	" 16	20*
Ap. 24	16	" 15	123	" 18	9	" 20	4
Ap. 25	32	" 17	86	" 20	17	" 25	4
May 3	28	" 20	220+	" 23	10	" 29	4
May 5	18	June 4	137			May 6	4
May 9	17					" 16	3
May 12	14					" 28	71**
						June 9	8
						" 17	17
						July 7	5
						" 14	2

Source: Appendix B. Note that the 1986 ice reconnaissance maps could not be found

* implies that the bergs were mostly inshore

** bergs situated N W of the Banks

TABLE 6.2 Summary of new icebergs south of 48°N during 1983 to 1988

	New icebergs south of 48°N.					
Month	1983	1984	1985	1986	1987	1988
Jan.	9	0	2	0	2	0
Feb.	165	0	57	3	14	0
March	124	101	129	40	48	8
April	339	953	208	60	76	95
May	465	484	205	59	29	33
June	168	227	247	24	127	20
July	76	335	123	18	15	19
Aug.	4	93	39	0	2	10
Sept.	0	9	32	0	0	2
Oct.	0	3	0	0	0	0
Nov.	0	11	0	0	0	0
Dec.	0	7	0	5	0	0
TOTAL	1350	2223	1042	204	313	187

Source: International Ice Patrol

* SLAR was in use from 1984.

* Note the IIP count is slightly different from the totals in Table 6.2 because IIP's iceberg year extends from Oct. 1 to Sept. 30 & the above numbers pertain to the January 1 to December 31 period of each year.

this is the largest number of icebergs ever to be reported by IIP, only 7 iceberg groundings are inferred in 1984. This is attributed to the fact that the packice did not encroach onto the Grand Banks, remaining mainly beyond the 200m isobath that year (Fig. 6.3). When the packice receded northwards, the icebergs were released from the packice beyond the 200m isobath in deeper water within the regime of the Labrador current. As a result, the majority of the icebergs drifted around the Banks instead of being carried onto the Banks and potentially grounding.

1985: In 1985, the packice encroached onto the Grand Banks inside the 200m isobath as well as southward into Flemish Pass (Figs. 6.4 and 6.5). Seven icebergs are inferred to have grounded in the 1985 iceberg season. Even though many more icebergs crossed 48°N in April 1984 (a total of 953) than in April 1985 (a total of 208), the packice encroached onto the Banks only in 1985. Thus, the seven icebergs inferred to have grounded in that year are attributed to the emplacement of a population of icebergs on the Banks by the packice.

1986: The number of icebergs arriving was greatly reduced in 1986, totalling only 204 (reported by IIP) for the year. Husky tracked only 35 icebergs and no groundings were inferred. This result is attributed to the scarcity of bergs. The packice encroached onto the Banks in 1986 (Fig. 6.6) and except for the lack of bergs in April and May, groundings would probably have occurred.

1987: In 1987, easterly winds forced packice and icebergs to hug the coastline (Fig. 6.7). As a result, the packice did not reach the Banks. Husky tracked only 39 icebergs in all of 1987 and IIP

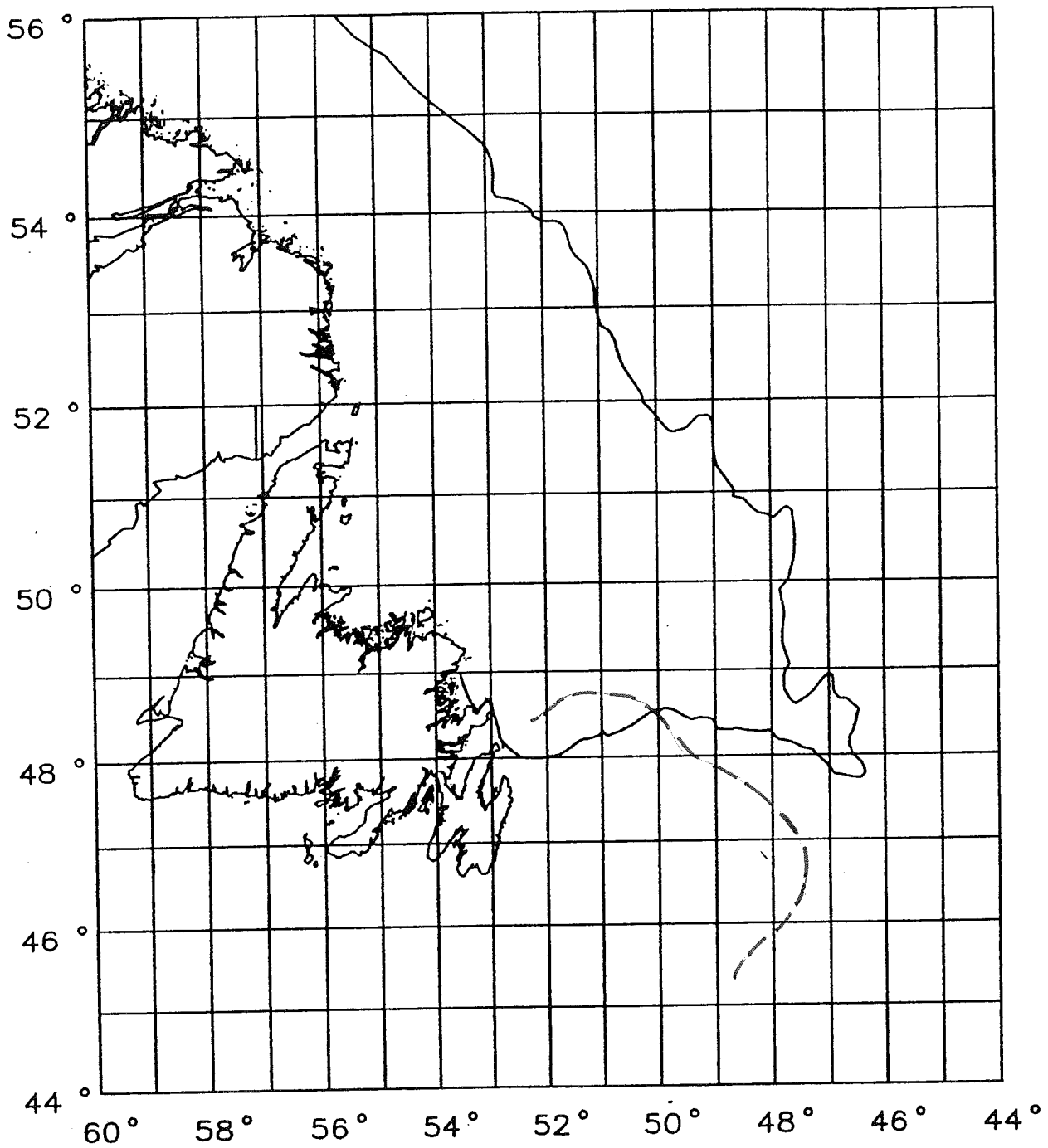


Figure 6.3 Sea Ice Edge For For March 29,1984 Digitized From AES Composite Maps

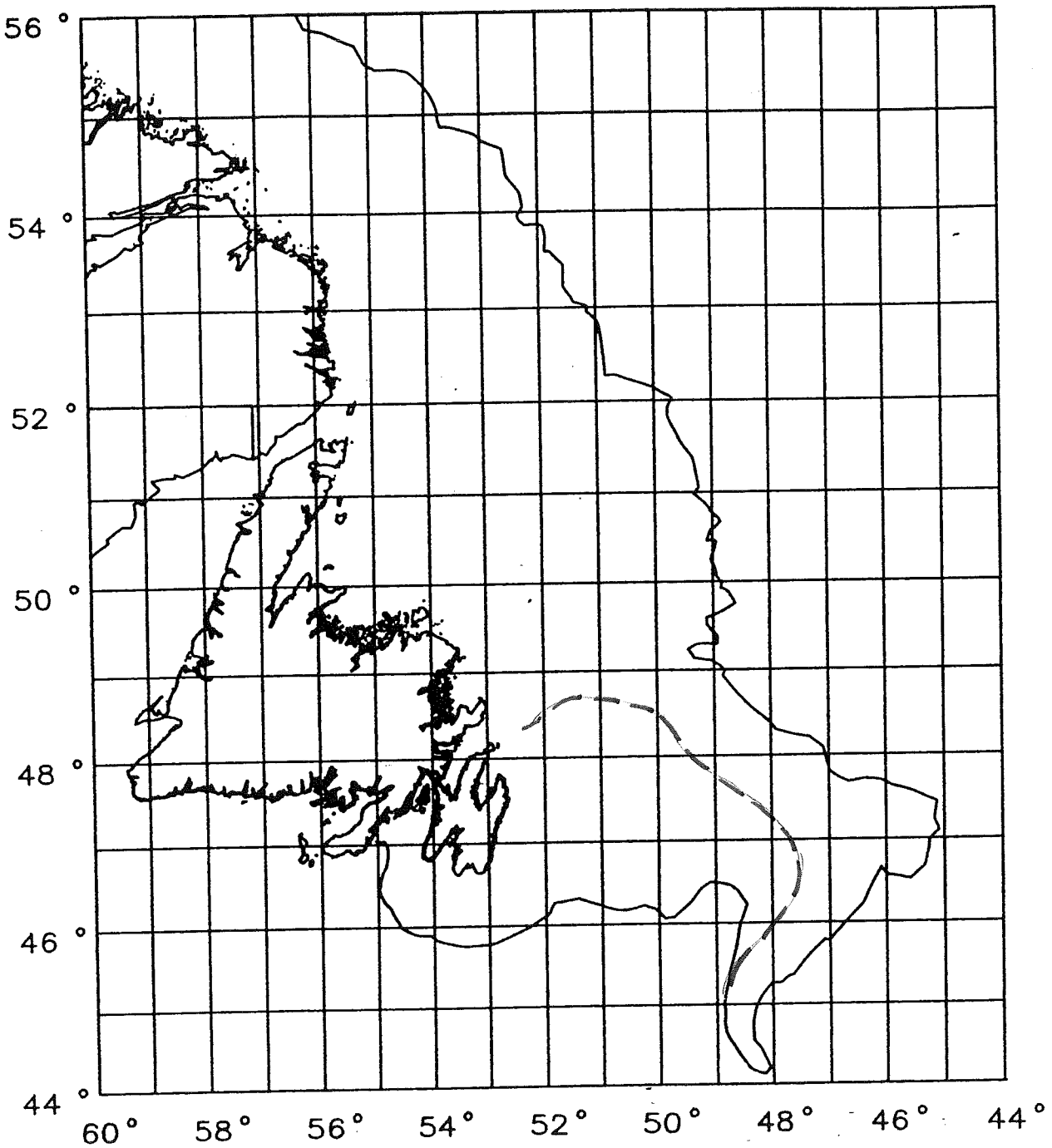


Figure 6.4 Sea Ice Edge For March 10,1985 Digitized From AES Composite Maps

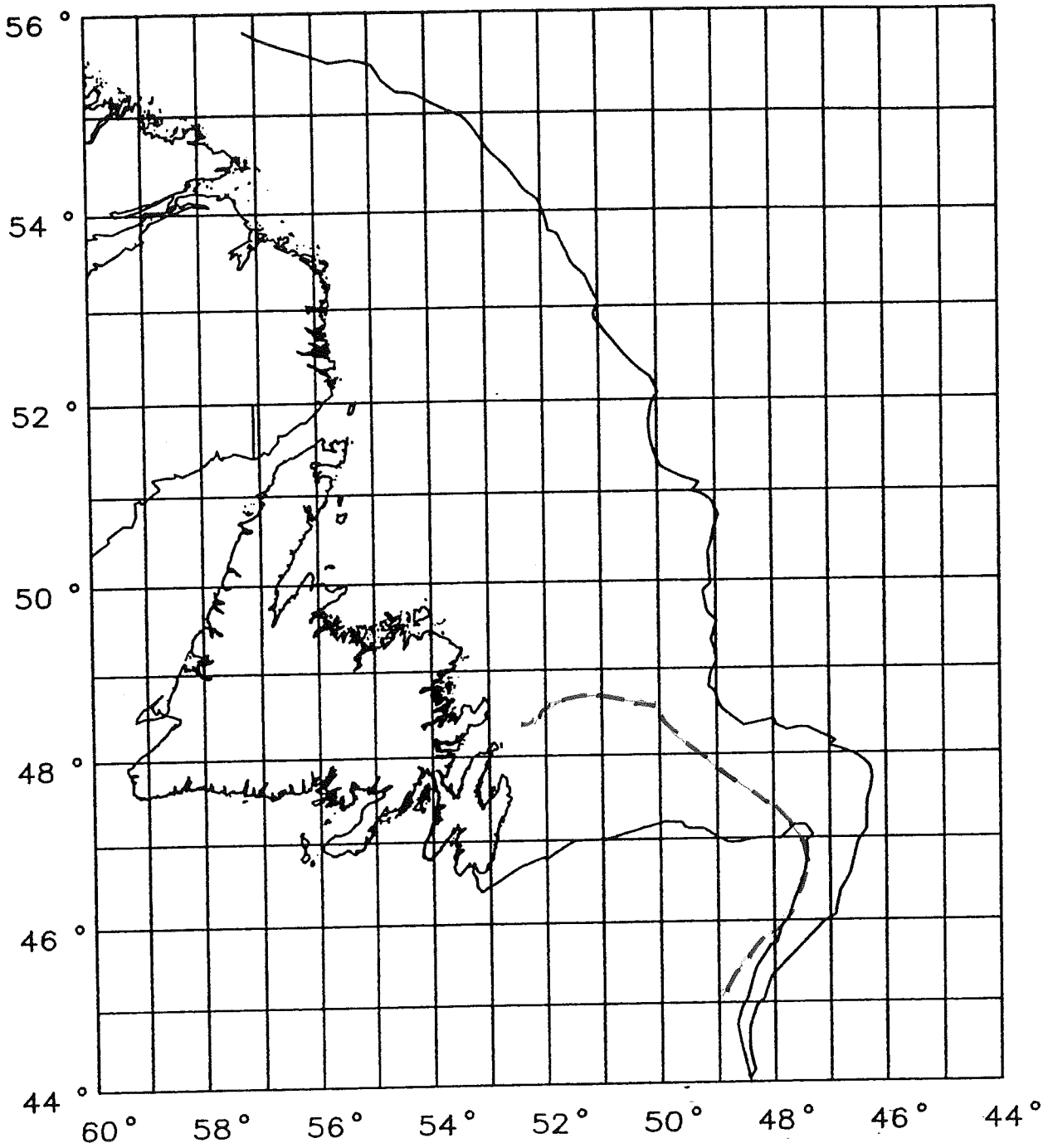


FIGURE 6.5 Sea Ice Edge For March 20,1985 Digitized From AES Composite Maps

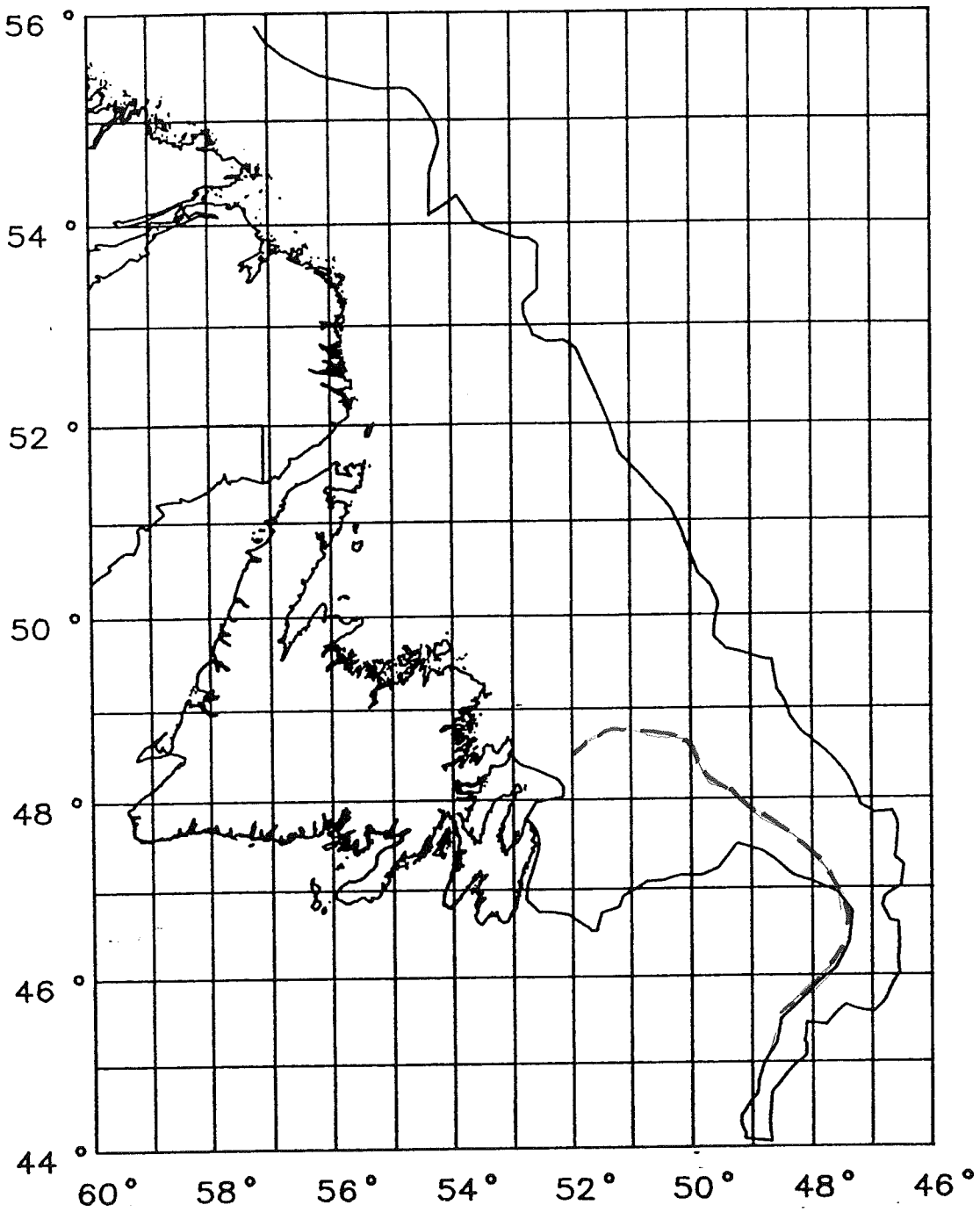


Figure 6.6 Sea Ice Edge For March 23,1986 Digitized From AES Composite Maps

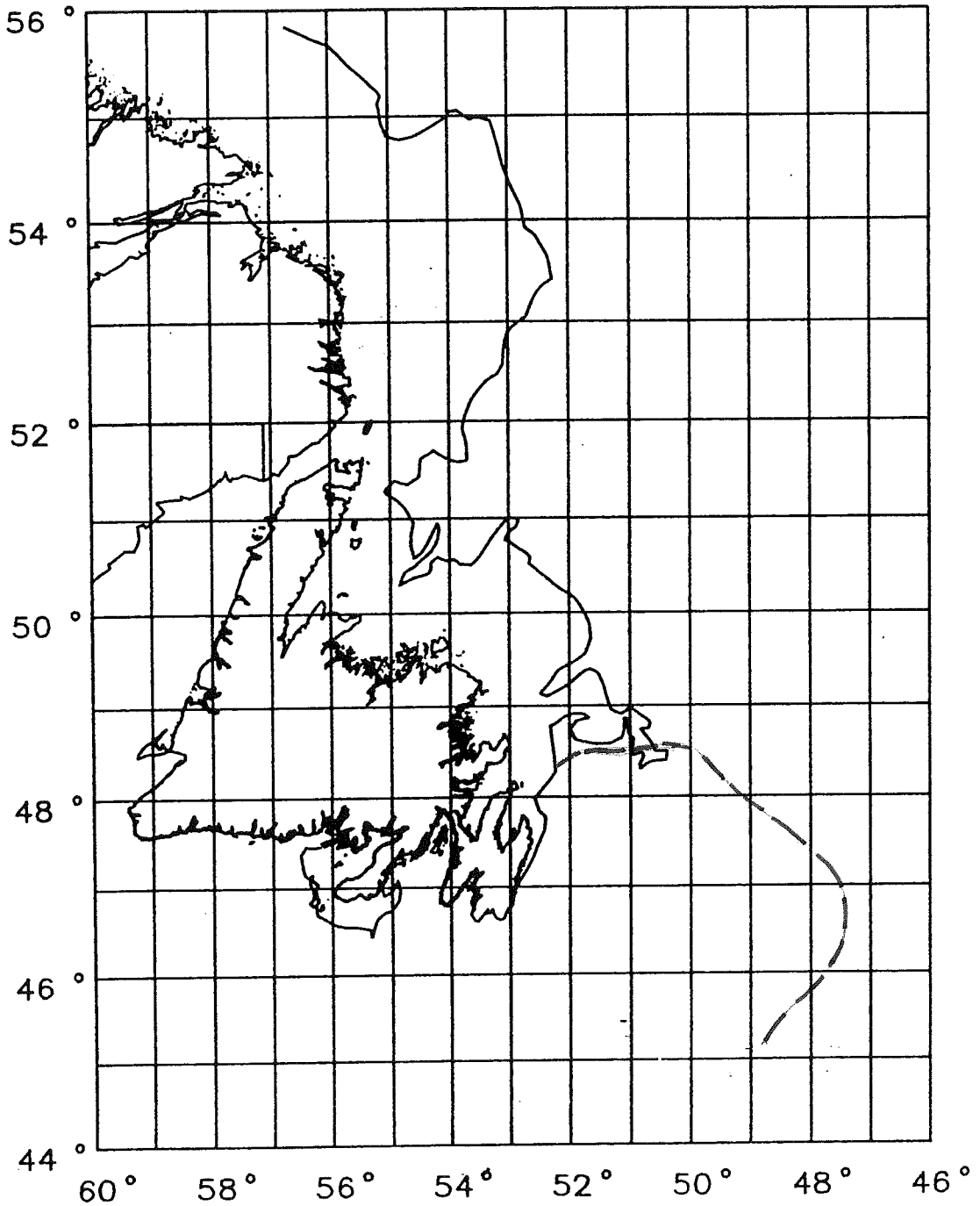


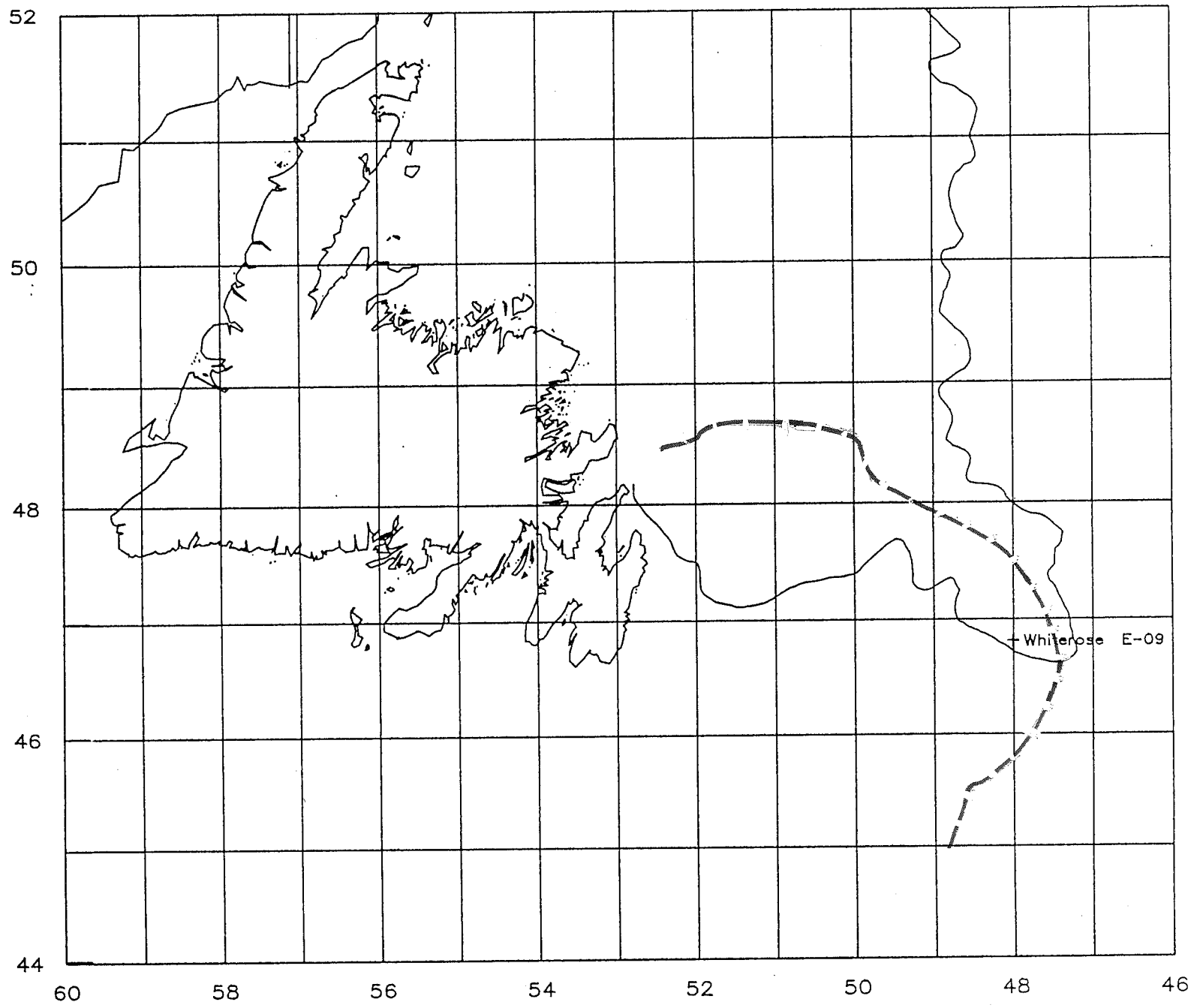
Figure 6.7 Sea Ice Edge For April 15,1987 Digitized From AES Composite Maps

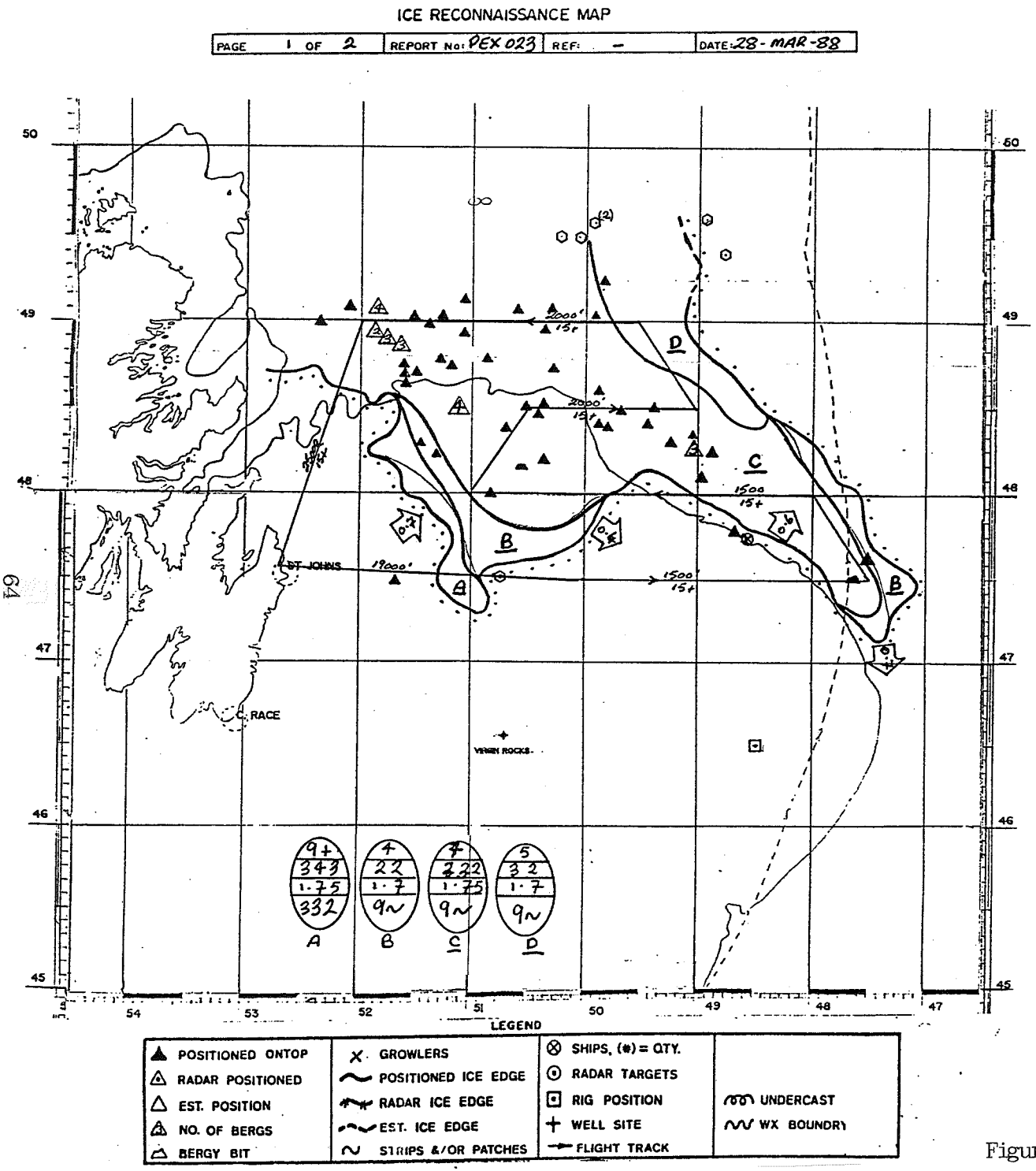
tracked a total of only 313 icebergs. Many of the reported icebergs were situated in the Avalon Channel close to Newfoundland. One iceberg grounding was inferred in 1987, presumably owing to the lack of packice on the Grand Banks and a relatively small iceberg population.

1988: In 1988, packice extended as far south as 47°N and into the Flemish Pass (Fig. 6.8), depositing about 60 icebergs just outside the 200m isobath on March 28 as observed by ice reconnaissance (Fig. 6.9). High easterly winds during early April drove the bergs across the Banks in a south-westerly direction (Fig. 6.10) leaving 4 grounded (Fig. 6.11). When the drill rig returned on April 21, seven of the 18 icebergs observed in 1988 were on track. Included in this count were the four grounded icebergs and 3 smaller ice masses presumed to have calved from the 4 grounded bergs. More small ice masses were calved later for a total count of 18 tracked icebergs. IIP tracked a total of 187 icebergs in 1988.

1989: In 1989, the packice extended early and far onto the Banks (Fig. 6.2) according to the aerial ice reconnaissance reports. Release of about 90 bergs from the packice commenced about March 9, which is somewhat earlier than usual. Two of the first four icebergs tracked in 1989 are inferred to have grounded. No total berg count is available from Husky for the current year, nor is a total count available from IIP.

Figure 6.8 MAXIMUM SOUTHERLY AND EASTERLY EXTENT OF SEA ICE - 1988





DATE: 88/3/28

PILOT: Jon Lee

OBSERVER: Pip Rudkin

OTHER: J

TASK AREA/ROUTE NO: 2

TIME OFF: 1227

TIME ON: 1716

TOTAL AIR TIME: 4.8

PREVAILING VISIBILITY: 15+

AVERAGE ALTITUDE: 2000ft

AVERAGE WIND: W-15

AVERAGE SEA STATE: 1-2m

TOTAL TARGETS: 9

TOTAL VESSELS: 0

TOTAL BERGS: 60

Figure 6.9 Ice reconnaissance map, March 28, 1988

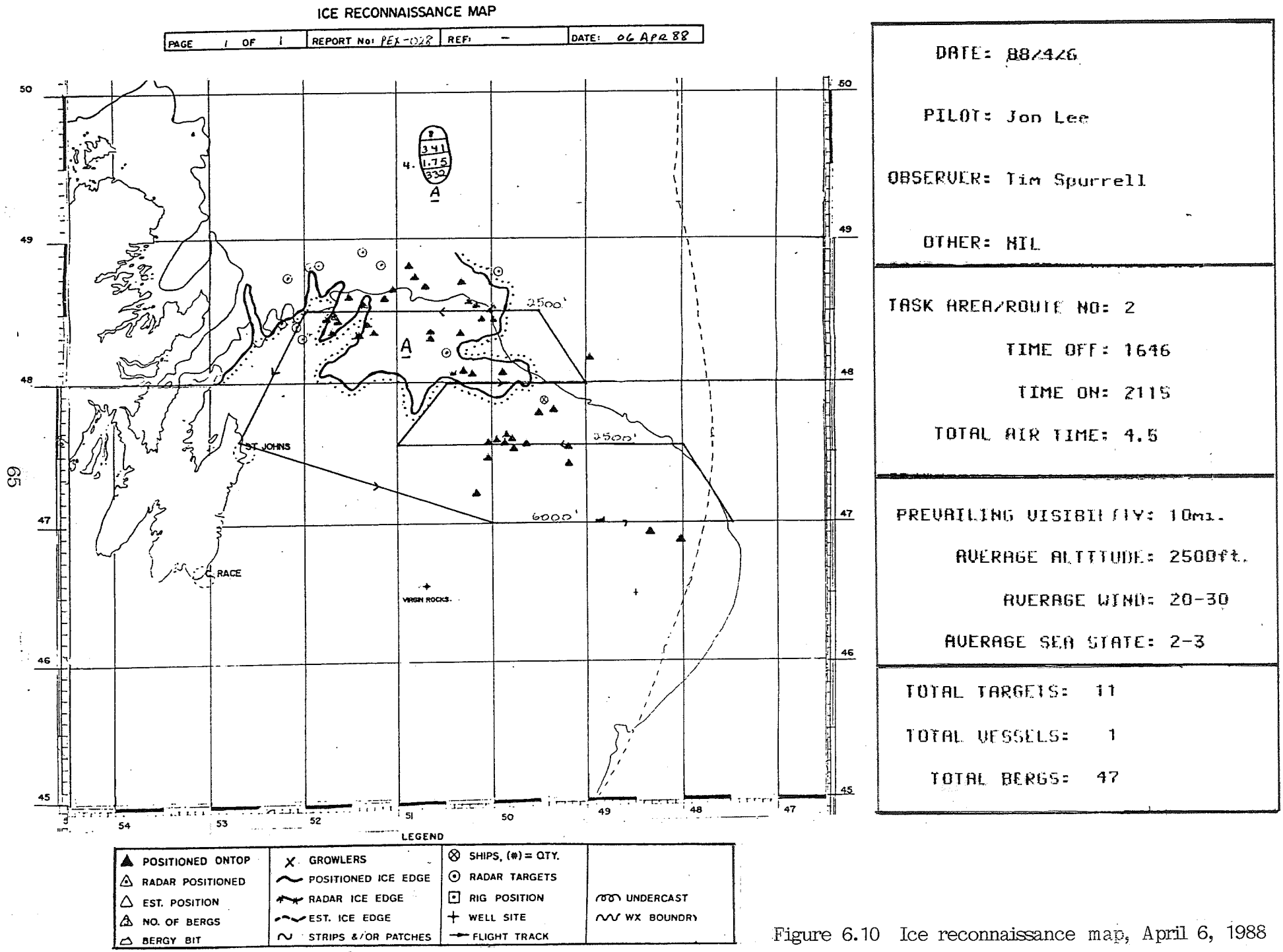
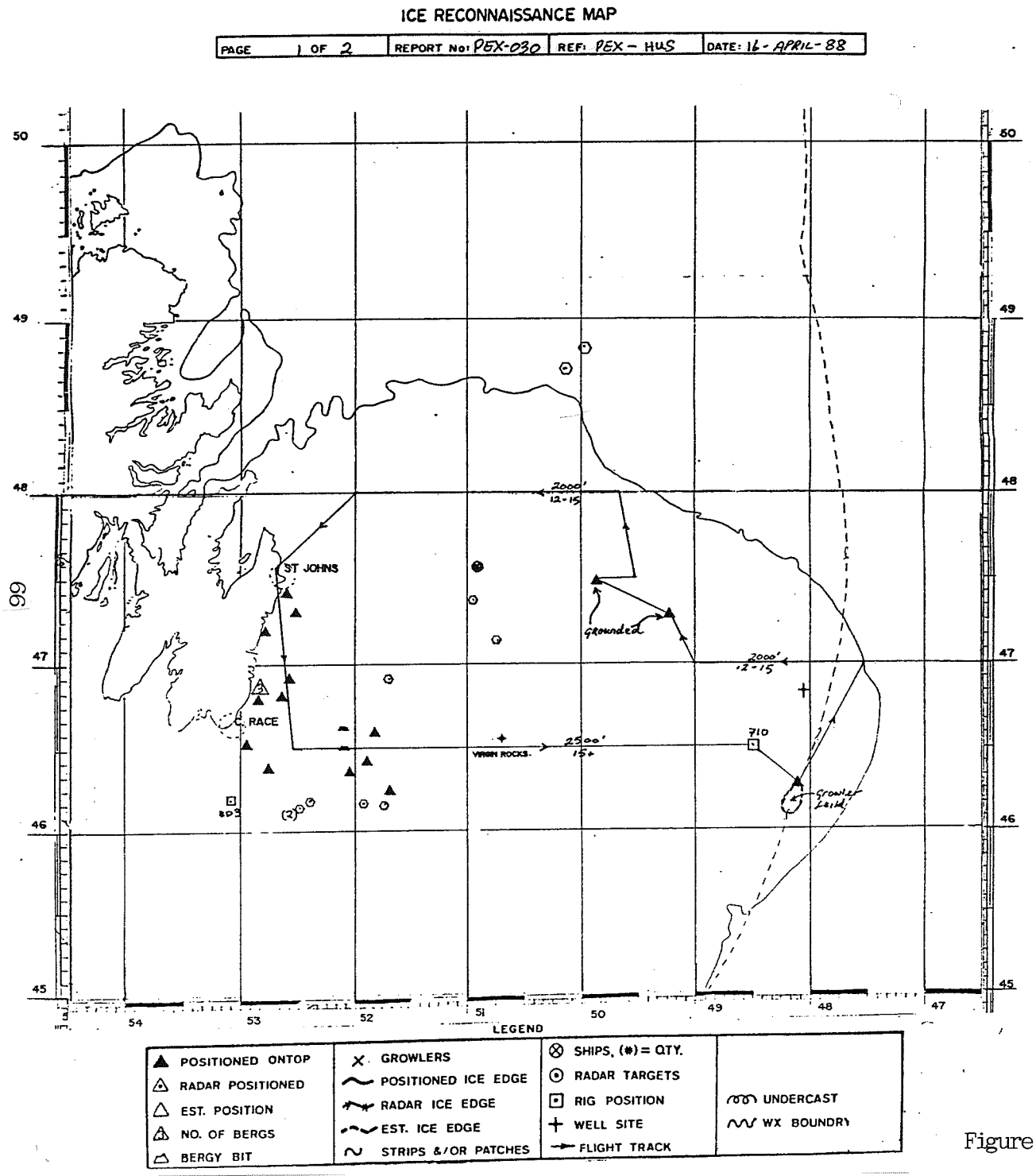


Figure 6.10 Ice reconnaissance map, April 6, 1988



DATE: 88/4/16

PILOT: Mark Knowles

OBSERVER: Pip Rudkin

TASK AREA/ROUTE NO:

TIME OFF: 1340

TIME ON: 1805

TOTAL AIR TIME: 4.4

PREVAILING VISIBILITY: 12-15

AVERAGE ALTITUDE: 2000ft

AVERAGE WIND: N-15

AVERAGE SEA STATE: 2-3m

TOTAL TARGETS: 10

TOTAL VESSELS: 1

TOTAL BERGS: 20

Figure 6.11 Ice reconnaissance map, April 16, 1988

7. DISCUSSION

The data base, which consists of icebergs tracked by oil companies on the Grand Banks from 1983 to 1989, has proven useful in inferring occasions of definite groundings. Based on the analysis of the drift track data, definite groundings, inferred by zero drift/stationarity for at least 24 hours, were experienced by 27 icebergs. A total of 44 groundings are inferred for the 27 bergs and the results are summarized in section 5.

Iceberg count and percentage of grounded icebergs.

In Table 7.1, the number of grounded bergs and the percentage of bergs grounded are presented. Before jumping to conclusions about the total berg population from which grounded bergs derived, it should be noted that the Petro-Canada and Mobil Oil iceberg counts are considered to be subsets of the larger counts by Husky Oil in 1984 and 1985. The reason for this is that Husky Oil was drilling at more northerly locations and Husky Oil rigs observed more icebergs than were observed from other rigs. In 1984, 112 icebergs were counted by Husky Oil and the approximately 70 bergs counted by Mobil Oil and the 57 bergs counted by Petro-Canada are considered subsets of the 112. Likewise, in 1985, the 84 bergs counted by Petro-Canada at North Trinity and the 75 bergs counted at North Ben Nevis are taken as subsets of the much larger (234) berg count made by Husky Oil. These two Petro-Canada drilling locations are very close and therefore, the larger count is presented in Table 7.1. The percentage of tracked icebergs which grounded or the frequency of

TABLE 7.1 Iceberg Statistics

Year	Operator	Number of tracked icebergs.	Grounded iceberg numbers.	Number of grounded icebergs.	Percentage grounded.
1983	Mobil Oil	736	095, 104, 135, 241, 292, 649.	6	0.9 0.0
1984	Husky Oil	112	none	0	0.0
	Mobil Oil	70*	037, 050, 1381	3	5.7
	Petro-Canada	57*	014, 015, 028 036.	4	7.0
1985	Husky Oil	234*	002, 004 014, 019, 061.	5	2.1
	Petro-Canada	84*	026.	1	1.2
	BIO data	1	BIO 002.	1	not applic.
1986	Husky Oil	35	none	0	0.0
1987	Husky Oil	39	028.	1	2.6
1988	Husky Oil	18	001, 005, 013, 015	4	6.7**
1989	Husky Oil	not available	001, 004.	2	not applic.

* Mobil Oil and Petro-Canada tracked iceberg populations are considered to be subsets of the larger Husky Oil iceberg population.

**Note that Husky Oil tracked 18 bergs but the population from which the 4 grounded bergs originated was 60 as observed by air reconnaissance prior to drift across the Grand Banks.

grounding have been calculated. The values range from a low of zero% to a high of 7%, the mean value being 2.5%. This compares reasonably well with the 4.5% value derived by El Tahan et al, 1985 for well sites along the coast of Labrador. There is obviously a large spread in the frequency of groundings but the data suggests that about 2.5% of the icebergs tracked in the area of inferred groundings (Figs. 5.1 and 5.2) can be expected to ground. It is sometimes difficult to decide which count of icebergs to use in the assessment of frequency of grounding. For example, in 1988, Husky Oil had 18 bergs on track. From this information, one would conclude that 4 of the 18 bergs had grounded. In fact, the 4 bergs were part of a larger population of about 60 bergs which were seen by search radar. As it turned out, this larger population drifted across the Grand Banks in a south-westerly direction due to a major north-east wind event. Four of the 60 bergs were too large and grounded. Subsequently, calving of 14 other identifiable ice masses occurred. This accounts for the 18 bergs tracked by Husky Oil in 1988. If the 18 bergs had been taken as the source population for grounding, the percentage frequency of grounding would ahve been 22.2%. The reason for Husky's low count of bergs in 1988 is that drilling was suspended when the 60 bergs were present, and because 1988 was a year with few ice bergs on the Grand Banks.

The Grand Banks acts as a filter. Bergs with drafts less than about 68m will not ground on the north-east and northern part of the Banks. Although the groundings inferred in this study are considered to represent a good estimate of definite groundings as per specified criteria, the number should be taken as a MINIMUM.

The reason for this is that a number of other bergs were noted as being grounded for short periods by supply vessels. The short term groundings are not included in the count of definite groundings because the stringent criteria were not met. Another important reason for considering the derived count of grounded bergs as a minimum is that the observation periods did not always include the entire iceberg season. The presence of packice and icebergs precluded drilling operations on a number of occasions.

ICEBERG TRANSGRESSION ONTO THE GRAND BANKS

In an effort to come to grips with the question of the portion of bergs which come up onto the Grand Banks and the portion which remains in the Labrador Current regime, the drift tracks of all icebergs tracked by Husky Oil during 1984 and 1985 were plotted. These data were plotted because:

1) a large number of bergs were tracked in 1984 and 1985.

2) it was possible to plot and examine all drift tracks in Husky's data set for 1984 and 1985 in the area defined by 46°-30°N to 48°-30'N and 47°W to -49°-30'W.

3) we have full confidence that collective industry data identified all large icebergs grounded within the area defined by 45°-58'N to 47°-45°N and 47°W to 49°-30'W.

The greatest observed depth of grounding is 149m, and therefore the 150m depth contour has been taken as the boundary between the Grand Banks and the Labrador Current regime. A count was made of the icebergs within the 150m isobath for 1984 and 1985. For the area analyzed (46-30°N to 47°-45'N and 47°W to 50°-30'W), the following results apply:

In 1985: *48 of the 234 icebergs tracked by Husky Oil transgressed within the 150m contour line.

* five of the 48 icebergs, which transgressed onto the Grand Banks, are inferred to have grounded.

*the percentage of the iceberg population transgressing onto the Grank Banks is 48/234=20.5%.

Note: 1 additional iceberg grounded within the 150m contour line, but it was situated west of the specified area and 1 other berg grounded within the 150m contour line south of the specified area.

In 1984: *9 of the 112 icebergs tracked by Husky Oil transgressed within the 150m isobath and three other bergs tracked by Mobil Oil are inferred to have grounded. Also, 4 bergs tracked by Petro-Canada are inferred to have grounded.

* none of the icebergs tracked by Husky Oil are inferred to have grounded.

* the percentage of the iceberg population which transgressed onto the Grand Banks is (9+3+4)/112=14.3%.

We do not know the proportion of icebergs from Petro-Canada and Mobil Oil iceberg data sets, which transgressed the 150m isobath, but we know by inference that icebergs in these data sets grounded and therefore must have transgressed the 150m contour line. These bergs are taken to be part of Husky's population of icebergs. The data are presented in Table 7.1.

Relationship between IIP iceberg count south of 48°N and the iceberg count by Oil companies which operated on the Grand Banks

It is the opinion of Husky Oil (Mr. Tom Murphy, percomm., 1989) that all icebergs were observed and tracked by Husky Oil within 100nm in the west to north quandrant from their northern drill

rig on the Grand Banks. Their confidence was based on the four levels of ice-surveillance available.

1) Atmospheric Environment Service SLAR flights.

2) dedicated site-specific radar flights with SLAR initially, then with a Litton V3 search radar and finally with a Litton V5 search radar.

3) supply vessel surveillance.

4) continuous radar surveillance from each drill rig.

The most intense surveillance was concentrated near rig locations of course, but surveillance extended as far west as 51°-15'W from about 47°-30'W, a distance of 165nm. The total iceberg counts made by industry on the Grand Banks are quite small compared with the count of icebergs south of 48°N by IIP. However, we have confidence that the vast majority of icebergs on the Grand Banks were tracked by collective industry surveillance, and attribute the larger IIP count to the following:

* IIP counts icebergs throughout the entire year
* Industry counted icebergs while operating and missed part of some iceberg seasons.
* IIP counts all icebergs south of 48°N from the Newfoundland coast and eastward; this is a much greater area than the area of interest to industry operating on the Grand Banks.
* The bergs drifting through the Avalon Channel and eastward north of 48°N were not generally counted by industry.

For all the above reasons, it is not surprising that IIP counts are always greater than industry counts.

Although the definite groundings derived in this study are considered as a minimum, and other possible groundings are a certainty, it would be erroneous to apply the derived frequency of grounding to the total count of bergs by IIP. The bottom line

is that all definite grounded bergs were tracked and apart from some other possible groundings of short duration, the number of definite groundings inferred in this study is all there is.

Scour Rate

In the present study, the rate of scouring is inferred from inferred groundings in the northern Grand Banks area. The region of groundings extends from 45°-58°N to 47°-45'N and from 48°W to 51°-15'W, between the 68m and the 150m isobaths, an area of about 31000km^2. Thus, the annual scouring rate is estimated as 44 scours/31000 km / 7 years = 0.020 scours/100 km^2 - year. The rate derived above from the 1983-9 iceberg data is about half of the lowest rate estimated by Lewis et al (1987). Lewis et al concluded that the annual scouring rate for the northern margin of the Grand Banks ranges from 0.08 to 1.05 scours/100 km^2 - year and from 0.04 to 0.35 for the Hibernia area. These conclusions were based on 4 types of analysis: 1) geological inference of the age of inception of the present late Holocene ice scour population using the onset of ice-rafted sediment observed in cores from the adjacent Northeast Newfoundland Shelf, 2) calculation of scour frequency from iceberg flux and draft information, 3) seabed mapping and remapping, using probability theory to estimate upper bound for the scour rate and 4) the estimation of scour replenishment rates from estimates of sedimentary scour degradation. The difference in scour rates derived by Lewis et al and in the present study may be due to unobserved scours which no doubt occurred during the period of observation. Groundings of large bergs for long periods of time

would not have been missedduring observation periods, but it is a virtual certainty that short term scouring or grounding events occurred, but were not observed. For example, some icebergs in the Mobil Oil iceberg data sets were noted as grounded by supply vessels but are not included amongst the definite groundings because certain criteria were not met. Also, groundings may have been missed when the observing drill rigs were not present on the Grand Banks (see Table 2.2). Lewis and Parrot (1987) found long-term scouring rates of about 0.04 scours per 100 km^2 - year for the Hibernia region. This implies 1 scour every 25 years in each 100 km^2 area. For zones of greater scour density, on the northern margin of the Grand Banks, in water depths of 140 to 160m, a scour rate of about 1.05 scours/100 km^2 - year was estimated. This rate implies the generation of 1 new scour each year in every 100 km^2 area. Gaskill et al (1985) applied assumed sedimentation rates on the Grand Banks and estimated scour rates of 0.0009 scours/100 km^2 - year. This rate is equivalent to 1 scour every 1100 years. Amos and Barrie (1985) derived scour frequency as a function of the rate of megaripple migration and the number of scours which crosscut megaripple fields: they concluded that scour frequency in the Hibernia area ranges from 0.05 to 0.6 scours/100 km^2 - year. The results of the above-mentioned estimates of scour rates are summarized in Table 7.2. Obviously, there is a great deal of scatter in the various estimates of scour rates. The minimum rate of scour derived in this study is based on definite groundings only (0.020 scours/100 km^2 - year). It is fully expected that this rate is

a minimum and that when a count of other possible groundings is made, the estimate of the scour rate will increase.

Table 7.2 Scour rates in the Hibernia area estimated from various sources

Investigator	Methods	Scours per 100 km^2-year	Return period 1 scour/100 km^2 every
Lewis and Parrot (1987)	Inferred from ratio of seabed scour contration to inferred scour population age.	0.04 to 0.35	25 to 3 years
Lewis et al (1987)	* geological inference * calculation of scour frequency from iceberg flux and draft information. * seabed mapping and remapping. * estimate of scour replenishment rates from estimatesof sedimentary scour degradation.	0.04 to 0.35	25 to 3 years
Gaskill et al (1985)	Assumed sedimentation rates.	0.0009	1100 "
Amos and Berrie (1985)	Scours as a function of megaripple migration.	0.05 to 0.60	20 to 2 "
Present study *	Analysis of iceberg drift tracks.	0.020	50 "

* The rate of scouring derived in this study is to be considered as a minimum rate owing to short-term grounding events which undoubtedly occurred, and because observation during part of some iceberg seasons were missed owing to the absence of drill rigs.

8. CONCLUSIONS

Based on the available industry iceberg drift tracks for the period 1983 to 1989, it is concluded that 27 icebergs definitely grounded a total of 44 times. Multiple groundings in progressively shallower water depths account for 61% of the inferred groundings which occurred between the 149m and the 74m isobaths. The 27 grounded icebergs should be taken as a minimum because grounding events were probably missed when the drill rigs were off location and because other possible groundings were noted by supply vessels. However, these did not meet our stringent criteria for definite groundings. Collective industry surveillance for icebergs in the Grand Banks area ensured that all icebergs were tracked while drilling proceeded and the mean grounding frequency is computed as 2.5% of the tracked populations. This value is considered as a minimum but compares well with the 4.5% grounding frequency found by El Tahan et al, 1985 for icebergs in the vicinity of drill rigs off Labrador. The derived rate of scour in this study is 0.020 scours/100 km^2-year. This scour rate is considered to be a minimum because it is suspected that other possible groundings occurred unobserved. The derived scour rate is about half of the lowest estimated scour rate inferred by Lewis et al, 1987. The success of the technique of using tracked iceberg drift data to infer scours and groundings has been demonstrated by 2 field surveys in which 2 of the scours inferred in this study were easily located and surveyed. The Husky Oil iceberg data suggests that the percentage of bergs which transgressed onto the Grand Banks within the 150m contour line varied from 14.3% to 20.5%. It is

felt that the present data review has revealed the minimum number of definite groundings on the Grand Banks according to our stringent criteria, and that other possible short-term grounding and scouring events may have occurred. The derived scour rate should be viewed in this light. Having defined definite groundings and the environmental circumstances involved in each case, the next logical step is to conduct field surveys to document the inferred groundings and scours.

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REPORT APPENDIX

App. #	ICEBERG
RA1	001 and 004/1989
RA2	001/1988
RA3	005/1988
RA4	013/1988
RA5	015/1988
RA6	002/1985
RA7	004/1985
RA8	014/1985
RA9	BIO 002/1985
RA10	026/1985
RA11	014/1984
RA12	015/1984
RA13	028/1984
RA14	036/1984
RA15	037/1984
RA16	050/1984
RA17	1381/1984
RA18	095/1983
RA19	104/1983
RA20	135/1983
RA21	241/1983
RA22	292/1983
RA23	649/1983
RA24	028/1987
RA25	019/1985
RA26	061/1985
RA27	Rejected bergs.

Legend used in the Data Appendix

KD	denotes	keel dragging
FD	"	free drift
G1	"	grounding number
●	"	grounded position
———	"	iceberg drift track
→	"	drift direction
095/1983	"	iceberg number/year
MB	"	medium berg
LB	"	large berg
SB	"	small berg
DDK	"	drydock berg
WDG	"	wedge shaped berg
PNC	"	pinnacle berg
TAB	"	tabular berg
E	"	estimated
M	"	measured
C	"	calculated
CPA	"	closest point of approach

RA1 Icebergs 001 and 004/1989

Iceberg 001 appeared near the edge of the packice (Fig. A-1) about March 8, 1989 at 47°-15' N and 48°-15' W, north of the drill rig Vinlander. Tracking of berg 001 commenced at 0800 local Newfoundland time on March 9, when it was located 35.2 nm away at a bearing of 11.2° (Table A1). The berg was still surrounded by loose packice (Fig. A-2). Despite 30 knot winds from the west during March 9 and north west winds the following day, berg 001 drifted due south out of the packice. The drift track crossed isobaths into shallower water in free drift until 0400 on March 10, when a towline was secured around the berg. A 60 ton tow line tension was maintained in an easterly direction in an effort to divert the berg towards the east and away from the Vinlander. Only slight alterations to the course were achieved. While under tow, the berg ran aground in 112m of water. Although the berg was firmly aground, towing continued for some time in an easterly direction. Despite several later attempts to tow the berg, it remained grounded for 45 days, finally drifting off to the north east on the 24th of April. It apparently dragged its keel over some distance and appeared to bump the bottom. What terminated the grounding was a reported lift or tilt on the 21st of April.

The groundings of berg 001 and 004 are attributed to the fact that the pack ice extended well within the 200m contour line. The bergs were thus delivered onto the Grand Banks by the packice. Tracking of the first three bergs to emerge from the packice commenced on March 9, and berg 004 emerged about 3 or 4 days later. These three icebergs drifted along parallel drift tracks as shown in Fig. A-2. Berg 001 was largest and grounded, whereas the other two bergs being smaller did not ground.

Berg 001 had a measured length of 162m, an estimated width of 100m and a sail height of 46m. The berg was pinnacle-shaped and had a mass estimated as 1.7

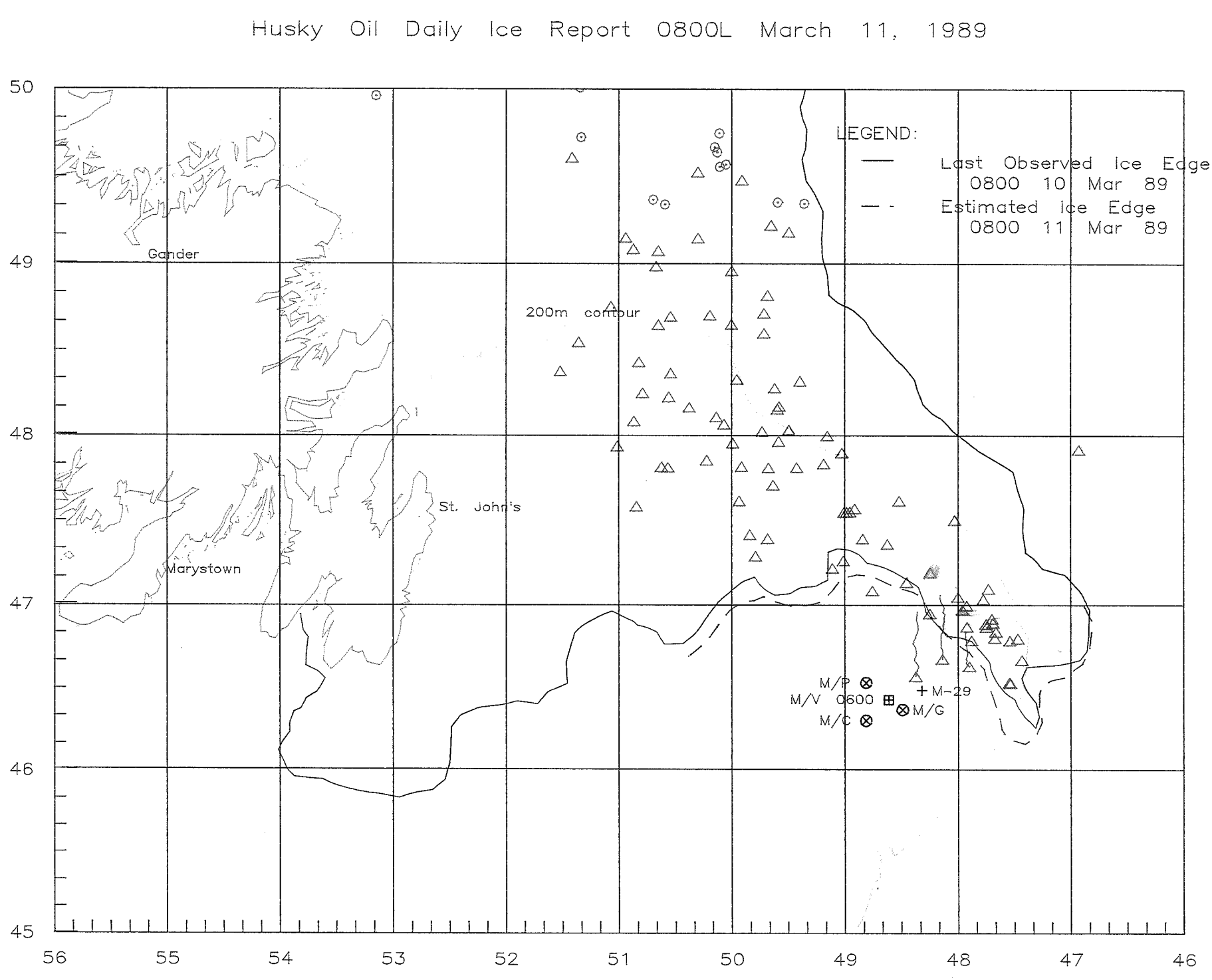


Figure A-1 Icebergs on the Grand Banks March 11, 1989

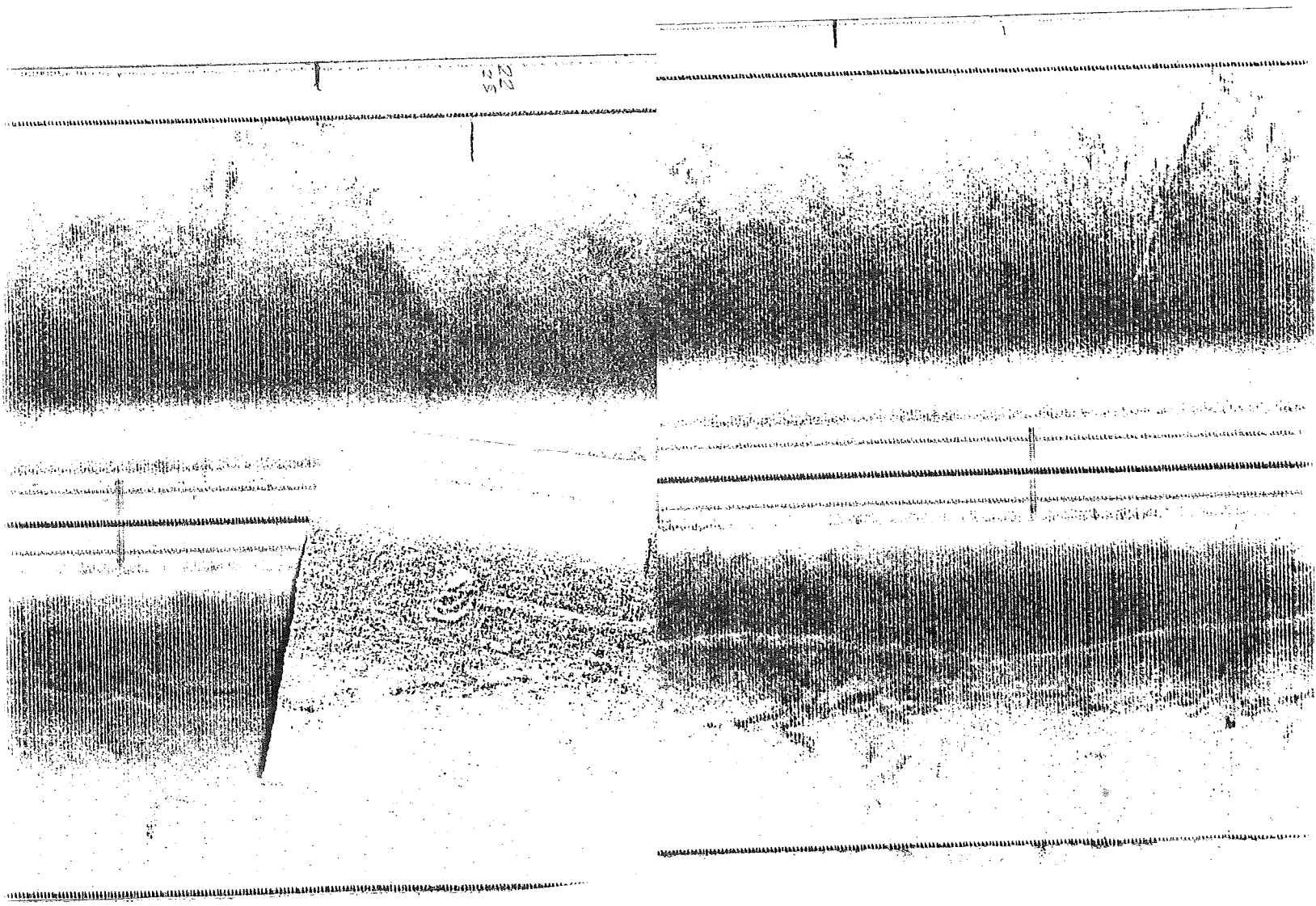


Figure A-4

Scour track left on the seabed by iceberg 001/1989

Source: Fader, 1989

RA2 Iceberg 001/1988

The circumstances surrounding the initial grounding (G1) of this iceberg in April, 1988 have been fully described by Woodworth-Lynas, 1989 and Banke, 1988 in two contact reports prepared for Husky Oil East Coast operations. The scour left on the seabed by berg 001 was documented by means of a side scan sonar survey described in the above reports and by resurvey in September, 1988 by AGC. Subsequent to its first grounding, the berg drifted southward and grounded again in 3 locations (G2, G3 and G4).

The above-water dimensions of iceberg 001 were first estimated from a supply vessel as 168m by 85m and the sail height was 31m. The berg was of the dry-dock type and had well-developed water line grooves. The berg was judged to be stable and amenable to towing, but as there was no drill rig at the Whiterose E-09 location at the time, there was no need to attempt towing. It is now known that the berg first scoured in 125m of water to a depth of 1m, which indicates a draft of 126m, notwithstanding any tilting of the berg during scouring. Due to inclement weather conditions at the time of the grounding, it was not possible to photograph the berg from the air. However, aerial photographs were taken on April 16 and 25 and stereo photographs were taken at the position of the berg's second grounding approximately 30nm south of Whiterose E-09.

Despite fog and low clouds, mapping of the berg was achieved; the key dimensions were determined by analysis and computer enhancement of the stereo-photographs (Fig. A-5) to be:

Length 207m

Width 114m

Sail height 40m

The computed volume of ice above the water line was 268,656 cubic meters which suggests a total mass of approximately 1.8 million tons. Atlantic Airways

mapping contractors, Geodata Ltd., St. John's estimated the possible volume error as ± 15%. Based on the observation that some mass was lost from the berg after grounding near Whiterose E-09, it is probable that iceberg 001 had a mass of approximately 1.9 million tonnes during its grounding near E-09.

The drift of berg 001/1988 is presented in Fig. A-6 and position data are given in Table A2. The berg was first observed at a distance of 37.7nm from the Whiterose E-09 location on the second of April 1988. By April 4, this distance was reduced to 9.9 nm. Two days later on April 6, the berg was situated 3.4nm north of the E-09 location, having drifted in a generally southwest direction into shallower water due to high winds and high sea-states from the northeast. For lack of information on the actual drift track between April 4 and 6, the track is shown as a straight line in Fig. A-7. Prior to grounding in 125m of water, the berg drifted in an area with greater water depth and it is therefore considered unlikely that scouring occurred prior to April 12, when the grounding event occurred. Woodworth-Lynas (1989) considers it more likely that the berg was grounded for at least 3 days, based on interpretation of the scour track. On April 12 at 1705 hours, the berg was confirmed grounded 1.9nm north of the E-09 location and remained grounded or moving slowly until 0200 hours on April 13, as evidenced by its 0400 position of only 0.8 nm at 326.1° from E-09. Thereafter, the iceberg grounded briefly, approximately 1.6 km north northwest of Whiterose E-09 and then continued its free drift on a generally southerly course without marking the seabed except for one possible short scour mark. The entire grounding event (G1) was documented by sonar during a survey conducted by Husky in July 1988 and again in a resurvey conducted by AGC in September, 1988 (Fig. A-8). Berg 001 drifted south from its first grounded position and grounded again about 30mm away. G2, G3 and G4 is presented in Fig. A-9. The winds during April 13 to 16 when the second grounding (G2) occurred, varied from 25kt from

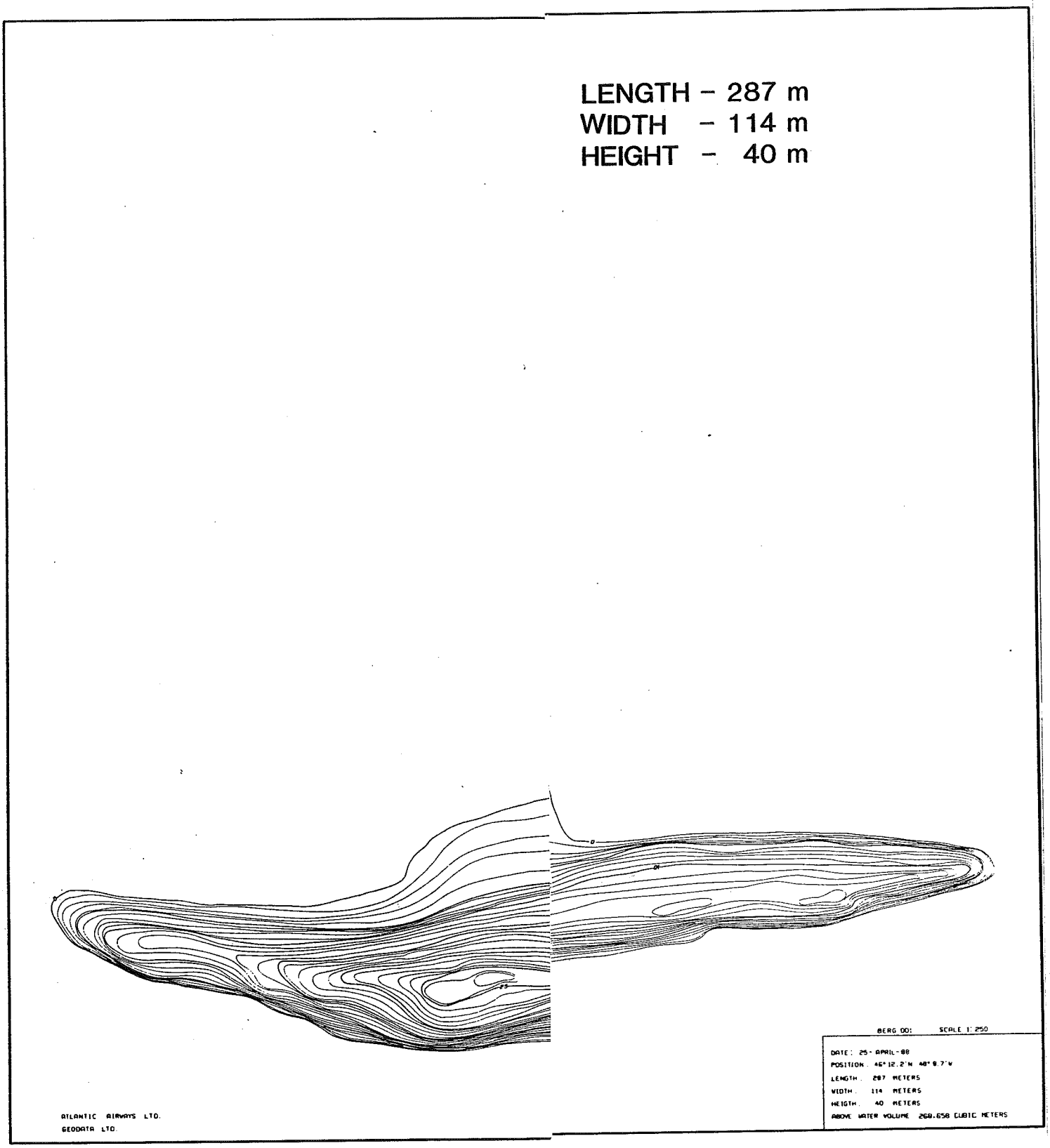


Figure A-5 Contour map of iceberg 001/1988

TABLE A1 Individual drifttrack listing for iceberg 001/1989

BERG 001

Springdale M-29 (Vinlander)
(46 28.80' N 48 19.49' W)

Iceberg Dimensions: Size = L Shape = PNC
Length = M162 Width = E100 Height = M046
Draft = S112 Mass = 1326456 Stability = -6.5

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Cal) Sign	TT (n)	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Mag.	Tow Force
09/03/89	0800	35.2	11.2	47 3.3	48 9.5	VCYS	0							
09/03/89	0900	33.9	11.3	47 2.0	48 9.8	VCYS	0	1.32	189	1.0	1.3			
09/03/89	1000	32.7	12.6	47 0.7	48 9.1	VCYS	0	1.39	160	2.0	2.7			
09/03/89	1100	31.7	14.3	46 59.5	48 8.1	VCYS	0	1.38	150	3.0	4.1			
09/03/89	1200	31.0	15.5	46 58.7	48 7.4	VCYS	0	0.93	149	4.0	5.0			
09/03/89	1300	29.3	15.5	46 57.0	48 6.1	VCYS	0	1.77	196	5.0	6.8			
09/03/89	1400	28.9	17.2	46 56.4	48 7.0	VCYS	0	0.96	128	6.0	7.7			
09/03/89	1500	27.4	17.3	46 55.0	48 7.6	VCYS	0	1.46	196	7.0	9.2			
09/03/89	1600	26.3	18.2	46 53.8	48 7.5	VCYS	0	1.20	177	8.0	10.4			
09/03/89	1700	24.8	18.2	46 52.4	48 8.2	VCYS	0	1.48	199	9.0	11.9			
09/03/89	1800	23.7	19.5	46 51.1	48 8.0	VCYS	0	1.31	174	10.0	13.2			
09/03/89	1900	22.7	20.2	46 50.1	48 8.1	VCYS	0	1.00	184	11.0	14.2			
09/03/89	2000	21.8	19.4	46 49.4	48 8.9	VCYS	0	0.89	218	12.0	15.1			
09/03/89	2100	21.0	19.8	46 48.6	48 9.1	VCYS	0	0.81	190	13.0	15.9			
09/03/89	2200	20.4	20.3	46 47.9	48 9.2	VCYS	0	0.70	186	14.0	16.6			
09/03/89	2300	19.8	21.1	46 47.3	48 9.1	VCYS	0	0.60	173	15.0	17.2			
10/03/89	0000	19.4	21.3	46 46.9	48 9.2	VCYS	0	0.41	190	16.0	17.6			
10/03/89	0100	18.8	22.5	46 46.2	48 9.0	VCYS	0	0.71	169	17.0	18.3			
10/03/89	0200	18.1	23.3	46 45.4	48 9.1	VCYS	0	0.80	185	18.0	19.1			
10/03/89	0300	17.9	23.9	46 45.2	48 8.9	VCYS	0	0.24	145	19.0	19.4			
10/03/89	0400	17.0	24.9	46 44.2	48 9.1	VCYS	0	1.01	188	20.0	20.4	[L]	80.0	E020
10/03/89	0500	16.8	26.9	46 43.8	48 8.4	VCYS	0	0.63	130	21.0	21.0	[L]	80.0	E055
10/03/89	0600	16.3	28.5	46 43.1	48 8.2	VCYS	0	0.71	169	22.0	21.7	[L]	90.0	E070
10/03/89	0700	15.8	29.1	46 42.6	48 8.3	VCYS	0	0.50	188	23.0	22.2	[L]	90.0	E070
10/03/89	0800	15.5	29.9	46 42.2	48 8.3	VCYS	0	0.40	180	24.0	22.6	[L]	90.0	E070
10/03/89	0900	15.2	30.4	46 41.9	48 8.3	VCYS	0	0.30	180	25.0	22.9	[L]	90.0	E070
10/03/89	1000	14.9	31.0	46 41.6	48 8.3	VCYS	0	0.30	180	26.0	23.2	[L]	90.0	E070
10/03/89	1100	14.6	31.4	46 41.3	48 8.4	VCYS	0	0.31	193	27.0	23.5	[L]	90.0	E070
10/03/89	1200	14.4	32.2	46 41.0	48 8.3	VCYS	0	0.31	167	28.0	23.8	[L]	90.0	E070
10/03/89	1300	14.3	32.7	46 40.8	48 8.3	VCYS	0	0.20	180	29.0	24.0	[L]	90.0	E070
10/03/89	1400	14.1	33.1	46 40.6	48 8.3	VCYS	0	0.20	180	30.0	24.2	[L]	90.0	E075
10/03/89	1500	13.9	33.5	46 40.4	48 8.3	VCYS	0	0.20	180	31.0	24.4	[L]	90.0	E075
10/03/89	1600	13.8	33.1	46 40.4	48 8.5	VCYS	0	0.14	270	32.0	24.6	[L]	120.0	E075
10/03/89	1700	13.3	34.5	46 39.8	48 8.5	VCYS	0	0.60	180	33.0	25.2	[L]	120.0	E075
10/03/89	1800	13.4	34.2	46 39.9	48 8.5	VCYS	0	0.10	360	34.0	25.3	[L]	120.0	E075
10/03/89	1900	13.4	34.2	46 39.9	48 8.5	VCYS	0	0.00	000	35.0	25.3	[L]	120.0	E075
10/03/89	2000	13.4	34.2	46 39.9	48 8.5	VCYS	0	0.00	000	36.0	25.3	[L]	120.0	E075
10/03/89	2100	13.7	33.8	46 40.2	48 8.4	VCYS	0	0.31	013	37.0	25.6	[L]	90.0	E075
10/03/89	2200	13.8	34.0	46 40.2	48 8.3	VCYS	0	0.07	090	38.0	25.7	[L]	90.0	E075
10/03/89	2300	13.8	34.0	46 40.2	48 8.3	VCYS	0	0.00	000	39.0	25.7	[L]	90.0	E075
11/03/89	0000	13.8	34.0	46 40.2	48 8.3	VCYS	0	0.00	000	40.0	25.7	[L]	90.0	E075
11/03/89	0100	13.8	34.0	46 40.2	48 8.3	VCYS	0	0.00	000	41.0	25.7	[L]	90.0	E075
11/03/89	0200	13.8	34.0	46 40.2	48 8.3	VCYS	0	0.00	000	42.0	25.7	[L]	90.0	E075
11/03/89	0300	13.8	34.0	46 40.2	48 8.3	VCYS	0	0.00	000	43.0	25.7	[L]	90.0	E075

11/03/89 0400 13.6 34.0 46 40.2 48 8.3 VCTS 0 0.00 000 44.0 25.7

Table A1 (continued)

BERG 001

Springdale M-29 (Vinlander)
(46 28.80' N 48 19.49' W)

Iceberg Dimensions: Size = L Shape = PNC
Length = M162 Width = E100 Height = M046
Draft = S112 Mass = 1326456 Stability = -6.5

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Cal) Sign	TT (h)	Speed (kts)	Dir. (T)	E.T. (n)	E.U. (n.mi)	Tow Type	Tow Hdg.	Tow Force
11/03/89	0500	13.6	34.2	46 40.2	48 8.2	VCTS	0	0.07	090	45.0	25.7			

10/03/89 1700 13.35 34.5 (CPA)
09/03/89 0800 35.18 11.2 (MDR)

SPEEDS (knots)

Min.	Max.	Mean	MadeGood	
0.00	1.77	0.57	0.51	(to 178 T; DRIFT RATIO = 0.90)

TOTAL NUMBER OF OBSERVATIONS = 46

Whiterose E-09 (Bow Drill 3)
(46 48.44′ N 48 1.38′ W)

Iceberg Dimensions: Size = M Shape = DDK
Length = E090 Width = E040 Height = E008
Draft = C59 Mass = 30758 Stability = 59.1

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (Kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
02/04/88	1332	37.2	10.6	47 25.0	47 51.3	GPCD	0							
04/04/88	1624	10.0	40.6	46 56.0	47 51.9	GPCD	0	0.57	181	50.9	29.0			
06/04/88	1751	3.4	359.7	46 51.8	48 1.4	GPCD	0	0.16	237	100.3	36.7			
09/04/88	1120	1.5	10.8	46 49.9	48 1.0	VCPQ	0	0.03	171	165.8	38.6			
12/04/88	1705	1.9	3.7	46 50.3	48 1.2	VCYS	0	0.01	337	243.6	39.1			
12/04/88	1800	1.9	3.7	46 50.3	48 1.2	VCYS	0	0.00	000	244.5	39.1			
12/04/88	2000	2.1	3.4	46 50.5	48 1.2	VCYS	0	0.10	360	246.5	39.3			
12/04/88	2200	1.9	3.7	46 50.3	48 1.2	VCYS	0	0.10	180	248.5	39.5			
13/04/88	0001	1.9	3.7	46 50.3	48 1.2	VCYS	0	0.00	000	250.5	39.5			
13/04/88	0200	1.9	3.7	46 50.3	48 1.2	VCYS	0	0.00	000	252.5	39.5			
13/04/88	0500	1.6	204.1	46 47.0	48 2.3	VCYS	0	1.14	193	255.5	42.9			
13/04/88	0600	1.6	233.1	46 47.5	48 3.2	VCYS	0	0.79	311	256.5	43.7			
13/04/88	0700	2.4	208.9	46 46.3	48 3.1	VCYS	0	1.20	177	257.5	44.9			
13/04/88	0800	2.9	205.3	46 45.8	48 3.2	VCYS	0	0.50	188	258.5	45.4			
13/04/88	0900	3.8	198.9	46 44.8	48 3.2	VCYS	0	1.00	180	259.5	46.4			
13/04/88	1000	4.7	192.9	46 43.9	48 2.9	VCYS	0	0.92	167	260.5	47.3			
13/04/88	1100	5.5	189.5	46 43.0	48 2.7	VCYS	0	0.91	171	261.5	48.2			
13/04/88	1200	6.5	185.6	46 42.0	48 2.3	VCYS	0	1.04	165	262.5	49.2			
13/04/88	1300	7.1	185.1	46 41.4	48 2.3	VCYS	0	0.60	180	263.5	49.8			
13/04/88	1400	7.9	184.1	46 40.6	48 2.2	VCYS	0	0.80	175	264.5	50.6			
13/04/88	1500	8.5	182.9	46 39.9	48 2.0	VCPQ	0	0.71	169	265.5	51.3			
13/04/88	1600	9.8	182.1	46 38.6	48 1.9	VCPQ	0	1.30	177	266.5	52.7			
13/04/88	1700	9.9	181.7	46 38.5	48 1.8	VCPQ	0	0.12	146	267.5	52.8			
13/04/88	1800	10.8	182.3	46 37.6	48 2.0	VCPQ	0	0.91	189	268.5	53.7			
13/04/88	1900	11.2	177.3	46 37.3	48 0.6	VCPQ	0	1.01	107	269.5	54.7			
13/04/88	2000	12.0	175.5	46 36.5	48 0.0	VCPQ	0	0.90	153	270.5	55.6			
13/04/88	2100	12.9	174.3	46 35.6	47 59.5	VCPQ	0	0.96	159	271.5	56.6			
13/04/88	2200	13.8	172.3	46 34.8	47 58.7	VCPQ	0	0.97	146	272.5	57.5			
13/04/88	2300	14.7	171.2	46 33.9	47 58.1	VCPQ	0	0.99	155	273.5	58.5			
14/04/88	0000	15.8	170.3	46 32.9	47 57.5	VCPQ	0	1.08	158	274.5	59.6			
14/04/88	0200	17.3	173.0	46 31.3	47 58.3	VCPQ	0	0.85	199	276.5	61.3			
14/04/88	0500	19.3	175.4	46 29.2	47 59.1	VCPQ	0	0.72	195	279.5	63.5			
14/04/88	0600	21.3	176.7	46 27.2	47 59.6	VCPQ	0	2.03	190	280.5	65.5			
14/04/88	0800	20.0	179.3	46 28.4	48 1.0	VCPQ	0	0.77	321	282.5	67.0			
14/04/88	0900	20.2	179.7	46 28.2	48 1.2	VCPQ	0	0.24	215	283.5	67.3			
14/04/88	1000	20.6	180.0	46 27.8	48 1.4	V023	0	0.42	199	284.5	67.7			
14/04/88	1400	21.9	181.8	46 26.5	48 2.4	V023	0	0.37	208	288.5	69.2			
14/04/88	2000	23.6	184.7	46 24.9	48 4.2	VXJG	0	0.34	218	294.5	71.2			
14/04/88	2100	23.8	184.3	46 24.7	48 4.0	VXJG	0	0.24	146	295.5	71.4			
14/04/88	2200	24.1	184.3	46 24.4	48 4.0	VXJG	0	0.30	180	296.5	71.7	[L]	135.0	E060
14/04/88	2300	24.6	182.9	46 23.9	48 3.2	VXJG	0	0.74	132	297.5	72.5	[L]	135.0	E060

TABLE A2 Individual drift track listing for iceberg 001/1988

Whiterose E-09 (Bow Drill 3)
(46 48.44′ N 48 1.38′ W)

Iceberg Dimensions: Size = M Shape = DDK
Length = E090 Width = E040 Height = E008
Draft = C59 Mass = 30758 Stability = 59.1

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
15/04/88	0000	25.0	181.6	46 23.4	48 2.4	VXJG	0	0.74	132	298.5	73.2	[L]	135.0	E060
15/04/88	0100	25.7	180.3	46 22.7	48 1.6	VXJG	0	0.89	142	299.5	74.1	[L]	135.0	E060
15/04/88	0200	26.4	179.4	46 22.0	48 1.0	VXJG	0	0.81	149	300.5	74.9	[L]	135.0	E060
15/04/88	0300	27.2	179.0	46 21.2	48 0.7	VXJG	0	0.83	166	301.5	75.7	[L]	135.0	E060
15/04/88	0400	27.9	178.6	46 20.5	48 0.4	VXJG	0	0.73	164	302.5	76.5	[L]	135.0	E060
15/04/88	0500	28.5	178.7	46 19.9	48 0.4	VXJG	0	0.60	180	303.5	77.1	[L]	135.0	E060
15/04/88	0600	29.0	178.8	46 19.4	48 0.5	VXJG	0	0.50	188	304.5	77.6	[L]	135.0	E060
15/04/88	0700	29.5	178.2	46 19.0	48 0.0	VXJG	0	0.53	139	305.5	78.1	[L]	135.0	E060
15/04/88	0800	29.7	179.2	46 18.7	48 0.8	VXJG	0	0.63	241	306.5	78.7	[L]	135.0	E060
15/04/88	0900	30.0	179.4	46 18.4	48 0.9	VXJG	0	0.31	193	307.5	79.0	[L]	135.0	E065
15/04/88	1000	30.2	179.4	46 18.2	48 0.9	VXJG	0	0.20	180	308.5	79.2	[L]	135.0	E065
15/04/88	1100	30.6	179.3	46 17.8	48 0.8	VXJG	0	0.41	170	309.5	79.6	[L]	135.0	E070
15/04/88	1200	30.8	179.0	46 17.6	48 0.6	VXJG	0	0.24	145	310.5	79.9	[L]	135.0	E070
15/04/88	1300	31.3	179.0	46 17.1	48 0.6	VXJG	0	0.50	180	311.5	80.4	[L]	135.0	E070
15/04/88	1400	31.8	179.2	46 16.6	48 0.7	VXJG	0	0.50	188	312.5	80.9	[L]	135.0	E070
15/04/88	1500	32.2	179.2	46 16.2	48 0.7	VXJG	0	0.40	180	313.5	81.3	[L]	135.0	E070
15/04/88	1600	32.5	179.4	46 15.9	48 0.9	VXJG	0	0.33	205	314.5	81.6	[L]	135.0	E070
15/04/88	1700	32.8	179.7	46 15.6	48 1.1	VXJG	0	0.33	205	315.5	81.9	[L]	135.0	E070
15/04/88	1800	33.1	180.0	46 15.3	48 1.4	VXJG	0	0.36	215	316.5	82.3	[L]	135.0	E070
15/04/88	1900	33.2	180.1	46 15.2	48 1.5	VXJG	0	0.12	215	317.5	82.4	[L]	135.0	E070
15/04/88	2013	33.3	181.0	46 15.1	48 2.2	VXJG	0	0.40	258	318.7	82.9			
15/04/88	2113	33.2	181.7	46 15.3	48 2.8	VXJG	0	0.46	296	319.7	83.4			
15/04/88	2359	34.0	182.3	46 14.5	48 3.4	VXJG	0	0.33	207	322.5	84.3			
16/04/88	0200	35.1	182.7	46 13.4	48 3.8	VXJG	0	0.56	194	324.5	85.4			
16/04/88	0400	36.1	183.7	46 12.4	48 4.8	VXJG	0	0.61	215	326.5	86.6			
16/04/88	0600	36.6	186.2	46 12.0	48 7.1	VXJG	0	0.82	256	328.5	88.3			
16/04/88	1620	36.7	189.4	46 12.2	48 10.1	VXJG	0	0.20	276	338.8	90.3			
16/04/88	1700	36.7	189.2	46 12.2	48 9.9	VXJG	0	0.21	090	339.5	90.5			
16/04/88	1800	36.8	189.3	46 12.1	48 10.0	VXJG	0	0.12	215	340.5	90.6			
16/04/88	1900	36.7	188.8	46 12.2	48 9.5	VXJG	0	0.36	074	341.5	90.9			
16/04/88	2000	36.7	188.8	46 12.2	48 9.5	VXJG	0	0.00	000	342.5	90.9			
16/04/88	2022	36.7	189.1	46 12.2	48 9.8	VXJG	0	0.56	270	342.8	91.2			
16/04/88	2100	36.8	189.1	46 12.1	48 9.8	VXJG	0	0.16	180	343.5	91.3	[L]	120.0	E050
16/04/88	2200	36.8	189.1	46 12.1	48 9.8	VXJG	0	0.00	000	344.5	91.3	[L]	125.0	E050
16/04/88	2300	36.8	189.1	46 12.1	48 9.8	VXJG	0	0.00	000	345.5	91.3	[L]	130.0	E050
16/04/88	2310	36.8	189.1	46 12.1	48 9.8	VXJG	0	0.00	000	345.6	91.3			
17/04/88	0100	36.8	189.1	46 12.1	48 9.8	VXJG	0	0.00	000	347.5	91.3			
17/04/88	0200	36.8	189.1	46 12.1	48 9.8	VXJG	0	0.00	000	348.5	91.3			
17/04/88	0300	36.8	189.1	46 12.1	48 9.8	VXJG	0	0.00	000	349.5	91.3			
17/04/88	0400	36.8	189.1	46 12.1	48 9.8	VXJG	0	0.00	000	350.5	91.3			
17/04/88	0500	36.8	189.1	46 12.1	48 9.8	VXJG	0	0.00	000	351.5	91.3			
17/04/88	0600	36.8	189.3	46 12.1	48 10.0	VXJG	0	0.14	270	352.5	91.4			
17/04/88	0800	36.8	189.1	46 12.1	48 9.8	VXJG	0	0.07	090	354.5	91.5			
17/04/88	1245	36.8	189.3	46 12.1	48 10.0	VCPQ	0	0.03	270	359.2	91.7			

Table A2 (continued)

Whiterose E-09 (Bow Drill 3)
(46 48.44′ N 48 1.38′ W)

Iceberg Dimensions: Size = M Shape = DDK
Length = E090 Width = E040 Height = E008
Draft = C59 Mass = 30758 Stability = 59.1

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
19/04/88	0800	36.8	189.3	46 12.1	48 10.0	VXJG	19	0.00	000	402.5	91.7			
20/04/88	0800	36.8	189.3	46 12.1	48 10.0	V023	19	0.00	000	426.5	91.7			
20/04/88	1551	35.1	186.7	46 13.6	48 7.3	GPCD	19	0.30	051	434.3	94.1			
21/04/88	0800	35.1	186.7	46 13.6	48 7.3	V023	19	0.00	000	450.5	94.1			
22/04/88	1600	36.4	189.7	46 12.6	48 10.3	VCBQ	19	0.07	244	482.5	96.4			
22/04/88	1740	36.4	189.7	46 12.6	48 10.3	VCBQ	19	0.00	000	484.1	96.4			
22/04/88	1830	36.4	189.7	46 12.6	48 10.3	VCBQ	19	0.00	000	485.0	96.4			
22/04/88	1900	36.4	189.7	46 12.6	48 10.3	VCBQ	19	0.00	000	485.5	96.4	[L]	40.0	E020
22/04/88	1940	36.4	189.7	46 12.6	48 10.3	VCBQ	19	0.00	000	486.1	96.4	[L]	40.0	E100
22/04/88	1955	36.4	189.7	46 12.6	48 10.3	VCBQ	19	0.00	000	486.4	96.4	[L]	90.0	E140
22/04/88	2045	36.4	189.7	46 12.6	48 10.3	VCBQ	19	0.00	000	487.2	96.4	[L]	90.0	E140
22/04/88	2050	36.4	189.7	46 12.6	48 10.3	VCBQ	19	0.00	000	487.3	96.4			
23/04/88	0800	36.4	189.7	46 12.6	48 10.3	VCBQ	19	0.00	000	498.5	96.4			
24/04/88	0800	36.4	189.7	46 12.6	48 10.3	VXJG	19	0.00	270	522.5	96.4			
25/04/88	0800	36.4	189.7	46 12.6	48 10.3	VXJG	19	0.00	090	546.5	96.4			
26/04/88	0800	36.4	189.7	46 12.6	48 10.3	VCBQ	19	0.00	000	570.5	96.4			
27/04/88	0800	36.4	189.7	46 12.6	48 10.3	VCBQ	22	0.00	000	594.5	96.4			
27/04/88	1725	36.4	189.7	46 12.6	48 10.3	VCBQ	22	0.00	000	603.9	96.4			
28/04/88	0300	36.4	189.7	46 12.6	48 10.3	VCBQ	22	0.00	000	613.5	96.4			
29/04/88	0400	36.4	189.7	46 12.6	48 10.3	VCBQ	22	0.00	101	638.5	96.4			
29/04/88	1202	35.9	189.3	46 13.0	48 9.8	GPCD	22	0.06	038	646.5	96.9			
30/04/88	1925	36.8	189.6	46 12.2	48 10.3	VCBQ	22	0.03	203	677.9	97.8			
30/04/88	2100	37.4	190.2	46 11.6	48 11.0	VCBQ	22	0.49	219	679.5	98.6			
30/04/88	2200	37.4	190.2	46 11.6	48 11.0	VCBQ	22	0.00	000	680.5	98.6			
30/04/88	2300	37.4	190.2	46 11.6	48 11.0	VCBQ	22	0.00	000	681.5	98.6			
01/05/88	0000	37.4	190.2	46 11.6	48 11.0	VCBQ	22	0.00	000	682.5	98.6			
01/05/88	0100	37.4	190.2	46 11.6	48 11.0	VCBQ	22	0.00	000	683.5	98.6			
01/05/88	0300	38.8	192.4	46 10.5	48 13.5	VCBQ	22	1.02	237	685.5	100.6			
01/05/88	0400	39.0	193.1	46 10.5	48 14.2	VCBQ	22	0.48	270	686.5	101.1			
01/05/88	0500	38.9	194.1	46 10.7	48 15.1	VCBQ	22	0.65	288	687.5	101.7			
01/05/88	0600	38.7	194.8	46 11.0	48 15.7	VCBQ	22	0.51	306	688.5	102.2			
01/05/88	0700	38.6	195.3	46 11.2	48 16.2	VCBQ	22	0.40	300	689.5	102.6			
01/05/88	0800	38.9	196.3	46 11.1	48 17.2	VCBQ	22	0.70	262	690.5	103.3			
01/05/88	2000	38.9	198.4	46 11.5	48 19.2	VCBQ	22	0.12	286	702.5	104.8			

Table A2 (continued)

Whiterose E-09 (Bow Drill 3)
(46 48.44' N 48 1.38' W)

Iceberg Dimensions: Size = M Shape = DDK
Length = E090 Width = E040 Height = E008
Draft = C59 Mass = 30758 Stability = 59.1

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
01/05/88	2100	38.8	199.5	46 11.9	48 20.2	VCBQ	22	0.80	300	703.5	105.6			
01/05/88	2200	38.7	199.7	46 12.0	48 20.3	VCBQ	22	0.12	326	704.5	105.7			
02/05/88	0100	37.5	201.1	46 13.4	48 21.0	VO23	22	0.49	341	707.5	107.2			
02/05/88	0200	37.3	200.0	46 13.4	48 19.9	VO23	22	0.76	090	708.5	107.9			
02/05/88	0300	37.3	200.0	46 13.4	48 19.9	VO23	22	0.00	000	709.5	107.9			
02/05/88	0400	37.8	200.8	46 13.1	48 20.9	VO23	22	0.75	246	710.5	108.7			
02/05/88	0500	37.8	200.8	46 13.1	48 20.9	VO23	22	0.00	000	711.5	108.7			
02/05/88	0600	37.9	201.3	46 13.1	48 21.4	VO23	22	0.34	270	712.5	109.0			
02/05/88	0700	37.9	201.3	46 13.1	48 21.4	VO23	22	0.00	000	713.5	109.0			
02/05/88	0800	38.1	202.0	46 13.1	48 22.1	VO23	22	0.48	270	714.5	109.5			
02/05/88	1000	38.2	202.2	46 13.1	48 22.3	VOGF	22	0.07	270	716.5	109.6			
02/05/88	1100	38.2	202.2	46 13.1	48 22.3	VOGF	22	0.00	000	717.5	109.6			
02/05/88	1300	38.5	201.2	46 12.5	48 21.6	VOGF	22	0.38	141	719.5	110.4	[L]	130.0	E050
02/05/88	1500	38.5	201.2	46 12.5	48 21.6	VCBQ	22	0.00	000	721.5	110.4	[L]	130.0	E050
02/05/88	1600	38.9	201.1	46 12.1	48 21.7	VCBQ	22	0.41	190	722.5	110.8	[L]	130.0	E050
02/05/88	1700	38.9	201.4	46 12.2	48 22.0	VCBQ	22	0.23	296	723.5	111.0	[L]	120.0	E040
02/05/88	1800	39.4	200.6	46 11.5	48 21.5	VCBQ	22	0.78	154	724.5	111.8	[L]	120.0	E040
02/05/88	1900	39.9	200.4	46 11.0	48 21.6	VCBQ	22	0.50	188	725.5	112.3	[L]	120.0	E050
02/05/88	2000	40.2	200.2	46 10.7	48 21.5	VCBQ	22	0.31	167	726.5	112.6	[L]	120.0	E040
02/05/88	2100	40.4	200.1	46 10.5	48 21.5	VCBQ	22	0.20	180	727.5	112.8	[L]	120.0	E040
02/05/88	2200	40.5	199.2	46 10.2	48 20.7	VCBQ	22	0.63	119	728.5	113.5	[L]	120.0	E040
02/05/88	2300	39.8	199.4	46 10.9	48 20.6	VOGF	22	0.70	006	729.5	114.2	[L]	120.0	E040
03/05/88	0000	39.9	198.3	46 10.6	48 19.6	VOGF	22	0.75	114	730.5	114.9	[L]	120.0	E040
03/05/88	0100	40.0	197.9	46 10.4	48 19.2	VOGF	22	0.34	126	731.5	115.3	[L]	120.0	E040
03/05/88	0200	40.0	197.2	46 10.2	48 18.6	VOGF	22	0.46	116	732.5	115.7	[L]	120.0	E040
03/05/88	0300	40.2	196.0	46 9.8	48 17.5	VOGF	22	0.86	118	733.5	116.6	[L]	120.0	E040
03/05/88	0400	40.5	195.2	46 9.4	48 16.8	VOGF	22	0.63	130	734.5	117.2	[L]	120.0	E040
03/05/88	0500	40.9	194.4	46 8.8	48 16.2	VOGF	22	0.73	146	735.5	117.9	[L]	120.0	E040
03/05/88	0600	41.1	193.8	46 8.5	48 15.6	VOGF	22	0.51	126	736.5	118.4	[L]	120.0	E040
03/05/88	0700	41.4	193.6	46 8.2	48 15.5	VOGF	22	0.31	167	737.5	118.7	[L]	120.0	E040
03/05/88	0800	41.6	193.3	46 8.0	48 15.3	VOGF	22	0.24	146	738.5	119.0	[L]	120.0	E040
03/05/88	0900	41.9	192.5	46 7.5	48 14.5	VOGF	22	0.74	132	739.5	119.7	[L]	120.0	E040
03/05/88	1000	42.0	191.8	46 7.3	48 13.9	VOGF	22	0.46	116	740.5	120.2	[L]	120.0	E040
03/05/88	1100	42.2	191.0	46 7.0	48 13.1	VOGF	22	0.63	119	741.5	120.8	[L]	120.0	M110
03/05/88	1200	42.1	189.8	46 7.0	48 11.8	VOGF	22	0.90	090	742.5	121.7	[L]	120.0	E55
03/05/88	1300	42.1	188.7	46 6.8	48 10.6	VOGF	22	0.85	104	743.5	122.6	[L]	120.0	E55
03/05/88	1400	42.6	187.8	46 6.2	48 9.8	VOGF	22	0.81	137	744.5	123.4	[L]	120.0	E55
03/05/88	1500	43.1	187.3	46 5.7	48 9.3	VOGF	22	0.61	145	745.5	124.0	[L]	120.0	E55
03/05/88	1600	43.7	186.9	46 5.1	48 9.0	VOGF	22	0.63	161	746.5	124.6	[L]	110.0	E55
03/05/88	1700	44.4	186.7	46 4.3	48 8.9	VOGF	22	0.80	175	747.5	125.4	[L]	110.0	E55
03/05/88	1800	44.6	186.5	46 4.1	48 8.7	VOGF	22	0.24	145	748.5	125.7	[L]	90.0	E55
03/05/88	1900	45.0	185.9	46 3.7	48 8.1	VOGF	22	0.58	134	749.5	126.2	[L]	90.0	E55
03/05/88	2000	44.9	185.8	46 3.8	48 8.0	VOGF	22	0.12	035	750.5	126.4	[L]	90.0	E55
03/05/88	2100	44.9	185.3	46 3.7	48 7.4	VOGF	22	0.43	104	751.5	126.8	[L]	90.0	E55
03/05/88	2200	45.2	185.0	46 3.4	48 7.1	VOGF	22	0.36	145	752.5	127.2	[L]	105.0	E50

Table A2 (continued)

Whiterose E-09 (Bow Drill 3)
(46 48.44′ N 48 1.38′ W)

Iceberg Dimensions: Size = M Shape = DDK
Length = E090 Width = E040 Height = E008
Draft = C59 Mass = 30758 Stability = 59.1

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (Kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
03/05/88	2300	45.1	184.7	46 3.5	48 6.7	VOGF	22	0.29	070	753.5	127.4	[L]	105.0	E50
04/05/88	0000	45.2	184.3	46 3.4	48 6.3	VOGF	22	0.29	110	754.5	127.7	[L]	105.0	E50
04/05/88	0100	45.3	183.9	46 3.2	48 5.8	VOGF	22	0.40	120	755.5	128.1	[L]	105.0	E50
04/05/88	0200	45.4	183.4	46 3.1	48 5.3	VOGF	22	0.36	106	756.5	128.5	[L]	105.0	E50
04/05/88	0300	46.1	182.8	46 2.4	48 4.7	VOGF	22	0.81	149	757.5	129.3	[L]	105.0	E50
04/05/88	0400	46.4	182.5	46 2.1	48 4.3	VOGF	22	0.41	137	758.5	129.7	[L]	105.0	E50
04/05/88	0500	46.9	182.1	46 1.6	48 3.9	VOGF	22	0.57	151	759.5	130.3	[L]	105.0	E50
04/05/88	0600	47.2	181.4	46 1.3	48 3.1	VOGF	22	0.63	119	760.5	130.9	[L]	105.0	E50
04/05/88	0700	47.2	181.3	46 1.2	48 2.9	VOGF	22	0.17	126	761.5	131.1	[L]	105.0	E50
04/05/88	0800	47.4	181.0	46 1.0	48 2.6	VOGF	22	0.29	134	762.5	131.4	[L]	105.0	E50
04/05/88	1100	48.5	180.9	45 59.9	48 2.5	VOGF	22	0.37	176	765.5	132.5	[L]	105.0	E70
04/05/88	1200	48.8	180.7	45 59.6	48 2.2	VOGF	22	0.36	145	766.5	132.8	[L]	105.0	E70
04/05/88	1300	48.8	180.4	45 59.6	48 1.9	VOGF	22	0.21	090	767.5	133.0			
04/05/88	1400	48.9	181.0	45 59.5	48 2.6	VOGF	22	0.49	258	768.5	133.5			
04/05/88	1500	48.8	181.2	45 59.6	48 2.9	VOGF	22	0.23	296	769.5	133.8			
04/05/88	1700	48.2	181.7	46 0.3	48 3.4	VCBQ	22	0.39	334	771.5	134.5			
04/05/88	1800	47.9	182.1	46 0.6	48 3.9	VCBQ	22	0.46	311	772.5	135.0			
04/05/88	1900	47.8	182.2	46 0.7	48 4.0	VCBQ	22	0.12	325	773.5	135.1			
04/05/88	2000	47.5	181.6	46 1.0	48 3.3	VCBQ	22	0.57	058	774.5	135.7			
04/05/88	2100	47.0	181.9	46 1.5	48 3.6	VCBQ	22	0.54	338	775.5	136.2			
05/05/88	0400	45.8	182.0	46 2.7	48 3.7	VCBQ	22	0.17	357	782.5	137.4			
05/05/88	0500	45.4	182.3	46 3.1	48 4.0	VCBQ	22	0.45	333	783.5	137.9			
05/05/88	0600	45.4	182.3	46 3.1	48 4.0	VCBQ	22	0.00	000	784.5	137.9			
05/05/88	0700	45.6	182.1	46 2.9	48 3.8	VCBQ	22	0.24	145	785.5	138.1			
05/05/88	0800	45.6	182.2	46 2.9	48 3.9	VCBQ	22	0.07	270	786.5	138.2			
05/05/88	0900	44.8	182.8	46 3.7	48 4.5	VCBQ	22	0.90	333	787.5	139.1			
05/05/88	1000	44.2	183.2	46 4.3	48 5.0	VCBQ	22	0.69	330	788.5	139.8			
05/05/88	1100	42.7	182.6	46 5.8	48 4.2	VCBQ	22	1.60	020	789.5	141.4			
05/05/88	1210	42.1	181.8	46 6.4	48 3.3	VCBQ	22	0.74	046	790.6	142.3			
05/05/88	1300	41.7	181.0	46 6.7	48 2.4	VCBQ	22	0.83	064	791.5	142.9			
05/05/88	1400	41.7	180.4	46 6.7	48 1.8	VCBQ	22	0.41	090	792.5	143.4			
05/05/88	1500	41.4	179.6	46 7.0	48 1.0	VCBQ	22	0.63	061	793.5	144.0			
05/05/88	1600	41.5	178.6	46 6.9	47 59.9	VCBQ	22	0.76	098	794.5	144.7			
05/05/88	1700	41.7	178.0	46 6.8	47 59.3	VCBQ	22	0.43	104	795.5	145.2			
05/05/88	1800	42.0	177.7	46 6.5	47 58.9	VCBQ	22	0.41	137	796.5	145.6			
05/05/88	1905	42.3	177.4	46 6.2	47 58.6	VCBQ	22	0.34	145	797.6	145.9			
05/05/88	2000	42.5	177.2	46 6.0	47 58.4	VCBQ	22	0.26	145	798.5	146.2			
05/05/88	2100	42.7	177.2	46 5.8	47 58.4	VCBQ	22	0.20	180	799.5	146.4			
05/05/88	2200	42.8	176.9	46 5.7	47 58.0	VCBQ	22	0.29	110	800.5	146.7			
05/05/88	2300	43.1	176.9	46 5.4	47 58.0	VCBQ	22	0.30	180	801.5	147.0			
06/05/88	0000	43.7	176.9	46 4.8	47 58.0	VCBQ	22	0.60	180	802.5	147.6			
06/05/88	0100	44.2	176.8	46 4.3	47 57.8	VCBQ	22	0.52	165	803.5	148.1			
06/05/88	0200	44.7	176.1	46 3.8	47 57.0	VCBQ	22	0.74	132	804.5	148.8			
06/05/88	0300	45.1	176.6	46 3.4	47 57.5	VCBQ	22	0.53	221	805.5	149.4			

Table A2 (continued)

Whiterose E-09 (Bow Drill 3)
(46 48.44' N 48 1.38' W)

Iceberg Dimensions: Size = M Shape = DDK
Length = E090 Width = E040 Height = E008
Draft = C59 Mass = 30758 Stability = 59.1

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
06/05/88	0400	45.7	176.4	46 2.8	47 57.2	VCBQ	22	0.63	161	806.5	150.0			
06/05/88	0500	46.7	176.1	46 1.8	47 56.8	VCBQ	22	1.04	165	807.5	151.0			
06/05/88	0900	48.9	176.1	45 59.7	47 56.5	VCBQ	20	0.53	174	811.5	153.2	[L]	180.0	E060
06/05/88	1000	49.2	176.4	45 59.3	47 56.9	VCBQ	20	0.49	215	812.5	153.6	[L]	180.0	E060
06/05/88	1100	49.6	176.4	45 58.9	47 56.8	VCBQ	20	0.41	170	813.5	154.0	[L]	180.0	E060
06/05/88	1200	50.3	176.2	45 58.3	47 56.5	VCBQ	20	0.63	161	814.5	154.7	[L]	180.0	E060
06/05/88	1300	51.0	176.1	45 57.6	47 56.4	VCBQ	20	0.70	174	815.5	155.4	[L]	180.0	E060
06/05/88	1400	51.4	176.3	45 57.1	47 56.6	VCBQ	20	0.52	195	816.5	155.9	[L]	180.0	E060
06/05/88	1500	52.3	176.3	45 56.2	47 56.5	VCBQ	20	0.90	176	817.5	156.8	[L]	180.0	E060
06/05/88	1600	52.8	176.3	45 55.7	47 56.5	VCBQ	20	0.50	180	818.5	157.3	[L]	180.0	E060
06/05/88	1700	53.8	176.5	45 54.7	47 56.6	VCBQ	20	1.00	184	819.5	158.3	[L]	180.0	E060
06/05/88	1800	54.5	176.6	45 54.0	47 56.7	VCBQ	20	0.70	186	820.5	159.0	[L]	180.0	E060
06/05/88	1900	55.2	176.8	45 53.3	47 56.9	VCBQ	20	0.71	191	821.5	159.7	[L]	180.0	E060
06/05/88	2000	55.7	177.2	45 52.8	47 57.5	VCBQ	20	0.65	220	822.5	160.4	[L]	200.0	E060
06/05/88	2200	57.1	177.7	45 51.4	47 58.0	VCBQ	20	0.72	194	824.5	161.8	[L]	200.0	E060
07/05/88	0000	58.0	178.2	45 50.5	47 58.8	VCBQ	20	0.53	212	826.5	162.9	[L]	200.0	E060
07/05/88	0200	59.0	178.5	45 49.5	47 59.2	VCBQ	20	0.52	195	828.5	163.9	[L]	200.0	E060
07/05/88	0400	60.2	178.8	45 48.2	47 59.6	VCBQ	20	0.66	192	830.5	165.2	[L]	200.0	E060
07/05/88	0600	61.9	179.4	45 46.5	48 0.5	VCBQ	20	0.91	200	832.5	167.0	[L]	200.0	E060
07/05/88	2000	67.2	182.8	45 41.3	48 6.1	VXJG	20	0.46	217	846.5	173.5			
07/05/88	2200	68.4	183.1	45 40.1	48 6.8	VXJG	20	0.65	202	848.5	174.8			
08/05/88	0000	69.4	183.8	45 39.2	48 8.0	VXJG	20	0.61	223	850.5	176.1			
08/05/88	0200	70.2	184.4	45 38.4	48 9.1	VXJG	20	0.55	224	852.5	177.2			
08/05/88	0400	70.9	185.4	45 37.9	48 11.1	VXJG	20	0.74	250	854.5	178.6			
08/05/88	0600	70.9	185.5	45 37.9	48 11.2	VXJG	20	0.03	270	856.5	178.7			
08/05/88	0800	70.9	185.6	45 37.9	48 11.4	VXJG	22	0.07	270	858.5	178.8			
08/05/88	1000	70.9	185.6	45 37.9	48 11.4	VXJG	22	0.00	000	860.5	178.8			
08/05/88	1200	71.1	185.6	45 37.7	48 11.4	VXJG	22	0.10	180	862.5	179.0			
08/05/88	1400	71.5	185.5	45 37.3	48 11.2	VXJG	22	0.21	161	864.5	179.5			
08/05/88	1600	72.0	185.5	45 36.8	48 11.3	VXJG	22	0.25	188	866.5	180.0			
08/05/88	1800	71.9	185.8	45 36.9	48 11.8	VXJG	22	0.18	286	868.5	180.3			
08/05/88	2000	72.1	186.5	45 36.8	48 13.1	VXJG	22	0.45	264	870.5	181.2			
08/05/88	2200	71.9	187.0	45 37.1	48 14.0	VXJG	22	0.35	296	872.5	181.9			
09/05/88	0000	71.1	187.4	45 37.9	48 14.7	VXJG	22	0.47	329	874.5	182.9			
09/05/88	0400	70.2	188.7	45 39.0	48 16.7	VXJG	22	0.44	309	878.5	184.6			
10/05/88	0400	69.2	190.4	45 40.4	48 19.4	VOGF	22	0.10	307	902.5	187.0			
10/05/88	0600	69.3	190.6	45 40.3	48 19.9	VOGF	22	0.18	254	904.5	187.3			
10/05/88	0800	69.0	190.7	45 40.6	48 19.9	VOGF	22	0.15	000	906.5	187.6			
12/05/88	0000	58.1	190.8	45 51.4	48 17.2	VOGF	22	0.27	010	946.5	198.6			
12/05/88	0130	59.2	190.2	45 50.2	48 16.6	VOGF	22	0.85	161	948.0	199.8			
12/05/88	0230	58.8	190.0	45 50.5	48 16.2	VOGF	22	0.41	043	949.0	200.3			
12/05/88	0330	58.6	189.9	45 50.7	48 16.0	VOGF	22	0.24	035	950.0	200.5			

Table A2 (continued)

Whiterose E-09 (Bow Drill 3)
(46 48.44' N 48 1.38' W)

Iceberg Dimensions: Size = M Shape = DDK
Length = E090 Width = E040 Height = E008
Draft = C59 Mass = 30758 Stability = 59.1

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (Kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
12/05/88	1733	58.4	190.9	45 51.1	48 17.3	2329	22	0.07	294	964.0	201.5			
12/05/88	1900	58.0	191.0	45 51.5	48 17.4	2329	22	0.28	350	965.5	201.9	[L]	190.0	E35
12/05/88	2100	57.6	190.2	45 51.7	48 16.1	2329	22	0.46	077	967.5	202.8	[L]	190.0	E35
12/05/88	2300	57.7	189.1	45 51.5	48 14.6	2329	22	0.53	101	969.5	203.9	[L]	190.0	E35
13/05/88	0100	58.0	188.5	45 51.1	48 13.8	2329	22	0.34	126	971.5	204.5	[L]	190.0	E35
13/05/88	0300	59.6	189.2	45 49.6	48 15.2	2329	22	0.89	213	973.5	206.3	[L]	190.0	E40
13/05/88	0500	61.0	190.2	45 48.4	48 17.0	2329	22	0.86	226	975.5	208.1	[L]	190.0	E40
13/05/88	0700	61.7	190.6	45 47.8	48 17.8	2329	22	0.41	223	977.5	208.9	[L]	190.0	E40
13/05/88	0900	62.3	190.6	45 47.2	48 18.0	2329	22	0.31	193	979.5	209.5	[L]	190.0	E40
13/05/88	1100	63.3	190.1	45 46.1	48 17.5	2329	22	0.58	163	981.5	210.6	[L]	190.0	E40
13/05/88	1300	65.0	189.6	45 44.3	48 17.0	2329	22	0.92	169	983.5	212.5	[L]	190.0	E40
13/05/88	1500	66.9	189.8	45 42.5	48 17.8	2329	22	0.94	197	985.5	214.4	[L]	190.0	E40
13/05/88	1700	68.9	190.0	45 40.6	48 18.7	2329	22	1.00	198	987.5	216.4	[L]	190.0	E40
13/05/88	1900	69.8	191.4	45 40.0	48 21.3	2329	22	0.95	252	989.5	218.3	[L]	190.0	E40
13/05/88	2100	71.2	191.7	45 38.7	48 22.2	2329	22	0.72	206	991.5	219.7	[L]	190.0	E40
13/05/88	2300	72.5	191.9	45 37.5	48 23.0	2329	22	0.66	205	993.5	221.0	[L]	190.0	E40
14/05/88	0100	74.7	191.8	45 35.3	48 23.5	2329	22	1.11	189	995.5	223.2	[L]	190.0	E40
14/05/88	0300	75.4	191.9	45 34.7	48 23.9	2329	22	0.33	205	997.5	223.9	[L]	190.0	E40
14/05/88	0500	76.6	192.0	45 33.5	48 24.4	2329	22	0.62	196	999.5	225.2	[L]	190.0	E40
14/05/88	0700	78.3	192.1	45 31.9	48 25.1	2329	0	0.84	197	%1001.5	226.8			
15/05/88	0100	89.8	195.0	45 21.6	48 34.9		22	0.68	214	%1019.5	239.1	[L]	190.0	E040
15/05/88	0400	92.2	194.9	45 19.3	48 35.6	V023	22	0.80	192	%1022.5	241.5	[L]	0.0	
15/05/88	0535	94.7	195.0	45 17.0	48 36.8	V023	22	1.55	200	%1024.1	244.0			

09/04/88 1120 1.51 10.8 (CPA)
15/05/88 0535 94.68 195.0 (MDR)

SPEEDS (Knots)

Min.	Max.	Mean	MadeGood	
0.00	2.03	0.45	0.13	(to 194 T; DRIFT RATIO = 0.54)

TOTAL NUMBER OF OBSERVATIONS = 273

Table A2 (continued)

BERG 002

Whiterose E-09 (Bow Drill 3)
(46 48.44′ N 48 1.38′ W)

Iceberg Dimensions: Size = S Shape = DOM
Length = XXX Width = XXX Height = XXX
Draft = XXX Mass = XXX

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
02/04/88	1336	44.3	3.1	47 32.7	47 57.9	GPCD	0							
04/04/88	1619	15.2	10.5	47 3.4	47 57.3	GPCD	0	0.58	179	50.7	29.3			
06/04/88	1745	15.2	299.0	46 55.8	48 20.8	GPCD	0	0.36	245	100.2	47.1			

06/04/88 1745 15.18 299.0 (CPA)
02/04/88 1336 44.33 3.1 (MDR)

SPEEDS (knots)

Min.	Max.	Mean	MadeGood	
0.36	0.58	0.47	0.40	(to 203 T; DRIFT RATIO = 0.85)

TOTAL NUMBER OF OBSERVATIONS = 3

Whiterose E-09 (Bow Drill 3)
(46 48.44′ N 48 1.38′ W)

Iceberg Dimensions: Size = L Shape = DDK
Length = M152 Width = M094 Height = M025
Draft = M100 Mass = 381490 Stability = 28.2

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
14/04/88	1900	59.0	300.6	47 18.5	49 15.9	VCYS	0							
15/04/88	1700	59.0	300.6	47 18.5	49 15.9	VCYS	19	0.00	000	22.0	0.0			
15/04/88	2100	59.3	299.9	47 18.0	49 16.8	VCYS	19	0.20	231	26.0	0.8			
15/04/88	2107	59.3	299.9	47 18.0	49 16.8	VCYS	19	0.00	000	26.1	0.8			
16/04/88	1354	59.3	299.9	47 18.0	49 16.8	GPCD	19	0.00	000	42.9	0.8			
17/04/88	2205	59.4	299.1	47 17.3	49 17.6	VCBQ	19	0.03	218	75.1	1.7			
18/04/88	1000	59.4	299.8	47 17.9	49 17.0	VCYS	19	0.06	035	87.0	2.4			
18/04/88	2200	59.4	299.8	47 17.9	49 17.0	VCYS	19	0.00	000	99.0	2.4			
20/04/88	1010	59.2	299.9	47 18.0	49 16.7	VCYQ	19	0.01	064	135.2	2.6			
20/04/88	1454	58.7	299.9	47 17.7	49 16.0	VCYQ	19	0.12	122	139.9	3.2			
21/04/88	1230	61.3	292.4	47 11.8	49 24.5	VCYQ	19	0.38	225	161.5	11.5			
21/04/88	1330	61.2	291.8	47 11.2	49 24.7	VCYQ	19	0.62	193	162.5	12.1			
21/04/88	1430	61.3	291.7	47 11.1	49 24.9	VCYQ	19	0.17	234	163.5	12.3			
21/04/88	1530	61.3	291.8	47 11.2	49 24.9	VCYQ	19	0.10	001	164.5	12.4			
21/04/88	1930	61.2	291.7	47 11.1	49 24.8	VCYQ	19	0.03	146	168.5	12.5			
21/04/88	2030	61.3	291.7	47 11.1	49 24.9	VCYQ	19	0.07	270	169.5	12.6			
21/04/88	2130	61.4	291.8	47 11.2	49 25.0	VCYQ	19	0.12	326	170.5	12.7			
22/04/88	0000	61.4	291.8	47 11.2	49 25.0	VCYQ	19	0.00	000	173.0	12.7			
22/04/88	0400	60.9	292.7	47 12.0	49 23.8	VCYQ	19	0.29	046	177.0	13.9			
22/04/88	0500	60.7	293.1	47 12.3	49 23.3	VCYQ	19	0.46	049	178.0	14.3			
22/04/88	0700	60.6	293.2	47 12.3	49 23.0	VCYQ	19	0.10	090	180.0	14.5			
22/04/88	2040	60.4	293.3	47 12.3	49 22.7	VCYS	19	0.02	083	193.7	14.7			
23/04/88	0735	60.4	293.3	47 12.3	49 22.7	VCYS	19	0.00	206	204.6	14.8			
23/04/88	0815	60.4	293.3	47 12.3	49 22.7	VCYS	19	0.00	000	205.3	14.8			
23/04/88	0930	60.4	293.3	47 12.3	49 22.7	VCYS	19	0.00	000	206.5	14.8			
23/04/88	1200	60.4	293.3	47 12.3	49 22.7	VCYS	19	0.00	000	209.0	14.8			
23/04/88	1600	60.4	293.3	47 12.3	49 22.7	VCYS	19	0.00	000	213.0	14.8			
24/04/88	0800	60.4	293.3	47 12.3	49 22.7	VCYS	19	0.00	000	229.0	14.8			
25/04/88	0000	60.4	293.3	47 12.3	49 22.7	VCYS	19	0.00	000	245.0	14.8			
25/04/88	1018	60.6	292.6	47 11.7	49 23.4	GSLA	19	0.07	219	255.3	15.5			
25/04/88	1830	60.5	293.2	47 12.3	49 22.9	VCYS	19	0.08	030	263.5	16.2			
25/04/88	1900	60.4	293.3	47 12.3	49 22.7	VCYS	19	0.27	090	264.0	16.4			
26/04/88	0800	60.4	293.3	47 12.3	49 22.7	VCYS	19	0.00	000	277.0	16.4			
26/04/88	1200	60.4	293.3	47 12.3	49 22.7	VCYS	19	0.00	000	281.0	16.4			
27/04/88	0430	60.5	293.2	47 12.3	49 22.9	VCYS	22	0.01	270	297.5	16.5			

Table A3 Individual iceberg drift track listing for iceberg 005/1988

BERG 005

Whiterose E-09 (Bow Drill 3)
(46 48.44' N 48 1.38' W)

Iceberg Dimensions: Size = L Shape = DDK
Length = M152 Width = M094 Height = M025
Draft = M100 Mass = 381490 Stability = 28.2

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
27/04/88	1125	60.5	293.2	47 12.3	49 22.9	VCYS	22	0.00	000	304.4	16.5			
28/04/88	1340	59.6	292.0	47 10.8	49 22.4	GSLA	22	0.06	168	330.7	18.0			
28/04/88	1921	60.1	293.3	47 12.2	49 22.4	VXJK	22	0.25	000	336.4	19.4			
28/04/88	2200	60.1	293.3	47 12.2	49 22.4	VXJK	22	0.00	000	339.0	19.4			
29/04/88	0000	60.1	293.3	47 12.2	49 22.4	VXJK	22	0.00	000	341.0	19.4			
29/04/88	0400	60.2	293.2	47 12.2	49 22.5	VXJK	22	0.02	270	345.0	19.5			
29/04/88	0700	60.2	293.2	47 12.2	49 22.5	VXJK	22	0.00	000	348.0	19.5			
29/04/88	0900	60.2	293.2	47 12.2	49 22.5	VXJK	22	0.00	000	350.0	19.5			
29/04/88	1200	60.2	293.2	47 12.2	49 22.5	VXJK	22	0.00	000	353.0	19.5			
29/04/88	1600	60.2	293.2	47 12.2	49 22.5	VXJK	22	0.01	208	357.0	19.5			
29/04/88	2000	60.2	293.2	47 12.2	49 22.5	VXJK	22	0.01	028	361.0	19.6			
30/04/88	0000	60.2	293.2	47 12.2	49 22.5	VXJK	22	0.00	000	365.0	19.6			
30/04/88	0400	60.2	293.2	47 12.2	49 22.5	VXJK	22	0.00	000	369.0	19.6			
30/04/88	0800	60.2	293.2	47 12.2	49 22.5	VXJK	22	0.00	000	373.0	19.6			
30/04/88	2310	60.2	293.2	47 12.2	49 22.5	VXJK	22	0.00	000	388.2	19.6			
01/05/88	0212	61.0	293.1	47 12.4	49 23.6	VCYQ	22	0.26	285	391.2	20.4			
01/05/88	0334	61.6	292.9	47 12.4	49 24.6	VCYQ	22	0.50	270	392.6	21.0			
01/05/88	0430	61.6	292.9	47 12.4	49 24.6	VCYQ	22	0.00	000	393.5	21.0			
01/05/88	0530	61.7	292.9	47 12.4	49 24.7	VCYQ	22	0.07	270	394.5	21.1			
01/05/88	0630	61.7	292.9	47 12.4	49 24.7	VCYQ	22	0.00	000	395.5	21.1			
01/05/88	0730	61.7	292.9	47 12.4	49 24.7	VCYQ	22	0.00	000	396.5	21.1			
01/05/88	1220	61.7	292.7	47 12.2	49 24.8	VCYQ	22	0.04	199	401.3	21.3			
01/05/88	1935	61.9	292.6	47 12.2	49 25.2	VCYQ	22	0.03	270	408.6	21.6			
01/05/88	2125	62.0	292.5	47 12.2	49 25.3	VCYQ	22	0.02	270	410.4	21.7			
02/05/88	0035	62.0	292.5	47 12.2	49 25.3	VCYQ	22	0.00	000	413.6	21.7			
02/05/88	0400	62.0	292.5	47 12.2	49 25.3	VCYQ	22	0.00	000	417.0	21.7			
02/05/88	0600	62.0	292.5	47 12.2	49 25.3	VCYQ	22	0.00	000	419.0	21.7			
02/05/88	0800	61.8	292.6	47 12.2	49 25.1	VCYQ	22	0.03	090	421.0	21.8			
02/05/88	1000	61.9	292.6	47 12.2	49 25.2	VCYQ	22	0.03	270	423.0	21.9			
02/05/88	1200	61.9	292.6	47 12.2	49 25.2	VCYQ	22	0.00	000	425.0	21.9			
02/05/88	1730	62.0	292.6	47 12.3	49 25.3	VCYQ	22	0.02	326	430.5	22.0			
02/05/88	2000	62.3	292.3	47 12.1	49 25.9	VCYQ	22	0.18	244	433.0	22.4			
02/05/88	2210	62.5	292.1	47 11.9	49 26.3	VCYQ	22	0.16	234	435.2	22.8			
03/05/88	0000	62.3	291.7	47 11.5	49 26.2	VCYQ	22	0.22	171	437.0	23.2			
03/05/88	0200	62.2	291.5	47 11.2	49 26.2	VCYQ	22	0.15	181	439.0	23.5			
03/05/88	0400	62.3	291.7	47 11.5	49 26.2	VCYQ	22	0.15	001	441.0	23.8			
03/05/88	0600	62.5	292.1	47 11.9	49 26.3	VCYQ	22	0.20	351	443.0	24.2			
03/05/88	0800	62.5	292.1	47 11.9	49 26.3	VCYQ	22	0.00	000	445.0	24.2			
03/05/88	1000	62.4	292.1	47 11.9	49 26.2	VCYQ	22	0.03	090	447.0	24.3			
03/05/88	1200	62.4	292.1	47 11.9	49 26.2	VCYQ	22	0.00	000	449.0	24.3			
03/05/88	1400	62.4	292.1	47 11.9	49 26.2	VCYQ	22	0.00	000	451.0	24.3			

Table A3 (continued)

Whiterose E-09 (Bow Drill 3)
(46 48.44′ N 48 1.38′ W)

Iceberg Dimensions: Size = L Shape = DDK
Length = M152 Width = M094 Height = M025
Draft = M100 Mass = 381490 Stability = 28.2

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
04/05/88	0330	62.3	291.7	47 11.5	49 26.3	VCYQ	22	[illegible]	190	464.5	24.7			
04/05/88	0430	62.2	291.7	47 11.4	49 26.1	VCYQ	22	0.15	112	465.5	24.8			
04/05/88	0530	62.3	291.7	47 11.5	49 26.2	VCYQ	22	0.09	309	466.5	24.9			
04/05/88	0800	62.3	291.7	47 11.5	49 26.2	VCYQ	22	0.00	000	469.0	24.9			
04/05/88	1000	62.3	291.7	47 11.5	49 26.2	VCYQ	22	0.00	000	471.0	24.9			
04/05/88	1200	62.5	292.1	47 11.9	49 26.3	VCYQ	22	0.20	351	473.0	25.3			
04/05/88	1400	62.3	291.7	47 11.5	49 26.3	VCYQ	22	0.20	181	475.0	25.7			
04/05/88	1800	62.5	292.1	47 11.9	49 26.3	VCYQ	22	0.10	001	479.0	26.1			
05/05/88	0420	63.2	295.7	47 15.8	49 24.9	VCYQ	22	0.39	014	489.3	30.1			

MAX POSSIBLE 64 - 4 days

20/04/88 1454 58.66 299.9 (CPA)
05/05/88 0420 63.16 295.7 (MDR)

SPEEDS (knots)

Min.	Max.	Mean	MadeGood	
0.00	0.62	0.08	0.01	(to 246 T; DRIFT RATIO = 0.22)

TOTAL NUMBER OF OBSERVATIONS = 85

Table A3 (continued)

BERG 006

Whiterose E-09 (Bow Drill 3)
(46 48.44' N 48 1.38' W)

Iceberg Dimensions: Size = S Shape = DDK
Length = M29 Width = M26 Height = M6
Draft = C34 Mass = 4832 Stability = 41.4

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
05/05/88	0415	63.2	295.7	47 15.8	49 24.9	VCYQ	20							
05/05/88	0500	63.3	295.8	47 16.0	49 25.0	VCYQ	20	0.28	342	0.8	0.2			
05/05/88	0600	63.7	296.5	47 16.9	49 25.0	VCYQ	20	0.90	001	1.8	1.1			
05/05/88	0700	63.8	296.9	47 17.3	49 24.9	VCYQ	20	0.41	010	2.8	1.5			
05/05/88	1008	64.0	298.2	47 18.7	49 24.1	VCYQ	20	0.48	022	5.9	3.0			
05/05/88	1307	64.0	299.2	47 19.6	49 23.4	VCYQ	20	0.34	028	8.9	4.0			
05/05/88	1600	63.7	299.0	47 19.3	49 23.2	VCYQ	20	0.11	156	11.8	4.4			
05/05/88	2110	62.4	296.6	47 16.4	49 23.2	VCYQ	20	0.56	181	16.9	7.3			
06/05/88	0000	63.1	295.6	47 15.7	49 24.8	VCYQ	20	0.46	237	19.8	8.6			
06/05/88	0255	62.5	295.6	47 15.5	49 24.1	VCYQ	20	0.18	113	22.7	9.1			
06/05/88	0455	62.0	295.8	47 15.4	49 23.3	VCYQ	20	0.28	100	24.7	9.6			
06/05/88	0800	60.5	295.6	47 14.6	49 21.4	VCYQ	20	0.49	122	27.8	11.2			
06/05/88	0957	60.2	295.3	47 14.2	49 21.2	VCYQ	20	0.22	162	29.7	11.6			
06/05/88	1207	60.1	295.0	47 13.9	49 21.3	VCYQ	20	0.14	193	31.9	11.9			
06/05/88	1515	60.9	295.8	47 14.9	49 21.8	VCYQ	20	0.34	342	35.0	12.9			
06/05/88	1757	60.6	297.1	47 16.0	49 20.5	VCYQ	20	0.53	039	37.7	14.4			
06/05/88	2035	59.9	297.7	47 16.3	49 19.2	VCYQ	20	0.36	071	40.3	15.3			
07/05/88	0630	57.8	302.5	47 19.5	49 13.0	VCYS	20	0.54	053	50.3	20.6			
07/05/88	0800	57.1	303.4	47 19.9	49 11.4	VCYS	20	0.78	070	51.8	21.8			
07/05/88	0900	57.5	302.9	47 19.7	49 12.2	VCYS	20	0.58	250	52.8	22.4	[L]	225.0	E070
07/05/88	1000	57.4	302.9	47 19.6	49 12.2	VCYS	20	0.10	180	53.8	22.5	[L]	225.0	E070
07/05/88	1100	57.5	302.6	47 19.4	49 12.5	VCYS	20	0.29	226	54.8	22.8	[L]	225.0	E070
07/05/88	1200	57.6	302.4	47 19.3	49 12.7	VCYS	20	0.17	234	55.8	22.9	[L]	225.0	E070
07/05/88	1400	58.1	302.5	47 19.6	49 13.3	VCYS	20	0.25	306	57.8	23.4	[L]	225.0	E070
07/05/88	1600	57.8	301.8	47 18.9	49 13.5	VCYS	20	0.36	191	59.8	24.1	[L]	225.0	E070
07/05/88	1800	58.1	302.1	47 19.3	49 13.6	VCYS	20	0.20	351	61.8	24.5	[L]	225.0	E070
07/05/88	2000	58.2	301.3	47 18.7	49 14.3	VCYS	20	0.38	219	63.8	25.3	[L]	225.0	E070
07/05/88	2200	58.7	300.1	47 17.9	49 15.9	VCYS	20	0.68	234	65.8	26.7	[L]	225.0	E070
08/05/88	0000	60.0	299.1	47 17.6	49 18.4	VCYS	20	0.87	260	67.8	28.4	[L]	225.0	E070
08/05/88	0200	61.2	297.9	47 17.1	49 20.7	VCYS	20	0.82	252	69.8	30.1	[L]	225.0	E070
08/05/88	0400	62.5	297.9	47 17.7	49 22.5	VCYS	20	0.68	296	71.8	31.4	[L]	225.0	E070
08/05/88	0600	63.0	297.1	47 17.2	49 23.7	VCYS	20	0.48	239	73.8	32.4	[L]	225.0	E070
08/05/88	0800	63.4	297.1	47 17.3	49 24.3	VCYS	20	0.21	284	75.8	32.8	[L]	225.0	E070
08/05/88	1000	63.2	295.7	47 15.8	49 24.9	VCYS	20	0.78	196	77.8	34.4	[L]	225.0	E070
08/05/88	1200	62.9	293.7	47 13.7	49 25.9	VCYS	20	1.11	198	79.8	36.6	[L]	225.0	E070
08/05/88	1400	63.6	291.7	47 11.9	49 28.0	VCYS	20	1.16	219	81.8	38.9	[L]	225.0	E070
08/05/88	1600	64.7	290.3	47 10.9	49 30.3	VCYS	20	0.93	238	83.8	40.7	[L]	237.0	E070
08/05/88	1800	65.7	289.1	47 9.9	49 32.4	VCYS	22	0.88	235	85.8	42.5	[L]	240.0	E070
08/05/88	2000	66.8	287.9	47 9.0	49 34.6	VCYS	22	0.88	239	87.8	44.3	[L]	240.0	E070
08/05/88	2200	68.1	286.8	47 8.1	49 37.0	VCYS	22	0.94	241	89.8	46.1	[L]	230.0	E070
09/05/88	0000	69.8	286.0	47 7.7	49 39.7	VCYS	22	0.94	258	91.8	48.0	[L]	230.0	E070
09/05/88	0200	71.4	285.4	47 7.4	49 42.2	VCYS	22	0.87	260	93.8	49.8	[L]	220.0	E070
09/05/88	0400	72.7	285.0	47 7.2	49 44.3	VCYS	22	0.72	262	95.8	51.2	[L]	220.0	E070

Husky Oil Daily Ice Summary.

SITE SPECIFIC

Springdale M-29

RADIUS: 40 nm.

T-TIME: 7.0 hrs

ZONES			(nm.)
WHITE	ZONE	=	2.0
RED	ZONE	=	4.0
ORANGE	ZONE	=	7.0
YELLOW	ZONE	=	19.0
BLUE	ZONE	=	31.0

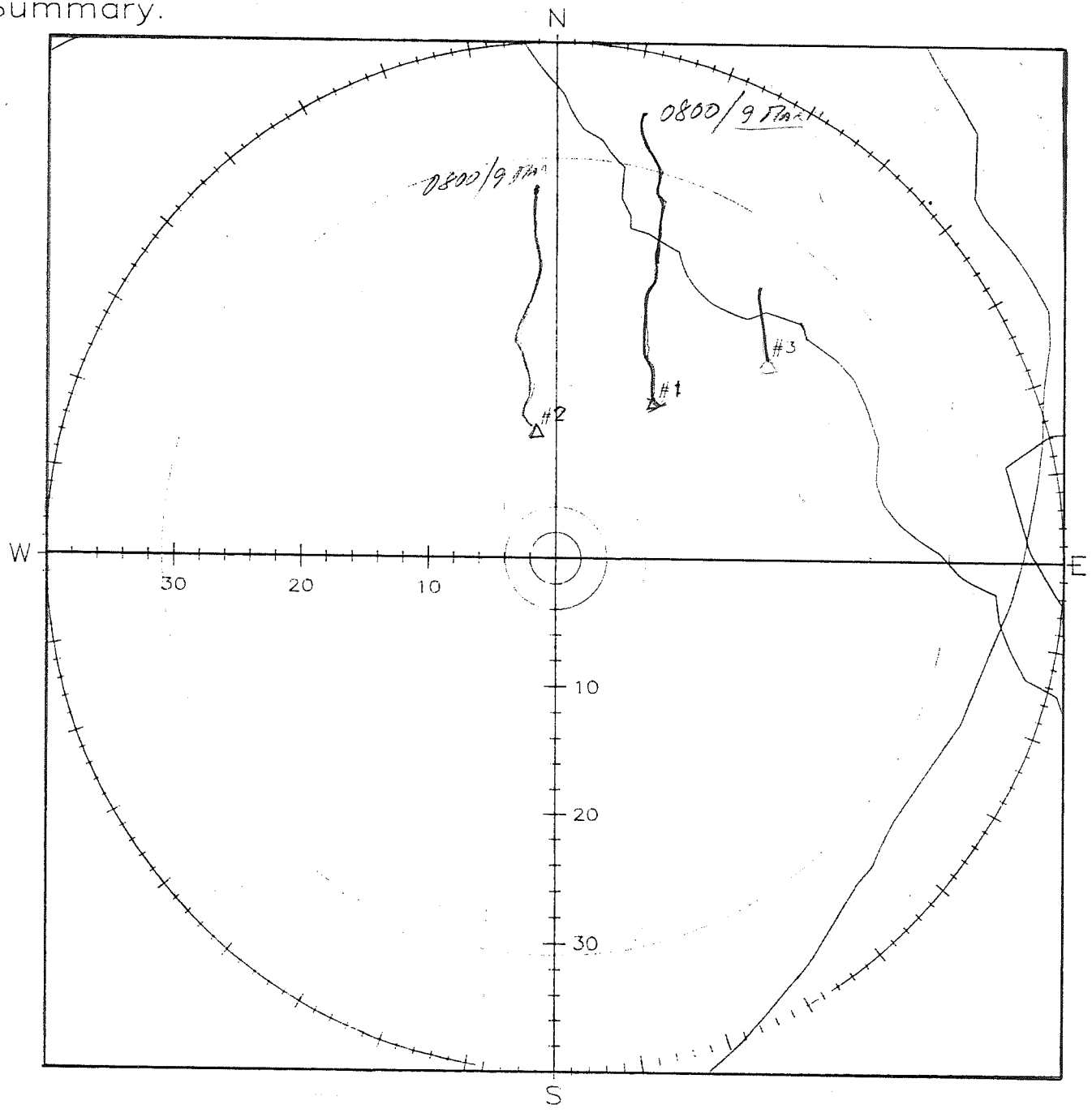


Figure A-2 Site-specific plot for 3 icebergs drifting away from the ice edge March 10-11, 1989

million tonnes. Despite basically westerly winds and a tow direction to the east, the berg continued to drift due south (Fig. A-3) into shallower water, a result which suggests that a net current of about 30 cm/s opposed the combined wind and tow forces. This net current is derived from forcing calculations involving winds, tow forcing and currents. The drift rate of the berg reduced from a maximum of 1.77 knots to zero when the berg grounded. Prior to grounding, the drift speeds decreased starting about 0800 on March 10. However, some oscillation in the drift speed occurred on March 9 and early on March 10. By 2300, the berg was definitely grounded and this implies that keel dragging occurred over a distance of at least 3 nm. Based on this inferred grounding, AGC conducted a side scan sonar survey a few weeks after the berg had drifted away and found an iceberg furrow at least 8nm long on the sea bed beneath the berg's pregrounding trajectory. In 112m water depth, the furrow terminated in a 5m deep pit with a diameter of 90m (Fader, 1989). A 3m high berm surrounded the pit. Based on the 112m water depth and the 5m deep pit, the draft of berg 001 is taken to be 117m. This suggests that dragging on the bottom probably commenced in 117m of water which in turn implies a scour length of about 11nm. Fig. A-4 illustrates the pit and a part of the iceberg furrow.

Iceberg 004/1989

Iceberg 004/1989 was a large berg, which drifted free from the pack ice and grounded in 100m of water at 46° -44.4'N. and 48° -27.4' W. The grounding occurred at 1705-12-03 and lasted 3 or 4 days. On the 16th of March, the berg was found adrift, and it was then towed into deeper water. Berg 004 was 300m in length at the water line. The sail height was 50m and the mass was estimated as 3 million tonnes. The grounded position is indicated in Fig. 5.2. No other information is available regarding this grounding.

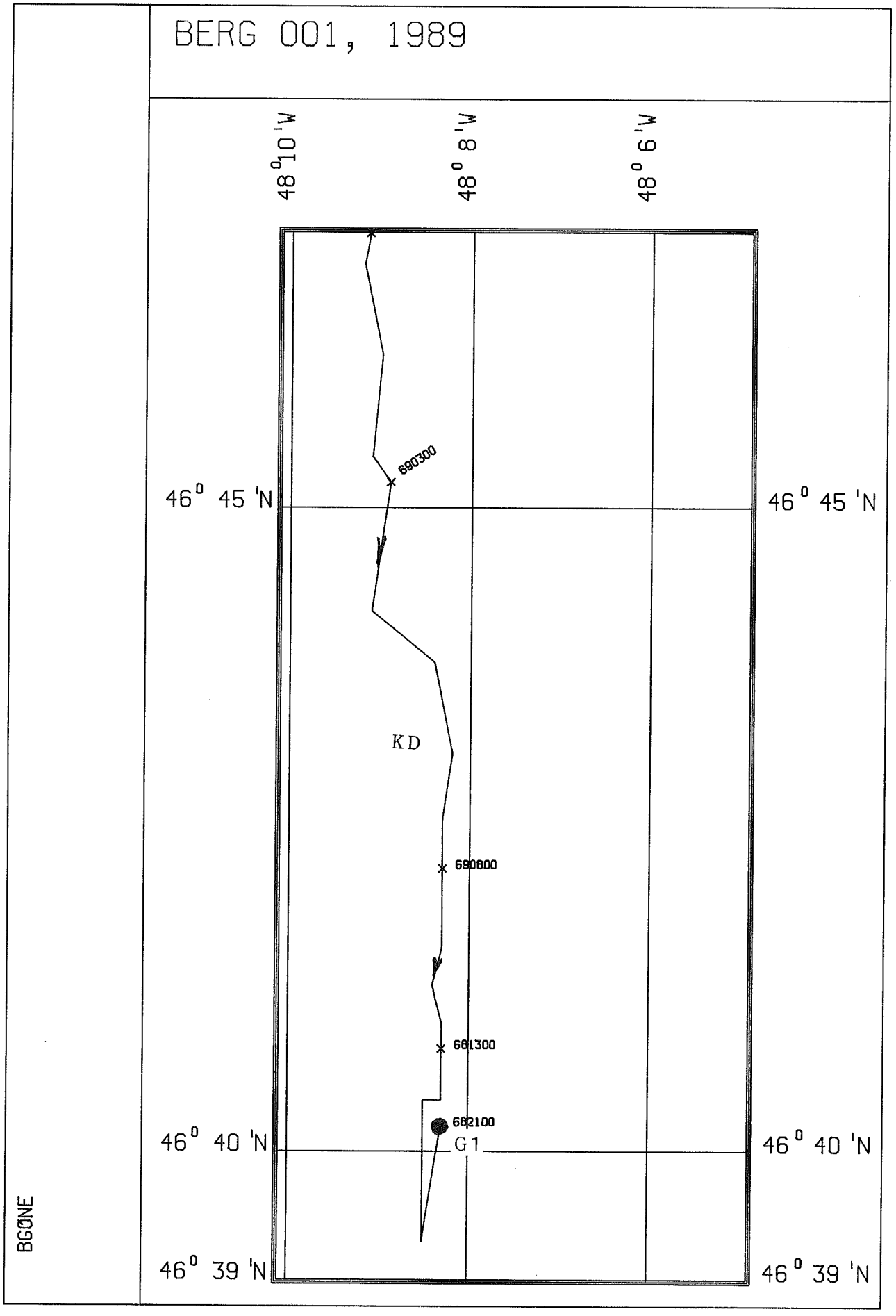


Figure A-3 Drift track of iceberg 001/1989

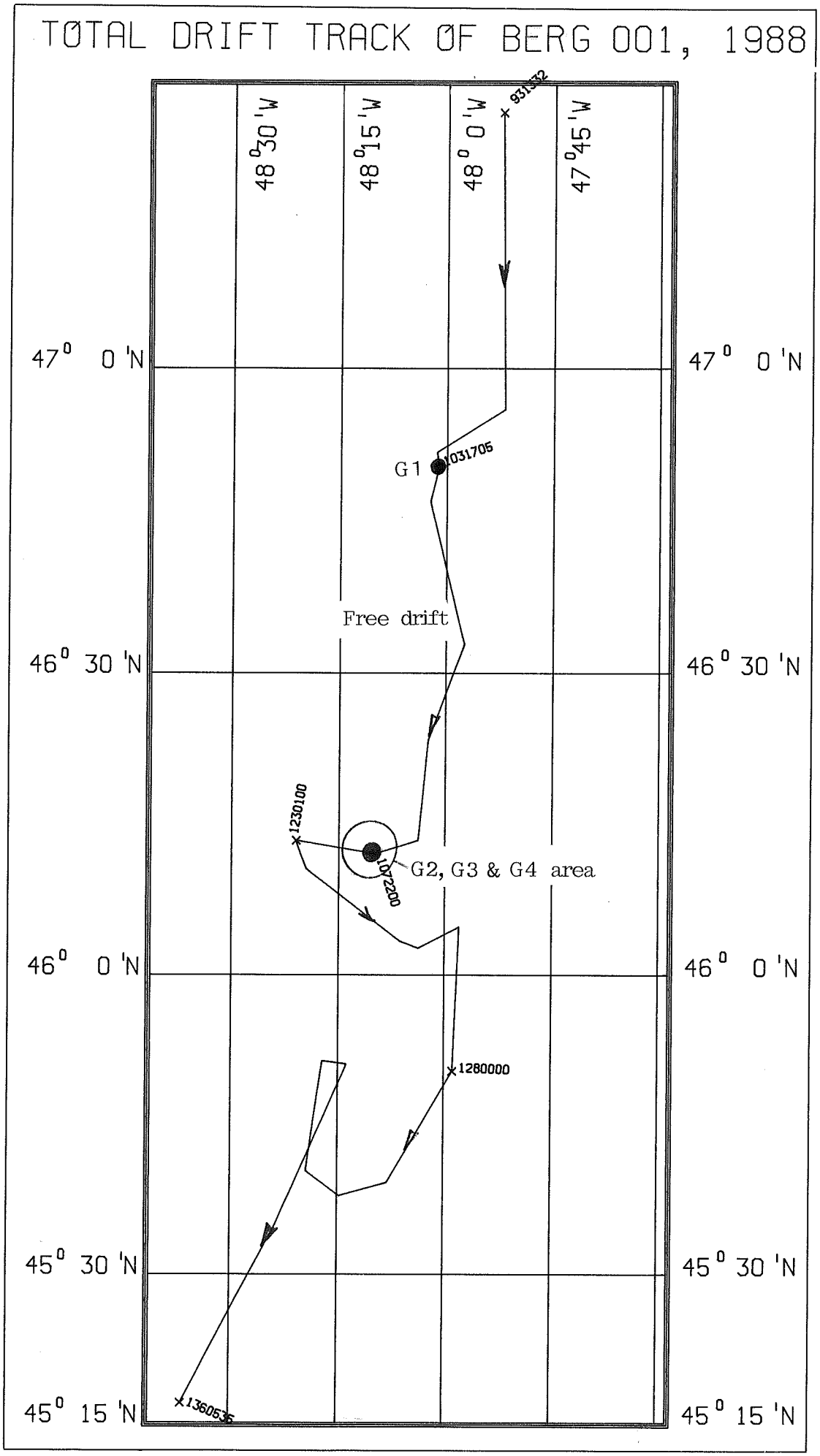


Figure A-6 Entire drift track of iceberg 001/1988

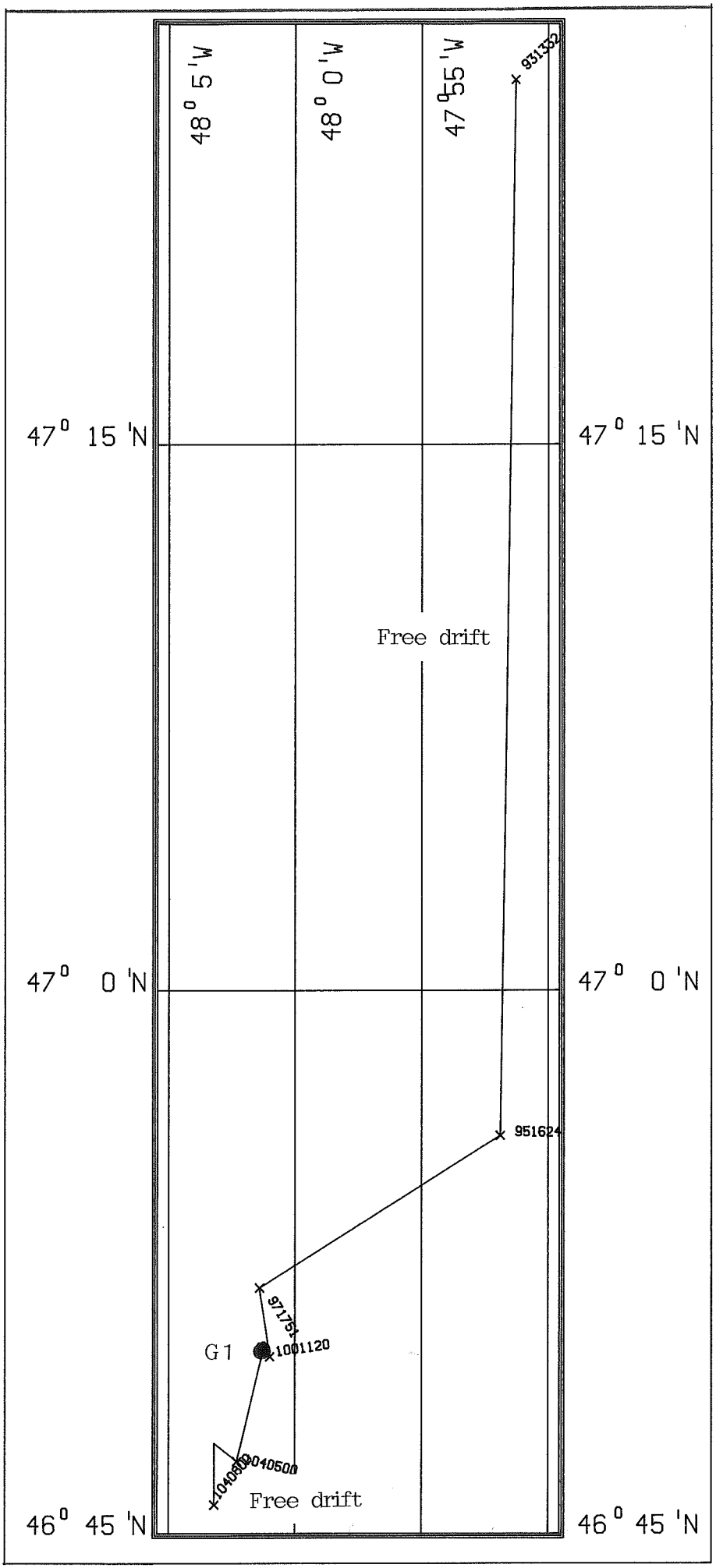


Figure A-7 Drift track of iceberg 001/1988 prior to grounding G1

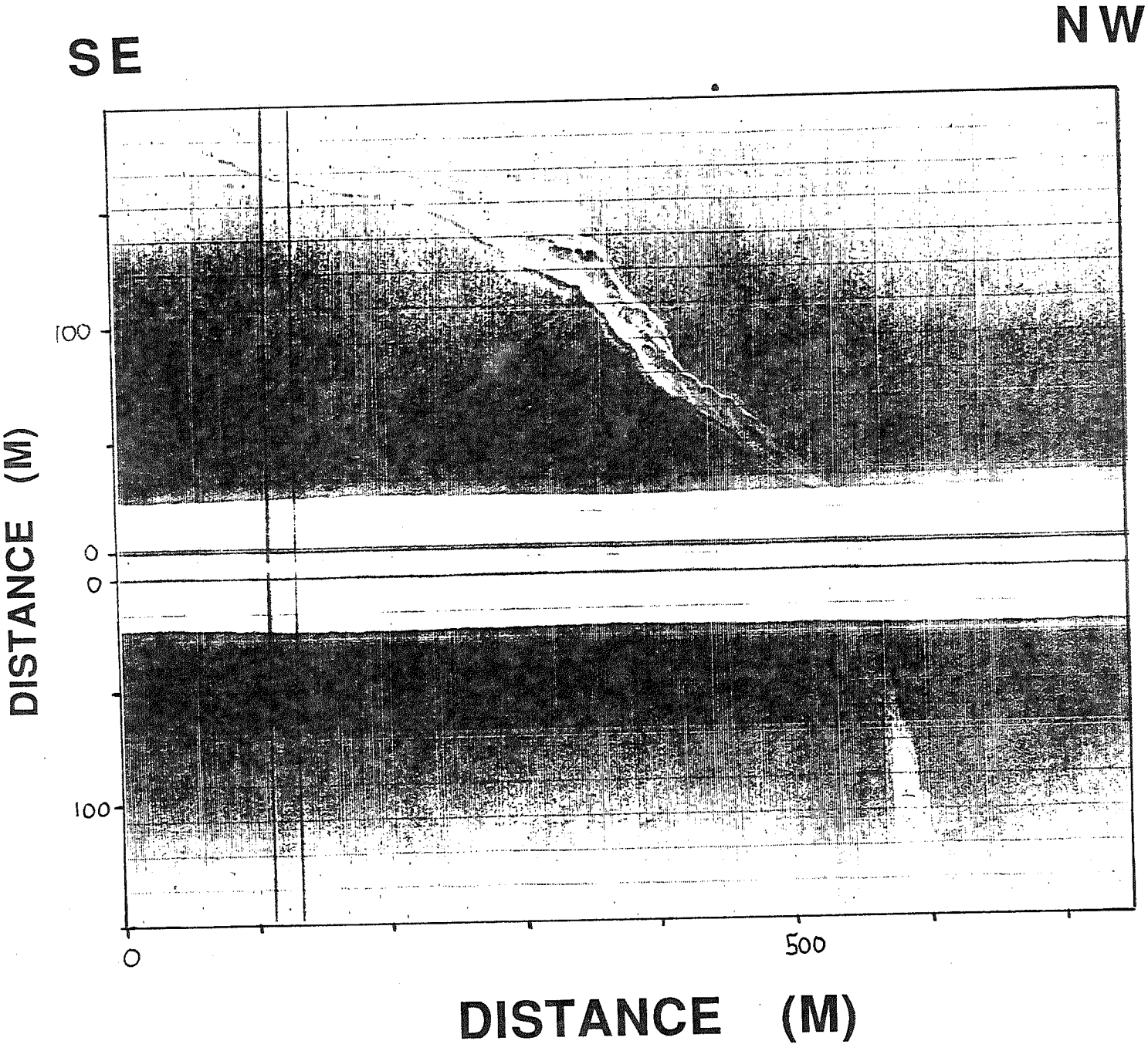


Figure A-8 Scour track on the seabed at grounded position G1 caused by iceberg 001/1988

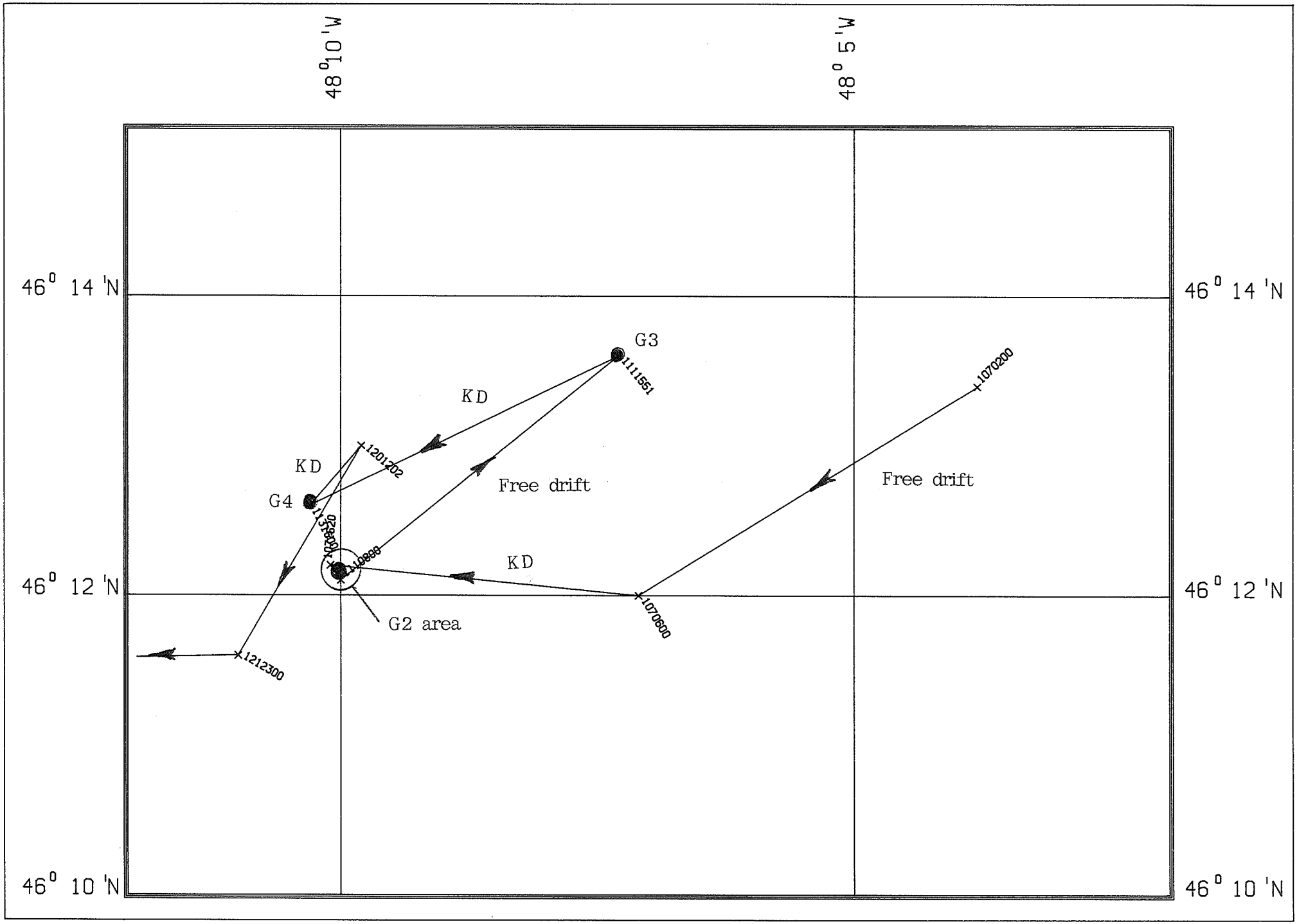


Figure A-9 Drift track of iceberg001/1988 associated with groundings G2,G3 and G4

RA3 Iceberg 005/1988

Berg 005 was one of the four icebergs which grounded during April, 1988. The berg was photographed by stereocamera on April 20 (Fig. A-10) which indicated a volume of ice of 48968 cubic meters above the water line. The horizontal dimensions at the water lines were 112X102 m and the sail height was 18m. The mass was calculated as 350,000 tonnes and the draft was approximately 100m evidenced by the fact that the water depth was 100m at the berg's first grounding location. Tracking of Berg 005 commenced at 1900 hrs. on April 14 (Table A3) and continued until 0420 hrs. on May 5. Grounding and scouring occurred as early as April 15, when the berg was in a water depth of 100m. It is presummed that Berg 005 was forced into shallower waters during the N.E. wind event which occurred April 11-12. Referencing Figs. A-11 & A-12 and Table A3, it can be seen that from April 14 to 20, a total displacement of only 2.6nm occurred. This suggests that scouring and grounding occurred during this period. The winds were generally weak from the northeast which probably contributed to the south-westerly drift from 1454 - 20 April until 1230 - 21 April. The berg probably grounded again at G2 for about 12 hours then drifted about 1.5 nm in a north-easterly direction in response to 25 knot southwest winds on April 22. During the evening of the 22nd., the berg grounded again (at G3) and remained grounded until 0000 - 25 April. The berg was virtually stationary during April 26, 27 and 28 and zero drift velocity was noted again from 0000 hrs. April 29 to 2310 hrs. April 30, just east of grounding site G3. On the 30th of April, the berg drifted a few miles westward and grounded again at position G4 at 1935 hrs. on May 1st. The water depth was 88m. In conclusion, it is inferred that 4 groundings occurred during the 21 days of tracking of Berg 005; a drift distance of only 30.1 nm was observed during the period. The site-specific target plot (Fig. A-12) shows the drift track relative to the Whiterose E-09 location.

the NNW on the 13th to 10kt SSW and NE on the 14th and 15th respectively. On the 16th, the berg grounded in position G2. The winds were 20kt from the north, but the drift was basically westward. The berg grounded in 104m of water in the G2 area for about 3.5 days. On the 20th of April, the berg drifted about a mile to the northeast against 10kt winds and grounded at G3 in about 106m in water depth. The berg remained at G3 for about half a day; it then is inferred to have dragged its keel over a distance of about 2nm towards the southwest against 15 to 25kt winds from the south west. The berg then grounded again in about 104m water depth (G4 in Fig. A-9). The berg remained grounded from April 22 to 29, despite SSW winds of up to 30 kt. On the 29th of April, the berg moved off from G4 in a southwesterly direction. Keel dragging and free drift is inferred for the drift after liftoff. The winds were 15kt from the north but the drift was into shallower water west of G4, followed by drift towards the southeast and then southward.

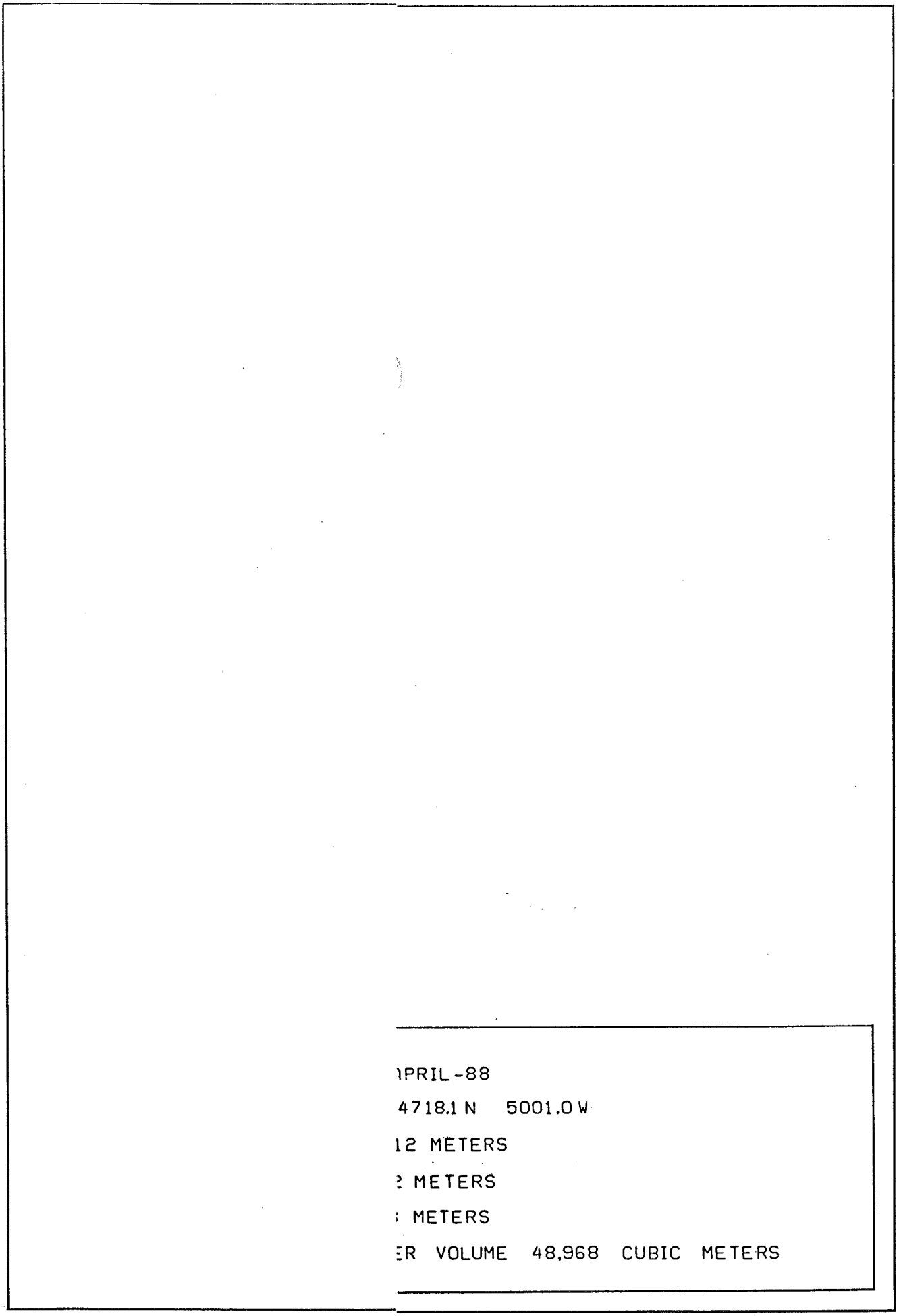


Figure A-10 Contour map of iceberg 005/1988

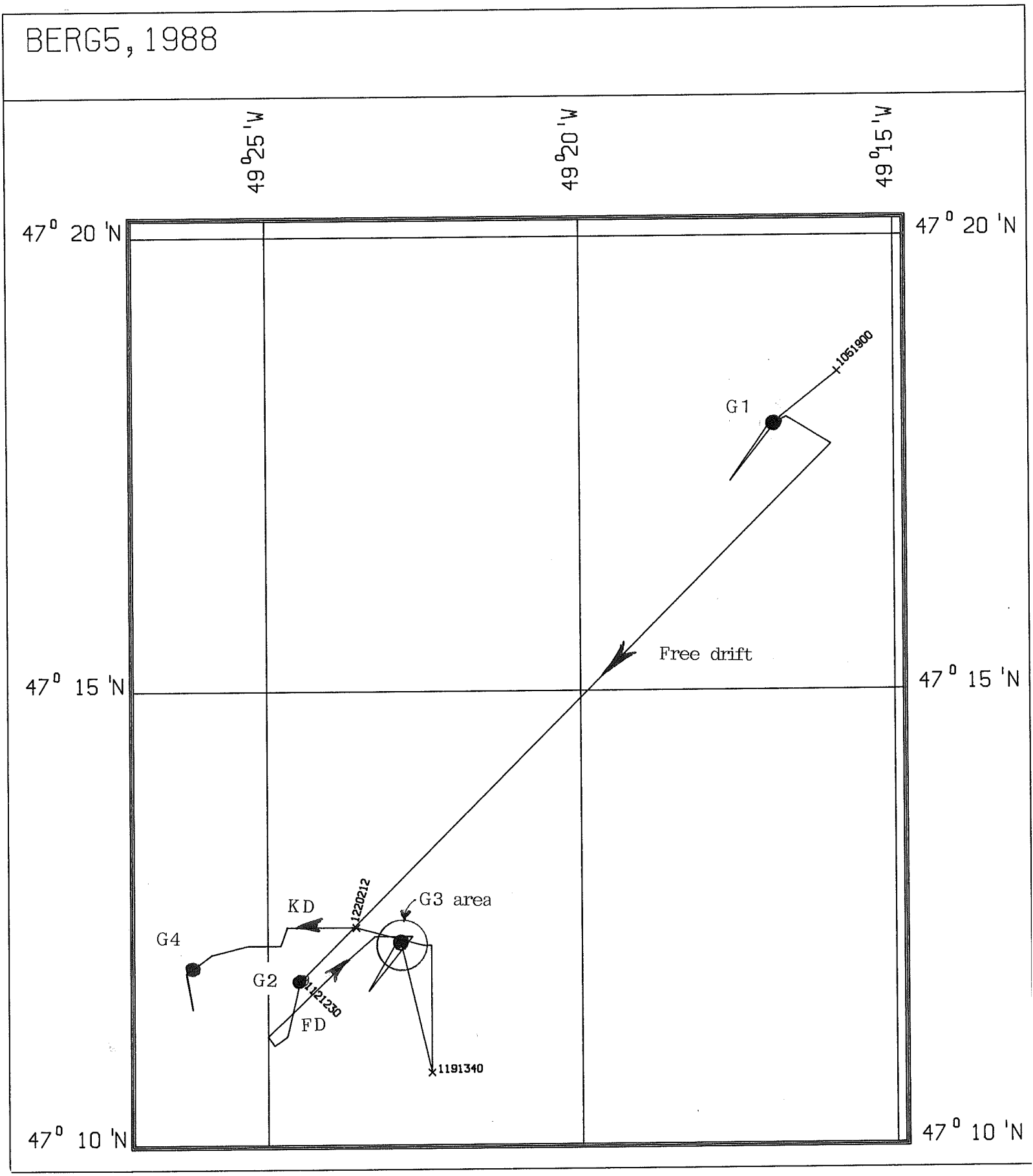


Figure A-11 Drift and scour track of iceberg 005/1988

Figure A-12 Site-specific target plot for iceberg 005/1988

SITE SPECIFIC
TARGET PLOT

SURROUNDING Area w.r.t.
Whiterose E-09
(Bow Drill 3)
46 48' 26.24" N
48 1' 22.65" W

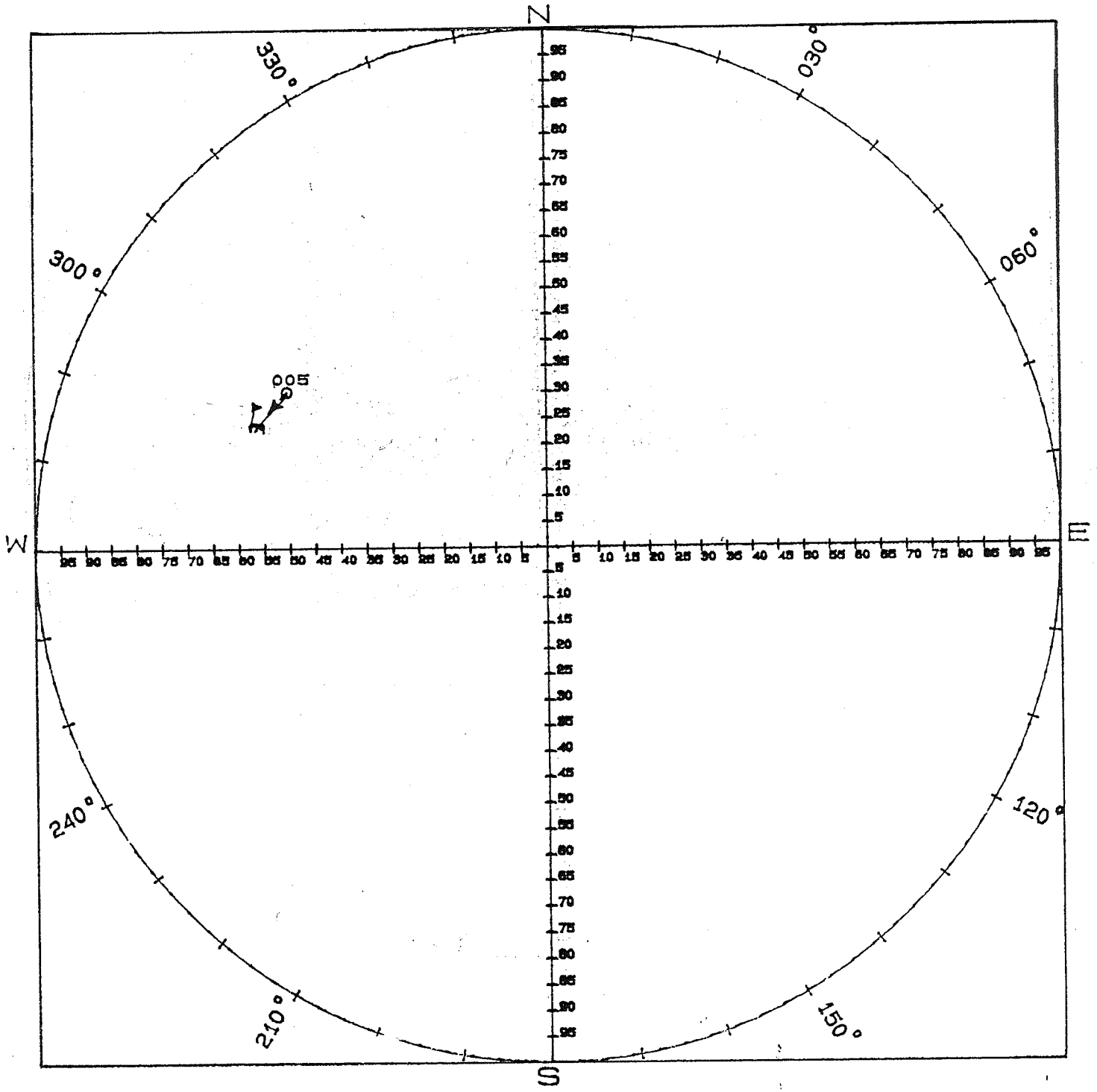
From 1900 L April 14, 1988
to 0420 L May 05, 1988
(20 days, 9.33 hours)

1 Iceberg Tracked.
85 Observations.

Radius = 100.0 n. mi.
Tic Interval = 5.0 n. mi.

Whiterose E-09 is at
the Center of Plot.

DISTANCE TRACKED (n.mi)	CPA (n.mi.)	MEAN SPEED (kts)
30.1	58.7	0.1



RA 4 Iceberg 013/1988

Berg 013 was one of the four icebergs which grounded during April, 1988 (Fig. A-13). This berg was 182m long and 125m wide at the water line and had a sail height of 25m as determined from stereophotography (Fig. A-14). The berg was of the drydock type with an estimated mass of 1 million tonnes. Drafts of 84 and 78m are indicated by the water depth where scouring and grounding occurred. Tracking and plotting of this iceberg commenced on the 16th of April and continued until May 24th. The drift data are presented in Table A4. Drift track positions reveal slow drift from the start in Fig. A-13 until the first grounding position G1 at 47°-13.1N & 49° 42.0W. The berg remained in this position from 2046-04-28 until 0400-04-30 after which the berg drifted southwest and grounded again at grounding position G2 (47° -7.5'N & 49° -48.3'W) on April 30 at 2350. It remained at this location until 0440 on May 3rd. Thereafter it drifted west, then northwest and continued to drift as shown in Fig. A-13. On the 20th of May, the berg stopped for a few hours at the end of the plotted track. It was towed away from that final position on the 20th of May which suggests that the berg was probably free-drifting prior to towing.

BERG 013

Whiterose E-09 (Bow Drill 3)
(46 48.44' N 48 1.38' W)

Iceberg Dimensions: Size = B Shape = BBB
Length = M16 Width = M08 Height = M03
Draft = C19 Mass = 1152

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force	(X)	(N)
16/04/88	1433	86.7	290.0	47 18.1	50 1.0	GPCD	19									
18/04/88	0056	85.0	293.9	47 22.8	49 55.5	VCBQ	19	0.18	039	34.4	6.0				77.71	34.44
20/04/88	0955	86.5	289.5	47 17.3	50 1.0	VCBQ	19	0.12	215	91.4	12.7				81.54	28.87
20/04/88	1900	87.8	289.9	47 18.3	50 2.6	VXJK	19	0.16	313	100.5	14.2				82.56	29.89
25/04/88	1255	81.9	290.9	47 17.7	49 53.7	GPCD	19	0.05	096	214.4	20.3				76.51	29.22
27/04/88	0300	77.5	291.9	47 17.3	49 47.0	VXJK	19	0.12	095	252.5	24.9				71.91	28.91
27/04/88	1245	76.6	291.5	47 16.5	49 46.0	VCYS	19	0.11	140	262.2	25.9				71.27	28.07
28/04/88	1346	71.7	289.4	47 12.3	49 40.6	GSLA	22	0.22	139	287.2	31.5				67.63	23.82
28/04/88	2000	72.9	289.8	47 13.1	49 42.0	VXJK	22	0.20	310	293.5	32.7				68.59	24.69
28/04/88	2046	72.8	289.8	47 13.1	49 41.9	VXJK	22	0.09	090	294.2	32.8				68.45	24.66
28/04/88	2200	72.8	289.8	47 13.1	49 41.9	VXJK	22	0.00	000	295.5	32.8				"	"
29/04/88	0000	72.9	289.8	47 13.1	49 42.0	VXJK	22	0.03	270	297.5	32.8				68.59	24.69
29/04/88	0400	72.9	289.8	47 13.1	49 42.0	VXJK	22	0.00	000	301.5	32.8				"	"
29/04/88	0700	72.9	289.8	47 13.1	49 42.0	VXJK	22	0.00	000	304.5	32.8				"	"
29/04/88	0800	72.8	289.8	47 13.1	49 41.9	VXJK	22	0.07	090	305.5	32.9				"	"
29/04/88	1200	72.8	289.8	47 13.1	49 41.9	VXJK	22	0.00	000	309.5	32.9				"	"
29/04/88	1600	72.8	289.8	47 13.1	49 41.9	VXJK	22	0.01	025	313.5	32.9				"	"
30/04/88	0400	72.8	289.8	47 13.1	49 41.9	VXJK	22	0.00	205	325.5	33.0				"	"
30/04/88	0800	73.4	288.0	47 11.1	49 43.8	VXJK	22	0.60	213	329.5	35.4				69.81	22.68
30/04/88	1000	73.3	287.7	47 10.7	49 43.8	VXJK	22	0.20	181	331.5	35.8				69.83	22.29
30/04/88	2350	75.2	284.9	47 7.8	49 47.8	VXJK	22	0.29	224	345.3	39.8				72.67	19.34
01/05/88	0900	75.4	284.6	47 7.5	49 48.3	VXJK	22	0.05	229	354.5	40.2				72.96	19.01
01/05/88	1105	75.4	284.6	47 7.5	49 48.3	VXJK	22	0.00	000	356.5	40.2				"	"
01/05/88	2245	75.3	284.7	47 7.5	49 48.2	VCYQ	22	0.01	090	368.2	40.3				72.84	19.11
02/05/88	1343	75.6	284.7	47 7.6	49 48.6	VXJK	22	0.02	290	383.2	40.6				73.13	19.18
02/05/88	1600	75.3	284.7	47 7.5	49 48.2	VCYQ	22	0.13	110	385.5	40.9				72.84	19.11
03/05/88	0440	75.2	284.6	47 7.4	49 48.0	VCYS	22	0.01	126	398.1	41.0				72.77	18.96
03/05/88	1545	76.5	284.2	47 7.2	49 50.0	VCYQ	22	0.12	262	409.2	42.4				74.16	18.7
03/05/88	1900	77.1	283.4	47 6.3	49 51.2	VCYQ	22	0.38	223	412.5	43.6				75.00	17.8
03/05/88	2000	78.2	283.2	47 6.3	49 52.9	VCYQ	22	1.16	270	413.5	44.8				76.13	17.8
03/05/88	2130	79.2	283.0	47 6.3	49 54.4	VCYQ	22	0.68	270	415.0	45.8				77.17	17.82
03/05/88	2300	79.8	283.0	47 6.4	49 55.3	VCYQ	22	0.41	279	416.5	46.4				77.75	17.95
04/05/88	0000	80.1	282.7	47 6.1	49 55.8	VCYQ	22	0.46	229	417.5	46.9				78.14	17.61
06/05/88	0916	87.2	286.5	47 13.2	50 4.0	GPCD	20	0.16	322	474.7	55.9				83.61	24.77
06/05/88	1000	86.6	286.7	47 13.3	50 3.1	CCG	20	0.85	081	475.5	56.5				82.95	24.88

Table A4 Individual drift track listing for iceberg 013/1988

BERG 013

Whiterose E-09 (Bow Drill 3)
(46 48.44' N 48 1.38' W)

Iceberg Dimensions: Size = B Shape = BBB
Length = M16 Width = M08 Height = M03
Draft = C19 Mass = 1152

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (Kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
07/05/88	0900	79.1	292.0	47 18.0	49 49.0	CCG	20	0.47	064	498.5	67.3			
08/05/88	2145	76.5	288.9	47 13.2	49 47.5	VCYS	22	0.13	169	535.2	72.2			
08/05/88	2345	76.9	288.7	47 13.1	49 48.2	VCYS	22	0.24	258	537.2	72.6			
09/05/88	0145	78.6	289.7	47 14.9	49 49.9	VCYS	22	1.06	328	539.2	74.8			
09/05/88	0345	78.8	289.0	47 14.1	49 50.6	VCYS	22	0.47	211	541.2	75.7			
09/05/88	0600	80.1	289.2	47 14.8	49 52.3	VCYS	22	0.60	301	543.5	77.1			
09/05/88	0800	80.4	289.7	47 15.5	49 52.5	VCYS	22	0.36	350	545.5	77.8			
09/05/88	1000	80.6	289.8	47 15.8	49 52.6	VCYS	22	0.15	348	547.5	78.1			
10/05/88	0720	86.3	291.4	47 19.9	49 59.4	VXJK	22	0.29	312	568.8	84.2			
11/05/88	0000	88.8	291.9	47 21.6	50 2.4	VCYQ	22	0.16	310	585.5	86.9			
14/05/88	1915	85.5	299.9	47 31.1	49 50.4	VCYS	22	0.14	041	676.7	99.5			
16/05/88	1116	80.2	297.1	47 25.0	49 46.2	GPCD	22	0.17	155	716.7	106.2			
17/05/88	0520	75.4	295.8	47 21.2	49 41.1	VCBQ	22	0.28	138	734.8	111.3			
19/05/88	0001	75.9	287.9	47 11.7	49 47.3	VCYS	26	0.24	205	777.5	121.7			
19/05/88	0530	75.6	289.0	47 13.0	49 46.2	VCYQ	26	0.28	030	783.0	123.2			
20/05/88	0217	79.6	288.1	47 13.2	49 52.3	VXJK	26	0.20	273	803.7	127.4			
20/05/88	0500	79.7	288.4	47 13.6	49 52.3	VXJK	26	0.15	001	806.5	127.8			
20/05/88	0600	79.8	288.4	47 13.6	49 52.5	VXJK	26	0.14	270	807.5	127.9			
20/05/88	0700	79.8	288.4	47 13.6	49 52.5	VXJK	26	0.00	000	808.5	127.9			
20/05/88	0800	79.8	288.4	47 13.6	49 52.5	VXJK	26	0.00	000	809.5	127.9			
20/05/88	1200	81.4	288.1	47 13.7	49 54.9	VXJK	26	0.41	273	813.5	129.6	[N]	240.0	E050
20/05/88	1400	82.2	287.4	47 13.0	49 56.4	VXJK	26	0.62	236	815.5	130.8	[N]	240.0	E050
20/05/88	1600	82.8	286.8	47 12.4	49 57.6	VXJK	26	0.51	234	817.5	131.9	[N]	240.0	E050
20/05/88	1800	83.6	286.1	47 11.6	49 59.1	VXJK	26	0.65	232	819.5	133.2			
20/05/88	2230	84.0	285.4	47 10.7	50 0.2	VXJK	26	0.26	220	824.0	134.3			
21/05/88	0100	83.8	285.3	47 10.6	49 59.8	VXJK	26	0.12	110	826.5	134.6			
21/05/88	0300	83.9	285.6	47 11.0	49 59.8	VXJK	26	0.20	001	828.5	135.0			
21/05/88	0500	82.0	286.0	47 11.1	49 56.9	VXJK	26	0.99	087	830.5	137.0			
21/05/88	0700	81.1	286.2	47 11.1	49 55.6	VXJK	26	0.44	090	832.5	137.9			
21/05/88	0900	80.5	286.1	47 10.8	49 54.8	VXJK	26	0.31	119	834.5	138.5			
21/05/88	1100	80.2	286.1	47 10.7	49 54.3	VXJK	26	0.18	106	836.5	138.9			
21/05/88	1430	79.1	286.4	47 10.7	49 52.6	VXJK	26	0.33	090	840.0	140.0			
21/05/88	1520	79.2	286.2	47 10.5	49 52.9	VXJK	26	0.35	226	840.8	140.3			
21/05/88	1810	79.8	285.3	47 9.5	49 54.2	VXJK	26	0.47	222	843.6	141.7	[L]	250.0	E060
21/05/88	2000	80.6	284.3	47 8.4	49 55.8	VXJK	26	0.85	225	845.5	143.2	[L]	250.0	E060
21/05/88	2200	81.8	283.3	47 7.2	49 58.0	VXJK	26	0.97	232	847.5	145.2	[L]	250.0	E060

Table A4 (continued)

BERG 013

Whiterose E-09 (Bow Drill 3)
(46 48.44′ N 48 1.38′ W)

Iceberg Dimensions: Size = B Shape = BBB
Length = M16 Width = M08 Height = M03
Draft = C19 Mass = 1152

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
22/05/88	0000	83.1	282.4	47 6.3	50 0.3	VXJK	26	0.91	240	849.5	147.0	[L]	250.0	E060
22/05/88	0200	84.3	281.9	47 5.8	50 2.2	VXJK	26	0.70	249	851.5	148.4	[L]	250.0	E060
22/05/88	0500	86.5	281.2	47 5.3	50 5.7	VXJK	26	0.82	258	854.5	150.8	[L]	250.0	E060
22/05/88	0700	87.5	280.6	47 4.6	50 7.4	VXJK	26	0.68	239	856.5	152.2	[L]	250.0	E060
22/05/88	0900	88.3	279.8	47 3.5	50 8.8	VXJK	26	0.73	221	858.5	153.6	[L]	250.0	E060
22/05/88	1100	89.5	278.9	47 2.3	50 10.8	VXJK	26	0.92	229	860.5	155.5	[L]	250.0	E060
22/05/88	1430	89.6	278.8	47 2.1	50 11.0	VXJK	26	0.07	215	864.0	155.7			
24/05/88	1020	82.5	282.6	47 6.5	49 59.3	VXJK	26	0.21	061	907.8	164.9			

28/04/88 1346 71.75 289.4 (CPA)
22/05/88 1430 89.58 278.8 (MDR)

SPEEDS (Knots)

Min.	Max.	Mean	MadeGood	
0.00	1.16	0.32	0.01	(to 175 T; DRIFT RATIO = 0.07)

TOTAL NUMBER OF OBSERVATIONS = 79

Table A4 (continued)

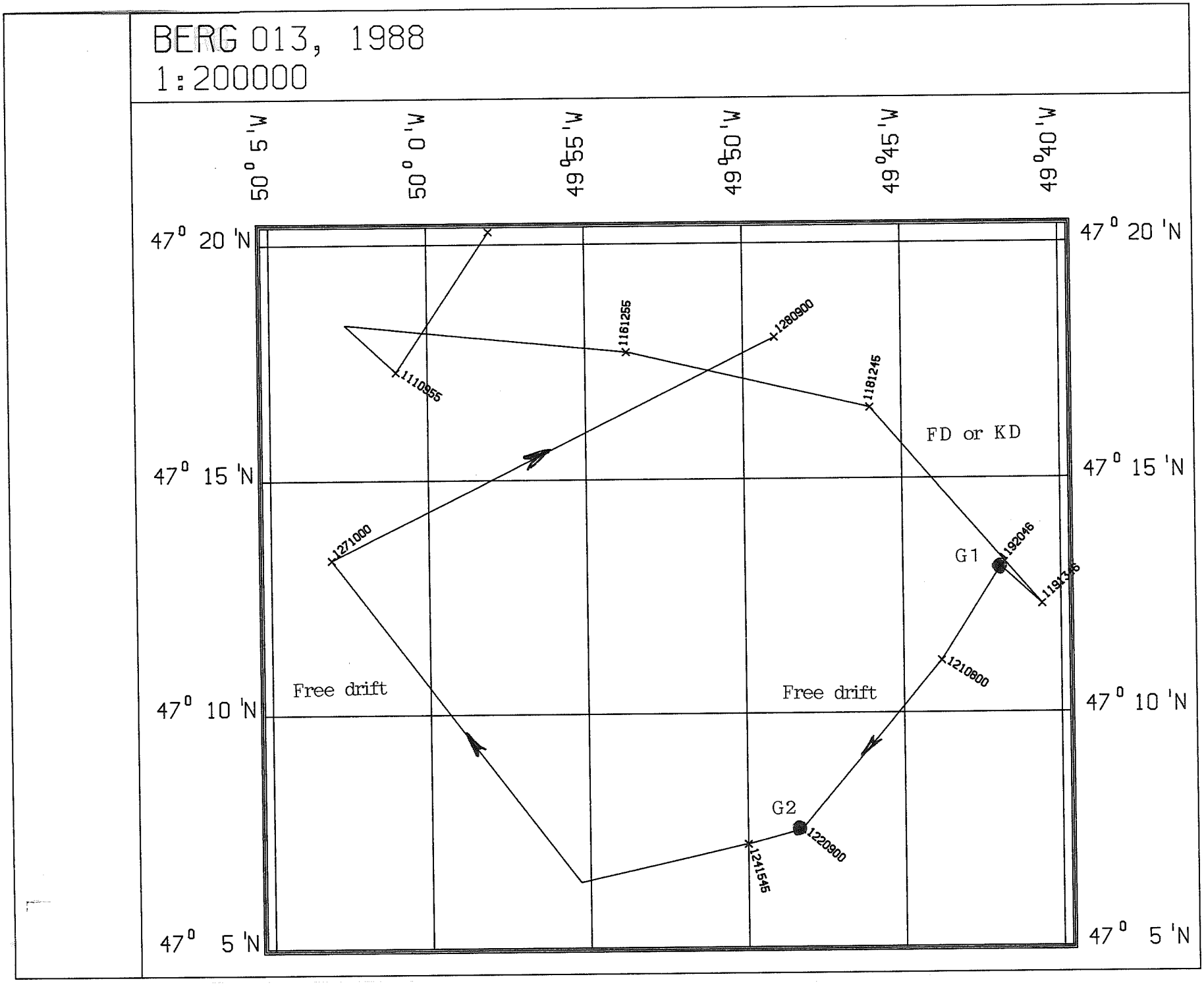


Figure A-13 Drift track of iceberg 013/1988

PRIL-88

4717.7 N 4916.0 W

32 METERS

5 METERS

5 METERS

ER VOLUME 138,252 CUBIC METERS

Fig 5.14

FIGURE 5.14

RA5 Iceberg 015/1988

Iceberg 015 was another of the four icebergs which scoured and grounded on the Grand Banks during April 1988. This berg was not photographed by stereocamera, but the dimensions were measured by sextant and radar from supply vessels. At the water line, the berg measured 185m long and 137m wide. The measured sail height was 33.8m. The draft was at least 96m as evidenced by the fact that the berg grounded in 96m of water. The mass was estimated as 915,000 tonnes. This berg, along with other bergs, attempted to cross the Grand Banks during April as a result of northeast winds (Table A5) and currents, but due to its' draft the berg ran aground. The berg's positions and drift speed are presented in Table A6 starting from April 16 and ending June 16. The general drift track is presented in Fig. A-15 and a more detailed plot of the drift track covering the grounding period, is presented in Fig. A-16. The period involved is April 20 to June 6. It can be seen that a total of 10.8 nm of drift occurred in the 5 days (April 20-25). The drift rate was 0.07 kn towards the SE. The winds at the time varied from NE 10 - April 20

SW 15 - April 21

SW 25 - April 22

WSW 20 - April 23

WNW 20 - April 24

SE 25 - April 25

These wind speeds suggest that a greater drift rate should have resulted during April 20 - 25. It is tempting to conclude that scouring may have occurred during this period. Between April 25 and 27, the berg drifted a distance of 11.2 nm. This is possibly a free drift period judging by the distance drifted although some scouring may have occurred. On the 27 of April, the berg entered an area of grounding (G1 in Fig. A-16) and remained in the general area until May 4,

drifting a total distance of 4.6 nm in a period of 118.2 hours. The grounding area G1 is regarded as a definite grounding of berg 015.

Table A5 Wind data for April, 1985

April	0600 hour		1800 hour	
	Wind speed(kts)	From	Wind speed(kts)	From
3	10	NW	10	W
4	15	W	10	W
5	10	SW	25	NNW
6	25	NW	15	NW
7	10	SW	30	S
8	30	SW	10	S
9	30	SW	15	S
10	10	SE	10	SE
11	40	S	30	W
12	20	SSW	25	SE
13	30	SW	40	W
14	30	NW	20	NW
15	20	WNW	10	SW
16	30	WSW	25-30	SW
17	30	S	35	SW
18	30	SW	25	SW
19	40	SW	20	SW
20	25	W	25	W
21	15	SW	10	WSW
22	10	S	10	W
23	15	SE	10	S
24	20	E	30	S
25	45	S	25	S

26	15	S	20	ESE
27	15	S	15	S
28	10	S	10	E
29	10	E	20	SSE
30	15	SSW	10	W

Source: Surface Analysis prepared by Maritime Weather Center

BERG 015

Whiterose E-09 (Bow Drill 3)
(46 48.44' N 48 1.38' W)

Iceberg Dimensions: Size = M Shape = DDK
Length = M107 Width = E065 Height = M024
Draft = C72 Mass = 178271 Stability = 8.9

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
16/04/88	1654	124.5	292.0	47 35.1	50 51.3	GPCD	19							
20/04/88	0700	124.4	291.4	47 33.8	50 51.8	2329	19	0.02	196	86.1	1.3			
20/04/88	1303	123.8	291.6	47 34.0	50 50.7	GPCD	19	0.13	075	92.2	2.1			
25/04/88	1237	117.4	288.8	47 26.3	50 44.7	GPCD	19	0.07	153	211.7	10.8			
27/04/88	1406	107.1	288.0	47 21.5	50 31.0	VCYS	22	0.21	117	261.2	21.2			
27/04/88	1510	107.6	287.7	47 21.1	50 32.0	VCYS	22	0.78	238	262.3	22.0			
29/04/88	1052	108.0	288.0	47 21.8	50 32.2	GPCD	22	0.02	350	306.0	22.7			
30/04/88	0040	108.0	287.9	47 21.6	50 32.4	VO23	22	0.02	215	319.8	23.0			
01/05/88	0033	107.3	287.8	47 21.2	50 31.5	VXJG	22	0.03	123	343.7	23.7			
03/05/88	0730	107.3	287.8	47 21.2	50 31.5	VCYS	22	0.00	000	398.6	23.7			
04/05/88	0905	108.0	286.7	47 19.5	50 33.3	VXJG	22	0.08	216	424.2	25.8			
04/05/88	1215	108.1	287.8	47 21.5	50 32.5	CG29	22	0.66	016	427.4	27.9			
06/05/88	0900	98.6	288.1	47 19.0	50 19.0	VCYS	20	0.21	105	472.1	37.4			
07/05/88	1400	97.7	288.7	47 19.8	50 17.3	VXJK	20	0.05	056	501.1	38.8			
10/05/88	0500	98.3	287.9	47 18.6	50 18.7	VXJK	22	0.02	219	564.1	40.4			
11/05/88	0100	98.1	288.0	47 18.7	50 18.4	VCYQ	22	0.01	064	584.1	40.6			
11/05/88	1830	97.9	287.9	47 18.6	50 18.1	VXJK	22	0.01	116	601.6	40.8			
13/05/88	2349	98.5	287.9	47 18.8	50 19.0	VCYQ	22	0.01	288	654.9	41.5			
14/05/88	2035	97.7	288.2	47 19.0	50 17.6	VCYS	22	0.05	078	675.7	42.4			
16/05/88	1101	98.5	288.1	47 19.0	50 18.9	GPCD	22	0.02	270	714.1	43.3			
18/05/88	2140	98.3	287.9	47 18.7	50 18.7	VCYS	26	0.01	156	772.8	43.6			
19/05/88	0700	93.8	288.2	47 17.8	50 12.2	VCYQ	26	0.48	102	782.1	48.1			
20/05/88	1530	97.7	287.9	47 18.5	50 17.9	VCYS	26	0.12	280	814.6	52.1			
21/05/88	0300	97.9	288.1	47 18.9	50 17.9	VXJK	26	0.03	001	826.1	52.5			
21/05/88	0500	98.0	288.2	47 19.1	50 18.0	VXJK	26	0.11	342	828.1	52.7			
24/05/88	0500	98.0	288.2	47 19.1	50 18.0	VCYQ	26	0.00	000	900.1	52.7			
24/05/88	1050	98.0	288.2	47 19.0	50 18.0	VXJK	26	0.02	181	905.9	52.8			

Table A6 Individual drift track for iceberg 015/1988

BERG 015

Whiterose E-09 (Bow Drill 3)
(46 48.44' N 48 1.38' W)

Iceberg Dimensions: Size = M Shape = DDK
Length = M107 Width = E065 Height = M024
Draft = C72 Mass = 178271 Stability = 8.9

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
28/05/88	1228	91.7	295.4	47 27.7	50 3.2	GPCD	26	0.14	050	%1003.6	66.2			
30/05/88	1222	86.1	297.3	47 27.9	49 53.9	VC85	26	0.13	088	%1051.5	72.5			
31/05/88	2200	92.3	296.8	47 30.0	50 2.5	GCML	26	0.18	290	%1085.1	78.7			
01/06/88	0230	91.0	297.0	47 29.7	50 0.7	VCYQ	26	0.28	104	%1089.6	80.0			
02/06/88	2300	91.3	297.0	47 29.9	50 1.0	VCYS	26	0.01	315	%1134.1	80.3			
05/06/88	0135	91.5	297.2	47 30.3	50 1.0	VCYS	26	0.01	001	%1184.7	80.7			
05/06/88	2310	91.2	297.3	47 30.3	50 0.6	VXJK	26	0.01	090	%1206.3	80.9			
07/06/88	2105	90.8	309.6	47 46.3	49 44.6	GQKK	26	0.42	035	%1252.2	100.4			
09/06/88	0847	91.2	318.2	47 56.4	49 31.1	GQKK	26	0.38	042	%1287.9	114.1			
09/06/88	1438	90.9	321.1	47 59.2	49 25.7	GPCD	26	0.79	053	%1293.7	118.7			
10/06/88	1142	89.4	327.7	48 4.0	49 12.0	IIP	26	0.50	063	%1314.8	129.2			
12/06/88	1455	78.7	344.9	48 4.4	48 31.7	SLE	26	0.53	089	%1366.0	156.4			
13/06/88	1900	78.3	357.7	48 6.7	48 6.1	VCYQ	26	0.62	082	%1394.1	173.9			
13/06/88	2000	78.0	358.1	48 6.4	48 5.3	VCYQ	26	0.62	119	%1395.1	174.5			
13/06/88	2100	77.6	358.2	48 6.0	48 4.9	VCYQ	26	0.48	146	%1396.1	175.0			
13/06/88	2200	77.4	358.4	48 5.8	48 4.5	VCYQ	26	0.34	126	%1397.1	175.3			
14/06/88	0800	78.5	3.9	48 6.8	47 53.5	VCYQ	26	0.75	082	%1407.1	182.8			
14/06/88	0900	78.3	4.2	48 6.5	47 52.8	VCYQ	26	0.56	122	%1408.1	183.4			
14/06/88	1000	78.0	5.0	48 6.1	47 51.3	VCYQ	26	1.09	112	%1409.1	184.5			
14/06/88	1100	77.6	5.4	48 5.7	47 50.5	VCYQ	26	0.67	126	%1410.1	185.2			
14/06/88	1200	77.4	5.9	48 5.4	47 49.7	VCYQ	26	0.62	119	%1411.1	185.8			
14/06/88	1345	76.9	6.3	48 4.9	47 48.8	VCYQ	26	0.45	129	%1412.9	186.6	[L]	90.0	
14/06/88	1500	76.9	6.6	48 4.8	47 48.3	VCYQ	26	0.28	106	%1414.1	186.9			
14/06/88	1600	76.7	6.9	48 4.6	47 47.7	VCYQ	26	0.45	116	%1415.1	187.4	[L]	90.0	E050
14/06/88	1700	76.7	7.6	48 4.5	47 46.3	VCYQ	26	0.95	096	%1416.1	188.3	[L]	90.0	E070
14/06/88	1800	77.0	8.4	48 4.6	47 44.8	VCYQ	26	1.02	084	%1417.1	189.4	[L]	90.0	E070
14/06/88	1900	77.3	9.3	48 4.7	47 42.9	VCYQ	26	1.29	086	%1418.1	190.6	[L]	90.0	E070
14/06/88	2000	77.8	10.7	48 4.9	47 40.1	VCYQ	26	1.90	084	%1419.1	192.5	[L]	90.0	E070
14/06/88	2200	78.3	12.2	48 5.0	47 36.9	VCYQ	26	1.08	087	%1421.1	194.7	[L]	90.0	E070
15/06/88	0000	78.7	14.1	48 4.8	47 33.1	VCYQ	26	1.29	094	%1423.1	197.3	[L]	90.0	E070
15/06/88	0200	78.8	15.8	48 4.3	47 29.7	VCYQ	26	1.18	102	%1425.1	199.6	[L]	90.0	E
15/06/88	0400	79.1	17.4	48 3.9	47 26.4	VCYQ	26	1.13	100	%1427.1	201.9	[L]	90.0	E070
15/06/88	0600	79.6	18.5	48 3.9	47 24.1	VCYQ	26	0.78	090	%1429.1	203.5	[L]	90.0	E070
15/06/88	0800	80.6	19.7	48 4.3	47 21.2	VCYQ	26	1.00	078	%1431.1	205.5	[L]	90.0	E060

Table A6 (continued)

Whiterose E-09 (Bow Drill 3)
(46 48.44′ N 48 1.38′ W)

Iceberg Dimensions: Size = M Shape = DDK
Length = M107 Width = E065 Height = M024
Draft = C72 Mass = 178271 Stability = 8.9

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (Kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
15/06/88	1000	81.9	21.1	48 4.8	47 17.7	VCYQ	26	1.21	078	%1433.1	207.9	[L]	90.0	E075
15/06/88	1200	83.1	22.9	48 5.0	47 13.5	VCYQ	26	1.42	086	%1435.1	210.7	[L]	90.0	E075
15/06/88	1400	84.3	24.6	48 5.1	47 9.5	VCYQ	26	1.35	088	%1437.1	213.4	[L]	90.0	E075
15/06/88	1600	85.5	26.6	48 4.9	47 4.7	VCYQ	26	1.63	094	%1439.1	216.7	[L]	90.0	E075
15/06/88	1800	86.6	28.4	48 4.6	47 0.5	VCYQ	26	1.43	096	%1441.1	219.6	[L]	90.0	E075
15/06/88	2000	87.6	30.0	48 4.3	46 56.6	VCYQ	26	1.33	096	%1443.1	222.2	[L]	90.0	E075
15/06/88	2200	88.7	31.6	48 4.0	46 52.7	VCYQ	26	1.33	096	%1445.1	224.9	[L]	90.0	E075
16/06/88	0000	89.6	32.7	48 3.8	46 49.8	VCYQ	26	0.99	096	%1447.1	226.8	[L]	90.0	E050
16/06/88	0200	89.9	33.2	48 3.7	46 48.7	VCYQ	26	0.38	098	%1449.1	227.6	[L]	90.0	E060
16/06/88	0400	90.9	33.4	48 4.3	46 47.3	VCYQ	26	0.56	058	%1451.1	228.7	[L]	90.0	E060
16/06/88	0600	92.5	34.0	48 5.1	46 44.9	VCYQ	26	0.90	064	%1453.1	230.5	[L]	90.0	E060
16/06/88	1000	94.9	35.5	48 5.7	46 39.9	VCYQ	26	0.86	080	%1457.1	233.9	[L]	90.0	E085
16/06/88	1200	96.9	36.9	48 5.9	46 35.3	VCYQ	26	1.56	086	%1459.1	237.1	[L]	90.0	E090
16/06/88	1400	99.3	37.9	48 6.8	46 31.2	VCYQ	26	1.45	072	%1461.1	240.0	[L]	90.0	E090
16/06/88	1600	101.9	38.8	48 7.9	46 26.9	VCYQ	26	1.55	069	%1463.1	243.1	[L]	90.0	E090
16/06/88	1800	103.4	38.8	48 9.0	46 25.5	VCYQ	26	0.72	040	%1465.1	244.5			
16/06/88	1900	103.9	38.8	48 9.4	46 24.9	VCYQ	26	0.57	045	%1466.1	245.1			

14/06/88 1600 76.72 6.9 (CPA)
16/04/88 1654 124.53 292.0 (MDR)

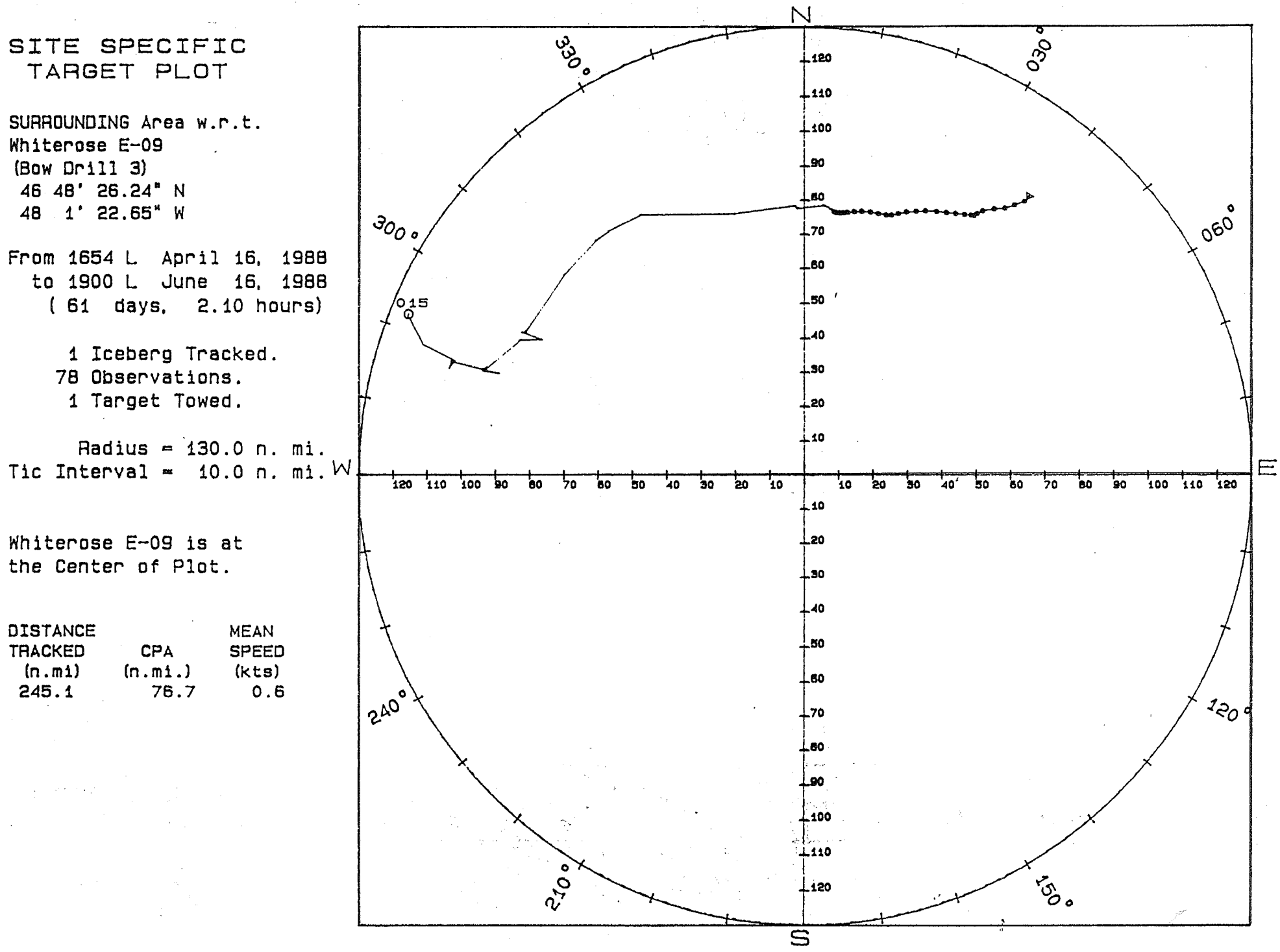
SPEEDS (Knots)

Min.	Max.	Mean	MadeGood	
0.00	1.90	0.58	0.13	(to 079 T; DRIFT RATIO = 0.75)

TOTAL NUMBER OF OBSERVATIONS = 78

Table A6 (continued)

Figure A-15 Site-specific target plot for iceberg 015/1988



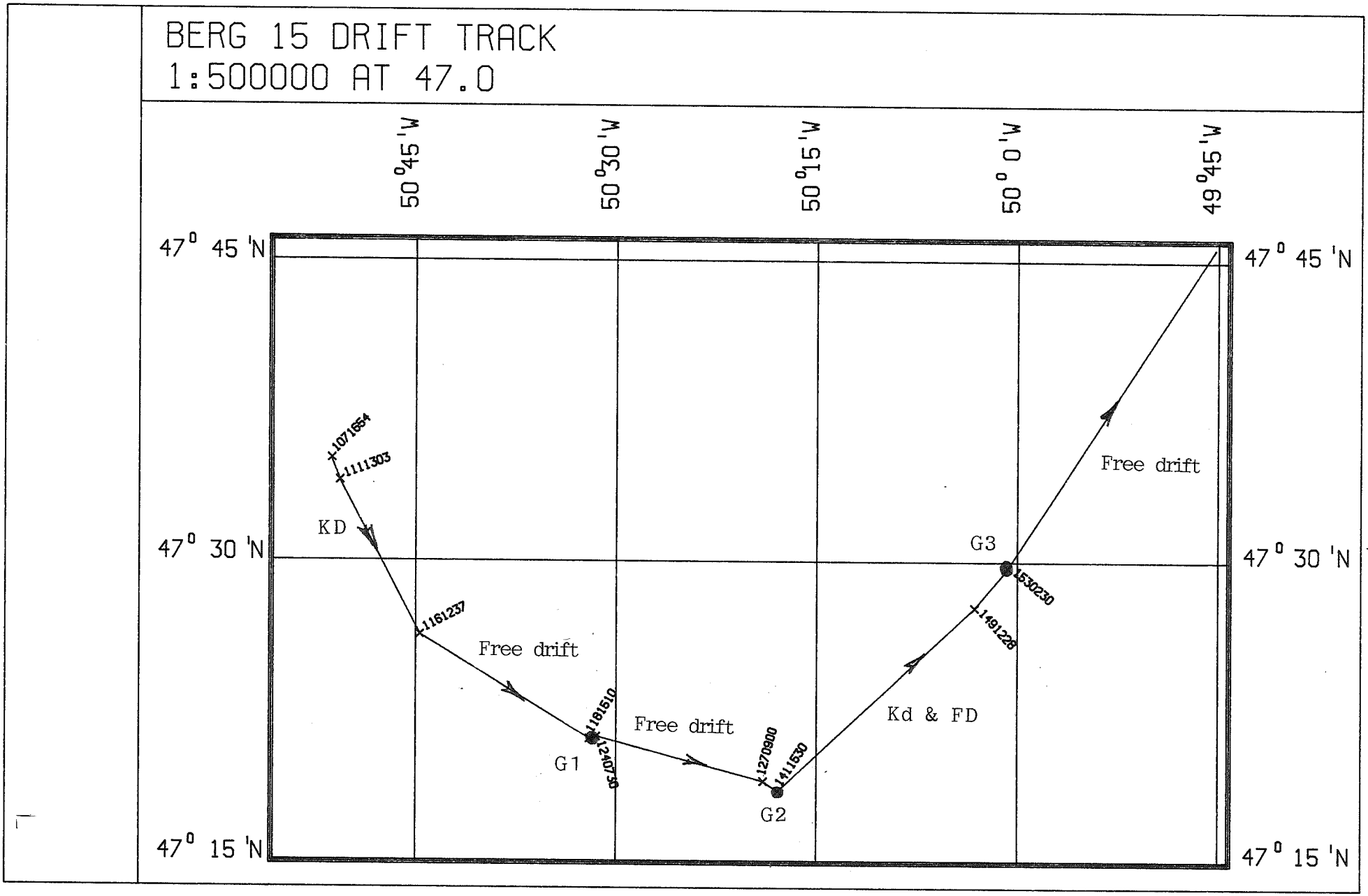


Figure A-16 Drift track of iceberg 015/1988

RA6 Iceberg 002/1985

Iceberg 002 was grounded for the entire period of observation April 2 to 17, 1985 at 47°-18.0'n and 48°-41.5'w. The berg was a pinnacle type berg 133m long and 59m wide at the water line with a sail height of 35m. The berg was aground in 118m of water. It probably drifted into its grounded position from an north-easterly direction. The berg mass was computed as 490,000 tonnes but it was probably larger, as the draft estimate was well below the actual depth of grounding. Since it is not known exactly when the berg grounded, it is not possible to make statements regarding wind conditions during grounding, however, weather forecasts for the 5 days previous to the first observation on April 2 indicate that westerly winds prevailed. The grounded position is presented in Fig. A-17, with respect to the North Ben Nevis P-93 drilling location and the drift data, or in this case, lack of same, is presented in Table A7. In searching for scours in the vicinity of this grounded position, it may be expedient to search to the northeast. The drift-off probably was towards the northeast into deeper water as winds during the latter half of April were generally from the southwest (Table A5).

Summary

1 definite grounding at 47°-18.0'N and 48°-41.5'W in 118m of water from April 2 to April 17, 1985 (possibly longer).

BERG 002

N. Ben Nevis P-93 (BOW DRILL 3)
(46 42.80′ N 48 28.57′ W)

Iceberg Dimensions: Size = M Shape = PNC
Length = M133 Width = M59 Height = M35
Draft = C78 Mass = 488868

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
02/04/85	1510	36.2	346.0	47 17.9	48 41.4	XXXX							
02/04/85	1645	36.2	346.0	47 17.9	48 41.4	XXXX	0.00	000	1.6	0.0			
02/04/85	2030	36.3	345.9	47 18.0	48 41.5	XXXX	0.04	318	5.3	0.1			
03/04/85	0230	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	11.3	0.1			
03/04/85	0530	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	14.3	0.1			
03/04/85	0830	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	17.3	0.1			
03/04/85	1130	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	20.3	0.1			
03/04/85	1430	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	23.3	0.1			
03/04/85	1730	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	26.3	0.1			
03/04/85	2030	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	29.3	0.1			
03/04/85	2330	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	32.3	0.1			
04/04/85	0230	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	35.3	0.1			
04/04/85	0530	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	38.3	0.1			
04/04/85	0830	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	41.3	0.1			
04/04/85	1130	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	44.3	0.1			
04/04/85	1430	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	47.3	0.1			
04/04/85	1730	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	50.3	0.1			
04/04/85	2024	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	53.2	0.1			
04/04/85	2306	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	55.9	0.1			
05/04/85	0230	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	346	59.3	0.1			
05/04/85	0530	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	62.3	0.1			
05/04/85	0830	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	65.3	0.1			
05/04/85	1130	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	166	68.3	0.2			
05/04/85	1430	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	71.3	0.2			
05/04/85	1730	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	74.3	0.2			
05/04/85	2030	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	77.3	0.2			
05/04/85	2330	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	80.3	0.2			
06/04/85	0230	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	83.3	0.2			
06/04/85	0530	36.3	345.9	47 18.0	48 41.5	XXXX	0.00	000	86.3	0.2			
11/04/85	1747	36.5	347.9	47 18.5	48 39.8	XXXX	0.01	067	218.6	1.4			
17/04/85	0810	36.4	347.2	47 18.3	48 40.4	XXXX	0.00	244	353.0	1.9			

02/04/85 1645 36.17 346.0 (CPA)
11/04/85 1747 36.51 347.9 (MDR)

SPEEDS (knots)

Min.	Max.	Mean	MadeGood	
0.00	0.04	0.00	0.00	(towards 060 deg T)

TOTAL NUMBER OF OBSERVATIONS = 31

Table A7 Individual drift track listing for iceberg 002/1985

TIME TRACKED (h)	DISTANCE TRACKED (n.mi)	CPA (n.mi.)	MEAN SPEED (kts)	MAX. SPEED (kts)	MEAN DIR. (to, T)
353.0	1.9	36.2	0.0	0.0	060

SITE SPECIFIC TARGET PLOT

SURROUNDING Area w.r.t.

NORTH BEN NEVIS P-93
(BOW DRILL 3)
46 42' 48.10" N
48 28' 34.24" W

From 1840 GMT April 02, 1985
to 1140 GMT April 17, 1985
(14 days, 17.00 hours)

1 Target Tracked.
31 Observations.

Radius = 48.0 n. mi.
Tic Interval = 5.0 n. mi.

NORTH BEN NEVIS P-93 is at the Center of Plot.

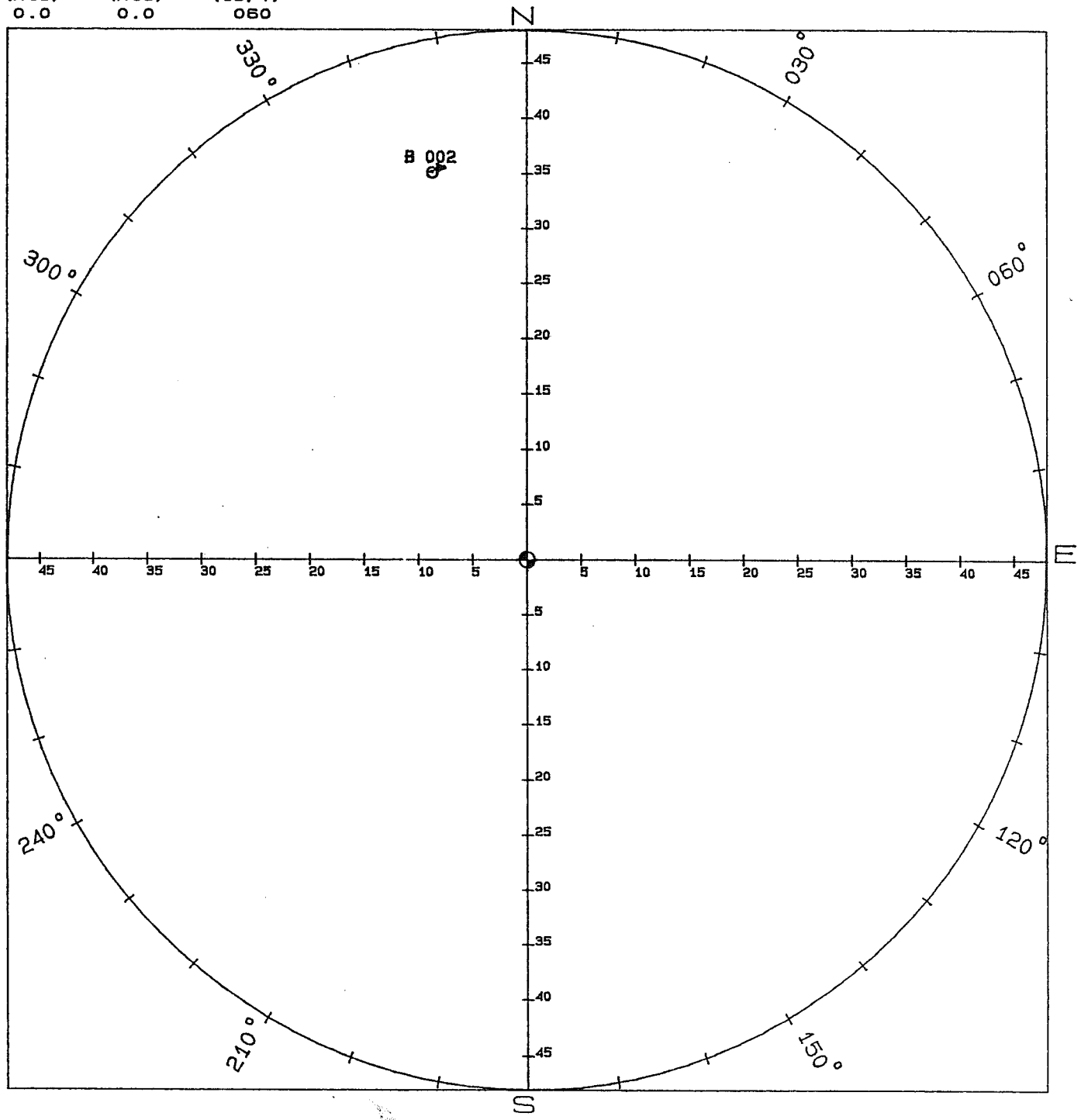


Figure A-17 Site-specific target plot for iceberg 002/1985

RA7 Iceberg 004/1985

Iceberg 004 was a tabular iceberg measuring 132m long and 123m wide at the water line. The sail height was 30m and the calculated mass was 1.7 million tonnes. The draft was estimated as 100m but it was actually closer to 115m, as evidenced by the water depth in the grounding area. The berg was first observed on April 4, 1985 drifting slowly towards 125° into shallower water. The winds were light westerlies at the time, 10 to 15 knots, (Table A8). The berg is presumed to have dragged on the bottom when first observed (Fig. A-18). During the subsequent 20 days, April 4 to 24, the berg dragged its keel a total distance of 7.1nm within an area of 1nm square, the area being situated between 47°-26.5'N and 47°-27.5'N and between 48°-55.0'W and 48°-57'W (Fig. A-19). It may be possible to interpret 2 or 3 separate keel dragging/grounding events within the area, but considering uncertainties in positional accuracy, it is only possible to conclude that keel dragging occurred, along with 1 definite grounding at 47°-26.9'n, 48°55.3'w on April 4 to 5. Slight movement occurred on the 20th and 21st of April, but the berg remained within the area until 1430 on April 24. Between 1430 and 2300 on the 24th, the berg drifted into deeper water towards the northwest, no doubt driven by the high wind (to 30 kts) in that direction. There was probably some keel dragging at first but the 0.42kn drift speed suggests that free drift occurred. Figure A-18 shows the subsequent drift track to the NNW and then due east. The drift data for iceberg 004 terminated on April 25, when the total drift distance was only 17.6nm. This constitutes the first part of the northwest drift track after lift-off from the grounded location shown in Fig. A-19. The remaining part of the drift track must have been based on a subsequent data set for berg #016 which was logged from the Conquest drilling location (same iceberg but different designation).

It is concluded that 1 definite grounding of berg 004 occurred at 47°-26.9'N and

BERG 004

N. Ben Nevis P-93 (BOW DRILL 3)
(46 42.80′ N 48 28.57′ W)

Iceberg Dimensions: Size = M Shape = TAB
Length = M132 Width = M123 Height = M30
Draft = M100 Mass = 1734005

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)
04/04/85	1055	48.1	337.3	47 27.2	48 55.8	XXXX				
04/04/85	1430	47.7	337.6	47 26.9	48 55.3	XXXX	0.13	125	3.6	0.5
04/04/85	1730	47.7	337.6	47 26.9	48 55.3	XXXX	0.00	000	6.6	0.5
04/04/85	2024	47.7	337.6	47 26.9	48 55.3	XXXX	0.00	000	9.5	0.5
04/04/85	2306	47.7	337.6	47 26.9	48 55.3	XXXX	0.00	000	12.2	0.5
05/04/85	0230	47.7	337.6	47 26.9	48 55.3	XXXX	0.00	000	15.6	0.5
05/04/85	0530	47.7	337.6	47 26.9	48 55.3	XXXX	0.00	000	18.6	0.5
05/04/85	0830	47.7	337.6	47 26.9	48 55.3	XXXX	0.00	000	21.6	0.5
05/04/85	1130	47.7	337.6	47 26.9	48 55.3	XXXX	0.00	000	24.6	0.5
05/04/85	1200	47.7	337.5	47 26.9	48 55.4	XXXX	0.17	248	25.1	0.6
11/04/85	1755	48.1	338.3	47 27.5	48 54.7	XXXX	0.01	036	175.0	1.3
20/04/85	1030	47.8	337.0	47 26.8	48 56.0	XXXX	0.01	232	383.6	2.5
20/04/85	1140	47.7	337.0	47 26.7	48 55.9	XXXX	0.10	157	384.8	2.6
20/04/85	1217	47.7	337.0	47 26.7	48 55.9	XXXX	0.00	000	385.4	2.6
20/04/85	1240	47.4	337.0	47 26.4	48 55.8	XXXX	0.78	157	385.8	2.9
20/04/85	2100	47.8	337.0	47 26.8	48 56.0	XXXX	0.05	337	394.1	3.3
21/04/85	0515	47.5	337.4	47 26.7	48 55.4	XXXX	0.05	104	402.3	3.7
21/04/85	0815	48.3	336.2	47 27.0	48 57.2	XXXX	0.42	284	405.3	5.0
21/04/85	1918	47.5	337.0	47 26.6	48 55.9	XXXX	0.09	115	416.4	6.0
21/04/85	2315	47.5	337.0	47 26.5	48 55.8	XXXX	0.01	157	420.3	6.0
22/04/85	0215	47.5	337.0	47 26.5	48 55.8	XXXX	0.00	000	423.3	6.0
22/04/85	0815	47.5	337.0	47 26.5	48 55.8	XXXX	0.00	000	429.3	6.0
22/04/85	1415	47.5	337.6	47 26.7	48 55.1	XXXX	0.08	071	435.3	6.5
23/04/85	0815	47.8	337.6	47 27.0	48 55.3	XXXX	0.02	338	453.3	6.9
23/04/85	1715	47.7	337.8	47 27.0	48 55.0	XXXX	0.02	099	462.3	7.1
24/04/85	0830	47.7	337.8	47 27.0	48 55.0	XXXX	0.00	000	477.6	7.1
24/04/85	1430	47.7	337.8	47 27.0	48 55.0	XXXX	0.00	000	483.6	7.1
24/04/85	2300	50.9	336.0	47 29.3	48 59.0	XXXX	0.42	311	492.1	10.6
25/04/85	0000	51.4	335.0	47 29.4	49 0.5	XXXX	1.02	275	493.1	11.6
25/04/85	0100	52.5	335.0	47 30.4	49 1.2	XXXX	1.10	335	494.1	12.7
25/04/85	0200	53.2	335.0	47 31.0	49 1.6	XXXX	0.70	335	495.1	13.4
25/04/85	0300	54.1	334.0	47 31.4	49 3.4	XXXX	1.30	288	496.1	14.7
25/04/85	0400	55.0	334.0	47 32.2	49 4.0	XXXX	0.90	334	497.1	15.6
25/04/85	0500	56.S	335.0	47 33.8	49 3.6	XXXX	1.62	011	498.1	17.3
25/04/85	0600	56.6	335.0	47 34.1	49 3.7	XXXX	0.30	335	499.1	17.6

20/04/85	1240	47.38	337.0	(CPA)
25/04/85	0600	56.60	335.0	(MDR)

SPEEDS (Knots)

Min.	Max.	Mean	MadeGood	
0.00	1.62	0.27	0.02	(towards 322 deg T)

Table A8

TOTAL NUMBER OF OBSERVATIONS = 35 Individual drift track listing for iceberg 004/198

TIME TRACKED (h)	DISTANCE TRACKED (n.mi)	CPA (n.mi.)	MEAN SPEED (kts)	MAX. SPEED (kts)	MEAN DIR. (to, T)
254.6	116.8	32.3	0.6	1.9	054

Figure A-18 Site-specific target plot for iceberg 004/1985

SITE SPECIFIC TARGET PLOT

SURROUNDING Area w.r.t.

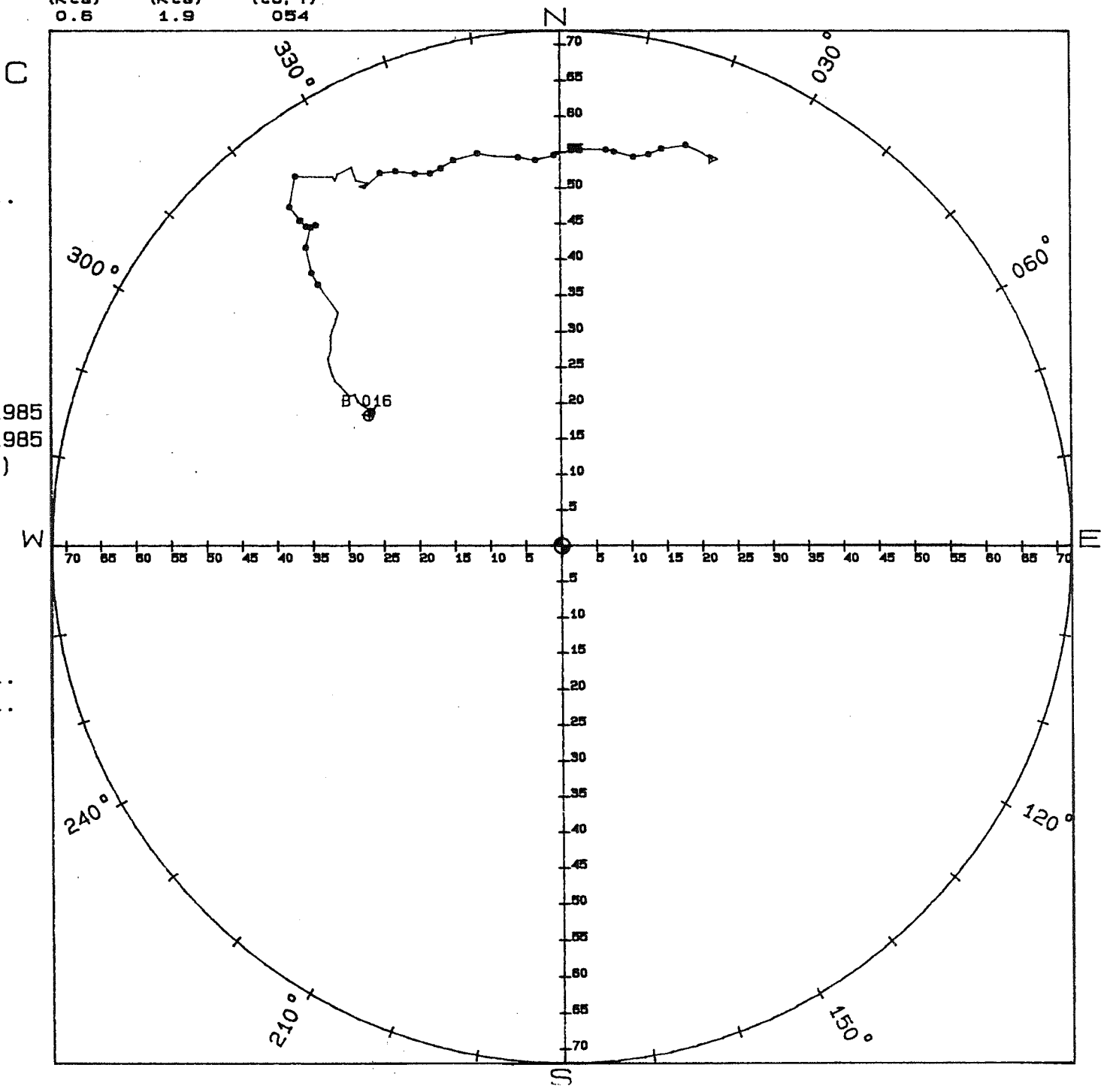
CONQUEST K-09
(BOW DRILL 2)
47 8' 34.00" N
48 15' 44.00" W

From 1400 GMT April 20, 1985
to 0438 GMT May 01, 1985
(10 days, 14.63 hours)

1 Target Tracked.
87 Observations.
1 Target Towed.

Radius = 72.0 n. mi.
Tic Interval = 5.0 n. mi.

CONQUEST K-09 is at the Center of Plot.



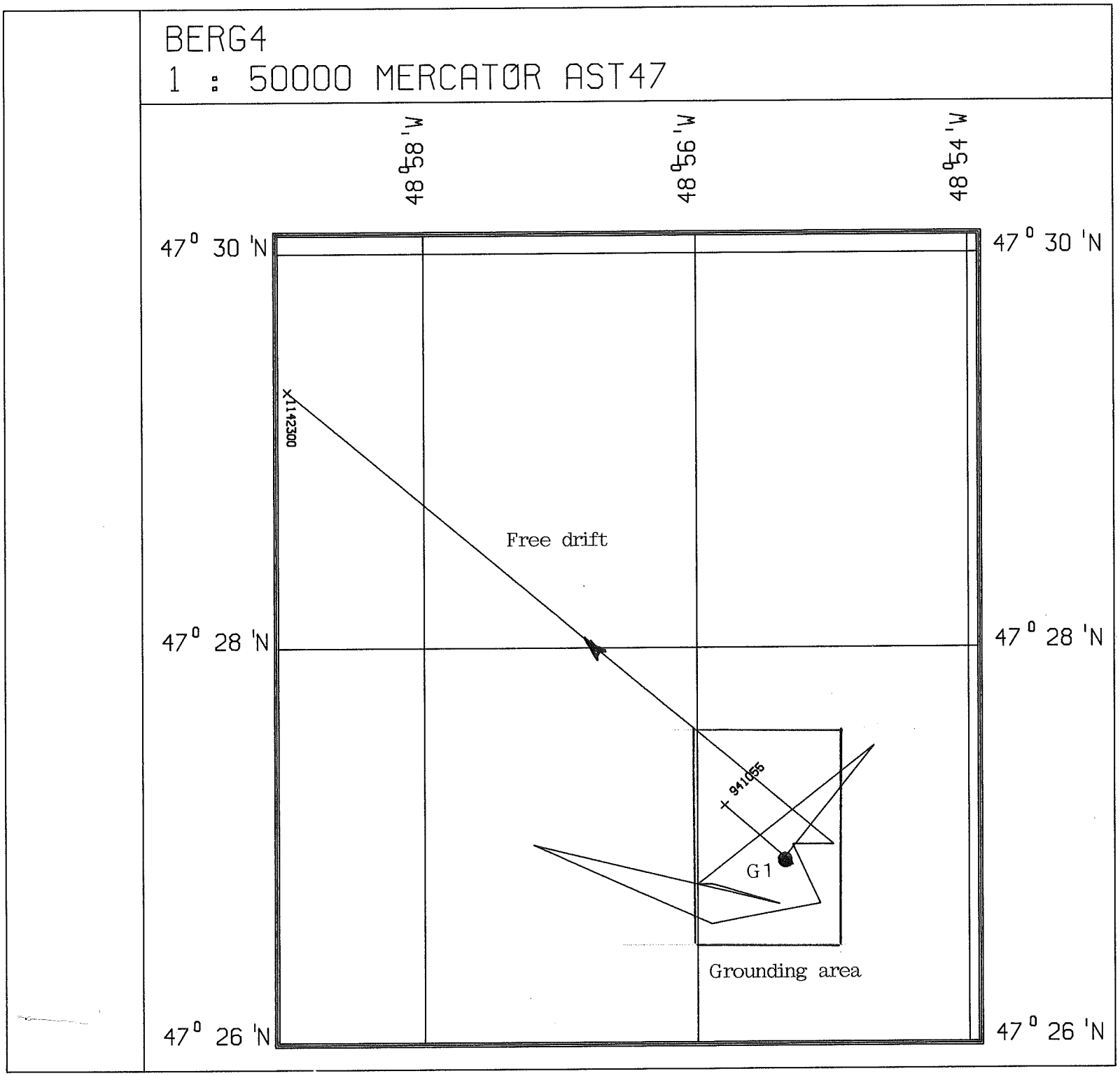


Figure A-19 Drift track of iceberg 004/1985 during grounding

RA8 Iceberg 014/1985

Iceberg 014 was first tracked on the 15th of April, 1985 (Table A9). The berg's waterline dimensions were determined to be 360m by 92m. The sail height was 42m and judging by the grounded position, the draft must have been about 106m. The mass was estimated as 4 million tonnes. Wind records are not available, owing to an absence of drill rigs on the Grand Banks at the time; however, Surface Analysis of winds (Table A5) for April 14 to 16, indicates NW to WSW winds of 20 to 30 knots while the berg was grounded. When the berg drifted free on April 18, it drifted to the northwest; probably in response to 30 knot winds from the southwest. The drift data are presented in Table A9 and the drift track is plotted in Fig. A-20. It is inferred that free drift preceeded the grounding. In Table A9, it should be noted that positional errors are thought to influence the positions on the 16 and 17 of April. The berg is inferred to have grounded at 47°-5.4'N and 51°-13.9'W during a total of 54 hours (from 0100-16-04 to 0730-18-04). In searching for scours, it is recommended that the search be conducted within the elliptical envelopes shown in Fig. A-21. Since this berg was the largest inferred grounded berg, it may be of interest with respect to the possible existence of a bottom pit.

BERG 014

CONQUEST K-09 (BOW DRILL 2)
(47 8.57′ N 48 15.73′ W)

Iceberg Dimensions: Size = M Shape = SPH
Length = M360 Width = M92 Height = M42
Draft = C106 Mass = 4060724

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	Speed (Kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
15/04/85	0530	120.8	268.3	47 5.0 51	13.2	XXXX							
15/04/85	0600	120.9	268.3	47 5.0 51	13.3	XXXX	0.20	268	0.5	0.1			
15/04/85	0700	120.9	268.3	47 5.0 51	13.3	XXXX	0.00	000	1.5	0.1			
15/04/85	2128	120.9	268.1	47 4.6 51	13.3	XXXX	0.03	178	16.0	0.5			
15/04/85	2340	120.9	268.1	47 4.6 51	13.3	XXXX	0.00	000	18.2	0.5			
16/04/85	0100	121.3	268.5	47 5.4 51	13.9	XXXX	0.70	333	19.5	1.5			
16/04/85	0200	121.3	268.5	47 5.4 51	13.9	XXXX	0.00	000	20.5	1.5			
16/04/85	0230	121.3	268.5	47 5.4 51	13.9	XXXX	0.00	000	21.0	1.5			
16/04/85	0330	121.3	268.5	47 5.4 51	13.9	XXXX	0.00	000	22.0	1.5			
16/04/85	0430	121.3	268.5	47 5.4 51	13.9	XXXX	0.00	000	23.0	1.5			
16/04/85	0630	121.3	268.5	47 5.4 51	13.9	XXXX	0.00	000	25.0	1.5			
16/04/85	0800	121.3	268.5	47 5.4 51	13.9	XXXX	0.00	000	26.5	1.5			
16/04/85	0830	121.3	268.5	47 5.4 51	13.9	XXXX	0.00	000	27.0	1.5			
16/04/85	1200	121.3	268.5	47 5.4 51	13.9	XXXX	0.00	000	30.5	1.5			
16/04/85	1315	121.3	268.5	47 5.4 51	13.9	XXXX	0.00	000	31.8	1.5			
16/04/85	1610	121.3	268.5	47 5.4 51	13.9	XXXX	0.00	000	34.7	1.5			
16/04/85	2200	120.9	268.1	47 4.6 51	13.3	XXXX	0.16	153	40.5	2.4			
17/04/85	0330	120.9	268.1	47 4.6 51	13.3	XXXX	0.00	000	46.0	2.4			
17/04/85	1037	120.7	268.0	47 4.4 51	13.0	XXXX	0.04	135	53.1	2.7			
18/04/85	0030	121.3	268.5	47 5.4 51	13.9	XXXX	0.09	329	67.0	3.9			
18/04/85	0430	121.3	268.5	47 5.4 51	13.9	XXXX	0.00	000	71.0	3.9			
18/04/85	0730	121.3	268.5	47 5.4 51	13.9	XXXX	0.00	000	74.0	3.9			
18/04/85	1313	120.2	268.9	47 6.3 51	12.4	XXXX	0.24	051	79.7	5.3			
18/04/85	1400	120.0	268.9	47 6.3 51	12.1	XXXX	0.26	089	80.5	5.5			
18/04/85	1500	119.6	268.9	47 6.3 51	11.5	XXXX	0.40	089	81.5	5.9			
18/04/85	1600	118.9	269.1	47 6.7 51	10.5	XXXX	0.81	058	82.5	6.7			
18/04/85	1700	118.7	269.2	47 6.9 51	10.2	XXXX	0.29	043	83.5	7.0			
18/04/85	1800	117.7	269.6	47 7.7 51	8.8	XXXX	1.30	050	84.5	8.3			
18/04/85	1900	117.2	269.9	47 8.4 51	8.0	XXXX	0.79	039	85.5	9.1			
18/04/85	2000	116.5	270.4	47 9.4 51	7.0	XXXX	1.24	035	86.5	10.3			
18/04/85	2100	115.9	271.1	47 10.8 51	6.2	XXXX	1.54	024	87.5	11.9			
18/04/85	2200	115.7	271.6	47 11.8 51	5.9	XXXX	1.03	013	88.5	12.9			
18/04/85	2300	115.0	271.8	47 12.2 51	4.8	XXXX	0.81	062	89.5	13.7			
19/04/85	0000	114.3	272.6	47 13.8 51	3.7	XXXX	1.75	026	90.5	15.4			
19/04/85	0100	114.4	273.0	47 14.6 51	3.9	XXXX	0.80	356	91.5	16.2			
19/04/85	0200	114.1	273.3	47 15.1 51	3.4	XXXX	0.67	030	92.5	16.9			
19/04/85	0300	113.8	273.6	47 15.7 51	2.9	XXXX	0.67	030	93.5	17.6			
19/04/85	0400	113.5	274.2	47 16.9 51	2.4	XXXX	1.23	018	94.5	18.8			
19/04/85	0500	113.3	274.5	47 17.5 51	2.0	XXXX	0.63	023	95.5	19.4			
19/04/85	0600	112.5	274.9	47 18.2 51	0.8	XXXX	1.12	050	96.5	20.6			
19/04/85	0700	112.3	275.1	47 18.5 51	0.4	XXXX	0.44	032	97.5	21.0			
19/04/85	0800	112.1	275.6	47 19.5 51	0.0	XXXX	1.00	017	98.5	22.0			
19/04/85	0900	111.0	275.9	47 20.0 50	58.4	XXXX	1.25	068	99.5	23.2			

Table A9 Individual drift track for iceberg 014/1985

BERG 014

CONQUEST K-09 (BOW DRILL 2)
(47 8.57′ N 48 15.73′ W)

Iceberg Dimensions: Size = M Shape = SPH
Length = M360 Width = M92 Height = M42
Draft = C106 Mass = 4060724

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
19/04/85	1000	110.4	276.3	47 20.7	50 57.4	XXXX	0.98	044	100.5	24.2			
19/04/85	1100	109.9	276.7	47 21.4	50 56.5	XXXX	0.92	040	101.5	25.1			
19/04/85	1200	109.6	277.0	47 21.9	50 56.0	XXXX	0.65	034	102.5	25.8			
19/04/85	1300	108.7	277.6	47 22.9	50 54.5	XXXX	1.45	046	103.5	27.2			

19/04/85 1300 108.70 277.6 (CPA)
18/04/85 0730 121.30 268.5 (MDR)

SPEEDS (knots)

Min.	Max.	Mean	MadeGood	
0.00	1.75	0.51	0.21	(towards 036 deg T)

TOTAL NUMBER OF OBSERVATIONS = 47

Table A9 (continued)

TIME TRACKED (h)	DISTANCE TRACKED (n.mi)	CPA (n.mi.)	MEAN SPEED (kts)	MAX. SPEED (kts)	MEAN DIR. (to, T)
103.5	27.2	108.7	0.5	1.7	036

Figure A-20 Site-specific target plot of iceberg 014/1988

SITE SPECIFIC TARGET PLOT

SURROUNDING Area w.r.t.

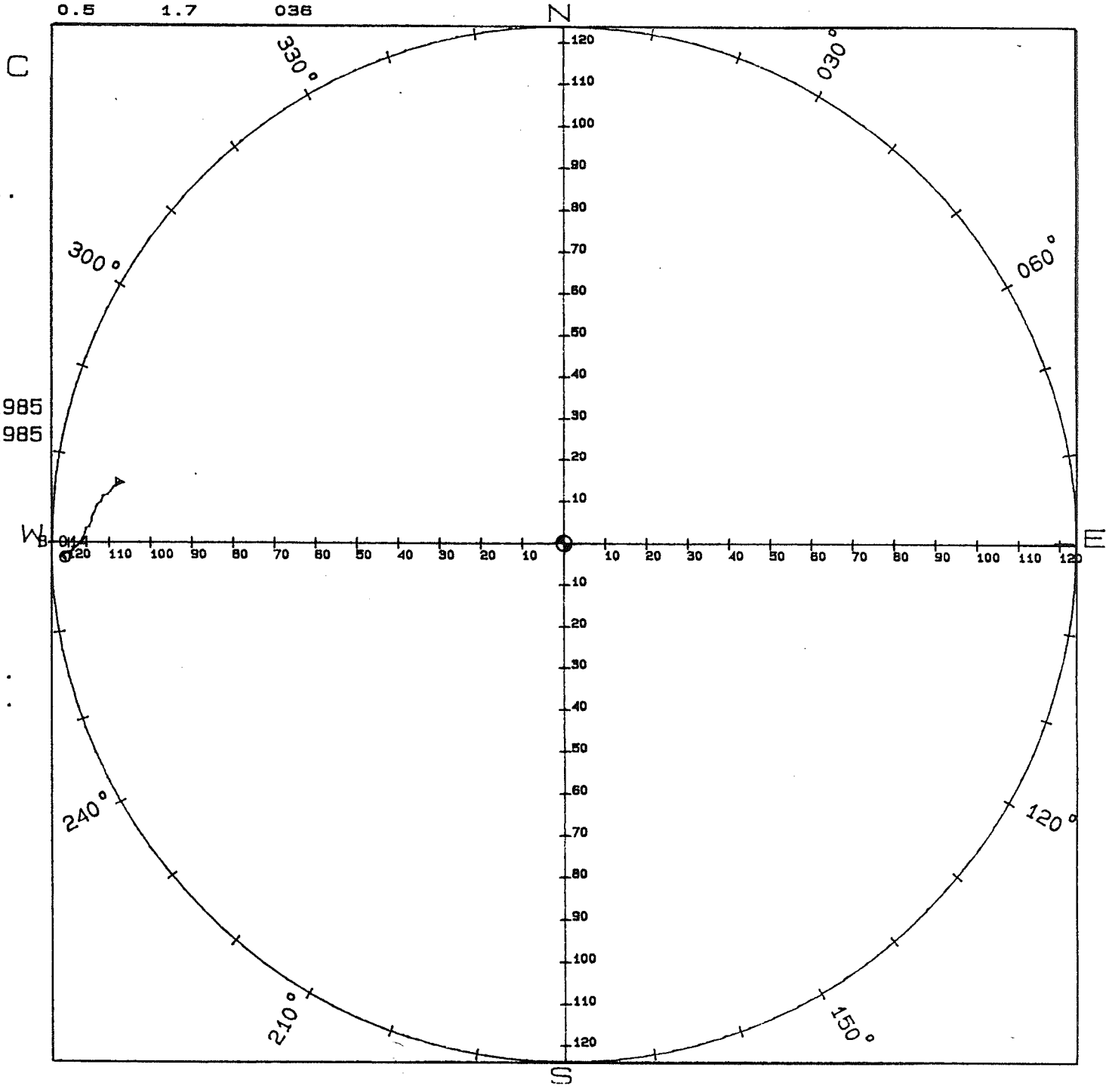
CONQUEST K-09
(BOW DRILL 2)
47 8' 34.00" N
48 15' 44.00" W

From 0900 GMT April 15, 1985
to 1630 GMT April 19, 1985
(4 days, 7.50 hours)

1 Target Tracked.
47 Observations.

Radius = 124.0 n. mi.
Tic Interval = 10.0 n. mi.

CONQUEST K-09 is at the Center of Plot.



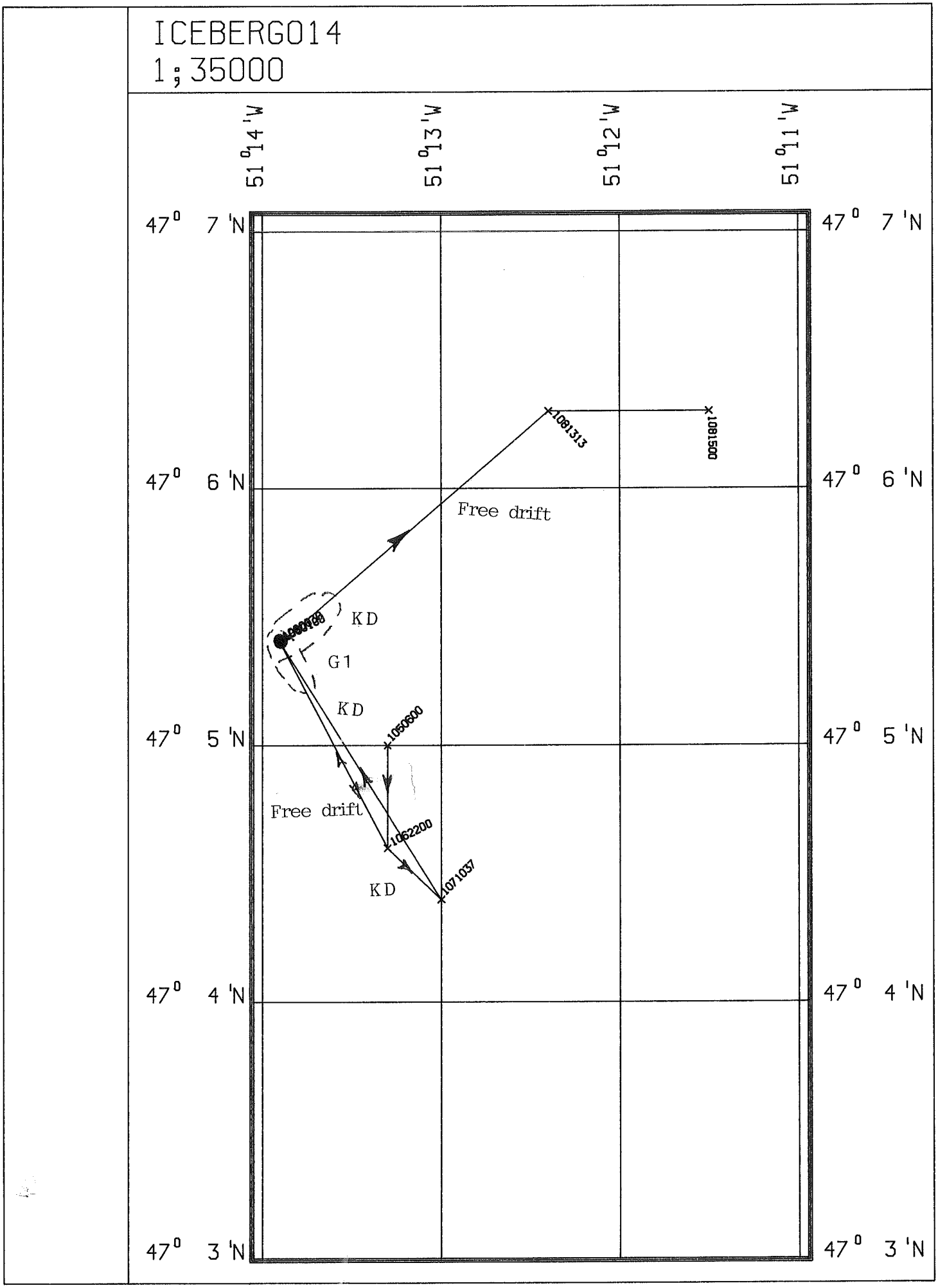


Figure A-21 Drift track of iceberg 014/1985 during scouring

RA9 Iceberg BIO 002/1985

This iceberg was monitored in its grounded position by Dr. S.D. Smith of the Bedford Institute of Oceanography. The berg was grounded for at least 2 days at 47°-45.03'N and 50°-49.85'W on April 30 and May 1, 1985 (Table A10). The water dept is 130m at this location. The water-line dimensions were 224m long and 137m wide. The sail height was 24m and the draft must have been about 135m. The berg was large and blocky and the above-water volume of ice was 280000m: the mass was estimated as 2 million tonnes. The berg was found aground and therefore no information is available regarding the drift prior to grounding or afterwards. While monitoring the berg for drift, which obviously did not occur, photographs were taken (Fig. A-22) and a plan view of the sail was prepared (Fig. A-23). In searching for a scour from this iceberg, it is advisable to commence side-scan sonar surveys at the grounded position: 1. because the exact grounding position was accurately established and 2. because the drift prior to and after grounding is not known.

Summary:

Iceberg BIO 002/1985 was grounded for at least 2 days at exactly 47°-45.03'N and 50°-49.85'W.

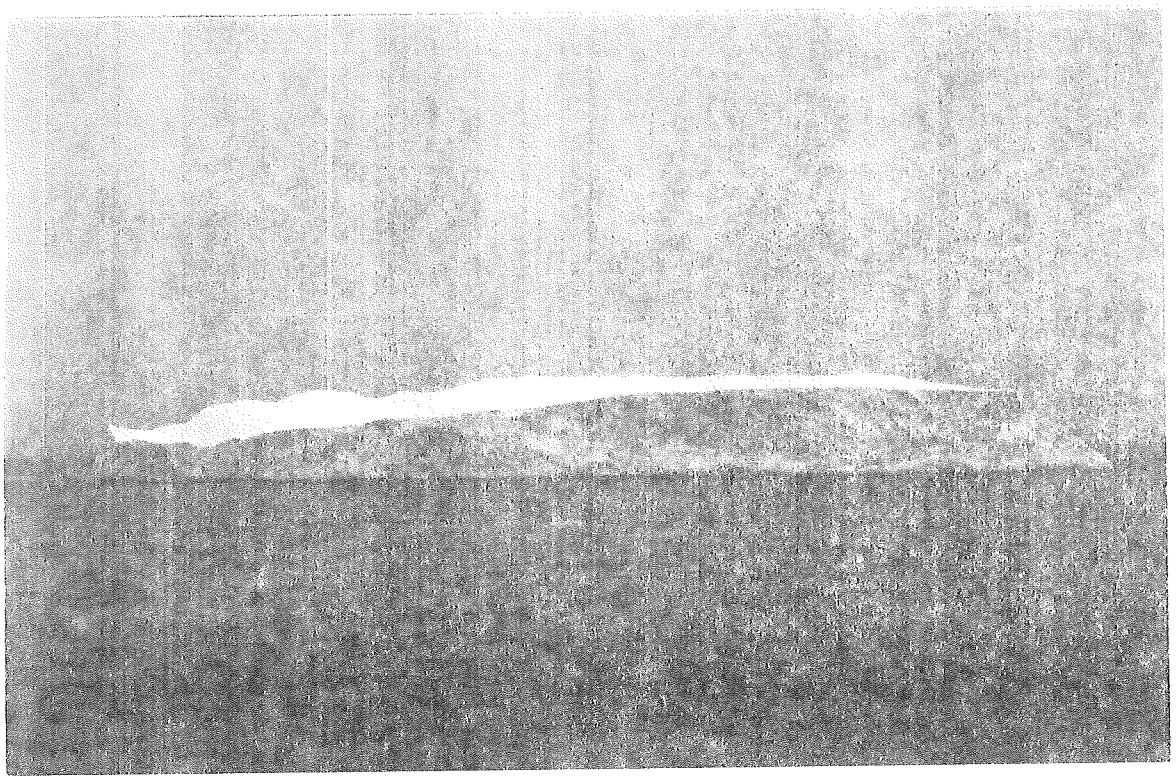
Berg No. : BIO 2

Date:	30 April, 1985	Survey Started:	17:00 UT
Latitude:	47° 45.03 N	Longitude:	50° 49.85 W
Shape:	Blocky, Large	Status:	Grounded

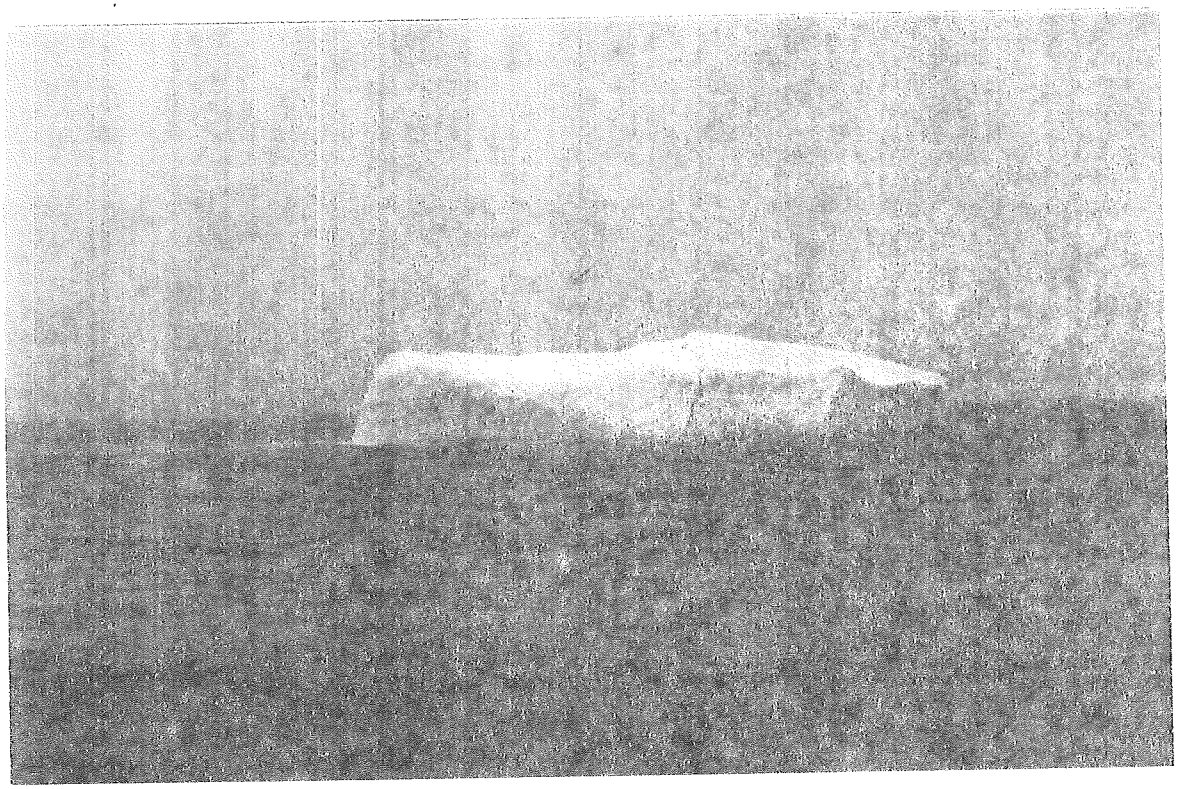
H	24 m
L	224 m
W	137 m
D	130 m
Vabove	280,000 m^3
Mass	2,000,000 tonnes

Comments: Berg was found in exact position of last report and upon further inspection was found to be grounded.

Table A10 Iceberg BIO 002

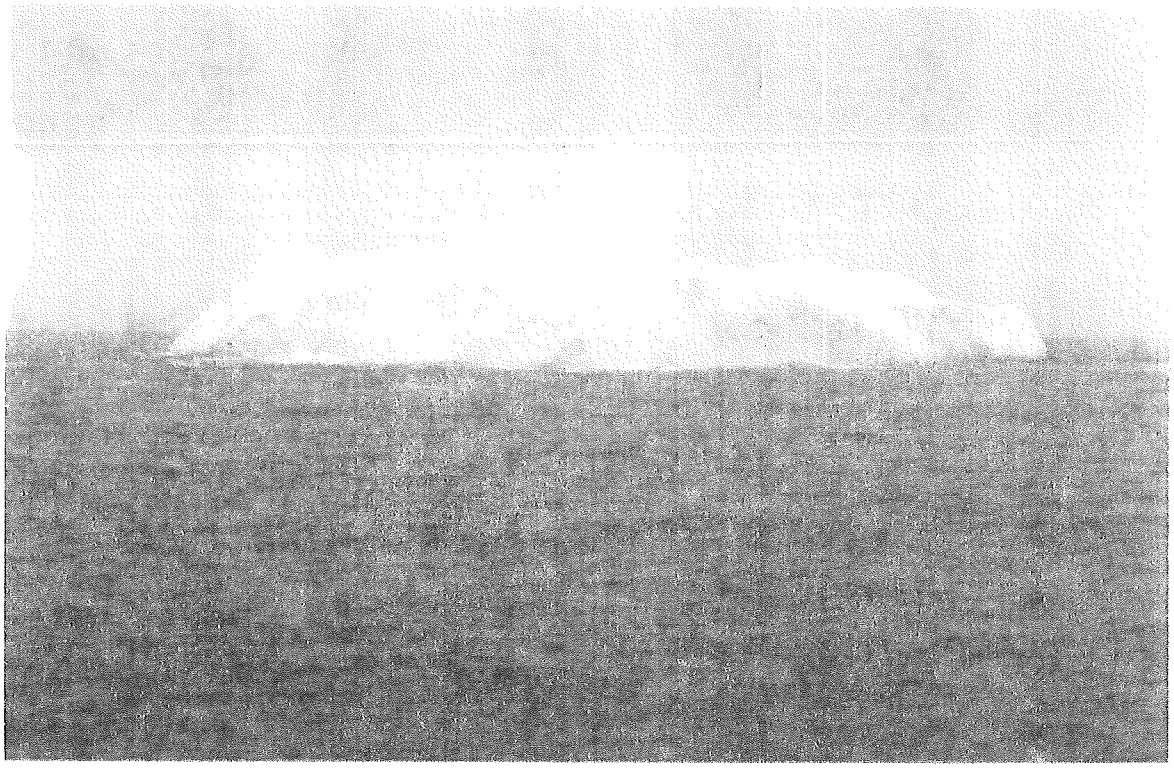


BIO 2 NORTH

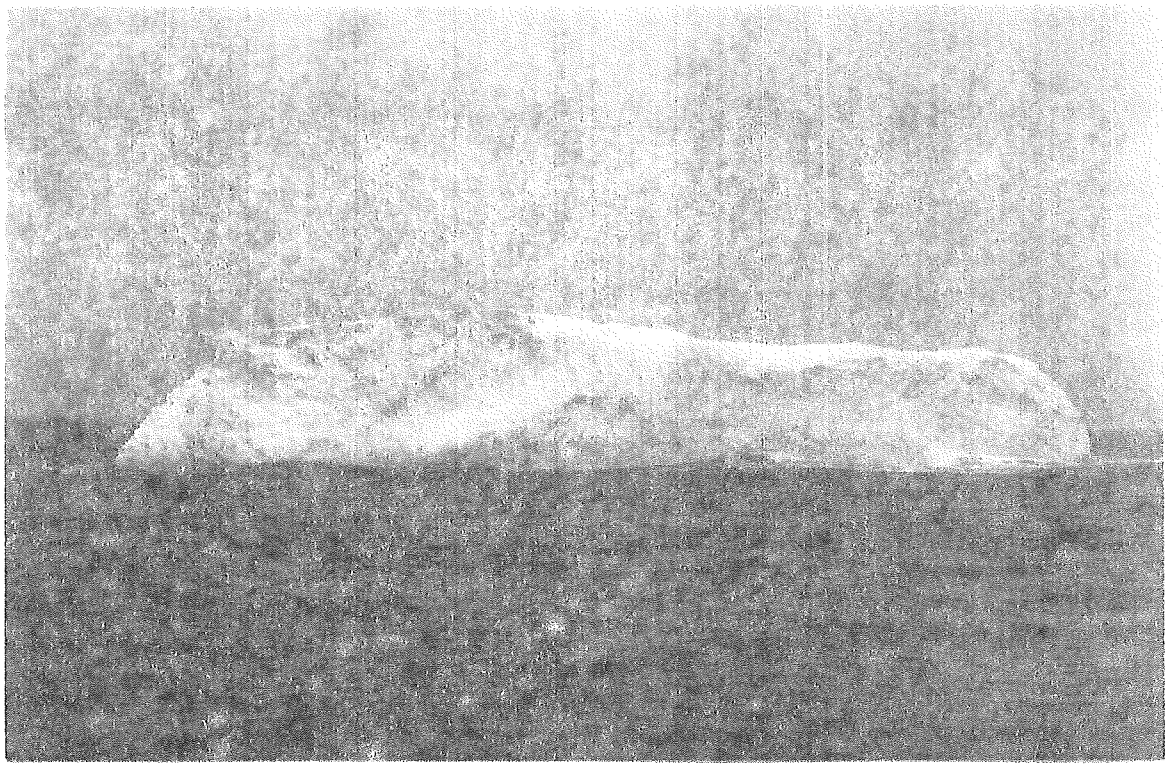


BIO 2 EAST

Figure A-22 (continued)



BIO 2 154°



BIO 2 265°

Figure A-22 Photographs of iceberg BIO 002/1985

BIO ICEBERG SURVEY 1985

PLAN VIEW: BERG # BIO 2

Figure A-23 Plan view of iceberg BIO 002/1985

RA10 Iceberg 026/1985

Iceberg 026 definitely grounded in position 45°-58.6'N and 48°-05.0'W about 39.2nm @ 157° from the North Ben Nevis drilling location at 46°-34.0'N and 48°.26.1'W (Fig. A-24). The berg was grounded or dragging its keel on May 31 and remained grounded in 120m of water until June 6. Between 1530 on June 6 and 0030 on June 7, a half mile increase in distance from the rig was noted and no further observations were made (Table A11). The berg was of the spherical type with a water line length of 120m, a width of 100m and an estimated sail height of 30m. The draft was estimated as 77m which is far short of the 120m water depth at the grounding location. The mass was estimated as 1.1 million tonnes but the actual mass was probably greater. During the 156 hours of observation, a net displacement of 1.1nm was noted towards 156° from the first position. It is not known when the berg actually grounded or when it drifted away from the grounded position and it is therefore not possible to reach conclusions regarding wind conditions involved in the movement of this berg.

Grounding summary:

Position	Location	From	To
G1	45°-58.6'N & 48°-05.0'W	1430-31-05	1530-0606

WEST BEN NEVIS B-75
46 34.0 N 48 26.1 W

OBSERVED TRACK PLOT & SUMMARY FOR ICEBERG : S26

Observed from : 1230 31 May 85 to : 0030 7 Jun 85 (GMT)
Hours Tracked : 156 hrs # of Observations : 12
Distance tracked : 2.6 nm. Net Displacement : 1.1 nm
Closest Approach : 38.7 nm. 158° at 1230 31 May 85

Iceberg track : ———— Tow operations : ----------
Scale : 42 nm

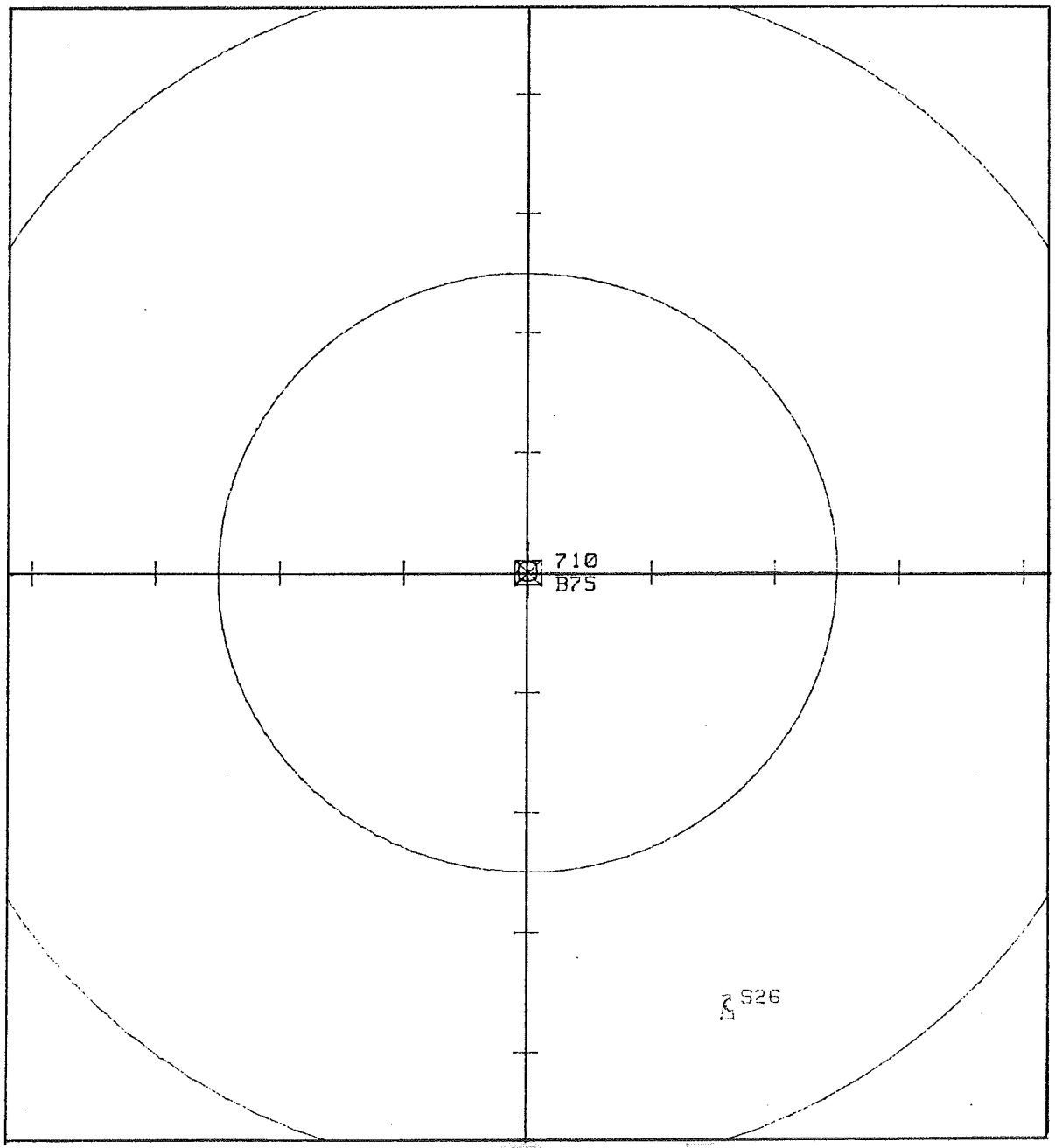


Figure A-24 Drift track of iceberg 026/1985

WEST BEN NEVIS B-75
46 34.0 N 48 26.1 W
1985

Iceberg : S26 page 1

Characteristics :

Size	Shape	Length	Width	Height	Draft	Mass
LB	SPH	E 120	E 100	E 30	E 77	E 1080

Summary of the Iceberg Track

Time tracked : 156.0 hrs.
Total Distance : 2.6 nm.
Net Displacement : 1.1 nm.

Position Observations : 12

Time (GMT)	Date (GMT)	Range (nm)	Bear (deg)	Speed (knots)	Dir (deg)	Status	Towhead (deg)	Tension (tons)
1230	31 May	38.7	158	0.0	0			
1430	31 May	38.8	157	.4	80			
1830	31 May	39.1	157	.1	190			
2230	31 May	39.3	157	.1	159			
0230	1 Jun	39.3	157	0.0	90			
1000	1 Jun	39.1	157	0.0	339			
1430	1 Jun	39.2	157	.1	233			
2230	1 Jun	39.2	157	0.0	90			
1230	2 Jun	39.2	157	0.0	90			
1940	5 Jun	39.2	157	0.0	90			
1530	6 Jun	39.3	158	0.0	226			
0030	7 Jun	39.8	158	.1	156			

Table A11 Individual drift track listing for iceberg 026/1984

RA11 Iceberg 014/1984

Nothing is known about this berg except that it was grounded 16.0 nm @ 209° from the Terra Nova K-08 drilling location (Fig. A-25) when the SEDCO 710 returned to drill there on April 21, 1984. The berg was grounded in 78m of water at 46°-13.5'N and 48°-41.6'W and remained grounded for at least 5 days. The last position taken on April 26 indicates the same original position noted on the 21st. Any scour left on the seabed by this berg is probably located east and northeast from the grounded position because of greater water depths in those areas.

Grounding summary:

Position	Location	From	To
G1	46°-13.5'N & 48°-41.6'W	0700-21-04	1800-26-04

ICEBERG TRACK – 84TN014

SITE: TERRA NOVA K-08 VESSEL: SEDCO 710

PERIOD: APR 21 0700Z – APR 26 1800Z

NUMBER OF HOURS MONITORED : 131.0

C.P.A. (n.mi.) :16.0

MEAN DIRECTION FROM DEG. TRUE : .0

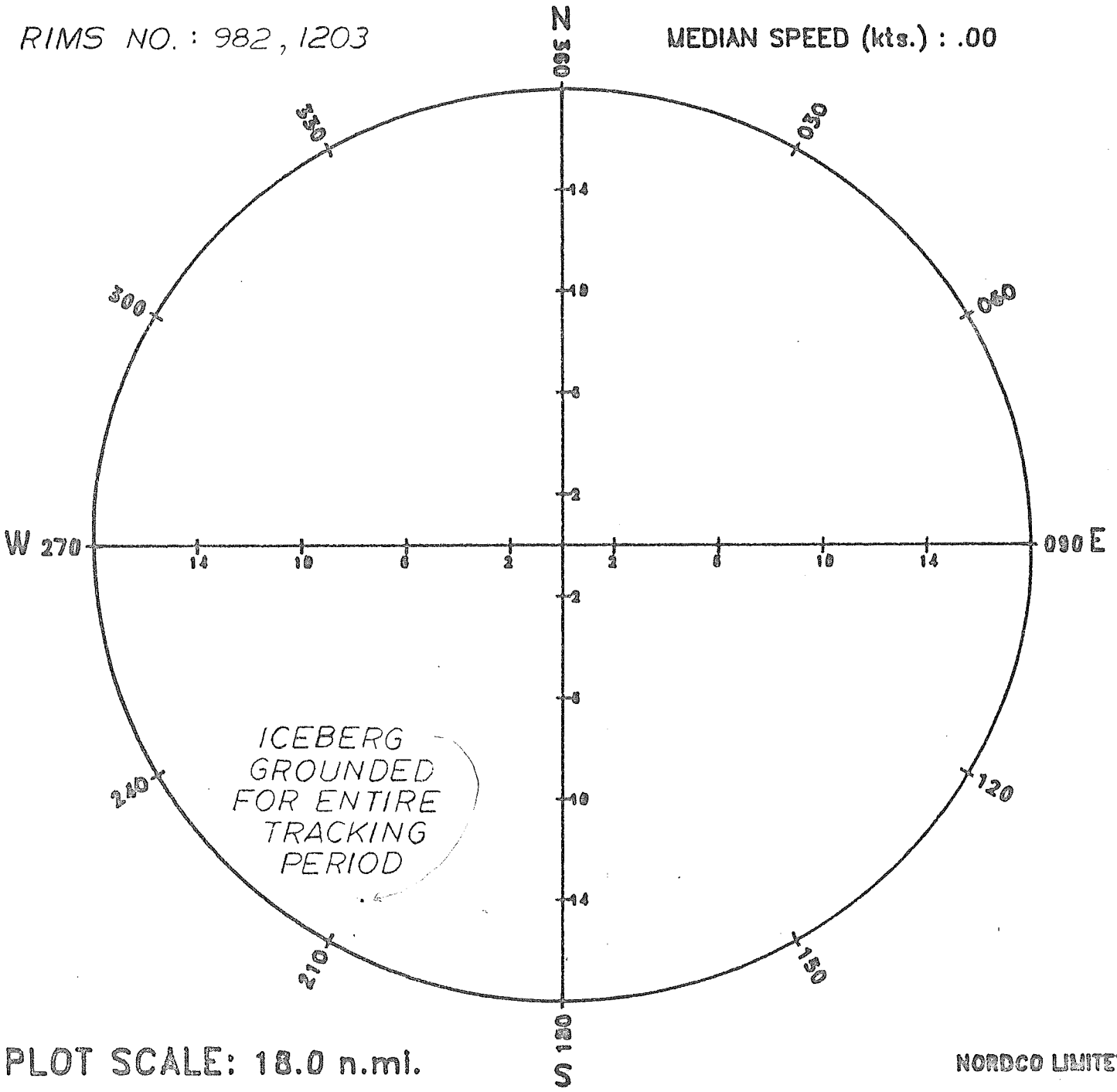
RIMS NO. : 982, 1203

MINIMUM SPEED (kts.) : .00

MAXIMUM SPEED (kts.) : .00

MEAN SPEED (kts.) : .00

MEDIAN SPEED (kts.) : .00



PLOT SCALE: 18.0 n.mi.

NORDCO LIMITED

Figure A-25 Grounded position of iceberg 014/1984

RA12 Iceberg 015/1984

The drift track of berg 015 is presented in Fig. A-26. Iceberg 015 grounded a total of three times between Julian day 112 and 130 in 1984. Groundings G2 and G3 of this berg are the same as those noted for iceberg 057 by Mobil Oil. The berg was a tabular berg measuring 100m by 78m at the water line. The sail height was 33m and the draft decreased from about 90m at grounding location G1 to about 74m at grounding locations G2 and G3 (Fig. A-27). The positional log (Table A12) indicates that this iceberg was first observed in grounding position G1 at 46°-19.3'N and 48°-32.7'W. The berg remained grounded from Julian day 112 to 117 (April 21 to 26), then apparently drifted in free drift about 4nm due west into shallower water, about 85m deep. The winds at the time, on April 26, were easterly at speeds up to 45 knots which probably is why the berg lifted off its grounded location, G1 and drifted westward. After the free drift, which lasted about 3 hours, the berg probably started scouring in about 85m of water and is inferred to have dragged its keel 5nm towards 320° into a depth of 74m. The period of keel dragging was 2.5 days and the winds varied from 22 to 42 knots from an easterly direction. About a day of free drift apparently followed the period of keel dragging and then the berg ran aground again on April 30 at grounding position G2 (46°-20.8'N & 48°-45.3'W) the water depth being 72m. The berg remained grounded at G2 until May 7, when the berg dragged its keel about half a nautical mile towards the east and grounded again at grounding location G3 in 72m of water. The berg remained grounded at G3 (46°-20.8'N and 48°-44.8'W) for two days. The keel dragging on May 7 was probably facilitated by south-west winds with wind speeds to 30 knots on May 6 and 7. On May 9, northwest winds to 33 knots probably assisted in dislodging the berg from G3 and no doubt expedited its drift towards the south in free drift. The last reported position was logged on May 11 (Table A12).

Table A 12 Individual drift track listing for iceberg 015/1984

84TN015.TRK

409 84TN015

112	0700	195.0	10.00	0.00	0.0	
117	1600	195.0	10.00	0.00	0.0	R
117	1700	191.0	10.30	1.10		
117	1800	198.0	10.70	1.34		
117	1900	206.0	11.40	1.87		
117	2000	206.0	11.40	0.00	0.0	R
117	2100	207.0	11.40	0.20	296.5	R
117	2200	207.0	11.40	0.00	0.0	R
117	2300	207.0	11.40	0.00	0.0	R
118	0000	207.0	11.40	0.00	0.0	R
118	0100	207.0	11.40	0.00	0.0	R
118	0200	207.0	11.40	0.00	0.0	R
118	0300	209.0	11.30	0.41	312.2	R
118	0400	210.0	11.50	0.28	254.4	R
118	0500	210.0	11.50	0.00	0.0	R
118	0600	210.0	11.50	0.00	0.0	R
118	0700	210.0	11.50	0.00	0.0	R
118	0800	210.0	11.50	0.00	0.0	R
118	0900	210.0	11.50	0.00	0.0	R
118	1000	210.0	11.50	0.00	0.0	R
118	1100	210.0	11.50	0.00	0.0	R
118	1200	210.0	11.50	0.00	0.0	R
118	1300	210.0	11.50	0.00	0.0	R
118	1400	210.0	11.50	0.00	0.0	R
118	1500	210.0	11.50	0.00	0.0	R
118	1600	210.0	11.50	0.00	0.0	R
118	1700	210.0	11.50	0.00	0.0	R
118	1800	210.0	11.50	0.00	0.0	R
118	1900	211.0	11.50	0.20	300.5	R
118	2000	211.0	11.50	0.00	0.0	R
118	2145	214.0	11.30	0.36	321.0	R
118	2300	214.0	11.30	0.00	0.0	R
119	0000	214.0	11.30	0.00	0.0	R
119	0100	214.0	11.30	0.00	0.0	R
119	0200	214.0	11.30	0.00	0.0	R
119	0300	214.0	11.30	0.00	0.0	R
119	0400	214.0	11.30	0.00	0.0	R
119	0500	214.0	11.30	0.00	0.0	R
119	0600	214.0	11.40	0.10	214.0	R
119	0700	214.0	11.40	0.00	0.0	R
119	0800	214.0	11.30	0.10	34.0	R
119	0900	214.0	11.40	0.13	41.	
119	1000	214.	11.40	0.00	0.0	R
119	1100	214.0	11.40	0.00	0.0	R
119	1200	220.0	11.10	1.22	381.2	R
119	1300	222.0	11.10	0.39	311.0	R
119	1400	223.0	11.30	0.28	254.3	R
119	1500	225.0	11.20	0.41	328.	
119	1600	226.0	11.30	0.22	290.	
119	1700	226.0	11.30	0.00	0.	
119	1800	226.0	11.30	0.00		
119	1900	226.0	11.30	0.00	0.	
119	2000	226.0	11.30	0.00	0.0	R
119	2100	226.0	11.30	0.00	0.0	R
119	2200	227.0	11.30	0.20	316.5	R
119	2300	228.0	11.30	0.20	317.5	R
120	0000	228.0	11.30	0.00	0.0	R
120	0100	229.0	11.30	0.20	318.5	R
120	0200	230.0	11.30	0.20	319.5	R
120	0300	232.0	11.40	0.41	306.8	R
120	0400	232.0	11.50	0.10	232.0	R
120	0500	232.0	11.50	0.00	0.0	R
120	0600	232.0	11.50	0.00	0.0	R
120	0700	232.0	11.50	0.00	0.0	R
120	0800	232.0	11.50	0.00	0.0	R
120	0900	232.0	11.50	0.00	0.0	R
120	1000	235.0	10.50	1.15	23.6	R
120	1200	229.0	10.50	0.55	142.0	R
120	1300	238.0	11.40	1.94	295.9	R
120	1400	244.0	11.90	1.32	308.7	R
120	1700	232.0	11.40	0.10	52.0	R
120	1800	232.0	11.70	0.10	232.0	R
120	1900	243.0	11.80	0.23	296.5	R
120	2000	243.0	11.90	0.10	233.0	R
120	2100	234.0	11.80	0.23	349.3	R
120	2200	233.0	11.80	0.21	324.5	R
121	0200	240.0	12.20	0.28	306.6	R
121	0800	235.0	11.90	0.18	131.6	R
121	0900	235.0	12.00	0.00	235.0	R
128	1400	236.0	12.00	0.00	0.0	R
128	1500	238.	11.80	0.29	101.6	R
128	1600	236.0	11.80	0.21	325.5	R
128	1700	234.0	11.80	0.41	145.0	R
128	1800	234.0	11.80	0.00	0.0	R
128	1900	234.0	11.80	0.00	0.0	R
128	2000	234.0	11.70	0.10	54.0	R
128	2100	234.0	11.60	0.10	54.0	R
128	2200	234.0	11.70	0.10	234.0	R
128	2300	234.0	11.00	0.70	54.0	R
129	0000	234.0	11.70	0.70	234.0	R
129	0100	234.0	11.70	0.00	0.0	R
129	0200	234.0	11.70	0.00	0.0	R
129	0300	234.0	11.70	0.00	0.0	R
129	0500	235.0	11.60	0.11	350.7	R
129	0600	235.0	11.60	0.00	0.0	R
129	0700	235.0	11.60	0.00	0.0	R
129	0800	235.0	11.65	0.05	235.0	R
129	0900	235.0	11.60	0.05	55.0	R
129	1000	235.0	11.60	0.00	0.0	R
129	1100	235.0	11.60	0.00	0.0	R
129	1200	235.0	11.60	0.00	0.0	R
129	1300	235.0	11.60	0.00	0.0	R
129	1400	235.0	11.60	0.00	0.0	R
129	1500	235.0	11.60	0.00	0.0	R
129	1600	235.0	11.60	0.00	0.0	R
129	1700	235.0	11.60	0.00	0.0	R
129	1800	233.0	11.60	0.40	144.0	R
129	1900	234.0	11.60	0.20	323.5	R
129	2000	234.0	11.70	0.10	234.0	R

Table A 12 (continued)

129	2200	234.0	11.70	0.00	0.0	R
129	2300	234.0	11.70	0.00	0.0	R
130	0000	234.0	11.70	0.00	0.0	R
131	2200	229.0	12.50	0.06	178.6	R
131	2300	226.0	12.90	0.78	168.5	R
132	0000	222.0	13.50	1.10	167.1	R
132	0100	221.0	13.90	0.47	190.6	R
132	0200	220.0	14.70	0.64	303.2	R
132	0300	218.0	15.70	1.31	195.0	R
132	0430	216.0	16.50	0.55	173.7	R
132	0500	216.0	16.60	0.20	216.0	R
132	0605	216.0	17.50	0.83	216.0	R
132	0720	215.0	17.50	0.24	125.5	R
132	0815	214.0	17.60	0.35	142.6	R
132	0910	216.0	17.70	0.68	295.8	R
132	1050	213.0	17.60	0.56	118.3	R

ICEBERG TRACK – 84TN015

SITE: TERRA NOVA K-08

VESSEL: SEDCO 710

PERIOD: APR 21 0700Z – MAY 11 1050Z

NUMBER OF HOURS MONITORED : 483.5

C.P.A. (n.mi.) :10.0

MEAN DIRECTION FROM DEG. TRUE : 47.3

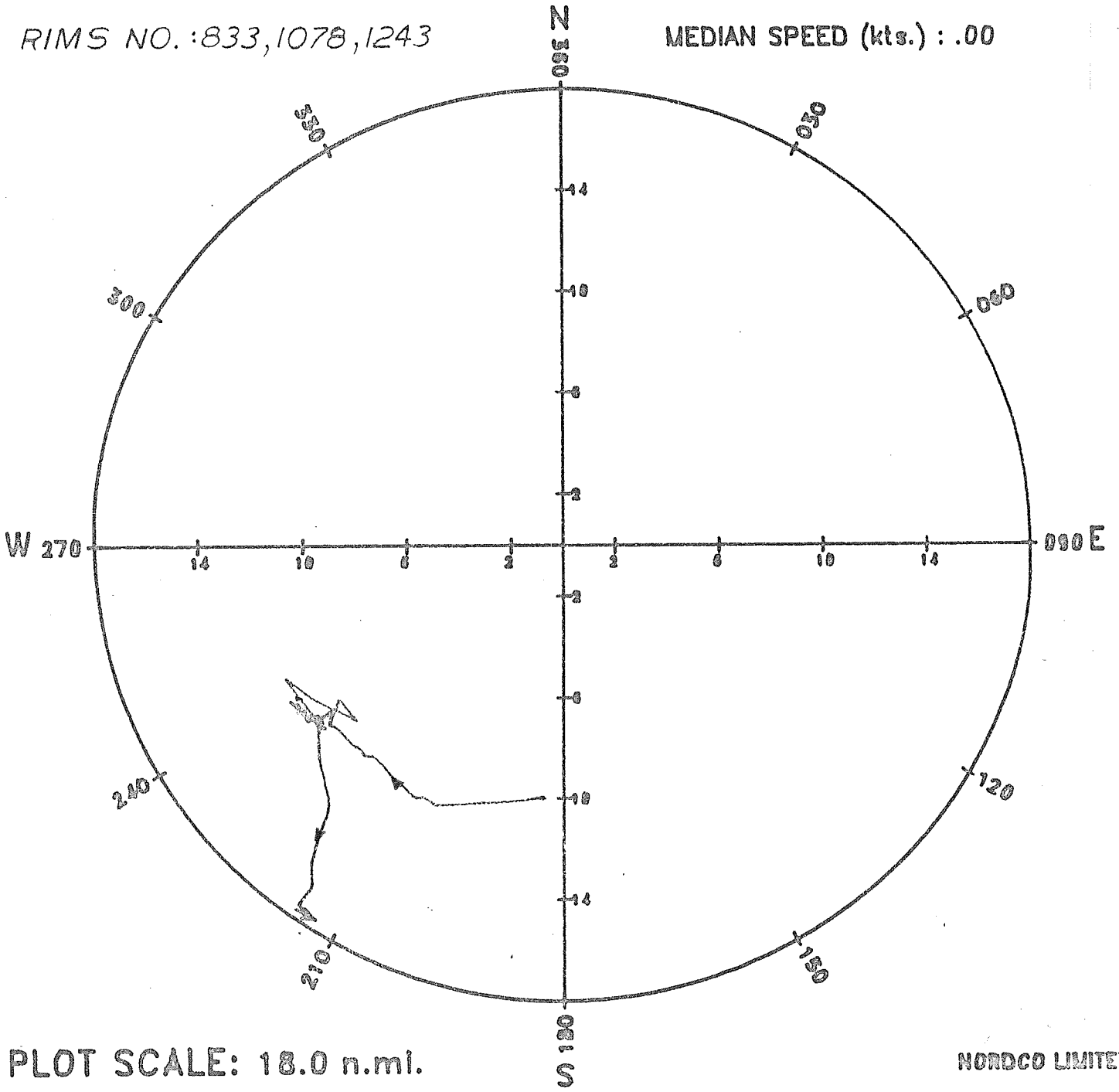
RIMS NO. :833,1078,1243

MINIMUM SPEED (kts.) : .00

MAXIMUM SPEED (kts.) : 1.94

MEAN SPEED (kts.) : .08

MEDIAN SPEED (kts.) : .00



PLOT SCALE: 18.0 n.mi.

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Figure A-26 Iceberg track 84 TN015

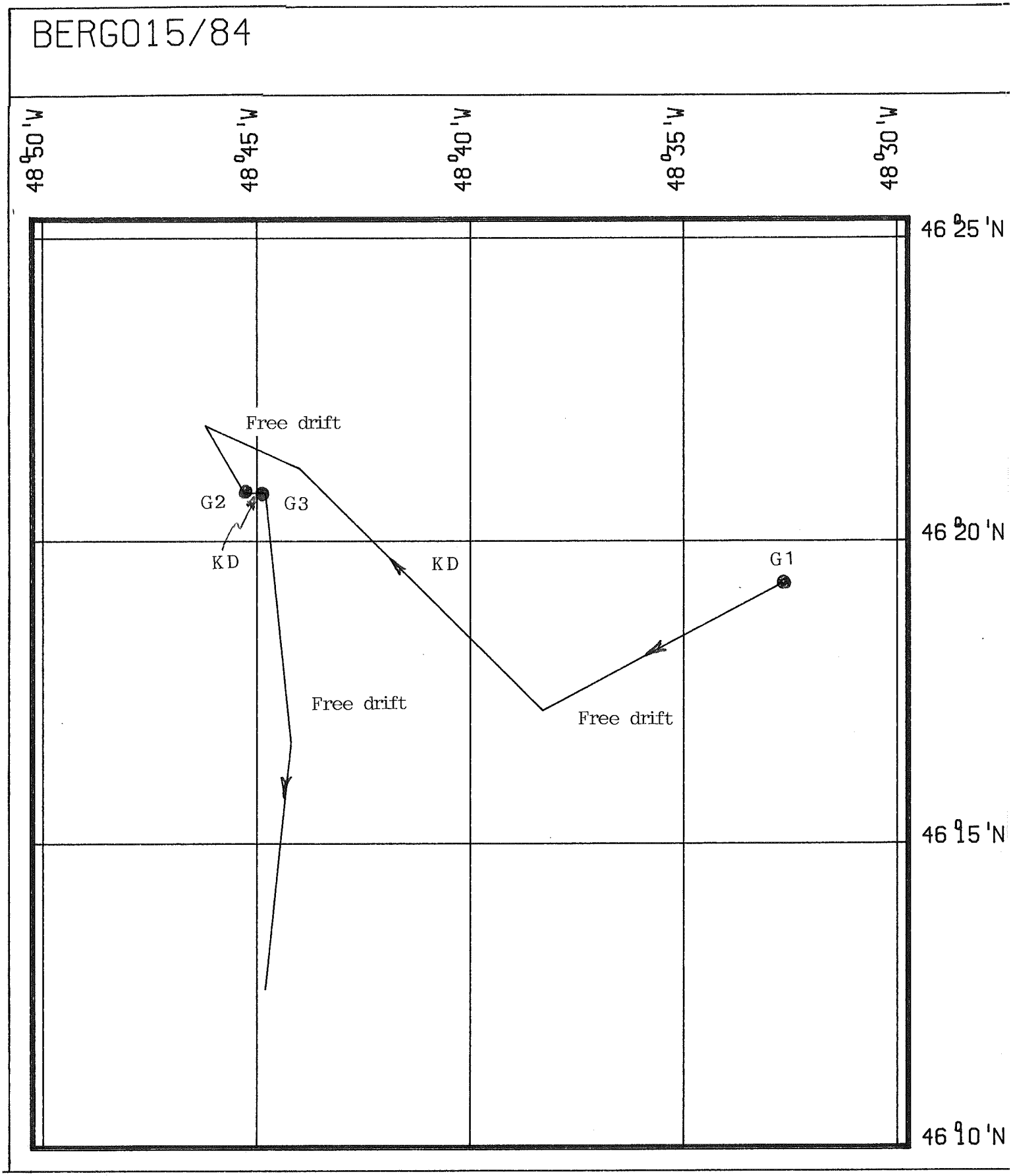


Figure A-27 Drift track of iceberg 015/1984

In summary, iceberg 015/1984

* was grounded in grounding position G1 at 46°-19.3'n & 48°-32.7'W for 5 days between April 21 and 26, 1984; the water depth was 90m.
* drifted in free drift 4nm due west into 85m water depth in a matter of 3 hours on April 26.
* dragged its keel from 85m water depth to 74m, a distance of 5nm towards 320° in a matter of 2.5 days.
* drifted in free drift for a day
* grounded on April 30 in 72m of water in grounding position G2 at 46°-20.8'N and 8°-45.3'W, and remained at G2 until May 7.
* dragged its keel about half a nautical mile due east on May 7.
* grounded at grounding location G3 on May 7 in 72m of water at 46°-20.8N and 48°-44.8'W and remained grounded for 2 days.
* drifted southward on May 9.

Note: Ranges and bearings shown in Table A12 are referenced to the drilling location Terra Nova K-08 at 46°-27.5'N and 48°-31.0'W.

RA13 Iceberg 028/1984

During April 23 and 24, Berg 028 drifted in free drift from the northeast, then basically southward into shallower water. The drift track is presented in Fig. A-28 and Table A13. The berg finally grounded in 68m of water depth at 46°-29.7'N and 48°-46.3'W at 0900 on April 25 (day 116). This grounded position is 10.8 nm at 255° from Terra Nova K-08. There may have been some scouring prior to grounding, which is inferred from reduced drift speeds during day 115 (Fig. A-29). The berg remained grounded until 1800 hours on April 26 when it moved towards the west-south-west. Scouring may have occurred, and it is possible that a second grounding occurred 11.8nm @ 254° during day 118. During free drift prior to grounding, the winds varied from light northerly to 42 knots. The winds were probably instrumental in forcing the berg to drift into shallower water in a southerly direction. On the 26th of April, high easterly winds to 42 knots probably dislodged the berg from the grounded location (11.8nm @ 254°) and forced it to drag its keel into somewhat shallower waters in a west-south-west direction.

In summary, iceberg 028/1984 grounded for two days in 68m of water at 10.8nm & 255° from Terra Nova K-08 (46°-24.7'N and 48°-46.3'W). Probable scouring is inferred for the area to the northeast and to the west-south-west of the grounded position.

84TN028.TRK

95 84TN028

114	0200	341.0	11.50	0.00	0.0	R
114	0400	329.0	10.60	1.24	228.8	R
114	0500	325.0	10.60	0.74	252.0	R
114	0600	321.0	10.60	0.74	217.7	R
114	0700	317.0	10.50	0.74	236.8	R
114	0800	312.0	10.60	0.93	230.7	R
115	0900	308.0	10.60	0.74	220.0	R
114	1000	309.0	10.40	0.27	86.0	R
114	1100	299.0	10.80	1.89	226.2	R
114	1200	296.0	10.70	0.57	197.4	R
114	1300	295.0	10.70	0.19	205.5	R
114	1400	293.0	10.70	0.37	204.0	R
114	1500	292.0	10.50	0.27	155.3	R
114	1700	291.0	10.60	0.10	230.0	R
114	1800	290.0	10.20	0.44	134.9	R
114	1900	289.0	10.40	0.27	247.5	R
114	2000	288.0	10.40	0.18	198.8	R
114	2100	286.0	10.20	0.41	167.9	R
114	2200	286.0	10.10	0.10	100.0	R
114	2300	285.0	9.90	0.27	146.6	R
115	0000	283.0	10.00	0.36	210.1	R
115	0100	281.0	9.90	0.36	175.9	R
115	0200	279.0	9.70	0.40	159.7	R
115	0300	279.0	9.70	0.00	0.0	R
115	0400	278.0	9.60	0.20	197.8	R
115	0500	277.0	9.60	0.17	169.5	R
115	0600	277.0	9.60	0.00	0.0	R
115	0700	277.0	9.60	0.00	0.0	R
115	0900	275.0	9.70	0.18	20	R
115	0900	272.0	9.70	0.00	0.0	R
115	1000	271.0	9.70	0.17	18	R
115	1100	270.0	9.70	0.17	180.5	R
115	1200	269.0	9.70	0.17	179.3	R
115	1300	269.0	9.70	0.00	0.0	R
115	1400	268.0	9.70	0.17	178.9	R
115	1500	267.0	9.70	0.17	177.5	R
115	1600	266.0	9.80	0.20	206.9	R
115	1700	265.0	9.80	0.17	175.5	R
115	1800	264.0	9.90	0.20	204.7	R
115	2000	263.0	10.00	0.10	203.9	R
115	2130	263.0	9.90	0.07	83.3	R
115	2300	263.0	9.90	0.00	0.0	R
116	0000	263.0	9.90	0.00	0.0	R
116	0100	262.0	10.00	0.20	202.4	R
116	0200	261.0	10.00	0.17	171.8	R
116	0300	260.0	10.00	0.17	170.5	R
116	0400	260.0	10.20	0.20	260.3	R
116	0500	258.0	10.50	0.47	207.7	R
116	0600	257.0	10.50	0.18	16	R
116	0700	256.0	10.50	0.18	166.9	R
116	0800	256.0	10.60	0.10	256	R
116	0900	255.0	10.60	0.19	165	R
116	1000	255.0	10.60	0.00	0.0	R
116	1100	255.0	10.60	0.00	0.0	R
116	1200	255.0	10.70	0.10	255.0	R
116	1300	255.0	10.70	0.00	0.0	R
116	1400	255.0	10.70	0.00	0.0	R
116	1500	255.0	10.80	0.10	98.9	R
116	1600	255.0	10.80	0.00	0.0	R
116	1700	255.0	10.80	0.00	0.0	R
116	1800	255.0	10.80	0.00	0.0	R
116	1900	255.0	10.80	0.00	0.0	R
116	2000	255.0	10.80	0.00	0.0	R
116	2100	255.0	10.80	0.00	0.0	R
116	2200	255.0	10.80	0.00	0.0	R
116	2300	255.0	10.80	0.00	0.0	R
117	0000	255.0	10.80	0.00	0.0	R
117	0100	255.0	10.80	0.00	0.0	R
117	0200	255.0	10.80	0.00	0.0	R
117	0300	255.0	10.80	0.00	0.0	R
117	0400	255.0	10.80	0.00	0.0	R
117	0500	255.0	10.80	0.00	0.0	R
117	0600	255.0	10.80	0.00	0.0	R
117	0700	255.0	10.80	0.00	0.0	R
117	0800	255.0	10.80	0.00	0.0	R
117	0900	255.0	10.80	0.00	0.0	R
117	1000	255.0	10.80	0.00	0.0	R
117	1100	255.0	10.80	0.00	0.0	R
117	1200	255.0	10.80	0.00	0.0	R
117	1300	255.0	10.80	0.00	0.0	R
117	1400	255.0	10.80	0.00	0.0	R
117	1500	255.0	10.80	0.00	0.0	R
117	1600	255.0	10.80	0.00	0.0	R
117	1700	255.0	10.80	0.00	0.0	R
117	1800	255.0	10.80	0.00	0.0	R
117	1900	254.0	11.50	0.73	239.0	R
117	2000	254.0	11.60	0.10	254.0	R
117	2120	253.0	11.70	0.17	189.7	R
117	2200	253.0	11.70	0.00	0.0	R
117	2300	254.0	11.80	0.33	317.5	R
118	0000	254.0	11.80	0.00	0.0	R
118	0100	254.0	11.80	0.00	0.0	R
118	0200	254.0	11.90	0.00	0.0	R
118	0300	254.0	11.90	0.00	0.0	R
118	1900	255.0	10.80	0.00	0.0	R
114	2000	255.0	10.80	0.00	0.0	R
114	2100	255.0	10.80	0.00	0.0	R
114	2200	255.0	10.80	0.00	0.0	R
114	2300	255.0	10.80	0.00	0.0	R
117	0000	255.0	10.80	0.00	0.0	R
117	0100	255.0	10.80	0.00	0.0	R
117	0200	255.0	10.80	0.00	0.0	R
117	0300	255.0	10.80	0.00	0.0	R
117	0400	255.0	10.80	0.00	0.0	R
117	0500	255.0	10.80	0.00	0.0	R
117	0600	255.0	10.80	0.00	0.0	R
117	0700	255.0	10.80	0.00	0.0	R
117	0800	255.0	10.80	0.00	0.0	R
117	0900	255.0	10.80	0.00	0.0	R
117	1000	255.0	10.80	0.00	0.0	R
117	1100	255.0	10.80	0.00	0.0	R
117	1200	255.0	10.80	0.00	0.0	R
117	1300	255.0	10.80	0.00	0.0	R
117	1400	255.0	10.80	0.00	0.0	R
117	1500	255.0	10.80	0.00	0.0	R
117	1600	255.0	10.80	0.00	0.0	R
117	1700	255.0	10.80	0.00	0.0	R
117	1800	255.0	10.80	0.00	0.0	R
117	1900	254.0	11.50	0.73	239.0	R
117	2000	254.0	11.60	0.10	254.0	R
117	2120	253.0	11.70	0.17	189.7	R
117	2200	253.0	11.70	0.00	0.0	R
117	2300	254.0	11.80	0.33	317.5	R
118	0000	254.0	11.80	0.00	0.0	R
118	0100	254.0	11.80	0.00	0.0	R
118	0200	254.0	11.90	0.00	0.0	R
118	0300	254.0	11.90	0.00	0.0	R

Table A 13

Individual drift track listing for iceberg 028/1984

ICEBERG TRACK – 84TN028

SITE: TERRA NOVA K–08 VESSEL: SEDCO 710

PERIOD: APR 23 0200Z – APR 27 0300Z

NUMBER OF HOURS MONITORED : 97.0

C.P.A. (n.mi.) :9.6

MEAN DIRECTION FROM DEG. TRUE : 104.4

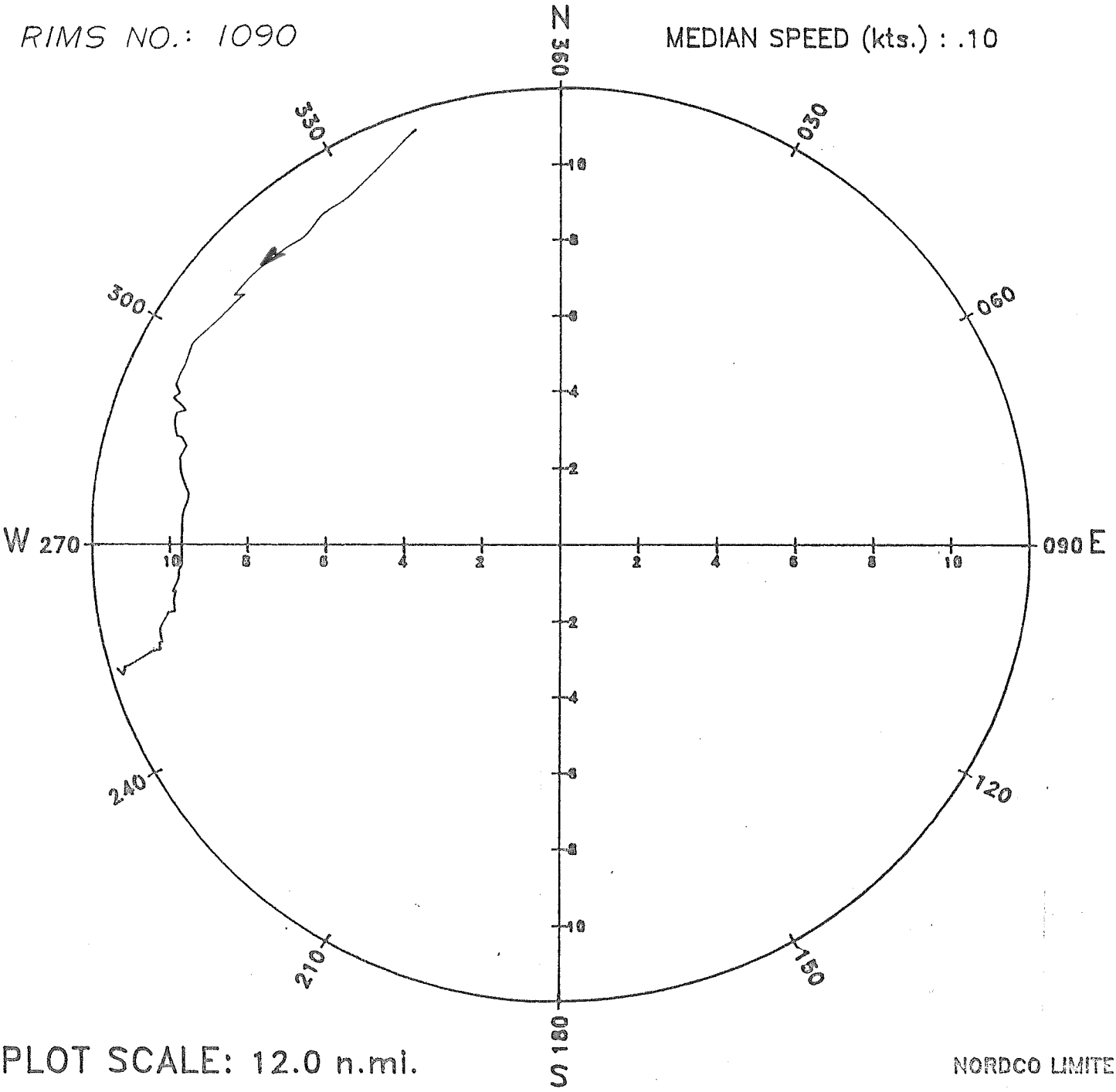
RIMS NO.: 1090

MINIMUM SPEED (kts.) : .00

MAXIMUM SPEED (kts.) : 1.89

MEAN SPEED (kts.) : .18

MEDIAN SPEED (kts.) : .10



PLOT SCALE: 12.0 n.mi.

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Figure A–28 Iceberg track 84TN028

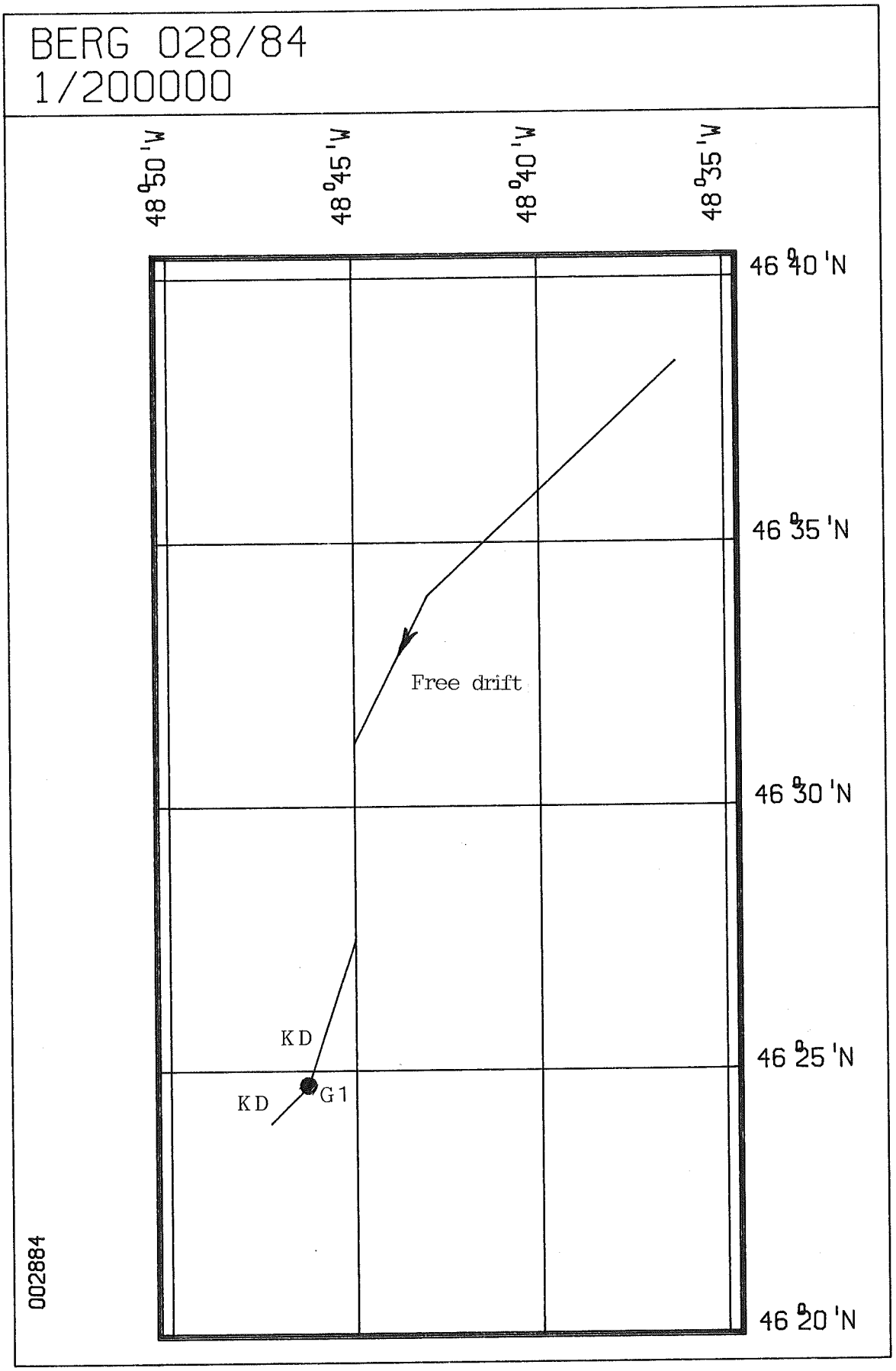


Figure A-29 Drift track of iceberg 028/1984

RA14 Iceberg 036/1984

The drift track of this iceberg is presented in Fig. A-30. No range and bearing data are available, which is very unfortunate because there is no doubt that this berg grounded, perhaps several times. Positions were taken from Fig. A-30 to produce the drift plot shown in Fig. A-31. The low mean drift speed (0.11 knots) indicates a prolonged period of grounding somewhere along the drift track; probably at 46°-27.8'N and 48°-43.0'W which is 8.6nm & 272° from the drilling location Terra Nova K-08. This grounded location is in 75m of water, which is the shallowest depth along the drift track. Therefore it is considered safe to infer grounding in this location and a possible lead-in scour in the north-north-east direction. About 11nm of drift track preceeds the inferred grounding which may have occurred about April 23 or 24. Wind records indicate that north-north-west winds to 45 knots occurred on April 23; on April 24, northwest winds to 42 knots gradually decreased to light northerly during the morning of April 25. The winds on April 23 would have been conducive to drift towards the south-south-west as shown in Fig. A-30. The berg probably remained grounded until May 6, when 30 knot winds from the southwest occurred. The berg may have moved off location on May 6 and drifted towards the east-north-east. This implies that 26nm of drift would have occurred between the early morning hours of May 6 and 1700 hours on May 8 (a period of 37 hours). West-north-west winds to 31 knots on May 8 no doubt contributed to the drift. The implied drift rate is 26 nm/37 hours = 0.7 knots, which is not unreasonable at all considering the wind conditions.

In summary, iceberg 036/1984 is inferred to have grounded at 46°-27.8'N and 48°-43.0'W for a maximum period of 11 days (April 24 to May 6, 1984). Keel dragging is assumed to have occurred from the north-north-east along the drift track leading into the grounded position.

Nancy this is new please add to existing text

BERG 036 (UPDATED)

Owing to confusion by Petro Canada and Nordco regarding numbering of icebergs, the drift track of berg 036 was not matched initially to its table of positions which was labelled berg 031. It is now evident that the two match up and it is possible to specify the actual grounding. Berg 036 was initially observed on day 114, 1984 at 1730 hours at 327° and 12,6 n.m. removed from Terra Nova K08. (Table A-13A) It remained in this position for 9½ hours which may constitute a possible grounding in about 85 m. of water. Between 0500 day 115 and 1400 day 116, the berg drifted a distance of 10,4 n.m. to the S.S.E. into shallower water to ground at grounding position G1 in 75 m. water depth. The drift could have been either free drift or keel dragging or a combination. The drift speeds presented in Table A13-A indicate a low (0.07 knot) drift speed for the period 0500-0800 on day 115 which suggests keel dragging. The maximum drift speed was 0.98 knots but as observed in the drift of iceberg 001/1989, it is entirely possible for an iceberg to drag its keel at high speeds. There fore, it is virtually impossible to say whether or not keel dragging took place. However, 45 knots wind from the N.N.W. during the drift period would probably have exerted sufficent driving forces to overcome keel drag including grounding along part of the drift track. By 0700 hours on day 116, the berg was stationary and remained in this grounded position (G1) until 1400 hours on day 128, a period of 12 days. By 1500 hours the berg had obviously drifted free into deeper water towards the north east as shown in Fig.A-30. Drift speeds to 1.54 knots were noted.

In summary a single grounding (G1) is inferred in a water depth of 78 m. in position 46° 27.8'N and 48°-43.0°W for a period of 12 days. It is possible that grounding occurred at the start of the drift track about 46° 38'N and 48°-41'W. Scouring may have occurred between two positions.

ICEBERG TRACK – 84TN036

SITE: TERRA NOVA K-08 VESSEL: SEDCO 710

PERIOD: APR 23 1300Z – MAY 8 1700Z

NUMBER OF HOURS MONITORED : 364.0

C.P.A. (n.mi.) :4.2

MEAN DIRECTION FROM DEG. TRUE : 29.2

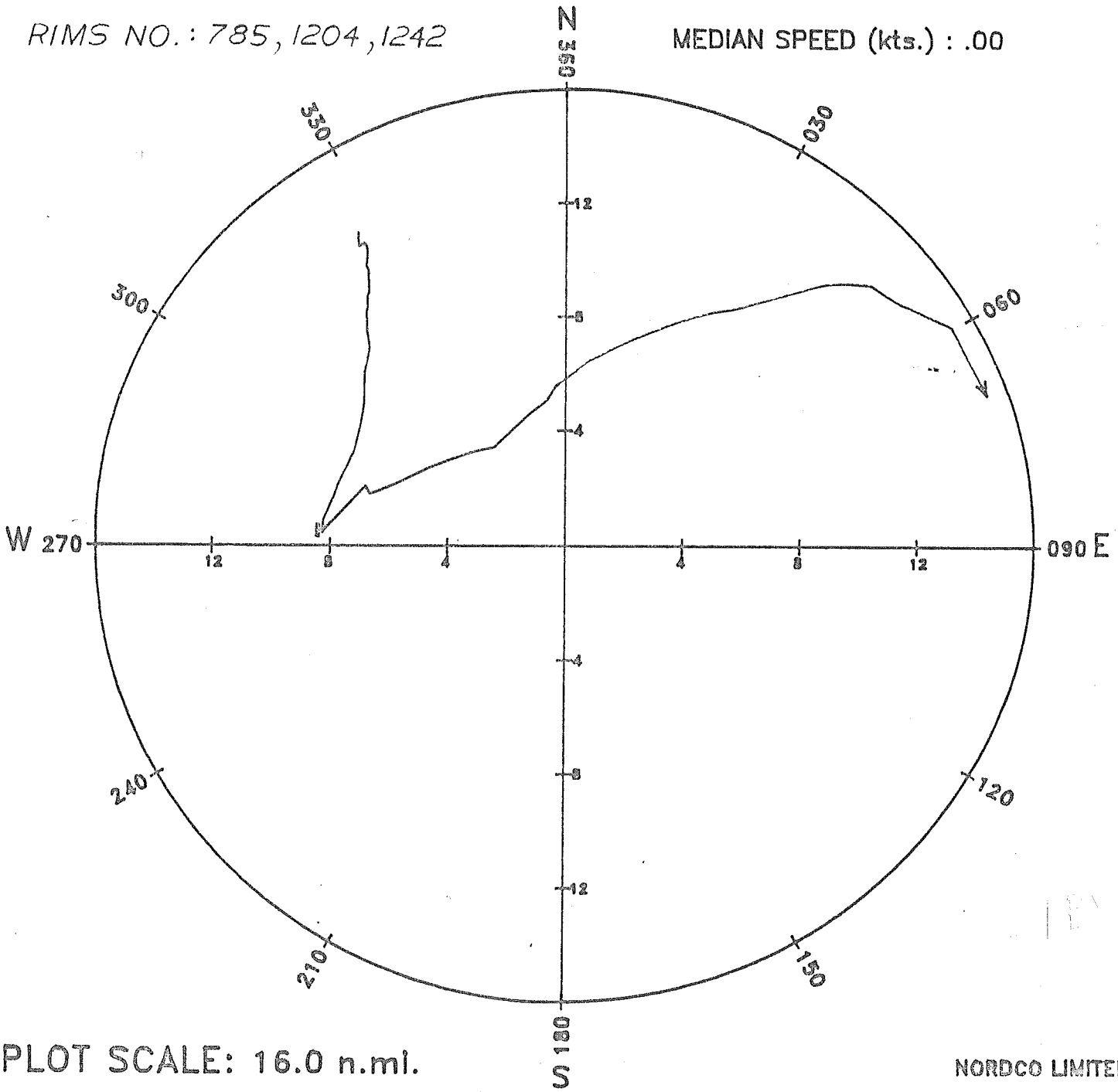
RIMS NO.: 785, 1204, 1242

MINIMUM SPEED (kts.) : .00

MAXIMUM SPEED (kts.) : 2.66

MEAN SPEED (kts.) : .11

MEDIAN SPEED (kts.) : .00



PLOT SCALE: 16.0 n.mi.

NORDCO LIMITED

Figure A-30 Iceberg track 84TN036

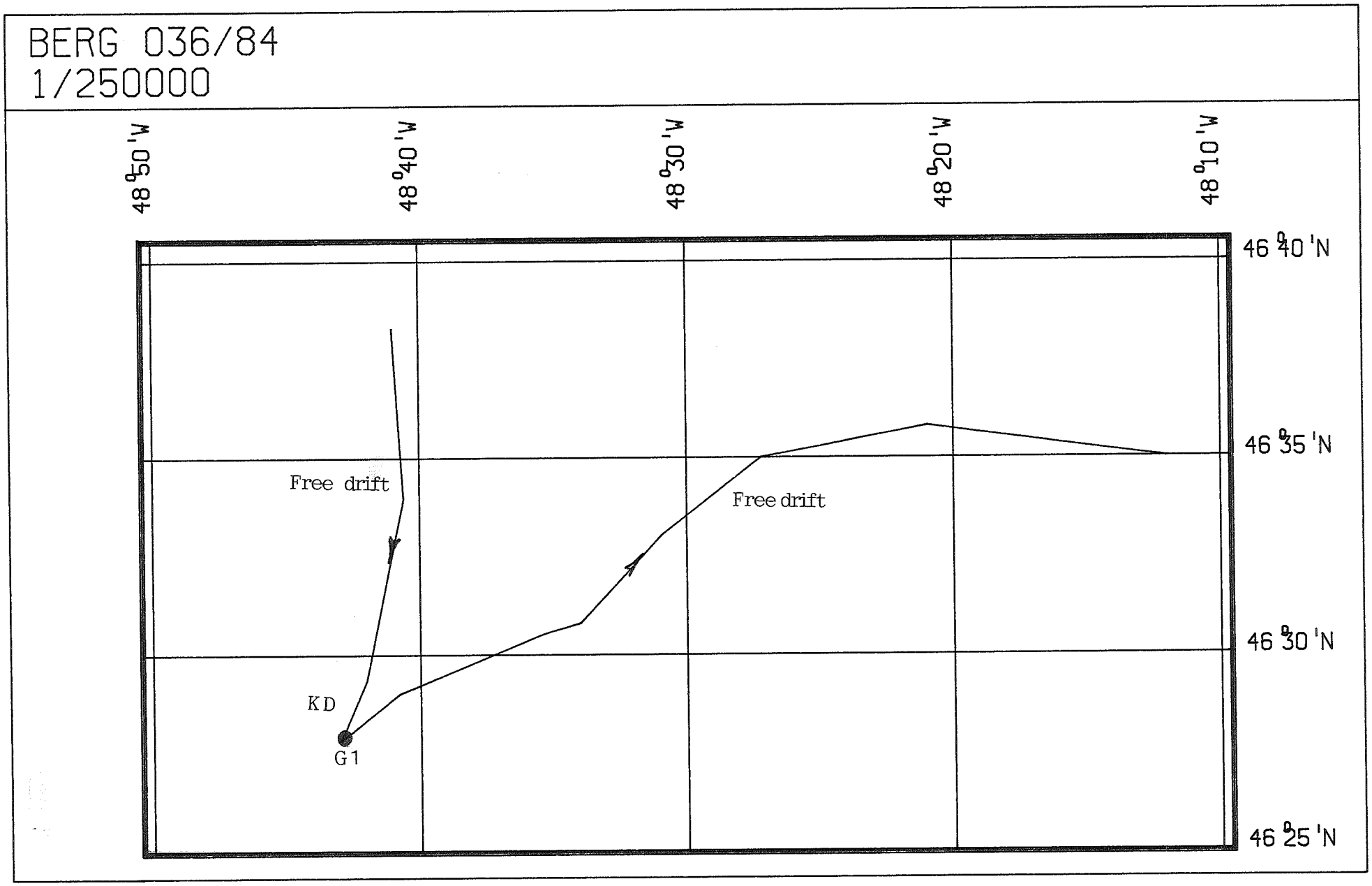


Figure A-31 Drift track of iceberg 036/1984

84TN031.TRK
353 84TN031

114	1300	327.0	13.00	0.00	0.0	R
114	1400	326.0	12.60	0.46	175.7	R
114	1600	327.0	12.60	0.11	56.5	R
114	1730	327.0	12.60	0.00	0.0	R
114	1830	327.0	12.60	0.00	0.0	R
114	1900	327.0	12.60	0.00	0.0	R
114	2000	327.0	12.60	0.00	0.0	R
114	2100	327.0	12.60	0.00	0.0	R
114	2200	327.0	12.60	0.00	0.0	R
114	2200	327.0	12.60	0.00	0.0	R
114	2300	327.0	12.60	0.00	0.0	R
115	0000	327.0	12.60	0.00	0.0	R
115	0100	327.0	12.60	0.00	0.0	R
115	0200	327.0	12.60	0.00	0.0	R
115	0300	327.0	12.60	0.00	0.0	R
115	0400	327.0	12.60	0.00	0.0	R
115	0500	327.0	12.60	0.00	0.0	R
115	0800	327.0	12.40	0.07	147.0	R
115	0900	326.0	12.10	0.37	182.0	R
115	1000	325.0	11.90	0.29	191.8	R
115	1100	325.0	11.70	0.20	145.0	R
115	1200	324.0	11.40	0.36	178.4	R
115	1300	323.0	11.10	0.36	176.7	R
115	1400	322.0	11.00	0.22	205.1	R
115	1500	321.0	10.70	0.35	173.8	R
115	1600	320.0	10.60	0.21	202.2	R
115	1700	319.0	10.30	0.35	170.8	R
115	1800	318.0	10.10	0.27	180.2	R
115	2000	316.0	9.60	0.30	171.5	R
115	2130	311.0	9.10	0.64	192.0	R
115	2300	305.0	8.40	0.77	180.6	R
116	0000	300.0	8.10	0.78	189.9	R
116	0100	294.0	7.90	0.86	193.6	R
116	0200	287.0	8.00	0.98	206.4	R
116	0300	281.0	8.10	0.85	200.8	R
116	0400	276.0	8.30	0.74	204.1	R
116	0500	273.0	8.30	0.43	184.5	R
116	0600	274.0	8.40	0.18	329.0	R
116	0700	274.0	8.40	0.00	0.0	R
116	0800	274.0	8.40	0.00	0.0	R
116	0900	274.0	8.40	0.00	0.0	R
116	1000	274.0	8.40	0.00	0.0	R
116	1100	274.0	8.40	0.00	0.0	R
116	1200	274.0	8.40	0.00	0.0	R
116	1300	274.0	8.40	0.00	0.0	R
116	1400	273.0	8.40	0.15	183.5	R
116	1500	273.0	8.40	0.00	0.0	R
116	1600	273.0	8.40	0.00	0.0	R
116	1700	273.0	8.40	0.00	0.0	R
116	1800	273.0	8.40	0.00	0.0	R
116	1900	273.0	8.40	0.00	0.0	R
116	2000	273.0	8.40	0.00	0.0	R
116	2100	273.0	8.40	0.00	0.0	R
116	2200	273.0	8.40	0.00	0.0	R
116	2300	273.0	8.40	0.00	0.0	R
117	0000	273.0	8.40	0.00	0.0	R
117	0100	273.0	8.40	0.00	0.0	R
117	0200	273.0	8.40	0.00	0.0	R
117	0300	273.0	8.40	0.00	0.0	R
117	0400	273.0	8.40	0.00	0.0	R
117	0500	273.0	8.40	0.00	0.0	R
117	0600	273.0	8.40	0.00	0.0	R

Note This Is Actually #032 Not 031

[illegible]

A15-A

Drift

TABLE A13-A INDIVIDUAL DRIFT TRACK LISTING FOR [illegible]

117	0800	273.0	8.40	0.00	0.0	R
117	0900	273.0	8.40	0.00	0.0	R
117	1000	273.0	8.40	0.00	0.0	R
117	1100	273.0	8.40	0.00	0.0	R
117	1200	273.0	8.40	0.00	0.0	R
117	1300	273.0	8.40	0.00	0.0	R
117	1400	273.0	8.40	0.00	0.0	R
117	1500	273.0	8.40	0.00	0.0	R
117	1600	273.0	8.40	0.00	0.0	R
117	1700	273.0	8.40	0.00	0.0	R
117	1800	273.0	8.40	0.00	0.0	R
117	1900	273.0	8.40	0.00	0.0	R
117	2000	274.0	8.50	0.18	329.4	R
117	2100	273.0	8.50	0.15	183.5	R
117	2200	273.0	8.40	0.10	93.0	R
117	2300	273.0	8.50	0.10	273.0	R
118	0000	273.0	8.40	0.10	93.0	R
118	0100	273.0	8.40	0.00	0.0	R
118	0200	273.0	8.40	0.00	0.0	R
118	0300	273.0	8.50	0.10	273.0	R
118	0400	274.0	8.40	0.18	37.6	R
118	0500	274.0	8.40	0.00	0.0	R
118	0600	274.0	8.40	0.00	0.0	R
118	0700	274.0	8.40	0.00	0.0	R
118	0800	274.0	8.40	0.00	0.0	R
118	0900	274.0	8.40	0.00	0.0	R
118	1000	274.0	8.40	0.00	0.0	R
118	1100	274.0	8.40	0.00	0.0	R
118	1200	274.0	8.40	0.00	0.0	R
118	1300	274.0	8.40	0.00	0.0	R
118	1400	274.0	8.40	0.00	0.0	R
118	1500	274.0	8.40	0.00	0.0	R
118	1600	274.0	8.40	0.00	0.0	R
118	1700	273.0	8.50	0.18	217.6	R
118	1800	273.0	8.50	0.00	0.0	R
118	1900	275.0	8.50	0.30	4.0	R
118	2000	275.0	8.50	0.00	0.0	R
118	2145	274.0	8.40	0.10	150.4	R
118	2300	275.0	8.40	0.12	4.5	R
119	0000	275.0	8.40	0.00	0.0	R
119	0100	275.0	8.40	0.00	0.0	R
119	0200	275.0	8.40	0.00	0.0	R
119	0300	275.0	8.40	0.00	0.0	R
119	0400	275.0	8.40	0.00	0.0	R
119	0500	275.0	8.40	0.00	0.0	R
119	0600	275.0	8.40	0.00	0.0	R
119	0900	275.0	8.40	0.00	0.0	R
119	1000	275.0	8.40	0.00	0.0	R
119	1100	275.0	8.40	0.00	0.0	R
119	1200	275.0	8.40	0.00	0.0	R
119	1400	275.0	8.40	0.00	0.0	R
119	1500	275.0	8.40	0.00	0.0	R
119	1600	275.0	8.40	0.00	0.0	R
119	1700	275.0	8.40	0.00	0.0	R
119	1800	275.0	8.40	0.00	0.0	R
119	1900	275.0	8.40	0.00	0.0	R
119	2000	275.0	8.40	0.00	0.0	R
119	2100	275.0	8.40	0.00	0.0	R
119	2200	275.0	8.40	0.00	0.0	R
119	2300	275.0	8.40	0.00	0.0	R
120	0000	275.0	8.40	0.00	0.0	R
120	0100	273.0	8.50	0.31	202.7	R
120	0200	273.0	8.50	0.00	0.0	R
120	0300	273.0	8.50	0.00	0.0	R
120	0400	273.0	8.50	0.00	0.0	R

120	0600	273.0	8.50	0.00	0.0	R
120	0700	273.0	8.50	0.00	0.0	R
120	0800	273.0	8.50	0.00	0.0	R
120	0900	273.0	8.50	0.00	0.0	R
120	1000	273.0	8.50	0.00	0.0	R
120	1100	273.0	8.50	0.00	0.0	R
120	1200	273.0	8.50	0.00	0.0	R
120	1300	273.0	8.50	0.00	0.0	R
120	1400	273.0	8.50	0.00	0.0	R
120	1500	273.0	8.50	0.00	0.0	R
120	1600	273.0	8.50	0.00	0.0	R
120	1700	273.0	8.50	0.00	0.0	R
120	1800	273.0	8.50	0.00	0.0	R
120	1900	273.0	8.50	0.00	0.0	R
120	2000	273.0	8.50	0.00	0.0	R
120	2100	273.0	8.50	0.00	0.0	R
120	2200	273.0	8.50	0.00	0.0	R
120	2300	273.0	8.50	0.00	0.0	R
121	0000	273.0	8.50	0.00	0.0	R
121	0100	273.0	8.50	0.00	0.0	R
121	0200	273.0	8.50	0.00	0.0	R
121	0300	273.0	8.50	0.00	0.0	R
121	0400	273.0	8.50	0.00	0.0	R
121	0500	273.0	8.50	0.00	0.0	R
121	0600	273.0	8.50	0.00	0.0	R
121	0700	273.0	8.50	0.00	0.0	R
121	0800	273.0	8.50	0.00	0.0	R
121	0900	273.0	8.50	0.00	0.0	R
121	1000	273.0	8.50	0.00	0.0	R
121	1100	273.0	8.50	0.00	0.0	R
121	1200	273.0	8.50	0.00	0.0	R
121	1300	273.0	8.50	0.00	0.0	R
121	1400	273.0	8.50	0.00	0.0	R
121	1500	273.0	8.50	0.00	0.0	R
121	1600	273.0	8.50	0.00	0.0	R
121	1700	273.0	8.50	0.00	0.0	R
121	1800	273.0	8.50	0.00	0.0	R
121	1900	273.0	8.50	0.00	0.0	R
121	2000	273.0	8.50	0.00	0.0	R
121	2100	273.0	8.50	0.00	0.0	R
121	2200	273.0	8.50	0.00	0.0	R
121	2300	273.0	8.50	0.00	0.0	R
122	0000	273.0	8.50	0.00	0.0	R
122	0100	273.0	8.50	0.00	0.0	R
122	0200	273.0	8.50	0.00	0.0	R
122	0300	273.0	8.50	0.00	0.0	R
122	0400	273.0	8.50	0.00	0.0	R
122	0500	273.0	8.50	0.00	0.0	R
122	0600	273.0	8.50	0.00	0.0	R
122	0700	273.0	8.50	0.00	0.0	R
122	0800	273.0	8.50	0.00	0.0	R
122	0900	273.0	8.50	0.00	0.0	R
122	1000	273.0	8.50	0.00	0.0	R
122	1100	273.0	8.50	0.00	0.0	R
122	1200	273.0	8.50	0.00	0.0	R
122	1300	273.0	8.50	0.00	0.0	R
122	1400	273.0	8.50	0.00	0.0	R
122	1500	273.0	8.50	0.00	0.0	R
122	1600	273.0	8.50	0.00	0.0	R
122	1700	273.0	8.50	0.00	0.0	R
122	1800	273.0	8.50	0.00	0.0	R
122	1900	273.0	8.50	0.00	0.0	R
122	2000	273.0	8.50	0.00	0.0	R
122	2100	273.0	8.50	0.00	0.0	R
122	2200	273.0	8.50	0.00	0.0	R

123	0000	273.0	8.50	0.00	0.0	R
123	0100	273.0	8.50	0.00	0.0	R
123	0200	273.0	8.50	0.00	0.0	R
123	0300	273.0	8.50	0.00	0.0	R
123	0400	273.0	8.50	0.00	0.0	R
123	0500	273.0	8.40	0.10	93.0	R
123	0600	273.0	8.50	0.10	273.0	R
123	0700	273.0	8.50	0.00	0.0	R
123	0800	273.0	8.40	0.10	93.0	R
123	0900	273.0	8.40	0.00	0.0	R
123	1000	273.0	8.40	0.00	0.0	R
123	1100	273.0	8.40	0.00	0.0	R
123	1200	273.0	8.40	0.00	0.0	R
123	1300	273.0	8.40	0.00	0.0	R
123	1400	273.0	8.40	0.00	0.0	R
123	1500	273.0	8.40	0.00	0.0	R
123	1600	273.0	8.50	0.10	273.0	R
123	1700	273.0	8.50	0.00	0.0	R
123	1700	273.0	8.50	0.00	0.0	R
123	1800	273.0	8.50	0.00	0.0	R
123	1900	273.0	8.50	0.00	0.0	R
123	2000	273.0	8.50	0.00	0.0	R
123	2100	273.0	8.50	0.00	0.0	R
123	2200	273.0	8.50	0.00	0.0	R
123	2300	273.0	8.50	0.00	0.0	R
124	0000	273.0	8.50	0.00	0.0	R
124	0100	273.0	8.50	0.00	0.0	R
124	0200	273.0	8.50	0.00	0.0	R
124	0300	273.0	8.50	0.00	0.0	R
124	0400	273.0	8.50	0.00	0.0	R
124	0500	273.0	8.50	0.00	0.0	R
124	0600	273.0	8.50	0.00	0.0	R
124	0700	273.0	8.50	0.00	0.0	R
124	0800	273.0	8.50	0.00	0.0	R
124	0900	273.0	8.50	0.00	0.0	R
124	1000	273.0	8.50	0.00	0.0	R
124	1100	273.0	8.50	0.00	0.0	R
124	1200	273.0	8.50	0.00	0.0	R
124	1300	273.0	8.50	0.00	0.0	R
124	1400	273.0	8.50	0.00	0.0	R
124	1500	273.0	8.50	0.00	0.0	R
124	1600	273.0	8.50	0.00	0.0	R
124	1700	273.0	8.50	0.00	0.0	R
124	1800	273.0	8.50	0.00	0.0	R
124	1900	273.0	8.50	0.00	0.0	R
124	2000	273.0	8.50	0.00	0.0	R
124	2100	273.0	8.50	0.00	0.0	R
124	2200	273.0	8.50	0.00	0.0	R
124	2300	273.0	8.50	0.00	0.0	R
125	0000	272.0	8.40	0.18	148.4	R
125	0100	272.0	8.40	0.00	0.0	R
125	0200	272.0	8.40	0.00	0.0	R
125	0300	272.0	8.40	0.00	0.0	R
125	0400	272.0	8.40	0.00	0.0	R
125	0500	272.0	8.40	0.00	0.0	R
125	0600	272.0	8.40	0.00	0.0	R
125	0700	272.0	8.40	0.00	0.0	R
125	0800	272.0	8.40	0.00	0.0	R
125	0900	272.0	8.40	0.00	0.0	R
125	1000	272.0	8.40	0.00	0.0	R
125	1100	272.0	8.40	0.00	0.0	R
125	1200	272.0	8.40	0.00	0.0	R
125	1300	272.0	8.40	0.00	0.0	R
125	1400	272.0	8.40	0.00	0.0	R
125	1500	272.0	8.40	0.00	0.0	R

125	1700	272.0	8.40	0.00	0.0	R
125	1800	272.0	8.40	0.00	0.0	R
125	1900	272.0	8.40	0.00	0.0	R
125	2000	272.0	8.40	0.00	0.0	R
125	2100	272.0	8.40	0.00	0.0	R
125	2200	272.0	8.50	0.10	272.0	R
125	2300	272.0	8.50	0.00	0.0	R
126	0000	272.0	8.50	0.00	0.0	R
126	0100	272.0	8.50	0.00	0.0	R
126	0200	273.0	8.40	0.18	36.6	R
126	0300	273.0	8.40	0.00	0.0	R
126	0400	272.0	8.40	0.15	182.5	R
126	0500	272.0	8.40	0.00	0.0	R
126	0600	272.0	8.40	0.00	0.0	R
126	0700	272.0	8.40	0.00	0.0	R
126	0800	272.0	8.40	0.00	0.0	R
126	0900	272.0	8.40	0.00	0.0	R
126	1000	272.0	8.40	0.00	0.0	R
126	1100	272.0	8.40	0.00	0.0	R
126	1200	272.0	8.40	0.00	0.0	R
126	1300	272.0	8.40	0.00	0.0	R
126	1400	272.0	8.40	0.00	0.0	R
126	1500	272.0	8.40	0.00	0.0	R
126	1600	272.0	8.40	0.00	0.0	R
126	1700	272.0	8.40	0.00	0.0	R
126	1800	272.0	8.50	0.10	272.0	R
126	1900	272.0	8.40	0.10	92.0	R
126	2000	272.0	8.40	0.00	0.0	R
126	2100	272.0	8.40	0.00	0.0	R
126	2200	273.0	8.40	0.15	2.5	R
126	2300	273.0	8.40	0.00	0.0	R
127	0000	273.0	8.40	0.00	0.0	R
127	0100	273.0	8.40	0.00	0.0	R
127	0200	273.0	8.40	0.00	0.0	R
127	0300	273.0	8.40	0.00	0.0	R
127	0400	273.0	8.40	0.00	0.0	R
127	0500	273.0	8.40	0.00	0.0	R
127	0600	273.0	8.40	0.00	0.0	R
127	0700	273.0	8.40	0.00	0.0	R
127	0800	273.0	8.40	0.00	0.0	R
127	0900	273.0	8.40	0.00	0.0	R
127	1000	273.0	8.40	0.00	0.0	R
127	1100	273.0	8.40	0.00	0.0	R
127	1200	273.0	8.40	0.00	0.0	R
127	1300	273.0	8.40	0.00	0.0	R
127	1600	273.0	8.40	0.00	0.0	R
127	1700	273.0	8.40	0.00	0.0	R
127	1800	273.0	8.40	0.00	0.0	R
127	1900	273.0	8.40	0.00	0.0	R
127	2100	273.0	8.40	0.00	0.0	R
127	2200	272.0	8.50	0.18	216.6	R
127	2300	272.0	8.50	0.00	0.0	R
128	0100	272.0	8.50	0.00	0.0	R
128	0200	272.0	8.50	0.00	0.0	R
128	0300	272.0	8.40	0.10	92.0	R
128	0400	273.0	8.40	0.15	2.5	R
128	0500	273.0	8.40	0.00	0.0	R
128	0600	273.0	8.40	0.00	0.0	R
128	0700	273.0	8.40	0.00	0.0	R
128	0800	273.0	8.40	0.00	0.0	R
128	0900	273.0	8.40	0.00	0.0	R
128	1000	273.0	8.40	0.00	0.0	R
128	1100	273.0	8.40	0.00	0.0	R
128	1200	273.0	8.40	0.00	0.0	R
128	1300	273.0	8.40	0.00	0.0	R

128	1500	280.0	7.60	1.02	42.9	R
128	1540	287.0	7.10	1.54	42.6	R
128	1600	285.0	6.90	0.95	156.7	R
128	1700	290.0	6.20	0.90	68.2	R
128	1800	300.0	5.40	1.29	63.2	R
128	1900	308.0	4.90	0.87	68.8	R
128	2000	317.0	4.50	0.84	70.9	R
128	2100	325.0	4.20	0.68	77.2	R
128	2200	336.0	4.40	0.85	46.9	R
128	2300	344.0	4.70	0.70	44.8	R
129	0000	353.0	5.10	0.87	51.1	R
129	0100	357.0	5.60	0.62	31.8	R
129	0200	2.0	6.00	0.64	51.2	R
129	0300	7.0	6.50	0.74	52.0	R
129	0500	17.0	7.50	0.79	62.8	R
129	0600	22.0	8.10	0.91	68.1	R
129	0700	26.0	8.70	0.84	68.4	R
129	0800	31.0	9.50	1.13	73.3	R
129	0900	35.0	10.10	0.91	81.8	R
129	1000	35.0	10.10	0.00	0.0	R
129	1200	44.0	12.70	1.57	74.1	R
129	1300	46.0	13.20	0.67	87.1	R
129	1400	49.0	13.80	0.93	97.2	R
129	1500	53.0	14.10	1.02	123.9	R
129	1600	60.0	15.20	2.10	115.0	R
129	1700	70.0	15.30	2.66	152.9	R

RA15 Iceberg 037/1984

Iceberg 037 was grounded during the entire observation period 0830-18-04 to 1130-19-04 at 46°-40.8'N and 48°-36.3'W. There is no information on the drift prior to grounding and no information on the actual time of grounding. It is therefore not possible to make statements regarding environmental conditions which caused this berg to run aground. The berg had waterline dimensions of 75m in length and 50m in width. The sail height was 22m and the draft was about 92m based on the fact that the grounding occurred in 90m of water. The mass was calculated as 147000 tonnes and the berg was classified as a medium size, pinnacled iceberg. The relevant information is contained in Table A14.

In summary, Iceberg 037/1984 grounded for at least 1 full day at 46°-40.8'N and 48°-36.3'W in 90m of water.

LONG RANGE BERG LOG

BERG NO. I-037 RIG NAME West Venture RIG LOCATION H-C-96 DATE 18 Apr 84

DATE / TIME	LATITUDE	LONGITUDE	RANGE	BEARING	SOURCE	NOTES
18 / 0830	46 40.7	48 36.5	7.1	129	P 5	0830 - Berg Grounded
1155	46 40.8	48 36.3	7.2	128	"	1155 - " "
1405	46 40.8	48 36.3	7.2	128	"	" "
1745	46 40.8	48 36.3	"	"	"	" "
2045	46 40.8	48 36.3	"	"	"	" "
2345	46 40.8	48 36.3	"	"	"	" "
19 / 0220	46 40.8	48 36.3	"	"	"	" "
0535	46 40.8	48 36.3	"	"	"	" "
0845	46 40.8	48 36.3	"	"	"	" "
1130	46 40.8	48 36.3	"	"	"	" "

		est. or measured
HEIGHT	32	E
LENGTH	75	E
WIDTH	50	E
MASS	146,800 T	E
DRAFT	90	M

NOTES AND COMMENTS

Med PNC Berg

Table A 14 Individual drift track listing for iceberg 037/1984

RA16 Iceberg 050/1984

Iceberg 050 was grounded during the entire period of observation, 2248-30-04 to 1445-04-05, a total of at least 3.5 days (Table A15 and A16). Information regarding drift of this berg prior to grounding at 47°-06.5'N and 48°-40.0'W is not available. It is not known when the berg drifted away from the grounded position and it is not possible to decide what environmental factors caused the berg to run aground in the first place and to drift off eventually. Despite several towing attempts described in Table A16, the berg did not budge from the grounded position. The observed positions are shown in Table A15 along with dimensions of the berg. The water line length was 100m and the width was 70m. The sail height was 22m and the draft was measured as 115m. The berg was grounded in 106m of water and the mass was calculated as 0.3 million tonnes.

In summary: Iceberg 050/1984 was grounded for at least 3.5 days at 47°-06.5'N and 48°-40.0'W in 106m of water.

LONG RANGE BERG LOG

1254

BERG NO. T-050 RIG NAME West Venture RIG LOCATION H-C-96 DATE 30 Apr '8

DATE / TIME	LATITUDE	LONGITUDE	RANGE	BEARING	SOURCE	NOTES
30Apr/ 2248	4706.5	48 41.4	21.6	008	Boltentor	See tow log
02 May/ 0840	47 07.8	48 36.6	21.6	008	Boltentor	Berg still grounded
02 May/ 0845	47 06.5	48 40.0	21.6	008	P5	P5 Replaces Boltentor
02 May/ 2345	4706.5	48 40.0	21.6	008	P5	2248 position suspect
02 May/ 2345	4706.2	48 39.9	"	"	Boltentor	Boltentor Resumes monitoring # 1254
03 May/ 2038	4706.7	48 39.7	"	"	"	Berg still grounded two boat tow has failed, see tow log
04 May/ 1435	4706.2	48 39.7	"	"	Boltentor	

		est. or measured
HEIGHT	25	E
LENGTH	78	E
WIDTH	30	E
MASS	54,290	E
DRAFT	109	E

NOTES AND COMMENTS

Medium Pinnacle
1st tow by Boltentor on 30 April fails
2nd tow by Boltentor and Raventure on 03 May, fails. See tow log.
Berg is grounded beginning 2248 Z on 30 April and up until 1445Z / 04 May
Differences in lat and long are to NAU. system.

Table A15 Individual drift track listing for iceberg 050/1984

48°-55.3'W from April 4 to 5 and that keel dragging, scouring and grounding occurred within the defined 1nm square area from April 4 to 24, 1985, a period of at least 20 days. Lead-in scours probably exist in the NW and NE sector leading into the area. Lift-off from 47°-27.0'N & 48°-55.0'W must have been fairly quick, as free drift towards the northwest is indicated 8.5 hours after the last grounded position fix on the 24th of April. Berg 004 is also berg 016 observed from the Conquest K.09 drilling location. The drift track is of conquest berg 016 shown in Fig. A-18.

TOWING LOG

DRILLING VESSEL WEST VENTURE

LOCATION HIBERNIA C-96

TOWING VESSEL BOLTENTOR / RAVENSTURM

DATE 3 MAY '84

T-050

TOW Nº 12 BERG Nº 1254

TOWING SYSTEM USED TOW ROPE

TIME THAT VESSEL IS INSTRUCTED TO TOW 03 MAY 0130Z

TIME THAT TOW COMMENCED 3 MAY 0545Z

TIME THAT ICEBERG RELEASED

TIME OF COMPLETION OF REQUIRED MAINTENANCE AND STORAGE

ESTIMATED ICEBERG PARAMETERS:

Mass 274,120 tonnes

Waterline length E 100 metres

Height E 22 metres

Width E 70 metres

Draught M 115 metres

NOTES & COMMENTS ON TOWING OPERATION

BOLTENTOR & RAVENSTURM EACH TAKING AN END OF BOLTENTOR'S TOW ROPE AND ATTEMPTING TO TOW BERG 1254, WHICH IS GROUNDED, TOWARDS THE EAST.

Date (GMT)	Time (GMT)	Range (n. mi.)	Bearing (deg T)	Tow Heading (deg T)	Tow Force (tonne)	Power Input (%)	CHRONOLOGY
① 3 MAY	0545	21.3	009	090			① TOW COMMENCES - BOATS HAVE GOOD SOLID
							GRIP ON BERG.
②	0845	21.3	009	090	70		② NO MOVEMENT, BERG STILL GROUNDED
	1145	21.3	009	090			BERG STILL GROUNDED
							1235 - BOATS INSTRUCTED TO TOW 360°
③	1745	21.3	009	360	85		③ TOW ABORTED, BERG STILL AGROUND
							RAVENSTURM RETURNING TO W/U
							BOLTENTOR STANDING BY AND
							MONITORING BERG # 1254

E ESTIMATED

FENCO NEWFOUNDLAND LIMITED

Table A16 Towing log for iceberg 050/1984

RA17 Iceberg 1381/1984

Iceberg 1381 was grounded in 90m of water at 47°-29.8'N and 49°-35.4'W (Fig. A-32) when it was first observed at 1145-26-05. It is not known when grounding took place; therefore the conditions at the time of grounding are not known. The berg remained grounded until at least 1145-30-05. The minimum grounding period was 4 days. On the 31st of May, the berg was drifting away from the grounding at 0.2 knots towards 115°. The winds at the time were 30 knots from the west, which increased to about 40 knots on the 2nd of June. These high winds no doubt caused the easterly drift after lift-off from the grounded position. It is considered possible that scouring may have occurred while the berg drifted east from the grounded position on May 31. As indicated in Table A17, the berg displaced about 90000 tonnes and had a water-line length of 90m and a width of 23m. The sail height was 24m, and the draft must have been about 92m considering the fact that grounding occurred in 90m of water.

In summary: Iceberg 1381/1984 was grounded for at least 3.5 days at 47°-29.8'N and 49°-35.4'W in 90m of water.

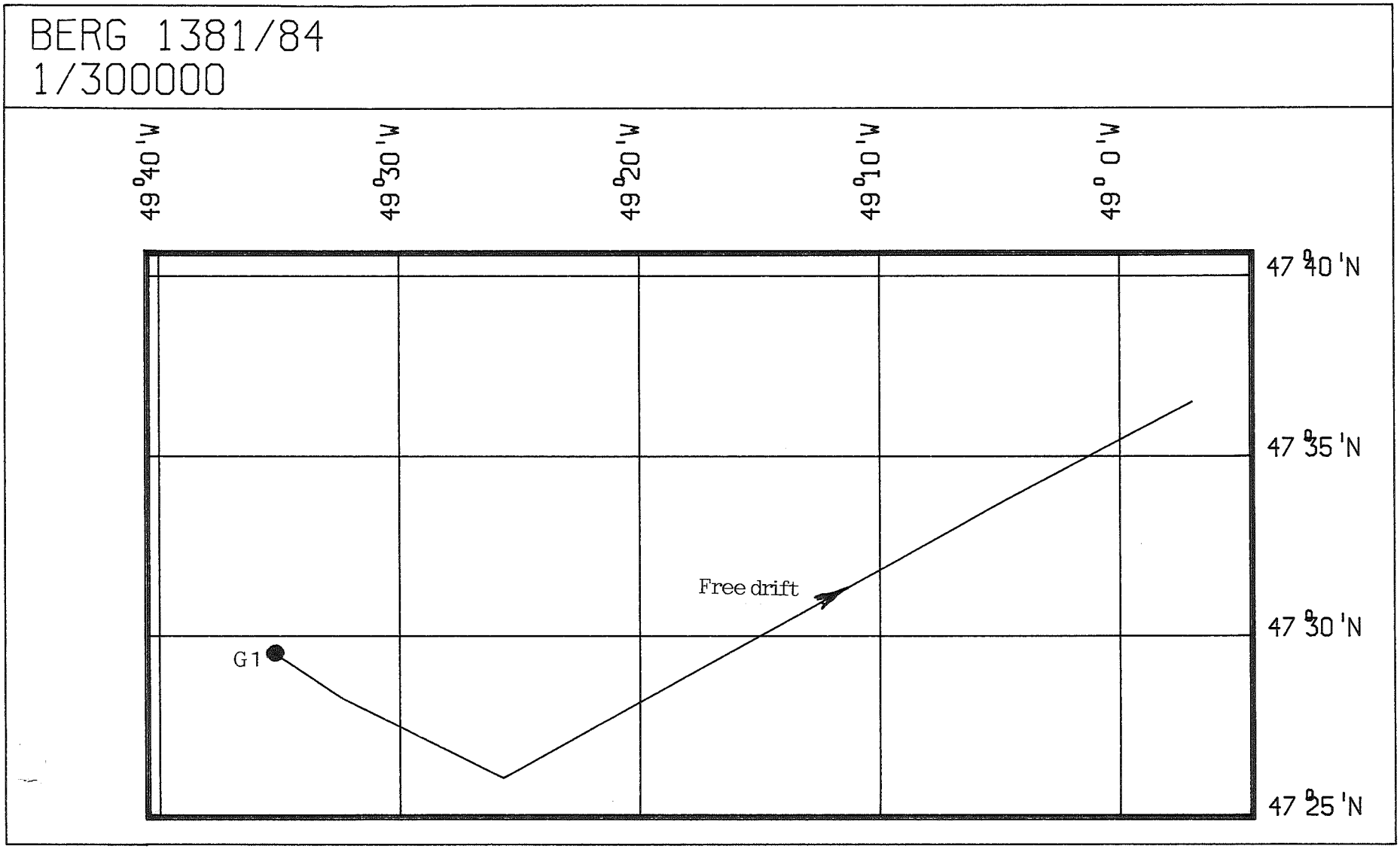


Figure A-32 Drift track of iceberg 1381/1984

LONG RANGE BERG LOG

BERG NO. 1381 RIG NAME WEST VENTURE RIG LOCATION HIBERNIA C-96 DATE 26 MAY 84

DATE / TIME	LATITUDE	LONGITUDE	RANGE	BEARING	SOURCE	NOTES
26 1145Z	47 29.5	49 35.2	56.0	321	SCHNEIDERTURM	
26 1445Z	47 29.5	49 35.2	56.5	321	"	BERG GROUNDED
27 2345Z	47 29.8	49 35.4	56.0	321	"	" "
28 0245Z	47 29.8	49 35.4	56.0	321	"	" "
29 0845Z	47 29.8	49 35.4	56.0	321	"	" "
29 1145Z	47 29.8	49 35.4	56.0	321	"	" "
30 1145Z	47 28.3	49 33.5	54.5	321	KAMMERTURM	" "
31 2130Z	47 26.04	49 25.7	49.0	325	"	drifting 115° 0.2kts
31 2345Z	47 28.4	49 26.6	51.0	326	"	
01 1445Z	47 31.0	49 13.0	49.5	336	"	DRIFT 070°/0.7 KTS
02 1445Z	47 33.7	49 05.0	50.5	343	"	
03 0700Z	47 36.5	48 57.0	51.7	350	SCHNEIDERTURM	DRIFT 065° 2.3 KT

		est. or measured
HEIGHT	24	E
LENGTH	90	E
WIDTH	23	E
MASS	88 400	E
DRAFT		

SCALE: 1 SQUARE = _____ METRES

NOTES AND COMMENTS

FENCO NEWFOUNDLAND LIMITED

Table A17 Individual drift track listing for iceberg 1381/1984

RA18 Iceberg 095/1983

Iceberg 095 was definitely grounded at 3 separate locations from February 21 to April 1, 1983 in water depths ranging from 93m to 86m. The berg probably had a draft exceeding the water depth by a few meters at each of the three grounding locations. Berg 095 was first observed on Feb. 20 at 47°-10.0'N and 49°-15.8W (Table A18). By the 21st, the berg had drifted about 8.5nm NNW owing to 40 knot winds from the SSE. Keel dragging may have occurred while drifting during the 20th. This inference is based on the fact that the berg drifted from a position with 80m of water to ground in a water depth of 93m at G1. By 0900 hours on February 21, berg 095 was aground at grounding position G1 at 47°-18.7'N and 49°-18.7'W (Fig. A-33). The water depth was 93m, and the berg remained aground until sometime on Feb. 23. Between Feb. 23 and 25, keel dragging is inferred by the short 4.5nm displacement towards the SSE and grounding position G2 at 47°-15.0'N and 49°-15.7W. The water depth was 90m at this grounded location. The berg remained grounded at G2 until March 23. It then drifted 2nm south against 40 knot southerly winds to ground in 86m of water at grounding location G3. (47°-13.0N and 49°-16.7'W). After being aground for 8 days, the berg drifted northwards during April 1, apparently in free drift. The winds during April 1 and the preceeding day were light (10 knots) from the south and southeast. The berg's last reported position, on April 6, places it in about 85m of water, about 13nm southwest of G1. The winds during early March were westerly at 20 knots, which would not be of direct assistance to the bergs drift into shallower water, but the up to 90 knot northerly winds on April 6 undoubtedly assisted the drift to the south-west into shallower water. It is possible that the berg grounded again but there is no information on the drift after 1800 on April 6. Berg 095 had a water-line length of 180m and a width of 100m. The sail height was noted as 15m and the draft must have been about 95m at G1 and reduced to about 92m at G2. It probably had a draft of 88m or so at grounding position G3.

The grounding sequence of the three inferred groundings of iceberg 095/183 can be summarized as follows:

* free drift or possible keel dragging towards the NNW during Feb. 20 and 21 from 80m to 93m water depth.
* grounding G1 for two days at 47°-18.7'N and 49°-18.7'W in 93m of water.
* keel dragging towards the SSE a distance of about 4nm from 93m to 90m water depth. Keel dragging proceeded during Feb. 23 and 24.
* grounding G2 from Feb. 25 to March 23 in 90m of water at 47°-15.0'N and 49°-16.7'W.
* keel dragging from G2 to G3 on March 24; a distance of 2nm due south from G2.
* grounding G3 from March 24 to April 1 at 47°-13.0N and 49°-16.7'W in 86m of water.
* drifted into deeper water towards the NNE during April 1. The berg must have lost mass and draft because it drifted into about 84m water depth by April 6.

Mitton (1988) interpreted surveyed scour tracks from berg 095 as:

* grounding in about 95m of water followed by
* 3.5km of scouring towards the south in an "s" configuration (this correspondences with the inferred keel dragging between G1 and G2).
* scouring towards the northwest to finally terminate in a pit about 90m in diameter (this correspondences to the inferred keel dragging between G2 and G3 and the grounding of the berg at G3).

BERG 095/83
1/300000

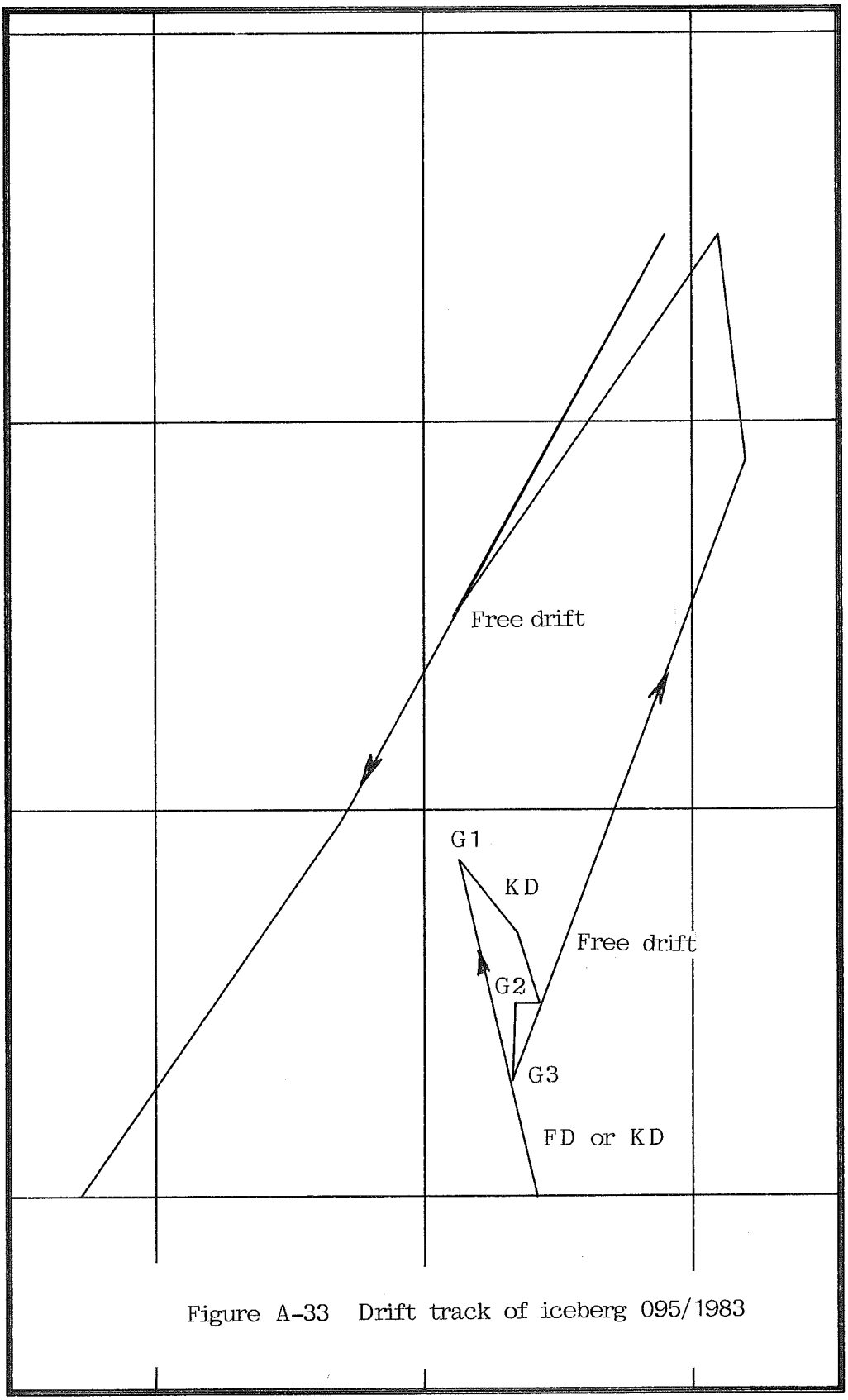


Figure A-33 Drift track of iceberg 095/1983

Table A18 Drift positions of iceberg 095/1983

Month	Day	Hour	Latitude (°-'N)	Longitude (°-'W)	
02	20	0900	47-10.0	49-15.8	Free drift possible keel dragging
"	21	"	47-18.7	49-18.7	Inferred grounding G1
"	22	"	"	"	
"	23	"	"	"	
"	24	"	47-16.8	49-16.5	Inferred keel dragging
"	25		47-15.0	49-15.7	Inferred grounding G2
03	23	"	"	49-16.6	Inferred keel dragging
03	24		47-13.0	49-16.7	Inferred grounding G3
04	01	"	"	"	
"	"	1800	47-29.0	49-08.0	Free drift
"	02	0900	47-34.8	49-09.0	
"	03	0900	47-25.0	49-18.9	
"	04	"	47-34.8	49-11.0	
"	05	"	47-19.8	49-23.0	
"	"	1800	47-10.0	49-32.8	

Water-line length - 180m
Water-line width - 100m
Sail height - 15 m
Maximum draft - 95m
Water depth at G1 - 93m
" " " G2 - 90m
" " " G3 - 86m

RA19 Iceberg 104/1983

Iceberg 104 was estimated to be 210m long and 162m wide at the water line and to have a sail height of 42m. The draft is estimated as 155m based on the grounded depth of 149m. The berg drifted into its grounded position in 149m of water at grounding position G1 (47°-35.8'N and 49°-08.0W) due to a high speed wind event during March 7 and 8 (Table A19). The winds were basically NNW varying from 70 knot peak winds on March 6 to about 30 knots on March 9. The drift previous to grounding must have been basically free drift towards 210° in water depths beyond 150m (Fig. A-34). The berg drifted about 16nm during the 9 hours previous to grounding at G1. The berg is estimated to have grounded by 0900 hours on March 11, and it evidently remained aground until at least April 10. There were probably two groundings; the first being at G1 and the second being 1nm due south. This, the second inferred grounding (G2) was at 47°-34.8'N and 49°-08.0'W where the water depth is 149m. Keel dragging is inferred for the area between G1 and G2. When searching for a scour (s) from this berg, it would probably be expedient to survey across 49°-08.0'W between 47°-35.8 and 47°-34.8'N and pick up the scour.

In summary: Iceberg 104/1983 is inferred to have:

* drifted in free drift NW of the grounded position prior to grounding
* grounded at G1 at 47°-35.8'N and 49°-08.0'W for 7 days
* dragged its keel about 1nm due south to grounding position G2
* grounded at G2 at 47°-34.8'N and 49°-08.0'W for 22 days.

Table A19 Drift positions of iceberg 104/1983

Month	Day	Hour	Latitude (°-'N)	Longitude (°-'W)	
03	02	0900	48-30.8	50-31.8	
"	03	"	48-45.0	50-59.0	
"	04	"	49-02.8	50-21.9	
"	05	"	49-18.8	51-05.8	Free drift
"	06	"	49-16.9	50-54.0	
"	07	"	49-12.0	50-34.8	
"	08	"	48-25.0	49-15.9	
"	08	1800	48-11.0	49-05.9	
"	09	0900	47-47.7	48-54.0	
"	10	"	47-30.0	49-08.0	
"	10	1800	47-29.0	49-04.9	
"	11	0900	47-35.8	49-08.0	Inferred grounding G1
"	18	"	"	"	Inferred keel dragging
"	19	"	47-34.8	49-08.0	Inferred grounding G2
04	10	0900	"	"	

Water-line length - 210m
Water-line width - 162m
Sail height - 42m
Draft - 155m
Water depth @ G1 & G2 - 149m

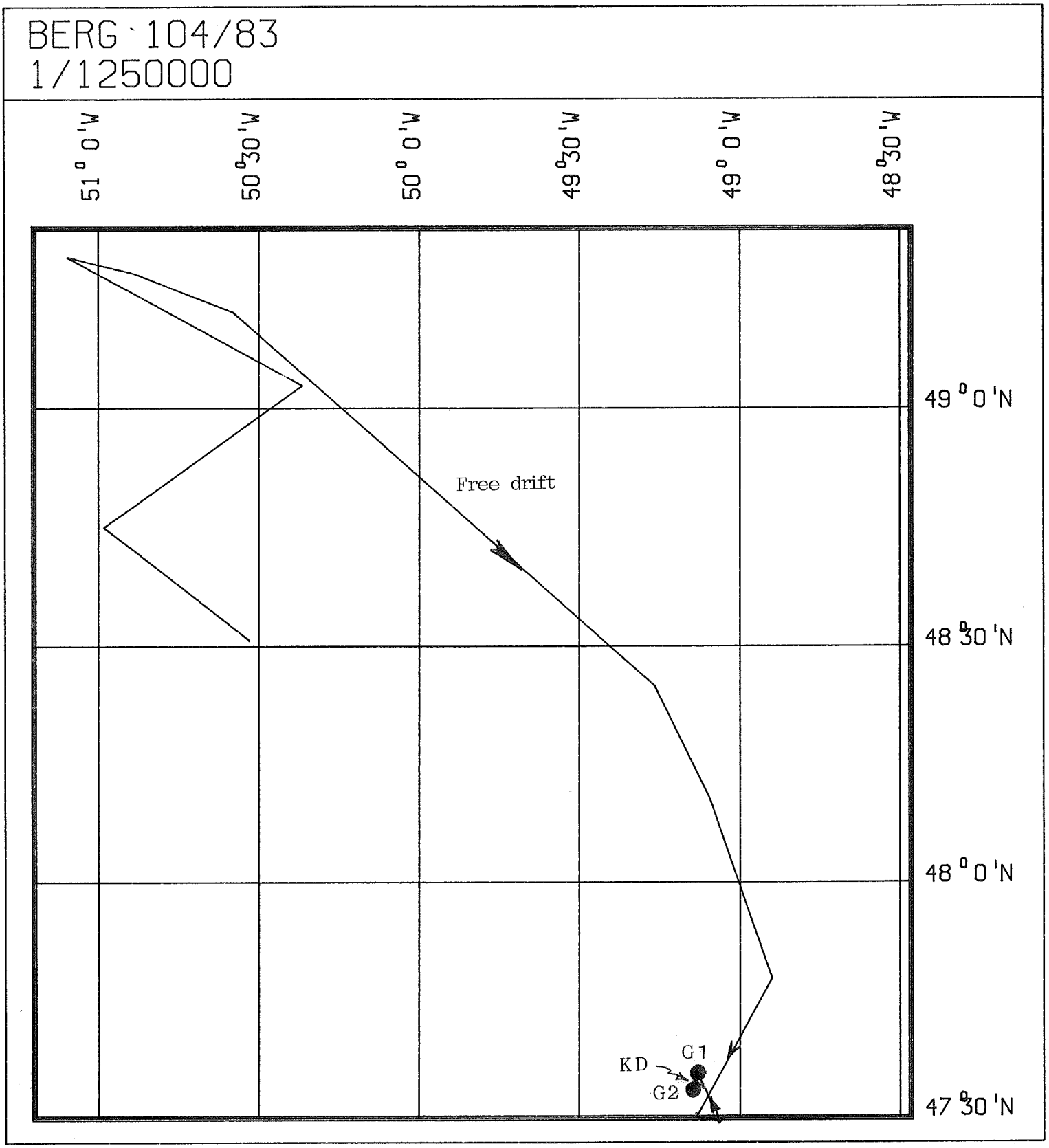


Figure A-34 Drift track of iceberg 104/1983

RA20 Iceberg 135/1983

Iceberg 135 was noted as a medium size berg which was first observed on April 5 (Table A20). The berg drifted in a westerly direction due to easterly winds to 40 knots. At 0900 on the 9th of April, the berg was located at 46°-58'N and 48°-01.7'W (Fig. A-35) and is inferred to have dragged its keel about 2nm from this position to its grounded position G1 at 47°-00.0N and 48°-02.6'W. The berg was grounded by 0900 hours on April 10 and it was still in the same grounded position at 0900 hours on April 11. The water depth is about 137m. The keel dragging towards the NNW on April 9 was probably induced by 40 knot winds. The curious thing about this berg's drift is that according to the noted positions in Table A20, the berg drifted freely in water depths of about 120m which is shallower than the depth at G1. The only explanation is that the berg must have increased its draft prior to grounding because:

1) it drifted freely in shallower water previous to grounding
2) dragging of the keel is inferred in 135m of water (2nm in 24 hours)
3) grounding is inferred in 137m of water by zero drift during 24 hours

The increase in draft is not unusual owing to rotation of bergs. The draft is taken as 140m at the time of the inferred grounding.

In summary, Iceberg 135/1983 is inferred to have:

* drifted freely in shallower water depths prior to grounding
* dragged its keel about 2nm from 46°-58.0'N and 48°-01.7'W to 47°-00.0'N and 48°-02.6'W
* grounded in 137m water depth for at least 1 day at 47°-00.0'N and 48°-02.6'W.

The last position was logged on April 11 and indicates the berg in its grounded position. No further positions are available.

Table A20 Drift positions of iceberg 135/1983

Month	Day	Hour	Latitude (°-'N)	Longitude (°-'W)	
04	05	1800	46-55.0	47-34.9	
"	06	0900	46-40.0	47-47.7	
"	07	1800	47-00.7	47-53.0	
"	08	0900	46-56.0	48-03.9	Free drift
"	"	1800	46-51.9	48-08.0	
"	09	0900	46-58.0	48-01.7	Inferred Keel dragging
'	10	0900	47-00,0	48-02.6	
"	11	0900	"	"	Inferred grounding G1

Berg size - Medium

Draft - 140m

Water depth @ G1 137m

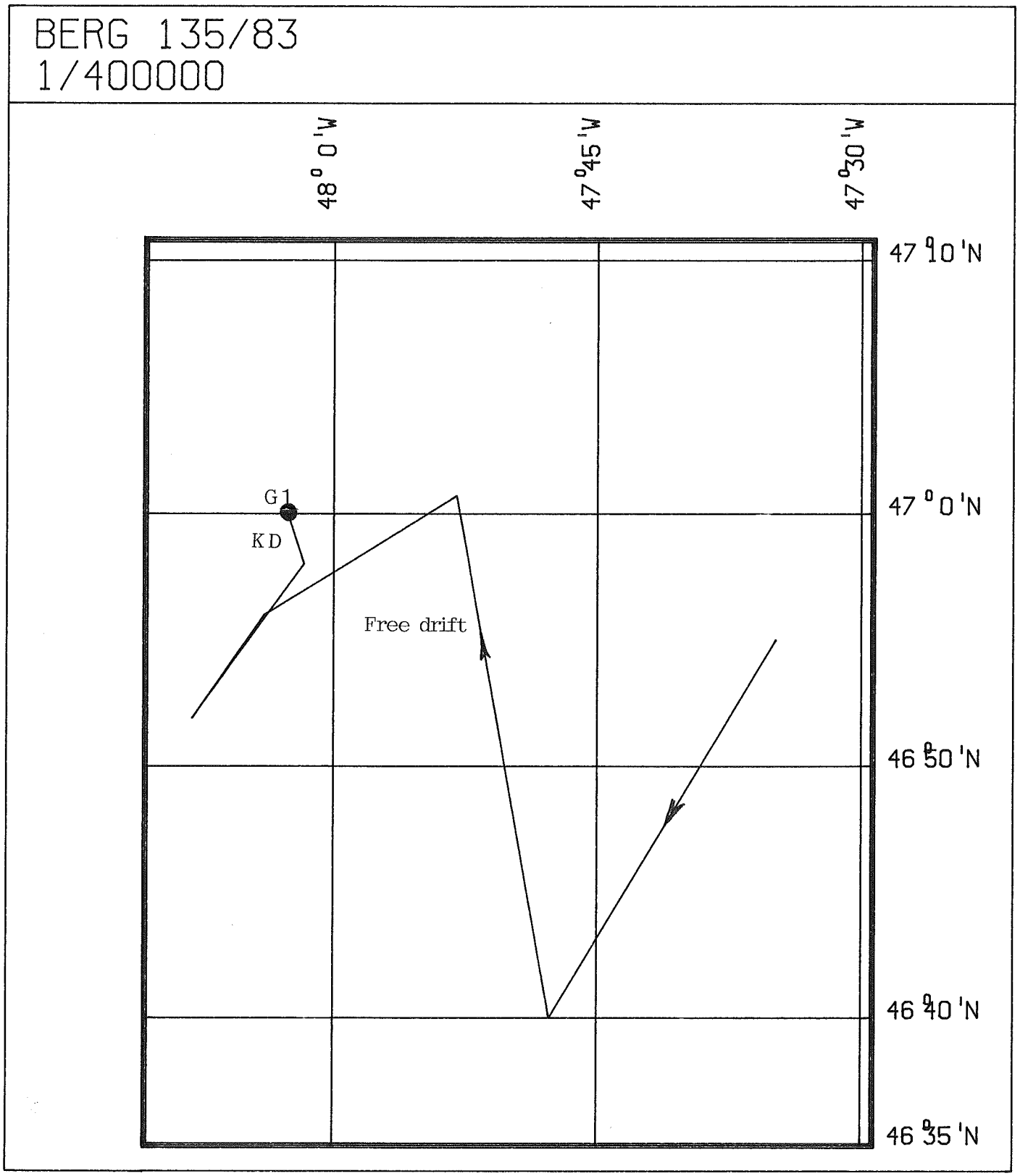


Figure A-35 Drift track of iceberg 135/1983

RA21 Iceberg 241/1983

This berg was noted to be a large iceberg. Only three positions were logged as shown in Table A21. The berg was grounded for at least two days at 46°-45.6'N and 48°-21.9'W in 104m of water. The drift prior to grounding is not known, nor is the duration of grounding. Likewise, the drift track after grounding ceased is not known. In searching for a scour from this grounding, it is recommended that searching should start at the grounded position and advance basically to the northeast.

In summary: Iceberg 241/1983 grounded only once, at 46°-45.6'N and 48°-21.9'W. The grounding lasted at least two days, April 19 to 21 and occurred in 104m of water depth.

Table A21 Drift positions of iceberg 241/1983

Month	Day	Hour	Latitude (°-'N)	Longitide (°-'W)	
04	19	0900	46-45.6	48-21.9	Inferred grounding
04	20	"	"	"	
"	21	"	"	"	

Berg size - noted as "large"

Draft - 106m

Water depth - 104m at the grounded position

RA22 Iceberg 292/1983

Only 4 positions were logged for this iceberg in Table A22. The first two positions infer 1 day of grounding (G1) at 47°-00.9'N and 48°-35.9'W. The berg was aground in 108m water depth when first logged on the 22nd of April and remained at G1 for at least 1 day. Between 0900 on April 23 and 24, the berg is inferred to have dragged its keel about 3nm to the south-south-east (Fig. A-36). By 0900 on April 24, the berg was aground in 106m of water at 46°-58.0'N and 48°-34.8'W. It was still in this grounded position (G2) when last monitored on April 25. No information is available regarding the berg's characteristics and the draft is inferred as 110m based on the 108m water depth at G1. During April 23 or early on the 24th when the berg moved from G1 to G2, the winds were from the southeast at 25 knots and opposed the berg's drift to the SSE into slightly shallower waters. Keel dragging is inferred for the 3nm between G1 and G2, although it may be that free drift occurred.

In summary: Iceberg 292/1983

* was aground for at least 1 day at G1 (47°-00.9'N and 48°-35.9'W) in 108m water depth
* is inferred to have dragged its keel about 3nm SSE against opposing winds.
* was aground at G2 for at least 1 day at 46°-58.0'N and 48°-34.8'W.

Table A22 Drift positions of iceberg 292/1983

Month	Day	Hour	Latitude (°-'N)	Longitude (°-'W)	
04	22	0900	47-00.9	48-35.9	Inferred grounding G1
04	23	"	"	"	Inferred keeldragging
04	24	"	46-58.0	48-34.8	Inferred grounding G2
04	25	"	"	"	

Water depth at G1 - 108m

" " " G2 - 106m

Draft - 110m

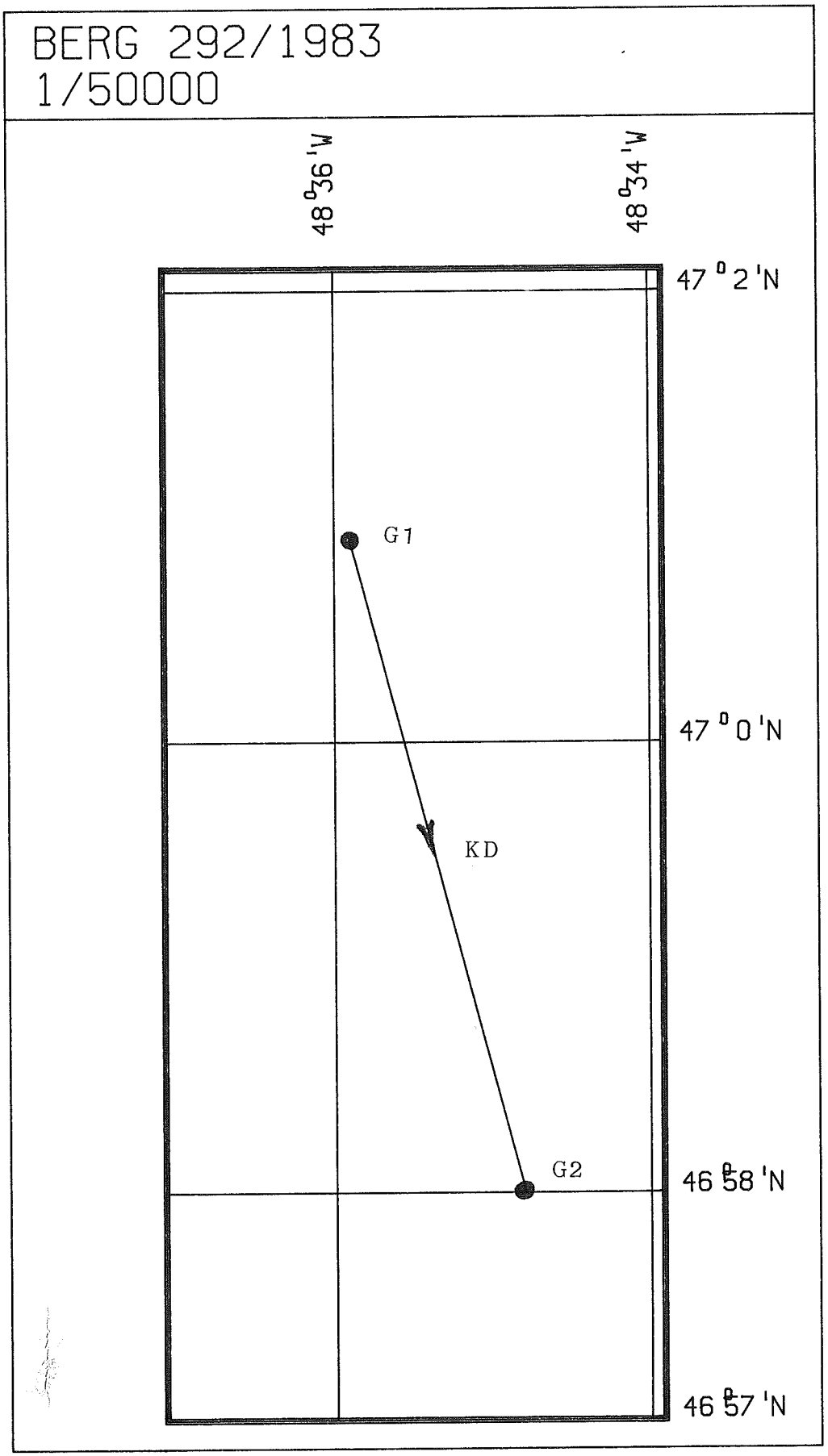


Figure A-36 Drift track of iceberg 292/1983

RA23 Iceberg 649/1983

The tracked positions for this berg are presented in Table A23 and the track is plotted in Fig. A-37. This iceberg was first observed in a water depth of 95m on the 29th of May, 1983 at 0900 about 2nm SSE of the grounded position G1. Keel dragging is inferred for the 2nm distance displaced during the 24 hours between the first observation and the grounded position G1 @ 47°-06.9'N and 48°-43.0'W. The winds were 20 knots from the east-south-east on April 23 which probably assisted the berg in its drift towards the north-north-west to G1. Grounding is inferred for the period 0900-30-05 to at least 0900-02-06; a total of three days. Free drift of this berg probably occurred after 3 days of grounding sometime between the 2nd and 4th of June in a north-easterly direction into deeper water. It is possible that a short scour exists to the northeast of G1, but due to the rapid drop-off of the bottom, the scour is probably very short. The berg itself had a sail height of 60m and the water-line dimensions were 135m by 38m. The draft must have been at least 97m considering the inferred keel dragging in water depths from 95 to 86m prior to grounding at G1 in 86m of water.

In summary: Iceberg 649/1983

* dragged its keel about 2nm towards the WNW on April 23
* grounded at G1 (47°-06.9'N and 48°-43.0'W) for at least 3 days
* then drifted off towards the northeast then southeast into deeper water.

Table A23 Drift positions of iceberg 649/1983

Month	Day	Hour	Latitude (°-'N)	Longitude (°-'W)	
05	29	0900	47-04.8	48-42.0	Inferred keel dragging
"	30	"	47-06.9	48-43.0	
06	02	"	°	"	Inferred grounding
"	04	"	47-17.9	48-25.0	
"	05	"	47-17.9	48-10.0	
"	06	"	47-10.0	47-58.3	
"	08	"	46-43.0	47-34.9	Free drift
"	09	"	46-38.0	47-19.9	
"	10	"	46-26.0	47-01.9	
"	11	"	46-19.8	47-00.0	
"	12	"	46-16.8	46-55.0	

Water-line length	- 135m
" " width	- 38m
Sail height	- 60m
Draft	- 97m
Water depth at G1	- 95m

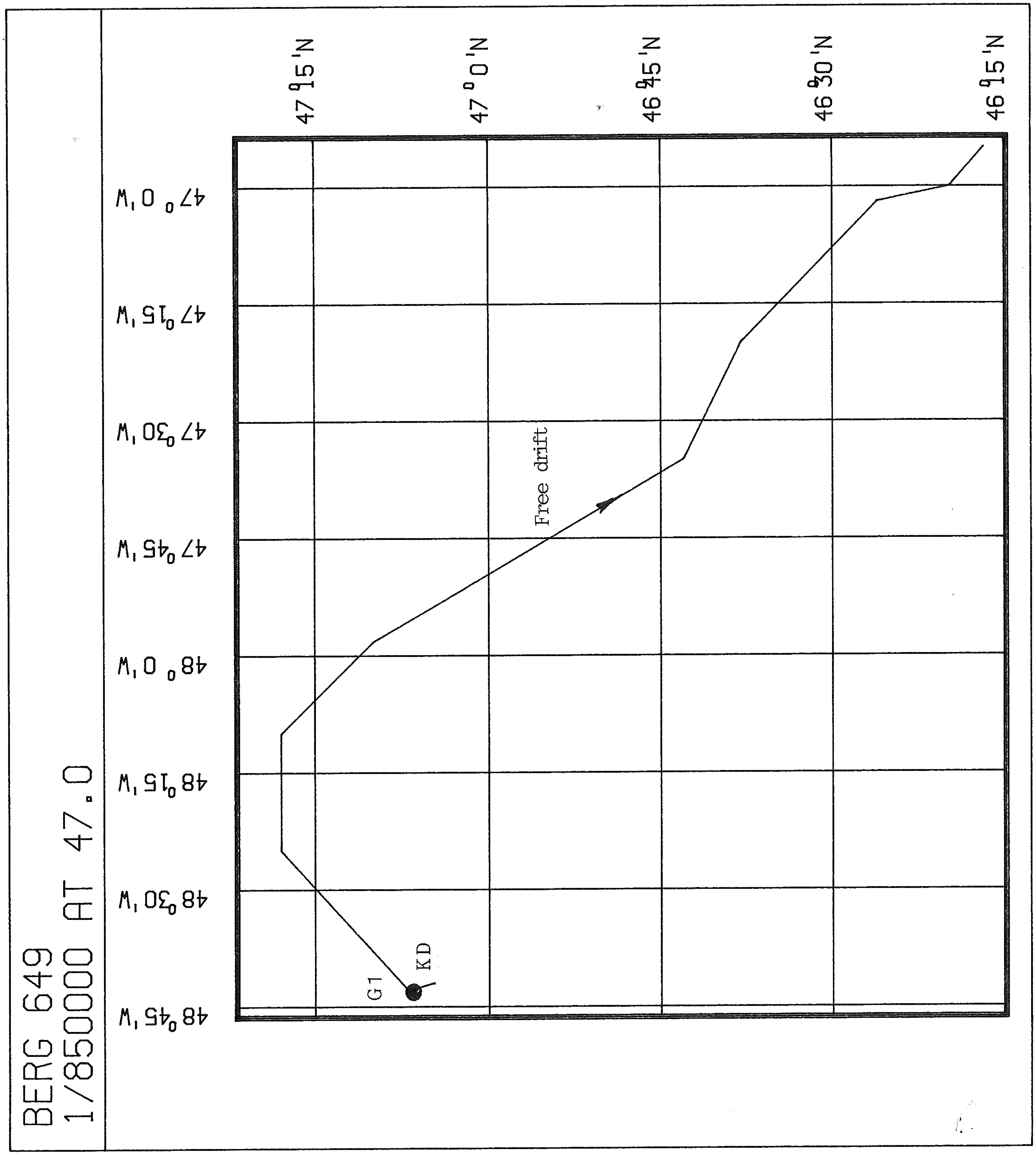


Figure A-37 Drift track of iceberg 649/1983

RA24 Iceberg 028/1987

This was a large spherical berg. The length was measured as 166m; the width as 81m and the sail height was 21m. The draft was estimated to be 85m which was about right considering that the berg grounded in 85m of water on two occasions. Wind data are missing for March 9 and 10 when the berg is inferred as grounded at grounding position G1 (47°-19.5'N and 49°-42.8'W). Refer table A24 and fig. A-38. The berg was first observed on March 9 at 1100 hours local time and it remained stationary until at least 0800 hours on March 10. The next observation was made on March 17. The berg had drifted a distance of 15.4 nm towards 262° as a result of easterly winds (up to 40 knots) on March 16. If this were true, it means that the berg might have grounded at G1 for up to 7 days; ie. from March 9 to 16. It is possible that the berg was grounded for a longer period because it was already aground when first observed on March 9. During the 17 and 18, high winds (to 42 knots) from the SSW, south and SSE forced the berg to drift towards the west and to ground again in 80m of water at grounding position G2 (47°-23.5'N and 50°-02.9'W). The berg was aground by 0600 hours on March 19, and remained aground for three days at least. On the 25th, the berg was adrift heading south west into deeper waters.

In summary, Iceberg 028/1987 is inferred to have:

* grounded at grounding position G1 (47°-19.5'N and 49°-42.8'W) for at least 1 day during March 9 and 10. It may have been aground for up to 7 days.
* drifted westward on March 17 and 18 to ground at grounding position G2 (47°-23.5'N and 50°-02.9'W) for about 3 days, from March 19 to 22.
* drifted free from G2 sometime between March 22 and 25, heading into deeper waters.

BERG 028

Bonne Bay C-73 (Bow Drill 3)
(46 32.18' N 48 11.51' W)

Iceberg Dimensions: Size = L Shape = SPH
Length = M166 Width = M081 Height = M021
Draft = C85 Mass = 824283 Stability = -12.5

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
09/03/87	1100	78.3	307.2	47 19.5	49 42.8	VXGB	1							
09/03/87	1200	78.3	307.2	47 19.5	49 42.8	VXGB	1	0.00	000	1.0	0.0			
09/03/87	1300	78.3	307.2	47 19.5	49 42.8	VXGB	1	0.00	000	2.0	0.0			
09/03/87	1400	78.3	307.2	47 19.5	49 42.8	VXGB	1	0.00	000	3.0	0.0			
10/03/87	0800	78.3	307.2	47 19.5	49 42.8	VXGB	1	0.00	000	21.0	0.0			
17/03/87	2000	89.8	300.2	47 17.3	50 5.1	VXGB	10	0.09	262	201.0	15.4			
17/03/87	2100	90.0	300.4	47 17.7	50 5.1	VXGB	10	0.40	001	202.0	15.8			
18/03/87	0000	90.3	301.3	47 19.1	50 4.4	VCYQ	10	0.49	019	205.0	17.3			
18/03/87	0300	89.5	302.2	47 19.9	50 2.4	VCYQ	10	0.53	060	208.0	18.9			
18/03/87	0600	89.1	302.6	47 20.2	50 1.5	VCYQ	10	0.23	064	211.0	19.6			
18/03/87	0900	89.6	302.6	47 20.5	50 2.0	VCYQ	10	0.15	312	214.0	20.0			
18/03/87	1200	89.7	303.0	47 21.0	50 1.7	VCYQ	10	0.18	023	217.0	20.6			
18/03/87	1500	89.8	303.6	47 21.9	50 1.1	VCYQ	18	0.33	025	220.0	21.6			
18/03/87	1800	90.1	303.3	47 21.6	50 1.8	VCYQ	18	0.19	238	223.0	22.1			
19/03/87	0600	91.7	304.0	47 23.5	50 2.9	VCYQ	21	0.17	339	235.0	24.2			
19/03/87	0900	91.7	303.9	47 23.4	50 3.0	VCYQ	21	0.04	215	238.0	24.3			
19/03/87	1200	91.7	304.0	47 23.5	50 2.9	VCYQ	21	0.04	035	241.0	24.4			
19/03/87	1800	91.7	304.1	47 23.6	50 2.8	VCYQ	21	0.02	035	247.0	24.5			
19/03/87	2100	91.9	304.1	47 23.7	50 3.0	VCYQ	21	0.06	306	250.0	24.7			
20/03/87	0000	91.8	304.1	47 23.6	50 3.0	VCYQ	21	0.03	181	253.0	24.8			
20/03/87	0300	92.0	304.1	47 23.7	50 3.2	VCYQ	21	0.06	306	256.0	25.0			
20/03/87	0600	91.9	304.0	47 23.6	50 3.1	VCYQ	22	0.04	146	259.0	25.1			
20/03/87	0900	91.9	304.0	47 23.6	50 3.1	VCYQ	22	0.00	000	262.0	25.1			
20/03/87	1200	91.9	304.0	47 23.6	50 3.1	VCYQ	22	0.00	000	265.0	25.1			
22/03/87	0405	91.9	304.0	47 23.6	50 3.1	VXJF	22	0.00	000	305.1	25.1			
25/03/87	1935	95.4	291.7	47 7.5	50 21.0	VXJF	22	0.23	218	392.6	45.4			
26/03/87	0200	94.5	290.1	47 4.6	50 21.2	VCYQ	22	0.45	183	399.0	48.3			
26/03/87	0300	94.7	289.8	47 4.3	50 21.6	VCYQ	22	0.41	223	400.0	48.7			
26/03/87	0500	94.8	289.2	47 3.4	50 22.2	VCYQ	22	0.50	205	402.0	49.7			
26/03/87	0900	93.3	287.4	47 0.1	50 21.5	VCYQ	22	0.83	173	406.0	53.1			
26/03/87	1100	93.9	288.4	47 1.8	50 21.7	VCYQ	22	0.85	356	408.0	54.8	[L]	208.0	E060
26/03/87	1500	94.3	286.6	46 59.1	50 23.4	VCYQ	22	0.74	204	412.0	57.7			
27/03/87	2100	102.7	282.3	46 54.1	50 37.8	VCYQ	22	0.37	243	442.0	68.9			
28/03/87	0300	102.6	282.0	46 53.5	50 37.9	VCYQ	22	0.10	187	448.0	69.5			
28/03/87	0600	104.2	281.4	46 52.7	50 40.5	VCYQ	22	0.66	246	451.0	71.4			
28/03/87	0900	105.7	281.0	46 52.3	50 42.8	VCYQ	22	0.54	256	454.0	73.1			
28/03/87	1200	106.3	280.8	46 52.1	50 43.7	VCYQ	22	0.22	252	457.0	73.7			

Table A24 Individual drift track listing for iceberg 028/1987

BERG 028

Bonne Bay C-73 (Bow Drill 3)
(46 32.18' N 48 11.51' W)

Iceberg Dimensions: Size = L Shape = SPH
Length = M166 Width = M081 Height = M021
Draft = C85 Mass = 824283 Stability = -12.5

DATE	TIME L	Range (n.mi)	Brng. (T)	Lat. (dd mm)	Long. (dd mm)	Call Sign	TT (h)	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	Tow Type	Tow Hdg.	Tow Force
28/03/87	1500	107.4	280.4	46 51.5	50 45.5	VCYQ	22	0.46	244	460.0	75.1			
28/03/87	1800	108.8	279.9	46 50.9	50 47.7	VCYQ	23	0.54	248	463.0	76.7			
28/03/87	2100	108.8	280.2	46 51.4	50 47.7	VCYQ	23	0.17	001	466.0	77.2			
29/03/87	0000	110.3	280.4	46 52.0	50 49.7	VCYQ	23	0.50	294	469.0	78.7			
29/03/87	0300	111.1	280.4	46 52.3	50 50.8	VCYQ	23	0.27	292	472.0	79.5			
29/03/87	0600	112.6	280.5	46 52.7	50 52.9	VCYQ	23	0.50	286	475.0	81.0			
29/03/87	0900	113.9	281.0	46 54.0	50 54.5	VCYQ	23	0.56	320	478.0	82.7			
29/03/87	1200	114.4	281.1	46 54.2	50 55.2	VCYQ	23	0.17	293	481.0	83.2			
29/03/87	1500	115.0	281.4	46 54.9	50 55.9	VCYQ	23	0.28	326	484.0	84.1			
29/03/87	1800	116.4	281.5	46 55.3	50 57.9	VCYQ	23	0.47	286	487.0	85.5			
29/03/87	2100	117.8	281.8	46 56.3	50 59.7	VCYQ	23	0.52	309	490.0	87.1			
30/03/87	0000	118.6	282.2	46 57.2	51 0.7	VCYQ	23	0.37	323	493.0	88.2			
30/03/87	0300	119.6	281.9	46 56.8	51 2.3	VCYQ	23	0.39	250	496.0	89.3			
30/03/87	0600	121.0	281.3	46 55.9	51 4.7	VCYQ	23	0.63	242	499.0	91.2			
30/03/87	0900	122.8	281.2	46 56.1	51 7.2	VCYQ	23	0.57	277	502.0	93.0			
30/03/87	1200	123.4	280.8	46 55.4	51 8.3	VCYQ	23	0.35	228	505.0	94.0			
30/03/87	1500	124.2	280.6	46 55.0	51 9.6	VCYQ	23	0.33	246	508.0	95.0			
30/03/87	1800	124.6	280.2	46 54.3	51 10.3	VCYQ	23	0.29	215	511.0	95.8			
30/03/87	2100	124.7	280.2	46 54.3	51 10.5	VCYQ	23	0.05	270	514.0	96.0			
31/03/87	0000	124.7	280.2	46 54.2	51 10.5	VCYQ	23	0.03	181	517.0	96.1			
31/03/87	0300	124.8	280.1	46 54.1	51 10.7	VCYQ	23	0.06	234	520.0	96.2			
31/03/87	0600	125.6	279.7	46 53.4	51 12.1	VCYQ	23	0.40	234	523.0	97.4			
31/03/87	0900	126.9	279.6	46 53.3	51 14.0	VCYQ	23	0.44	266	526.0	98.8			
31/03/87	1200	127.5	279.6	46 53.4	51 14.8	VCYQ	23	0.19	280	529.0	99.3			
31/03/87	1500	128.1	279.6	46 53.6	51 15.7	VCYQ	23	0.21	288	532.0	100.0			
31/03/87	1800	129.1	279.4	46 53.3	51 17.2	VCYQ	23	0.36	254	535.0	101.0			
31/03/87	2100	130.5	279.4	46 53.4	51 19.3	VCYQ	23	0.48	274	538.0	102.5			
02/04/87	0000	136.2	280.7	46 57.5	51 26.8	VCYQ	23	0.24	309	565.0	109.0			

10/03/87 0800 78.27 307.2 (CPA)
02/04/87 0000 136.19 280.7 (MDR)

SPEEDS (Knots)

Min.	Max.	Mean	MadeGood	
0.00	0.85	0.29	0.13	(to 253 T; DRIFT RATIO = 0.69)

TOTAL NUMBER OF OBSERVATIONS = 65

Table A24 (continued)

SITE SPECIFIC TARGET PLOT

SURROUNDING Area w.r.t.
Bonne Bay C-73
(Bow Drill 3)
46 32' 10.74" N
48 11' 30.51" W

From 1100 L March 09, 1987
to 0000 L April 02, 1987
(23 days, 13.00 hours)

1 Iceberg Tracked.
65 Observations.
1 Target Towed.

Radius = 140.0 n. mi.
Tic Interval = 10.0 n. mi.

Bonne Bay C-73 is at the Center of Plot.

DISTANCE TRACKED (n.mi)	CPA (n.mi.)	MEAN SPEED (kts)
109.0	78.3	0.3

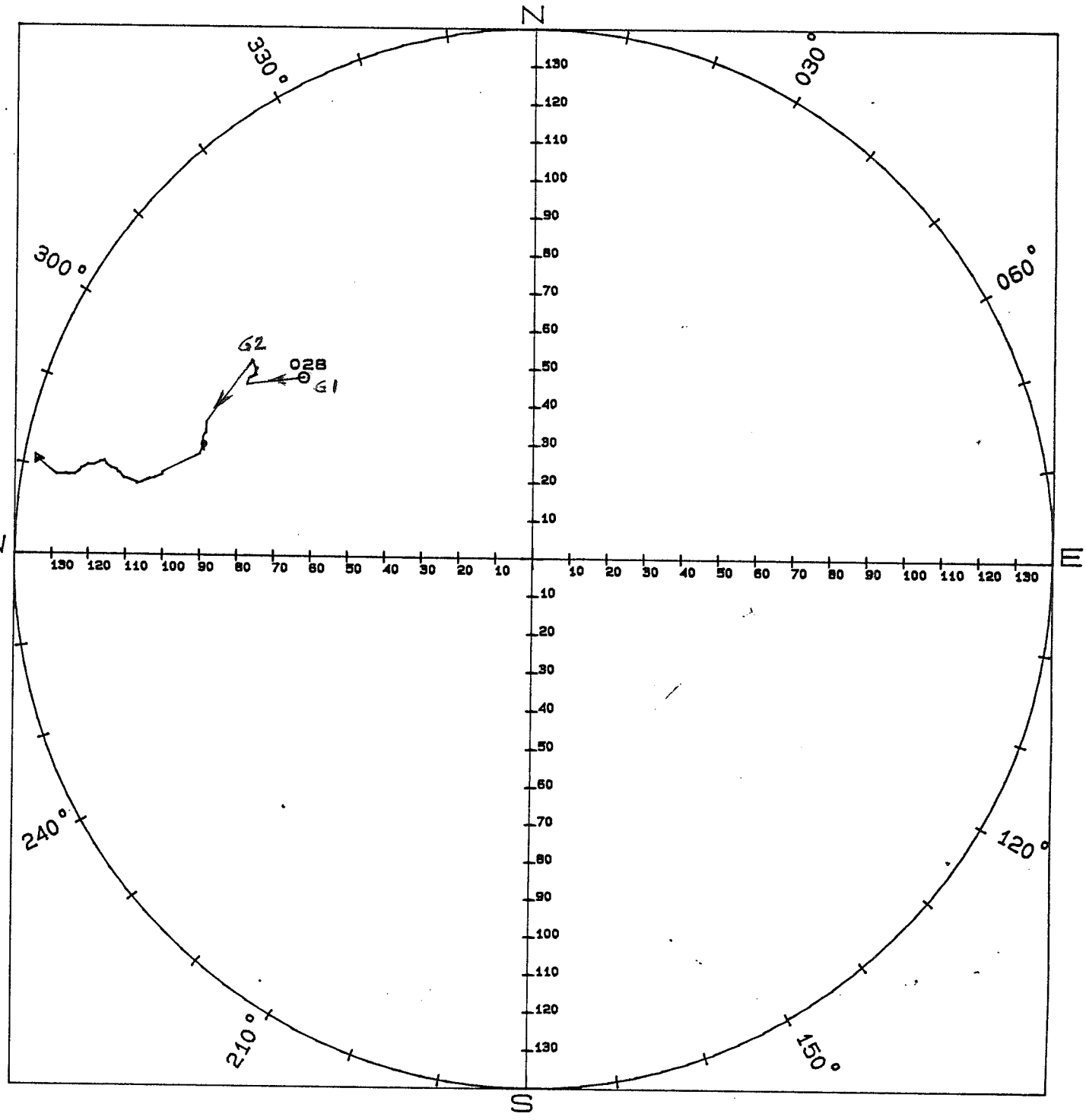


Figure A-38 Drift track of iceberg 028/1987

RA25 Iceberg 019/1985

This iceberg was large. The mass was 3.2 million tonnes. At the water-line, the berg measured 196m by 123m and the sail height was 46m. The draft was estimated as 100m. The berg was first observed on April 28 at a range of 70.4 nm from Conquest K-09. On the 7th of May, 9 days later, the berg was located at 70.1 nm and 297.8° from Conquest K-09 (Table A25). Grounding is inferred at this location (Fig. A-39) at 47°-41'N and 49°47.5'W for the 9 days involved. The water depth was about 95m at this, the first of two inferred groundings. On May 16, the berg was drifting towards the south. It is assumed that the berg drifted away from its first grounded position on May 15 due to 55 knot northerly winds. This implies that the berg may have been grounded at G1 for as long as 17 days. It is possible that keel dragging occurred on May 16 in a southerly direction from G1. In any case, by 2130 hours on May 16, the berg was aground again at grounding location G2 (47°-25.5'N and 49°-45.8'W) in 88m of water. The berg was still aground at G2 when the last observation was made on June 7. This indicates that the grounding period at G2 was at least 22 days.

In summary it is inferred that two groundings were experienced by iceberg 019/1985 from April 28 to June 7, 1985. Grounding G1 occurred at 47°-41'N and 49°-47.5'W for a minimum of 9 days and possibly a maximum of 17 days. The second grounding G2 occurred on May 16 at 47°-25.5'N and 49°-45.8'W and lasted until at least June 7, a period of 22 days. Keel dragging is inferred for part of the drift track between G1 and G2.

CONQUEST K-09 (BOW DRILL 2), 1985

DATE	TIME GMT	Range (n.mi)	Brng. (T)	TT (h)	Speed (Kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)	
28/04/85	1823	70.40	297.0	15	0.00	000	0.0	0.0	
28/04/85	2030	70.90	298.0	15	0.63	005	2.1	1.3	
28/04/85	2130	70.40	297.0	15	1.33	185	3.1	2.7	
28/04/85	2330	70.60	298.0	15	0.62	018	5.1	3.9	
01/05/85	1245	70.40	298.2	20	0.01	067	66.4	4.2	
01/05/85	2345	70.80	298.6	20	0.06	349	77.4	4.9	
05/05/85	1156	70.30	297.9	20	0.01	178	161.6	5.9	
07/05/85	0015	70.10	297.8	20	0.01	149	197.9	6.1	
16/05/85	0830	67.00	292.1	25	0.03	181	422.1	13.6	
16/05/85	0930	67.00	291.7	25	0.47	202	423.1	14.0	
16/05/85	1030	66.40	291.0	25	1.01	165	424.1	15.1	
16/05/85	1130	65.80	290.4	25	0.92	160	425.1	16.0	
16/05/85	1230	65.10	289.6	9	1.15	163	426.1	17.1	
16/05/85	1330	64.40	288.8	9	1.14	161	427.1	18.3	
16/05/85	1430	63.90	287.7	9	1.33	176	428.1	19.6	
16/05/85	1530	63.60	287.3	9	0.54	164	429.1	20.1	[LINE TOW]
16/05/85	1630	63.80	287.3	9	0.20	287	430.1	20.3	[LINE TOW]
16/05/85	1730	63.70	287.2	9	0.15	155	431.1	20.5	[LINE TOW]
16/05/85	1830	63.70	286.9	9	0.33	197	432.1	20.8	
16/05/85	1930	63.80	286.4	9	0.57	207	433.1	21.4	
16/05/85	2030	63.60	286.1	9	0.39	165	434.1	21.8	
16/05/85	2130	63.60	285.8	9	0.33	196	435.1	22.1	
16/05/85	2230	63.70	285.7	9	0.15	238	436.1	22.3	
16/05/85	2330	63.80	285.6	9	0.15	238	437.1	22.4	
		63.8	286						
17/05/85	0030	~~64.20~~	~~285.6~~	9	0.40	286	438.1	22.8	
17/05/85	0630	63.70	285.9	9	0.10	072	444.1	23.4	
28/05/85	1130	62.00	286.5	9	0.01	085	713.1	25.2	
07/06/85	1130	63.50	285.7	9	0.01	256	953.1	27.0	

28/05/85 1130 62.00 286.5 (CPA)
28/04/85 2030 70.90 298.0 (MDR)

SPEEDS (knots)

Min.	Max.	Mean	MadeGood	
0.01	1.33	0.45	0.02	(to 174 T; DRIFT RATIO = 0.55)

TOTAL NUMBER OF OBSERVATIONS = 28

Table A25 Individual drift track listing for iceberg 019/1985

TIME TRACKED (h)	DISTANCE TRACKED (n.mi)	CPA (n.mi.)	MEAN SPEED (kts)	MAX. SPEED (kts)	MEAN DIR. (to, T)
953.1	27.0	62.0	0.4	1.3	174

SITE SPECIFIC TARGET PLOT

SURROUNDING Area w.r.t.

CONQUEST K-09
(BOW DRILL 2)
47 8' 34.00" N
48 15' 44.00" W

From 1823 GMT April 28, 1985
to 1130 GMT June 07, 1985
(39 days, 17.12 hours)

1 Target Tracked.
28 Observations.
1 Target Towed.

Radius = 72.0 n. mi.
Tic Interval = 5.0 n. mi.

CONQUEST K-09 is at the Center of Plot.

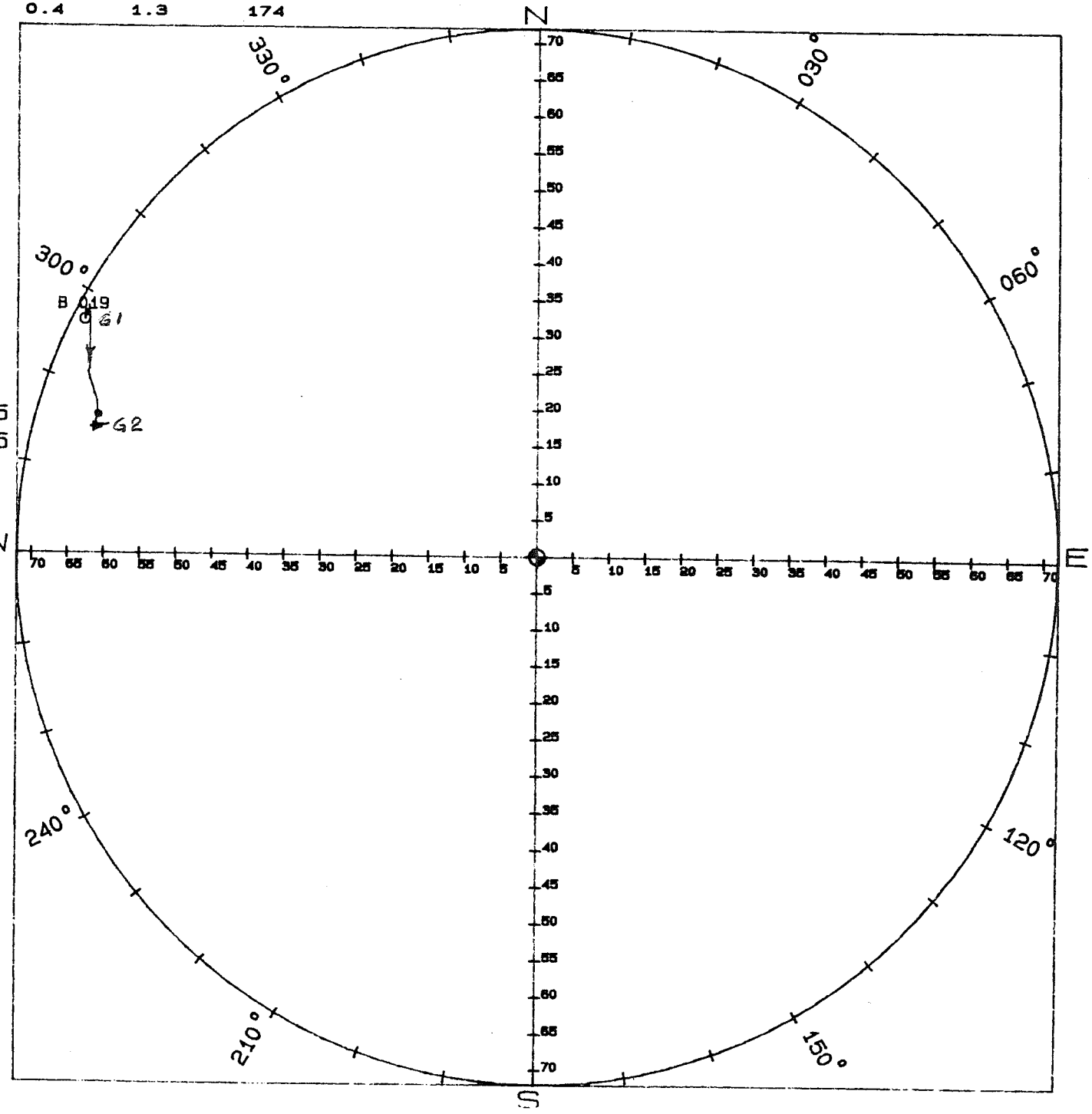


Figure A-39 Drift track of iceberg 019/1985

RA26 Iceberg 061/1985

No information is available on the dimensions of this berg. All that is known is that it drifted as shown in Table A26 and Fig. A-40. Only four position observations were made and 24 hours of stationarity occurred between 1720 hours on May 26, 1985 and 1720 hours on May 27. Considering the 125m water depth at the grounded location (46°-10.8'N and 47°-58'W) and the fact that the berg drifted in from deeper waters to the north east, it is reasonable to infer that this berg definitely grounded. The drift of the berg from deep to less deep water areas is attributed to 44 knot easterly winds which occurred during May 25 and 26, 1985.

In summary, one definite grounding is inferred for berg 061/1985 in 125m of water at 46°-10.8'N and 47°-58'W for at least 24 hours.

BERG 061

NORTH BEN NEVIS P-93 (BOW DRILL 3), 1985

DATE	TIME GMT	Range (n.mi)	Brng. (T)	TT (h)	Speed (kts)	Dir. (T)	E.T. (h)	E.D. (n.mi)
26/05/85	0130	44.70	99.0	24	0.00	000	0.0	0.0
26/05/85	0510	43.40	102.0	24	0.72	220	3.7	2.6
26/05/85	1720	38.91	146.4	18	2.58	222	15.8	34.0
27/05/85	1720	38.91	146.4	18	0.00	000	39.8	34.0

27/05/85	1720	38.91	146.4	(CPA)
26/05/85	0130	44.70	99.0	(MDR)

SPEEDS (knots)

Min.	Max.	Mean	MadeGood	
0.00	2.58	1.10	0.85	(to 222 T; DRIFT RATIO = 1.00)

TOTAL NUMBER OF OBSERVATIONS = 4

Table A26 Individual drift track listing for iceberg 061/1985

TIME TRACKED (h)	DISTANCE TRACKED (n.mi)	CPA (n.mi.)	MEAN SPEED (kts)	MAX. SPEED (kts)	MEAN DIR. (to. T)
39.8	34.0	38.9	1.1	2.6	222

SITE SPECIFIC TARGET PLOT

SURROUNDING Area w.r.t.

NORTH BEN NEVIS P-93
(BOW DRILL 3)
46 42' 48.10" N
48 28' 34.24" W

From 0130 GMT May 26, 1985
to 1720 GMT May 27, 1985
(1 days, 15.83 hours)

1 Target Tracked.
4 Observations.

Radius = 48.0 n. mi.
Tic Interval = 5.0 n. mi.

NORTH BEN NEVIS P-93 is at the Center of Plot.

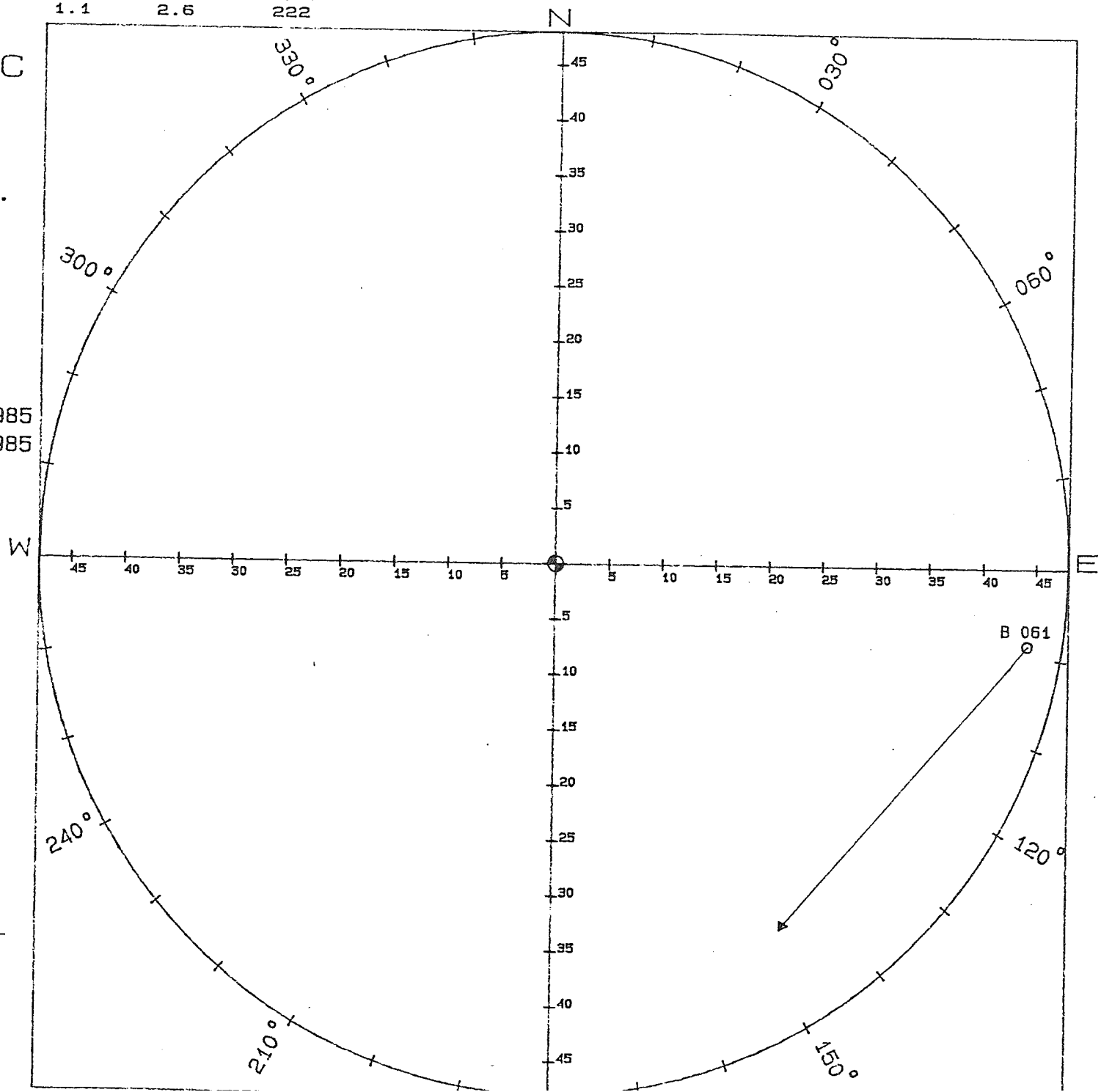


Figure A-40 Drift track of iceberg 061/1985

RA27 Rejected icebergs

During the data review, candidate grounded icebergs were selected and later exposed to analysis regarding actual scouring, grounding, keel dragging and free drift. As a result of the analysis, two of the candidate bergs were rejected on the grounds that the water depth was too great for grounding.

Iceberg 024/1985

In reviewing the 7 positions covering the 26 hour observation period of iceberg 024, it is difficult to conclude that it actually grounded owing to the fact that that the water depth in the area is about 215m. While the 1 nm net movement during the period of observation suggests grounding, the total drift distance, noted as 10.9 nm, suggests free drift of 0.3 to 1.0 knots. It is possible that navigational errors were involved. It is also possible that keel dragging occurred and the great water depth indicates that if grounding or keel dragging occurred, the berg must have been very large indeed. Information regarding berg dimensions is lacking. The available data are presented in Table A27 and Fig. A-41. Berg 024 is included in this report because of the possible grounding or scouring in the 215m water depth, but is rejected as a definite grounding on the grounds that it is unlikely that a berg with a draft in excess of 200m occurred. If a search for scours were to be conducted, the area of interest is 46°-11'N and 47°-38.4'W.

Iceberg 003/1983

Low drift rates were noted on January 12, 1983 at 48°-10'N and 47°-37'W (Table A25). Free drift occurred on the 13th, prior to a two day period of stationarity at 48°-21'N and 47°-17'W. The berg was stationary by 0900 hours on the 14th in about 2000m of water. On the morning of the 17th, the berg drifted freely to the NNE of the stationary location. The berg itself was about 80m long and 50m wide at the water-line and the sail height was 30m. Judging by the 2000m water depth at the location of stationarity, grounding is rejected completely.

WEST BEN NEVIS B-75
46 34.0 N 48 26.1 W

OBSERVED TRACK PLOT & SUMMARY FOR ICEBERG : S24

Observed from : 0030 30 May 85 to : 0230 31 May 85 (GMT)
Hours Tracked : 26 hrs # of Observations : 7
Distance tracked : 10.8 nm. Net Displacement : 1.0 nm
Closest Approach : 39.6 nm. 119° at 1630 30 May 85

Iceberg track : ———— Tow operations : ----------
Scale : 37 nm

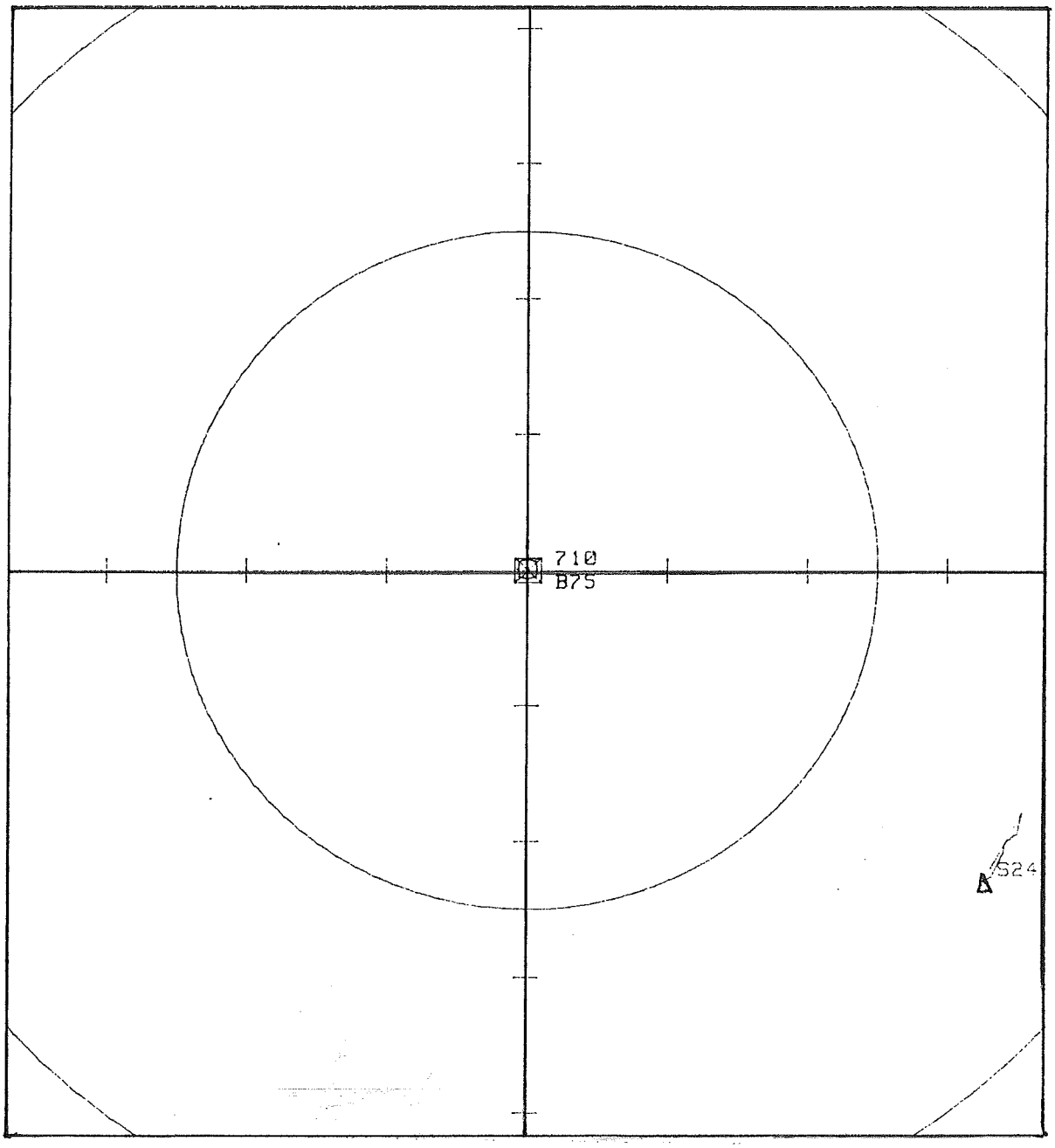


Figure A-41 Track plot of rejected iceberg 024/1983

WEST BEN NEVIS B-75
46 34.0 N 48 26.1 W
1985

Iceberg : S24 page 1

Characteristics :

Size	Shape	Length		Width		Height		Draft		Mass	
		X	0	X	0	X	0	X	0	X	0

Summary of the Iceberg Track

Time tracked : 26.0 hrs.
Total Distance : 10.9 nm.
Net Displacement : 1.1 nm.

Position Observations : 7

Time (GMT)	Date (GMT)	Range (nm)	Bear (deg)	Speed (knots)	Dir (deg)	Status	Towhead (deg)	Tension (tons)
0030	30 May	39.8	125	0.0	0			
1630	30 May	39.6	119	.3	28			
1830	30 May	40.0	121	.8	194			
2030	30 May	39.6	122	.5	232			
2230	30 May	39.9	123	.4	192			
0030	31 May	40.1	126	1.0	206			
0230	31 May	39.8	127	.3	243			

Table A27 Individual drift track listing for rejected iceberg 024.