CASE HISTORIES OF THE GROUNDINGS OF ICEBERGS 001 AND 004 DURING MARCH, 1989 ON THE GRAND BANKS OF NEWFOUNDLAND

SUBMITTED TO:

THE ATLANTIC GEOSCIENCE CENTRE AT THE BEDFORD INSTITUTE OF OCEANOGRAPHY, DARTMOUTH, NOVA SCOTIA

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ACKNOWLEDGEMENTS

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ABSTRACT

Several thousand icebergs are calved annually from glaciers in Greenland and the eastern arctic. Each year, some of these drift southward, on average about 400, to the Grand Banks of Newfoundland. A portion of this flux of icebergs contacts the seabed, resulting in scouring of the seafloor sediments. In order to provide case histories of the iceberg grounding process, two recent iceberg groundings, which resulted in the formation of scours and a large pit, have been documented on the eastern Grand Banks following an oil-industry iceberg monitoring program in 1989. The environmental conditions and circumstances leading to the two groundings are presented herein, along with documentation of part of the scour and the pit generated during one of the groundings.

1. INTRODUCTION

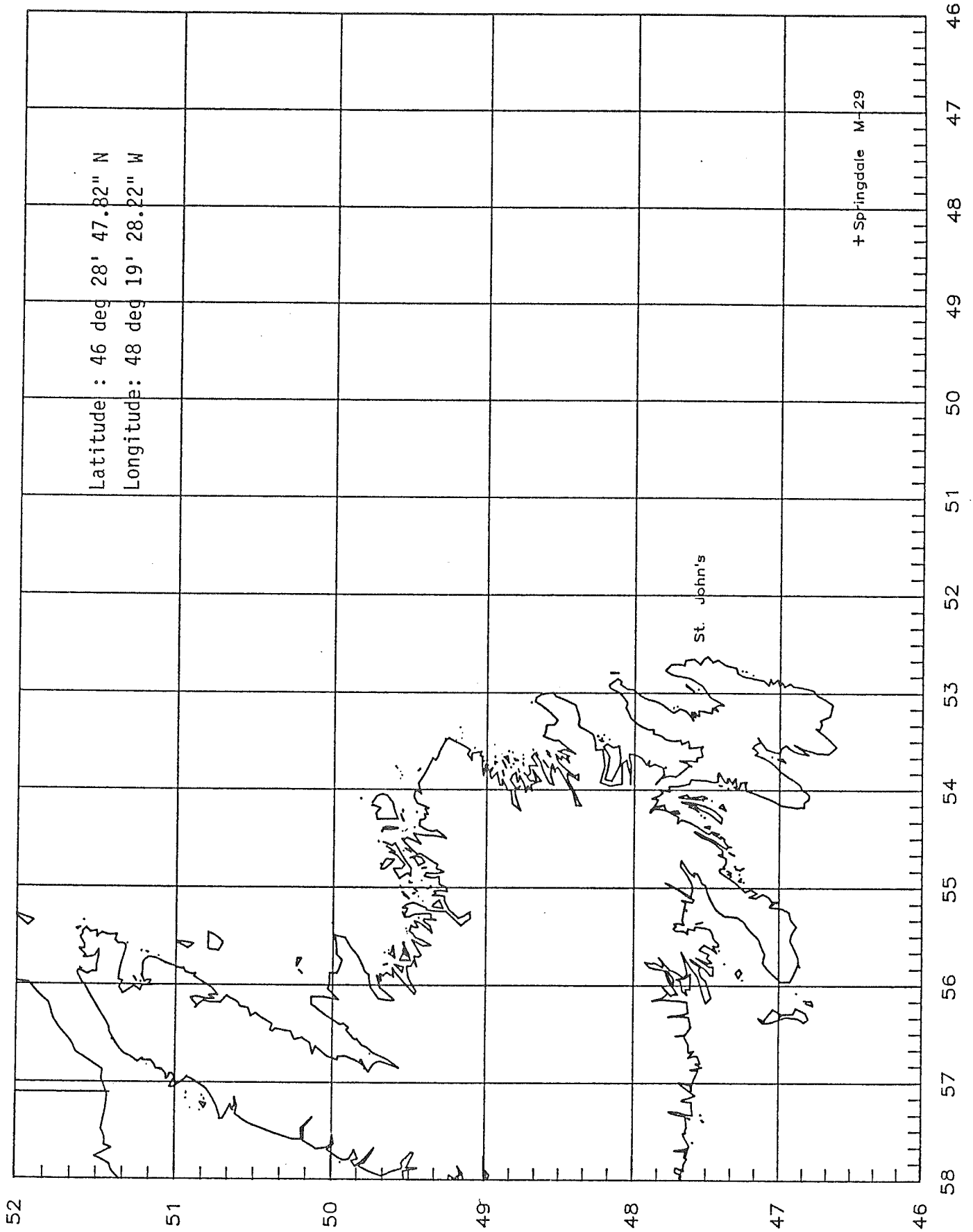
Iceberg keels which scour the seabed of the Grand Banks of Newfoundland raise questions regarding the need for protection of potential oil and gas facilities such as pipelines and wellheads. Grounding icebergs produce long linear scour furrows on the seabed as well as circular scours (depressions) termed iceberg pits. Numerous furrows and pits have been documented in site-specific and regional geophysical surveys on the Grand Banks of Newfoundland. Scours are typically in the order of 1m deep, 10 to 100m wide and vary from hundred of meters to kilometers in length. The processes controlling iceberg scour need to be better understood. The environmental forcing consists of winds, currents, waves and the inertia of the berg. Some or all of these forces are opposed by the interaction of the iceberg keel with the seabed during scouring. To further understand the grounding processes and the rate of scouring, a series of case histories of recent groundings has been assembled with the assistance of the offshore oil-industry (Banke, 1989).

Early in 1989, observations associated with drilling activities at the Texaco Springdale M-29 wellsite (Fig. 1.1) documented two separate iceberg groundings (Icebergs 001 and 004). Berg 001 was a large 1.3 million tonne iceberg which drifted southward from the edge of the packice on March 9 and grounded in 112m of water on March 10, 1989. The berg remained grounded for 45 days, drifting free on April 24. This grounding provided a unique opportunity to document the grounding process of a large iceberg for which winds and currents are available from a nearby drill rig, and hourly drift track positions were logged for the presumed free drift and keel dragging phase to final grounding. Not only is the drift track during scouring known, but also part of the resulting scour below the noted drift track has been documented. About 15 km of the 20 km inferred scour was surveyed by the Atlantic Geoscience Centre only 11 days after the berg drifted free from the grounded position (Fader, 1989). The scour is less than 1m deep and about 20m wide. The scour terminated in a pit about 90m in diameter and 5m deep surrounded by a 3m high berm. The other grounded iceberg, Berg 004, drifted southward from the packice and grounded for about 4 days in 100m of water.

In this report we present the environmental conditions which prevailed during the two grounding events and the resulting drift tracks. The information consists of the following:

* winds and currents measured at a nearby drill rig.
* packice extent documented by aerial ice reconnaissance.
* drift track of each iceberg logged by the drill rig and supply vessels.
* towing records documented by supply vessels.
* iceberg photographs and measurements.
* the underwater profiles of berg 001.
* sonar record of part of the 15 km surveyed scour.

These data represent all the information available for the two grounded icebergs, 001 and 004.



Springdale M-29 Wellsite Location Map

Figure 1.1

2. PACKICE AND ICEBERG SETTING.

Although the grounding processes of Bergs 001 and 004 are the prime concern in these "case histories", it is also of interest to know something about the physical setting which delivered the bergs to the northeast Grand Banks, there to ground. Several sources of information are available; on January 30, 1989, the International Iceberg Patrol (IIP) conducted iceflight number 10 and identified a total of 86 icebergs and some other targets scattered along the Labrador coast as shown in Fig. 2.1. The closests icebergs to the Springdale M-29 drilling location on the Grand Banks were then about 500 km to the northwest. It is surmised that this berg group drifted to the southeast with the developing packice and by March 11, about 89 icebergs were on plot by Texaco using Husky Oil's ice data management system (Fig. 2.2). The apparent drift rate was about 13 km per day which is in agreement with the 10 to 20 cm/sec drift rate of packice reported by Peterson and Symonds, 1988. Most of the icebergs in Fig. 2.2 were located well within the 200m isobath and still within the packice. By March 9, three icebergs had come free of the packice and drifted south along parallel drift tracks. The drift tracks of these three bergs are presented in Fig. 2.3. Icebergs 2 and 3 were small bergs whereas Berg 001 was a large 1.3 million-tonne which drifted freely during part of March 9 and grounded on March 10 about 25.5 km from the Springdale M-29 location. The berg was grounded at a bearing of 034° T from the drill rig. Iceberg 004 also drifted free from the packice a few days later and subsequently grounded. The remaining icebergs eventually drifted free as the packice retreated northward. The main point to note about the presence of icebergs within the packice is the close association of icebergs and packice suggesting that the packice movement is responsible for the icebergs' location in shallow waters, removed from the direct influence of the Labrador Current in deeper water. This hypothesis is verified by the observation that the season for grounding of bergs is well correlated with the presence of packice within the 200m isobath (Banke, 1989).

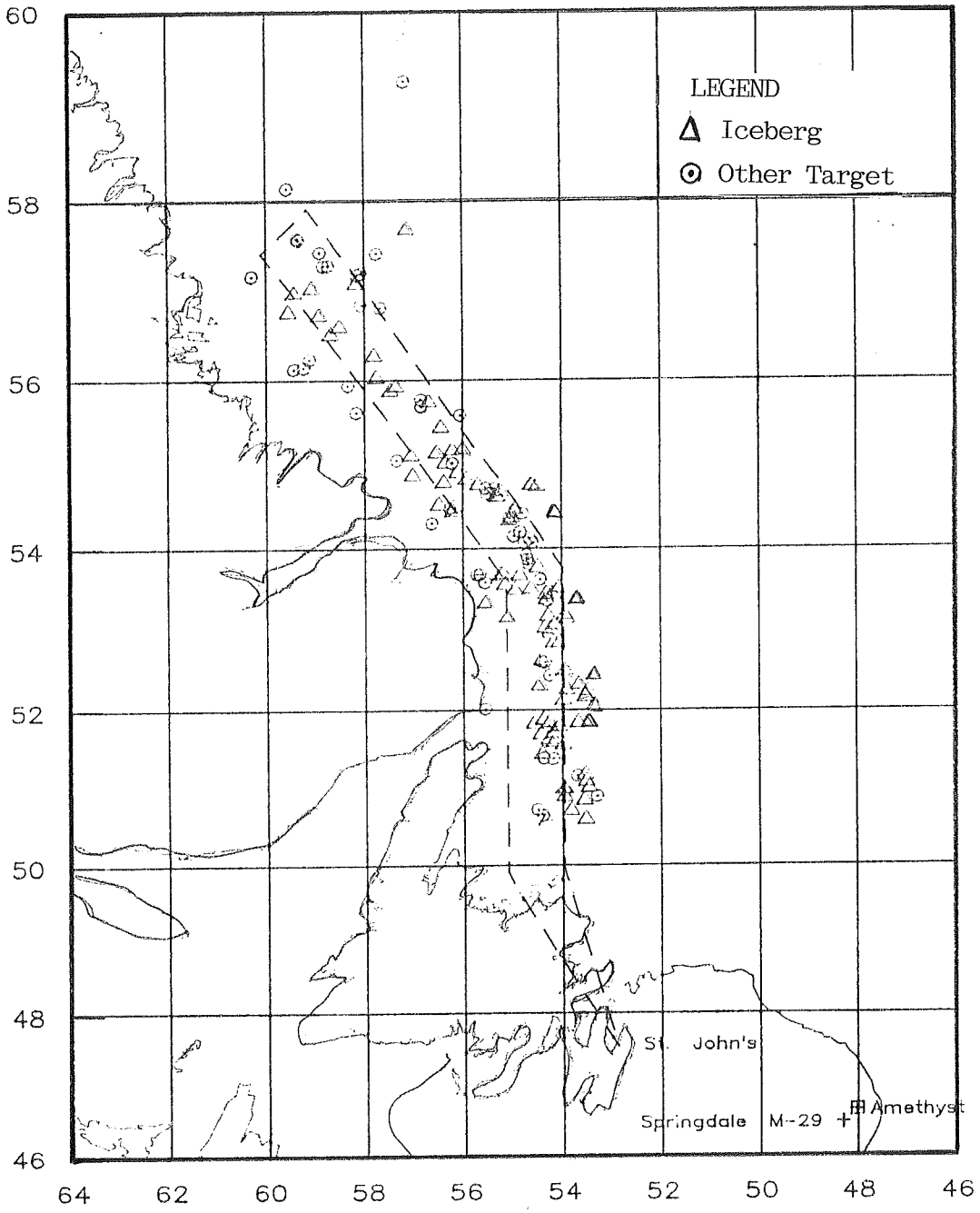


Figure 2.1 IIP Flight #010 January 30, 1989

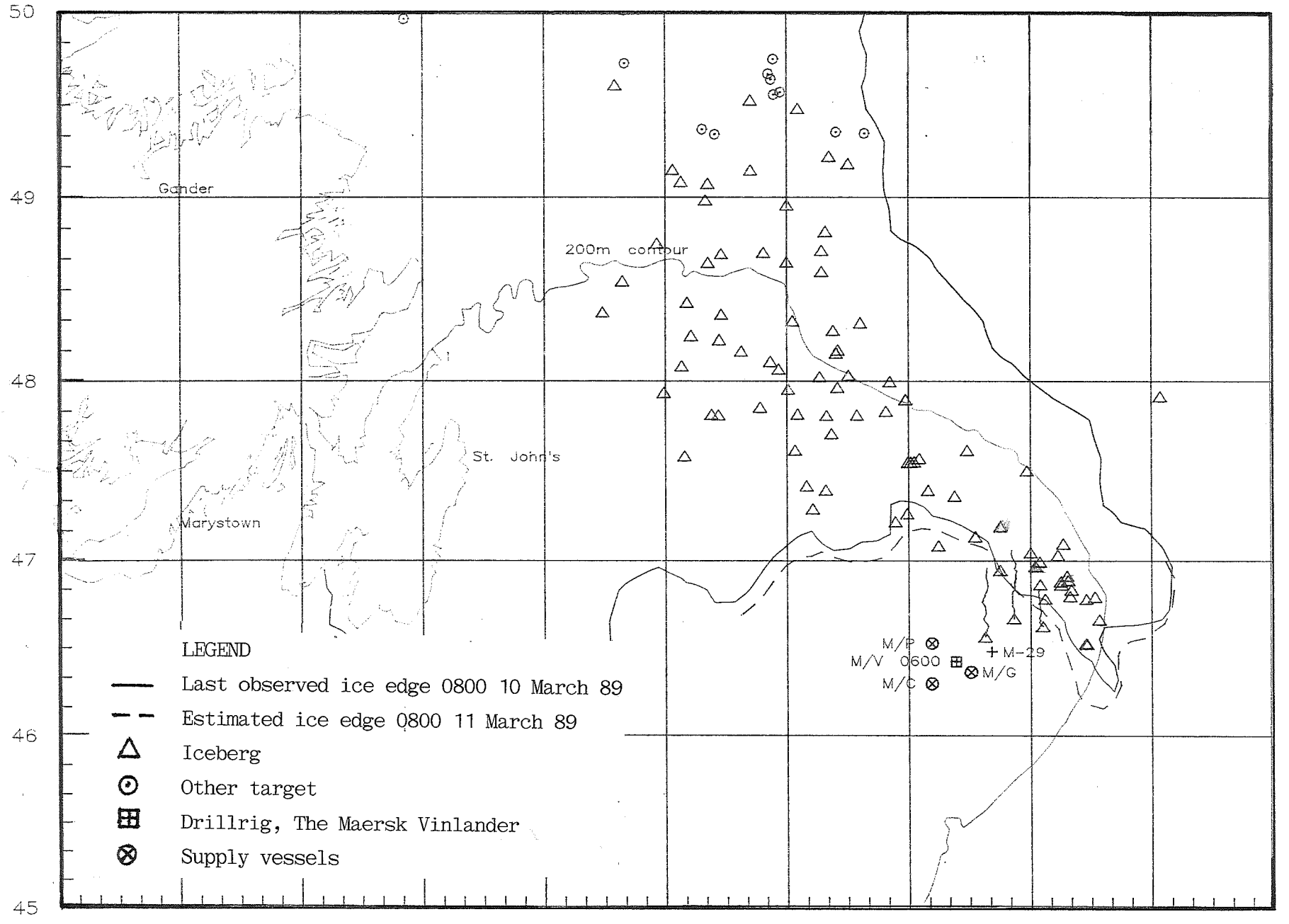


Figure 2.2 Husky Oil Daily Ice Report 0800L March 11, 1989

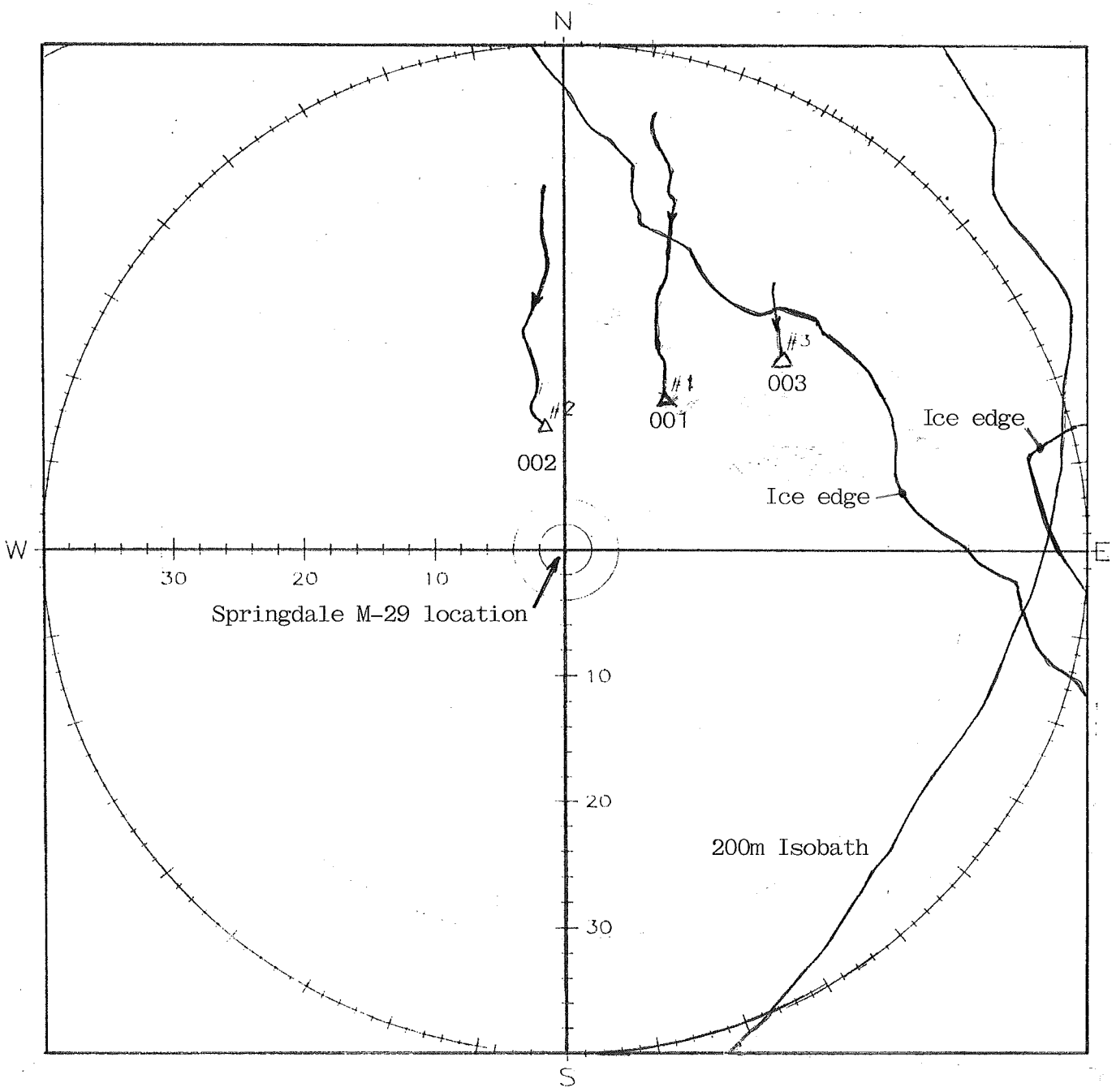


Figure 2.3 Detailed drift tracks of 3 icebergs on March 9 and 10, 1989

3. ICEBERG 001.

Iceberg 001 was a large pinnacled berg measuring 217m by 119m at the waterline. The berg was photographed from an altitude of 370m on the 8th of April, while the berg was grounded. The photographs are presented in Figs. 3.1 to 3.5 and it is evident that underwater rams extended horizontally outward about 50m from the berg below the water surface. The sail height was about 46m and the draft was about 117m. This draft estimate is inferred from the fact that the berg grounded at the 112m isobath and there created a 5m deep pit. The pit was about 90m in diameter. This information is useful in interpreting the underwater iceberg shape which is presented below. The pit and 15 km of the scour extending north from the grounded location were surveyed by AGC (Fader, 1989) on May 5, only 11 days after the berg drifted free. The underwater profiles were measured by Geonautics Ltd. using a side-looking sonar while the berg was grounded. The raw sonar data were analyzed and interpreted by Geonautics as part of this project in an overall effort to complete the information for this case history. A total of 8 underwater profiles of Berg 001 were taken and presented in Fig. 3.6. Two profiles were taken of the north side of the berg (Figs. 3.7 and 3.8) and Fig. 3.9 shows the two profiles together. A single profile was taken of the east side (Fig. 3.10) and five profiles were taken of the south side (Figs. 3.11 to 3.15). A composite of the five profiles is presented in Fig. 3.16. No profiles were taken of the west side of the berg and no notice was taken of the bergs' orientation, all of which makes interpretation more difficult. The underwater rams seen in Fig. 3.1 are evident in the profiles prepared by Geonautics. The maximum horizontal extent of the rams on the north side was about 32m (Fig. 3.9). No rams existed on the east side but on the south side, the rams extended a maximum of 20m. It was hoped that information on the rams could be used to infer berg orientation while grounded, but unfortunately this does not seem feasible.

Figure 3.1 Plan view of iceberg 001

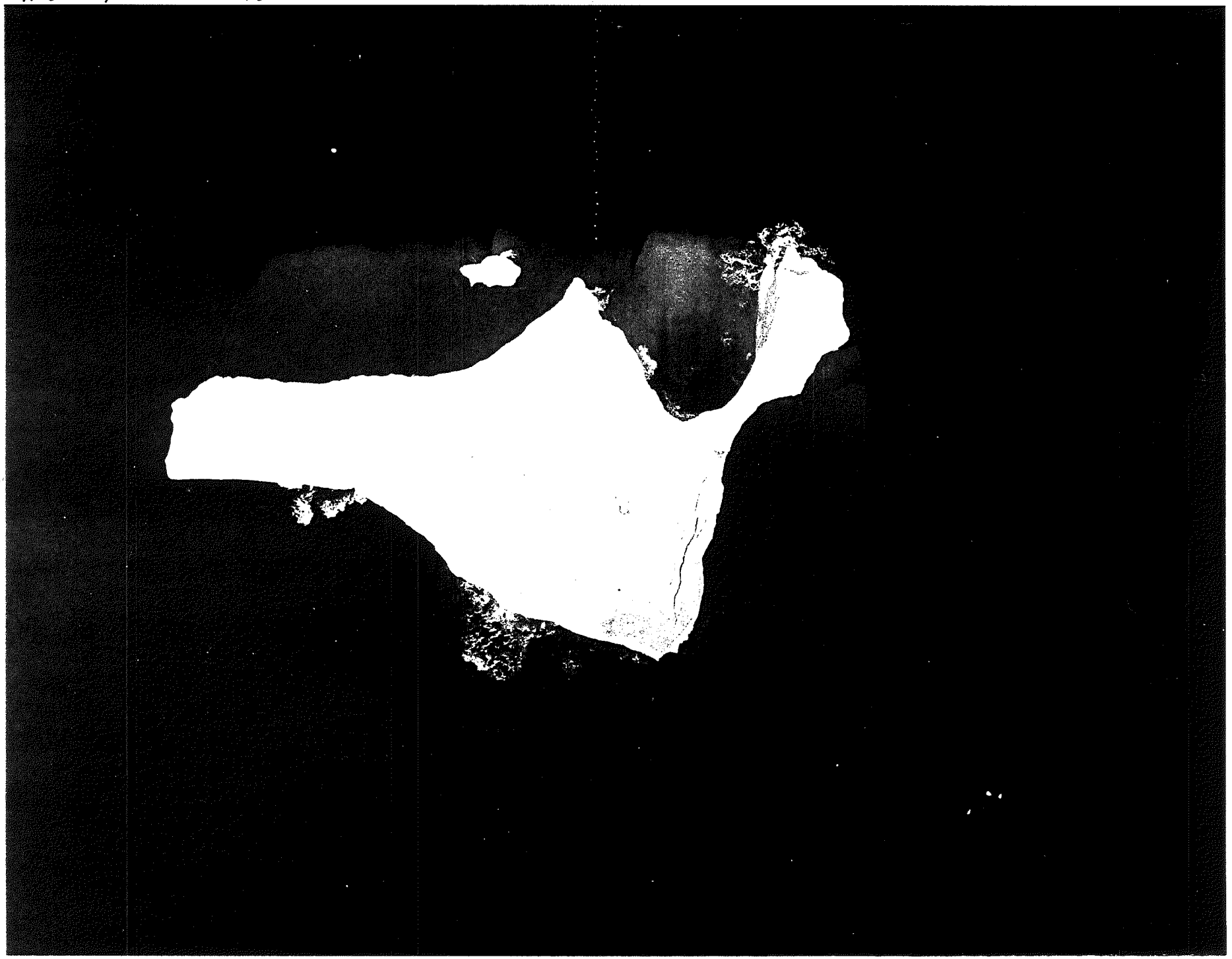


Figure 3.2 Plan view of iceberg 001

Figure 3.3 Plan view of iceberg 001

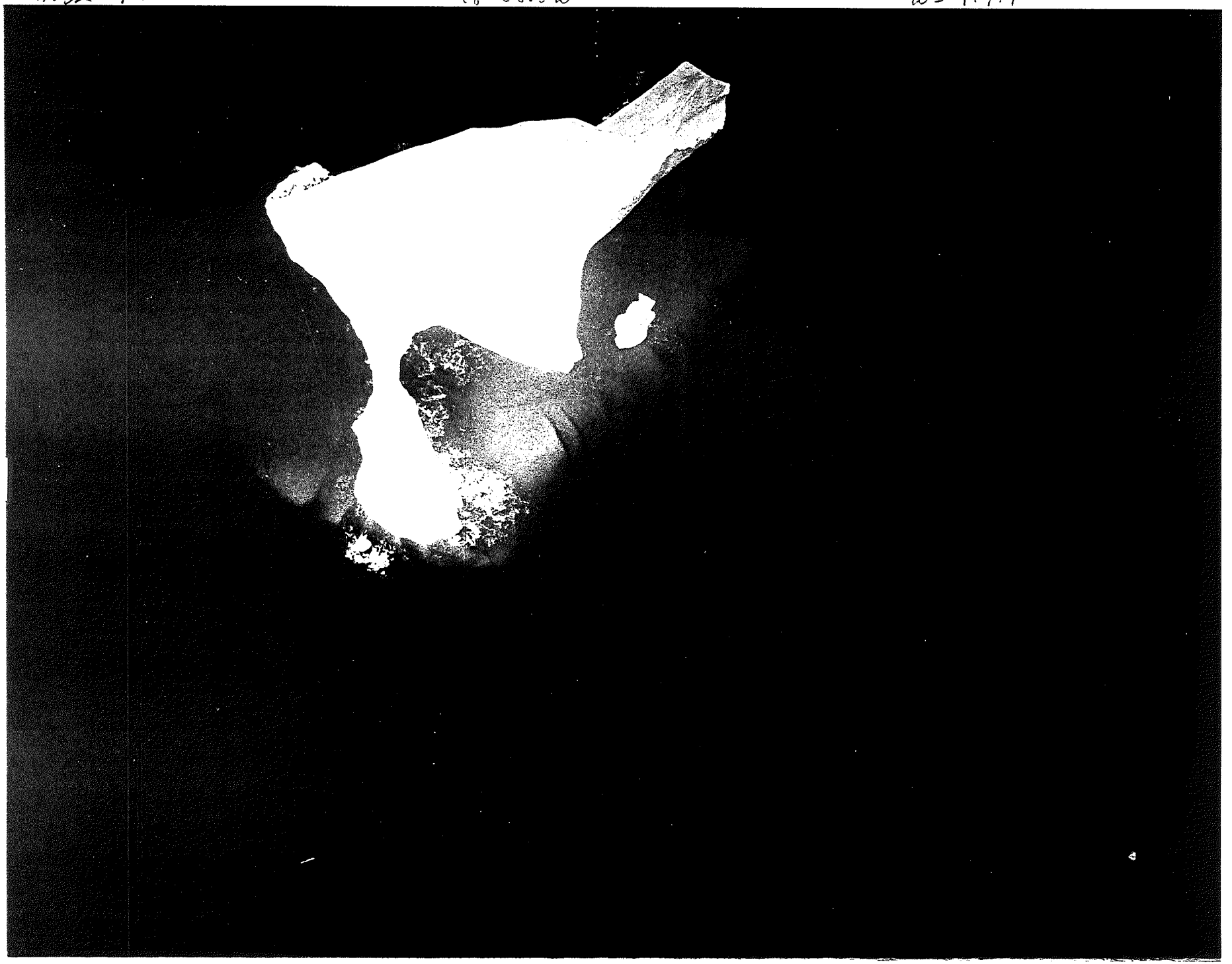


Figure 3.4 Plan view of iceberg001

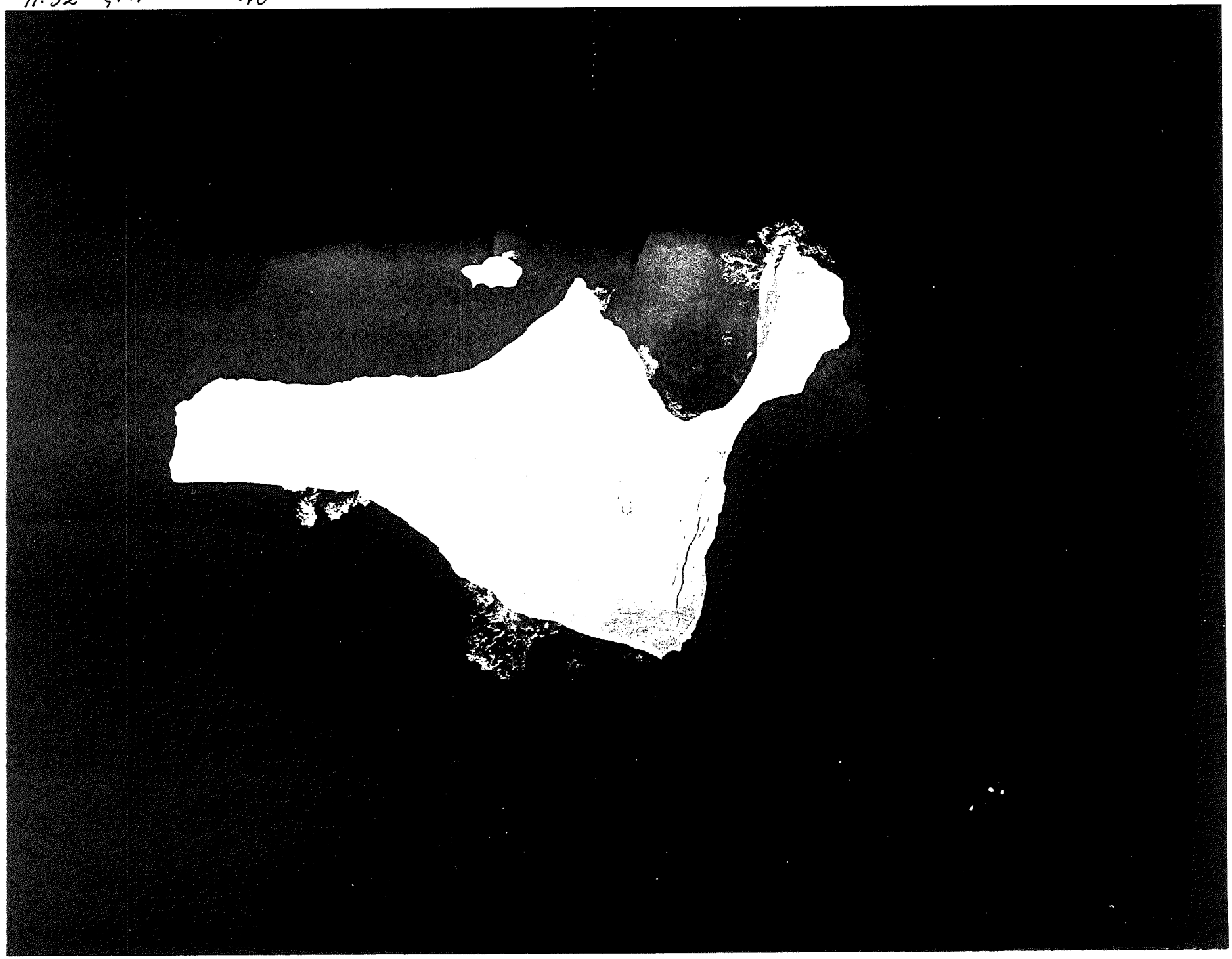


Figure 3.5 Plan view of iceberg 001

Note: Regarding all depth scales - the 100m depth is set 1 division too low.

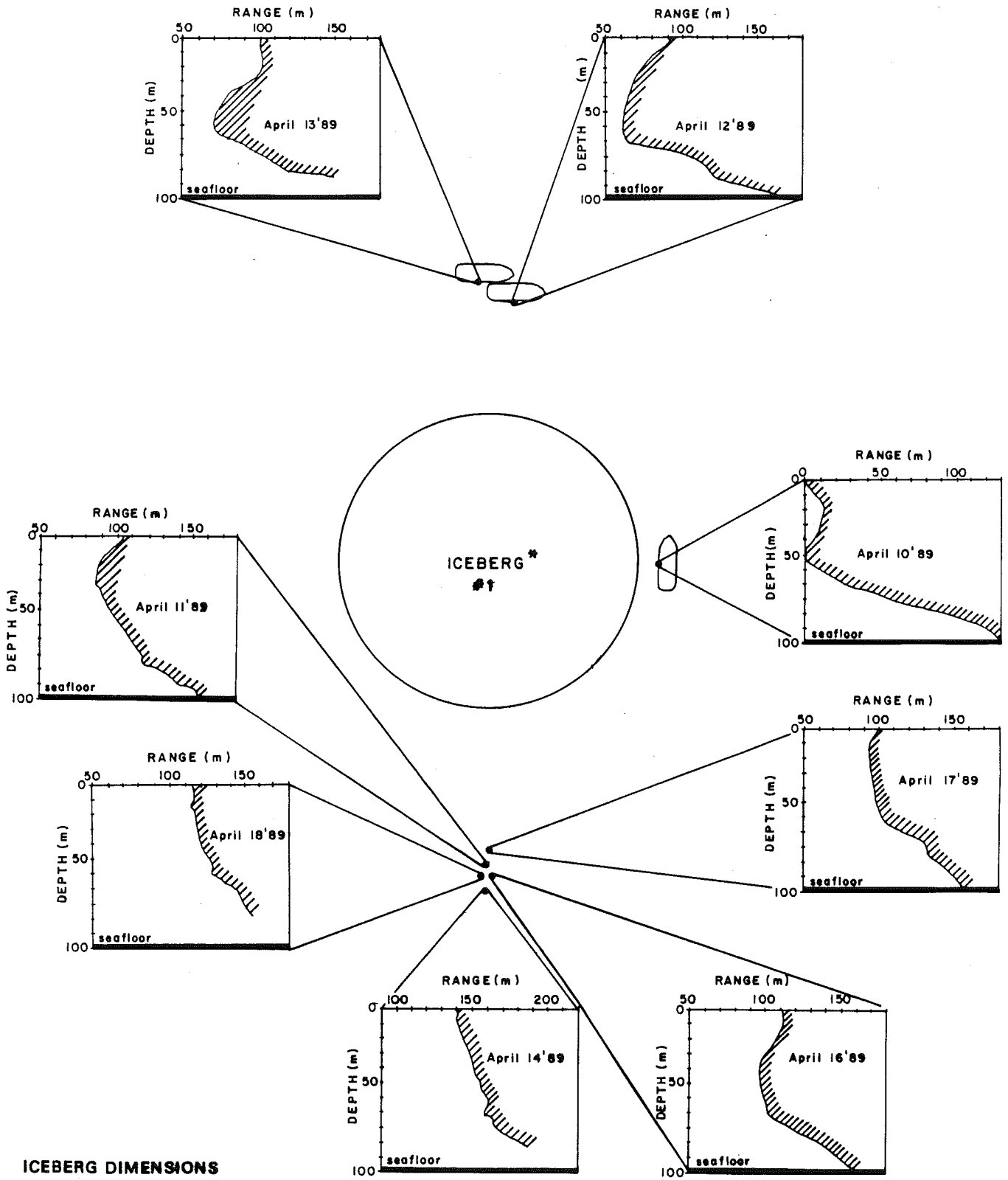


Figure 3.6 Plan view of vessel positions while measuring the underwater profiles of iceberg 001.

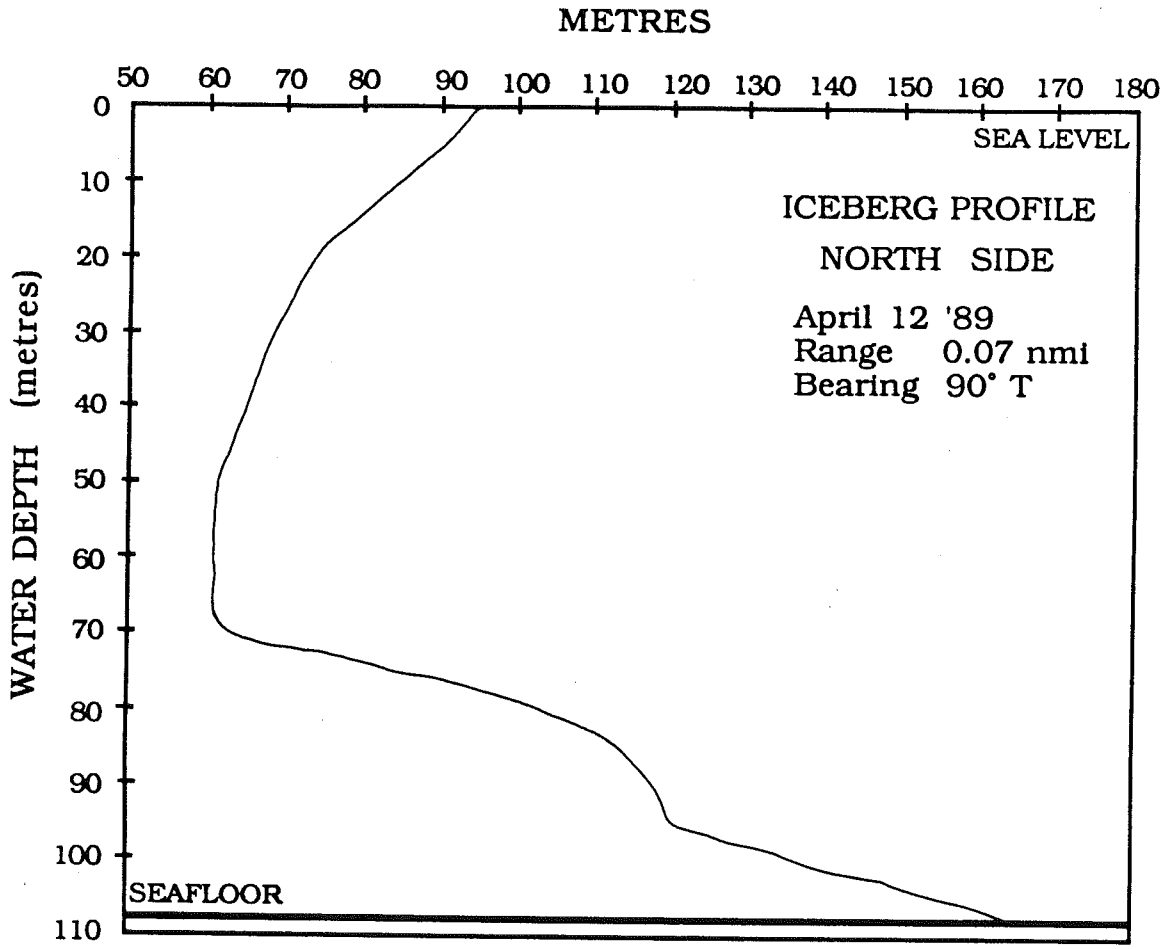


Figure 3.7 Iceberg profile north side

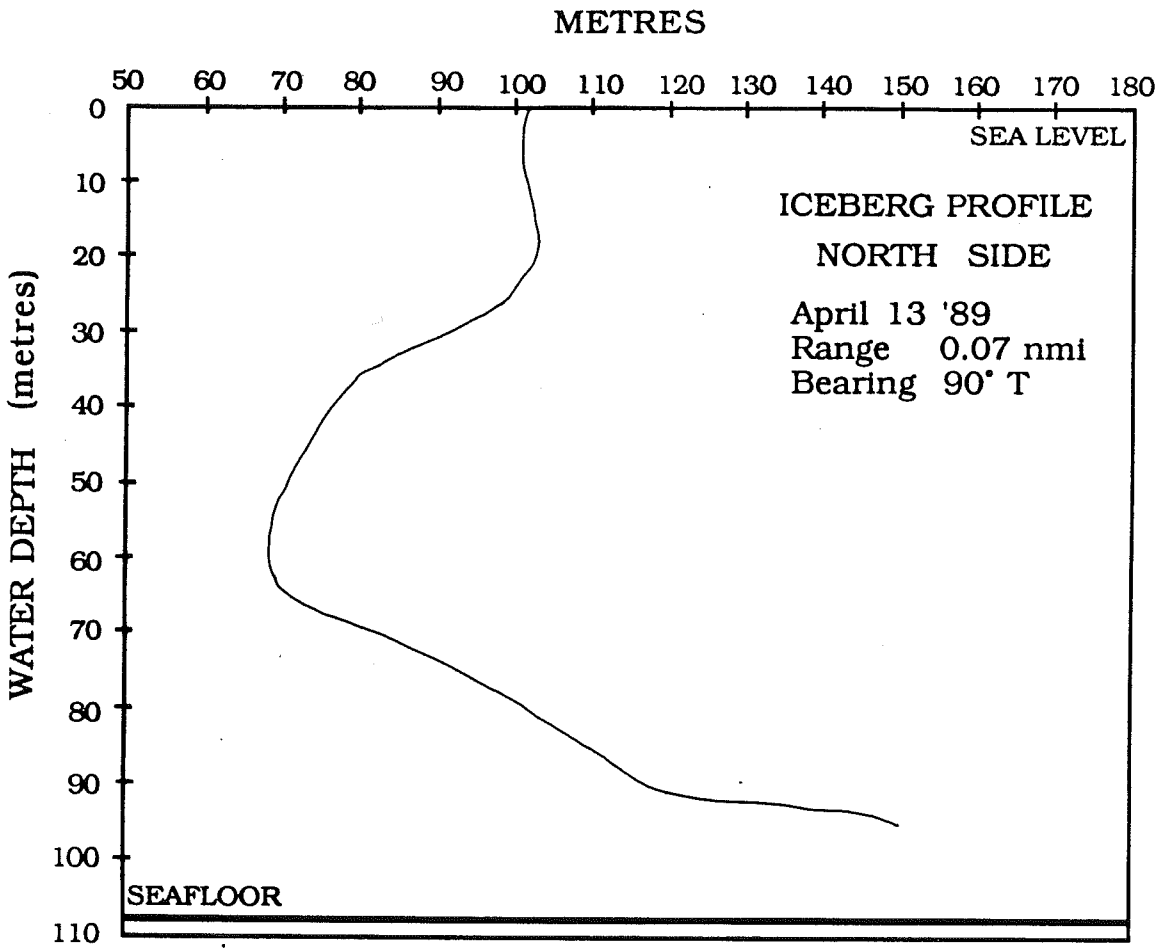


Figure 3.8 Iceberg profile north side

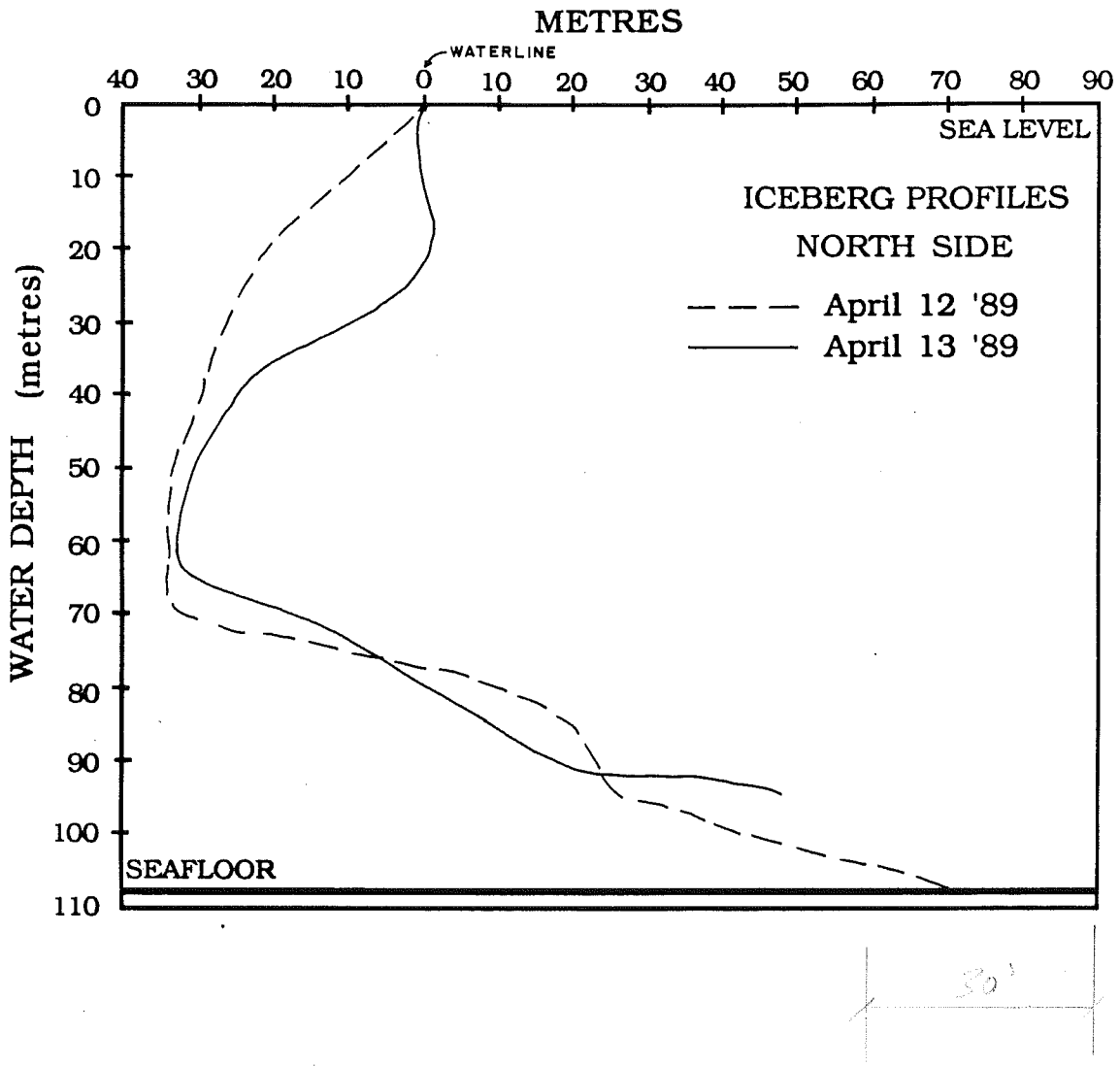


Figure 3.9 Composite of the two profiles of the north side

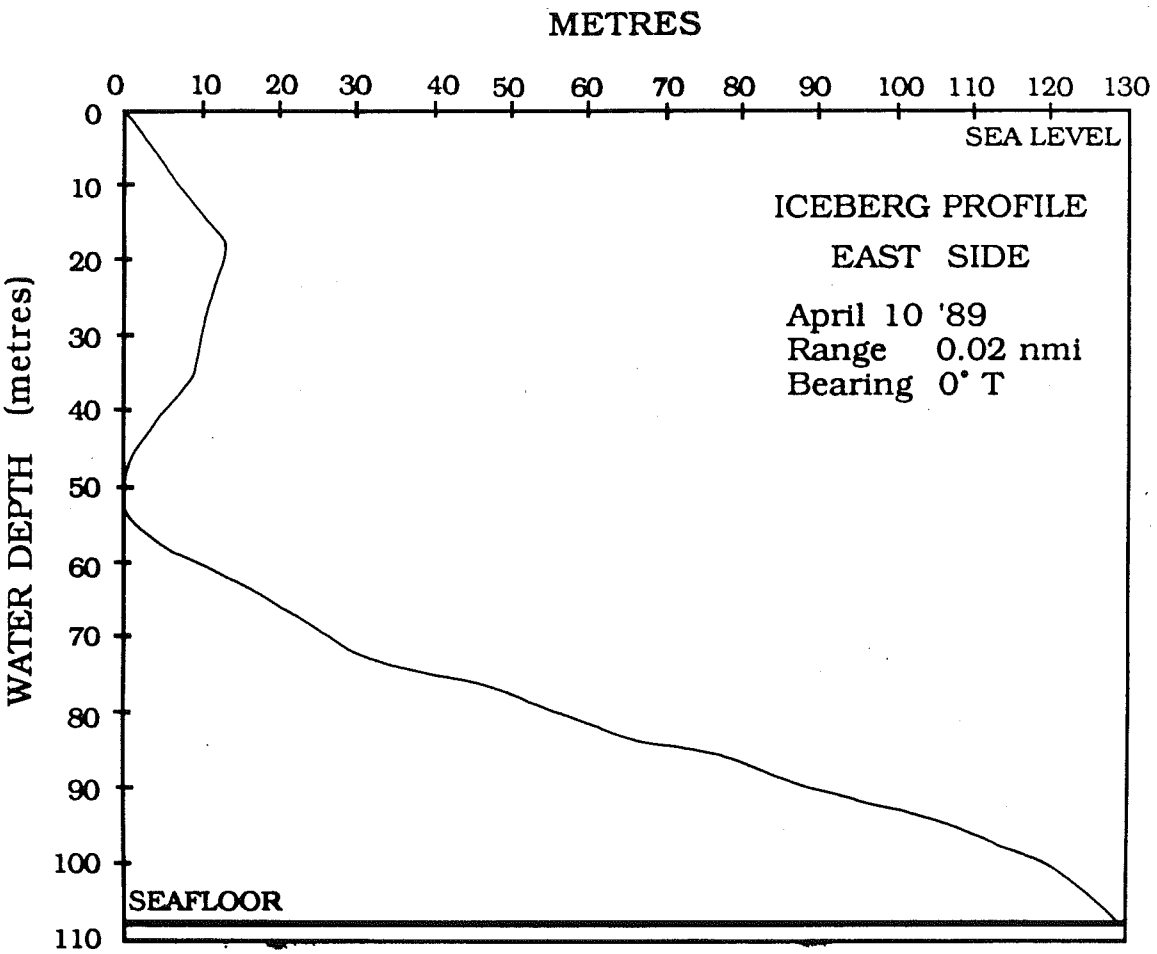


Figure 3.10 Iceberg profile east side

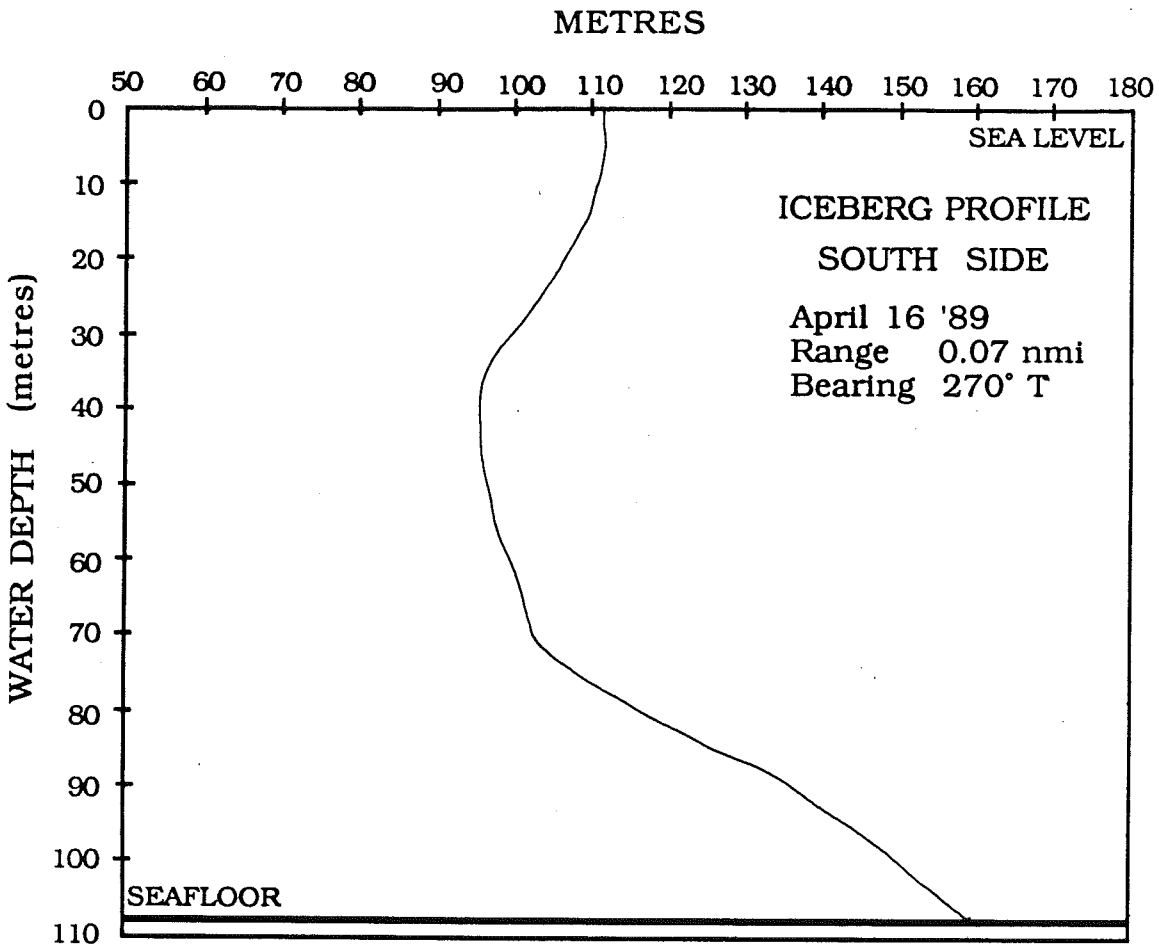


Figure 3.11 Iceberg profile south side

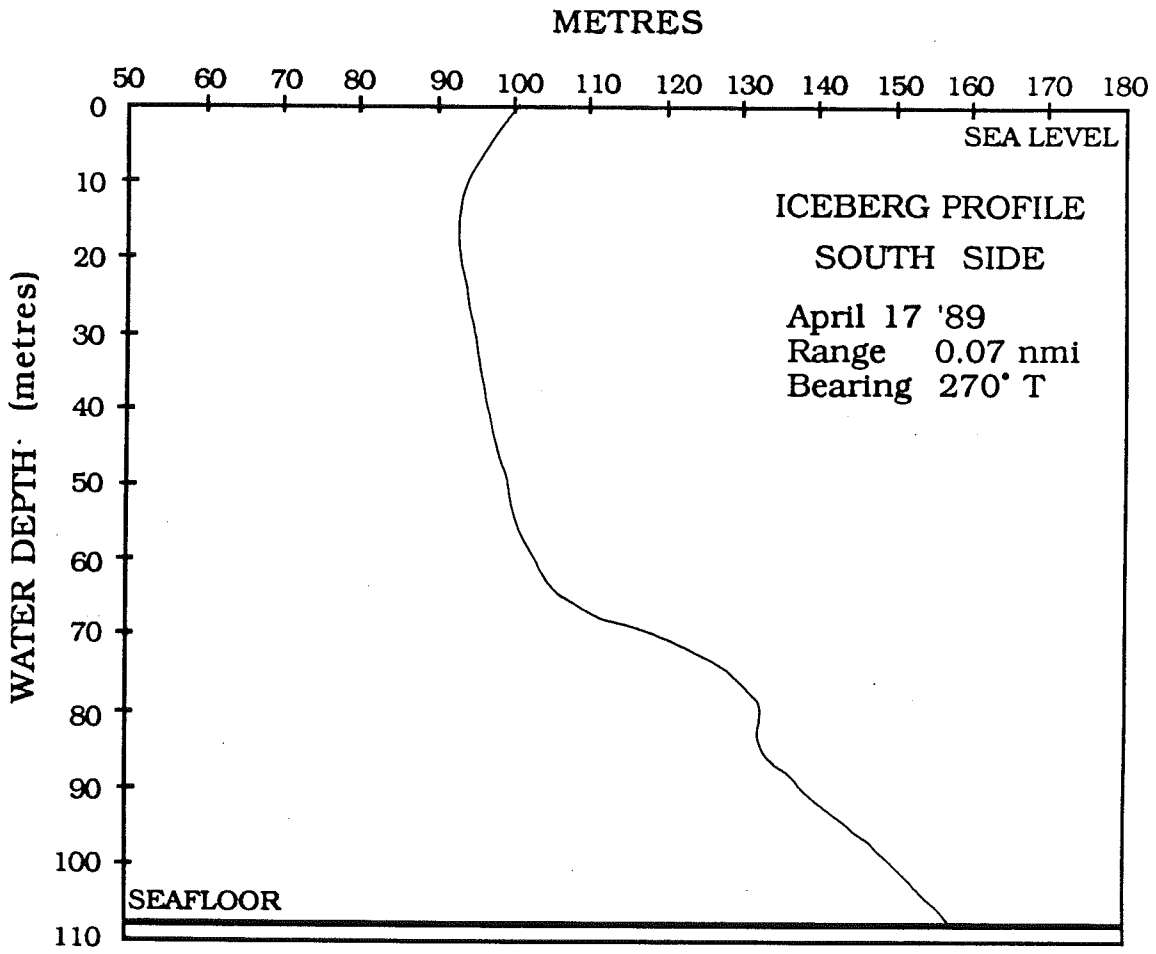


Figure 3.12 Iceberg profile south side

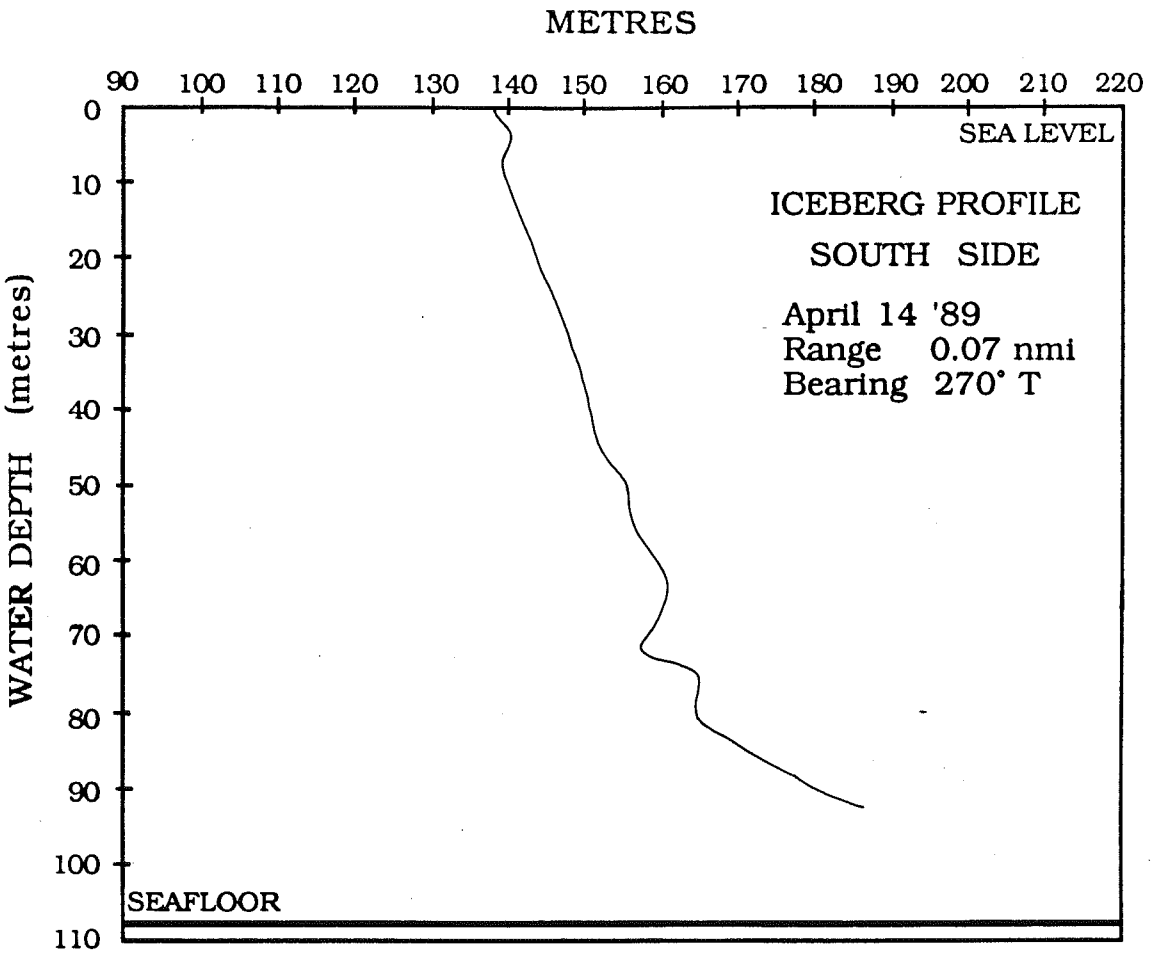


Figure 3.13 Iceberg profile south side

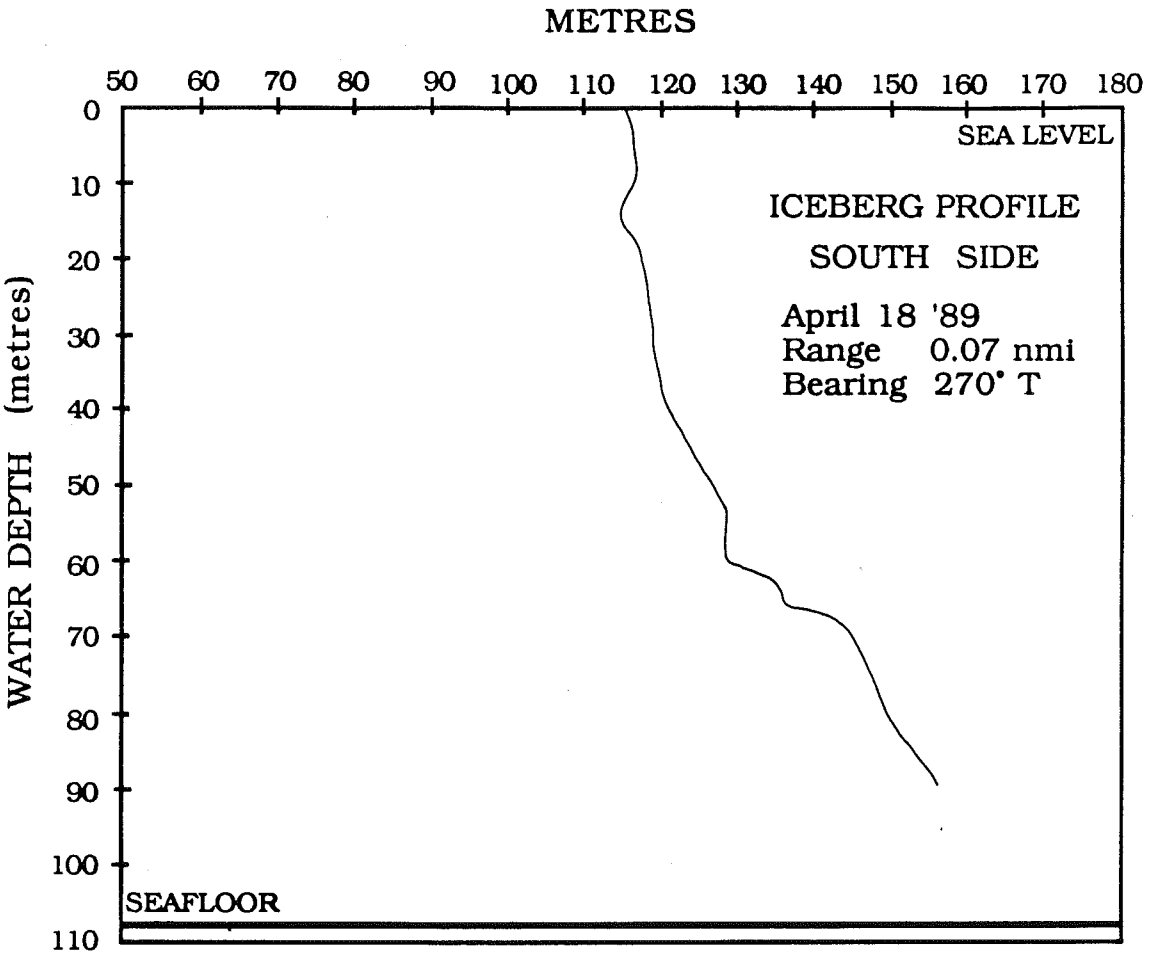


Figure 3.14 Iceberg profile south side

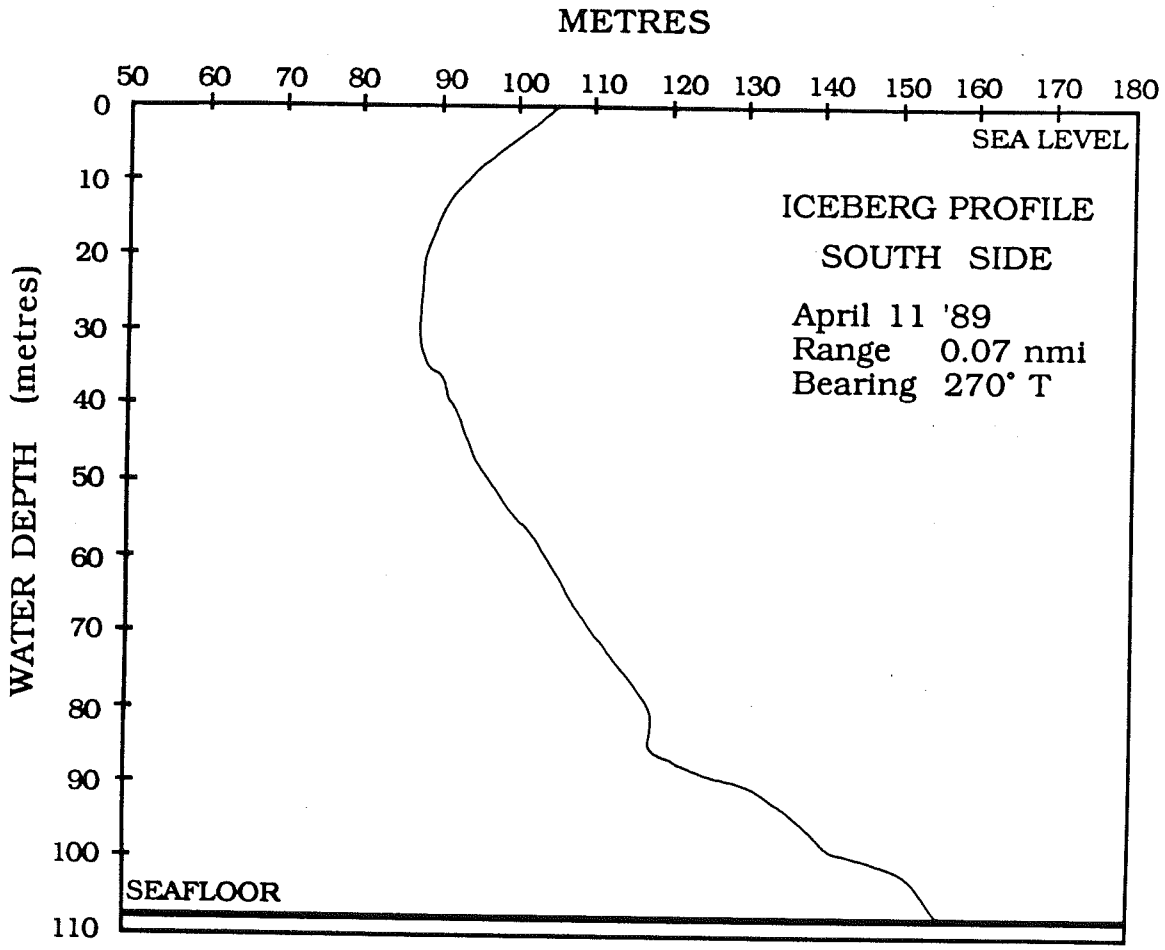


Figure 3.15 Iceberg profile south side

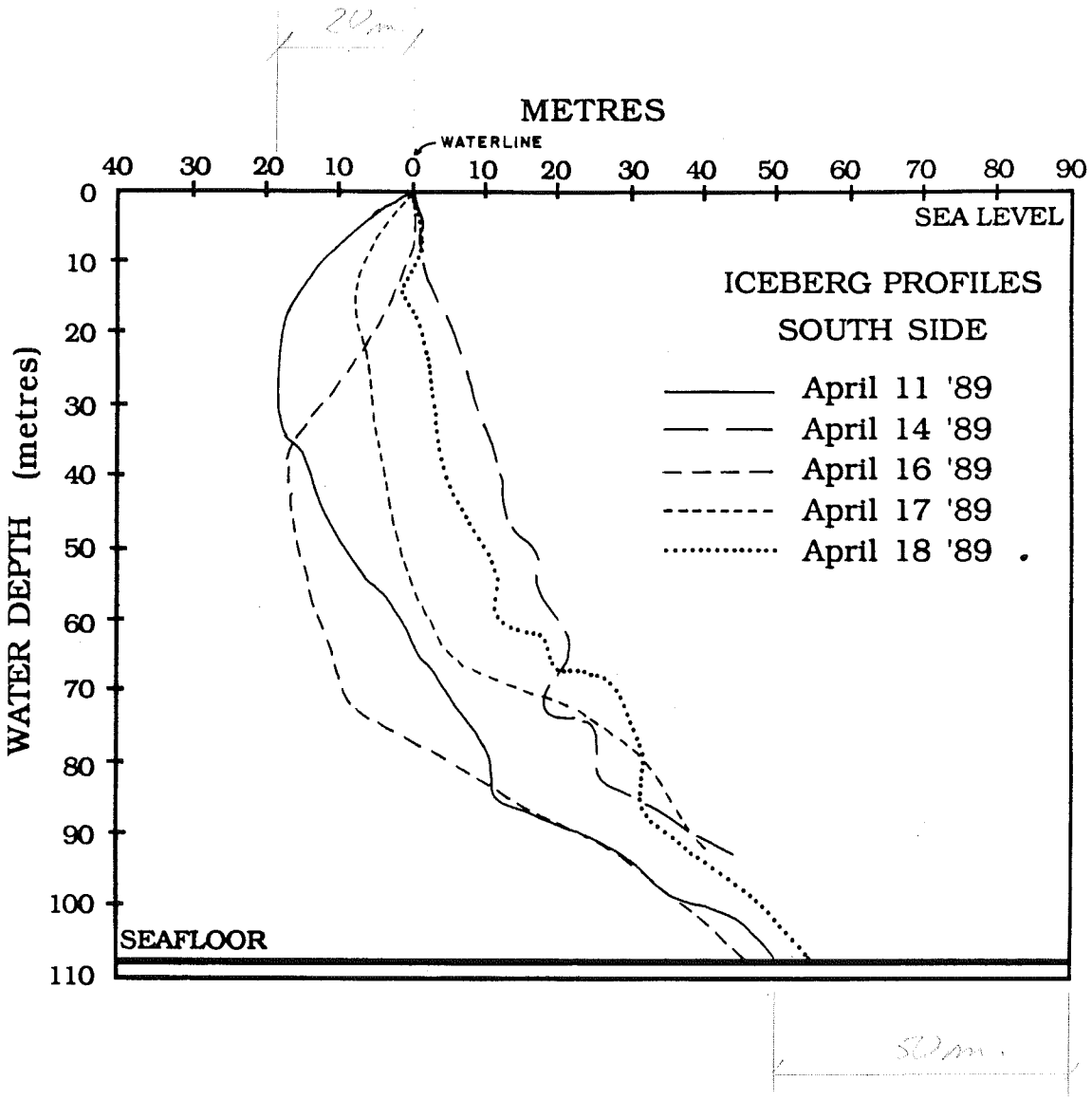


Figure 3.16 Composite of 5 profiles of the south side

4. DRIFT TRACK OF ICEBERG 001.

The positions of Berg 001 during free drift southward from the packice on March 9 and the hourly positions of the berg during 28 hours of scouring from the 117m isobath to the 112m isobath where the berg grounded, are presented in Table 4.1 and are plotted in Figs. 4.1 and 4.2. The berg was first tracked at 0800 on March 9 about 35.2 nm (65 km) from the drill rig Maersk Vinlander drilling at Springdale M-29 situated at 40°-28.8'N by 48°-19.49'W. The berg was tracked from the first observed position to the grounded position which was located about 46 km south of the initial position; the tracking period being 38 hours. The berg was firmly grounded in a water depth of 112m by 2200 hours on March 10, 1989. The berg was aground at this location (46°-40.2'N by 48°-08.3'W) until April 24, when it drifted free. The berg drifted north into deeper water as shown in Fig. 4.1. All in all, Berg 001 was tracked for a total of 52 days as presented in Table 4.1.

4.1 TOWING DURING SCOURING.

As indicated in Table 4.1, attempts were made to tow the berg towards the east; ie. into deeper water and further away from the Maersk Vinlander. Tow forces ranged from a low of 20 tonnes initially to about 75 tonnes. The tow attempt started at 0400 on March 10 when the berg was already dragging its keel. The towing efforts were of no avail, as the berg continued its southward drift into shallower waters. It was not obvious to the captain of the supply vessel that the berg was grounded and the five hours of towing after grounding occurred did not succeed in budging the berg. Later attempts to tow the berg using the combined thrust of two supply vessels had the same result. Considering the implications of the subsequent sonar survey that the bergs' keel was imbedded 5m into the bottom and that a berm up to 3m high surrounded the 90m diameter pit, it is not surprising that the tow attempts were unsuccessful.

BERG \01

Springdale M-29 (Maersk Vinlander)
(46 28.80' N 48 19.47' W)

Berg dimensions in meters
Berg mass in tonnes
L = Large berg
PNC = Pinnacle berg
M =Measured, S = Surveyed

Iceberg Dimensions: Size = L Shape = PNC
Length = M217 Width = M119 Height = M046
Draft = S112 Mass = 2114387 Stability = -3.1

Table 4.1 Hourly positions of iceberg 001

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
09/03/89	0800	35.2	11.2	47 3.3	48 9.5	VCYS	17							
09/03/89	0900	33.9	11.3	47 2.0	48 9.8	VCYS	17	1.32	189	1.0	1.3			
09/03/89	1000	32.7	12.6	47 0.7	48 9.1	VCYS	17	1.39	160	2.0	2.7			
09/03/89	1100	31.7	14.2	46 59.5	48 8.1	VCYS	17	1.38	150	3.0	4.1			
09/03/89	1200	31.0	15.5	46 58.7	48 7.4	VCYS	19	0.93	149	4.0	5.0			
09/03/89	1300	29.3	15.5	46 57.0	48 8.1	VCYS	19	1.77	196	5.0	6.8			
09/03/89	1400	28.9	17.2	46 56.4	48 7.0	VCYS	19	0.96	128	6.0	7.7			
09/03/89	1500	27.4	17.3	46 55.0	48 7.6	VCYS	19	1.46	196	7.0	9.2			
09/03/89	1600	26.3	18.2	46 53.8	48 7.5	VCYS	19	1.20	177	8.0	10.4			
09/03/89	1700	24.8	18.1	46 52.4	48 8.2	VCYS	19	1.48	199	9.0	11.9			
09/03/89	1800	23.7	19.4	46 51.1	48 8.0	VCYS	19	1.31	174	10.0	13.2			
09/03/89	1900	22.7	20.1	46 50.1	48 8.1	VCYS	19	1.00	184	11.0	14.2			
09/03/89	2000	21.8	19.4	46 49.4	48 8.9	VCYS	19	0.89	218	12.0	15.1			
09/03/89	2100	21.0	19.8	46 48.6	48 9.1	VCYS	19	0.81	190	13.0	15.9			
09/03/89	2200	20.4	20.3	46 47.9	48 9.2	VCYS	19	0.70	186	14.0	16.6			
09/03/89	2300	19.8	21.0	46 47.3	48 9.1	VCYS	19	0.60	173	15.0	17.2			
10/03/89	0000	19.4	21.3	46 46.9	48 9.2	VCYS	19	0.41	190	16.0	17.6			
10/03/89	0100	18.8	22.4	46 46.2	48 9.0	VCYS	7	0.71	169	17.0	18.3			
10/03/89	0200	18.1	23.2	46 45.4	48 9.1	VCYS	7	0.80	185	18.0	19.1			
10/03/89	0300	17.9	23.9	46 45.2	48 8.9	VCYS	7	0.24	145	19.0	19.4			
10/03/89	0400	17.0	24.8	46 44.2	48 9.1	VCYS	7	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	7	0.63	130	21.0	21.0	[L]	80.0	E055
10/03/89	0600	16.3	28.4	46 43.1	48 8.2	VCYS	7	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	7	0.50	188	23.0	22.2	[L]	90.0	E070
10/03/89	0800	15.4	29.8	46 42.2	48 8.3	VCYS	7	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	7	0.30	180	25.0	22.9	[L]	90.0	E070
10/03/89	1000	14.9	30.9	46 41.6	48 8.3	VCYS	7	0.30	180	26.0	23.2	[L]	90.0	E070
10/03/89	1100	14.6	31.3	46 41.3	48 8.4	VCYS	7	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	7	0.31	167	28.0	23.8	[L]	90.0	E070
10/03/89	1300	14.2	32.6	46 40.8	48 8.3	VCYS	7	0.20	180	29.0	24.0	[L]	90.0	E070
10/03/89	1400	14.1	33.0	46 40.6	48 8.3	VCYS	7	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	7	0.20	180	31.0	24.4	[L]	90.0	E075
10/03/89	1600	13.8	33.0	46 40.4	48 8.5	VCYS	7	0.14	270	32.0	24.6	[L]	120.0	E075
10/03/89	1700	13.3	34.4	46 39.8	48 8.5	VCYS	7	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	5	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	5	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	5	0.00	000	36.0	25.3	[L]	120.0	E075
10/03/89	2100	13.7	33.7	46 40.2	48 8.4	VCYS	5	0.31	013	37.0	25.6	[L]	90.0	E075
10/03/89	2200	13.7	34.0	46 40.2	48 8.3	VCYS	5	0.07	090	38.0	25.7	[L]	[illegible]	E075
10/03/89	2300	13.7	34.0	46 40.2	48 8.3	VCYS	5	0.00	000	39.0	25.7	[L]	90.0	E075
11/03/89	0000	13.7	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	13.7	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	13.7	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	13.7	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	13.7	34.0	46 40.2	48 8.3	VCYS	0	0.00	000	44.0	25.7			

Springdale M-29 (Maersk Vinlander)
(46 28.80' N 48 19.47' W)

Iceberg Dimensions: Size = L Shape = PNC
Length = M217 Width = M119 Height = M046
Draft = S112 Mass = 2114387 Stability = -3.1

Table 4.1 (continued)

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
11/03/89	0500	13.6	34.0	46 40.2	48 8.3	VCYS	0	0.01	110	45.0	25.7			
14/03/89	1500	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.01	264	127.0	26.6			
14/03/89	1520	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.03	301	127.3	26.6			
14/03/89	1600	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	128.0	26.6			
14/03/89	1700	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	129.0	26.6			
14/03/89	1800	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	130.0	26.6			
14/03/89	1900	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	131.0	26.6			
14/03/89	2000	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	132.0	26.6			
14/03/89	2100	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	133.0	26.6			
14/03/89	2200	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	134.0	26.6			
14/03/89	2300	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	135.0	26.6			
15/03/89	0000	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	136.0	26.6			
15/03/89	0100	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	137.0	26.6			
15/03/89	0200	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	138.0	26.6			
15/03/89	0300	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	139.0	26.6			
15/03/89	0500	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	141.0	26.6			
15/03/89	0700	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	143.0	26.6			
15/03/89	0930	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	145.5	26.6			
15/03/89	1200	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	148.0	26.6			
15/03/89	1400	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	150.0	26.6			
15/03/89	1730	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	153.5	26.6			
16/03/89	1304	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	173.1	26.6			
17/03/89	1827	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	202.5	26.6			
18/03/89	0000	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	208.0	26.6			
18/03/89	0600	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	214.0	26.6			
18/03/89	0800	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	216.0	26.6			
18/03/89	1000	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	218.0	26.6			
18/03/89	1200	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	220.0	26.6			
18/03/89	1400	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	222.0	26.6			
18/03/89	1500	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	223.0	26.6			
18/03/89	2000	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	228.0	26.6			
19/03/89	0000	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	232.0	26.6			
21/03/89	0200	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	282.0	26.6			
21/03/89	0400	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	284.0	26.6			
21/03/89	0600	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	286.0	26.6			
21/03/89	0700	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	287.0	26.6			
21/03/89	0740	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	287.7	26.6	[L]	80.0	E085
21/03/89	0900	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	289.0	26.6	[L]	80.0	E085
21/03/89	1100	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	291.0	26.6	[L]	45.0	E090
21/03/89	1300	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	293.0	26.6	[L]	100.0	E070

Springdale M-29 (Maersk Vinlander)
(46 28.80' N 48 19.47' W)

Iceberg Dimensions: Size = L Shape = PNC
Length = M217 Width = M119 Height = M046
Draft = S112 Mass = 2114387 Stability = -3.1

Table 4.1 (continued)

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
21/03/89	1500	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	295.0	26.6	[L]	110.0	E070
21/03/89	1700	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	297.0	26.6	[L]	120.0	E080
21/03/89	1900	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	299.0	26.6	[L]	150.0	E080
21/03/89	2000	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	300.0	26.6	[L]	150.0	E080
21/03/89	2100	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	301.0	26.6	[L]	70.0	E085
21/03/89	2300	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	303.0	26.6	[L]	45.0	E085
22/03/89	0100	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	305.0	26.6	[L]	45.0	E085
22/03/89	0300	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	307.0	26.6	[L]	40.0	E085
22/03/89	0400	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	308.0	26.6	[L]	25.0	E085
22/03/89	0500	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	309.0	26.6	[L]	25.0	E060
22/03/89	0700	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	311.0	26.6	[L]	15.0	E050
22/03/89	0900	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	313.0	26.6	[L]	15.0	E050
22/03/89	1100	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	315.0	26.6	[L]	30.0	E050
22/03/89	1300	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	317.0	26.6	[L]	45.0	E050
22/03/89	1500	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	319.0	26.6	[L]	45.0	E050
22/03/89	1700	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	321.0	26.6	[O]	45.0	E000
22/03/89	1900	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	323.0	26.6	[O]	43.0	E150
22/03/89	1901	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	323.0	26.6	[O]	43.0	E150
22/03/89	1902	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	323.0	26.6			
22/03/89	2100	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	325.0	26.6	[O]	45.0	E000
22/03/89	2300	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	327.0	26.6	[O]	45.0	E140
23/03/89	0100	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	329.0	26.6	[O]	45.0	E140
23/03/89	0300	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	331.0	26.6	[O]	45.0	E140
23/03/89	0500	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	333.0	26.6	[O]	45.0	E140
23/03/89	0700	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	335.0	26.6	[O]	90.0	E140
23/03/89	0900	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	337.0	26.6	[O]	93.0	E140
23/03/89	1024	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	338.4	26.6	[O]	93.0	E140
23/03/89	1025	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	338.4	26.6			
23/03/89	1300	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	341.0	26.6			
23/03/89	1500	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	343.0	26.6	[O]	25.0	E000
23/03/89	1550	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	343.8	26.6	[O]	25.0	E100
23/03/89	1700	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	345.0	26.6	[O]	45.0	E200
23/03/89	1813	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	346.2	26.6	[O]	45.0	E200
23/03/89	1814	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	346.2	26.6			
30/03/89	1600	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	512.0	26.6			
30/03/89	1900	13.2	31.0	46 40.1	48 9.6	VCYS	0	0.00	000	515.0	26.6			
30/03/89	2000	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	516.0	26.6			
30/03/89	2100	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	517.0	26.6			
30/03/89	2300	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	519.0	26.6			
31/03/89	0000	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	520.0	26.6			
31/03/89	0100	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	521.0	26.6			
31/03/89	0200	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	522.0	26.6			
31/03/89	0300	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	523.0	26.6			

Springdale M-29 (Maersk Vinlander)
(46 28.80′ N 48 19.47′ W)

Iceberg Dimensions: Size = L Shape = PNC
Length = M217 Width = M119 Height = M046
Draft = S112 Mass = 2114387 Stability = -3.1

Table 4.1 (continued)

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
31/03/89	1625	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	536.4	26.6			
01/04/89	1720	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	561.3	26.6			
01/04/89	1800	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	562.0	26.6			
01/04/89	1900	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	563.0	26.6			
01/04/89	2000	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	564.0	26.6			
01/04/89	2100	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	565.0	26.6			
01/04/89	2200	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	566.0	26.6			
01/04/89	2300	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	567.0	26.6			
02/04/89	0000	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	568.0	26.6			
02/04/89	0200	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	570.0	26.6			
02/04/89	0300	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	571.0	26.6			
02/04/89	0400	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	572.0	26.6			
02/04/89	0500	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	573.0	26.6			
02/04/89	0600	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	574.0	26.6			
02/04/89	0700	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	575.0	26.6			
02/04/89	0800	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	576.0	26.6			
02/04/89	0900	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	577.0	26.6			
02/04/89	1000	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	578.0	26.6			
02/04/89	1100	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	579.0	26.6			
02/04/89	1200	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	580.0	26.6			
03/04/89	0130	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	593.5	26.6			
03/04/89	0230	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	594.5	26.6			
03/04/89	0330	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	595.5	26.6			
03/04/89	0430	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	596.5	26.6			
03/04/89	0530	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	597.5	26.6			
03/04/89	0630	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	598.5	26.6			
03/04/89	0930	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	601.5	26.6			
03/04/89	1100	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	603.0	26.6			
03/04/89	1200	13.2	31.0	46 40.1	48 9.6	VCYQ	0	0.00	000	604.0	26.6			
04/04/89	2000	13.2	31.0	46 40.1	48 9.6	VCBQ	6	0.00	000	636.0	26.6			
05/04/89	0000	13.2	31.0	46 40.1	48 9.6	VCBQ	6	0.00	000	640.0	26.6			
05/04/89	1130	13.2	31.0	46 40.1	48 9.6	VOMR	9	0.00	000	651.5	26.6			
05/04/89	1420	13.2	31.0	46 40.1	48 9.6	VCYQ	9	0.00	000	654.3	26.6			
05/04/89	1600	13.2	31.0	46 40.1	48 9.6	VCBQ	9	0.00	000	656.0	26.6			
05/04/89	2000	13.2	31.0	46 40.1	48 9.6	VCBQ	9	0.00	000	660.0	26.6			
06/04/89	0000	13.2	31.0	46 40.1	48 9.6	VCBQ	9	0.00	000	664.0	26.6			
06/04/89	1200	13.2	31.0	46 40.1	48 9.6	VCYQ	11	0.00	000	676.0	26.6			
07/04/89	1200	13.2	31.0	46 40.1	48 9.6	VCYQ	11	0.00	000	700.0	26.6			
08/04/89	1200	13.2	31.0	46 40.1	48 9.6	VCYQ	12	0.00	000	724.0	26.6			

Springdale M-29 (Maersk Vinlander)
(46 28.80' N 48 19.47' W)

Iceberg Dimensions: Size = L Shape = PNC
Length = M217 Width = M119 Height = M046
Draft = S112 Mass = 2114387 Stability = -3.1

Table 4.1 (continued)

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
09/04/89	1200	13.2	31.0	46 40.1	48 9.6	VCYQ	12	0.00	000	748.0	26.6			
09/04/89	1600	13.2	31.0	46 40.1	48 9.6	VCYQ	12	0.00	000	752.0	26.6			
09/04/89	2000	13.2	31.0	46 40.1	48 9.6	VCYQ	12	0.00	000	756.0	26.6			
10/04/89	0000	13.2	31.0	46 40.1	48 9.6	VCYQ	12	0.00	000	760.0	26.6			
10/04/89	0400	13.2	31.0	46 40.1	48 9.6	VCYQ	12	0.00	000	764.0	26.6			
10/04/89	1200	13.2	31.0	46 40.1	48 9.6	VCYQ	12	0.00	000	772.0	26.6			
10/04/89	2000	13.2	31.0	46 40.1	48 9.6	VCYQ	12	0.00	000	780.0	26.6			
11/04/89	0000	13.2	31.0	46 40.1	48 9.6	VCYQ	12	0.00	301	784.0	26.6			
11/04/89	0400	13.2	31.0	46 40.1	48 9.6	VCYQ	12	0.00	000	788.0	26.6			
11/04/89	0800	13.2	31.0	46 40.1	48 9.6	VCYQ	12	0.00	121	792.0	26.6			
11/04/89	1200	13.2	31.0	46 40.1	48 9.6	VCYQ	12	0.00	000	796.0	26.6			
11/04/89	1600	13.2	31.0	46 40.1	48 9.6	VCYQ	12	0.00	000	800.0	26.6			
11/04/89	2000	13.2	31.0	46 40.1	48 9.6	VCYQ	12	0.00	301	804.0	26.6			
12/04/89	1200	13.2	31.0	46 40.1	48 9.6	VOMR	12	0.00	270	820.0	26.6			
13/04/89	1200	13.2	31.0	46 40.1	48 9.6	VOMR	12	0.00	090	844.0	26.6			
14/04/89	1200	13.2	31.0	46 40.1	48 9.6	VOMR	12	0.00	000	868.0	26.6			
15/04/89	1200	13.2	31.0	46 40.1	48 9.6	VOMR	12	0.00	000	892.0	26.6			
16/04/89	1200	13.2	31.0	46 40.1	48 9.6	VOMR	12	0.00	000	916.0	26.6			
17/04/89	1200	13.2	31.0	46 40.1	48 9.6	VOMR	12	0.00	000	940.0	26.6			
18/04/89	1200	13.2	31.0	46 40.1	48 9.6	VOMR	12	0.00	000	964.0	26.6			
19/04/89	1200	13.2	31.0	46 40.1	48 9.6	VOMR	8	0.00	121	988.0	26.6			
20/04/89	1200	13.2	31.0	46 40.1	48 9.6	VOMR	12	0.00	250	1012.0	26.6			
21/04/89	1200	13.2	31.0	46 40.1	48 9.6	VOMR	12	0.00	000	1036.0	26.6			
22/04/89	1200	13.2	30.9	46 40.1	48 9.6	VOMR	12	0.00	290	1060.0	26.6			
23/04/89	1200	13.2	30.9	46 40.1	48 9.6	VOMR	12	0.00	000	1084.0	26.6			
24/04/89	0500	14.5	31.3	46 41.2	48 8.5	VCBQ	12	0.08	035	1101.0	27.9			
24/04/89	0600	15.1	28.4	46 42.1	48 9.0	VCBQ	9	0.96	339	1102.0	28.9			
24/04/89	0700	15.5	26.2	46 42.7	48 9.5	VCBQ	9	0.69	330	1103.0	29.6	[L]	30.0	M050
24/04/89	0800	15.8	25.4	46 43.1	48 9.6	VCBQ	9	0.41	350	1104.0	30.0	[L]	30.0	M070
24/04/89	0900	16.4	23.1	46 43.9	48 10.1	VCBQ	9	0.87	337	1105.0	30.9	[L]	30.0	M070
24/04/89	1000	17.4	22.0	46 44.9	48 10.0	VCBQ	9	1.00	004	1106.0	31.9	[L]	30.0	M070

BERG 001

Springdale M-29 (Maersk Vinlander)
(46 28.80′ N 48 19.47′ W)

Iceberg Dimensions: Size = L Shape = PNC
Length = M217 Width = M119 Height = M046
Draft = S112 Mass = 2114387 Stability = -3.1

Table 4.1 (continued)

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
24/04/89	1100	17.9	22.9	46 45.3	48 9.3	VCBQ	9	0.63	050	1107.0	32.5	[L]	30.0	M070
24/04/89	1200	18.6	23.7	46 45.8	48 8.6	VCBQ	9	0.69	044	1108.0	33.2	[L]	30.0	M070
24/04/89	1300	19.2	24.9	46 46.2	48 7.7	VCBQ	9	0.74	057	1109.0	33.9	[L]	30.0	M070
24/04/89	1500	20.6	26.5	46 47.2	48 6.1	VCBQ	9	0.74	048	1111.0	35.4	[L]	30.0	M070
24/04/89	1600	21.0	27.6	46 47.4	48 5.3	VCBQ	9	0.58	070	1112.0	36.0	[L]	30.0	M070
24/04/89	1700	21.7	28.1	46 47.9	48 4.6	VCBQ	9	0.69	044	1113.0	36.7	[L]	30.0	M070
24/04/89	1800	22.1	28.3	46 48.3	48 4.2	VCBQ	9	0.48	034	1114.0	37.2	[L]	30.0	M070
24/04/89	1900	22.5	29.1	46 48.5	48 3.5	VCBQ	9	0.52	067	1115.0	37.7	[L]	30.0	M070
24/04/89	2000	22.7	29.1	46 48.6	48 3.4	VCBQ	9	0.12	034	1116.0	37.8	[L]	30.0	M070
24/04/89	2100	23.0	28.9	46 48.9	48 3.3	VCBQ	9	0.31	013	1117.0	38.1	[L]	30.0	M070
24/04/89	2200	23.3	29.3	46 49.1	48 2.9	VCBQ	9	0.34	054	1118.0	38.5	[L]	30.0	M070
24/04/89	2300	23.4	29.2	46 49.2	48 2.9	VCBQ	9	0.10	006	1119.0	38.6	[L]	30.0	M070
25/04/89	0000	23.7	29.6	46 49.4	48 2.4	VCBQ	9	0.39	059	1120.0	39.0	[L]	30.0	M070
25/04/89	0100	23.8	30.1	46 49.4	48 2.1	VCBQ	9	0.21	090	1121.0	39.2	[L]	30.0	M070
25/04/89	0200	24.1	30.9	46 49.5	48 1.4	VCBQ	9	0.49	078	1122.0	39.7	[L]	30.0	M07
25/04/89	0300	24.3	32.0	46 49.4	48 0.7	VCBQ	9	0.49	102	1123.0	40.1	[L]	30.0	M07
25/04/89	0400	24.6	32.6	46 49.5	48 0.2	VCBQ	9	0.36	074	1124.0	40.5	[L]	30.0	M070
25/04/89	0500	24.9	33.0	46 49.7	47 59.7	VCBQ	9	0.40	060	1125.0	40.9	[L]	30.0	M070
25/04/89	0600	25.2	33.3	46 49.9	47 59.3	VCBQ	9	0.34	054	1126.0	41.2	[L]	30.0	M070
25/04/89	0700	25.5	34.4	46 49.8	47 58.5	VCBQ	9	0.56	100	1127.0	41.8	[L]	30.0	M070
25/04/89	0800	26.0	36.0	46 49.8	47 57.2	VCBQ	11	0.89	090	1128.0	42.7	[L]	30.0	M070
25/04/89	0900	26.4	36.5	46 50.0	47 56.6	VCBQ	11	0.46	064	1129.0	43.1	[L]	30.0	M070
25/04/89	1000	26.8	37.8	46 50.0	47 55.5	VCBQ	11	0.76	090	1130.0	43.9	[L]	30.0	M070
25/04/89	1500	28.5	44.8	46 49.0	47 50.2	VCBQ	11	0.76	105	1135.0	47.7	[L]	30.0	M070
25/04/89	1600	28.8	46.6	46 48.6	47 49.0	VCBQ	11	0.92	116	1136.0	48.6	[L]	30.0	M070
25/04/89	1700	28.9	48.4	46 48.0	47 48.0	VCBQ	11	0.91	131	1137.0	49.5	[L]	30.0	M050
25/04/89	1800	29.0	49.4	46 47.7	47 47.4	VCBQ	11	0.51	126	1138.0	50.0	[L]	30.0	M050
25/04/89	1900	29.1	50.6	46 47.3	47 46.7	VCBQ	11	0.63	130	1139.0	50.6	[L]	30.0	M050
25/04/89	2000	29.4	51.2	46 47.2	47 46.1	VCBQ	11	0.42	104	1140.0	51.1	[L]	30.0	M050
25/04/89	2100	29.9	52.3	46 47.1	47 45.0	VCBQ	11	0.76	098	1141.0	51.8	[L]	30.0	M050
25/04/89	2300	29.9	50.7	46 47.7	47 45.8	VCBQ	11	0.41	317	1143.0	52.6	[L]	30.0	M050
26/04/89	0000	30.0	51.0	46 47.7	47 45.5	VCBQ	9	0.21	090	1144.0	52.8	[L]	30.0	M070
26/04/89	0100	30.2	50.5	46 48.0	47 45.6	VCBQ	9	0.31	347	1145.0	53.2	[L]	30.0	M070
26/04/89	0200	30.4	50.6	46 48.1	47 45.3	VCBQ	9	0.23	064	1146.0	53.4	[L]	30.0	M070
26/04/89	0300	30.8	50.5	46 48.4	47 44.8	VCBQ	9	0.46	049	1147.0	53.8	[L]	30.0	M070
26/04/89	0400	31.2	50.1	46 48.8	47 44.6	VCBQ	9	0.42	019	1148.0	54.3	[L]	30.0	M070
26/04/89	0500	31.5	49.6	46 49.2	47 44.6	VCBQ	9	0.40	360	1149.0	54.7	[L]	30.0	M070
26/04/89	0600	31.9	50.2	46 49.2	47 43.8	VCBQ	9	0.55	090	1150.0	55.2	[L]	30.0	M070
26/04/89	0700	32.1	49.4	46 49.7	47 44.0	VCBQ	9	0.52	344	1151.0	55.7	[L]	30.0	M07
26/04/89	0800	32.5	49.3	46 50.0	47 43.6	VCBQ	9	0.41	042	1152.0	56.1	[L]	30.0	M07
26/04/89	1000	33.1	50.1	46 50.0	47 42.5	VCBQ	9	0.38	090	1154.0	56.9	[L]	30.0	M070
26/04/89	1100	33.4	50.2	46 50.2	47 42.1	VCBQ	9	0.34	054	1155.0	57.2	[L]	30.0	M070
26/04/89	1200	33.8	50.8	46 50.2	47 41.3	VCBQ	9	0.55	090	1156.0	57.8	[L]	30.0	M070
26/04/89	1300	33.9	51.2	46 50.0	47 41.0	VCBQ	9	0.29	134	1157.0	58.1	[L]	30.0	M070
26/04/89	1400	34.1	51.5	46 50.0	47 40.6	VCBQ	9	0.27	090	1158.0	58.3	[L]	30.0	M070

Springdale M-29 (Maersk Vinlander)
(46 28.80' N 48 19.47' W)

Iceberg Dimensions: Size = L Shape = PNC
Length = M217 Width = M119 Height = M046
Draft = S112 Mass = 2114387 Stability = -3.1

Table 4.1 (continued)

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
26/04/89	1500	34.1	52.0	46 49.8	47 40.3	VCBQ	9	0.29	134	1159.0	58.6	[L]	30.0	M070
26/04/89	1600	34.2	52.1	46 49.8	47 40.1	VCBQ	9	0.14	090	1160.0	58.8	[L]	30.0	M070
26/04/89	1700	34.1	52.0	46 49.8	47 40.3	VCBQ	9	0.14	270	1161.0	58.9	[L]	30.0	M070
26/04/89	1800	34.4	51.3	46 50.3	47 40.4	VCBQ	9	0.50	352	1162.0	59.4	[L]	30.0	M070
26/04/89	1900	34.9	51.1	46 50.7	47 39.9	VCBQ	9	0.53	040	1163.0	59.9	[L]	30.0	M070
26/04/89	2000	35.4	51.6	46 50.8	47 39.0	VCBQ	9	0.63	081	1164.0	60.6	[L]	30.0	M070
26/04/89	2100	35.7	52.0	46 50.8	47 38.5	VCBQ	9	0.34	090	1165.0	60.9	[L]	30.0	M070
26/04/89	2200	36.4	53.0	46 50.7	47 37.1	VCBQ	9	0.97	096	1166.0	61.9	[L]	30.0	M070
26/04/89	2300	36.8	54.2	46 50.3	47 36.0	VCBQ	9	0.86	118	1167.0	62.7	[L]	30.0	M070
27/04/89	0000	37.3	55.9	46 49.7	47 34.5	VCBQ	11	1.19	120	1168.0	63.9	[L]	30.0	M070
27/04/89	0100	37.5	57.2	46 49.1	47 33.5	VCBQ	11	0.91	131	1169.0	64.8	[L]	30.0	M070
27/04/89	0200	37.8	59.1	46 48.2	47 32.2	VCBQ	11	1.27	135	1170.0	66.1	[L]	30.0	M070
27/04/89	0300	38.0	60.2	46 47.7	47 31.4	VCBQ	11	0.74	132	1171.0	66.8	[L]	30.0	M070
27/04/89	0400	38.2	61.6	46 47.0	47 30.5	VCBQ	11	0.94	138	1172.0	67.8	[L]	30.0	M070
27/04/89	0500	38.4	63.7	46 45.8	47 29.3	VCBQ	11	1.46	145	1173.0	69.2	[L]	30.0	M070
27/04/89	0600	38.5	65.1	46 45.0	47 28.7	VCBQ	11	0.90	153	1174.0	70.1	[L]	30.0	M070
27/04/89	0700	38.5	65.9	46 44.5	47 28.3	VCBQ	11	0.57	151	1175.0	70.7	[L]	30.0	M070
27/04/89	0800	38.7	67.3	46 43.7	47 27.5	VCBQ	11	0.97	145	1176.0	71.7	[L]	60.0	M030
27/04/89	0900	39.0	68.0	46 43.4	47 26.9	VCBQ	11	0.51	126	1177.0	72.2	[L]	90.0	M070
27/04/89	1000	39.0	68.8	46 42.9	47 26.5	VCBQ	11	0.57	151	1178.0	72.8	[L]	90.0	M070
27/04/89	1100	39.1	70.0	46 42.2	47 26.0	VCBQ	11	0.78	154	1179.0	73.6	[L]	90.0	M070
27/04/89	1200	39.6	70.5	46 42.0	47 25.2	VCBQ	11	0.59	110	1180.0	74.1	[L]	90.0	M070
27/04/89	1300	40.1	71.1	46 41.8	47 24.3	VCBQ	11	0.65	108	1181.0	74.8	[L]	90.0	M070
27/04/89	1400	40.6	71.8	46 41.5	47 23.3	VCBQ	11	0.75	114	1182.0	75.5	[L]	90.0	M070
27/04/89	1500	41.3	72.8	46 41.0	47 22.0	VCBQ	11	1.03	119	1183.0	76.6	[L]	90.0	M070
27/04/89	1600	42.3	74.1	46 40.4	47 20.3	VCBQ	11	1.32	117	1184.0	77.9	[L]	90.0	M070
27/04/89	1700	43.2	75.7	46 39.5	47 18.6	VCBQ	11	1.48	127	1185.0	79.4	[L]	90.0	M070
27/04/89	1800	43.4	77.1	46 38.5	47 18.0	VCBQ	11	1.08	157	1186.0	80.5	[L]	90.0	M070
27/04/89	2000	43.5	78.5	46 37.5	47 17.5	VCBQ	11	0.53	161	1188.0	81.5	[L]	90.0	M070
28/04/89	0255	40.3	84.4	46 32.7	47 21.2	VCBQ	11	0.78	208	1194.9	86.9			
28/04/89	0530	40.4	84.6	46 32.6	47 21.1	VCBQ	11	0.05	145	1197.5	87.1			
28/04/89	0700	40.7	85.6	46 31.9	47 20.5	VCBQ	11	0.54	149	1199.0	87.9			
28/04/89	0800	41.0	85.9	46 31.7	47 20.0	VCBQ	11	0.40	120	1200.0	88.3			
30/04/89	1600	40.0	137.7	45 59.2	47 40.5	VCYQ	12	0.63	203	1256.0	123.6			
30/04/89	1700	40.1	139.0	45 58.5	47 41.4	VCYQ	12	0.93	222	1257.0	124.6			

23/04/89 1200 13.18 30.9 (CPA)
27/04/89 2000 43.50 78.5 (MDR)

SPEEDS (knots)

Min.	Max.	Mean	MadeGood	
0.00	1.77	0.28	0.05	(to 163 T; DRIFT RATIO = 0.54)

TOTAL NUMBER OF OBSERVATIONS = 278

SITE SPECIFIC TARGET PLOT

SURROUNDING Area w.r.t.
Springdale M-29
(Maersk Vinlander)
46 28' 47.82" N
48 19' 28.22" W

From 0800 L March 09, 1989
to 1700 L April 30, 1989
(52 days, 9.00 hours)

1 Iceberg Tracked.
276 Observations.
1 Target Deflected.

Radius = 60.0 n. mi.
Tic Interval = 5.0 n. mi.

Springdale M-29 is at
the Center of Plot.

DISTANCE TRACKED (n.mi)	CPA (n.mi.)	MEAN SPEED (kts)
123.1	13.2	0.3

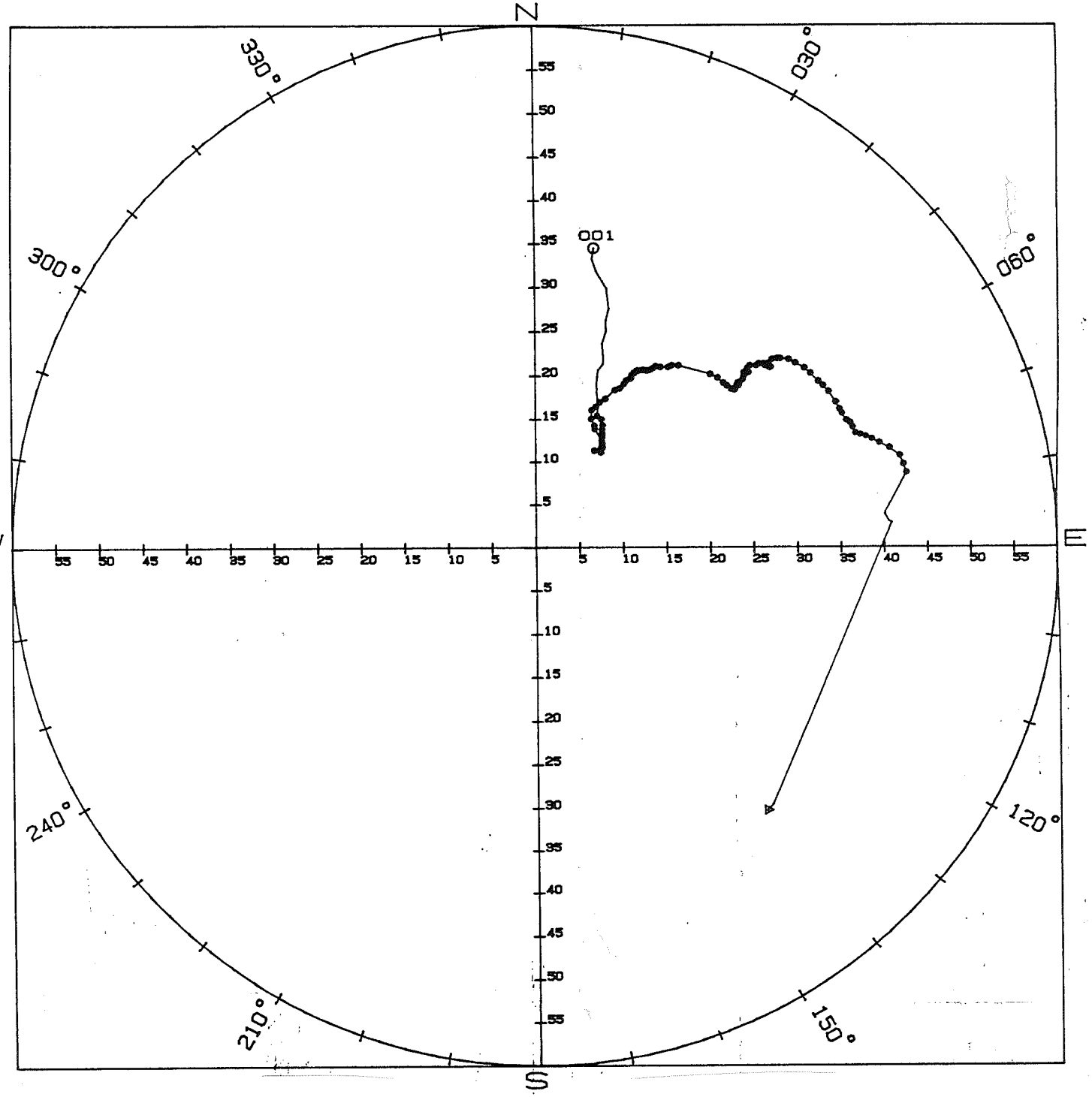


Figure 4.1 Complete drift track of iceberg 001

4.2 INTERPRETATION OF DRIFT DATA.

The drift track (Fig. 4.2) and the inferred iceberg draft (117m) suggests that the following sequential grounding events occurred.

1) the berg drifted freely during the first 10 hours of observation, and drifted a distance of 13.2 nm (24.6 km) from 0800 to 1800 hours on March 9. The mean free drift speed was 1.32 knots (0.7 m/sec) and the winds were from the northwest to WNW at 36 to 29 knots (Section 5). The drift was almost due south into shallower water.

2) at 1800 hours, the berg is inferred to have commenced scouring where the inferred draft is equal to the water depth (117m).

3) scouring is inferred for the next 28 hours until the berg grounded solidly. The berg drifted towards the south while scouring with a maximum speed of 1.01 knots (0.5 m/sec). During the 28 hour inferred scour period, the winds were westerly at first and then changed to WSW while the wind speeds decreased from a high of 27 knots to a low of 10 knots at the time of solid grounding. It should be noted that the winds partly opposed the drift towards the south during March 10.

4) the inferred scouring distance is 11.5 nm (21 km) for the inferred scouring period (1800- March 9 to 2200- March 10) and the mean drift speed was 0.41 knots (0.2 m/sec)

5) by 2200 hours on March 10, the berg was firmly grounded in 112m of water. at 46°-40.0'N by 48°-08.5'W.

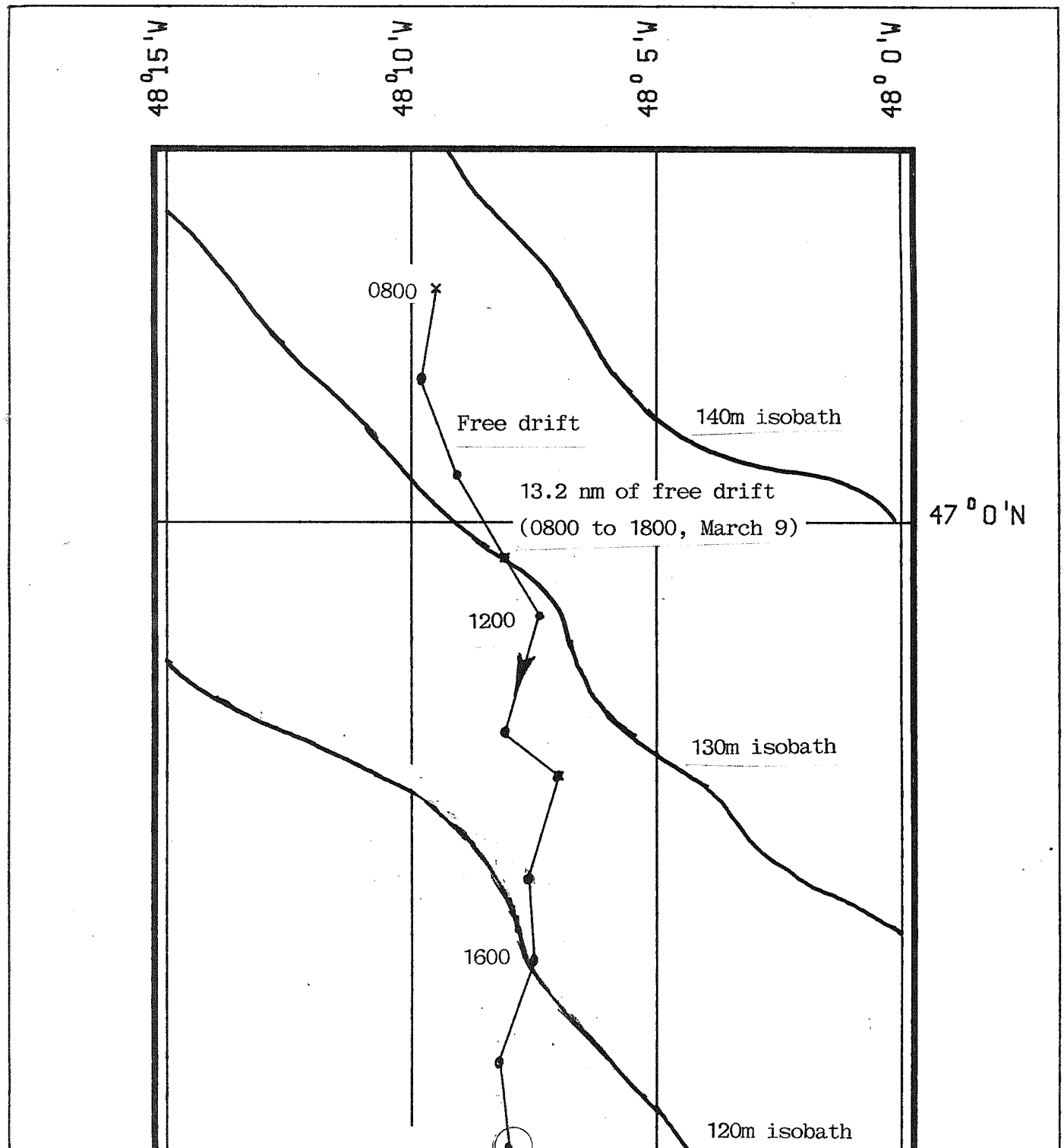
6) the berg remained stationary until April 24; a period of 45 days. Several attempts were made to tow the berg from its solidly grounded position, all to no avail.

7) the berg shifted position (tilted) several times after April 21, suggesting adjustments due to ice deterioration (T. Murphy, personal communication, 1989).

8) the berg drifted free on April 24 and drifted towards the north into deeper water as a result of ice deterioration and winds from the SSE as shown in Fig. 4.1.

9) during May 5, the Atlantic Geoscience Centre conducted a geophysical survey along 13 km of the scour and the pit (Fader, 1989).

The release of the berg from the grounded position was precipitated by oscillations on April 21 and by 54 knot winds from the SSE on April 23.


48°15'W
48°10'W
48° 5'W
48° 0'W
0800
Free drift
140m isobath
13.2 nm of free drift
(0800 to 1800, March 9)
47° 0'N
1200
130m isobath
1600
120m isobath

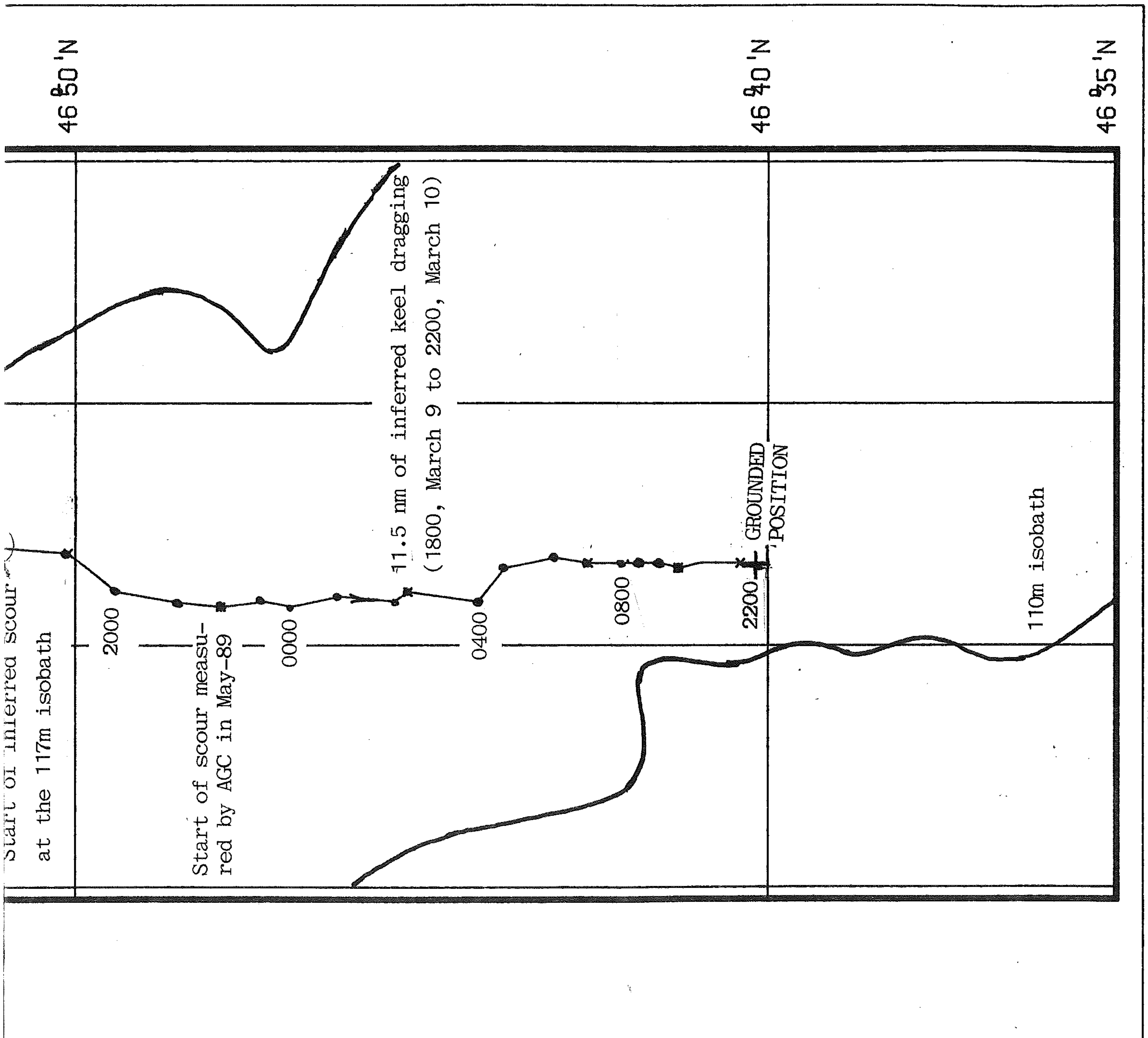


Figure 4.2 Detailed drift track of iceberg 001 for March 9 and 10, 1989

4.3 DRIFT SPEED DURING SCOURING ON MARCH 9 AND 10

The drift speeds involved in the scouring process are of interest to modellers of scours. It is evident that relatively high speeds were maintained during the scouring period. At the 117m isobath where scouring is inferred to have started, the drift speed was 1.31 knots (0.7 m/sec). We know that the scour is at least 15 km long and that the speed at that location was 0.7 knots (0.37 m/sec). The maximum speed attained by Berg 001 while scouring along the 15 km long portion of the scour was 1 knot (0.52 m/sec), and the speed decreased to zero at the grounded position. Assuming that the total scour length is 11.5 nm (21 km), the mean drift speed was 0.41 knots (0.2 m/sec) during the inferred 28-hour scour period. For the known 15 km long scour segment, the mean drift speed was 0.3 knots (0.15 m/sec) during the known 24-hour scour period. These values compare with a mean free drift speed of 1.32 knots (0.7 m/sec) during the 10-hour free drift period preceeding the start of the inferred scouring at the 117m isobath. The mean drift speed of 0.3 knots (0.15 m/sec) during the last 24 hours of scouring is less than half of the 0.68 knot (0.35 m/sec) free drift speed of berg 003, which drifted towards the south during the same period about 15 nm (28 km) to the southeast. The drift speeds are tabulated below.

Drift speed during 10 hours of free drift prior to grounding.

Mean speed 1.32 knots (0.7 m/sec)
Maximum speed 1.77 knots (0.9 m/sec)
Mimimum speed 0.93 knots (0.5 m/sec)

Keel dragging speed for the known 15 km long scour.

Mean speed 0.30 knots (0.15 m/sec)
Maximum speed 1.01 knots (0.5 m/sec)
Minimum speed 0.00 knots (0.0 m/sec)

Keel dragging speed for the 21 km long inferred scour.

Mean speed 0.41 knots (0.2 m/sec)
Maximum speed 1.31 knots (0.7 m/sec)
Minimum speed 0.00 knots (0.0 m/sec)

4.4 DRIFT SPEEDS DURING GROUNDING AS A FUNCTION OF WATER DEPTHS.

It is obvious by viewing the drift track (Fig. 4.2) that the hourly displacements along the drift track towards the south into shallower waters decrease along the track. During the last hour of scouring, the displacement was only 0.07 nm (130m). The drift track has been segmented into discrete components in order to find a relationship between drift speed and water depth or as a function of the differences between the 117m inferred draft and the water depth.

				Drift speed(s) (kn)			Water depth	Draft - Depth
March	Time period	Hours	Status	Mean	Max.	Min.	(meters)	▲ D (meters)
9	0800-1800	10	FD	1.32	1.77	0.96	136 to 117	117 -117 = 0
9	1800-2200	4	KD	0.85	1.00	0.70	117 to 115	117 -115 = 2
9-10	2200-0200	4	KD	0.63	0.80	0.41	115 to 114	117 -114 = 3
10	0200-0600	4	KD	0.65	1.01	0.24	114 to 113	117 -113 = 4
10	0600-1000	4	KD	0.38	0.60	0.3	113 to 112	117 -112 = 5
10	1000-2200	12	KD	0.20	0.60	0.00	112 to 112	112 -112 = 0

FD = free drift, KD = keel dragging

Linear regression of the mean drift speed (S) and ▲D, the difference between water depth and iceberg draft (117m), can be expressed by the equation:

$$S = 1.31 - 0.21 \blacktriangle D \qquad (1)$$

The drift speed is in knots. Equation (1) relates the drift speed of iceberg 001 while keel dragging to other known and relevant parameters. It is recognized that equation (1) by itself may be of local significance only, but it may be useful also for comparison with as yet underived relationships of scouring speeds and ▲D, for example, for other known icebergs and scours.

5. WIND DATA

The relevant wind data are presented in Table 5.1. These data were collected at the Maersk Vinlander at an elevation of 76.2m by a Weather Measure W 102 anemometer. The data are taken to be representative of winds at adjacent iceberg locations owing to the large scales involved with wind systems over oceans. Wind data are discussed in the interpretation of iceberg drift data.

DAY/HOUR MATRIX OF SELECTED HOURLY DATA FOR
Springdale M-29 - FEBRUARY 1989

WIND SPEED/DIRECTION (kts/!T)

TYPE OF ANEMOMETER: Weather Measure W102

ELEV. 76.2 m
46-28-48 N 48-19-28 W

Table 5.1 Wind data — Wind speeds in knots, M = missing data

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
10																						27 WSW	26 SW	23 WSW
11	21 SW	M M	M M	24 W	M M	M M	19 WSW	18 WSW	14 WSW	07 WSW	07 W	03 WSW	09 SSE	09 SSE	06 ESE	11 E	16 E	23 E	23 E	23 E	21 ENE	20 ENE	22 ENE	35 NE
12	35 NE	26 NE	19 NE	11 SSW	20 NNW	32 NNW	36 NW	30 NW	30 W	27 W	22 WSW	23 WSW	18 WSW	19 SW	19 SSW	21 SSW	20 SSW	21 SSW	23 S	23 S	23 S	30 S	M M	35 SSE
13	40 SSE	44 SSE	41 S	45 S	38 S	42 SSE	45 S	45 SSE	46 SSE	46 SSE	44 SSE	47 SSE	44 S	43 S	45 S	40 SSW	35 SSW	29 SW	24 SW	18 WNW	23 NNW	31 N	35 N	33 N
14	31 N	32 NNW	36 NNW	36 NNW	33 NNW	30 NNW	42 NNW	39 WNW	30 NNW	26 N	24 N	18 N	15 N	18 N	13 N	11 NNW	08 NNW	M M	08 NNW	06 N	02 NNW	03 SW	M M	M M
15	12 S	M M	M M	19 S	M M	M M	22 S	23 S	25 SSW	26 SSW	28 SSW	32 SSW	35 SSW	33 SSW	40 S	34 SSW	31 SSW	37 SW	31 SW	30 W	28 W	26 W	M M	M M
16	19 W	M M	M M	11 WSW	M M	M M	18 SW	12 SW	06 SW	11 SW	10 SW	02 WSW	03 SSE	03 SE	06 E	43 E	07 NE	05 E	01 N	07 WSW	13 W	18 W	M M	M M
17	26 W	M M	M M	30 WNW	M M	M M	28 W	37 W	31 W	45 WNW	29 NNW	25 NW	28 WNW	37 W	36 WNW	39 W	35 W	34 W	38 W	40 W	39 W	40 W	39 W	37 W
18	40 W	42 W	36 W	39 W	44 WNW	40 W	42 W	40 W	37 W	37 W	39 W	37 W	33 W	36 W	38 W	41 W	39 W	40 W	39 W	31 W	34 W	32 W	32 W	33 W
19	32 W	27 W	30 W	31 W	32 WSW	30 WSW	30 WSW	31 WSW	30 SW	26 W	27 W	28 WSW	28 WSW	20 WSW	27 WSW	21 WSW	19 W	19 W	17 WSW	16 SW	13 SW	18 SW	14 SW	13 SW
20	12 SW	10 SW	09 SSW	07 S	09 SSW	05 SSW	06 SSW	04 W	04 WNW	04 NNW	12 NNW	15 NW	18 NW	18 NW	20 NW	21 WNW	23 WNW	21 W	24 W	24 W	30 W	27 W	28 W	26 W
21	26 W	22 W	19 WSW	22 WSW	28 W	26 W	21 W	22 WNW	21 W	16 W	17 W	15 WSW	14 SW	16 SW	17 SW	20 SSW	23 SW	22 SW	21 SW	23 SW	23 SW	21 SW	22 SW	20 SSW
22	22 SSW	22 SSW	21 S	23 S	26 S	28 S	34 S	38 S	42 S	40 SSW	41 SSW	43 SSW	44 SSW	42 SSW	42 SSW	41 SSW	42 SSW	41 SSW	41 SSW	41 SSW	41 SW	39 SW	38 SW	38 SSW
23	42 SW	44 SSW	45 SSW	45 SSW	45 SSW	45 SW	45 SW	47 SW	47 SW	45 SW	45 SW	44 SW	42 SW	29 WSW	28 SW	33 SW	28 SW	29 SW	23 SW	24 SW	28 SW	37 SW	41 SW	43 SW
24	44 SW	43 SW	41 SW	42 SW	38 SW	27 WSW	27 SW	29 SW	31 SW	26 W	12 NNW	11 NE	11 NE	15 NNE	18 NNE	13 NNE	10 NNE	11 NNE	11 NNE	10 NNE	12 NNE	09 NNE	19 NNE	22 NNE

DAY/HOUR MATRIX OF SELECTED HOURLY DATA FOR
Springdale M-29 - FEBRUARY 1989

WIND SPEED/DIRECTION (kts/!T)

TYPE OF ANEMOMETER: Weather Measure W102

Table 5.1 (cont'd)

ELEV. 76.2 m
46-28-48 N 48-19-28 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
25	22 NNE	23 NNE	23 NNE	20 NNE	20 NNE	20 NNE	20 NNE	20 NNE	25 NNE	23 NNE	22 NNE	25 NNE	25 NNE	26 W	28 ENE	25 ENE	25 ENE	25 ENE	24 ENE	25 ENE	25 ENE	25 ENE	25 ENE	30 ENE
26	30 ENE	30 ENE	30 E	30 E	30 E	25 E	22 SSW	29 SW	29 SW	30 SW	31 SW	30 SW	30 SW	27 W	30 SW	30 SW	26 SW	25 SW	25 SW	25 SW	23 SW	21 SW	24 WSW	25 SW
27	24 SW	23 SW	23 SW	19 SW	16 SW	17 WSW	15 SW	15 WSW	16 WSW	11 WSW	11 WSW	09 WSW	08 WSW	10 SW	11 WSW	09 SW	11 W	10 WSW	10 WSW	09 W	02 WNW	00 C	07 SSE	06 ESE
28	17 E	15 E	23 E	30 E	16 E	35 SSW	33 SSW	32 SSW	32 SSW	28 SSW	27 W	31 WSW	34 W	41 W	49 W	42 W	41 W	37 W	41 W	37 W	37 W	37 W	35 W	37 W

DAY/HOUR MATRIX OF SELECTED HOURLY DATA FOR
Springdale M-29 - MARCH 1989

WIND SPEED/DIRECTION (kts/!T)

TYPE OF ANEMOMETER: Weather Measure W102

Table 5.1 (cont'd)

ELEV. 76.2 m
46-28-48 N 48-19-28 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
1	37	35	36	35	32	36	30	31	28	30	24	20	20	11	06	07	03	00	04	06	10	09	07	11
	W	W	W	W	WNW	WNW	WNW	W	W	WNW	WNW	W	W	NW	NW	WNW	NW	C	SE	E	SSE	E	E	NE
2	21	20	20	23	26	25	25	28	35	33	37	37	35	28	31	33	28	25	26	23	22	18	19	20
	NE	NE	NE	NNE	N	NW	NW	WNW	W	W	W	W	W	WSW	WSW	WSW	W	W	WSW	W	WSW	WSW	SW	SW
3	15	17	23	18	19	27	36	38	33	36	29	27	27	23	23	24	35	26	29	29	27	28	24	32
	SW	SSW	WSW	WSW	WSW	W	W	W	N	W	W	W	W	WSW	WSW	WSW	W	WSW	W	W	WSW	W	W	W
4	32	27	35	32	33	35	38	37	36	38	38	42	37	41	44	40	41	40	41	37	38	36	32	31
	W	W	W	W	W	WNW	WNW	WNW	W	WNW	WNW	WNW	WNW	WNW	WNW	WNW	WNW	WNW	WNW	WNW	WNW	WNW	NW	NW
5	25	29	27	26	22	22	22	20	20	21	21	17	14	13	12	12	10	06	08	14	12	14	08	08
	NW	NW	NW	NW	WNW	NW	NW	NW	NW	WNW	NW	NW	NW	NNW	NW	NW	NW	WNW	NW	W	W	W	SW	SW
6	11	15	18	21	24	24	24	24	23	27	30	34	37	33	27	48	54	44	42	34	36	35	37	36
	SW	SW	SW	SSW	SSW	SW	SSW	SSW	SSW	SSW	SSW	S	S	S	S	S	SSW	SSW	SW	SW	WSW	WSW	WSW	WSW
7	46	40	41	40	43	44	38	44	46	40	43	43	40	39	36	35	30	31	28	23	17	18	18	19
	WSW	W	W	WSW	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
8	18	22	22	25	22	21	24	24	25	20	28	28	26	28	30	29	35	33	28	29	32	32	30	33
	W	N	N	N	NNW	NNW	NNW	NNW	NNW	NNW	NW	NW	NW	WNW	WNW	WNW	WNW	WNW	WNW	WNW	NW	NW	NW	NW
9	33	35	35	38	38	38	38	38	36	36	29	32	32	34	33	32	31	32	29	27	29	23	24	23
	WNW	WNW	WNW	NW	WNW	NW	NW	NW	WNW	NW	NW	NW	WNW	WNW	WNW	WNW	WNW	WNW	W	W	WNW	W	W	W
10	24	25	23	27	25	24	26	28	26	25	22	21	21	17	17	16	15	14	13	10	10	10	12	10
	W	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	W	WSW	WSW	W	NW	NW	NNW	NNW	N
11	18	22	18	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
	N	NW	N	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
12	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
13	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
14	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
15	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

DAY/HOUR MATRIX OF SELECTED HOURLY DATA FOR
Springdale M-29 - MARCH 1989

WIND SPEED/DIRECTION (kts/!T)

TYPE OF ANEMOMETER: Weather Measure W102

Table 5.1 (cont'd)

ELEV. 76.2 m
46-28-48 N 48-19-28 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
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	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
21	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
22	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
23	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
24	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
25	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
26	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
27	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
28	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
29	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	
30	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

DAY/HOUR MATRIX OF SELECTED HOURLY DATA FOR
Springdale M-29 - MARCH 1989

WIND SPEED/DIRECTION (kts/!T)

TYPE OF ANEMOMETER: Weather Measure W102

Table 5.1 (cont'd)

ELEV. 76.2 m
46-28-48 N 48-19-28 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
31	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

DAY/HOUR MATRIX OF SELECTED HOURLY DATA FOR
Springdale M-29 - APRIL 1989

WIND SPEED/DIRECTION (kts/!T)

TYPE OF ANEMOMETER: Weather Measure W102

Table 5.1 (cont'd)

ELEV. 76.2 m
46-28-48 N 48-19-28 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
1	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
2	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
3	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	26	28	29	29	25	M	M
	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	NW	WNW	WNW	WNW	NW	M	M
4	16	M	M	15	M	M	16	13	12	15	13	10	12	11	14	13	13	12	12	12	11	13	M	M
	W	M	M	WSW	M	M	WSW	W	W	WSW	W	W	WSW	SW	SW	WSW	SW	WSW	SW	SW	SW	SW	M	M
5	15	M	M	20	M	M	24	25	25	26	28	32	35	26	29	30	24	23	22	26	26	25	M	M
	SSW	M	M	S	M	M	S	S	S	S	S	S	S	S	SSW	SSW	SSW	SSW	SW	WSW	W	W	M	M
6	24	M	M	23	M	M	21	22	22	25	27	28	26	25	23	20	21	20	19	16	15	10	M	M
	W	M	M	WSW	M	M	WSW	W	W	W	W	WNW	WNW	WNW	WNW	W	W	WNW	W	WNW	NW	W	M	M
7	10	M	M	18	M	M	15	15	15	20	22	18	23	19	18	23	22	25	29	30	30	33	M	M
	SSW	M	M	SW	M	M	WSW	WSW	WSW	WSW	W	WSW	W	WSW	SW	SW	SW	SW	SW	SW	SW	SW	M	M
8	34	M	M	29	M	M	22	24	19	20	17	12	11	06	10	08	10	12	08	08	18	31	M	M
	SW	M	M	SW	M	M	WSW	SW	WSW	WSW	WSW	WSW	SW	SSW	SSW	S	SSW	S	SSW	SSW	SSW	SSW	M	M
9	40	M	M	35	M	M	40	38	38	23	30	29	31	31	33	29	32	30	33	33	28	26	31	30
	SSW	M	M	SW	M	M	SSW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	WSW	SW	SSW	SW
10	32	29	27	21	19	18	24	31	30	29	33	33	33	34	35	33	36	34	29	28	26	29	24	M
	SW	SW	SW	SW	SW	SW	WSW	W	W	WSW	WSW	WSW	WSW	WSW	W	W	WSW	WSW	WSW	WSW	WSW	WSW	WSW	M
11	24	M	M	24	M	M	17	15	18	20	19	19	19	20	18	21	23	24	20	21	18	17	M	M
	WSW	M	M	SW	M	M	WSW	SW	SW	SW	SW	SW	WSW	SW	SW	SW	SW	SW	WSW	WSW	W	WNW	M	M
12	09	M	M	06	M	M	07	06	09	09	09	13	16	15	14	14	12	15	14	15	15	14	M	M
	NW	M	M	NNW	M	M	NE	ENE	ENE	ENE	ENE	NE	ENE	ENE	ENE	ENE	ENE	NE	NE	NNE	NE	NE	M	M
13	13	M	M	12	M	M	12	14	13	13	13	14	13	11	06	14	12	14	15	20	21	17	M	M
	NE	M	M	NNE	M	M	NNE	NNE	NNE	N	N	N	N	N	NNW	W	WNW	W	W	W	W	WNW	M	M
14	16	M	M	14	M	M	16	13	11	11	16	17	14	11	10	10	11	09	11	11	09	09	M	M
	NW	M	M	WNW	M	M	WNW	W	WSW	SW	SW	WSW	WSW	WSW	WSW	W	SW	SW	SW	SSW	SSW	SW	M	M
15	12	M	M	21	M	M	26	26	29	31	32	34	34	30	31	28	32	28	29	24	25	23	M	M
	ESE	M	M	ESE	M	M	ENE	ENE	ENE	ENE	NE	NE	NE	ENE	NE	ENE	ENE	ENE	ENE	ENE	ENE	ENE	M	M

DAY/HOUR MATRIX OF SELECTED HOURLY DATA FOR
Springdale M-29 - APRIL 1989

WIND SPEED/DIRECTION (kts/!T)

TYPE OF ANEMOMETER: Weather Measure W102

Table 5.1 (cont'd)

ELEV. 76.2 m
46-28-48 N 48-19-28 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	18	M	M	34	40	41	46	46	43	41	39	37	35	31	34	34	32	29	29	25	26	25	M	M
	NE	M	M	NNE	NNE	NNE	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	M	M
17	21	M	M	20	M	M	14	13	13	14	16	14	13	13	13	15	18	17	18	20	20	19	M	M
	N	M	M	NNE	M	M	NNE	NE	NE	NE	NE	NE	ENE	ENE	ENE	ENE	ENE	ENE	ENE	ENE	ENE	ENE	M	M
18	25	M	M	25	M	M	25	24	25	25	26	27	26	26	27	29	30	30	33	30	30	32	M	M
	ENE	M	M	ENE	M	M	ENE	ENE	ENE	ENE	ENE	ENE	ENE	ENE	ENE	NE	NE	NE	NE	NE	NE	NE	M	M
19	28	M	M	31	M	M	28	26	25	25	22	22	21	20	19	20	18	19	16	15	16	17	M	M
	NE	M	M	NE	M	M	NE	NE	NE	NE	NE	NE	NE	NE	NE	NNE	NNE	NNE	NNE	NNE	NNE	NNE	M	M
20	17	M	M	16	M	M	09	06	04	01	02	00	00	02	06	06	08	11	14	16	22	24	M	M
	NNE	M	M	N	M	M	NNE	NE	NNE	NE	ENE	C	C	S	S	S	S	S	S	S	SSE	SSE	M	M
21	25	M	M	21	M	M	31	25	21	23	21	21	23	21	21	22	20	18	20	20	24	23	22	24
	SE	M	M	S	M	M	W	W	W	W	WSW	WSW	WSW	WSW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
22	22	20	21	19	21	21	18	17	15	14	11	09	18	16	16	18	13	12	22	30	31	30	33	46
	SW	SW	SW	SW	SSW	SW	SW	SSW	SW	SW	SSW	S	S	S	SSE	SSE	ESE	ESE	ESE	E	E	ENE	ENE	E
23	46	44	21	21	50	48	54	52	51	52	53	52	42	31	27	25	23	23	20	19	19	17	17	13
	E	E	S	S	SSE	SSE	SSE	SSE	SSE	SSE	SSE	S	S	SW	SW	SSW	SW	SW	SW	SW	SW	WSW	W	WNW
24	09	06	05	05	05	10	11	09	10	06	11	17	21	17	23	24	24	23	23	20	20	25	23	12
	W	WNW	W	WSW	S	ESE	SSE	SE	E	ESE	SE	SSE	SSE	SSE	SSE	SSE	SSE	SSE	SSE	SE	ESE	E	ESE	ESE
25	24	20	24	25	27	25	10	04	09	09	08	23	28	32	28	26	28	27	27	25	24	20	15	12
	ESE	ESE	ESE	SE	SE	SE	S	SE	W	NW	NNW	WNW	WNW	W	W	W	WSW	WSW	W	W	WSW	WSW	W	SW
26	06	03	05	08	13	11	15	17	17	22	16	18	18	14	14	15	16	16	18	23	04	10	30	39
	W	S	ESE	E	E	ENE	NE	NE	NE	NE	NE	NE	NE	NE	NE	ENE	ENE	ENE	ENE	ESE	E	W	WNW	W
27	39	34	34	30	29	29	27	29	35	29	31	33	31	27	31	31	32	32	32	33	33	31	29	29
	W	WSW	WSW	WSW	SW	SW	SW	SW	SW	SW	SW	WSW	WSW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
28	29	25	25	22	20	16	14	12	11	10	12	14	16	20	23	23	24	22	23	26	24	22	20	08
	SSW	SSW	SSW	SSW	SSW	SW	SW	SW	SW	SW	SSW	SSW	SSW	SW	SW	SW	SSW	SSW	SSW	S	S	S	S	E
29	08	11	16	24	21	19	23	26	23	25	22	20	24	25	24	25	24	22	23	25	21	22	21	22
	E	E	NNE	NNE	N	NNW	WNW	W	W	W	WSW	WSW	SW	SW	SW	SW	SW	WSW	WSW	WSW	WSW	WSW	WSW	WSW
30	21	24	21	18	19	25	22	24	31	27	32	30	32	33	33	30	30	32	27	29	25	24	25	22
	W	W	W	W	WSW	W	WNW	WNW	WNW	WNW	WNW	NW	NW	NW	WNW	NW	WNW	NW	NW	NW	NW	NW	NW	NW

6. CURRENTS

The only current data available for the area of grounding of Berg 001 was collected at the nearby drill rig, the Maersk Vinlander. A Neil Brown DRCM-2 profiling current meter was used to measure currents at a depth of 30m every three hours while the rig was on location. The distance from the rig to Berg 001, while scouring occurred, varied from a high of 23.7 nm (44 km) to a low of 13.7 nm (25 km) at the grounded position. The available current data are presented in Table 6.1. For each measurement of currents, three pieces of information are shown. The top number indicates the depth of measurement (30m); the number below indicates the current speed in knots, while the current direction is presented as for example NNW directly below the current speed. As discussed in the interpretation of drift data, the winds contributed to the free drift on March 9, but during keel dragging on March 10, the wind did not contribute to the southward drift of Berg 001. Therefore the driving force sufficient to effect 21 km of scouring must have been supplied by loss of berg momentum and by local currents. Considering the distances separating the location of the current measurements and the depth of same, it is not surprising that as indicated in Fig. 6.1, the current speeds during free drift on March 9 are much less than the free drift speed of the berg. The higher free drift speeds of Berg 001 can be explained partly by the fact that high (60 km/hour) winds from the WNW occurred, and possibly by higher overall currents at the berg locations along the free drift track. During the inferred 28 hour keel dragging period, the currents at the rig decreased to a low of 0.07 knots (0.04 m/sec) and then increased to 0.334 knots (0.18 m/sec) just before the berg grounded at 2200 hours. It is evident that the drift speeds of the berg exceeded the measured currents even during the keel dragging period. This suggests that the overall currents at the berg were much greater (about 3 times greater) than the currents measured at the rig at a depth of 30m. The current directions at the rig were generally towards the south-west as presented in Table 6.1. The current data and iceberg drift data are summarized in Table 6.2 for March 9 and 10, 1989.

DAY/HOUR MATRIX OF SELECTED HOURLY DATA FOR
Springdale M-29 - MARCH 1989

CURRENT DEPTH/SPEED/DIRECTION (m/kts/!T)

TYPE OF CURRENT METER: Neil Brown DRCM-2

Table 6.1 Current data

46-28-48 N 48-19-28 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
1	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.311	M	M	.233	M	M	.178	M	M	.262	M	M	.297	M	M	.161	M	M	.083	M	M	.077	M	M
	WNW	M	M	WNW	M	M	W	M	M	W	M	M	NW	M	M	NW	M	M	NNE	M	M	SE	M	M
2	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.206	M	M	.347	M	M	.254	M	M	.036	M	M	.225	M	M	.221	M	M	.180	M	M	.136	M	M
	SW	M	M	WSW	M	M	WNW	M	M	SSW	M	M	S	M	M	SW	M	M	SW	M	M	SW	M	M
3	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.128	M	M	.204	M	M	.132	M	M	.066	M	M	.118	M	M	.206	M	M	.101	M	M	.027	M	M
	SW	M	M	W	M	M	WNW	M	M	SSE	M	M	SW	M	M	W	M	M	NW	M	M	N	M	M
4	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.227	M	M	.470	M	M	.470	M	M	.068	M	M	.029	M	M	.219	M	M	.215	M	M	.174	M	M
	SSW	M	M	W	M	M	W	M	M	NNW	M	M	WSW	M	M	W	M	M	WNW	M	M	WNW	M	M
5	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.116	M	M	.237	M	M	.377	M	M	.169	M	M	.027	M	M	.180	M	M	.303	M	M	.260	M	M
	WSW	M	M	W	M	M	W	M	M	N	M	M	SSW	M	M	W	M	M	NW	M	M	NNE	M	M
6	030	030	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.209	.209	M	.190	M	M	.264	M	M	.241	M	M	.213	M	M	.165	M	M	.118	M	M	.161	M	M
	E	E	M	S	M	M	W	M	M	WNW	M	M	ENE	M	M	ESE	M	M	ENE	M	M	SE	M	M
7	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	030	M
	.392	M	M	.557	M	M	.519	M	M	.464	M	M	.132	M	M	.347	M	M	.495	M	M	.460	.460	M
	SSE	M	M	SSW	M	M	SW	M	M	WNW	M	M	SSW	M	M	SSW	M	M	SW	M	M	W	W	M
8	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	030	030	M	M
	.064	M	M	.415	M	M	.583	M	M	.660	M	M	.433	M	M	.464	M	M	.616	M	.738	.738	M	M
	W	M	M	SSW	M	M	SW	M	M	WSW	M	M	WSW	M	M	SW	M	M	WSW	M	W	W	M	M
9	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.291	M	M	.373	M	M	.748	M	M	.796	M	M	.427	M	M	.305	M	M	.384	M	M	.415	M	M
	W	M	M	SSW	M	M	SW	M	M	WSW	M	M	WSW	M	M	SW	M	M	SW	M	M	W	M	M
10	M	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	M	M	M	.198	M	M	.163	M	M	.120	M	M	.099	M	M	.178	M	M	.071	M	M	.334	M	M
	M	M	M	SE	M	M	SSW	M	M	WSW	M	M	NNW	M	M	ESE	M	M	SW	M	M	NNW	M	M

DAY/HOUR MATRIX OF SELECTED HOURLY DATA FOR
Springdale M-29 - MARCH 1989

CURRENT DEPTH/SPEED/DIRECTION (m/kts/!T)

TYPE OF CURRENT METER: Neil Brown DRCM-2

Table 6.1 (cont'd)

46-28-48 N 48-19-28 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
11	030	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
	.272	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
	N	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
12	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
	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
13	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
	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
14	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
	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
15	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	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
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
	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
	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
	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
	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	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	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M

DAY/HOUR MATRIX OF SELECTED HOURLY DATA FOR
Springdale M-29 - APRIL 1989

CURRENT DEPTH/SPEED/DIRECTION (m/kts/!T)

TYPE OF CURRENT METER: Neil Brown DRCM-2

Table 6.1 : (cont'd)

46-28-48 N 48-19-28 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	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
	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
2	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
	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
3	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
	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
4	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
	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
5	M	M	M	M	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	M	M	M
	M	M	M	M	M	M	.449	M	M	.396	M	M	.081	M	M	.104	M	M	.118	M	M	M	M	M
	M	M	M	M	M	M	WNW	M	M	NNW	M	M	ENE	M	M	SSE	M	M	W	M	M	M	M	M
6	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.095	M	M	.297	M	M	.272	M	M	.295	M	M	.064	M	M	.213	M	M	.281	M	M	.235	M	M
	E	M	M	S	M	M	WSW	M	M	NW	M	M	S	M	M	SW	M	M	W	M	M	NW	M	M
7	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.087	M	M	.394	M	M	.575	M	M	.507	M	M	.110	M	M	.295	M	M	.369	M	M	.561	M	M
	E	M	M	S	M	M	SW	M	M	W	M	M	W	M	M	S	M	M	WSW	M	M	NW	M	M
8	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.239	M	M	.132	M	M	.390	M	M	.555	M	M	.412	M	M	.093	M	M	.431	M	M	.491	M	M
	NNW	M	M	SSW	M	M	WSW	M	M	WNW	M	M	NNW	M	M	W	M	M	W	M	M	WNW	M	M
9	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	030	030	030	030	030
	.380	M	M	.066	M	M	.145	M	M	.233	M	M	.186	M	M	.239	M	M	.227	.268	.242	.252	.231	.182
	NNW	M	M	N	M	M	S	M	M	WSW	M	M	W	M	M	SSW	M	M	SSW	SW	SW	WSW	WNW	W
10	030	030	030	030	030	030	030	030	030	030	030	030	030	030	030	030	030	030	030	030	M	030	030	M
	.173	.085	.097	.202	.250	.279	.338	.377	.361	.377	.340	.293	.246	.242	.346	.417	.511	.588	.655	.684	M	.647	.612	M
	W	SW	S	S	SSW	SSW	SSW	SW	SW	SW	WSW	SW	SW	SSW	SSW	S	SW	S	S	SSW	M	SW	SW	M

DAY/HOUR MATRIX OF SELECTED HOURLY DATA FOR
Springdale M-29 - APRIL 1989

CURRENT DEPTH/SPEED/DIRECTION (m/kts/!T)

TYPE OF CURRENT METER: Neil Brown DRCM-2

Table 6.1 (cont'd)

46-28-48 N 48-19-28 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
11	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.505	M	M	.291	M	M	.256	M	M	.318	M	M	.332	M	M	.285	M	M	.377	M	M	.342	M	M
	W	M	M	SW	M	M	S	M	M	SSW	M	M	SW	M	M	SSW	M	M	S	M	M	SSW	M	M
12	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.423	M	M	.328	M	M	.231	M	M	.184	M	M	.229	M	M	.223	M	M	.297	M	M	.311	M	M
	SW	M	M	WSW	M	M	SSW	M	M	SSW	M	M	SSW	M	M	S	M	M	S	M	M	S	M	M
13	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.353	M	M	.322	M	M	.200	M	M	.221	M	M	.184	M	M	.169	M	M	.153	M	M	.136	M	M
	SW	M	M	WSW	M	M	WSW	M	M	SSW	M	M	SSW	M	M	SW	M	M	SSW	M	M	SSW	M	M
14	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.264	M	M	.447	M	M	.365	M	M	.136	M	M	.184	M	M	.103	M	M	.089	M	M	.104	M	M
	SW	M	M	W	M	M	WNW	M	M	WNW	M	M	WSW	M	M	WSW	M	M	W	M	M	SW	M	M
15	030	M	M	030	M	M	030	M	M	030	030	030	030	030	030	030	030	030	030	030	030	030	M	M
	.244	M	M	.305	M	M	.363	M	M	.311	.215	.165	.301	.163	.305	.279	.241	.219	.184	.138	.116	.064	M	M
	SW	M	M	W	M	M	NW	M	M	NW	WNW	WNW	WNW	WNW	WNW	WNW	WNW	NW	NW	NNW	NNW	N	M	M
16	030	M	M	030	M	M	030	030	030	030	030	030	030	030	030	030	030	030	030	M	M	030	M	M
	.202	M	M	.262	M	M	.534	.493	.548	.427	.346	.194	.186	.083	.108	.087	.099	.064	.066	M	M	.036	M	M
	SSW	M	M	WSW	M	M	W	W	W	WNW	NW	NW	NNW	NNW	NNW	NNW	NW	W	N	M	M	S	M	M
17	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.122	M	M	.174	M	M	.026	M	M	.085	M	M	.019	M	M	.169	M	M	.285	M	M	.365	M	M
	S	M	M	SW	M	M	WNW	M	M	WNW	M	M	ESE	M	M	WSW	M	M	WNW	M	M	NW	M	M
18	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.147	M	M	.019	M	M	.116	M	M	.241	M	M	.138	M	M	.034	M	M	.246	M	M	.215	M	M
	NE	M	M	ENE	M	M	NW	M	M	N	M	M	NNE	M	M	WSW	M	M	NNW	M	M	N	M	M
19	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.112	M	M	.173	M	M	.299	M	M	.248	M	M	.073	M	M	.066	M	M	.147	M	M	.153	M	M
	ESE	M	M	SSW	M	M	WSW	M	M	NW	M	M	N	M	M	SSW	M	M	WNW	M	M	N	M	M
20	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.209	M	M	.244	M	M	.132	M	M	.048	M	M	.217	M	M	.231	M	M	.139	M	M	.054	M	M
	E	M	M	S	M	M	SSW	M	M	NE	M	M	ESE	M	M	SSE	M	M	SW	M	M	NNW	M	M

DAY/HOUR MATRIX OF SELECTED HOURLY DATA FOR
Springdale M-29 - APRIL 1989

CURRENT DEPTH/SPEED/DIRECTION (m/kts/!T)

TYPE OF CURRENT METER: Neil Brown DRCM-2

Table 6.11 (cont'd)

46-28-48 N 48-19-28 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
21	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.246	M	M	.279	M	M	.025	M	M	.042	M	M	.130	M	M	.056	M	M	.367	M	M	.309	M	M
	E	M	M	SE	M	M	SSE	M	M	WNW	M	M	E	M	M	SSE	M	M	W	M	M	WNW	M	M
22	030	M	M	022	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.068	M	M	.583	M	M	.400	M	M	.351	M	M	.159	M	M	.301	M	M	.371	M	M	.367	M	M
	E	M	M	SW	M	M	SW	M	M	WSW	M	M	SW	M	M	SSW	M	M	SSW	M	M	WSW	M	M
23	030	M	030	030	M	M	030	M	M	030	030	030	030	M	030	030	M	M	030	M	M	030	M	M
	.272	M	.116	.116	M	M	.036	M	M	.025	.066	.165	.256	M	.412	.449	M	M	.478	M	M	.246	M	M
	WNW	M	W	W	M	M	NW	M	M	ENE	SE	SE	ESE	M	SSE	SSE	M	M	S	M	M	WSW	M	M
24	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.316	M	M	.165	M	M	.252	M	M	.161	M	M	.097	M	M	.235	M	M	.309	M	M	.130	M	M
	NW	M	M	E	M	M	SE	M	M	S	M	M	S	M	M	SE	M	M	SSE	M	M	S	M	M
25	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.081	M	M	.198	M	M	.151	M	M	.139	M	M	.068	M	M	.246	M	M	.404	M	M	.470	M	M
	SSW	M	M	SE	M	M	WSW	M	M	WNW	M	M	WNW	M	M	S	M	M	SSW	M	M	SW	M	M
26	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.447	M	M	.322	M	M	.412	M	M	.460	M	M	.491	M	M	.466	M	M	.507	M	M	.528	M	M
	WSW	M	M	SW	M	M	SSW	M	M	SW	M	M	SW	M	M	SSW	M	M	SSW	M	M	WSW	M	M
27	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.505	M	M	.497	M	M	.452	M	M	.404	M	M	.324	M	M	.069	M	M	.346	M	M	.398	M	M
	SW	M	M	SW	M	M	SSW	M	M	SW	M	M	W	M	M	SSW	M	M	SSE	M	M	S	M	M
28	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	030
	.367	M	M	.231	M	M	.145	M	M	.097	M	M	.110	M	M	.136	M	M	.260	M	M	.326	M	.266
	SW	M	M	SW	M	M	SW	M	M	SSW	M	M	S	M	M	SSE	M	M	SE	M	M	SSE	M	S
29	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	M	M	M
	.266	M	M	.182	M	M	.064	M	M	.159	M	M	.151	M	M	.075	M	M	.165	M	M	M	M	M
	S	M	M	SSW	M	M	S	M	M	SE	M	M	M	M	M	S	M	M	SE	M	M	M	M	M
30	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M	030	M	M
	.285	M	M	.258	M	M	.099	M	M	.114	M	M	.114	M	M	.091	M	M	.060	M	M	.165	M	M
	S	M	M	SW	M	M	NW	M	M	NE	M	M	SSW	M	M	SSW	M	M	SSW	M	M	SSE	M	M

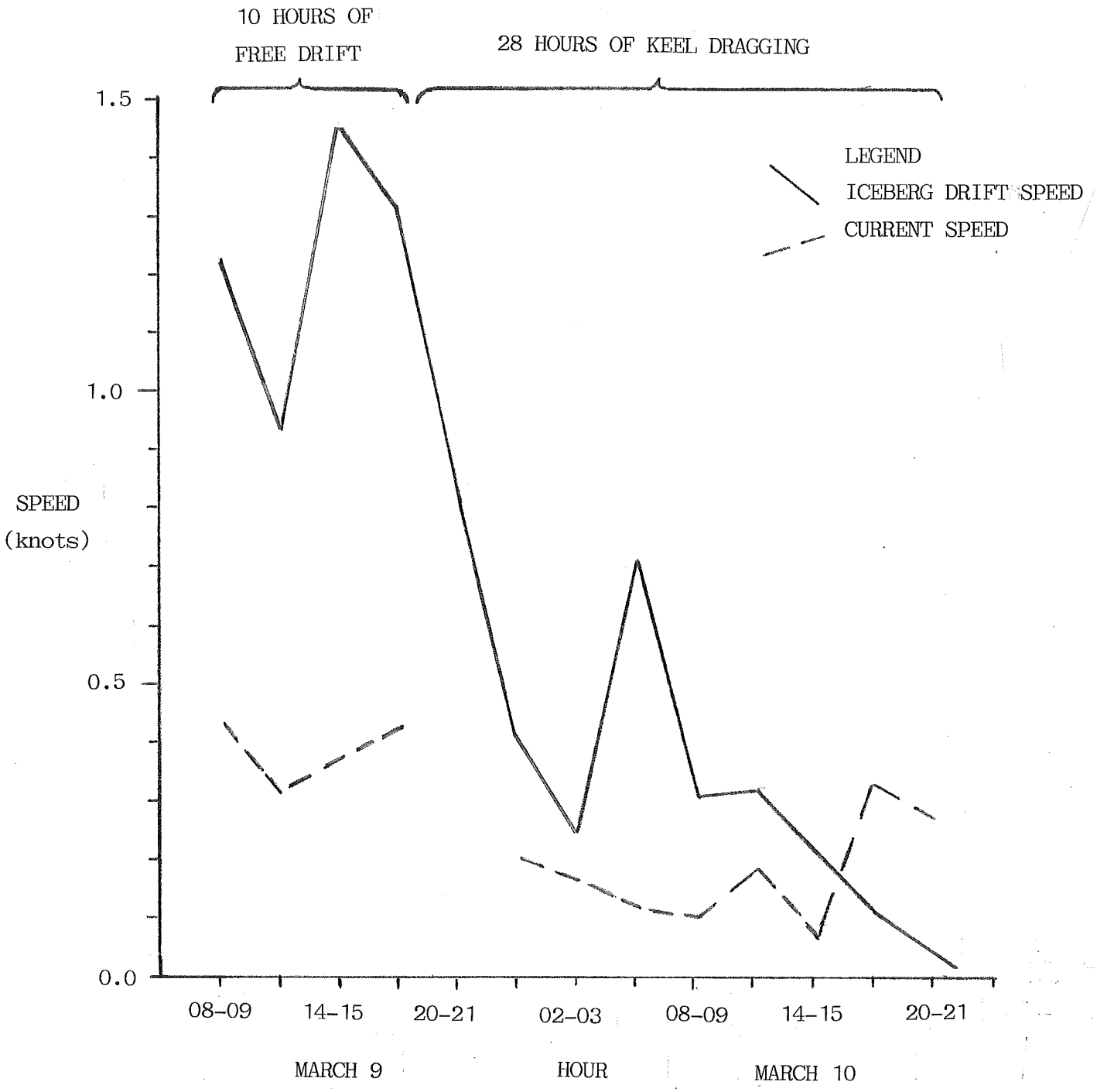


Figure 6.1 Iceberg drift speeds on March 9 and 10 and current speeds at the Springdale M-29 wellsite

Table 6.2 Currents and the drift speeds of Berg 001.

March	Hour	Current speed (knots)	Iceberg drift speed (knots)	Current direction.	Iceberg drift direction.
9	0800	0.43	1.32	WSW	189° (S)
9	1100	0.31	0.93	SW	149° (SSE)
9	1400	0.38	1.46	SW	196° (S)
9	1700	0.42	1.31	W	174° (S)
9	2000	Missing	0.81	Missing	190° (S)
9	2300	0.20	0.41	SE	190° (S)
10	0200	0.16	0.24	SSW	145° (SE)
10	0500	0.12	0.71	WSW	169° (S)
10	0800	0.10	0.30	NNW	180° (S)
10	1100	0.18	0.31	ESE	167° (S)
10	1400	0.07	0.20	SW	180° (S)
10	1700	0.33	0.10	NNW	- (N)
10	2000	0.27	0.31*	N	- (N)

* Navigational error, based on the sonar record of the scour and pit.

6.1 ON-BANK CROSS-ISOBATH CURRENTS AND ICEBERG DRIFT

On the north-east Grand Banks, vorticity manifests itself as a component of the cross-isobath velocities. In the area of groundings of icebergs 001 and 004, Isenor (1989) noted large on-bank flows within the core of the Labrador current. The noted speeds were in the 20 to 40 cm/sec range. Iceberg 001 drifted southward at a mean free drift speed of 1.32 knots (0.7 m/sec) and crossed isobaths as presented in Fig 4.2. The isobaths were crossed obliquely at about 45°. Although WNW winds assisted the free drift of the berg, the high rate of drift (up to 1.77 knots) strongly suggests the occurrence of high cross-isobath currents. During keel dragging on March 10, the winds were westerly to WSW and partly opposed the drift of Berg 001. The winds applied a load towards the east while a tow load of about 75 tonnes was applied in an easterly direction, but the berg continued its on-bank cross-isobath drift. The drift speeds while keel dragging occurred, reached a maximum of 1 knot (0.5 m/sec). All this suggests that a high speed on-bank cross-isobath current event occurred on March 9 and 10. The current directions presented in Table 6.2 indicate some scatter but the occurrence of higher currents is associated with a general south-west flow; ie. a cross-isobath flow onto the banks. As mentioned in section 6., the current speeds are only about a third of the drift speeds of Berg 001. This difference may be attributed to a lack of coherence in currents over distances of 5 to 10 km along the north-eastern Grand Banks.

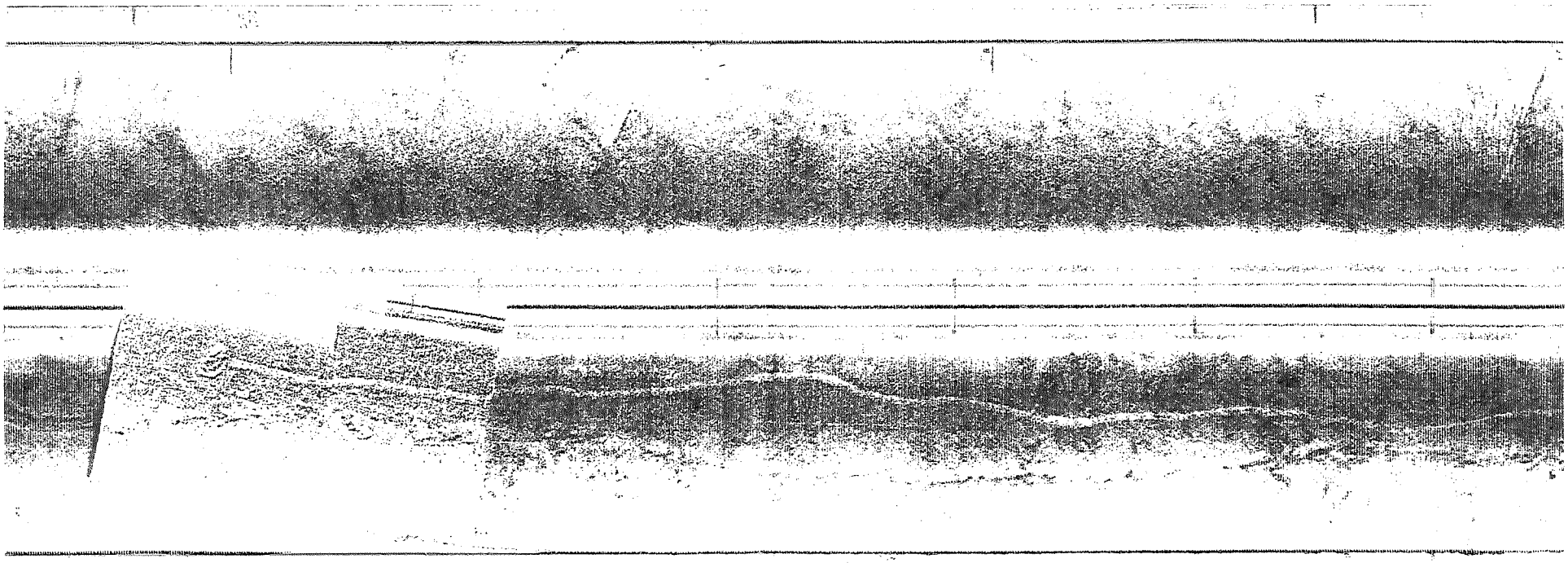


Figure 7.1 Sonar record of part of the 8 nm long scour surveyed by AGC, May 5, 1989

7. SIDE-SCAN SONAR RECORD OF THE SCOUR GENERATED BY BERG 001.

On May 5, a mere 11 days after Berg 001 drifted free from the grounded position, a geophysical survey was conducted by the Atlantic Geoscience Centre (Fader, 1989). The object of the survey was to document the presence of the scour and to measure the scour width, depth and length. The grounding had been identified in a study of inferred "definite" groundings on the Grand Banks of Newfoundland (Banke, 1989). The side-scan records obtained during the May 5 survey have been interpreted at AGC and described in detail by Parrot et al, 1989. Owing to the fact that the keel dragging drift track of Berg 001 was known prior to conducting the survey, the scour was found right at the start of the survey. The scour furrow lies directly below the drift track plotted in Fig. 4.2. Using a 70 KHz and a 100 KHz side-scan sonar, a segment of the furrow extending northward 8nm (15 km) from its terminal was mapped. At the northern end of the survey, the scour is 20m wide and less than 1m deep. At the southern end of the survey (ie. at the pit), a 5m deep depression in the seabed exists. The pit is 90m in diameter and has a berm up to 3m high. A segment of the surveyed furrow and the pit is presented in Fig. 7.1. The scour furrow is linear and runs from north to south into shallower waters. An older scour runs parallel to the new 001 scour in slightly deeper water. The surveyed segment of the new scour is 15 km long as mentioned above, but the total inferred scour length is 11.5 nm (21 km). As mentioned elsewhere in this report, the draft of Berg 001 is inferred to be 117m and it is this draft estimate which has been used to infer the total scour length. The assumption is that with a draft of 117m, keel dragging would have commenced in 117m of water and the 117m isobath intercepts the scour track about 21 km north of the pit.

Discussions with D.R. Parrot indicate that a crossing of the scour was observed in the side-scan sonar records. It is certainly possible that the berg dragged its keel at the crossing point after drifting free from its grounded position. In Fig. 4.1, the drift track of the berg indicates that the berg drifted across the original scour track about 5 nm (9 km) north of the grounded position. At the time, about 1130 hours on April 24, the berg drifted towards the north-east at 0.96 knot (0.5 m/sec). If a scour exists running across the original scour, it is clear that keel dragging occurred at high speed. The wind at the time was only 20 knots from the SSE. Therefore off-shelf currents of 20 to 30 cm/sec must have occurred.

8. ICEBERG 004

This iceberg was a wedge shaped berg with a water line length of 298m, width of 154m, sail height of 38m and a draft of 103m (Table 8.1). The mass was calculated to be 4.1 million tonnes. Unfortunately neither photographs nor underwater shape measurements were made of this large iceberg.

8.1 DRIFT TRACK OF BERG 004

Berg 004 was first tracked at azimuth 353.6° and range 16.1 nm from the Springdale M-29 drilling location at 1743 on March 12. During the following 41 hours (ie. until the next observation) the berg drifted about 3.4 nm WSW into shallower water to its grounded position in 100m water depth (Figs. 8.1 and 8.2). Owing to the absence of positions between the initial and second (grounded) positions, it is only possible to conclude that the berg dragged its keel if the draft were 103m as shown in Table 8.1. This seems a reasonable draft estimate considering the fact that the berg grounded in 100m of water for a period of at least 33 hours (ie. from 1100-March 14 to 2000-March 15). It is certainly possible that grounding occurred prior to 1100 on March 14 and it is also possible that grounding persisted beyond 2000 on March 15. Therefore the minimum grounding period is taken as 33 hours and the maximum may be as great as 4 days. What is known is that on the 17th of March at 1500, the berg was drifting towards the NNE. The wind at the time was 50 to 60 knots from the west. The high wind event probably caused the berg to drift off its grounded location on the 17th. In summary, iceberg 004 is inferred to have scoured a distance of 3.4 nm (6.3 km) from the 103m to the 100m isobath between March 12 and 14, 1989. The berg grounded for at least 33 hours and possibly as long as 4 days at position 46°-44.1'N by 48°-27.0'W at the 100m isobath. The berg was aground until at least 2000 on March 15, and on March 17 at 1500, the berg was apparently adrift about 6 nm to the north-east at free drift speeds. It is possible that scouring occurred towards the north-east from the grounded position when the berg drifted free.

BERG 004

Springdale M-29 (Maersk Vinlander)
(46 28.80′ N 48 19.47′ W)

Iceberg Dimensions: Size = L Shape = WDG
Length = M298 Width = M154 Height = M38
Draft = M103 Mass = 4097458 Stability = -0.3

Berg dimensions in meters
Berg mass in tonnes
L = Large berg
WDG = Wedge shaped
M = Measured

Table 8.1 Hourly positions of iceberg 004

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
12/03/89	1743	16.1	353.6	46 44.8	48 22.1	GPCD	0							
14/03/89	1100	16.1	341.4	46 44.1	48 27.0	VCYS	0	0.08	258	41.3	3.4			
14/03/89	1800	16.1	341.4	46 44.1	48 27.0	VCYS	0	0.00	000	48.3	3.4			
14/03/89	1900	16.1	341.4	46 44.1	48 27.0	VCYS	0	0.00	000	49.3	3.4			
14/03/89	2000	16.1	341.4	46 44.1	48 27.0	VCYS	0	0.01	161	50.3	3.4			
14/03/89	2100	16.1	341.4	46 44.1	48 27.0	VCYS	0	0.01	341	51.3	3.5			
14/03/89	2200	16.1	341.4	46 44.1	48 27.0	VCYS	0	0.00	000	52.3	3.5			
14/03/89	2300	16.1	341.4	46 44.1	48 27.0	VCYS	0	0.00	000	53.3	3.5			
15/03/89	0000	16.1	341.4	46 44.1	48 27.0	VCYS	0	0.00	000	54.3	3.5			
15/03/89	0545	16.1	341.4	46 44.1	48 27.0	VCYS	0	0.00	000	60.0	3.5			
15/03/89	0700	16.1	341.4	46 44.1	48 27.0	VCYS	0	0.00	000	61.3	3.5			
15/03/89	1430	16.1	341.4	46 44.1	48 27.0	VCYS	0	0.00	000	68.8	3.5			
15/03/89	1730	16.1	341.4	46 44.1	48 27.0	VCYS	0	0.00	000	71.8	3.5			
15/03/89	2000	16.1	341.4	46 44.1	48 27.0	VCYS	0	0.00	000	74.3	3.5			
17/03/89	1500	21.0	351.9	46 49.6	48 23.8	VCYS	0	0.14	022	117.3	9.4			
17/03/89	1600	21.7	352.9	46 50.3	48 23.4	VCYS	0	0.75	021	118.3	10.1			
17/03/89	1645	21.7	353.4	46 50.4	48 23.1	VCYS	0	0.31	064	119.0	10.3			
17/03/89	1800	21.9	354.9	46 50.6	48 22.3	VCYS	0	0.47	070	120.3	10.9			
17/03/89	1910	22.5	356.8	46 51.3	48 21.3	VCYS	0	0.84	044	121.5	11.9	[L]	80.0	E000
17/03/89	2000	22.8	357.9	46 51.6	48 20.7	VCYS	0	0.61	054	122.3	12.4	[L]	80.0	E065
17/03/89	2200	23.1	2.0	46 51.9	48 18.3	VCYS	0	0.84	080	124.3	14.1	[L]	80.0	E085
18/03/89	0000	22.8	5.8	46 51.5	48 16.1	VCYS	0	0.78	105	126.3	15.7	[L]	100.0	E085
18/03/89	0200	23.1	8.7	46 51.6	48 14.4	VCYS	0	0.59	085	128.3	16.8	[L]	100.0	E085
18/03/89	0400	23.5	11.4	46 51.8	48 12.7	VCYS	0	0.59	080	130.3	18.0	[L]	100.0	E085
18/03/89	0600	24.2	15.0	46 52.2	48 10.3	VCYS	0	0.85	076	132.3	19.7	[L]	100.0	E040
18/03/89	0800	24.9	18.7	46 52.4	48 7.8	VCYS	0	0.86	083	134.3	21.4	[L]	100.0	E040
18/03/89	1000	25.6	22.7	46 52.4	48 5.1	VCYS	0	0.93	090	136.3	23.3	[L]	120.0	E040
18/03/89	1200	25.7	26.4	46 51.8	48 2.8	VCYS	0	0.84	111	138.3	25.0	[L]	70.0	E050
18/03/89	1400	25.4	29.9	46 50.8	48 1.0	VCYS	0	0.80	129	140.3	26.6	[L]	80.0	E060
18/03/89	1600	24.7	32.3	46 49.7	48 0.2	VCYS	0	0.62	153	142.3	27.8	[L]	110.0	E060
18/03/89	1800	24.4	34.6	46 48.9	47 59.3	VCYS	0	0.51	142	144.3	28.8	[L]	120.0	E060
18/03/89	2000	24.6	37.1	46 48.4	47 57.8	VCYS	0	0.56	114	146.3	29.9	[L]	120.0	E065
18/03/89	2200	25.5	39.5	46 48.5	47 55.8	VCYS	0	0.69	088	148.3	31.3	[L]	120.0	E075
19/03/89	0000	26.4	43.1	46 48.1	47 53.2	VCYS	0	0.92	103	150.3	33.1	[L]	120.0	E060
19/03/89	0200	28.0	44.1	46 48.9	47 51.1	VCYS	0	0.82	061	152.3	34.8	[L]	70.0	E060
19/03/89	0400	30.1	47.6	46 49.1	47 47.1	VCYS	0	1.38	086	154.3	37.5	[L]	70.0	E060
19/03/89	0600	31.9	50.1	46 49.3	47 43.8	VCYS	0	1.14	085	156.3	39.8	[L]	70.0	E060
19/03/89	0800	33.8	52.1	46 49.6	47 40.6	VCYS	0	1.11	082	158.3	42.0	[L]	70.0	E060
19/03/89	1000	35.3	54.0	46 49.5	47 37.9	VCYS	0	0.93	093	160.3	43.9	[L]	80.0	E065
19/03/89	1200	35.5	54.8	46 49.3	47 37.2	VCYS	0	0.26	113	162.3	44.4	[L]	85.0	E065
19/03/89	1400	35.7	54.2	46 49.7	47 37.3	VCYS	0	0.20	350	164.3	44.8	[L]	100.0	E065
19/03/89	1600	36.3	53.3	46 50.5	47 37.1	VCYS	0	0.41	009	166.3	45.6	[L]	60.0	E065

Springdale M-29 (Maersk Vinlander)
(46 28.80′ N 48 19.47′ W)

Iceberg Dimensions: Size = L Shape = WDG
Length = M298 Width = M154 Height = M38
Draft = M103 Mass = 4097458 Stability = -0.3

Table 8.1 (continued)

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
19/03/89	1800	37.3	52.3	46 51.6 47 36.4		VCYS	0	0.60	023	168.3	46.8	[L]	60.0	E080
19/03/89	2000	39.2	52.5	46 52.7 47 34.1		VCYS	0	0.96	055	170.3	48.7	[L]	60.0	E080
19/03/89	2200	41.2	53.0	46 53.6 47 31.5		VCYS	0	1.00	063	172.3	50.7	[L]	60.0	E080
20/03/89	0000	41.8	55.8	46 52.3 47 29.1		VCYS	0	1.05	128	174.3	52.8	[L]	130.0	E070
20/03/89	0200	41.9	58.2	46 50.9 47 27.6		VCYS	0	0.87	143	176.3	54.6	[L]	140.0	E070
20/03/89	0400	42.2	60.5	46 49.6 47 26.0		VCYS	0	0.85	140	178.3	56.3	[L]	160.0	E060
20/03/89	0615	41.9	62.4	46 48.2 47 25.4		VCYS	0	0.65	163	180.5	57.7	[L]	115.0	E060
20/03/89	0800	42.4	64.5	46 47.1 47 23.7		VCYS	0	0.92	133	182.3	59.4	[L]	140.0	E060
20/03/89	1000	42.0	67.9	46 44.6 47 22.9		VCYS	0	1.28	167	184.3	61.9	[L]	150.0	E065
20/03/89	1200	41.2	72.0	46 41.5 47 22.5		VCYS	0	1.56	175	186.3	65.0	[L]	150.0	E065
20/03/89	1400	40.3	76.9	46 37.9 47 22.4		VCYS	0	1.80	179	188.3	68.6	[L]	150.0	E065
20/03/89	1600	39.4	82.1	46 34.2 47 22.8		VCYS	0	1.85	184	190.3	72.3	[L]	150.0	E065
20/03/89	1800	37.8	86.4	46 31.2 47 24.6		VCYS	0	1.62	202	192.3	75.6	[L]	150.0	E040
20/03/89	1801	37.8	86.4	46 31.2 47 24.6		VCYS	0	1.14	184	192.3	75.6			
20/03/89	1900	37.4	88.5	46 29.8 47 25.2		VCYS	0	1.46	196	193.3	77.0			
20/03/89	2000	37.1	91.1	46 28.1 47 25.6		VCYS	0	1.72	189	194.3	78.8			
20/03/89	2100	36.9	92.6	46 27.1 47 26.0		VCYS	0	1.04	195	195.3	79.8			
20/03/89	2200	36.8	94.8	46 25.7 47 26.3		VCYS	0	1.41	188	196.3	81.2			
20/03/89	2300	36.3	97.0	46 24.4 47 27.2		VCYS	0	1.44	205	197.3	82.6			

12/03/89 1743 16.11 353.6 (CPA)
20/03/89 0800 42.45 64.5 (MDR)

SPEEDS (Knots)

Min.	Max.	Mean	MadeGood	
0.00	1.85	0.72	0.22	(to 118 T; DRIFT RATIO = 0.52)

TOTAL NUMBER OF OBSERVATIONS = 61

SITE SPECIFIC TARGET PLOT

SURROUNDING Area w.r.t.
Springdale M-29
(Maersk Vinlander)
46 28' 47.82" N
48 19' 28.22" W

From 1743 L March 12, 1989
to 2300 L March 20, 1989
(8 days, 5.28 hours)

1 Iceberg Tracked.
61 Observations.
1 Target Towed.

Radius = 60.0 n. mi.
Tic Interval = 5.0 n. mi.

Springdale M-29 is at the Center of Plot.

DISTANCE TRACKED (n. mi)	CPA (n. mi.)	MEAN SPEED (kts)
82.6	16.1	0.7

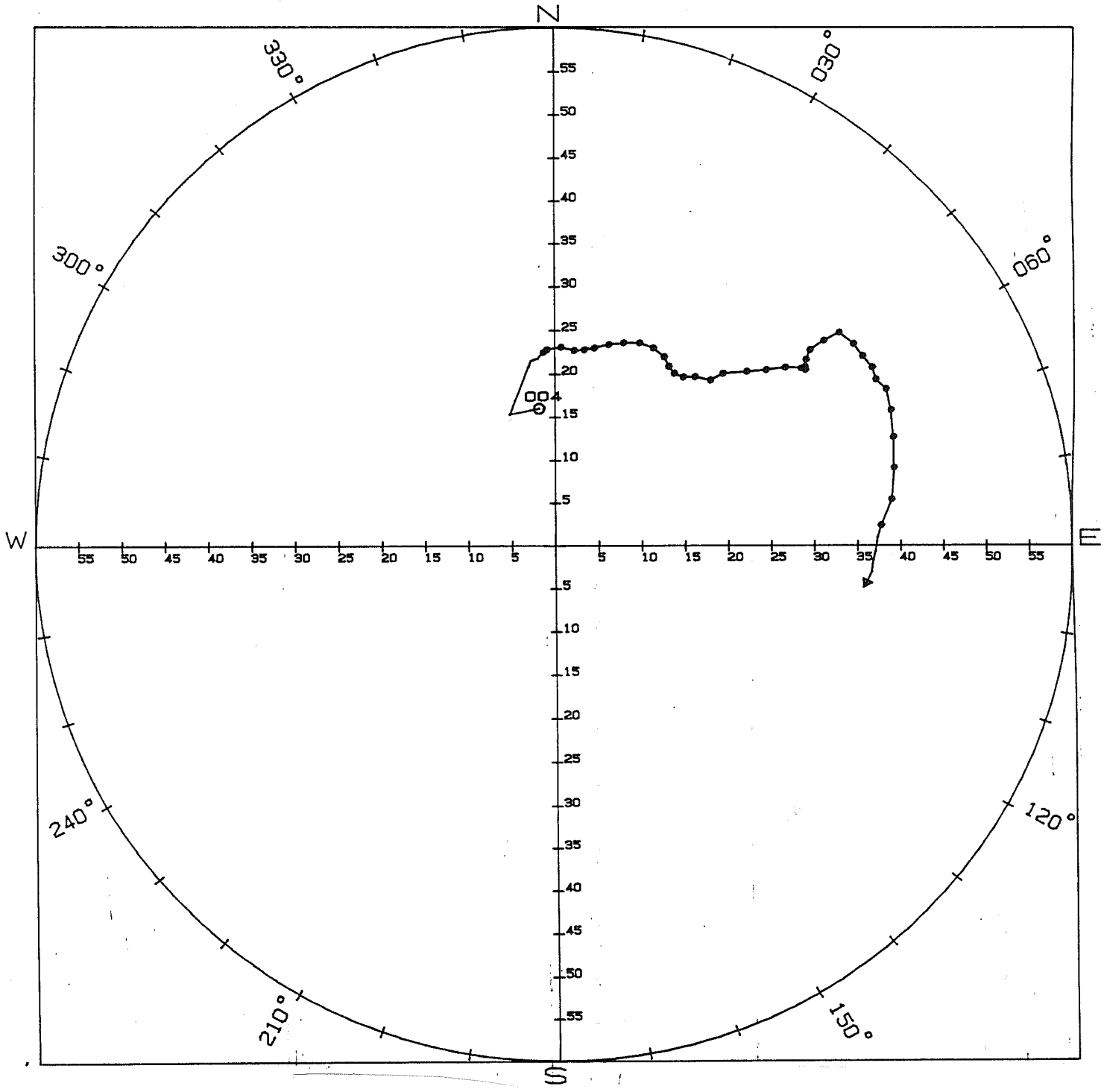


Figure 8.1 Drift track of iceberg 004

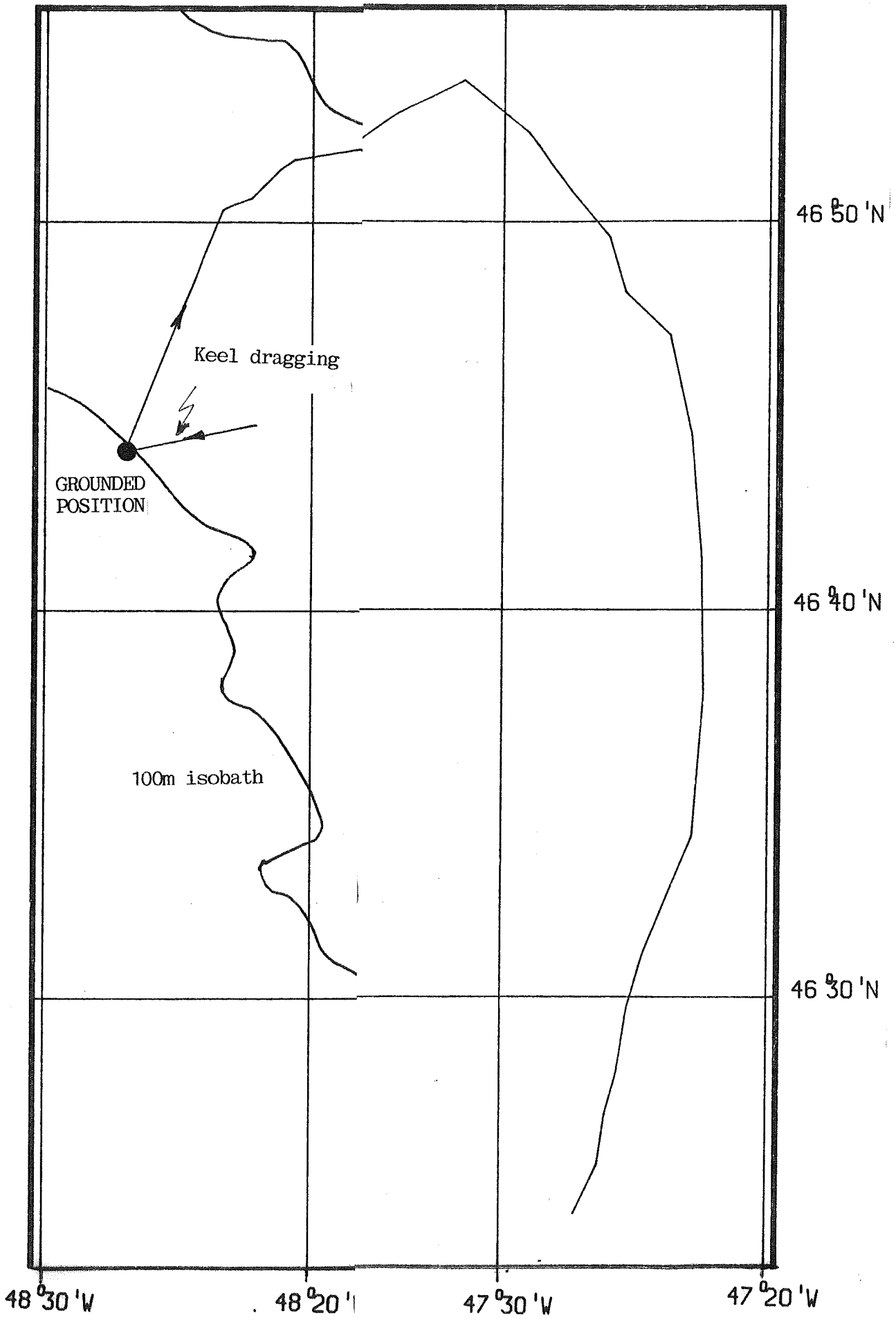


Figure 8.2 Detailed drift track of iceberg 004

9. DISCUSSION AND CONCLUSIONS

In the study of iceberg scours on the Grand Banks, the value of case histories can hardly be overstated. Knowledge of the circumstances which lead to the presence of icebergs on the Grand Banks and the subsequent groundings, contribute to the understanding of scour processes. Information on environmental factors such as winds and currents, and detailed iceberg drift track information permits case histories of iceberg grounding events to be documented. In combination with detailed surveys of the scours generated by keel dragging icebergs, complete case histories can be compiled. As far as the author knows, only two other case histories of iceberg groundings on the Grand Banks exist; iceberg 88-001 and 83-095. With the addition of the two case histories discussed in this report, the population of case histories has doubled. The case history of iceberg 89-001 consists of wind and current data and detailed hourly iceberg positions as well as information regarding 15 km of the 21 km long inferred scour furrow. To complete this case history, we were fortunate enough to obtain photographs of the sail and underwater profiles of the berg while grounded. Altogether the information for iceberg 89-001 is complete. Unfortunately the same cannot be said for iceberg 89-004. Only berg dimensions and drift track information is available; neither wind nor current data are available for the period of scouring and grounding. The inferred 6.3 km long scour has not been surveyed yet and awaits detailed mapping by side-scan sonar, high resolution seismic reflection profiling and echo-sounding. In the compilation of the data in this report, all available sources have been utilized. Because icebergs 001 and 004 generated the most recent scours on the Grand Banks, these features offer an excellent opportunity to study new scour formation and degradation. Such information will be useful in the interpretation of the rates of scouring on the northeastern Grand Banks, a topic that is relevant to the question of the probability of icebergs dragging keels across buried pipelines.

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