GSC OPEN FILE 850

A COMPILATION OF MARINE MAGNETOMETER DATA FROM THE SOUTHWEST LABRADOR SEA

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1. Introduction

Marine magnetometer data collected in the southwest Labrador Sea have been compiled, adjusted, and processed for public distribution in three forms:

1. digital files containing point values of magnetic anomaly and total magnetic field, along with cruise, time, and position descriptors;
2. plots of magnetic anomaly profiles along ships' tracks, at a scale of 1 to 250,000;
3. preliminary contour maps of magnetic anomaly at a scale of 1 to 250,000.

2. Areas covered and sources of data

The data lie within twenty-four areas defined in the Natural Resource Map (NRM) Series as shown in Figure 1. Digital files and profile plots exist for each of the twenty-four map areas; contour maps have been produced for all but three areas where data were insufficiently dense for contouring purposes.

Total magnetic field data were collected over the period 1972-80 on the ten research and survey cruises listed in Table 1.* All cruises were sponsored by agencies operating out of the Bedford Institute of Oceanography: the Atlantic Region of the Canadian Hydrographic Service, and the Atlantic Geoscience Centre of the Geological Survey of Canada.

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*Quantities of cruise data points used in each map are listed in the Appendix.

Proton precession magnetometers were used for all measurements, with the sensors towed a minimum of two ship lengths astern. Navigation for the most part was performed with a combination of rho-rho Loran-C and satellite navigation. Positioning accuracy is estimated to be 200 metres or better.

3. Adjustments to the data

All data preparations related to this release were done prior to the introduction of the new International Geomagnetic Reference Fields (IGRF) in late 1981 (IAGA Division 1 Working Group 1, 1981). Magnetic anomaly values were therefore calculated with reference to the now-supplanted IGRF 1965 and IGRF 1975 models: the 1965 model was used for data collected in the years up to and including 1975, while the 1975 model was used for years 1976 and beyond.

The nine-year interval betwen the first and last measurements, coupled with the recognized deficiences in the secular variation components of the older IGRF models (Dawson and Newitt, 1978) made it necessary to apply various adjustments to the anomaly values to achieve some degree of mutual consistency between overlapping and contiguous data sets. These adjustments were derived from inspections of profile plots, and from an analysis of discrepancies of track crossover points; they were applied to selected portions of data as levelling corrections between parallel and crossing tracks. The net effect of this adjustment process was to reduce track crossover discrepancies while shifting data levels up or down to achieve "reasonable" continuity of geomagnetic field features between adjacent tracks, as well as between contiguous map areas.

Levelling adjustments to compensate for errors in the IGRF secular variation corrections were applied to magnetic anomaly values only, and not to total field values.

Diurnal corrections were not applied to any of the data.

4. Digital file contents and formats

All data have been written in 24 files on 9-track magnetic tape, each file corresponding to one NRM area. See Table 2 for an index to files, and Figure 1 for a file index by area.

The original tape produced at AGC and furnished to the EMR Computer Science Centre for public distribution is EBCDIC-coded at 1600 bpi. On user request to CSC, the data can be supplied at 800, 1600, or 6250 bpi, at a cost of $500.

In addition to containing all the point values inside a one-degree (latitude) by two-degree (longitude) map area, each file also includes all the external data points that lie within .5 degree (latitude or longitude) of the map boundary - see Figure 2. External points are included in each map file primarily for use by automatic contouring programs, in order to minimize contour shifts across boundaries of neighbouring charts.

Within any given map file, each data point is written as one record containing the following six variables:

1. Time and cruise identification
2. Latitude
3. Longitude
4. Magnetic anomaly
5. Total magnetic field
6. Adjustment to the anomaly

The record is written using FORMAT (I12, I7, I7, I5, I5, I4). For example:

750182711648 525010 497374 -28953987 -12

Based on this example, the record variables are defined as follows:

1. Time: a twelve-digit number where the first two digits are year number, the next three are cruise number, followed by a three-digit (Julian) day number and a four-digit time (hour and minute in GMT).
2. Latitude: in degrees and decimal degrees x 10000.
3. Longitude: in degrees and decimal degrees x 10000. West longitudes are positive.
4. Magnetic anomaly: value derived by subtracting the appropriate IGRF reference field from the total field, followed by an adjustment (variable no. 6) as described in Section 3.
5. Total magnetic field: the earth's magnetic field, as measured by the magnetometer.
6. Adjustment to the anomaly: levelling correction that has been applied only to the magnetic anomaly. (See Section 3).

5. Profile plots of the magnetic anomaly

These plots display the variations in the anomaly field as a function of position along ships' tracks. The tracks serve as position-dependent abscissae; field strength ordinates are plotted perpendicular to the tracks at a scale of 800 nanotesla per 2.54 cm. Projection is Lambert Conformal at a scale of 1 to 250,000 with standard parallels 50°N and 60°N.

The adjusted magnetic anomaly values were used to produce these profiles. For any given map area, all points in the corresponding digital file are shown, i.e. internal points plus the external points described in Section 4.

The profile plots submitted to this Open File were produced originally as working drawings for the purpose of assessing the quality and distribution of data. On the original plots, positive magnetic anomalies were drawn in red and negative anomalies in blue. Depending on the process used to produce copies of these plots, colours may be difficult to tell apart: in the Ozalid process, red is reproduced more strongly than blue.

6. Contour maps of the magnetic anomaly

Contour maps have been drawn in 21 of the 24 map areas pertaining to this Open File. Projection is UTM, at a scale of 1 to 250,000.

Contours were generated by the CalComp General-Purpose Contouring Package II (GPCP-II). As our version of GPCP had a limited input capacity, data volumes in each map area were first reduced by a gridded averaging technique: all point values within pre-defined map "cells" were averaged, and the resulting mean values were then assigned to the cell mid-points.

Cell sizes (in minutes of latitude by minutes of longitude) for pre-gridding were: 2 x 2 , 2 x 3, and 3 x 4. Further gridding was performed by GPCP, using the pre-gridded and averaged values to define a new matrix of point values. Cell sizes for GPCP gridding were 1 x 2, 2 x 3, and 2 x 4. See Figure 3 for the disposition of cell sizes by area.

Cell sizes for pre-gridding and GPCP gridding were not identical for all map areas. The choice of size depended very much on factors such as density of data points and track spacing, and was the subject of considerable experimentation. Selection was made on the basis of whichever combination gave the most "reasonable" contours consistent with the nature and distribution of the data.

Contours matched reasonably well across most map boundaries, although minor cosmetic adjustments were necessary to produce smooth transitions between adjacent map areas. These were done by hand.

There were five boundary pairs where contours resisted all efforts at matching: neither cosmetic adjustments, nor changing the corrections for secular variations, nor altering the grid cell size, were successful at producing agreement between these adjacent data sets. These problems may be due in part to uncorrected diurnal variations, or to data collected during highly disturbed days. The boundaries so affected are indicated as heavy lines in Figure 3.

Borders of the 1 to 250,000 contour maps carry an indication as to whether contours were cosmetically adjusted, or whether no match exists.

7. Computer contouring versus hand contouring

Data described in this report have been hand contoured at a smaller scale and released in a previous Open File dealing with the whole of the Labrador Sea (Srivastava, 1979). A comparison of the earlier and the present set of contour maps shows general agreement between major features and anomaly field strengths, but considerable variance in detail.

These discrepancies are hardly surprising when one considers the very different procedures used in producing the two sets of maps. The manual technique used in the earlier work was a more "interpretive" process, featuring numerous manual levelling adjustments that were selected to preserve the general pattern of magnetic lineations known to exist in the Labrador Sea. These adjustments were not fed back into the digital files, but rather were applied directly to point values that had been posted on the inter-

preter's work sheets. Further, the anomaly values used in the hand contouring process were calculated with IGRF 1965 only and not with a combination of IGRF 1965 and IGRF 1975 such as used in the computer process.

The hand-contoured map was drawn by an experienced interpreter who was familiar with the geology and potential field characteristics of the region. Working from raw data, it would be difficult to reproduce exactly this map by a digital process, because of: (a) the subjective nature of the hand-contouring method; and (b) the fact that the manually-applied levelling adjustments are not available in digital form.

The contour maps presented in this Open File are a first attempt at producing a "quality" computer-drawn contour map from a large and diverse collection of geomagnetic data set. It is clear that our approach needs further improvement if we are to generate good magnetic contour maps through an automated process. Two problem areas can be identified immediately, and solutions should be available to us soon: (a) improved secular variation corrections through use of the new IGRF models; and (b) improved pre-gridding techniques that bypass the known deficiencies of the GPCP gridding procedure (see for example, November/December 1981 Newsletter of the EMR Computer Science Centre).

We therefore anticipate that a more satisfactory set of contour maps will be produced in due course from the same data bank. In the meantime, readers may wish to apply their own contouring methods to the digital data files that form part of this Open File. We would appreciate receiving sample outputs from those who do.

8. Acknowledgements

Shiri Srivastava and John Woodside contributed to the processing and preparation of the data through helpful comments and suggestions. The late Brian MacIntyre rendered considerable assistance in the early stages of this compilation project by sharing with us his extensive knowledge of cruise histories and data availability.

9. Bibliography

Computer Science Centre, Dept. of Energy, Mines and Resources. 1981: GTRIGR: a program for rectangular gridding based on triangles. November/December 1981 CSC Newsletter.

Dawson, E. and Newitt, L.R. 1978: IGRF comparisons; Physics of the Earth and Planetary Interiors, v. 16, p. 1-6.

IAGA Division 1 Working Group 1. 1981: International Geomagnetic Reference Fields: DGRF 1965, DGRF 1970, DGRF 1975, AND IGRF 1980; EOS, v. 62, p. 1169.

Srivastava, S.P. 1979: Marine gravity and magnetic anomalies map of the Labrador Sea; Geological Survey of Canada, Open File Report 627.

TABLE 1 - CRUISES

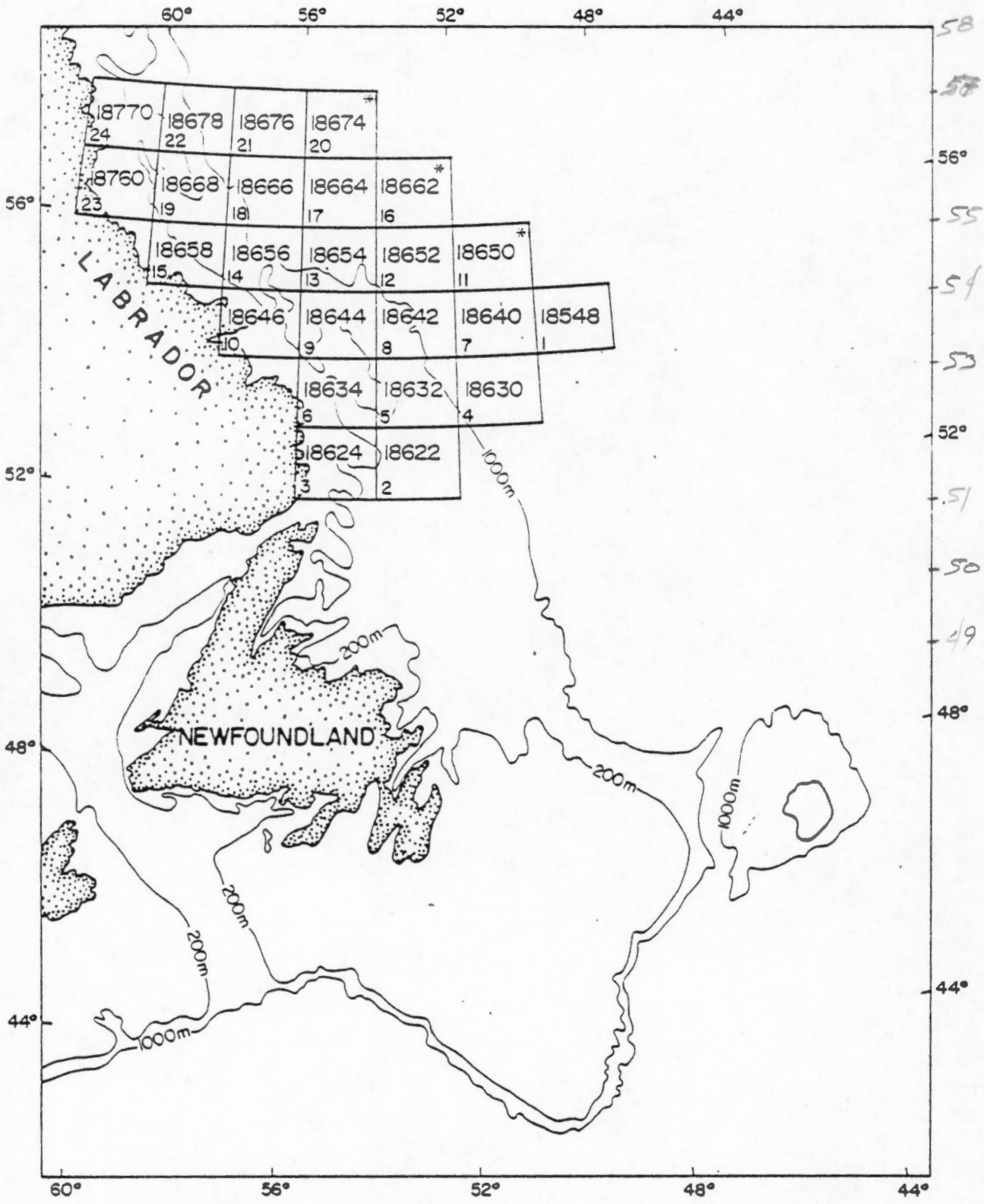
Year	Ship	Cruise Number
1972	HUDSON	72-025
1973	DAWSON	73-027
1974	MINNA	74-023
1974	HUDSON	74-026
1975	HUDSON	75-009
1975	MARTIN KARLSEN	75-018
1976	MARTIN KARLSEN	76-019
1977	MARTIN KARLSEN	77-016
1978	MARTIN KARLSEN	78-019
1980	HUDSON	80-035

TABLE 2 - DIGITAL FILES AND NATURAL RESOURCE MAP AREAS

File No.	NRM
1	18548
2	18622
3	18624
4	18630
5	18632
6	18634
7	18640
8	18642
9	18644
10	18646
11	18650
12	18652
13	18654
14	18656
15	18658
16	18662
17	18664
18	18666
19	18668
20	18674
21	18676
22	18678
23	18760
24	18770

FIGURE CAPTIONS

1. Natural Resource Map (NRM) areas described in this Open File report. Digital files, profile plots, and preliminary contour maps have been produced for all areas except the three indicated with asterisks, which had insufficient data for contouring purposes. Five-digit numbers identify each map area in the NRM numbering scheme. One- or two-digit numbers describe the order in which the digital map files were written to magnetic tape.
2. NRM map area and external 1/2° margin. For each map area described in this Open File report, a digital file exists that contains all points within the map area and the external margin.
3. Cell sizes in minutes of latitude and of longitude for pre-gridding (upper dimensions) and GPCP gridding (lower dimensions) in the 21 map areas for which data was contoured. Heavy lines indicate map boundaries where contour lines don't match.


60°
56°
52°
48°
44°
18770
24
18678
22
18676
21
18674
20
18760
23
18668
19
18666
18
18664
17
18662
16
18658
15
18656
14
18654
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18652
12
18650
11
18646
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18644
9
18642
8
18640
7
18548
1
18634
6
18632
5
18630
4
18624
3
18622
2
LABRADOR
NEWFOUNDLAND
1000m
200m
200m
200m
1000m
1000m
58
57
56°
55
54
53
52°
51
50
49
48°
44°

FIGURE 1

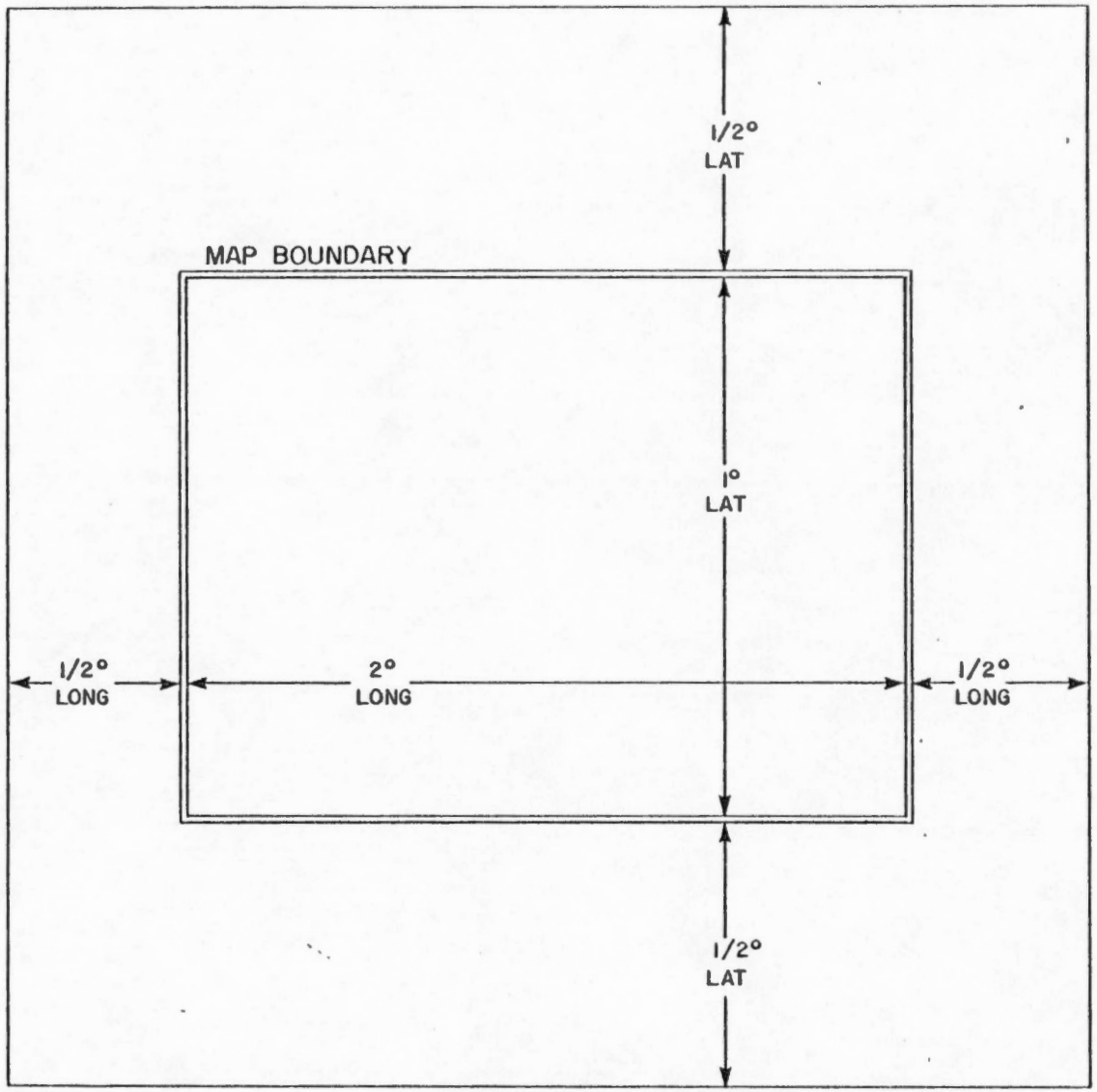

FIGURE 2

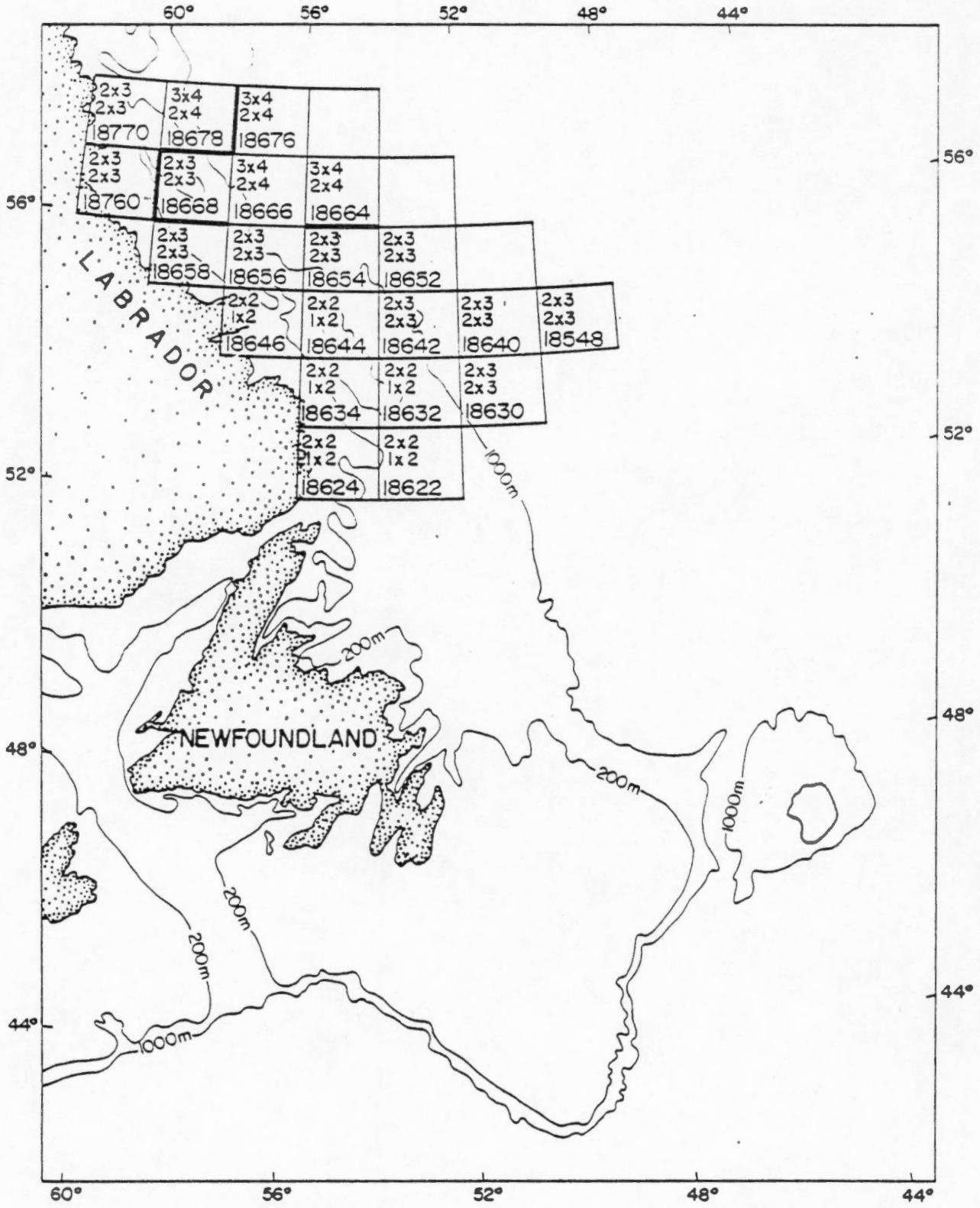
60°
56°
52°
48°
44°
LABRADOR
NEWFOUNDLAND
1000m
200m
2x3 2x3 18770
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FIGURE 3

APPENDIX

QUANTITIES OF DATA POINTS PER CRUISE AND MAP AREA

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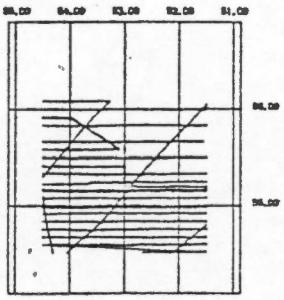

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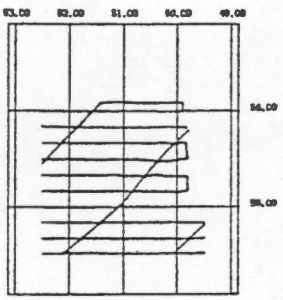

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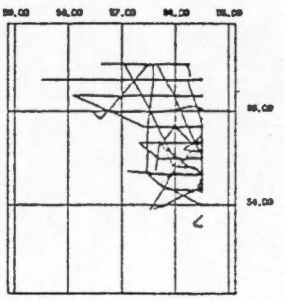

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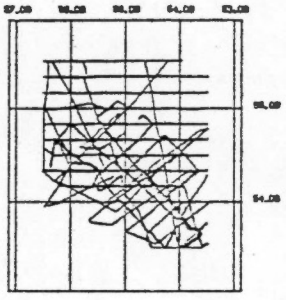

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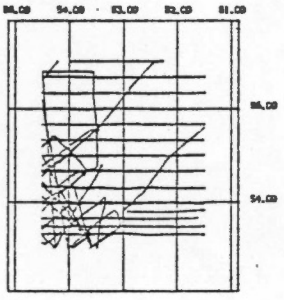

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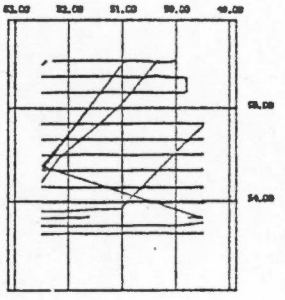

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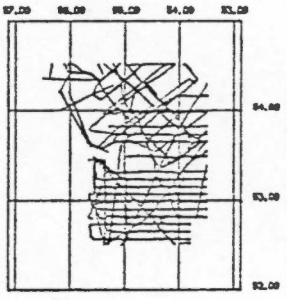

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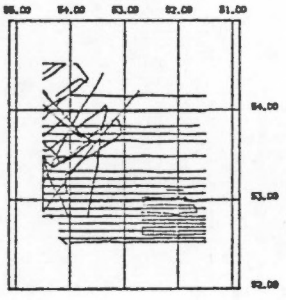

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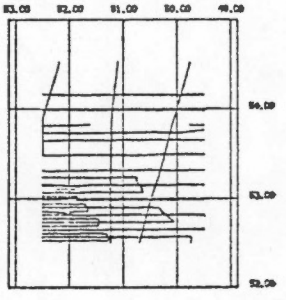

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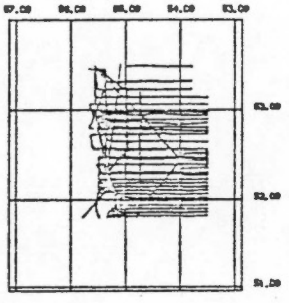

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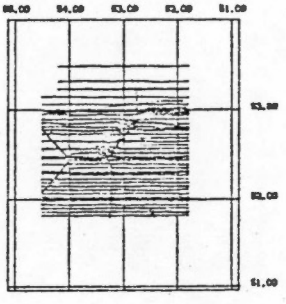

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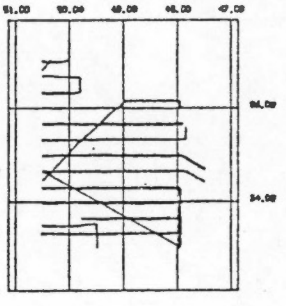

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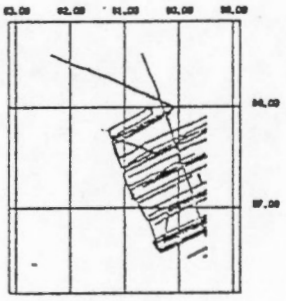

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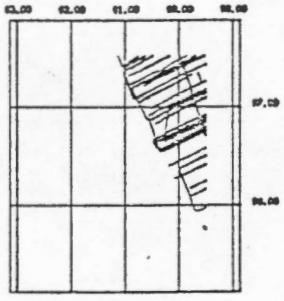

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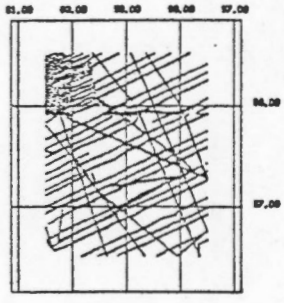

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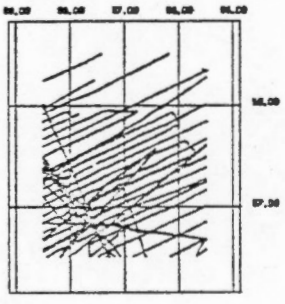

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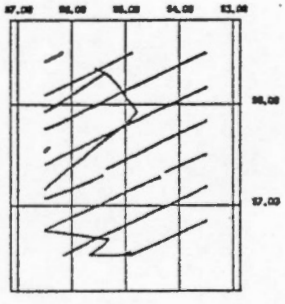

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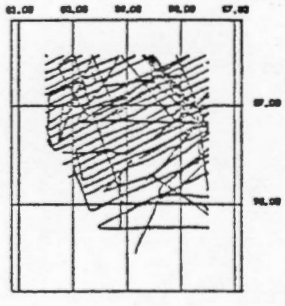

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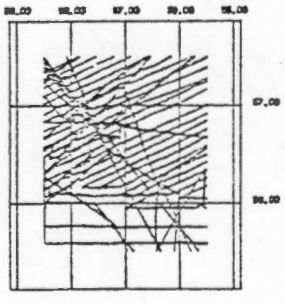

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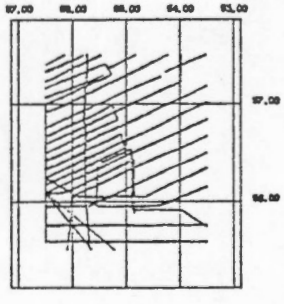

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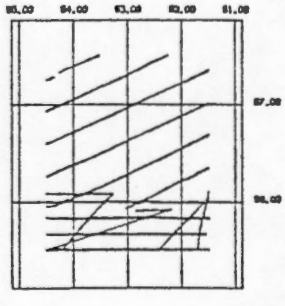

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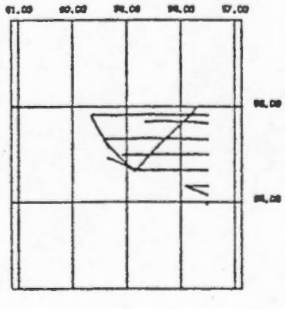

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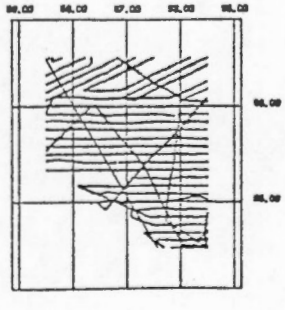

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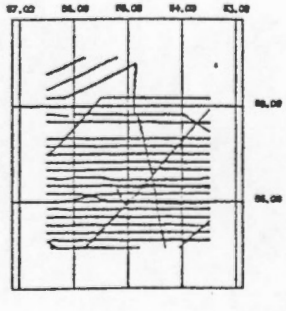

A1781 - INFORMATION OF MA MAP FILE

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CRUISE AND STATIONS :       99999          0

FILE NAME          18658
CRUISE AND STATIONS :       72025       2504
CRUISE AND STATIONS :       99999          0

FILE NAME          18662
CRUISE AND STATIONS :       72025       2813
CRUISE AND STATIONS :       74023       4576
CRUISE AND STATIONS :       99999          0

FILE NAME          18664
CRUISE AND STATIONS :       74023       4349
CRUISE AND STATIONS :       74026        582
CRUISE AND STATIONS :       77016       5220
CRUISE AND STATIONS :       78019       2781
CRUISE AND STATIONS :       99999          0

FILE NAME          18666
CRUISE AND STATIONS :       73027       7887
CRUISE AND STATIONS :       74023       4303
CRUISE AND STATIONS :       77016       8880
CRUISE AND STATIONS :       78019       3766
CRUISE AND STATIONS :       99999          0

FILE NAME          18668
CRUISE AND STATIONS :       73027       7213
CRUISE AND STATIONS :       74023       3209
CRUISE AND STATIONS :       77016      10693
CRUISE AND STATIONS :       99999          0

FILE NAME          18674
CRUISE AND STATIONS :       73027       1801
CRUISE AND STATIONS :       74023       4251
CRUISE AND STATIONS :       99999          0

FILE NAME          18676
CRUISE AND STATIONS :       73027       7270
CRUISE AND STATIONS :       74023       4705
CRUISE AND STATIONS :       77016       8044
CRUISE AND STATIONS :       99999          0

FILE NAME          18678
CRUISE AND STATIONS :       76019      10553
CRUISE AND STATIONS :       77016      10209
CRUISE AND STATIONS :       99999          0

FILE NAME          18760
CRUISE AND STATIONS :       77016       3940
CRUISE AND STATIONS :       80035       1710
CRUISE AND STATIONS :       99999          0

FILE NAME          18770
CRUISE AND STATIONS :       77016       5492


CRUISE AND STATIONS :       80035       3003
CRUISE AND STATIONS :       99999          0
TOTAL STATIONS     347753
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