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MARINE MAGNETIC SURVEYS

ABOARD THE M.V. NELLA DAN, 1979/80

- OPERATIONAL REPORT

by

H.M.J. Stagg, A.R. Fraser, and R.A. Dulski

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SUMMARY

In co-operation with Antarctic Division of the Department of Science and the Environment, towed magnetometer surveys were conducted aboard the M.V. Nella Dan during her four relief voyages to Australian Antarctic stations of the 1979/80 summer season. These surveys were the commencement of a program to obtain coverage at 60 n. mile spacing in a band across the Southern Ocean between Australia and the Mawson region, and at 20 n. mile spacing across the continental margin adjacent to the Australian Antarctic Territory. Existing regional coverage in these areas ranges from sparse across most of the Southern Ocean to almost non-existent on the Antarctic continental margin.

A computer-based data acquisition system was installed in the rear hold of the vessel, and a winch for streaming and retrieving the magnetometer sensor was fitted to the rear mooring deck on the starboard side. Magnetic data were recorded at 10-second intervals on cassette tape, at one-minute intervals on teletype print-out, and as a continuous trace on strip-chart recorder paper. Navigation data in the form of print-outs of satellite fixes and positions of major course and speed changes were obtained from the ship's Tracor satellite navigation system. Intermediate dead-reckoned positions at regular intervals were listed where possible, and bathymetric data were collected when the water depth was within range of the ship's Atlas echo-sounder (less than 3500 m).

About 30 000 line-km of good-quality magnetic data were obtained during the four voyages, demonstrating the practicability of conducting magnetic surveys aboard the Nella Dan. The main problems encountered were the lack of adequate protection for the data acquisition system in the rear hold, and the cumbersome procedure involved in acquiring navigation and bathymetric data. It is recommended that these problems be overcome by housing the data acquisition system in a small container in the hold, and by interfacing the Tracor satellite navigator and Atlas echo-sounder with the data acquisition system, to acquire navigation and bathymetric data automatically.

1. INTRODUCTION

Every year between October and March, the Danish Lauritsen Line polar vessels Nella Dan and Thala Dan transport relief supplies to Australia's Antarctic bases for the Antarctic Division of the Department of Science and the Environment. These voyages provide an opportunity to collect many thousands of kilometres of under-way data at low cost and relatively little inconvenience to the supply operations. Until recently, however, two factors have discouraged the collection of under-way geophysical data. Firstly, the accuracy of navigation has been so crude as to make any data obtained of little value in solving outstanding scientific problems, and secondly the stern configuration of both vessels is not satisfactory for the installation and operation of a marine seismic cable.

While the modifications necessary to allow seismic work have yet to be made, a medium-accuracy Tracor satellite-navigation system has been installed by the Antarctic Division to improve the accuracy of shipboard navigation. Although the system's performance falls short of the requirement for precise survey work, it provides position fixes with an accuracy of about ½ n. mile with intermediate positions good to 1 to 2 n. miles. It is now possible to navigate the ship to maintain an acceptable line separation at a line spacing of 20 n. miles.

BMR therefore approached the Antarctic Division in late September 1979 advocating that a program should be implemented immediately to acquire total magnetic field intensity data both on the Antarctic continental margin and over the deep ocean basins. This would be the first practical and useful step in implementing a marine geoscience program in Antarctic waters. The aim of the magnetic surveys would be to obtain coverage at 60 n. mile spacing in a band across the Southern Ocean between Australia and the Mawson region, and at 20 n. mile spacing across the continental margin adjacent to Australian Antarctic Territory. Existing regional coverage in these areas ranges from sparse across most of the Southern Ocean to almost non-existent on the Antarctic continental margin. Analysis of the magnetic data should provide some indication of variations in sedimentary thickness on the Antarctic continental margin, and would therefore be a useful guide in the planning of future seismic work. In addition, data in the deep ocean basin will provide a better definition of the magnetic lineation pattern and the structure of the area between Australia and Antarctica, and by correlation with the magnetic data from earlier surveys it will provide better control for the Australian Geomagnetic Reference Field (AGRF).

Approval for the program was given and the survey equipment, consisting principally of a Geometrics G 801 proton-precession magnetometer and a computer-based data acquisition system (DAS) was installed on the Nella Dan a few days before the first relief voyage, to Macquarie Island in October 1979. The acquisition system was put together within two days by taking many of the software modules and hardware from the Marine Geophysics Group's major acquisition system, previously used on the Cape Pillar. Much of the computer software was simplified and streamlined so that inexperienced personnel would be able to operate the system on Nella Dan without difficulty. A comprehensive operations manual was provided, giving instructions at a basic level in the initialisation and operation of the system and operation of the magnetometer. This approach was necessitated by the uncertainty of obtaining berths for Marine Geophysics Group personnel on some voyages.

Although the sytem was reduced from that used on the Cape Pillar, recording only magnetic and time data, the flexibility exists to expand it to enable recording of navigation, bathymetric, and other data.

Magnetic data were recorded on the four relief voyages of the Nella Dan in the 1979/80 season - Voyage 1 to Macquarie Island, Voyage 2 to the edge of the sea-ice off Mawson, and Voyages 3 and 6 to Davis and Mawson. The magnetic surveying on each voyage is discussed in this report.

2. DATA ACQUISITION SYSTEM (DAS)

Schematic diagrams of the configuration of the peripherals of the DAS on the Nella Dan and the flow of data in the DAS are included as Figures 1 and 2. A detailed description of the system operation can be found in Whitworth & Stagg (1980).

The software operated in the following way:
Normally, control of the computer resided with the processing program. This control was broken every second when the digital clock provided an interrupt to the computer which caused the interrupt program ACQ13 to run. If the time was not a sample time (not a 10-second time), control was immediately returned to the processing program. If the time was a 10-second time, ACQ13 immediately sampled the clock (two 16-bit words) and the magnetometer (one 16-bit word) and stored these data in a cyclic input buffer that had a capacity for 4 hours of 10-second data (1440 samples). After data were acquired, control was returned to the processing program.

The processing program normally waited in a loop, testing whether operator intervention was required (indicated when bit 0 in the computer S-register was on) and whether new data had been acquired. Once data had been acquired, the following processing sequence was executed .

1. The input data were converted to BCD format and placed in the processing buffer.
2. Time jumps (positive or negative) were tested for, and coped with if found.
3. The converted magnetic value was checked against an operator-supplied value (16665) which the computer should record if the magnetometer was turned off. Should such a number be detected, it was replaced by 10^{10}.
4. The fifth digit (tens of thousands of nanoteslas) was added to each magnetic value; this must be done since only 4 BCD digits can be recorded through a 16-bit interface card. The fifth digit was supplied by the operator at system initialisation.
5. BCD conversion errors were checked for, and reported on the teletype if found.
6. Input or output buffers could be dumped on the system teletype by the operation by use of certain bits in the S-register.

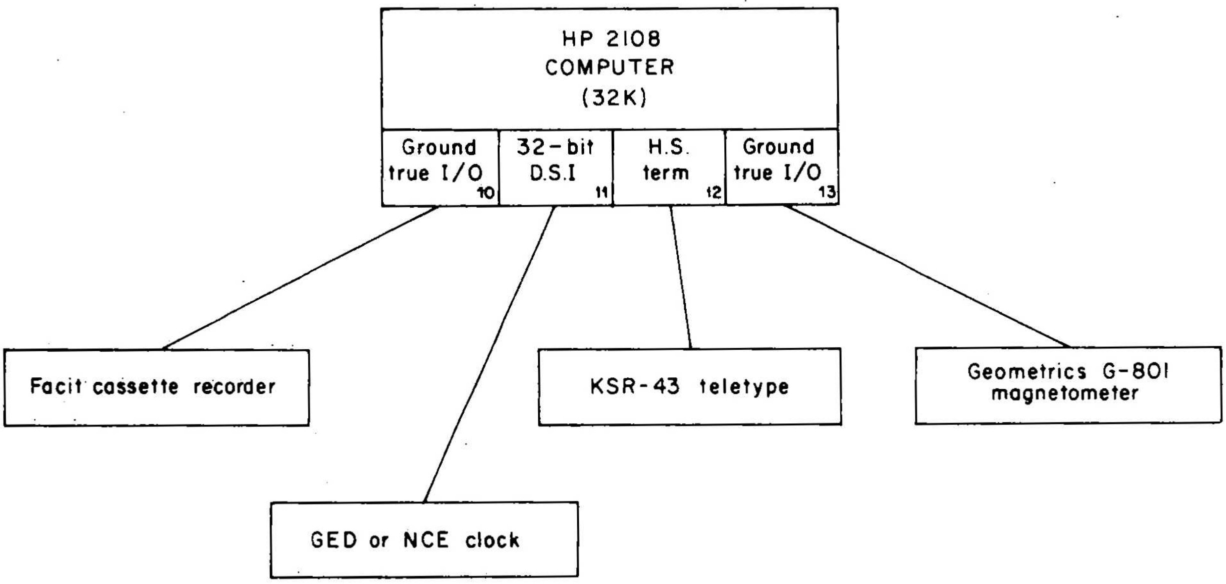

Fig. 1 Data Acquisition System - Peripherals

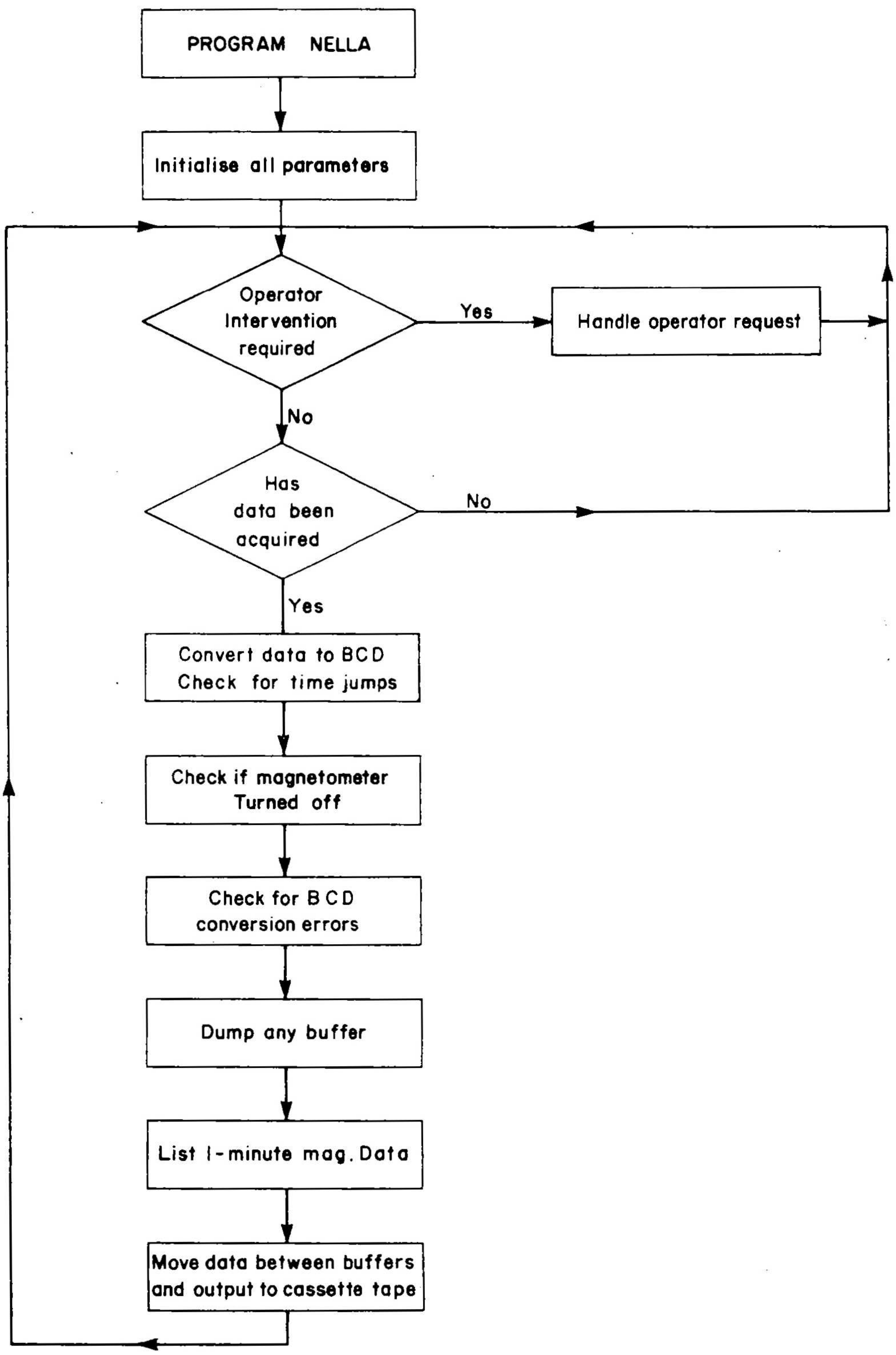

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Fig. 2 Data acquisition system — data flow

7. Every 10 minutes the previous ten 1-minute magnetic values were listed on the teletype.
8. The data were moved from the processing buffer to the output buffer; every 2 minutes the output buffer was written on to the cassette tape.

The operator program system had the following facilities:

1. The Survey number could be set or changed.
2. Cassette recording could be turned off or on. This facility was included in case the cassette recorder broke down irretrievably; in such a case, recording of the 10 minute data on the teletype terminal would continue.
3. The value used to check whether the magnetometer is turned off could be set or changed.
4. The fifth digit in the magnetic value could be set or changed. The digit was normally set to correspond to the magnetometer reading on system initialisation. It would need to be reset only if the computer lost track of it, for example during a burst of noise.
5. The cassette tape could be ejected. Tape changes were normally done in this way.
6. An informative message could be written on the system terminal.

As it was considered likely that only one operator would be available to run the DAS on the Nella Dan, precautions were built in where possible, to circumvent equipment failure during periods of unattended operations. In particular, should the Facit cassette recorder go down (for example, because of an automatic system tape eject or a blown fuse) it was important to avoid an indefinite hang-up of processing while data were waiting to be written to tape. which would eventually cause data to be lost through overwriting of the cyclic input buffer. It was for this reason that the input buffer was limited to 4 hours. In addition, if the program found the cassette drive to be continuously down, recording on cassette was automatically turned off after 3 hours 53 minutes, just before the input buffer overflowed (this is an automatic equivalent of operator program 2, outlined above). Should this occur, recording of 1-minute data on the teletype would continue. The only other pieces of hardware that can be dispensed with if it breaks down is the teletype;

in this case, data would still be written to tape. If either the Facit or the teletype broke down it was essential that power to the system be maintained at all times, as it would otherwise be impossible to reload or initialise the program. If this had happened, recording of the magnetic data would have continued in analogue form only.

3. NAVIGATION

The principal shortcoming of operating a marine survey on the Nella Dan is the low quality of the navigation data available. The primary navigation system is a Tracor satellite navigator interfaced with an Anschutz gyro-compass and a Bordmesstechnik pressure log. A Texas Instruments Silent 700 teletype terminal is also interfaced with the satellite navigator.

The Tracor satellite navigator is a simple "black box" system, well suited to the requirements of merchant shipping but of inferior standard for geophysical work. With the exception of the teletype, the electronics are contained in a box measuring approximately 0.5 x 0.25 x 0.25 m, within which are an LSI-11 computer card (a modification of a PDP-11), a memory card containing the computer program in read-only memory, and a satellite receiver interface card. Connections from the speed and heading instruments go to the memory card. The satellite receiver accepts only one satellite channel (400 MHz) and uses up to eight 2-minute Doppler counts per pass in computing a position fix. Fixes are automatically accepted or rejected according to rigid criteria (elevation, number of Doppler counts received, etc.). No facility exists for the operator to force a fix to be accepted or rejected.

The front panel is occupied by a small VDU which normally displays the current time (GMT), latitude, and longitude (to 0.1' of arc updated every second) and has a keyboard. The keyboard is used to "dial-up" different information and print it or display it on the screen, or to allow the operator to input information required by the computer. The available operator programs are summarised in the Appendix.

The Silent 700 terminal is used only to provide a hard copy of positions, and has no interactive capability. Accepted satellite fixes are printed automatically as time, latitude, longitude, course, speed, time of last fix, and time of next fix. In addition, the current dead-reckoning (DR) position can be printed out by keying-in one of the operator programs.

Although the Tracor satellite navigation system installed on the *Nella Dan* is unsophisticated, positions of acceptable accuracy could be obtained by careful and frequent recording of data. Accordingly, dead-reckoning positions were recorded at 10 minute intervals on Voyage 3 and at 30 minute intervals on Voyage 6. On Voyages 1 and 2, dead-reckoning positions were recorded when course or speed was changed but not at regular intervals.

4. BATHYMETRIC DATA

Nella Dan is equipped with two echo-sounders - an Atlas Echograph 600 (AZ-6011) 33 KHz instrument with a maximum recording depth of about 3500 m, and an Atlas Echograph 480, with a transmission frequency of 100 KHz and a maximum recording depth of only 1000 m. Both produce continuous analogue strip-chart records. The latter instrument also has an Atlas-Filia digital read-out.

The Atlas Echograph 600 was operated during those parts of Voyages 2, 3, and 6 when water depths were within its range. The strip-chart was annotated at hourly intervals and times, positions, depths, and depth ranges were logged every 10 minutes, for eventual incorporation in a digital file combined with position and magnetic data.

5. EQUIPMENT INSTALLATION

It was recognised, before the survey commenced, that there would be difficulty finding a suitable site on the ship for the computer equipment. The original intention was to bolt the equipment rack in its shipping container to one side of the tween-decks above the No. 3 (after) hold. Unfortunately, this proved to be impossible as the container was fractionally too high; in addition, Antarctic Division felt there was insufficient deck space to spare for it. The only practical solution was to bolt the rack and the teletype table in the corner of the tween-decks behind the access ladder. This location was highly unsatisfactory as there was no way of controlling the environment and there was insufficient protection from loose cargo in the hold. Power for the computer equipment was taken from the *Nella Dan's* 230-V a.c. 60-Hz supply. The power outlet is a plug behind a fluorescent lamp in the forward starboard corner of the tween-decks.

Installation of the magnetometer winch on the stern deck was less of a problem. It was welded to the starboard side of the deck and the rear wall of the cabins. This area is particularly wet in heavy seas, and on Voyage 1 the winch motor was frequently doused with salt water, causing it to break down. The problem was overcome before the start of Voyage 2 by raising the winch 0.3 m above the deck level on an angle-iron frame. Power for the winch motor was taken from a 220-V d.c. power point in the welding store on the port side near the stern. The magnetometer deck leader was installed from the winch along the underside of the helicopter deck, entering the hold through a watertight marine gland in the after-port corner of the hatch coaming.

6. VOYAGE 1, TO MACQUARIE ISLAND (Fig. 3)

BMR Survey/Cruise No:

Survey 31 Cruise 1

Observers:

H.M.J. Stagg, BMR Marine Geophysics Group
R.A. Dulski, BMR Marine Geophysics Group

Itinerary:

Departed Melbourne	19/10/79 (day 292)
Arrived Macquarie Island	23/10/79 (day 296)
Departed Macquarie Island	27/10/79 (day 300)
Arrived Melbourne	1/11/79 (day 304)

Equipment Performance and Data Quality

The purpose of this cruise was to complete installation of the equipment, test the data acquisition system, and study the best ways of collecting navigation and bathymetric data from systems already installed on the vessel. In fact, data were collected successfully for more than 90% of the time at sea, thus yielding 4000 line-km of useful magnetic data.

Only minor troubles were experienced with the equipment. A fuse in the Facit cassette recorder blew on 31 October resulting in the loss of 1½ hours of digital data, although analogue recording continued without a break. Frequent immersion of the winch in salt water on the return journey eventually caused the winch motor to short-circuit, which in turn caused fuses to blow in the 220-V d.c. power supply. The magnetometer was retrieved by hand with difficulty on the approach to Port Phillip Heads. At the end of the voyage a frame was fitted beneath the winch to raise it about 30 cm above deck level and new sealing rings were inserted in the motor to protect it from sea water. The computer failted to correctly execute its firmware diagnostics when restarted at Macquarie Island for the return journey. This may have been due to the cold conditions, as the system returned to normal when the computer warmed up. This problem also occurred on later voyages.

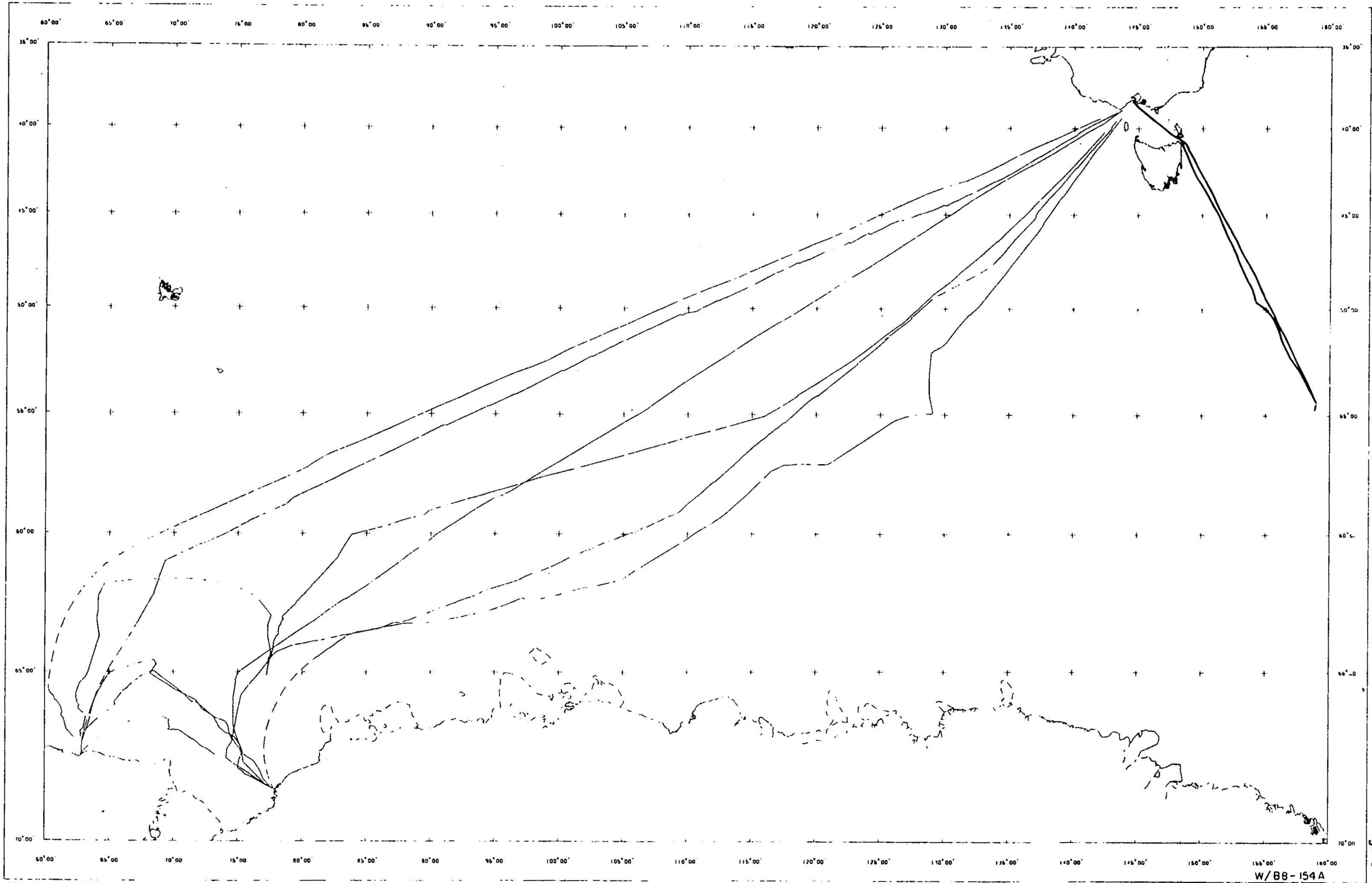
Description of Data

Navigation data: Listings were obtained from the ship's satellite of satellite fixes, and dead-reckoning positions at course and speed changes. No attempt was made to collect dead-reckoning positions at regular intervals. The ship's track is shown in Figure 3.

Bathymetric data: None were obtained.

Time and magnetic data: These were recorded on cassette tape at 10-second intervals for about 90% of the time at sea. One-minute values were recorded on computer printout, and a continuous analogue trace of total magnetic intensity was recorded on strip-chart paper.

The quality of magnetic data varied from excellent (about 2 nT peak-to-peak) in calm seas to poor (8-10 nT) in rough seas.

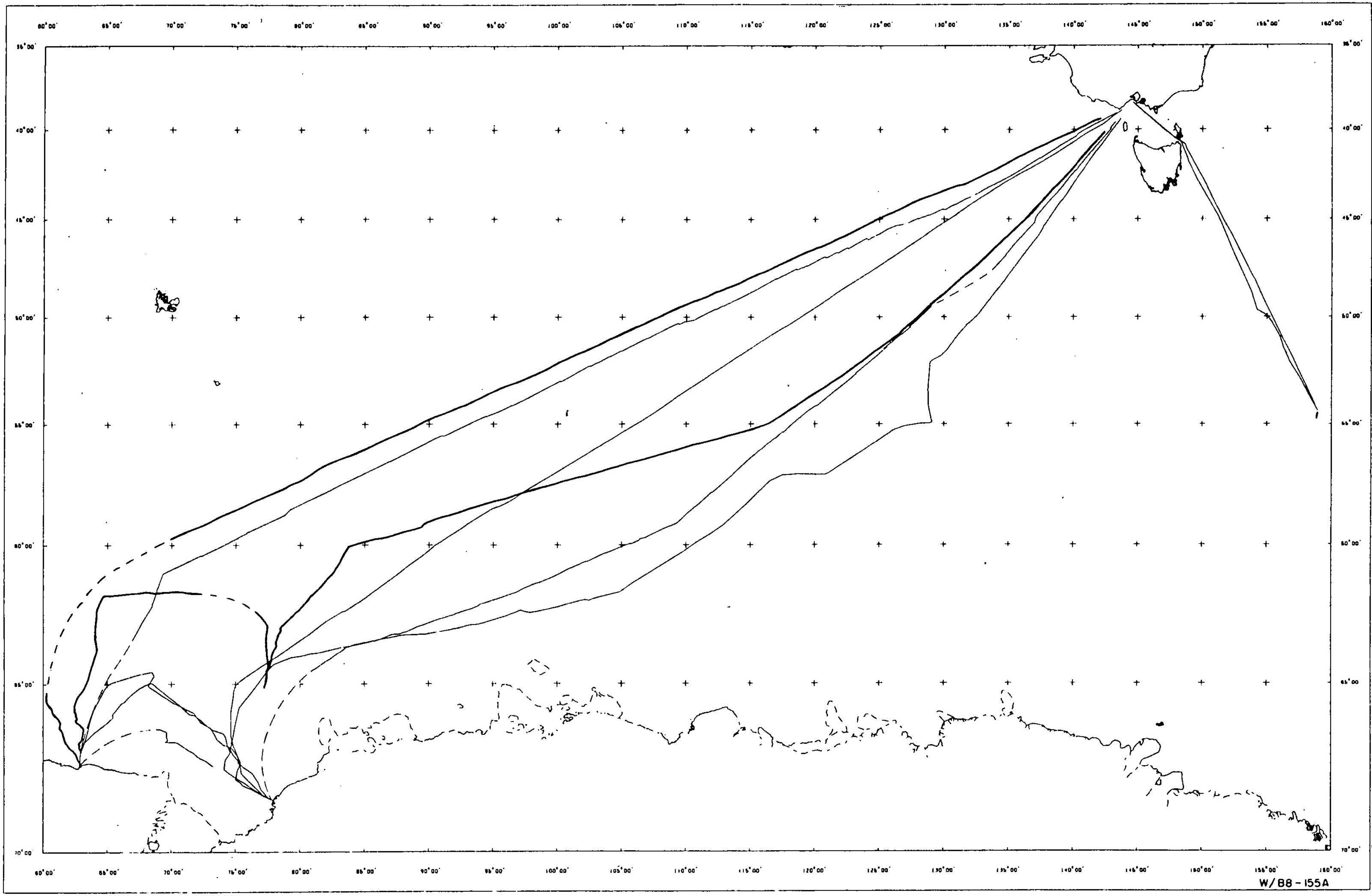


(Based on W/BB-153A) Record 1980/68

NELLA DAN MARINE SURVEYS, 1979-1980

Fig. 3 SHIPS TRACKS - VOYAGE 1

Fig. 3



(Based on W/88-153A) Record 1980/68

—— SHIPS TRACK
- - - - - APPROXIMATE TRACK

NELLA DAN MARINE SURVEYS, 1979-1980

Fig.4 SHIPS TRACKS - VOYAGE 2

7. VOYAGE 2, TO MAWSON ICE EDGE (Fig. 4)

BMR Survey/Cruise No:

Survey 31, Cruise 2

Observers:

S. Scherl, BMR on downward trip;

R. Williams, Antarctic Division on return trip

Itinerary:

Departed Melbourne	9/11/79 (day 313)
Arrived Mawson ice edge	26/11/79 (day 330)
Departed Mawson ice edge	30/11/79 (day 334)
Arrived Melbourne	14/12/79 (day 348)

An attempt was made to approach Davis within helicopter-flying distance, but this failed because of the extent of the pack-ice.

Equipment Performance and Data Quality

The equipment generally performed well, and noise levels in the magnetic data were acceptably low, ranging from 102 nT in calm seas to 6-12 nT in rough seas. Although data were recorded for only 21 out of 33 days at sea, most of the time lost was due to pack-ice in the region of Antarctica, which prevented towing of the magnetometer sensor.

Minor problems were experienced with the equipment as detailed below:

1. The data acquisition system could not be started up at the beginning of the voyage, causing the loss of one day's digital data. During the unsuccessful attempts to set the S-register, the mains failure/battery light remained on or flashed on and off, suggesting that the power lead to the computer was not properly connected. Analogue data were recorded for the time the digital system was down.
2. On the first few days of the return trip, there was difficulty in tuning the magnetometer. When the coarse range was changed from 48-59 to 55-73, the counts became erratic and jumped about 1000 nT. The problem eventually disappeared and may have been

due to failure to use the fine tuning adjustment in the centre of the tuning knob.

3. The teletype was damaged while being reloaded with paper, and was out of service for the last 4 days of the return trip. Recording on cassette continued, cassettes being changed by use of the EJECT button on the Facit recorder.
4. An error apparently occurred in the conversion of day number after day 339 (1600), resulting in the recorded value being 10 days too high.
5. Magnetic values recorded between 339.1800 and 340.0820 were 10 000 nT too high. The error problem was corrected at 340.0820, by using an operator intervention program to change the magnetic value.
6. Random jumps were observed on the magnetometer strip-chart profile during the last four hours of recording. They were probably caused by BCD conversion errors, which were detected after the damaged teletype had been replaced in Melbourne at the end of the voyage. The conversion errors were partly eliminated by replacing one of the BCD buffer cards in the magnetometer.

Description of Data

Navigation data: Listings were obtained of satellite fixes, and dead-reckoned positions at course and speed changes for the periods 313.1747 - 323.0621 and 337.0533 - 347.1446. Dead-reckoning positions at 10, 15, 20, or 30-minute intervals were obtained for the periods 322.2240 - 325.1040, 329.1400 - 330.1125, 334.1415 - 335.0845, and 337.1517 - 338.1400. Positions were listed every few hours in the period 325.1215 - 329.1030, but are not available at all in the period 335.0845 - 337.1517.

Bathymetric data: Water depths were listed during the four periods when dead-reckoning information was collected, on the Antarctic continental margin and over the Gaussberg Ridge.

Time and magnetic data: These were recorded on cassette tape at 10-second intervals, on teletype print-out at one-minute intervals, and on strip-chart paper. There are no data on cassette from the start of the survey to 314.2349, and no teletype print-out from 343.1030 to the end of the survey.

8. VOYAGE 3, TO DAVIS AND MAWSON (Fig. 3)

BMR Survey/Cruise No:

Survey 31/32, Cruise 3

Observer:

A.R. Fraser, BMR Marine Geophysics Group

Itinerary:

Departed Melbourne	20/12/79 (day 354)
Arrived Davis	3/1/80 (day 3)
Departed Davis	10/1/80 (day 10)
Arrived Mawson	13/1/80 (day 13)
Departed Mawson	17/1/80 (day 17)
Arrived Davis	20/1/80 (day 20)
Departed Davis	20/1/80 (day 20)
Arrived Melbourne	1/2/80 (day 32)

Equipment Performance and Data Quality

The equipment generally performed well, with noise levels in the magnetic data ranging from 1-3 nT in calm seas to 5-12 nT in rough seas. Of the 32 days at sea, 24 were successful recording days, 3 were lost due to equipment malfunction, 3.5 due to adverse ice conditions, and 1.5 due to shallow water and/or the presence of other shipping. The performance of each item of equipment is discussed below.

Magnetometer: The most serious malfunction was that of the magnetometer, which was out of service for a total of about 3 days' sea time on the approach to Davis, and between Davis and Mawson. The problem was manifested as a deterioration and eventual loss of signal about 30 to 60 minutes after the magnetometer had been switched on (following a period when it had been either off or on standby).

For a number of reasons, the problem was initially attributed to a fault in either the sensor or the cabling. Steps taken to eliminate the problem included replacement of the fluid in the sensor, replacement of the electrical plugs at the winch, and resealing of the towing cable/sensor connection. Checks were made of the console electronics using the test sensor and oscillator, and of the earthing of the sensor shield and the console, but no fault could be found.

These steps were unsuccessful, although good data were recorded for about 15 hours on the journey between Davis and Mawson, before the problem returned. Eventually the problem was eliminated by replacing the pre-amplifier card in the magnetometer console. This was done shortly after leaving Mawson for the return journey to Davis.

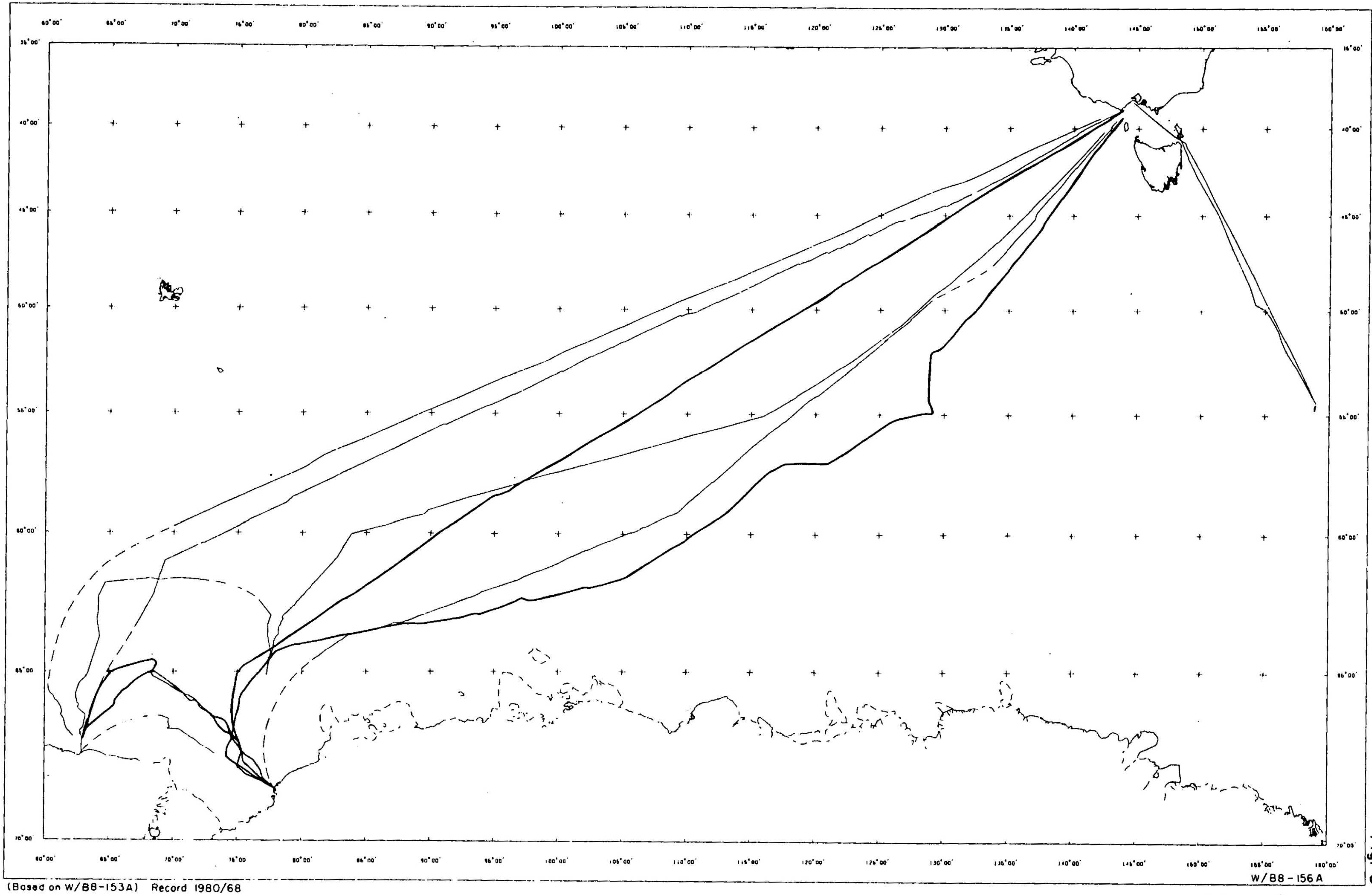
Other problems with the magnetometer system were minor ones and are summarised below:

1. The digital counter display unit in the console was replaced at Davis as the ten-thousands digit in the display did not light up.
2. The Hewlett-Packard chart recorder broke down twice on the journey from Melbourne to Davis. This was due to a break in the electrical connections to the styli, and new wires had to be soldered in.
3. Seawater leaked into the electrical plugs at the winch on the Davis-Melbourne leg, causing loss of signal. The plugs were replaced within an hour, and sealed with 'Silastic' sealant/adhesive instead of insulating tape. The problem did not recur.
4. The connection to the test sensor was found to be faulty.
5. The sensor fluid was observed to contain sediment in suspension when replaced at Davis.
6. A persistent BCD error was present in the magnetometer output. This resulted in 800 being added on to the recorded value, unless the middle digit was an 8 or 9, in which case the value was correct. The problem was due to a fault in one of the BCD buffer cards of the magnetometer, and was eliminated when the card was replaced in Melbourne at the end of the survey. The errors can be processed out of the data without difficulty.

<u>GED Clock</u>: The performance of the GED Clock was monitored by comparison with VNG radio time signals every few days and more frequently by comparison with the NCE clock attached to the chart recorder. The GED clock was found to gain about 1.5 seconds per week.

<u>DAS Software</u>: Only minor problems affected the DAS software, as summarised below:

1. An error occurred in the conversion of day number for days 355 to 359 (recorded value 10 days too low).



(Based on W/88-153A) Record 1980/68

Fig. 5

SHIPS TRACK

APPROXIMATE TRACK

NELLA DAN MARINE SURVEYS, 1979-1980

Fig. 5 SHIPS TRACKS - VOYAGE 3

2. The system did not accept the new year and continual 'Output Blcok Resynchronised' messages were printed on the teletype. It was necessary to reload the program at Davis.
3. One-minute magnetic values were not printed out for several days after leaving Davis.

Tracor Satellite Navigation System: On several occasions after a satellite pass there were time jumps of 2 minutes which were corrected only after a delay of 20 to 60 minutes.

Other equipment: The Facit cassette recorder, teletype, echo-sounder, and magnetometer winch performed satisfactorily for the entire survey.

Description of Data

Navigation data: Listings of satellite fixes and positions of course and speed changes were obtained from the Tracor satellite navigation system. In addition, dead-reckoned positions displayed on the panel of the Tracor system were logged manually at 10-minute intervals.

Bathymetric data: Water depths were logged at 10-minute intervals while the ship was over the Antarctic continental margin, and over the Australian continental margin on the return trip.

Time and magnetic data: These were recorded at 10-second intervals on cassette tape, at one-minute intervals on teletype printout, and as a continuous trace on strip-chart paper.

9. VOYAGE 6, TO DAVIS AND MAWSON (Fig. 6)

BMR Survey/Cruise No:

Survey 32, Cruise 4

Observers:

ANARE scientist on downward voyage.
S. Scherl, BMR, on return.

Itinerary:

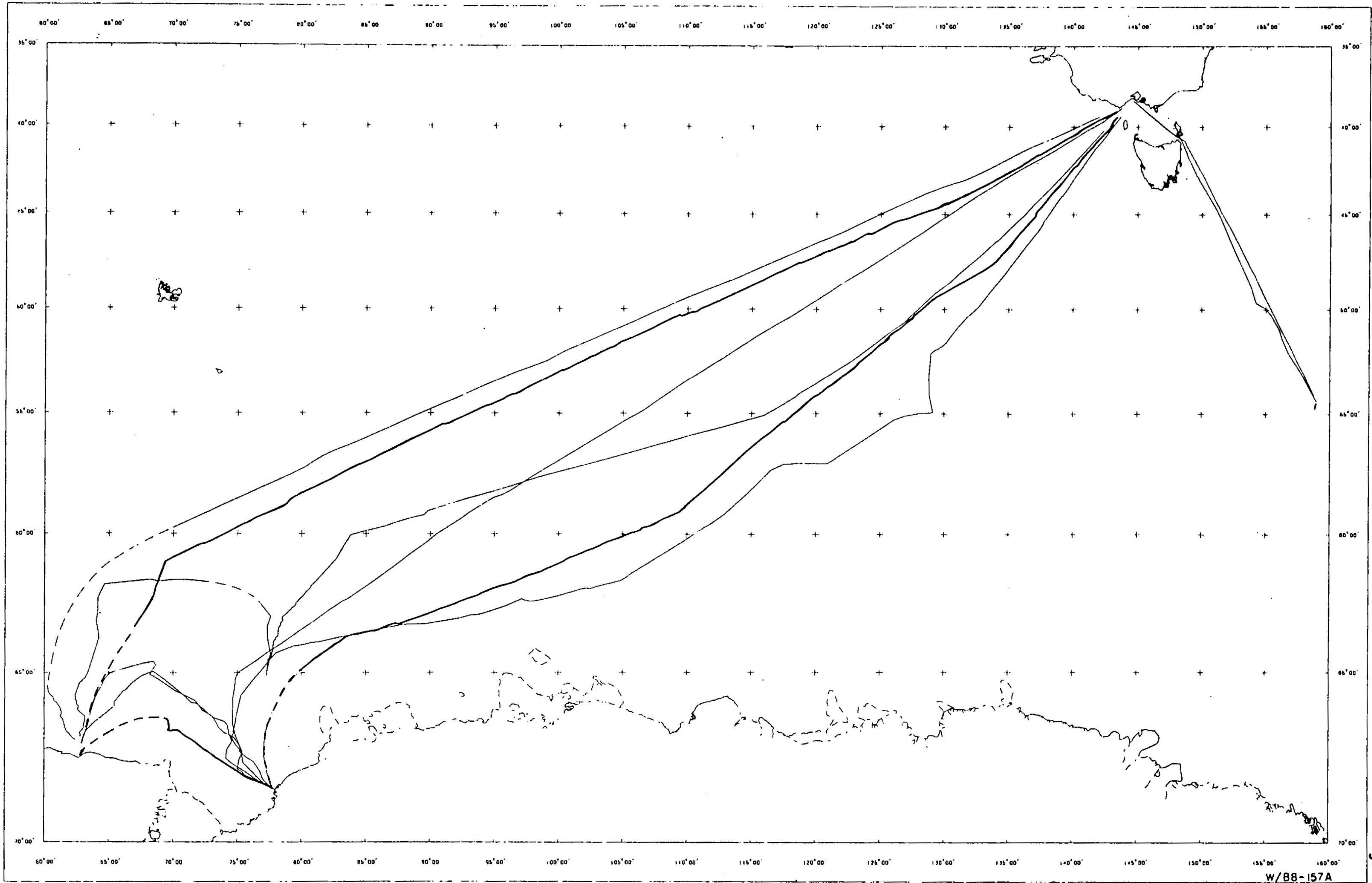
Departed Melbourne	8/2/80 (day 39)
Arrived Davis	19/2/80 (day 50)
Departed Davis	26/2/80 (day 57)
Arrived Mawson	4/3/80 (day 64)
Departed Mawson	7/3/80 (day 67)
Arrived Melbourne	20/3/80 (day 80)

Equipment Performance and Data Quality

Insufficient time was available before the start of the survey to give adequate training to the ANARE scientist who operated the data acquisition system on the downward voyage. This, combined with a malfunctioning of the magnetometer, caused the loss of about five days of recording.

No data were recorded for the first three days of the voyage, presumably because the observer was unable to get the acquisition system started. From 42.0050 to 48.1420, the data recorded appear to be of good quality, except for a period of erratic counts between 41.2155 and 44.2235. After 48.1420, a fault in the magnetometer console caused total loss of data until the ship reached Davis. At Davis the phase lock card in the console was replaced and the magnetometer generally performed well for the remainder of the survey.

Although there was little loss of data on the return voyage from Mawson, the observer was unable to locate the box containing the supply of blank data cassettes, and was consequently compelled to record about 1½ days per cassette, instead of one day as required. In addition, the teletype and strip-chart paper became damp as a result of the wet conditions in the hold, and this caused repeated paper jamming problems. Conditions in the hold became wet during a blizzard which struck the ship near Mawson.



(Based on W/88-153A) Record 1980/68

Fig. 6

SHIPS TRACK

APPROXIMATE TRACK

NELLA DAN MARINE SURVEYS, 1979-1980

Fig. 6 SHIPS TRACKS - VOYAGE 6

Description of Data

Navigation data: Half-hourly dead-reckoning positions and satellite fixes were recorded on print-out of the Tracor satellite navigation system.

Bathymetric data: These were listed at 10-minute intervals in Antarctic Division's log-book while the ship was crossing the Antarctic continental margin. No copy of the data is presently with BMR.

Time and magnetic data: These were recorded on cassette tape at 10-minute intervals, on teletype print-out at one-minute intervals, and on strip-chart paper.

10. CONCLUSIONS AND RECOMMENDATIONS

The four voyages yielded about 30 000 line-km of good-quality magnetic data, demonstrating the practicability of acquiring magnetic and other data aboard the Nella Dan. With the co-operation of the ship's officers and Antarctic Division, it should be possible to continue varying the track slightly between voyages, and so build up the required areal coverage of magnetic data over a period of years. Work on the Antarctic continental margin was severely restricted by adverse ice conditions, particularly in the Prydz Bay region. However, the pack-ice was unusually late in clearing this season and it should be possible to obtain a more systematic coverage in the future, particularly if BMR is able to operate the magnetometer during the FIBEX (First International Biomass Experiment) project next season.

There are several obstacles to the continuing success of the program, which should be considered when further work is planned. These are discussed below and are followed by a list of recommendations for improving the facilities on the Nella Dan.

Acquisition of navigation and bathymetric data

Although satellite fixes and positions at major changes of course or speed were obtained without difficulty on all the voyages, there were problems in acquiring intermediate dead-reckoning positions at frequent and regular intervals. On Voyage 3, volunteers from amongst the ship's passengers maintained a 24-hour bridge watch to list 10-minute DR positions and water depths, and on Voyage 6 the ship's officers collected half-hourly DR positions. On other voyages, however, DR positions were not collected, owing mainly to a shortage of available people to maintain a watch. Similar problems applied to the acquisition of bathymetric data from the ship's Atlas echo-sounder.

The best way round the problem would be to interface both the Tracor satellite navigation system and the Atlas echo-sounder with BMR's data acquisition system. In this way, positional and depth data could be acquired automatically at 10-second intervals and recorded with time and magnetic data on cassette tape. An examination made of the Tracor system at the end of Voyage 3 by R. Whitworth indicated that it is practicable to acquire navigation data automatically.

Exposure of the equipment

The situation of the data acquisition system, in a corner of the rear hold, meant that the equipment was exposed to damage by impact with poorly secured boxes of supplies in the hold, or by the deleterious effects of moisture, salt, or cold. Moisture in the hold caused the tele-type and strip-chart paper to become damp and this resulted in frequent paper jamming problems on Voyages 3 and 6. Moisture and/or cold may have been the main cause of the frequent difficulty in starting up the data acquisition system on all voyages.

If the equipment is to remain in the rear hold, it should be housed in a small container fitted with a heater and air filter.

Manning the equipment

While the assistance of ANARE personnel in operating the data acquisition system on Voyages 2 and 6 is gratefully acknowledged, there is a strong need for Marine Geophysics Group personnel to operate the equipment and co-ordinate the geophysical operation as a whole. This is to ensure that all procedures are rigorously followed; in particular, that data records are consistently properly documented and catalogued, that the DAS log-book is updated according to BMR requirements, and that the quality of data is closely monitored and controlled at all times. Marine Geophysics Group personnel would be better able to deal with emergencies such as malfunctioning of the magnetometer or data acquisition system.

Recommendations

The main improvements which should be made to existing facilities on the Nella Dan are as follows:

1. A small container (1.8 x 1.8 x 1.4 m would be suitable) fitted with a heater and air filter should be installed in the rear hold to house the data acquisition system.
2. Provision should be made for the automatic recording of navigation and bathymetric data, by interfacing the Tracor satellite navigator and Atlas Echograph 600 with the BMR data acquisition system (Fig. 7). This would require installation of BMR's Edo digital depth converter next to the echo-sounder, slight modifications to the Tracor satellite navigator, and the running of multi-core cable from the bridge to the rear hold. No major problems are envisaged.

3. Anti-roll vanes should be fitted to the magnetometer sensor to reduce noise in the magnetic data (as high as 10-15 nT) caused by the typically heavy rolling seas between latitudes 40° and 60°S.
4. ANARE scientists conduct experiments using a fluorometer and temperature probe to record analogue information while the ship is under way. The equipment is sited in the rear luggage locker, near the BMR data acquisition system, and BMR could assist the experiments by recording the data digitally. A multi-pair cable passed through a marine gland in the hatch coaming, plus installation of a second equipment rack to take the Hewlett-Packard Multi-programmer (Fig. 7) are the only significant requirements. It would be advantageous to provide more twisted pair wiring than is immediately required, to allow for additional digital recording if the need arises.
5. An echo-sounder that is capable of reaching the deep ocean floor (5000+ m) is needed if maximum benefit is to be obtained from the many traverses across the deep ocean basins.
6. An improved satellite navigation/dead-reckoning system is required. The present Tracor system is of rudimentary design and is suitable only for broad reconnaissance work. The existing pressure log oscillates up to 3 knots in heavy weather and needs to be replaced with a more precise instrument, preferably a two-component electro-magnetic log. While a modern Doppler sonar system would be superior, it would be difficult to justify the extra cost considering the marginal suitability of the <u>Nella Dan</u> as a marine geoscience platform.

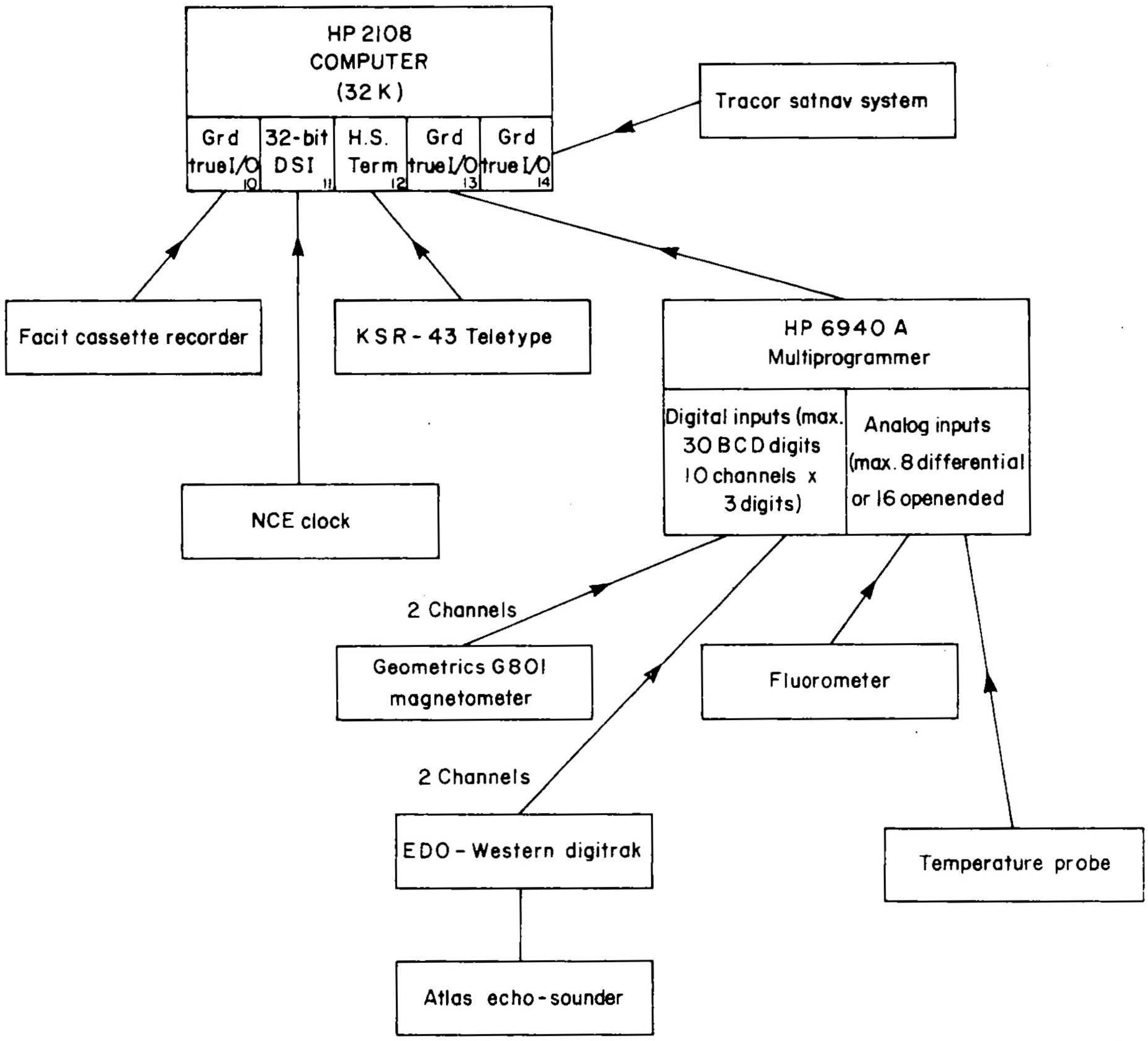


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Fig. 7 Data acquisition system – Stage II

11. REFERENCE

WHITWORTH, R., & STAGG, H.M.J., 1980 - Marine magnetic surveys aboard the M.V. Nella Dan, 1979/80 - operations manual. Bur. Miner. Resour. Record 1980/35 (unpubl).

APPENDIX - Operator programs available on the Tracor satellite navigator.

The following operator programs are available on the Tracor satellite navigator for the entry, display, or control of various information.

ENTRY
- Latitude
- Longitude
- Time (GMT)
- Antenna height
- Manual speed
- Manual or initial heading
- Destination latitude
- Destination longitude
- Log factor

DISPLAY
- Last valid fix
- *Last fix quality
- Distance and bearing to destination (great circle)
- Destination latitude and longitude
- Speed
- Heading
- Antenna height
- Alert time (next pass)
- Distance and bearing to destination (rhumb line)
- Log factor

CONTROL
- Enter auto-heading mode
- Enter auto-speed mode
- Print position data
- Diagnostic check

* Last fix quality displays the following

- Satellite number
- error code (0(zero) if fix accepted)
- maximum elevation
- number of iterations to compute fix
- number of 2-minute Doppler intervals used