BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

RECORD 1987/38

MACQUARIE ISLAND GEOMAGNETIC OBSERVATORY

ANNUAL REPORT, 1985

BY

Wendy WELSH

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Contents

SUMMARY

Geomagnetic recordings were continued at the Macquarie Island Geophysical Observatory during 1985. The work described in this report was part of the Bureau of Mineral Resources and Antarctic Division contribution to the 1985 Australian National Antarctic Research Expeditions.

The photo-electronic magnetograph system recorded X, Y, Z and F in digital and analogue modes throughout the year. Control observations were performed weekly.

Unprocessed control observations were forwarded weekly, and variometer data were forwarded in February and December 1985, to BMR Canberra.

CHAPTER 1: INTRODUCTION

The geophysical observatory on Macquarie Island has recorded geomagnetic activity since 1950. The observatory was operated by the Officer in Charge from the Antarctic Division, Department of Science, Phil Barnaart, as part of the Australian National Antarctic Research Expedition's (ANARE) station on the island. An outline of the observatory history is given in Appendix A, and the coordinates of the magnetic station are listed in Table 1.

Phil Barnaart took over the geomagnetic observatory routines from the BMR observer, Wendy Prohasky, on 26 October 1984. Dave Barrett, the Upper Atmosphere Physics (UAP) engineer was responsible for equipment maintenance. Bob Lachal took over the observatory routines for 1986 on 8 December 1985.

CHAPTER 2: PHOTO-ELECTRONIC MAGNETOGRAPH

2.1 Magnetograph System

The photo-electronic magnetograph (PEM) system (Figure 1) consists of four variometers which monitor the geographic north (X), geographic east (Y), vertical (Z, positive downwards) and the total field (F) components of the geomagnetic field. The magnetograph records the variations of these components, plus temperature, in analogue mode at 20 mm/hr on a 6 channel W+W chart recorder, and digitally as minute averages on an Edas2 data logger with internal analogue to digital conversion.

The total field, measured with an MNS 2.6 Proton Precession Magnetometer, was recorded as 2 components: 0-990 nT and 0-99 nT. Temperature was measured by a Doric with the thermistor near the X variometer. Y, X, Z, F(0-990), F(0-99) and T were recorded on channels 1-6 respectively. The construction and operation of the photo-electronic magnetometers is outlined in Bureau of Mineral Resources, Australia, Record 1985/39, *Handbook for MPE-1 photo-electronic magnetometer (horizontal), MPE-2 photo-electronic magnetometer (vertical) and MCC-1 magnetometer controller*, 3rd edition, by K.J.Seers and G.W.Black.

2.2 Wiring

In the rush and confusion of the 1984 and 1985 changeovers the wiring from the X and Y PEM's was swapped and remained undetected until 1986. That is, X was recorded on channel 2 and Y was recorded on channel 1 from 24.10.1984, 0500 U.T. to 01.03.1986, 0000 U.T.

On top of this, the polarity of the X and Y PEM's was carefully reversed during the 1984 changeover. It is planned to return these to normal during the 1986 changeover.

2.3 Magnetograph System Tests

2.3.1 Scale Values

X, Y and Z scale value pulses of 39.6 mA were initiated through the MCC-1 PEM controller daily as a system check, and weekly with the control observations. F scale values were carried out weekly by recording 996-999 nT and 0 nT. Simultaneous temperature and Edas temperature counts were also monitored weekly. Calibration constants and scale values are listed in Table 2.

2.3.2 Temperature Coefficients

The temperature coefficients listed in Table 2 were determined from linear regression analyses.

2.4 Data Reduction and Publication

Absolute observations of H, D and F were used to calibrate digitally recorded X, Y and Z. The calculations are detailed in Appendix B. Raw observation data were telexed weekly; Figure 2 shows the observation/telex form used.

Preliminary monthly mean values derived from the mean of each month's absolute observations were published in the BMR's Geophysical Observatory Reports. Preliminary instrument corrections were applied to these data:

Element	Correction added
H	-13 nT
D	A collimation angle of 5° 32.28' was used with alpha calculated separately for each observation.
F	0 nT

The PEM baseline values (BLV) listed in Table 3 do not include instrument corrections. Alpha was calculated separately for each observation. The scatter in the BLV determinations is similar to the La Cour BLV scatters of past years.

The preliminary monthly mean values listed in Table 4 were derived from the five International Quiet Days in each month. The preliminary corrections adopted were

H	-17 nT	
D	0 min	(as above)
F	0 nT	

Geomagnetic annual mean values for 1975 to 1985 are listed in Table 5. The values for 1980 onwards have been updated. They represent mean International Quiet Day values with F and D corrections of zero, and QHM 177 H corrections of -13, -14, -15, -16, -16, -17 nT for 1980 to 1985 respectively.

CHAPTER 3: MAGNETOMETERS

3.1 Absolute Instruments

Control observations for H, D and F were made weekly using the following magnetometers:

H & D: QHM 177 (therm. 1083) with Askania circle 640616
F: PPM Austral 525

Observations of H and D were made on pier E, and F on pier W. The reference mark for D was Anchor Rock (AR).

3.2 F Pier Differences

No pier difference observations were undertaken during 1985.

The 1984 pier difference results indicated the total field at pier W was 1 nT greater than at pier E, and at pier N in the PPM hut was 8 nT less than at pier E.

3.3 Reference Marks

A set of reference mark round of angle observations was carried out during the 1985/6 changeover (Table 6). The angles agree well with those determined in January 1982 by surveyors from the Tasmanian Department of Lands (Table 7).

3.4 Comparisons

Since the unmanning of Macquarie Island it has not been possible for a geophysicist to undertake instrument comparisons on the island. Consequently the QHM's are rotated annually to allow the instrument comparisons to be carried out at the Canberra magnetic observatory (CNB). QHM's 177 and 178 were comprehensively compared at CNB during January 1986, then returned to Macquarie Island in February. QHM 179 was used for observations during 1986. Austral 525 comparisons were carried out with Elsec 770/189 as the travelling standard. The magnetometer comparison results are detailed in Table 8.

ACKNOWLEDGEMENTS

The author and the BMR thank Phil Barnaart and Dave Barrett for undertaking the magnetic observatory tasks with precision and dedication. These tasks were additional to their routine duties.

APPENDIX A: GEOMAGNETIC OBSERVATORY HISTORY, MACQUARIE ISLAND

Buildings

1948 - Start of ANARE station on Macquarie Island.

1950 - Magnetic variometer and absolute huts erected.

1968 - Geophysics office constructed.

1979 - Science building constructed - included geophysics office, Upper Atmosphere Physics laboratory and office for the Officer in Charge.

1984 - Proton precession magnetometer hut constructed.

Magnetic Observatory

Aug 1950 - Watts horizontal intensity variometer no. 61911 was installed. Scale value was 3.5 nT/mm.

1951 - Watts H-variometer returned to Australia. 3-component normal La Cour magnetograph installed. Scale values: H, 12 nTmmm; D, 0.9 '/mm; Z, 13 nT/mm.

Apr 1960 - 3-component insensitive La Cour magnetograph installed to supplement the existing sensitive magnetograph. Scale values: H, 63 nT/mm; D, 2.25 '/mm; Z, 59 nT/mm.

Dec 1962 - Normal La Cour magnetograph was replaced by a La Cour rapid run magnetograph (180 mm/hr). The insensitive La Cour magnetograph was modified to increase the sensitivity of the H and Z variometers by changing the H fibre and replacing the Z magnet. Scale values were:

	Before Normal	After Rapid-run	Before Insensitive	After Normal
H (nT/mm)	12.6	5.4	63	24.6
D ('/mm)	0.92	1.03	2.35	2.35
Z (nT/mm)	14.2	5.3	59	20.6

26 Feb 1968 - On 26 Feb the D fibre was replaced in an attempt to reduce erratic drift. On 9 Mar the H fibre was replaced - scatter and drift continued. The H scale value was reduced to 23.7 nT/mm.

1 Feb 1970 - H variometer fibre was replaced in the normal magnetograph. This reduced the H scale value to 19.3 nT/mm, and eliminated steep drift.

1978 - Recording ceased on the rapid run magnetograph.

Feb 1982 - Rapid run magnetometers returned to Australia.

Jan 1984 - Digital and analogue recording from X and Y photo-electronic magnetomereters (PEM's) commenced.

Oct 1984 - Digital and analogue recording from MNS proton precession magnetometer commenced.
- Recording ceased on La Cour normal-run magnetograph.
- Digital and analogue recording from Z PEM commenced.
- Daily operation of magnetic observatory handed over to Antarctic Division Staff.
- La Cour normal-run magnetograph and remains of rapid-run magnetograph returned to Australia.

Mar 1986 - X recorded on channel 2, Y recorded on channel 1 of Edas2 from 0500 UT, 24.10.1984 to 0000 UT, 01.03.1986.

APPENDIX B: THE CONVERSION OF OBSERVED H, D AND F TO X, Y AND Z BASELINES

Introduction

The conversion from absolute values of H, D and F to X, Y and Z baseline values involves adjusting the observed values of H, D and F to a single time. X, Y and Z are then calculated from H, D and F leaving a simple situation where the observed value, ordinate, scale value, etc are known for each element X, Y and Z.

Calculations

1. Calculate observed horizontal intensity, declination and total intensity. Changes in declination during the QHM observation are calculated from the variometer data:

   delta-D = 3437.75(delta-Y.cosD - delta-X.sinD) / H (min west)

   ,where - H(nT) and D(positive easterly) are representative values of the geomagnetic field.
   - delta-X(nT) and delta-Y(nT) are the changes in digital values from the variometers multiplied by their respective scale values. The change is taken in the sense of

     1st 0-pi minus 1st 0-pi
     1st 0-pi minus 1st +pi
     1st 0-pi minus 1st -pi
     .
     .
     1st 0-pi minus 2nd 0-pi

   - delta-D is a correction to the circle readings and is added.

2. Calculate delta-H, D and F to bring the observed H, D and F to a standard time. These delta formulae use changes in X, Y, Z and temperature (T) calculated from the variometer data.

   delta-H = delta-X.cosD + delta-Y.sinD (nT)

   delta-D = 3437.75(delta-Y.cosD - delta-X.sinD) / H (min west)

   delta-F = (H.delta-X.cosD + H.delta-Y.sinD + Z.delta-Z) / F (nT)

   ,where
   delta-Y(nT) = delta-Y(counts).Y scale value + delta-T.Y temp coeff

   Delta-Y is calculated as

   Y counts at standard time - average Y counts during observation

   ,similarly for X and Z.

Delta-temperature is calculated as

T at standard time - average T during observation

As in (1) above, H(nT), D(positive easterly), Z(nT, negative in the southern hemisphere) and F(nT) are representative values of the magnetic field.

Delta-H, delta-D and delta-F are corrections and are added to their respective field values.

3. Now that H, D and F have been converted to a single time, the equivalent observed X, Y and Z can be calculated as follows:

$$X = H.\cos D \quad (nT)$$
$$Y = H.\sin D \quad (nT)$$
$$Z = -\sqrt{F.F - H.H} \quad (nT)$$

4. X, Y and Z baselines can now be calculated from the observed values (part 3), ordinates (digital values from the time chosen to be the standard time) and scale values in the normal way.

APPENDIX C: THE USE OF QHM'S FOR DECLINATION OBSERVATIONS AT MACQUARIE ISLAND

By P. Kelsey

Introduction

The Quartz Horizontal Magnetometer (QHM) is used to measure the horizontal component of the earth's magnetic field. It can also be used to measure the declination. Since the conversion of the Macquarie Island observatory to quasi-unattended operation in October 1984, the declination has been measured using a QHM. The index of correction required for the calculation of declination from QHM observations is derived for the three Macquarie Island magnetometers and their individual characteristics of operation are discussed.

Absolute Instruments and Observation Routine

The BMR's Macquarie Island geophysical observatory ran a La Cour normal-run magnetograph until October 1984. The absolute instruments used to calibrate the variometer were three QHM'S, 177, 178 and 179, a proton precession magnetometer (PPM) MNS2.2 and an Askania circle 640616. A standard set of absolute observations during 1983 was:

Order	Field Measurement	Instrument
1	Declination	Dec 506
2	Total Intensity	MNS2.2
3	Horizontal Intensity	QHM 177
4	"	QHM 178
5	"	QHM 179
6	Total Intensity	MNS2.2
7	Declination	Dec 506

QHM Observations and Angles

QHM observations of horizontal magnetic field intensity (H) were made using the standard schedule (Wienert, 1970). QHM reading positions and angles are given in Figure 3. When the QHM is used to take declination readings a sighting on a geographic reference mark is made before and after the QHM observation.

Calculation of Declination From QHM Observations

$$D = Dq + U$$

,where D is declination as measured with a declinometer;
Dq is declination as measured with a QHM;
U is the index of correction of the QHM as a declinometer.

Thus the index of correction, U, of the QHM is required.

$$U = C - a$$

,where C is the collimation angle;
a is the angle due to residual torsion in the QHM fibre.

It has been observed previously (McGregor, 1967) that when these two effects, collimation angle and residual torsion, are included, declinometer observations using QHM's are of the same quality as those made using declinometers.

Calculation of Residual Torsion in the QHM Fibre

When θ is small the residual torsion, $a = \frac{\theta . \cos\emptyset}{1-\cos\emptyset}$ *

To make accurate observations of Dq the residual torsion, a, must be calculated for each individual observation. Thus, to allow the calculation of a, a QHM H reading must be made in conjunction with the declination reading, as a is calculated from θ and ∅ which are derived from the angles observed during the H observation.

(* All symbols are defined in the footnote.)

Collimation Angle

The collimation angle, C, is the angle between the normal to the QHM mirror and the magnetic axis of the magnet. C should be constant for each QHM. The collimation angles of QHM's 177, 178 and 179 were calculated from the 1983 Macquarie Island H observations using:

$$C = U + a$$
$$= (D - Dq) + a$$

The reference mark reading was taken as the average of the four reference readings taken during the declination observations with Dec 506 before and after the QHM readings. Dq was obtained from the average of the two zero readings of the QHM observations. D was scaled from the magnetograph, care being taken that it reflected correctly the value of the zero readings of the QHM observations. The residual torsion, a, was calculated from each QHM observation. The collimation angles, C, are listed in Table A.

TABLE A - Collimation angles of QHM's 177, 178 and 179

QHM	Mean C	S.D.	Range	Number of data points excluded
177	5° 32.3'	0.6'	3.0'	8
178	59.7'	0.7'	3.4'	4
179	1° 22.6'	1.0'	4.0'	1

As C is calculated from declination measurements its scatter should be slightly largerthan the scatter in the D BLV's of the La Cour variometer. The standard deviation for the D BLV of 1983 was 0.5'.

Physical Characteristics of the QHM's

QHM 179 unclamps smoothly and has the brightest image. It also has the shortest free period of oscillation. QHM 177 has a bright image, but unclamps poorly. QHM 178 has a cloudy image and unclamps less smoothly than QHM 177.

Conclusion

As QHM 179 is the easiest of the three QHM's to use and unclamps smoothly it would be expected that its results would be the most reliable, especially the first zero torsion angle. However, the opposite is true as QHM 179 displayed the most scatter in observed values of the collimation angle.

QHM 177 has traditionally been the standard for Macquarie Island. Its unclamping is tollerable, and it produced the least scatter of collimation angles, so it will continue to be used in preference to the other two.

To use QHM 177 to make declination observations:

1. A mark reading is taken before and after the QHM observation;
2. The value of declination from the QHM observation is given by

$$D = Dq + (C - a)$$

,where $C = 5\ \ 32.3'$ for QHM 177

$a = \frac{\theta . \cos \phi}{1 - \cos \phi}$;and must be calculated from the -2pi,0,+2pi angles from the QHM observation.

FOOTNOTE: Explanation of symbols

A1, A2, ...	Circle readings of normal to mirror
a	Angle due to residual torsion
a1, a2	Deflection angles when n = +2, n = -2
Az	Azimuth from true south of reference mark
B	Circle reading of reference mark
C	Collimation angle, angle between normal to mirror and magnetic axis of magnet
D	Declination as measured by declinometer
Dq	Declination as measured by QHM
H	Horizontal intensity
n	An integer, $n\pi$ equals applied torsion
U	Index correction of QHM as a declinometer (= D - Dq = C - a)
θ	Half the inequality between deflection angles (= (a1 - a2)/2)
ϕ	Mean deflection angle (= (a1 + a2)/2)

References

McGregor, P.M., 1967, Notes on the use of the QHM magnetometer in the measurement of horizontal intensity and declination. *Bureau of Mineral Resources, Australia, Record* 1967/140.

Weinert, K.A., 1970, Notes on geomagnetic observatory and survey practice. UNESCO 1970.

TABLES

1 STATION DATA FOR MACQUARIE ISLAND MAGNETIC ABSOLUTE HUT, 1985

Geographic	latitude	54° 30.0' S
	longitude	158° 57.0' E
Geomagnetic*	latitude	-60.6°
	longitude	244.6°
Elevation		8 metres
Foundation		basalt

* The geomagnetic coordinates are based on the 1980.0 DGRF model of the geomagnetic field.

2 MAGNETOGRAPH PARAMETERS, 1985

Component	Scale value	Standard dev. or correlation	Temperature coefficient	Nominal calibration current	Coil constant
24.10.84 to 31.11.85					
X	0.1996	+/- 0.0005 nT/ct	5.1 nT/°C	40 mA	8.03 nT/mA
Y	0.1996	+/- 0.0003 nT/ct	3.5 nT/°C	40 mA	8.03 nT/mA
01.11.84 to 30.05.85					
Z	-0.2008	+/- 0.0006 nT/ct	-19.5 nT/°C	40 mA	8.03 nT/mA
31.05.85 to 31.11.85					
Z	-0.2013	+/- 0.0003 nT/ct	-19.5 nT/°C	40 mA	8.03 nT/mA
24.10.84 to 31.11.85					
F (0-990)	0.4014	+/- 0.0002 nT/ct	-	990 nT	
F (0-99)	0.04009	+/- 0.00002 nT/ct	-	99 nT	
T	0.00184 °C/ct	99.98 %	-	-	-

3 OBSERVED BASELINE VALUES, 1984/5

Date	U.T. hr min	Baseline value	Standard deviation	Remarks
X, True north intensity		(nT)		
24 Oct 1984	05 00	11323	3	
10 Feb 1985	00 00	11314	4	drift
10 Jun 1985	00 00	11307	1	drift
19 Aug 1985	00 00	11303	2	drift
Y, True east intensity		(nT)		
24 Oct 1984	05 00	6154	4	
18 Feb 1985	00 00	6149	2	drift
01 Nov 1985	00 00	6145	0	drift
Z, Vertical intensity		(nT)		
24 Oct 1984	05 00	-63640	2	
10 Feb 1985	00 00	-63649	4	drift
30 May 1985	07 40	-63588	1	photodiode replaced
28 Jul 1985	00 00	-63585	3	drift
11 Oct 1985	01 40	-63570	5	PEM tests
F(0-990), Total field		(nT)		
24 Oct 1984	05 00	64010	3	
F(0-99), Total field		(nT)		
24 Oct 1984	05 00	64806	2	
T, Temperature		(°C)		
24 Oct 1984	05 00	-3.27	0.05	
22 Mar 1985	23 15	-3.30	0.02	inspection tour of mag huts
15 Aug 1985	01 00	-3.34	0.03	activity around mag huts

Note: X, Y, Z, F(0-990) and F(0-99) baseline datums are 5000 counts;
T baseline datum is 0 counts.

4 PRELIMINARY MONTHLY MEAN GEOMAGNETIC VALUES, 1984/5

Month	X (nT)	Y (nT)	Z (nT)	F (nT)	D (° 'E)
1984					
Oct	11 036	6138	-63 638	64 879	29 04.8
Nov	11 035	6136	-63 630	64 871	29 04.6
Dec	11 038	6141	-63 618	64 860	29 05.4
1985					
Jan	11 037	6142	-63 616	64 858	29 05.8
Feb	11 021	6141	-63 617	64 856	29 07.7
Mar	11 021	6141	-63 618	64 857	29 07.6
Apr	11 018	6143	-63 615	64 854	29 08.3
May	11 025	6145	-63 619	64 859	29 08.0
Jun	11 015	6145	-63 615	64 853	29 09.3
Jul	11 015	6147	-63 613	64 851	29 09.8
Aug	11 012	6147	-63 605	64 843	29 10.2
Sep	11 009	6150	-63 604	64 842	29 11.4
Oct	11 007	6154	-63 594	64 832	29 12.5
Nov	11 013	6151	-63 586	64 825	29 11.2

5 GEOMAGNETIC ANNUAL MEAN VALUES, 1975-1985

Year	D (° 'E)	I (° ')	H (nT)	X (nT)	Y (nT)	Z (nT)	F (nT)
1975	27 43.2	-78 38.2	12847	11373	5976	-63926	65204
1976	27 51.6	-78 39.1	12822	11336	5992	-63891	65165
1977	27 59.8	-78 39.9	12802	11304	6010	-63861	65132
1978	28 11.3	-78 41.1	12773	11258	6034	-63838	65103
1979	28 19.6	-78 42.3	12745	11219	6047	-63807	65067
1980	28 28.9	-78 43.3	12717	11178	6064	-63770	65026
1981	28 36.1	-78 44.2	12691	11142	6075	-63726	64977
1982	28 47.7	-78 45.4	12664	11098	6100	-63703	64950
1983	28 55.0	-78 46.1	12644	11068	6114	-63670	64913
1984	29 03.3	-78 46.6	12628	11039	6133	-63645	64886
1985	29 09.5	-78 46.9	12616	11017	6147	-63608	64847
Mean annual changes							
1975 - 1985	8.6	-0.9	-23	-36	17	32	-36
1975 - 1980	9.1	-1.0	-26	-39	18	31	-36
1980 - 1985	8.1	-0.7	-20	-32	17	32	-36

6 REFERENCE MARK ROUND OF ANGLE OBSERVATIONS

Mark code	Description	Mean Circle 640616 readings 5/12/1985	Angular differences
AR	Anchor Rock	138° 6.42'	
			2.78'
NMI	Rock formation near western shoreline	138° 9.20'	
			183° 15.72'
SM	The Nuggets rock formation	321° 24.92'	
			176° 41.50'
AR	Anchor Rock		

7 REFERENCE MARK AZIMUTHS

Mark code	Description	Azimuth	Angular differences
AR	Anchor Rock	353° 41.27'	
			2.95'
NMI	Rock formation near western shoreline	353° 44.22'	
GOW	Centre of large geophysics office window	46° 36.21' *	183° 15.66'
SM	The Nuggets rock formation	176° 59.88'	
			176° 41.39'
AR	Anchor Rock		

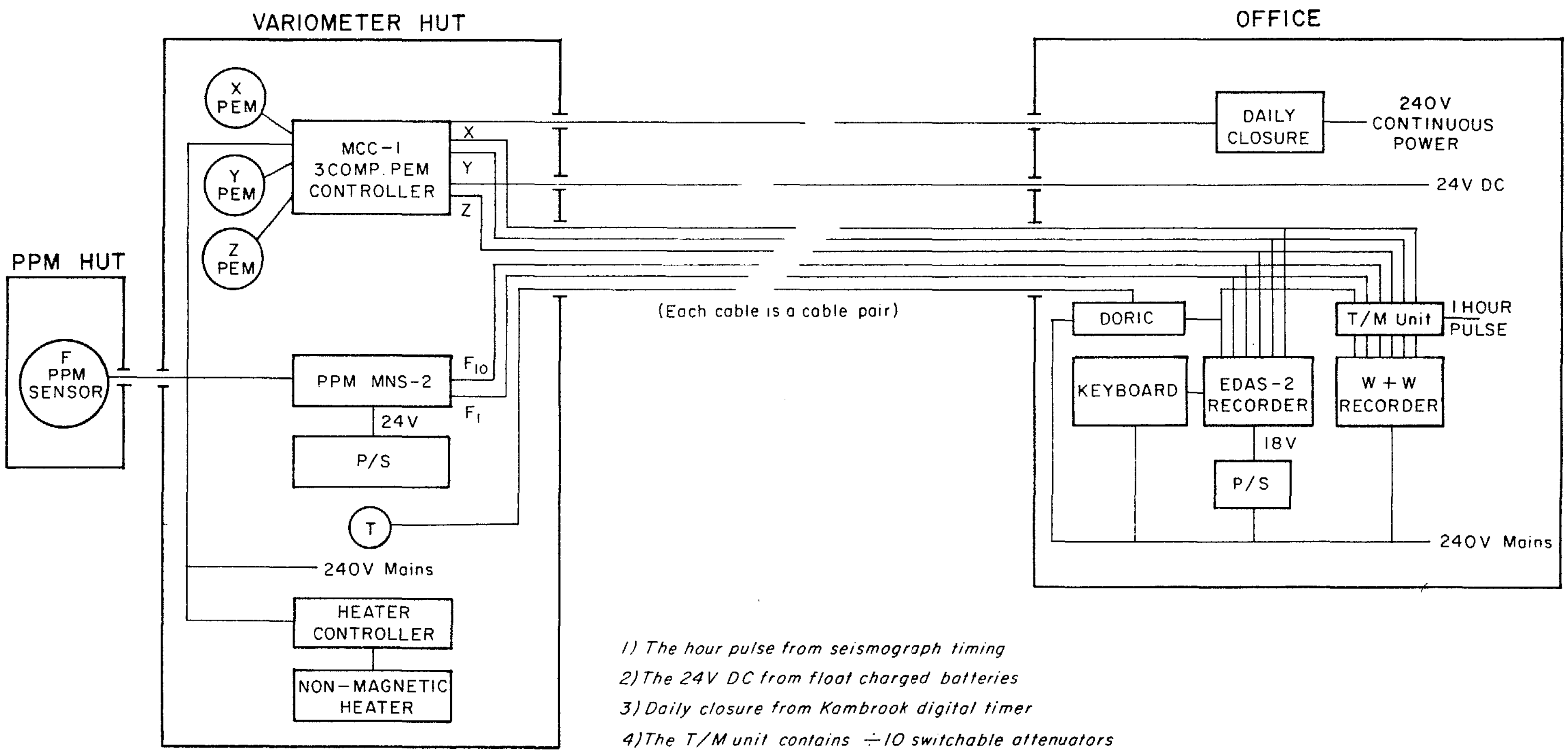
* This angle deduced from round of angle observations.

8 MAGNETOMETER COMPARISONS AT CNB

Date	Inst A	Inst B	Difference (A - B) at H=23700 nT		Observers
14,15 Jan 1986	QHM 460	QHM 177	-19.3 nT	(-0.00081H)	APH/JFS
15 Jan 1986	QHM 461	QHM 177	-20.9 nT	(-0.00088H)	APH/JFS
16 Jan 1986	QHM 462	QHM 177	-22.3 nT	(-0.00094H)	APH/JFS
15 Jan 1986	QHM 460	QHM 178	-14.4 nT	(-0.00061H)	APH/JFS
15 Jan 1986	QHM 461	QHM 178	-13.4 nT	(-0.00057H)	APH/JFS
16 Jan 1986	QHM 462	QHM 178	-12.3 nT	(-0.00052H)	APH/JFS
22,23 Jan 1986	Ruska 4813	QHM 177	C=5° 36.8'	alpha=4.7'	APH/JFS
23 Jan 1986	Ruska 4813	QHM 178	C=20.4'	alpha=16.8'	APH/JFS
14,15,16 Jan 1986	PVM	QHM 177	-20.2 nT	(-0.00086H)	APH/JFS
15,16 Jan 1986	PVM	QHM 178	-12.8 nT	(-0.00054H)	APH/JFS
14,15,16 Jan 1986	PVM	QHM 460	1.6 nT	(0.00007H)	APH/JFS
14,15,16 Jan 1986	PVM	QHM 461	-0.1 nT	(-0.000004H)	APH/JFS
14,15,16 Jan 1986	PVM	QHM 462	-0.4 nT	(-0.00002H)	APH/JFS
20 Mar 1986	E770/189	Aust 525	4 nT		RPL
08 Oct 1985	MNS2.3	E770/189	-4.6 nT		WDW

Observers:
- APH A. Hitchman
- JFS J. Salib
- RPL R. Lachal
- WDW W. Welsh

Figure 1 MACQUARIE ISLAND
PHOTOELECTRIC MAGNETOGRAPH SYSTEM



1) The hour pulse from seismograph timing

2) The 24V DC from float charged batteries

3) Daily closure from Kambrook digital timer

4) The T/M unit contains ÷10 switchable attenuators

24/09/354

DIVISION OF GEOPHYSICS,
BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS

Figure 2 MAGNETIC OBSERVATIONS MACQUARIE ISLAND

2 * YEAR | MONTH | DAY | OBSERVER | OHM | THERMOMETER | CIRCLE | PPM | MARK

3 PPM F READINGS

4 * U.T. | MEAN F | DIGITAL COUNTS: X | Y | Z | F_{10} | F_1 | T

5 MARK * | TEMPERATURE | DEGREES | A | B

6 O *

7 +2π *

8 −2π *

9 −2π *

10 +2π *

11 O *

12 MARK *

13 * MEAN F

14 PPM F READINGS

SCALE VALUES

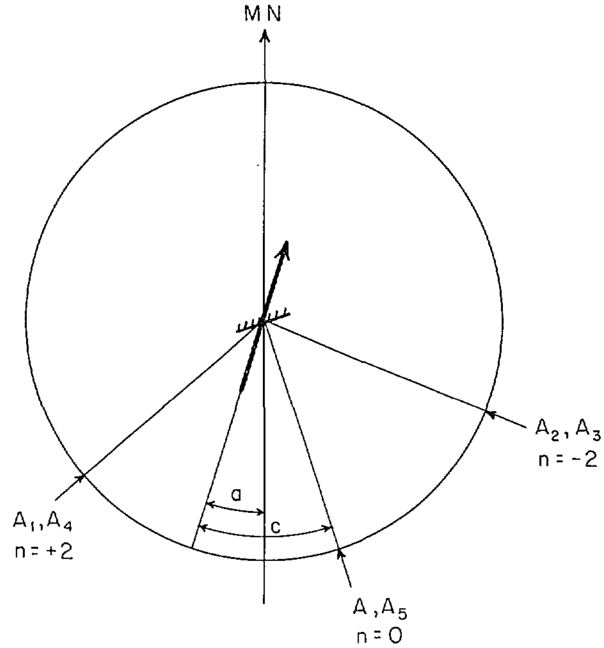
15 * X MAX | X MIN | X MAX | Y MAX | Y MIN | Y MAX | Z MAX | Z MIN | Z MAX

16 * F_{10} MAX | F_{10} MIN | F_1 MAX | F_1 MIN | F SET 9 | DORIC TEMP/COUNTS

* *LINES TO BE TELEXED TO B.M.R., CANBERRA: ONE SPACE ONLY BETWEEN BLOCKS.*

24-2/17

A. DETERMINATION OF H

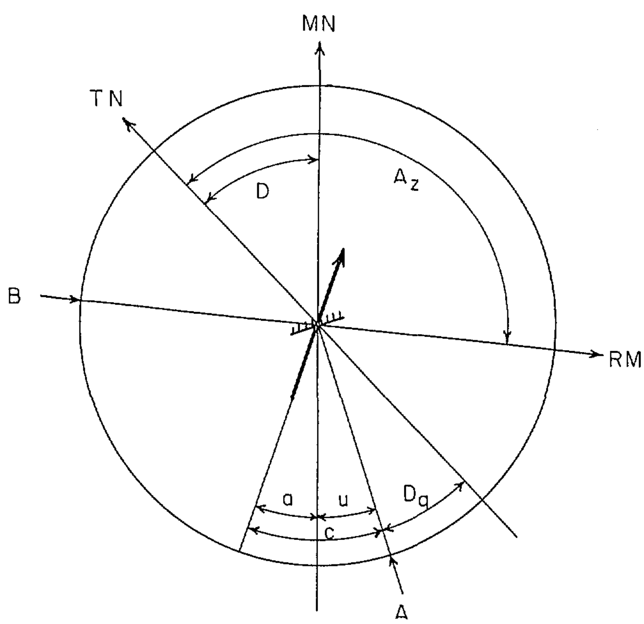


STANDARD SCHEDULE

Setting	n	Circle reading	Time (min)
1	0	A	0
2	+2	A_1	2
3	-2	A_2	4
4	-2	A_3	5
5	+2	A_4	7
6	0	A_5	9

$$a_1 = A_1 - A$$
$$a_2 = A - A_2$$
$$\emptyset = (a_1 + a_2)/2$$
$$\theta = (a_1 - a_2)/2$$

B. DETERMINATION OF D



$$D_q = A_z - (B - A)$$
$$D = A_z - (B - A) + u$$
$$= D_q + u$$

FIGURE 3. QHM READING POSITIONS AND ANGLES
(after McGregor 1967)

G82/2-66