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MACQUARIE ISLAND GEOPHYSICAL OBSERVATORY

ANNUAL REPORT, 1978

by

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CONTENTS

SUMMARY

Geomagnetic and seismological recordings were continued at the Macquarie Island Geophysical Observatory throughout 1978. The rapid-run magnetograph which had been in operation since 1963 was closed down in February.

No major problems were encountered during the year. The seismic signal cable broke down several times due to moisture entering the large number of joints, and a new cable was eventually laid in August.

Work on the new science building proceeded to the lock-up stage. The geophysics office will be transferred to the science building in 1979, and the old office will be used to house the emergency radio transmitter.

1. INTRODUCTION

This report describes the operation of the Geophysical Laboratory at Macquarie Island from 20 November 1977 until 23 November 1978. The observatory is the responsibility of the Bureau of Mineral Resources, Geology & Geophysics, which maintains continuous geomagnetic and seismological recordings as part of the program of the Australian National Antarctic Research Expeditions (ANARE). Facilities and logistics are provided by the Antarctic Division, Department of Science.

The author succeeded Michael Sexton in November 1977 and was succeeded by Kevin Wake-Dyster in November 1978.

2. GEOMAGNETISM

Two sets of 3-component magnetographs were in continuous operation at the beginning of 1978: a La Cour normal-run (20 mm/hr) magnetograph and a La Cour rapid-run (180 mm/hr) magnetograph. The normal-run magnetograph operated throughout the year, but rapid-run recording ceased in February because the equipment was difficult to maintain and there was no demand for the data. The normal-run magnetograph was calibrated eight times a month to determine the scale value and baseline for each of the traces (Tables 1 and 2). The temperature trace was calibrated by noting the temperature of the Z variometer thermometer each day at record change (Table 3).

Magnetic data (K-indices, preliminary monthly mean values, baseline determinations, and scale values) were telexed at the end of each month to BMR in Canberra. Table 4 shows the monthly mean magnetic values during 1978. These values were calculated using the final adopted baselines shown in Table 2 together with the mean monthly ordinates for each trace as originally determined on Macquarie Island. The annual mean values from 1968 to 1978 are shown in Table 5.

Normal-run magnetograph

The recorder functioned well during the year, only needing occasional adjustments of the cylindrical lenses to improve the traces. On 23 December 1977, the recorder was bumped while adjusting the rapid-run magnetograph, but only minor record loss resulted as the recorder was soon re-aligned. On 3 September 1978, the position of the traces had to be changed so that the H upper reserve trace continued to be recorded during large storms. This adjustment resulted in the only major record loss of the year - approximately sixty hours. The latter adjustment also resulted in a change of scale value for the H and D traces.

To obviate the need for changing the silica gel in each of the variometers, a cause of baseline changes, a box of silica gel was placed in the variometer room and changed when necessary.

The temperature coefficient of the H variometer was determined by a least-squares fit to the available data. This gave a value of 3.2 ± 0.2 nT/^{o}C, so the adopted value of 3.0 nT/^{o}C was retained. The temperature coefficient of the Z variometer was found to be very small so the adoption of zero was continued.

The H baseline showed a marked cyclic change during the year, with a maximum value in June and a minimum value in the summer months. This appears to be a temperature effect, but no reason for it could be found. The Z baseline showed a reverse effect, with a minimum in June, probably due to the use of the H baseline value in it's calculation (i.e. $Z^2 = F^2 - H^2$).

Rapid-run magnetograph

Recording was discontinued on 8 February. On 15 February, the frame of the apparatus was removed from the concrete slab and placed in the corner of the variometer hut. This caused a noticeable baseline change in the D-trace, but had no effect on the other traces.

Absolute instruments

Absolute instruments used during the year were:

H : QHMs 177, 178, 179

D : Askania Declinometer 640505 and Circle 640620

Z : BMZ 236, Elsec PPM 424 (in conjunction with QHMs)

The PPM head was placed on Pier W and gave readings of the total field intensity, F. The vertical intensity, Z, was calculated using the values of H derived from QHM observations on Pier E, which is the standard pier. Inter-pier observations, which were made monthly, indicated a pier difference of approximately 0.5 nT. The pier difference was taken as zero and no correction was applied for it.

BMZ observations were also made on Pier W. On 9 January 1978, the BMZ was stripped and cleaned. Comparison of the BMZ baseline values with the Z baseline values derived from PPM observations gave the following mean differences:

Zp - BMZ 236 = 66 ± 4 nT (1 Dec 1977 to 9 Jan 1978)

Zp - BMZ 236 = 93 ± 6 nT (9 Jan 1978 to 31 Dec 1978)

The value of 66 nT agrees with Sexton's value of 69 nT for 1977.

No trouble was experienced with the three QHMs during 1978. However, it was noted that the QHM thermometers gave noticeably different readings, after allowing for corrections, when placed in the same environment. The thermometers used should therefore be recalibrated.

The declinometer behaved well during the year except during September, when it suddenly started to give very erratic readings in a range of 1-3 minutes lower than the expected reading. The declinometer resumed its normal good behaviour in October. No reason could be found for its eccentricities during september.

The PPM gave a lot of trouble due to various causes, e.g. bad joints in the cable and interference from the camp emergency transmitter. The aerial for this transmitter was close to the absolute hut, and when the transmitter was operating, the PPM gave erratic readings and was unusable.

Intercomparisons

Intercomparisons between the following instruments were made at Macquarie Island in November 1978:

1. QHM 172, QHM 177, HTM 704
2. Declinometer 640505 with Circle 640620, and Declinometer 333 with Circle 813
3. PPM 424, PPM 271, Geometrics PPM 816

The following results were obtained; unfortunately the activity of the magnetic field during the intercomparisons has probably reduced their accuracy:

1. QHM 172 - QHM 177 = + 18 $\pm$ 4 nT (8 obs.)
   HTM 704 - QHM 177 + - 14 $\pm$ 2 nT (8 obs.)

   QHM 172 correction in November 1978 was 0.00225 H nT
   = -28.8 nT with H = 12800 nT
   Therefore correction to QHM 177 is -28.8 + 18 = <u>-11 nT</u>

   HTM 704 correction in November 1978 was 0.00025 H nT
   = 3.2 nT with H = 12800 nT
   Therefore correction to QHM 177 is 3.2 - 14 = <u>-11 nT</u>
   which agrees with the correction using QHM 172.

Comparisons of the QHM 177, 178, 179 baselines for each month at Macquarie Island during 1978 yielded the following results:

QHM 177 - QHM 178 = 7.7 $\pm$ 0.5, (taken as 8 nT)
QHM 177 - QHM 179 = 8.5 $\pm$ 1.0, (taken as 9 nT)

Thus the following corrections were adopted for the three QHMs during 1978.

QHM 177	-11 nT
QHM 178	- 3 nT
QHM 179	- 2 nT

The preliminary values actually used at Macquarie Island during 1978 were -10, -3, 0 nT respectively.

2. Declinometer 333 - Declinometer 505 = -0.1' ± 0.9
The correction for Declinometer 333 is rather uncertain, but a value of -0.8' is indicated.
Therefore correction to Declinometer 505 = -0.9'

The scatter in the observations was large due to the activity of the field during intercomparisons, and this result is not very close to the value of +0.5' used for Declinometer 505 in the preliminary declinometer baseline value calculations during 1978. This value of +0.5' has been used in the final baseline calculations shown in Table 2 because the intercomparison value was so uncertain.

3. (i) The comparison of Geometrics 816 against PPM 424 yielded no definite result, as the scatter of the 816 observations was so large that a meaningful average could not be calculated. However, PPM 424 gave a consistent series of results.

(ii) In the comparison of PPM 424 against PPM 421, both instruments gave consistent readings, the result being

PPM 424 - PPM 421 = 0 nT

Orientation tests

The orientations of the magnets in the three normal-run variometers were determined on 21 July. The results are shown in Table 6. The values for the D and Z magnets compare well with previous determinations (Gidley, in prep.; Sexton 1981). However, the H determination of 1.3° North of Prime Vertical shows a large deviation from the results of Gidley and Sexton (0.1°S of PV, 0.34°N of PV), but agrees well with a determination in January 1979 (1.4°N of PV) (Wake-Dyster, 1981).

Parallax

The parallax correction for the normal-run magnetograph was zero for all traces before the adjustment of the magnetograph on 3 September 1979. This adjustment affected the parallax of the D trace, which required a correction of -1 minute for the remainder of the year.

The parallax correction is given by:
True Time of Event = Observed Time of Event + Correction

Pier difference

Two piers were used for absolute observations. The standard pier, Pier E, was used for QHM and declinometer observations. Pier W, approximately one metre west of Pier E, was used for PPM and BMZ observations. Once a month the PPM was operated with the head on Pier E to obtain a pier difference. This difference was approximately 0.5 nT, and was taken as zero; i.e. no correction was applied to the PPM observations.

A large number of observations made in November 1979 gave a similar result.

Pier movements

During declinometer observations in 1978, it was noticed that the circle reading of the North Mark changed from week to week. To check whether the pier was warping, the circle reading of Anchor Rock was read in addition to the North Mark over a period of 3 months during declinometer observations. Table 7 shows the difference in azimuths between North Mark and Anchor Rock as calculated above, and also as calculated from previous determinations of the Anchor Rock and North Mark azimuths.

To check the warping of Pier E, the circle readings of the North Mark were plotted against the time of year. The resulting graph showed a definite cycle with a minimum in February-March, and maximum in December. The difference between the maximum and the minimum was approximately 4.0 minutes. Since this warping would affect all circle readings, it would make no difference to the calculated declination value.

3. SEISMOLOGY

Two seismographs operated at Macquarie Island during 1978, a vertical seismograph and a horizontal (N-S) seismograph. The vertical seismograph consisted of a Willmore

Mark II seismometer with a Geotech telemetry amplifier, discriminator, and 60 mm/min recorder plus a galvonometer and galvonometer control box.

The telemetry amplifier and discriminator were a hang-over from the old plateau seismograph system which used a long land-line to telemeter the signal to the geophysics office.

The horizontal (N-S) system consisted of a Willmore Mark I seismometer with a galvonometer and galvonometer control box and an obsolete 60 mm/min BMR recorder. The optical system was poor, although improvements to it gave some good records towards the end of the year.

The attenuation of each seismograph was varied according to the prevailing weather conditions. The vertical seismograph was usually operated at 32 or 34 dB and the horizontal seismograph at 6 or 8 dB. Table 11 shows how the seismograph magnification is affected by the different attenuation settings.

The free periods for the vertical and horizontal seismometers and associated galvonometers were measured five times during the year. The results, which were consistent, are given in Table 8 together with the magnification at 1 Hz and 32 dB attenuation.

The vertical seismometer was calibrated three times during the year, giving similar calibration curves in each case. The calibration procedure is described in previous reports (e.g. Gregson et al., in prep.). Table 10 shows the magnification of the seismograph for varying periods, compared with the results for the previous 2 years (Sexton, 1981; Gidley, in prep.).

Seismic data were telexed to BMR Canberra, and thence to the United States Geological Survey (USGS) for the preliminary determination of epicentres (PDE).

Only one event, that shown in Table 9, was felt on the island. This earthquake was not recorded by any Australian or New Zealand stations so a magnitude and location could not be determined. The earthquake was not recorded at TOO ($\Delta = 20^{\circ}$) which indicates that the body wave magnitude was less than 4.2.

4. ANCILLARY EQUIPMENT

The power and timing requirements for both seismic and magnetic equipment were obtained from a central console in the geophysics office. In addition, the seismic observatory had a backup power and timing supply which automatically came into operation if the power and timing cable from the geophysics office was broken. This cable was broken a number of times during the year, mainly because of the trench being excavated between the main camp area and the new science building. Owing to the large number of joints in this cable it became very unreliable, and in August a new seismic cable was laid with only two joints in it. The power and timing were controlled by a 50 Hz, 240 V inverter, which was externally synchronised by an EMI clock to ensure a constant 50 Hz. The inverter gave a fair amount of trouble from various causes at the beginning of the year.

The EMI clock ran well throughout the year, losing an average of about 40 ms per day. The clock was corrected each day by using the time signal from VNG in Melbourne.

The power for the magnetic and seismic light sources was separate from the main power supply. The seismic lamps were operated from a supply in the seismic hut itself, and the power was regulated at 10 V. This 10 V regulator broke down in February, and another 10 V regulator was built to a similar design to that used to regulate the power for the magnetic lamps.

5. ACKNOWLEDGEMENTS

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TABLE 1

MAGNETOGRAPHS PARAMETERS

Component	Mean observed scale value	Adopted scale value	Standard Deviation		Temp Coeff.
			Scale value	Baseline	
NORMAL-RUN					
01 JAN-02 SEP					
H	19.37	19.4	0.07	1.5 nT	3.2
D	2.35	2.35	0.01	0.3 min	-
Z	20.72	20.7	0.08	3.5 nT	0
03 SEP-31 DEC					
H	19.34	19.3	0.08	2.0 nT	3.2
D	2.6	2.36	0.01	*	-
Z	20.74	20.7	0.12	2.5 nT	0
RAPID-RUN					
H	5.19	5.2	0.10	-	-
D	1.00	1.0	0.00	-	-
Z	6.46	6.5	0.10	-	-

D scale values are in minutes/mm

H and Z scale values are in nT/mm

Temperature coefficient is in nT/^{o}C

* Baseline too scattered to assign a standard deviation

TABLE 2

BASELINE VALUES, NORMAL-RUN MAGNETOGRAPH

Date 1978	U.T. h	m	Baseline	Remarks
Horizontal			BHs nT	
Jan 01	00	00	12606	
Feb 01	00	00	12615	Adjustment
Mar 01	00	00	12612	Adjustment
May 01	00	00	12616	Adoption
Sep 03	04	00	12611	Adjustment
Declination			BD (E)	
Jan 01	00	00	26°23.5	
Jan 17	00	00	26°35.9	Adjustment
Feb 15	04	00	26° 38.0	R/R Frame REmoval
Jun 01	00	00	26° 38.6	Adoption
Vertical			BZs nT	
Jan 01	00	00	63783	
Feb 01	00	00	63795	Adjustment
Mar 01	00	00	63790	Adoption
July 01	00	00	63785	Adoption
Nov 01	00	00	63788	Adoption

BHs - the H baseline at standard temperature (5°C)
BZs - the Z baseline at standard temperature (5°C)
BD - the D baseline

TABLE 3

NORMAL-RUN Z THERMOGRAPH PARAMETERS, 1978

From	To	St, ^{o}C/mm	Bt, ^{o}C
01 Jan	31 Jan	1.49	-69.3
01 Feb	04 Jul	1.44	-65.9
05 Jul	03 Sep	1.53	-68.8
03 Sep	21 Nov	1.48	-67.0
22 Nov	31 Dec	1.49	-67.7

$t = Bt + St.T$, where t = Z variometer temperature

Bt = Baseline of temperature trace

St = Scale value of temperature trace

T = Ordinate of temperature trace (mm).

TABLE 4

PRELIMINARY MONTHLY MEAN MAGNETIC VALUES, 1978

Month	H	D (East)		Z	F
	nT	o	'	nT	nT
Jan	12780	28	04.8	-63837	65104
Feb	12777	28	06.4	-63845	65111
Mar	12775	28	08.8	-63846	65112
Apr	12770	28	09.9	-63849	65114
May	12772	28	10.9	-63855	65120
Jun	12780	28	11.4	-63850	65116
Jul	12774	28	12.3	-63830	65096
Aug	12774	28	13.0	-63827	65093
Sep	12766	28	13.5	-63829	65093
Oct	12766	28	13.9	-63830	65094
Nov	12766	28	16.2	-63834	65098
Dec	12771	28	14.2	-63824	65089
Mean	12773	28	11.3	-63838	65103

TABLE 5

GEOMAGNETIC ANNUAL MEAN VALUES, 1968-1978

Year	D (East) °	D (East) '	I °	I '	H nT	X nT	Y nT	Z nT	F nT
1968	26	54.7	-78	29.7	13053	11639	5908	-64132	65447
1969	27	02.3	-78	30.8	13026	11602	5921	-64099	65409
1970	27	09.6	-78	32.1	12996	11563	5932	-64078	65383
1971	27	13.3	-78	33.3	12963	11527	5930	-64032	65331
1972	27	22.1	-78	34.4	12937	11489	5947	-64008	65302
1973	27	27.6	-78	35.8	12905	11451	5951	-63985	65273
1974	27	34.3	-78	37.6	12865	11404	5955	-63956	65237
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
Mean Annual Change		+ 07.66		-01.14	-28.0	-38.1	+12.6	+29.4	-34.4

TABLE 6

ORIENTATIONS OF NORMAL-RUN VARIOMETER MAGNETS

Date	Component	Reference Field	Magnet N Pole	Orientation	N Pole
21 Jul '78	H	12768 nT	E	1.3°	N
	D	28° 09,9'	N	0.8°	E
	Z	63856 nT	N	0.5°	Down

H Prime Vertical taken as 119.7°

D Reference Line taken as 29.0°

TABLE 7

ANCHOR ROCK AND NORTH MARK AZIMUTHS

Object	Azimuth determined by	Azimuth	(N.M. - A.R.)
North Mark	National Mapping 1957	353^{o} 44.3'	
Anchor Rock	National Mapping 1957	353^{o} 40.4'	3.9'
Anchor Rock	Major, 1967 (1)*	353^{o} 38.4'	5.9'
Anchor Rock	Major, 1967 (2)+	353^{o} 41.9'	2.4'
	Davies, 1978		3.0' $\pm$ 1.4

* Determined using Station Plan Coordinates, 1963

\+ Determined using Major's Coordinates, 1967 (Major, 1971)

TABLE 8

SEISMOGRAPH PARAMETERS

Seismograph	Seismometer free period	Galvanometer free period	Magnification at 1 Hz, 32 dB Attenuation
Vertical	1.0	0.2	6200
Horizontal	1.1	0.2	-

TABLE 9

EARTHQUAKE FELT ON MACQUARIE ISLAND, 1978

Date	P Arrival time			Magnitude MB(ERL)	Distance	Intensity
	Hr	Min	Sec			
Feb 09	06	59	35.6	4.2	30 km	MM III

TABLE 10

VERTICAL SEISMOGRAPH MAGNIFICATION
AT 32 dB ATTENUATION

Period	Magnification x1000		
	This report	SEXTON, 1977	GIDLEY, 1976
0.1 secs	11.0	10.8	17.9
0.2	28.5	32.0	29.6
0.3	27.0	29.0	26.5
0.4	22.0	24.0	22.8
0.5	18.0	19.2	17.4
0.6	14.25	16.0	14.1
0.7	11.8	13.5	11.3
0.8	9.75	11.5	9.5
0.9	8.0	9.3	7.9
1.0	6.2	7.5	6.1
1.1	4.6	5.3	4.9
1.2	3.6	4.0	3.7
1.3	2.7	2.8	3.0
1.4	2.15	2.2	2.3
1.5	1.65	1.75	1.75
1.6	1.3	1.35	1.35
1.8	0.82	0.9	0.88
2.0	0.56	0.65	0.62

TABLE 11

CHANGE IN SEISMOGRAPH MAGNIFICATION BETWEEN 2 dB LEVELS OF ATTENUATION

Attenuator	P-P amplitude of 1 Hz sine wave	Amplitude relative to 32 dB attenuation	Change in amplitude between levels
26	103.0 mm	1.99	
			1.28
28	80.4	1.56	
			1.25
30	64.3	1.24	
			1.24
32	51.7	1.00	
			1.31
34	39.5	0.76	
			1.33
36	32.15	0.62	
			1.29
38	24.7	0.48	
			1.31
40	18.85	0.36	
			1.22
42	15.4	0.30	
		Mean	1.27 ± 0.03
		Theoretical	1.26