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ANNUAL REPORT

MACQUARIE ISLAND 1974

by

J.J. Walsh

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SUMMARY

Geomagnetic and seismological recording was continued at the Macquarie Island Geophysical Observatory throughout 1974. The MQI seismograph on the plateau, after a period of intermittent operation, ceased operation in early January. The backup seismograph MCQ on the isthmus was used for the rest of the year.

Other equipment faults were frequent during the year making smooth running of the Observatory difficult; nevertheless record losses were not unduly great, and reliable results were obtained for about 95% of the year.

INTRODUCTION

This Record outlines the operation of the magnetic and seismological observatories at Macquarie Island from 2 December 1973 to 24 November 1974, when they were the responsibility of the author.

The Observatories are manned annually by the Bureau of Mineral Resources Geology and Geophysics (BMR) as part of the program of the Australian National Antarctic Research Expeditions (ANARE); they commenced operation in 1950 (seismological) and 1951 (magnetic). The Antarctic Division, Department of Science provides all logistic support for the work. Table 1 gives co-ordinates of the recording sites used.

The author succeeded Mr P.J. Hill in 1973, and was succeeded in turn by Mr J. Silic; Mr G.R. Small from the Canberra HQ Observatory Group accompanied the 1973 Relief Voyage and inspected the observatories during the changeover visit. The 1974 changeover was a very hasty affair (it lasted about 12 hours) so many handing over procedures had to be curtailed; the most adverse effect was on the intercomparison of the magnetometers, and consequently the results are not very accurate.

GEOMAGNETISM

Magnetometers

Absolute control measurements were made with the following instruments:

Declination: Askania declinometer 640505, base 640620

Horizontal intensity: QHMs 177, 178, 179 (the suspension of QHM 179 was broken in July 1974)

Vertical intensity: BMZ 236

Total intensity: Elsec PPM 421

All instruments were read about semi-weekly, except for the PPM which was inoperative for a few weeks in January 1974.

During the changeover in November 1974 very limited sets of intercomparisons gave these results:

Dec. 812 - Dec. 505 = -2.1'
QHM. 172 - QHM. 177 = -18 nT
HTM. 704 - QHM. 177 = 12 nT
PPM. 271 - PPM. 421 = 6 nT

The first-named instruments in each determination were travelling standards from Toolangi Observatory. The last result is very doubtful because of the disturbance level during the short time available.

The external pier for supporting the PPM sensor was in a poor and unstable state, so it was not used. Instead the PPM measurements were made on the BMZ pier W. Unfortunately after 24 March the BMZ was not removed from the absolute hut during the F measurements and as a consequence the F readings have to be corrected by -25 nT. This correction was subsequently confirmed by Mr Silic from comparison measurements made in 1975.

Magnetographs

Two sets of magnetographs were kept recording continuously; they were La Cour 3-component magnetographs, one a normal-run (15 mm/h) and the other a rapid-run (180 mm/h). Some minor problems were encountered with each and are outlined in the following sections.

Normal-run magnetograph. Parameters of the magnetograms are included in Tables 2 and 3.

Orientation tests were made on 2 November and the results are shown in Table 4. It was necessary to replace some of the circuit components to enable the tests to be completed satisfactorily.

The magnetogram calibrator MCO-1 began to give a high scatter in the measured scale values about mid-year. Observation of the current with a meter showed that it was the right value, but the elongate nature of the spots indicate that the current was not strictly constant during the test. The errors became worse until failure of the unit in early November and explain the larger than normal standard deviations shown in Table 2. The problem was found to be the failure of the 6V2 Zener reference diode, which was replaced. A digital voltmeter from Auroral physics was used to re-calibrate the MCO-1 to one part in 500. Replacement of the unit with an equivalent from Australia at changeover was unsuccessful because the replacement unit did not work properly. The present unit, although operational, is not truly calibrated and should be replaced during the 1975 summer changeover.

The Z thermograph is the most sensitive and it was the only one calibrated and used for temperature control. The scale values and baseline values for the thermograph are shown in Table 5. They were derived by inspection of graphs of the observations.

Total record losses for the year amounted to 7.3 days; there were further partial losses for about 10.6 days. The main causes of loss were:

(a) Abrupt fluctuations in lamp intensities from unknown causes; these occasionally fogged some of the records.

(b) A loose gear-wheel, which caused drum slippage.

(c) An earthquake on 5 June displaced the D and H traces and caused some partial losses.

(d) An artificial disturbance of the H variometer on 28 January caused loss of record for two days.

(e) Gradual movement of the recording slit, which frequently caused severe reduction of baseline intensities.

(f) TMU programmer faults, which produced timing errors and uncertainties on several occasions.

Rapid-run magnetograph. Parameters of the magnetograph are given in Tables 1, 2 and 6. Scale values were determined once a month; the orientations of the magnets were not checked during the year.

Record losses were about 13 days total and 3 days partial and were caused mainly by:

(a) Failure to return the prism-sledge to the start position after record changes.

(b) The earthquake of 5 June, as described above.

(c) Fading of the record across the magnetogram, apparently cured by adjusting the main long mirrors.

(d) Abrupt changes in lamp intensity as occurred on the normal magnetograph.

Data and results

Preliminary monthly mean values and K indices were cabled to the Melbourne Observatory Group and have been published in 'Geophysical Observatory Report Vol. 22'. A summary of the monthly values and of the K indices is given in Table 7, and Table 8 give the annual mean values 1964-1974.

SEISMOLOGY

Two seismographs and two sites were used at various times during the year (Table 1). The sites are the original one on the isthmus (MCQ) and one on the plateau (MQI). The latter is joined by a landline to the Geophysics Office, and was established in an attempt to improve the recording of regional earthquakes (McMullan, 1974). Problems were encountered with both systems as described below, and caused a total loss of about 15 days recordings.

The total number of earthquakes recorded during the year was 198, of which 13 were felt at the base by at least one person (Table 11), and 24 were reported in NOAA pde sheets (Table 10). The seismograph parameters for MCQ are noted in Table 9. Some T phases are shown in Table 12; other suspected T phases were recorded but are not reported here because the relevant epicentres were not fixed by NOAA. The speed of the drum was not enough to resolve T phases adequately.

Plateau seismograph MQI

The system failed a few weeks after the 1973 changeover owing to breaks in the cable. Attempts to repair the breaks were hampered by the lack of a soldering iron capable of effective operation in the open; a butane torch provided by the diesel mechanic helped greatly although it lacked a suitable tip.

Generally the cable was in poor condition:

(a) kinks had caused several electrical faults

(b) most joints were corroded and there was insufficient slack to allow satisfactory repair

(c) the protective covering had been abraded at the poles along the suspended part of the line.

(d) a short in the buried part of the line (on the isthmus) proved impossible to find.

Also, the fibre-glass vaultlet was prone to flooding; therefore, operations at the plateau site were abandoned and the equipment was returned to the office. It is the author's opinion that unless the telemetry link and vaultlet are greatly improved there is no point in continuing with site MQI; Plate 3 of Hill (1973) also gives strong support for abandoning the site.

Isthmus seismograph MCQ

This comprised a BMR recorded (30 mm/min), Willmore Mark I seismometer and Geotech 0.2s galvanometer (see Table 10), and was operated for most of the year. The main difficulties encountered with this instrument were:

(a) Frequent failures of the drum to traverse, and occasional irregular traverse rates.

(b) Insufficient battery capacity to provide more than about 20 minutes stand-by power.

(c) Cutting of the time-mark cable at the ANARE Station, which lies between the Geophysics Office and the MCQ vault. Re-burying of the cable in a deeper trench overcame this problem.

(d) Loss of timing after power failures, when the discharged batteries caused errors in the TMU program unit.

BUILDINGS AND SERVICES

During the year, the absolute hut was damaged by sparring bull elephant seals. Two windows were broken. As there was not any replacement glass available, temporary repairs were made by the carpenter. The carpenter also repaired the roof of the Geophysics Office, and the author completely repainted the interior of the Office. Most of the stocks of spares and the Library were transferred to the Rookery Building to provide more space in the Office.

The EMI clock had a gaining rate of about 1.1 s per day, which is outside the adjustment range. A replacement clock was sent in November 1974, but this was damaged on installation, and the clock which was present during 1974 was retained.

The lead acid accumulators should be replaced as they produce problems when there is a power failure. The proton magnetometer batteries are also in bad repair and will hold a charge for a short time only. Nickel-cadmium batteries sent to replace the ones on Macquarie Is were non-operational during changeover; a tested pack will be sent during the summer changeover in 1975.

OTHER DUTIES

Tide gauge

A tide gauge belonging to the Horace Lamb Centre for Oceanographic Research, Flinders University, which was sited in Buckles Bay, was kept in operation during the year. The tide gauge was out of action for about one month while repairs were made (July 22-August 13) to the siphoning system. New tubing and a new protective pipe were installed. The old rubber hose had perished and was affecting the siphon action. The old steel pipe in which the hose was housed also had to be replaced with a PVC pipe. New fittings were needed at both ends to take the new system.

It was necessary to weight the PVC pipe heavily, owing to its lighter construction. An initial attempt using a very large piece of steel failed because it was not heavy enough; high seas dashed the pipe on to the beach and another new pipe had to be installed. Finally four large empty soda-acid fire extinguisher cases were filled with rock and lashed to the end of the pipe. The unit was then placed back in operation. The sensitivity of the system to wave action had been heightened, but otherwise, for all practical purposes, the system was unaltered. The PVC pipe cannot be considered permanent and there was no steel pipe left on the base for replacement. Future installation of a brass pipe may be necessary. Losses of record were incurred when the gauge stuck. This was remedied with a little oil. Clipping of the pen excursion had occurred a few times during the year because of high tides, and the clockwork mechanism stopped some hours prematurely on a few occasions. Errors in the chart time were due to imperfect placement of the paper on the drum. This amounted to only a small error of a couple of minutes throughout the day; this error was maintained for the several days the chart was on. Time marks were done with less frequency in the latter half of the year. A practice of writing the date and time on the record was adopted instead of recording it elsewhere.

Station duties

A share of the usual stations duties was taken: these included mess assistance ("slushy"), Sunday duty cook, garbage clearance and building maintenance.

ACKNOWLEDGEMENTS

Thanks go to all members of the 1974 expedition for their support and congenial company, in particular D. Severin (Physicist), Dave Sharpe (OIC), and Chris Russel (Radio Tech).

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TABLE 1. MACQUARIE ISLAND SITE DATA

	Magnetic Observatory	Isthmus Seismo(MCQ)	Plateau Seismo (MQI)
Latitude			
Geographic	54°30.0'S	54°29.9'S	54°31.2'S
Geomagnetic	-61.1°		
Longitude			
Geographic	156°57.0'E	158°57.4'E	158°55.8'E
Geomagnetic	243.1°		
Elevation (m)	8	14	250

TABLE 2. MAGNETOGRAPH PARAMETERS

Component	Mean Observed Scale Value	Adopted Scale Value	Standard Deviation Scale value Baseline*	Temp. Coeff nT/^{o}C
Normal-Run				
H	19.48	19.50	0.25	3.0
D	2.36	2.35	0.13	
Z	20.80	20.80	0.19	0.0
Rapid-Runs				
H	5.36	5.40	.013	
D	1.02	1.00	.002	
Z	6.24	6.20	.012	

D values are in minutes of arc
H and Z values are in nT.
* not derived.

TABLE 3. OBSERVED BASELINE VALUES, NORMAL-RUN MAGNETOGRAPHS

Date	UT h	UT m	Baseline	Remarks
Horizontal Intensity (uncorrected)				
1973				
Dec 01	00	00	12 748	
1974				
Jan 01	00	00	12 752	Adoption.
Jan 27	23	00	-	Trace lost due to disturbance of instrument
Jan 30	03	00	12 672	Restored trace
Jun 05	12	00	13 067	Trace displaced due to earthquake
Jun 11	01	00	12 658	Restored trace
Aug 01	00	00	12 654	Adoption
Declination uncorrected				
1973				
Dec 01	00	00	26°54.9'	Adopted after PJH orientation tests
1974				
Jan 01	00	00	26°55.7'	Adoption
Feb 19	02	00	27°07.0'	Adjustment to baseline
Jun 05	12	00	27°07.4'	Trace mirror displaced due to earthquake
Oct 01	00	00	27° 07.0'	Adoption
Vertical Intensity uncorrected				
1973				
Dec 01	00	00	-63 780	
through				
1974				
Nov 24	24	00		

TABLE 4. ORIENTATION OF VARIOMETER MAGNETS

Component	Reference Field	Date	Magnet Orientation N Pole
Normal-Run			
H	12860 nT	02.10.74	0.1° N Pole N of PV
D	27.6°E	02.10.74	0.8°N Pole E of PV
Z	63981 nT	02.10.74	0.7° N below Hor
Rapid-Run			
	Not determined		

TABLE 5. NORMAL-RUN THERMOGRAPH 1974 (Z)

Month	St °C/mm	Adopted St °C/mm	bt°C
Dec 73	1.35	1.40	-65.2
Jan 74	1.44		-65.2
Feb 74	1.33		-65.0
Mar 74	1.35		-64.8
Apr 74	1.45		-64.6
May 74	1.37		-64.4
Jun 74	1.38		-64.2
Jul 74	1.38		-64.0
Aug 74	1.37		-63.8
Sep 74	1.31		-63.8
Oct 74	1.33		-63.8
Nov 74	-		-63.8

(a) Adopted scale values apply for the entire interval 01 Dec 73 through 30 Nov 1974.

TABLE 6. RAPID-RUN PARALLAX CORRECTIONS (SECONDS)

Component	Correction
D	+03
H	+22
Z	+26

UT = Observed time and correction

TABLE 7. PRELIMINARY MONTHLY MEAN VALUES, 1974

Month 1974	H nT	D ° East '	Z nT	F	K index
Jan	12886	27 30.1 E	-63963	65248	2.28
Feb	12879	27 30.9	-63962	65245	2.52
Mar	12862	27 32.3	-63952	65233	3.29
Apr	12860	27 33.8	-63954	65234	3.01
May	12869	27 33.6	-63957	65239	2.56
Jun	12865	27 34.1	-63949	65230	2.34
Jul	12863	27 33.5	-63961	65241	2.65
Aug	12857	27 35.7	-63950	65229	2.63
Sep	12858	27 37.1	-63951	65231	2.99
Oct	12861	27 35.4	-63961	65241	3.29
Nov	12861	27 36.4	-63955	65235	2.64
Dec	12857	27 38.5	-63952	65232	3.17
Mean	12865	27 34.3 E	-63956	65237	2.77

TABLE 8. GEOMAGNETIC ANNUAL MEAN VALUES 1964-1974

Year	D	I	H	X	Y	Z	F
1964	26 17.0	-78 24.7	13174	11812	5834	-64249	65586
1965	26 28.6	-78 25.5	13152	11773	5864	-64214	65547
1966	26 37.6	-78 26.7	13121	11729	5881	-64175	65503
1967	26 46.5	-78 28.5	13084	11681	5894	-64166	65486
1968	26 54.7	-78 29.7	13053	11639	5908	-64132	65447
1969	27 2.3	-78 30.8	13026	11602	5921	-64099	65409
1970	27 9.6	-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
Mean annual change	+7.73	-1.19	-30.9	-40.8	+14.1	+28.3	-34.9

TABLE 9. SEISMOGRAPH CONSTANTS

Date	Seismometer	Galvo FP (s)	Seismo FP (s)	Galvo Damping	System Damping	Deflection for Ground Motion Up
Mar 28	Willmore Mk I	0.90	0.2	19.8:1	4.0:1	Up
Apr 04	" " "	0.86	0.2	12.9:1	3.4:1	Up
Nov 23	" " "	0.90	0.2	12.9:1	3.4:1	Up

TABLE 10. EARTHQUAKES RECORDED AT MACQUARIE ISLAND AND LISTED IN NOAA PDE SHEETS

Date	Station	Arrival Time uT hms	Geographic Co-ords Lat	Long	Depth	Magnitude MB	Region
Dec 28	MCQ	13 49 296	14.47S	166.6E	26	6.4	New Hebrides Islands
Dec 29	"	00 26 590	15.1S	166.9E	47	6.2	" " "
Jan 02	"	10 55 340	22.5S	68.4W	105	6.4	Northern Chile
Jan 10	"	08 58 50	14.4S	166.9E	34	6.7	New Hebrides Islands
Jan 30	"	10 02 29	5.2S	134.1E	N	5.9	Aroe Island Region
Mar 04	"	12 45 35	18.8S	177.7W	N	-	Fiji Islands Region
Mar 06	"	19 38 332	36.6S	177.1E	N	-	East Coast Nth I. NZ
Mar 23	"	14 34 375	23.9S	179.8E	535	6.1	Sth of Fiji Islands
Apr 06	"	12 17 53	49.0S	163.2E	N	5.5	Auckland Islands
Apr 13	"	04 20 101	53.0S	159.1E	N	4.9	Mac Is Region
Apr 21	"	06 55 135	55.5S	163.9E	N	5.1	" " "
Apr 27	"	07 31 22	26.2S	175.9E	45	6.1	Sth of Tonga
May 17	"	21 05 31	6.5S	106.8E	131	6.0	Java
Jun 02	"	05 11 498	61.2S	154.2E	N	5.3	Balleny Islands
Jun 04	"	04 21 54	15.8S	175.2W	276	6.0	Tonga Islands
Jun 04	"	04 47 03	60.5S	154.4E	276	5.4	West of MCQ Is

TABLE 10 (Cont'd)

Date	Station	Arrival Time uT hms	Geographic Co-ords Lat	Long	Depth	Magnitude MB	Region
Jul 02	"	23 32 45	29.1S	176.0W	N	6.8	Kermadic Is Region
Aug 13	"	14 47 22	55.5S	146.3E	N	5.6	West of MCQ Is
Aug 29	"	10 19 335	73.4N	55.1E	N	6.4	Novaya Zemlya
Sep 07	"	20 53 16	9.8S	108.4E	N	6.1	Sth of Java
Oct 11	"	07 55 486	13.3S	112.3W	N	5.0	Nth East Is Cordillera
Oct 12	"	08 35 275	60.7S	153.9E	N	-	West of MCQ Is
Oct 29	"	03 23 218	6.9S	129.5E	N	6.5	Banda Sea
Nov 02	"	22 27 096	15.2S	174.1W	N	5.6	Tonga Islands

TABLE 11. INTENSITIES OF LOCAL EARTHQUAKES

Date 1974	Arrival Time (UT) at Recording Station	h	m	s	MM Intensity at ANARE Station
Feb 27	EP	23	46	290	III
Mar 06	EP	02	01	18	II
Mar 21	EP	11	20	59	II
Apr 13	IPD	04	20	100	IV
Apr 15	EP	08	30	58	II
Jun 01	IPC	05	32	347	II - III
Jun 04	IPC	14	23	490	II
Jun 05	(Origin time)	11	44	21	IV
Jun 08	IPC	08	08	457	IV
Jun 08	EP	09	40	085	III
Aug 06	EP	09	36	24	I
Aug 14	EP	16	11	46	III
Nov 13	IPC	19	47	495	III

TABLE 12. T PHASES MACQUARIE ISLAND 1974

Date	Origin Time UT (hms)	Geographic Co-ords Lat	Long	Depth	Region	Station	Recorded T Max Time UT (hms)	MB Mag
Dec 29	00 19 311	15.1S	166.9E	47	New Hebrides Is		01 50 50	6.2
Apr 06	12 16 228	49.0S	164.2E	N	Auckland Is Region	MCQ	24 00	5.5
Apr 13	04 19 455	53.0S	159.1E	N	Macquarie Is Region		21 52	4.9
Apr 21	06 54 279	55.5S	163.9E	N	Macquarie Is Region		28 30	5.1
Apr 27	07 24 540	26.2S	175.9W	45	Sth of Tonga Is		04 12	6.0