BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

RECORD 1982/27

MACQUARIE ISLAND GEOPHYSICAL OBSERVATORY, ANNUAL REPORT, 1981

by

W. Williams

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SUMMARY

The Macquarie Island Geophysical Observatory continued operations throughout 1981 with no major interruption to service.

Preliminary seismological and geomagnetic data were forwarded to Australia weekly and monthly respectively.

1. INTRODUCTION

The Macquarie Island Geophysical Observatory is operated by a geophysicist from the Observatory Group, Bureau of Mineral Resources, Geology and Geophysics (BMR), Department of National Development and Energy. The station on Macquarie Island is run as part of the program of the Australian National Antarctic Research Expeditions (ANARE) with logistic support supplied by Antarctic Division, Department of Science and the Environment. Station data are given in Table 1, and a brief station history is in the Appendix.

The seismograph comprised a short-period vertical component (SP-Z) Willmore seismometer and photographic paper recorder. Preliminary phase data were telexed at the beginning of each week to BMR Canberra via the Antarctic Division.

The magnetograph comprised three La Cour variometers and a normal-run BMR recorder. The resulting photographic record was processed daily. Twice weekly a full set of absolute magnetic observations was carried out. These consisted of two PPM readings, two declinometer readings, and three QHM readings. A telex was forwarded to BMR Canberra at the end of each month, containing the following magnetic data: H-, D- and K-indices and the preliminary baseline and monthly mean values for H, D and Z (Table 2). The preliminary corrections applied to these data are listed in Table 3. Occasional BMZ readings were made to serve as a back-up for the PPM.

Table 4 lists the geomagnetic annual mean values from 1971 to 1981.

The author took over the Observatory from Peter Davies on 19 October 1980, and was followed by Geoff Thomas, the stand-in observer for the summer period, on 23 October 1981.

2. GEOMAGNETIC OBSERVATORY

La Cour magnetograph (20 mm/hour)

The La Cour magnetograph functioned satisfactorily throughout the year. Only occasional maintenance was necessary, such as adjustment of the horizontal slit in front of the recording drum and removal of cobwebs from the trace and time-mark lamps.

The horizontal intensity (H) baseline was shifted on 28 January when a local earthquake moved the variometer. The baseline was readjusted on 9 February.

The same drift in the H-baseline was observed as noted by Davies (1981) with a maximum value in June and a Minimum in the summer months; this is reflected in the baselines (Table 5). Davies (1982) examined the effect of relative humidity on baseline values and reported "little dependence of baseline values on relative humidity over the small range observed", and then points out that any effect would be masked by the ". . . errors inherent in determining baseline values". No reason was found for this baseline drift.

The declination (D) baseline gradually disappeared toward the end of July. The cause of this is undetermined but both the baseline main trace and time trace were lost. These were restored on 31 July by adjustment of the rack deflecting prisms.

The vertical intensity (Z) baseline value remained constant throughout the year.

Baseline values are listed in Table 5.

D and H scale values were constant but the Z scale value changed at the end of May; the cause is undetermined.

The temperature coefficients were zero for D and Z, and 3.0 nT/^{o}C for H. The scale values and temperature coefficients are listed in Table 6.

Parallax corrections were taken as zero for all traces for the year.

Orientation tests

Orientation tests were made on 13 July after a test run two days earlier. Results are shown in Table 7, and compare favourably with those in other years (see Table 8).

Absolute instruments

Absolute instruments used during the year were:

H = QHMs 177 (standard), 178, 179

D = Askania declinometer 640505 and 640620

Z = PPM MNS2/2, BMZ 236 (backup).

The BMZ 236 was kept in the Geolab when not in use.

Observations for H and D were carried out on Pier E, and the detecting head for the MNS2 was set on Pier W. The mark azimuths for D are listed in Table 9. As in previous years the total intensity pier difference was taken as zero (Davies, 1981). The vertical intensity and Z-baseline values were calculated using the MNS2 readings in conjunction with the previous month's H-baseline value.

The operation of the MNS2/2 became suspect during the year. Contacts on the printed circuit boards were found to be corroded and operation was satisfactorily restored after the unit was cleaned.

Trouble was experienced with the MNS2/2 during the 1981 summer culminating in total failure on 19 February. The -IOV rail (internal) had been extensively damaged during manufacture; operation was restored by bridging the damaged section.

Results from the declinometer 505 were not as consistent as required. Occasionally D-baseline values were scattered by about two minutes. Similar occurrences have been mentioned in earlier reports (e.g. Davies, 1981, 1982) but no significance has been attached to it. The problem appears to arise in the declinometer and not from the variometer (see Davies, 1981). The three QHMs and BMZ gave no trouble.

Following the standard procedure a comparison of all absolute instruments was made during changeover (Table 10). Unfortunately the changeover period was cut short by two days and only one set of intercomparisons was completed.

H-intercomparisons. The instrument differences between the travelling standards (QHM 172, HTM 704) and QHM 177 (Table 10) were found by comparing the instruments through the observed baselines. The instrument difference between QHM 177 and QHM 178, and between QHM 177 and QHM 179 were derived from the year's observed H-baseline.

PPM intercomparison. The travelling standard, PPM Elsec 595/144, was compared with the Macquarie Island PPM MNS2/2 (Table 10). No significant difference in readings was recorded, so the correction was taken as zero as in previous years.

Declinometer intercomparison. The travelling standard, Askania declinometer 580 333, with circle 508 810, was compared with the Macquarie Island Askania 640505 and circle 640620 (Table 10). The differences between the declinometers with two sets of readings was 3.3'.

Magnetometer corrections. The preliminary corrections used during the year in the determinations of monthly results are given in Table 3.

3. SEISMOLOGICAL OBSERVATORY

The seismograph consists of a short-period vertical (SP-Z) Willmore Mark II seismometer (free period 1.0s), a galvanometer control box, a galvanometer (free period 0.2s) and a photodrum recorder rotating at 60 mm/min. Time marks are supplied via cable from a digital EMI clock situated in the instrument room in the new Science Block. There is also a Mercer back-up chronometer. Comparison radio time marks were placed on the seismogram every evening, when radio reception from VNG was generally satisfactory. The EMI clock tended to stay well within the prescribed error rate of 50 ms per day. The seismograph parameters are listed in Table 11.

The photographic records were changed at 00 UTC and processed daily. Preliminary arrival times were telexed weekly to BMR Canberra.

Macquarie Island lies on an active plate margin; it is thus subject to seismic disturbances, and a number of mild tremors are usually felt at the station each year.

The largest was recorded on 28 January at 1927 UTC (29 January 0627 local). The estimated intensity was about MM III. This same tremor caused a shift in the H-baseline trace on the magnetogram.

Towards the middle of June, Canberra HQ advised that the seismic recorder polarity had been reversed, probably sometime in 1980. Tests on 21 June confirmed the inverted polarity; it was corrected on 28 June and earlier records were re-annotated.

Calibrations were carried out daily at the beginning and end of each seismogram, using the electronic calibrator unit. A current of 5 mA gave a deflection of 28.8 mm at a 12 dB setting on the galvanometer control box. The damping ratio was kept at about 17:1 for the year. The calibration curve for the seismometer is shown in Figure 1.

The galvanometer control box was left set at 12 dB from 12 December 1980. Previously it had been set on 14 dB from station handover on 29 October 1980. The practice of varying the dB setting according to the daily conditions (e.g. sea, wind, etc.) was ceased.

4. CONTROL EQUIPMENT

The poser and timing equipment is located in an instrument room off one end of the Geolab in the new Science Block. From here underground cables carry signals to and from the magnetograph hut and the seismograph vault. A separate battery room is in the Block, connected by cabling to the instrument room. The battery room is also shared by the Upper Atmospheric Physics Group.

The EMI digital clock was exchanged early in the year because, although the timing was satisfactory, the comparison circuit did not function. The exchanged clock was returned to Canberra at the end of the year. The replacement clock lost about 5 ms/day.

A new aerial was constructed for radio time signal reception.

Rechargeable batteries were placed in the magnetic calibrator unit.

Stand-by batteries were either on continuous charge or charged and maintained monthly.

All other equipment operated satisfactorily with no major faults.

5. BUILDING MAINTENANCE

No major building maintenance was undertaken during the year. Minor repairs were effected when necessary and a small amount of painting was done.

The south wall of the Geolab leaked when rain combined with southerly winds. Repairs were attempted but the fault lies in the construction of the building and became the province of the carpenter. The wall still leaks. Another leak occurred, this time in the darkroom sink. Unfortunately several containers of fixer and hypo eliminator were damaged before it was repaired.

The remote buildings (seismograph hut, magnetograph hut and absolute hut) are all in reasonable condition thanks to the efforts of my predecessors. They will, with constant attention, last for some time to come.

Much of the cable that was installed on the plateau in 1972 to transmit signals from the remote seismic site, has been removed, in a general clean up of the plateau. Several lengths have been used on other projects as well as by the upper Atmospheric Physics group when installing the new Photometer hut.

6. OTHER DUTIES

The standard additional station duties were carried out over the year. These included three weeks on slushie duties, occasional extra cooking while the cook was absent, council jobs such as garbage runs, painting etc. Along with this the author was also station second-in-charge which involved extra duties when the OIC was absent.

7. ACKNOWLEDGEMENTS

Thanks go to all the members of the 1981 expedition for their support and good company over the year. In particular our OIC, Angus Hume, and Electrical Engineer, Mark Femeri, for changing records while I was on trips down the Island.

8. REFERENCES

DAVIES, P.M., 1981 - Macquarie Island Geophysical Observatory, Annual Report, 1978. Bureau of Mineral Resources, Australia, Record, 1981/18.

DAVIES, P.M., 1982 - Macquarie Island Geophysical Observatory, Annual Report, 1980. Bureau of Mineral Resources, Australia, Record, in prep.

APPENDIX

1. Geophysical Observatory History

Macquarie Island

Buildings

1948 - Start of ANARE station on Macquarie Island.

1949 - Seismograph Hut constructed - included geophysics office.

1950 - Magnetic Variometer Hut erected.

- Magnetic Absolute Hut erected.

1968 - Geophysics Office constructed.

1979 - Science Building constructed - included geophysics office, upper atmospheric physics laboratory and office for the Officer in Charge.

Seismological Observatory

1950 - Two-component, short-period, Wood-Anderson seismograph (east-west and north-south) installed.

December 1953 - Replacement two-component, short-period Wood-Anderson seismographs installed.

February 1956 - Short-period Grenet vertical siesmograph installed in addition to Wood-Anderson seismograph.

January 1961 - Benioff three-component short-period seismograph installed to replace existing Grenet and Wood-Anderson Seismographs.

November 1962 - Benioff vertical seismograph retained; the two horizontal component seismographs returned to Australia.

December 1967 - Willmore Mark I vertical seismometer used to test sites near seismic hut for seismic noise, the Willmore then replaced the Benioff, which was returned to Australia.

December 1969 - Willmore Mk I seismometer was replaced by a Willmore Mk II vertical seismometer. The Mk I seismometer was retained to enable sites on the plateau to be tested for microseismic noise.

1972 - Two Willmore Mk II seismometers used concurrently during part of the year; one situated on the plateau and one in the seismic hut.

January	1973 -	Willmore Mk II in seismic hut was returned to Australia and replaced by a Willmore Mk I. Willmore Mk II remained in use on plateau.
	1974 -	Plateau system failed early 1974.
	1975 -	Willmore Mk I continued to operate in seismic hut. Willmore Mk II used to test sites on Wireless Hill for seismic noise.
	1976 -	Willmore Mk II used in seismic hut in vertical position as previously. Willmore Mk I used to set up horizontal (north-south) seismograph in seismic hut.
	1979 -	Early in year, horizontal component recording was discontinued.
October	1980 -	Willmore Mk I returned to Australia, leaving Willmore Mk II vertical seismograph in seismic hut.

Magnetic Observatory

August	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 nT/mm; D, 0.9'/mm; Z, 13 nT/mm.
April	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.
December	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 are shown below.

	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. 9 March 1968, 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.

<u>MAGNETIC OBSERVATORY</u> (Absolute Instruments)

Date	Declination	Horizontal Intensity	Vertical Intensity	
	Instrument/Circle	QHM	PPM	BMZ
1950	DCK 158	DCK 158		
1951	QHMs	QHMs 177,178,179		64
1952	QHMs	177,178		64
1953	QHMs	177,179		64
1954	QHMs	178,179		64
1955	QHMs	177,178		64
1956	DCK 158	177,179		64
1957	DCK 158	178,279		64
1958	DCK 158	177,178		64
1959	DCK 158	178,179		64
1960	(instrument numbers not specified)			
1961	DCK 158	177,178		64
1962	DCK 158	178,179		64
1963	DCK 158	177,179		64
1964	DCK 158	177,179		64
1965	640505/640620	177,178		64
1966	640505/640620	177,179		64
1967	640505/640620	178,179		64,236
1968	640505/640620	177,178,179	592/339	236
1969	640505/640620	177,178,179	592/339	236
1970	640505/640620	172,177,179	592/339	236
1971	640505/640620	172,177,178	592/339,434	236
1972	640505/640620	172,177,178,179	592/421	236
1973	640505/640620	177,178,179	592/421	236
1974	640505/640620	177,178,179	592/421	236
1975	640505/640620	172,177,178	592/421	236
1976	640505/640620	177,178,179	592/421	236
1977	640505/640620	177,178,179	592/421	236
1978	640505/640620	177,178,179	592/424	236
1979	640505/640620	177,178,179	592/271	236,221A
1980	640505/640620	177,178,179	592/271	236
1981	640505/640620	177,178,179	MNS2/2	236

Notes

1. QHMs were used to measure declination between 1951 and 1956. To improve the accuracy of D observations, the Kew Magnetometer 159 was re-introduced in 1956.

2. Between 1951 and 1968, QHMs 177, 178, 179 were used, two at Macquarie Island while the other one was being re-standardised in Australia. In 1968, QHM 172 was added to this list. From 1976 QHMs 177, 178, 179 were left permanently at Macquarie Island and standardised during intercomparison observations once a year.

3. From 1968 an Elsec PPM was used for F absolutes. Z baselines derived from the F absolutes and the previous month's H baseline.

MAGNETIC OBSERVATORY (Intercomparison Instruments)

Date	Declination	Horizontal Intensity	Vertical Intensity	
	ASKANIA/CIRCLE		PPM	BMZ
1955	508813	QHM 179		121
1956	508813	QHM 178		115
1957	509320/508813	QHM 177,288		121
1958	509320/508813	QHM 179, HTM 5010154		211
1959	instruments not specified			
1960	580339/	QHM 178, HTM 154		221A
1961	580339/	QHM 174, 179		221A
1962	instrument numbers not specified			
1963		QHM 178	MNZ-1/1	211
1964		QHM 177	MNZ-1/1	221
1965	640505/	QHM 177	MNZ-1/1	221
1966	640812	QHM 178, HTM 154	Elsec	
1967	640812	QHM 177, HTM 154	Elsec	
1968	640812	HTM 154		
1969	580333/	QHM 172, HTM 154		
1970	580333/	QHM 178, HTM 704	592/424	
1971		QHM 173, 179		
1972	580333/	QHM 174, HTM 704	592/339	
1973	509320/	QHM 172, HTM 704	595/339	
1974	640812/	QHM 172, HTM 704	592/271	
1975	640812/	QHM 179, HTM 704	592/271, 340	
1976	640812	QHM 172, HTM 704	592/424	
1977	640812/508810	QHM 172, HTM 704	592/424, 429 Geom. 816/1023	
1978	580333/508813	QHM 172, HTM 704	592/271, Geom. 816/1023	
1979	580333/508813	QHM 172, HTM 704	Geom. 816/1023	
1980	580333/508813	QHM 172, HTM 704	MNS2/2	
1981	580333/508810	QHM 172, HTM 704	595/144	

APPENDIX 2

There are intentions within the BMR to automate the Macquarie Island Magnetic Observatory. The following are arguments in support.

a) In talks with the Upper Atmospheric Physics group of Antarctic Division, Kingston, Tasmania, it was suggested that they would be more than happy to see the variometer results in digital form. Digital data would be more suitable for their investigations of upper atmosphere phenomena. The use of the small computer at Macquarie Island was suggested as at present it is under-utilized.

b) The direct recording of magnetic data onto tape would also eliminate the need for a variometer hut of the type currently in use. In its place a small shelter would be adequate.

c) Since the installation of a helicorder in the seismograph, photographic processing has been reduced to hardly one magnetogram per day. Automation would eliminate photographic processing entirely.

Table 1

Station Data for Macquarie Island 1981

	Magnetic Absolute Hut	Seismograph Station (MCQ)
Geographic latitude	54°30.0'S	54°29.9'S
longitude	158°57.0'E	158°57.4'E
Geomagnetic latitude	-61.1°	
longitude	243.1°	
Elevation (m)	8	14
Foundation	Basalt	Basalt

Table 2

Preliminary Monthly Mean Geomagnetic Values and K-Indices, 1981

Month (1981)	H (nT)	D ° '(E)	Z (nT)	F (nT)	K
Jan	12710	28 31.5	63746	65001	1.4
Feb	12705	28 35.9	63739	64993	2.0
Mar	12684	28 36.4	63747	64997	2.2
Apr	12687	28 36.7	63749	64999	2.5
May	12686	28 37.4	63752	65002	2.0
Jun	12695	28 38.3	63742	64994	1.1
Jul	12683	28 38.6	63748	64997	1.8
Aug	12681	28 39.6	63738	64987	1.7
Sep	12674	28 40.0	63726	64974	1.3
Oct	12671	28 40.7	63725	64973	2.8
Nov	12674	28 37.9	63716	64964	3.2
Dec	12688	28 37.3	63688	64940	2.9
MEAN	12687	28 37.6	63735	64985	2.1

Table 3

Preliminary Instrument Corrections Macquarie Island 1981

M'meter	QHM 177	QHM 178	QHM 179	Ask 505	MNS2/2
Correction (nT)	-13	-7	-6	+1.0'	0
(xH)	- 0.00102	- 0.00055	- 0.00047	-	-

Table 4

Geomagnetic Annual Mean Values, 1971-1981

YEAR	D		I		H	X	Y	Z	F
	o	'(E)	o	'	nT	nT	nT	nT	nT
1981	28	37.6	-78	44.6	12687	11136	6078	-63735	64985
1980	28	28.8	-78	43.0	12723	11183	6067	-63768	65025
1979	28	19.6	-78	42.3	12745	11219	6047	-63807	65067
1978	28	11.3	-78	41.1	12773	11258	6034	-63838	65103
1977	27	59.8	-78	39.9	12802	11304	6010	-63861	65132
1976	27	51.6	-78	39.1	12822	11336	5992	-63891	65165
1975	27	43.2	-78	38.2	12847	11373	5976	-63926	65204
1974	27	34.3	-78	37.6	12865	11404	5955	-63956	65237
1973	27	27.6	-78	35.8	12905	11451	5951	-63985	65273
1972	27	22.1	-78	34.4	12937	11489	5947	-64008	65302
1971	27	13.3	-78	33.3	12963	11527	5930	-64032	65331
Mean Annual Change									
1971-1981		8.43		-1.13	-27.6	-39.1	+14.8	29.7	-34.6
1976-1981		9.20		-1.10	-27.0	-40.0	17.2	31.2	-36.0
1971-1976		7.66		-1.16	-28.2	-38.2	12.4	28.2	-33.2

Table 5

Observed Mean Baseline Values, 1981

Date 1981	UT h	UT m	Baseline	Remarks
Horizontal intensity			BHs nT	
Jan 01	00	00	12457	
Jan 28	00	00	12223	Earthquake
Feb 09	00	00	12424	Adjustment
Apr 25	00	00	12428	Drift
Jun 28	00	00	12432	Drift
Aug 26	00	00	12428	Drift
Declination			BD (E)	
Jan 01	00	00	26°06.0'	
Apr 01	00	00	26°04.8'	Drift
Aug 01	00	00	26°54.0'	Adjustment
Vertical intensity			BZs * nT	
Jan 01 through	00	00	-63531	
Sep 30	24	00		
Temperature			BT °C	
Jan 01 through	00	00	-79.7	
Sep 30	24	00		

* Derived from H and F (MNS2/2)

Table 6

Magnetograph Parameters, 1981

Component	Scale Value	Calibration Current	Temperature Co-efficient
H	19.42 nT/mm	60.0 mA	3.0 nT/C°
D	2.36 min/mm	20.0 mA	0
Z Jan 01-May 31	20.68 nT.mm	40.0 mA	0
Jun 01-Dec 31	20.79 nT/mm		
T	1.42 C°/mm	-	-

Table 7

Orientation Tests for La Cour Variometer Magnets, 13 July 1981

Component	Reference	Magnet	Orientation	N-Pole
H	12692 nT	East	0.70°	North
D	28°42/E	North	0.58°	East
Z	63748 nT	North	0.59°	Down

Table 8

Orientation Comparison 1974-1981

Year	H	D	Z
1981	0.70°	0.58°	0.59°
1980	0.20°	0.7°	0.6°
1979	0.2°	1.1°	0.6°
1978	1.30°	0.8°	0.5°
1976	0.1°	1.1°	0.5°
1974	0.1°	0.8°	0.7°

Table 9

Reference Mark Azimuths 1981

Mark	Symbol	Azimuth from Pier E
North Mark	NM	$353^{o}44.3'$ ($-6^{o}15.7'$)
Anchor Rock	ANC	$353^{o}40.4'$ ($-6^{o}19.6'$)

Table 10

Magnetometer Comparisons, 1981

Date (1981)	Inst A	Inst B	Difference (A-B) nT at H = 12700 nT	
Oct 22	QHM 172	QHM 177	24	(0.00189H)
Oct 22	HTM 570704	QHM 177	-8	(-0.00063H)
Oct 22	Dec 580333	Dec 640505	+3.3'	
Oct 22	Elsec 595/144	MNS 2/2	+1 nT	
Through Routine Baseline Values			(nT)	
Jan 01-Jan 27	177	178	11	
	177	179	10	
Jan 28 - Feb 08	177	178	9	
	177	179	9	
Feb 09 - Apr 24	177	178	9	
		179	9	
Apr 25 - Jun 27	177	178	8	
		179	9	
Jun 28 - Aug 06	177	178	8	
		179	9	
Aug 27 - Sep 30	177	178	7	
		179	11	
Mean	177	178	9	(0.00071H)
	177	179	10	(0.00079H)

Table 11

Seismograph Parameters 1981

Willmore Mark II Seismometer		
Free Period	1.0 s	
Galvanometer Free Period	2.0 s	
Calibration Current	5.0 mA	
Calibration Deflection	29 mm	
Damping Ratio	7:1	
Attenuator Settings	29 Oct 1980-12 Dec 1980	14dB
	12 Dec 1980-23 Oct 1981	12dB
Gain of Seismic system	2700	
at 12dB 1Hz	(see calibration curve)	
Polarity: 19 Oct 1980 - 28 Jun	Page down	Ground motion down
28 Jun - 23 Oct 1981	Page up	Ground motion up

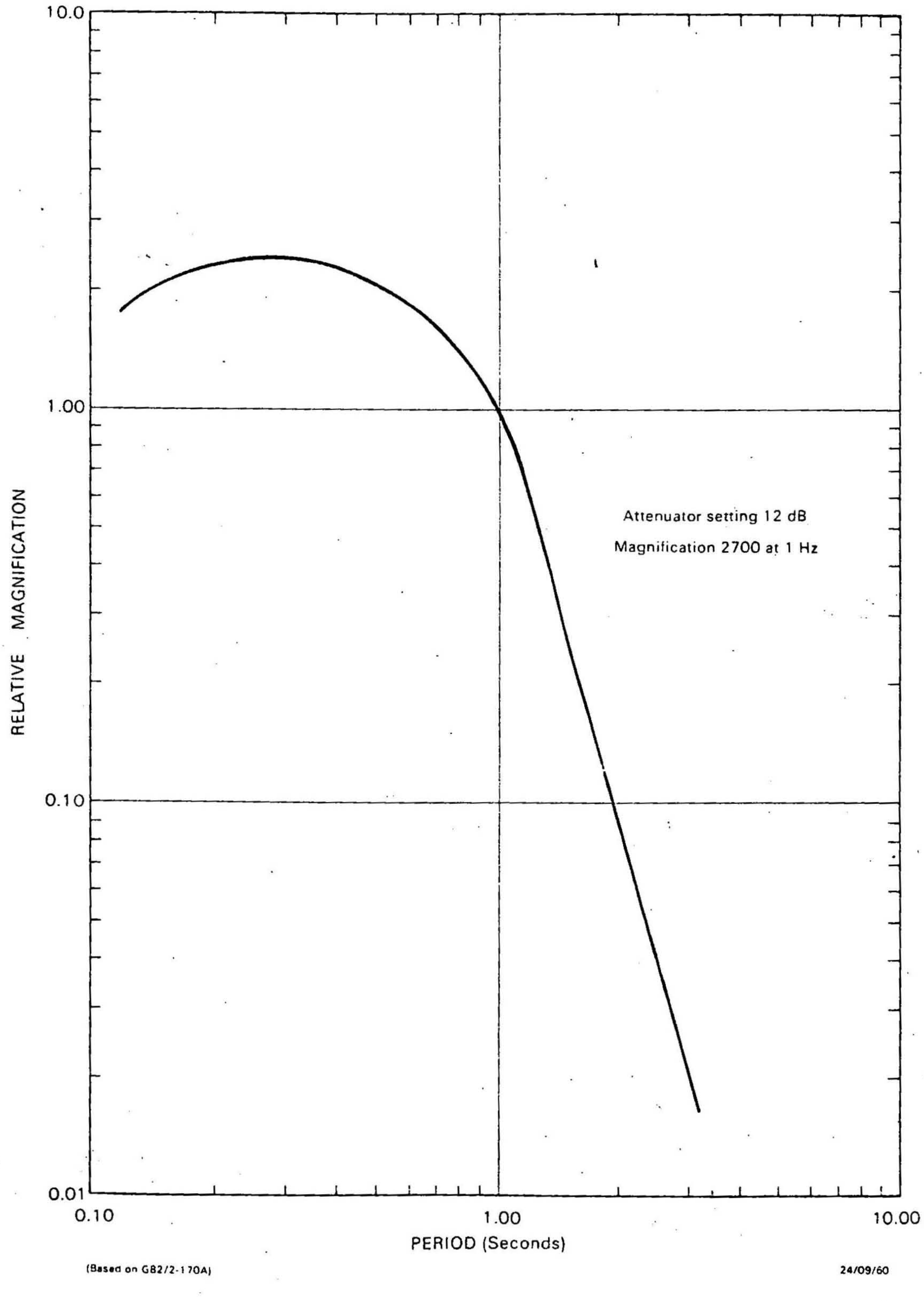

Fig. Macquarie Island, SP-Z seismograph calibration curve