BMR RECORD 1986/21

MACQUARIE ISLAND GEOPHYSICAL OBSERVATORY

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by

W.D. PROHASKY

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SUMMARY

Geomagnetic and seismological recordings were continued at the Macquarie Island Geophysical Observatory during 1984. The work described in this report was part of the Bureau of Mineral Resources contribution to the 1984 Australian National Antarctic Research Expeditions.

The photographic La Cour normal-run magnetograph was operated until October 1984 and then replaced by photoelectric X,Y and Z magnetometers and a Proton Precession Magnetometer with data recorded in both analogue and digital modes.

The seismograph comprised a short-period Willmore Mk II vertical seismometer and a visual drum recorder. Both were replaced by identical reconditioned instruments on 24 October 1984. Five earthquakes were felt by expeditioners during the year.

Preliminary magnetic data was forwarded monthly to BMR Canberra. Preliminary seismic data was forwarded weekly to BMR Canberra until June, then weekly to NEIS, Denver, via the Bureau of Meteorology's Global Telecommunication System (GTS).

1. INTRODUCTION

The geophysical observatory on Macquarie Island has recorded geomagnetic and seismic activity since 1950. The observatory was operated by a geophysicist from the Bureau of Mineral Resources, Division of Geophysics, as part of the Australian National Antarctic Research Expedition's (ANARE) station on the island. Logistic support was provided by the Antarctic Division of the Department of Science. An outline of the observatory history is given in Appendix 1, and the coordinates of the magnetic and seismic stations are listed in Table 1.

The author arrived at Macquarie Island on 18 October 1983 on the N.V. Nella Dan to replace Peta Kelsey, and departed, also on the Nella Dan, on 26 October 1984. The upgraded geomagnetic system and routines were taken over by the 1985 Officer In Charge, Phil Barnaart, with Dave Barret, the Upper Atmosphere Physics (UAP) engineer responsible for equipment maintenance. The upgraded seismic system and routines were handed over to the Bureau of Meteorology team headed by Arthur Giese, with Kevin Shepherd, the Meteorological Technician, responsible for interpretation, reporting and maintenance.

2. GEOMAGNETISM

The La Cour normal-run magnetograph was operated until 8 October 1984. Photoelectric magnetometers (PEM's) and an MNS 2.2 Proton Precession Magnetometer were installed and recording commenced on 24 January 1984 for X and Y, 5 October for F, and 24 October for Z.

La Cour magnetograph

The La Cour normal-run (20 mm/hr) magnetograph system on Macquarie Island, described by Kelsey (1985), functioned satisfactorily during 1984 with a total of 73 hours record loss. This loss occurred during installation of the PEM's, a power failure and faulty record changes. The quality of the photographic records was occasionally reduced by incorrect recorder lid placement and staining due to the sediment in the rinsing water used in processing. These were mainly problems for stand-in operators. Power spikes produced when the inverter tripped out triggered the TMU2 timing control unit, causing its minute counting system to jump forward, and necessitating a correction of usually minus one minute. The presence of a Cathode Ray Oscilloscope in the variometer hut during PEM installation caused occasional, short-duration baseline shifts and trace instability.

La Cour magnetograph tests

PARALLAX

Ten parallax tests were performed during the year. The adopted parallax corrections are given in table 2; they compare well with Peta Kelsey's 1983 results.

SCALE VALUES

A magnetograph calibrator MC01 was used in conjunction with helmholtz coils to determine H,D and Z scale values eight times monthly. Calibration constants and scale values are listed in Table 3.

TEMPERATURE COEFFICIENTS

Temperature coefficients listed in Table 3 were determined from linear regression analyses.

ORIENTATION

No orientation tests were carried out during 1984. The tests by Peta Kelsey in October 1983 gave acceptable results consistent with values obtained in previous years (Table 4).

Photoelectric magnetograph system

DESCRIPTION

The PEM system 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 four field components in analogue mode at 20 mm/hr on a 6 channel W+W chart recorder, and digitally as 1 minute averages on an Edas2 data logger with internal analogue to digital conversion.

The total field component was measured with an MNS 2.2 proton precession magnetometer previously used for absolute observations. It was recorded as two components: 0-990 nT and 0-99 nT, due to the magnetometer's output configuration.

Temperature was measured by a Doric with the thermistor near the X variometer.

X, Y, Z, F(0-990), F(0-99), and T were recorded on channels 1-6 respectively on both systems.

INSTALLATION

Figure 1 illustrates the layout of the entire PEM system. Of the three piers in the variometer hut, the westernmost pier supports the X variometer, the easternmost pier supports the Y variometer, and the southernmost pier supports the Z variometer. The MNS electronics, its 24 V DC power supply and the MCC-1 3 component PEM controller were installed on the control room bench.

Orientation of the X and Y variometers was determined using the original orientation marks in the variometer hut, and is accurate to 1/4 degree. The three levelling screws of each were secured in position using Polyfilla.

The setup of the X and Y circuit boards was not without incident due to static sensitive integrated circuits and congestion of components near test point M5. Trace instability in the X PEM due to a faulty LED was rectified by a BMR technical officer, Greg Black, during the 1984/5 changeover. The Z PEM was also installed at this time. Although a simple task for a technician, the circuit board setup is a laborious task for an amateur.

Figure 2 shows the cabling between magnetic huts at the author's departure. All cables were installed in conduit buried to about 200 mm.

The Doric thermograph was calibrated using 1% resistors made up to 100K ohms (-I, +V), 1.602K ohms (+I, +V, 100°C, adjust Span), and 25.425K ohms (+I, +V, 0°C, adjust Zero). The front panel switches were F,5,4,2,1 - on, 3 - off during the calibration, and 5,4,2,1 - on, F,3 - off for normal operation.

The Dick Smith NDS-1 clock supplied with the system was unsuitable: the 10 minute and 1 hour timing chips were incapable of delivering sufficient current to drive the relay in the distribution box without malfunctioning, and power spikes continued to confuse the clock even after the addition of an input filter. The NDS-1 was returned to HQ and 10 second duration hour pulses were taken from UAP's Systron Donner timing system.

Photoelectric magnetograph system tests

SCALE VALUES

X and Y scale value pulses of 39.5 mA were initiated through the MCC-1 PEM controller daily. Simultaneous temperature and Edas temperature counts were also monitored daily.

PPM scale values were carried out twice weekly by recording 997-999 nT and 0 nT.

Calibration constants and scale values are listed in Table 3.

TEMPERATURE COEFFICIENTS

The temperature coefficients listed in Table 3 were determined from linear regression analyses.

TIME COEFFICIENTS

There is a drift with time of X and Y PEM outputs due to detorsioning of the QHM fibres (see also Crosthwaite, 1986). The drift of the X PEM was quite large at 0.3 nT/day, while the drift of the Y PEM was not significant over the four month period during which baselines were determined.

Magnetometers

Control observations for H,D,Z and F were made eight times monthly using the following magnetometers:

H: QHM 177 (therm. 1083) (standard), 178 (therm. 618), and 179 (therm. 1651)
D: Askania declinometer 640506 with circle 640616
Z: BMZ 236 with thermometer 671
F: PPM MNS 2.2

Observations of H and D were made on pier E; Z and F on pier W. The reference mark for D was North Mark Inner (NMI).

Both the BMZ and PPM were used for absolute measurements until 10 August 1984, when the PPM was installed for continuous operation. Data collected from these observations between 01 November 1983 and 10 August 1984 were used to determine accurate instrument corrections for the BMZ (Table 7).

F Pier differences

Seven sets of pier difference observations between pier W and pier E, consisting of ten alternating total field measurements, were carried out during the year. The results consistently indicated the total field strength at Pier W to be 1 nT greater than at Pier E.

One set of pier difference observations between pier W and pier N, in the

PPM hut, consisting of twenty alternating total field measurements carried out on 8 August 1984, indicated the total field strength at pier W to be 9 nT greater than at pier N.

Reference mark azimuths

Four sets of reference mark round of angle observations were carried out from pier E at regular intervals during the year. The observed angles from all four observations agreed well with the angles determined in January 1982 by surveyors from the Tasmanian Department of Lands (Table 5), (Ferguson, 1985).

The PPM hut, built in August 1984, blocks the view from pier E to NMXI, the old auroral camera stand, so GOW, the timber in the centre of the large geophysics office window, was adopted as a new mark.

A seasonal twisting of the pier of approximately 2 minutes in a west from north direction from summer to winter is clearly indicated by the observations. November 1983, February, May and August 1984 readings are listed in Table 6.

Comparisons

During the October 1984 changeover, installation and modification of the PEM's left only one and a half days for comparison observations. Although the magnetic field was very noisy on the first afternoon, one set each of QHM and declinometer comparisons were completed, and later discarded when the results were found to be inconsistent. The field was quieter the following day and the remaining three sets each of QHM and declinometer comparisons were completed.

X and Y baselines from these 3 sets of QHM comparisons are very scattered with standard deviations averaging about 30 nT. The PEM scatter seems to have commenced during the 1984/5 changeover, as the 1985 baselines are similarly poor. Magnetic contamination during the confusion of a hectic changeover may have also contributed to the scatter.

Applying first order linear corrections to the observed values of H gave errors almost as large as the instrument differences themselves, so no QHM comparison results are listed.

Applying first order linear corrections to the observed declination gave much more consistent results.

PPM comparisons were not carried out during the changeover as the Geometrics 816/1024 was found to be unoperational, and there was insufficient time for repairs. On return to Australia the Macquarie Island NMS 2.2 was compared with the Canberra Observatory MNS 2.3 which had been recently checked and adjusted.

Contiguous BMZ 236 and PPM MNS 2.2 magnetic observations were carried out eight times monthly during the year.

Magnetometer comparison results and instruments are listed in Table 7.

Data reduction and publication

LA COUR MAGNETOGRAPH

The observed baseline values for the Macquarie Island La Cour magnetograph are listed in Table 8. Most baseline value changes occurred while opening the magnetometers to replace hydrated silica gel. Other changes were due to an earthquake, PEM installation, and changes in the BMZ instrument correction.

Preliminary monthly mean geomagnetic values were determined from the five to ten magnetically quietest days each month (K-index sum less than 18). This information, along with scaled H, D and K indicies, preliminary mean baseline values, and mean scale values for the month, was telexed to BMR Canberra. Preliminary instrument corrections applied to the mean geomagnetic values during 1983/4 are given in Table 9.

The preliminary monthly mean and annual mean geomagnetic values for 1983/4 are given in Table 10, and the annual mean geomagentic values for the last ten years in Table 11. Recent trends in secular variation continued with D becoming more easterly by 6.7 minutes, H decreasing by 14 nT, and Z decreasing in magnitude by 32 nT.

PHOTOELECTRIC MAGNETOGRAPH

The observed baseline values for the PEM are listed in Table 8. The baseline value changes were caused by system modifications.

The increase in precision expected from the new digital system is only seen in the temperature baselines where the standard deviations are an order of magnitude smaller than for the La Cour system.

As the new digital system only records averages, it is not possible to use spot values in the reduction of the absolute observations. The X PEM baseline determinations have approximately the same spread as the La Cour H baselines, while the Y PEM baseline spread is much greater,as reflected in the post- 5 May scale values. After replacing the LED in the Y PEM during changeover the scale value scatter was reduced.

3. SEISMOLOGY

Seismograph

Seismic activity was detected using a Willmore Mk II seismometer (free period 1.0s) situated in the seismic vault; the output was amplified by a Teledyne EA310 amplifier then transmitted via underground shielded cable to the geophysics laboratory where it was recorded using an AR311 amplifier and a Geotech R10 recorder, modified by BMR for visual recording. The seismograph parameters are listed in Table 12.

The setting of the EA310 pre-amplifier was 24 dB throughout the year. The setting of the AR311 helicorder amplifier (Table 13) was generally 24 dB except on days with light winds and low wave noise, when the attenuation was decreased to 18 dB.

Time marks were supplied to the records by a Systron-Donner clock owned by the UAP group. The recorder was powered by synchronous 240V 50 Hz AC from an inverter.

Seismograph calibrations and tests

DAILY TESTS

Calibration pulses were applied daily at each end of the seismograms. These were nominally 8 mA until 31 March 1984, then 4 mA for 18 dB attenuation and 8 mA for 24 dB attenuation, as the 8 mA pulse at 18 dB was slightly too large for the siesmogram paper, being 5.5 cm peak to peak.

As a time check, one second time mark pulses from a Labtronics radio receiver type 21 were recorded daily for one to two minutes except when precluded by poor radio reception.

CALIBRATIONS AND TESTS

The seismograph was calibrated, and the free period and polarity were checked, on 2 November 1983 with Peta Kelsey (results are given in Kelsey (1985)), and also on 21 March and 28 August 1984 (Figure 3, Tables 14 and 15).

The free period of the system was consistently 1.0s and the polarity was maintained such that an upward ground movement corresponded to the deflection of the helicorder pen "up" the record.

Seismic data

A total of 19 hours of seismic record was lost during the year. Losses were caused primarily by a power failure and seismic system tests.

Preliminary seismic data were forwarded weekly to BMR Canberra for distribution internationally until 1 June 1984, then weekly via the Bureau of Meteorology's Global Telecommmunications System (GTS) direct to the National Earthquake Information Service (NEIS), Denver, U.S.A. with BMR receiving messages automatically. All data messages were also sent to Dumont D'urville at their request.

Seismicity

Table 16 lists 39 earthquakes of Richter magnitude ML=2.0 or greater which occurred in the vicinity of Macquarie Island from November 1983 to October 1984. The largest was on 2 July 1984, and was felt with intensity V on the Modified Mercalli intensity scale (MM).

4. CONTROL EQUIPMENT

The timing and power controls for the seismograph and magnetograph were located in an instrument room off the main Geophysics laboratory. Batteries and an inverter (Saunders Type 10303) were located in a special battery room, which is shared with the UAP group.

A dark room was also shared with the UAP group until the La Cour magnetograph was removed in October 1984.

Timing

Timing for the MCQ geophysical observatory seismic and La Cour systems was provided by UAP's Systron-Donner clock. Hour marks for the PEM analogue records were initially provided by a Dick Smith digital clock (NDS-1). However, even after the addition of a high frequency filter, the clock was very sensitive to power fluctuations, so on 15 May 1984 it was replaced by hour pulses from the Systron-Donner.

The Systron-Donner timing system was very reliable with a drift of much less than 10 ms/day. A time code reader (Model 8230) and a time decorder, both on loan from the UAP group, interface the incoming signal. The time decorder sent 1 hour, 1 minute and 10 second pulses direct to the seismic recording system; and sent 1 minute signals to the Time Mark Programme Unit (TMU2) which directed 5 minute, plus first and fifty-ninth minute signals to the La Cour magnetograph.

The TMU2 functioned reliably except when power spikes passed through the mains due to the inverter tripping out, and produced a false trigger at the TMU2, causing its internal clock to step forward one minute.

A GED clock was used during the year to supply a 50 Hz signal to the Saunders inverter, but was not used for timing.

Power

Primary power was provided to the seismograph and the La Cour magnetograph by an inverter; secondary power was provided through a Stabilac voltage stabilizer running on station mains. Control was switched between these systems by a Power and Timing Control Unit (PPT1). The Stabilac voltage stabilizer and the PPT1 ran reliably during the year; the inventer displayed an intermittent fault.

The Saunders 24/240V inverter was synchronized by a 50 Hz signal from the GED clock and ran from two heavy duty batteries which were trickle charged from the station mains.

The inverter commenced malfunctioning shortly after a station mains overvoltage of 272 volts on 12 December 1983: the inverter's circuit breaker failed to operate. Extensive efforts were made to fix the inverter, ranging from checking and adjusting to replacing circuit board components and finally to redesigning, making and installing a new circuit board using available components. All to no avail. On 6 August 1984 an internally synchronized 24/240V inverter was borrowed from the Bureau of Meteorology on the island. This ran reliably and was replaced during changeover by an internally synchronized 24/240V inverter from BMR.

Cables and wiring

To free a 12-core cable for the photoelectric magnetometers, the La Cour scale values and orientation tests wiring was moved onto the 12-core power and timing cable. After installation of the X and Y PEM's the spare cable carried X, Y and temperature information to the instrument room, and 24V D.C. plus scale value trigger pulses to the PEM controller. With the introduction of the PPM for continuous recording, an extra cable was installed in the conduit between the geophysics laboratory and the variometer hut. The 24V D.C. supply was transferred to this 2-core cable, enabling the PPM wiring to be included on the 12-core cable. Prior to installation of the Z PEM the La Cour magnetograph was removed from the variometer hut, freeing the original power and timing cable for the Z PEM wiring.

Separate trenchs were dug between the PPM and variometer huts for the PPM detector cable and for the station mains. Both cables were installed in conduit.

All loose cables in the geophysics laboratory instrument room and in the variometer hut were installed in ducting during the year.

5. BUILDINGS AND MAINTENANCE

PPM hut

To maintain the continuity of geomagnetic data, recording of the total field (F) was commenced before the La Cour magnetometer was stopped. A separate, permanent variometer hut was erected to house the PPM sensor. This avoided interference to the variometers and provided a vibration-free mounting to preclude induction signals in the coil. The new hut is located midway between the two original magnetic huts. A floor plan at the hut is given in Figure 4, and its location is shown in Figure 5.

Variometer and absolute huts

No maintenance was carried out to the Variometer or Absolute huts. Stainless steel turn buckles and cable were ordered for the western, windward walls of both buildings. The plastic Vinclad cladding on both buildings is old and brittle and should be replaced. In the interim extra sheets have been ordered to replace/patch the existing panels.

Seismic hut

The seismic hut was reconditioned during 1984. Two coats of hydroseal were applied to the roof; the eastern wall of the cold porch was reclad with galvanized iron; all exterior walls were scraped and repainted; and the exterior door was furnished with door knobs. Disused seismic equipment and wiring were removed from the hut.

Geophysics office

Fibreglass batts and sisilation were installed by the carpenter above the ceiling of the science building during 1984. No other maintenance was carried out to the geophysics office.

6. OTHER DUTIES

Saturday duties consisting of station building maintenance, the sorting of supplies and stores, repairs to roads and field huts, and fuel farm modifications were performed during 1983/4. Domestic duties of rostered slushy duty in the mess, donga and science block areas, garbage runs and occasional cooking were done. Occasional help was given to the UAP group, and to the Doctor for his Sooty Albatross monitoring program.

7. ACKNOWLEDGEMENTS

The author thanks all members of the Macquarie Island party for their assistance and companionship during 1983/4. Special thanks are due to Ivan Taylor, Malcolm Lambert and Roger Welsh for changing records when the author was away from base, and to Roger Welsh and David Rasch for their instruction and assistance with electronic troubleshooting.

8. REFERENCES

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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.
1984 -	Proton precession magnetometer hut constructed.

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 seismograph 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.

December	1981	- Seismic recording system changed from photographic to visual.
24 Oct	1984	- Replacement short-period Willmore Mk II vertical seismometer and visual drum recorder installed.
26 Oct	1984	- Daily operation of seismological observatory handed over to Bureau of Meteorology staff.

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. On 9 March 1968 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.
February	1982	- Rapid Run magnetometers returned to Australia.
January	1984	- Recording from X and Y photoelectric magnetometers (PEM's) commenced.
October	1984	- Recording from proton precession magnetometer MNS 2.6 commenced.
		- Recording ceased on La Cour normal-run magnetograph.
		- 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.

APPENDIX 2

Magnetic observatory intercomparison instruments

Date	Declination ASKANIA/CIRCLE	Horizontal Intensity	Vertical Intensity PPM	Vertical Intensity 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	instruments numbers not specified			
1963		QHM 178	MNS-1/1	211
1964		QHM 177	MNS-1/1	221
1965	640505/	QHM 177	MNS-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	MNS-2/2	
1981	580333/508810	QHM 172, HTM 704	595/144	
1982	640505/508813	QHM 172, HTM 704	595/144	
1983	640505/508813	QHM 172, HTM 704	Geom. 816/767	
1984	640505/508813	QHM 172, HTM 704	MNS-2/3	

TABLE 1

Station data for Macquarie Island

	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	-60.6°	
longitude	244.6°	
Elevation (m)	8	14
Foundation	basalt	basalt

TABLE 2

Parallax of La Cour magnetometer 1983/4

Trace	Correction
D	-1.5 min
H	+0.3 min
Z	0.0 min
T	0.0 min

TABLE 3

Magnetograph parameters, 1983/4

Component	Scale value	(standard deviation or correlation)	Temperature coefficient	Time coefficient	Nominal calibration current	Coil constant
LA COUR MAGNETOGRAPH						
D	2.36 +/-	0.01 min/mm	0	-	20 mA	8.04 nT/mA
H	19.35 +/-	0.05 nT/mm	2.4 nT/°C	-	60 mA	8.04 nT/mA
Z	20.98 +/-	0.13 nT/mm	0	-	40 mA	7.49 nT/mA
T	1.43 C/mm	99.25 %	-	-	-	-
PHOTOELECTRIC MAGNETOGRAPH (PEM)						
25/01/84 - 04/04/84:						
X	-0.1991 +/-	0.0009 nT/ct	-5.4 nT/°C	-	40 mA	8.03 nT/mA
Y	-0.1997 +/-	0.0009 nT/ct	3.0 nT/°C	-	40 mA	8.03 nT/mA
05/04/84 - 22/10/84:						
X	0.1991 +/-	0.0009 nT/ct	-5.4 nT/°C	0.3 nT/day	40 mA	8.03 nT/mA
Y	0.202 +/-	0.004 nT/ct	3.0 nT/°C	0	40 mA	8.03 nT/mA
09/08/84 - 22/10/84:						
F(0-990)	0.3980 +/-	0.0004 nT/ct	-	-	990 nT	
F(0-99)	0.0403 +/-	0.0003 nT/ct	-	-	99 nT	
25/01/84 - 21/02/84:						
T(PEM)	0.00182 °C/ct	99.85 %	-	-	-	-
22/02/84 - 22/10/84:						
T(PEM)	0.001849 °C/ct	99.99 %	-	-	-	-

NOTE: 1. Standard temperature is 5.0 °C for both magnetograph systems.
2. Zero time is taken as 0000, 8 July 1984 U.T. for the PEM system. The magnetograph was not fully calibrated prior to this time.

TABLE 4

Orientation comparison, 1978-1983

Year	D	H	Z
1978	0.8	1.3	0.5
1979	1.1	0.2	0.6
1980	0.7	0.2	0.6
1981	0.6	0.7	0.6
1982	0.4	0.6	0.5
1983	1.1	0.6	0.9

TABLE 5

Reference mark azimuths

Mark Code	Description	Azimuth
AR	Anchor Rock	353° 41.27'
NMI	Rock formation near western shoreline	353° 44.22'
NMXI	Old auroral camera stand	28° 09.42'
GOW	Centre of large geophysics office window	46° 36.21' *
SM	The Nuggets rock formation	176° 59.88'

* This azimuth deduced from round of angle observations.

TABLE 6

Reference mark round of angle observations

Mark code	Description	Circle 640616 readings				
			10/11/83	8/2/84	14/5/84	6/8/84
AR	Anchor Rock	138°	14.95'	13.10'	14.50'	15.25'
NMI	Rock formation near western shoreline	138°	12.20'	10.30'	11.15'	12.45'
NMXI	Old auroral camera stand	172°	40.30'	38.45'	39.25'	-
GOW	Centre of large geophysics office window	191°	-	-	-	7.35'
SM	The Nuggets rock formation	321°	30.90'	29.05'	30.20'	31.10'

TABLE 7

Magnetometer comparisons, 1984

Date	BMR Standard (A)	MCQ magnetometer (B)	Difference (A-B) nT
From 01 Nov 83	MNS 2.2	BMZ 236	+108.4 *
From 21 Nov 83	"	"	+120.2 *
From 09 Aug 84	"	"	+106.3 *
25 Oct 84	Dec 640505 Circle 508813	Dec 640506 Circle 640616	-4.2' +/- 0.8'
02 Dec 84	MNS 2.3	MNS 2.2	+12.21 **
Through routine baseline values			
	QHM 177	QHM 178	+7
	QHM 177	QHM 179	+8

* Differences from Z baseline values.

** These comparisons were carried out by Dr Peter Hopgood of the BMR Geomagnetism Section shortly after the MNS 2.3 had been checked and adjusted.

TABLE 8

Baseline values, 1983/4

Date	U.T. Hr min	Baseline value	Standard Deviation	Remarks
LA COUR MAGNETOGRAPH				
Declination		BD (E)		
01 Nov 1983	00 00	27° 0.7'	0.7'	
21 Dec 1983	22 10	26°59.4'	0.6'	silica gel replacement
27 Jan 1984	01 00	27° 1.4'	0.5'	"
04 Apr 1984	07 00	27° 0.0'	0.4'	"
10 Sep 1984	01 35	27° 3.0'	0.4'	"
Horizontal intensity		BHs (nT)		
01 Nov 1983	00 00	12490	2	
02 Jul 1984	14 25	12442	2	earthquake, MM = V

Vertical intensity		BZs (nT)		
01 Nov 1983	00 00	63445	4	
18 Nov 1983	03 00	63450	4	silica gel replacement
21 Nov 1983	03 30	63446	5	change in BMZ 236 correction
21 May 1984	01 44	63456	4	silica gel replacement
09 Aug 1984	02 45	63469	3	change in BMZ 236 correction
10 Sep 1984	01 20	63460	4	silica gel replacement

Vertical intensity*		BZs (nT)		
01 Nov 1983	00 00	63553	3	
18 Nov 1983	03 00	63567	4	silica gel replacement
21 May 1984	01 44	63575	3	"

Temperature		BT (°C)		
01 Nov 1983	00 00	-81.3	0.1	
18 Nov 1983	02 53	-80.7	0.2	silica gel replacement
27 Jan 1984	01 00	-80.5	0.1	"
04 Apr 1984	07 00	-80.8	0.1	"
21 May 1984	01 43	-79.9	0.2	"
25 Sep 1984	03 35	-80.0	0.1	"

PHOTOELECTRIC MAGNETOGRAPH

X, true north intensity		(nT)	
07 Jul 1984	00 00	10994	11

Y, true east intensity		(nT)	
07 Jul 1984	00 00	6091	3

Temperature	(°C)			
25 Jan 1984	00 00	1.67	0.03	
03 Feb 1984	00 00	1.73	0.02	thermistor shifted
21 Feb 1984	03 00	-3.25	0.03	Edas2 input module modified
03 Aug 1984	00 00	-3.31	0.03	Cable pulled through conduit connecting variometer hut and geophysics office
28 Sep 1984	05 00	-3.27	0.02	Edas2 zero input adjusted

---

* BZs derived from H and F (MNS 2.2)

Note 1. Instrument corrections have not been applied.
2. BHs are derived from QHM 177(1083).
3. X and Y baselines are derived from QHM 177(1083) using a collimation angle of +332.28 minutes.
4. X and Y baseline datum is 5000 counts.
5. PEM X and Y baseline determinations commenced on 7 July 1984.

TABLE 9

Preliminary instrument corrections, 1983/4

Magnetometer		Correction
ASK 640506		0.0 min
QHM 177		-13 nT
QHM 178		-04 nT
QHM 179		-03 nT
BMZ 236	Nov 1983	+100 nT
	Dec 1983-Oct 1984	+120 nT
PPM MNS 2.2		0.0 nT

TABLE 10

Preliminary monthly mean geomagnetic values and K-indices, 1983/4

Month	D(E) (° ')	H (nT)	Z (nT)	F (nT)	K
Nov 1983	28 57.7	12655	-63655	64901	27.1
Dec 1983	28 58.4	12649	-63644	64889	23.3
Jan 1984	28 59.1	12647	-63644	64888	21.5
Feb 1984	29 00.2	12634	-63644	64886	24.6
Mar 1984	29 02.0	12632	-63650	64891	26.4
Apr 1984	29 02.3	12633	-63657	64898	24.8
May 1984	29 03.0	12632	-63655	64896	23.5
Jun 1984	29 03.9	12631	-63652	64893	18.5
Jul 1984	29 03.6	12630	-63647	64888	20.0
Aug 1984	29 04.5	12631	-63651	64892	20.5 *
Sep 1984	29 04.8	12631	-63645	64886	25.4 *
Mean	29 01.8	12637	-63649	64892	23.2

* Z calculated through BMZ baselines.

TABLE 11

Geomagnetic annual mean values, 1974-1984

Year	D(E) (° ')	I (° ')	H (nT)	X (nT)	Y (nT)	Z (nT)
1974	27 34.3	-78 37.6	12 865	11 404	5955	-63 956
1975	27 43.2	-78 38.2	12 847	11 373	5976	-63 926
1976	27 51.6	-78 39.1	12 822	11 336	5992	-63 891
1977	27 59.8	-78 39.9	12 802	11 304	6010	-63 861
1978	28 11.3	-78 41.1	12 773	11 258	6034	-63 838
1979	28 19.6	-78 42.3	12 745	11 219	6047	-63 807
1980	28 28.8	-78 43.0	12 723	11 183	6067	-63 768
1981	28 37.6	-78 44.6	12 687	11 136	6078	-63 735
1982	28 48.0	-78 45.4	12 665	11 098	6101	-63 710
1983	28 55.1	-78 45.8	12 651	11 074	6118	-63 679
1984	29 01.8	-78 46.2	12 637	11 049	6132	-63 647
Mean annual changes						
1974 to 1984	8.8	-0.9	-23	-36	18	31
1974 to 1979	9.1	-0.9	-24	-37	18	30
1979 to 1984	8.4	-0.8	-22	-34	17	32

TABLE 12

Seismograph parameters

WILLMORE MARK II SEISMOMETER	
Free period	1.0 sec
EA310 preamplifier filters	0.5 Hz to 12.5 Hz
Low pass filter cutoff	2 Hz
Amplifier attenuation settings	
EA310	24 dB
AR311	24/18 dB
Magnification at 1 Hz	
21 March 1984	2810/5240
28 August 1984	3510/6340
Calibration coil motor constant	2.3/2.1 N/A
Mass	4.75 kg

TABLE 13

Attenuation settings for helicorder amplifier AR311

November 1983	
24 dB	01-03,06,08-21,23,25-30
18 dB	04-05,07,22,24
December 1983	
24 dB	01-06,09,13-18,21,23-25,27,29-31
18 dB	07-08,10-12,19-20,22,26,28
January 1984	
24 dB	01-02,04-15,17-18,24,27-29,31
18 dB	03,16,19-23,25-26,30
February 1984	
24 dB	01-03,07-14,17-29
18 dB	04-06,15-16
March 1984	
24 dB	01,05,07-09,11-12,14-15,17-31
18 dB	02-04,06,10,13,16
April 1984	
24 dB	01-21,24-30
18 dB	22-23
May 1984	
24 dB	01-03,05-08,15-17,21-25,27-30
18 dB	04,09-14,18-20,26,31
June 1984	
24 dB	02-30
18 dB	01
July 1984	
24 dB	02,06,12,14-31
18 dB	01,03-05,07-11,13
August 1984	
24 dB	01-06,09-14,16-18,20,22,26-28,31
18 dB	07-08,15,19,21,23-25,29-30
September 1984	
24 dB	01-13,15-18,20-21,26-27,30
18 dB	14,19,22-25,28-29
October 1984	
24 dB	01-02,04-05,07-15,17,19-23
18 dB	03,06,16,18

TABLE 14

Seismograph magnifications, 21 March 1984

EA310 amplifier setting = 24 dB
AR311 attenuator setting = 24 dB

Period (sec)	Magnification (x 1000)	Period (sec)	Magnification (x 1000)
0.07	9.99	0.8	3.64
0.1	12.25	0.9	3.12
0.12	12.46	1.0	2.81
0.15	12.35	1.1	2.48
0.17	12.98	1.2	2.20
0.2	12.25	1.3	1.93
0.25	10.84	1.5	1.48
0.3	9.14	2.0	0.653
0.4	7.14	3.0	0.117
0.5	5.78	4.0	0.0309
0.6	4.99	5.0	0.00980
0.7	4.14		

TABLE 15

Seismograph magnifications, 28 August 1984

EA310 amplifier setting = 24 dB
AR311 attenuator setting = 24 dB

Period (sec)	Magnification (x 1000)	Period (sec)	Magnification (x 1000)
0.07	8.36	0.8	4.96
0.1	9.84	0.9	4.22
0.12	10.82	1.0	3.51
0.15	11.29	1.1	2.93
0.17	11.34	1.2	2.44
0.2	11.27	1.3	2.01
0.25	11.15	1.5	1.38
0.3	10.75	2.0	0.545
0.4	9.73	3.0	0.106
0.5	8.33	4.0	0.0261
0.6	7.17	5.0	0.00918
0.7	5.87		

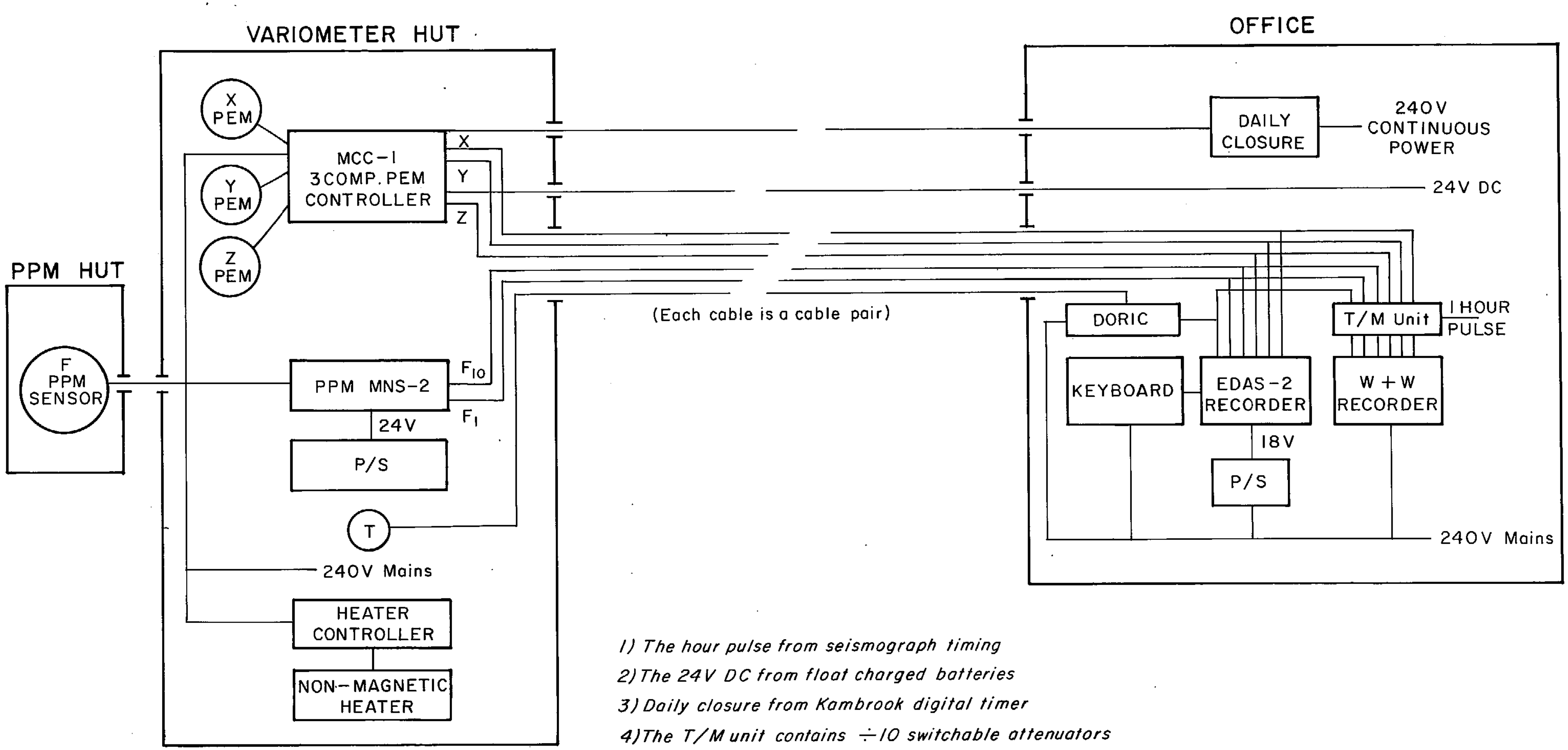
TABLE 16

Macquarie Island earthquakes 1983/4

Date		Origin time U.T.	Magnitude ML	Intensity MM
1983				
Nov	05	20 57 32.6	4.1	
	06	02 04 48.5	4.4	
	16	05 30 36.0	2.7	
	18	14 05 51.8	2.8	I
	22	05 09 25.4	3.5	
	24	04 12 28.2	2.1	
		05 39 36.8	5.0	
	30	00 55 06.0	3.0	
Dec	07	07 43 10.9	-	III
		15 31 54.1	2.3	
		15 32 31.9	2.2	
	10	14 06 26.8	3.3	
		18 50 26.8	2.5	
	12	09 35 14.0	4.5	
	15	01 58 22.2	2.8	
		06 37 39.0	3.0	
	23	12 29 06.9	-	II
		13 03 01.3	3.2	
1984				
Feb	05	04 13 08.8	2.1	
	07	23 10 31.1	2.5	
	10	20 48 36.8	2.3	
	13	20 05 01.5	3.8	
	15	20 27 36.0	3.4	
Mar	01	23 52 27.5	3.6	
Apr	12	10 11 45.0	3.8	
May	07	05 07 10.8	3.8	
	21	18 07 14.7	4.0	
	23*	05 17 18.6	5.4	
	24	05 44 59.3	3.9	
	28	15 10 32.4	3.1	
Jul	02	14 25 32.5	-	V
	09	15 18 57.2	2.2	
	27	16 58 00.2	3.2	
Sep	13	13 15 57.3	3.8	
	22	16 11 09.3	3.0	
	23	16 26 07.8	3.0	
Oct	01	04 46 50.5	-	III
	20	10 49 32.0	3.0	
	21	20 02 07.0	3.2	

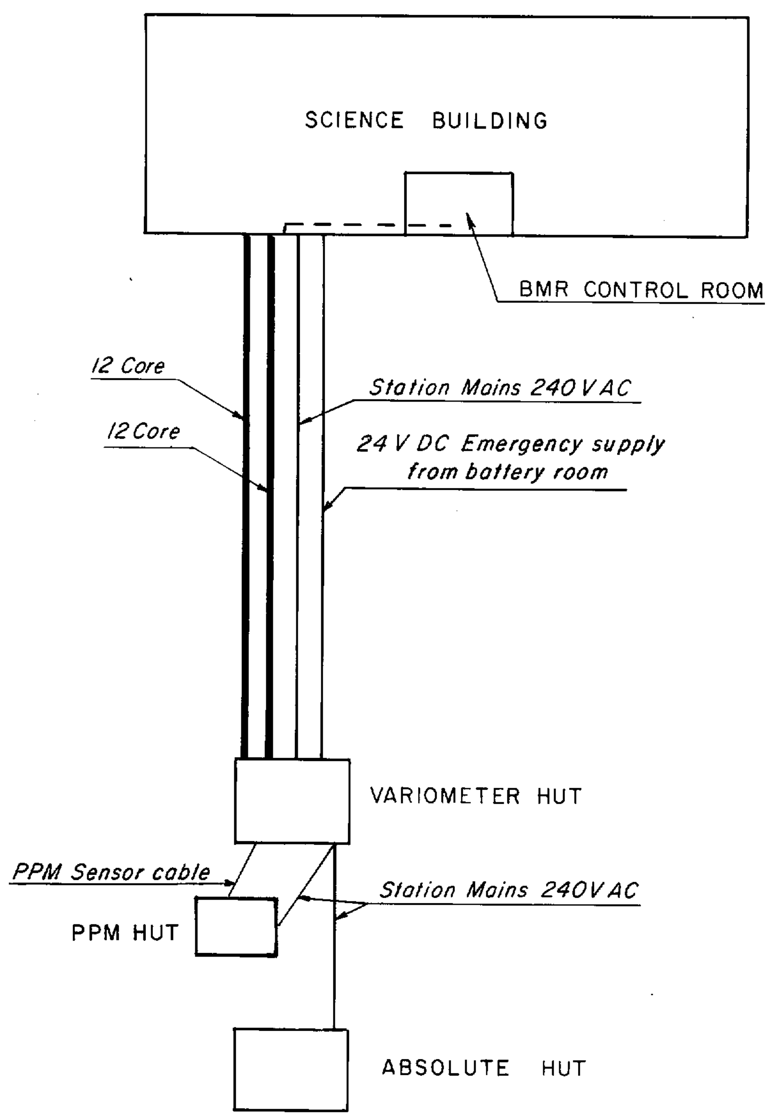
* ISC solution - O.T.: 05 16 34.0
lat.: 51.88° S
long.: 161.08° E
depth: 10 km
magnitude: mb 5.8, Ms 5.8

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

Figure 2 CABLING BETWEEN HUTS, MACQUARIE ISLAND



1) 12-core cable to Variometer Hut ante-room services X and Y PEMs, PPM-F, Doric temperature sensor and remote S.V. trigger.

2) 12-core cable to Variometer Hut cold porch services Z PEM.

3) Conduits between Science and Variometer Hut, and Variometer Hut and Absolute Hut also contain spare cables

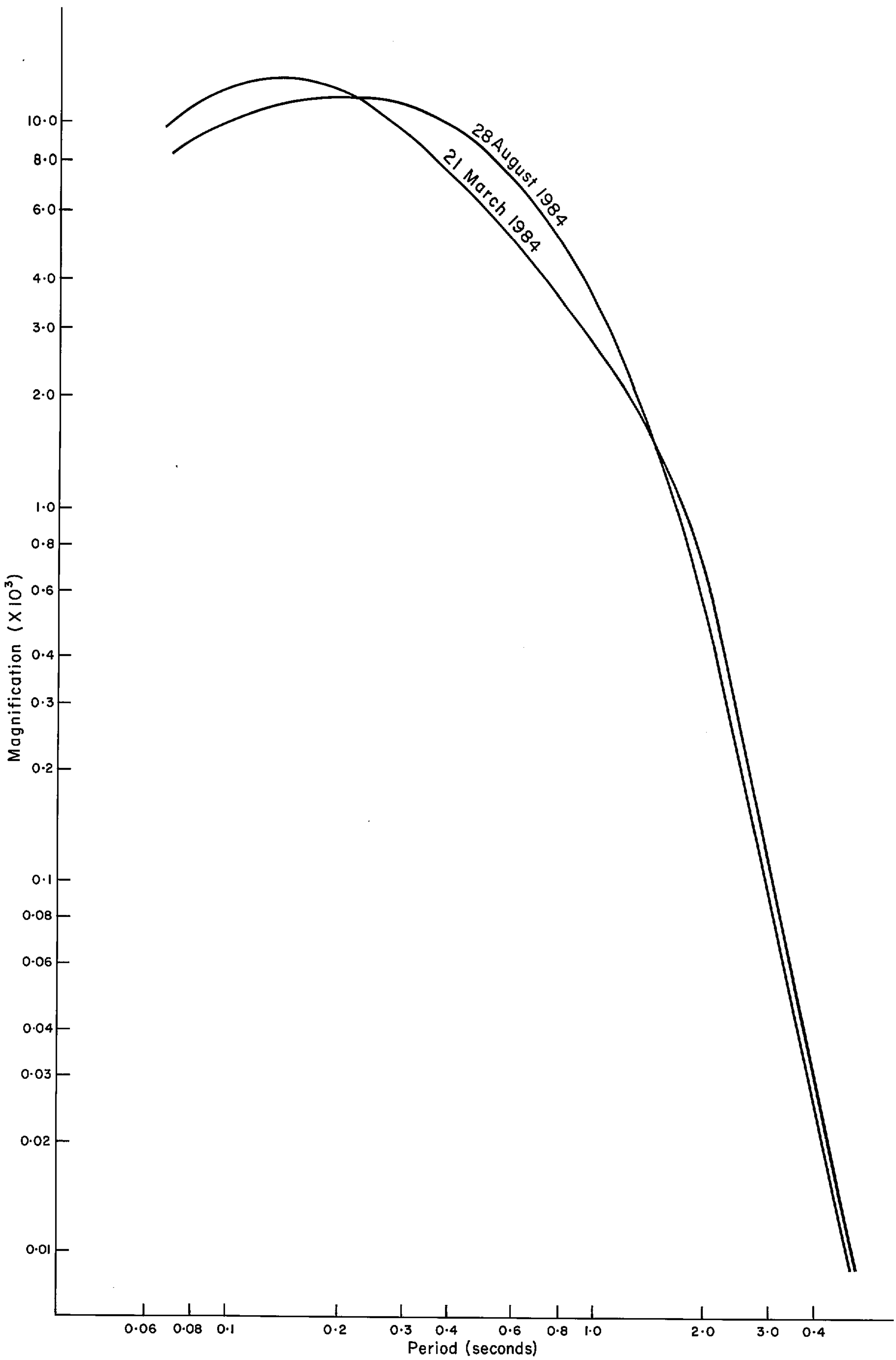


Figure 3 Macquarie Island SP-Z curves, 1984

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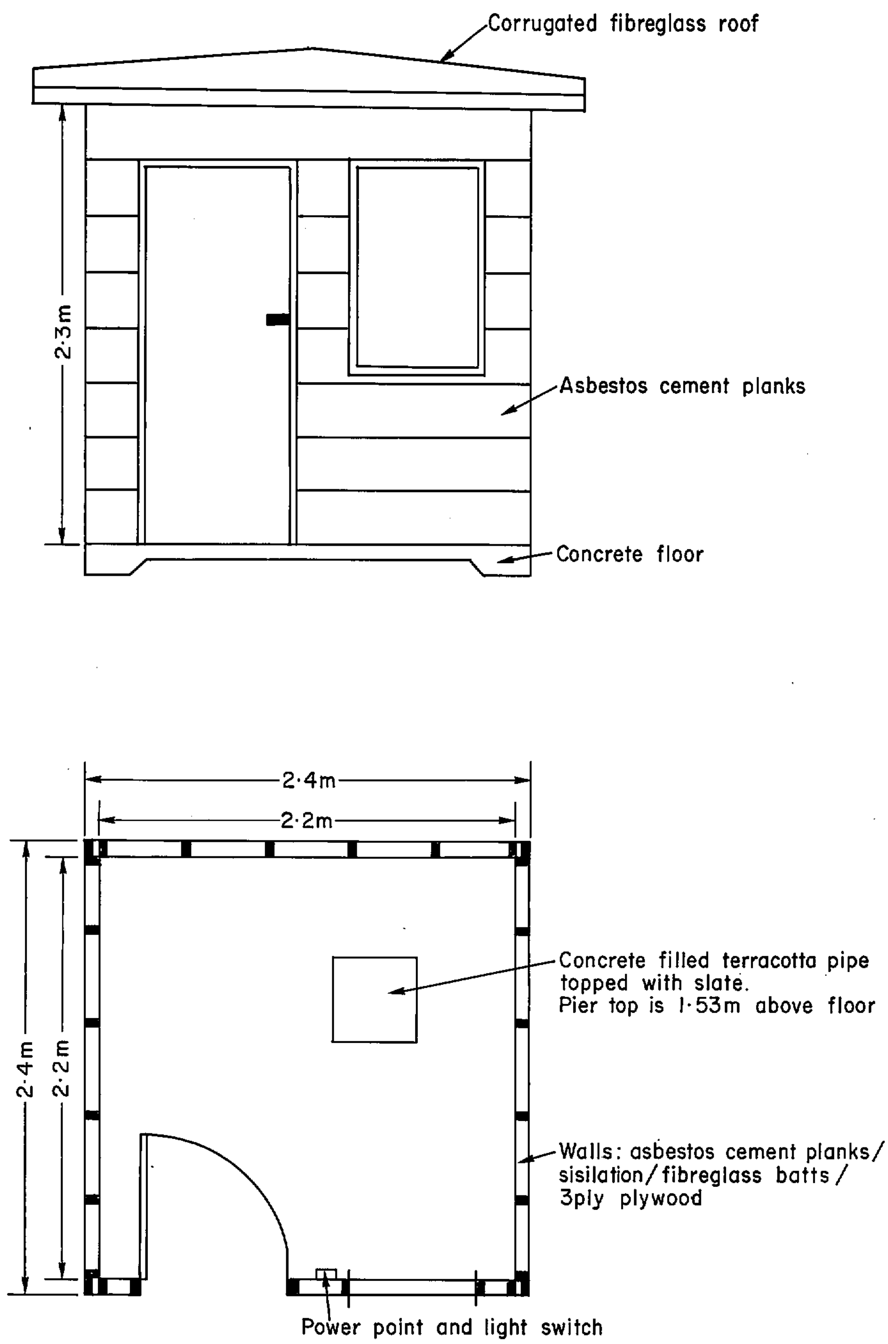

Figure 4. PPM hut, Macquarie Island

Record 1986/21 24/09/357

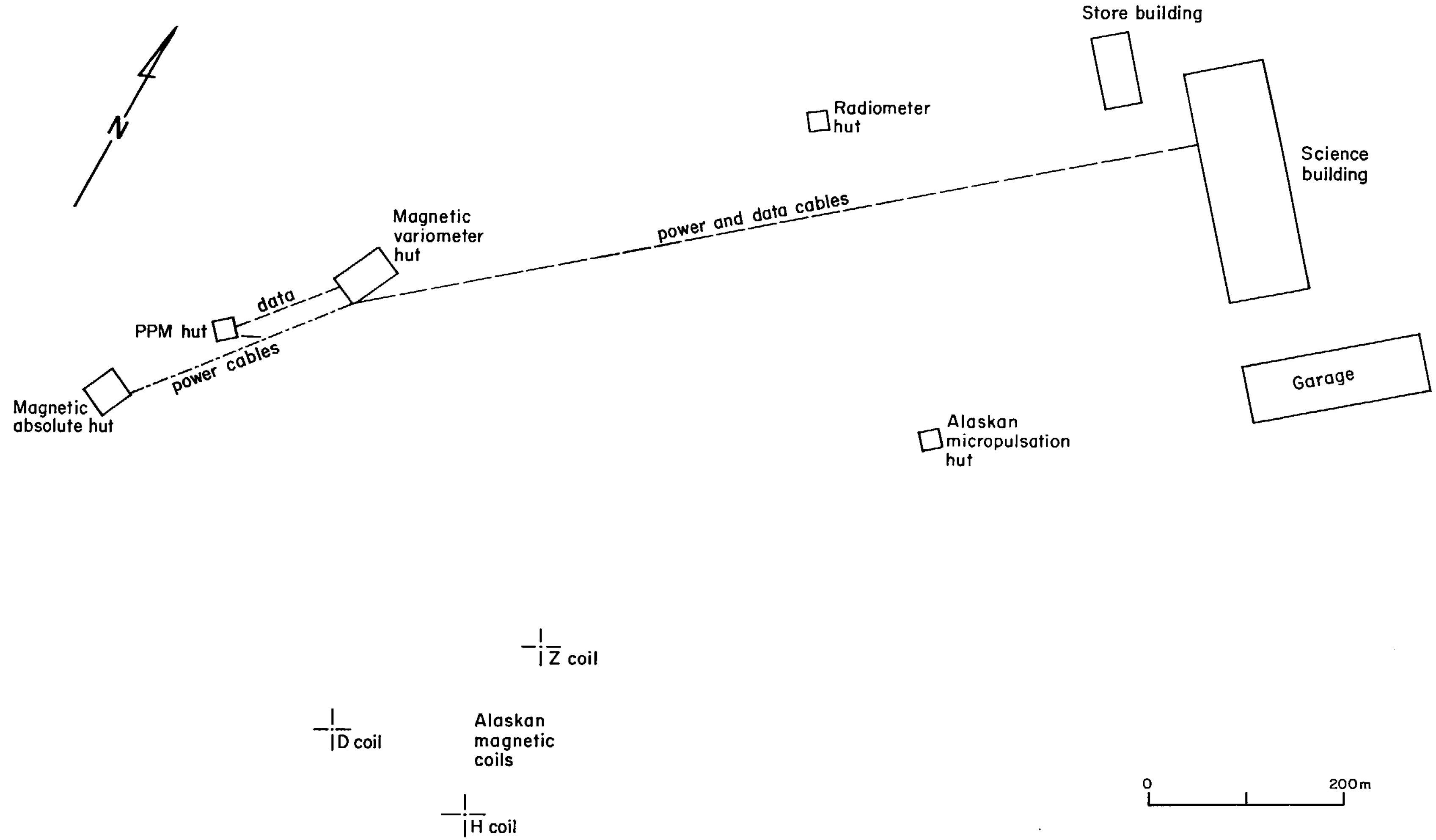

Figure 5. Geomagnetic huts, Macquarie Island

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24/09/358