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RECORD

Record 1981/19

Macquarie Island Geophysical Observatory,

Annual Report 1979

by

K.D. Wake-Dyster

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SUMMARY

Recording of the geomagnetic field and seismic activity was continued at Macquarie Island Geophysical Observatory, Sub-Antarctica during 1979. Recording instruments included a La Cour magnetograph and a vertical component Willmore seismograph. Preliminary data were forwarded on a regular basis to Australia.

Construction of a new Geophysics office located in the new Science/ Administration block continued during 1979. Measurements of the vertical magnetic field intensity were made at Hurd Point and Bauer Bay as part of an 'island effect' study.

1. INTRODUCTION

Macquarie Island Geophysical Observatory was established in 1950 by the Bureau of Mineral Resources, Geology and Geophysics (BMR), Department of National Development. The station's history is given in Davies' (in preparation) annual report for 1980.

The magnetic observatory during 1979 consisted of a NORMAL-RUN La Cour magnetograph. Absolute magnetic observations for magnetogram base-line control were made using three QHMs, one PPM, one declinometer, and one BMZ. The seismic observatory consisted of a vertical component and horizontal component Willmore seismographs until 2 January when the horizontal component seismograph was closed down due to operational problems and its limited scientific usefulness.

The author assumed observatory operations from Peter Davies on the 24 November 1978 and was succeeded on 26 October 1979 by Peter Davies again.

Activities of the BMR at Macquarie Island are a part of the Australian National Antarctic Research Expeditions (ANARE), with logistic support supplied by Antarctic Dvision, Department of Science and the Environment.

2. MAGNETIC OBSERVATORY

Continuous recording of geomagnetic field components H, D and Z was maintained during 1979 with a total loss of only 6 hours NORMAL magnetograph record. The record loss was mainly due to recorder maintenance and weather conditions affecting the photographic record emulsion.

La Cour magnetograph

The magnetograph operated well all year with only minor adjustments necessary. These included the lubrication of recording drum bearings, occasional adjustment of the recording slit and adjustments to colliminating lenses. The variometer lenses required cleaning on several occasions to remove water droplets which formed when sudden changes in weather conditions caused severe condensation.

Standard 240 V AC 50 Hz power derived from the Advance Inverter supply was used to drive the synchronous recorder motor with time-mark control from the EMI digital clock. Lamp power was supplied by a modified version of the PMZ-1 observatory rectifier.

To decrease the collection of moisture within the variometer hut a container of silica gel was changed on a weekly basis (Davies, 1981). However effect of the silica gel was difficult to observe and variometer baseline values remained relatively constant for the year. The installation of a thermostatically controlled heater set at the standard temperature of 5°C would be a much more effective method of controlling humidity within the variometer room than using silica gel.

Baseline value control

Variometer calibration observations and scale-value measurements were performed seven to eight times per month to monitor baseline values of the H, D and Z components of the magnetograph. Instruments used for absolute observations included QHMs 177, 178 and 179, Declinometer 640505 (with circle 640620) and PPM 271. Pier difference measurements between Pier E and Pier W were made monthly for vertical intensity as PPM measurements were normally measured on Pier W with Pier E being the standard reference pier where H and D measurements were taken. Monthly observations of vertical intensity were taken using both BMZ 236 and BMZ 221A in order to determine their respective instrument corrections. BMZ 236 was a stand-by instrument in case PPM 271 malfunctioned and BMZ 221A was used as the field instrument.

Intercomparison measurements between the Macquarie Island and the standard comparison instruments from Australia were made during a short changeover period in late October 1979. Comparison instruments included QHM 172, HTM 704 Declinometer 333 (with circle 508813), Geometrics PPM Type 816 S/N 1023 and an Elsec PPM. The Elsec PPM failed to operate but intercomparisons were made using all other instruments. Derived instrument corrections from the intercomparisons are listed in Table 12.

Magnetograph calibrator MC01 C was used as a current source to the Helmhotz scale-value coils for scale-value determinations. Applied currents were monitored with Data Precision digital multimeter, Model 245, S/N 23820. The digital multimeter (DMM) was sent to Australia in November 1978 for repair and returned to Macquarie Island in February 1979. During that time another Data Precision DMM and a borrowed Fluke DMM were used to monitor applied currents. After comparing the DMMs against each other the specified output currents of the MC01 were used as the final adopted scale value coil currents. Coil constants and adopted scale value coil currents are given in Tables 3 and 4 respectively.

Table 2 lists the mean observed and adopted scale values for H, D and Z magnetogram traces.

Adopted baseline values are given in Table 5.

Parallax tests

Parallax tests were performed in February and June with comparable results between both sets of measurements. Results from these tests are listed in Table 9.

Preliminary data

K-indices, preliminary baseline values, scale values and preliminary monthly mean values were transmitted monthly to Canberra to be included in the BMR Monthly Observatory reports. Preliminary monthly mean geomagnetic values and K-index values for 1979 are listed in Table 10. Values of the geomagnetic annual means from 1969 to 1979 for Macquarie Island are tabulated in Table 11.

Orientation tests

Several sets of orientation tests on the magnetograph were carried out during the year to monitor any changes in the orientation of variometer magnets. Local earth tremors at Macquarie Island occasionally disturb the variometers causing variometer magnets to be displaced out of acceptable orientation alignments, and is it a good practice to do several orientation tests during the year to check any movements.

Orientation tests performed on the H and D variometers late in 1978 were made to check orientation tests made earlier in 1978. Similar results were obtained but the H ex-orientation was greater than $\pm 1^{\circ}$ off the EPV suggesting that the variometer requires adjustment. The scale-value/orientation reference coils mounted around the variometers were checked against the variometer room wall marks for alignment. It was found that the H coils were aligned 119.7° and the D coils correctly aligned at 29.0° T. The H SV/OR coils were later realigned at 119.0° with a complete set of orientation tests made on 15 March 1979. A further set of orientation tests were made on 17 September 1979 to check the previous results.

It should be noted that it is very difficult to align accurately the SV/OR coils around the variometers due to the small size of the coils. This is exemplified by the fact that the H SV/OR coils were measured and aligned at 119.7^{o} before being adjusted to 119.0^{o}. However, the measured H ex-orientation angle (with coils used as reference field and meridian) changed from 1.4^{o} N of EPV to 0.1^{o} N of EPV giving a descrepancy of 0.7^{o} in alignment accuracy. Because it is not possible to perfectly align coils it would be worthwhile assigning an error factor to ex-orientation values. D and Z orientation tests compared well with previous results. The Z orientations were performed using the orientation bench provided and the 759.5 nTm^3 Z orientation magnet as used in previous years. Table 6 lists the results of the orientation tests conducted.

3. SEISMOLOGICAL OBSERVATORY

Seismic activity was monitored throughout 1979 using a vertical component seismograph. A horizontal (N-S) seismograph system consisting of a Mk 1 Willmore seismometer, galvanometer control box, galvanometer and an antiquated 60 mm/hr recorder operated until 2 January when it was closed down due to problems with the lamp source and poor record quality.

The vertical seismograph consisted of a MkII Willmore seismometer with the signal output going into a telmetry amplifier system, galvanometer control box and galvanometer with a UED photographic recorder being used. The telemetry system was introduced some years earlier in an attempt to improve the performance of the station by siting the seismometer some distance from the isthmus. It is still in use although the seismometer is now located in the seismic vault system but this resulted in an unacceptibly low gain due to the impedance mismatch between the seismometer coil and the galvanometer control box and galvanometer. The 3.3 kohm impedance of the seismometer coil is designed to be matched into an amplifier of approx 4 kohm input impedance. To remove the telemetry system satisfactorily it will be neccessary to introduce an amplifier suited to the present seismometer or a low impedance seismometer coil.

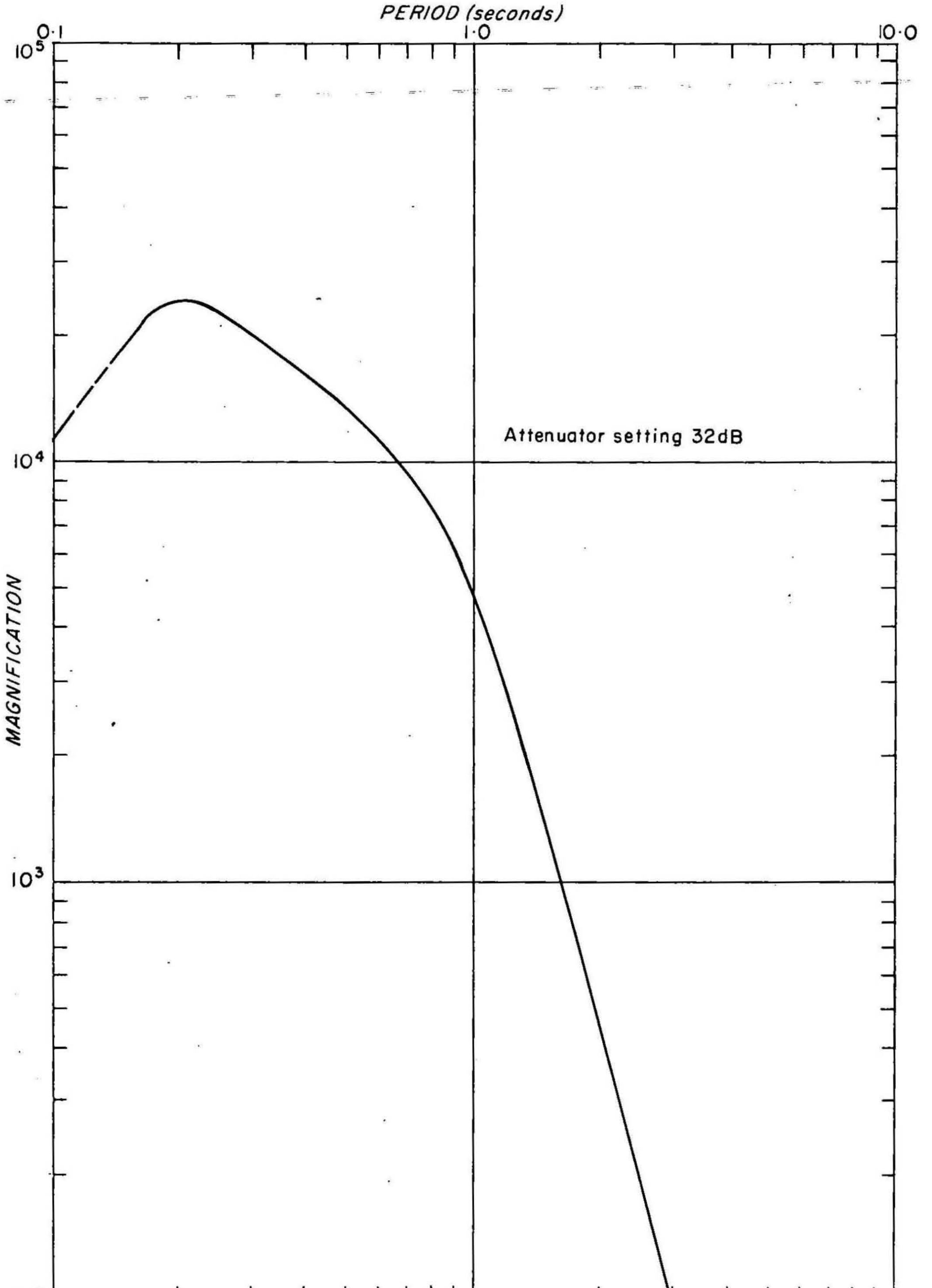

Fig. 1 Magnification curve SP-Z seismograph (from 8 Aug 1979)

Maintenance

All parts of the vertical seismograph system worked well all year except for the telemetry system and a back-up inverter supply for the telemetry system. With the first failure of the telemetry system the complete telemetry system was removed for repair and adjustment, and the seismograph system connected in the lower gain set-up without an amplifier. The unit containing the discriminator, and the ± 9 and ± 12 V DC supplies was so badly wired and set-out that the whole unit was rewired to make some sort of logical sense. The problem with the telemetry system amounted to two blown fuses in the HP ± 9 V DC power supply for the discriminator. Both these fuses blew on one more occasion but the cause could not be found.

The AWA Inverter, which acted as a standby power supply for the telemetry system in case of station mains failure, began blowing fuses on the mains input later in the year. The unit was examined but no cause could be found for the fault. The inverter was exchanged with a spare which operated faultlessly for the remainder of the year.

A new 12 V - 10 V DC regulated converter was constructed to supply the seismograph recording lamp as the old unit built in 1978 required updating due to poor design features.

The function generator built into the Willmore calibrator unit by Gidley in 1976 failed late in the year. Attempts were made to make it operational but with no success. The function generator circuitry was removed from the calibrator unit and a HP 3381A Function Generator was borrowed from the UAP physicist in later frequency response tests.

Calibrations

During January a calibration coil and calibration magnet attachments were fitted to the Willmore seismometer such that daily calibration pulses could be applied to the system. The pulse lengths were measured each day to monitor any changes in the magnification of the seismograph with changes in attenuation setting. The attenuation of the seismograph was changed according to the prevailing weather conditions, with wind speed and direction, and roughness of the sea being the main causes in determining microseism noise levels.

Weight lift and seismograph system tests were carried out during the year to check seismograph parameters such as motor constant, seismometer free period, galvanometer free period and galvanometer damping.

Frequency response tests were made to check the magnification of the seismograph with varying periods of oscillations of the seismometer. The frequency response of the seismograph changed only slightly in overall magnification when the telemetry system was overhauled and adjusted. Results of the tests compared well with previous measurements in other years.

Data

Preliminary seismic data was telexed to BMR Canberra twice a week and then forwarded to the National Earthquake Information Service(US Geological Survey (USGS))for preliminary determination of earthquake epicentres. Final seismic data analysis could not be done due to the bulletins from the USGS not being available at the time of report writing.

Four local events were felt during the year of Intensity II - III. Numerous local events caused small deflections in the H and D magnetograph traces but were to small to be felt by occupants on the island.

Table 13 gives a list of the felt events with S - P arrival time differences, and felt intensities on the island.

4. CONTROL EQUIPMENT

The power and timing equipment located in the geophysics office was similar to that used in other years. However, following a station mains cable failure to the Seismic Vault in the middle of the year, extensive rewiring was made in the seismic vault of power and lighting circuits by the electrician. The equipment cabling in the seismic vault was also updated and rerouted to improve the internal appearance of the vault and logic of the wiring system.

EMI clock

The EMI clock operated without failure although the advance and retard buttons sometimes remained activated when adjusting the time. The clock rate of losing 40 msec/day during 1978 was adjusted to near zero on my arrival and only occasionally drifted to $\pm$ 10 msec/day from zero. Two Mercer chronometers operated on a standby basis all year and provided a secondary timing system.

TMU-2

The timemark programming unit (TMU-2) operated without problems except for occasional advancements due to spurious pulses.

Time signals

Radio time signals from VNG, Lyndhurst, Victoria, Australia were received on all except a few days to enable time correction of the EMI Clock. A new aerial was constructed during January to improve the quality of time signals received although it was of poor design. A new dipole aerial should be constructed when the new geophysics office is occupied.

Cables

Power and timing cables between the geophysics office and the magnetic and seismic huts operated without any problems during the year however care was necessary to prevent vehicles operating in their vicinity from causing breaks.

A new six-core shielded cable was installed late in the year between the new Science/ Administrative building and the seismic hut in readiness for occupation of the new geophysics office. To prevent damage occurring to the cable it was placed in the underground cable duct connecting the services to the new building and should be safe from any damaging external sources.

New cables were ordered to interconnect the magnetic huts with the new geophysics office for installation during 1980.

5. BUILDING MAINTENANCE

The magnetic huts and seismic hut required continual maintenance due mainly to the aging of the buildings and dampness of the environment.

During the year the magnetic absolute hut was painted externally where necessary after recaulking of the window panes and the interior painting stripped where moisture entry into panels has occurred over the years. The panels were allowed to dry out and then repainted in an off-white colour to allow better observing conditions for the QHMs and Declinometer. Guy wires for the absolute and variometer huts were continually replaced due to damage from elephant seals. Exterior wooden sections of the magnetic variometer were also painted and two holes in the outer PVC sheet cladding were repaired.

Temporary repairs to the PVC sheeting on the roof of the absolute hut were made late in the year after an airdropped package hit the absolute hut with no other damage sustained.

The seismic hut required some recaulking between the slabs of the roof panels and the majority of the hut was painted externally whenever suitable weather conditions prevailed.

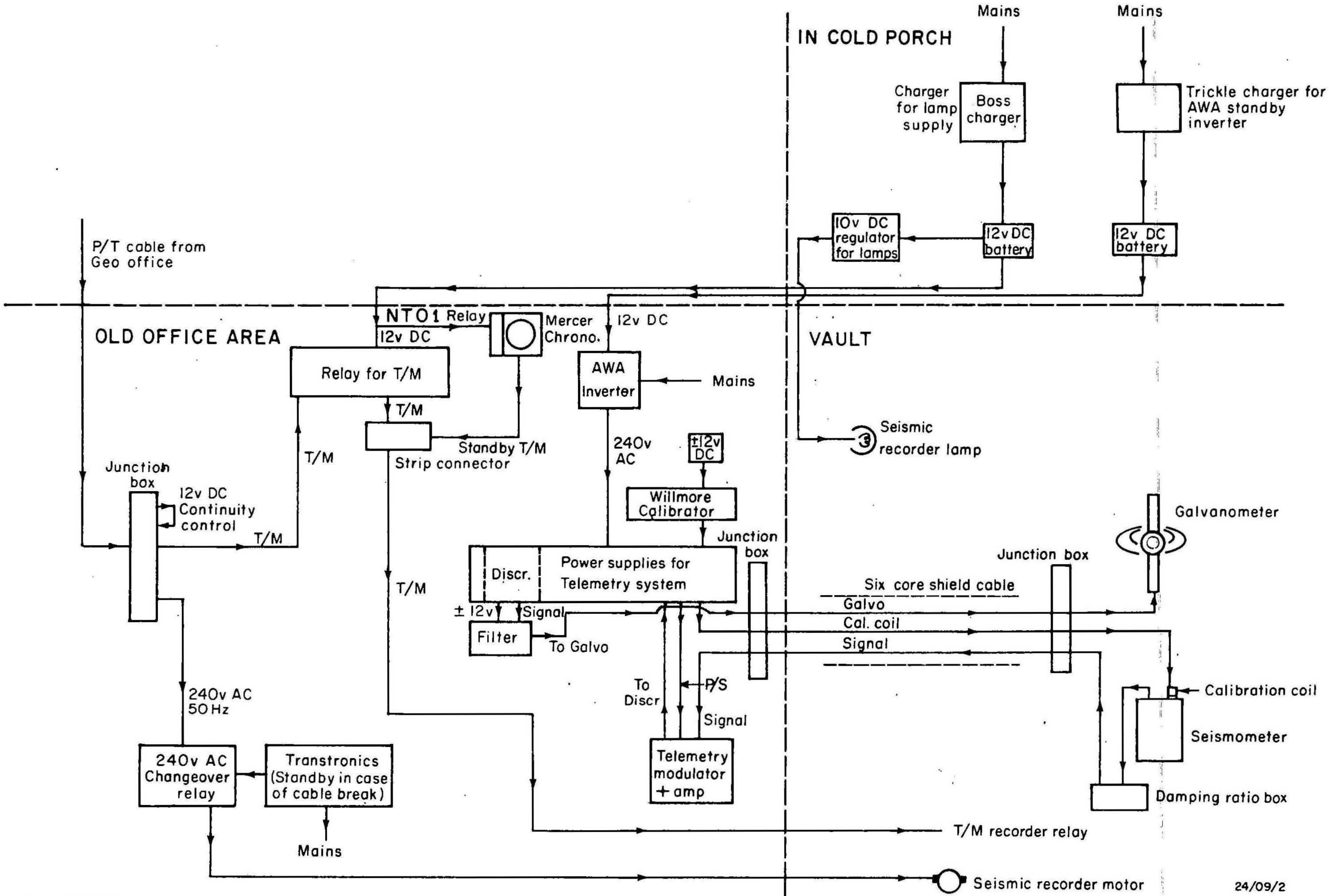

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Fig. 2 Seismic hut cable layout, 1979

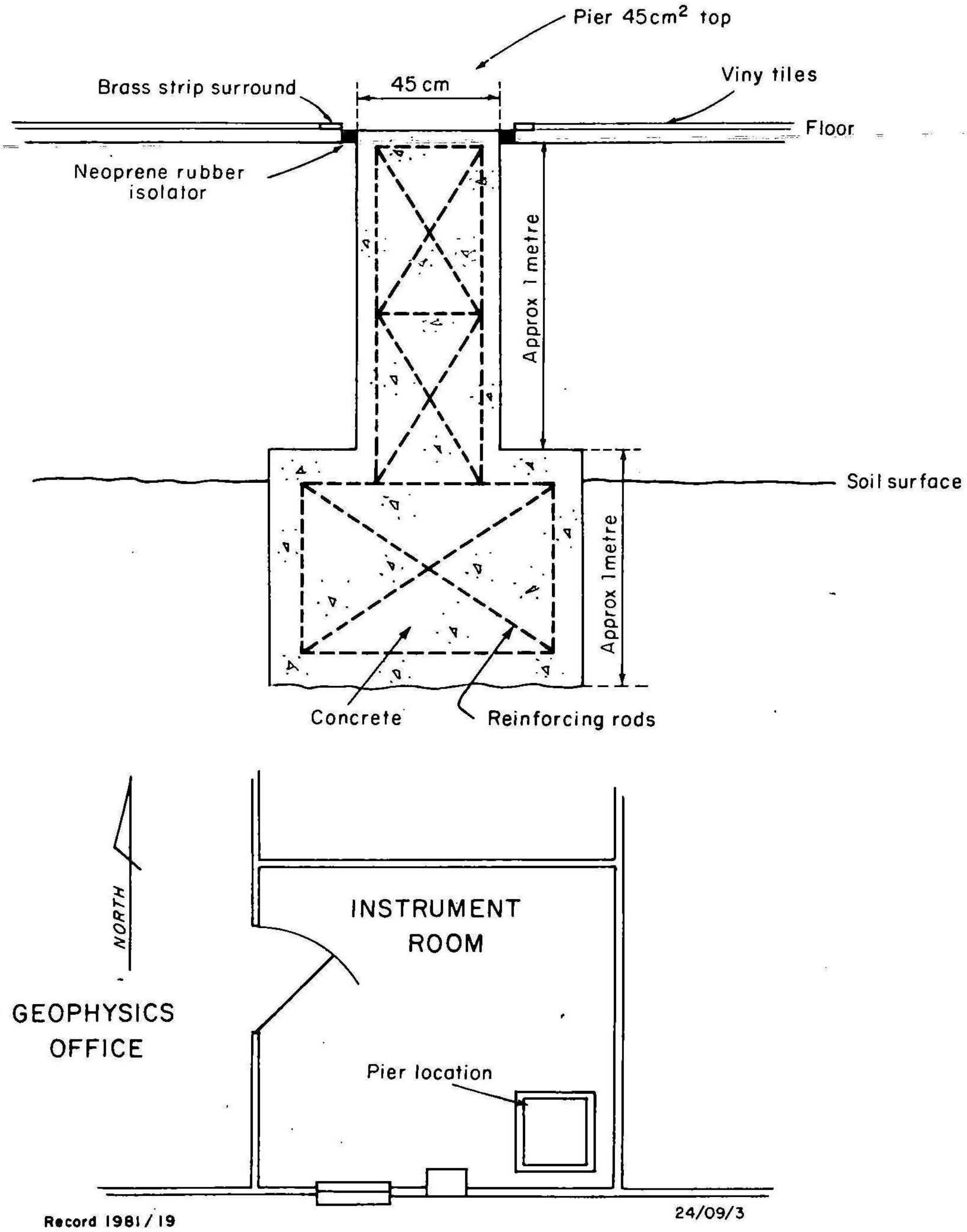

Fig. 3 Diagram of test pier, instrument room, new science/amministration building

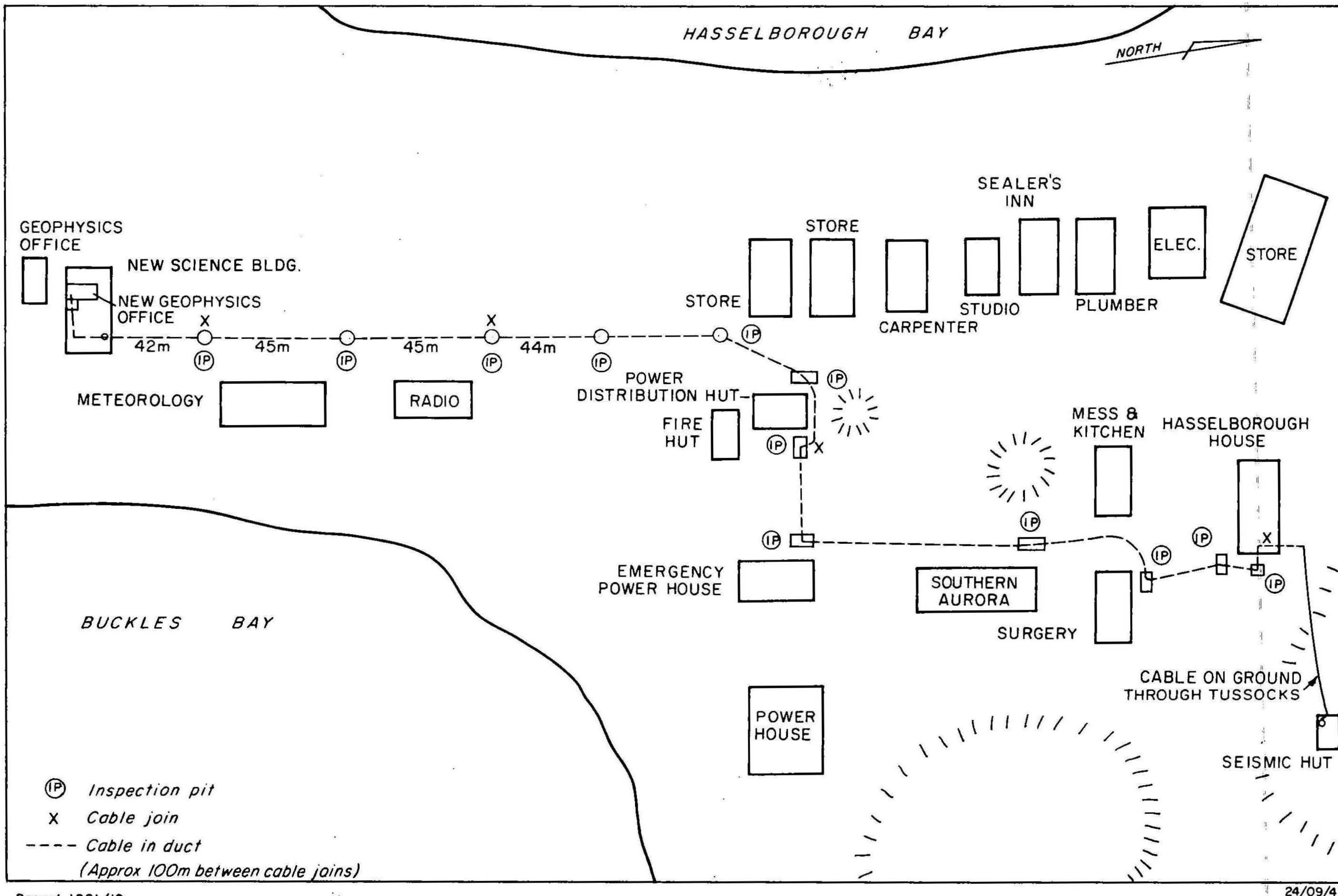

Fig.4 Cable location from science building to seismic hut

The absolute magnetic hut is gradually rotting away due to dampness entering panels and underlying support beams and an inspection by the carpenter suggested that the building should be replaced within two years. The other buildings are suffering the same syptoms to a lesser degree but will probably succumb with time to the same fate as the absolute hut.

No maintenance was made on the geophysics office although the interior required some repainting but it was thought that this would be best done when the new geophysics office became occupied.

6. OTHER DUTIES

Normal duties around the base were performed throughout the year including kitchen duties and care of ablution areas. Extensive help was given to the building program in completing the interior finishing of the Science/Administrative building as well as other projects around the base. A seismic test pier with its top flush with floor level and 45 cm^2 was constructed in the geophysics instrument room in the new building. The author was also the stand-in UAP physicist while he was absent from the base.

7. ACKNOWLEDGEMENTS

The author wishes to express thanks to the 1979 Macquarie Island party for assistance and co-operation in allowing observatory operations to run smoothly during the year.

Special thanks are due to John Trethewey for changing records during the absence of the author from the base and for solving electronic problems when they arose on occasions.

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APPENDIX

Calculation of Helmholtz-Gaugin Coil Constants for SV/OR magnetograph Coils

The Helmholtz-Gaugin coils installed on the NORMAL magnetograph in 1970 had coil constants derived by physical measurements of the dimensions of the coils. Doubt has been raised in later years on the accuracy of the determined values as opposed to deriving the coil constants by experiment. Some problems exit in measuring the coil constants by experiment, especially in selecting a suitable instrument to fit inside the coils.

Another method to determine the coil constant is to calculate the scale values by an alternative method and work backwards to the normal way of deriving scale values using the SV/OR coils.

The scale values of the H, D and Z magnetograph components can be calculated by plotting ordinate value (in millimetres) against the observed value of the component at the same particular time. It is important that for each point plotted the baseline values have not altered over the selected time interval. By a least squares fit of the plotted points, a scale value for the component selected can be calculated. By applying a known current to the coils and measuring the resultant, deflection of the component trace and using the calculated scale value from the method above, a value for the coil constant can be calculated.

Using the above approach the coil constant for the Z component SV coils was calculated to be 7.49 nT/mA however the Z SV coil is one manufactured by Askania and not of the BMR type. The same approach was applied to the D component of the magnetograph which is fitted with a BMR type SV/OR H-G coils. The measured value of the SV coil constant for the D component was 8.11 nT/mA. The value of the coil constant which has been adopted and used in previous years by using the dimensions of the coils has a value of 8.04 nT/mA.

As the method gives an identical value of the coil constant of the Z component SV coil as the value calculated by the manufacturer, and the value that has been adopted over a considerable length of time, it is probably worthwhile persuing in order to calculate all BMR type SV/OR coils, coil constants, since the values are probably more reliable than those calculated by measuring the coil dimensions.

Table 1

Station Data

	Magnetic	Seismological
Name	Macquarie Island	Macquarie Island
Code	MCQ	MCQ
Latitude geographic	54° 30.0' S	54° 29.9' S
geomagnetic	-61.1	
Longitude geographic	158° 57.0' E	158° 57.4' E
geomagnetic	243.1	
Elevation (m)	8	14
Foundation	Basalt	Basalt

Table 2

Magnetograph Parameters

Component	Mean observed scale value	Adopted scale value	Standard Deviation(from adopted value)	Mean observed temp. coeff. (nT/°C)	Adopted temp. coeff (nT/°C)
Normal					
H	19.33	19.3	0.06	2.9	3
D	2.35	2.35	0.02	-	-
Z	20.87	20.9	0.13	0.1	0

Table 3

Magnetograph Scale Value and Orientation Coil Constants

Component	Coil constant ($nT.mA^{-1}$)	Component	Coil constant ($nT.mA^{-1}$)
H S.V.	8.04	H OR.	8.04
D S.V.	8.04	D OR.	8.04
Z S.V.	7.49	Z OR.	-

Table 4

Scale Value Currents

Component	MC01 current setting used (mA)	Adopted scale value current (mA)
Normal		
H	40	40.0
D	15	15.0
Z	40	40.0

Table 5

Adopted Baseline Values (Corrected), Normal Magnetograph 1979

Date		UT h	UT m	Baseline	Remarks
Horizontal Instensity				BHs (nT)	
Jan	01	00	00	12609	Adopted
Feb	01	00	00	12608	"
Mar	01	00	00	12609	"
Apr	01	00	00	12610	"
May	01	00	00	12611	"
June	01	00	00	12612	"
Aug	01	00	00	12611	"
Oct	01	00	00	12610	"
Nov	01	00	00	12609	"
Declination				BD(E)	
Jan	01	00	00	26° 38.5'	Adopted
Apr	01	00	00	26° 38.6'	"
May	01	00	00	26° 38.7'	"
June	01	00	00	26° 38.8'	"
Nov	01	00	00	26° 38.7'	"
Dec	01	00	00	26° 38.6'	"
Vertical Intensity				BZs* (nT)	
Jan	01	00	00	63788	Adopted
Dec	05	00	20	63562	Baseline Mirror adj.

* Derived from H and F (PPM 271)

Table 6

Orientations of Variometer Magnets

Date	Component	Reference field	Magnet N Pole	Orientation	N Pole	Remarks
13-12-78	H NORM	12776 nT	E	1.4°	N	SV/OR coils aligned 119.7° T
15-03-79	H NORM	12754 nT	E	0.1°	N	SV/OR coils realigned to 119.0° T
17-09-79	H NORM	12738 nT	E	0.2°	N	
13-12-78	D NORM	28.30° T	N	0.9°	E	
15-03-79	D NORM	28.27° T	N	1.1°	E	
17-09-79	D NORM	28.34° T	N	1.1°	E	
15-03-79	Z NORM	63818 nT	N	0.6°	Down	
17-09-79	Z NORM	63804 nT	N	0.6°	Down	

Table 7

Orientation Test Data

Component	Source	Current (mA)	Switch position	Field produced
H NORM	Manual	300	HI +	E
D NORM	Manual	300	DI +	N
Z NORM	Deflector Magnet ($M = 759.5$ nT m^{-3}) (Measured by Major, 1971)			

Table 8

Thermograph Parameters, 1979

(Z Variometer)

From	UT	Date To		Observed St °C/mm	Adopted St °C/mm	Bt °C	Remarks
1-179	0000	1-2-79	0000	1.47	1.47	-66.6	Adopted
1-2-79	0000	16-3-79	0000			-66.4	"
16-3-79	0000	18-4-79	0000			-66.0	"
18-4-79	0000	7-8-79	0000			-65.8	"
7-8-79	0000	1-11-79	0000			-66.2	"
1-11-79	0000	5-12-79	0020			-66.5	"
5-12-79	0020	6-12-79	0000	1.42	1.42	-80.5	Baseline
6-12-79	0000	1- 1-80	0000			-83.4	Mirror Adj.

St - Z Thermograph scale value

Bt - Z Thermograph baseline value

Table 9

Parallax Test Results, Normal Magnetograph

Trace	Correction
H	0
D	-1.5 min
Z	+0.5 min
Tz	0

Table 10

Preliminary Monthly Mean Geomagnetic Values and K-Indices 1979

Month	D (East)	H nT	Z nT	F nT	K
January	28° 14.9'	12768	63827	65092	3.2
February	16.1	12754	63818	65080	2.8
March	17.8	12747	63819	65080	2.8
April	18.5	12743	63819	65079	3.0
May	18.8	12744	63815	65075	2.3
June	19.6	12745	63809	65069	1.8
July	20.2	12744	63804	65064	1.7
August	20.4	12738	63804	65063	2.4
September	20.4	12736	63804	65063	2.4
October	21.7	12741	63792	65052	2.5
November	23.4	12742	63781	65041	2.3
December	23.2	12739	63786	65046	2.2
Mean	28° 19.6'	12745	63807	65067	2.5

Table 11

Geomagnetic Annual Mean Values, 1969-1979

Year	D	I	H	X	Y	Z	F
	o ' (E)	o '	nT	nT	nT	nT	nT
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 41.2	12772	11257	6033	-63838	65102
1979	28 19.6	-78 42.3	12745	11219	6047	-63807	65067
Mean Annual Change	+7.73	-1.15	-28.1	-38.3	+12.6	+29.2	-34.2

Table 12

Magnetic Instrument Corrections (1979)

	Instrument	Preliminary corr.	Adopted corr	Adopted corr. (H,Z in nT)
(Mcq)	QHM 177	-10 nT (at 12760 nt)	-11 nT(at 12760 nT)	-0.00086 H
	QHM 178	- 3 nT (")	- 4 nT(")	-0.00031 H
	QHM 179	0 nT (")	- 3 nT(")	-0.00024 H
	DEC 505 and CIR 620	+ 0.5 mins	+ 0.5 mins	
	PPM 271	0 nT	0 nT	
	BMZ 236		+ 80nT (at-63800 nT)	-0.00125 Z
	BMZ 221A		-122 nT (at -63800 nT)	+0.00191 Z
(Intercomp)	HTM 704		+ 2 nT (at 12760 nT)	+0.00015 H
	QHM 172		-29 nT (at 12760 nT)	-0.00225 H
	DEC 333 and CIR 813		- 0.6 mins	

Table 13

Local Earthquakes Felt at Macquarie Island, 1979

Date	Arrival time (UT)				S-P (secs)	Intensity
Mar 06	IPD	14	13	150	3	III-IV
Apr 23	IPC	21	54	579	16	II
Oct 15	IPC	11	51	329	1.1	II
Oct 15	IPC	13	47	202	0.8	III

Table 14

Magnfication of Vertical Seismograph at

different attenuation settings

Attenuation Setting (dB)	Magnification at 1 Hz	(from 8/8/79)
28	7700	
30	6000	
32	4700	
34	3800	
36	3000	
38	2300	