BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD 1984/35

RECORD

MAWSON GEOPHYSICAL OBSERVATORY

ANNUAL REPORT, 1982

BY

R.P. SILBERSTEIN

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SUMMARY

The work described in this report was part of the BMR contribution to the 1982 Australian National Antarctic Research Expeditions. This contribution consisted of continuous recording of seismic activity and the geomagnetic field. Instruments were two La Cour magnetographs (a normal and a sensitive), a three component Benioff short period seismograph and a Press-Ewing long period vertical seismograph.

In August the Sensitive magnetograph was removed from service.

Preliminary data were forwarded twice weekly to Australia and all Antarctic geophysical stations.

1. INTRODUCTION

Mawson Geophysical Observatory is operated by the Bureau of Mineral Resources (BMR), Division of Geophysics, as part of the Australian National Antarctic Research Expeditions (ANARE) at Mawson, Australian Antarctic Territory. Logistic support is provided by the Antarctic Division of the Department of Science and Technology. Station details are listed in Table 1.

The observatory commenced operation in 1955 with the installation of a three component La Cour magnetograph from Heard Island (Oldham, 1957). Since then numerous instrument changes have taken place (see Appendix 1).

The author arrived at Mawson on 24 January 1982 on the M.V. Nella Dan, to relieve Alan Marks. The 1983 replacement geophysicist, Bob Cechet, arrived on 25 February, also on the Nella Dan, and after briefing and familiarisation, the author departed on 8 March , 1983.

A brief call at Heard Island was made on 12 March 1983, during which observations were taken of magnetic Declination and total magnetic intensity (Appendix 2).

2. MAGNETIC OBSERVATORY

The elements H, D and Z were recorded during 1982 with a total record loss of 3 1/2 days. Simultaneous record loss of both Normal and Sensitive records was six hours, during an equipment rearrangement in the Geophysics Office. The Sensitive variometer ceased operation on August 1 when it was dismantled to allow for the installation of the new Photo- electronic Magnetograph (PEM) in 1983.

In addition, 9 days total of Normal Z trace were lost in January (trace too faint while observer was in the field) and 27 hours of D trace were lost from September 14th 0400 UT - September 15th 0700 UT (adjustments).

Recorders

Two adjustments were made to the Normal La Cour recorder optical system.

1) The D time-mark trace was not recording upon the author's arrival and was restored in March.

2) The D upper-reserve trace was not recording and defied all attempts to restore it. Fortunately, the trace was not often required and its lack resulted in only 3 hours total loss of D trace during exceptional storms.

Occasionally, some of the replacement operators had trouble with the drum drive gears on the normal magnetograph not engaging. This has been a recurring problem (A. Marks, 1982) and resulted from a roughness in the motor clamp slider. As record loss was minimal, it was deemed not worth dismantling the recorder. All substitute operators were required to run the Sensitive magnetograph as a back-up.

The Sensitive magnetograph presented no problems during the year except for occasional (6 days in the year) appearance of ghost traces of the H trace. These two extra traces were dark, wide traces offset in ordinate and abscissa and occurred only for complete records, and were thought to be associated with positioning of the drum cover. No absolute cause was established, but they may have been due to stray reflections and they were eliminated by careful replacement and settling of the drum cover. These were also noticed in previous years (A. Marks, 1982). the Sensitive magnetograph was removed from service in August, except for the occasional use as back-up by substitute operators. In January it was disassembled and packed for return to Australia.

The HP-608 electrostatic paper chart recorder failed when the hour/minute gear selector bent. No spares were available for this part and a temporary repair was effected.

Magnetograph Tests

Orientation Tests. Orientation of the normal variometer magnets was measured on 23rd and again on 27th January 1983. Results are listed in Table 2. No adjustments were made.

Parallax Tests. Parallax tests were made every month at first and then every two months as there proved to be negligible parallax between traces and their time marks, except for the D-normal trace which developed a very slight parallax between the trace and time-mark trace, but a marked (2 mm) parallax between the trace and baseline time marks. This parallax was noted and accounted for in all measurements for the trace.

Scale values. Scale values for H, D and Z were made six times a month for the normal magnetograph and once a month for the sensitive magnetograph.

The MC01 calibrator unit failed once during the year and an operational amplifier was replaced. A slight problem arose when the batteries were cold and/or flat. This resulted in instability in the rise cycle, and a slight drop in output current. The remedy was to allow longer warm-up time and/or relace the batteries.

Magnetometers

Absolute magnetic field observations of H, D and F were made six times each month. These were used to establish preliminary baseline values for the magnetograms. The BMZ was used once every two months to maintain control for its use as as a back-up to the PPM.

At one stage in the year the proton precision magnetometer MNS2/1 slowed its cycling rate and required a greater number of cycles to "lock on" to the magnetic field. This was found to be due to a low volume of fluid in the magnetometer sensor head. It is presumed that fluid leaked out while the head was very hot during a two-day continuous run. The remedy for the heating problem is to slow the cycling rate for continuous runs.

Comparisons. In February and March 1983 intercomparison measurements were made by the author between the resident instruments QHM300, Declinometer 580332 and Askania circle 611665, PPM MNS2/1 and travelling standards QHM 172, HTM 570704, Declinometer 640505, with Askania circle 508813 and Geometrics PPM 816/767 (Table 3).

Differences between QHM 300 and QHM 301, QHM 302 were determined from the routine observations.

Preliminary corrections used throughout the year are listed in Table 4.

Temperature baseline and scale value

Temperature trace baseline and scale values were determined using the temperature measured daily during the record change routine.

From this a plot of H and Z baselines at temperature against temperature was used to calculate the temperature by means of heater control unit PZC-1 switching four 1000 Watt heaters. Only two problems occurred with this system. The first was the blown fuses, as mentioned earlier. This was due to chattering the switching circuit. It was partially alleviated by connecting one or two heaters on permanently.

The second problem was the raising of the temperature up to +8°C during periods of the summer months. No remedy could be found for this.

Data

The ten magnetically quietest days of each month were used to establish mean monthly values for H, D and Z components of the magnetic field. This data, together with K-index values were telexed to BMR Canberra

Scale values, observed baselines and preliminary mean monthly and K-index values are shown in Tables 5,6 and 7, respectively. Annual mean values for the period 1973-1982 are listed in Table 8.

Maintenance

No major maintenance of buildings or equipment was necessary. Periodically holes in both the absolute and the variometer houses were sealed up with caulking compound to exclude drifting snow. Fuses in the variometer heater circuit blew occassionally due to a relay chattering in the thermostat circuit. Consultation on return to Canberra suggested that this circuit was not operating correctly and the 1983 Mawson observer was advised to change thermostat control units.

3. SEISMOLOGICAL OBSERVATORY

The seismograph consisted of two short period horizontal Benioff seismometers with a Benioff photographic recorder, and one short period vertical Benioff seismometer and a Press-Ewing long period vertical seismometer connected to Geotech 'Helicorder' heat-pen recorders. The entire horizontal system was located in the surface seismic vault. The two vertical seismometers were located in the 13 metre deep cosmic ray telescope vault and the recorders were in the Science office. The seismograph details are listed in Table 9.

Maintenance

The long period seismograph was not operating at the time of the author's arrival. The problem was initially thought to be due to a lack of spares for the pen travel motor. It was later found that the initial motor failure was due to the travel limit switches having come loose and out of position and hence not disconnecting power when the pen had travelled to the edge of the drum. The result was the destruction of one of the gears in the drive gearbox whenever the recorder was allowed to run over about 26 hours. the unit was serviced and the gearbox rebuilt from others found in the store and the long period seismograph commenced operation on August 20th. A block diagram of the Vertical Seismograph System is shown in Figure 2.

The position of the long period seismometer boom required several adjustments before the system settled down.

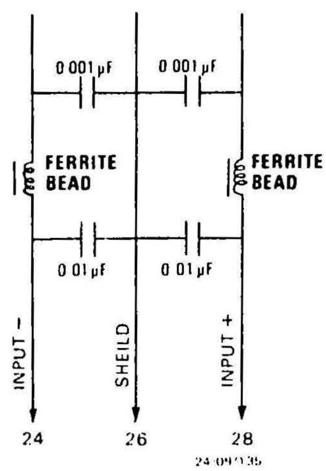

Fig 1. Filter circuit for S.P. galvanometers

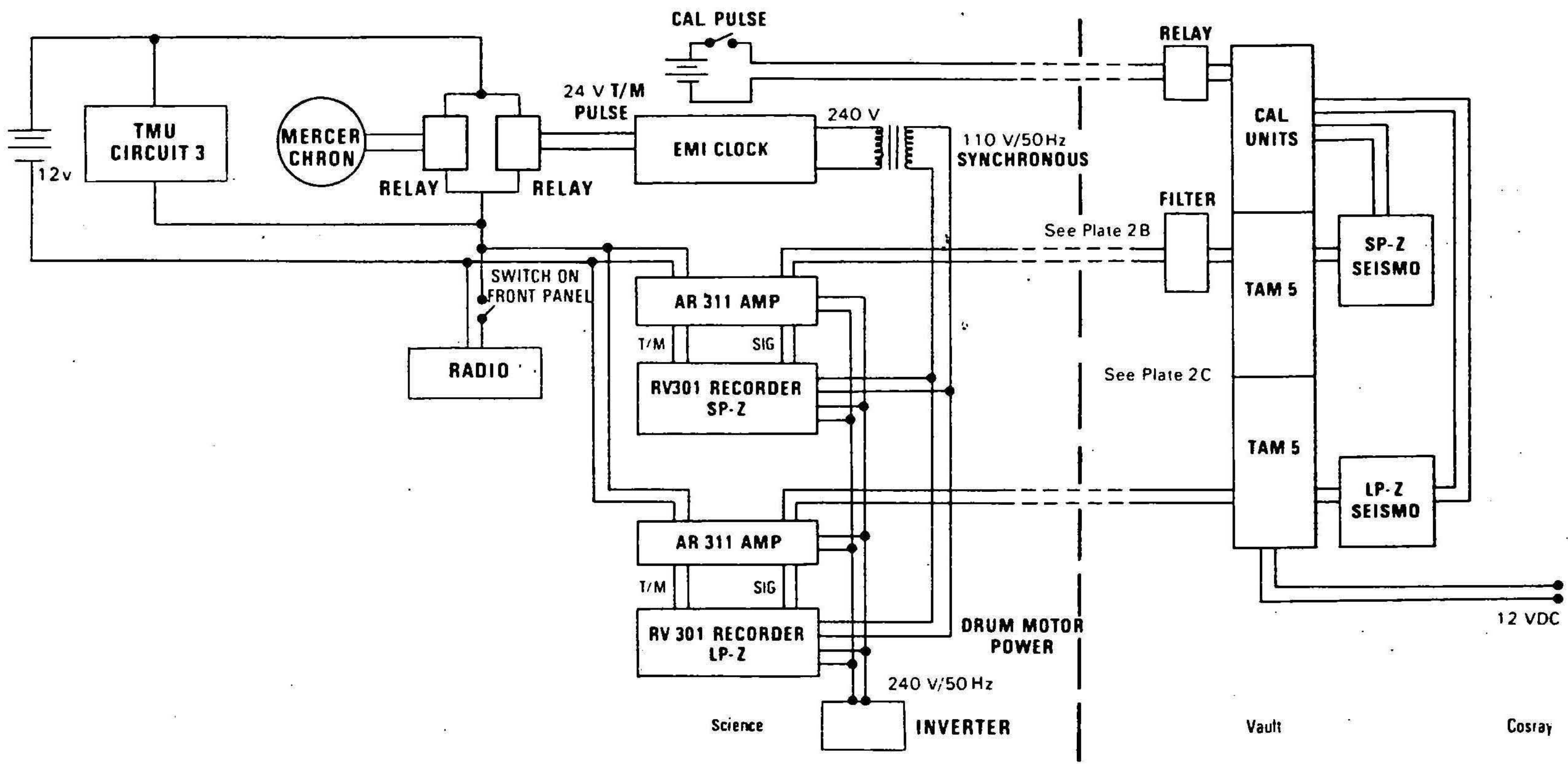

Fig 2. Vertical Seismograph systems

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The long period drum speed was reduced from four revolutions per hour to one revolution per hour, in common with other long period systems.

Occasional adjustments were made to the Benioff recorder as required. Occasionally the North-South component trace would be offset by a step, sometimes several times, and this was though to be due to radio frequency pckup in the lines to the galvanometer being rectified at dirty contacts. The problem was largely, but not completely, eliminated by the installation of filters (see Fig. 1) in the lines before both galvanometers

During blizzards the long period trace showed extreme high frequency noise. This appeared to be related to wind rather than static charge build up and suggested a bad connection somewhere in the line. This bad connection was never found.

The short period vertical component showed a strong 50 Hz signal (only visible at high gain settings) which appeared to be associated with a ground loop. Several attempts to locate it failed.

The only other problems with the seismograph system were broken cables - once by a shovel, once by blasting and several times during summer by vehicles. None of these resulted in record loss except the shovel incident which cut the long period signal line betweenb the cosmic ray vault and the Science office.

Calibrations

Calibration pulses were applied daily to each short period component at the beginning and end of each record.

Weight lift and frequency response tests were made in November, December 1982 and January and February 1983. The results are shown in Table 10 and Figures 3 and 4.

Several problems were encountered with the calibration procedure, particularly the long period seismograph. It was discovered that the long period calibration unit was not connected and appeared not to have been for some time. The temperature compensating servo control was also disconnected which would mean that the seismometer was temperature sensitive. This was felt to be unimportant as the seismometer vault temperature varied by less than one degree over the period from winter to summer (average - 5.0°C).

Not all parameters for the long period seismometer were available, including the mass value, expected values for G (the electromechanical motor constant), position of the centre of mass of the boom and position at centre line of the mass on the boom. The point on the boom at which the lift weight should be placed is somewhat arbitrary. In the absence of a position at centre of gravity weight lift tests were attempted from two different positions on the boom. However it proved virtually impossible to balance the 10 mg mass on the shaft of the boom. Head office recommendation was to dismantle the seismometer and determine the position at the centre of gravity using spring balances. It was decided that this exercise would be difficult (two adequate spring balances could not be found) and should be unnecessary as data should be obtainable from the manufacturer. This data was, however, not readily available on the author's return and parameters have been assumed to correspond to those given for a World Wide Standard Seismograph Network instrument. (These are given in Table 9).

A problem of interference between the two vertical seismographs was evident showing as a step offset on the long period record on pushing the calibrator button of the short period seismograph. This offset slowly decayed. It strongly resembled the discharge curve of a capacitor and was probably a product of the

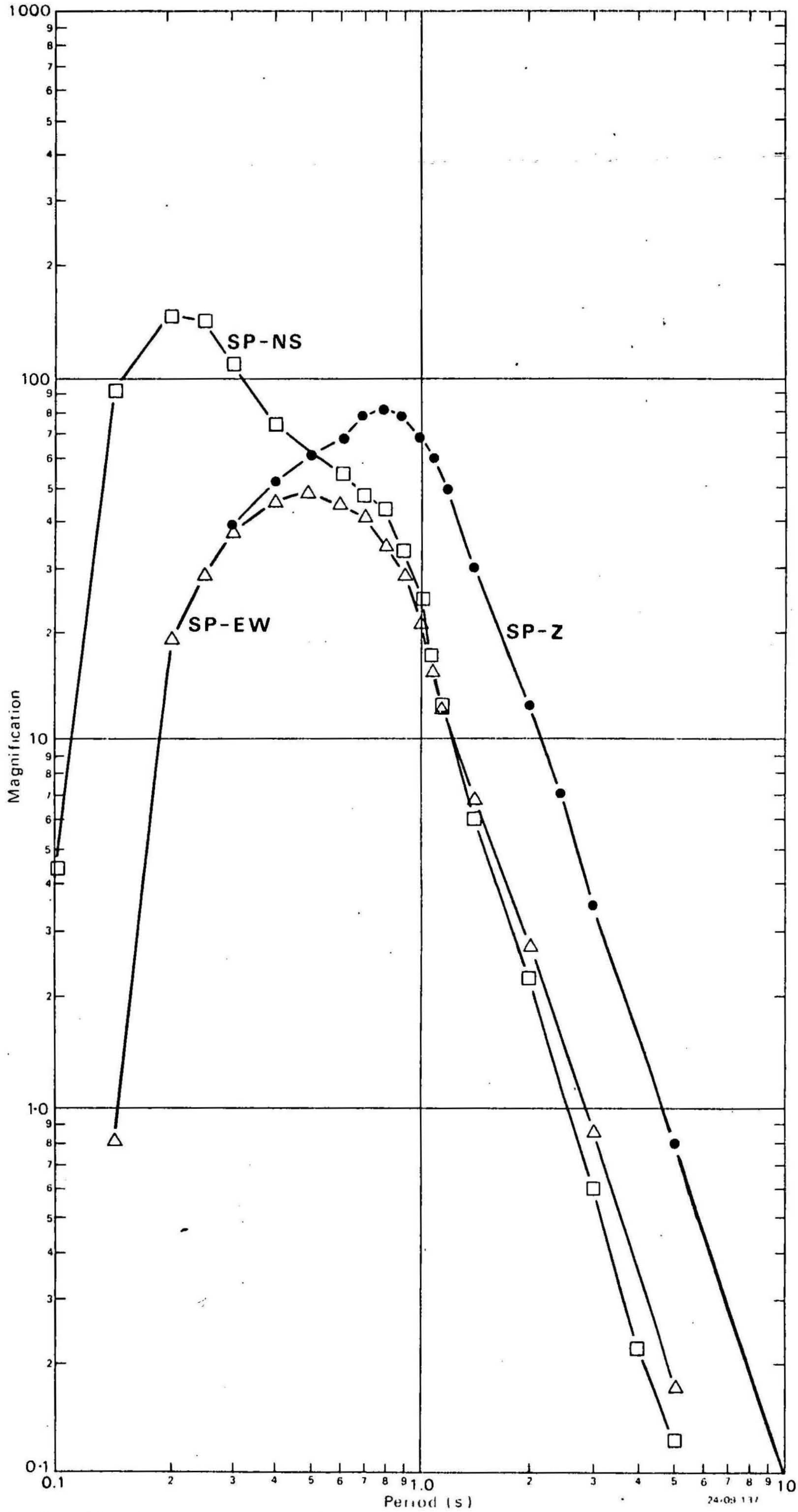

Fig 3. Magnification curves: SP–Z, SP–NS, SP–EW seismographs, Mawson 1982.
Attenuater settings: Vertical 12 dB, Horizontal 6 dB

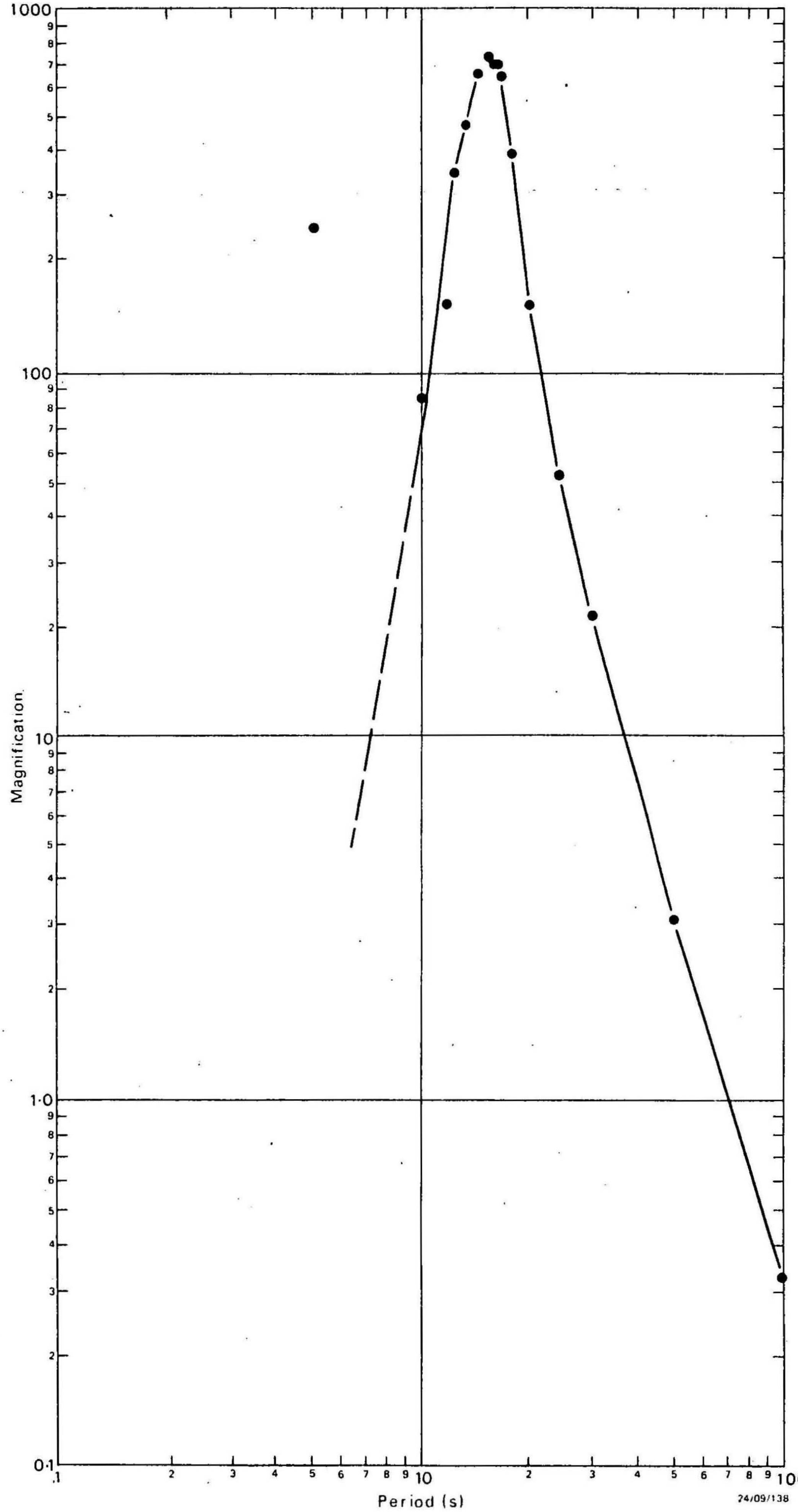

Fig 4. Magnification curve: LP—Z seismograph, Mawson 1982.
Attenuator setting 30dB

circuitry of the seismograph rather than a real seismometer-seismometer coupling. The only common feature of the two circuits was the power supply and it is recommended that this be altered to a separate one for each system.

The short period North-South horizontal seismograph has its record inverted with South-up on the seismograms. It was unknown how long this situationhad existed but was left undisturbed as no instructions were issued otherwise. The polarity of this system was incorrectly reported in the record for 1981 (Marks, 1982) as "North-up".

From the calibration curve of the long period seismograph it can be seen that the seismometer was under-damped (Shown by the narrow peak). The apparent rise in magnification below 10 second period is partly artificial due to the low amplitudes measured and partly due to the affect of the short period in the equation.

The calibration curve of the North-South seismograph shows a resonance at 0.2 second period corresponding to the free period of the galvanometer. This was probably due to an interference of the passive noise filter and the galvanometer.

Data

P-phase arrival times were reported twice weekly to Canberra Observatories Group and all Antarctic Stations. S-phase and other phase arrival times, and period and amplitude data were reported whenever possible

A total of 1201 events were reported in the 13 months February 1092 till end February 1983. Of these 918 were detected in the 7 months June till December. The system was recording most sensitively during August, September and October when the thick sea ice provided a very stable environment in which to reduce attenuation of the recorders (see table 10).

4. CONTROL EQUIPMENT

There were no major modifications of the power and timing equipment during 1982. All lead acid 12V and 6V batteries were replaced during the year. A Dc-Ac inverter was installed to provide power to the helicorder pens and amplifiers in the event of power failure. Several wiring changes were also made as detailed in a later paragraph (see "EMI clock").

Timemark Programming Unit (TMU-1)

This unit functioned correctly all year except for two recurring problems. One of these was related to connections in the PPT-1 power and timing distribution panels and will be outlined in a later paragraph. The other was the occasional self advancement of the unit by one minute. This appeared to be associated with statis charge build-up as it was particularly bad during blizzards, once advancing itself by five minutes before detection. The only remedy was to turn the unit off until the time had proceeded to one minute ahead of the unit and then turn it back on. This problem has occurred since the TMU was first installed (Smith, 1971; Wake-Dyster, 1981; Marks, 1982). Although timemarks could be taken straight from the EMI clock it was decided to leave the TMU in service as it provided 5 minute marks and the EMI only 10 minute marks. The TMU also provided a back-up in case of digital clock failure (as occurred in October-November).

Time Signals

Radio signals from VNG, Lyndhurst, Victoria were used on most days to provide accurate correction for the EMI crystal clock. Occasionally WWV Hawaii was used but it was usually found that if VNG could not be received then neither could WWV. The WWV signals also had a more complex. Propagation times for WWV and VNG signals were provided by the Ionospheric Prediction Service and were, VNG - 22 mS and WWV-Hawaii - 50 mS.

The radio relay output was connected to the time mark inputs on the amplifiers to allow time pips to be recorded on the seismograms.

EMI digital clock

The EMI clock provided time mark pulses and 50 Hz synchronous 240V power for all systems. The rate of this clock varied continually during the year, defying all attempts to stabilise it. The amount of drift appeared to be room temperature dependent but was difficult to define exactly.

In November there was catastrophic failure of components in the clock inverter, and time mark pulse circuits. The cause of this failure appeared to be under-design of a modification to the voltage regulation circuit. The clock was rebuilt using certain modifications necessary either because of lack of available spares or to upgrade the protection of certain sections of the circuit. These repairs are the subject of a separate report made to the BMR workshops, which accompanied the clock on its return to Australia after a replacement arrived.

A result of this failure was the highlighting of a number of deficiencies in the Emergency Power and Timing circuit. 1) Drum drive power came direct from the clock and hence there was no back-up on clock failure. This was remedied by connecting to the power and timing board.

2) Time marks for helicorders were wired in series, presumaly because the EMI gives 24V pulses. This was modified so that the two helicorder time marks came in parallel from the "EMI Relay" driven from the clock with a 12V battery in series. This would also provide helicorder timemarks from the back-up Mercer chronometer when necessary, with hour marks, and 10 minute marks bweing available from the TMU circuit No. 3 (see Figure 2).

3) When the "Mode" was set to "IMU" and the "Chronometer" switch set to "Compare". then the TMU seemed to become unstable and went into a continuously advancing status, advancing approximately one pulse each second.

With the TMU switched off (other switches as above) the timemarks came fromthe Mercer Chronometer.

With the "Mode" switched to "Direct", the timemarks came from the EMI.

The above conditions were not necessarily repeatable, with occasional spurious things happening.

The main conclusion to be drawn from the above is that the power and timing circuitry was in disarray. The author constructed a reasonably failsafe system which, although diffwering in some places from the specifications, would guarantee power and timing back-up for all equipment. The author recommends that the relocation of both magnetic and seismic eqiupment be taken as an ideal opportunity to completely rewire the control circuitry. This would require a certain amount of down time of the system but during an extended change-over with the experienced outgoing geophysicist helping the incoming one, would be a worthwhile exercise for the long-term good of the observatory.

5. OTHER DUTIES

During the year the author took part in normal routine duties around the station, such as kitchen slushy duties, Saturday afternoon station projects, and nightwatch, as well as occasional labour intensive construction projects such as concrete pouring. The author also assisted the Ionospheric Prediction Service and Cosmic Ray physicists in perfrming their daily routines while they were away from the station.

6. ACKNOWLEDGEMENTS

The author wishes to express his thanks to the Mawson 1982 wintering party for their assistance and co-operation. In particular, special thanks are due to Charles Willock for helpful advice on electronics problems, to Julie Campbell, Jim Cooper and Dave Pottage for performing the chart change routine while the author was absent from the station, and to Jerry Curchin for repeatedly reconnecting power to the horizontal seismic vault.

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APPENDIX 1

HISTORY OF INSTRUMENTATION UP TO 1982

A brief summary of the development of Mawson Geophysical Observatory in terms of instrumentation until 1982 is presented below.

(a) GEOMAGNETIC

May 1955	:	Absolute instruments used for regular observations of H, D & Z (Oldham, 1957).
Jul 1955	:	Continuous recording commenced by three-component normal La Cour magnetograph (Oldham, 1957).
1957	:	Bar-fluxmeter magnetograph installed (Pinn, 1961).
Jan 1961	:	Three-component insensitive La Cour magnetograph installed and recording commenced (Merrick, 1961).
Dec 1967	:	Bar-fluxmeter magnetograph withdrawn (Dent, 1971).
Sep 1968	:	Insensitive La Cour magnetograph converted to medium sensitivity and renamed normal magnetograph. The normal La Cour magnetograph was renamed sensitive magnetograph (Smith, 1971).
Feb 1975	:	15 mm/hr normal recorder replaced by 20 mm/hr recorder (Hill, 1978).
Dec 1975	:	15 mm/hr sensitive recorder replaced by 20 mm/hr recorder.
Mar 1981	:	MNS2 proton precession magnetometer installed for absolute measurements.
Aug 1982	:	Sensitive recorder removed.

(b) SEISMOLOGICAL

Jul 1956	:	Three-component Leet-Blumberg seismograph (Pen-and-ink recorder) installed.
1960	:	Three-component seismograph installed consisting of Benioff seismometers (free period 1.0 s) and three-channel BMR single drum recorder. Z galvanometer 0.2 s free period, horizontal galvanometers free period 70 s (Merrick, 1961).
Feb 1963	:	BMR recorder replaced by Benioff 60 mm/min three-channel recorder. 14 s free period horizontal galvanometers installed (Black, 1965).
Sep 1970	:	14 s free period horizontal galvanbometers replaced by short period (0.2 s) galvanometers (Robertson, 1972).
Dec 1973	:	Z seismometer transferred to vault beneath Cosray building (Almond, 1975).

Apr 1977	:	Transfer of Geophysics office, including power and timeing of Wombat (Science Block).
1978	:	Recording of SP-N Benioff seismometer discontinued (Petkovic in prep.).
Jul 1981	:	Helicorder hot-pen recorder installed for SP-Z and LP-Z; and SP-N Benioff restored.

APPENDIX 2

A BRIEF ENCOUNTER WITH HEARD ISLAND, 12/3/83

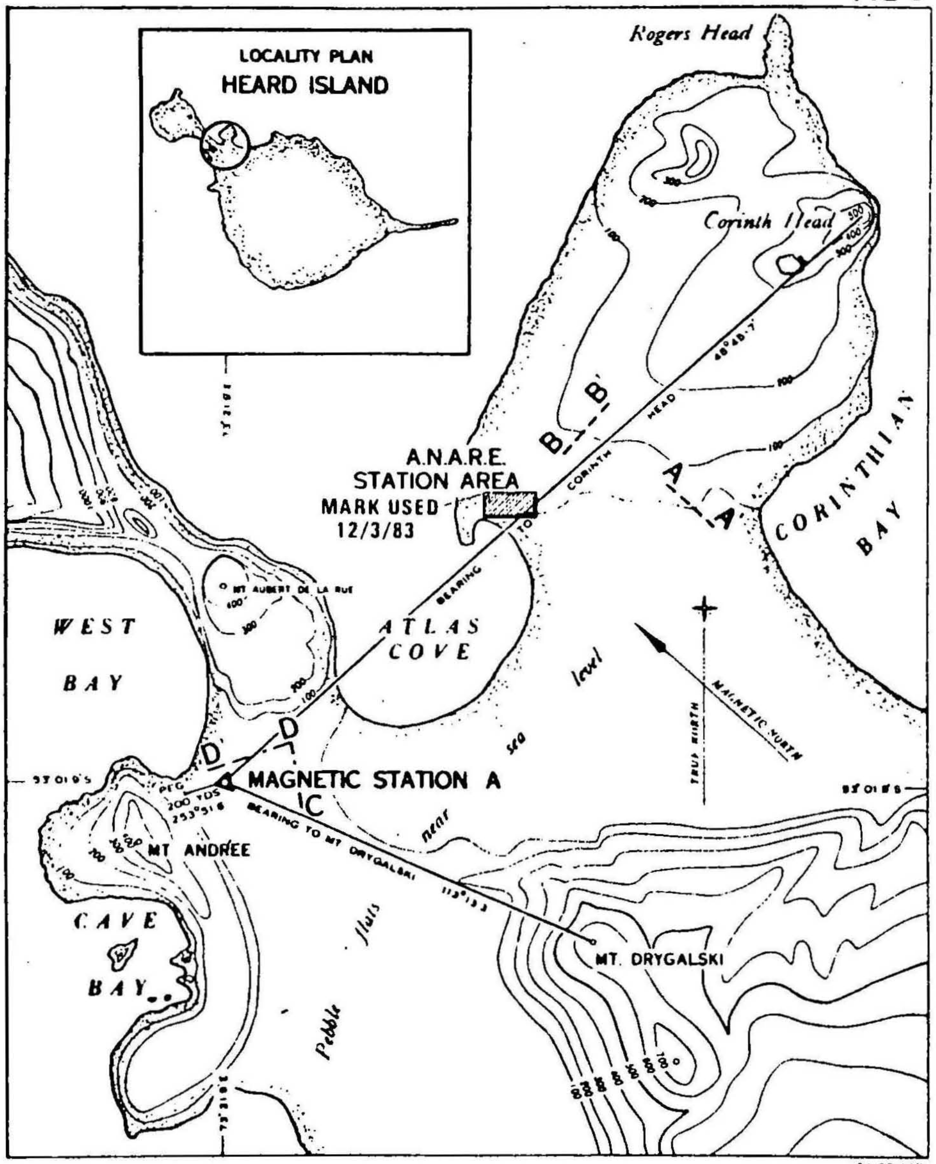
While on the return voyage from Mawson, the M.V. "Nella Dan" made a brief visit to Heard Island. The purpose of the visit was to check on the condition of the ANARE station and undertake brief biological, geological and geomagentic surveys.

The author made observations of magnetic declination and total field intensity. Location of the station and a mark description are given below (Figures 5 and 6). there were two piers at the magnetic station. Only the one further from the ANARE station was vertical and it was used to mount the instruments.

Declination was calculated as 48°24.1'W from the mean of two observations using an mark azimuth of°48 45.7'.

The mean value for F is: 50350 nT at 0749 UT.

FIG 6



VERTICAL INTENSITY VARIOMETER TRAVERSES

MAGNETIC STATION A AND ENVIRONS

0 0.25 0.50 0.75 MILES

Fig 5. Heard Island

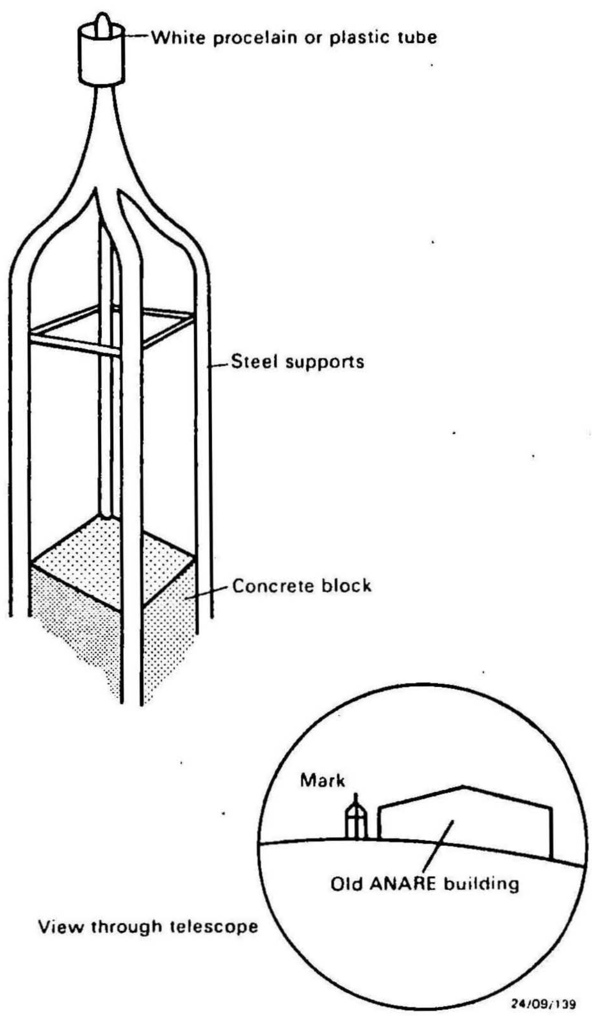


Fig 6. Heard Island mark

TABLE 1
STATION DATA FOR MAWSON 1982

	Magnetic Absolute Hut	Seismometers (Z)	Seismometers (N,E)
Geographic latitude	67°36.0'S	67°36.4'S	67°36.2'S
longitude	62°52.0'E	62°52.3'E	62°52.5'E
Geomagnetic latitude	-73.1°		
longitude	102.9°		
Elevation (m)	10	15	8
Foundation	Precambrian Granite	Precambrian Granite	

TABLE 2
RESULTS OF ORIENTATION TESTS ON NORMAL MAGNETOGRAPH
ON JAN 23 AND 27, 1983

Component	Reference	Magnet N	Ex Orientation	N-Pole
H	18455	E	0.60°	South
D	63°22.3' West	N	0.31°	West
Z	-46519 nT	N	0.99°	Down

TABLE 3
INTERCOMPARISONS OF MAGNETOMETERS, 1982-83

Date 1983	Instrument A	Instrument B	Difference (A-B) at H = 18450
Feb 26/27	QHM 172	QHM 300	43 nT = .0023H
Feb 26/27	HTM 570704	QHM 300	-5 nT = -.00027H
Feb 27/28	Ask 580505	Ask 580332	-0.8'
Mar 07*	Geometrics 816/767	MNS2/1	0.9 nT

Through routine baseline determinations Feb 1982-Feb 1983

QHM 300 - QHM 301 = 2.5 nT
QHM 300 - QHM 302 = -2.7 nT

* Results of PPM intercomparison conducted on Mar 01 discarded.

Values are at standard temperature (0°C) with no instrument corrections applied.

TABLE 4
PRELIMINARY INSTRUMENT CORRECTIONS, 1982

Instrument	Correction at H = 18485 nT	Correction
QHM 300	- 5 nT	-.000270H
QHM 301	- 1 nT	-.000054H
QHM 302	- 7 nT	-.000380H
Askania Dec 332	0	-
MNS2.1	- 1 nT	-

TABLE 5
MAGNETOGRAPH PARAMETERS 1982

Component	Scale Value	Calibration Current	Temperature Coefficient
Normal		(Mean)	
H	21.2 nT/mm	59.9 mA	0.8 nT/°C
D	2.43 min/mm	39.9 mA	-
Z	22.8 nT/mm	69.9 mA	-1.0 nT/°C
Tz	1.73°C/mm	-	-
Th	2.48°C/mm	-	-
Sensitive			
H	9.6 nT/mm	30.0 mA	
D	0.87 min/mm	10.0 mA	
Z	10.6 nT/mm	29.9 mA	

TABLE 6
OBSERVED BASELINE VALUES FOR NORMAL MAGNETOGRAPH, 1982

Date	Baseline		Remarks
Horizontal Intensity	BH		
Jan 01	17410 nT		Changes probably due to humidity and temperature
Jun 01	17407 nT		
Oct 01	17410 nT		
Declination	BD(W)		
Jan 01	61°41.3'		
Feb 01	61°42.7'		Change of operator
Apr 01	61°43.9'		Optics adjustment
Sept 15 (0700 UT)	61°45.7'		Optics adjustment
Vertical Intensity	BZ		
Jan 01	-46430 nT		
Temperature	BTz	BTh	
Jan 01	-87.3°C	-38.0°C	

TABLE 7
PRELIMINARY MEAN MONTHLY AND K-INDEX VALUES 1982

	H nT	D(W) ° '	Z nT	F nT	K-INDEX
January	18465	-63 18.6	-46643	50165	3.7
February	18436	-63 19.8	-46650	50161	4.7
March	18433	-53 19.6	-46656	50165	3.3
April	18419	-63 21.5	-46626	50132	3.7
May	18435	-63 22.4	-46617	50130	3.5
June	18421	-63 23.0	-46618	50126	3.8
July	18426	-63 22.9	-46615	50125	4.1
August	18411	-63 21.8	-46613	50117	4.0
September	18424	-63 22.5	-46615	50124	4.2
October	18437	-63 23.5	-46601	50116	3.9
November	18482	-63 21.6	-46582	50115	4.1
December	18405	-63 21.0	-46558	50064	4.3
Mean	18433	-63 21.2	-46616	50128	3.9

TABLE 8
GEOMAGNETIC ANNUAL MEAN VALUES, 1972-1982

YEAR	D(W) °	D(W) '	I °	I '	H nT	X nT	Y nT	Z nT	F nT
1972	-62	11.4	-68	53.1	18381	8575	-16257	-47600	51026
1973	-62	17.6	-68	49.7	18391	8551	-16281	-47486	50923
1974	-62	24.8	-68	47.2	18390	8516	-16298	-47380	50824
1975	-62	31.4	-68	44.0	18397	8488	-16321	-47269	50723
1976	-62	37.3	-68	40.0	18418	8470	-16354	-47157	50626
1977	-62	43.9	-68	36.9	18525	8442	-16376	-47051	50530
1978	-62	51.9	-68	35.5	18421	8402	-16392	-46986	50468
1979	-62	57.9	-68	32.9	18425	8375	-16411	-46890	50380
1980	-63	05.8	-68	29.8	18432	8340	-16436	-46784	50284
1981	-63	14.6	-68	27.1	18443	8303	-16467	-46705	50215
1982	-63	21.2	-68	25.5	18433	8267	-16475	-46616	50128
Mean annual changes									
1972-1982		-7.0		2.8	5.2	-30.8	-21.8	98.4	-89.8
1972-1977		-6.5		3.2	8.8	-26.6	-23.8	109.8	-99.2
1977-1982		-7.5		2.3	1.6	- 5.0	-21.6	97.0	-80.4

TABLE 9
SEISMOGRAPH PARAMETERS, 1982

Component	SP-Z	SP-NS	SP-EW	LP-Z
Seismometer				
Type	Benioff	Benioff	Benioff	Press-Ewing
Free Periods	1.0	1.0	1.0	16.3
Galvanometer				
Type	-	Geotech	Lehner-Griffith	-
Free Period(s)		0.2	0.2	
Power supply	SSC-1	-	-	SSC-1
Preamplifier				
Type	TAM5	-	-	TAM5
Gain setting	96dB	-	-	96dB
Attenuator setting	0dB	-	-	0dB
Bandpass filter	.1-10 Hz	-	-	.01-.2 Hz
Recorder Amplifier				
Type	Geotech.	-	-	Geotech
Model	AR-311			AR-3111
Attenuator setting	Recorded on seismogram	See Table 10		On seismogram
Recorder				
Type	Geotech.	Benioff	Benioff	Geotech.
Model	RV-301	Photographic	Photographic	RV-301
Chart Rate	60 mm/min	60 mm/min	60 mm/min	15 mm/min
Calibrator				
Motor constant(N/A)	1.55	1.27	1.25	0.20
Coil Resistance(ohm)	247	249	258	3.3
System				
Damping	8:1	8:1	8:1	low
Magnification at 1 sec +	71K	25.5K	21.8K	162#
Peak Magnification (Period)+	81K(0.8)	157K (0.2	49K (0.5)	742(#16)
Mass (kg)	107.5	107.5	107.5	11.2#
Polarity	up-up	South-up*	East-up	down-up*

\# Parameters for the long period seismometer were not available so the following (applicable for a World Wide Standard Seismograph Network instrument) were used:

Mass = 11.2 kg
Distance of centre of gravity of boom from pivot = .3081 m
Distance of centre line of masses from pivot (weight lift point) = .3564 m

\+ Magnifications for Horizontal seismographs quoted for attenuator setting = 6; for short period vertical for 12 dB setting and for long priod 30 dB (and Magnification at 20 seconds quoted instead of 1 second).

* The polarity of the North-South seismograph was incorrectly listed in the 1981 report (Marks, 1982) as North-up. The polarity of the long period seismograph is incorrectly marked onthe seismograms as up-up.

TABLE 10

RELATIVE MAGNEIFICATION HORIZONTAL SEISMOGRAPHS, 1982

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a. Relative Magnification of Horizontal Seismographs for the period February 1982 to February 1983, with respect to magnification at attenuator setting = 6.

(Attenuator settings are shown in parentheses)

Feb 0	0.42 (9)	0.35	Nov. 07	1.5 (4)	1.4 (4)
April 08	0.64 (8)	0.57 (8)	" 12	1.0 (6)	1.0 (6)
" 17	0.84 (7)	0.79 (7)	Dec 31	0.64 (8)	0.57 (8)
" 18	1.0 (6)	1.0 (6)			
" 28	1.2 (5)	1.2 (5)	1983		
May 14	1.5 (4)	1.4 (4)	Jan 07	0.22 (10)	0.07 (10)
July 05	0.64 (8)	0.57 (8)	" 09	0.64 (8)	0.57 (8)
" 06	1.5 (4)	1.4 (4)	" 16	0.84 (7)	0.79 (7)
Oct 25	1.8 (3)	1.8 (3)	" 19	0.64 (8)	0.57 (8)
Nov 03	0.84 (7)	0.79 (7)	" 27	1.0 (6)	1.0 (6)
" 04	1.2 (5)	1.2 (5)	" 28	0.64 (8)	0.57 (8)
" 05	0.84 (7)	0.79 (7)	Feb 04	0.64 (8)	0.35 (9)

The attenuator settings for the vertical seismographs are marked on the seismograms. Magnifications relative to 12 dB setting are listed below.

b.

Setting	SP-Z	LP-Z
30 dB	0.13	0.12
24 dB	0.25	0.25
18 dB	0.48	0.50
12 dB	1.0	1.0
6 dB	1.98	not measured
