BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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RECORD

MAWSON GEOPHYSICAL OBSERVATORY

ANNUAL REPORT, 1983

by

R. P. CECHET

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SUMMARY

Geomagnetic and seismological recordings were continued at the Mawson Geophysical Observatory, Antarctica, during 1983. The work described in this report was part of a BMR contribution to the 1983 Australian National Antarctic Research Expeditions.

Recording instruments included a La Cour Normal Magnetograph, a three component Benioff Seismograph, and a Press-Ewing Long Period Vertical Seismograph. A two component Photo-Electronic Magnetometer was installed and preliminary test data obtained. Preliminary magnetic data was forwarded monthly to BMR Canberra, and seismic data was forwarded weekly to BMR Canberra 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 the Heard Island Observatory (see Oldham, 1957). Since then numerous instrument changes have taken place (Appendix 1).

The author arrived at Mawson on 25 Februay 1983 on the M.V. Nella Dan, to relieve Ritchie Silberstein. The 1984 replacement geophysicist, Peter Crosthwaite, arrived on 2 February 1984, also on the Nella Dan . After a short period of briefing and familiarisation, the author departed on 3 February 1984.

2. MAGNETIC OBSERVATORY

Variations of the geomagnetic field components H,D, and Z, were recorded by a normal La Cour Magnetograph. Control observations were made regularly. A photo-electronic Magnetograph (PEM) was installed and measured the X and Y components of the magnetic field.

La Cour Magnetograph

Continuous recording was maintained during 1983 with a total record loss of 141 hours (1.6%). Major causes of record loss were during the PEM installation, poor storage of exposed magnetograms, recorder drum sticking, jammed drum gears and orientation tests.

Upon the author's arrival, the following problems were noted with the La Cour recorder optics:

1) D-time mark trace was not recording
2) D-upper reserve trace was not recording

Unsuccessful attempts to rectify the situation were made by Silberstein prior to departure. The reserve D trace was required only during exceptional storm conditions. Data loss was minimal and only for short periods on approximately five occasions. The intensities and thickness of individual traces varied quite markedly. The above information was sent to Canberra in request for guidance. No other action was taken.

Occasionally there were minor problems with the recorder drum sticking due to incorrect recorder lid placement and jammed drive gears resulting from roughness in the motor clamp slider. This was mainly a problem for operators who lacked experience with the system.

Standard 50 Hz, 240 V AC from the Advance Electronics Inverter (250 W) was supplied to the recorder motor.

The Department of Housing and Construction (DHC) started a quarry site at Mawson in early December. The original quarry site was 40 metres southwest of the variometer hut. The first few blasts in this area showered the west (magnetic) wall of the variometer hut causing some superficial damage. After consultation with DHC pointing out to them that they were blasting in a science only area, local support was strong enough to cause a new quarry site to be chosen. The regular blasting during summer at the new quarry site northwest of the rock crusher 80 to 100 metres from the variometer hut caused the plaster to crack around the variometer bases and Helmholtz coil assemblies. Re- plastering was required. No movement of the H and D variometers was detected through the baselines. However, the height of the Z variometer magnet may have changed. (See Orientation Tests). The position of the variometer hut in relation to the rock crusher is shown in Figure 1. Recorder lamps were frequently replaced, especially when there was rebuilding activity near the variometer hut. There was a high correlation between intense blasting in the area west of the variometer hut and recorder lamp failure.

<u>Baseline Value Control</u>

Absolute magnetic observations of H, D and F or Z were made six times each month. Instruments used for absolute observations included QHM's 300, 301 and 302, Declinometer 580332, PPM MNS2/1, and BMZ 62.

Scale value determintions for H, D and Z were made four to six times each month. The five magnetically quietest days of each month were used to establish a mean monthly value for the H, D and Z components of the magnetic field.

Intercomparison measurements between the resident instruments and the travelling standards were made by R Silberstein in February and March 1983 and by P Crosthwaite in February 1984. Details are shown in Table 2.

Preliminary corrections used at Mawson in 1983/4 are listed in Table 3.

The removal of the old observatory pendulum clock, and the introduction of the PEM after removal of old fittings and cabling caused jumps in the baselines for H and D. An exceptionally large blast at the rock crusher site which showered the main base area 150 metres away with rock, caused a Z baseline jump.

Table 4 lists adopted baseline values for the normal magnetograph.

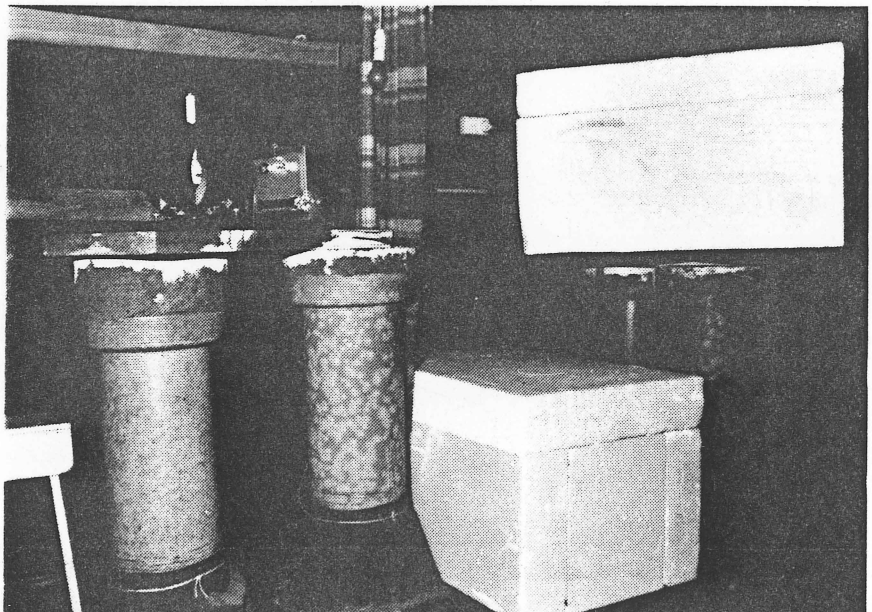
Magnetograph calibrator MC01-B was used as the current source for Helmholtz coils for scale value determinations, and applied coil currents were monitored with a Data Precision digital multimeter. Several intregrated circuits (operational amplifiers) and one drive transistor (OC22) were replaced during the early part of the year. The cause was finally narrowed down to static voltage on the cable from the La Cour control box being discharged when the MC01-B was connected to the cable. After component replacement, measured currents differed greatly from the specified currents of the MC01. A Fluke 8000A DVM was used to recalibrate the MC01. The final adopted scale-value coil currents are listed in Table 5.

When not allowed sufficient time to warm up, the MC01 calibrator would display instability in the rise cycle with an accompanying drop in the output current as monitored by the DVM. Similar circumstances resulted from flat batteries.

A declination mark observing light was constructed and installed above the declination mark. The light was a 25 W globe in a double insulated perspex container that was blacked out except for a 3 mm slit. It proved very useful in the time period around mid-winter and when performing night-time observations.

Absolute observations were normally conducted after the evening meal but before auroral activity commenced (11pm to 2am). This was normally the

Magnetic station area. Variometer hut (centre) Rock crusher (foreground)



P.E.M. instrument sensors in variometer hut.

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Fig. 1 P.E.M. sensors and variometer hut photographs magnetically quietest time of the day.

Absolute Instruments

Declinometer 580332 performed well throughout the year. After my first set of observations for the year, it was found that there was torsion in the fibre. This was corrected immediately. De-torsioning had no effect on the baseline. The three QHM's require cleaning especially QHM 302. However, more importantly, the thermometers require re-calibration and thermometer 1401 on QHM 301 reads approximately 0.5°C high. (See Table 6)

BMZ 62 as used for absolute observations after the PPM became unserviceable in June. The Z-baseline value shows a large drift which can partly be attributed to the age of the BMZ and also to the fact that the BMZ was also used for field observations when not being used for baseline control.

The PPM MNS2/1 failed due to moisture penetrating its outside weather- proof shelter. The shelter had been poorly positioned in 1981, in line with the drift pattern of the absolute hut. The shelter had been buried many times by drift snow, being uncovered before every set of absolute measurements. The head and cable were tested and found to be serviceable. The cable was recovered after the summer thaw. The PPM was not functioning on the author's departure.

Temperature Control

The thermistor heater control units (PZC-1) did not function correctly throughout the whole year. The unit would not cut out gradually. Instead it chattered between ON/OFF levels. Both (PZC-1) units exhibited the same problems, however, the temperature in the variometer hut remained near 0°C with a daily variation of up to 1 to 2°C.The temperature setting control of the heater control units must be adjusted seasonally due to variation in the ambient temperature range affecting the vertical temperature gradient in the variometer hut. The thermistor is positioned on the roof of the hut, two metres above the magnetograph.

The bar heater elements required replacement after current surges in the station power supply. During winter the power demand of the four heaters frequently tripped the circuit breaker in the science office connected to East Bay magnetic hut supply. A 32 amp circuit breaker was installed which eliminated the problem.

It was found that of the four heaters in the variometer hut only two were required during summer (both connected to the control unit), while in winter a third heater was needed and was permanently switched on.

H and Z variometer temperatures were measured daily during routine record changes in order to determine the temperature trace baselines and scale values. From this a plot of baselines at temperature against temperature was used to calculate the temperature coefficients, qh and qz . (See Table 7). The Z temperature trace was used for the adoption of baseline values and temperature coefficients. The thermograph parameters are listed in Table 8.

Parallax tests

Parallax tests were made every month. There was negligible parallax between H and Z traces and their time marks. The D time-mark trace was missing and defied attempts to restore it. The H baseline time-mark trace was used for the D-normal trace. A 1.5 mm parallax existed between these two traces. this parallax was noted and accounted for in all measurements from the D-normal trace.

Orientation tests

Orientation tests were conducted on 10 January 1984. Before commencing orientation tests, variometer wall mark positions (See Fig 3) were checked. Orientation tests were postponed until the blasting in the area near the variometer hut was virtually completed. Only minor bench blasting in the new quarry site was continuing. Variometer coil alignments were checked by suspending a plumb bob from a string connecting the wall marks. The coil alignments were in a direction N64°W (ie 296°True).

The magnetic moment of the Z variometer deflector magnet was measured by Wolter in 1976 (Wolter 1981/7). He reported a value of 491.4 nTm-3 using a QHM to make the measurement. The measurement may have been affected by changes in declination. A BMZ is normally used for the calibration procedure. The value obtained by Wolter was consistent with the ageing of the magnet since 1969 (5% reduction).

Z orientation test results were not consistent with measurements by Marks 1981 and Silberstein 1982. No errors could be found in the calculations. The setting up procedure was similar to that used by Silberstein in 1982. It is possible that the height of the Z-variometer magnet or the deflector magnet may have changed due to the blasting in the area. The height was not checked, however, in hindsight the U-tube method described in the Magnetic Observatory Manual by McComb should be employed. This was suggested to the 1984 Geophysicist.

All H and D orientation test results are consistent with previous measurements. Scale value and orientation coil constants are listed in Table 9. Currents applied to the H and D orientation coils, the source used, and magnetic field directions produced by different switch settings, are listed in Tables 10 and 11.

Preliminary Data

K-indices, preliminary baseline values, scale values, and preliminary monthly mean values were transmitted monthly to BMR Geomagnetism Section, Canberra and all Antarctic stations.

Observed baselines and adopted scale values are shown in Tables 4 and 7. Preliminary monthly mean geomagnetic field values and annual mean values are listed in Tables 12 and 13. K-index values for 1983 are listed in Table 12.

Photo - Electronic Magnetograph (PEM) Installation

Variometer hut preparation. Installation began in May with removal of the old wiring and fittings for the La Cour Sensitive Magnetograph. The concrete block tops of the piers were then removed, cleaned, re-grouted on top for a flat finish, then repositioned on the pier bases in a new orientation. The old sensitive magnetograph instrument pier top was oriented with its long edge running east-west (true). The recorder pier top was oriented with its long edge running north-south (true). The pier tops were as level as was possible under the conditions. (See Fig 2).

There were no power points in the variometer room of the variometer hut, so two double power points were installed, one on each of the magnetic east and south walls. Lighting was also installed above each PEM pier. Red darkroom safety light boxes were used so that the PEM could be operated with the lights on.

The existing curtain was lengthened so that it split the variometer room in

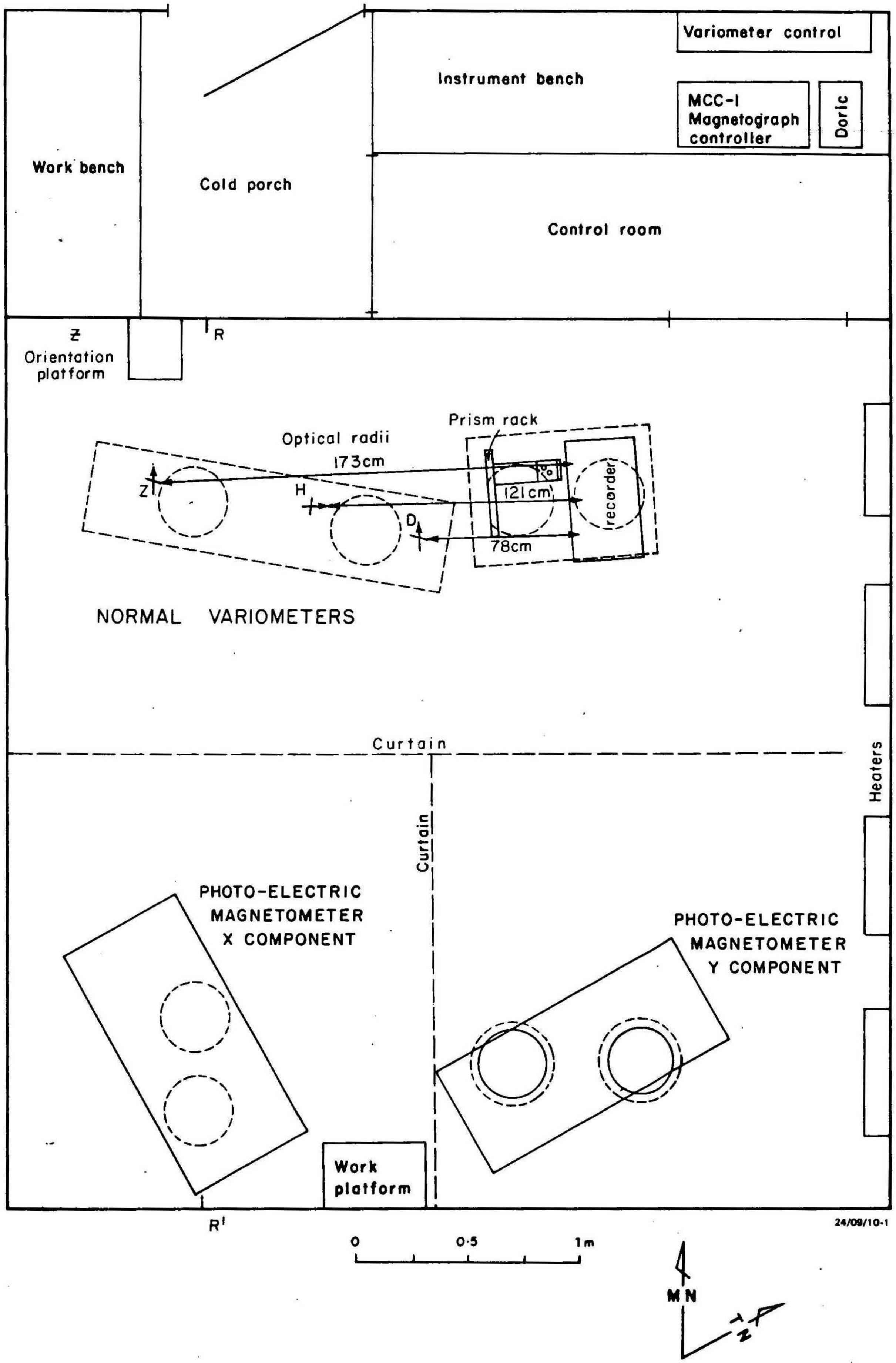


Fig. 2 Variometer building, instrument locations and variometer optical radii

two. Another curtain was installed so that the PEM area was split into an area for each instrument. The reason for this was to enable work to be carried out on one PEM sensor without interfering with the other instrument.

A small wooden work bench was constructed and positioned on the south (magnetic) wall of the variometer hut. This proved very useful during the setting up procedure.

Installation. The Y-component of the PEM was set up on the old recording pier with the QHM at the north end of the pier. The X-component was set up on the old instrument pier with the QHM at the west end of the pier. (See Figure 1) The orientation coils were set up using the wall mark survey lines in the variometer hut. (See Figure 3)

The setting up procedure outlined in the handbooks for MPE-1 photo-electronic magnetometer and MCC-1 magnetometer controller (BMR Record 1983/12) was followed and no problems were encountered.

The magnetograph controller is located in the variometer hut control room along with the Doric temperature monitor. The magnetograph recorders (two HP Moseley 7100B) were located in the science office. The 6 pair shielded cable which was to make the 80 meter link between the variometer hut and the science office did not arrive at Mawson. There was no other spare signal cable of sufficient length on base so an old length of 6 pair solid core unshielded telephone cable was used. This cable proved unsuitable as its path was under antenna systems and so it picked up noise during transmitting schedules. Performance was also poor during high winds in blizzards (blizz static) and during ionosonde transmissions. The cable was used until the 1984 geophysicist arrived with a replacement cable. The signals on the lines are:

(a) X magnetometer
(b) Y magnetometer
(c) temperature (d) auto scale-value current sequence remote trigger

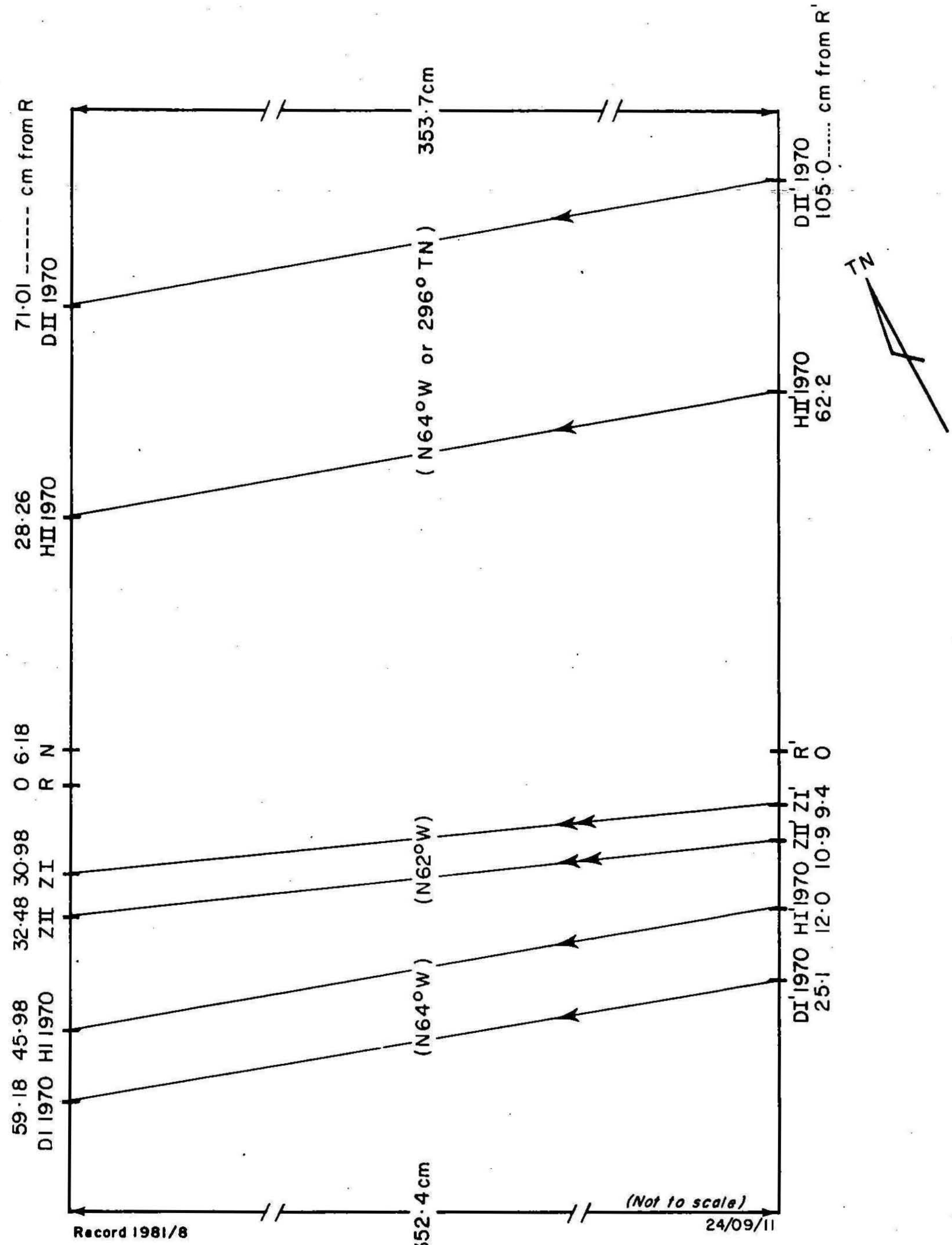
System performance In comparison to the La Cour magnetograph the X and Y components of the PEM performed well. Referring to Fig 4, PEM X and Y traces for micropulsations; the response is very pleasing. Normal scale value for each component was 15 nT/mm. The auto scale value current is 40 mA.

Temperature monitoring was provided by a Doric temperature sensor. The voltage output of the Doric was 100 MV corresponding to 10°C. These voltages were too small to record on the office recorder. Due to the high degree of local interference a line amplifier was constructed (gain = 150) and installed in the MCC-1 magnetograph controller. This gave a range of 15 volts corresponding to 10°C. The Doric and line amplifier were bench tested and found to function suitably. The temperature sensing system was installed with the probe in the Y-magnetometer thermal cover. Once in the variometer hut, the temperature sensing system ceased to function.

Peter Crosthwaite continued with this problem. He found that the analogue card of the Doric would not function, possibly because it was too cold in the variometer hut control room. (The temperature at times fell to -5°C , the average temperature being approximately -2°C.)

Thus, it was not possible to obtain data on the temperature coefficients of the X and Y magnetometers.

Thermal covers were constructed for each magnetometer. Six inch polystyrene foam was used, the interior surfaces blacked out with non-reflective black paper. There is a significant temperature difference between the X and Y magnetometers



Notes: *R′ − R* : *Reference direction (wall apertures for survey line) − 301°29·1′TN*
R′ − N : *Line normal to walls − 302°29·1′TN*
HI, DI, ZI : *Wall marks associated with SENSITIVE magnetograph*
HII, DII, ZII : *Wall marks associated with NORMAL magnetograph*

Fig. 3 Variometer hut, Mawson: wall mark locations

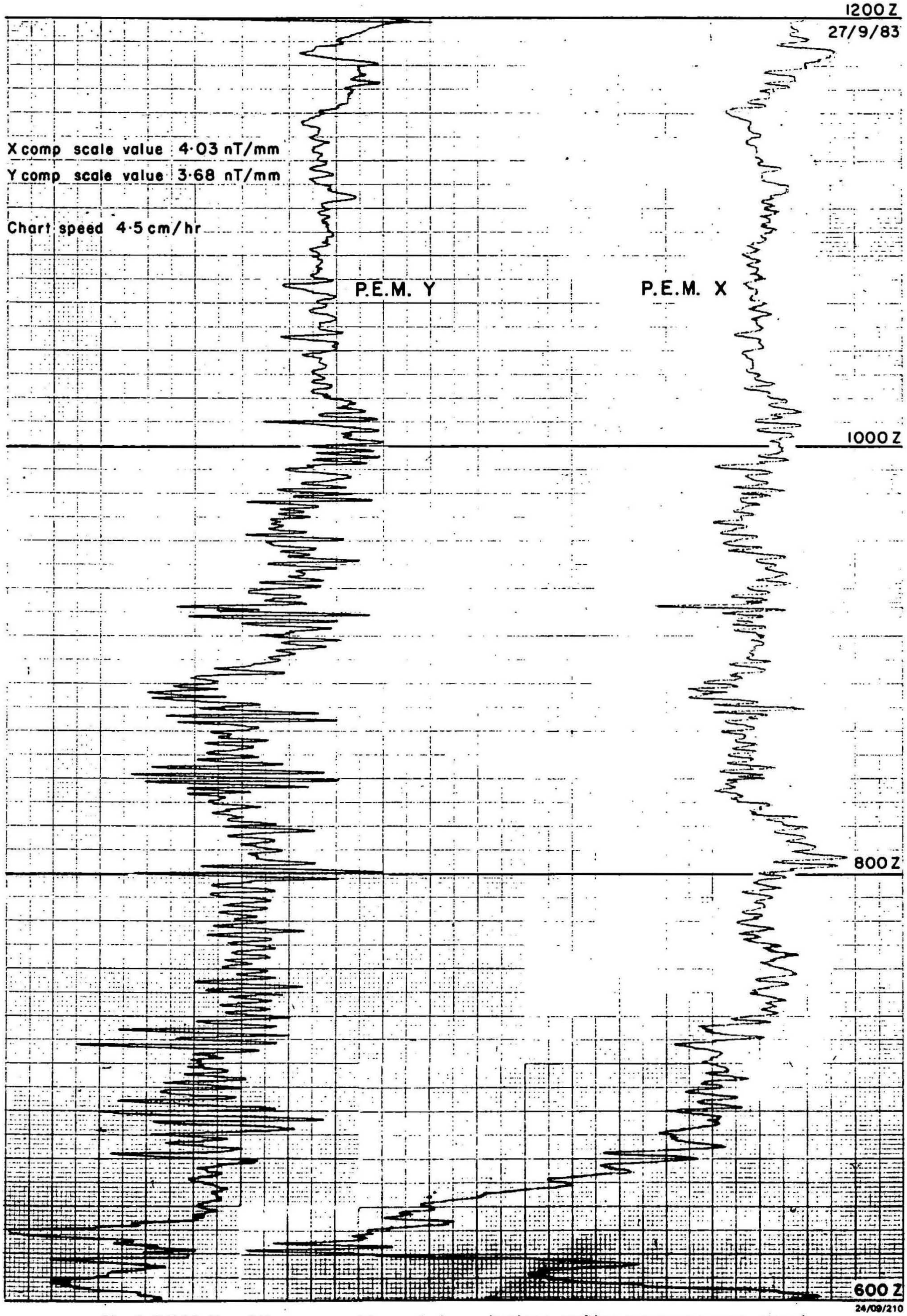


Fig. 4 P.E.M. X and Y component traces (micropulsations, sudden commencement, storm)

due to their distance from the heaters. (See Fig 2). The thermal covers greatly reduce the temperature range to which the magnetometers are subjected. Two Doric temperature sensors should be used. However, there is space for one temperature only to be recorded on the present Edas-2 cassette recorder, and we should try to minimize the amount of data recorded. (The Z-component of the PEM will be installed in 1985.) Another option is to retain the thermal covers, and use circulating fans (two units) to unify the temperature in the room. A high sensitivity thermograph can be used for a chart record to monitor performance.

3. SEISMOLOGICAL OBSERVATORY

Recorders

The vertical seismograph system consisted of one short-period vertical Benioff seismometer and a Press-Ewing long-period vetical seismometer connected to Geotech "Helicorder" heat-pen recorders. The horizontal seismograph system consisted of two short period horizontal Benioff seismometers with a Benioff photographic recorder. The vertical system was located in the cosmic ray telescope vault (situated 13 metres below the cosmic ray physics building) and the recorders were in the science office. The horizontal system was located in the surface seismic vault on East Arm near the transmitter building. The seismograph details are listed in Table 14.

Maintenance

The horizontal recorder drive gears were cleaned and greased in August as part of the yearly service.

Radio frequency (RF) interference which produced DC offset of traces was an intermittent problem experienced in 1982. (Silberstein 1984) This was finally traced to RF pick-up by dirty attenuator potentiomters located in the galvanomter control boxes. This problem also occurred in 1977. (Wake- Dyster, 1981). The problem re-occurred later in the year but this time it was traced to a poor cable connections. The seismic hut is 50 metres from the transmitter hut and on the edge of an antenna farm where transmission power greater than 10 KW is common.

Extreme high frequency noise on the long period trace during blizzards continued to occur during 1983, as experienced in 1982. The problem seemed to be related to wind speed rather than static charge build-up, suggesting the poor cabling was the problem. However after checking all the visible cable connections no improvement occurred. This problem should be rectified with the installation of the new cable from science to the cosray physics building.

It was found that there was a significant amount of noise induced in the cable before the cosray to science connection (output of TAM5 controller). Four measures were taken to reduce the noise;

1) The BMR noise suppressor at the input to the TAM5 was removed.

2) The TAM5 units were wrapped in silver paper (which was earthed) and re-inserted into the racks.

3) Microphone cable was installed to connect the seismometers to the TAM5 units. The shield of the cable was connected to the seismometer cases to stop the seismometer coils acting as aerials.

4) Twin shielded cable was used from the TAM5 units to the connection of the

cosray/science cable.

At similar amplifier settings the noise was greatly reduced. These measures allowed the SPZ attenuation to be decreased by 6dB.

Some experiments were made using filters at the input of the AR320 amplifier to reduce some of the noise picked up on the cosray/science cable. A cascaded passive RC low-pass filter was used (See Fig 5). A cascaded system increases the slope of the filter characteristics without affecting the time constant of the single filter. Low pass filtering is the most common method of enhancing the signal-to-noise ratio. Earthquake seismic signals have major frequency components near 1 Hz with a bandwidth extending less than 10Hz. A low-pass filter with a RC time constant and hence bandwidth necessary to minimize the affect on the signal frequencies was chosen.

At Mawson it was decided to have the following cut-off frequencies and thus time constants.

Short Period; cut-off Freq = 5Hz (T = 0.2 secs)
RC = 0.032 secs

Long Period; cut-off freq = 0.1Hz (T=10 secs)
RC = 1.6 secs

The LPZ seismograph was investigated regarding the system noise. The filter was used and the SPZ pyro cable was used for the science/cosray instrumentation connection. It was found that when the LPZ gain was increased (approx 24dB), a noisy sinusoidal signal with an envelope shape was recorded on the seismogram. The cause of this noise was finally narrowed down to the beating of the station power generators (one Caterpillar generator, one Dorman generator) when they are operating at slightly different frequencies. When the frequency of one of the generators was varied, the shape of the envelope varied.

The SPZ pyrotanex cable (cosray/science) was balanced and functioned satisfactorily. However it is normally used for carrying power not low voltage signals.

The LPZ cable (cosray/science) is made up of a number of different cables (see cables, Section 4). The input to this cable is balanced (from TAM5). The output to the AR320 is not balanced. The link (cosray/science) has a longitudinal hum which is not equal on both channels (40% difference).

The differential input and the apparent push/pull circuit design of the AR320 amplifier/attenuator poorly attenuates the longitudinal hum.

The interference has been suppressed by low-pass filtering but the large unbalance in the cable seems too great for the balance control of the AR320 to handle.

The AR320 should significantly reduce any line noise due to its differential input and push/pull arrangement. However when Mawson Radio VLV is transmitting and the seismometer gain is increased 12dB above the operational level, the morse code can be read using the seismometer pen.

Mawson has extreme noise problems due to the numberof experiments, instrumentation, construction and radio communications operating in a very small area.

Our noise problems should diminish greatly once the new cosray/science cable

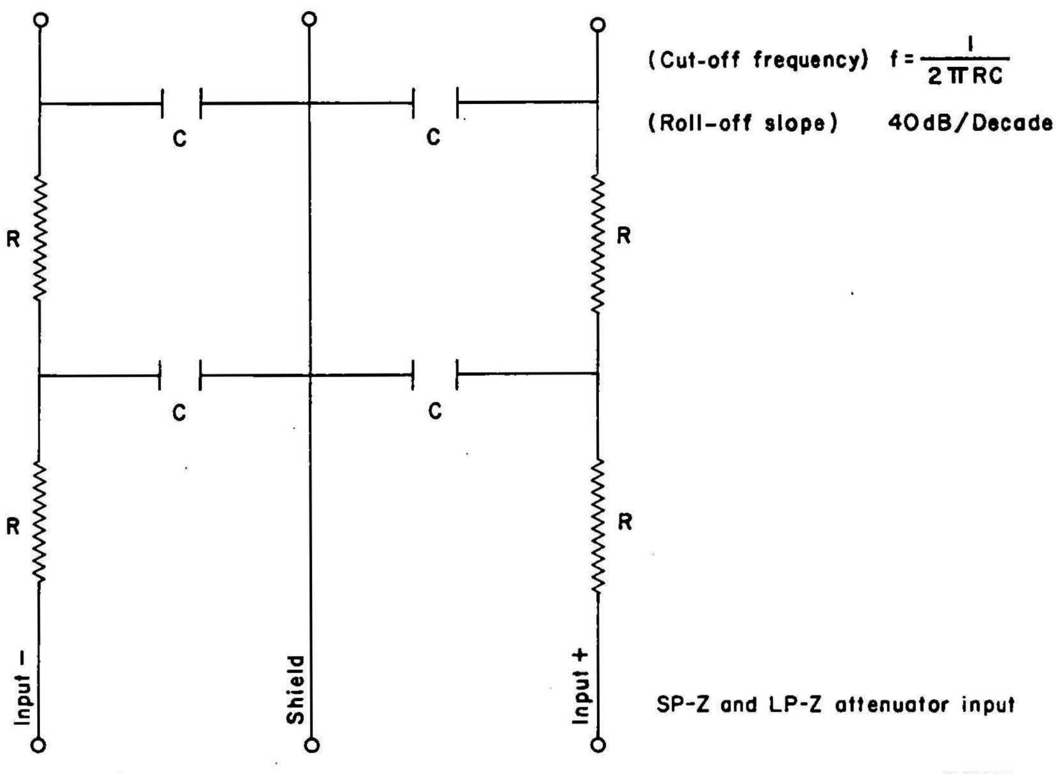


Fig. 5 Cascaded passive R.C. low pass filter

is installed.

The gains on all the TAM5 units were tested. The large variation in the gain and the extremely long time for the circuit to totally stabilise was surprising. The TAM5 amplifiers should have all been trimmed at the BMR to the same gain (ie. 120 dB flatout), and adjustments should now be made.

The Benioff seismometers mass positioning was checked monthly. Adjustments were made as required.

The positioning of the LPZ seismometer boom was very sensitive to atmospheric pressure changes and room temperature. When large low pressure systems passed to the north of the station the seismometer boom would bottom out.

A thermostatically controlled heating system was installed which held the temperature to 7°+/- 0.5°C.

There existed a temperature compensating servo control for the LPZ. It was not connected and literature concerning its function and and connection could not be found.

The seismometer boom centre was postioned three quarters of the distance up the operating range of the seismometer mass movement. The mass tended to bottom out so this was done to give it a greater working lower limit of movement.

The current pulse unit was not functioning when the author arrived. The unit was repaired and re-installed with new batteries.

Calibrations

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

Weight lift and frequency response tests were made in November and December 1983. Results are shown in Tables 15 and 16 and Figures 6 and 7.

The short period vertical seismograph (SPZ) was calibrated on December 15 1983. The calibration curve is similar to the one produced in 1981 with very little change to the magnification at the various TAM5 and AR320 settings.

The long period vertical seismograph (LPZ) was calibrated on November 30 1983. In 1982 a number of problems were experienced with calibration and interpretation of results of the tests. (Silberstein, 1984)

A similar procedure was followed and the following parameters were determined.

Natural free period (T) = 15.8 secs
Overshoot ratio (E) = 0.89
(No external damping was the normal 1983 mode)
Mechanical damping factor (hm) = 0.036
Critical Damping Resistance (CDR) = 1860 ohms

The full calibration procedure was performed with no external loading resistor (normal mode underdamped) and also with a loading resistor of 1.8 K (damped). The 1.8K resistor does not critically damp the seismometer. It is slightly underdamped. The calibration curves for both these states can be found in Figure 7.

From the calibration curve of the long period seismograph (no loading

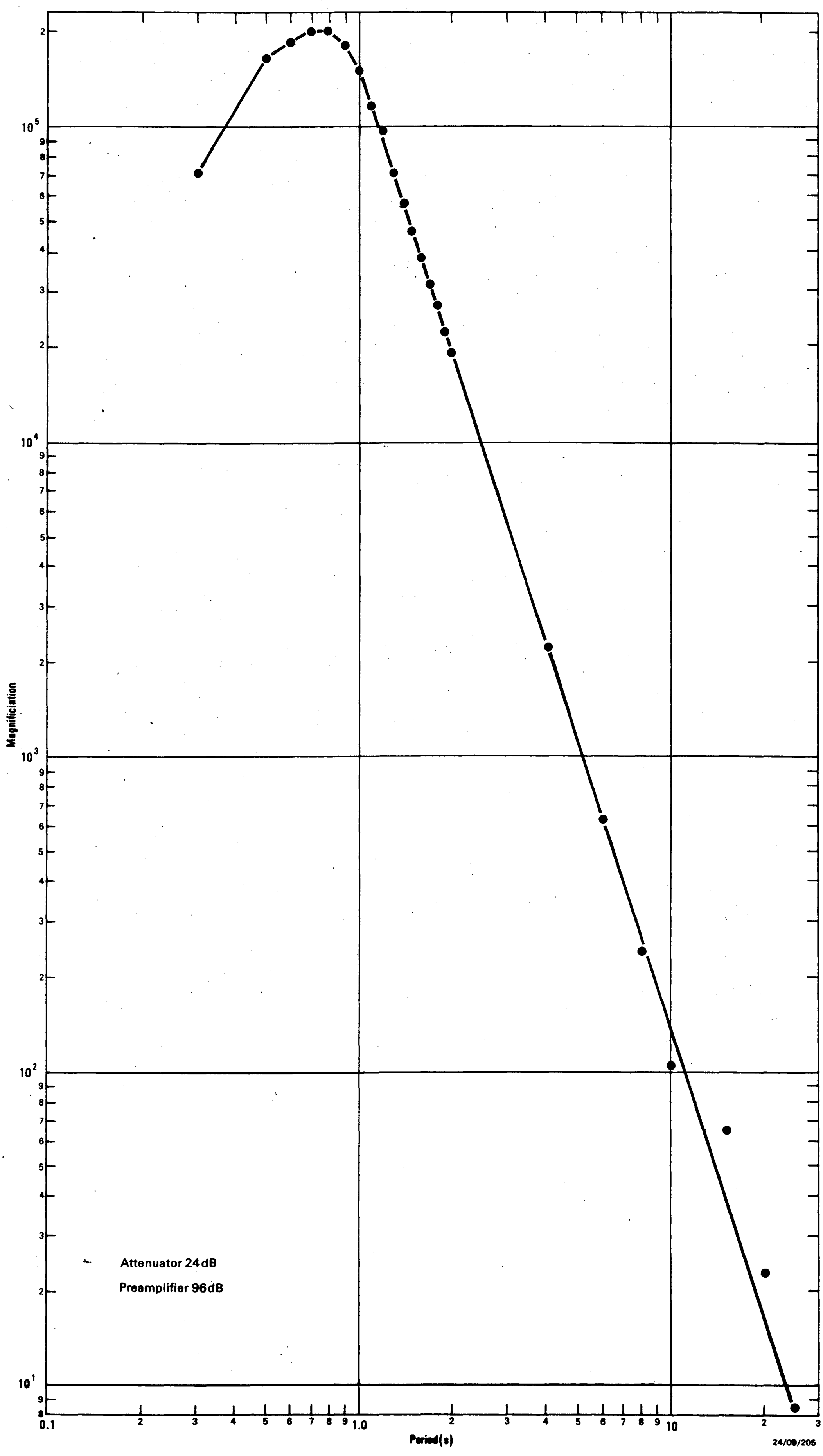


Fig. 6 Magnification curve: SP–Z seismograph, 1983

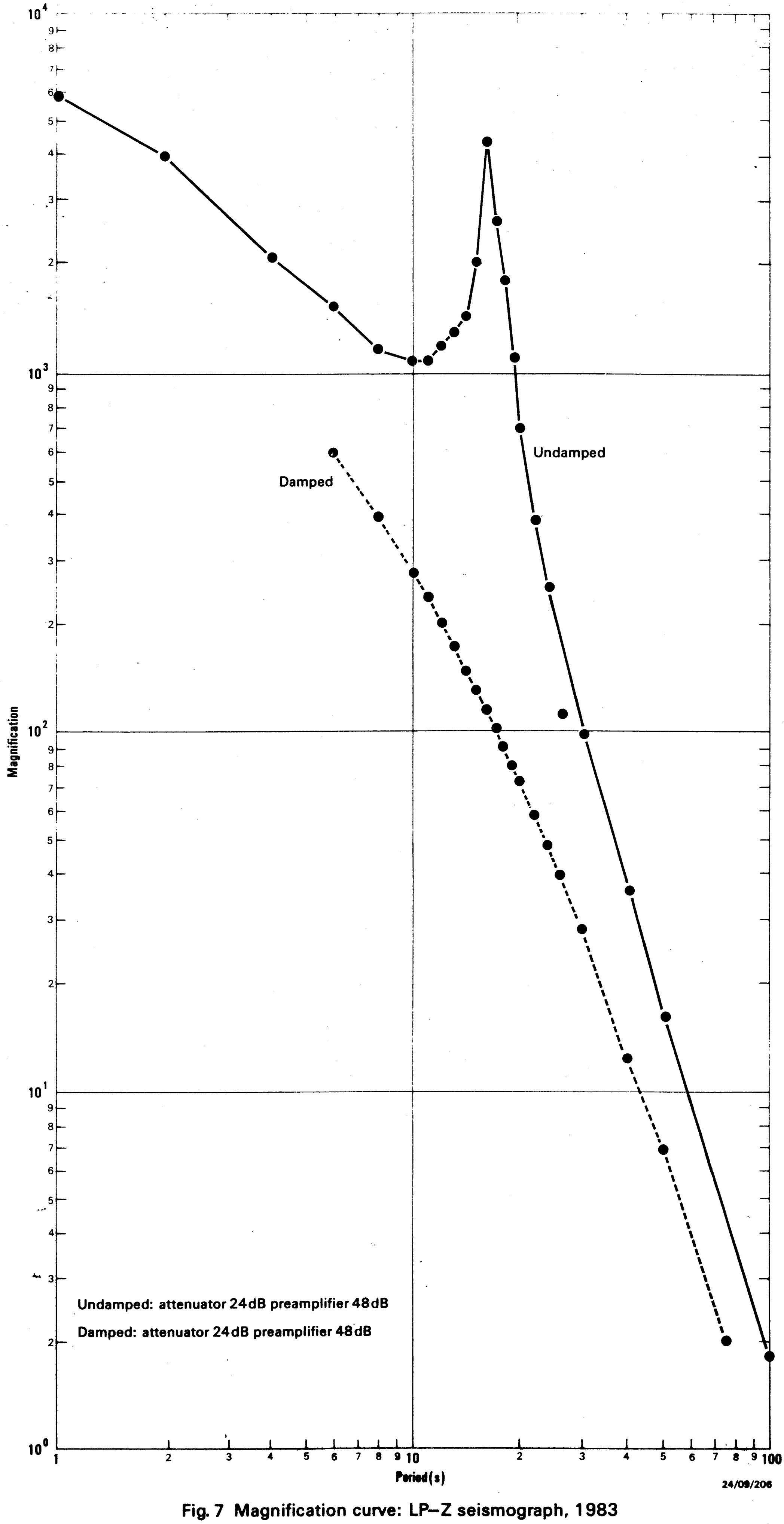


Fig. 7 Magnification curve: LP–Z seismograph, 1983

resistor) it can be seen that the seismometer is well underdamped (shown by the narrow peak surrounding the natural free period of the seismometer). The damped curve exhibited the shape expected and suggested that damping the seismometer was essential. After consultation with R. Smith (BMR Earthquake Seismology) on return to Australia, it was decided to damp the LPZ seismometer with a damping resistance of 1.8K.

Damping factor (ht) = 0.81
Overshoot ratio (E) = 0.067

The LPZ seismograph magnifications for both the damped and underdamped states are contained in Table 16.

The apparent rise in magnification below a period of 10 seconds is artificial because there is induction betwen the calibration coil and the recording coil. In fact both coils are wound around the same former so that they act as a transformer at high frequencies (low periods).

The horizontal seismograph systems (north-south and east-west) were to be calibrated during the change-over period before moving the seismometers to the cosray vault and connecting them to the helicorder heat pen system. The change over was shortened to two days and this task had to be deferred. The horizontal seismographs attenuator settings for 1983/84 are shown in Table 17. Calibrations carried out in 1981 (See Marks 1982) were used for amplitude determinations.

Data

P-phase arrival times were reported weekly to BMR Canberra Earthquake Seismology section and to all Antarctic stations. The data was relayed on to the US Geological Survey, National Earthquake Informaton Service, Denver Colorado.

S-phase and other phase arrival times, long period data and period and amplitude data were reported whenever possible.

A total of 716 events (not including local ice-quakes) were reported in the 14 months January 1983 to February 1984. Of these 582 events were detected in the 8 months May till December. During this period the sea-ice provided a damping environment to reduce sea wave noise thus allowing the gain of the recorders to be increased.

4. CONTROL EQUIPMENT

Power and timing equipment

Many modifications to the power and timing equipment occurred during 1983. The EMI clock (which also has an inbuilt 50 W inverter) was replaced by a G.E.D. observatories clock (no inverter capability) and two inverters; a D.C. Electronics 100 W inverter and an Advance Electronics 250 W inverter.

A new timing connection board and a PEM timing hour-mark relay box (6 channels available) were constructed. All timing was then obtained from the G.E.D. clock. The TMU was retained as a backup unit. New seismic amplifiers/attenuators (AR320) and new Helicorder heat-pens were installed.

Several wiring changes were made to the instrumentation in the rack in the science office. Some of the older instrumentation (TMU and Mercer relays) are removed to a new rack. These units were expected to be phased out in the near future. The new rack also contained the PEM recorders (2 HP Moseley 7100B chart recorders and a Leeds & Northrop back-up chart recorder).

Room on the old rack was allocated to the seismic recording system upgrade to 4-channel helicorder recording (2-channels per helicorder). A system diagram of the power, signal and timing layout is contained in Figure 8. Power and timing circuitry is in a poor state. (see Silberstein, 1984).

There are a number of deficiencies in the emergency power and timing circuitry. On power failure the PPT-1 power distribution panel switches to secondary power (station mains) which has a significant voltage difference compared to inverter power. The helicorder heat pens do not function after power change over as they are very sensitive to the voltage of the power signal.

Timing mode switching does not function as expected. Fortunately two clocks were available (EMI/GED) so it was not necessary to use a chronometer when the timing failed. Both chronometers fail to keep time to a sufficient accuracy to be used as secondary timing units. Servicing of these units is long overdue.

The two inverters are not compatible. (see Inverters; this section). The Boss charger does not deliver enough current to drive the whole system. (8 amps maximum output). The system requires a new inverter (approximately 500 W) and a charger that will deliver up to 20 amps at 24V and which can be switched to cycle the battery bank on a monthly or bi-monthly basis.

The cabling from the science office to the various huts and the wiring and layout of connections and service boards in the instrument rack are in a state of disarray.

The relocation of both the magnetic and seismic systems provides an ideal opportunity to rewire the instrument racks and construct proper power boards and data (external signal) connection boards, most suitably positioned on the walls behind the instrument racks. The power and timing panel (PPT-1) should be removed and a redesigned version installed.

The battery bank was moved from the geophysics workshop to the darkroom. (see Figure 9) The darkroom has an exhaust fan and the door is usually open. Acid fumes were not a problem. This small room was considered the best location as photographic recording is being termined in 1984. The two inverters were also installed in the darkroom. All cells (12V and 6V) were replaced during the course of the year.

<u>Time-mark programming unit (TMU-1)</u>

The unit experienced a number of problems during the year. Firstly when the load on the 12V supply system was increased by introducing new instrumentation, the TMU failed due to low input power voltage. This problem was intermittent and varied according to battery charger setting. The increased current demand caused a large voltage drop between the battery and power distribution panel (PPT-1). The wiring was upgraded which solved the problem. The two recurring problems experienced in 1982 (see Silberstein, in prep) continued during 1983.

The static build-up problem caused by dry blowing snow and strong winds in blizzards was tackled with little success. The units chassis was connected to the science building structure which was considered as providing the best earth provided that the cladding panels were interconnected. No improvement was obtained.

The UAP section (Antarctic Division) have found over the years that blizz static is indeed a complicated and frustrating problem. In 1983 they experimented with an earth grid consisting of many bore holes with pipes in a

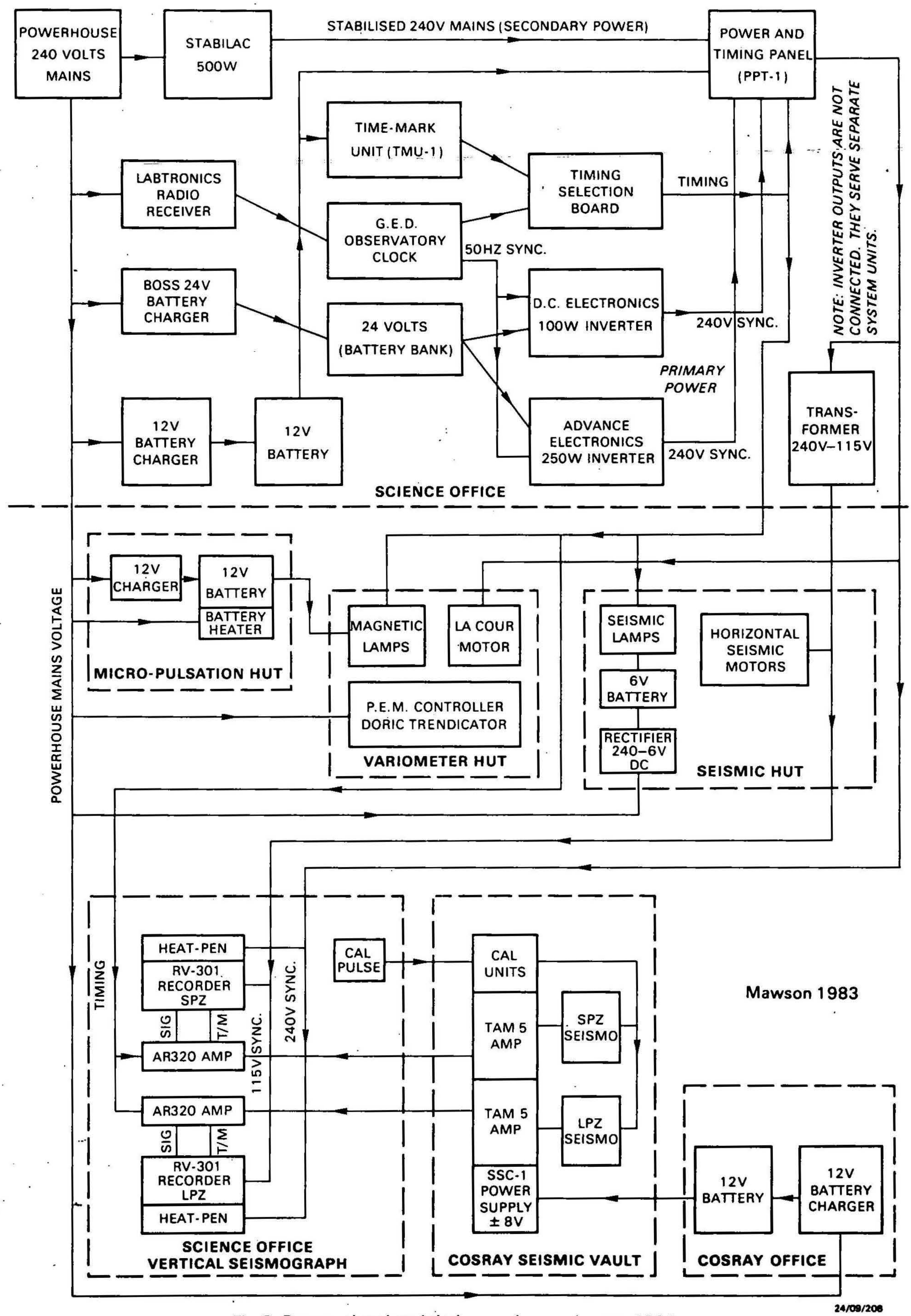


Fig. 8 Power, signal and timing equipment layout, 1983

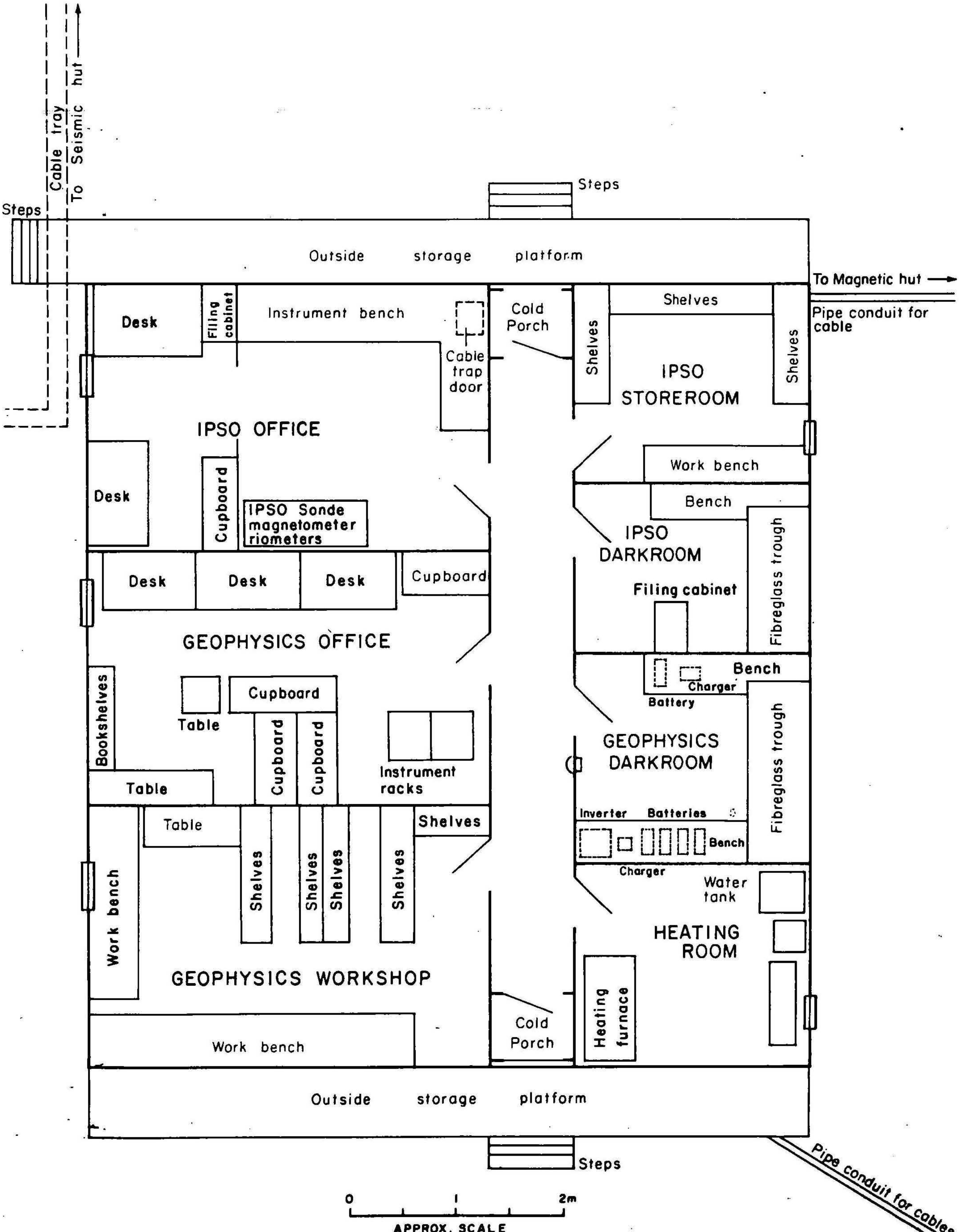


Fig. 9 Layout of science block, 1983

24/09/8-1

salt solution. Considerable success was claimed by the physicist. This grid should be investigated for joint use by BMR and IPS in the science building.

EMI Clock

Upon the authors arrival, the EMI clock provided time mark pulses and 50Hz synchronous 240V (50 watt) power for all systems.

In August the clock fan seized and the unit overheated and experienced major circuitry failure. The clock failure caused the DC electronics inverter to malfunction. (see inverters, this section).

There had been some major modifications to the EMI circuitry in previous years. The clock was rebuilt and modified slightly due to lack of available spares. The rate of the clock was difficult to stabilise after the rebuild, the amount of drift being room temperature dependent. An external fan was installed to cool the circuitry.

The clock was retained as a secondary timing source and returned to Australia with the author.

GED Clock

The GED clock became the primary timing source upon failure of the EMI clock. Difficulty had been experienced with obtaining 5MHz from the crystal. The maximum obtainable frequency with full adjustment was 4999300 Hz.

The crystal oven was dismantled and it was found that the crystal had been getting very hot. There were burn marks on the card and the crystal shield was badly discoloured. Component C1 on the board (trimming capacitor in series with crystal) was a 68 PF capacitor and not a 39 PF capacitor as in the circuit diagram. A 39 pF capacitor was inserted and with minor frequency adjustment the 5 MHz crystal frequency was obtained.

Synchronising the clock with the radio time signal was found to be more difficult than with the EMI clock. A modification had been made to the clock signal input to improve performance. A monostable had been inserted to disable the clock input for 900ms after a radio pulse had been inserted. Thus just after the circuit is enabled the next radio pulse occurs. This modification was not a significant improvement. The reason for this is that the clock inverter transmits large amounts of noise into the clock mainframe. These random noise spikes disturb the 1 second pulse input into the clock. Other modifications have been tried to improve the situation:-

(a) inserting opto-isolators,
(b) relocating the power supply from the mother-board, and
(c) shielding the inverter.

The problem still remains and further development work is required.

Inverters

Two inverters were used in 1983 to power separate systems.

(a) D.C. Electronics (100W)
(b) Advance Electronics (250W)

The D.C. electronics inverter failed when the EMI clock overheated. The inverter synchronising input provided by the clock probably went to a DC level (upon clock failure) which caused the inverter to lock in one state (no chopping within the inverter). The inverter tried to draw a massive current from the 24V supply and melted the cables to the battery terminals. There was no fuse on the input power to the inverter, an obvious design fault.

The two inverters were not compatible. The 50Hz frequency sync input impedence of each unit was:-

(a) D.C. Electronics (12 K)
(b) Advance Electronics (245)

The voltage of the GED clock synchronising output was 12V peak to peak. When this output was loaded by the Advance Electronics inverter the on load output voltage was 3.73 V peak to peak. This was sufficient to enable the inverter to synchronise; the specifications listed the requirement as 4Vpeak to peak. With the two inverters on line, buffer amplifiers were required to boost the voltage and isolate the units.

<u>Time signals and antennae</u>

Radio time signals were received from VNG, Lyndhurst Victoria, Australia and from WWVH, Hawaii and WWV, California, USA.

Propogation times for these signals, provided by the Ionospheric Prediction Service were: VNG -22 ms, WWVH Hawaii -50 ms, and WWV California -60 ms.

The VNG signal was used on most days for correction of the G.E.D. clock. The WWV signals have a more complex tone and tend to more frequently give spurious correction readouts on the clock comparator than the VNG signals.

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

The dipole antenna erected in 1977 blew down in a blizzard in August. The support poles were too fatigued to be used again. A 200 metre long wire Ionospheric Prediction Service (IPS) antenna (which at the time, was not being used) was used to replace our antenna and greatly improved the signal. This antenna was not oriented in the optimum direction and it was to be used for IPS work in 1984. This antenna was broken by the jib of a passing crane in December 1983. The broken wires were joined and the antenna was re- erected.

It would be advantageous to construct and test an antenna system in our workshops and send it to Mawson. A trap dipole antenna tuned to the following frequencies: 7.5 MHZ VNG, 10.0 MHZ WWV, 12.0 MHZ VNG, and 15.0 MHZ WWV; could be aligned in the optimal direction which in fact is in line with the katabatic wind direction. This idea has merit and requires further investigation because of the difficulty in obtaining good radio signals in Antarctica.

<u>Cables</u>

The Mawson No. 3 site plan (August 1984) which illustrates the building and cableway locations is shown in Figure 10. This drawing shows the new science to cosray cable route (installed by Crosthwaite in March 1984) and the proposed science to new variometer hut cable routes. The old cable routes are illustrated in Figure 3 (Wake-Dyster, 1981).

Sections of the old science to cosray cable line, which runs a torturous path through the old camp area, contain six-core shielded PVC covered cable (at least 200 metres) which can be reused.

The link from science to the seismic hut is 7-core pyrotenax which is in

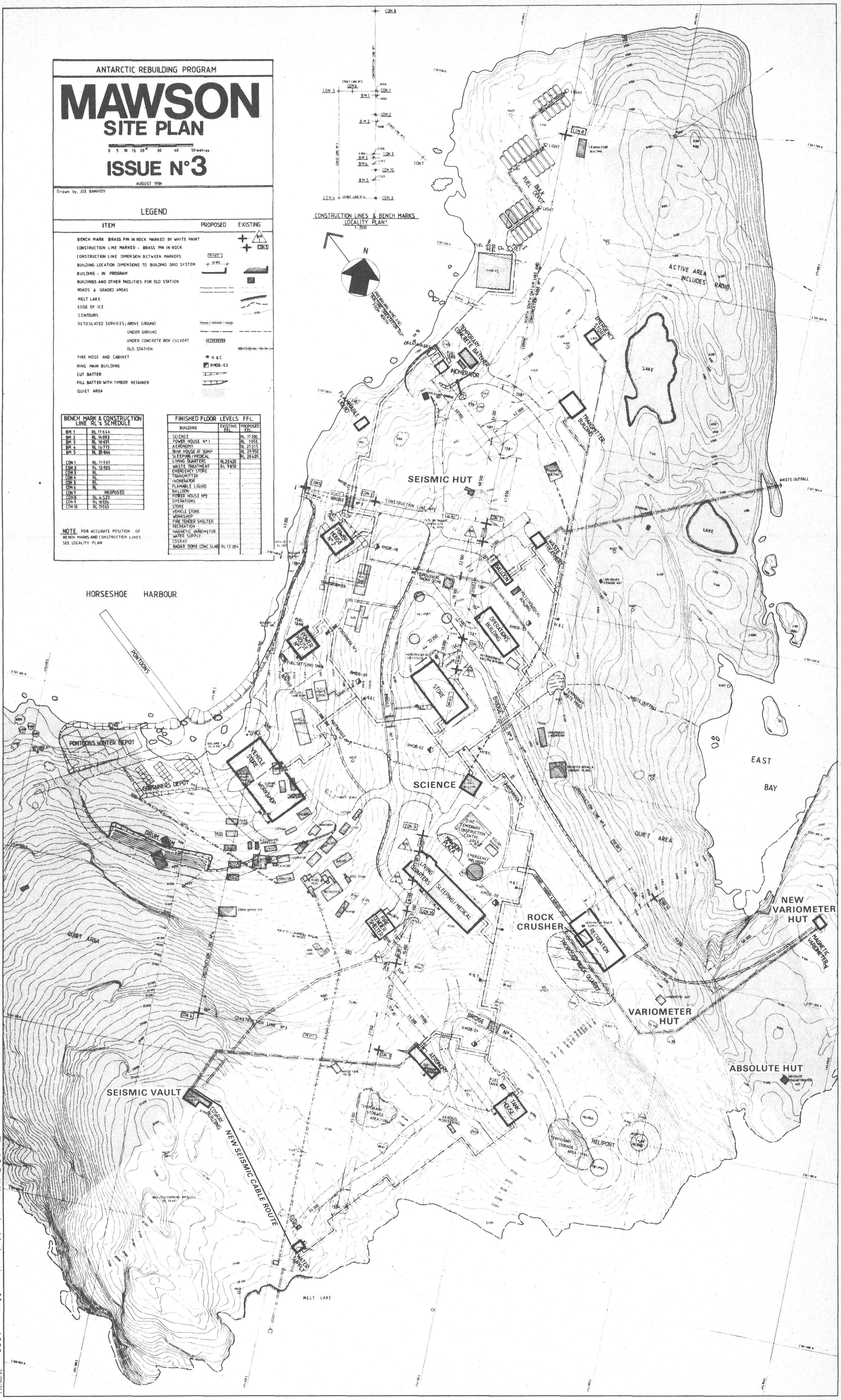


Fig. 10 Building and cable locations, Mawson 1983

good condition apart from one section where it has been crushed many times by vehicle tyres and tracks. This cable can also be reused.

Three cables were cut during the 1983/84 summmer rebuilding program by vehicular traffic. The major causes were lack of care and suicidal driving technique over the rough granite areas surrounding the station.

5. FIELD MAGNETIC OBSERVATIONS

Magnetic observations were made at two sites west of Mawson during a field trip to Taylor Rookery (near Taylor Glacier) and Cape Bruce (AAT proclamation site). The sites were at Oldham Island, 53 km west of Mawson, and near Campbell Head, 120 km west of Mawson. Data and station descriptions are in Appendix 2.

6. BUILDING MAINTENANCE

One of the first tasks that was commenced upon arrival at Mawson was the cleaning and reorganising of the BMR Geophysics rooms in the science building. A large amount of old junk was dumped and other items of value but no longer used, were stacked in boxes ready for return to Australia.

Shelves were constructed in the workroom and darkroom and the geophysics office chart storage bench was restored and modified. The geophysics office was extensively reorganised. A diagram of the layout of the science office can be found in Figure 9. A small workbench on wheels was constructed for use in front of the instrument racks when modification work was being undertaken.

Guy wires to our buildings (seismic, variometer and absolute huts) were tightened soon after my arrival and remained secure through the year. The geophysics huts required little maintenance during the year. Cartridge gun commercial sealant was used to plug air graps in building walls. Drift snow also came into the buildings via the skirting on the piers. Tears were repaired and seals improved.

The three huts are in reasonable structural condition considering that they have been continually buffeted by strong winds for thirty years. The seismic vault in the base of the cosray shaft was completely concreted in preparation for the installation of the horizontal seismometers in 1984.

7. OTHER DUTIES

During the year the normal routine station duties were performed. These included kitchen duties, night watch, Saturday afternoon station projects, rubbish runs and brewing and bottling home brew beer.

Occasionally a helping hand was given in labour intensive construction projects such as concrete pouring, building frame construction and building relocations.

The author assisted the Ionospheric Prediction Service (IPS) and the Bureau of Meteorology personnel in performing their daily routines while they were away from the station. Two months before the flyoff voyage, the IPS physicist broke his writing arm in a recreation vehicle accident. The author assisted him until his replacement arrived, (replacement arrived two months early on the flyoff) and then due to the six hour changeover,assisted in the training and orientation of the new physicist.

The author was also the station photographer. This was a thankless position which required an excessively large part of the author's spare time both in running around the station obtaining a comprehensive portfolio of the year's events, and also in the darkroom developing the station's and other expeditioner's film.

The darkrooms were completely refurbished in the early part of the year. New benches and shelves were constructed, the floors were covered with cement slabs, cracks in the walls and ceiling were repaired to stop dust from entering the rooms, an extra drying cabinet and drying racks were built, and all the rooms were completely painted.

8. ACKNOWLEDGEMENTS

The author wishes to express his thanks to the Mawson 1983 wintering party for their assistance and cooperation.

In particular, special thanks are due to Zain Rahmat and Vic Kitney for performing the daily routine work while the author was absent from the station. Thanks also to Ron Webb (station electrician) for his help with new cabling and rewiring, and to Alan Silson (station carpenter) for his help with the new shelving and restoration of furniture in the geophysics office.

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APPENDIX 1
History of Instrumentation up to 1984

A brief summary of the development of Mawson Geophysical Observatory in terms of instrumentation until 1983/84 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).
Jan 1968	: Elsec 592 proton - precession magnetometer used for absolute measurements. (Smith, 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. (Hill, 1978).
Mar 1981	: MNS2 proton precession magnetometer installed for absolute measurements. (Marks, 1982).
Aug 1982	: Sensitive recorder removed. (Silberstein, 1984).
Jul 1983	: Photo electric magnetometer (PEM) X and Y components installed.
Jul 1983	: MNS2/1 Proton precession magnetometer ceased operation.

(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).

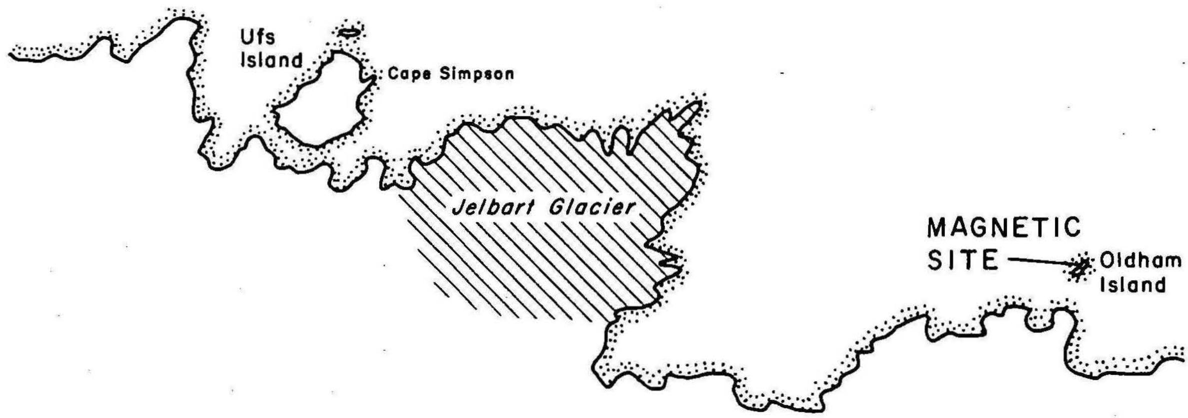
Feb 1963	:	BMR recorder replaced by Benioff 60 mm/min three-channel recorder. 14 s free period horizontal galvanometers installed (Black, 1965).
Sep 1970	:	14 s free period horizontal galvanometers replaced by short period (o.2 s) galvanometers (Robertson, 1972).
Dec 1973	:	Z seismometer transferred to vault beneath Cosray building (Almond, 1975).
Apr 1977	:	Transfer of Geophysics office, including power and timing to Wombat (Science Block).
1978	:	Recording of SP-N Benioff seismometer discontinued (Petkovic in prep.).
Mar 1978	:	Press-Ewing (LPZ) long period vertical seismometer installed. (Petkovic, in prep)
Jul 1981	:	Helicorder hot-pen recorder installed for SP-Z and LP-Z; and SP-N Benioff restored. (Marks, 1982).
Mar 1983	:	Vault beneath cosray building fully concreted in readiness for movement of SP-N and SP-E. Thermostatically controlled heating introduced to stabilise LPZ.
Aug 1983	:	Four Teledyne-Geotech seismic amplifiers (AR320) installed, for connection to two twin Heat-pen recorders.

APPENDIX 2
FIELD MAGNETIC OBSERVATIONS

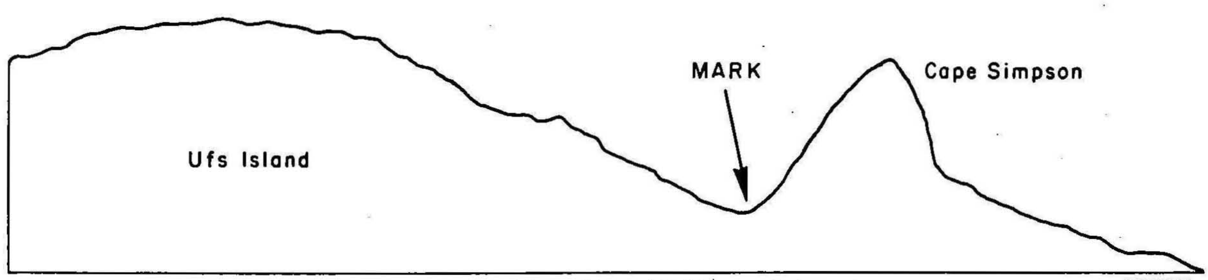
Place	Date	Latitude ° ' "	Longitude ° ' "	UT	D ° '	UT	H nT	UT	Z nT
Oldham I	28-11-83	67 31 20	61 34 20	0849	-64 46.5*	0856	17890		
				0901	-64 42.0*	0925	17837		
				0920	-64 41.0*				
				0931	-64 42.0*				
Azimuth mark - Dip between Uffs I. and Cape Simpson						Azimuth	279°57' 30"		
Campbell Head	14-11-83	67 25 10	60 49 13	1055	197 12.8+	1104	18992	1146	-45974
				1111	197 14.6+	1214	19064	1154	-45956
				1209	197 06.0+				
				1220	197 04.8+				
Azimuth mark - Peak of island to the east					Azimuth ~ 100°degrees				

* values of D have a correction of -1°15.0' applied for QHM 302
+ no sunshots were possible. These are the angle of declination from the mark.

MAP: Division of National Mapping sheets SQ40-41/15 and part SR40-41/3
MAWSON and MT TWINTOP MAC.ROBERTSON LAND

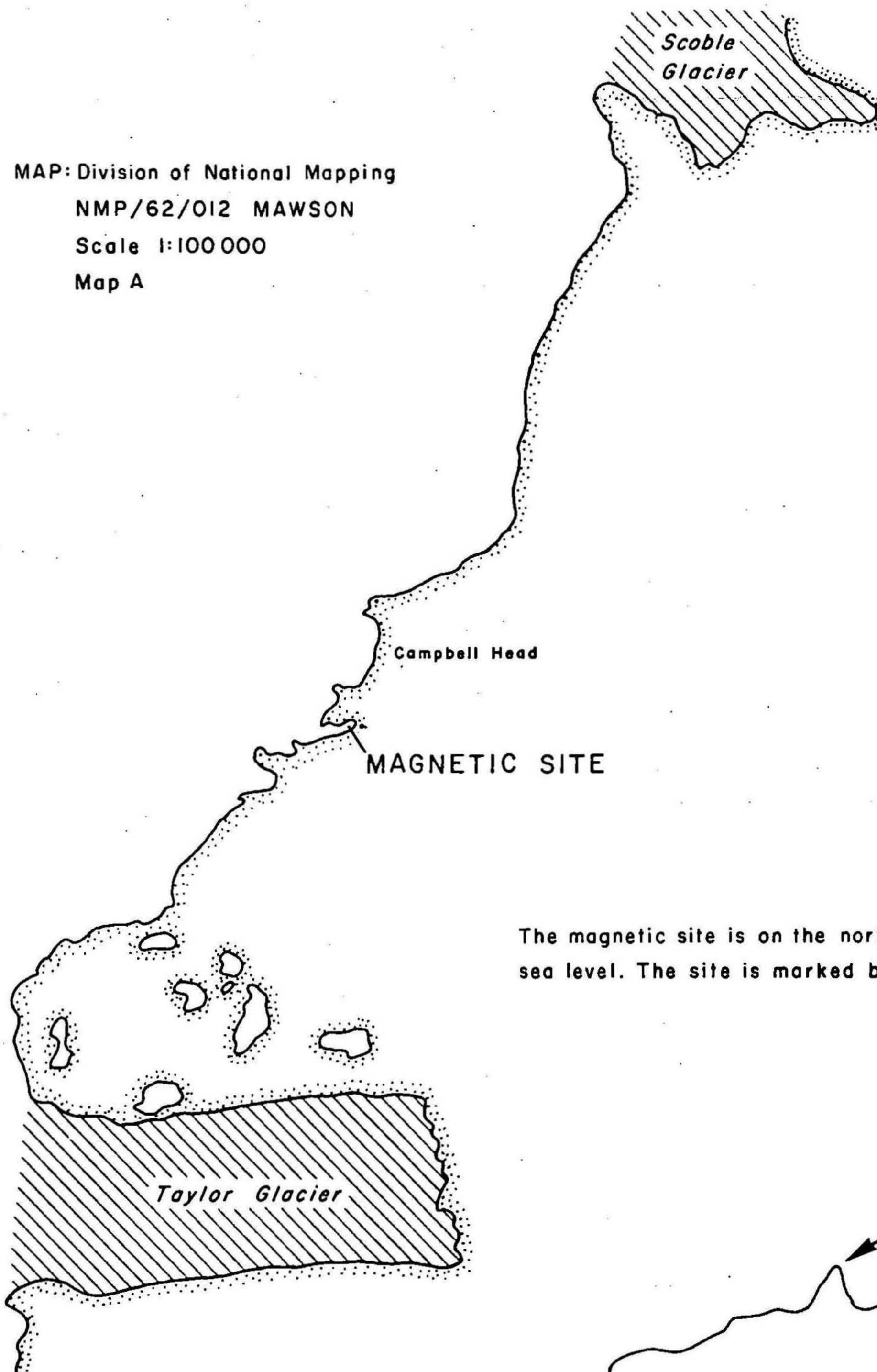


The magnetic site is on the western side of the island on a flat area 10 metres above sea level. The site is marked by a cairn.

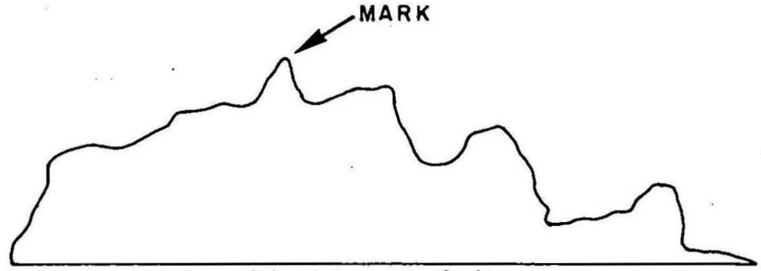


Magnetic site, Oldham Island

MAP: Division of National Mapping
NMP/62/012 MAWSON
Scale 1:100 000
Map A



The magnetic site is on the north face of the hill, 15 metres above sea level. The site is marked by a cairn.



Island to east of site

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Magnetic site near Campbell Head

TABLE 1
STATION DATA FOR MAWSON 1983

	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
MAGNETOMETER INTERCOMPARISONS 1983/84

Date	Instrument A	Instrument B	Difference (A-B)at H=18450 nT
1984 Feb 19/23	QHM174	QHM300	35nT = 0.0019H
1984 Feb 19/23*	HTM570704	QHM300	3nT = 0.00016H
1984 Feb 19/23	ASK640505	ASK580332	-0.9'
Through routine baseline determinations Feb 1983-Feb 1984			
	QHM300	QHM301	1.6nT
	QHM300	QHM302	-5.4nT

*The results quoted are averages. They are considered unsatisfactory due to inconsistent results producing large error ranges. These intercomparison results should be discarded.
Values are at standard temperature (0°C) with no instrument corrections applied.

TABLE 3
PRELIMINARY INSTRUMENT CORRECTIONS 1983

INSTRUMENT	CORRECTION AT H=18485nT	CORRECTION
QHM300	-5nT	-0.00027H
QHM301	-1nT	-0.000054H
ASKANIA DEC580332	0	-
MNS2/1	-1nT	-
BMZ 62	+6nT	-

TABLE 4
OBSERVED BASELINE VALUES
NORMAL MAGNETOGRAPH 1983

Date	UT h	UT m	Baseline Value	+/-	Remarks
Declination			BD(W)		
Jan 01	00	00	61°45.4'	0.8'	
Mar 31	08	00	61°42.0'	1	Pendulum clock removed
Horizontal intensity			BHs nT		
Jan 01	00	00	17404	5	
Mar 31	08	00	17415	3	Pendulum clock removed
May 18	00	00	17426	4	PEM installation
Vertical intensity			BZs* nT		
Jan 01	00	00	46432	3	
Feb 20	00	00	46427	4	
Feb 28	00	00	46423	3	
Mar 05	00	00	46418	3	
Mar 10	00	00	46413	4	
May 01	00	00	46418	5	
Jun 01	00	00	46423	4	
Jun 24	00	00	46428	3	
Jul 12	00	00	46423	3	
Jul 18	00	00	46418	3	
Jul 24	00	00	46413	3	
Jul 31	00	00	46408	3	
Aug 06	00	00	46403	3	
Aug 12	00	00	46398	3	
Aug 18	00	00	46393	3	
Aug 23	00	00	46398	3	
Sep 01	00	00	46403	4	
Sep 10	00	00	46408	4	
Sep 20	00	00	46413	4	
Sep 29	00	00	46418	4	
Oct 09	00	00	46423	4	
Oct 18	00	00	46428	4	
Oct 28	09	00	46411	4	Blast at rock crusher site

*Between Jan 01 to Jun 03 BZs derived from H and F (PPM MNS2.1)

TABLE 5
SCALE VALUE CURRENTS

Component	MC01 Calibrator Setting	DMM Current (mA)
H	60	59.9
D	40	39.9
Z	70	69.9

TABLE 6
QHM THERMOMETER COMPARISON

Temperatures(°C) QHM thermometers 300	301	302	Differences 301-300	302-300
-1.60	-1.16	-1.84	0.44	-0.24
17.28	17.84	17.36	0.56	0.08
1.64	2.20	1.52	0.56	-0.08
10.96	11.44	10.76	0.48	-0.20
5.76	6.48	5.84	0.72	0.08
1.52	1.92	2.60	0.40	0.08
5.24	5.80	5.08	0.56	-0.16
4.76	5.40	4.76	0.64	0.00
11.20	11.74	11.04	0.54	-0.16
-6.16	-5.80	-6.88	0.64	-0.72
-6.18	-5.64	-6.28	0.54	0.10
3.60	4.04	3.28	0.44	-0.32
9.96	10.12	9.56	0.16	-0.30
0.48	1.00	0.32	0.52	-0.16
11.88	12.24	11.52	0.36	-0.36
10.36	10.56	9.84	0.20	-0.52
9.64	10.16	9.28	0.52	-0.36
5.20	5.56	4.92	0.36	-0.28
11.28	11.92	11.20	0.64	-0.08
11.64	11.96	11.52	0.32	-0.12
	Average differences		0.48	-0.16

TABLE 7
MAGNETOGRAPH PARAMETERS

Component	Scale Value Preliminary	Adopted	Standard Deviation	Scale Value Temperature °C/mm
H	21.2	21.3	0.1 nT	2.47
D	2.44	2.44	0.02 min	-
Z	22.8	22.8	0.1 nT	1.73

D scale values are in minutes/mm
H and Z scale values are in nT/mm

TABLE 8
THERMOGRAPH PARAMETERS 1983/84

Date FROM	TO	OBSERVED TEMP SCALE VALUE (St) °C/mm	ADOPTED TEMP SCALE VALUE (St) °C/mm	BASELINE TEMPERATURE (Bt)°C
Z THERMOGRAPH				
1/1/83	31/2/83	1.73	1.73	-87.0
1/3/83	31/8/83	1.73	1.73	-87.4
1/9/83	2/10/83	1.73	1.73	-87.2
3/10/83	31/11/83	1.89	1.73	-85.6
1/12/83	15/12/83	1.89	1.73	-85.4
16/12/83	24/12/83	1.72	1.73	-84.0
25/12/83	31/2/84	1.72	1.73	-83.6
H THERMOGRAPH				
1/1/83	31/2/84	2.47	2.47	-38.3

TABLE 9
MAGNETOGRAPH SCALE VALUE AND ORIENTATION COIL CONSTANTS

COMPONENT	SCALE VALUE CONSTANT nT Ma-1	ORIENTATION CONSTANT nT mA-1
H	8.07	8.07
D	8.07	8.07
Z	7.49	-

TABLE 10
ORIENTATION TESTS; APPLIED COIL CURRENTS

COMPONENT	SOURCE	CURRENT (mA)	SWITCH POSITION	FIELD PRODUCED
H	Manual	300	H2+	E
D	Manual	300	D2+	N
Z	Deflector magnet (M = 491.4 nTm-3 Sept 1977)			

TABLE 11
ORIENTATION OF VARIOMETER MAGNETS

DATE	COMPONENT	REFERENCE FIELD	EX-ORIENTATION MAGNET N POLE		REMARKS
Jan 1983	H	18455 nT	E	0.8°S	
Jan 1984	H	18450 nT	E	0.8°S	
Jan 1983	D	63°22.3'West	N	0.3°W	
Jan 1984	D	63°28.0'West	N	0.3°W	
Jan 1983	Z	-46519nT	N	0.9°D	
Jan 1984	Z	-46445nT	N	4.1°D	Doubtful

TABLE 12
PRELIMINARY MEAN MONTHLY AND K-INDEX VALUES 1983/84

MONTH	D ° '	H nT	Z nT	F nT	K
January	63 22.7W	18455	-46519	50046	3.9
February	19.8	18449	-46544	50067	4.3
March	26.0	18424	-46552	50065	4.1
April	27.8	18406	-46578	50083	4.6
May	26.6	18437	-46531	50051	3.7
June	26.8	18442	-46514	50037	3.4
July	27.7	18436	-46491	50013	3.6
August	28.2	18439	-46472	49996	3.5
September	28.5	18436	-46476	49999	3.6
October	29.0	18440	-46464	49989	3.8
November	28.7	18449	-46451	49981	4.2
December	28.0	18451	-46445	49976	4.0
January	29.7	18437	-46426	49953	3.8
February	29.2	18445	-46438	49967	3.9
Mean 1983	63 26.6	18439	-46503	50025	3.9

TABLE 13
GEOMAGNETIC ANNUAL MEAN VALUES, 1973-1983

Date	D °	D '	I °	I '	H nT	X nT	Y nT	Z nT	F nT
1973	-62	17.6	-58	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	18425	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	14.6	-68	27.1	18443	8303	-16467	-46705	50215
1982	-63	21.2	-68	25.5	18433	8267	-16475	-46616	50128
1983	-63	26.6	-68	22.3	18439	8245	-16493	-46503	50025
Mean annual changes									
1973-1983		-6.9		2.7	4.8	-30.6	-21.2	98.3	-89.8
1973-1978		-6.9		2.8	6.0	-29.8	-22.2	100.0	-91.0
1978-1983		-6.9		2.6	3.0	-31.4	-20.2	96.6	-88.6

TABLE 14
SEISMOGRAPH PARAMETERS

Component	SP-Z	SP-N	SP-E	LP-Z
Seismometer				
Type	Benioff	Benioff	Benioff	Press-Ewing
Free period(s)	1.0	1.0	1.0	15.8
Galvanometer				
Type	-	Geotech	Lehner-Griffith	-
Free period(s)		0.2	0.2	
Power Supply	PP2	-	-	PP2
Preamplifier				
Type	TAM5	-	-	TAM5
Gain setting	96dB	-	-	48dB
Attenuator setting	OdB	-	-	OdB
Bandpass filter	0.1-10Hz	-	-	.01-.2Hz
Recorder Amplifier				
Type	Geotech.	-	-	Geotech
Model	AR-320			AR-320
Attenuator setting				
Nominal (dB)	24	6	6	24
Actual	see seismograms	(see Table 17)	(see Table 17)	see seismograms
Recorder				
Type	Geotech.	Benioff	Benioff	Geotech.
Model	RV-301	Photographic	Photographic	RV-301
Chart Rate	60mm/min	60mm/min	60mm/min	15mm/min
Calibrator				
Motor Constant(N/A)	1.55	1.27	1.25	0.20
Coil Resistance(ohm)	247	249	258	3300
System				
Damping	8:1	8:1	8:1	28:1(1983) 1.2:1(1984)
Magnification	150K	25.5K	21.8K	712
Nominal(period)	(1s)	(1s)	(1s)	(20s)
Peak(Period)	201K(0.8)	157K (0.2)	49K(0.5)	4.2K(16)
Mass (kg)	107.5	107.5	107.5	11.2#
Polarity	up-up	South-up	East-up	up-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 = 11.2kg
Distance of centre of gravity of boom from pivot = 0.3081m
Distance of centre line of masses from pivot weight lift point = 0.03564m

TABLE 15

VERTICAL SHORT-PERIOD SEISMOGRAPH MAGNIFICATIONS

TAM5 AMPLIFIER SETTING = 96dB AR320 ATTENUATOR SETTING = 24dB

PERIOD T (SEC)	MANIFICATION	PERIOD T (SEC)	MAGNIFICATION
0.3	71.1K	1.6	38.3K
0.5	167K	1.7	31.3K
0.6	180K	1.8	26.8K
0.7	209K	1.9	22.5K
0.8	209K	2.0	19.3K
0.9	183K	4.0	2.26K
1.0	150K	6.0	628
1.1	117K	8.0	239
1.2	97.7K	10.0	104
1.3	72.0K	15.0	64.4
1.4	58.0K	20.0	28.8
1.5	46.8K	25.0	8.46

The amplifier and attenuator settings for the SPZ seismograph are marked on the seismograms. Magnifications relative to the 96/24dB setting are listed below.

AMPLIFIER SETTING	SPZ MAGNIFICATION	ATTENUATOR SETTING	SPZ MAGNIFICATION
84dB	0.26	36dB	0.25
90dB	0.51	30dB	0.51
96dB	1.00	24dB	1.00
102dB	2.08	18dB	1.96
		12dB	3.82

TABLE 16
VERTICAL LONG-PERIOD SEISMOGRAPH MAGNIFICATIONS

TAM5 AMPILIFIER SETTING = 48dB AR320 ATTENUATOR SETTING = 24dB

PERIOD T (SEC)	MAGNIFICATION (Undamped)	MAGNIFICATION (Damped by 1K resistor)
1.0	5.91K	
2.0	3.94K	
4.0	2.11K	
6.0	1.52K	596
8.0	1.17K	397
10.0	1.08K	277
11.0	1.08K	236
12.0	1.20K	201
13.0	1.31K	173
14.0	1.44K	148
15.0	2.01K	131
16.0	4.19K	115
17.0	2.16K	102
18.0	1.80K	90.5
19.0	1.11K	81.0
20.0	712	72.6
22.0	392	58.8
24.0	255	48.3
26.0	113	40.0
30.0	98.7	28.1
40.0	36.2	13.0
50.0	16.1	6.88
75.0		2.01
100.0	1.79	0.767

TAM5 AMPLIFIER SETTING = 48dB
AR320 ATTENUATOR SETTING = 24dB

The amplifier and attenuator settings for the LPZ seismograph are marked on the seismograms. Magnifications relative to the 48/24dB setting are listed below.

AMPLIFIER SETTING	LPZ MAGNIFICATION	ATTENUATOR SETTING	LPZ MAGNIFICATION
48dB	1.00	36dB	0.29
54dB	1.88	30dB	0.53
60dB	3.48	24dB	1.00
		18dB	1.84

TABLE 17
HORIZONTAL SEISMOGRAPH ATTENUATOR SETTING 1983

DATE	COMMON ATTENUATOR (SYSTEM) dB	GALVANOMETER CONTROL BOX ATTENUATOR SP-EW	SP-NS
Jan 01	6	8	8
Jan 07	6	10	10
Jan 09	6	8	8
Jan 16	6	7	7
Jan 19	6	8	8
Jan 27	6	6	6
Jan 28	6	8	8
Feb 04	6	8	9
Mar 08	6	8	8
Mar 23	6	7	7
Apr 10	6	6	6
May 12	6	4	4
Jun 20	6	2	2
Aug 11	6	2	2
Nov 16	6	2	2
Dec 27	6	4	4