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Record 1978/115

MAWSON GEOPHYSICAL OBSERVATORY
ANNUAL REPORT 1972

by

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SUMMARY

Geomagnetic and seismological observatories were maintained at Mawson, Antarctica, during 1972. The main instruments were La Cour normal and sensitive magnetographs and a three-component Benioff seismograph.

The magnetograph rectifier and the heating system for the variometer hut were redesigned, and a new seismic vault 12 metres underground was prepared for occupation.

Regional magnetic observations were carried out at Davis in February 1972, and at Traverse Island in the William Scoresby Archipelago in August 1972.

1. INTRODUCTION

This Record outlines the geophysical work carried out by the Bureau of Mineral Resources (BMR) at Mawson, Antarctica, during 1972. The work was part of the program of the Australian National Antarctic Research Expeditions (ANARE), and was supported logistically by the Antarctic Division, Department of Supply.

Mawson Geophysical Observatory was established in 1955 with the installation of a three-component La Cour magnetograph (Oldham, 1957). Since that time it has been enlarged, and in 1972 there were two magnetographs (a normal and sensitive), a three-component Benioff seismograph, and a visual magnetic recorder operated from an Elsec proton-precession magnetometer. Principal events in the observatory's history are shown in the Appendix.

The author arrived at Mawson on M.V. Nella Dan in late February 1972 after a brief stop at Davis, where magnetic observations were made. Josko Petkovic, the 1971 geophysicist, completed the indoctrination before leaving for Australia. The author operated the observatory until February 1973, when Richard Almond arrived to take over.

2. MAGNETIC OBSERVATORY

Two La Cour magnetographs were operated during the year; these were known as the normal and sensitive magnetographs. Each magnetograph comprised a D, H, and Z variometer, with a La Cour recorder driven by a synchronous motor which produced a chart rate of 15 mm/hr. Details of variometers are documented in previous reports (Oldham, 1957; Merrick, 1961; Smith, 1971).

Magnetometers and intercomparisons

Absolute observations were made up to 8 times per month; the elements measured were total intensity (F), vertical intensity (Z), horizontal intensity (H), and declination (D).

Quartz horizontal force magnetometers (QHM) 300, 301, and 302 were used for H measurements; Z was calculated from values of F obtained with Elsec proton magnetometer PPM 592/340 and values of H derived from the normal magnetograms. BMZ 62 was available as a back-up to the PPM, and its correction was obtained through monthly baseline determinations. D observations were made with Askania declinometer 332, circle 611665.

Differences in F between the inside pier S and the outside pier A were measured on an average of once a month.

Calibrator MC01-A was used to determine the magnetogram scale values. With a digital voltmeter its reference voltage was found to be 4.9992 volts, i.e. it was correct to better than 0.02%.

The intercomparison instruments used in January and February 1973 were HTM 704, QHM 174, and declinometer 333 from Toolangi Observatory; the measured differences were:

QHM 300 - QHM 174 = -28.3 ± 1.3 nT

QHM 300 - HTM 704 = 4.0 ± 1.3 nT

Ask 332 - Ask 333 = - 0.3 ± 0.2 min

QHM differences during 1972 as determined from the baseline values were:

QHM 300 - QHM 301 = -1.5 ± 1.6 nT

QHM 300 - QHM 302 = -0.5 ± 1.6 nT

Standard deviations of baseline values were: H, 1.6 nT; D, 0.2': Z, 1.6 nT.

Recorder lamp power supply

A PMZ-1 rectifier with an output of 6.7 V provided power for trace and time-mark lamps and time-mark relays. It was unsatisfactory for the following reasons:

(1) Owing to the station power supply being overloaded, the lamp intensity varied whenever the variometer room heater switched on or off. When the mains voltage fell, the voltage across the 2500 microfarad capacitor changed from 10.5 V to 9.2 V which lowered the rectifier output by 0.3 V; this decreased the lamp intensity sufficiently for the traces to be affected.

(2) In 1971 Petkovic had to increase the output of the original PMZ-1 from 6V to 6.7V to give good time-mark intensities. Consequently the standby 6V battery was no longer able to maintain lamp intensities whenever the mains failed. This meant that there would be a record loss unless the potentiometer settings in the variometer hut were changed.

The rectifier was modified to overcome these deficiencies by:

(1) The addition of more windings to the transformer, so that the voltage across the capacitor had a mean value of about 16V. This did not solve the problem of the capacitor voltage varying with the heater switching, but the voltage was always high enough for the output to be at a steady 6.7 volts. With the capacitor voltage higher than in the original design the power transistor (Q1 in circuit diagram) was taking more power, so the original power transistor TIP-35A had to be replaced by a more powerful RCA 2N-3055.

(2) A constant-current source was designed to provide a constant current to the 8.2-V Zener diode, thus making the voltage drop across the Zener independent of the capacitor voltage, as long as that voltage was above a minimum value of about 10 V. With the constant-current source in the circuit the 6V standby battery was replaced by a 12V battery so that when the station power failed, the capacitor voltage (12V) was high enough to keep the rectifier output at 6.7 V. When the station power was on, and the capacitor voltage between 16 and 17 V, the battery was trickle-charged through the 5-ohm resistor.

Station power

In winter the station power was slightly overloaded, and on a few occasions the power to the magnetic huts was cut - through the power switch in the Auroral camera building switching off. For this reason it was decided to leave the light in the absolute hut turned on so that, if power to the magnetic huts was off, the geophysicist or the night watchman would notice it quickly from a distance.

MC03 circuit board

As a consequence of a break in the pyrotenax cable, resulting in a short circuit between 240V power lines and the 6V time-mark lines within the four-core cable, the two transistors AY6102 forming part of a time-mark circuit failed; also the suspension of the ammeter which records the current in the time-mark circuit was destroyed (cf. Petkovic, 1971)

Temperature control

A thermistor suspended from the variometer roof operated 6V and 25V relays. These switched on a microswitch closing the heater circuit. Having the heater current flow through the microswitch proved to be very troublesome.

In early May, when the outside temperature fell and the heaters were switching more often, a 7.5 A microswitch short-circuited and failed to switch off the heaters. The microswitch was carrying a current to about 8 A, so it was replaced by a 10 A switch, which also failed under similar conditions in late May. It was then decided to replace the microswitch by a magnetic contactor and use the microswitch to provide the closure for the contactor coil. This worked well because the microswitch carried a current of only 0.5 A.

However, after another set of failures (caused by, e.g. snow entering the microswitch, failure of the DC rectifier for the 25V/8000-ohm relay) the system was simplified.

The Schmidt trigger, which incorporated the thermistor, was modified and made to switch on a relay that provided the closure for the contactor. This system worked reasonably well and it gave a temperature range of less than 2°C. The only major failures of the system were the shorting of a protective capacitor, and a loss in the gain in one of the Schmidt-trigger transistors.

Proton magnetometer and F recording

Continuous recording was discontinued in June after a failure of a pre-amplifier and the mechanical relay unit. After replacing these units, there were no more spares, so it was decided to discontinue the recording and use the PPM only for absolutes.

The failure of the mechanical relay unit was due to the burning of contacts (cf. Major, 1969; Petkovic, 1971). John Major attributed the problem to continuous working of the PPM.

Upon obtaining spares from Australia it was attempted to resume the recording. Then it was discovered that the new transmitter installed by IPSO in November caused electrical interference if the sensing head was on the old pier. The head had to be resited; this was left to the incoming geophysicist.

Continuous recording of F was not essential to the program. The pulsations recorder in Auroral Physics, and IPSO's magnetic disturbance bulletins, provided sufficient information to decide whether it was magnetically quiet enough to do absolute observations.

Just before the author's return to Australia the two Plessey plugs fell apart. When repairing them it was discovered that they were in very bad condition, and it was doubtful whether they would last another year.

Lamps

The semicircular contacts between the lamps and the lamp holders were prone to corrosion. Servisol applied to the area normally solved the problem, which was characterised by sudden discrete jumps or continuous fluctuations in the lamp current.

This was a very annoying problem because upon replacing the lamps it was usually necessary to adjust the optics.

Record losses

The major cause of record loss was fogging of the paper during relieving operations. Other reasons for loss were disengagement of gears on the recorder, orientation test preparations, adjustments to optics, cleaning of lamps, and once in August for inability to reach the magnetic hut to change the record, because of a blizzard.

3. SEISMOLOGICAL OBSERVATORY

The three-component Benioff seismograph operated continuously with few problems and no major breakdowns.

In late March it was noticed that the drum rotation was not uniform at the start of most days. The motor and feed screws were lubricated and friction clutches adjusted, but the problem persisted. By installing an extra heater in the recording room, the drum rotation became normal. This proves that Benioff recorders should not be operated at low temperatures.

In early March the SPZ optics were re-aligned to give a better focussed spot. In August, one more 150-W heating globe was installed in the seismometer room to prevent ice forming on the seismometer masses and causing them to stick. On three very cold days the extra globe still did not solve the problem entirely. On these days the seismometer was made to 'free period' for about three minutes at the beginning of the day. In August the E-W time-mark mirror unit was sticking and causing intermittent loss of time marks. This was repaired.

Record loss was slight. Blown bulbs were the greatest single cause apart from a 12-hour loss in SPZ in early March, when the optics were shaken out of alignment by vibrations caused by high winds.

On 3 August a whole day was lost because the author's stand-in could not reach the seismic hut during a heavy blizzard.

On 30 November a fault occurred in the pyrotenax cable that supplied power and time marks to the seismograph. The fault is easily identified by chattering of the relay (in the geophysical office switchboard) that switches on the standby power in case of a clock power failure.

It was discovered that a fault in pyrotenax cable can be noticed earlier, if the cable break is not clean. Upon developing the record for 30 November it was noticed that the time-marks were lost ten hours before the power line failed. This was due to the lowering of the resistance between the pair of timing cables to 10 000 ohms as the water penetrated the cable. This resistance between the time-pair was low enough to cause the closure of the time-mark relay, whereas the power line was not affected for another ten hours as more water entered the cable. So, if the loss of time-marks is noticed early enough further deterioration can be prevented.

The fault was not repaired until late December because blizzards in early December made it impossible to work outside, and the cable was found to be faulty in numerous places.

While the cable was out of action the recording drums were driven by station power and the time marks were provided by a chronometer placed in the seismic hut.

The geophysics office standby chronometer (Mercer 21171) was used initially, but it had to be replaced by a chronometer from Cosray Physics because its rate was too high and too erratic. The Cosray chronometer had an almost constant rate of about 0.3 s per day.

Chronometer No 21171 was cleaned in an ultrasonic bath and its rate was adjusted. It finally failed when a link in the winding chain broke.

Seismic lamp power

For most of the year power for the lamps and time-mark relays was provided by an old rectifier in the switchboard of the seismic hut. It was found to be very satisfactory. This left the PMZ-1, which had been intended to provide the power, to act as a back-up in case of a failure or need of modification to either the magnetograph or seismic rectifier. For this reason it is suggested that the old rectifier be kept in use.

Data

Seismic cables were sent three to four times a week to Melbourne office and once a week to Antarctic stations. On return to Australia a final analysis of the results was made and the results were punched on cards for ISC in Scotland. About 200 events recorded at Mawson were not located by USCGS, but in the opinion of the author they were genuine earthquakes and were included in the final bulletin. A large number of "ice-quakes" were recorded. Some of these were hard to distinguish from genuine earthquakes.

As was noted in earlier reports the sensitivity of the station was greatest during the period of maximum fast ice. Attenuators were varied according to the weather (to minimise losses due to wind noise) and with the season.

The monthly distribution of events was:

January	57	July	169
February	16	August	216
March	60	September	211
April	85	October	170
May	194	November	130
June	120	December	60

Total 1478

New seismograph vault

A new vault located 12 metres underground off the Cosray shaft, was prepared for occupation. Temperature measurements showed only a very small diurnal variation, which should make the pit very suitable.

In the preparation for shifting the vertical seismometer to the new vault it was shown that the seismic signal would reach the galvanometer situated in the old recording room, 600 m away, without appreciable loss in amplitude. However, there was insufficient cable at the base to enable the seismometer to be shifted.

4. CONTROL EQUIPMENT

Control equipment in the geophysical office is adequately described in previous records (e.g. Robertson, 1972). In 1972 no permanent additions were made to the equipment and there were no major failures. Difficulties encountered were minor ones and simple to trace.

The Time Marker Unit (TMU) would trigger spuriously from time to time, but this was a minor problem, which occurred mostly during blizzards. Occasionally during blizzards building vibration would shake the 1A fuse out of its housing. This was easily rectified by taping the fuse holder to the TMU body.

The new ham radio aerial was permanently diverted into the geophysical office and improved the radio reception. During blizzards the radio reception was very poor, but this was not really a problem because the EMI clock rate was a steady 30 ms a day.

In December, 1972 an EMI clock with the sixth hour identification program was received. The installation of this clock was basically the same as the old clock installation except that for the sixth hour identification to appear on the seismograph, the time closures to the seismograph had to come directly from the clock. This was achieved by having the clock closures in parallel to TMU seismic closures. In case of clock failure the time marks would then be provided by the TMU as in the original installation, but the sixth hour identification would be lost.

The new EMI clock had to be returned to Australia, because late in February 1973 the mechanism for changing the input power to the clock from 240 VAC to 24 VDC had become faulty.

5. FIELD OBSERVATIONS

The magnetic station at Davis was re-occupied in February 1972 and measurements of H, Z, and D were made. Unfortunately at the time of the occupation a severe magnetic storm was in progress.

The station at Traverse Island in William Scoresby Archipelago was occupied in August 1972. This trip ended tragically, with the death at Taylor Glacier of our radio operator, Ken Wilson.

6. MAINTENANCE AND STATION DUTIES

The buildings and equipment were in good condition when the author took over from Petkovic.

A hole in the wall of the variometer hut was repaired, and the station's ham radio aerial was diverted into the geophysical office. This improved radio reception.

In January/February 1973 the author together with IPSO's Physicist acted as Auroral Physicist.

Domestic duties including nightwatch, "slushy", snow collection, fuel distribution, garbage disposal, and painting and maintenance of communal buildings, were performed in addition to geophysical work.

7. ACKNOWLEDGEMENTS

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APPENDIX

Principal Events, Mawson Geophysical Observatory

Year	
1954	Magnetic site tested and chosen
1955	Magnetic observatory established with a three-component La Cour magnetograph. Buildings used ex-Heard Island.
1956	Three-component Leet-Blumberg seismograph installed in new seismograph hut.
1957	Bar fluxmeter variograph installed.
1960	Leet-Blumberg seismograph replaced by a three-component Benioff system. Three-component insensitive La Cour magnetograph installed.
1967	Bar fluxmeter variograph dismantled.
1968	Insensitive magnetograph (1960) converted to normal sensitivity (21 nT/min for H, 22 nT/min for Z, and 2.44 min/mm for D). The 1955 magnetograph with sensitivity of 10.5 nT/min for Z, 9.5 nT/min for H, and 0.87 min/mm left unaltered.
	Automatic magnetograph calibrator installed.
	TMU-1 programmer installed to provide time marks to magnetic and seismic systems.
	Synchronous motor drives were fitted to magnetograph recorders.
1970	Two medium-period (14 s) seismic galvanometers replaced by short-period ones on E and N recorders.
	EMI clock incorporated in the system to provide power and time marks to seismic and magnetic systems.
	Helmholtz scale value and orientation coils fitted on normal magnetograph.
1971	Helmholtz scale value and orientation coils fitted on sensitive magnetograph.
1971/72	New seismic valut excavated and prepared for occupation.

TABLE 1

NORMAL BASELINE VALUES
(no correction applied)

Date	Time (U.T.)	From	To	Reason
H. Baseline (standard deviation 1.6 nT)				
1. 2.72	0000		17380	
14. 5.72	1000	17380.0	17375.5	Optical adjustment
1. 6.72	0300	17375.5	17368.0	Optical adjustment varometer temperature dropped to -20°C
2. 8.72	0300	17368.0	17370.0	Optical adjustment
2.10.72	0300	17370.0	17372.0	" "
2.11.72	1200	17372.0	17383.0	Removed MC01-A
14.11.72	100	17383.0	17371.0	MC01-A resited
25.11.72	0600	17371.0	17383.0	Removed MC01-A
8.12.72	0000	17383.0	17375.0	Overheating of hut
18. 1.73	1500	17375.0	17362.0	MC01-A resited
D. Baseline (standard deviation 0.2 min)				
1. 2.72			60° 34.5'	
20. 4.72	0600	60° 34.5'	33.2'	System vibrated excessively during a blizzard
14. 5.72	1000	33.2'	31.3'	Optical adjustment
1. 6.72	0300	31.3	33.4	Optical adjustment
1. 9.72	0300	33.4	32.6	" "
2.10.72	0300	32.6	32.8	" "
1.11.72	0000	32.8	33.3	Unknown
1. 1.73	0000	33.3	33.7	Unknown
Z. Baseline (standard deviation 1.6 nT)				
1. 2.72	0000		47132	
14. 5.72	1000	47132	47138	Optical adjustment
1. 6.72	0300	47138	47148	Optical adjustment and variometer temperature dropped to -20°C
1.11.72	0000	47148	47150	Unknown
8.12.72	0000	47150	47156	Excessive heat
NORMAL Z temperature (°C)				
1. 2.72			-97.8°C	

TABLE 2

SCALE VALUES AND TEMPERATURE COEFFICIENTS

COMPONENT		SV	Temperature Coefficient
H	NORMAL	21.15 $\pm$ 0.05 nT/mm	0 nT/°C
D	NORMAL	2.44 $\pm$ 0.01 min/mm	
Z	NORMAL	22.65 $\pm$ 0.05 nT/mm	0.0 nT/°C
H	SENSITIVE	9.55 $\pm$ 0.05 nT/mm	
D	SENSITIVE	0.870 $\pm$ 0.005 min/mm	
Z	SENSITIVE	10.45 $\pm$ 0.05 nT/mm	
Tz	NORMAL	1.73 °C/mm	
Tz	SENSITIVE	1.1 °C/mm	

TABLE 3

PRELIMINARY MAGNETIC MONTHLY MEAN VALUES

Based on selected quiet days

Month	H nT	D °	D '	Z nT
January	18384	62	06.5W	-47658
February	18376	62	08.0	-47640
March	18370	62	10.5	-47639
April	18379	62	11.4	-47617
May	18380	62	12.1	-47609
June	18380	62	11.1	-47603
July	18386	62	11.5	-47593
August	18378	62	12.2	-47585
September	18376	62	13.2	-47580
October	18381	62	13.0	-47571
November	18393	62	13.8	-47562
December	18383	62	13.0	-47544
Mean 1972	18381	62	11.4	-47600

TABLE 4

ANNUAL MEANS VALUES (1962-1972)

YEAR	D		I		H	X	Y	Z	F
	o	'	o	'	nT	nT	nT	nT	nT
1962	-60	30.1	-69	21.1	18333	9027	-15955	-48650	51990
1963	-60	45.2	-69	17.6	18356	8968	-16015	-48562	51915
1964	-60	59.2	-69	15.4	18353	8901	-16049	-48460	51819
1965	-61	12.6	-69	13.1	18356	8840	-16086	-48368	51734
1966	-61	24.0	-69	09.6	18362	8790	-16121	-48235	51612
1967	-61	34.4	-69	07.2	18374	8747	-16158	-48168	51553
1968	-61	43.8	-69	05.2	18365	8698	-16174	-48060	51449
1969	-61	53.0	-69	03.4	18353	8649	-16186	-47954	51346
1970	-62	0.5	-69	00.4	18358	8616	-16209	-47840	51241
1971	-62	05.3	-68	56.4	18375	8602	-16236	-47719	51135
1972	-62	11.4	-68	53.1	18381	8575	-16257	-47600	51026
Average rate of change	-10.1'		+2.8'		+5 nT	-45 nT	-30 nT	+105 nT	-96 nT