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Mawson Geophysical Observatory, Annual Report 1966

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SUMMARY

The author was Observer-in-Charge of the Geophysical Observatory at Mawson, Antarctica, for the period February 1966 to February 1967, during which time the magnetic and seismic observatories were maintained in accordance with standard practice.

Modifications to the instruments and ancillary equipment and difficulties experienced during the running of the observatory are described.

No opportunities arose for taking field observations on the return voyage to Australia owing to the difficulties of negotiating the pack ice and landing on the continent.

1. INTRODUCTION

The Bureau of Mineral Resources established an observatory at Mawson, Antarctica, during 1955, when a three-component normal-run La Cour magnetograph was installed (Oldham, 1957). Subsequently an insensitive three-component La Cour magnetograph, a bar fluxmeter, and a three-component Benioff seismograph have been installed (Merrick, 1961; Pinn, 1961).

2. SEISMOGRAPHS

The observatory is equipped with a three-component set of short-period Benioff seismometers, the vertical and the two horizontal seismometers driving 1-second and 15-second galvanometers respectively. The seismograph operated continuously through the year with only minor failures.

Some Z records were lost during February and early March, when after some hours of operation, the Z trace grew fainter until it disappeared altogether. This was caused by the ageing of the filament in the lamp. When the lamp was replaced, this problem was overcome.

A double trace was evident on the N-S record during the months July, August, and September. Frequent adjustments to the mirror systems were made during these months, and by October the trace was again normal.

The motor driving the recording drum was cleaned and oiled during June.

3. MAGNETIC OBSERVATORY

Fluxmeter

Previous modifications to the recording section of the bar fluxmeter have been described by Branson (1965) and Haigh (1967). These included mounting the drive externally to the camera to facilitate record changing.

Problems experienced during the year included the following:

(1) Jamming of the photographic paper in the camera window.

(2) Breakage of drive springs.

(3) Failure of the synchronous drive to start after a power stoppage.

(4) Failure of time-mark relays.

The jamming of the paper was the most common cause of fluxmeter record loss. In the majority of cases, the paper went through the camera for 8 to 16 hours before the jamming commenced and therefore the reason for its jamming was not apparent. After a considerable loss of records in May the fluxmeter was cleaned thoroughly, but some record continued to be lost through the remainder of the year. The author believes it is possible to incorporate a warning system based on the increase in force required to pull the paper through the camera when the paper starts to jam.

The two drive springs which were carried as spares were used by June. A spare length of spring was obtained from the general camp stores and when cut to the required length gave reasonable service, the ends being re-made when the spring broke.

After the day's records had been changed, it was neccessary (as part of the record change procedure) to ensure that the drive was operating. On most occasions, the drive was found to be operating satisfactorily, but sometimes it had to be started by applying a slight pressure to the gear wheels in the drive mechanism. It was not always possible to know when short power stoppages had occurred during the day, and record loss resulted from failure of the drive to start after some of them.

The chronometer used to put the time marks on the seismic records also supplied time marks for the fluxmeter records, via P.M.G. type relays. When the developed records did not show time marks, the relay contacts were cleaned and the time marks were restored.

Magnetograph drives

A serious problem which existed for a major part of the year was the repeated failure of the magnetograph drives to operate continuously. The first instance of drive stoppage was 22nd April when the insensitive record was lost.

Repeated stoppages of the normal magnetograph drive on 7th May led to its being replaced by one of the spare drives.

The insensitive drive stopped three times during May and was replaced on 15th June (after repeated stoppages during record change on that day).

Both the replacement drives gave some trouble through the remainder of the year. The number of days lost (including part days) from September 1966 to January 1967 were:

	Normal	Insensitive
Sept. 1966	5	14
Oct. 1966	9	2
Nov. 1966	5	4
Dec. 1966	11	3
Jan. 1967	2	12

Because of the better record of non-stoppage of the insensitive drive, the normal and insensitive drives were interchanged. This partly accounts for the sudden change in the stoppage pattern between December and January.

Both drives had weights of approximately 600g to actuate the drive mechanism. It was possible sometimes to keep the drives working by increasing the weights to 1000g and later to 1400g.

An escapement controls the rate of rotation of the drum and the rotation is caused by a weight attached to the drum through a spur wheel.

Two spring loaded pawls ensure engagement of the weight and the spur wheel. The weight can be raised to its starting position by the ratchet action of the pawls on the tapered side of the gear teeth.

With constant wear over a long period the gear teeth on both normal and insensitive drums have become worn, and sometimes the pawls slipped one or more teeth while in the driving position; this was apparent by the appearance of gaps on part of the record, and double traces on other parts of the same record.

While no record was lost owing to this type of problem, the interpretation of the record was made more difficult.

In August and December, the spur wheels and pawls on both drums were cleaned and the gear teeth dressed to remove burrs.

Modifications and repairs to scale value instruments

The method of determining the scale values, and the instrument used have been described by Haigh (1967). The only modification effected to this instrument was in the wiring to take external batteries. With this modification, it was possible to change the batteries easily to maintain the current in the coils at 40 mA and 80mA in the normal and insensitive variometers respectively.

The milliammeter monitoring the lamp currents to the normal magnetograph gave erratic values when compared with a portable ammeter. During September , it was removed, cleaned, and put back into service; it operated satisfactorily through the remainder of the year.

Insensitive D variometer

On developing the insensitive magnetogram of 20th July, it was noticed that the D and D base traces were not on the record. After adjustments to the lens and prism systems, both traces were again focused on the magnetogram; however, eight days of the D record were lost owing mainly to the appearance of reserve H or Z traces, which had been mistaken for the D trace during these adjustments.

At this time, the author was instructing another member of the party on the procedures of changing records and it is presumed that the recorder lens was misaligned probably by brushing a sleeve against it during the record change.

Z variometer

The Z baseline value varied $\pm$ 5 gammas about the mean from January to June 1966. After June, the baseline value changed by approximately 30 gammas per month. The monthly mean baseline values sent from Mawson were:

May	47967
June	950
July	48008
August	038
September	049
October	084
November	144
December	163

As these were preliminary values only, the changes were not considered unusual. The drift is possibly due to large daily changes in temperature affecting the bi-metallic strip in the compensating mechanism - these large temperature changes occurred after June 1966 (see below). Another possible cause could be the friction of the Z magnet on its support.

During November and December, it was noted that the Z trace did not record when the field went below the value of about 48,000 gammas. It was thought that the trace was at the end of the normal range for the prism setting, and that the trace would appear by adjustment to the reserve prisms. The opinion was supported because all the reserve prisms for the Z trace had been either removed or rotated through a large angle to prevent any light being transmitted through the prisms to the variometer.

In subsequent adjustments, the Z temperature trace (which had not been observed during the year) was recovered, but the Z trace was not. The trace was recovered entirely by adjustment of the magnet supports in the variometer by V. Dent, the 1967 observer.

<u>Routine measurements</u>

The following measurements were made by the author during the year.

<u>Absolutes</u>. To determine the baseline values, absolute values of H, D, and Z observed twice weekly - one set to be calculated in full at Mawson for use as preliminary data for monthly returns, and the other set to be calculated on returning to Canberra.

<u>Intercomparisons</u>. During the change-over period in February 1967, the instruments which had been used through the year (QHMs 300 and 301, ASK332, and BMZ62) were compared with instruments (QHMs 302 and 174, ASK812, and PPM magnetometer) which had been brought from Toolangi, Victoria.

Satisfactory comparisons were obtained for H and D. However, the pier difference reading between the locations of the PPM magnetometer and BMZ 62 was not taken, and final comparisons for Z will not be computed until this observation is made at change-over 1968.

Azimuths. The surveyor was asked to check the bearings of the marks used for absolute observations. Three attempts were made to measure the marks but as the results were not satisfactory, it was decided to retain the same azimuth angles as had been used in the previous year. It was necessary to use only one mark for declination observations; it was the one bearing 85°45.6'T.

Orientation tests. No orientation tests were made. These tests had been scheduled for December 1966, but by that time the Z variometer and both magnetograph drives were giving continuous trouble and it was decided to leave these tests until these troubles had been rectified.

The 1966 results show that the rate of change in the declination was 15 minutes per year increasing to the west, a rate which has been constant since the start of the observatory. Also the change in H is in agreement with previous years' results. From the above general trends it is concluded that the misorientation would be slight.

Variometer hut heaters

Black (1965) has described the installation of temperature control in the magnetograph hut. The temperature inside the vault remained constant at approximately 1.5°C throughout February and March. During April and May, the temperature was less constant but within the range -1.5°C to +4.5°C. After June, the temperature varied over much wider limits. A check of the temperature control circuit showed that the temperature sensing element was faulty. The sensing element originally came from a radiosonde used for meteorological observations, but was of a type no longer used at Mawson. A sensing element from a radiosonde in current use was substituted but temperature control was still not satisfactory.

The temperature control circuit was designed so that when the vault temperature dropped below 1°C (this temperature could be set in the range 0°C to 8°C) a solenoid closed and turned on the heaters in the vault. If the temperature in the vault rose above 2°C the solenoid open-circuited the heaters and thus ensured stable temperature conditions.

The solenoid was maintained periodically, but the set of contacts needed replacement eventually. A new set of contacts was made but arcing prevented the 'breaking' action of the solenoid and thus the heaters in the vault could not be controlled. There were no spare solenoids available at Mawson which could carry the heater circuit current.

The magnetograph drives often stopped operating when the temperature was below -5°C and so some degree of temperature control was achieved by manually open-circuiting the solenoid and then setting it to operate when the temperature in the vault fell to 0°C, and limiting the maximum temperature by manually turning off one or more of the four 1000-watt heaters; this depended on the cloud cover and the month. By these means, the average vault temperature at 0600 GMT (the time of record change) was approximately 12°C.

4. TIME CONTROL

The timing for the magnetic and seismic sections of the observatory was derived from different timing units in the geophysics office; a pendulum clock for the magnetic, and a chronometer for the seismic and fluxmeter.

Magnetic observatory

Time marks are put on the magnetic record by a light source actuated from the pendulum clock. The light pulse is of four-seconds duration at intervals of five minutes; the hour marks are three four-second pulses at one-minute intervals centred on the hour.

On four occasions during the year, it was noticed when the daily record had been developed that some time marks were missing. This was due to dirty contacts. The time marks were restored after the contacts were cleaned.

The most common reason for the loss of time marks was pendulum clock stoppages. The duration of these stoppages varied, depending mainly on when they were noticed.

The cause of the pendulum stoppages were blizzards or high winds. At Mawson most blizzards and surface (gravity) winds come from the south-east, thus the east wall of the geophysics office is subjected to wind-induced vibration, which also causes vibration in the other walls. Rubber and polystyrene foam have been placed above and below the clock, but the hut vibration still affects the period of the pendulum, which ultimately stops.

Consideration was given to re-locating the clock on an internal wall, but Haigh had had similar difficulties when the clock was on an internal wall and had transferred the clock to its present location.

Thus it is the author's opinion that pendulum clocks are unsuitable in locations of high and varied wind velocities.

Seismic observatory

Time marks are put on the seismic record by a relay-mirror that deflects the light beam for four seconds at the start of each minute, eight seconds at the start of the 6th, 12th, 18th, and 24th hours, and thirty seconds at the start of all other hours. A relay and an inclined ballrace rotary-solenoid have been incorporated into the timing circuit to give the hour pulses, and through the year worked satisfactorily.

Loss of seismic time marks was experienced on two days owing to dirty contacts in the P.M.G. type relays in the seismic vault.

The chronometer was sensitive to temperature change and so the temperature in the office was kept at 20°C. When the oil heater flame was blown out during blizzards, a small electric radiator was placed near the chronometer, and by these means the rate of the chronometer was stabilised at +1.8 seconds per day.

Both the seismic and magnetic time marks were lost for the period 5th to 7th July 1966, when the blade of a D4 bulldozer cut the camp telephone cable Repairs to the cable were effected during the following days.

Time signals

During change-over 1966, an army DUKW accidently ran into the aerial support adjacent to the geophysics office. Temporary repairs to the aerial were made during February, and in March a new aerial was constructed.

The Australian time service signal VNG was audible except in extreme radio disturbances. During October, the P.M.G. ran a series of experimental transmissions in which the pulse length was varied. On the existing Eddystone receiver in the geophysics office, the shorter time pulses (5, 20, 50 ms) were very difficult to hear, and less satisfactory for rating the chronometer than the normal longer pulses.

The chronometer and the pendulum clock were checked daily against the time signal. The rates of both clocks were satisfactory - the pendulum clock rate was approximately -5 seconds per day, and the chronometer rate was +1.8 seconds per day.

5. POWER AND POWER FAILURES

The station generating capacity was not sufficient to meet the normal power requirements especially when the CTH7 communications transmitter was being used. Consequently, there were power failures, and from the daily log these occurred on the 18th, 25th, and 29th March, 21st June, 14th, 18th, and 20th July, and 5th September. No record was kept of the times when over-voltage and under-voltage occurred when the 'paralleling' of the generators took place, as no apparent damage was sustained in the observatory.

However, the bar fluxmeter sometimes required manual starting of the drive and thus some records were lost owing to minor, brief power failures.

The power requirements at Mawson are separated into three categories and are controlled by separate master switches in the power room: scientific, camp essential, and camp non-essential. The scientific load comprises instruments which must be operating continuously; the camp essential load consists of the surgery and radio transmitters, i.e. load to which power should be available at all times; the camp non-essential loads consisted of power to the kitchen, mess, recreation room, and sleeping huts. If for any reason the generators become overheated, the load is removed in the order: camp non-essentials, camp essentials, scientific.

In discussion with the O.I.C., electrician, and senior diesel mechanic, it was decided to transfer the geophysics office power load from the camp non-essential load to the camp essential load to bring it into line with the auroral office and I.P.S.O. office.

There was a considerable number of oral complaints to the author concerning the amount of power used in heating the several observatory buildings. Economies were effected in the following ways:

(1) Seismic vault - substitution of one 1000-watt heater for the existing 2500-watt 'turbo fan' in the recording room. In the months June, July, and August, an additional 500-watt radiator was installed.

(2) Magnetic hut - switching off all or some of the four 1000-watt heaters when essential.

(3) Absolute hut - using the heater only during the observations.

(4) Geophysics office - using one 500-watt heater adjacent to the chronometer when the Coleman oil heater was not operating.

The power position should be greatly improved in 1967 as a new generator of increased capacity was landed during change-over 1967.

6. MAINTENANCE AND STATION DUTIES

Buildings

During the year, all the geophysical buildings received regular maintenance. The painting of the exterior of the seismic vault and the absolute hut was hampered by a general scarcity of aluminium paint; however, the office was painted, and sections of the variometer hut which obviously needed painting were painted.

The rubber seals at the junction of the floor and the concrete piers in the variometer hut were replaced and sealed with mastic during the spring months. The rubber joints in the seismometer vault were renewed and sealed with mastic.

During December, water began to penetrate the office from the junction between the roof panels and from around the skylights. Rubber sealing compound fixed the windows but water still penetrated from the roof panel junctions after the application of sealer. It is not considered serious because water only enters after snow fall in the mid-summer months; during winter, the office is weathertight.

Geophysics office oil heater

The geophysics office is equipped with the Coleman type oil heater which was installed in 1965. The author had been informed that trouble had been experienced in operation of the oil heater during 1965. During 1966, considerable difficulty was sustained in maintaining a stable temperature in the office during blizzards, as the heater flame was often extinguished by a violent gust of wind after a comparative 'lull'.

The location of the heater is adjacent to the east wall of the building and the wind direction at Mawson is almost invariably from the south-east. Forty feet up-wind of the office is the timber stack, and progressively through the year a snow drift builds up towards the wall of the geophysics office.

It is the author's opinion that some of the problems in the oil heater are due to this timber stack, which causes considerable variation in the turbulence patterns near the wall of the office.

Throughout the year, the length of chimney and the degree of control by both back pressure flaps were varied; control was achieved during either calm or high winds,but became difficult when violent fluctuations occurred.

Camp maintenance and duties

During the year, the author completed his rostered camp duties as slushy (2 weeks and 2 days), and nightwatches (18). In addition to the above duties, normal camp maintenance was carried out (usually on Saturday afternoons). Among these duties were included the re-sealing of the mess hut roof, erection of new vehicles workshop, removal and relocation of bulk fuel storage tanks, removal of old food dumps from the ice and their relocation near the hangar, and the painting of the interior of the Balleny sleeping hut.

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