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RECORD No. 1967/27

MAWSON GEOPHYSICAL OBSERVATORY.

ANNUAL REPORT 1964

by

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ILLUSTRATIONS

SUMMARY

The magnetic and seismic observatories at Mawson, Antarctica, were maintained in continuous operation during 1964.

It is suggested that Mawson is the most effective coastal station in Greater Antarctica for the recording of teleseismic first arrivals.

The seasonal variation in recording capability at Mawson is illustrated.

Magnetometer thermometers should be calibrated regularly, as differences of more than 1°C were measured between individual thermometers, giving rise to large possible errors in baseline values.

The results of scientific work will be published in separate reports.

1. INTRODUCTION

The author arrived at Mawson station on M.V. Nella Dan on 16th February 1964 as geophysicist to succeed I. A. Black, who departed 25th February. On 3rd January 1965, J. E. Haigh in turn arrived to begin his term as observer, although the author did not leave Mawson until 1st March 1965. During this eight week period when two geophysicists were on the station together, J. E. Haigh became familiar with observatory operation and during most of February was carrying out all routine observatory work.

Normal operation and instrumentation of the observatory has been fully described in previous reports (Oldham, 1958; McGregor, 1959; Pinn, 1961; Merrick, 1961; and Black, 1965).

2. STATE OF BUILDINGS AND MAINTENANCE

The seismic hut was in good condition both inside and out. However, drift snow entered the seismometer room from the gaps about the base of the pier. New rubber strip was fitted around the pier to prevent this.

The variometer house was also in good condition. Occasionally some drift snow entered the inner room via the foot of the piers, but this was not a serious problem. The absolute house was in good condition.

The office building was in a quite satisfactory condition. The interior was repainted at the end of the year in order to restore the office to cleanliness after the Coleman stove had covered the room and all its contents with a dense layer of soot. This was caused by the stove damper sticking open during the peak of a great blizzard, with winds of up to 140 mph. Some of the records and books lying about at the time show permanent traces of this disaster. The walls and ceiling were scrubbed down and then brightened with a thick coat of paint.

Opportunity was taken during the upset caused by cleaning and painting to take stock of the office contents and to organise and reduce the cupboard and shelf contents which had apparently been accumulating for years.

The Coleman oil stove gave some trouble early in the year until its vagaries were better understood. After careful adjustment it gave excellent service for most of the remainder of the year except for one or two occasions. The chimney crown iced up during blizzards on two occasions and was found to be unnecessary after a trial period without it.

The office snow-melter leaked at one stage and was repaired by welding.

3. SEISMOLOGICAL OBSERVATORY

As in previous years, a three-component Benioff seismograph was in operation. The vertical component consisted of a one-second seismometer driving a fifth-of-a-second galvonometer; the horizontal components each used a one-second seismometer driving a 15-second galvanometer. Recording was at 60 mm/min. Generally, operation was quite satisfactory. However, a number of troubles occurred as described below.

The most serious trouble was the failure of a time-marking relay at the end of May. The cause of failure could not be determined, and no spare was available. Timing for this N/S record for the remainder of the year was obtained by overlaying it on the E/W, these components being switched off and on together. An accuracy of one or two seconds could usually be achieved, and as first arrivals were not concerned, this was usually sufficient.

Other troubles were minor and routine, for instance, failure of recording and seismometer heater lamps, breakage of the surface line passing time-marks from the chronometer (in the office) to the observatory building, and occasional need for adjustment of the recording optics.

Relevelling of the longer-period galvanometers was necessary once during the year. The reason for the disturbance is unknown.

The chronometer gave satisfactory service throughout the year, and its rate generally was kept small, so that time corrections could almost always be read to 1/10 second with confidence. On a few occasions, time corrections became uncertain to within one or two seconds as a result of temperature disturbances in the office, which was normally thermostatically controlled. This usually occured in conjunction with stove trouble.

Twice-weekly bulletins of first arrivals and other prominent phases were sent to the United States Coast & Geodetic Survey (USCGS) via Head Office. About 1250 analyses were passed to the International Seismological Research Centre after return to Australia. Over 800 of these earthquakes had already been located by USCGS from preliminary data, and another 200 confirmed by other stations. The distribution in time of these 1000 earthquakes (Plate 1) shows the strong seasonal effect observed at many Antarctic coastal stations. This is attributed to the effect of fast-ice strongly reducing microseisms of oceanic origin. During the three-month summer period when the coast is adjacent to open water, earthquakes are recorded only infrequently. The time of maximum frequency of recorded earthquakes coincides well with the time of maximum thickness of fast-ice (usually September to October). This is probably also the time of maximum extent of the fast-ice.

The attenuation applied to the seismic signal was varied from time to time according to the prevailing level of microseisms. In addition to the seasonal variation in background noise, noise from the larger blizzards during the year usually succeeded in completely blanketing the records. The full available attenuation range (0 to 30 db) was used during the year, and even at 30 db, records were unusable during the strongest blizzards.

During 1964, USCGS assigned many more earthquake magnitudes in preliminary lists than in previous years. This allowed the teleseismic recording capabilities of Mawson to be estimated. During winter, teleseisms with magnitudes down to about $M_{CGS} = 4.0$ were commonly recorded at epicentral distances as great as 85^{o}. Teleseisms at about the PKP focal distance (145^{o}) with magnitudes almost as low as this (about $M_{CGS} = 4.2$) were also recorded. Mawson is probably the most valuable of the coastal stations in Greater Antarctica, at least for purposes of earthquake location. For instance, during the months September to October, Mawson recorded more shocks than Mirny and Wilkes, in the approximate ratio 4:2:1. This information was obtained by comparing preliminary bulletins. The ratio in favour of Mawson is not so extreme in the noisier months. Mawson may be more favoured by fast-ice formation during the winter.

Minor projects carried out on 1964 seismological data after return to Australia included examination of multiple PKP arrivals in the light of work done by Bolt (1962) and Adams and Randall (1964). Of the recently reported branches, GH was observed frequently, but IJ was not observed definitely at all, and doubtfully only once. Also, sequences of intermediate depth shocks from the South Sandwich Islands were noted, members of which had unusual features in the irregular occurrence of the core reflection phases PcP and ScP. Details may be obtained from the author.

4. MAGNETIC OBSERVATORY

Standard magnetographs

Scale values of the La Cour magnetographs were:

	Normal sensitivity	Insensitive
H	9.55 gammas/mm	51.6 gammas/mm
Z	10.00 gammas/mm	50.8 gammas/mm
D	0.86 minute/mm	2.44 minutes/mm
	or 4.60 gammas/mm	or 13.0 gammas/mm

H and Z scale values were determined by the Helmholtz coil method. They were not done with strict regularity, because it was believed that better results would be obtained by less regular but multiple observations during periods known to be relatively quiet.

Standard deviations for these observations are given in Table 1 (normal magnetograph). Comparison of the 1964 means and standard errors of the means with those of each of the three previous years show that the mean H and Z scale values have been stable during this time and that the mean can be meaningfully adopted to the second decimal place (see Table 2). D scale values were determined once by the coil method and also by direct observation using the declinometer.

Record loss from the normal instrument was very small throughout the year. Clockwork drive failure was the cause on the few occasions when loss occurred. This was also the explanation of losses from the insensitive magnetograph, which were more frequent. The drives were cleaned and oiled each time, and this was always sufficient to restore satisfactory operation.

Loss of time-marks was occasionally serious. Both instruments are timed from one La Cour pendulum clock in the office, and again surface lines are used to transmit time-marks to the observatory building. Breaks in the line occurred on several occasions; twice, during blizzards, repairs could not be carried out immediately. Losses of up to two and three days' duration ensued each time. The clock itself stopped once but cleaning and oiling restored operation, and no other trouble was experienced with it.

A peculiar trouble occurred in the normal instrument about half way through the year, which left a residual effect for the remaining months. It was found one day that, after normal operation for several hours, the drum had become detached from the escapement regulating its rotation, had spun freely until its drive weight had reached the floor, and then stopped. This caused record loss for the remainder of the day. Maintenance of the knife-connector removed most of the fault. However, during the remainder of the year, intermittent periods occurred when a small sudden gain of the drum took place once a day. Measurement showed that the jump was always equivalent to the gaining of a single tooth by the connector. The position of the jump on the record was progressive from day to day, but analysis did not point to any particular tooth as the cause. This residual jump could not be permanently removed.

In 1964, the mean position of both the D and Z traces of the normal instrument migrated as usual because of secular variation. During the year they reached sufficiently close to the edges of their recording spaces to cause excessive use of reserve spots. Both traces were recentred, using the prisms of the respective variometers: D at the end of September; Z at the end of November. However, in the case of the D variometer, it is recommended that in future such adjustments be made by rotating the complete variometer.

Absolute instruments

QHMs 300 and 302, BMZ 62, and Askania declinometer 630332 were used to provide baseline control. 1964 was the first year in which the Askania declinometer was used at Mawson; it was introduced at the changeover. Intercomparison of these instruments with others brought from Australia was carried out in the 1963/64 and 1964/65 changeover periods (see Table 3). The intercomparison instruments included a proton precession magnetometer on each occasion.

Intercomparison of BMZ 62 using its normal field magnet was made with BMZ 62 using a long-range field magnet provided for it. Declination measured with QHM 300 was compared with that measured with the Askania declinometer.

The Askania circle was used for QHM observations instead of the QHM circle used before 1964. Scatter in both D and H baselines derived from QHM observations made with the new circle was less than that observed in previous years when the QHM circle was used.

H-baseline observations were generally satisfactory. During the last three months of the author's observations, scatter in QHM 302 values increased substantially relative to the scatter in QHM 300 (see Table 2). The reason for this is not known.

Late in the year it was observed by chance that the readings on the BMZ thermometers were not the same, so a careful series of measurements was carried out to determine their relative differences. Z-baseline values had previously been assumed to be independent of the particular thermometer used.

The ranges of the four thermometers were:

-20 to 0°C (No. 1174)

-10 to 10°C

0 to 20°C (No. 1171)

10 to 30°C

The thermometers were compared in pairs having overlapping ranges. The following method was used. A clean beaker was heavily insulated with cotton wool at the top, bottom, and sides. The thermometers were bound in mutual contact and immersed in liquid in the beaker so that only the reading stems protruded from the insulation. For the lower temperature measurements a brine solution containing ice was used and temperatures as low as -17°C were achieved. Before commencing each series of measurements, several hours were allowed for the system to come to equilibrium. Measurements were made at intervals during re-warming from the minimum temperature.

All the measured differences were greater than accounted for by the reading corrections supplied for the thermometers (see Table 4). The -20 to 0°C thermometer was particularly bad, being about 1°C different from the others, equivalent to about 20 gammas in baseline values. However, baselines were found to be overcorrected when adjustment was made for this thermometer difference (see Plate 2). Because ten months intervened between the period when adjustments were necessary (April to May 1964) and the time at which the thermometers were compared (February 1965), it seems likely that the thermometer errors may be changing with time. This indicates that regular checks should be made on all thermometers supplied to observatories. Z-baselines were otherwise satisfactory (see Table 2).

Bar fluxmeter

This operated faultlessly except for one period of about ten days. At this time, the take-up spool was not functioning and paper became jammed in the cassette. The trouble was caused by a slack driving spring. In the process of replacing this spring, a brass boss was broken from the driving axle, and most of the delay was caused by the difficulty in repairing it.

Reporting of data

Monthly mean values of the three magnetic elements as scaled from the ten quietest days per month were reported to Head Office. K indices were also reported monthly. Before 1964, all three components were used for the determination of K values, but from 1964 onwards, only H and D are to be used. All three individual components continued to be reported to Head Office, however.

Magnetic phenomena (sudden commencements, bays, etc.) were compiled after return to Australia, for transmittal to international bodies.

Study of magnetic activity

During 1964, a great deal of time was occupied by the author in computational work for a statistical study of features of the horizontal and vertical magnetic activity at Mawson, and also at Macquarie Island, Wilkes, Mirny, and Byrd stations. This was based on K indices, which were kindly sent from these latter stations by radio on request. Progress results of this study will be published elsewhere.

Field observations

The magnetic elements H, D, and Z were observed at Davis station, 400 miles east of Mawson, by the author late in January 1965. The days were magnetically quiet, and the weather calm and clear, so that good observations were achieved without great discomfort.

5. ACKNOWLEDGEMENTS

Mr. J. F. Stalker carried out observatory routines during the 20 days in which the author was absent from the station, and thanks are due to him for the efficient way in which the work was done.

The author is grateful to Mr. D. Seedsman, and to Mr. P. Jacquemin for their technical advice during the year. Mr. P. Dawson and Mr. A. O'Shea made welding and other repairs for which the author is also thankful.

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TABLE 1

Standard deviations of baseline and scale-value observations relative to adopted values

	H	Z
Baseline (gammas)	*1.7 (QHM 300)) (24 obs.) 2.1 (QHM 302))	**1.8 (25 obs.)
Scale-value (gamma/mm)	0.09 (38 obs.)	0.11 (37 obs.)

* First nine months of year (see text). Corresponding figures for last three months were 1.3 and 3.4 (9 observations)

** Neglecting observations with bad thermometer.

TABLE 2

H and Z scale-values 1961-1964 *

Year	H (gammas/mm)	Z (gammas/mm)
1961	** 9.56 $\pm$ 0.012 (11 obs.)	10.05 $\pm$ 0.015 (28 obs.)
1962	9.55 $\pm$ 0.027 (40 obs.)	10.01 $\pm$ 0.018 (38 obs.)
*** 1963	9.53 $\pm$ 0.022 (47 obs.)	10.05 $\pm$ 0.020 (47 obs.)
1964	9.54 $\pm$ 0.015 (38 obs.)	10.03 $\pm$ 0.020 (37 obs.)

* 1961-1963 means and standard deviations recomputed by author

** Change in H scale-value during year. Mean refers to value after change

*** Original observations computed to one decimal place only.

TABLE 3

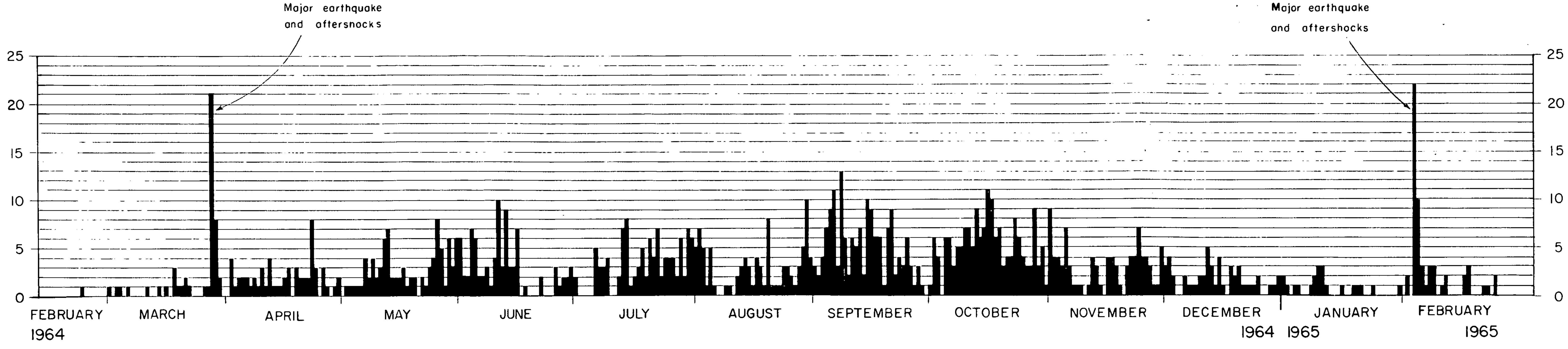
Magnetometer comparisons

Date	Instruments	
	Station	Intercomparison
Feb 1964	QHM 300	QHM 302
	QHM 301	HTM 154
	BMZ 62	BMZ 211
		PPM
Mar/Apr 1964	QHM 300 (D)	Askania 630332
Feb 1965	QHM 300	QHM 301
	QHM 302	QHM 172
	BMZ 62	BMZ 211
		PPM
		BMZ 62 (Long Range)

TABLE 4

BMZ thermometer differences

Thermometer	Adopted difference with thermometer 1	Range of comparison
1. -10 to 10°C	-	-
2. -20 to 0°C	1.15°C	$-10\frac{1}{2}$ to $-1\frac{1}{2}$°C on 1
3. 0 to 20°C	0.4°C	$\frac{1}{2}$ to 8°C on 1
4. 10 to 30°C	0.3°C	$11\frac{1}{2}$ to 13°C on 3



DAILY NUMBERS OF CONFIRMED EARTHQUAKES RECORDED AT MAWSON BETWEEN 21 FEB 1964 AND 25 FEB 1965

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G158-67
TO ACCOMPANY RECORD No. 1967/27

EFFECT OF ADJUSTING Z-BASELINE VALUES FOR THERMOMETER DIFFERENCES
MAWSON 1964

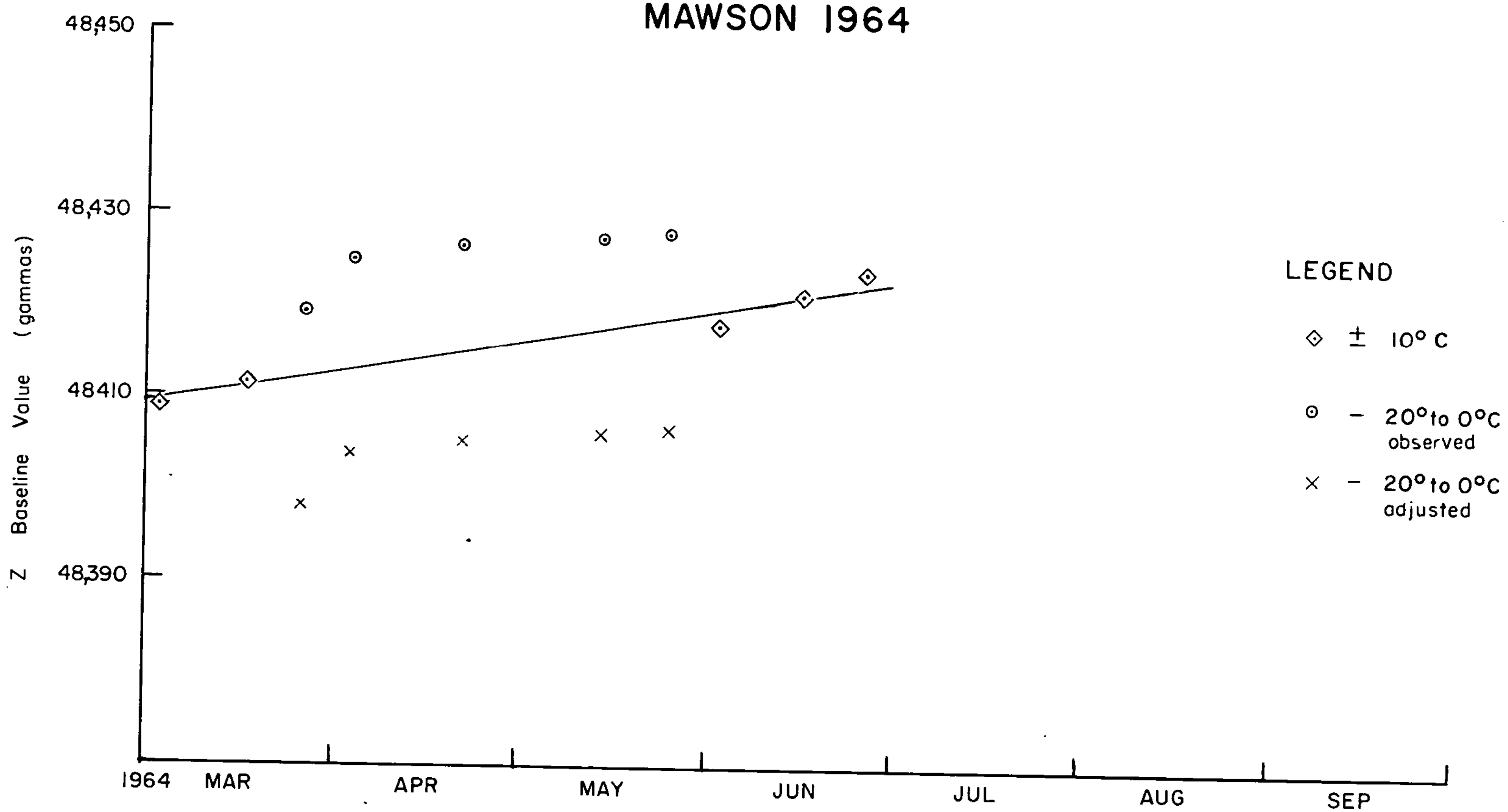


PLATE 2

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.

TO ACCOMPANY RECORD No. 1967/27

G158–68