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GEOPHYSICAL WORK AT MACQUARIE ISLAND

DECEMBER 1956 - DECEMBER 1957.

by

J.R. CLEARY.

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CONTENTS

ABSTRACT

A description is given of magnetic and seismological observatory operation at Macquarie Island from December 1956 to December 1957. Results of intercomparison observations, scale value determinations and calculation of variometer temperature co-efficients are included. Specific problems encountered during the year are discussed, and suggestions offered for the improvement of the present setup.

1. INTRODUCTION

Since March 1948, a programme of scientific research has been conducted at Macquarie Island (Lat.54°30'S, Long.158°57'E) by the Antarctic Division, Department of External Affairs. Seismological and magnetic observatories have been in operation at the station since 1950/51, and are manned from year to year by a geophysicist of the Bureau of Mineral Resources, Geology and Geophysics. The writer was engaged in this capacity during the Australian National Antarctic Research Expedition at the island from December 1956 to December 1957.

Much information concerning the station and observatories has been given in previous records by Oldham (1953), McGregor (1954), Tenni (1954) and Robertson (1957).

2. MAGNETIC OBSERVATORY

A. Magnetographs.

Magnetic recording equipment at the island consists of a set of low-sensitivity La Cour variometers with a 15mm/hour recorder. No adjustments to the variometers were necessary in 1957, as orientation angles and trace ordinates had been adjusted by B.G. Cook during the previous year.

The clockwork recorder drive jammed on a number of occasions during the year, with a resultant total loss of about 70 hours' record. This type of failure, a common one at Macquarie Island, can be attributed in most cases to the presence of dust or corrosion in the drive mechanism. Instead of waiting for breakdown to occur before replacing the drive with a spare, it is recommended that in future the drive be replaced and cleaned about every four months.

Some loss of time marks from the magnetograms occurred when the main shaft of the pendulum clock developed (for reasons undiscovered) a tendency to slide forwards, with the result that the hour hand was pushed against the hour-mark contact, causing stoppage. Unfortunately realignment of the clock was not easy to achieve without other defects being introduced, but finally a position was found where no stoppage occurred provided the drive chain was not fully wound. This proved a satisfactory compromise.

Deterioration of the silvering on the magnetograph prisms continued to such an extent that certain of the light-spots became too faint to be recorded during magnetically disturbed periods. This was partly remedied by increasing the lamp intensity whenever such conditions were known to prevail. A new set of prisms was sent from Melbourne in December 1957, and during changeover operations four D reserve prisms and the Z main spot prism were replaced.

The Z variometer baseline value increased by about 40 gammas in the course of the year. The change was produced by :-

a) Trace "jumps", which occurred mainly during drying agent replacements.

b) A gradual baseline drift. The reason for this is unknown, but such an effect could be produced by the accumulation of dust or corrosion at the knife-edges.

It is most desirable that these changes in baseline be kept to a minimum. The Z variometer has been designed so that it can be evacuated and hermetically sealed (La Cour, 1930), and this feature should be used to achieve more stable conditions. A simple vacuum pump would probably be suitable for the purpose.

B. Scale Values.

(i) H and Z variometers. H and Z scale values were determined weekly, using Helmholtz-Gauguin coils. A scatter of about 0.7γ/mm was present in the measurements, due mainly to the high average level of magnetic disturbance at the station. For this reason it was preferred to use the mean scale values for 1956, rather than "current" values, in the calculation of K indices and provisional monthly means. That the scale values are sufficiently constant for this purpose can be seen from the following table.

Year	Mean E_h	Mean E_z
1955	12.48 γ/mm.	14.17 γ/mm.
1956	12.51 "	14.09 "
1957	12.46 "	14.06 "

(ii) D Variometer. Since 1952, the scale value adopted for the D variometer has been 0.890 min/mm. In the calculation of this figure from torsion tests, it had been assumed that the plano-convex prism at the side of the variometer was mounted with the plane face outwards. A careful examination in 1957 showed this assumption to be incorrect, and recalculation gave a scale value of 0.905 min/mm (c.f. McComb, 1952, p.75).

In 1957 another torsion test determination was performed, and in addition the scale value was calculated directly from the regression line of 1957 D absolutes.

The results of the different determinations are tabulated hereunder :-

Year	Method	E_D
1952	Torsion test	0.905min/mm.
1952	Helmholtz coil	0.914 "
1957	Torsion test	0.905 "
1957	Regression line	0.913 "

On the basis of these figures, a D scale value of 0.91 min/mm has now been adopted.

C. Temperature Co-efficients of Variometers.

When 1957 H baselines were analysed, it was found that the temperature co-efficient of the H variometer is not constant throughout the temperature range. It appears that this is due to a defect in the temperature compensation system of the variometer, as corresponding discontinuities are to be found in the variation with temperature of the H temperature ordinate. The fault apparently originated during adjustments to the temperature compensation strip in January 1953. At this time the effective length of the strip was reduced to almost zero, and as this would bring the clamping block into close proximity to the compensating prism, it is possible that bending of the strip with change in temperature causes these parts to foul each other.

The following values were obtained for the H temperature co-efficient.

Temperature Range	Temperature Co-efficient
- 3° to+ 5° C	1.0 γ/° C
+ 5° to+11° C	3.3 "
+11° to+14° C	5.0 "

Analysis of Z baselines for Z temperature co-efficient proved difficult because of changes in the baseline value through-out the year. In previous years, no significant Z temperature co-efficient has been detected.

D. Absolute Measurements.

H, D and Z baselines were determined weekly, using the following instruments :-

(i) Horizontal Intensity: QHMs 178 and 179.

(ii) Vertical Intensity: BMZ 64.

(iii) Declination: Kew Pattern Magnetometer, Dovers, Charlton and Kent No.158.

Prior to 1956, QHMs were used for the determination of D baselines, but the degree of scatter in the results obtained was considered unsatisfactory. Analysis of baselines obtained in 1957 using the DCK158 Magnetometer gave a standard deviation of ±0.5 minutes of arc - a reasonable figure for a station at this latitude.

E. Intercomparison Observations.

(i) The following intercomparison observations were made during the 1956/57 occupancy :-

(a) December, 1956 (with B.G. Cook).

BMZ 64 intercompared with Wide Range BMZ 115.
DCK 158 " " Askania Magnetometer 508813(for D).

(b) January, 1957.

QHM 179 intercompared with QHM 178.

(c) October-November 1957.

QHM 179 intercompared with QHM 178.

(d) December, 1957 (with A. Turpie).

BMZ64 intercompared with Wide Range BMZ 121
DCK 158 " " Askania Magnetometer 508813(for D).
QHMs 177, 178, 179 intercompared with Askania Magnetometer 508813 (for D).
QHM 179 intercompared with Askania QHMs 177 and 178 (for H).

All intercomparisons were made through magnetogram baselines.

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(ii) Results.

December, 1956.

Z115 - Z64 = - 48 gammas (8 sets each).
D508813 - D158 = 0'·2 (9 sets each).

January 1957.

H 179 - H178 = 0.00022H (7 sets each).

October - November, 1957.

H179 - H178 = 0.00022H (10 sets each)

December, 1957. (Telegraphed results - subject to check).

Z121 - Z64 = - 54 gammas (10 sets each).
D508813 - D158 = +0'.5)
D508813 - D177 = +6'.3) 10 sets Askania 508813
D508813 - D178 = -6'.5) 8 sets each QHM
D508813 - D179 = -2'.5) 8 sets DCK 158

H179 - H178 = 0.00045 H)
H179 - H177 = 0.00015 H) 3 sets each QHM

Previous to 1956 the QHMs had been used for D absolute observations, and they are included in the December 1957 intercomparisons as a check on an apparent drift in their IMS corrections. This has since been traced to variability in the torsion correction (γ) of QHM 177, the variability appearing also in the IMS corrections of QHMs 178 and 179 which had been obtained by intercomparison with QHM 177. When the correct torsion corrections are applied, the apparent IMS drift disappears.

There remains, however, an apparent jump of about 2 minutes in the IMS corrections calculated for all D instruments from 1956 and 1957 intercomparisons (this includes DCK 158 intercomparison in December 1956, and DCK 158 and the three QHMs in December 1957). For this reason the DCK 158 IMS correction must be considered as doubtful pending further intercomparisons.

F. Azimuth Determinations.

The azimuth of the North mark from the East Pier was again redetermined. It had been intended to do this by transference of azimuths from Station A, but after a two days' unsuccessful search for this station, it was decided to use Station B instead (see McGregor, 1954, for details of magnetic stations).

The effect of this latest determination was simply to add to the confusion of results previously obtained. A summary of these results follows :-

Observer	Azimuth	Method
McGregor, 1952	353° 40'.9	Transference from Station A
Tenni, 1953	353° 41'.1	" " " "
Robertson, 1954	353° 39'.5	Sunshots
Cleary, 1957	353° 40'.0	Transference from Station B

This multiplicity of values is probably caused by (a) instrumental errors, and (b) shifting of the concrete blocks which mark the reference stations (as both stations are located in seal wallows, this is not unlikely).

To remedy the present unsatisfactory state of affairs, it is very desirable that more observations be made using a reliable instrument, preferably by a trained surveyor.

3. SEISMOLOGICAL OBSERVATORY

A. Adjustment to Instruments.

Both Wood-Anderson horizontal seismometers were found to be slightly over-damped, and their damping coefficients were adjusted to 0.85. Some difficulty was experienced with damping tests, because the high damping ratio (150:1) required a large initial displacement, and this introduced problems related to light intensity. Robertson (1957) overcame the difficulty by using a filter to cut down the light intensity in the undeflected position. However, the method of disturbing the system by blowing air onto the mirror has other disadvantages, so it was decided to try a different approach. The instrument was tilted slightly by a quick rotation of one of the levelling screws, thus displacing the trace from one zero position to another further down the paper. This displacement corresponds to "amplitude of first oscillation" of the pendulum system, provided the time taken to tilt the instrument is small compared to the period of the system. The advantages of the method are that normal lamp intensity can be used, and that the amount of displacement is easily controlled.

The mean free periods of both horizontal instruments were verified as 1 second.

Following severe disturbance of the E-W seismometer by a strong local tremor, this instrument was completely readjusted.

The Grenet vertical force seismometer, which had been installed by B.G. Cook the previous year, required no maintenance during 1957.

B. Power Supply.

At present the anomalous situation exists that the seismometer lamps are supplied by a 6V accumulator, while the recorder drives are mains operated. The current drain on the accumulator is considerable, and it must be fed continuously by a battery charger. Much precious office space is taken up by all this gear, and it is recommended that the lamps be changed over to mains operation.

4. GENERAL

In addition to normal routine work during the year, the following repairs, improvements, etc., were undertaken :-

(a) The 100-ohm relay belonging to the clock comparison signal lamp system in the absolute hut (Robertson, 1957) was replaced, and the new relay tested for possible effect on absolute measurements.

(b) The milliameter in the magnetograph lamp circuit was replaced, and the old meter incorporated in the seismometer lamp circuit.

(c) The variometer scale value panel was rewired.

(d) Trays, lights, etc. in the darkroom were re-arranged for greater ease in processing records, and to reduce the possibility of trays being contaminated by spillage.

(e) A shadow board was constructed on one wall of the darkroom, because tools formerly kept in the store-room were being rapidly spoiled by weather.

(f) The office interior was painted, and a fluorescent lamp installed. The linoleum on the office floor was replaced

(g) Masonite sections were cut to fit inside "current record" boxes, to keep records flat. A format was drawn up on a masonite board of 3-hour intervals and hourly scaling intervals, etc., to aid preparation of monthly quiet-day curves.

(h) Very little information existed for the assistance of the incoming geophysicist during the first difficult months of occupancy. To remedy this, a detailed set of notes on routines, etc., was prepared and typed.

(i) The magnetic and seismic huts were painted.

5. RESULTS

Provisional monthly magnetic means, magnetic K-indices and preliminary earthquake analyses were telegraphed to Australia from Macquarie Island at the end of each month, and were published in the monthly bulletins issued by the Bureau of Mineral Resources.

A report is to be published which will include tables of final mean hourly values of the magnetic elements, sudden commencements, and principal magnetic storms. A separate bulletin will contain final earthquake analyses for the year.

6. ACKNOWLEDGEMENTS

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