COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

RECORDS

1957, No. 105

GEOPHYSICAL WORK AT MACQUARIE ISLAND, DECEMBER, 1955 - DECEMBER, 1956.

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CONTENTS

ABSTRACT

Information is given, and suggestions made, regarding the operation of magnetic and seismological observatories at Macquarie Island during the year December, 1955 to December, 1956. In particular, results are given of orientation tests and of inter-comparison observations made during the year, and details are given of adjustments to variometers.

1. INTRODUCTION

The writer, an officer of the Bureau of Mineral Resources, Geology and Geophysics, was geophysicist with the Australian National Antarctic Research Expedition to Macquarie Island from December, 1955 to December, 1956.

Particulars of the station and observatories, and of the operation of the observatories, are given in reports by Oldham (1953), McGregor (1954), Tenni (1954) and Robertson (1957).

2. MAGNETIC OBSERVATORY

A. Orientation tests and adjustments to variometers.

(i) Previous work.

In 1955, Mann established a known true bearing ($24^{\circ}05.9'$) through the variometer room. Helmholtz-Gaugain coils, aligned by eye with a thin cord parallel to the meridian, were used to apply known fields along the magnetic meridian and prime vertical to the D and H variometers, respectively. Using a bearing of $24^{\circ}55'$ for the magnetic meridian, Mann obtained values of the angle of exorientation of the magnets, (September-October, 1955):-

H : Ex = 71 minutes,

D : Ex = 64 minutes.

The sense of these exorientation angles was not determined.

(ii) Orientation tests - May, 1956.

In May, 1956, orientation deflections were repeated, the direction of the field applied in each case being determined. Coil currents of approximately $\pm$200mA. were used for H deflections, and currents of approximately $\pm$75mA. for the D deflections. (The coil constant was 7.49 gammas/mA.).

(a) H orientation test - 11th May, 1956.

The coil was aligned to give fields directed in azimuth perpendicular to $24^{\circ}55'$. The ammeter used was VML 11386 (500mA. range).

Ammeter reading	Ammeter temperature	Current applied	Total current	Coil constant	Total deflection	Scale value	Ex*
+199mA.	6.5°C	+194.8mA.	391.6mA.	7.49γ/mA.	6.9mm.	12.5γ/mm.	101'
-201mA.	6.9°C	-196.8mA.					

A "+ve" current through the coil produced a field directed east to west.

The "+ve" current deflected the H spot in the direction of decreasing H. The north end of the magnet was therefore oriented south of east.

A previous determination using half the above currents, and with the coil aligned less precisely, also gave Ex* = 101'.

The mean declination for May, 1956, was $24^{\circ}53'$. Therefore, referring the exorientation to the mean meridian for 1956.4:-

Ex = $1^{\circ}43'$, north end south of east.

(b) D orientation test - 29th May, 1956.

The coil was aligned to give fields directed in azimuth 24°55'. The ammeter used was VML 11386 (100 mA. range).

Ammeter reading	Ammeter temperature	Current applied	Total current	Coil constant	Total deflection	Scale value	Ex(*)
+74.0mA.	8.2°C	+72.8mA.	146mA.	7.49γ/mA.	4.9mm	3.45γ/mm.	53'
-74.3mA.	8.7°C	-73.2mA.					

A "+ve" current through the coil produced a field directed north to south. The "+ve" current deflected the D spot in the direction of decreasing declination. The north end of the magnet was therefore oriented west of north.

The mean declination for May-June, 1956, was 24°53'. Therefore, referring the exorientation to the mean meridian for 1956.4 :-

Ex = 51', north and west of north.

(c) Comparison with results of 1955.

If the exorientation angles obtained by Mann are referred to mean declination at the time, viz, 24°43' + 3'(θ), they become 80' and 55' for H and D, respectively.

There is good agreement between the results for D, and approximate agreement between those for H (ϕ).

(iii) Re-orientation of magnets.

(a) D.Variometer

For some time, declination had been recorded largely by the first positive reserve spot. It was desirable that the main spot be brought back to a suitable ordinate, and that advantage be taken of this opportunity to improve the orientation of the D magnet. Adjustment was made on 7th July, 1956.

Before adjustment, the declinometer torsion head read 150°and the circle 118°. The mean ordinate of the main spot was about 84mm, that is, the 1st +ve reserve spot ordinate was about -11mm.

The torsion head was turned clockwise through 145° to read 5°. This moved the 1st +ve reserve spot about 43mm. That is, the north end of the D magnet was moved about 51 minutes towards the east.

The whole instrument was turned on its base to give a suitable main spot position. The circle then read 117°.

(*) Referred to meridian 24°55'.

(θ) 3' correction to 1955 D baselines obtained from 1955.9 intercomparisons.

(ϕ) Subsequent to Mann's H orientation deflections, the H variometer was bumped, resulting in a shift of the recording spot position. It was noticed in 1956 that the torsion head was not clamped. Rotation of the torsion head seems a likely explanation, which would also explain the discrepancy between exorientation angle-determinations.

The torsion head was turned through 1° to compensate for the circle reading change of 1°.

The baseline mirror was adjusted to give a suitable baseline position.

After adjustment, the torsion head read 6° and the circle read 117°. The mean ordinate of the main spot was about 21 mm.

(b) H Variometer.

Since the shift in the recording spot of the H variometer referred to in an earlier footnote, the H ordinate had been too small, bringing the reserve spot on to the sheet more frequently than necessary. Adjustments to increase the H ordinate and to improve the orientation of the H magnet were made on 19th September, 1956.

Before adjustment, the torsion head read 13°. The mean ordinate was about zero.

The torsion head was turned anticlockwise to move the recording spot a distance up the sheet of about 85mm. That is, the north end of the H magnet was moved about 1°41' towards the north.

The small (upper) prism was rotated to give a main spot ordinate of about 20mm.

After adjustment, the torsion head read 15°. The mean ordinate was about 16mm.

Note: The torsion head was found unclamped, and clamping after adjustment was found impractical. The spot position is very sensitive to slight adjustment of the torsion head, and clamping invariably changed the ordinate considerably.

(iv) Orientation tests - October, 1956.

Tests were made in October, 1956 subsequent to re-orientation of the H and D variometer magnets.

(a) H orientation test - 13th October, 1956.

The coil was aligned to give fields directed in azimuth vertical to 24°55'. The ammeter used was VML 11386 (500 mA. range).

Ammeter reading	Ammeter temperature	Current applied	Total current	Coil constant	Total deflection	Scale value	Ex*
+442mA.	7.8°C	435mA.	868mA.	7.49γ/mA.	1.9mm.	12.5γ/mm	13'
-440mA.	8.1°C	433mA.					

A field directed east to west deflected the H spot in the direction of decreasing H. The north end of the magnet was therefore oriented south of east.

A previous determination during a somewhat disturbed period gave Ex* = 8' approximately.

The mean declination in October, 1956, was 24°56'. Therefore, referring the exorientation to the mean meridian for 1956.8 :-

Ex = 12', north end south of east.

(b) D orientation test - 17th October, 1956.

The coil was aligned to give fields directed in azimuth 24°55'. The ammeter used was VML 11386 (500 mA range).

Ammeter reading	Ammeter temperature	Current applied	Total current	Coil constant	Total deflection	Scale value	Ex(*)
+202mA.	6.9°C	198mA.	391mA.	7.49γ/mA.	4.1 mm	3.45γ/mm.	17'
-197mA.	7.0°C	193mA.					

A field directed north to south deflected the D spot in the direction of decreasing declination. The north end of the magnet was therefore oriented west of north.

The mean declination for October, 1956, was 24°56'. Therefore, referring the exorientation to the mean meridian for 1956.8 :-

Ex = 18', north and west of north.

(v) Summary.

Magnet	1956.4		1956.8		Date of re-orientation.
	Ex	Sense	Ex	Sense	
D	51'	N. end W. of N.	18'	N. end W. of N.	7. 7. 56.
H	1°43'	N. end S. of E.	12'	N. end S. of E.	19. 9. 56.

B. Battery Box.

The battery box was strengthened and anchored more securely. The engineer, H.Price, considerably improved the weatherproofing by covering the roof and windward side of the box with canvas, which was tarred before painting. He also fitted a new A.C. switch and distribution board.

A new 6-volt control and distribution board was fitted, fuses being inserted in the charger circuit and in both legs of the 6-volt supply.

In September, 1956, the two existing 6-volt, 13 plate, accumulators were replaced by one 6-volt, 19 plate, accumulator. The charging rate was set at about ½ amp.

Wires were soldered to the battery terminals in order to dispense with battery clips, which soon corrode and cause considerable trouble.

An earth stake for the A.C. supply was driven in some yards from the battery box, away from the magnetic huts. The magnetic effect of this stake could not be detected at a distance of one-fifth of its final distance from the variometer.

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* Referred to meridian 24°55'.

C. Magnetograph Reserve Spots.

Inspection of magnetograms for 1952 to 1956 reveals that a gradual decrease in intensity of the reserve spots has occurred over this period.

Examination of the reserve spot prisms showed that the silvering on many prisms was badly tarnished and, in some cases, peeling off. Light beams reflected by these prisms were very much weaker than the direct beams.

The poor intensity, during 1956, of the D reserve spots in particular, at times made interpretation of the D trace very difficult during disturbed conditions. These difficulties will no doubt increase as the deterioration of the silvering continues.

It is therefore recommended that a replacement set of prisms be obtained, and that these be installed during the 1957-58 relief operations.

D. Absolute Instruments.

Instruments used to control baselines during 1956 were :-

(i) Horizontal intensity : Q.H.M. 177 and 179. Q.H.M. 179 taken to Macquarie Island in December, 1955, to replace Q.H.M. 178, which was returned to Melbourne for comparison tests.

(ii) Vertical intensity : B.M.Z. 64.

(iii) Declination : Kew-pattern magnetometer, Dover, Charlton and Kent, No. 158.

This magnetometer replaced the Q.H.Ms. for weekly D baseline determinations from January, 1956. The change was made because of the difficulty in reading a mark accurately with the Q.H.M. telescope and the large scatter obtained in the D baselines. However, little improvement in this scatter was observed in the baselines after this magnetometer was introduced.

E. Intercomparison Observations.

(a) Intercomparison Observations, December, 1955.

During the relief operations of December, 1955, intercomparison observations were made between semi-absolute instruments in use at Macquarie Island and instruments brought from Melbourne. Observers were P.E. Mann, I.B. Everingham and the writer.

All intercomparisons were made through magnetogram baselines.

The standard deviations of the mean values given below are based on the internal consistency of each series of observations.

(a) Horizontal intensity - 12th, 13th, 14th December, 1955.

Q.H.M. 177, 178 and 179 were intercompared. Four sets of observations were made with each magnetometer. The results obtained were :-

$H_{179} - H_{177} = 0.00035H \quad (\pm 0.00014H)$

$H_{179} - H_{178} = 0.00046H \quad (\pm 0.00002H)$

(b) Vertical intensity - 11th December, 1955.

Intercomparison observations were made between B.M.Z. 64 and wide-range B.M.Z. 121 brought from Melbourne. Eight sets of observations were made with each instrument. The results obtained were :-

$Z_{121} - Z_{64} = -64$ gammas ($\pm$ 1 gamma)

(c) Declination - 11th to 15th December, 1955.

Intercomparison observations were made between Q.H.M. 177, 178, 179 and Askania Magnetometer 508813. Twelve sets of observations were made with each instrument. The results obtained were :-

$D_{508813} - D_{177} = 3.1$ minutes ($\pm$ 0.2')

$D_{508813} - D_{178} = -7.9$ minutes ($\pm$ 0.3')

$D_{508813} - D_{179} = -4.6$ minutes ($\pm$ 0.3')

The original constants supplied by Rude Skov were used for computing these results.

(ii) Intercomparison Observations, November, 1956.

(a) Horizontal Intensity - 19th and 20th November, 1956.

Q.H.M. 177 and 179 were intercompared. Twelve sets of observations were made with each instrument. The results obtained were :-

$H_{179} - H_{177} = 0.00027H \quad (\pm 0.00002H)$

(iii) Intercomparison Observations, December, 1956.

Intercomparison observations were made during the relief operations of December, 1956, by J. Cleary and the writer. Intercomparison instruments used were wide-range B.M.Z. 115 and Askania Magnetometer 508813 (for D). Subsequently, Cleary intercompared Q.H.M. 178 and 179.

Final results are not available at the time of writing; provisional results telegraphed from Macquarie Island are :-

$Z115 - Z_{64} = .49$ gammas.

$H_{179} - H_{178} = 0.00022H.$

$D_{508813} - D_{158} = 0.4$ minutes.

3. SEISMOLOGICAL OBSERVATORY

A. Grenet Seismograph

A short-period Grenet vertical component seismograph was installed at Macquarie Island during February, 1956. No

serious problems were encountered in its installation.

This instrument was found to be excellent in recording P-type phases, which are recorded badly or not at all by the horizontal Wood-Anderson type instruments. During the nine months from March to November, 1956, forty teleseisms (not recorded by the Wood-Anderson) were recorded by the Grenet.

B. Seismograph Battery.

The accumulator supplying 6 volts for the seismograph recorders was replaced in November, 1956, by a new accumulator.

4. GENERAL

A. Painting of Buildings.

Although it would be desirable to paint all huts twice a year, it is unlikely that time and weather will allow this. It is suggested that those walls and roofs exposed to the prevailing wind and sand blast should be painted before the winter, and all buildings completely repainted during the spring.

It was found during 1956 that much of the paint on the magnetic buildings could be peeled off in sheets, due to dampness of the wall and roof panels. Paint was stripped from these areas, which were allowed to dry and then given a good undercoat of red lead before being repainted.

B. Power Supply.

All power supply cables to seismic and magnetic huts are underground. Some trouble with leakages was experienced during 1956 due to moisture entering the cables through buried joints. The engineer, H. Price, uncovered all the joints and rejoined the cables in termination boxes above ground.

The A.C. wiring in the magnetic battery box and some wiring in the office and darkroom were replaced by the engineer.

Power failures were very rare and loss of seismic trace due to this cause was very slight.

C. Suggestions on Preparations prior to Departure.

(i) Wherever possible, packing cases should be limited in size and weight to enable easy handling by two men.

(ii) It is most important to allow for the possibility of loss of a case overboard during unloading operations. Entire supplies of such key items as photographic paper and chemicals should not be packed in a single container.

(iii) Cases should be conspicuously marked "Bureau of Mineral Resources", and should have individual markings, A,B, etc., corresponding to a list of contents of each case.

(iv) During unloading operations, cases are frequently subject to spray, and may be stacked in the rain. It is important that cases containing goods which might be damaged by salt or moisture should be lined with tarred paper and sealed with PC49.

A bag of dehydrated silica gel should be included in such cases to prevent condensation when the temperature drops.

(v) If possible, the relieving geophysicist should attend to the packing of every item himself.

5. ACKNOWLEDGEMENTS

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