COMMONWEALTH OF AUSTRALIA
DEPARTMENT OF NATIONAL DEVELOPMENT
BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS

RECORDS 1954, No. 33

GEOPHYSICAL WORK AT MACQUARIE ISLAND

APRIL 1953 - DECEMBER 1953

by

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ILLUSTRATIONS

ABSTRACT

This report covers the work done by the author who was geophysicist with the Australian National Antarctic Research Expedition at Macquarie Island from April to December, 1953. It is a sequel to Records 1953/30 and 1954/32 and deals with observatory routine and maintenance and other general duties required of the geophysicist. The report contains the results of absolute magnetic observations and initial earthquake phases.

Detailed tables of scientific results will be published separately in reports at present in preparation.

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1. INTRODUCTION.

Macquarie Island, Lat. 54° 30' S, Long. 158° 57' E, situated 850 miles south-south-east of Tasmania, has, since 1948, been the site of a scientific station controlled by the Australian National Antarctic Research Expedition.

The Bureau of Mineral Resources, Geology and Geophysics is responsible for the equipping, staffing and maintenance of a magnetic and a seismological observatory on the island. The writer, an officer of the Bureau, was geophysicist at Macquarie Island from April to December, 1953, succeeding Messrs. W.R. Flower 1950, W.H. Oldham 1951 and P.M. McGregor 1952.

2. MAGNETIC OBSERVATORY.

(a) Housing.

The magnetic instruments are housed in two huts which have previously been described (Oldham, 1953 and McGregor, 1954). These were in fair condition on the writer's arrival in April, 1953, but deteriorated rapidly during the winter. Sand, blown by the prevailing strong westerly wind, removed all the paint from the western sides of the roofs and most of the paint from the western walls.

The huts were painted late in the year as soon as the weather improved sufficiently.

(b) Equipment.

(i) Magnetographs.

The recording instruments consisted of a set of low-sensitivity La Cour variometers and a 15 millimetre/hour recorder. (Plate 1, Fig. 1).

During the previous year, fading of the trace, attributed to condensation of moisture on the glass surfaces of the recording system, had been noticed. The extremely high humidity at Macquarie Island is responsible for this trouble. As a remedy, all exposed glass surfaces were coated with an anti-dimming compound containing rutile, alcohol and "Lissapol C". By renewing this coating about once each three months, trace fading has been avoided.

As an aid to reducing humidity the drying agent inside the variometers was changed from silica gel to phosphorus pentoxide.

While the writer was absent from main camp, the recorder ceased operating on two occasions after about ten or eleven hours of satisfactory recording. Mr. J.T. Bishop, the cosmic-ray physicist on the island, who was looking after the variometers, informed the writer of this fact by radio, and acting on his advice, replaced the weight-driven recorder clock by a spare. On the writer's return, tailweights were fitted to the drive chains, as it was considered that lack of tension in the free end of the chains may have caused the stoppages. Since these changes, the recorder has been operating satisfactorily.

Altogether, approximately 70 hours' record was lost during the period April-November 1953.

The variometer control panel in the magnetograph hut was partly rewired during the year, and the two knife-switches used in scale value determinations were replaced by a five-position rotary switch. This eliminated the variations in scale value current noticed when using the old switches and which were probably caused by poor contacts.

The scale value circuit was improved by the addition of a first-grade milliammeter, for which the temperature correction had been determined by the Defence Research Laboratories, Department of Supply, Maribyrnong. A thermometer, placed near the milliammeter, was used to determine the temperature at the times of scale-value determinations.

(ii) Absolute Magnetic Equipment.

The instruments used in absolute determinations were QHM's 177 and 179, and BMZ No.64, (Plate 1, Fig. 2). QHM 179 was brought to the Island by the writer to replace QHM 178, which was returned to Melbourne for intercomparison with standard instruments.

(c) Routine Work and Maintenance.

In April and July, intercomparison observations were made with the QHM's to determine -

(i) the I.M.S. correction of QHM 177,

(ii) the I.M.S. correction of QHM 179 used as a declinometer.

Consistent results were obtained in the two series of intercomparisons.

Grooved brass footplates were fitted to the two instrument piers in the absolute hut so that the instruments could be oriented in the same direction for each determination of the components of the earth's magnetic field.

An unsuccessful search was made for Magnetic Station A, but this station is no longer necessary, the azimuths from Station C being known (Oldham, 1953).

In 1952, absolute magnetic measurements were made at Caroline Cove at the S.W. corner of the island (McGregor,1954) but azimuth observations could not be made. In October 1953, the writer went to Caroline Cove to take azimuth measurements so that McGregor's results could be finalised. Unfortunately, continuous cloud cover did not permit accurate sights to be taken and it will be necessary for the observations to be repeated.

At the main camp, sunshots, to determine the azimuth of the declination marks from the pier in the absolute hut, were taken at various times during the year when weather permitted. (Plate 1, Figs. 3 and 4).

In addition to this work, the following routine, established by the previous geophysicist, was carried out:-

(i) Scaling mean hourly values of each magnetic element: Horizontal Intensity (H), Vertical Intensity (Z) and Declination (D).

(ii) Absolute determination of H,D & Z four times per month.

(iii) Determination of H & Z scale values four times per month in conjunction with (ii).

(iv) Calculation of monthly mean values of H,D & Z.

(v) Parallax tests on the recorder once per month.

(vi) Determination of K-Index for each three-hourly period.

(vii) Listing of magnetic storms and sudden commencements.

(viii) Daily determination of chronometer rates and corrections to standard time.

3. SEISMOLOGICAL OBSERVATORY.

(a) Housing.

The seismograph is housed in a concrete hut erected on rock on the southern slope of Wireless Hill at the north end of Macquarie Island (McGregor, 1954). The seismograph and recorder are mounted on a concrete pier, isolated from the hut floor, and standing on rock.

The office and darkroom are in a wooden hut joined to the seismograph hut and connected by an internal door. Both huts were in good condition on the writer's arrival, but leaks tended to appear along the junction of the wooden and concrete sections. These were remedied by the application of P.C. 49, a job that needs to be done periodically.

The water supply (a Furphy tank) was adequate for darkroom needs and showed no sign of running out.

(b) Equipment.

The seismological equipment consisted of a two-component short period Wood-Anderson type seismograph aligned in a North-South and East-West direction, recording continuously on photographic paper. Drum speed was 30 millimetres/minute. Minute and hour time marks were placed on the record from a Mercer chronometer, checked daily against station WWVH (Honolulu).

Focussing of the two light spots and adjustment of their intensity to a satisfactory level caused some difficulty. It was necessary to arrive at a compromise between a light not too bright for a relatively steady trace and yet not too faint to record satisfactorily the sharp movements recorded in local earthquakes.

Early in the year, the system of time marking was altered so that the light beam was deflected for five seconds each minute and at the hourly deflection the light intensity was increased. This enabled the arrival times of earthquake phases to be determined more accurately.

Damping tests were made each month and as the instruments were seriously underdamped (damping co-efficient 0.1) some effort was made to increase the damping. Mild steel strips were placed under the magnet pole pieces to lessen the air gap and thereby increase the magnetic flux, but this effected only a slight increase in damping. The field strengths in the air gaps were determined experimentally and the values cabled to Head Office in Melbourne so that stronger magnets could be sent to Macquarie Island with the relief ship.

(c) Routine Work and Maintenance.

Many local earthquakes, some very close to the Observatory, were recorded, as well as approximately twenty teleseisms, including earthquakes in Japan and Peru. Two of the local earthquakes were felt on the island.

The routine seismological programme was:-

(i) Preliminary scaling and interpretation of all shocks recorded. Jeffreys and Bullen travel time tables were used for the interpretation.

(ii) Sdaling of period and amplitude of microseisms on both components at 0,6,12 and 18 hours GMT.

(iii) Determination of damping co-efficients once per month.

(iv) Determination of instrumental free periods twice per year.

During December, 1953, the writer assisted the relieving geophysicist, Mr. C.S. Robertson, to instal a new two-component seismograph of similar type. This instrument had a more satisfactory damping co-efficient (up to 0.85) and better focussing.

4. GRAVITY OBSERVATIONS.

During the change-over periods in April and December 1953, gravity readings were taken at four-hourly intervals for a period of several days. The instruments, a Worden and a Norgaard gravimeter, were set up in the meteorological store, where the gravity station had previously been established. The results of these observations will be the subject of a separate report. Rock densities were measured to aid in the computation of the gravity results. The average density of 2.6 grammes per cubic centimeter was used in the computation.

5. AURORAL OBSERVATIONS.

The visual auroral watch was shared by six members of the party, including the writer, and entailed a sunset to sunrise watch, observations being taken each quarter hour. The type, position and intensity of auroral displays and the amount of cloud cover were noted on a special form. The results were sent direct to the Australian National Antarctic Research Expedition.

So that the geophysicist might obtain some sleep after a night's watch, Mr. J.T. Bishop, the cosmic-ray physicist, was instructed in the routine changing of, and photographic processing of, both magnetic and seismic records.

In addition to the visual auroral watch, a programme of simultaneous parallactic photography of selected auroral forms was undertaken by the scientific members of the expedition under the direction of the A.N.A.R.E. This necessitated the writer making two trips to the southern end of the island where an auxiliary station had been established. Altogether, about three weeks were spent by the writer at the Southern Camp. During his absence, the routine changing and processing of records was done by Mr. J.T. Bishop.

6. GENERAL.

Routine maintenance of the radio equipment (used for checking chronometers against station WWVH) comprised minor adjustments to the office radio and the erection of a new antenna. The presence of the old antenna interfered with the antenna for the ionospheric noise recorder.

Two weeks of each thirteen were spent as either cook's assistant or mess orderly. These jobs occupied several hours per day and allowed only routine scientific duties to be done during these weeks.

General camp duties occupied about two days per month. These duties consisted of renovation and repair work to the camp buildings. On many occasions it was necessary to assist in work which required the services of several men. These duties included stores handling, seal branding and penguin-ringing.

7. RESULTS.

A separate report containing detailed tabulations of scientific results of the magnetic work carried out is in course of preparation. It was thought appropriate nevertheless, that tables showing the values of the magnetic elements determined regularly by semi-absolute measurement should be given in Appendix 1.

Initial earthquake phases which were recorded have also been presented in Appendix 2

8. CONCLUSIONS AND RECOMMENDATIONS.

(a) Magnetic.

(i) If, in future, any work is to be done on the correlation between auroral and magnetic disturbances, a lower-sensitivity variometer and a quick-run recorder would be of great value. The present La Cour variometers and recorder produce records which are too disturbed for detailed correlation.

(ii) The magnetic huts should be painted at least once every six months. The roofs need special attention. Some type of insulating material, capable of being laid on the exterior of the wooden roofs would be of great value in temperature control and in preservation of the roofs. It would be necessary to use a white material or one capable of taking a coat of white paint.

(b) Seismological.

A short-period vertical component seismograph would be of great value at Macquarie Island both for local shocks and teleseisms. It would enable the P phases to be more readily identified. A seismograph located at the auroral station at the south end of the island would be useful in the study of local seismicity. It would be an advantage to have a recording speed of 60 millimetres/minute or higher on this seismograph.

(c) General.

So that the routine duties of the geophysicist may be satisfactorily carried out during his absence from camp, it is desirable that at least two other members of the expedition be instructed in the changing and processing of records. If only one other person is so instructed, it is possible that both he and the geophysicist may be absent at the same time.

9. ACKNOWLEDGEMENTS.

The writer wishes to thank members of the staff of the Bureau of Mineral Resources, especially Messrs. L.S. Prior and C.A. van der Waal for their interest and help in the publication of this report.

Thanks are also due to all members of the 1953 A.N.A.R.E. party on Macquarie Island, especially Mr. J.T. Bishop, for their help during the writer's stay on the island.

10. REFERENCES.

Oldham, W.H., 1953 - Report on Work at Macquarie Island 1951/52, Bur.Min.Res.Geol.&Geophys., Records 1953, No.30.

McGregor, P.M., 1954 - Geophysical Work at Macquarie Island, April, 1952-April, 1953. Bur.Min.Res.Geol. & Geophys., Records 1954, No.32.

APPENDIX 1.

ABSOLUTE MAGNETIC OBSERVATIONS

Date	G.M.T.	Horizontal Intensity	G.M.T.	Declination East	G.M.T.	Vertical Intensity
1953		(gammas)				(gammas)
April 8					0414	-64,583
15	0216	13353	0153	24° 15.2'	0148	-64,542
23	0555	13427	0555	24° 08.0'	0552	-64,586
28	0207	13355	0207	24° 15.8'	0202	-64,551
May 12	0135	13348	0135	24° 15.2'	0132	-64,546
22	0354	13369	0353	24° 10.0'	0352	-64,593
26	0115	13353	0116	24° 13.2'	0115	-64,540
29	0414	13359	0414	24° 14.8'	0412	-64,547
June 8	0419	13366	0419	24° 15.4'	0417	-64,543
9	0156	13367				
10	0152	13363				
13	0419	13376	0418	24° 15.0'	0416	-64,564
19	0416	13365	0415	24° 14.4'	0414	-64,543
25	0057	13347	0056	24° 15.8'	0052	-64,534
26					2333	-64,535
July 8	0401	13360	0401	24° 16.6'	0400	-64,558
13	0416	13371	0415	24° 18.0'	0415	-64,538
21	0446	13361	0445	24° 19.6'	0444	-64,540
31	0047	13338	0046	24° 19.0'	0042	-64,552
Aug. 6	0423	13366	0415	24° 19.8'	0414	-64,541
16	0422	13349	0422	24° 21.8'	0420	-64,568
21	0441	13358	0441	24° 19.9'	0440	-64,533
31	0359	13423	0358	24° 15.4'	0357	-64,575
Sept. 2	0405	13364	0403	24° 20.3'	0403	-64,548
7	0042	13344	0041	24° 17.8'	0040	-64,554
22	0448	13518	0447	24° 23.4'	0446	-64,636
27	0420	13473	0420	24° 22.8'	0420	-64,607
Oct. 3	0127	13350	0127	24° 21.1'	0126	-64,541
11	0140	13350	0140	24° 22.2'	0139	-64,529
25	0501	13453	0502	24° 22.8'	0459	-64,559
31	0142	13342	0141	24° 23.4'	0140	-64,546
Nov. 7	0406	13405	0406	24° 24.6'	0405	-64,565
13	0417	13512	0417	24° 24.8'	0417	-64,608
23	0449	13374	0448	24° 26.9'	0448	-64,532
29	0357	13384	0359	24° 30.2'	0357	-64,561
30			0922	24° 21.3'		

APPENDIX 2.

INITIAL EARTHQUAKE PHASES

Date	Phase	Time (G.M.T.)
1953 April 6	iP_{NE}	00 45 26
	eS_{E}	52 50
	iPg_{NE}	03 11 58
	iSg_{NE}	12 01
7	iPg_{E}	08 53 19
	iSg_{NE}	53 23
	iPg_{NE}	18 14 41
	iSg_{NE}	14 45
	iPg_{N}	22 31 38
	iSg_{N}	31 44
8	iPg_{N}	10 52 40
	iSg_{N}	52 48
19	iPg_{N}	01 17 32
	iSg_{N}	17 34
22	iPg_{N}	15 38 25
	iSg_{N}	38 34
23	iPg_{N}	14 54 05
	iSg_{N}	54 13
23	iP_{E}	16 33 07
	eS_{N}	40 15
26	eL_{N}	12 24 17
26	iPg_{NE}	20 59 42
	iPg_{N}	23 42 19
	iSg_{N}	42 23
30	eP_{E}	06 33 32
	eS_{E}	39 03
May 6	iPg_{E}	02 43 27
	iSg_{E}	43 30
9	iPg_{E}	23 01 11
	iSg_{E}	01 18
11	eL_{N}	10 33 31
13	iPg_{E}	19 05 13
	iSg_{E}	05 21
26	iPg_{E}	21 29 15
	iSg_{E}	29 17
June 2	iPg_{NE}	15 45 53
	iSg_{N}	45 58
5	iPg_{E}	21 19 45
	iSg_{E}	19 55
10	iPg_{NE}	18 46 33
	iSg_{NE}	46 36
13	iPg_{E}	00 42 02
	iSg_{NE}	42 07
1953 June 15	iPg_{NE}	03 21 17
	iSg_{NE}	21 21
18	iPg_{NE}	08 11 06
	iSg_{NE}	11 09
	iPg_{NE}	18 17 57
	iSg_{NE}	17 59
21	iPg_{NE}	01 31 24
	iSg_{E}	31 28
22	iPg_{NE}	04 54 20
	iSg_{NE}	54 24
25	iP_{E}	10 53 10
	eS_{N}	11 00 38
25	iP_{E}	10 54 14
	eS_{N}	11 01 44
26	iPg_{NE}	19 31 24
	iSg_{E}	31 28
July 2	iP_{NE}	07 03 43
	iS_{N}	09 09
4	iPg_{NE}	23 40 21
	iSg_{N}	40 26
6	iPg_{NE}	19 50 02
	iSg_{NE}	50 08
	iPn_{NE}	19 54 12
	iSn_{E}	54 50
	iSg_{NE}	55 00
16	iPg_{NE}	09 56 42
	iSg_{NE}	56 45
19	iPg_{NE}	21 58 27
	iSg_{NE}	58 30
20	iPg_{NE}	19 17 52
	iSg_{NE}	17 55
26	iPg_{NE}	19 05 28
	iSg_{NE}	05 35
28	iPg_{NE}	07 05 45
	iSg_{NE}	05 47
29	iP_{NE}	23 26 18
	iS_{N}	32 58
Aug. 3	iPg_{N}	23 15 58
	iSg_{NE}	16 02
6	iPg_{NE}	04 57 57
	iSg_{NE}	57 58
15	iPg_{E}	12 38 32
	iSg_{E}	38 33

APPENDIX 2 (C'td.)

Date	Phase	Time (G.M.T.)
1953		
Aug. 19	iPg_{NE}	15 18 38
	iSg_{E}	18 39
21	iPg_{NE}	18 43 07
	iSg_{E}	43 09
25	Tremors	(05 49 22
		(08 33 19
		(09 10 40
		(12 26 36
26	Tremor	08 33 07
26	iPn_{NE}	05 59 00
	iSn_{NE}	59 39
28	iPg_{NE}	07 46 58
	iSg_{NE}	47 03
29	iPg_{NE}	09 20 19
	iSg_{E}	20 21
	iP_{NE}	16 09 31
Sept. 1	iPg_{NE}	08 28 19
	iSg_{NE}	28 27
5	iPg_{NE}	06 02 20
	iSg_{NE}	02 22
14	eL_{E}	00 42 47
	iPg_{NE}	13 19 40
	iSg_{E}	19 44
29	eL_{N}	03 48 27
	eL_{E}	03 48 39
	iPg_{E}	08 31 29
	iSg_{NE}	31 34
29	eP_{NE}	01 41 12
	iS_{N}	44 49
30	Tremor	08 30 18
Oct. 2	iP_{NE}	01 05 19
	eS_{NE}	06 26
4	iPg_{NE}	10 43 02
	iSg_{NE}	43 14
	iPg_{NE}	15 51 25
	iSg_{NE}	51 27
8	iPg_{NE}	15 30 41
	iSg_{NE}	30 44
	iP_{NE}	22 31 05
	eL_{N}	32 26
11	iPg_{NE}	21 00 30
	iSg_{N}	00 39
13	iPg_{E}	17 55 33
	iSg_{NE}	55 36
18	iPg_{NE}	19 36 10
	iSg_{E}	36 14
1953		
Oct. 21	iP_{NE}	03 39 36
	eS_{N}	41 43
26	iPn_{NE}	07 30 16
	iSn_{NE}	44
	iPg_{N}	07 31 56
	iSg_{NE}	31 59
Nov. 4	iP_{NE}	03 57 01
	eS_{NE}	04 03 19
	iP_{E}	04 12 44
	iP_{N}	04 12 46
	iPg_{NE}	05 46 16
	iSg_{NE}	46 19
	iP_{NE}	12 35 38
	eS_{N}	42 00
10	iPg_{NE}	13 56 32
	iSg_{NE}	56 39
11	iPg_{N}	16 23 03
13	L_{E}	19 36 34
16	L_{E}	17 35 31
20	iP_{E}	03 14 26
	eS_{NE}	15 41
21	ePg_{N}	21 06 03
	iSg_{E}	06 07
24	iPg_{NE}	15 55 41
	iSg_{E}	55 44
	iP^{x}_{NE}	16 34 15
	iSg_{NE}	34 30
25	iP_{E}	18 01 50
	iS_{NE}	11 42
26	iP^{x}_{NE}	15 47 55
	iSg_{NE}	48 11
27	iPg_{NE}	06 08 21
	iSg_{N}	08 26
Dec. 2	L_{N}	04 54 29
3	iPg_{NE}	03 44 26
	iSg_{NE}	44 31
7	iPg_{NE}	15 09 54
	iSg_{NE}	10 01
9	iPn_{NE}	15 37 07
	iSn_{NE}	37 29
10	iPg_{E}	18 36 09
	iSg_{NE}	36 10
12	L_{NE}	18 20 25
13	iPg_{NE}	10 22 42
	iSg_{NE}	22 48
15	iPg_{NE}	15 46 58
	iSg_{NE}	47 05

PLATE I

Fig. 1. La Cour Variometers.

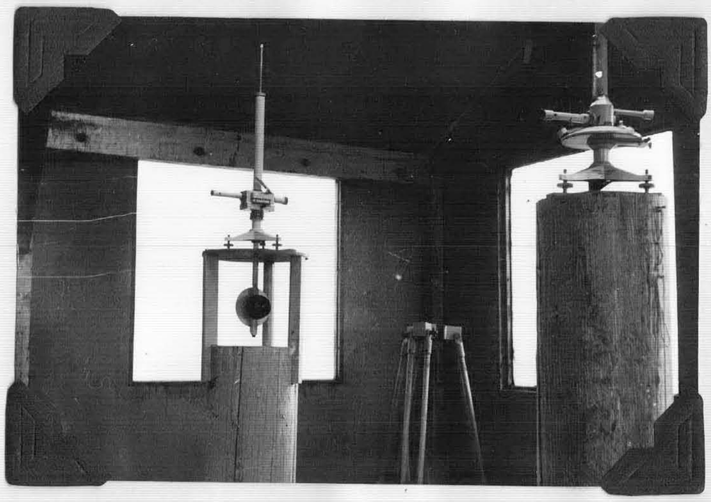

Fig. 2. BMZ and QHM Instruments.

Fig. 3. South Declination Marks
(i) Seaward of the two rocks (The Nugget).
(ii) Post between the two rocks.

Fig. 4. North Declination Mark
(i) Summit of rock between the two huts.