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BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

RECORDS:

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RECORD NO. 1968/41

Macquarie Island Geophysical Observatory, Annual Report 1966

by

E.J. MUIR

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SUMMARY

Two La Cour magnetographs and a short-period vertical Benioff seismograph were in operation at Macquarie Island throughout 1966.

A 'Transtronics' constant frequency power supply was installed and modified for automatic change-over to battery operation in event of mains failures.

The La Cour pendulum clock failed and major repairs were carried out.

The scientific results are not included in this report but will be published separately.

1. INTRODUCTION

The seismological observatory at Macquarie Island has been in operation since 1950 and the magnetic observatory since 1951.

R.G. Sutton(in preparation)has described the 1965 operations. The author was in charge of the observatories from 16th December 1965 to 10th December 1966. He was succeeded by J.A. Major.

The instruments operating in 1966 were normal-run and rapid-run La Cour magnetographs, and a short-period vertical Benioff seismometer with a BMR recorder.

Descriptions of the observatory and routines have been given in earlier reports by van Erkelens (1961), Hollingsworth (1960), and Turpie (1959).

2. MAINTENANCE AND IMPROVEMENTS

Maintenance required during 1966 was light, thanks to the excellent work done in 1965; however, the following work was carried out.

Buildings

Painting. Both magnetic buildings and two walls of the seismic building were painted on the outside and the seismic office and darkroom were finished on the inside.

Weatherproofing. Bituminous compound was twice applied to the joints in the concrete seismic vault roof to prevent water dripping in to the plinth, but the main trouble appeared to be seepage along the underside of the roof which is in direct contact with the side of Wireless Hill.

Roofing. Several sheets of galvanised iron on the storeroom roof were badly rusted and were replaced by the carpenter.

Water supply

The water supply header tank was periodically cleared of vegetable matter, mostly spirogyra. A water filter has since been sent down, so the darkroom water should now be much cleaner.

Improvements

Darkroom and offices. Several modifications were made to the interior of the darkroom with a twofold aim:

(1) to make storage of small items tidier and more convenient;

(2) to protect tools and other items liable to damage from a damp atmosphere.

The shelf above the sink was rebuilt and two wooden cupboards were installed on this shelf.

A tool cupboard was made to fit on the east wall above the developing dishes to replace the old shadow board. Small electric lamps were fitted to raise the inside temperature to help keep the tools dry. (For a given percentage water vapour in the air, the relative humidity decreases with increasing temperature.)

Immersion heaters for warming developer and fixer were inconvenient and unreliable (Sutton, in prep), so the developing and fixing dishes were stood on small wooden frames with several 25-watt red pilot lamps underneath. These lamps were left on continuously and maintained the solutions at approximately the required temperature.

The AWA radio which was used for receiving VNG time signals was found to radiate excessively at the local oscillator frequency. This caused interference to the riometer, not only whenever the set was tuned to certain frequencies, but there was also a transient whenever it was switched on. An AR7 receiver was installed as an alternative and this caused no trouble, probably because it had two radio frequency stages.

The fluorescent light in the seismic office was found to cause radio interference; it was replaced with two incandescent lamps.

Magnetic Observatory. A new box to house the batteries and charger for the magnetic observatory was completed and installed by the carpenter and the electrician. This job was carried over from 1965 (Sutton, in prep).

3. MAGNETIC OBSERVATORY

Magnetometers

The Absolute instruments used throughout 1966 were:

BMZ 64
QHM 177
QHM 179
Askania declinometer 640 505
Askania circle 640 620

Intercomparison instruments

In the December 1966 intercomparisons, the absolute instruments listed above were compared with:

ELSEC proton magnetometer
QHM 178
HTM 154
Askania declinometer 812

QHM 178 remained at Macquarie Island and QHM 177 was returned to Melbourne.

Magnetographs

There were two continuously recording La Cour magnetographs operating throughout 1966, one of 14-mm/hour chart speed, and one rapid-run of 180-mm/hour chart speed.

Standard La Cour variometers were used for all three components of each set. Relevant data are given in Table 1.

Tests. Following an earth tremor at 1158Z on the 5th April the normal-run H fibre unwound and the torsion head had to be reset. This necessitated orientation tests and further adjustments had to be made.

Orientation tests were made on all variometers except the rapid-run Z between the 11th and 21st July. Table 2 contains the results of these tests, together with the results of the 1966 tests adjusted to the fields at the time of the 1965 tests. An estimate of the likely errors is also given and it can be seen that where comparison is valid, results for both years agree to within the limits of experimental error.

Control observations. Normal-run scale value and absolute observations were made twice weekly. Rapid-run scale values were determined monthly. From these results, scale value and baseline values were adopted. Plots of scale values showing adopted values appear in Plate 1. The industrial standard meter VML 14260 previously used for measuring scale value currents was returned to Melbourne for calibration. Meter VML 21164 was used from March onwards.

In order to check on the consistency of the scale value meter, a potentiometer incorporating a Weston standard cell was constructed and used to monitor the scale value observations. The circuit is given in Plate 2. The null indicator of the potentiometer was a 50-microamp centre zero meter. The proximity of this meter to the normal-run variometers led to small steps in D and H baseline values when the potentiometer was installed on January 14 and removed on November 18. The potentiometer increased the H baseline by about 4 gammas and decreased the D baseline by about 0.2 minute. This potentiometer was returned to Australia in December 1966, and has since been calibrated and found to null at a current of (62.82 - 0.035T) mA where T is the temperature in the range 0-20°C. All scale value adoptions have been based on this, which is why the 1966 scale values appear to be somewhat higher than those adopted for 1965.

A leakage detector for the normal-run scale value coils was installed to guard against errors in scale value determinations caused by current leakage between the Helmholz coils and their metal frames. No such leakage was observed.

Early in the year a fibre was broken in the Askania declinometer. The replacement fibre was made of tungsten. Difficulty in the identification of azimuthal reference marks was experienced owing to the lack of proper diagrams, so a photograph of Anchor Rock with the azimuthal references clearly marked is shown in Plate 3.

A larger concrete pier was cast directly over the old proton precession magnetometer comparison pier, and a removable wooden stand made to fit on top. The wooden stand was made to avoid damage from weather and seals.

Artificial interference. During the 1966-67 change-over period, three large induction magnetometers for micropulsation work were installed by J. Annexstad for the Geophysical Institute, University of Alaska. As these were to be sited approximately 100 feet from both the absolute and variometer huts, tests were made to assess the likely amount of interference. This was done by observing the Askania declinometer as one of the induction coils was carried gradually closer from an easterly direction. Deflection was first noticed when the coil was 50 feet from the declinometer. Minimum observable deflection for the Askania is 0.1 minute, on the telescope scale and this corresponds to a change in Y of 0.4 gamma at Macquarie Island. Since the magnetometers were to be situated 100 feet from the magnetic observatory, and the field of a magnetic dipole varies as the inverse third power of distance, this degree of interference was considered tolerable.

Record losses. A total of approximately five days rapid-run and eight days normal-run record was lost throughout the year. Normal-run losses arose mostly from attempted adjustments aimed at improving trace densities, whereas rapid-run losses were mainly due to human errors such as forgetting to reset the sledge or leaving the mask in place after scale value determinations.

4. SEISMIC OBSERVATORY

Seismograph

This consisted of a short period (1 second) Benioff seismometer, a 0.2-second galvanometer, and a BMR recorder which ran at 30 mm per minute. The seismograph was unchanged from 1965 and has been adequately described by Sutton (in prep). Results of routine seismograph tests appear in Table 3.

Chronometers and timemark circuitry

Chronometer 19090 stopped and was replaced with 18385 on the 3rd September. Details are given in Chapter 5.

The 10-ohm 25-watt wire-wound variable resistor in series with the recorder lamp became noisy and was replaced. The replacement became noisy after several weeks. It is strongly recommended that a transistor regulator be installed, as suggested by Sutton (in prep).

Seismometer tests

During the first seismometer tests, the Benioff mass was found to stick as pointed out by Sutton (in prep). To remedy this the transducer air gaps were reset in accordance with instructions given in the handbook. It took several attempts to obtain the correct free period, which was adjusted by means of the suspension ribbons.

At intervals of about two months, the free period, damping, and magnification of the seismometer were checked. The results appear in Table 3 and are consistent with those of Sutton. They are also consistent with those of Gregson (1965) if the highest attenuation setting in his Table 4 to be taken as 30 dB and not 28 dB.

During these tests and adjustments, it was noticed that free period adjustment strongly affects damping ratio, hence free period adjustments should be made <u>before</u> damping adjustments.

<u>Constant Frequency supply</u>

On December 20 1965, a 'Transtronics' constant frequency power supply was installed to supply the synchronous motor of the seismic recorder. This eliminated variations in recorder speed with mains fluctuations. Frequency from this supply drifted slowly, possibly owing to temperature changes in the vault and occasional adjustment of frequency was necessary.

On the original unit, the output frequency adjustment was inside the case, so adjustment required removal of the top cover. This was inconvenient, so a 10-turn Helipot was mounted on the front panel. This also enabled a finer adjustment of frequency to be obtained so that recorder speed could be adjusted to within approximately 1 part in 5000.

The unit was further modified to incorporate a standby battery (No. 6 dry cells) and mains operated change-over relay so that recording was not interrupted by brief failures of the mains supply. It is understood that a crystal clock with 28-volt standby batteries will be installed shortly, so it is suggested that these reserve batteries could also serve the 'Transtronics' in place of the dry cells currently in use.

<u>Record losses</u>

Approximately six days of record was lost throughout the year; two days owing to absence of timemarks through poor wiring; two days owing to mistakes made in modifying the 'Transtronics' power supply; and one day owing to faulty engagement of the traversing screw, as well as a number of minor causes.

5. CHRONOMETERS AND TIMEMARK CIRCUITRY

<u>Seismic chronometers</u>

When the author arrived at the observatory, Mercer chronometer No. 19090 was in use. No. 18385 was supplied as a spare. Trouble was soon experienced with intermittent hour marks on 19090. This was due to two separate faults:

(a) wires from the hour contact to the terminals on the case were only loosely twisted thus making intermittent contact. These were soldered;

(b) the minute indicating hand was loose on its shaft and was not depressing the hour contacts properly. This was remedied by slitting the inner end of the brass minute hand and squeezing in a vice so as to make it a tight push fit on the shaft. The hour contacts themselves were then bent to set the duration of the hour mark to approximately 20 seconds, ending on the hour.

After these repairs the chronometer rate was in error by some minutes per day. This was thought to be due to loose balance wheel weights but even after these were tightened the rate was difficult to adjust and prone to sudden jumps, which necessitated further adjustment.

This chronometer broke a mainspring on August 3, so was replaced with 18385, which gave no trouble, although its rate varied from +1 to +4 seconds per day. Hour marks from this chronometer took the form of missed minute marks. Minute marks for both chronometers were of 4 seconds duration, the trailing edge occurring on the minute.

Seismic timemark deflection circuitry

Only minor troubles were experienced throughout the year. The main causes of trouble were connections that had become loose or dirty over the years. The OC71 transistor which operated the timemark deflection relay was replaced with an ACY19, which has a higher current rating.

La Cour pendulum clock

This clock, which supplied the timemarks for both the normal-run and rapid-run magnetographs stopped several times during early October; finally, on 17th October it stopped and could not be restarted. Upon dismantling it was noticed that the pallets were badly pitted; these were polished with a slipstone, which apparently affected their shape, as the clock still refused to run.

Since the escape lever had obviously been bent and reshaped before, it was decided to make another. An new lever was made from mild steel, hardened in 'Hardite' and polished with a slipstone. The escape lever bushes were drilled to a larger size and the new escape lever with larger pivots was installed. The clock then ran satisfactorily, but required twice the normal tension in the driving chain. This was obtained by removing a pulley and hanging the weight directly from the chain. The clock was returned to service on 31st October.

After these repairs, the clock gave no further trouble, apart from stopping once because 'instrument oil' with which it had been lubricated went 'gummy'. Thorough cleaning with carbon tetrachloride and lubrication with watch oil remedied this. A replacement clock was received in December; the old clock has since been returned to Melbourne for complete overhauling.

Arrangements for temporary timemarks

While the La Cour clock was inoperative a temporary system was employed. This utilised timemarks from the Mercer seismic chronometer. The Mercer provided minute marks of 4 seconds duration with the mark on the hour missed (sometimes!) Timemarks every minute would have been much too frequent for the magnetic records, so by means of a transistor binary and several relays, only alternate chronometer pulses were used. The pulses were carried along a field telephone cable which was laid between the seismic office and the variometer hut.

There was sufficient spacing between timemarks for legibility, but interpretation was sometimes difficult because the Mercer occasionally did not miss the minute mark on the hour. A close inspection was therefore necessary in order to ascertain whether the marks in any one hour represented odd or even minutes.

This system operated satisfactorily for about two weeks, until the La Cour clock was returned to service, and was retained as a precaution for a further two months.

The possibility of laying permanent cables from the seismic office to the variometer hut was investigated and appeared feasible. If this were done, one crystal clock located in the seismic office could serve both observatories and time corrections for magnetograms would then become negligibly small.

It is understood that a crystal clock is to be installed in the near future, so it is felt that an underground cable with as many spare conductors as possible should be considered now.

Direct recording of VNG time signals on seismograms

This was achieved by means of a torch globe connected across the loudspeaker terminals of the AR7 receiver. This light operated a phototransistor (OC44 with paint removed) connected across the chronometer contacts. This simple arrangement operated satisfactorily even on days of moderately poor reception.

As mentioned in Chapter 2, the AWA type IC-6770 receiver interfered with the riometer. The AR7 with which it was replaced is very old and it is felt that a new receiver designed especially for the operation of relays from VNG signals is warranted.

6. NON-GEOPHYSICAL DUTIES

During the year certain non-geophysical work was undertaken. With the exception of Assistant Cook ('Slushy') duties, most of this work was voluntary. Times spent on non-geophysical work excluding recreation are tabulated below.

Duty	Days	Hours
Assistant/relieving cook	22	
General camp duties		63
Biological field assistance	20	
Other assistance to Biologists		27
Garbage collection and disposal		38
Tide gauge		23
Assistance with preparation of Midwinter Magazine		135
Assistance with unloading during change-over	1½	
Design and construction of radio preselector for field station reception		9
TOTAL:	43½	295

Total time spent on non-geophysical work other than recreation (allowing 10 hours for 1 day) was 73 days.

7. ACKNOWLEDGEMENTS

The author is grateful for the general co-operation by all members of the 1966 party, and for particular assistance from Mr A. Crabbe for carrying out routine work during the author's absences; Mr G. Pickering for his invaluable assistance with the repair of the La Cour clock; and Mr A. Parker for his assistance with maintenance and repair of buildings.

8. REFERENCES

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Table 1

Magnetograph data

Component		Nominal scale value	Standard deviations: Scale value	Standard deviations: Baseline value
Normal run	D	2.35 minute/mm	--	±0.2 minute
	H	24.7 gammas/mm	± 0.1gamma/mm	±2 gammas
	Z	20.8 gammas/mm	± 0.1gamma/mm	±3 gammas
Rapid run	D	1.02 minute/mm	± 0.02minute/mm	
	H	5.41 gammas/mm	± 0.04 gamma/mm	
	Z	6.07 gammas/mm	± 0.06 gamma/mm	

Table 2

Table of orientations

Component		Date (July 1966)	Magnet N Pole
Normal run	D	13	N 0.3° W
	H*	13	E 0.6° S
	H*	15	E 0.8° S
	H*	15	E 0.7° S
	H*	20	E 0.1° S
	Z	20	N 0.1° Down
Rapid run	D	15	N 0.3° E
	H	15	W 0.4° S
	Z		S

* Adjustments made between these tests

(Magnetic meridian used: 26° 40'E; values corrected to monthly mean field)

Comparison of 1966 and 1965 orientation tests

Component		1966 magnet orientations adjusted to August 1965 Mean Field	Magnet orientation from 1965 tests
Normal run	H	N.A.*	N.A.*
	D	26.3°	26.2°
Rapid run	H	296.3°	296.5°
	D	26.9°	26.6°

* Not applicable because variometer adjustment changed since 1965

Estimated maximum errors:

D	± 0.2°
H	± 0.2°
Z	± 0.25°

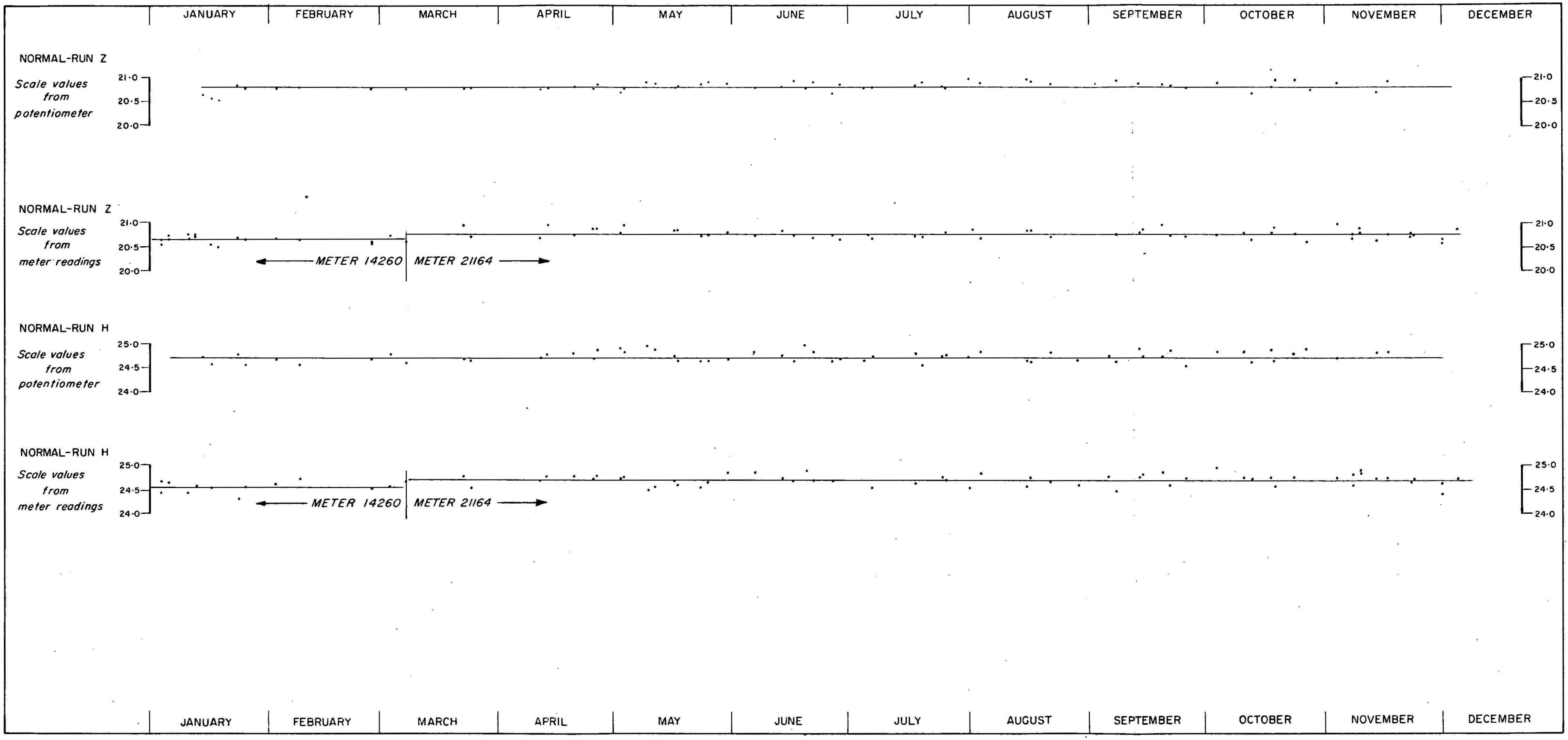
Table 3

Results of seismograph tests

Date 1966	Free period (sec)	Damping ratio	Magnification	Attenuator setting(dB)	Galvanometer damping ratio
15/1*	0.82	4.5		20	19.6
22/1*	0.98	9.9	6166	24	
28/1*	0.98	11.2	7710	22	
28/1*		12.8	7780	22	
3/2*	0.99	16.0	8130	22	
28/4	0.99	16.2	10,704	20	
13/5		17.5	5080	26	
8/7	0.99	16.8	6556	24	19.4
11/10	0.98	17.9	5152	26	
11/10		16.4	4070	28	
4/11*	1.00	23.7	3266	30	
5/11*	1.01	16.8	3203	30	
5/11		15.8	5043	26	

* Test carried out after adjustment

PLATE I



FROM SCALE VALUES DETERMINED WITH POTENTIOMETER,

ADOPT:- $S_Z = 20{\cdot}8$

$S_H = 24{\cdot}7$

FOR WHOLE YEAR

MACQUARIE ISLAND, 1966

NORMAL-RUN SCALE VALUE ADOPTIONS

To Accompany Record No. 1968/41

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SCALE VALUE POTENTIOMETER CIRCUIT

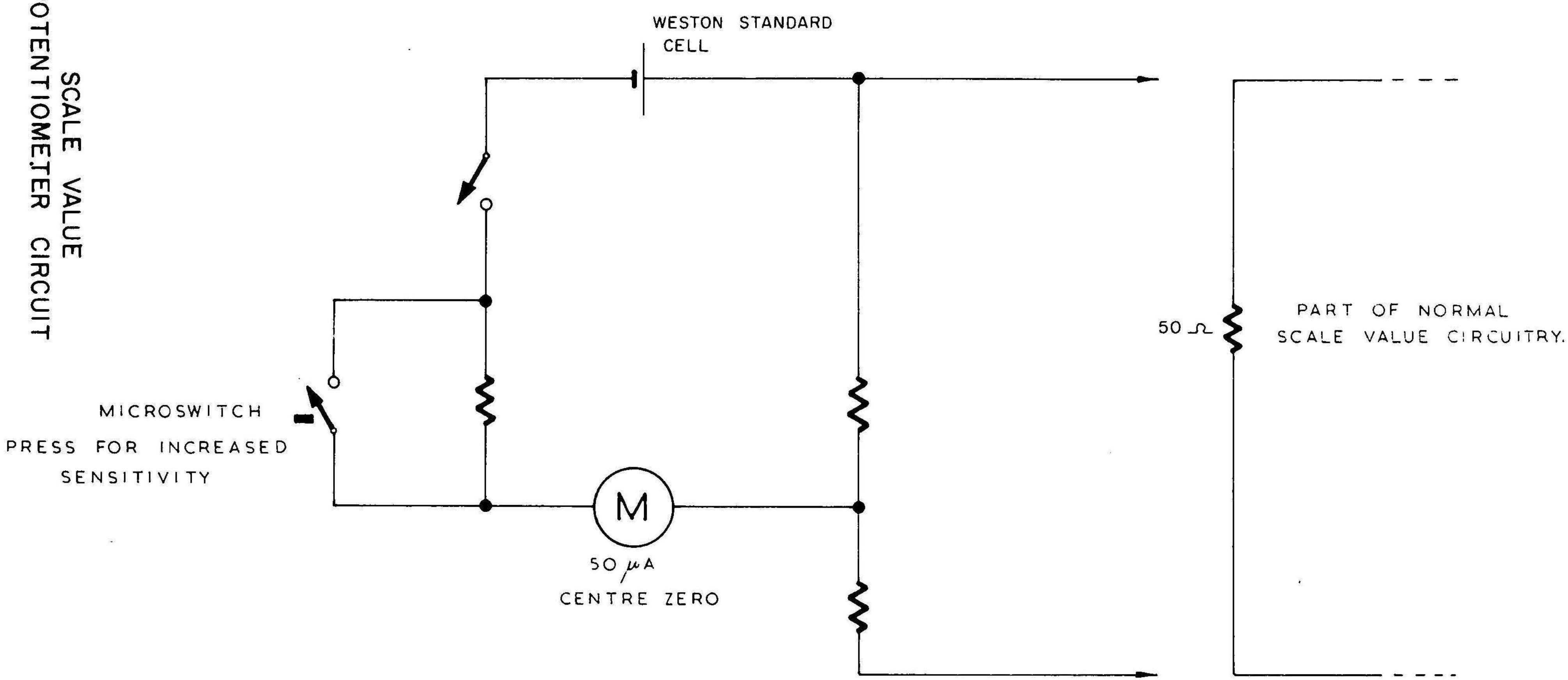
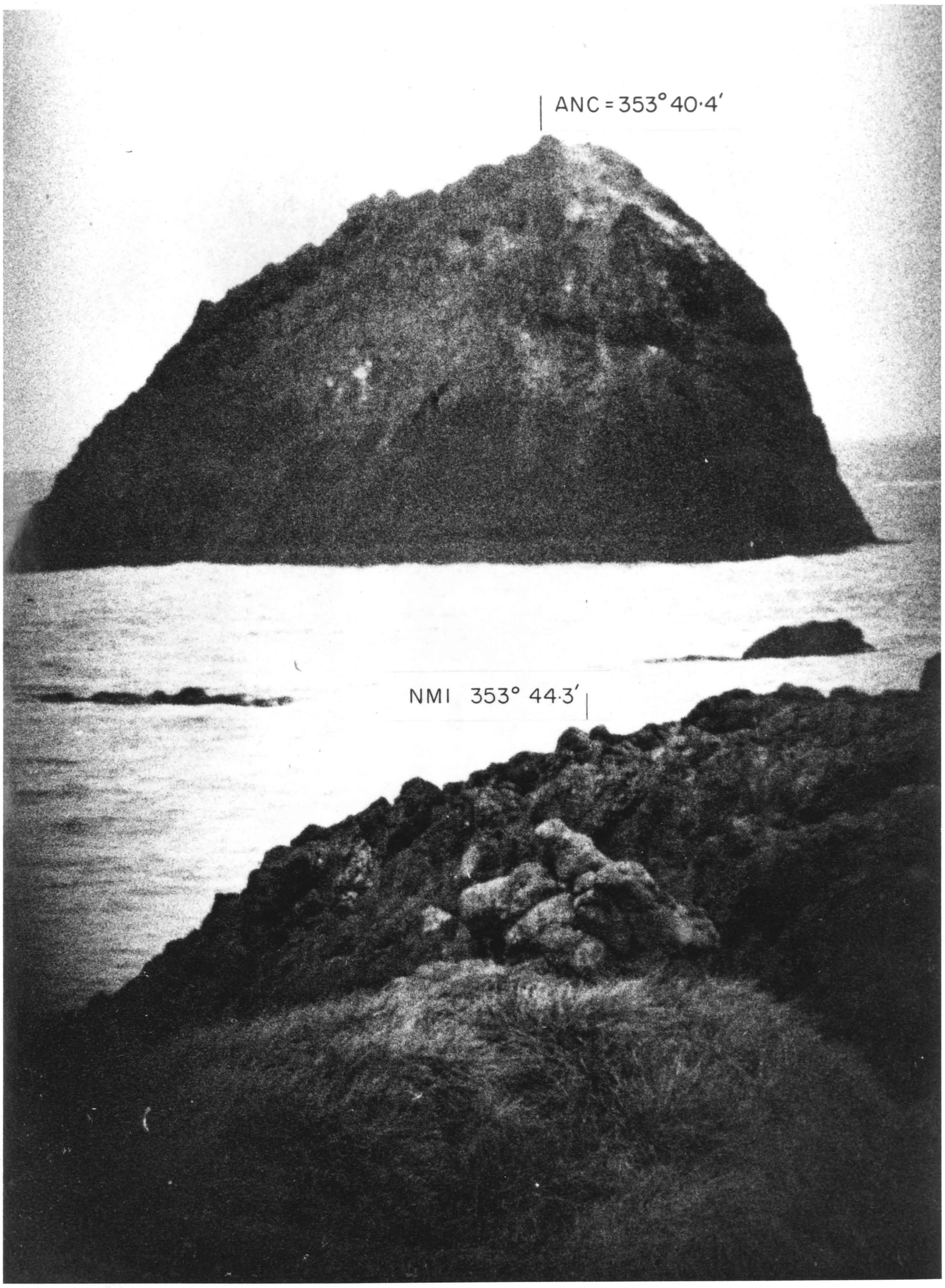


PLATE 2

To Accompany Record No. 1968/41

G54-80



MACQUARIE ISLAND
ANCHOR ROCK
SHOWING AZIMUTHAL MARKS