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RECORD No. 1965/23

MACQUARIE ISLAND GEOPHYSICAL OBSERVATORY WORK, 1963

by

P. J. GREGSON

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SUMMARY

A normal-run La Cour magnetograph and a short-period vertical Benioff seismograph were in operation at Macquarie Island throughout 1963. Early in the year a rapid-run La Cour magnetograph was installed. The normal-run magnetograph and seismograph were modified during the year.

Scientific results are not included but will be published later.

1. INTRODUCTION

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

R.J.S. Cooke (1963) has described the 1962 operations. The author was in charge of the observatories from 11th December 1962 to 20th December 1963. He was succeeded by G.D. Lodwick.

The instruments operating in 1963 were a normal-run and a rapid-run La Cour magnetograph, and a vertical-component short-period Benioff seismometer with a B.M.R. Recorder.

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

2. GENERAL

Buildings

Normal upkeep of the observatory buildings was carried out during the year. The exteriors of the office, darkroom, and the variometer and absolute magnetic buildings were painted in October and November. Scraping and caulking preceded painting where necessary. The interiors of the office and darkroom were painted during the winter. Early in the year the roof of the absolute magnetic building was painted with bituminous paint and then covered with canvas fastened with copper nails. Another coat of bituminous paint was applied to the canvas. However, the canvas deteriorated during the year because of high winds, and it finally blew off early in December.

Although the magnetic buildings leaked occassionally at the joints and the exterior beams had rotted in places, they showed no marked deterioration during the year and should be satisfactory for a year or two.

The office and the seismic vault were in good condition. Leaking continued at the junction of the vault and office as in previous years. One serious leak developed in the centre of the roof on the seismic vault at the junction of two concrete slabs. This was right above the seismic recorder, and water ruined a day's record. The water also short-circuited the 240-volt power supply. The leak was repaired by using blackjack, a bitumen compound.

Power

As part of the camp programme, all of the 240-volt wiring of the observatory buildings was renewed. The supply line to the magnetic huts now runs from the south-west corner of the garage to the south-east corner of the variometer hut and is buried two feet deep. This should eliminate the possibility of cutting the cable by the bulldozer, as occurred in previous years.

At the same time, the 6-volt D.C. wiring was renewed except for the wiring to the normal-run magnetograph, which had been installed in 1961, and one pair between the variometer and absolute huts, which was still in good condition.

A new station power plant, which came into operation in March, eliminated power restrictions. It enabled the office heater, with a new thermostat, to be used and so helped in drying photographic records.

Water

The rubber drain pipe of the darkroom sink had perished and was replaced. The water supply was sufficient except for short periods of a few days when it was frozen.

Additional duties

Apart from the normal camp duties the author, as second in charge of the station, had additional duties during the absence of the officer-in-charge from the station. Routine running of the all-dky camera was carried out during the absence of the Auroral Physicist. During November the author surveyed the station area with a theodolite and chain, and drew a detailed plan for the Antarctic Division.

3. MAGNETIC OBSERVATORY

Instruments

In 1962 two normal-run La Cour magnetographs were operated. One was of normal sensitivity and the other of low sensitivity (Cooke, 1963). The normal-sensitivity magnetograph was dismantled in December 1962 to make room for a La Cour rapid-run magnetograph which was ex-Watheroo (1933-1958). Modifications to the magnetograph since it left Watheroo included the addition of damping chambers to all three variometers, and a levelling magnet to the Z-variometer. The old normal-sensitivity Z-magnet was used but in the reverse orientation, i.e. with north pole southwards, to increase the sensitivity.

The insensitive magnetograph was modified to increase the sensitivity of the H- and Z-variometers. This was done by using a new H-fibre (No.528) and a new Z-magnet.

Table 1 shows the changes made.

TABLE 1. Changes in magnetographs and scale values

	Magnetographs 1962		Magnetographs 1963		
	Normal	Insensitive	Rapid-run	Normal	
H	12.6	63	5	24.6	gammas/mm
D	0.92	2.35	1.03	2.35	minutes/mm
Z	14.2	59	5.3	20.6	gammas/mm

Orientation, scale value, parallax, free-period, damping, and temperature compensation tests were made during or soon after installation and modification of the magnetographs. The results are summarised below with other variometer data in Tables 2 and 3.

Routine recording for both magnetographs commenced on 12th December 1963.

Orientation tests

Three pairs of perspex strips were fixed to the north and south walls of the variometer hut to assist in coil orientations. They were graduated from 25°30' to 27°30' in six-minute steps. The pairs were for the normal D, normal H, and rapid-run variometers. Orientation tests were made early in 1963 on both rapid-run and normal magnetographs using Helmholtz coils for H- and D-variometers and a BMZ supplementary magnet for the Z-variometers. The magnetic meridian used was 26°06'E of N.

Free period and damping of rapid-run magnetograph

It is desirable to damp the rapid-run variometer magnets to obtain a more uniform response over a wide range of frequencies. Copper damping blocks had been fitted before installation at Macquarie Island with varied success : the Z-magnet was well damped, the D-magnet partly damped and the H-magnet almost undamped. During the year the D-variometer had to be adjusted to prevent the magnet fouling on the damping block.

Damping coefficients were determined; the values, which are given in Table 3, were derived from the equation

$$\text{damping factor} = \frac{\log a_o/a_1}{\sqrt{1.862 + (\log a_o/a_1)^2}}$$

where a_o/a_1 is the amplitude ratio of successive magnet oscillations. The ratio a_o/a_1 was determined visually.

The free period was determined by visual observation.

From the damping coefficient and the free period (see Table 3) the theoretical dynamic scale value was calculated. This was found to peak sharply with D and H for periods of 2.5 seconds and 3.7 seconds, giving amplification factors of 1.35 and 11.9 respectively above the zero frequency sensitivity. Phase angles (the period lag of the responding variometer magnets behind the vibrating magnetic field) were also calculated. Plates 2, 3, and 4 show variations in amplification factors and phase angles for varying frequencies. Although the curves are theoretical they indicate that the records are unsatisfactory for magnetic variations with periods below six seconds.

TABLE 2. Normal-run variometer data

	H	D	Z
Fibre number	528	846	-
Torsion constant (dyne-cm/10^5 min of arc)	14.3	0.2	-
Magnet number	H171	D172	-
Magnetic moment (c.g.s.)	-	-	99
Magnet orientation	N end E	N end N	N end N
Ex-orientation (minutes, 23/1/63)	+28 (N end N of P.V.	+32 (N end N of Mer.	(-19 N end (down
Scale value	24.6 γ/mm	2.35 $'$/mm	20.6 γ/mm
Parallax correction (minutes, 23/1/63)	-0.8 min	+1.6 min	-0.8 min
Recording sense	+ve up	+ve up	+ve down
Temperature coefficient (gammas/^{o}C)	1.3	-	see below
Recording distance	1140 mm	738 mm	1633 mm

Drum rotation : The drum was driven by a La Cour clockwork drive at one revolution per day i.e. 15 mm/hour.

TABLE 3. Rapid-run variometer data

	H	D	Z
Fibre number	1130	928	-
Torsion constant (dyne-cm/10^5 min of arc)	4.06	0.066	-
Magnet number	H76	D86	-
Magnet orientation	N end W	N end N	N end S
Ex-orientation (minutes, 20/1/63)	(-12 (N end S of P.V.	-49 N end W of Mer.	-14 N end down
Scale value* (at installation)	5.0 γ/mm	1.03 ′/mm	5.3 γ/mm
Lens focal length (cm)	161	175	161
Recording sense	+ve down	+ve up	+ve up
Total range	1700 γ	370'	1900 γ
Free period (sec)	3.70	1.77	2.55
Damping coefficient	0.021	0.157	0.568
Temperature coefficient (gammas/°C at installation)	+3	-	-1
Recording distance	-	1710.8 mm	

* Plate 1 shows observed monthly and final adopted scale values.

Drum rotation:- Initially the drum was driven by an Eschenhagen clockwork drive at 180 mm/hour. The clockwork drive was replaced by a Venner synchronous motor (one revolution/two hours, anticlockwise movement) on 5th October.

Temperature compensation

Tests on the rapid-run variometers during installation showed temperature coefficients of approximately +3 and -1 gammas/°C for the H and Z variometers respectively.

Temperature coefficients for the normal-run variometers were calculated from weekly absolute determinations. The H-variometer was found to be well compensated with a coefficient of 1.3 gammas/°C (baseline increasing with temperature) for the year. The Z-variometer was not compensated during the first half of the year as the brass strip designed for insensitive use was used instead of a bimetallic temperature strip. The mean magnet temperature coefficient over this period (12th December 1962 to 31st July 1963) was determined as +14.7 gammas/$^{\circ}$C (baseline increasing numerically with temperature). The brass strip was replaced on 1st August with the strip from the old variometer. Tests showed that a strip of 3.9 mm gave a coefficient of 1.3 gammas/$^{\circ}$C and this was used for the remainder of the year. With such a short strip length the baseline mirror was partly masked by the temperature prism. The baseline mirror was therefore replaced by a larger one.

Control observations

Baseline control was achieved by regular semi-absolute observations and scale-value determinations. These were carried out at weekly intervals when conditions permitted.

Absolute observations were made with QHM177 and QHM179, BMZ64, and a Kew-pattern magnetometer DCK158. These instruments, except DCK158, were compared with QHM178 and long-range BMZ211 from Toolangi, in December 1963. A proton precession magnetometer (MNZ-1 No. 1) was also used during intercomparisons to determine the total field simultaneously with BMZ observations. The fibre of QHM177 was broken during intercomparisons and so this instrument was returned to Melbourne instead of QHM179.

Little difficulty was experienced with these instruments except QHM177, in which the magnet carrier kept sticking to the clamp. The normal trouble of breakage of DCK fibres occurred, but with experience this became less frequent.

The azimuth mark used for the D-observations was normally Anchor Rock. The alternative Post Mark was checked at regular intervals to determine any movement of the post caused by cattle as experienced by Cooke (1963). Its azimuth remained at 177° 03.0' throughout the year.

The absolute control panel was renewed.

Magnetograph operation

A new control panel was installed for the rapid-run magnetograph. The circuit is shown in Plate 5.

Record looses for the year were considerable, especially for the rapid-run magnetograph. The main cause of record loss in this case was the failure of the sledge to operate. A summary of causes of record loss is given below:

	Rapid-run	Normal-run
Drum jamming or failure of sledge to move.	315 hours	58 hours
Clockwork failure	16	66
Lamp failure	48	28
Adjustments & hut re-wiring	8	5

The La Cour clockwork drive for the normal-run magnetograph ran satisfactorily except for one occasion when it stopped for no apparent reason. The Eschenhagen clockwork drive for the rapid-run slowed down during cold weather and stopped at low temperatures. The clockwork was replaced in October as the spring broke and the escapement bearings were badly worn. A Venner synchronous motor (1 rev/2 hours) was used as a replacement. Initial trouble was experienced, the drum rotation being irregular, but this was corrected by adjusting the gears and removing the weight that drives the drum.

The La Cour pendulum clock operated satisfactorily, but its rate varied considerably between summer and winter. Wind vibration appears to be the cause of daily variations in rate.

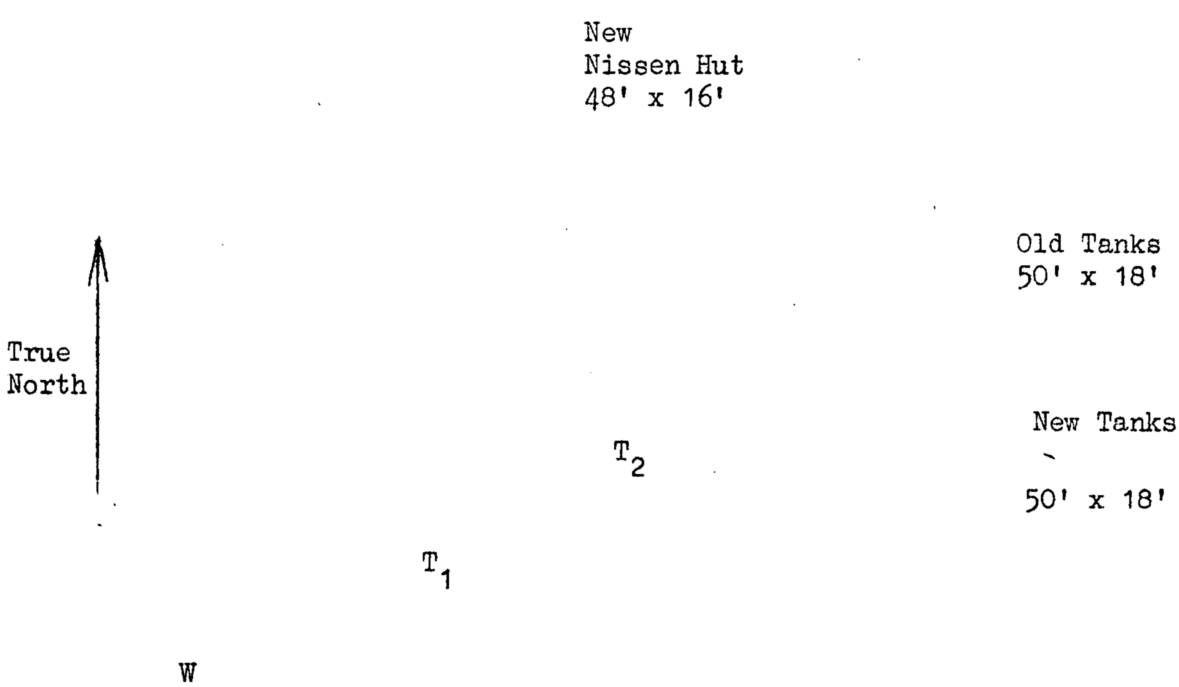
Magnetic data

Monthly reports comprising K-indices and preliminary monthly mean values of the three elements based on ten selected quiet days were transmitted to Melbourne. From October 1963 the K-index components for each element (H, D, and Z) were reported. From September 1963 reports of daily mean disturbance levels were sent to Hobart University for advance planning of summer cosmic ray balloon flights at Macquarie Island and Alaska.

All other data were reported annually.

Permanent magnetic disturbances

To determine the effect of proposed bulk fuel tanks to be erected in December 1963 approximately 120 yds from the absolute hut, a series of readings was taken with BMZ64 on 9th December at two stations between the absolute hut and proposed tank site. Readings were repeated by G.D. Lodwick on 9th January 1964, after the tanks had been erected.



Only an approximate effect could be determined as a galvanised iron Nissen hut was also erected about 100 yards from the absolute hut. However, calculations show that nearly all the effect is due to the fuel tanks. The equivalent vertical field produced at the absolute hut by the fuel tanks is +2 gammas.

4. SEISMIC OBSERVATORY

The seismograph in operation during 1962 was modified in December 1962. The two Benioff horizontal seismometers and the recorder were returned to Melbourne. One Benioff short-period vertical seismometer was left at Macquarie Island. The period of the seismometer was 1.00 seconds and that of the galvanometer 0.2 seconds. The seismometer was used with a single drum B.M.R. (Wood Anderson type) photographic recorder with a paper speed of 30 mm/minute.

Routine recording began on 12th December 1962.

The seismic control panel was reconstructed because previously it had been in two parts The circuit diagram is given in Plate 6.

Time marks were obtained from a Mercer chronometer and were put on the record as trace deflections every minute for 4 seconds (from 56-60 seconds) and every hour for 20 seconds (from 59 min 40-60 seconds). The chronometer was checked daily with WWV, and the rate remained at about one second per day. Occasionally continuous deflection of the trace occurred; this was corrected by cleaning the contacts of either the chronometer or the time-mark relay.

Minor record losses occurred owing to lamp failure, paper unrolling, and water leakage through the roof above the recorder. Twice the galvanometer was accidently left shorted after adjustments had been made. After renewing the light-source globe it was difficult to obtain a good focus. The procedure was simplified by following the method described by Turpie (1959).

Seismometer period, damping, and magnification

The free period of the seismometer was checked on 19th February and adjusted from 0.96 seconds to 1.00 seconds.

The system was found to operate with maximum damping (coefficient = 0.3, see p. 3) when the damping control settings were set at "7" for the seismometer and "7" for the galvanometer. These were the settings used during normal operation.

It was generally found that microseismic disturbance due to surf and wind necessitated attenuation settings of "26" or "30" on very windy days. On exceptionally calm days settings of "24" could be used. Attenuation was altered according to the microseismic level. Weight lift tests were made to obtain magnifications at a period of one second and at various attenuation settings. The results are shown in Table 4.

TABLE 4. Magnification at 1 c/s

Attenuation setting	Damping setting S.	Damping setting G.	Damping ratio a_o/a_1	Magnification at 1 c/s
18	7	7	4.2	13,200
20	7	7	4.2	10,300
22	7	7	4.2	3600
24	7	7	4.2	6500
26	7	7	4.2	5000
28	7	7	4.2	3200

Shocks recorded

During the year about 40 distant shocks were reported. The data were transmitted to Head Office twice weekly. About 60 shocks from the Macquarie Island region were recorded. Four of these were felt and nine were reported to Head Office. As in previous years, the heavy microseismic disturbance - and hence the need for a low magnification - was the reason so few shocks were recorded. Subsequent analysis of records, with the assistance of United States Coast and Geodetic Survey data, made it possible to detect another 30 distant quakes.

5. ACKNOWLEDGEMENTS

The author is grateful for the general cooperation by all the members of the 1963 party and for particular assistance from : Mr. C.B. Ellwood for carrying out routine work during the author's absence; Mr. P.R. Whyte, electrician, for his assistance during field observations and instrument adjustments and also for his co-operation, during the re-wiring of buildings, in keeping record loss to a minimum; and Mr. F. de Silva for his assistance during instrument adjustments.

6. REFERENCES

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MACQUARIE ISLAND 1963

OBSERVED AND ADOPTED STATIC SCALE VALUES FOR RAPID-RUN MAGNETOGRAPH

(Observation made using Helmholtz coils)

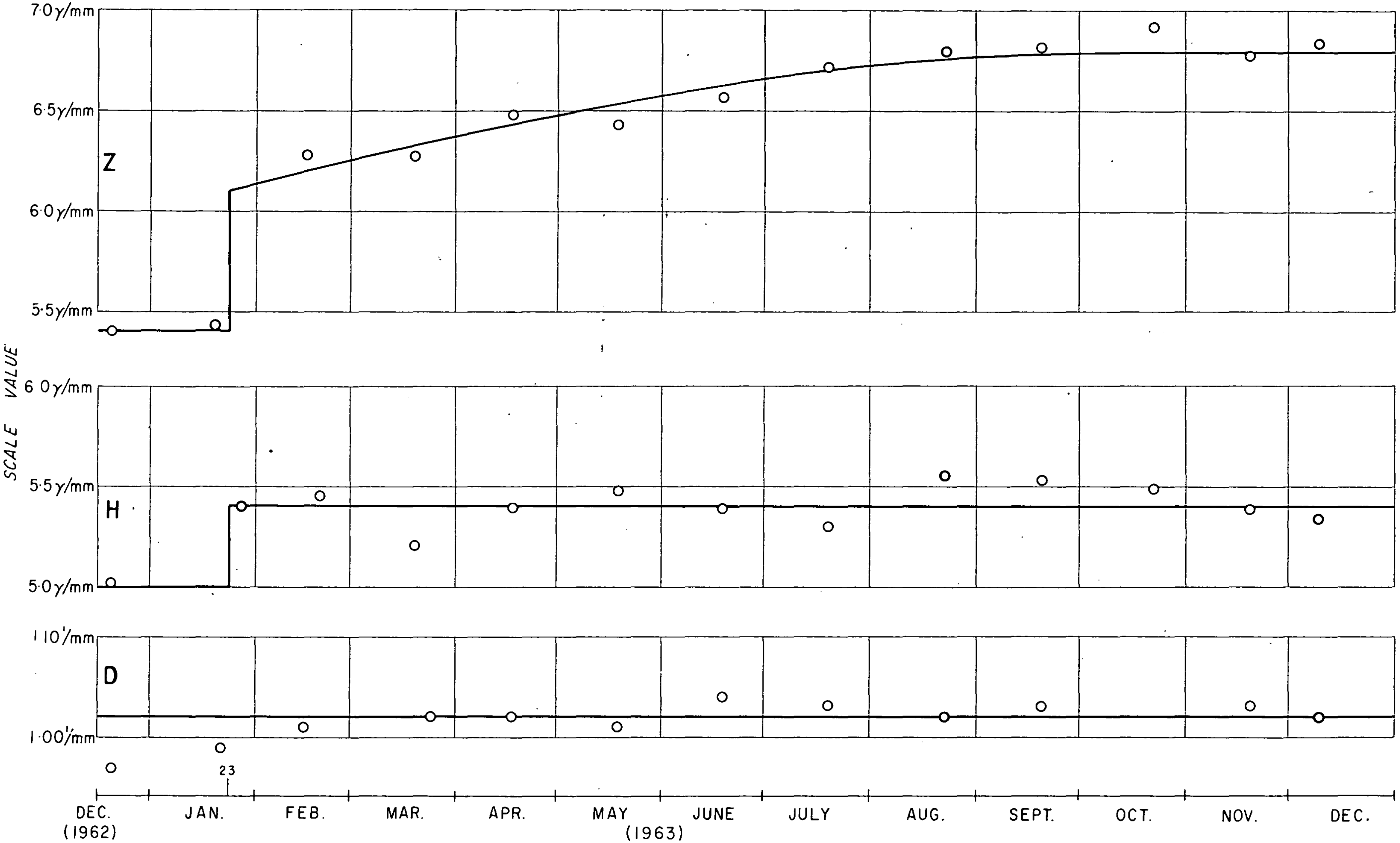
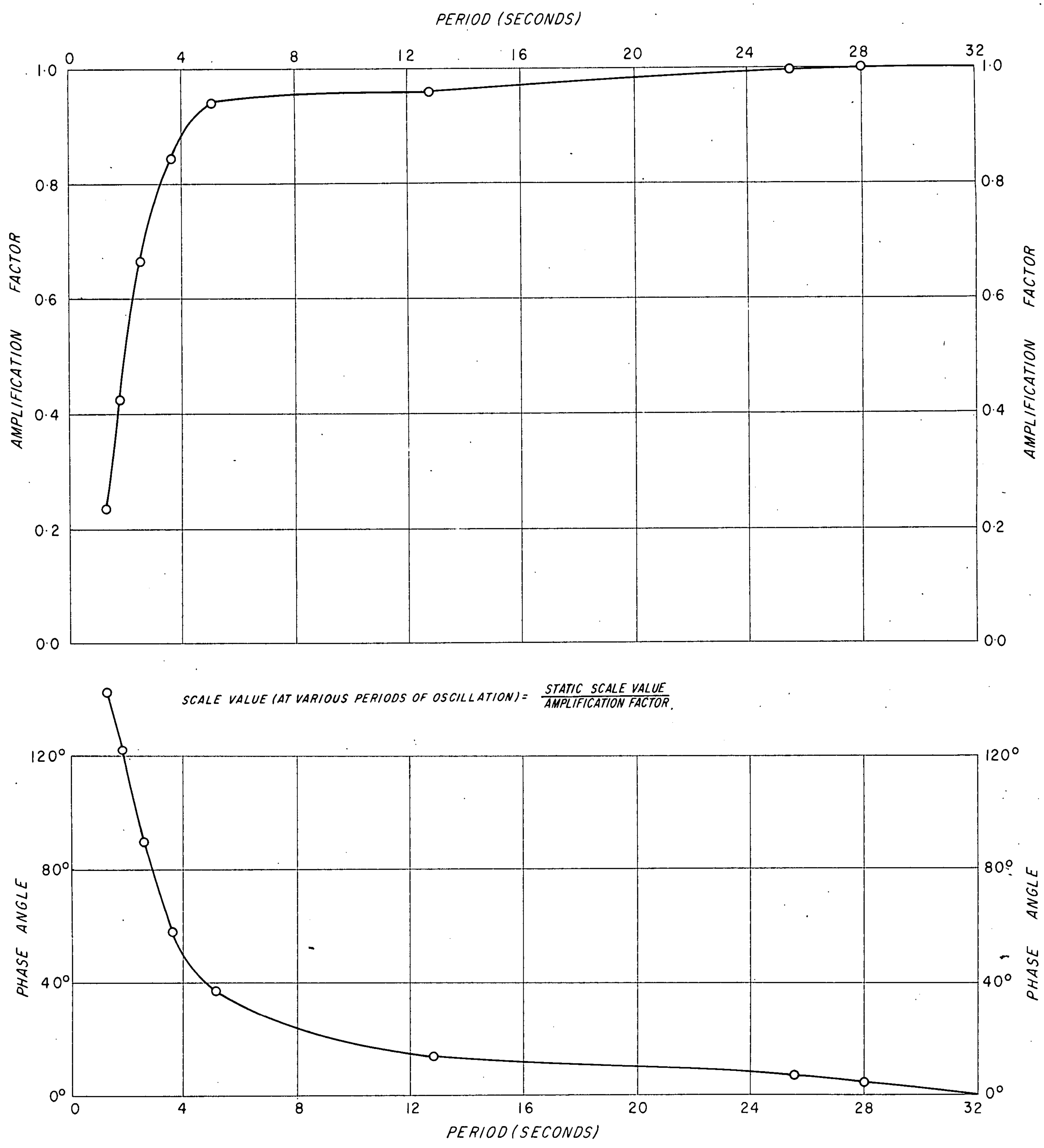


PLATE 1

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS. G82/2-7

TO ACCOMPANY RECORD No.1965/23



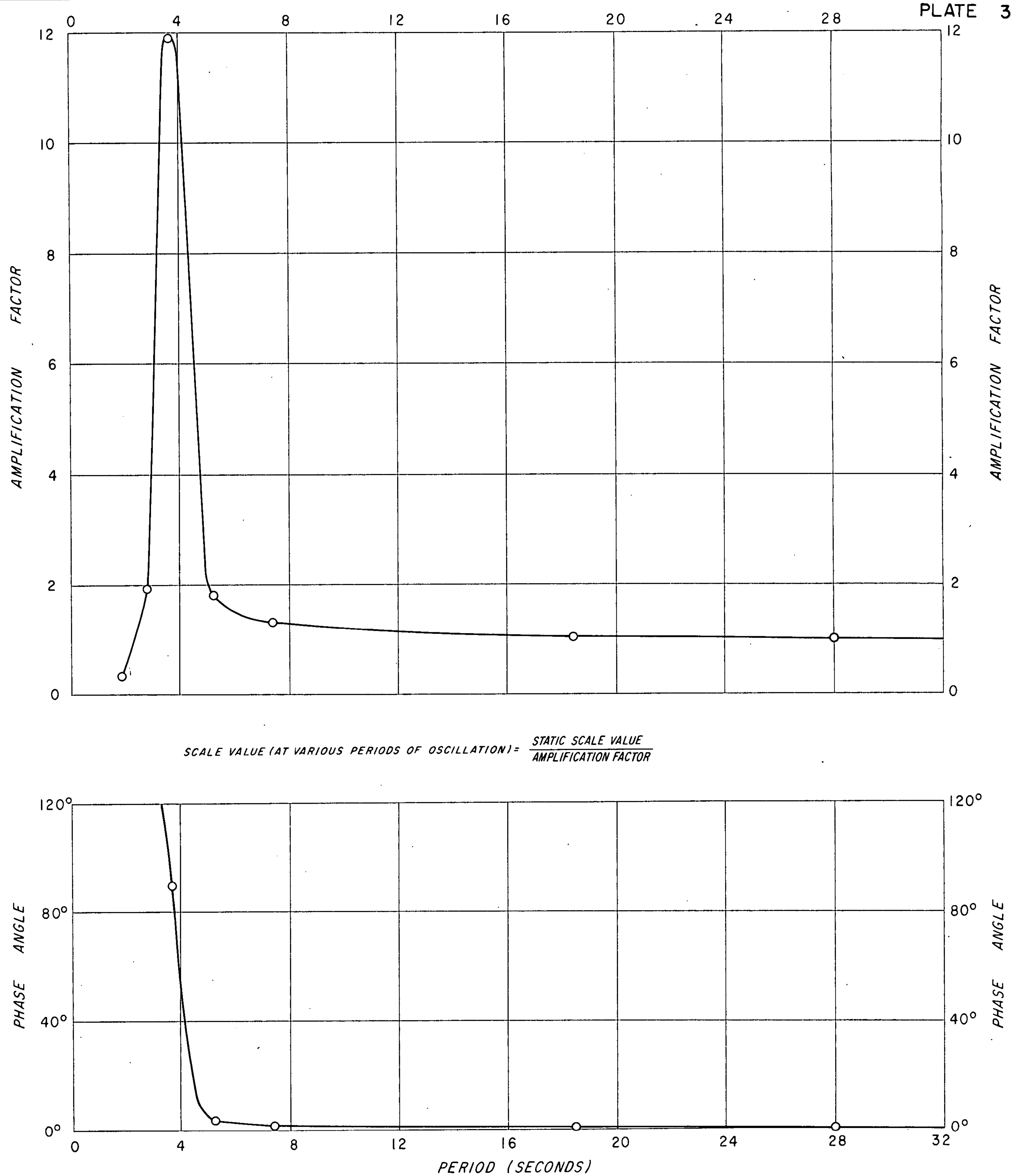
MACQUARIE ISLAND 1963

CALIBRATION CURVES FOR RAPID-RUN Z-VARIOMETER

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS. G82/2-10

TO ACCOMPANY RECORD No 1965/23

PLATE 3



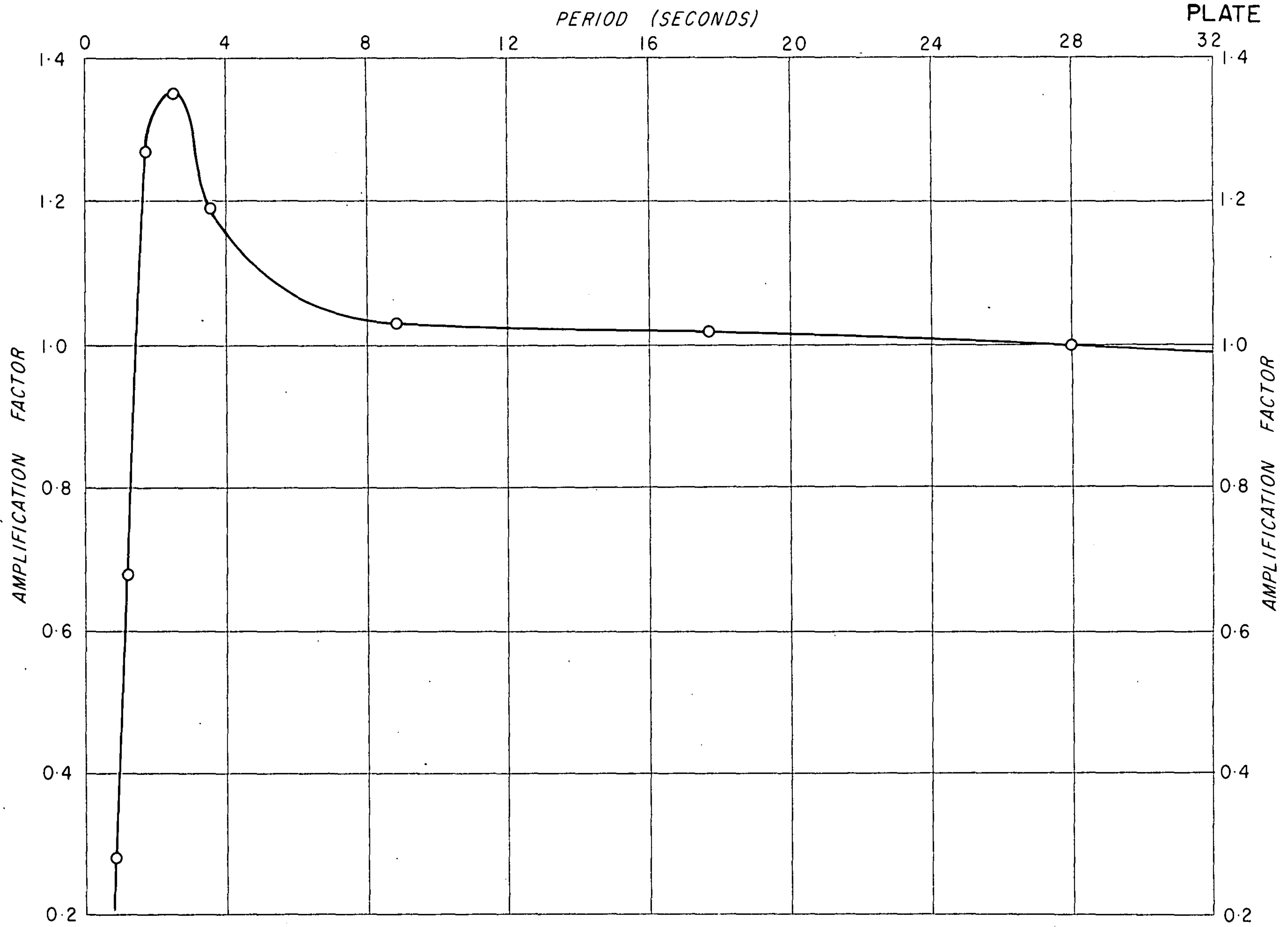
MACQUARIE ISLAND 1963

CALIBRATION CURVES FOR RAPID-RUN H-VARIOMETER

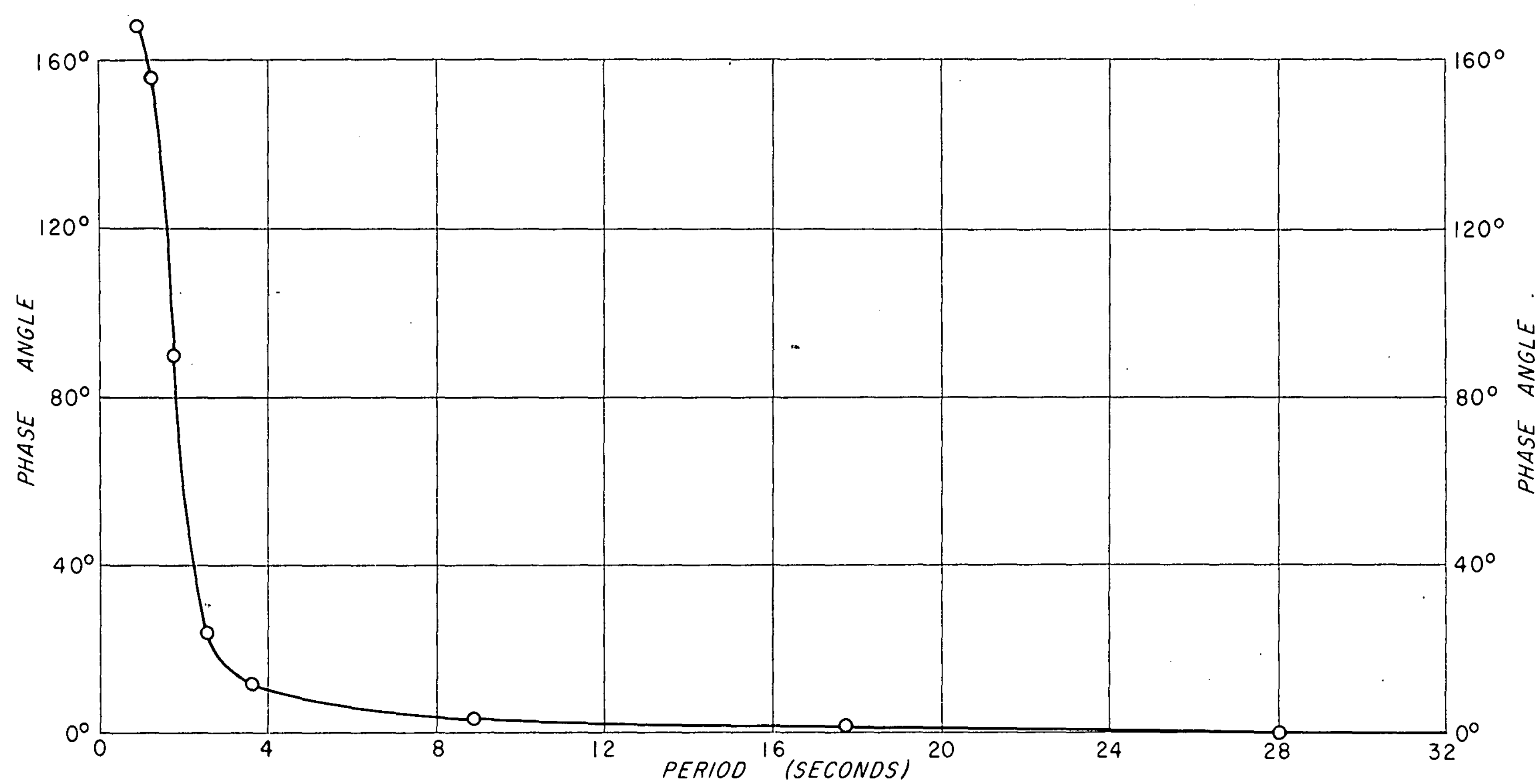
GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS. G 82/2-9

TO ACCOMPANY RECORD No 1965/23

PLATE 4



SCALE VALUE (AT VARIOUS PERIODS OF OSCILLATION) = $\frac{\text{STATIC SCALE VALUE}}{\text{AMPLIFICATION FACTOR}}$

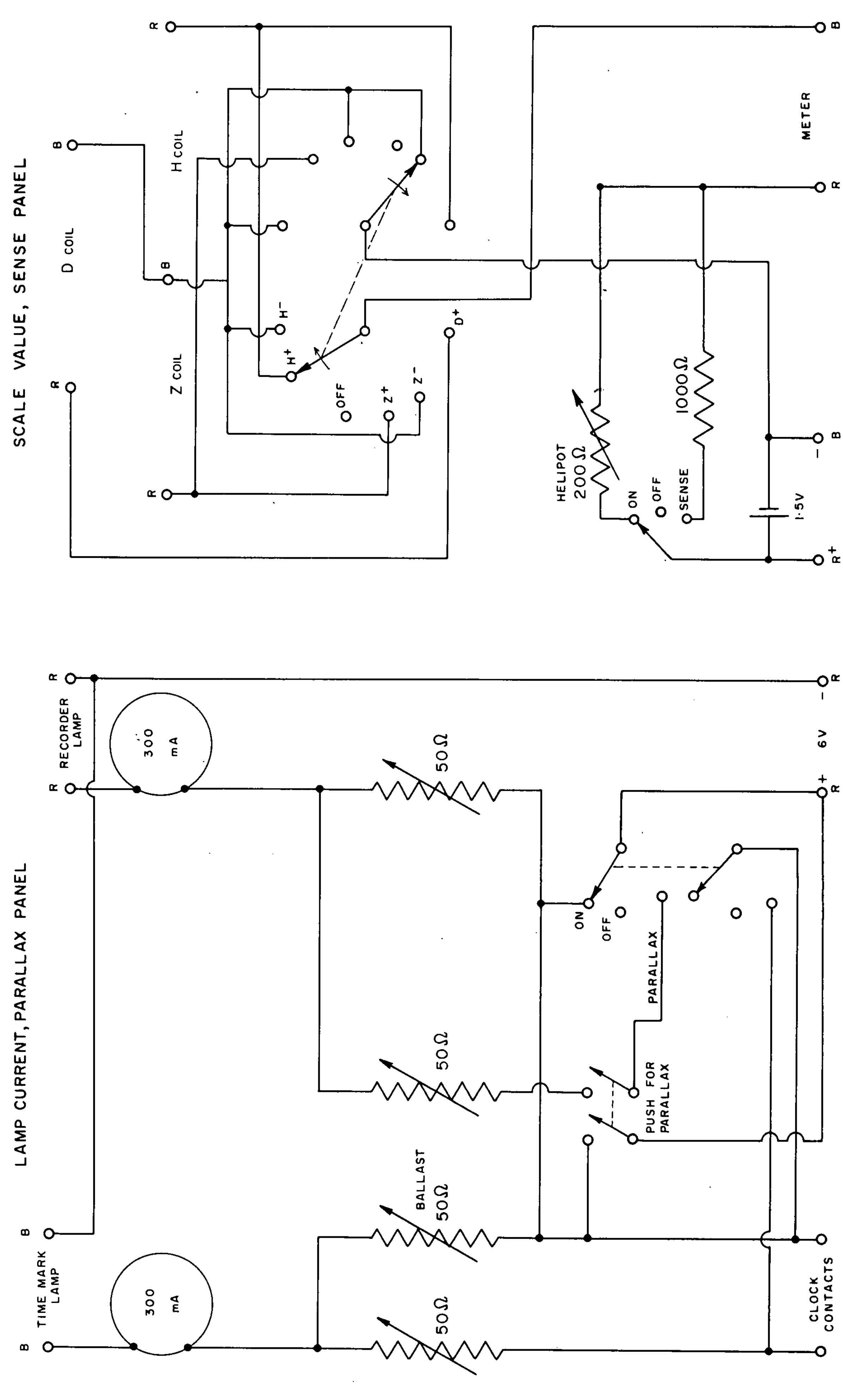


MACQUARIE ISLAND 1963

CALIBRATION CURVES FOR RAPID-RUN D-VARIOMETER

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS. G82/2-8

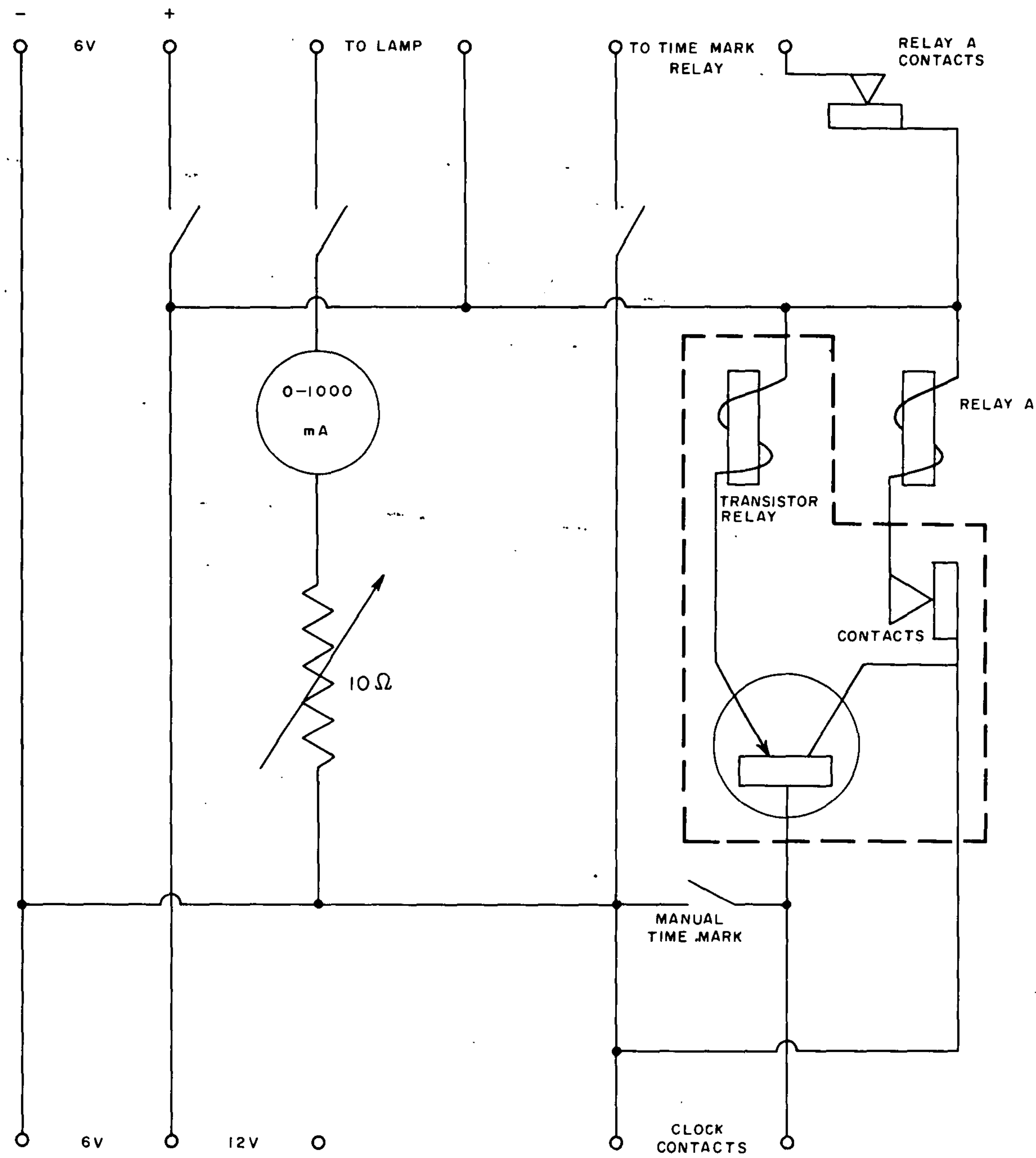
TO ACCOMPANY RECORD No 1965/23



CONTROL PANEL FOR RAPID-RUN MAGNETOGRAPH

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G82/2-5

TO ACCOMPANY RECORD No. 1965/23



TRANSISTOR RELAY: 7 R/T
RELAY A: 6R

SEISMIC CONTROL PANEL

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 82/2-6
TO ACCOMPANY RECORD No. 1965/23