COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1965/184

MAWSON GEOPHYSICAL OBSERVATORY WORK, ANTARCTICA 1962

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ILLUSTRATIONS

SUMMARY

The magnetic and seismological observatories at Mawson (Antarctica) were in operation throughout 1962. The La Cour magnetograph was standardised several times per month. Over 700 earthquakes were recorded on the Benioff seismograph. An attempt to calibrate the seismograph in February 1963 was only partly successful. Abnormally cold weather caused difficulties in maintaining the scientific programme.

1. INTRODUCTION

The Mawson observatory was started in 1955 by Oldham with the installation of a La Cour magnetograph. An insensitive La Cour magnetograph and a bar-fluxmeter have since been added to the magnetic observatory. There is also a seismic station with a set of Benioff seismometers recording three components of motion.

The station sites, instruments, installation, and routines have been adequately described in previous reports (Oldham, 1957; Pinn, 1961).

2. FIELD WORK

The voyage to Mawson on the M.S. Nella Dan in January 1962 included the relief of Davis Base. Here the writer spent five afternoons re-occupying the magnetic station. The station is marked by a wooden peg and a cairn on the rock area 50 yds south of the road from the beach to the camp (Plates 2, 3).

No permanent azimuth mark had been established previously. The azimuth mark chosen was the survey mark on Anchorage Island (Plates 1, 3). David Carstens, the surveyor attached to the ANARE party, determined the azimuth of this mark, and this value was used in the calculations. The azimuth mark was used a second time when the writer re-occupied the station in February 1963, after a year at Mawson. A guyed wooden cross had been erected during 1962 near the survey cairn (Plate 1). This cross was over eight feet high and had a 44-gallon petrol drum as the base. The survey cairn was too feet high with a pole protruding from it.

The return voyage to Davis in 1963 included a landing on the Amery Ice Shelf where observations of H, D, and Z were made.

At Heard Island the attempt to do observations on the site of the old absolute hut was unsuccessful, owing to bad light and lack of time.

3. MAINTENANCE

The geophysics office at Mawson was in good repair except for the floor. In November 1962 this floor was covered with Masonite. As the outside paintwork on the seaward and waste-pipe side of the building deteriorated rapidly, these walls were repainted. Small sections of the inside of the office also were repainted.

The chimney of the Coleman stove was replaced. The new chimney was protected from the metal pipe rack on the east wall. The chimney was replaced a second time when it was moved inside to improve the efficiency of the stove. The fuel pipes to the stove were replaced by pipes of increased diameter to prevent ice blockages. As in 1961, when the temperature dropped below $0^{o}F$, Aviation Turbine Kerosene was satisfactorily used instead of diesoleum.

The exteriors of the seismic and magnetograph huts were painted in bituminous aluminium paint. This paint is unsatisfactory as it does not reflect the solar radiation sufficiently, owing to the bitumen content.

The rubber strips between all the instrument piers and floors were replaced.

Cracks in the absolute hut which allowed snow to enter on the windward side of the building were filled.

4. MAGNETIC OBSERVATORY

Magnetographs

The normal and insensitive magnetograph records were changed at 0600 G.M.T. each day. Little record was lost during the year. The clockwork drive on the insensitive magnetograph was replaced and cleaned after a stoppage. The replaced drive weight jumped over the teeth of the ratchet wheel several times despite the effect of the counterweight described by Oldham (1957).

The appearance of ghost traces on the normal magnetograph in late spring and early summer seemed to be associated with the violent temperature changes. The H and Z cylindrical lenses were adjusted in an unsuccessful attempt to eliminate these ghosts.

Hollingsworth (1962) had ordered non-magnetic heaters for the magnetograph hut. These were installed but not used because of the acute power shortage.

Absolute values and scale values

Semi-absolute values of the magnetic field were observed about four times each month as magnetic conditions and weather permitted. The declination observations were made with magnetometer QHM 300. Horizontal intensity was measured with QHMs 300 and 302. QHM 301 was returned to Melbourne with the intercomparison instruments at the end of 1961 for comparison at Toolangi. The vertical intensity was measured with BMZ 62.

During 1962 Mawson had the coldest winter on record. The prolonged period of ten days with temperatures around -30°F produced unusual hardship. The single-bar non-magnetic radiator was not sufficient to maintain the temperature in the absolute hut within the range of the QHM thermometers. Therefore a kerosene heater was used to keep the temperature in this hut at a reasonable level. This heater was removed to a suitable distance from the hut while the absolute observations were made.

Bar-fluxmeter

The bar-fluxmeter described by Pinn (1961) ran continuously during the year with little loss of record. On two occasions the spring drive on the paper take-up spool broke; this caused jamming of the photographic paper. Power failures and broken time lines accounted for the remaining losses. Components H, D, and Z were recorded on one record until December 1962. During gales, especially those accompanied by snow, the Z trace was broadened by wind noise. This appeared to be due to snow accumulating on top of the coil and allowing the vibration of the hut covering the coil to be transmitted to the Z coil.

The Z and H coils and galvanometers were packed and returned to Melbourne by the relief ship at the end of 1962. To improve the remaining D trace, which tended to wander off the photographic paper owing to the large temperature changes in the seismic hut in summer, a reserve trace was created by means of a glass prism.

5. SEISMIC OBSERVATORY

Instruments

Benioff seismometers with natural period one second were used for all three components of motion. The vertical seismometer was connected to a 0.2-s short-period galvanometer. The horizontal seismometers were connected to 70-s long-period galvanometers. The recording unit made in the Bureau's workshops was replaced by a Benioff recorder in 1963.

The horizontal seismometers were near-critically damped by a separate damping circuit. The vertical seismometer had the damping circuit incorporated in the circuit used for recording.

The long-period N-S galvanometer tended to move off level, causing the coil to stick in a fixed position. This may have been due to the replacement of the galvanometer gold fibre suspension by Merrick (1961) and Hollingsworth (1962). If these fibres are not perfectly axial the levelling becomes critical. The temperature of the seismic recording hut varied with the outside temperature and solar radiation, and so caused the heavy plastic-covered leads from the seismometer to the galvanometer to expand and contract. This action moved the galvanometers on the pier and altered their levelling. The movement could be traced by the score marks on the slate surface from the galvanometer legs.

Long-period "fluctuations" and "bays"

Long-period "fluctuations" with a period of 40-70 seconds were recorded. These had also been noticed by Hollingsworth (1962). The "fluctuations" were associated with wind which effectively cooled the seismometer hut. The loss of heat from the hut surface appeared to be the main factor in producing this phenomenon. It is likely that these "fluctuations" are caused by "convective overturn" as described by Sutton (1962). The "fluctuations" are reported not to occur with the newly installed 14-second galvanometers.

"Bays" occurred simultaneously on both horizontal components. They consisted of a large deflection of amplitude 10 mm and period one minute, followed by a strongly damped oscillatory recovery. Attempts were made to produce these "bays" on purpose by an ebonite rod carrying a static charge but the resulting deflections were negligible. Underwood (1960) suggested that such "bays" were mechanically produced by shock movements of the pier caused by ice movements. A similar shock movement could be produced by the differential contraction of pier and seismometer with temperature. At Mawson the E-W galvanometer gave a large number of "bay"-like deflections as well as the simultaneous bays which are probably a result of the misaligned fibre.

Teleseisms

Over 700 teleseisms were recorded during 1962. Most of them were recorded between May and December. During these seasons the surface of the sea freezes forming thick sea ice; the microseismic activity is low and it is possible to use a higher sensitivity. The records were read daily for teleseisms and these data were transmitted twice weekly to Melbourne for forwarding by airmail to the United States Coast and Geodetic Survey. From June the International Union of Geodesy and Geophysics and the British Seismological Committee requested revised phases from Mawson for processing in a computer system for the International Seismological Summary publication. The phases P, pP, PKP, pPKP, S, and SKS were identified from USCGS epicentral data, and correctly identified phases were transmitted every ten days.

Thermostat and temperature control

A thermostat was re-installed in the seismic recording hut to keep the temperature constant and eliminate drifting of the traces. The long-period records often had adjacent traces overlapping because of the change in torsion of the suspension with temperature. A similar effect was noted by Underwood (1960). The thermostat installation resulted in the variation in lamp intensity noticed by Hollingsworth (1962). The galvanometers still moved off level, but the overlapping of the traces was eliminated.

Calibrations

A Willmore bridge and oscillator were taken to Mawson for the period of the 1963 change-over. The calibration was conducted firstly on the vertical instrument. The coil configuration of this circuit made the calibration difficult, and extra resistors were introduced into the circuit to bring the seismometer coil resistance within the balance of the bridge. High microseismic activity during the change-over permitted a calibration only with 16 db as the minimum setting of the attenuator. This calibration curve is drawn in Plate 4.

Only one of the two long-period horizontal seismometers was calibrated. Its calibration curve is shown in Plate 4. No extra resistors were necessary in the circuit, and the attenuator was set at zero. The shape of the curve departs markedly from that of the typical calibration curve for this instrument. The shape of the curve for periods between 0.2s and 2s suggests that the seismometer was underdamped. The completion of the calibration was curtailed by a breakdown in the electronic circuit of the bridge; voltage surges noticed in the camp during change-over were probably the cause of this breakdown.

6. TIME CONTROL

Time marks

The time marks from the La Cour clock were transmitted from the office to the magnetograph hut by a temporary telephone line. This line was replaced after it had been damaged during the change-over. The clock maintained a constant rate of two seconds per day and was kept within six seconds of G.M.T.

A Mercer chronometer, making one-minute contacts and an extra contact on the hour, was used to supply time marks for the seismic and bar-fluxmeter recorder.

The corrections of both clocks were determined daily from radio signals from WWV and WWVH.

The lines connecting the chronometers in the office to the instruments were field telephone cables. It was hoped to lay a heavy duty telephone cable throughout the camp, from which scientific personnel would have lines available for their programmes. It was proposed that the chronometer lines be incorporated in this cable in 1962. However, the cable was not laid until 1963.

Time signals

Time signals were obtained from WWV on the Eddystone receiver on the 5-, 10-, and 15-Mc/s bands. Severe magnetic storms and gale force winds with high drifting snow made reception impossible on certain days. An indoor aerial system to receive radio signals during high drift was erected inside the office; however, static discharge of metal objects in the camp area still interfered with signals during high drifts.

The power-supply valve in the Eddystone receiver was replaced twice during the year. The mechanical section of the band tuning was tightened. The tuning system showed signs of wear.

7. PHOTOGRAPHIC ROUTINES

The office/darkroom was adequately heated until the period in mid-winter when the average temperature for ten days was 30°F. Large temperature gradients were noticed in the darkroom. The photographic chemicals sometimes froze in the trays situated near the outside wall of the room, and the chemicals deteriorated rapidly after freezing. Severe power restrictions prevented the use of the electric snow melter except for very limited periods. This combination of factors made the processing of records difficult.

On one occasion the trace surface came off the paper. This was attributed to a physical temperature difference in solution temperatures greater than 10°C rather than a chemical action as suggested by Hollingsworth (1962).

8. ACKNOWLEDGEMENTS

The author would like to express his gratitude to the expedition members Peter Trost, John Phillips, and John William who changed the traces during his absence from camp.

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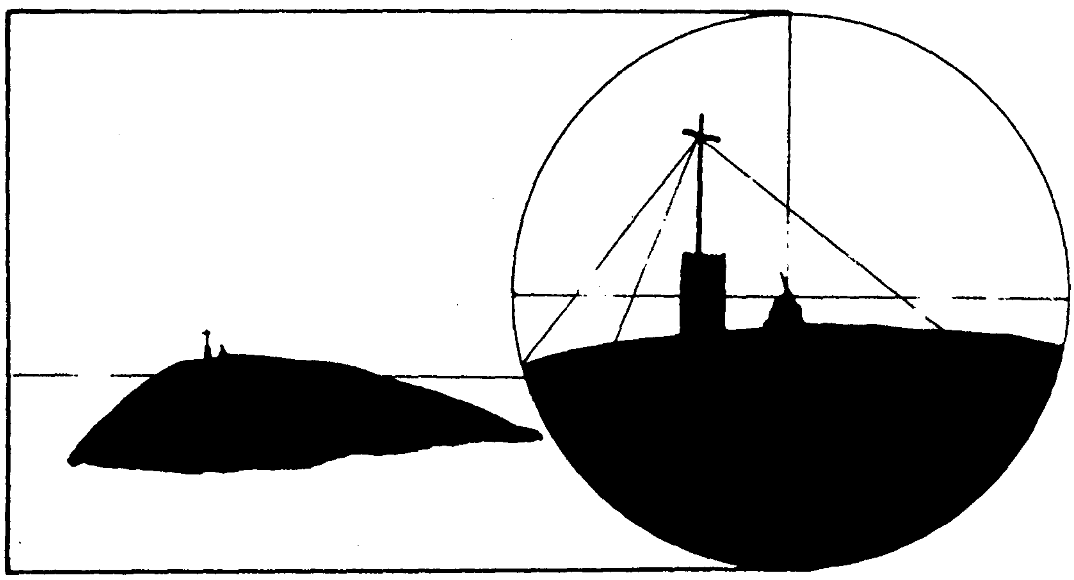

AZIMUTH MARK ON ANCHORAGE ISLAND

1963

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS G437-1

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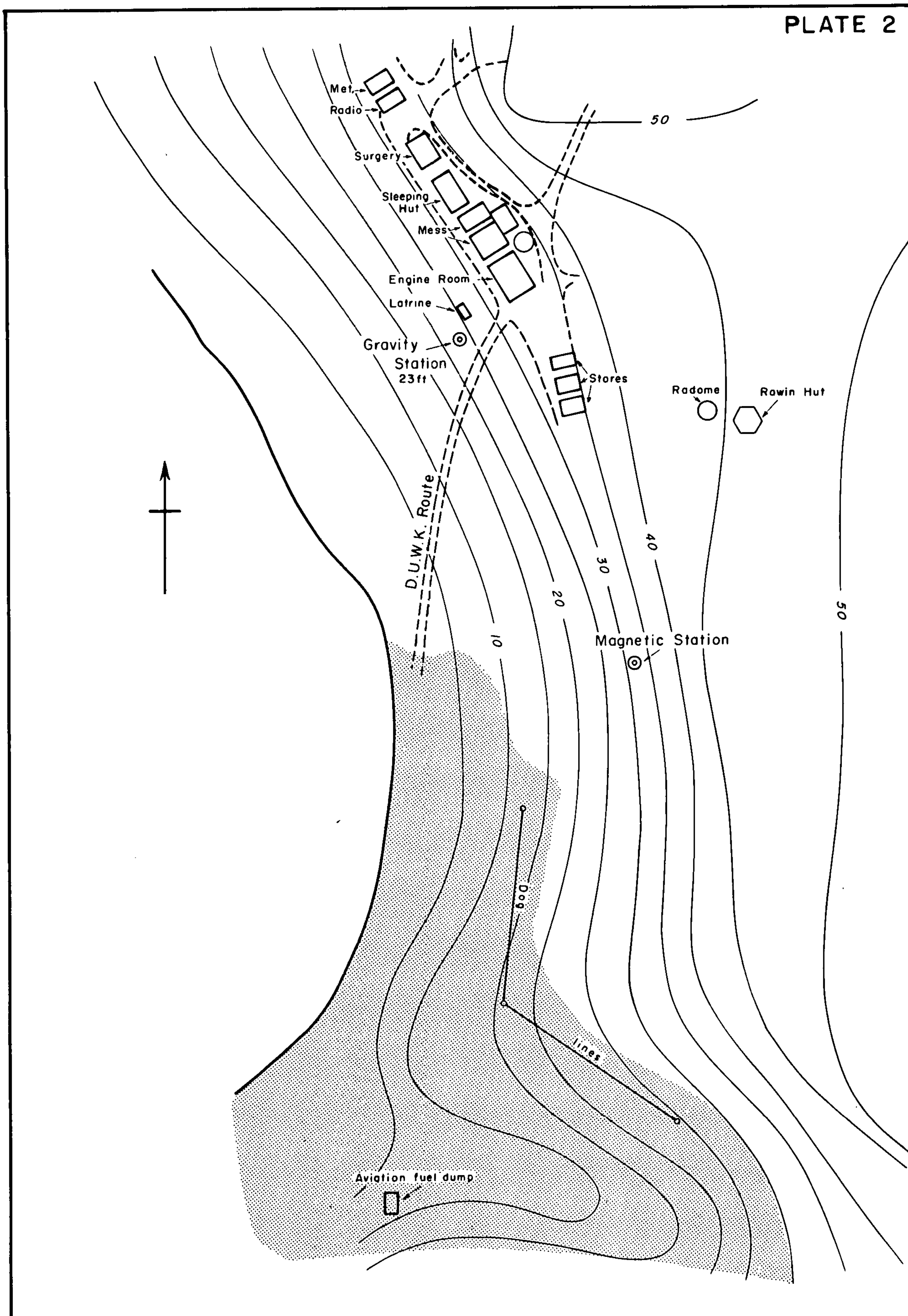
PLATE 2



DAVIS BASE MAGNETIC STATION

1963

Sand beach

YARDS

100 50 0 100

Contour interval 5 feet

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G 437-2

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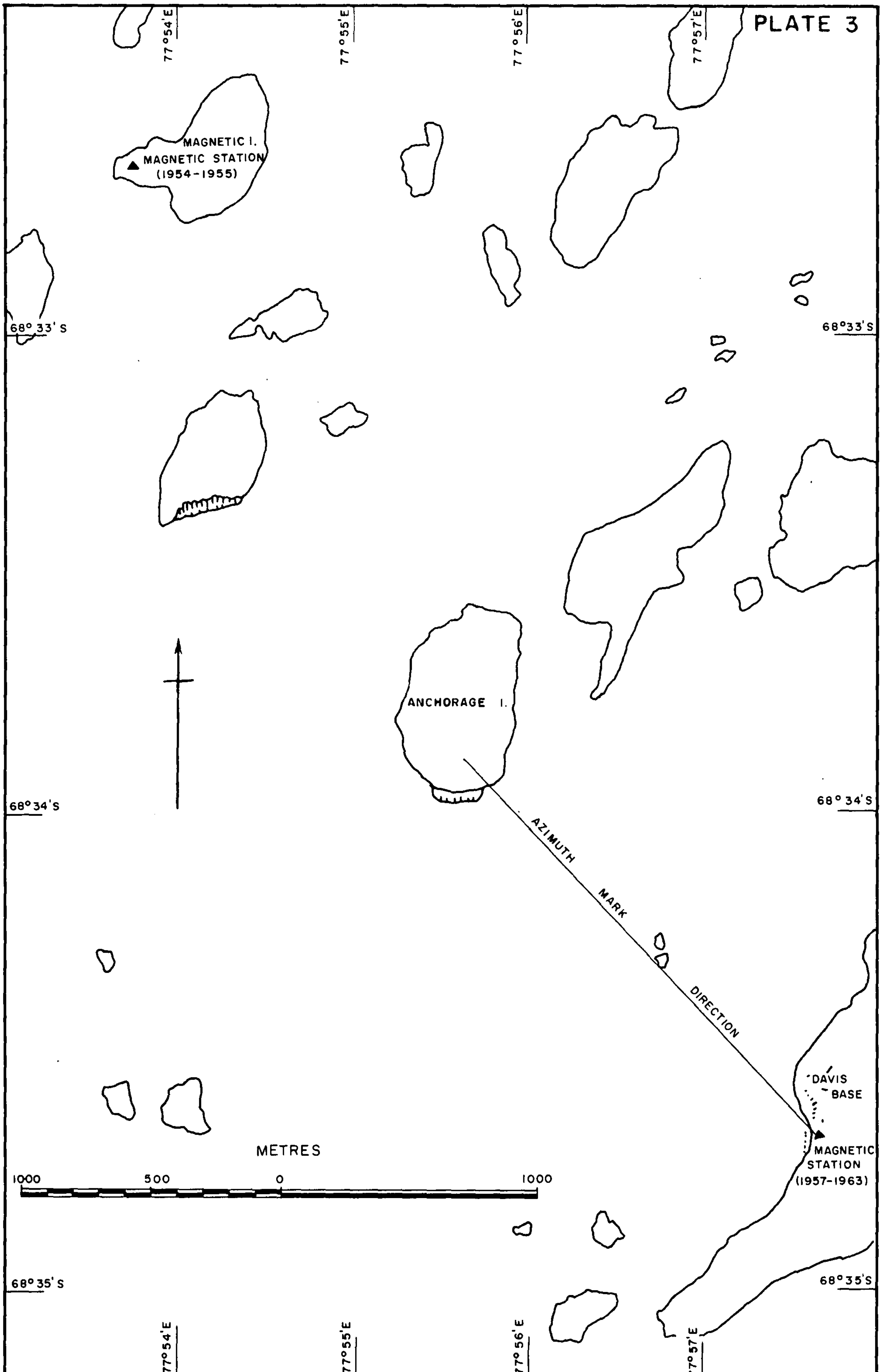

DAVIS BASE AND
MAGNETIC ISLAND (VESTFOLD HILLS)
MAGNETIC STATIONS

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

G437-3

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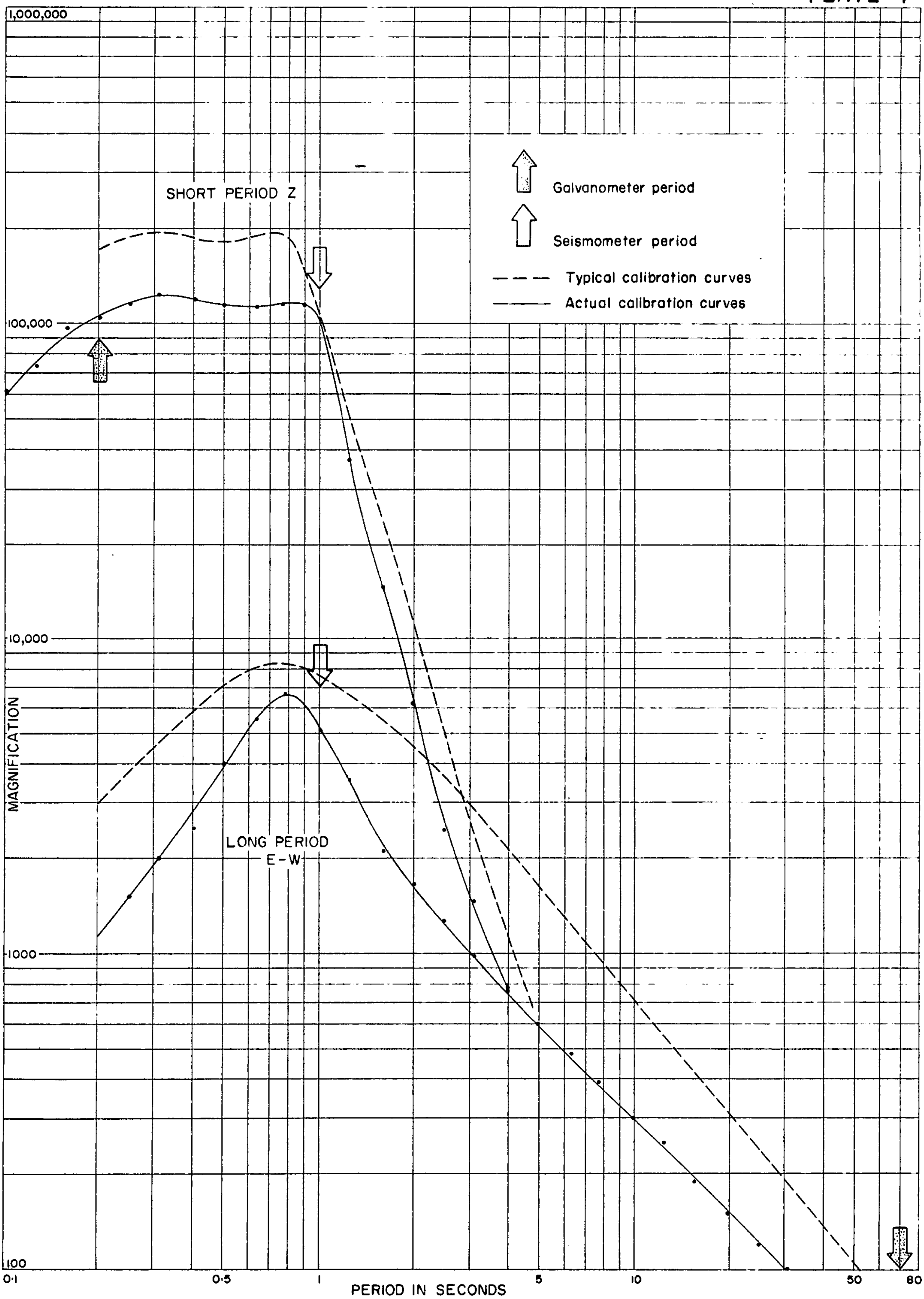
PLATE 4



MAWSON
SEISMOLOGICAL OBSERVATORY

MAGNIFICATION CURVES FOR BENIOFF SEISMOGRAPH DETERMINED WITH THE WILLMORE CALIBRATION BRIDGE

(Based on G82/2-2)

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