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MAWSON GEOPHYSICAL OBSERVATORY, ANNUAL REPORT 1975

by

P.J. Hill

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CONTENTS

TABLES

PLATES

SUMMARY

Operation of the Mawson Geophysical Observatory during 1975, when the author was observer-in-charge, is described in this Record. Continuous recording of the geomagnetic field and seismic activity was maintained by two three-component La Cour magnetographs (NORMAL and SENSITIVE) and a three-component short-period Benioff seismograph. Regular geomagnetic absolute observations were made as a control for the magnetographs. As soon as acquired, earthquake and monthly magnetic data were sent to the BMR office in Melbourne - final analysis of data was completed on return to Australia. The original 15 mm/hour magnetograph recorders (NORMAL and SENSITIVE) were replaced by new 20 mm/hour recorders to comply with an IAGA recommendation. During the 1975-76 summer the author took part in the Australian National Antarctic Research Expedition to Enderby Land and made geomagnetic and gravity measurements.

1. INTRODUCTION

The Mawson Geophysical Observatory, Australian Antarctic Territory, is one of five observatories run by the Bureau of Mineral Resources, Geology and Geophysics (BMR) for the study of geomagnetism and seismology. It commenced operation in 1955 (Oldham, 1957) with continuous recording of three geomagnetic components: horizontal intensity (H), declination (D), and vertical intensity (z); in the next year a three-component seismograph was added (McGregor, pers. comm.). Since then a number of changes in equipment and instrumentation have taken place (see appendix). The observatory is part of the scientific program of the Australian National Antarctic Research Expeditions (ANARE), for which logistic support and accommodation is provided by the Antarctic Division, Department of Science. BMR supplies the equipment and observer.

The author flew into Mawson by helicopter from M.V. Nella Dan on 20 December 1974. Soon after, Peter Cameron, the 1974 geophysicist left by tractor train for Knuckey Peaks, the base camp of the 1974-75 Enderby Land expedition; he returned a few weeks later. M.V. Nella Dan sailed into Mawson Harbour in February for the annual relief of the station. In the following summer the pattern was repeated when Philip Wolter, the 1976 geophysicist, arrived at Mawson on 25 December. From 30 December to 2 February 1976 the author made magnetic and gravity field measurements and assisted the surveyors as part of the 1975-76 Enderby Land expedition. Mawson was left on 11 February for return to Melbourne via the Amery Ice Shelf where an unmanned ANARE magnetic and auroral observatory was to be installed, and geomagnetic observations were to be done by the author. Unfortunately this project had to be abandoned owing to persistent bad weather, which made helicopter operations too hazardous.

Co-ordinates and other data for the recording sites are shown in Table 1.

2. GEOMAGNETIC OBSERVATORY

Instruments and observations

Variations of three geomagnetic field components (H, D, and Z) were recorded by two La Cour magnetographs, a) NORMAL and b) SENSITIVE. The

La Cour magnetograph is described in standard observatory texts (e.g. McComb, 1952; Wienert, 1970). The photographic records were changed daily between 0255 and 0259 UT.

The H and D variometers each have two sets of orthogonal Helmholtz coils fitted, one set for scale-value determinations and the other for orientation tests. There is only one set of coils on each Z variometer, for making scale-value tests; bar deflector magnets are used for orientation tests. A BMR magnetograph calibrator supplied accurate current values to the coils, though for NORMAL H and D orientation tests, which require larger currents, a manual calibration setup was employed.

Baseline control was maintained by regular observations in the absolute hut using quartz horizontal magnetometers (QHM) for H, an Askania fibre declinometer for D, and proton precession magnetometer (PPM), in conjunction with the magnetogram values of H for Z. As a backup for Z baseline control, measurements were also made by magnetometric zero balance (BMZ).

Modifications

The original La Cour recorders which operated at a speed of 15 mm/h were replaced by 20 mm/h recorders to comply with Resolution 19 made at the Kyoto Assembly of the International Association of Geomagnetism and Aeronomy, 1973 to standardise magnetograms. The new recorders were constructed in the BMR workshops; apart from increasing the drum diameter to provide the desired paper speed, no major changes were made to the original design.

A new recorder for the NORMAL magnetograph was installed on 12 February 1975. At the end of the year another 20 mm/h recorder arrived; and it was interchanged with the existing SENSITIVE recorder on 29 December 1975. In both change-over the operation went smoothly, and only a few hours' record was lost.

The PMZ-1 observatory rectifier which supplied the low voltage power to the magnetograph lamps had been housed in a wooden box outside the variometer building. This box and 12V standby lead-acid battery were completely exposed to the weather. To provide protection, and to avoid problems such as entry of drift snow and temperature fluctuations (which caused variations in voltage and so lamp intensities) it was decided to move the unit to the vacant micropulsation hut. According to the auroral electronics engineer there were no plans to occupy the hut in the foreseeable future. The transfer took place on 28 December 1974. Because of the greater distance to the micropulsation hut (about 40 metres), thicker cable was required to reduce the voltage drop in the new line.

After the new NORMAL magnetograph recorder was installed, higher lamp intensities were needed because the photographic paper for this recorder (Kodagraph P4-C) was slower than the paper used before (Kodagraph FPS). The rectifier circuit was modified (CR2 to 3.3V t 6.8V zoner diodes, R1 to 300 ohms) to produce 8.5V output with a 2-ohm load. To restore NORMAL ballout and SENSITIVE trace and ballast lamp currents to their former values, high-wattage wire resistors were soldered in at the lamp rheostats of the control panel in the variometer building.

In December 1975, the resistor in the SENSITIVE trace rheostat was removed after installation of the new recorder - once again, because the slower (Kodograph P4-C) photographic paper had to be used.

Blizzards and the variometer building

The variometer building is situated on a fairly flat area of rock completely exposed to the prevailing winds and blizzards sweeping down from the ice plateau, predominantly from the southeast. Annual mean wind speeds recorded at the Mawson meteorological station (200 metres downwind from the variometer building) are typically between 20 and 25 knots, and gusts in excess of 100 knots are not uncommon.

On magnetograms after a blizzard broadening of the traces due to high-frequency oscillations occurred, corresponding to the periods of maximum wind speed. This was considered unavoidable in view of the tremendous buffetting of winds on the building, and had been observed by the author on records of previous years (e.g. 1972).

The effect is greater on the SENSITIVE magnetograph traces than on the NORMAL, probably because the SENSITIVE variometers are closer to the windward wall and have a greater optical magnification. Because H and D variometer magnets are suspended on fibres rather than pivoted on knife edges as in the Z variometers, their traces are affected more.

On 17 September the most severe blizzard of the year reached its height with a mean wind speed of 85 knots and gusts in excess of 120 knots. On the records all traces and baselines were affected. On the NORMAL magnetogram, though baselines were fuzzy the effect was more pronounced in the magnet traces, which were widened as much as several mm. A number of small displacements across the record of all traces and baselines amounting to about 3 mm could be seen, indicating that relative movement between recorder and variometer piers had occurred. Similar effects were observed on the SENSITIVE magnetogram except that the deflections of H and D traces became increasingly violent until the H trace dissappeared altogether. At the height of the blizzard the Z trace exhibited erratic deflections and suddenly disappeared from the record as well.

The SENSITIVE H and Z variometers were inspected. The H magnet was hanging in incorrect orientation; this was remedied by turning the torsion head to return the trace. In the Z variometer the recording magnet had shifted off the agates and was lying askew. Because the greased joint of the variometer's glass top was stuck it was necessary to remove the variometer from the pier to the control room where it could be worked on. The magnet and agate bearings were cleaned and the unit was re-installed on the pier, thus restoring recording.

The SENSITIVE variometer pier is very close to the windward wall of the building (see Plate 1, Smith, 1971) - it was suspected that flexing of the wall was causing it to knock against the pier resulting in jarring of the variometers.

This theory was tested about a week later when a slightly less severe blizzard raged. While wind gusts were around 90 knots, the spacing between wall and pier was measured - the gap diminished to as little as 3 mm (compared to 22 mm measured later on a calm day). Obviously then, it was flexing of the wall onto the pier that caused the trouble on 17 September. Although gusts to 102 knots occurred overnight during the second blizzard, there was no disturbance of the variometers (apart from minor vibration of the recording magnets), indicating that gusts over about 110 knots were required before the wall contacted the pier.

Apparently there had been an awareness of the problem in 1971; Petkovic (1973) stated that "This (building deterioration) was particularly bad in the variometer hut where the 'creep' of the windward wall was beginning to interfere with the piers'. On inspecting the exterior of the building it was found that the pounding of wind and drift over the years had caused some deformation and movement of the walls. Though not serious yet, thought will have to be given to replacing the existing structure in perhaps 5 to 10 years' time with one of solid construction, perhaps brick or concrete.

To prevent the problem recurring the windward wall was reinforced effectively in November with the help of the carpenter. A hardwood beam (10 cm x 10 cm) was mounted along the outside about half way up the wall and 7 cm away, and 2.5 m hardwood beam was fixed on the inside of the wall; two 38-cm brass bolts with suitable spacers were inserted to pull the wall towards the outside beam.

Absolute observations

For control of magnetograph baselines, absolute observations were done five or six times per month, using the following instruments:

H	QHMs 300, 301, 492
D	Askania declinometer 332 and circle 611665
Z	Elsec PPM 339 (in conjunction with the QHMs)
Z	BMZ 62

Magnetometers which had been standardised at Toolangi Observatory were taken to Mawson for the summer so that intercomparisons could be done with the Mawson instruments. The intercomparisons (through the baselines), done between 26 and 30 December 1974 were:

HTM 704 and QHM 492 against QHM 300
Askania declinometer 812 against Askania declinometer 332
Elsec PPM 339 against Elsec PPM 340

It should be noted that the 100 KHz internal time-base of PPM 339 was 1.7 Hz low when tested at BMR just prior (4/12/74) to being taken to Mawson to replace PPM 340. This implies that at Mawson PPM 339 would read 0.9 nT high.

Differences between Mawson instruments, derived from baseline values determined throughout the year, are shown in Table 2. Long-range BMZ 121A was compared before and after the field work of the 1975-76 summer.

Scale value determinations

In December 1975 Philip Wolter brought a calibrated digital multimeter (Data Precision, model 245) which was used to check the MCO-1B magnetograph calibrator, used for supplying scale-value and orientation currents to the Helmholtz coils. Only slight differences (Table 3) were detected between the settings of MCO-1B and the actual currents flowing.

Table 3 shows the results of the 1975 scale-value determinations. NORMAL magnetograph scale-value tests were usually done straight after the absolute observations (i.e. five or six times per month); SENSITIVE magnetograph tests were done monthly.

Scale-value currents were monitored by portable sub-standard milliammeter 14261 which was also read as a backup for MCO-1B. The mean of these readings over the year compared with the true current as measured by the digital multimeter enabled corrections to 14261 to be calculated.

Test current (mA)	Correction to be applied to 14261 reading (mA)
10	-0.05
30	+0.05
40	+0.15
60	+0.25
70	+0.35

After the daily change of records NORMAL H and Z variometer temperatures were read (also done for SENSITIVE H and Z variometers until the end of February, when readings were reduced to once per week). Heating in the variometer room is thermostatically controlled - in 1975 the temperature ranged from about -4°C to +5°C (at 0300 UT). From least-squares analysis of NORMAL Z thermograph trace-ordinate and temperature, temperature scale values were computed and 1.80°C/mm was adopted for the year (Table 4).

Baseline values and temperature coefficients

The 1975 NORMAL Z temperature baseline values are given in Table 4, and NORMAL H, D, and Z baseline values are set out in Table 5. In calculation of the latter no instrument corrections were applied; H values were calculated from mean QHM 300, 301, and 492 observations (except for the period from January to 12 February when the mean of QHM 300 and 492 values was used), and Z values were calculated from F (PPM 339) and H derived from the NORMAL H variograph.

To determine NORMAL H and Z ordinate temperature coefficients (qH, qZ), observed baseline values were plotted against variometer temperature for periods of stable baseline; as well as this, least-squares analysis by computer was done. The scatter in baseline values and the small temperature range precluded accurate solutions. For the longest period of stable Z baseline value (22 February to 17 September), the computations gave qZ = 1.9 nT/^{o}C - a value of 2.0 nT/^{o}C was adopted. The results indicated a trend of about 0.5 nT/^{o}C for qH, but not being very conclusive, 0.0 nT/^{o}C (used in previous years) was adopted.

Orientation tests

On 23 June orientation tests were done on the H and D variometers of both magnetographs. Alignments of the Helmholtz coils were checked using the azimuth marks on the wall-strips of the variometer room, and were found to be as set in October 1974 (Cameron, 1976) i.e. 64.0^{o}W. For the tests, currents of 100 mA and 300 mA were used for the SENSITIVE and NORMAL variometers, respectively.

After the severe blizzard of 17 September, coil alignments and recording magnet orientations were rechecked on 22 September (SENSITIVE H and D). No significant changes were observed.

NORMAL and SENSITIVE Z variometer orientation tests were done on 3 October. To level and position the deflector magnet accurately an adjustable platform (Smith, 1971) was used. Levelling from recording magnet to deflector magnet was done by a U arrangement (two glass tubes joined by plastic tubing) partly filled with a coloured mixture of water and methylated spirits (to prevent freezing) - height adjustments were made to the meniscuses. To determine the magnetic moment of the deflector, it was set up on a BMZ tripod in the meridian 128 cm magnetic south of the NORMAL H variometer. By reversing and scaling the deflections of the H trace on the magnetogram, magnetic moment was calculated as 5060 cgs units. This compares well with the value 5180 cgs units determined in 1969 (Major, 1971), considering that some ageing must have taken place since that time.

For the NORMAL Z test, an orientation bench mounted on the wall north of the variometer was used, the deflector being aligned in the meridian 54 cm from the recording magnet. The BMZ tripod was again required for positioning the deflector for the SENSITIVE Z test - it was placed broadside to the recording magnet, 74.5 cm on the recorder side.

The results of all orientation tests are summarised in Table 6; all ex-orientation angles (Ex) are less than 1° except for NORMAL D and SENSITIVE H.

The NORMAL D value is N 1.7°E; the cause of this ex-orientation will have to be investigated. Assuming that the azimuth marks on the wall-strips are correct, the ex-orientation could be due to residual torsion in the D fibre or alternatively due to some extraneous magnetic source nearby (perhaps a combination of the two). The fact that Ex is to the east adds weight to the latter explanation - as the NORMAL D variometer is the closest variometer to the control room, it is possible that some equipment therein is sufficiently magnetic to cause a significant deflection of the D magnet from the meridian. It was established in earlier years (e.g. Major, 1971), for example, that the La Cour pendulum clock on the wall of the control room (1.3 m from the normal D variometer) has some effect on the NORMAL magnetograph.

The orientation of the SENSITIVE H recording magnet was E1.3°S at the last test of 22 September. Because the H field shows a secular increase, Ex would be expected to get smaller. However, because the rate of H increase is relatively slow (about 5 nT per year), and as D is increasing westerly comparatively rapidly (0.1° per year), Ex will in fact get larger. Therefore the orientation of the SENSITIVE H magnet will have to be adjusted some time in the near future.

Parallax corrections

Both magnetograms were tested once per month for timing parallax. The results are produced in Table 7; parallax corrections are to be added to times indicated by time marks of the corresponding traces.

Pier differences

Two piers for absolute observations were in use at Mawson in 1975, the standard pier inside the absolute hut which was used for QHM, declinometer and BMZ observations, and the external pier (E) used for PPM observations of F (total field intensity). Normally F readings were made from the heated absolute hut, since Elsec electronics are not designed for operation below $0^{o}C$. As the Elsec instrument box is magnetic, it is not possible to make F measurements on the standard pier from within the hut because of its small size.

At pier E the PPM head was mounted permanently on a wooden tripod. For pier comparisons a spare PPM head in a wooden box was placed on the standard pier, and the Elsec instrument box was taken outside - sets of readings were taken alternately (by switching cables) from the standard pier and pier E as rapidly as possible. This was done on average once per month, the result for the year being (in terms of F):

Standard pier - pier E = +1 nT

F recording

Continuous recording of F (total intensity), by the observatory standard PPM (via digital-to-analogue converter) on a Moseley 680 chart recorder, was discontinued early in 1975 (although the equipment was left available for reassembly if required).

The original purpose of the equipment had been to provide a usable absolute F record to replace Z, but because the analogue output proved to be non-linear, this idea was abandoned. Thereafter the sole purpose of the set-up had been to enable the geophysicist to get some idea of the geomagnetic activity before proceeding with absolutes. Although this was useful, almost as good information could be obtained from the morning's records, taking into account the daily pattern of activity. Disadvantages were that continuous operation of the PPM hardware greatly increased chances of electronics failure (Major, 1971; Silic (in prep.); Cameron, 1976); also, after carrying the instrument box from office to absolute hut through air at temperatures down to $-30^{o}C$ in winter, some time had to be allowed for warming up, as the electronics were unreliable below $0^{o}C$. In addition, after the woodstack on which the sensing head was mounted in 1975 was dismantled and removed, no suitable alternative location near the geophysics office was available - the magnetic gradient near the buildings being too great.

For these reasons it was decided to reserve the PPM instrument for absolutes only, taking it from the absolute hut only when recharging of the NiCd batteries was required (and when the standard pier was in use).

Data

The normal magnetograms were scaled daily for K-indices (K = 9 corresponds to 1500 nT or more) and mean hourly values of H, D, Z, and T (Z) ordinates. Monthly data consisting of K-indices, monthly mean values, baselines, and scale values were transmitted by telex to the BMR office in Melbourne as soon as they were available, usually within a day or two of the end of the month. The 1975 preliminary monthly geomagnetic values and K-indices are presented in Table 8., and Table 9 gives the annual mean values of the field since 1965.

On return to Australia, magnetograph parameters were recomputed in Canberra, and all SENSITIVE and NORMAL magnetograms microfilmed. Final BMR magnetic data are forwarded to the World Data Centres.

3. SEISMOLOGICAL OBSERVATORY

Continuous recording of seismic activity was maintained throughout the year by a three-component short-period Benioff seismograph. Ground motion was detected by a vertical (Z) seismometer in the underground vault below the Cosray building and two horizontal (N-S, E-W) seismometers in the seismic hut, where the triple-drum photographic recorder was also located. Record changes were made daily at about 0310 UT.

Cables to seismic hut

When the vertical seismometer was transferred to the Cosray underground vault in 1973 (Almond, 1975), Z signals were transmitted to the recorders by sections of Pyrotenax cable between cosray and the geophysics office, and then by PVC two-core shielded cable from there to the seismic hut. The latter cable was laid along trayways, over the vehicle workshop and powerhouse, and from there along the ground for the remaining distance. Being soft it was susceptible to damage by vehicles passing over it (e.g. LARC in February) and wind vibrations (Cameron, 1976).

To ensure reliability of the Z signal link, particularly over the approaching winter, it was decided to replace the much repaired two-core cable with four-core Pyrotenax. On 5 May, with the help of the electrician the Pyrotenax cable was laid and connected into the geophysics office and seismic hut. To prevent vehicle damage across the roadways near the seismic hut, two water-pipe cable conduits were pinned securely to the rock.

No more trouble was experienced with the Z signal line, except during a blizzard in September when a loose section of old Pyrotenax over the radio office was abraded through. It was repaired by inserting a Pyrotenax joint and clamping the cable to the wall and roof.

The ageing Pyrotenax cable which supplied power and timing to the seismic hut failed in November. This recurring problem (Major, 1971; Petkovic, 1973; Silic (in prep.); Almond 1975) is believed to be caused by water (from melting snow and ice, as summer approaches and the days become warmer) which enters cracks in the copper sheath and reduces the inter-conductor resistance. Ice may already have been present in the cracked cable and would have been a good insulator until the thaw. Time marks to the seismic hut were restored by using the two spare leads in the new Z signal cable.

Calibrations

Seismograph data and results of calibration tests done throughout the year are set out in Table 10. As a continuous check on performance, daily sets of calibration pulses were applied to all records.

Magnifications were calculated by weight lift tests using the formula M = 800 (X1/Wt) from the Benioff seismometer manual (Geotechnical Corp., 1959) where

M = magnification at 1 Hz

X1 = trace deflection (mm)

Wt = mass (g) of the test weight

800 = empirical constant determined by shake table tests.

The Z, N-S, and E-W attenuator boxes were calibrated by applying a fixed calibration pulse and varying the attenuator settings.

In February 1975 the sinusoidal frequency response of the Z seismograph was determined using a Wavetek function generator. By combining the results of this with that of magnification tests and attenuator box calibrations, the MAW magnification curves of Plate 1 were obtained. Plate 2 shows the magnification at 1 Hz of the horizontal seismographs for different attenuator settings.

While doing horizontal seismometer weight lift tests in October, it was discovered that the polarity of the N-S seismometer output was reversed according to convention (this was traced back as far as the beginning of the year, and presumably was so before that). Correction was made on 8 October 1975 so that trace motion UP represented ground movement to the NORTH.

Seasonal changes in seismic noise level

A pronounced seasonal cycle of ambient seismic noise level occurs at Mawson. This is well illustrated by Plate 3 showing a plot of the daily number of earthquakes recorded per day over the whole year - a strong correlation exists with the condition of the sea-ice (similar findings were mentioned in earlier years e.g. Cooke, 1967). During February and March when the sea-ice had broken up and been blown out to sea, an average of less than one earthquake per day was recorded - while during the period June to October when the sea-ice was thick and (relatively) stable about six earthquakes per day were recorded.

Maps in "Atlas of Antarctica" (p. 126), a Russian publication, show that the average extent of the sea-ice off the coast at Mawson is a minimum in March and attains a maximum of 970 km in September and October.

In winter, because there is no local wave action and swells of the open sea are damped by the intervening sea-ice, there is a significant increase in the signal to noise ratio allowing lower seismometer attenuator settings to be used (see Table 11 for vertical and horizontal seismometer attenuator settings in 1975) with the result that a greater number of earthquakes are recorded. For example on the vertical seismograph magnifications at 1 Hz could be raised from 14 K in February and March to 63 K in July to November.

Data

Seismograms were examined and seismic phase times were scaled each dat (usually in the early afternoon when the records were sufficiently dry after photographic processing in the mornings). The phase data were telexed to the BMR office in Melbourne every one or two days for transmission to the Geological Survey, US Department of the Interior (Denver, USA) for inclusion in the Preliminary Determination of Epicentres (PDE) computations.

On return to Canberra, final seismic analysis (including log (A/T) measurements for calculation of body-wave magnitudes (m_b)) was completed and the data were sent to the International Seismological Centre (Newbury, United Kingdom). Data were submitted for 1327 events recorded at Mawson during 1975.

4. POWER AND TIMING

The Observatory's control equipment has remained almost unchanged since 1970 (Robertson, 1972), and in 1975 it continued to function satisfactorily.

Power failures occurred at Mawson fairly often, but were usually of short duration so the standby lead-acid batteries were adequate to maintain continuous operation.

EMI digital clock (no. 832) provided timing and accurate 50 Hz power to run the seismograph and magnetograph recorders. It was usually corrected daily using VNG (12 MHz) radio time-signals, and occasional adjustment of the rate was necessary to keep it less than about 150 milliseconds per day.

Spurious triggering of the BMR observatory programming unit (TMU) has been an ever-present (though minor) problem since introduction in 1968 (Smith, 1971). Apart from the occasional advancement of the TMU by 1 minute (usually during mains power failures) there were no problems in 1975 until October, when during a blizzard the spurious pulsing became excessive. Random pulsing ceased when timing to the TMU was switched from EMI to the standby Mercer chronometer, suggesting that extra pulses or transients from the EMI were causing the trouble (though originally it was thought that drift static was responsible). The EMI was checked (with the electronics engineer) but no fault could be located. Earthing of the equipment was double-checked and experimented with, but to no avail.

To restore reliable operation of the Observatory, seismic time marks were taken directly from the EMI and magnetic timemarks from the Mercer-driven TMU. After some weeks the spurious pulsing vanished and normal timing was re-introduced.

5. BUILDING MAINTENANCE AND IMPROVEMENTS

The geophysics office was painted and numerous smaller jobs were done throughout the year on the geophysics buildings to keep them in good condition. The protective metal cable covers in front of the office and the two pipe conduits for the magnetic Pyrotenax cable near the auroral building had worked loose. These were securely anchored by drilling into the rock and driving in rock-pins. Permanent 240V power wiring and fluorescent lighting were installed in the underground seismic vault by the electrician.

Construction of the new science block was commenced during the 1975-76 summer and is expected to be ready for occupation by BMR and IPS officers in 1977.

6. STATION DUTIES

In addition to their specific work program, expeditioners were expected to assist in the general maintenance of the base. Two weeks were spent as kitchen assistant ("slushie") and Sunday cook; rostered nightwatch was done about every three weeks; and on Saturday afternoons the whole camp was involved in set station chores. The author also looked after the auroral equipment on several occasions while the auroral physicist and electronics engineer were absent from the base.

7. REGIONAL GEOMAGNETIC AND GRAVITY MEASUREMENTS

The author was a member of the ANARE 1975-76 summer expedition to Enderby Land from 30 December 1975 to 2 February 1976. Centre of operations was the base camp established near Mount King in mid-December by a tractor train party from Mawson.

The top priority work was National Mapping geodetic surveying and aerial photography; glaciological measurements were made on the return tractor traverse by Antarctic Division glaciologists (who also did a number of D observations by compass-theodolite along the way); two BMR geologists and the geophysicist (author) each accompanied a surveyor to form three ground survey parties. Transport was by helicopter, and despite a shortage of fuel for the aircraft plus the fact that the field program was guided largely by the requirements of the geodetics, there was nevertheless some flexibility and a useful number of geomagnetic and gravity stations were occupied (several being re-occupations).

At all magnetic stations multiple measurements of all three components H, D, and Z were made by instruments QHM 301, Wild compass theodolite TO 104407, and long-range BMZ 121A. For the gravity work LaCoste & Romberg gravity meter G101 was used.

The following is a list of magnetic stations occupied: Fold Island, Alphard Island, Depot Island, Rippon depot, Rayner Peak, Mount Breckinridge, Proclamation Island, Mount King base, Mount McMaster, Mount Riiser-Larsen, Observation Island, Mount Pardoe, Pinn Island, Lamykin Dome. Gravity readings were taken at all these places except Depot Island and Mount Riiser-Larsen. In addition, gravity readings were taken at Latham Peak, Sheelagh Island, Mount Douglas, fuel depot 8 km north of Mount Douglas, and Molodezhnaya. On the return voyage to Australia, the gravity tie between Mawson and Australia was re-determined.

A detailed account of the geophysical field work with results, station descriptions etc., is given in a separate report (Hill, in prep.).

8. ACKNOWLEDGEMENTS

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APPENDIX

History of instrumentation before 1975

A brief outline of the development of Mawson Geophysical Observatory in terms of instrumentation before 1975 is presented below.

(a) Geomagnetic

May 1955	:	Absolute instruments used for regular observations H, D and Z (Oldham, 1957).
July 1955	:	With installation completed, continuous recording commenced by three-component normal La Cour magnetograph (Oldham, 1957).
1957	:	Bar-fluxmeter magnetograph installed (Pinn, 1961).
January 1961	:	Three-component insensitive La Cour magnetograph installed and recording commenced (Merrick, 1961).
December 1967	:	Bar-fluxmeter magnetograph withdrawn (Dent, 1971).
September 1968	:	Insensitive La Cour magnetograph converted to medium sensitivity and renamed normal magnetograph. The normal La Cour magnetograph was renamed sensitive magnetograph (Smith, 1971).

(b) Seismological

1956	:	Three-component Leet-Blumberg short-period seismograph (pen-and-ink recorder) installed (McGregor, pers. comm.).
1960	:	Three-component seismograph installed consisting of Benioff seismometers (free period 1.0 s) and three-channel BMR single-drum recorder. Galvanometer free periods were z 0.2 s and H 67 s nominal modified to about 30 s after repair of broken fibres. (Merrick, 1961).
February 1963	:	BMR recorder replaced by Benioff 60 mm/min three-channel recorder and 14 s free period horizontal galvanometers installed. (Black, 1965).

September 1970 : 14 s free period horizontal galvanometers replaced by short-period (0.2 s) galvanometers (Robertson, 1972).

December 1973 : Z seismometer transferred to underground vault beneath Cosray building (Almond, 1975).

TABLE 1

STATION DATA

	Magnetic	Seismological	
		Z	H
Name	Mawson	Mawson	
Code	MW	MAW	
Latitude geographic	67° 36' S	67°36.4'S	67°36.2'S
geomagnetic	-73.1°		
Longitude geographic	62° 53' E	62°52.3'E	62°52.5'E
geomagnetic	102.9°		
Elevation (m)	10	15	8
Foundation	Precambrian granite	Precambrian granite	

TABLE 2

MAGNETOMETER DIFFERENCES

1975

Horizontal intensity (nT)	Vertical intensity (nT)
QHM 300 - QHM 301 = -3 ± 4	Zp - BMZ 62 = -4 ± 7
QHM 300 - QHM 492 = +3 ± 4	Zp - BMZ 121A = -92 ± 5

Zp is derived from F (PPM 339) and H (mean QHM 300, 301, 492 observations); no instrument corrections have been applied.

TABLE 3

MAGNETOGRAPH SCALE VALUES

	Mean observed SV (and standard deviation)	Calibrator (MCO-1) current used mA	Digital multimeter reading mA	Corrected SV	Adopted Sv
NORMAL					
H nT/mm	21.50 ± 0.13	60.0	59.95	21.48	21.50
(a = 0 nT/mm^2)					
D min/mm	2.45 ± 0.02	40.0	39.9	2.44	2.44
Z nT/mm	22.73 ± 0.12	70.0	69.95	22.71	22.70
SENSITIVE					
H nT/mm	9.59 ± 0.09	30.0	30.0	9.59	9.60
(a = 0 nT/mm^2)					
D min/mm	0.863 ± 0.018	10.0	9.95	0.859	0.86
Z nT/mm	10.49 ± 0.10	30.0	30.0	10.49	10.50

TABLE 4

NORMAL Z THERMOGRAPH PARAMETERS, 1975

Date 1975	UT h m	St $^{o}C/mm$	Adopted St* $^{o}C/mm$	Bt ^{o}C
Jan 01	0000	1.87	1.80	-100.9
Feb 12	0900	1.98		-100.5
Feb 22	0516	1.72		-106.6
Sep 17	1400	1.61		-106.2
Oct 03	1100	1.84		-105.8

* Adopted St applies for all 1975

TABLE 5

OBSERVED MEAN BASELINE VALUES, NORMAL MAGNETOGRAPH

Date 1975	UT h	m	Baseline		Standard deviation	Remarks
Horizontal intensity			BHs			
			nT		nT	
* Jan 01	00	00	17117		2.9	
Feb 12	09	00	17113		2.2	Installed new recorder
Sep 17	14	00	17119		2.9	Severe blizzard
Declination			BD(W)			
			o	'	'	
Jan 01	00	00	60	38.1	0.1	
Jan 22	09	08	61	23.8	0.4	Variometer disturbed
Sep 17	14	00	61	19.2	0.6	Severe blizzard
Vertical intensity			BZs			
			nT		nT	
Jan 01	00	00	-47163		5.4	
Feb 22	05	16	-47096		2.2	Variometer adjustment
Sep 17	14	00	-47050		3.3	Severe blizzard
Oct 03	11	00	-47070		3.1	Orientation test

* Based on mean QHM 300, 492 observations (being in the field, 301 was unavailable)

TABLE 6

ORIENTATIONS OF VARIOMETER MAGNETS

Component	Reference field		Data	Magnet N pole		
NORMAL						
H	18398	nT	23-06-75	E	0.2°	N
D	62.5°	W	23-06-75	N	1.7°	E
Z	-47234	nT	03-10-75		0.0°	
SENSITIVE						
H	18398	nT	23-06-75	E	1.2°	S
	18398	nT	22-09-75	E	1.3°	S
D	62.5°	W	23-06-75	N	0.4°	W
	62.5°	W	22-09-75	N	0.5°	W
Z	-47243	nT	03-10-75		0.6°	DOWN

TABLE 7

PARALLAX CORRECTIONS (TO NEAREST 5 SECONDS)

Magnetograph	H	D	S
NORMAL	0	-5	0
SENSITIVE	0	0	+20

TABLE 8

PRELIMINARY MONTHLY MEAN GEOMAGNETIC VALUES AND K-INDEX 1975

Month	H, nT	D(West)		Z, nT	K
January	18411	62°	27.0'	-47309	3.9
February	396		28.7	315	4.2
March	388		30.1	306	4.1
April	400		30.2	296	3.7
May	391		30.8	282	3.8
June	398		31.0	266	3.6
July	392		32.0	259	3.7
August	389		32.9	254	3.5
September	397		33.0	243	3.2
October	395		33.7	242	3.2
November	401		33.6	238	3.8
December	408		33.6	221	3.6
MEAN	18397	62°	31.4'	-47269	3.7

TABLE 9

GEOMAGNETIC ANNUAL MEAN VALUES 1965-1975

Year	D		I		H	X	Y	Z	F
	o	'	o	'	nT	nT	nT	nT	nT
1965	-61	12.6	-69	13.1	18356	8840	-16086	-48368	51734
1966	-61	24.0	-69	09.6	18362	8790	-16121	-48235	51612
1967	-61	34.4	-69	07.2	18374	8747	-16158	-48168	51553
1968	-61	43.8	-69	05.2	18365	8698	-16174	-48060	51449
1969	-61	53.0	-69	03.4	18353	8649	-16186	-47954	51346
1970	-62	00.5	-69	00.4	18358	8616	-16209	-47840	51241
1971	-62	05.3	-68	56.4	18375	8602	-16236	-47719	51135
1972	-62	11.4	-68	53.1	18381	8575	-16257	-47600	51026
1973	-62	17.6	-68	49.7	18391	8551	-16281	-47486	50923
1974	-62	24.8	-68	47.2	18390	4516	-16298	-47380	50824
1975	-62	31.4	-68	44.0	18397	8488	-16321	-47269	50723
MEAN ANNUAL CHANGE	-7.88		+2.91		+4.1	-35.2	-23.5	+109.9	-101.1

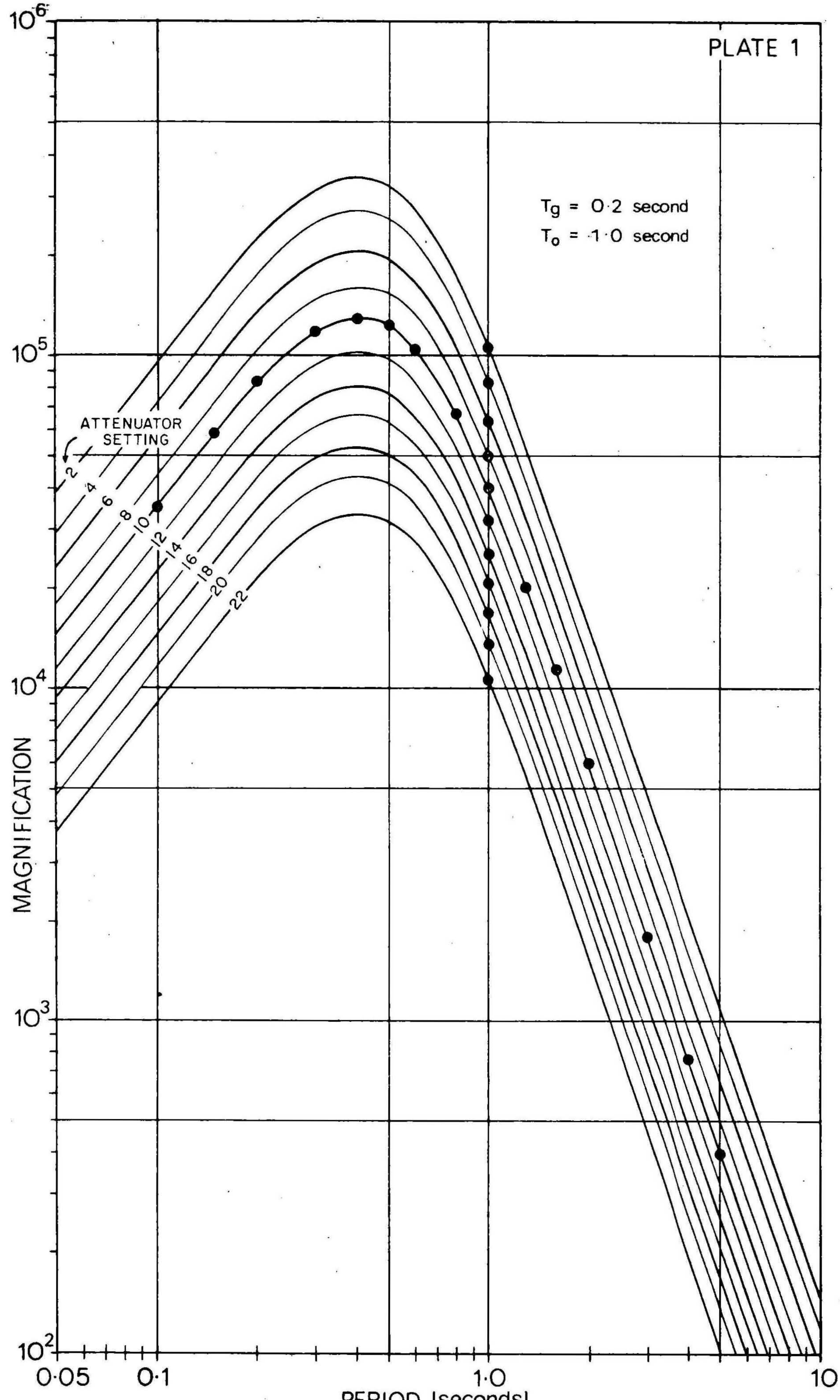
TABLE 10

SEISMOGRAPH PARAMETERS

COMPONENT	Z	N-S	E-W
Seismometer			
Type	Benioff	Benioff	Benioff
Free period(s)	1.00	0.94	0.94
Coil configuration (Geotechnical Corp., 1959)	B	B	F
Coil Rs (ohms)	146	420 (measured by Wolter, 1976)	420 (measured by Wolter, 1976)
Damping	-	-	-
Galvanometer			
Type	Geotech	Lehner-Griffith	Lehner-Griffith
Free period(s)	0.2	0.2	0.2
Coil Rg (ohms)	19	29	29
Damping	Overdamped	-	-
Calibrator			
Motor constant (N/A)	1.53	1.43	1.37
Recorder			
Type	Benioff	Benioff	Benioff
Chart rate	60 mm/min	60 mm/min	60 mm/min
System			
Damping	20:1	15:1	15:1
Magnification at Hz	40 K	21 K	22 K
Peak magnification/ period(s)	130 K/0.4	-	-
Attenuator setting	10	8	8
Polarity (trace motion for ground motion Up, North, and East respectively)	Up	Down Up (after 0526 UT on 8/10/75)	Up

TABLE 11
SEISMOMETER ATTENUATOR SETTINGS 1975

MONTH	DAY	TIME (UT)	ATTENUATOR Vertical	ATTENUATOR Horizontals
Jan	01	0000	10	8
Feb	09	1223	20	10
	17	1807	10	8
	18	0629	16	9
Mar	04	0406	20	10
	14	0317	16	9
	21	0520	10	8
	24	0317	6	6
	26	0309	10	8
Apr	01	0312	6	6
	02	0310	6	8
	04	0313	8	9
	05	0445	8	8
	06	0311	6	8
	14	0308	10	8
	19	0308	6	8
	21	0309	8	8
Jun	24	0310	4	8
	25	0314	8	8
Jul	02	0312	6	6
Sep	18	0430	12	9
	19	1226	6	6
Nov	10	0955	8	6
	20	0314	10	6

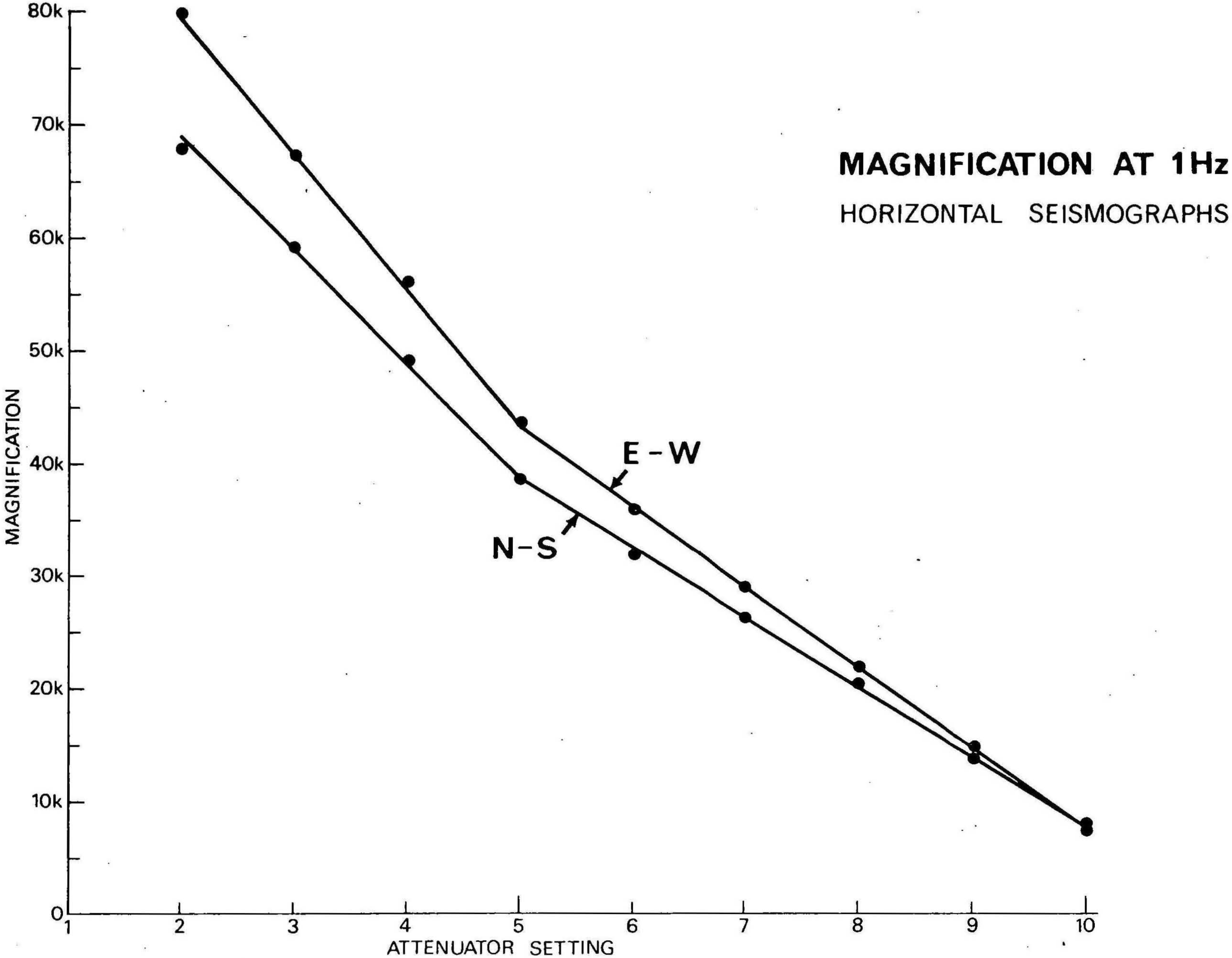


MAW MAGNIFICATION CURVES

Z SEISMOGRAPH

Record No. 1978/59

ANT/B9-70-1A



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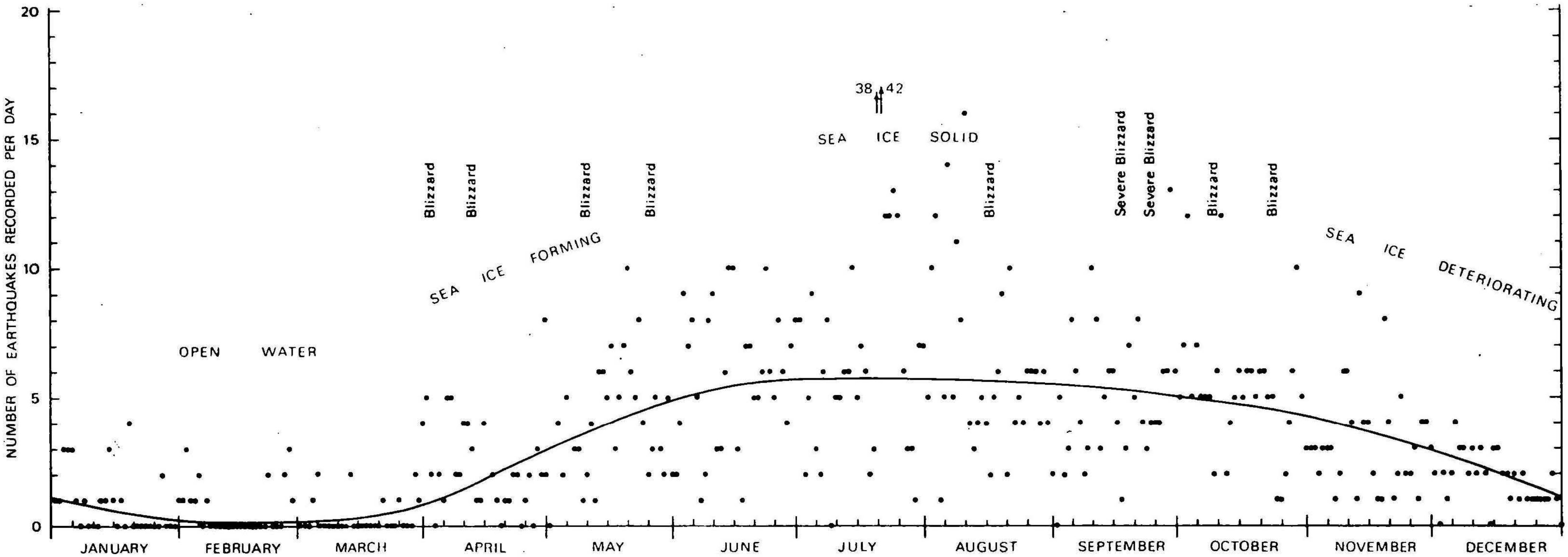
ANT/B9-71A

PLATE 2

Record No. 1978/59



SEASONAL VARIATION IN DAILY NUMBER OF EARTHQUAKES RECORDED - MAW 1975

ANT/B9-72AR

PLATE 3