# DEPARTMENT OF MINERALS AND ENERGY

# BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS



Record 1976/48



## MUNDARING GEOPHYSICAL OBSERVATORY

## ANNUAL REPORT 1975

by

P.J. Gregson and R.S. Smith

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CONTENTS



TABLES

PLATES

## SUMMARY

Basic programs in geomagneitic, ionospherics, and seismology were continued at the Mundaring Geophysical Observatory during 1975. The main instruments were an Eschenhagen normal-run magnetograph, an IPS Type IIIE ionosonde, and a Worldwide Standardized Seismograph System.

Seismographs were operated at Swan View, Kalgoorlie, Meekatharra, Marble Bar, and Giles. The seismograms from the seismograph at Kununurra, owned by the W.A. Government, were analysed. Accelerographs were operated at Meckering and Kununurra. Preparations were made for the installation of a Seismic Research Observatory in collaboration with the US Geological Survey.

The annual earthquake list shows details of 59 Western Australian earthquakes, 35 of which occurred in the southwest zone.

Intensity data were collected for two earthquakes with magnitudes greater than 4, from Fitzroy Crossing and the Pilbara area. The extent of intensity IV was defined for each earthquake.

## INTRODUCTION

The Mundaring Geophysical Observatory opened on 18 March 1959, and now controls operations at Mundaring (seismological and ionospheric recording), Gnangara (magnetic recording), Kalgoorlie, Meekatharra, Marble Bar, Giles, Kununurra, and Swan View (seismological recording). In co-operation with the United States Geological Survey, a Seismic Research Observatory (SRO) was programmed for installation at Narrogin. Preliminary work began during the year. Descriptions of the observatory and an outline of activity there to the end of 1974 have been given in previous records (e.g. Gregson & Smith, 1975); and principal events in the observatory's history are given in the Appendix. Discussion of non-routine projects is brief, as details will be reported separately.

## STAFF AND VISITORS

Observatory staff is listed in Table 1, and other personnel associated with the observatory's operations in Table 2. Staff absences for reasons other than recreation leave are summarized in Table 3, and conferences and training sessions attended or addresses given, in Table 4.

E.P. Paull (Geophysicist Class 1) remained on temporary transfer to the Toolangi Observatory Group all year. The observatory program was severely handicapped because his position was vacant all year.

Flexible working hours were introduced from 26 May. The scheme worked well with advantages to both the staff and the Department.

Two Geophysicists, P.J. Wolter and P.R. Gidley, were given training in observatory practice from July to September in preparation for Antarctic duty in 1976.

Visitors to the observatory are listed in Table 5.

## GEOMAGNETISM

### Normal magnetograph

The Eschanhagen 20 mm/hr magnetograph continued in operation at Gnangara.

The records for 2, 3 March were almost completely lost as the traces were very weak after a change to a different type of photographic paper. From April to June, the daily attendant encountered difficulty in loading the paper on the drum tightly

and in starting the drum in the correct position. Two visits were made to instruct the attendant and to fit a drum start indicator bar to the recorder, after which the loading was satisfactory. Minor modifications were made to the recording-lamp control circuit in September to improve current stability.

The EMI clock display jumped owing to interference during an electrical storm on 26 May, causing a correction to time marks of +44 seconds for one day.

No unexplained changes in H and D baseline values and scale values occurred during 1975.

On 23 July it was found that the Helmholtz coil fitted to the H variometer was set on an azimuth of 12.5°W. After the coil had been reset to its correct azimuth of 3.2°W, the measured scale values changed from 2.72 nT/mm to 2.66 nT/mm. This change correlates well with an increase in values of 0.04 nT/mm which would be expected from the mis-alignment of the Helmholtz coil. Scale-value observations before this change have not been corrected as the effect on calculated field values is insignificant and it is not known when the coils were first mis-aligned (although the scale values increased suddenly early in November 1974). On 30 July the H torsion head was adjusted approximately half a turn clockwise to reduce the number of negative ordinates. Orientation tests were performed before and after the adjustment.

The Z scale value rose from a minimum of about 5.72 nT/mm in February to a maximum of about 6.22 nT/mm in August, then fell to about 5.72 nT/mm in December. This behaviour is almost identical to that of the previous two years. Between 11 September and 16 September there was a sudden change in both the Z scale value and the Z baseline value. The cause is unknown and the change was adopted at 00 hours on 14 September. The seasonal variation in Z baseline values was only about 3 nT.

The standard deviations of the observed baseline and scale values from adopted values were:

| Element | Baseline value | Scale value |
|---|---|---|
| D | 0.26 min | - |
| H | 1.4 nT | 0.01 nT/mm |
| Z | 1.5 nT | 0.05 nT/mm |

Magnetograph tests

Temperature coefficients. Preliminary values used were qH = 0.4 nT/°C and qZ = 3.9 nT/°C. Lease squares analysis of the 1975 H and Z baseline value data gave values of qH = 0.4 nT/°C and qZ = 3.9 nT/°C, confirming the preliminary values used.

Orientation. Orientation tests were made on the H variometer magnet before and after the torsion head adjustments on 30 July; the results, adjusted to the mean magnetic field were:

| | | | |
|---|---|---|---|
| H: | E 0.4° N | 23 July | (ordinate -2.4 mm) |
| H: | E 1.4° N | 30 July | (ordinate +29.9 mm) |

Secular variation of both H and D will reduce the ex-orientation angle. No D or Z orientation tests were performed during 1975. Orientations of the recording magnets (N poles) in the mean magnetic field as at December 1975, estimated from previous results are as follows:

| | | |
|---|---|---|
| H: | E 1.4° N | (ordinate 28 mm) |
| D: | N 0.3° W | (ordinate 21 mm) |
| Z: | N 0.15° DOWN | (ordinate 31 mm) |

Parallax. No tests were performed during 1975 and it was assumed that the parallax remained unchanged from previous years. During 1973 it had been found that the parallax on variation trace time mark spots (but not on baseline spots or hour lines) was zero on all components. The parallax for other time marks can be measured from the trace time marks.

Scale values. A magnetograph calibrator MCO2 was used in conjunction with Helmholtz coils to determine H anc Z scale values once weekly. From February the calibrating current delivered was monitored using a moving coil or digital milliammeter, and from April the measured current rather than the current setting was used in calculations. On 29 April, the output of the calibrator was adjusted to 5.00 mA and thereafter adjustments were required frequently. On 1 July the calibrator failed and was repaired by replacing integrated circuit A2. In December, tests were conducted to determine the cause of current instability and these are continuing.

The D scale value was not determined during 1975.

## Magnetometers

Instruments in use during the year were Askania declinometer 509319 and PVM 116. Additional instruments read by trainee observers during August and September, but not used for adoptions were QHM 291, QHM 292, QHM 293, and BMZ 120.

In January the PVM coil base was returned to the office for tests to determine the cause of instability in level. There did not appear to be any excessive lateral movement in the bearing. However, lubricating fluid had found its way between the

mating surfaces of the lower bearing cone and the base plate. The surfaces were cleaned and three extra screws fitted, evenly spaced, between the existing ones to hold the bearing cone more securely. The upper joint between the bearing outer cone and moving table was treated similarly. The PVM was reinstalled on 12 February and proved satisfactory until October, when levelling again became difficult. On 4 November the coils were dismantled and the bearing cleaned. It was reassembled dry but proved to be too stiff. It was dismantled again on 18 November and lubricated with graphite powder suspended in turpentine. This made the coils very much easier to level and align. However by December, difficulty was once again experienced in levelling and the bearing became stiff. The lubricant was unsatisfactory as it had dried out and accumulated into high spots keeping the cone surfaces apart. Tests with other lubricants are continuing.

Comparisons

A set of intercomparison observations was made between PPM 131 (1st Order Survey) and the Gnangara PPM 116 on 2 December. The observations were made on piers Nm or Nw while simultaneously operating Geometrics PPM 1023 at an auxiliary station about 30 m south of the absolute house. The Gnangara PVM coil system is mounted on pier Nm and the toroidal (T) sensors were not used on this pier, as previous experience had shown them to be unreliable in the coils; cylindrical (C) and toroidal sensors were both used on pier Nw. The mean differences were:

PPM 116 - PPM 131 = 2.0 nT (Pier Nm, sensor C)

PPM 116 - PPM 131 = 1.2 - 1.7 nT (Pier Nw sensor T)

Sensor C - Sensor T = 0.7 nT (Pier Nw, PPM 116)

Pier Nm - Pier Nw = 2.5 nT (PPM 116, sensor C)

PPM 116 (C) - PPM 131 (T) = 1.9 to 2.4 nT (Pier Nw)

Some variation was noted in readings made with the survey toroidal sensor, but the pier and sensor differences agree well with previous results.

The oscillator frequency of each PPM was checked using a Hewlett-Packard Model 5381A frequency counter:

PPM 116: 5.449743 MHz, error 7 Hz low (0.1 nT high)

PPM 131: 4.449813 MHz, error 63 Hz high (0.7 nT low)

The observed F differences cannot therefore be explained as oscillator errors.

During August and September the Gnangara QHMs and BMZ were read once weekly by each Antarctic trainee observer. Assuming no correction to PVM 116, corrections derived were:

QHM 291, -31 nT (12 observations)
QHM 292, -37 nT (11 observations)
QHM 293, -5 nT (11 observations)
BMZ 120, +213 nT (12 observations)

Preliminary corrections used throughout the year were:

PVM 116: H 0; Z 0

Askania declinometer 509319 (circle 508135): +0.5 minutes.

Accessory equipment

The Askania horizontal-intensity visual recorder at the Mundaring office was operated throughout the year. The Antarctic trainee observers practised setting-up and calibration procedures on the La Cour recorder located at the office. The recorder ran continuously during August.

During March tape-recording pulsation magnetometers were set up at the Weir site and at Gnangara by B.J. Fraser and P.W. McNabb of the University of Newcastle, NSW. The equipment at the Weir site operated satisfactorily although several days' records were lost in April owing to a cable break; it has been maintained continuously by Mundaring staff. The equipment at Gnangara proved unsatisfactory, as signals transmitted from a nearby ABC broadcasting station were conveyed to the recorder through the 250V a.c. mains connection. An arrangement of relays and a clock to alternate batteries on load and charge was devised but failed after a short time owing to excessive voltage drop in the relay contacts. Attempts to overcome these problems were finally abandoned in June.

In March a survey of total intensity using PPM 116 was made between the Gnangara observatory and OTC transmitters, about 10 km away. It was found that the PPM operated satisfactorily to within 1 km of the OTC aerials. The survey was made when proposals were mooted re-locate a Radio Australia transmitter at the OTC site (the transmitter was eventually installed near Carnarvon).

Data reduction and publication

Mean hourly value reduction data was prepared in monthly batches about three months after recording. Magnetograms and reduction data were sent to headquarters to compute mean hourly

values. As a check on these values the first and thirteenth hours of D, H, and Z were hand-scaled and mean values calculated at Mundaring for direct comparison.

Monthly and annual mean values of D, H, Z, and F and mean K-index values at Gnangara for 1975 are listed in Table 6. The field values were derived from the ten local quiet days of each month by scaling an ordinate for each component from each magnetogram. Annual values for all components since 1965 compiled by the headquarters group are shown in Table 7. Recent trends in secular variations for H and D continued with H decreasing by about 34 nT, D becoming more westerly by about 1.6 minutes, and Z increasing in magnitude by about 19 nT. Monthly mean values of F increased by about 13 nT during 1975; Plate 8 shows the graphs of the annual mean values 1919-1975.

The distribution and publication of data continued as previously (for details see Record 1975/143, Annual Report 1974).

Miscellaneous requests were attended to, mainly for magnetogram copies and information on the geomagnetic field in Western Australia. A magnetogram copy and control data for 16 November were supplied to Project Magnet as a check for several aerial runs over Gnangara.

## IONOSPHERICS

### Equipment

The quarter-hourly sounding schedule was continued throughout the year using a model 3E ionosonde supplied by the Ionospheric Prediction Service (IPS), Department of Science. Components and circuit boards continued to be supplied by IPS.

193 hours (2.2%) of record were lost during the year. Losses were due to component failure, 39 hours; film jamming or breaking, 92 hours; and operator error, 62 hours.

The start and stop frequencies were adjusted in April from 0.95 to 1.0 MHz and 22.0 to 20.0 MHz respectively.

### Data distribution and publication

The scaling, distribution, and publication of data continued as previously (for details see Record 1974/103), but the following additional parameters were scaled from 1 April: h'E, Es type, h'Es, foF1, and h'F.

## SEISMOLOGY

### Seismograph stations

Permanent stations were operated throughout 1975 at Mundaring (MUN), Kalgoorlie (KLG), Meekatharra (MEK), Marble Bar (MBT), Kununurra (KNA), and Giles (GLS). In addition stations were operated for part of the year at Swan View (SWV) and Narrogin (NWA). No field recordings were made during the year.

Preliminary work on the installation of a Seismic Research Observatory at Narrogin/Mundaring commenced during the year.

The number of events reported from each station were:

MUN 703; KLG 619; MEK 724; MBT 492;
KNA 1730; SWV 49; GLS 772; NWA 63;
TOTAL: 5152.

A summary of record losses for all seismograph stations is given in Table 8; generally losses were less than in 1974.

Mundaring. The WWSSN seismograph continued to run satisfactorily until December, with almost no maintenance required on the control console. The light-dependent resistors in the programmer were adjusted in February and the strobe serviced in March. Minor modifications were made so that an EMI clock could supply time marks if the WWSS timing system failed. The LP recorder motor and bearings were replaced in March and serviced in December, and the SP recorder motor was replaced in May and November.

The timing system became erratic on 13 December after a fault caused the vault earth-system to become 'live'. An EMI clock was used for timing until replacement crystal and divider modules were received in January 1976 from Albuquerque.

The supplementary seismograph ran well. The sole cause of record loss was the recorder lamps failing. The lamps are running at nearly full brilliance. It is not possible to reduce the lamp current without a major modification to the optical system.

Kalgoorlie. The optics of the recorder became misaligned in July, resulting in nine days record loss. Minor irregularities developed in the recorder drive in the latter part of the year.

Meekatharra. This seismograph continued to operate as a single vertical component throughout the year.

A maintenance visit was made in October when the Johnson/Matheson seismometer was replaced by a Willmore Mark 2 seismometer. The former was returned to headquarters so that it could be fitted with a high impedance coil. The seismograph was re-calibrated (Pl. 3).

Marble Bar. This station continued to be the most unsatisfactory station with operator errors and power failures throughout the year. The helicorder stylus was broken while recording a local earthquake on 5 July. The recorder clutch became loose in January resulting in six days' record loss.

A program to resite the seismometer out of town at the airport, and the recording equipment in the Post Office, was deferred until 1976 because of delays in equipment deliveries and after shortage.

Kununurra. This station continued to operate exceptionally well.

Swan View. As a result of a break-in at the tunnel site in 1974, the doors to the seismometer housing were strengthened and an alarm was fitted. If the doors are tampered with, a siren will sound and a calibration pulse is applied to the seismogram in the Mundaring office. If the doors are forced open, a larger pulse is recorded at Mundaring. The seismograph was operational from 19 March to 15 August, when the telemetry equipment was removed for tests and calibrations, both at Mundaring and Kowen Forest (HQ). The calibrated equipment was reinstalled on 18 December (Pl. 4).

Giles. This station was out of service from 19 January to 10 April, and 26 October to 21 November. On both occasions, a maintenance visit was made by headquarters staff. The TAM5 preamplifier and power supply were faulty and were replaced on the first visit and the TAM 5 was replaced again on the second visit. The seismograph response changed after the replacement of the TAM5 on 21 November and the seismograph requires recalibration.

Narrogin. A temporary station was installed at Narrogin (120 km SE of Mundaring) on 2 August. A Willmore Mark 2 was installed at the Seismic Research Observatory site (see later). Data were telemetered back to Mundaring using FM on Telecom circuits. One of the SRO helicorders and the digital clock were used for recording the data. The station operated until 12 December and contributed valuable data for locating events in the southwest seismic zone.

Transportable. This unit was out of service all the year, receiving maintenance as time permitted. Repairs were made to the control console, recorder, and cab. The galvanometer broke during testing and was replaced with a modified Geotech 0.2 s period galvanometer. The unit was re-calibrated (Pl. 5).

## Seismic Research Observatory

As a co-operative project with the United States Geological Survey, a Seismic Research Observatory will be installed in Western Australia. The seismometer will be placed in a borehole at a depth of 100 metres at Narrogin. Signals from the seismometer will be transmitted by Telecom circuits to recorders at Mundaring and displayed visually on helicorders and recorded digitally on magnetic tape. Details of the SRO will be presented elsewhere.

## Accelerographs

Four MO2 accelerographs were in service throughout the year; two at Kunurra and two at Meckering, sites B and C. No seismic events were recorded.

## Explosion seismology

Seismic waves from mining blasts at Newman, Tom Price, Goldsworthy, Shay Gap, Sunrise Hill, and Paraburdoo were recorded regularly on some of the Western Australian seismographs. From August, the mining companies involved supplied monthly summaries of explosion times. This facilitated the differentation between explosions and earthquakes in the Pilbara region.

A large explosion at Newman on 18 October was recorded at MBT, GLS, MEK, MUN, KLG, and poorly at KNA and NWA. The Pn velocity between MEK and MUN was calculated as 8.44 km/s which is the same as the Pn velocity determined from the Geotraverse data (Everingham & Gregson, 1971).

## Stress measurements

Six sites were selected in the southwest seismic zone in preparation for in-situ stress measurements in 1976 by the Crustal Studies Group in co-operation with CSIRO. The sites had a minimum of weathering and low relief and were selected taking into account the recent seismicity near each; they were near Manmanning, Goomalling, Meckering, Quajabin Peak, Alderside, and Popanyinning.

Assistance was given to the Crustal Studies Group in conducting refraction tests to determine weathering thicknesses at each site.

## Seismicity

Table 9 lists 59 Western Australian earthquakes of magnitude ML = 2.0 or greater which occurred during 1975 and for which locations are available; 35 of them occurred in the south-west seismic zone.

Epicentres were initially determined graphically. For larger earthquakes not in the southwest seismic zone, which were recorded at four or more Australian stations, epicentres were re-determined by the headquarters group using a computer program. Better positions were obtained for earthquakes in the southwest seismic zone by using distance and azimuth from Mundaring.

Plates 1 and 2 show epicentres of Western Australian earthquakes and those located in the southwest seismic zone respectively. Those shown in Plate 1 had magnitudes mB = 4 or greater.

Kununurra area. Nine earthquakes were recorded between 35 km south and 160 km southwest of Kununurra. One other earthquake was located 112 km east-southeast of Kununurra. The largest, ML = 3.7, occurred on 5 August 160 km southwest of Kununurra. Two small earthquakes, ML = 2.0 and 2.6, occurred in April within 10 km of the Ord River Dam wall.

Southwest zone. Activity in the zone was lower than in 1974, with only eight earthquakes with ML greater than 2.9. The largest, ML = 3.7, occurred on 7 October 10 km southwest of Brookton. Several small earthquakes were located approximately 70 km east and southeast of Narrogin. There was previous activity in this area in the early 1960s (Everingham, 1968).

Other areas. Several isolated earthquakes with magnitude mB greater than 4 occurred during the year. These are shown in Plate 1.

## Earthquake intensities

Questionnaire forms were distributed for earthquakes which occurred near Fitzroy Crossing and in the Pilbara on 6 March and 24 July respectively, and the isoseismal maps are shown in Plates 6 and 7. The scarcity of population in both areas limited the availability of data; however, the results gave some ideas of the extent of intensity IV.

## Data distribution and publication

Distribution of seismic data continued as previously (for details see Record 1975/143). A punched-tape telex machine was installed in the office in January to facilitate the sending of preliminary data from all stations to the US National Earthquake Information Service.

Miscellaneous requests for seismogram copies, phase data, and information on W.A. seismic activity were attended to.

## EARTH-TIDE RECORDING

Mundaring Observatory was selected as one of eight Australian sites for recording earth-tides as a co-operative project with the International Centre of Earth Tides, Belgium. Continuous recordings were made from 18 July to 19 November at the Mundaring seismograph vault. The equipment was installed by the Regional Gravity Group, and Mundaring staff made daily checks and fortnightly calibrations.

The original recordings were sent to the International Centre in Belgium and a 35 mm copy to Professor Mather (University of NSW).

## NOTES ON WORKS PROJECTS

The following works were carried out during the year:

(a) The office darkroom was painted and the processing sink replaced (February).

(b) An area of about 100 $m^2$ outside the workshop was concreted and drained. This overcame drainage problems experienced previously and also increased the parking area (March).

(c) An insulated, air-conditioned hut was constructed at Narrogin to house control equipment at the SRO borehole site (June).

(d) A 17-cm cased borehole was drilled by contract to a depth of 110 metres at Narrogin for the SRO. A 1.5 x 1.5 metre concrete vaultlet was constructed at the well-head (June).

(e) The mains electrical wiring and switchboard at the Mundaring office was upgraded to allow for the additional load necessary to run the SRO. An air-conditiioner was installed in the SRO recording room, and a battery box constructed to house 20 x 6V lead calcium accumulators (June).

Items (c) and (e) were funded by the USGS as part of the SRO project.

## ACKNOWLEDGEMENTS

The assistance of the daily attendants listed in Table 2 is hereby acknowledged, as is the assistance of the Pilbara Shire Council for housing the Marble Bar seismograph. Punching of ISC cards was carried out by the Australian Bureau of Statistics (Perth) by arrangement with the Deputy Commonwealth Statistician.

The co-operation of the owners of each of the stress sites, and particularly Mr and Mrs K.J. and R.E. Quartermaine, owners of the SRO site at Narrogin, is greatly appreciated.

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## APPENDIX

## PRINCIPAL EVENTS

## MUNDARING GEOPHYSICAL OBSERVATORY 1957-1974

| | |
|---|---|
| 1957 May | Geomagnetic recording commenced at Gnangara (La Cour). |
| 1959 Mar 18 | Transfer of Observatory from Watheroo to Mundaring. |
| 1959 Apr 3 | Ionospheric recording commended (Type 2 ionosonde). |
| 1959 Jul 30 | MUN seismograph recording commenced (Benioff). |
| 1960 Mar - 1960 Oct | Atmospheric noise recording (for CSIRO). |
| 1960 Apr 30 | Eschenhagen normal magnetograph replaced La Cour at Gnangara. |
| 1960 May 1 | Cossor ionosonde replaced Tupe 2. |
| 1960 June 22 | Absolute magnetic observations commenced in new absolute house. |
| 1962 June | WWSS system commenced operation at MUN. |
| 1963 Apr 19-1963 Dec 17 | GRV seismograph operation. |
| 1963 May 30-1963 Dec 19 | NGN seismograph operation. |
| 1964 Nov 6 | KLG SP seismograph recording commenced. |
| 1965 Nov 29-1966 Aug 24 | LVS seismograph operation. |
| 1965 Nov | KNA SP-Z seismograph recording commenced; operation intermittent till Feb 1972. |
| 1967 Feb | Fremantle Region Upper Mantle Project. |
| 1967 Oct 26 | MEK SP-Z seismograph recording commenced. |
| 1968 Oct - 1968 Nov 26 | Field seismograph operation at Meckering. |
| 1968 Nov 16-1971 Dec 31 | AFMAG recording at Mundaring. |
| 1970 Jan 1 | Routine analysis of KNA seismograms commenced. |
| 1970 Feb 26 | IPS IIIE ionosonde replaced Cossor. |

APPENDIX (contd.)

| | |
|---|---|
| 1971 Feb 10-1972 Jul 31 | KAA SP-Z seismograph operation. |
| 1971 Nov 30 | Two MO2 accelerographs installed at Meckering. |
| 1972 Feb 29 | KNA seismograph upgraded to 3 components. |
| 1972 Mar 1 | MO2 accelerograph (PWD) installed at Kununurra. |
| 1972 June 27 | Proton scalar magnetometer introduced for Z baseline control. |
| 1972 Oct 12 | MBT SP-Z seismograph recording commenced. |
| 1972 Nov 16 | MO2 accelerograph (PWD) installed at Kununurra. |
| 1973 Jan 31 | Mobile SP-Z recording at various sites in SW seismic zone started. |
| 1973 Mar 30 | KLG - reduced to SP-z only. |
| 1973 May 1 | MEK - increased to 3 component SP. |
| 1973 May 23 | MUN - 2 Wood Andersons installed. |
| 1973 May 25 | MUN - Benimore SP-Z withdrawn; Benioff SP-Z started. |
| 1974 Apr 1 | Proton vector coils introduced for Z baseline control. |
| 1974 May 1 | Proton vector coils introduced for H baseline control. |
| 1974 June 17-31 | Riometer recording at Mundaring during solar eclipse (IPS). |
| 1974 Sep | GLS - SP-Z recording commenced. |
| 1975 Mar | Pulsation recording (University of NSW) at Gnangara (until June) and Weir sites. |
| 1975 Jul 18-Nov 19 | Earth-tide recording at Mundaring. |
| 1975 Mar 19-Aug 15, Dec 18 | SWV - SP-Z recording. |

TABLE 1

OBSERVATORY STAFF 1975

| Officer | Designation |
|---|---|
| P.J. Gregson | Geophysicist Class 3 |
| R.S. Smith | Geophysicist Class 2 |
| J. Silic (from 15 Dec) | Geophysicist Class 1 |
| G. Woad | Technical Officer Grade 2 |
| B.J. Page | Technical Officer Grade 1 |
| Y.M. Moiler (Mrs) | Typist Grade 1 |
| T.E. Creaser | Assistant Grade 1 |

TABLE 2

ASSOCIATED PERSONNEL 1975

| Name | Nature of duties |
|---|---|
| P.J. Wolter | Antarctic trainee (10 July - 2 October) |
| P.R. Gidley | Antarctic trainee (22 July - 2 October) |
| R. Calver | Vacation student 1974/75 |
| C. Johnston | Vacation student 1975/76 |
| B. Carling | Daily attendant, Gnangara |
| R. Kruger | Daily attendant, Kalgoorlie |
| D. Richardson | Daily attendant, Meekatharra |
| G. Edwards | Daily attendant, Marble Bar |
| J. Roberts | Daily attendant, Kununurra |
| Observer-in-Charge Weather Station | Daily attendant, Giles |

TABLE 3

OBSERVATORY STAFF ABSENCES 1975

| Nature of absence | No. of man days |
|---|---|
| Sick leave | 11 |
| Military service | 19 |
| Attendance at outstations and field operations | 4 |
| Conferences and training | 71 |
| Furlough | - |
| Paternity leave | 5 |
| Temporary transfer | 252 |
| TOTAL | 362 |

TABLE 4

CONFERENCES, ADDRESSES, AND TRAINING

| Officer | Date | Conferences |
|---|---|---|
| G. Woad | Aug 18-20 | Adelaide, 2nd ANZAAS Science Technology conference. |
| P.J. Gregson | Sep 29-Oct 1 | Canberra, OIC's meeting. |
| | | Addresses |
| G. Woad | Aug 20 | Seismic Research Observatory, W.A. 2nd ANZAAS Science Technology conference. |
| | | Training |
| G. Woad | Jan 31-Mar 9 | Albuquerque, New Mexico. Seismic Research Observatory training. One day each at USGS National Centre for Earthquake Research, Menlo Park, and Honolulu Observatory. |
| R.S. Smith | May 28-July 9 | Albuquerque, New Mexico. Seismic Research Observatory training. One day each at USGS National Centre for Earthquake Research, Menlo Park, and Honolulu Observatory. |
| B.J. Page | Apr 14-24 | Perth, Australian Telecom Commission course on Logic Principles. |

TABLE 5

VISITORS

| Visitor | Institute |
|---|---|
| Dr. D. Denham | BMR (Canberra) |
| Mr. D. Tarlington | BMR (Canberra) |
| Mr. G. Small | BMR (Canberra) |
| Mr. P. Bullock | BMR (Canberra) |
| Mr. J. Van Son | BMR (Canberra) |
| Mr. M. Kennedy | Department of National Resources |
| Mr. E. Edmiston | Department of National Resources (Perth) |
| Dr. B. Fraser | University of Newcastle |
| Mr. P. McNabb | University of Newcastle |
| Dr. B. Ducarme | Royal Observatory, Belgium |
| Mrs. Robinson | ANARE |
| Mr. D. Batson | Unitech, Texas |
| Mr. A. Van Every | Advanced Research Projects Agency, U.S. Embassy, Canberra |
| Mr. J. Trudinger | Dawes and Moore |

TABLE 6

PRELIMINARY MONTHLY MEAN GEOMAGNETIC VALUES AND K INDEX

1975

| Month | D(West) | H, nT | Z, nT | F, nT | K |
|---|---|---|---|---|---|
| January | 03° 10.5' | 23628 | 53485 | 58472 | 2.46 |
| February | 11.0 | 621 | 485 | 469 | 2.81 |
| March | 11.2 | 622 | 485 | 469 | 2.74 |
| April | 10.8 | 611 | 491 | 470 | 2.49 |
| May | 10.7 | 608 | 496 | 474 | 2.32 |
| June | 11.0 | 606 | 497 | 474 | 2.03 |
| July | 11.4 | 602 | 497 | 472 | 2.24 |
| August | 11.9 | 599 | 505 | 478 | 2.05 |
| September | 12.0 | 604 | 499 | 475 | 1.79 |
| October | 12.1 | 601 | 498 | 473 | 2.09 |
| November | 12.4 | 590 | 508 | 477 | 2.67 |
| December | 12.6 | 599 | 510 | 483 | 2.24 |
| Mean | 03° 11.5 | 23608 | 53496 | 58474 | 2.33 |

TABLE 7

GEOMAGNETIC ANNUAL MEAN VALUES 1965-1975

| Year | D ° ' | I ° ' | H nT | X nT | Y nT | Z nT | F nT | Notes |
|---|---|---|---|---|---|---|---|---|
| 1965 | -2 51.7 | -65 55.8 | 23907 | 23877 | -1194 | -53500 | 58599 | 2B |
| 1966 | 52.6 | 56.2 | 890 | 860 | 1199 | 499 | 591 | 2B |
| 1967 | 54.2 | 57.3 | 869 | 838 | 1209 | 499 | 582 | 2B |
| 1968 | 55.7 | 59.0 | 846 | 815 | 1217 | 494 | 568 | 2B |
| 1969 | 57.6 | 59.6 | 822 | 790 | 1230 | 487 | 552 | 2B |
| 1970 | 59.6 | -66 01.0 | 790 | 758 | 1242 | 474 | 527 | 2B |
| 1971 | -3 02.3 | 02.0 | 764 | 730 | 1260 | 459 | 503 | 2B |
| 1972 | 05.2 | 04.0 | 726 | 692 | 1278 | 454 | 483 | 2C |
| 1973 | 07.8 | 06.2 | 686 | 651 | 1292 | 460 | 472 | 2C |
| 1974 | 09.9 | 09.0 | 642 | 606 | 1304 | 477 | 470 | 2C |
| 1975 | 11.5 | 11.3 | 608 | 571 | 1314 | 496 | 474 | 2C |
| Mean annual change | -1.98 | -1.55 | -29.9 | -30.6 | -12.0 | +0.4 | -12.5 | |

NOTES: 2. Preliminary value B. Mean of hourly values, 5 IQ days
C. Mean of daily values, 10 Q days

TABLE 8

1975 SEISMOGRAM LOSSES

All components unless shown

| Cause | MUN WWSSN | MUN SUP | KLG | MEK | MBT | KNA | GLS ϕ |
|---|---|---|---|---|---|---|---|
| | | HOURS | | | | | |
| OPERATOR | | | | | | | |
| Late change | | | 81 | 88 | 408 | 3 | |
| Drum not reset | SP 1 | | 45 | 4 | 4 | | |
| | LP 2 | | | | | | |
| Paper reversed | SP-Z 24 | | | | | | |
| Paper off drum | | S 19 | | | | | |
| Switching | LP-E 30 | | | | | | |
| | SP 7 | | | | | | |
| Lamp intensity | | | | | | | |
| Fogging | SP-E 24 | | | 26 | | 24 | |
| POWER FAILURES | | | | | | | |
| Mains | | | | | 82 | 31 | |
| Batteries | | | | | | 24 | |
| RECORDER FAULTS | | | | | | | |
| Drum translation | SP 24 | | | | | | |
| | LP 25 | | | | | | |
| Blown lamp | SP-E36 | Z 45 | 23 | 59 | | | |
| | | S 19 | | | | | |
| | | E 59 | | | | | |
| Helicorder* | | | | | 397 | | |
| Drive motor | SP 102 | | | | | | |
| | LP 156 | | | | | | |
| Optics | | | 216 | | | | |
| CONTROL EQUIPMENT | | | | | | | |
| Clock | | | | | 3 | | |
| TAM 5* | | | | | | | 854 |
| MAINTENANCE | 3 | | | 52 | | | |
| TOTAL | 1065 | 132 | 365 | 229 | 759 | 82 | 854 |
| % | 2.0% | 0.5% | 4.2% | 2.6% | 8.7% | 0.9% | 13.4% |

* Includes replacement time

ϕ From 10 April 1975

TABLE 9

WESTERN AUSTRALIAN EARTHQUAKES 1975

| Date 1975 | Origin Time UT | Lat. °S | Long. °E | ML | mB | Remarks |
|---|---|---|---|---|---|---|
| Jan 06 | 09 00 23.3 | 16.18 | 128.90 | 2.9 | 3.3 | 50 km S Kununurra |
| 10* | 08 20 18.3 | 27.74 | 126.11 | | 5.6 | 500 km NE Kalgoorlie |
| 21 | 00 29 22.9 | 31.97 | 117.22 | 2.2 | | 5 km NE Mawson |
| 21 | 01 50 07.5 | 30.83 | 117.08 | 2.9 | 3.9 | 2 km NW Manmanning |
| 28 | 02 15 46 | - | - | 2.2 | 3.6 | 93 km from Marble Bar |
| Feb 08 | 11 33 37.8 | 24.9 | 116.1 | | 4.3 | 100 km E Gascoyne Junction |
| 20 | 17 03 19.8 | 16.2 | 128.8 | 1.6 | | 50 km S Kununurra |
| Mar 04 | 04 15 50.7 | 32.30 | 117.10 | 2.7 | 3.4 | 10 km NE Brookton |
| 05 | 17 52 05.3 | - | - | | 2.6 | 18 km from Marble Bar |
| 06* | 23 51 26.3 | 17.08 | 126.38 | | 5.2 | 150 km NE Fitzroy Crossing, felt MM V |
| 07* | 20 13 15.6 | 25.86 | 126.58 | | 4.9 | 200 km SW Giles |
| 12 | 20 09 36.8 | 31.0 | 118.2 | 2.9 | | Mukinbudin |
| 27 | 15 46 56.8 | 31.71 | 116.93 | 2.5 | | 10 km SW Meckering |
| 30 | 02 10 50.5 | 16.2 | 129.5 | 2.9 | | 112 km ESE Kununurra |
| Apr 13 | 10 38 31.0 | 16.05 | 128.7 | 2.0 | | 35 km S Kununurra |
| 18 | 14 45 51.8 | 16.04 | 128.64 | 2.6 | | 35 km S Kununurra |
| 18* | 16 34 32.6 | 24.40 | 113.86 | | 4.5 | 60 km NE Carnarvon |
| 26 | 16 38 24.7 | | | 3.0 | | 150 km from Kununurra |
| May 01 | 13 33 15.7 | 30.90 | 117.13 | 3.1 | 3.8 | 5 km SE Manmanning |
| 02 | 12 10 41.2 | 31.73 | 116.93 | 3.0 | 3.9 | 12 km S Meckering |

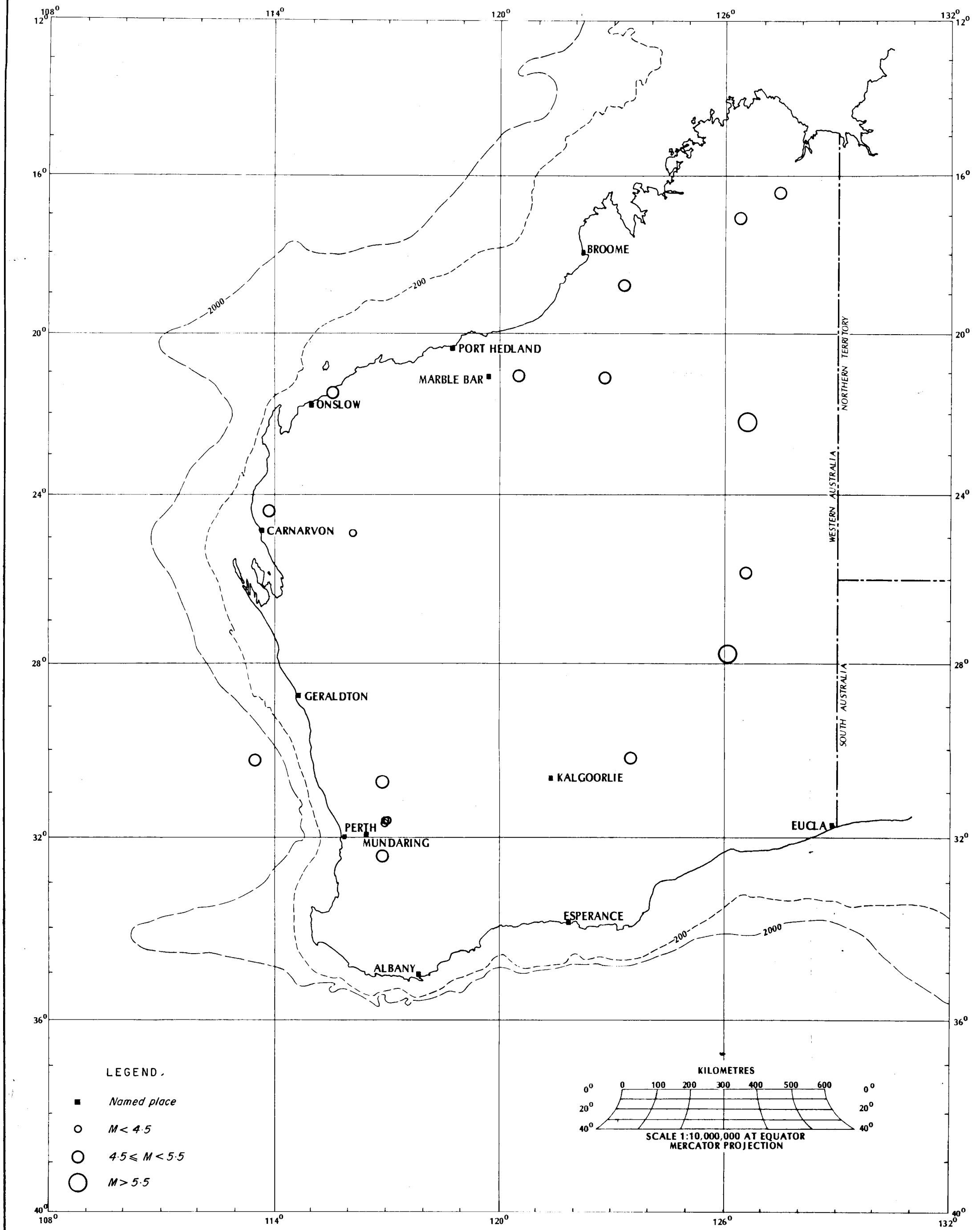
TABLE 9 (Contd.)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| May 06 | 01 49 01.4 | 16.6 | 128.8 | 2.0 | 3.3 | 95 km S Kununurra |
| 06 | 06 57 51.5 | 16.6 | 128.8 | 2.0 | 3.4 | 95 km S Kununurra |
| 10 | 14 06 47.0 | 31.63 | 117.16 | 2.8 | | 5 km E Meckering |
| 11* | 00 46 30.1 | 21.15 | 122.77 | | 5.0 | 300 km NE Marble Bar |
| Jul 08 | 14 02 28.8 | 31.78 | 117.04 | 2.3 | | 20 km S Meckering |
| 17 | 23 07 18.5 | 31.65 | 117.00 | 3.1 | | 3 km S Meckering |
| 21 | 21 39 45 | 30.2 | 123.5 | | (4.7) | 200 km E Kalgoorlie |
| 24 | 21 54 46.9 | 31.62 | 116.96 | 2.7 | | 5 km W Meckering |
| 24* | 22 23 41.7 | 21.09 | 120.47 | | 5.0 | 80 km NE Marble Bar, felt MM V |
| Aug 05* | 11 27 55.6 | 16.45 | 127.42 | 3.7 | | 160 km SW Kununurra |
| 23 | 19 22 00.3 | 30.77 | 116.90 | 3.5 | | 20 km NW Manmanning, felt Dowerin |
| 25* | 11 28 24.0 | 18.79 | 123.29 | | 4.7 | 150 km SE Broome |
| Sep 04 | 20 41 09.7 | 30.77 | 116.90 | 2.5 | | 20 km NW Manmanning |
| 07 | 06 21 08.9 | 32.95 | 118.05 | 2.9 | | 75 km E Narrogin |
| 11 | 12 23 51.8 | 31.64 | 117.03 | 3.2 | | 20 km S Meckering, felt |
| 19 | 12 54 46.0 | 30.76 | 116.92 | 2.6 | | 20 km NW Manmanning |
| 22 | 04 07 17.5 | 30.64 | 116.83 | 2.5 | | 6 km SW Ballidu |
| 22 | 07 24 17.2 | 30.64 | 116.83 | 2.8 | | 6 km SW Ballidu |
| 25 | 04 26 03.3 | 33.33 | 117.75 | 2.5 | | 75 km SE Narrogin |
| 27 | 00 26 26.0 | 31.68 | 116.96 | 1.9 | | 7 km SW Meckering |
| Oct 03* | 11 51 01.8 | 22.21 | 126.58 | | 5.6 | 350 km NW Giles |
| 07 | 06 55 57.2 | 31.67 | 116.98 | 3.3 | | 7 km SW Meckering, felt |
| 10 | 06 20 45.6 | 16.5 | 128.3 | 2.4 | | 100 km SW Kununurra |

TABLE 9 (Contd.)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Oct 10 | 14 00 08.4 | 32:44 | 116.92 | 2.4 | | | 10 km SW Brookton |
| 11 | 11 52 12.1 | 32.44 | 116.92 | 3.7 | | | 10 km SW Brookton, felt |
| 25 | 16 50 38.5 | 30.77 | 116.96 | 2.2 | | | 16 km NW Manmanning |
| 28 | 20 35 49.8 | 31.74 | 116.99 | 2.1 | | | 18 km S Meckering |
| Nov 02 | 12 04 23.5 | 31.70 | 117.06 | 2.3 | | | 10 km SW Meckering |
| 06 | 09 20 42.0 | 30.25 | 113.50 | | | 4.8 | 200 km SW Geraldton |
| 20 | 09 08 27.0 | 31.72 | 117.05 | 3.0 | | | 10 km S Meckering |
| 20 | 20 03 12.0 | 31.63 | 117.01 | 2.3 | | | 2 km S Meckering |
| 22 | 07 19 36.3 | 33.10 | 118.20 | 2.5 | | | 75 km E Narrogin |
| 22 | 20 38 43.5 | 33.10 | 118.13 | 2.4 | | | 74 km E Narrogin |
| 28* | 17 55 09.7 | (21.53) | (115.56) | | | 4.8 | 60 km NE Onslow |
| Dec 03 | 11 17 25.6 | 32.43 | 117.04 | 2.2 | | | 8 km S Brookton |
| 06 | 15 28 46.3 | 30.93 | 117.09 | 2.1 | | | 9 km S Manmanning |
| 11 | 04 56 25.7 | 31.35 | 116.61 | 1.7 | | | 13 km NW Jennacubine, felt |
| 12 | 06 16 58.0 | 31.72 | 117.03 | 2.4 | | | 10 km S Meckering, felt |
| 16 | 17 49 31.8 | (21.0) | (120.0) | 2.0 | | | 25 km from Marble Bar |

*Relocated using headquarters computer program

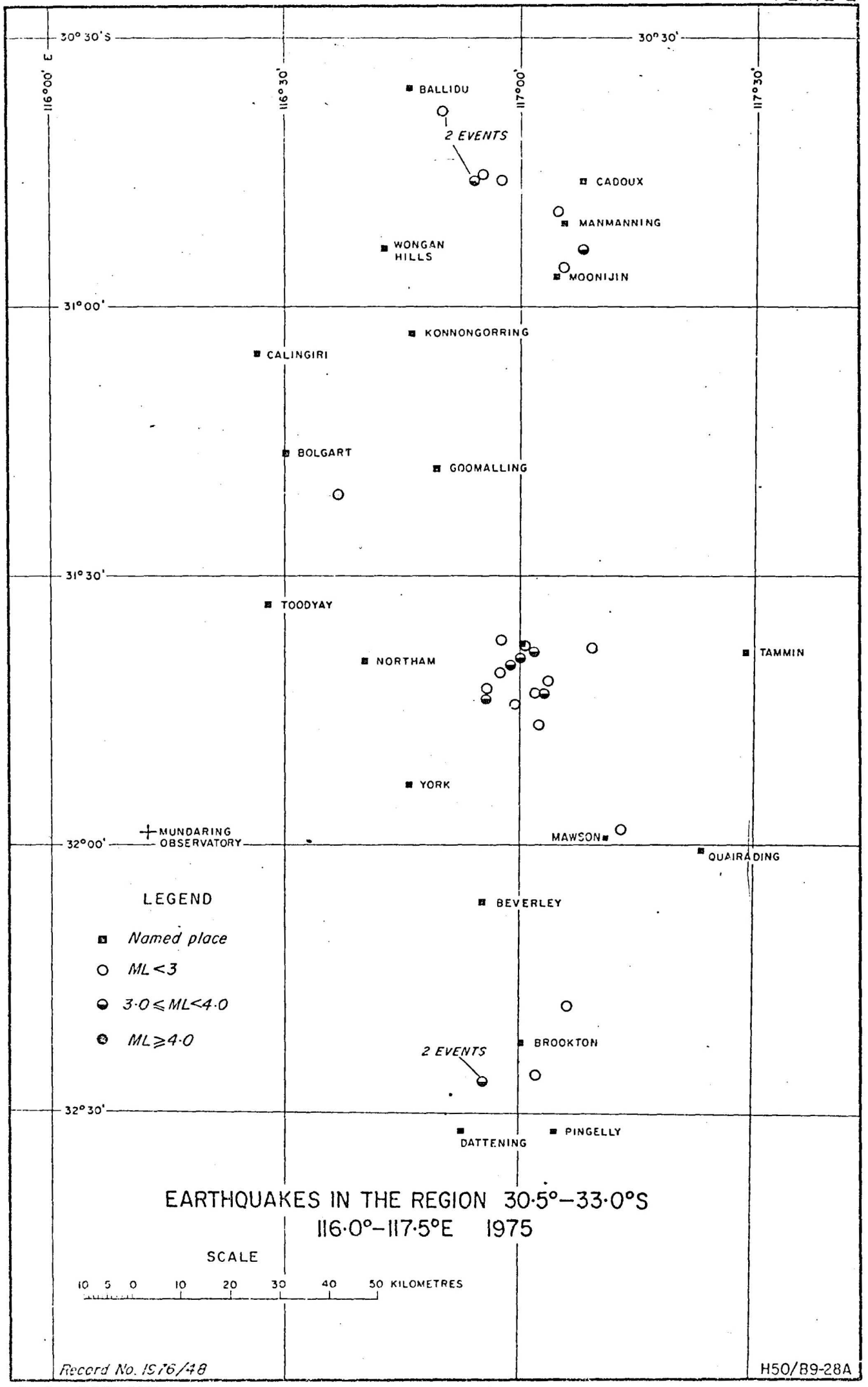



# LARGER EARTHQUAKES IN THE REGION OF WESTERN AUSTRALIA, 1975

*Record No.1976/48*

WA/B9-37

(Based on WA/BO-4)

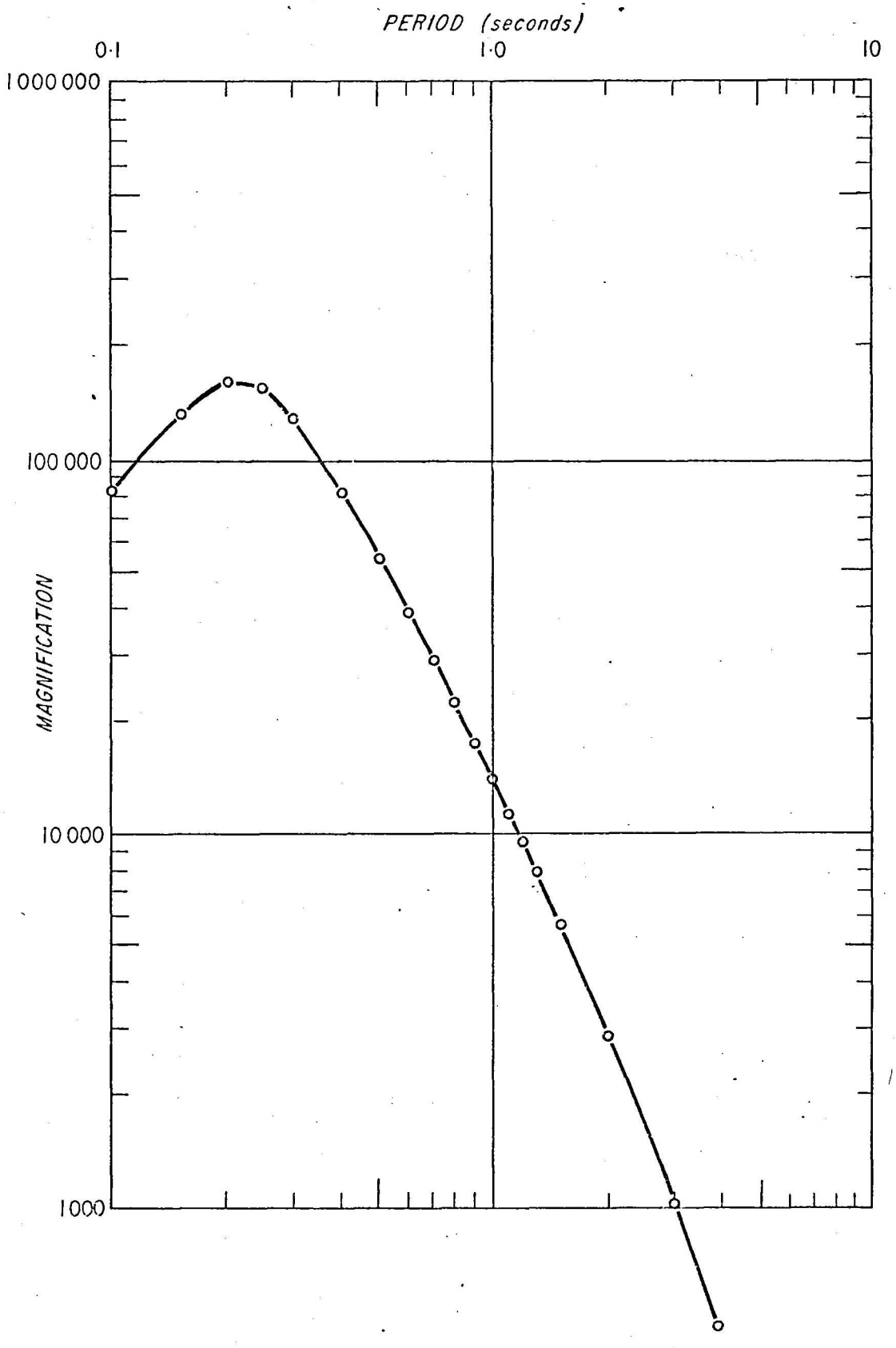



# EARTHQUAKES IN THE REGION 30·5°–33·0°S 116·0°–117·5°E 1975

Record No. 1576/48

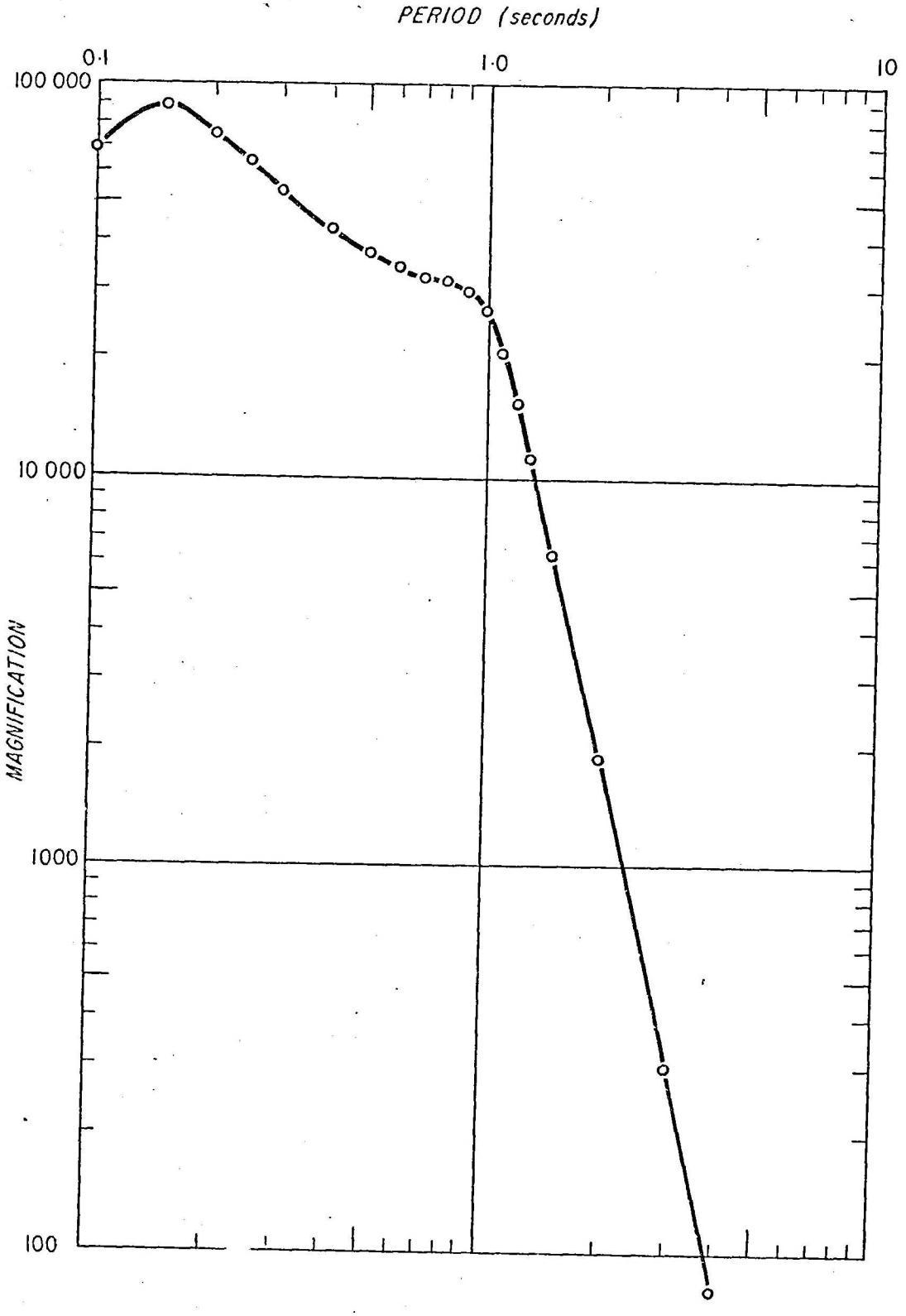
H50/89-28A

(Based on H50/80-36A)




CALIBRATION CURVE MEEKATHARRA Z SEISMOGRAPH

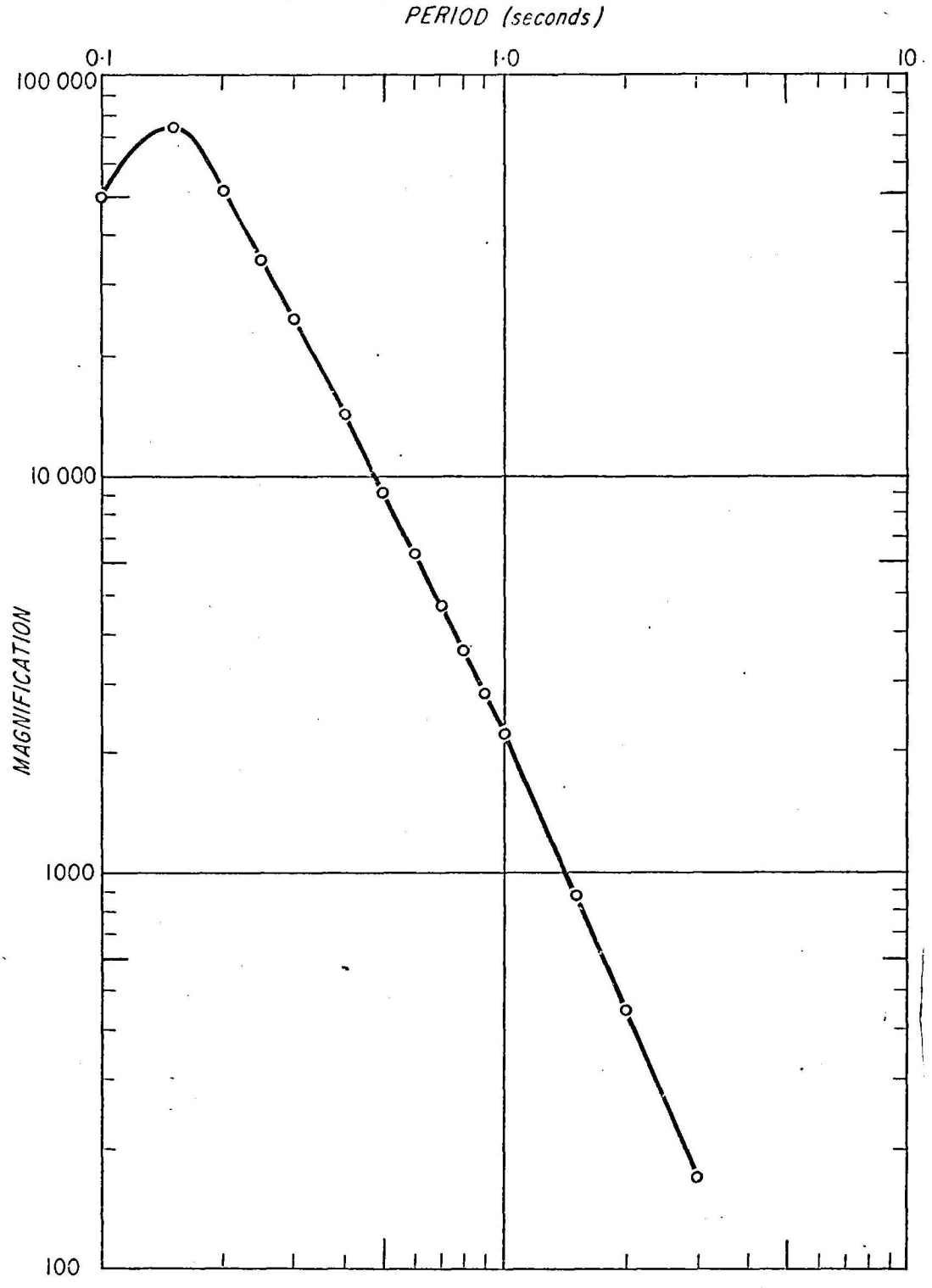
(FROM 28 OCTOBER 1975)




CALIBRATION CURVE SWAN VIEW Z SEISMOGRAPH

(FROM 18 DECEMBER 1975)

AMPLIFIER SETTINGS AS 330 0dB
AR 311 24 dB

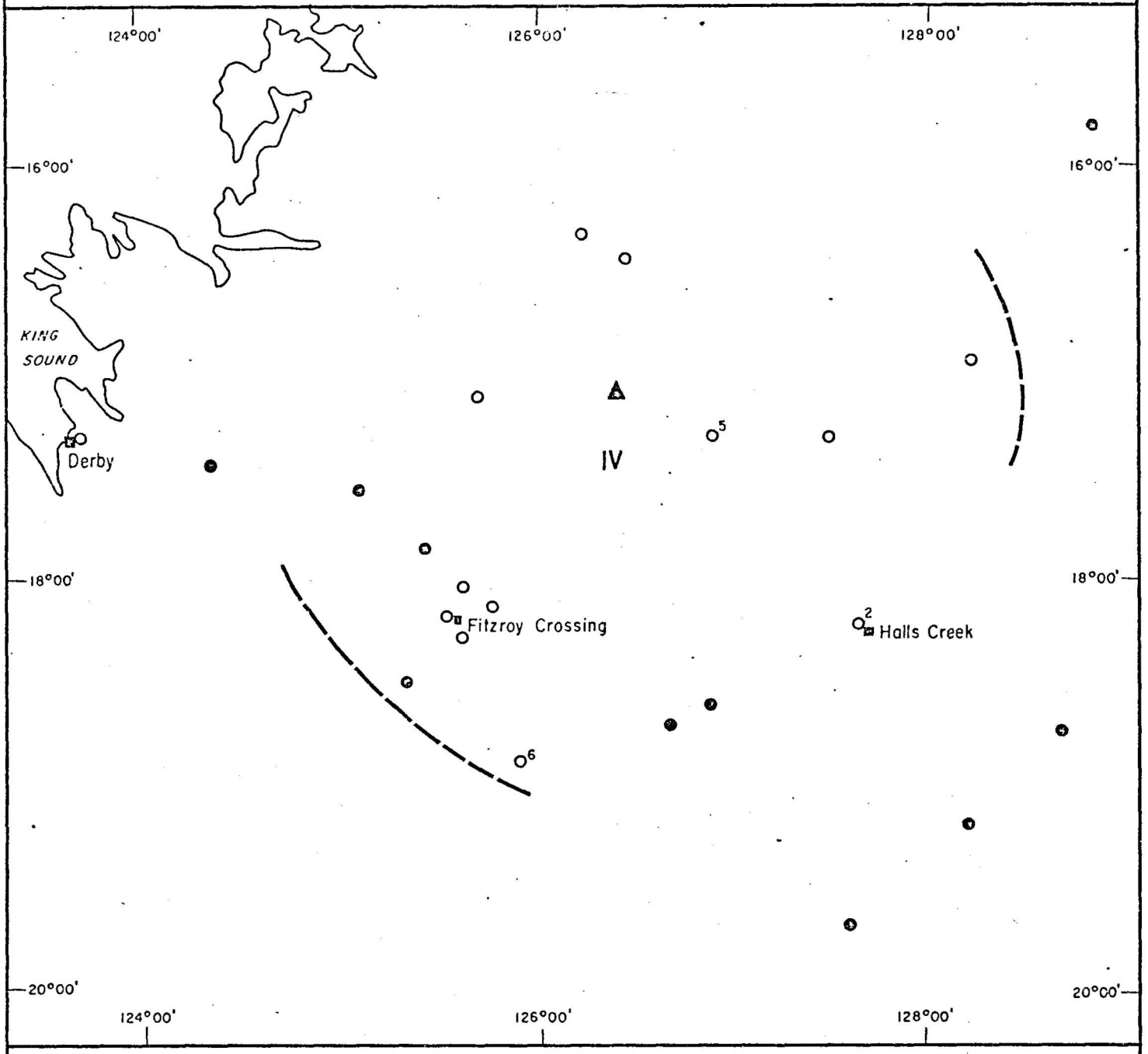



CALIBRATION CURVE TRANSPORTABLE SEISMOGRAPH

( FROM 5 DECEMBER 1975)

# ISOSEISMAL MAP OF A FITZROY CROSSING EARTHQUAKE WA

PLATE 6




KILOMETRES

100 0 100 200 300

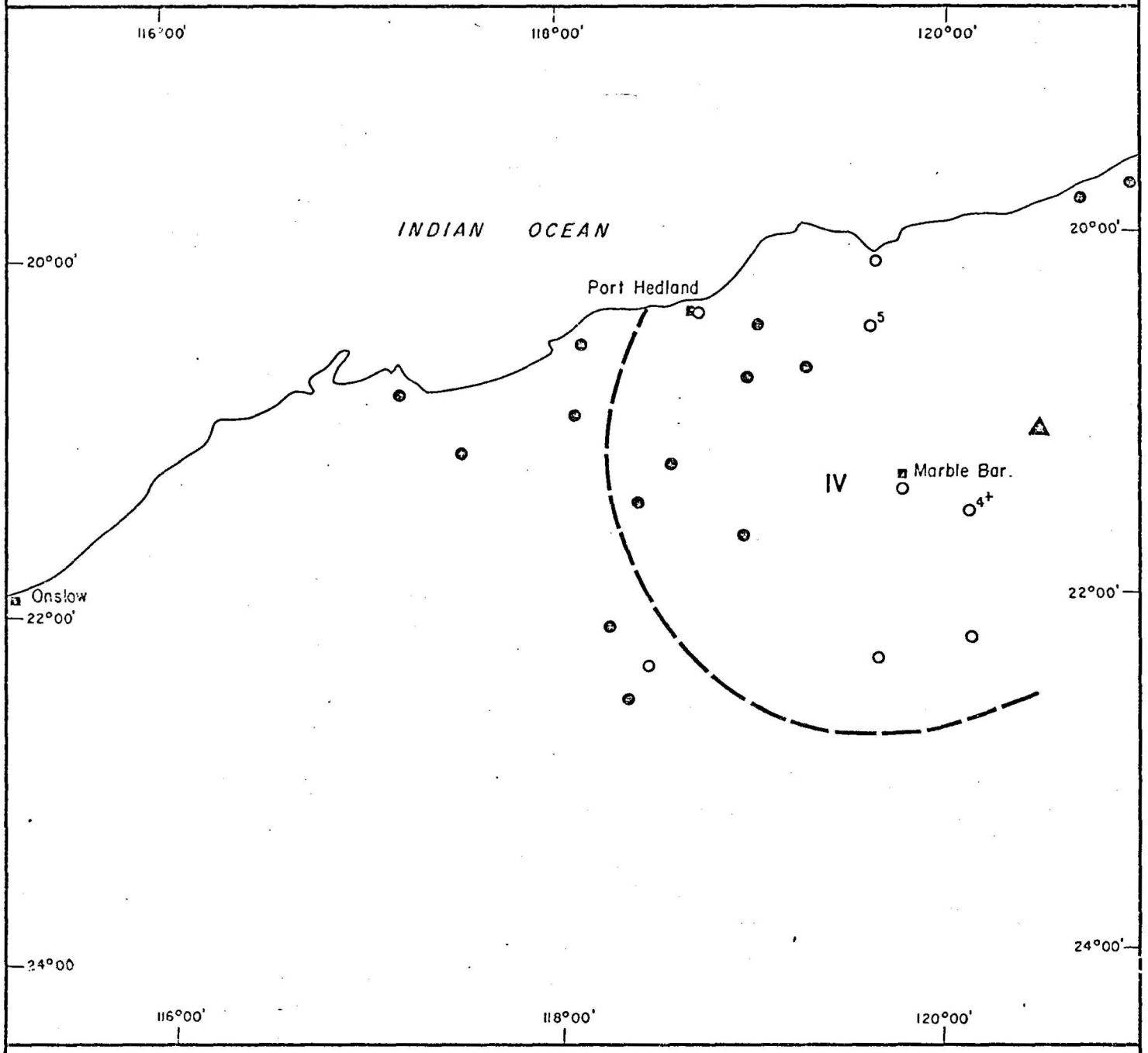
DATE : 6 MARCH 1975
TIME : 23:51:26·3
MAGNITUDE : 5·2 MB
EPICENTRE : 17·08°S 126·38°E

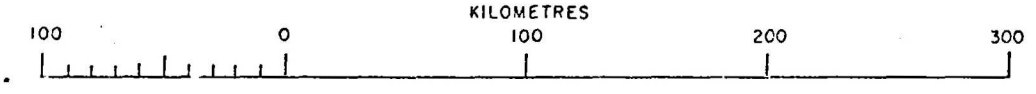
▲ EPICENTRE
○ EARTHQUAKE WAS FELT
⊕ EARTHQUAKE WAS NOT FELT
IV ZONE INTENSITY DESIGNATION (MM)

Small figure beside open circle indicates intensity is different from zone designation

# ISOSEISMAL MAP OF A PILBARA EARTHQUAKE WA

PLATE 7

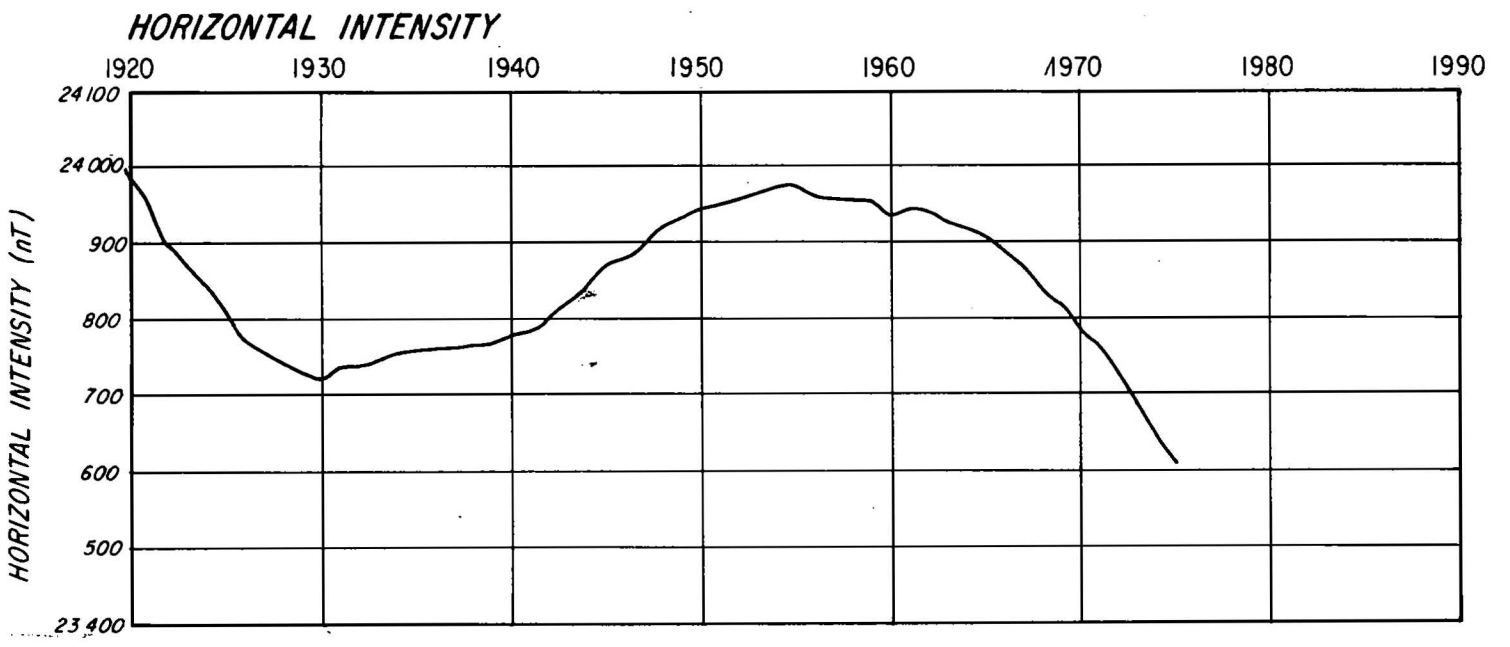


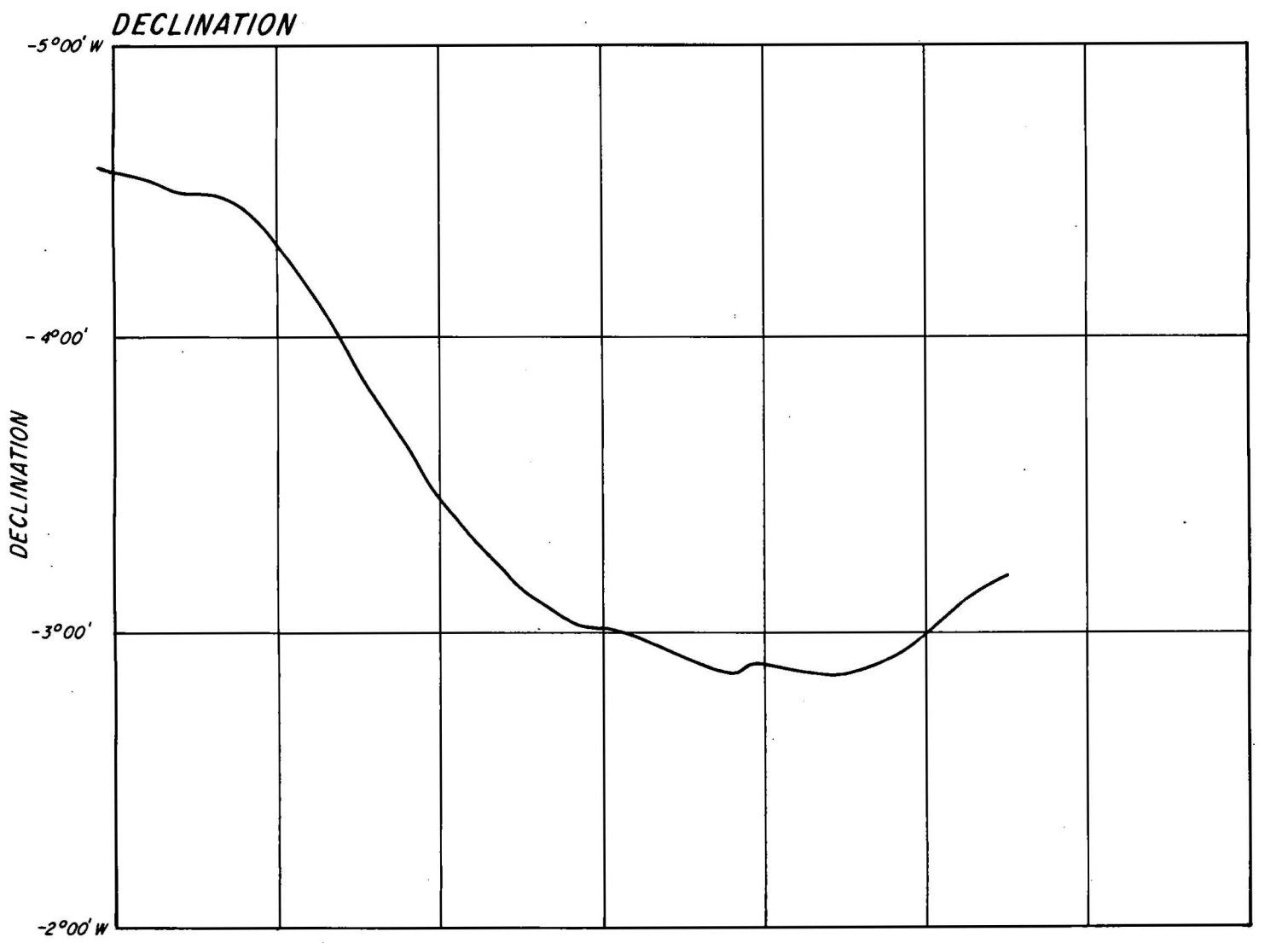



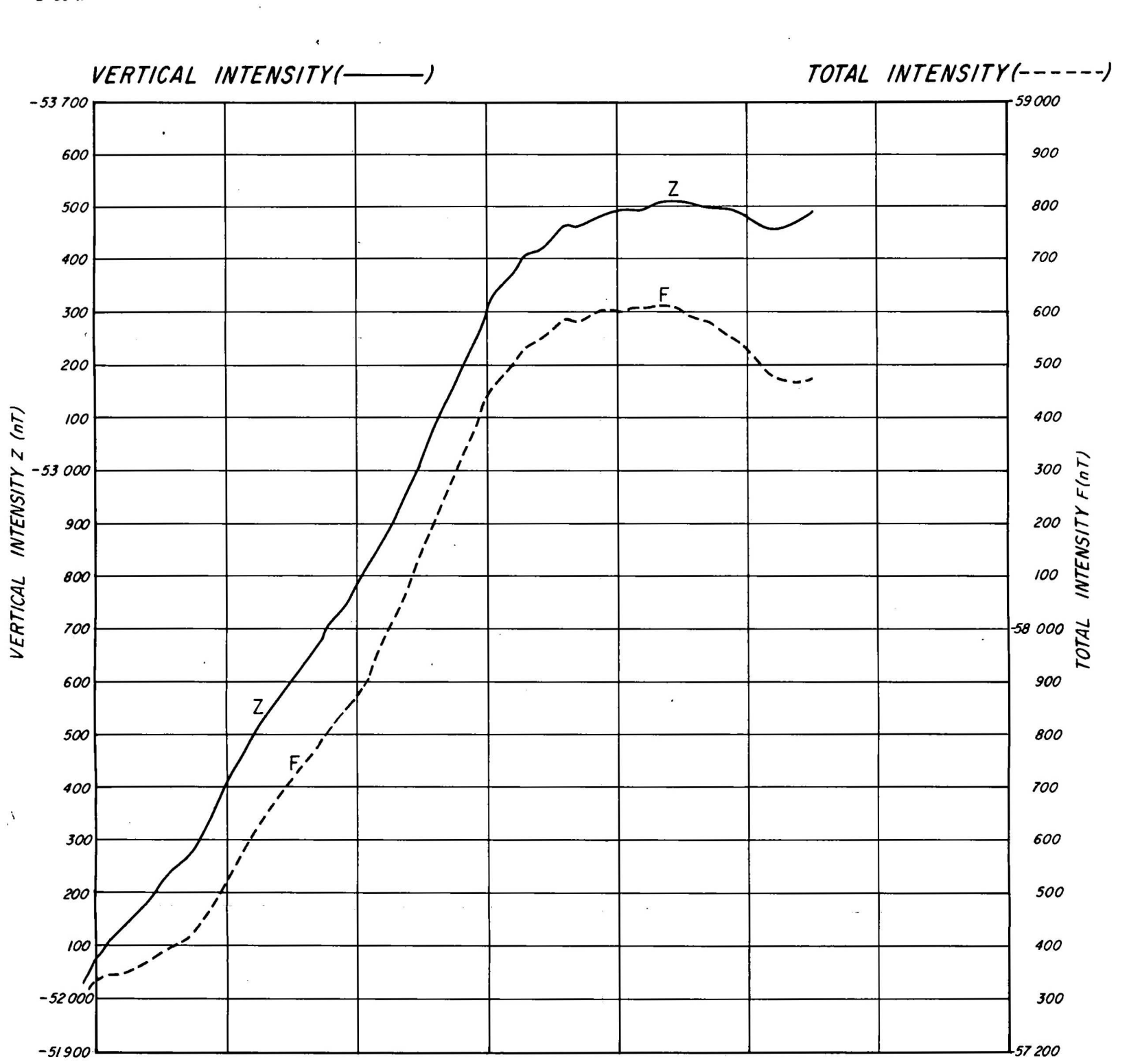

DATE : 24 JULY 1975
TIME : 22:23:41·7
MAGNITUDE : 5·0 (MB)
EPICENTRE : 21·09°S 120·47°E

△ EPICENTRE
○ EARTHQUAKE WAS FELT
◎ EARTHQUAKE WAS NOT FELT
IV ZONE INTENSITY DESIGNATION (MM)

Small figure beside open circle indicates intensity is different from zone designation




*Values before 1959 are Watheroo values adjusted to Gnangara by application of station differences observed in 1958.*

*(D scale is equal to H, Z and F scales.)*

# GEOMAGNETIC ANNUAL MEAN VALUES — 1919 — 1975

PLATE 8

Record No. 1976/48

H50/B9-27