DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1974/103

MUNDARING GEOPHYSICAL OBSERVATORY

ANNUAL REPORT 1973

by

P.J. Gregson and R.S. Smith

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SUMMARY

Basic programs in geomagnetism, ionospherics, and seismology were continued at the Mundaring Geophysical Observatory during 1973. The main instruments were an Eschenhagen normal-run magnetograph, and IPSD Type IIIE ionosonde, and a Worldwide Standardized Seismograph System.

Seismographs were operated at Kalgoorlie, Meekatharra, and Marble Bar. The seismograms from the seismograph at Kununurra owned by the W.A. Government were analysed. Three accelerographs were operated at Meckering.

The annual earthquake lists show details of 60 Western Australian earthquakes; 44 occurred in the southwest zone. Activity continued in the Lake McKay region. A detailed analysis was made of microtremors in the southwest seismic zone.

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, and Marble Bar (seismological recording). Descriptions of the observatory and an outline of activities there to the end of 1972 have been given in previous Records (e.g. Gregson & Smith, 1973); 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 attended or addresses given in Table 4.

P.J. Gregson attended the 17th Assembly of the International Association of Seismology and Physics of the Earth's Interior held in Lima in August; he also attended the annual Observatory Sub-Section program meeting in Canberra in August.

Visitors to the Observatory are listed in Table 5.

GEOMAGNETISM

Normal magnetograph

The Eschenhagen 20 mm/hour magnetograph continued to operate at Gnangara without loss of record. Timemarks were lost for one day in July owing to a short circuit in the timemark relay. In August (2 days) and November (2 days) timemarks were displaced owing to jumps in the display of the EMI clock, possibly caused by interference from lightning.

An adjustment was made to the torsion head on the H variometer on 16 October, to increase the trace ordinate by about 29 mm in order to reduce the number of negative ordinates.

The Z scale values rose from about 5.74 nT/mm in March to a maximum of about 6.20 nT/mm in August, then fell again to about 5.78 nT/mm in December.

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

Element	Baseline value	Scale value
D	0.24 minutes	
H	2.5 nT	0.01 nT/mm
Z	2.1 nT	0.04 nT/mm

D values from 23 October were not used in calculation of the standard deviation. From the beginning of November observed D values increased suddenly by about 0.6 minutes. This was found to be due to the spirit level supplied with PPM vector coils which had been installed on pier NM on 30 October.

After tests and removal of the complete coil assembly on 11 December, D baseline values returned to normal.

Magnetograph tests

Temperature coefficients. Least-squares analysis of the 1973 H and Z baseline data has confirmed the coefficients in use (qH = 0.4 nT/^{o}C and qZ = 3.2 nT/^{o}C).

Parallax. Tests were performed on 25 September and showed that the parallax on variation trace timemark 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.

Orientation. Tests made on the Eschenhagen magnetograph on 26 June and 11 July showed that the orientation of the H magnet (N pole) was E 0.6^{o} N. The reference meridian was 3.1^{o} W and the value of H was 23684 nT. After the torsion head adjustment, the orientation was measured on 23 October and found to be E 1.2^{o} N, which was the value expected after an ordinate increase of 29 mm. The orientation angle is expected to reduce by about 0.3^{o} annually owing to secular variation in H. The Z magnet was tested on 4 September and found to be N 0.2^{o} down in a mean field of 53463 nT. The orientation of the D magnet was not checked during 1973.

Ex-orientation angles measured in 1972 have been recalculated and the results reported in the 1972 report (Gregson & Smith, 1973) found to be in error. The correct values (N poles) were H magnet E 1.0^{o}N, D magnet N 0.3^{o}W, Z magnet N 0.3^{o} D. The reference meridian was 3.1^{o} W and the value of H was 23752 nT.

Scale values. A magnetograph calibrator MCO2 was used in conjunction with Helmholtz coils to determine H and Z scale values once a week. The calibrator failed to operate between 9-23 January, and required the replacement of integrated circuit A2. On 5 June it was noticed that the monitor meter indicated low currents, so on 18 June the reference voltage was adjusted from 4.95 to 5.00 volts. However, on 26 June it was found that the monitor meter again indicated low currents. Furthermore current decay was both difficult to initiate and the rate of decay uneven. The calibrator failed on 7 August so integrated circuit A2 was replaced and the reference voltage again adjusted from 4.95 to 5.00 volts.

It was assumed that the current had been 1 percent low from 5 June until the failure of the calibrator on 7 August, so all measured scale values for June and July were lowered slightly (H 0.03 nT/mm, Z 0.05 nT/mm). The calibrator failed again on 11 September and integrated circuit A2 was again replaced. The reference voltage was adjusted on 12 September from 5.08 to 5.00 volts; the actual current delivered by the unit was checked on 2 October and found to lie between 4.98 and 5.00 mA.

The D scale value was not determined during 1973.

Magnetometers

Instruments in use throughout the year were Askania declinometer 509319, QHM 291, QHM 292, QHM 293, BMZ 120 and the following Elsec proton precession magnetometers: PPM 329 (to 3 April), PPM 339 (10 April to 16 October) and PPM 116 (from 23 October). The PPM 116 is a direct reading type 595 used with a toroidal noise-cancelling sensor.

The Askania circle 508135 was cleaned in February then dismantled, cleaned, lubricated and adjusted on 18 October to overcome stickiness.

Throughout the year total intensity (F) measurements were made weekly. The values of F were combined with H values derived from the magnetograms to calculate Z baseline values. BMZ 120 was read weekly also and baseline values were calculated but were not used for control. BMZ 120 was bumped accidentally on 13 March, causing Z readings to become randomly scattered over a range of about 30 nT. The disc index error was found to have increased from about 0.15^{o} to about 0.6^{o} and become inconsistent. The BMZ was lubricated on 3 April then dismantled, cleaned, lubricated and adjusted on 19 September, after which both the disc index error and observed values became stable near the pre-March values.

Comparisons

Comparison observations were made on 8 and 9 November between the H and D instruments used for the regional magnetic survey and observatory instruments. No comparisons of observatory instruments with international standards were made in 1973.

The results of QHM comparisons carried out between 5 May and 27 June, 1972 were recalculated by arranging the simultaneous observations into balanced sets. The results differ slightly from those given in the 1972 report (Gregson & Smith, 1973) and are considered more reliable.

5 May-19 June 1972: Simultaneous observations

H.306-H.291 = -25.6 nT (4 observations)
H.293-H.291 = -29.0 nT (4 observations)
H.306-H.292 = -33.4 nT (4 observations)
H.293-H.292 = -35.2 nT (4 observations)

27 June 1972: Simultaneous observations

H.306-H.305 = -3.7 nT
H.306-H.291 = -25.3 nT
H.291-H.305 = -21.7 nT

Preliminary corrections used throughout the year were:

(a) QHM 291: -30 nT; QHM 292: -36 nT; QHM 293: 0 nT.

(b) BMZ 120: +226 nT (not used for baseline value control).

(c) 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, but was out of service from 8 April to 1 May owing to mechanical faults.

The normal-run La Cour variograph was operated at Mundaring by Antarctic trainees for short periods as part of their training program. During May it was operated continuously to provide magnetograms daily for the Canberra Observatory Group.

Data reduction and publication

Data distribution and mean hourly value reduction continued as for 1972.

Monthly and annual mean values of H, D, Z, and F, and mean K-index values at Gnangara for 1973 are listed in Table 6. The field values were derived from the ten local quiet days of each month, by scaling one ordinate for each component from each magnetogram. Annual values of all components since 1963 compiled by the HQ Group are shown in Table 7.

Recent trends in secular variations for H and D continued with H decreasing about 40 nT and D becoming more westerly by about 2 minutes. Mean values for Z increased numerically by about 11 nT to a maximum near the middle of the year then returned to near the January value, by December.

Miscellaneous requests were attended to, primarily for magnetogram copies and information on the geomagnetic field in Western Australia.

IONOSPHERICS

Equipment

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

463 hours (5.3%) of record were lost during the year compared with 460 hours during 1972. Component failure (216 hours) continued to be the main cause. 150 hours were lost during January while waiting for replacement units from IPSD. Further record losses (97 hours) were due to the film jamming and operator errors.

Data distribution and publications

Additional parameters were included in the scaling procedures for 1973. Parameters scaled and publications are summarized in the Table below.

Parameter	Hourly values scaled	Publications	
		Hourly values	Monthly medians
f min	Yes	IPSD	IPSD
foE	Yes		
foEs	Yes	IPSD	
fbEs	Yes	IPSD	
RS	Commenced 1 Jan		
FS	Commenced 1 Jan		
foF_2	Yes	IPSD	
$M(3000)F_2$	Yes	IPSD	IPSD, NOAA
FxI	Yes	IPSD	IPSD, NOAA
M(3000)I	Discontinued 1 Jan		
*h'F	Commenced 1 Jan		
*Es type	Commenced 1 Jan		

*Scaled on Priority Regular World Days (PRWD) only.

IPSD Ionospheric Prediction Service Division - monthly computer listings.

NOAA National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Ionospheric Data Series NOAA ISPDA-FA (Formerly CRPL-FA) - listing and f-plots.

The new parameters RS(= spreading in height of F2, or F) and FS(= spreading in critical frequency of F2, or F) are being used in a research project by Dr L. McNamara (IPSD). Values will be tabulated by IPSD when sufficient are available.

Monthly medians of the noon value of foF2 were sent by telegram to the International Radio Consultative Committee (Geneva) for the determination of the index IF2.

SEISMOLOGY

Seismograph stations

Permanent stations were operated throughout 1973 at Mundaring (MUN), Kalgoorlie (KLG), Meekatharra (MEK), Marble Bar (MBT) and Kununurra (KNA). In addition a

transportable seismograph was operated at Wongan Hills (WA1), Wagin (WA2) and Talbot Brook (WA3); details are summarized in Table 8.

The numbers of events reported by each station were: MUN 852; KLG 801; MEK 1034; MBT 887; KNA 2572; WA1 79; WA2 70; WA3 78; Total - 6372.

Mundaring. Seismographs at this station ran satisfactorily throughout the year and very little record was lost.

The WWSSN programmer was replaced in March and the short-period recorder motor in June. Repairs were made to the battery charger in August and October. Other faults were minor.

Two Wood Anderson torsion seismometers (Model TS-220, S/Ns 136, 137) were installed on 23 May recording on two channels of a triple drum Benioff recorder (ex. MEK). The peak magnification is 2040 for periods less than 0.2 seconds.

The Benimore vertical seismograph was modified on 25 May. Recording on the Willmore recorder was discontinued and the Willmore galvanometer was mounted on the third channel of the Benioff recorder (above). This enabled the peak magnification to be increased about three times to 480K. The seismogram produced is a standard 30 mm x 90 mm photographic record, which is easier to analyse than a Willmore seismogram. The seismograph was calibrated at installation (Plate 1).

Kalgoorlie. The station was reduced to a single component, short period, vertical seismograph on 30 March. The two Benioff horizontal seismometers and the triple drum recorder were transferred to Meekatharra. A Geotech single drum recorder (S/N 154) and a standard control console were installed. The seismograph was calibrated at installation (Plate 2).

Record losses, caused mainly by operator errors, were minor.

Meekatharra. This station was upgraded to a three component, short period, seismograph on 1 May. A standard control console was installed at the same time. Details of the instruments are given in Table 9. The seismograph was calibrated at installation and after. The magnification of the vertical component was reduced by 20 percent on 1 June (Plate 3).

The horizontal components were added to give better control over the location of earthquakes in the Gascoyne Junction-Onslow area, and offshore.

Ten days of vertical component records were lost in July owing to faulty optics in the recorder. Other losses were minor and were caused mainly by operator errors.

Marble Bar. Helicorder faults were the major cause of record loss at this station. Eight days were lost in August when a triac failed and some losses resulted from a broken stylus. Operator absences resulted in several days loss of record.

Kununurra. Battery system failures resulted in several days record loss during January and October.

Transportable. This unit produced some useful seismograms. Extended loss of mains power and the failure of a lightning protector in the mains power circuit resulted in considerable record loss prior to July. Modifications were made in November to the mains power distribution, and the recorder rotation speed was halved. The latter doubled the recording period from 27 days to 54 days. The seismograph was calibrated (Plate 4).

Explosion seismology

Seismic waves from mining blasts at Mt Newman, Mt Tom Price and other north-west mining towns were recorded regularly at Meekatharra and Marble Bar and occasionally at Mundaring. No analyses of these recordings have been made.

Accelerographs

A third MO2 accelerograph was installed in the Meckering area on 16 November. The Meckering accelerographs were checked by observatory staff and the Kununurra accelerographs by PWD staff every two or three months. Details of accelerographs in operation at 31 December, 1973 are shown in Table 10.

There was one unexplained triggering of the accelerograph Meckering (A) which may have been caused by the earthquake of 19 August; if so no useable record was produced.

Seismicity

Table 11 lists Western Australian earthquakes of magnitude ML = 2.0 or greater which occurred during 1973 and for which locations are available.

Epicentres were initially determined graphically. If an earthquake was recorded at four or more Australian stations, epicentres were determined by the headquarters group using a computer program for the relocation of earthquakes.

Plates 5 and 6 show epicentres of Western Australian earthquakes and those located in the southwest seismic zone respectively. The larger earthquakes in Plate 5 had magnitudes mB 4 or greater.

Activity in the southwest zone was slightly lower than in 1972. There were six earthquakes with ML greater than 2.9, the largest being ML = 3.8, 6 km south of Meckering on 19 August; 36 minor tremors (ML = 2.0 to 2.9) were located in the zone. One earthquake was located near Perenjori.

Activity continued in the Lake McKay region. Six earthquakes with mB greater than 4 were recorded. Five tremors with ML up to 2.4 occurred about 100 km southwest of Kununurra.

Events were recorded from near Marble Bar, about 100 km east of Onslow, 200 km northwest of Broome, 500 km southwest of Esperance and 600 km southwest of Perth.

Microtremors

A detailed study of microtremor activity in the southwest seismic zone was initiated. About 4000 tremors were analysed for the period July 1969 to June 1973. Preliminary results from the analysis were presented at ANZAAS (Perth, August 1973) and will be presented in more detail elsewhere.

Data distribution and publication

Data distribution continued as for 1972 with the distribution of preliminary monthly bulletins. Punched cards containing data from final analyses were prepared for data from July 1972 to June 1973, and forwarded to Canberra HQ for inclusion in the Australian data tapes sent to the International Seismological Centre, Edinburgh.

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

NOTES ON WORKS PROJECTS

The following new works were carried out during the year:

(a) Time signal receiving aerial masts were erected at the Kalgoorlie seismograph hut (November).

(b) Work commenced on additions to the workshop (October).

ACKNOWLEDGEMENTS

The assistance of the Regional Director and staff of the Department of Supply, Perth and the Department of Civil Aviation Officers (for outstation operation), Messers. J. Grant of Kalgoorlie and E. Tromans of Meekatharra is hereby acknowledged. The assistance of the Pilbara Shire for housing the Marble Bar seismograph is greatly appreciated. The assistance of Mr. G. Edwards in changing record at Marble Bar is acknowledged. Punching of ISC cards was carried out by the Bureau of Census and Statistics (Perth) by arrangement with the Deputy Commonwealth Statistician.

REFERENCES

GREGSON, P.J., & SMITH, R.S., 1973 - Mundaring Geophysical Observatory Annual Report 1972. Bur. Miner. Resour. Aust. Rec. 1973/154 (unpubl.).

APPENDIX

PRINCIPAL EVENTS

MUNDARING GEOPHYSICAL OBSERVATORY 1957-1973

1957	May	Geomagnetic recording commenced at Gnangara (La Cour).
1959	Mar 18	Transfer of observatory from Watheroo to Mundaring.
1959	Apr 3	Ionospheric recording commenced (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 Type 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.
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.

TABLE 1

OBSERVATORY STAFF 1973

Officer	Designation
P.J. Gregson	Geophysicist Class 3
R.S. Smith	Geophysicist Class 2
E.P. Paull	Geophysicist Class 1
G. Woad	Technical Officer Grade 2
B.J. Page	Technical Officer Grade 1
Y.M. Nardini (Miss)	Typist
T.E. Creaser	Assistant Grade 1

TABLE 2

ASSOCIATED PERSONNEL 1973

Name	Nature of duties
J.J. Walsh	Antarctic trainee (April to September)
P.J. Cameron	Antarctic trainee (July to September)
T. Pryor	Vacation student, 1972/73
C. Blyth	Vacation student, 1973/74
B. Carling	Daily attendant, Gnangara
D.C. Allen	Daily attendant, Kalgoorlie (To February)
J. Grant	Daily attendant, Kalgoorlie (From February)
E. Tromans	Daily attendant, Meekatharra
W. Till	Daily attendant, Kununurra
G. Edwards	Daily attendant, Marble Bar

TABLE 3

OBSERVATORY STAFF ABSENCES 1973

Nature of absence	No. of man days
Sick leave	6
Military service	20
Attendance at outstations and field operation	12
Other Branch surveys	6
Conferences	35
Furlough	24
	103

TABLE 4

CONFERENCES AND ADDRESSES

Officer	Date	Conferences
P.J. Gregson	Aug 7-10	Canberra - O.I.C.' meeting.
	Aug 13-Sep 07	Lima - IASPEI Assembly and visits to Seismological Establishments, San Francisco, and Brasilia.
R.S. Smith	Aug 13-17	Perth - ANZAAS meeting.
E.P. Paull	Aug 13-17	Perth - ANZAAS meeting.
		Addresses
R.S. Smith	Aug 17	ANZAAS - "Microtremors in the southwest of Western Australia".

TABLE 5

VISITORS

Visitor	Institute
Mr. J. Barlow	BMR (Canberra)
Mr. J. Grace	BMR (Canberra)
Mr. P. Cameron	BMR (Canberra)
Mr. P. Petkovic	BMR (Canberra)
Mr. J.C. Dooley	BMR (Canberra)
Dr. P. Wellman	BMR (Canberra)
Mr. A. Murray	BMR (Canberra)
Mrs. H. Hughes	BMR (Canberra)
Mr. L. Zeitlhofer	BMR (Canberra)
Dr. D. Denham	BMR (Canberra)
Dr. M. Dickson	BMR (Canberra)
Dr. E. Polak	BMR (Canberra)
Mr. I.B. Everingham	BMR (Port Moresby)
Mr. I.D. Ripper	BMR (Port Moresby)
Mr. R.F. Thyer	BMR (Retired)
Dr. G.B. Hill	W.A. Earthquake Advisory Committee (Chairman)
Mr. B. Bromell	Director of Civil Defence
Dr. D. Dunwoodie	Department Local Government
Mr. R. Gordon	Consultant Geologist
Mr. R.J.H. Thompson	Department of Minerals and Energy (Assistant Secretary, Management Services)
Mr. E. Edmiston	Department of Supply
Mr. D. Powell	Department of Science
Dr. D. Sutton	University of Adelaide
Mr. K. Stewart	WAPET
Mr. D. Witt	WAPET
Mr. D. Upton	Department of Minerals and Energy
Geophysics students	University of W.A.
Geophysics students	WAIT
Geophysics students	Leederville Technical College
Members	Science Teachers Association

TABLE 6

PRELIMINARY MONTHLY MEAN GEOMAGNETIC VALUES AND K INDEX

1973

Month	D(West)	H, nT	Z, nT	F, nT	K
January	3°06.5'	23708	-53449	58471	2.41
February	07.0	703	454	474	2.53
March	07.0	696	455	472	2.68
April	07.7	682	463	473	2.90
May	07.5	682	466	476	2.25
June	07.5	684	465	476	2.33
July	07.6	684	464	475	2.06
August	07.9	685	463	475	1.83
September	08.5	672	463	469	2.19
October	08.4	675	458	466	2.35
November	08.7	675	457	465	2.18
December	08.8	680	457	467	2.16
Mean	07.8	23686	-53460	472	2.32

TABLE 7

GEOMAGNETIC ANNUAL MEAN VALUES 1963-1973

Year	D ° '	I ° '	H nT	X nT	Y nT	Z nT	F nT	Notes
1963	-2°52.3	-65°54.1	23931	23901	-1199	-53503	58611	2B
1964	51.7	54.6	917	887	1194	506	608	2B
1965	51.7	55.8	907	877	1194	500	599	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
Mean Annual Change	-1.55	-1.21	-24.5	-25.0	-9.3	+4.3	-13.9	

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

TABLE 8

TRANSPORTABLE SEISMOGRAPH DATA

DISPOSITION 1973

Place Code	Wongan Hills WA1	Wagin WA2	Talbot Brook WA3
Co-ordinates			
Latitude	30°54.6' S	33°16.6' S	32°03.1' S
Longitude	116°43.7' E	117°20.2' E	116°38.6' E
Elevation	260 m	300 m	276 m
Foundation	Precambrian granite	Precambrian granite	Precambrian granite
Date of operation			
From	31 Jan 1973	6 Jun 1973	16 Nov 1973
To	21 May 1973	7 Nov 1973	
Parameters (all places)			
Component	SP-Z		
Ts (Seconds)	1.0		
Tg (Seconds)	0.1		
Magnification*	1.8K at 1.0S		
	13K at 0.1S		
Recording speed*	15 or 30 mm/min		
Instruments (all places)			
Seismometer	Willmore Mk 2; S/N 213862		
Galvanometer	Geotech (G10); S/N 4483		
Recorder	Geotech RF220; S/N 110		
Power supply	250V mains with 24V d.c. standby		
Clock	EMI		
Radio	Labtronics		

* Recording is on 70 mm film which can be enlarged, x 10 for record analysis.

TABLE 9

MEEKATHARRA SEISMOGRAPH DATA

Code

MEK

Co-ordinates

Latitude	26°36.8' S
Longitude	118°32.7' E
Elevation	520 m
Foundation	Precambrian sediments

Parameters

Component	SP-Z	SP-N	SP-E
Ts (Seconds)	1.25	1.0	1.0
Tg (Seconds)	0.25	0.25	0.25
Magnification at 1.0	15K	8K	8K
0.2	100K	36K	36K
Recording speed	60 mm/min		

Instruments

Seismometer	Johnson Matheson S/N 332	Benioff	Benioff
Galvanometer	Geotech (G10) S/N 5282	Geotech (G10) S/N 4340	Geotech (G10) S/N 4405
Recorder	Benioff three component		
Power supply	250V mains with 24V d.c. standby		
Clock	EMI		
Radio	Labtronics		

TABLE 10

WESTERN AUSTRALIAN ACCELEROGRAPHS

Station and ownership	Co-ordinates and date installed	Elevation (m)	Foundation	Serial Nos MO2	Serial Nos Block	Scale values (g/cm)* Ia	Scale values (g/cm)* Ia	Scale values (g/cm)* Ic
Meckering A (BMR)	31.594S 116.991E 30 November 1971	250	Alluvium over Precambrian granite	289	1166A	0.582	0.584	0.348
Meckering B (BMR)	31.694S 116.982E 30 November 1971	200	Alluvium over Precambrian granite	291	1462A	0.609	0.597	0.417
Meckering C (BMR)	31.813S 116.958E 16 November 1973	220	Alluvium over Precambrian granite	290	1196	0.590	0.560	0.394
Ord River Dam (PWD)	16.113S 128.738E 1 March 1972	120	Rock fill 3m clay core 90m, quartzite	245				
Ord River Abutment (PWD)	16.113S 128.737E 16 November 1972	60	Phyllite	244	1358A			

BMR: Bureau of Mineral Resources, Mundaring Geophysical Observatory

PWD: Public Works Department, W.A.

* g = acceleration due to gravity

TABLE 11

WESTERN AUSTRALIAN EARTHQUAKES 1973

Date 1973	Origin Time U.T.	Lat. °S	Long. °E	ML	mB	Remarks
Jan 07	18 18 49.0	16.60	128.55	2.4	3.6	SW Kununurra.
13*	08 08 01.2	17.08	121.06		4.6	NW Broome.
21	11 39 48.7	31.78	117.11	2.0	3.0	20km SSE Meckering.
27	16 16 27.3	31.60	117.03	2.2	3.4	3km E Meckering.
Feb 16	13 26 46.4	30.91	117.14	2.3	3.3	2km W Manmanning.
17	14 27 28.1	30.97	117.22	2.5	3.5	13km SE Manmanning.
18	00 51 47.8	31.69	117.06	2.2	3.5	9km SW Meckering.
26	14 35 17.1	31.70	116.95	3.0	4.0	17km S Meckering, felt.
28	22 42 06.3	30.90	117.08	2.8	3.7	5km S Manmanning.
Mar 10*	01 31 14.2	22.02	127.51	4.2	4.8	Lake McKay.
10*	03 09 19.4	21.79	127.45	4.1	4.8	Lake McKay.
10*	18 21 45.4	21.69	126.42		4.1	Lake McKay.
10*	20 32 13.9	21.92	126.49		4.2	Lake McKay.
11	02 40 44.8	31.40	117.11	3.0	3.8	27km NNE Meckering.
11*	16 04 16.7	21.96	127.44		5.0	Lake McKay.
15	02 01 00.0	30.90	118.25	2.5		Mukinbudin.
19	00 28 20.5	30.96	117.13	2.2	3.4	10km S Manmanning.
25*	06 12 37.2	29.55	116.79	2.9	3.8	Perenjori.
25	06 14 16.8	30.92	117.03	2.1		9km SW Manmanning.

TABLE 11 (contd.)

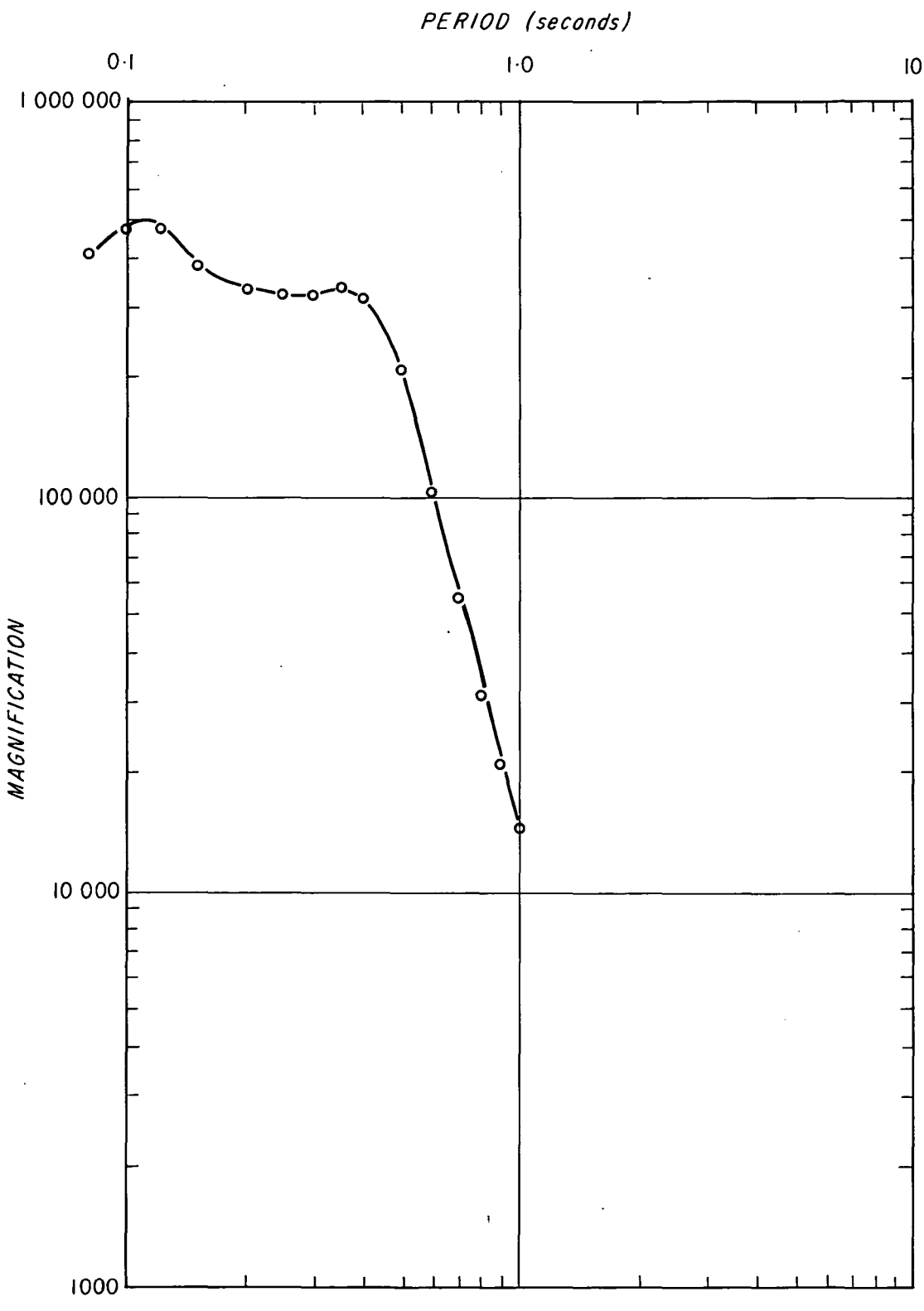
Date 1973	Origin Time U.T.	Lat. °S	Long. °E	ML	mB	Remarks
Mar 31	02 45 00.8	31.65	116.90	2.0	2.9	10km SW Meckering.
31	11 07 21.6	30.90	117.10	2.2	3.2	5km S Manmanning.
Apr 01	12 25 59.8	31.60	117.00	2.0		Meckering.
02	14 23 14.5	31.21	116.79	3.0	3.8	Dowerin.
10	18 59 56.9	30.59	117.01	2.4	3.7	3km N Meckering.
11	09 41 31.1	31.60	116.82	2.2	3.3	18km W Meckering.
25	15 27 08.6	16.30	128.20	2.1	3.6	SW Kununurra.
26	20 20 29.4	31.70	117.00	2.1	3.1	17km SSE Meckering.
30	00 58 42.5	31.77	117.00	3.3	4.3	18km S Meckering.
May 03	23 23 05.0	31.58	116.91	2.2	3.6	11km NW Meckering.
11	09 07 19.0	30.90	118.25	2.1		Mukinbudin.
11	23 20 31.6	16.60	128.50	1.7		SW Kununurra.
15	11 44 15.5	31.61	117.07	2.4	3.5	6km E Meckering.
19	02 17 45.8	31.71	117.08	2.1	3.1	12km SE Mukinbudin.
30	08 54 07.8	16.70	128.20	2.3	3.5	SW Kununurra.
Jun 10	08 07 14.0	21.20	119.70		3.6	Marble Bar.
14	08 44 08.9	31.67	116.97	2.3	3.2	6km SW Meckering.
18	19 34 13.0	33.50	110.20		5.4	Indian Ocean.
23	16 35 11.8	31.68	116.98	2.4	3.4	6km S Meckering.
29	13 52 41.2	30.82	116.90	2.3	3.7	20km W Manmanning.

TABLE 11 (contd.)

Date 1973	Origin Time U.T.	Lat. °S	Long. °E	ML	mB	Remarks
Jul 24	11 18 03.3	22.2	126.9	4.6	5.5	Lake McKay.
Aug 13	11 48 59.4	31.74	117.10	2.0	3.2	16km SW Meckering.
18	07 46 45.1	31.64	117.00	2.5	3.4	3km S Meckering.
19*	19 50 25.3	31.65	117.06	3.8	4.6	6km S Meckering.
Sep 01	14 04 04.8	31.74	117.04	2.8	3.5	13km SSE Meckering.
16	11 59 35.1	31.72	117.02	2.1	3.1	10km S Meckering.
21	20 26 24.2	31.64	116.95	2.4	3.4	5km SW Meckering.
23	09 09 05.0	30.90	117.10	2.2		Manmanning.
24	20 29 26.9	16.6	128.6	2.4	3.9	SW Kununurra.
25	02 29 45.3	31.65	117.00	2.0	3.6	5km S Meckering.
26	00 31 07.7	31.67	116.97	2.5	3.6	5km SW Meckering.
27	20 02 05.5	22.2	116.0	3.8	4.2	100km E Onslow, felt.
Oct 31	10 33 02.1	31.38	116.66	3.3	3.9	18km SE Bolgart.
Nov 17	20 40 45.6	31.63	116.96	2.6		5km W Meckering.
18	22 04 12.3	31.84	117.17	2.2	3.4	19km N Mawson.
20	12 54 24.4	31.65	117.03	2.0	3.3	4km SE Meckering.
Dec 04	09 30 42.0	21.9	116.3		3.9	130km E Onslow.
04	11 53 34.0	37.0	126.0		4.9	500km SE Esperance.
06	06 15 25.2	31.70	116.96	2.6	3.9	9km SW Meckering.
14	14 25 41.0	32.30	117.23	2.3	3.7	22km NE Brookton.
28	16 47 05.0	31.5	116.9	2.5	3.4	15 km NW Meckering.

* Relocated using HQ computer program.

PLATE 1



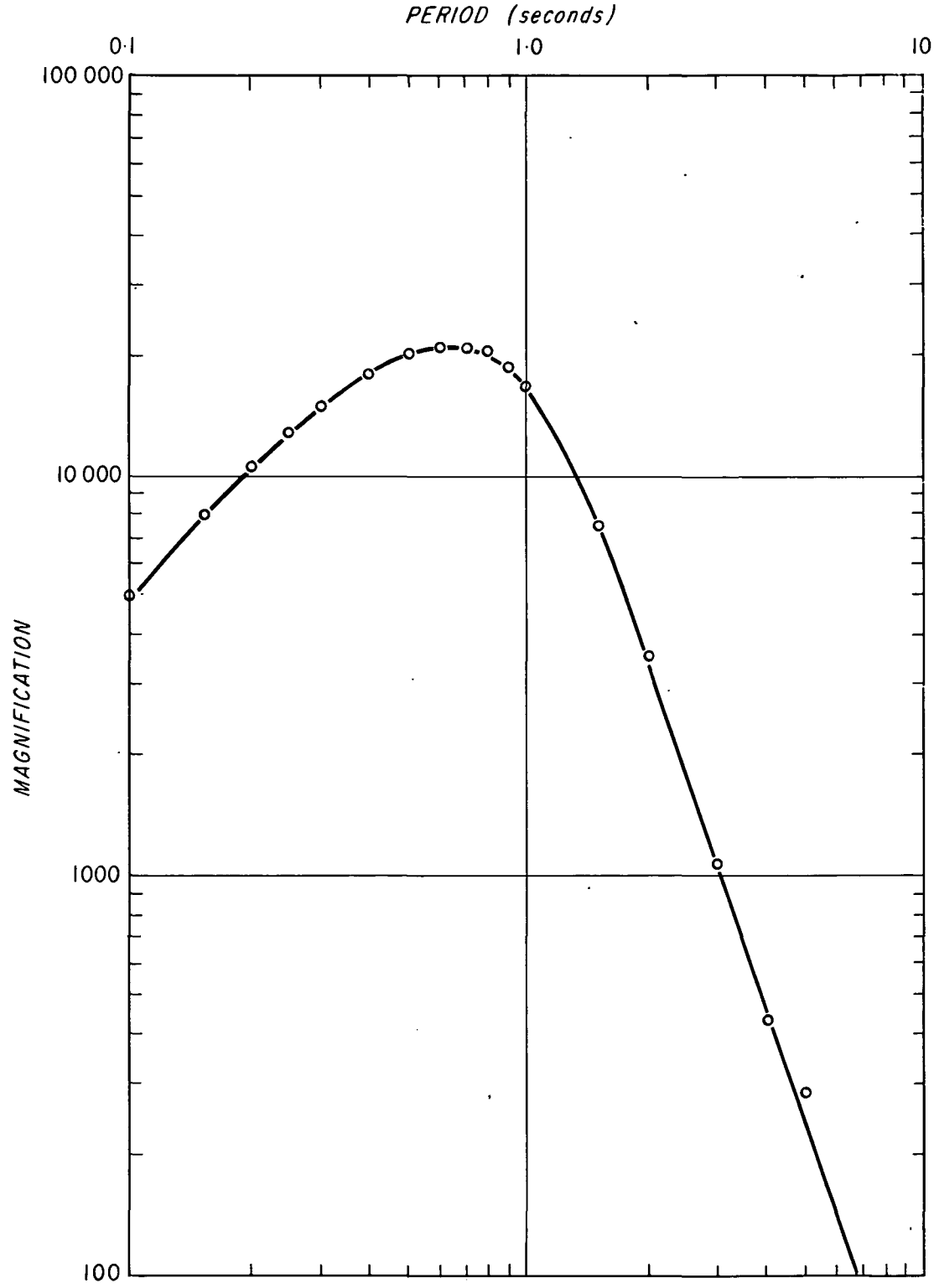
CALIBRATION CURVE MUNDARING HIGH GAIN Z SEISMOGRAPH

FROM 13 JUNE 1973

Record No. 1974/103

H50/89-17A

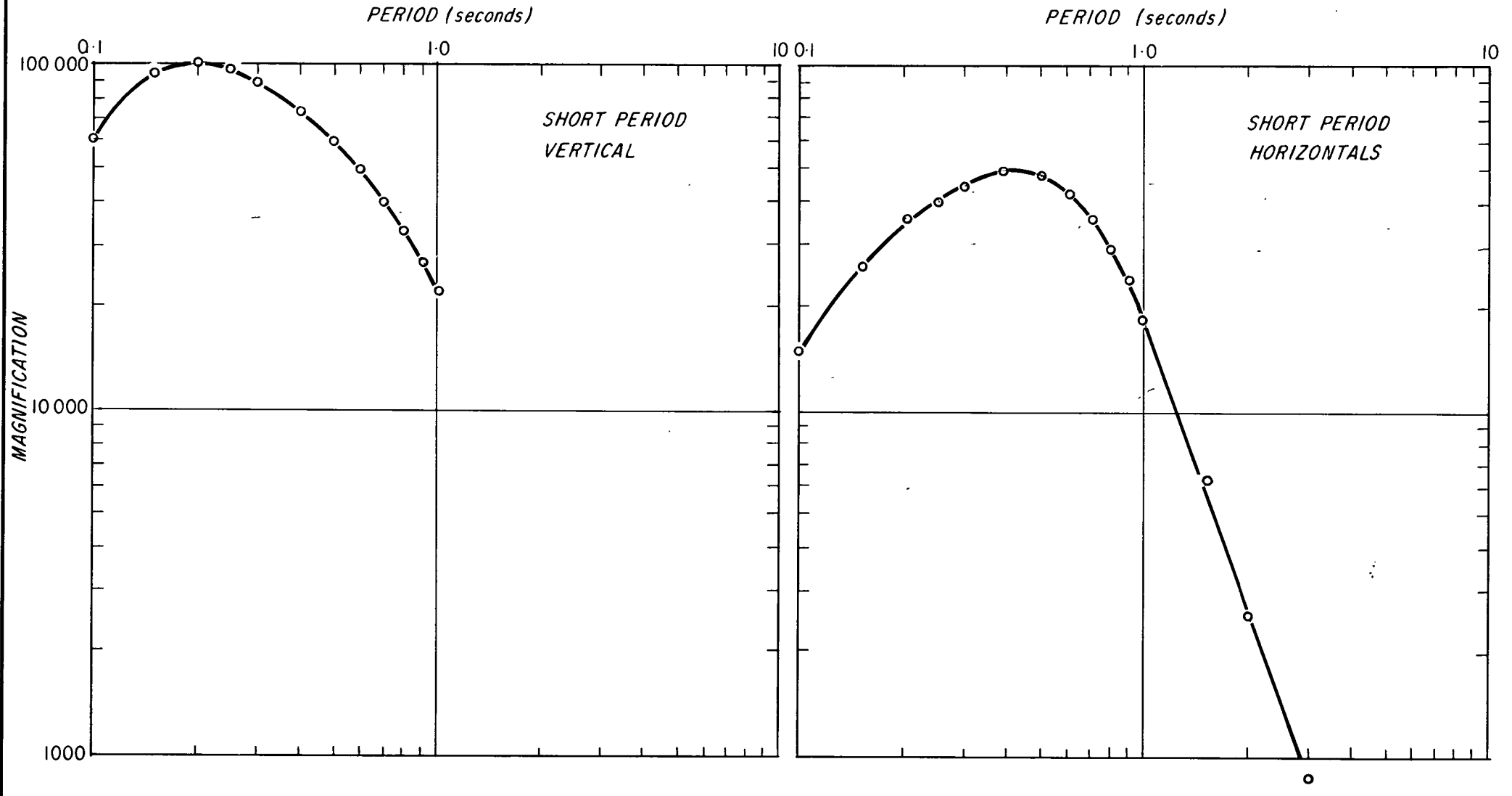
PLATE 2



CALIBRATION CURVE KALGOORLIE SEISMOGRAPH

FROM 29 MARCH 1973

Record No. 1974/103



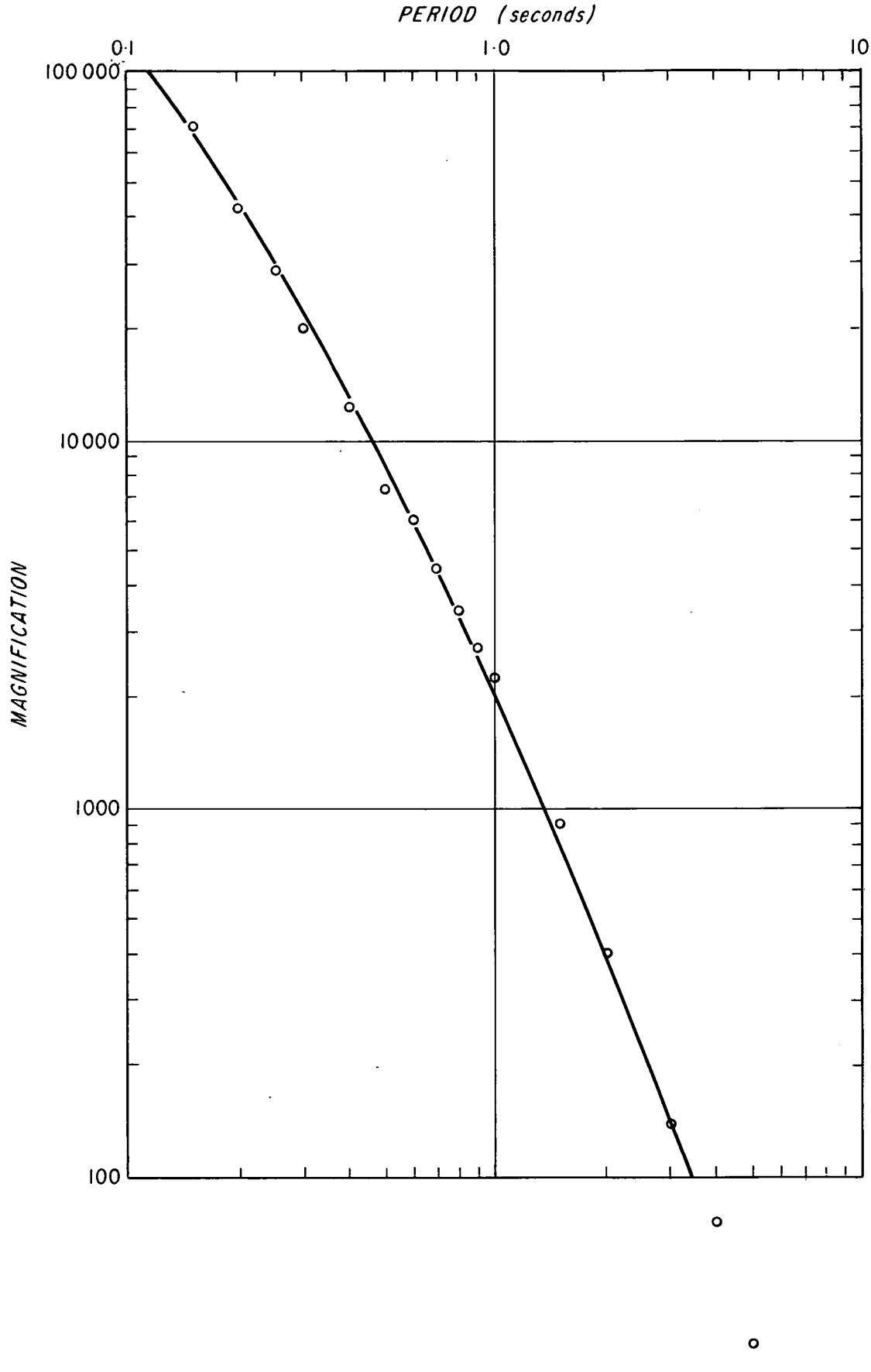
CALIBRATION CURVES MEEKATHARRA SEISMOGRAPHS

1 JUNE 1973

G50/89-5A

PLATE 3

PLATE 4



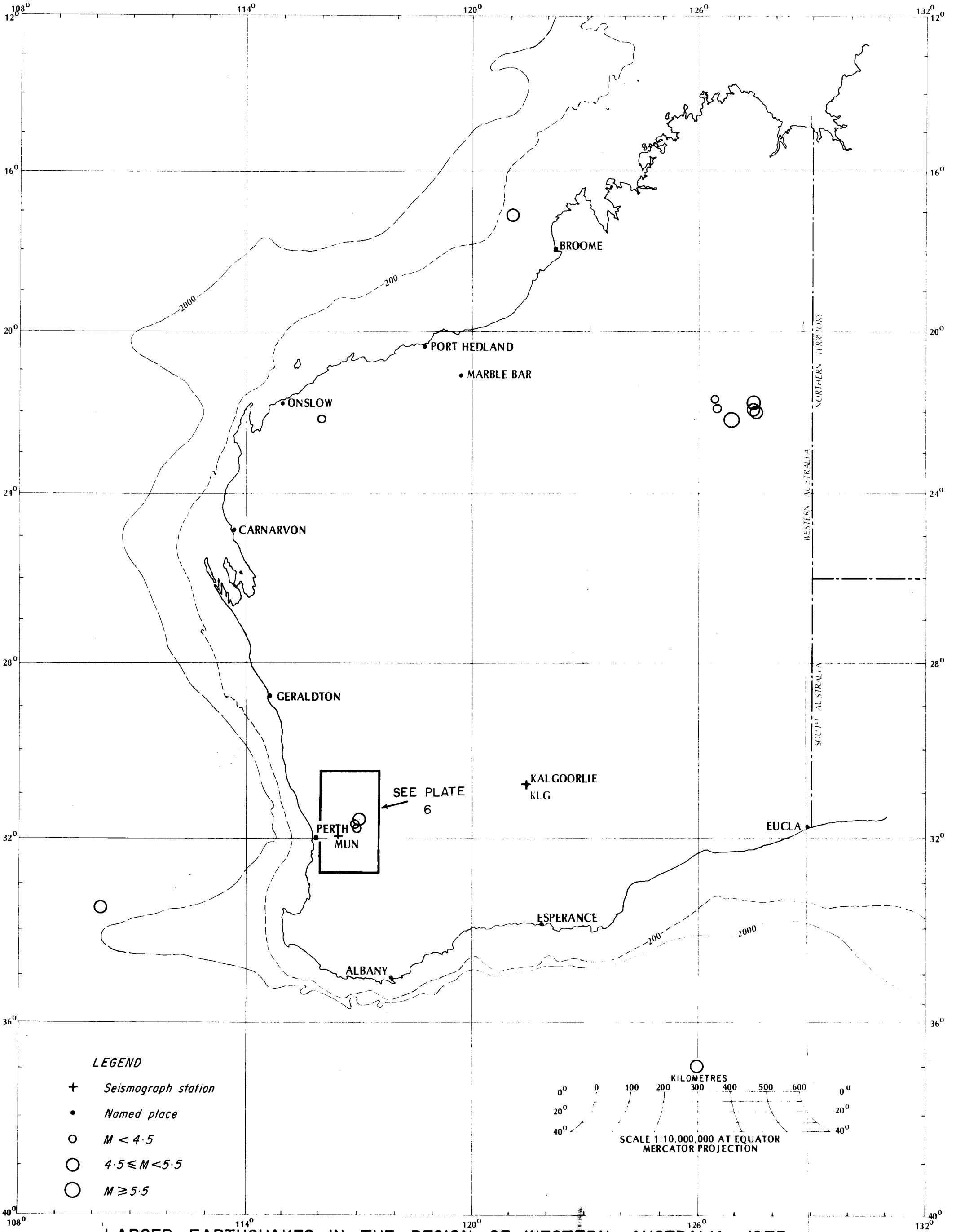
CALIBRATION CURVE TRANSPORTABLE SEISMOGRAPH

FROM 1 MAY 1973

Record No. 1974/103

H50/B9-18A

PLATE 5

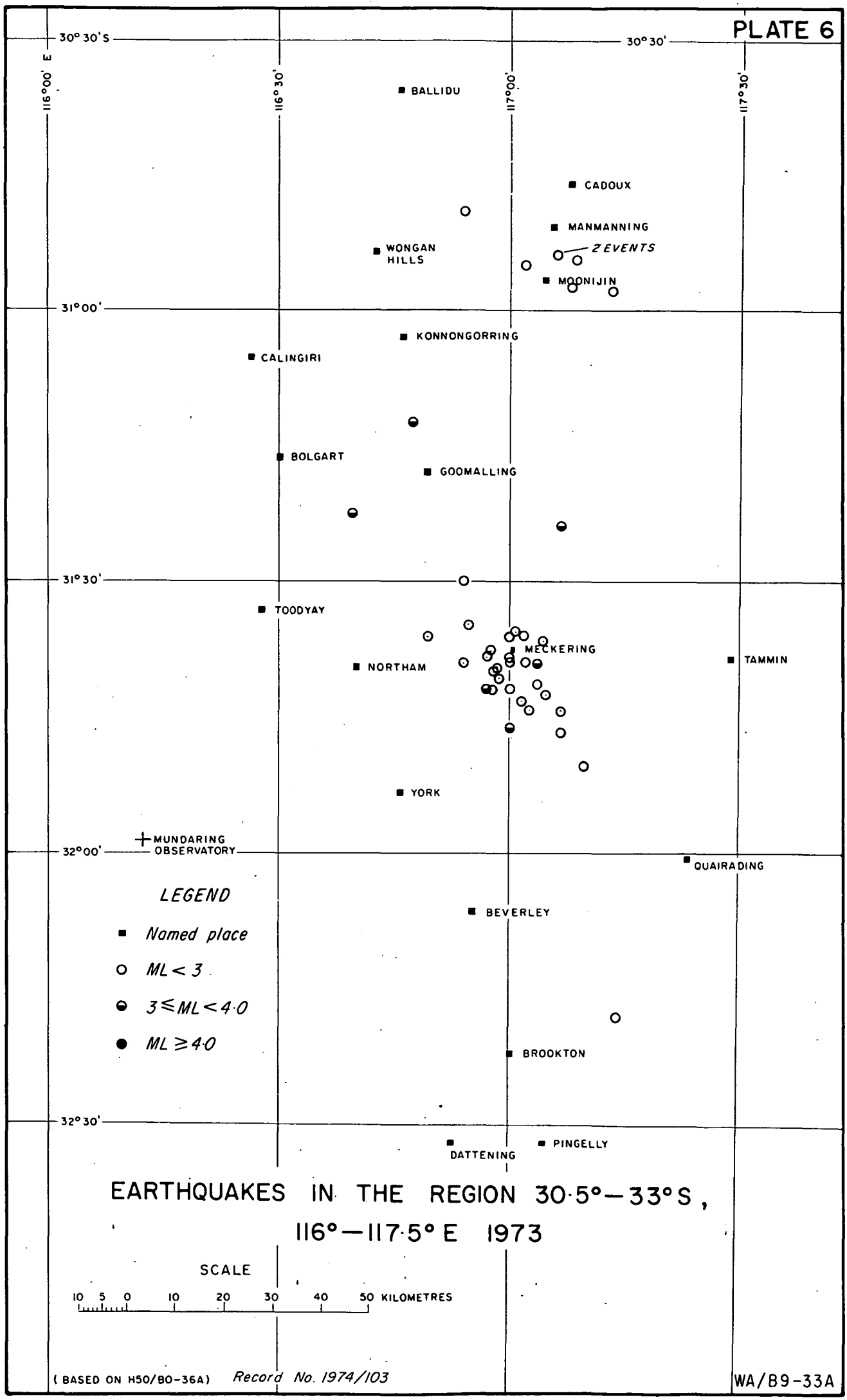


LARGER EARTHQUAKES IN THE REGION OF WESTERN AUSTRALIA, 1973

(Based on WA/BO-4) *Record No. 1974/103*

WA/B9-32

PLATE 6



EARTHQUAKES IN THE REGION 30·5°—33°S, 116°—117·5° E 1973

SCALE

10 5 0 10 20 30 40 50 KILOMETRES

(BASED ON H50/80-36A) *Record No. 1974/103*

WA/B9-33A