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Record 1972/48

MUNDARING GEOPHYSICAL OBSERVATORY, ANNUAL REPORT 1971

by

P.J. Gregson

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SUMMARY

During 1971, basic observatory programs were continued in geomagnetism, ionospherics, and seismology at the Mundaring Geophysical Observatory; the main instruments were the Eschenhagen normal-run magnetograph, an Ionospheric Prediction Service IIIE ionosonde, and a Worldwide Standardized Seismograph System.

Seismographs were operated at Kalgoorlie, Meekatharra, and Karratha, the last being installed on 10 February. Interpretation of seosmograms from the state owned seismograph at Kununurra was continued.

Epicentres of 65 Western Australian earthquakes were determined and annual lists completed. Earthquake activity in the southwest of Western Australia was reduced from the level of 1970 to about the level before October 1968. Activity continued in the Lake McKay region.

Three accelerographs were installed during the year, two at Meckering and one at Mundaring.

1. INTRODUCTION

The Mundaring Geophysical Observatory came into being on 18 March 1959 and now controls operations at Mundaring (seismological and ionospheric recording), Gnangara (magnetic recording), Kalgoorlie, Meekatharra, and Karratha (seismological recording). Descriptions of the Observatory and an outline of activities there to the end of 1970 have been given in previous records, (e.g. Gregson, 1971). Discussion of non-routine projects is brief, as details will be reported separately.

2. STAFF AND VISITORS

Observatory staff are listed in Table 1 and others 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.

B.J. Page commenced duty as Technical Officer Grade 1 on 27 January. R.S. Smith commenced duty as Geophysicist Class 2 on 22 April; on 27 July he commenced extended leave without pay to take up a twelve-month appointment as Production Assistant with the International Seismological Centre (ISC), Edinburgh.

The absence of a Class 2 geophysicist for the major portion of the year restricted the observatory's activities considerably.

Visitors to the observatory are listed in Table 5.

3. GEOMAGNETISM

Normal magnetograph

The Eschenhagen 20mm/hour magnetograph continued in operation at Gnangara. One day and several hours' recording were lost owing to fogging.

The Z baseline value changed more or less abruptly at the end of July. This occurred some time between weekly absolute observations but thorough inspection of the magnetograms did not reveal any discrete ordinate changes. It was assumed, therefore, that the change was spread uniformly over the week involved.

There were no other large baseline value or scale value changes during the year.

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

Element	Baseline value	Scale value
D	0.26 minutes	-
H	2.0 nT	0.02 nT/mm
Z	2.4 nT	0.04 nT/mm

New recording globes (Philips 3873C/23) and an associated control console were installed in November and resulted in improved recordings. The console comprises an MCO scale value calibrator, EMI digital clock, time control panel, recording lamp regulator, and automatic 24V battery charger. Provision is made so that a Mercer chronometer with minute closures can be used whenever an EMI clock is not available.

Magnetograph tests

Temperature coefficients. Least-squares analysis carried out on 1971 H baseline data confirmed the coefficient in use (QH = 0.4 nT/°C). No analysis of Z baseline data was made because of changes in the correction to BMZ 120. The value determined in 1970 (QZ = 3.2 nT/°C) was used.

Orientation. Tests made on the Eschenhagen magnetograph in July showed that the orientation of the H and D magnets (N poles) were E 0.2'N and N 0.3'W respectively. The reference meridian was 003.1°T and the value of H was 23,787 nT. These results were comparable with 1970 results (Gregson, 1971). No adjustments were made.

D scale value. One observation using a Helmholtz coil was made in July. The value determined was 1.05 minutes/mm.

Magnetometers

The fibre of QHM 293 was broken on 27 January during normal absolute observations. QHM 291 and 292 were used for the remainder of the year. Arrangements were made through Head Office for the repair of QHM 293; unfortunately it was damaged in transit from Rude Skov to Canberra and had to be returned to Rude Skov for repair (December).

BMZ 120 behaved erratically during September and October. The instrument was opened and cleaned on 1 November; this improved the consistency of the baseline values but altered the instrument correction by about 70 nT.

The torsion head of Askania declinometer 509319 was repaired in July, and the circle 508135 was cleaned in November.

Comparisons. Z baseline values given by BMZ 120 were compared with values ZP calculated from F (Elsec, S/N 271) and H (using adopted baseline values). The following results were obtained:

20 October: Z.120 - ZP = +298 nT (2 observations).

November to January 1972: Z.120 - ZP = +226 nT (24 observations).

The H baseline values at standard temperature used were 23703 nT and 23701 nT respectively.

Preliminary corrections. Those used throughout the year were:

(a) QHM.291, -22 nT; QHM.292, -30 nT; QHM.293, -6 nT (until 27 January).

(b) BMZ.120, 299 nT until 30 October.
226 nT from 1 November.

(c) Askania declinometer 509319, (circle 508135) + 0.5 minutes.

Accessory equipment

The Askania visual recorder at the Mundaring office was operated throughout the year.

Induction loop recordings were discontinued early in the year because a suitable galvanometer was not available.

An AFMAG recording instrument was operated throughout the year at Mundaring Weir for the metalliferous group of the Geophysical Branch. Recording was discontinued on 31 December.

Data reduction and publication

Data distribution and mean hourly value reduction continued as for 1970.

Monthly and annual mean values of H, D, and Z, and the mean K-index at Gnangara for 1971, 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. Previous annual values are listed by Gregson (1971).

Recent trends in secular variation for H, D, and Z continued with H decreasing about 30 nT, D becoming more westerly by about 2.0 minutes and Z decreasing numerically by about 20 nT.

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

4. IONOSPHERICS

Equipment

The quarter-hourly sounding schedule was continued throughout the year using a model 3E IPS ionosonde.

Nearly 400 hours of record were lost during the year (300 in the first six months) owing to three main causes:

(a) Component failure, 260 hours
(b) Station 250V power failure, 30 hours
(c) Film jamming and fogging, 100 hours.

The latter two causes have been eliminated by:

(a) Connexion to the State Electricity Commission 250V supply in February.

(b) The fitting of a five-day film cassette (ex Cossor ionosonde) to the ionosonde in place of single-day cassettes. This also eliminated a considerable wastage of film.

Data distribution and publications

Scaling procedures continued as for 1970. Hourly values of fmin, fEs, fbEs, M(3000)F2, FxI, and M(3000)I are published for BMR by the Ionospheric Prediction Service Division in their IPS-D series.

In addition monthly median and f-plots of F2 and M(3000)F2 are currently being published by the US Department of Commerce in their Ionospheric Data series CRPL-FA.

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

Several requests, mainly from IPSD for ionograms, were received during the year.

5. SEISMOLOGY

Seismograph stations

There were few changes to instrumentation at Western Australian seismograph stations. The changes are summarized in Table 7. Considerable time was spent on the design and construction of standard control consoles for Western Australian seismograph stations. The details of this equipment are given by Woad & Page (in prep.).

A short-period vertical-component seismograph was established at Karratha on 10 February in temporary housing supplied by the State Public Works Department. Details of the instruments and location are given in Table 8.

Mundaring. Seismographs at this station ran satisfactorily throughout the year with very little loss of record.

The periods of the short-period Z, N, and E and long-period Z seismometers were adjusted on 16 February.

The WWSSN control console continued to operate well with only minor faults. A zener diode in the recorder lamp regulator and several transistors in the power supply unit were replaced. The stroboscope was reinstalled in place of the phase shifter in May, and the heater for the long-period seismometer was repaired and replaced in November. High-capacity 24V lead acid batteries replaced the failing original WWSSN nickel cadmium batteries in October.

The Benimore vertical seismograph was changed from two recorders to one recorder (S/N 184806) in May as one of the 0.04-s galvanometers (S/N 89637) was broken. The recording speed was reduced from 120 mm/min to 60 mm/min. Recalibration confirmed the magnification curve obtained previously (Gregson, 1967).

Kalgoorlie. The three-component seismograph operated satisfactorily throughout the year. Minor problems were experienced with time signal reception, and the Eddystone receiver was replaced with an AWA transistor receiver in September.

Fluorescent KLG label plates were fitted to each recording drum.

Meekatharra. This station ran extremely well throughout the year with very little loss of record. On 29 April the seismometer was shifted into a new seismometer pit, and adjustments were made to the seismometer free period and galvanometer damping. The seismograph was calibrated, and the calibration curve is shown in Plate 1.

Karratha. Initial difficulties were experienced with time control and fogging of records owing to poor radio reception and inexperienced operators.

The seismograph was calibrated at installation (see Plate 2).

The site is not ideal as it is close to the sea and at times the microseisms make it impossible to interpret the seismograms. The station will be kept running until a high-magnification seismograph is established at Marble Bar.

Kununurra. The State Public Works Department purchased an EMI digital clock, which was installed in January. A lightning strike caused damage to the clock and time signal filter on 12 February. Recording was disrupted for two months while repairs were made. Recording from October onwards was spasmodic owing to building construction in preparation for a new three-component seismograph.

30-day recorder. This did not operate during the year as the galvanometer was still being repaired in the US.

The numbers of events reported from each station were: MUN-872; KLG-804; MEK-1161; KAA-375 (from 10 February); KNA-640 (eight months); Total - 3852.

Northwest site selection

Seventeen sites in four northwest towns (Newman, Tom Price, Karratha, and Marble Bar) were investigated for suitability as a seismograph site. Ground noise tests were carried out using a Willmore (Mk 2) seismometer, Geotech amplifier and Moseley recorder. The results and estimated peak magnification are summarized in Table 10.

Marble Bar was the quietest site tested and the logistics of developing and operating a seismograph station there are similar to those at other towns tested.

Explosion seismology

On 2 May a 524 t explosion was detonated near the Ord River dam site, to provide rock fill for the dam. The seismic waves from the blast were recorded at Western Australian seismograph stations at Mundaring (2166 km), Kalgoorlie (1935 km), Karratha (1355 km), and Kununurra (42 km). It was also recorded at field stations set up at Mundiwindi, (1227 km), Kumarina (1340 km) and Menzies (1695 km). Scientific results from the recordings are given by Denham, Simpson, Gregson, & Sutton (in press) and the operational aspects by Denham, Gregson, & Small (in prep.).

Tests were made with 25-kg cans of WWEL explosives for the Regional Structural Surveys Group during October and November. The explosives were detonated at water depths up to 200 metres with delays ranging from zero to sixty minutes. Charges detonated immediately were successful whereas any delay at depth reduced the effectiveness of the charge.

Ground noise tests

Ground noise tests were made for the State Public Works Department at the proposed new Perth Medical Centre, and on two occasions at the Bickley Observatory on top of a 12 metre high telescope tower. Ground movement up to 1 micron at periods of less than one second were recorded at the medical centre. This was acceptable for the proposed electron microscope. Vibrations at Bickley were less than the acceptable 1 micron at 0.3 seconds.

Accelerographs

Three MO2 accelerographs were received in June and were subsequently installed, one at Mundaring and two in the Meckering area, on 9 August and 30 November respectively (Table 9). They had not been triggered by 31 December.

Seismicity

Earthquake lists. 1971 earthquakes are listed in Tables 11-13.

The larger earthquakes (Table 11 and Plate 3) are those that were well recorded at more than one station and generally have a magnitude ML = 3.0 (mB about 4.0) or greater. Epicentres listed are given to one or two decimal places of a degree and are accurate to $\pm 0.1^{\circ}$ and $\pm 0.01^{\circ}$ respectively. Some of the northwest epicentres are shown in brackets as they are less accurate than $\pm 0.1^{\circ}$ because of the uncertainty in travel times in this area.

The minor earthquakes are divided into two tables. Table 12 lists those which occurred in the southern part of the State and were generally only recorded at Mundaring, with magnitudes less than ML = 3.0. Table 13 lists those in the northern part of the State.

Earthquakes in the southwestern part of the State. 1971 earthquakes which occurred in this region are plotted in Plate 4.

Activity in the central part of the Yandanooka-Cape Riche zone of seismicity was reduced from the 1970 level. There were only five earthquakes with ML greater than 2.9, and about 40 minor tremors. This level of activity is similar to that before the large Meckering earthquake in October 1968.

Two tremors ML 3.0 and 2.2 which occurred on 18 and 21 August near Doodlakine are of interest as they were well to the east of the Yandanooka-Cape Riche zone.

Earthquakes in the northern part of the State. Activity continued in the Lake McKay region although on a much reduced level from that in 1970. Five earthquakes with ML greater than 3.3 were recorded, compared with 160 in nine months of 1970.

Activity was evident in the Marble Bar-Port Hedland region.

Data distribution and publication

Preliminary data from all stations were distributed weekly to nine Australian stations and to: Wellington, Port Moresby, Rabaul, and the Seismology Division of the US NOAA (formerly CGS). Preliminary data were also sent by telegram two or three times per week to NOAA for preliminary determinations of epicentres.

A final analysis of data was made about four months after the event and distributed as a monthly bulletin to 17 stations. Phase data were sent to Canberra HQ for transmission on magnetic tape to the International Seismological Centre (ISC) Edinburgh. At 31 December final data to the end of July were completed.

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

6. NOTES ON WORKS PROJECTS

The following repairs, maintenance, new works, and alterations were carried out during the year:

(a) A seismometer vaultlet identical to that at KLG was installed at Meekatharra seismograph station to overcome drainage problems (February).

(b) The Mundaring Weir site was connected to the State Electricity Commission 250V mains supply (March).

(c) A door was installed in the south end of the bulk store to facilitate access (June).

(d) An air conditioner was installed in the ionospheric hut (July).

(e) New 250V power distribution boards were installed in the Weir site buildings and rewiring was carried out where necessary (September).

(f) The ionospheric hut ceiling was insulated (November).

7. 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), Messrs D. Allen of Kalgoorlie and E. Tromans of Meekatharra, is hereby acknowledged. The assistance of the State Public Works Department for housing the Karratha seismograph and of Mr H. Ausburn for record changing is greatly appreciated.

8. REFERENCES

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TABLE 1

OBSERVATORY STAFF 1971

Officer	Designation
P.J. Gregson	Geophysicist Class 3
R.S. Smith	Geophysicist Class 2 (from 22 April; on extended leave from 27 July)
E.P. Paull	Geophysicist Class 1
G. Woad	Technical Officer Grade 2
B.J. Page	Technical Officer Grade 1 (from 27 Jan.)
Y.M. Nardini (Miss)	Typist
T.E. Creaser	Assistant grade 1.

TABLE 2

ASSOCIATED PERSONNEL 1971

Name	Nature of duties
J. Silich	Antarctic trainee (Jan-Aug and Dec)
M.W. McMullan	Antarctic trainee (April-Sep)
J.W. Murray	Vacation student 1970/71
T. Pryor	Vacation student 1970/71, 1971/72
B. Carling	Daily attendant, Gnangara
D.C. Allen	Daily attendant, Kalgoorlie
E. Tromans	Daily attendant, Meekatharra
H. Ausburn	Daily attendant, Karratha
J. King	Daily attendant, Kununurra.

TABLE 3

OBSERVATORY STAFF ABSENCES 1971

Nature of absences	No. of man days
Sick	5
Military	26
Attendance at outstations and field operations	29
Other branch surveys	5
Conferences	5
Furlough	23
Total:	93

TABLE 4

CONFERENCES AND ADDRESSES

Officer	Date	Conference
P.J. Gregson	October 4-8	Canberra - Observers'-in-Charge meeting.
		Addresses
P.J. Gregson	March 17	Association of Legal Executors on earthquakes.

TABLE 5

VISITORS

Visitor	Institute
Mr J. King	Public Works Department, Kununurra
Mr B. Gaull	Recruit for Port Moresby Observatory
Prof. Akabone	Tokyo Astronomical Observatory
Mr E. Nelmes	National Development
Mr C. Johnson	BMR recruit
Mr A. Davies	Rabaul Observatory
Mrs A. Davies	Rabaul Observatory.

TABLE 6

PRELIMINARY MONTHLY MEAN VALUES OF GEOMAGNETIC ELEMENTS 1971

Month	H, nT	D(W)	Z, nT	$\bar{K}$
January	23782	3°00.9'	-53469	2.07
February	768	02.1	468	1.96
March	764	01.5	464	1.79
April	755	01.7	467	2.01
May	759	01.9	462	1.84
June	761	01.7	453	1.49
July	760	02.4	452	1.44
August	759	02.3	462	1.66
September	756	02.5	459	1.87
October	757	03.1	458	1.86
November	759	03.7	459	1.68
December	756	04.2	460	1.87
Mean	23761	3°02.3	-53461	1.80

TABLE 7

SEISMOGRAPH STATION INSTRUMENTS

This table lists only the changes in equipment at 31 December 1971 to that listed in Table 10 of the 1970 annual report (Gregson 1971).

Station	Replaced equipment	New equipment	Reason
KLG	Radio, Eddystone type 680 S/N FA 0093	AWA type Radiola	Poor time signal reception, overhaul required.
KNA	Clock, EMI S/N 844	EMI S/N 864*	* Purchased by Public Works Department.
	Radio, National type R317	Eddystone type* EC10 Mk2	

TABLE 8

KARRATHA SEISMOGRAPH DETAILS

Symbol:	KAA
Location:	Latitude 20° 46' 38" S Longitude 116° 51' 32" E
Elevation:	15 metres
Foundation:	Precambrian volcanics
Magnification:	31000 at 1.0 second
Date of installation:	11 February 1971
Instruments:	Seismometer - Willmore Mk2 Ts = 1.0 sec. S/N 234324
	Galvanometer - Geotech, model G10, Tg = 0.75 S/N 5283
	Recorder - Geotech, model R11, S/N 154
	Power supply - 250V mains, 24V d.c. standby
	Clock - EMI S/N 836
	Radio - Eddystone, type 680X
	Recording speed - 60mm/min

TABLE 9

ACCELEROGRAPH STATIONS

Station	Latitude S	Longitude E
Mundaring	31° 54.2'	116° 09.9'
Meckering A	31° 36.7'	116° 59.1'
Meckering B	31° 41.7'	116° 59.0'

TABLE 10

NORTHWEST SEISMOGRAPH SITE TESTS

Site	Description	Ground Type	Record Amplitude (mm) Period (Seconds) 0.2	0.4	0.5	1.0	1.4	Peak Magnification	Artifical Noise
NEWMAN									
1	Homestead	B	5			22		25000	Railway 1.5 km 5 per day.
2		A				20		30000	Railway 1.5 km 5 per day.
3	TV tower	A	20				20	10000-	Crushing plant.
4	Mt Whaleback	A	25	100				2000?	Crushing plant.
5	Airport Road	B				45		12000	
6		D				50		10000	
7	Airport	C			12			40000?	
MARBLE BAR									
8	Hotel	F	4			18		30000+	Town activity.
9		E			3	2		100000	
10	Airport	G			1			200000+	
11		G		1.5				100000+	State battery 2 km.
12	Rec. ground	E	2			10	6	50000	
TOM PRICE									
13	Motel	B	10	20			8	10000	Town activity.
14		A	2	3		10		40000	
15		A	6	5		20		25000	
16	Airport	B	6	5		20		25000	
KARRATHA	Town site	F						40000-	Sea.

A Lower Proterozoic basement outcrops.
B Recent fill over A.
C Recent valley fill over Archaean?
D Archaean granite basement.
E Archaean sediment and volcanic basement.
F Recent fill over E.
G Archaean granite basement.

TABLE 11

LARGER WESTERN AUSTRALIAN EARTHQUAKES 1971

(Generally recorded at MUN, KLG, MEK)

Date 1971	H. (UT)	Lat. °S	Long. °E	ML MUN	m' MUN	mB MUN	mB KLG	mB MEK	mB KAA	m	Remarks
Jan 14	17 44 16.3	23.9	113.2			4.9	4.8			4.9	150 km N Carnarvon
Feb 06	22 23 09	22.0	127.0					5.0		5.0	Lake McKay
Feb 18	12 06 11	(22.0)	(127.0)					4.4		4.4	Lake McKay
Mar 11	03 23 06	21.7	126.5			5.2	5.3		5.3	5.3	Lake McKay
Jul 06	03 39 54	22.5	127.5					4.4		4.4	Lake McKay
Jul 12	23 59 42	24.38	115.35					5.1		5.1	170 km NE Carnarvon depth 10 km
Jul 16	08 00 00	22.1	127.0			5.8	5.7			5.7	Lake McKay
Jul 16	12 32 26.9	31.62	117.09	4.0	4.7	4.5	4.8	4.5		4.7	8 km E Meckering, felt
Jul 31	14 57 00.0	31.43	117.15	3.0	4.0	3.8				3.9	20 km NE Meckering
Aug 04	00 27 47.4	31.19	116.47	3.1	4.1	4.1				4.1	12 km S Calingiri
Aug 18	17 20 51	31.75	117.85	3.0	4.0	4.1		3.8		4.0	8 km S Doodlakine, felt
Aug 29	08 07 58	31.0	111.9	3.2	4.1	4.2	(5.2)	4.9		4.4	430 km W Mundaring
Sep 10	16 34 13	27.0	127.9			3.9	4.3	4.2		4.2	520 km N Eucla
Sep 13	21 58 02	19.5	115.5			4.4	4.8	4.6	3.9	4.4	190 km NW Dampier
Sep 18	13 52 49	28.6	123.3	3.3ϕ	4.2ϕ		4.6	4.1		4.3	85 km E Laverton
Sep 28	04 24 30	23.1	115.3	3.0*	3.9*	4.1		4.1	(3.9)	4.1	180 km S Onslow
Dec 22	18 46 19	31.72	117.02	3.1	4.1	3.7	4.4	3.8		3.9	11 km S Meckering, felt

TABLE 12

MINOR TREMORS IN SOUTH WESTERN AUSTRALIA 1971

(Generally recorded only at MUN)

Date 1971	H. (UT)	ML	mB	Dist. km from MUN	Bearing °T from MUN	Remarks
Jan 03	19 14 54	2.4	3.4	88	067	5 km SW Meckering
" 05	21 22 48	2.0	3.3	85	063	2 km S Meckering
" 07	05 14 06	2.2	3.1	86	069	10 km S Meckering
" 10	00 11 59	2.1	2.7	111	090	5 km N Quairading
" 14	02 22 09	2.3	3.3	78	079	25 km S Meckering
" 22	12 49 07	2.3	3.5	87	078	26 km SSE Meckering
" 24	12 04 54	2.8	4.0	87	058	5 km N Meckering, felt
Feb 18	20 59 09	2.1	3.3	82	053	14 km NW Meckering
Mar 13	03 39 03	2.1	3.3	93	090	5 km N Mawson
" 23	20 54 54	2.9	3.9	81	066	7 km S Meckering
Apr 01	01 45 28	2.4	3.8	169	048	45 km E Moonijin
" 14	07 37 45	2.0	3.0	80	074	18 km S Meckering
May 05	06 52 10	2.6	3.6	78	068	11 km SSW Meckering
" 06	09 34 29	2.6	3.5	81	065	6 km SSW Meckering
Jun 02	14 03 51	2.9	4.3	83	068	8 km S Meckering, felt
" 12	02 03 53	2.3	3.3	77	067	8 km SW Meckering
" 13	07 40 25	2.2	3.5	80	068	10 km S Meckering
" 18	21 10 38	2.2	3.5	81	056	11 km NW Meckering
Jul 04	15 28 02	2.3	3.3	79	090	12 km W Mawson
" 11	06 14 12	2.2	3.5	80	061	6 km W Meckering
Aug 21	23 16 48	2.2	3.7	155	081	8 km S Doodlakine
Sep 10	04 34 11	2.2	3.5	81	067	8 km SW Meckering
" 19	13 34 26	2.4	3.7	93	097	9 km S Mawson

Date 1971	H. (UT)	ML	mB	Dist. km from MUN	Bearing °T from MUN	Remarks
Sep 19	17 14 21	2.4	3.6	89	086	9 km N Mawson
" 20	19 58 55	2.6	3.2	98	015	5 km SE Calingiri
" 20	22 26 30	2.5	3.2	98	015	5 km SE Calingiri
" 28	05 10 46	2.6	4.2	101	018	10 km E Calingiri, felt
Oct 02	15 53 16	2.6	3.3	84	069	10 km S Meckering
" 03	01 15 01	2.5	3.2	83	065	4 km S Meckering
" 19	00 52 30	2.5	3.4	110	020	16 km NE Calingiri
" 23	19 23 48	2.1	2.8	96	007	12 km SW Calingiri
" 28	09 21 33	3.1	3.7	86	068	Meckering, felt
Nov 07	02 13 46	2.0	3.0	83	052	23 km NW Meckering
" 07	23 17 16	2.3	3.3	78	053	22 km NW Meckering
" 13	21 00 32	2.5	3.3	97	014	5 km S Calingiri
" 17	15 40 45	2.9	3.8	88	074	20 km SE Meckering
" 17	19 54 23	2.3	2.8	96	074	20 km SE Meckering
" 27	20 59 11	2.2	2.9	81	073	20 km S Meckering
Dec 02	13 29 19	(2.5)	-	81	060	6 km W Meckering, felt
" 12	19 21 13	2.6	3.4	102	090	14 km W Mawson
" 14	12 17 53	2.4	3.2	149	(035)	Manmanning
" 21	10 29 03	2.8	-	88	(067)	5 km SE Meckering, felt
" 25	00 16 01	2.1	3.2	83	065	4 km S Meckering

TABLE 13

MINOR TREMORS IN NORTH WESTERN AUSTRALIA 1971

(Generally recorded only at MEK and KAA)

Date 1971	Hr. U.T.	Lat. °S	Long. °E	ML	m'	mB				m	Remarks
						MUN	KLG	MEK	KAA		
Feb 19	04 18 (56)	(21.0)	(119.2)	2.7*	3.8*				3.8	3.8	60 km SW Marble Bar
Mar 05	03 59 (22)	(21.8)	(119.2)						3.8	3.8	80 km SW Marble Bar
Mar 21	00 05 (28)	(21.1)	(119.5)	3.2*	4.2*				3.6	3.9	10 km W Marble Bar
Apr 03	04 00 (56)	(22.0)	(119.6)	3.1*	4.1*			3.7	4.1	4.0	100 km S Marble Bar
Apr 03	06 35 (18)	(22.1)	(119.0)	3.0*	4.0			4.2	4.0	4.1	130 km SW Marble Bar
Apr 15	17 48 (39)	(21.8)	(120.5)					4.2		4.2	110 km S Marble Bar
May 12	09 16 08	22.9	115.2					3.7	3.8	3.8	150 km S Onslow
May 19	04 22 17	22.9	115.5					4.2	4.0	4.1	55 km S Onslow
May 28	04 16 57	22.1	114.1					4.0	4.1	4.1	120 km SW Onslow
Jun 17	21 14 44			2.1ø	3.3ø			3.5		3.4	60 km from Meekatharra
Sep 13	21 58 (07)	(19.5)	(118.5)	3.1ø	4.0ø					4.0	100 km NW Port Hedland

Notes for Tables 10, 11, 12

ML Generally determined at MUN

* ML determined at KAA

ø ML " " MEK

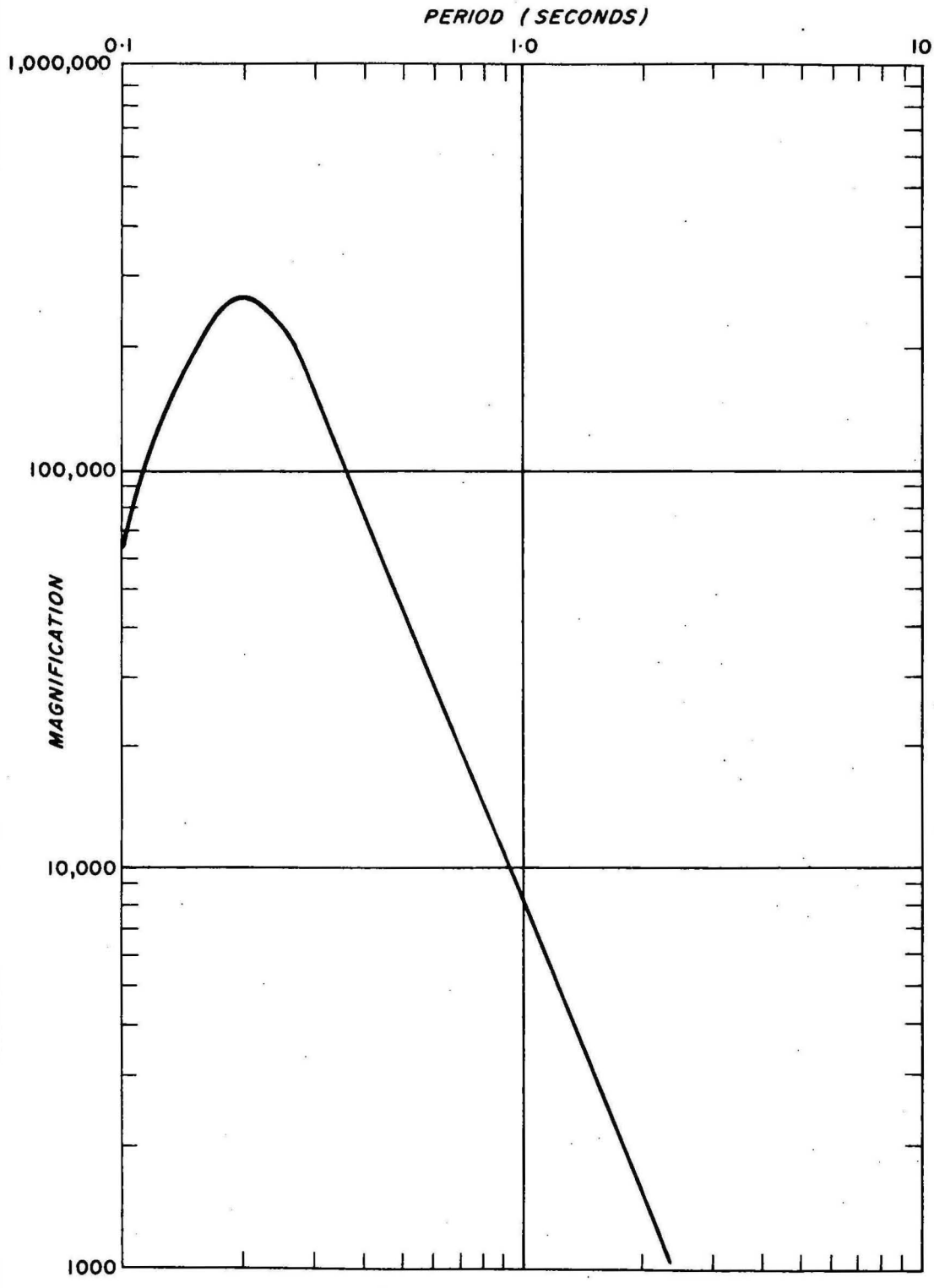
m' = 1.8 + 0.73 ML

mB = log (A/T) + A_o + 0.4 = mB (MUN, KLG, MEK, KAA) + 0.4
A_o from curve B (Everingham, 1968)

m = Unified magnitude (weighted mean of m' and mB)

( )= less accurate.

PLATE 1

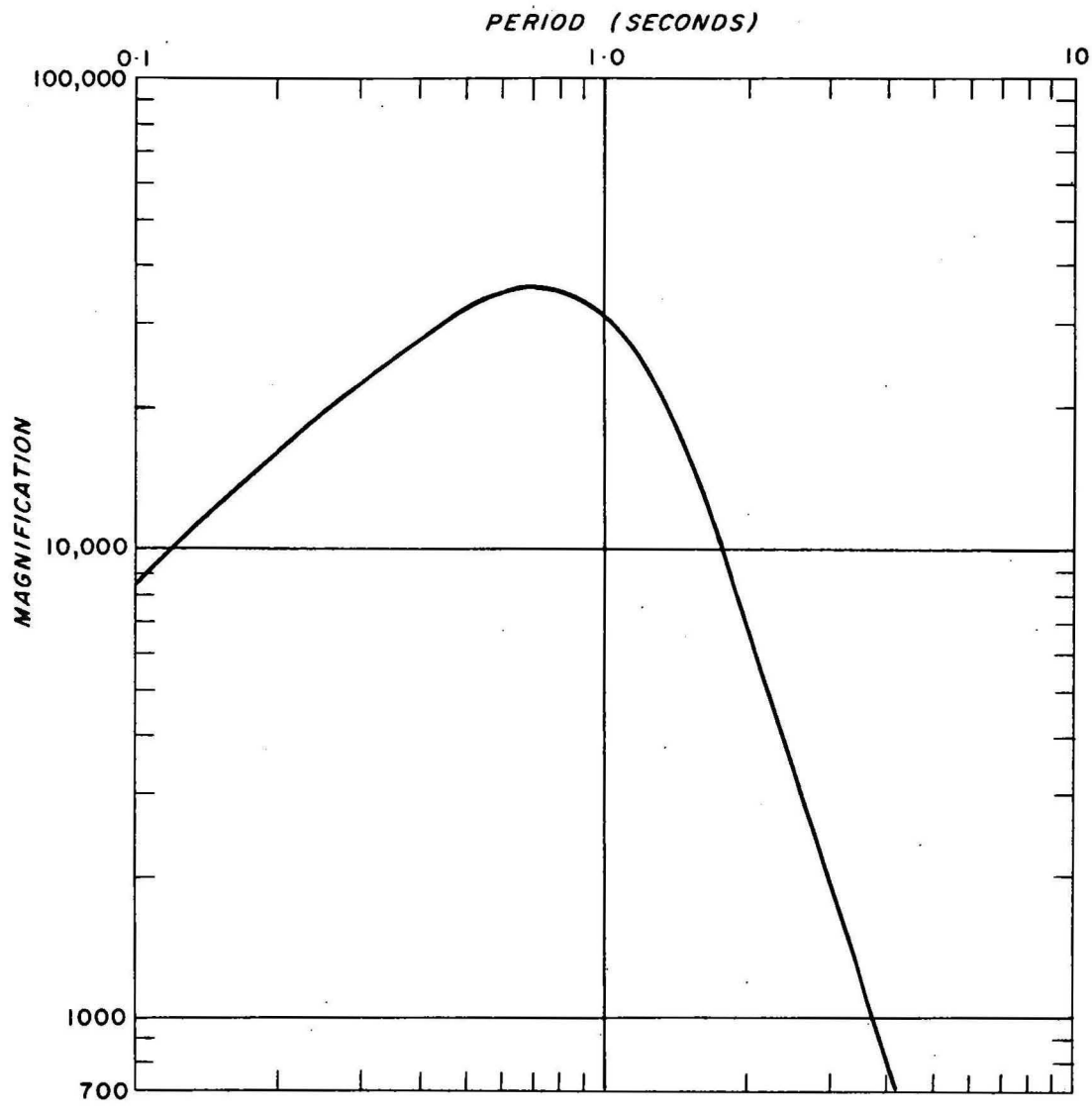


CALIBRATION CURVE

MEEKATHARRA SP-Z SEISMOGRAPH

To accompany Record No. 1972/48

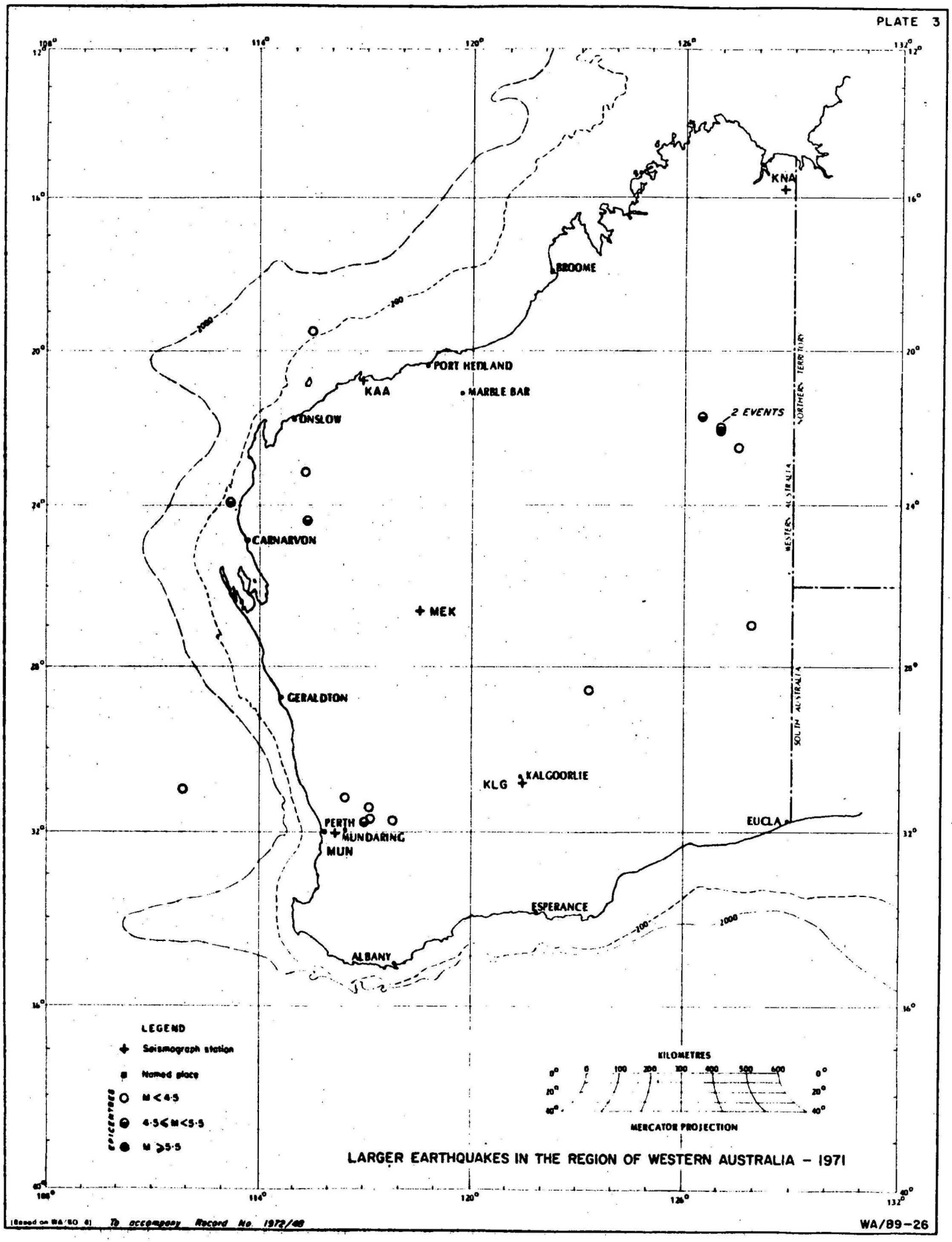
WA/B9-24A



CALIBRATION CURVE

KARRATHA SP-Z SEISMOGRAPH

PLATE 3

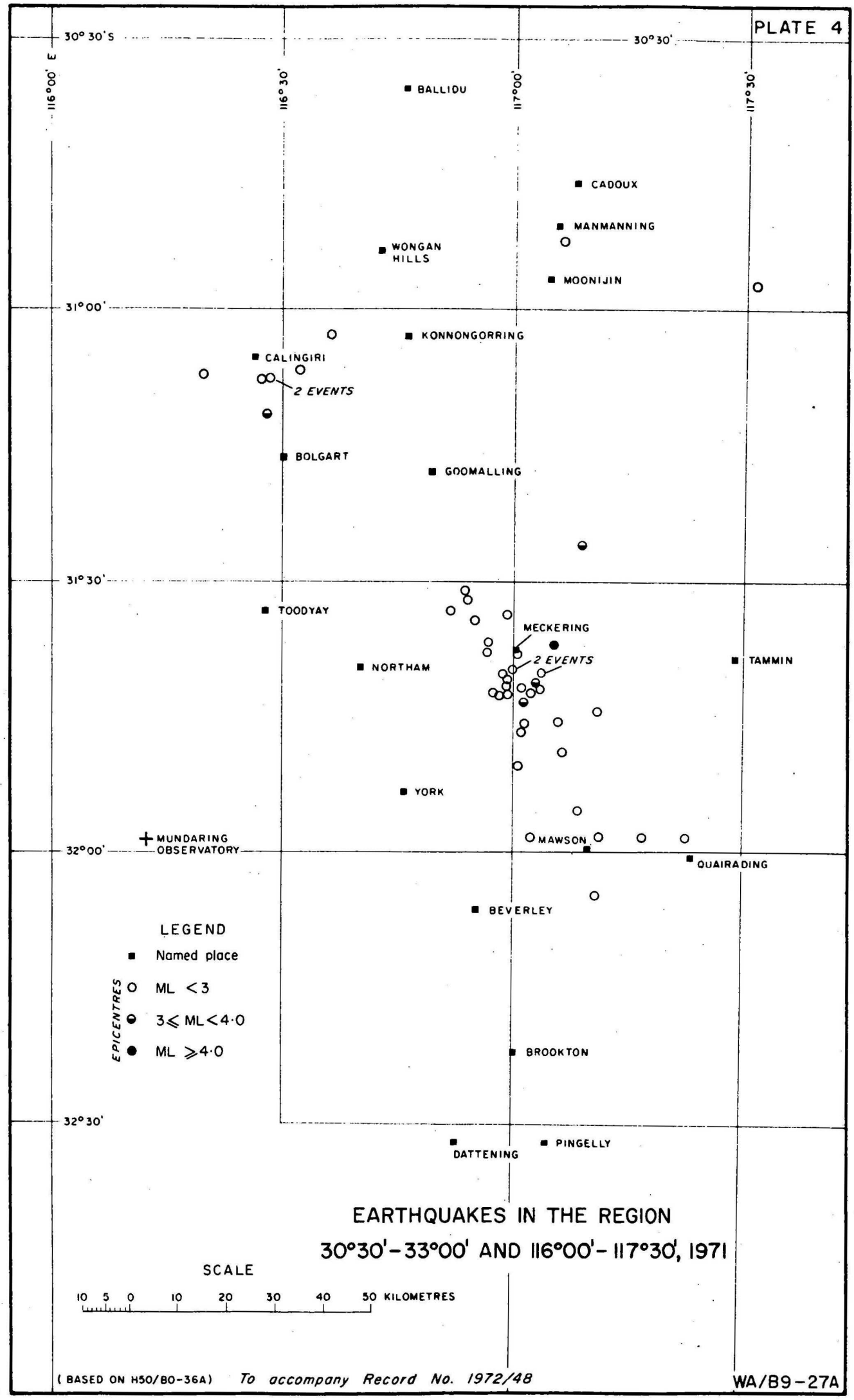


LARGER EARTHQUAKES IN THE REGION OF WESTERN AUSTRALIA – 1971

(Based on WA/80 6) To accompany Record No. 1972/48

WA/89-26

PLATE 4



EARTHQUAKES IN THE REGION 30°30'–33°00' AND 116°00'–117°30', 1971

(BASED ON H50/80-36A) *To accompany Record No. 1972/48*

WA/B9-27A