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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

1980/40

MUNDARING GEOPHYSICAL OBSERVATORY

ANNUAL REPORT 1978

by

P.J. Gregson

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SUMMARY

Basic programs in geomagnetism, ionospherics, and seismology were continued at the Mundaring Geophysical Observatory during 1978. The main instruments were an Eschenhagen normal-run magnetograph, an IPSD type 3E ionosonde, and a Worldwide Standard Seismograph.

Seismographs were operated at Swan View, Kalgoorlie, Meekatharra, Marble Bar, Warburton (transferred from Giles), Kununurra, and Narrogin (Seismic Research Observatory).

The annual earthquake list shows details of 66 Western Australian earthquakes, 22 of which occurred in the southwest seismic zone.

Isoseismal maps for earthquakes that occurred near Maroonah Homestead and Margaret River were prepared.

1. 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, Kununurra, and Swan View (seismological recording). The seismograph at Giles was dismantled and transferred to Warburton in June. In co-operation with the United States Geological Survey, a Seismic Research Observatory (SRO) is operated with the seismometers at Narrogin, and digital and visual recording at the Mundaring office. Descriptions of the observatory and an outline of activity 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.

2. 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 summarised in Table 3, and conferences attended and addresses given, in Table 4.

Visitors to the Observatory are listed in Table 5.

3. GEOMAGNETISM

Normal magnetograph

The Eschenhagen 20 mm/h magnetograph continued in operation at Gnangara. A relief operator failed to turn the recording lamp on, resulting in four days' record loss in January. A further two days' record was of poor quality as the recording paper was reversed when the operator loaded the recorder. Extensive mains power failures in april resulted in a total of two days' record loss.

The recording lamp brilliance fluctuated over several days in September. The fault was fixed by cleaning the control potentiometer. The mechanical ratchet relay counting minute pulses to provide five-minute time-marks was replaced in May. The new unit is an electronic counter designed and built by the BMR workshops. During July the unit started counting erratically so the mechanical counter was re-installed.

No large unexplained changes in the baseline or scale values occurred during 1978.

The Z scale value drifted from 5.70 nT/mm at the beginning of May to 6.14 nT/mm in August. The drift was reversed during October and November. These drifts coincide with the annual decrease and increase in vault temperature. Least-squares analysis of vault temperatures and scale value indicated that a relation of -0.036 nT/mm/˚C could exist between these quantities with a correlation coefficient of 0.91.

There was a slight decrease of about 5' in the D baseline value from May to August. Least-squares analysis of vault temperatures and baseline values indicated that a relation of about 0.1 minute/˚C could exist between these quantities.

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

Element	Baseline value	Scale value
D	0.24 min (1.6 nT)	-
H	2.4 nT	0.01 nT/mm
Z	1.4 nT	0.03 nT/mm

Magnetograph tests

Temperature coefficients. A value of qH = 0.0nT/˚C was used throughout the year. Least-squares analysis of Z baseline values and temperature gave a value of qZ = 2.4 nT/˚C. This value was used throughout the year.

Orientation. No orientation tests were made during the year. Orientations of the recording magnets (N poles) in the mean magnetic field at December 1978 estimated from previous results were as follows:

H: E 0.3˚S
D: N 0.3˚W
Z: N 0.1˚Down

Parallax. No tests were performed during 1978 and it was assued 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 MC02 was used in conjunction with Helmholtz coils to determine H and Z scale values once weekly. The unit failed once during the year and several integrated circuits required replacing.

Magnetometers

Instruments used for weekly absolute observations were Askania declinometer 309319 and PVM B/116/B. The latter comprised Elsec vector coil set B, Elsec proton-precession magnetometer S/N 116, and sensor set B.

The PVM coils gave none of the levelling problems experienced in previous years. Individual readings on the PPM tended to be slightly more scattered than previously but, this did not affect the overall consistency of the observations.

Comparisons. The Gnangara instruments and the First-Order Magnetic Survey instruments were compared on 10, 11, and 30 October. The survey instruments were PPM Elsec 120, QHM numbers 290,306,173 and declinometer Askania 509320.

H comparisons were made through baseline values from alternate observations with a QHM (pier NE) and the PVM (pier NM).

H. 290 - H. B/116/B = 35.3 nT (6 observations) = 1.50×10^{-3} H

H. 173 - H. B/116/B = 29.9 nT (6 observations) = 1.27×10^{-3} H

H. 293 - H. B/116/B = 7.3 nT (3 observations) = 0.31×10^{-3} H

H. 306 - H. B/116/B = 11.5 nt (3 observations) = 0.49×10^{-3} H

The pier difference is negligible and the average horizontal intensity was 23470 nT.

D comparisons were made through baseline values from alternate observations with declinometers on pier NE.

D. 320 - D. 319 = 0.8' (6 observations)

F comparisons were made from alternate observations with PPMs. The piers NE and NM were used and the instruments were changed during the sets of observations.

F. 120 - F. 116 = -2.4 nT (16 observations)

F. 1025 - F. 116 = -1.8 nT (16 observations)

Pier NE-Pier NM = -0.2 nT (16 observations)

The average total intensity was 58520 nT.

Preliminary corrections used throughout the year were:

(a) PVM B/116/B: H,0; Z,0

(b) 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 apart from two days in June when the clockwork drive was overhauled.

Magnetic pulsations tape-recording equipment was operated at the Weir site for the University of Newcastle. Apart from minor losses, recording was continuous.

Data reduction and publication

Mean hourly value reduction data were prepared in monthly batches about three months after recording. Magnetograms and reduction data were sent to Canberra headquarters when requested for derivation of hourly values. Checking of values for the first and thirteenth hours, as done in previous years, ceased in December 1977.

Monthly and annual mean values of H, D, Z, F, and mean K-index values at Gnangara for 1978 are listed in Table 6. The field values were derived from the ten local quiet days of each month by scaling a mean ordinate for each component from each magnetogram. Annual values for all components since 1968 are shown in Table 7. Recent trends in secular variation continued with H decreasing by about 47 nT, D becoming more westerly by 1.4 minutes, and Z increasing in magnitude by about 39 nT. The mean value for F rose by about 17 nT during 1978.

The distribution and publication of, and requests for geomagnetic data are shown in Table 10. Checked data for rapid variations and principal magnetic storms for 1977 were prepared for the IAGA Bulletin.

Dr. P. Mayaud visited the observatory in February and re-scaled K-indices for the period July 1976 to June 1977. There were numerous discrepancies with the original scalings made by observers. The reasons for the differences were difficult to localise because they varied a lot from one month to another and scalings were made by different observers. A small

percentage of the differences was due to a small error in the H gauge. The discrepancies and the philosophy and method of K-scaling were discussed with observers, and test scalings made after the discussions produced a more acceptable agreement between the observers. Dr Mayaud subsequently reported in detail on this work and his report is on files at the Observatory and at headquarters.

The international symbol for Gnangara changed from GN to GNA in March.

First-order magnetic survey

A network of 63 stations has been established Australia-wide for the purpose of making periodical repeat measurements to determine the pattern of secular change. These 'first-order' surveys are arranged by the headquarters surveys and reductions group, and during 1978 a survey was made to provide data for producing charts at epoch 1980.0.

From July to November, observatory personnel Gaull, Paull, and Page assisted headquarters staff in the re-occupation of 21 stations in WA and 4 in SA. Observations were made over intervals of about 60 hours at each station: magnetometers standardised against the BMR magnetic standards were made to calibrate a portable variograph (fluxgate H,D,Z and PPM F). Full details will be reported separately.

4. IONOSPHERICS

Equipment

The quarter-hourly sounding schedule was continued throughout the year using a model IIIE ionosonde; the ionosonde and spare components were supplied by the Ionospheric Prediction Service (IPS), Department of Science and the Environment 162 hours (1.8%) of record was lost during the year. Losses were due to component failure (81 hours), film jamming or running out (57 hours), and on one occasion a day's film was "developed" in water.

Although the record loss is an improvement on 1977, the quality of ionograms fluctuated. This was caused by fluctuating output power from the transmitter. All attempts to isolate the cause of the fluctuation were unsuccessful. During the year, the monitor CRO was repaired and the power unit (50V/12V/12V) and standby rechargeable cell were replaced.

Data distribution and publication

The scaling, distribution, and publication of data continued as previously (for details see Record 1976/48).

5. SEISMOLOGY

Seismograph stations

Permanent stations were operated throughout 1978 at Mundaring (MUN), Kalgoorlie (KLG), Meekatharra (MEK), Kununurra (KNA), Marble Bar (MBL), Swan View (SWV), and Narrogin (NWA0). The seismograph at Giles (GLS) was dismantled on 24 June and re-installed at Warburton (WBN) on 27 June because:

(a) The frequency of operator changes at Giles (about twice a year) caused operational problems.

(b) Warburton is better placed than Giles with respect to Alice Springs, Kalgoorlie, and Meekatharra stations.

(c) Warburton is more accessible than Giles.

The number of events reported from each station in 1978 was:
MUN 672; SWV 228; NWA0 833; KLG 179; MEK 446; MBL 1064;
KNA 425; GLS 121 (4 months), and WBN 202 (6 months).
TOTAL 4170.

A summary of all record losses from all seismograph stations is given in Table 8. Record losses from all stations were low, with the exception of Giles, Warburton, and Marble Bar (see below).

Mundaring. The WWSSN seismograph continued to be reliable. The 25 V regulator failed in April, which resulted in transistors shorting in the power amplifier, invertor output, and 10 second pulse amplifier. The strobe was replaced in April and the time-signal receiver was overhauled in October. Other faults were minor.

Kalgoorlie. This seismograph operated with little record loss. The calibrator failed and was replaced in February. General maintenance was carried out in September when the control console was shifted into the inner room for better temperature control.

Meekatharra. Record losses were minor. The calibrator failed and was replaced in February.

Marble Bar. A lightning strike at the remote site in March damaged the power supply. The seismograph was out of service for several days before repairs were effected. The seismograph was again out of service for several days when the PS112 power supply (± 12 V) failed in April. 238 hours of record was lost owing to the operator's late attendance or non-attendance to change records. General maintenance was carried out by observatory staff in August.

Kununurra. This station continued to operate exceptionally well with only minor record losses.

Swan View. The seismograph was out of service for 14 days while some of the equipment was used at other stations.

The State Public Works Department sealed the Swan View Tunnel with steel doors in October. This improved the security of the remote equipment.

Giles. The same operational problems existed as in 1977. Equipment and operational problems that would normally have resulted in minor record loss resulted in considerable loss because of the poor communication and the lack of experience of the operators. The station was dismantled on 24 June and transferred to Warburton.

Warburton. This seismograph commenced recording on 27 June. Station details are:

Latitude:	26.140°S
Longitude:	126.578°E
Height:	457 m
Code:	WBN
Magnification:	42K at 1.0 s, 825K at 0.15 s

Details of the station installation will be reported separately.

Fifty hertz noise interfered with recording for 13 days in November but the problem had disappeared by the time a service visit was made. All wiring was checked and found to be satisfactory. The 230 V a.c. power became unsynchronised on 29 November, and further interference made the seismograms unreadable from 18 December. The problems had not been solved by the end of the year.

Narrogin. Extensive mains power failures in April taxed the standby power supply. The high battery charging current drawn after reversion to the mains repeatedly tripped the mains circuit breaker. Subsequently the circuit breaker was found to be faulty and was replaced. Two days' record was lost in February when a Telecom amplifier failed. Other faults that occurred were minor and included:

(a) the failure of the tape recorder arm sense lamps;
(b) the translation wire on the LP-E helicorder fell off several times;
(c) the inverter power became unsynchronised; and
(d) the operating program blew.

An Albuquerque Seismological Laboratory maintenance team visited the observatory in June. Work carried out by them included:

(a) Charger/inverter modified. Now charges at 126V 8A. An external lamp was fitted to indicate when the mains and the internal power supplies were in phase. This facilitated the manual change-over from one to the other without damaging the changeover relay.

(b) Tape deck. The transport and logic board and the EOT/BOT sensor were replaced. General maintenance was carried out.

(c) Clock. ASL had reported millisecond problems on the tape. This is not evident during routine operation. The fault was due to a faulty connection on one of the boards.

(d) A new controller board at the remote end and a new program were tested. The former prrduced too much noise. The system was left as it was.

Field stations. The two field seismographs installed in the Meckering area during 1977 continued in operation throughout the year. A third seismograph was installed in the area in July.

Accelerographs

A fourth accelerograph was installed in the Meckering area in February. The sensitivities of the accelerograph triggers were increased for ground movements of relatively short periods. After this modification, the first Western Australian accelerogram was recorded in April. Details of the modification and data related to the accelerograph will be given separately.

Locations and installation dates of accelerographs are given in Table 12.

Seismicity

Table 9 lists 66 Western Australian earthquakes of magnitude ML = 2.0 or greater which occurred during 1978 and for which locations are available; 22 of them occurred in the southwest seismic zone.

Epicentres were determined graphically using Western Australian and, on a few occasions, other Australian stations. Sometimes more accurate locations were obtained when allowance for depth was made.

Plates 1 and 2 show epicentres of Western Australian earthquakes of magnitude ML = 3 or greater (mB = 4.0 or greater) and those in the southwest seismic zone respectively.

Southwest seismic zone. Activity in this zone was slightly less than for 1977. Apart from the Meckering area, activity was widespread from west of Kalbarri to northeast of Ravensthorpe.

Kununurra. Seven earthquakes occurred in this area, mostly within 200 km south to southwest of Kununurra. The largest, ML = 2.9, occurred on 2 August 186 km WSW of Kununurra.

Other areas. Five earthquakes of magnitude up to ML = 4.0 occurred east of Lake Tobin. A magnitude ML = 6.7 earthquake occurred in this region in 1970. Two small earthquakes, magnitude ML = 3.5 and 2.5, occurred near Meeberrie, the site of a magnitude 7 earthquake in 1941.

Earthquake intensities

Questionnaires were distributed for an earthquake (ML = 5.7) that occurred near Maroonah Homestead (250 km northeast of Carnarvon) on 1 May. About 40 questionnaires were distributed, of which about 75% were returned. An isoseismal map was prepared and is shown in Plate 3. Because of the sparseness of population a maximum intensity could not be determined. The radius of the isoseismal for intensity IV was about 160 km.

An isoseismal map was prepared (Plate 4) for a magnitude ML = 3.0 earthquake that occurred on 9 June, 14 km east of Margaret River. Information was obtained from reports from residents in the area. The earthquake was felt up to distances of 30 km, with a maximum intensity of V near the epicentre. The earthquake is of particular interest as it is located near the Dunsborough Fault.

Data distribution, publications, and requests

The distribution and publication of, and requests for seismological data are shown in Table 11.

6. NOTES ON WORKS PROJECTS

Minor repairs and maintenance were carried out on the observatory buildings. Three wall heaters were installed in the office during April.

7. ACKNOWLEDGEMENTS

The assistance of the daily attendants listed in Table 2 is hereby acknowledged. The co-operation of the Marble Bar Post Office for housing the Marble Bar seismograph is also acknowledged. Punching of ISC cards was carried out by the Australian Bureau of Statistics (Perth) by arrangement with the Deputy Commonwealth Statistician.

8. REFERENCES

GAULL, B.A., & WOAD, G., in prep. - Modification of the M02 accelerograph starter. Bureau of Mineral Resources, Australia, Record.

GREGSON, P.J., 1976 - Mundaring Geophysical Observatory Annual Report 1975. Bureau of Mineral Resources, Australia, Record 1976/48.

GREGSON, P.J., 1978 - Mundaring Geophysical Observatory Annual Report 1977. Bureau of Mineral Resources, Australia, Record 1978/73.

PAULL, E.P., & WOAD, G., in prep. - Installation of the Warburton seismograph. Bureau of Mineral Resources, Australia, Record.

APPENDIX

PRINCIPAL EVENTS

MUNDARING GEOPHYSICAL OBSERVATORY 1957-1978

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-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 Jun 22	Absolute magnetic observations commenced in new absolute house.
1962 Jun	WWSSN seismograph commenced operation at MUN.
1963 Apr 19-Dec 17	GRV seismograph operation.
1963 May30-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-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 Jun 27	Proton scalar magnetometer introduced for Z baseline control.
1972 Oct 12-1975 Feb	MBT SP-Z seismograph recording.
1972 Nov 16	MO2 accelerograph (PWD) installed at Kununurra.
1973 Jan 31	Mobile SP-Z recording at various sites in SW seismic zone started.

APPENDIX (continued)

1973 Mar 30	KLG reduced to SP-Z.
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 Jun 17-31	Riometer recording at Mundaring during solar eclipse.
1974 Sep-1978 Jun	GLS SP-Z recording.
1975 Jul 18-Nov 19	Earth-tide recording at Mundaring.
1975 Mar 19-Aug 15, Dec 18	SWV SP-Z recording.
1975 Sep 2-1976 Feb 5	NWA SP-Z recording.
1976 Mar 27	NWAO Seismic Research Observatory commenced.
1976 Jun	MBL SP-Z recording commenced.
1976 Sep-1977 Nov 27	XMI SP-Z recording.
1976 Oct	Special ionospheric sounding, solar eclipse (23 Oct).
1977 Nov 28	Third M02 accelerograph installed at Meckering.
1978 Feb	Fourth M02 accelerograph installed at Meckering.
1978 Jun 27	WBN SP-Z recording began (seismograph transferred from GLS).

TABLE 1

OBSERVATORY STAFF 1978

Officer	Designation
P.J. Gregson	Geophysicist Class 3
E.P. Paull	Geophysicist Class 2
B.A. Gaull	Geophysicist Class 1
G. Woad	Technical Officer Grade 2
B.J. Page	Technical Officer Grade 1
Y.M. Moiler (Mrs)	Clerical Assistant Grade 3
T.E. Creaser	Assistant Grade 1

TABLE 2

ASSOCIATED PERSONNEL 1978

Name	Nature of duties
J. Petkovic	Antarctic trainee (3-27 January)
B. Carline	Daily attendant, Gnangara
P. Maddren	Daily attendant, Kalgoorlie
B. Harvey	Daily attendant, Meekatharra
J. Bailey	Daily attendant, Marble Bar
J. Roberts	Daily attendant, Kununurra
Observer-in-Charge Weather Station	Daily attendant, Giles (until 24 June)
P. Green	Daily attendant, Warburton (27 June-20 December)
S. Steen	Daily attendant, Warburton (from 21 December)

TABLE 3

OBSERVATORY STAFF ABSENCES 1978

Nature of absence	No. of man-days
Sick leave	21
Special leave	2
Furlough	71
Military leave	10
Attendance at outstations and field operations	26
First-Order Magnetic Survey	113
	243

TABLE 4

CONFERENCES, ADDRESSES, AND TRAINING

Officer	Date	Address/Conference
P.J. Gregson	16 May	Session of finance at Administrative Services, Perth
B.J. Page	23-26 May	IPS Conference, Sydney
	29-30 May	Attended headquarters, BMR, Canberra
E.P. Paull	23 November	Mt Helena Primary School:- address on 'Earthquakes'

TABLE 5
VISITORS

Visitor	Institute
Prof. F. Hibbert	University of New England
Fr P.N. Mayaud	Institute de Physique du Globe (Paris)
Mr P. McNab	University of Newcastle
Dr B. Fraser	University of Newcastel
Dr H. Allison	C.S.I.R.O.
Mr P. Petruseuis	C.S.I.R.O.
Mr P.M. McGregor	BMR, Canberra
Mr. B. Brizzell	Albuquerque Seismological Laboratory, Maintenance Team
Mr. Hutchinson	State Emergency Service
Mr T. Shields	Albuquerque Seismological Laboratory, Maintenance Team
Mr G. Dushaw	Albuquerque Seismological Laboratory, Maintenance Team

TABLE 6
PRELIMINARY MONTHLY MEAN GEOMAGNETIC VALUES AND K-INDEX
1978

Month	D(West)	H, nT	Z, nT	F, nT	K
January	03°14.6	23512	53576	58508	1.99
February	14.6	502	576	504	2.65
March	14.3	490	584	507	2.63
April	14.0	474	588	504	2.80
May	14.6	478	600	516	2.55
June	14.8	480	598	515	2.50
July	15.2	471	595	509	1.74
August	15.0	481	597	515	2.15
September	15.6	474	600	515	2.46
October	16.1	472	612	525	2.42
November	16.2	468	613	524	2.60
December	15.7	475	614	528	2.42
Mean	03°15.1	23481	53596	58514	2.40

TABLE 7

GEOMAGNETIC ANNUAL MEAN VALUES 1968-1978

Year	D	I	H	X	Y	Z	F	Notes
	° /	° /	nT	nT	nT	nT	nT	
1968	-2° 55.7′	-65° 59.0′	23 846	23 815	-1217	-53494	58 568	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
1976	12.4	14.2	567	530	1318	528	486	2C
1977	13.6	17.0	528	491	1324	557	497	2C
1978	15.1	20.5	481	443	1332	596	514	2C
1968-78	-1.94	-2.15	-36.5	-37.2	-11.5	-10.2	-5.4	
1968-73	-2.42	-1.44	-32.0	-32.8	-15.0	6.8	-19.2	
1973-78	-1.46	-2.86	-41.0	-41.6	- 8.0	-27.2	8.4	

Notes: 2. Preliminary value B. Mean of hourly values, 5 IQ days

C. Mean of daily values, 10 Q days

TABLE 8

1978 SEISMOGRAPH RECORD LOSSES

CAUSE	MUN SP Z	MUN SP N	MUN SP E	WWSSN LP Z	WWSSN LP N	WWSSN LP E	MUN SUP SP Z	MUN SUP SP N	MUN SUP SP E	NWAO SP Z	NWAO SP Z	NWAO LP N	NWAO LP E	SWV	KLG	MEK	MBL	KNA SP Z	KNA SP N	KNA SP E	GLS	WBN
OPERATOR																						
Late change																						
Drum not reset				24	24	24								8	49	4	238	30	30	30	5	45
Paper reversed																						17
POWER FAILURES																						
Mains														2		19	6					4
Battery/DC																		34	34	34		
RECORDER FAULT																						
Lamp Blown		12							19											47		
Attenuator					94																	
Helicorder												5		39	12		2				59	23
CONTROL EQUIPMENT																						
Clock																		4	4	4		
Preamplifier																	281					
																	159					
Power supply PS112										32	32	32	32									
SRO program										30	30	30	30									
SRO remote														342								
Equipment elsewhere																						
LINE FAILURE										44	44	44	44									
MAINTENANCE										39	39	39	39	5			74					5
MISCELLANEOUS (see text)																					612	622
TOTAL	12		24	118	24				19	145	145	150	145	396	61	23	760	68	68	115	676	716
PERCENTAGE	0.1%		0.3%	1.3%	0.3%				0.2%	1.7%	1.7%	1.7%	1.7%	4.5%	0.7%	0.3%	8.7%	0.8%	0.8%	1.3%	16.1%	16.0%
MEAN PERCENTAGE			0.3%				0.1%				1.7%											

TABLE 9

WESTERN AUSTRALIAN EARTHQUAKES 1978

Date 1978	Origin Time U.T.	Lat °S	Long °E	Depth km	ML(MUN)	mB(MUN)	Remarks	No. of Stations
Jan 17	22 15 12	22.72	115.52	30	3.7		20 km S Nanutarra.	4
20	04 40 45.3	26.77	120.60	8	2.4		42 km SE Wiluna.	3
28	08 42 48.5	26.80	120.73		3.0		55 km SE Wiluna.	3
Feb 07	21 43 07	21.88	126.46	35	3.8		47 km E Tobin Lake.	10
13	06 13 22.2	16.50	128.66		2.5		84 km S Kununurra.	1
15	23 23 48.6	16.50	128.66		2.0		84 km S Kununurra.	1
Mar 02	01 32 19.2	33.07	117.92		2.2		65 km ESE Narrogin.	4
06	01 59 20	17.98	127.26	9	2.8		50 km NW Halls Creek.	4
08	17 57 24.3	22.49	120.50	23	3.6		110 km ESE Marble Bar.	5
13	14 57 32	24.32	115.80		3.2		100 km NE Gascoyne Junction.	3
16	13 48 14	27.56	112.51		2.9		160 km W Kalbarri.	2
18	06 14 49.5	16.05	128.78		2.0		32 km S Kununurra.	1
18	07 11 32	16.05	128.78		1.4		32 km S Kununurra.	1
18	14 49 09.7	30.66	117.42		2.1		18 km N Koorda.	3
18	17 06 43.5	30.60	117.45		2.1		26 km N Koorda.	3
Apr 03	15 39 37.2	27.3	126.0		2.7		130 km SW Warburton.	3
03	21 31 09.0	31.00	116.30		2.0		16 km NW Calingiri.	4
05	20 32 10	28.10	115.12		3.0		90 km NNE Geraldton.	5
May 01	03 42 52.5	23.51	115.54	13	5.7		220 km NE Carnarvon, felt, max. int. MMVI.	9
03	05 22 06	27.47	115.38		2.6		120 km ENE Kalbarri.	2
05	22 31 35.8	33.24	116.62		2.1		66 km SW Narrogin.	3
06	19 52 19.0	19.31	126.49	5(±40)	6.0		85 km SE Christmas Creek, felt, max. int. MMIV.	15
08	06 18 00.0	33.33	116.62		2.2		10 km W Darkin.	4
09	17 43 33.2	32.21	116.74		2.0		20 km SW Beverley.	3
28	12 48 08.2	31.61	116.97		2.1		4 km W Meckering.	4
May 31	17 25 11.5	32.76	125.25		3.3		35 km SW Pt Dover.	3
Jun 09	12 31 17.7	33.93	115.20	5	3.0		14 km E Margaret River, felt MM V.	4
23	11 32 37.5	33.36	118.09		2.2		32 km E Dumbleyung.	3
29	19 06 23.0	21.89	126.51	19	4.2		40 km E Lake Tobin.	9
30	03 41 16	21.89	126.51		3.1		40 km E Lake Tobin.	2
Jul 05	22 57 06	17.85	119.22		3.2		320 km W Broome.	4
10	16 48 20	21.25	120.14	19	3.8		33 km SSE Marble Bar.	5
12	09 00 30	21.40	122.49		2.5		285 km E Marble Bar.	3
15	12 04 17.9				2.7		200 km S Kununurra.	1
21	10 17 47.1	31.30	116.65		2.2		16 km W Goomalling.	4
27	20 45 31.4	33.45	117.73	6	3.5		13 km S Dumbleyung.	5

TABLE 9 (continued)

Date 1978	Origin Time U.T.	Lat °S	Long °E	Depth km	ML(MUN)	mB(MUN)	Remarks	No. of Stations
Aug 02	20 19 06.4	16.66	130.23		2.9		186 km WSW Kununurra.	3
06	19 12 21.4	34.00	117.53	0	2.0		10 km NW Tambellup.	3
15	18 23 08.0	31.40	117.18	0	2.7		27 km NE Meckering.	5
15	19 17 02.6	31.40	117.18	0	2.4		27 km NE Meckering.	2
15	20 15 47.3	31.40	117.18	0	2.4		27 km NE Meckering.	2
22	16 32 47.0	21.95	126.56	19	4.4		45 km E Tobin Lake.	8
24	12 36 44	20.38	116.11		2.8		20 km WNW Dampier.	3
31	00 35 47.6	21.98	126.54	19	4.6		45 km Tobin Lake.	7
31	18 11 09.1	22.03	118.67		2.9		40 km NE Wittenoom.	4
Sep 02	08 49 09.0	18.45	123.28	37	3.5		125 km SE Broome.	5
21	00 16 12.0	31.69	117.04	4	2.6		8 km SSE Meckering.	6
26	06 53 20.0	31.38	117.08	9	2.4		33 km NNW Dunderdin.	4
26	15 59 48.2	31.38	117.08	9	2.7		33 km NNW Cunderdin, felt, max. int. MMIV.	4
28	03 22 00.0	31.38	117.08	9	2.4		33 km NNW Cunderdin.	4
Oct 08	20 27 46.4	26.76	115.82	0	3.5		26 km NW Meeberrie, felt, max. int. MMIV.	4
08	20 32 17	26.76	115.82	0	2.5		26 km NW Meeberrie.	1
27	17 18 13	22.00	126.55	19	4.0		50 km E Lake Tobin.	9
28	03 26 01.4	30.90	117.23	13	3.6		18 km SE Cadoux.	6
Nov 03	14 19 09.5	31.73	116.87	10	3.0		20 km NE York, felt MM IV.	6
12	09 09 42.8	12.57	128.44	0	3.0		300 km W Manton Dam.	3
16	22 17 49.4	33.40	118.40	0	3.7		17 km NW Pingrup, felt MM IV.	4
19	07 14 53.8	34.40	118.40	0	2.7		17 km NW Pingrup.	2
23	16 20 39.8	25.89	126.03	0	2.6		60 km NW Warburton.	3
24	01 04 55.0	33.32	120.77	10	4.3		70 km ENE Ravensthorpe.	6
24	22 09 44.4	31.73	117.04	5	3.1		14 km S Meckering.	6
27	04 22 16.7	14.32	128.93	0	2.8		160 km N Kununurra.	2
28	11 46 55	30.14	124.57	15	3.0		300 km NW Rawlinna.	3
29	12 07 53.1	31.42	116.45	0	2.0		15 km N Toodyay.	4
Dec 12	06 51 36	22.02	126.43	19	4.7		35 km E Lake Tobin.	9
15	14 10 46	26.14	111.57	10	4.6		160 km W Dirk Hartog Is.	8

TABLE 10

GEOMAGNETIC DATA DISTRIBUTION

Data distribution

Weekly

Carpentaria Exploration, Kalgoorlie	Sampey Exploration, Midland
Scintrex Pty Ltd, West Perth	Basic Aerosurveys Pty Ltd, Kewdale
Professor G.R. Ellis, Hobart	Mr L.H. Poynter, Fawkner, Vic.
Mr R. Duffin, Gordon, NSW	Aerodata Services, Subiaco
Mr L.G. Duus, Subiaco	Mr J. Ashley, Bickley
Mr M. Nottle, South Perth	

Monthly

	K-indices	Rapid variations	Princical storms	Preliminary monthly means	Magnetogram 35-mm copy
BMR, Canberra	X[1]	X[1]	X[1]	X[1]	
IPS, Sydney	X	X			
WDC C1, Denmark	X	X			
WDC C2, Kyoto	X				
WDC A, Washington			X		X
ISGI, De Bilt	X[2]	X			
Dr Menvielle, France	X				

Annual

BMR, Canberra	Preliminary annual and monthly mean values
Dr Pushkov, IZMIRAN, Moscow	Preliminary annual and monthly mean values
WDC-2, Kyoto	Preliminary annual and monthly mean values

Data published

1. Geophysical Observatory Report, Bureau of Mineral Resources, Geology and Geophysics
2. IAGA Bulletin, Geomagnetic data

Data requested Institution	Type of data
Pacminex	Magnetogram copies
Geophysical Services	Magnetogram copies
Aerodata Services	Magnetogram copies and addition to K-index list
Dept of Geophysics, Flinders University	Magnetogram copies
CRA Exploration	Magnetic storm data, K-indices and magnetogram copies
Observatorio del Ebro	Magnetogram copies
Mr J. Ashley	K-indices

TABLE 11

SEISMOLOGICAL DATA DISTRIBUTION

Data distribution

Preliminary phase data is telexed about three times weekly to the USGS via the American Embassy, Canberra.

Monthly

Preliminary phase data is distributed monthly through the head office, Canberra, either as hard copy or microfiche to:

Bureau of Mineral Resources, Darwin
Meteorological & Geophysical Institute, Indonesia.
Australian National University, Canberra
Riverview College Observatory, Lane Cove
Physics Department, University of Adelaide
University of California, Berkeley
Department of Geology, University of Queensland
S. Miyamura, University of Tokyo
Seismological Observatory, Wellington
Geophysical Observatory, Melbourne
Geophysical Observatory, Port Moresby
Department of Geology, University of Tasmania
H. Doyle, University of Western Australia
Observatoire de Tananarive, Madagascar
Apia Observatory, Western Samoa
S.N. Mitra, New Delhi
Instituto Geofisica de Huancayo
U.S. Geological Survey, Colorado
Seismological Laboratory, California.

Data published

1. Phase data with preliminary epicentral data is published in an Earthquake Data Report by the United States Geological Survey.

2. Phase data with final epicentral data is published by the International Seismological Centre, Berkshire.

Data requested

Institution	Type of data
Akademie der Wissenchaften	Seismogram copies
Californian Institute of Technology	Seismogram copies
Public Works Department, Perth	Earthquake risk data
International Institute of Seismology & Earthquake Engineering	Seismogram copies
World Data Centre A	Seismogram copies
R.G. Bennett (insurance Co.)	Earthquake information
Trent Stehn (insurance Co.)	Earthquake information
Telecom	Earthquake risk information
R.S. Smith, BMR	Seismogram copies
United States Geological Survey	Seismogram copies
I.B. Everingham, BMR	Seismogram copies
K. Wake-Dyster, BMR	Calibration procedures
Defence Service Homes	Earthquake damage information
AMAX Petroleum	Gravity station data
Yale University	Seismogram copies
University of New Haven, Connecticut	Seismogram copies
D. Denham, BMR	Seismogram copies
Various insurance companies	Earthquake lists
General requests	Local earthquake information
Private geologist	Gravity data

TABLE 12

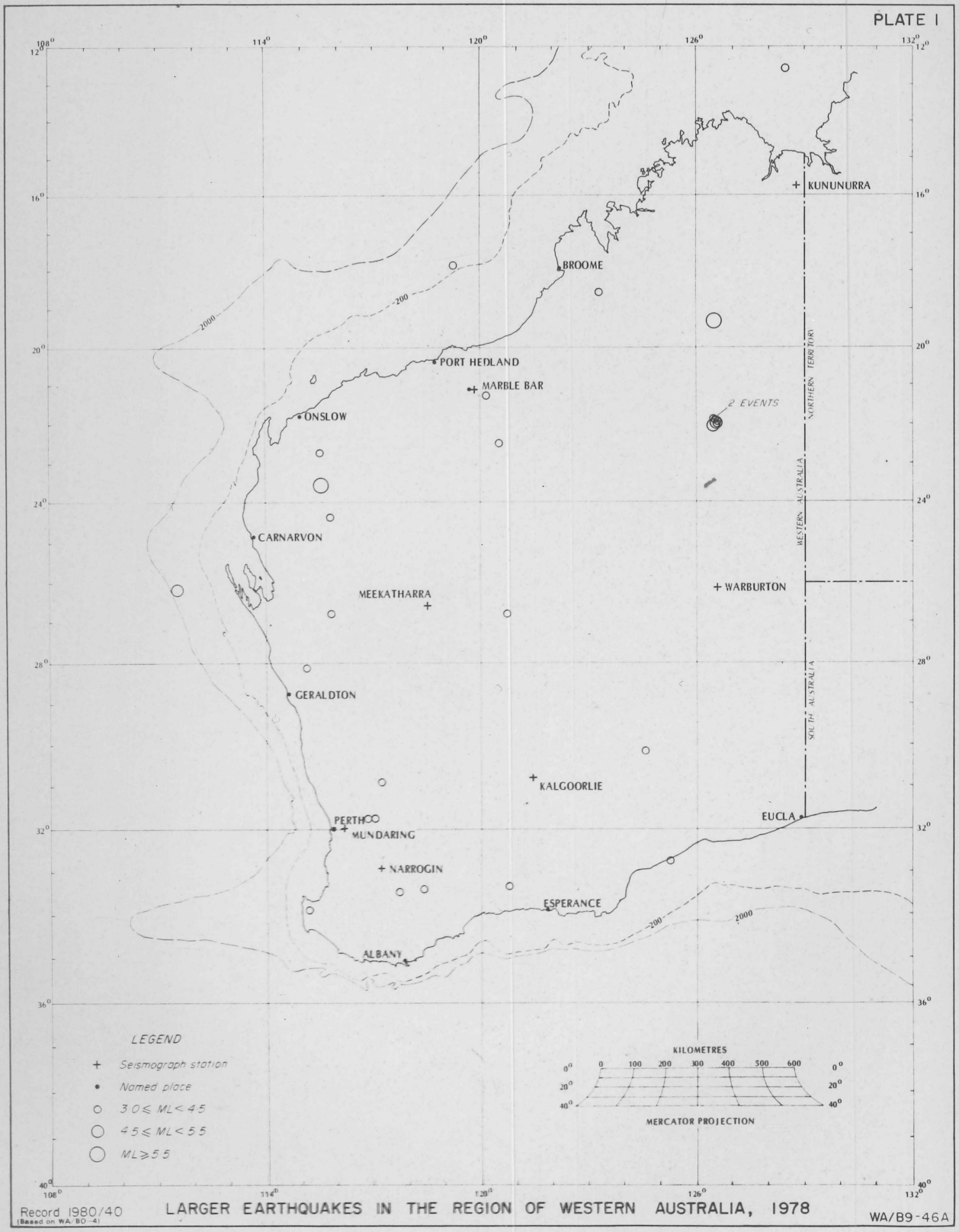
WESTERN AUSTRALIAN ACCELEROGRAPHS

Location & ownership	Co-ordinates & date installed	Elevation	Foundation
Meckering (BMR)	31.694S 116.982E 30 November 1971	200	Alluvium over Precambrian granite
Meckering (BMR)	31.813S 116.958E 16 November 1973	220	Alluvium over Precambrian granite
Meckering (BMR)	31.608S 117.002E 28 November 1977		Alluvium over Precambrian granite
Meckering (BMR)	31.659S 116.958E 22 February 1978		Alluvium over Precambrian granite
Ord River Dam (PWD)	16.113S 128.738E 1 March 1972	120	Rockfill 3 m clay core 90 m quartzite.
Ord River Abutment (PWD)	16.113S 128.738E 16 November 1972	60	Phyllite

BMR Bureau of Mineral Resources, Mundaring Geophysical Observatory

PWD Public Works Department, WA.

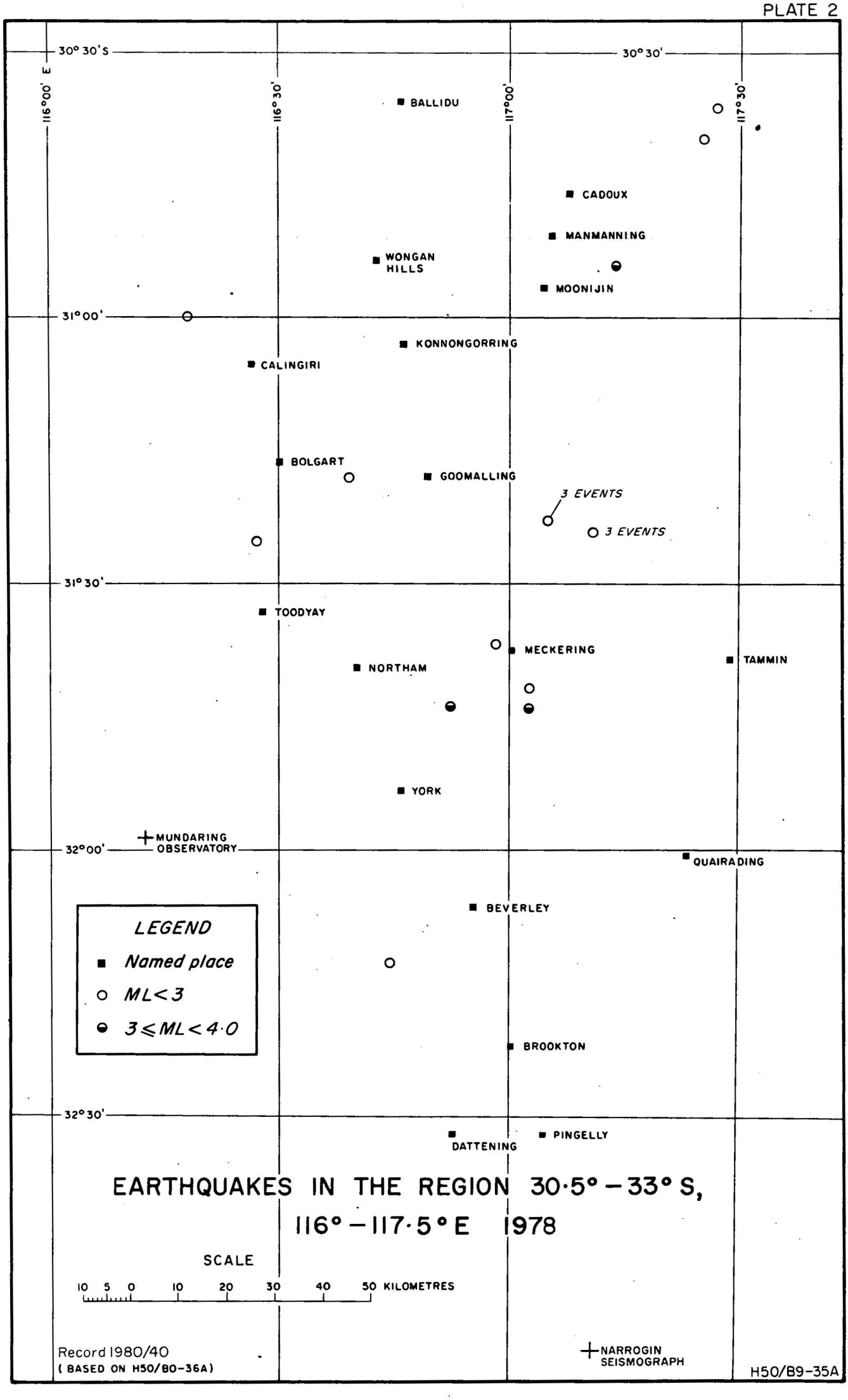
PLATE I



Record 1980/40
(Based on WA/BO-41)

LARGER EARTHQUAKES IN THE REGION OF WESTERN AUSTRALIA, 1978

WA/89-46A

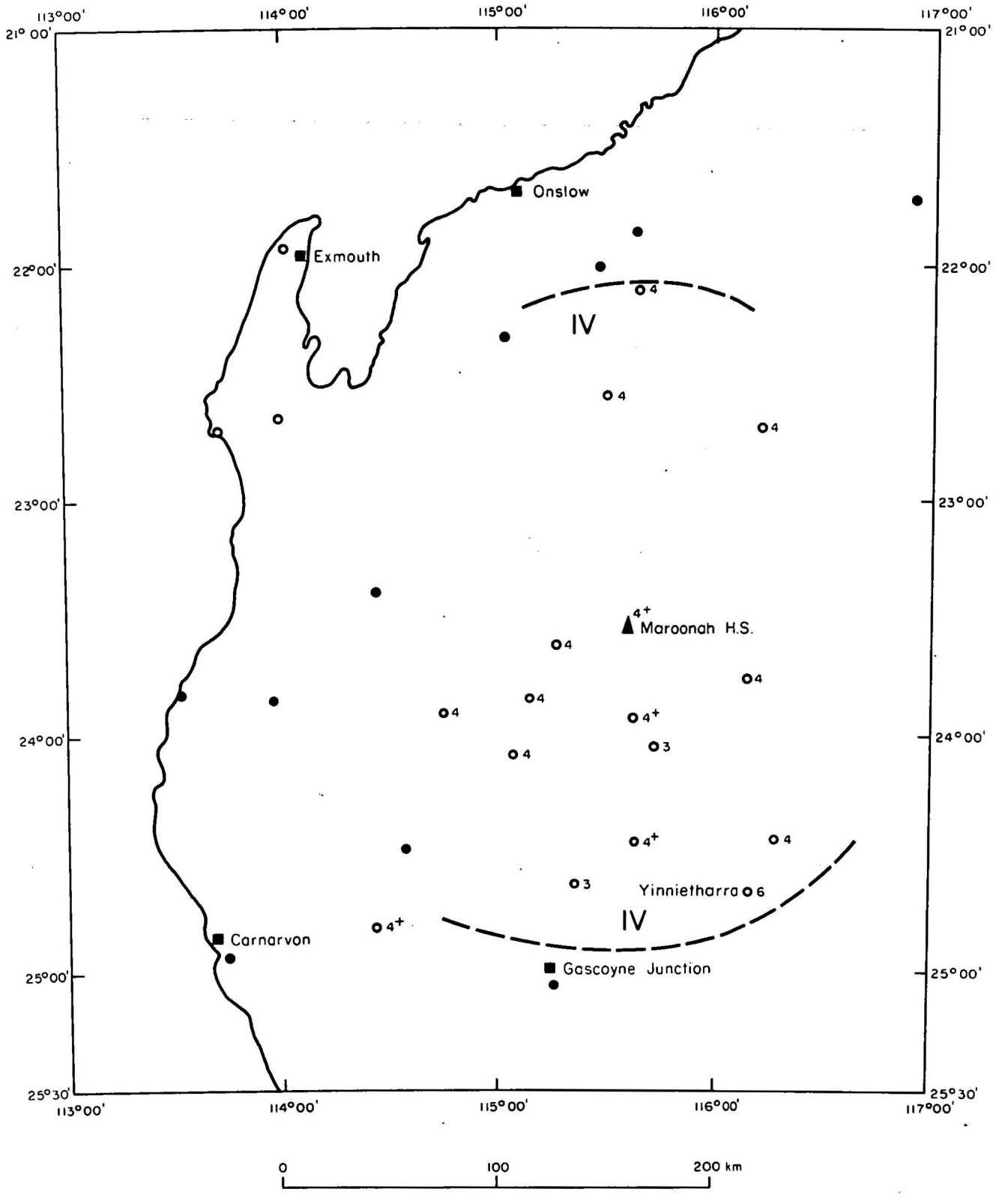


EARTHQUAKES IN THE REGION 30·5° – 33° S, 116° – 117·5° E 1978

Record 1980/40
(BASED ON H50/80-36A)

H50/B9-35A

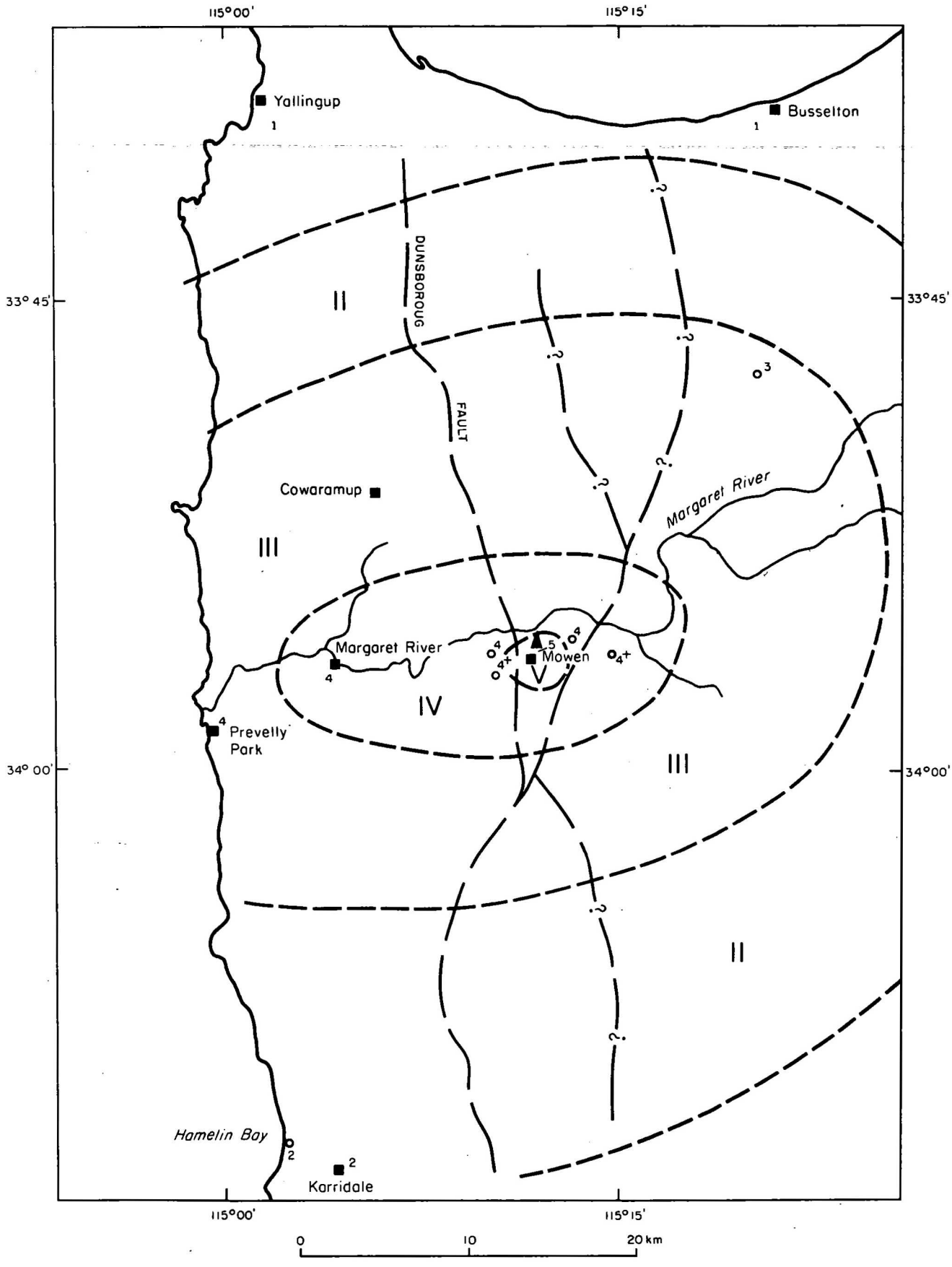
ISOSEISMAL MAP OF MAROONAH HOMESTEAD EARTHQUAKE WA 1 MAY 1978



DATE : 1 MAY 1978
TIME : 03:42:52.5 UT
MAGNITUDE : 5.7 ML
EPICENTRE : 23.51°S 115.54°E

▲ EPICENTRE
o EARTHQUAKE WAS FELT
• EARTHQUAKE WAS NOT FELT
IV ZONE INTENSITY DESIGNATION (MM)

ISOSEISMAL MAP OF MARGARET RIVER EARTHQUAKE WA 9 JUNE 1978



DATE : 9 JUNE 1978
TIME : 12:31:17·8 UT
MAGNITUDE : 3·0 ML
EPICENTRE : 33·93°S 115·20°E

▲ EPICENTRE
4 INTENSITY (MM)
IV ZONE INTENSITY DESIGNATION (MM)
——— FAULT, ? BURIED FAULT