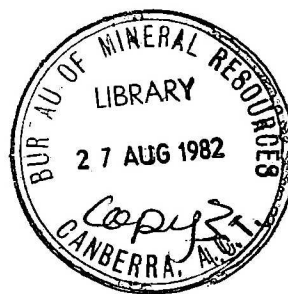


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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

1982/9

MUNDARING GEOPHYSICAL OBSERVATORY

ANNUAL REPORT 1980

by

P.J. Gregson

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SUMMARY

Basic programs in geomagnetism, ionospherics, and seismology continued at the Mundaring Geophysical Observatory during 1980. The main instruments were an Eschenhagen normal-run magnetograph, an IPS type 4B ionosonde, a Worldwide Standard Seismograph, and a Seismic Research Observatory.

Seismographs were operated at Mundaring, Swan View, Narrogin, Kalgoorlie, Meekatharra, Marble Bar, Warburton and Kununurra. An additional seismograph was installed at Nanutarra on 19 April 1980.

The annual earthquake lists show details of 161 Western Australian earthquakes, 110 of which occurred in the South-West Seismic Zone.

Isoseismal maps were prepared for earthquakes that occurred 150 km west of Fremantle and near Cadoux on 8 and 10 December, respectively.

1. INTRODUCTION

The Mundaring Geophysical Observatory opened on 18 March 1959, and now controls seismological recording at Mundaring, Swan View, Narrogin, Kalgoorlie, Meekatharra, Marble Bar, Kununurra and Warburton; magnetic recording at Gnangara; and ionospheric recording at Mundaring. The seismograph at Narrogin is a Seismic Research Observatory (SRO) and is operated in co-operation with the United States Geological Survey.

Descriptions of the observatory and an outline of activity there to the end of 1979 have been given in previous records (e.g. Gregson, 1980) 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; conferences attended and addresses given, in Table 4.

Mr B. Gaull (Science Class 1) was on transfer all year for Antarctic duty at Mawson. His absence, and the vacancy of the Assistant Grade 1 position, restricted the observatory's program considerably.

Training in observatory practice was given to Mr A. Marks in preparation for Antarctic duty in 1981.

Visitors to the observatory during 1980 are listed in Table 5.

3. GEOMAGNETISM

Normal magnetograph

The Eschenhagen 20mm/hr magnetograph continued to operate at Gnangara. It performed well, apart from two occasions when minor problems were experienced with time control, and there was no record loss during the year.

There were no abrupt changes either in the scale or baseline values during the year. As in previous years, the Z scale value drifted during the year. It changed from 5.70 nT/mm in April to reach a peak in July of 6.22 nT/mm. The drift reversed during October and November.

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

<u>Element</u>	<u>Baseline value</u>	<u>Scale value</u>
D	0.21 min (1.4 nT)	-
H	1.1 nT	0.01 nT/mm
Z	0.9 nT	0.04 nT/mm

These were similar to the standard deviations obtained for 1979 data.

Magnetograph tests

Temperature coefficients. Values of $q_H = 0.0 \text{ nT/}^\circ\text{C}$ and $q_Z = 2.4 \text{ nT/}^\circ\text{C}$ derived from 1978 data were used throughout 1980.

Orientation. Orientation tests were carried out on all variometers. Orientations of the recording magnets in the mean magnetic fields were:

23 July H: E 0.3°S
23 July D: N 0.3°W
23 July Z: N 0.25°UP

The values are consistent with the test carried out in July 1979.

Parallax. No tests were performed during 1980 and it was assumed that the parallax remained unchanged from previous years. During 1973 it had been found that the parallax on the 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 D scale value was determined using the Helmholtz coils on 23 July. The minute-scale value was calculated as 1.09/mm.

Magnetometers

Observations of D, H, and Z were made at weekly intervals. An Askania magnetometer (S/N 509319, circle 508135) was used throughout the year for D observations. A proton vector magnetometer (PVM B/5/Z) was used for combined observations of H and Z values. The PVM consisted of Elsec vector coils (set B), proton-precession magnetometer MNS-2/(S/N 5) and sensor (S/N Z). No changes were made to the magnetometer corrections which were: PVM H:0nT, Z:0nT; declinometer $+0.5'$.

Comparisons. No comparisons were made between instruments during the year.

A series of F readings on 18 June on pier NM made with and without the vector coils in place showed that the average value of F was 0.3 nT higher when the coils were on the pier. Eighty-four values were compared in 20 minutes.

Accessory equipment

The Askania horizontal-intensity visual recorder at the Mundaring office was operated throughout the year with minor record losses.

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

First-order magnetic survey

Observatory staff assisted Mr G. Small (Headquarters) with the occupation of the first-order magnetic station at Port Hedland during March in connection with the MAGSAT program.

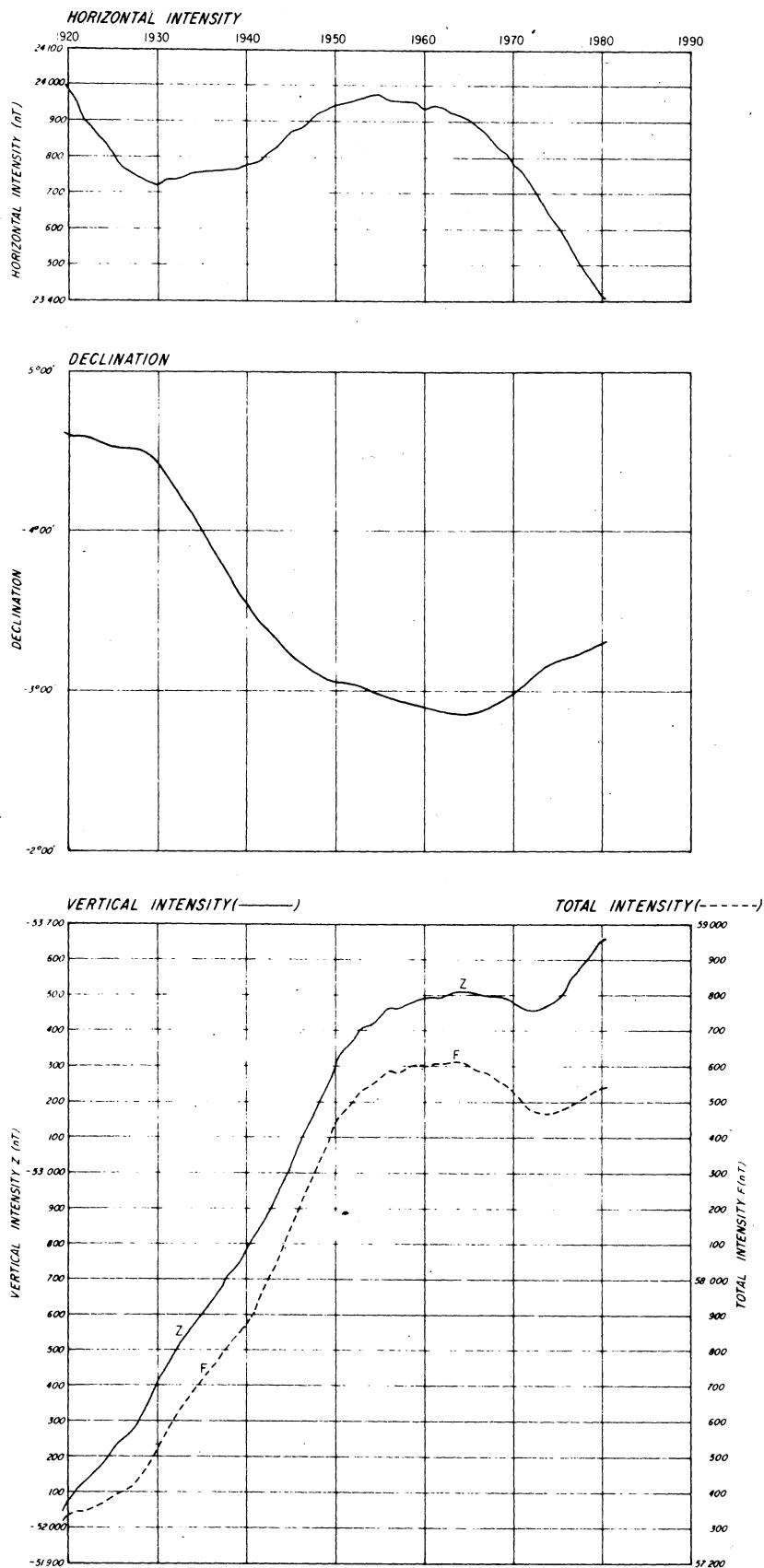
Data reduction and publication

As in previous years, mean hourly value reduction data were prepared in monthly batches and sent to headquarters. For the MAGSAT program, from September 1979, they were sent more rapidly, within a few weeks of the end of the month.

Monthly and annual mean values of H, D, Z, F and the K-index at Gwangara for 1980 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; F was derived from H and Z. Annual values for all components since 1970 are shown in Table 7. Recent trends in secular variation show H decreasing by 40 nT; D becoming more westerly by 1.3 minutes, and Z increasing in magnitude by 31 nT. The derived mean value of F has increased by 12 nT in recent years.

Figure 1 shows the graphs of annual mean values 1919-1980.

Fig 1



Values before 1959 are Watherao values adjusted to Gwangara by application of station differences:
 $GNA - WAT = D: -14.3'$; $H: -918 \text{ nT}$; $Z: -1256 \text{ nT}$
 (D scale is equal to H, Z and F scales in nT)

GEOMAGNETIC ANNUAL MEAN VALUES - 1919 - 1980

The distribution and publication of data continued as for 1980. From January 1980 Gwangara components of K-Index were stored on magnetic tape at headquarters. Data for rapid variations and principal magnetic storms for 1979 were prepared for the IAGA Bulletin.

Requests for geomagnetic data attended to during the year are listed in Table 10.

4. IONOSPHERICS

The quarter-hourly sounding schedule was continued throughout the year using a model 4B ionosonde. The ionosonde, spare components, and film were supplied by the Ionospheric Prediction Service (IPS), Department of Science and Technology.

The equipment operated satisfactorily during the year. Record loss during the year was low, the main causes being either the film jamming in the cassette or tearing. Attenuation of the signal of F2 critical frequencies at certain times of the day resulted in minor record loss.

Data distribution and publications

Observatory staff scaled the F2 critical frequency for every six hours UT and at local noon. The six-hourly values were telexed to IPS Sydney for use in forecasting ionospheric conditions. Monthly median noon values were telexed to the International Radio Consultative Committee (Geneva) for determination of the index IF2. The weekly film was sent to IPS Sydney for scaling all parameters. Distribution and publication continued as previously (for details see Gregson 1976).

5. SEISMOLOGY

Seismograph stations

Permanent seismograph stations were operated throughout 1980 at Mundaring (MUN), Narrogin (NWA0), Swan View (SWV), Kalgoorlie (KLG), Meekatharra (MEK), Warburton (WBN), Marble Bar (MBL) and Kununurra (KNA). A short-period vertical station was installed at Nanutarra on 19 April.

An insensitive seismograph was operated in the Mundaring office and field seismographs were operated near Kellerberrin in the south-west seismic zone for short intervals.

The number of events reported from each station in 1980 were:

MUN	810;	NWAO	892;	SWV	320
KLG	258;	MEK	982;	WBN	550 (6 months)
MBL	1163;	KNA	2055;	NAU	694
					TOTAL 7724

This is an increase of about 90% on the 1979 level resulting from -

Nanutarra (installation, 9 months) 18%

Warburton (more continuous operation) 10%

Kununurra (increased level of reporting) 32%

All other stations (level of reporting) 30%

A summary of all record losses from the permanent stations is given in Table 8. Losses from all stations decreased from 1979 with the exception of Meekatharra (marginal increase) and Warburton. The latter was not operational for six months of the year.

The reasons for record loss are discussed under individual station headings.

Mundaring. The WWSSN seismograph continued to be reliable. Three days of LP-E recording were lost when the seismometer jammed on its stop. Repairs were made to the strobe and power amplifier and the LP recorder bearings were replaced.

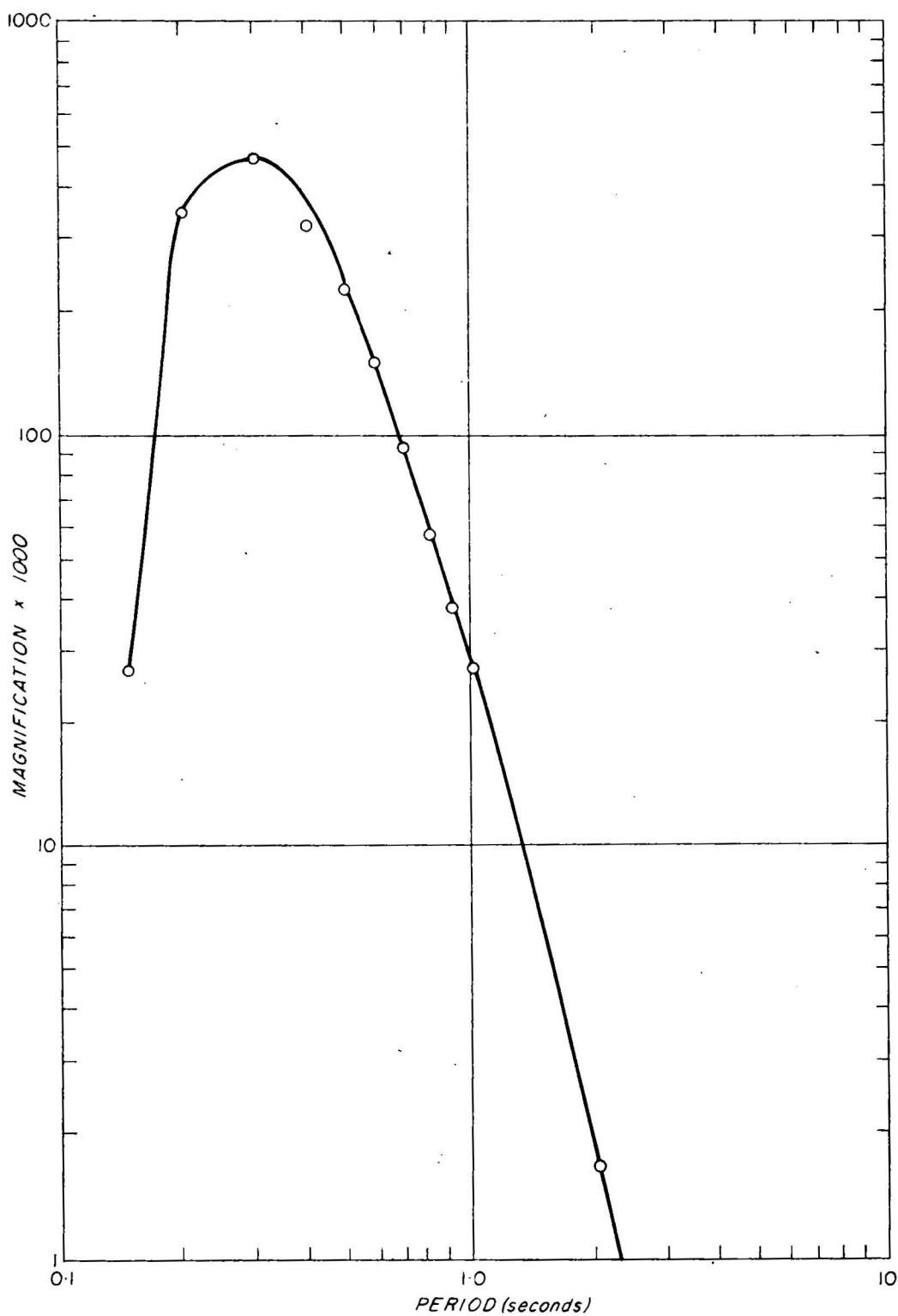
The supplementary and the office insensitive seismographs operated satisfactorily throughout the year.

Swan View. The seismograph was out of service from 23 December when the AS330 pre-amplifier was used at Marble Bar.

Narrogin. The overall performance of the SRO improved compared with the previous year. Faults that occurred during the year were:

- (a) The faulty tape unit 1 (November 1979) was repaired in January by replacing the magnetic tape controller board. The tape units failed twice more owing to a faulty magnetic interface board and the incorrect EOT/BOT voltage (+5V instead of 0).
- (b) The program would not load into the computer after it was apparently contaminated. The spare program was used.
- (c) The test-set controller failed at the remote site preventing automatic and manual calibrations. The unit was replaced.
- (d) The station power supply failed twice, resulting from firstly a burnt out transistor and current meter and secondly a burnt out magnetic amplifier.

Fig 2



CALIBRATION CURVE NANUTARRA SEISMOGRAPH

FROM 19 APRIL 1980

- (e) Resistors in the battery charger at the remote site burnt out. This resulted in the batteries discharging excessively. However, they recovered after the charger was repaired.
- (f) A line equaliser in Telecom's Narrogin exchange failed during an electrical storm causing loss of data. Minor repairs included:
- (g) Replacement of tape recorder arm sense lamps.
- (h) Replacement of clock.

The computer's 8K memory was replaced by a 16K memory and a new software program was used from May. The new program prevents automatic daily calibrations if there is an earthquake in progress. Time corrections can also be stored on the magnetic tapes.

Maintenance visits to the station by personnel from the Albuquerque Seismological Laboratory were made in January, May and December.

Kalgoorlie. This seismograph operated satisfactorily. The main reason for record loss was late attendance by the local operator.

Meekatharra. This seismograph operated satisfactorily. The main reason for record loss was late attendance by the local operator.

A standard DC distribution panel was installed in April.

Warburton. The seismograph was out of service because of numerous changes in staff and the instability of the Warburton community until 4 June, when a service visit was made. Absence of operating staff resulted in a further forty days' record loss towards the end of the year.

Mains power problems during the period June to December caused the clock to stop on numerous occasions. Other minor problems were difficult to diagnose because of poor communications with the station. These problems seemed to have been cured by January 1981.

Nanutarra. This seismograph commenced recording on 19 April and has operated satisfactorily since. Station details are:

Latitude:	22°32.65'S
Longitude:	115°30.00'E
Altitude:	80 m
Code:	NAU
Magnification:	28 k at 1.0s; 453 k at 0.25s

The calibration curve is shown in Figure 2.

Details of the station installation will be reported separately.

Marble Bar. Faults at this station were numerous and varied as shown below:

- (a) A relief operator did not attend the seismograph for four days.
- (b) In January cyclone Amy produced large microseisms which obliterated recording.
- (c) High mains voltage damaged the PS112 power supply twice. A dropping transformer was installed in the mains supply to prevent further damage.
- (d) A replacement battery at the remote site failed to hold its charge.
- (e) Intercell connections in one of the two solar panels deteriorated and required repairing in May.
- (f) The EMI clock became unstable in September and the time jumped up to $1\frac{1}{2}$ seconds on several occasions making time control uncertain. The clock was replaced.
- (g) Extensive lightning in December damaged the AS330 pre-amplifier and DC/DC inverter unit. It is planned to remove the Telecom^o pole, located near the vaultlet, which is acting as a lightning conductor.

Kununurra. This seismograph operated satisfactorily throughout the year. The main reason for record loss was late changing of records.

Field stations. A Sprengnether MEQ800 field seismograph continued to operate spasmodically until April at Meckering (Morrell's farm). It was serviced and re-installed at Kellerberrin on 16 December.

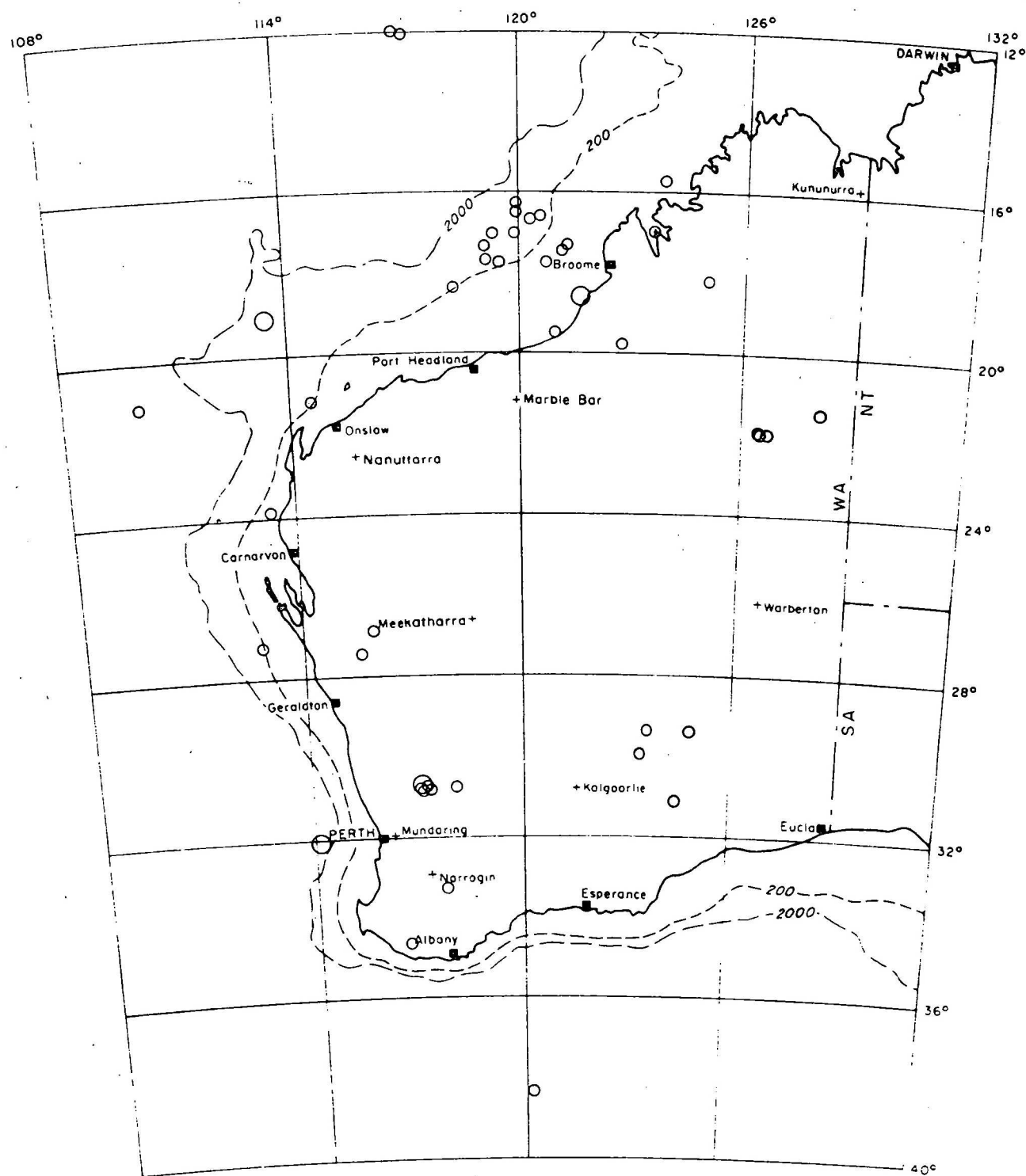
Accelerographs

Six MO2 accelerographs were operated during the year. Four were located in the Meckering area (Kelly's, Morrell's, Springbett's and Richardson's farms). The last was withdrawn from service on 16 December as it would not trigger because of a fault on the run-control board. The film-drive mechanism was repaired on two instruments in June.

The other two MO2 accelerographs were operated by the State Public Works Department (PWD) at Kununurra. The PWD also operated a Kinematics SMA-1 accelerograph at Mundaring Weir.

Three earthquakes near Meckering on 21 January, 21 August and 11 October each triggered an accelerograph in the area. The maximum ground accelerations are summarised in Table 11.

Fig 3



LEGEND

- + Seismograph station
- Named place
- $ML < 4.5$
- $4.5 \leq ML < 5.5$
- $ML \geq 5.5$

(Base on 24/WA/5) Record 1982/9

**LARGER EARTHQUAKES IN THE REGION OF
WESTERN AUSTRALIA 1980**

24/WA/1

Seismicity

Table 9 lists 161 earthquakes of magnitude $ML > 2.0$ which occurred in Western Australia during 1980.

Epicentres were determined graphically using Western Australian stations and, where applicable, other Australian stations. Depths were assigned wherever possible.

Figures 3 and 4 show epicentres of Western Australian earthquakes with magnitudes $ML > 3.0$ ($mB > 4.0$) and those in the Southwest Seismic Zone respectively.

Southwest Seismic Zone. Seventy-seven of the 110 earthquakes that occurred in the Zone were located in the Cadoux area; the largest took place on 10 December and had a magnitude $ML = 5.0$.

Activity occurred as far east as Bencubbin, and south as far as Rocky Gully (30 km north of Walpole).

A magnitude $ML = 5.2$ earthquake occurred on 8 December, 150 km west of Fremantle. It was the first earthquake to be recorded from that region.

Broome area. Two areas offshore from Broome were active during the year. There were seven earthquakes in the vicinity of the 1979 Rowley Shoals earthquake (approx 260 km NW Broome), the largest with magnitude $ML = 4.3$. Several earthquakes occurred 100 to 150 km northwest of Broome.

Kununurra. Seven earthquakes up to magnitude $ML = 3.2$ occurred from 54 km south to 125 km southwest of Kununurra.

Other areas. The remaining earthquakes were scattered throughout the state and offshore. Those above magnitude $ML = 4$ were: 100 km SW Broome ($ML = 4.7$); 220 km SW Broome (4.3); 250 km NE Kalgoorlie (4.2); 170 km N Derby (4.0) and Lake Tobin (4.0).

Earthquake intensities

Isoseismal maps were prepared for two earthquakes from information received from the distribution of questionnaires:

8 December. (Figure 5) This earthquake was located 150 km west of Fremantle and had a magnitude $ML = 5.2$. The maximum intensity reported was MM V at Fremantle and Cape Naturaliste. Felt intensities in the Perth region were

generally higher to the east of the Darling Fault even though the earthquake was to the west of the fault. The earthquake was felt up to 350 km from the epicentre.

10 December. (Figure 6) This earthquake was located near Cadoux and had a magnitude $ML = 5.0$. The maximum intensity reported was MM VI at Cadoux. The earthquake was felt up to 250 km from the epicentre.

Data distribution, publication and requests

The distribution of data continued as for 1978 (see Gregson, 1980). Requests for seismological data attended to during the year are listed in Table 10.

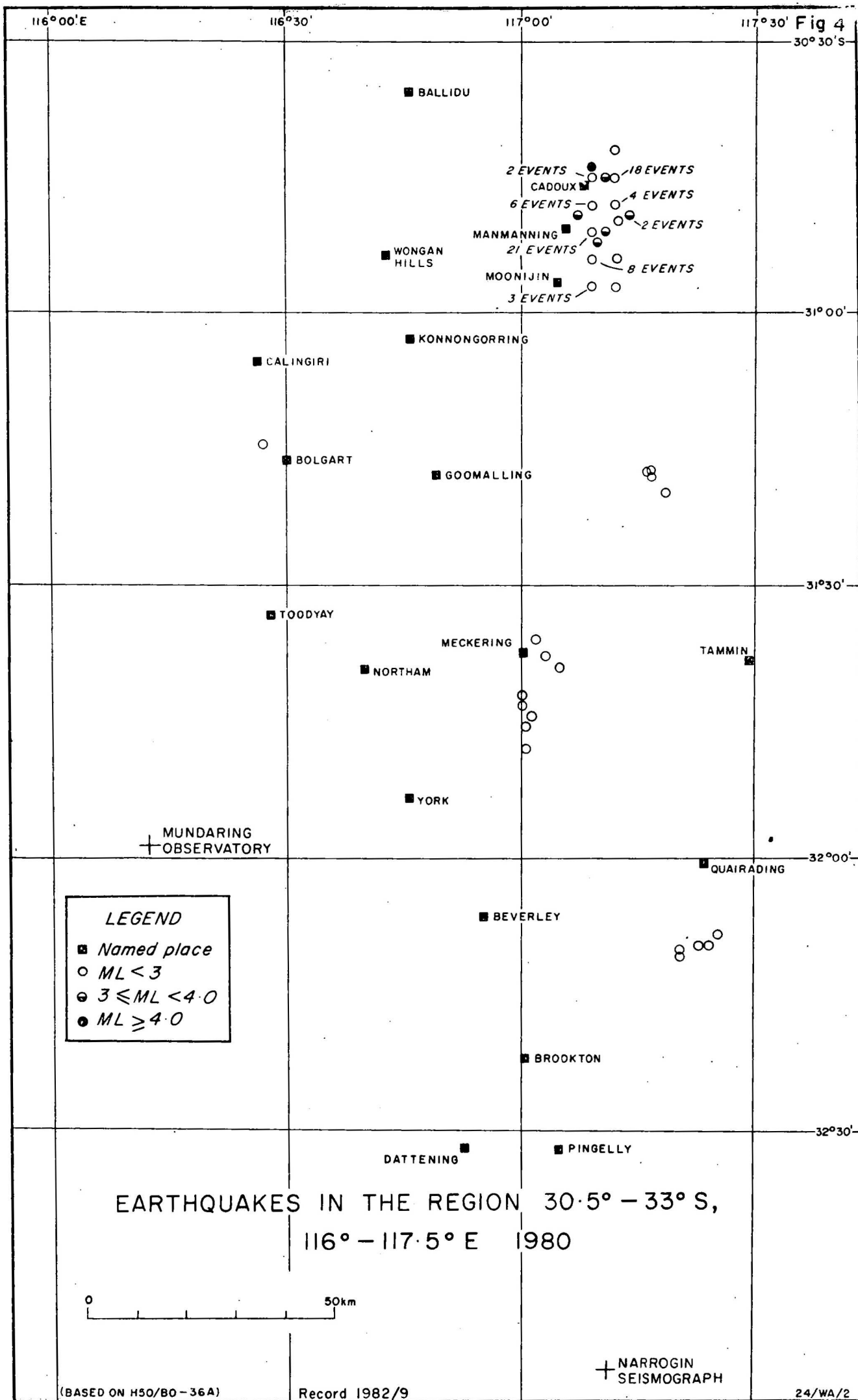
6. ACKNOWLEDGEMENTS

The assistance of the daily attendants listed in Table 2 and the co-operation of Australia Post for housing the Marble Bar seismograph is acknowledged. The operation of seismographs during the year in the Meckering and Kellerberrin areas by Mrs F. Morrell and Mr J. Stevens is appreciated.

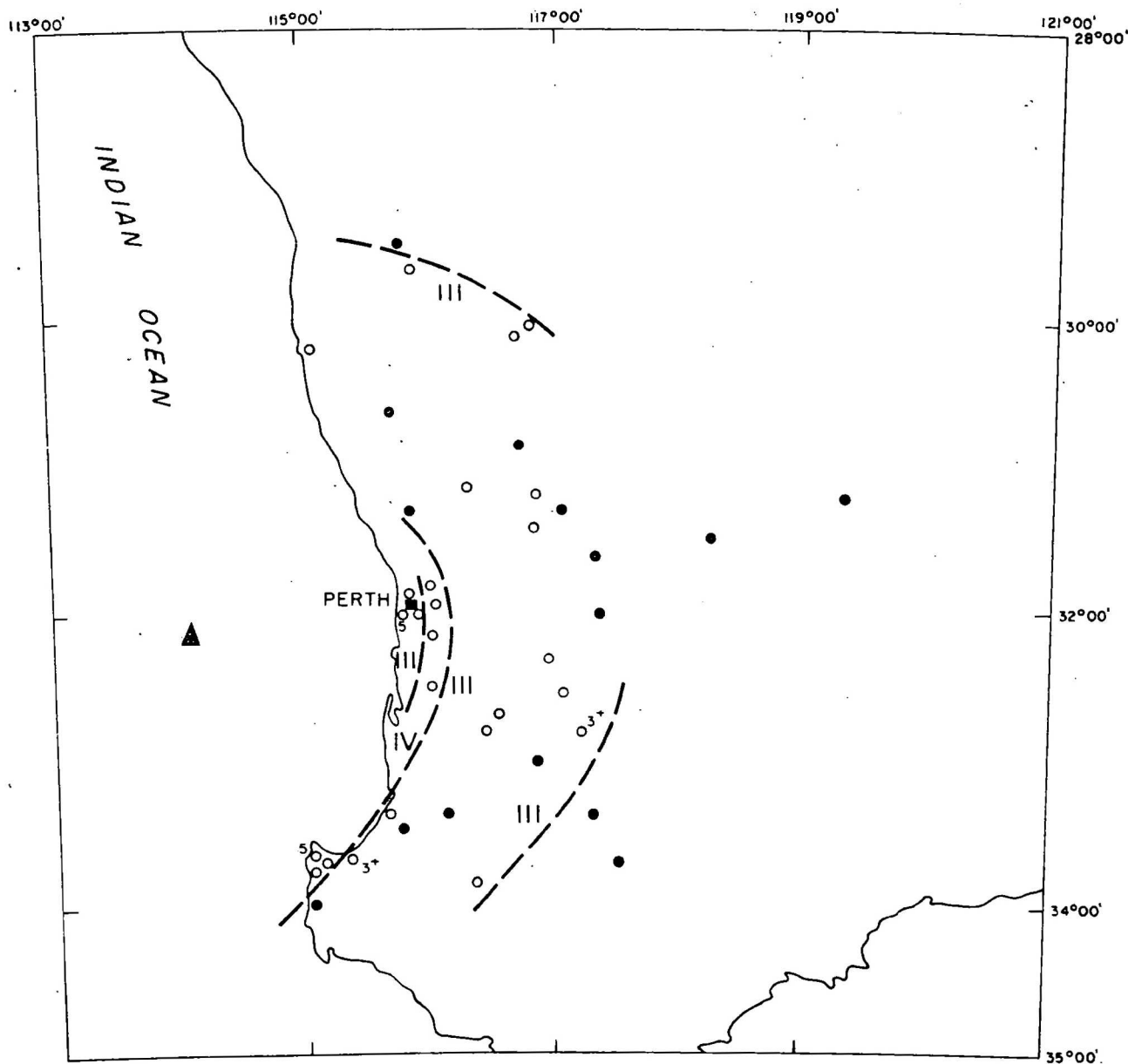
7. REFERENCES

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

GREGSON, P.J., (1980) - Mundaring Geophysical Observatory Annual Report 1979.
Bureau of Mineral Resources, Australia, Record 1980/51.



ISOSEISMAL MAP OF THE OFFSHORE (FREMANTLE) EARTHQUAKE, WA Fig 5 08 DECEMBER 1980



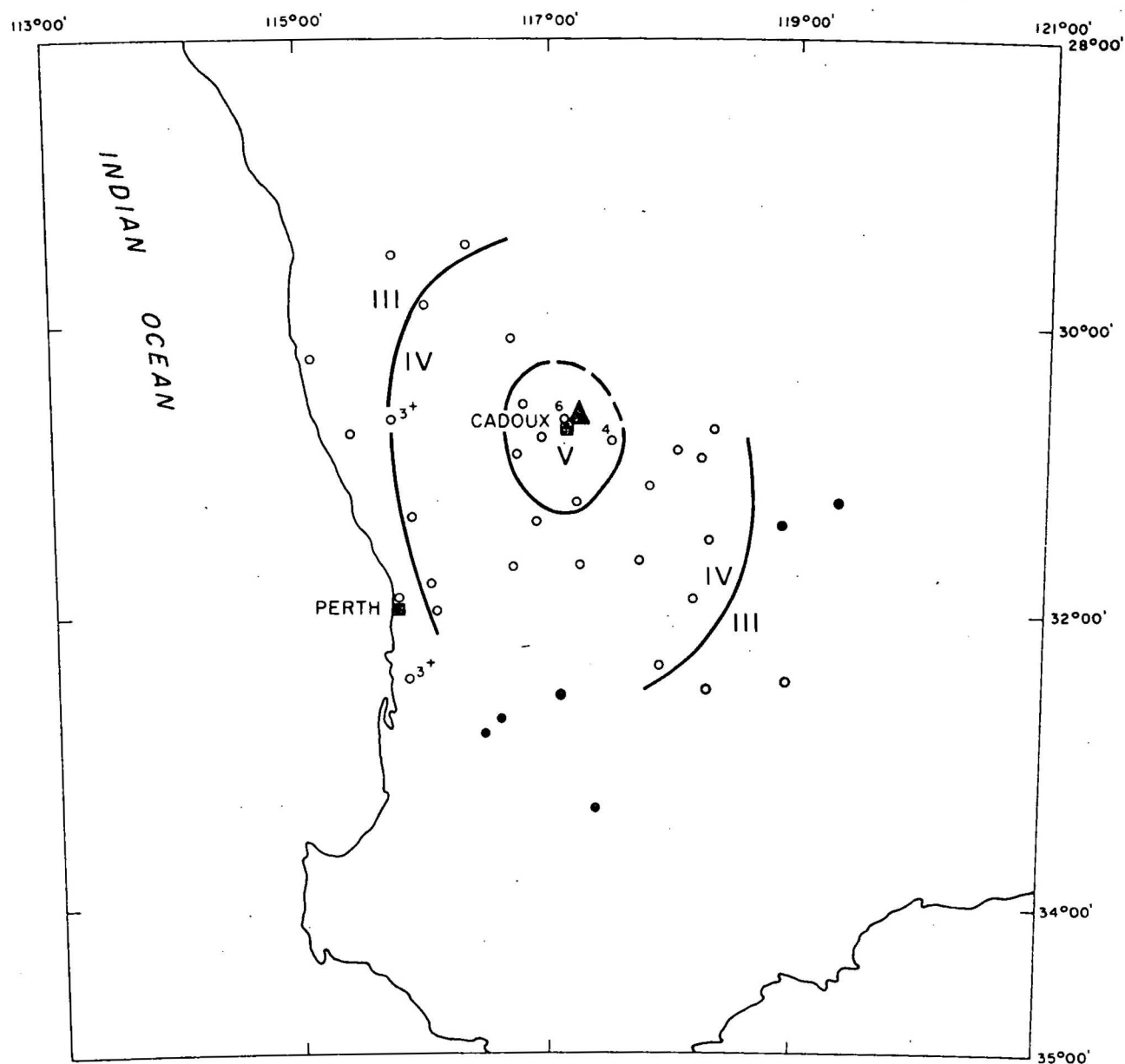
DATE : 08 DECEMBER 1980
 TIME : 00:12:07.8 UT
 MAGNITUDE : 5.2 ML
 EPICENTRE : 32.12°S 114.11°E
 DEPTH : 37 km

▲ EPICENTRE
 ○ EARTHQUAKE WAS FELT
 ● EARTHQUAKE WAS NOT FELT
 ||| ZONE INTENSITY DESIGNATION (MM)

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

ISOSEISMAL MAP OF THE CADOUX EARTHQUAKE, WA 10 DECEMBER 1980

Fig 6



DATE : 10 DECEMBER 1980
TIME : 04:35:05.6 UT
MAGNITUDE 5.0 ML
EPICENTRE 30.73°S 117.15°E
DEPTH : 13 km

▲ EPICENTRE
○ EARTHQUAKE WAS FELT
● EARTHQUAKE WAS NOT FELT
||| ZONE INTENSITY DESIGNATION (MM)

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

APPENDIX
PRINCIPAL EVENTS
MUNDARING GEOPHYSICAL OBSERVATORY 1957-1980

1957 May	Geomagnetic recording commenced at Gnangara (La Cour).
1959 Mar 18	Transfer of observatory from Watheroo to Mundaring
1959 Apr 03	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 01	Cossor ionosonde replaced type 2.
1960 Jun 22	Absolute magnetic observations commenced in new absolute house.
1962 Jun	WWSSN system commenced operation at MUN.
1963 Apr 19-Dec 17	GRV seismograph operation.
1963 May 30-Dec 19	NGN seismograph operation.
1964 Nov 06	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 01	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 01	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.
1973 Mar 30	KLG reduced to SP-Z
1973 May 01	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 01	Proton vector coils introduced for Z baseline control.
1974 May 01	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 Sep 02-1976 Feb 05	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	A third M02 accelerograph installed at Meckering.
1978 Feb	A fourth M02 accelerograph installed at Meckering.
1978 Jun 27	WBN SP-Z recording commenced.
1980 Apr 19	NAU SP-Z recording commenced.

TABLE 1

OBSERVATORY STAFF 1980

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 2
Y.M. Moiler (Mrs)	Clerical Assistant Grade 3

* Temporary duty at Mawson throughout 1980

TABLE 2

ASSOCIATED PERSONNEL 1980

NAME	NATURE OF DUTIES
B. Carling	Daily attendant, Gnangara
R. Kruger	Daily attendant, Kalgoorlie (till Dec.)
P. Maddren	Daily attendant, Kalgoorlie (from Dec.)
R. Tatham	Daily attendant, Marble Bar
B. Harvey	Daily attendant, Meekatharra (till July)
R. Kimber	Daily attendant, Meekatharra (from July)
J. Roberts	Daily attendant, Kununurra
H. Dedner	Daily attendant, Nanutarra (from April)
A. Marshall (Mrs)	Daily attendant, Warburton
A. Marks	Antarctic trainee (7 July-29 August)
W. Meyer	Technical Officer Grade 2 (relief staff) 16 Jan-30 May
N. Fenttiman (Mrs)	Clerical Assistant (relief Staff) 95 days
J. Tulk (Mrs)	Clerical Assistant (relief Staff) 11 days
P. Fenttiman	Ground maintenance (till July)
L. Olley	Ground maintenance (from July)
N. Fenttiman (Mrs)	Cleaning (till Dec)
L. Page (Mrs)	Cleaning (from Dec)

TABLE 3

Observatory Staff Absences, 1980

Nature of absences	No. of man-days
Sick leave	104
Special leave	2
Furlough	64
Military leave	18
Attendance at outstations and field operation	34
Magnetic survey	11
Temporary transfer	249
Conferences & training	<u>8</u>
	490*

*Clerical assistant and technical officer relief staff were available for 106 and 85 day respectively.

TABLE 4

CONFERENCES, ADDRESSES AND TRAINING, 1980

Officer	Date	Address/Conference
P.J. Gregson	March 10	Addressed Royal Astronomical Society (WA Branch) - Earthquakes
P.J. Gregson	October 29	Addressed State Emergency Service (Volunteers) - Earthquakes
P.J. Gregson and E.P. Paull	November 27	Attended Australian Standards Association Seminar - Earthquake Code - Perth.

TABLE 5
VISITORS 1980

Visitors	Institution
Mr B. Brizzell	Albuquerque Seismological Laboratory
Dr. J. Lewis	State Geological Survey
Dr D. Denham	Bureau of Mineral Resources
Mr L. Alexander	CSIRO
Mr G.R. Small	Bureau of Mineral Resources
Staff Members	Bickley Astronomical Observatory
Geophysics Students	University of WA
Mr I.B. Everingham	Bureau of Mineral Resources
Dr D.J.Sutton	Adelaide University
Mr R.S. Mather	Geological Survey of WA
Mr M.J. Robertson	CSIRO Canberra
Mr G. Olsen	CSIRO Perth
Mr C. Edwards	CSIRO Perth
Mr D. Taylor	Australian Survey Office

TABLE 6
PRELIMINARY MONTHLY MEAN GEOMAGNETIC VALUES AND K-INDICES

Month	D(West)	H,nT	Z,nT	F,nT	K
January	3°17.4'	23433	53640	58535	2.35
February	17.3	425	642	534	1.96
March	17.4	425	638	530	1.43
April	17.5	410	644	529	1.82
May	17.6	409	647	532	1.57
June	17.5	402	650	532	1.93
July	17.8	404	652	534	1.54
August	17.9	405	655	538	1.72
September	17.8	402	655	536	1.68
October	18.2	397	663	536	2.22
November	18.4	396	668	546	2.45
December	18.8	395	669	546	2.43
	3°17.8	23409	53652	58536	1.93

GEOMAGNETIC ANNUAL MEAN VALUES 1970-1980

Year	D	I	H,nT	X,nT	Y,nT	Z,nT	F,nT	Notes
1970	-2°59.6'	-66°01.0'	23790	23758	-1242	-53474	58527	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
1979	16.5	23.1	444	405	-1339	624	525	2C
1980	17.8	25.7	409	370	-1346	652	536	2C

Annual rates of change

1970-1980	-1.82	-2.47	-38.1	-38.8	-10.4	-17.8	0.9
1970-1975	-2.38	-2.06	-36.4	-37.4	-14.4	-4.4	-10.6
1975-1980	-1.26	-2.88	-39.8	-40.2	-6.4	-31.2	12.4

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

C. Mean daily values, 10 days

TABLE 8
1980 SEISMOGRAPH RECORD LOSS

Causes	MUN WWSSN						MUN SUP			NWA0				SWV	KLG	MEK	WBN	NAU	MBL	KNA			
	SP			LP			SP			LP		SP											
	Z	N	E	Z	N	E	Z	N	E	Z	N	E	Z							N	E		
<u>OPERATOR</u>																							
Late change															94	82	13	2	104	61	61	61	
Unmanned																	1120						
Drum not reset	23	23	23	3	3	3	48	24	47					76	29								
Paper reversed																							
<u>POWER FAILURES</u>																							
Mains											13	13	13	13	4	36		14	8	3	15	15	15
Battery DC																				95	14	14	14
<u>RECORDER</u>																							
Lamp blown	29		12		2	31		5															17
Recorder																	58						
Recording pen										19			48				17			8			
<u>CONTROL EQUIPMENT</u>																							
PS112																				111			
AS330																				261			
Equipment elsewhere														210									
SRO program										26	26	26	26										
LINE FAILURE										50	50	50	50	1						71			
<u>MAINTENANCE</u>																							
										57	57	57	57				13	2		6			
<u>SEISMOMETER</u>																							
Jammed						72																	
TOTAL	52	23	35	3	3	77	79	24	52	165	146	146	194	283	169	170	1149	10	695	90	90	107	
Percentage	0.6	0.3	0.4	-	-	0.9	0.9	0.3	0.6	1.9	1.7	1.7	2.2	3.2	1.9	1.9	23	0.1	7.5	1.0	1.0	1.2	
			0.4						0.6			1.9					0	*			1.1		

o * based on 6 months and 9 months operation.

TABLE 9

WESTERN AUSTRALIAN EARTHQUAKES, 1980

Date 1980		Origin Time U.T.	Lat. °S	Long. °E	Dept km	ML(MUN)	MB(MUN)	Remarks	No. of Stations
Jan	04	14 27 35.6	(30.75)	(117.15)		2.3		Cadoux area	3
	04	15 35 11.1	(30.75)	(117.15)		2.5		Cadoux area	3
	04	15 41 05.0	(30.80)	(117.20)		2.4		Cadoux area	3
	10	12 57 17.9	(30.85)	(117.15)		2.3		Cadoux area	3
	14	13 56 58.5	32.17	117.34	(10)	1.8		17 km SSW Quairading	3
	15	21 31 35.2	32.14	117.42	(10)	2.1		13 km S Quairading	3
	21	17 16 13.8	31.63	117.05	10	2.7		3 km E Meckering	5
	21	17 20 01.7	31.60	117.03	10	2.9		3 km NE Meckering	5
	21	20 09 34.5	(30.85)	(117.15)		2.3		Cadoux area	4
	22	05 29 37.2	(30.90)	(117.15)		2.3		Cadoux area	2
	28	02 27 05.5	29.59	117.31	(37)	2.4		50 km SW Paynes Find	4
	28	19 35 44.7	30.83	117.21	3	2.9		10 km Se Cadoux	5
	31	11 04 39.5	30.40	117.30	25	2.6		43 km NNE Cadoux	4
Feb	03	15 02 12.4	33.72	117.25	5	2.8		28 km W Katanning	4
	06	16 57 37.0	(30.85)	(117.15)		2.0		Cadoux area	3
	06	17 17 11.5	30.82	117.23	3	3.2		11 km SE Cadoux	5
	07	02 26 54.4	(30.85)	(117.15)		2.5		Cadoux area	3
	07	22 57 36.6	31.24	116.45	5	2.3		17 km S Calingiri	3
	09	18 50 52.2	19.78	122.74	(8)	3.8		210 km SSE Broome	4
	10	01 32 44	19.78	122.74	(8)	3.0		210 km SSE Broome	1
	11	06 29 23.3	(30.75)	(117.20)		2.4		Cadoux area	3
	13	22 36 30.2	32.16	117.40	(5)	2.1		16 km S quairading	3
	16	10 32 20.5	(30.75)	(117.20)		2.3		Cadoux area	3
	18	12 47 17.9	15.85	128.48		1.4		32 km WSW Kununurra	1
	29	10 03 45.0	31.72	117.00	(5)	2.0		12 km S Meckering	4
Mar	05	15 30 59.0	32.16	117.38	(10)	2.3		15 km S quairading	3
	08	00 51 38.3	31.13	124.41	(19)	3.2		80 km E zanthus	3
	08	19 38 59.2	(30.85)	(117.15)		2.0		Cadoux area	2
	13	15 07 59.7	32.18	117.34	10	2.1		18 km S quairading	2
	15	07 09 50	18.62	121.64	19	4.7		100 km SW Broome	8

TABLE 9

Date 1980	Origin Time U.T.	Lat. S	Long. E	Dept km	ML(MUN)	MB(MUN)	Remarks	No, of Stations
Apr	01	15 22 10.2	17.05	123.65	(37)	3.6	25 km N Derby	5
	01	18 48 08.4	17.76	120.74	(37)	3.9	160 km W Broome	4
	02	17 11 55.6	16.54	119.97	(37)	4.0	280 km NW Broome	4
	04	13 17 18.1	33.15	118.20	0	2.8	12 km ENE Kukerin	5
	05	04 58 38.0	30.87	117.16	5	3.1	12 km SSE Cadoux	5
	09	05 42 28.9	17.36	119.19	(37)	3.9	330 km WNW Broome	4
	19	07 44 38.6	19.08	113.45	37	4.7	330 km NW Onslow	6
	21	09 38 10.5	31.74	117.02	19	2.2	13 km S Meckering	3
	28	16 42 02.0	33.43	117.76	3	2.3	10 km S Dumbleyung	3
May	01	12 31 11.0	18.36	118.31	(37)	3.0	220 km N Pt Hedland	2
	04	06 23 04.0	(30.90)	(117.15)		2.3	Cadoux area	3
	06	00 27 13.6	(30.70)	(117.20)		2.2	Cadoux area	3
	06	19 06 24.2	17.38	121.28	(37)	3.5	115 km NW Broome	5
	10	19 41 52.1	33.48	117.84		2.3	20 km SE Dumbleyung	3
	14	08 30 48.8	(30.90)	(117.15)		2.6	Cadoux area	3
	16	15 44 31.0	(30.80)	(117.20)		2.1	Cadoux area	3
	19	13 34 45.0	30.79	118.05	6	2.8	19 km E Bencubbin, Felt MM 111	5
	19	22 53 43.7	30.82	118.08	9	3.0	21 km E Bencubbin, Felt MM IV	5
	22	06 50 49.4	25.52	116.50	(10)	2.9	230 km NW Meekatharra	4
	25	23 48 12.7	(30.85)	(117.15)		2.4	Cadoux area	3
	28	21 03 37.6	(30.85)	(117.15)		2.3	Cadoux area	3
	30	14 17 45.3	31.76	117.01		2.0	15 km S meckering	3
	30	16 49 29.9	(30.85)	(117.15)		2.1	Cadoux area	3
	31	10 30 10.4	(30.80)	(117.20)		2.5	Cadoux area	3
Jun	01	07 22 30.3	30.85	117.18	13	3.7	11 km SE Cadoux, Felt MM V	7
	02	04 34 18.5	(30.75)	(117.20)		2.6	Cadoux area	3
	03	14 01 40.0	21.42	128.14	33	3.7	100 km NW Lake McKay	7
	05	09 04 58.0	(30.85)	(117.15)		2.4	Cadoux area	3
	08	15 13 01.7	25.69	115.97	10	2.4	270 km NW Meekatharra	3

TABLE 9

Date 1980	Origin Time U.T.	Lat. °S	Long. °E	Dept km	ML(MUN)	MB(MUN)	Remarks	No. of Stations
Jun	12	07 25 52.0	26.89	115.90	37	3.2	260 km W Meekatharra	5
	12	20 29 38.0	33.43	117.75	5	2.7	11 km S Dumbleyung	3
	14	10 10 14.8	(30.85)	(117.15)		2.1	Cadoux area	3
	16	13 20 30.8	31.80	117.01	0	2.3	20 Km S Meckering	3
	20	03 29 46.9	(30.75)	(117.20)		2.0	Cadoux area	3
	20	10 26 37.1	(30.75)	(117.20)		2.0	Cadoux area	3
	22	08 46 35.0	16.36	119.97	37	3.8	300 km NW Broome	6
	22	16 20 32.6	17.67	119.19	(37)	3.6	Rowley Shoals	4
	27	02 00 02.0	(30.75)	(117.20)		2.3	Cadoux area	3
Jul	03	08 47 13.5	35.57	117.94	3	2.3	18 km W Nyabing	3
	04	04 04 27.2	17.77	119.53	(37)	3.4	60 km SE Rowley Shoals	3
	04	18 11 38.7	28.62	112.82	(10)	2.6	40 km E Laverton	4
	06	04 00 44.0	16.64	120.58	(37)	3.4	225 km NW Broome	4
	14	01 17 09.1	16.24	128.65	(10)	1.8	54 km S Kununurra	2
	15	14 38 55.1	(30.80)	(117.15)		2.3	Cadoux area	3
	16	05 13 32.5	(30.85)	(117.15)		2.2	Cadoux area	2
	16	06 55 29.2	16.24	128.65		2.0	54 km S Kununurra	2
	19	05 15 07.0	16.53	128.63		2.4	88 km S Kununurra	2
	20	06 11 38	21.13	110.00	10	4.2	430 km WNW Exmouth	5
	21	06 04 56.3	(30.75)	(117.20)		2.1	Cadoux area	3
	22	08 29 51.6	(30.90)	(117.15)		2.3		
	26	06 41 41.2	16.88	128.37	(19)	2.8	125 km SW Kununurra	3
	26	21 03 26.9	16.88	128.37	(19)	2.0	125 km SW Kununurra	1
	26	14 11 38.9	30.82	117.23	6)	3.2	11 km SE Cadoux, felt	
							MM IV	6
	29	07 43 29.3	(30.75)	(117.20)		2.1	Cadoux area	3
	30	19 07 28.0	(30.90)	(117.15)		2.8	Cadoux area	3
	30	20 06 18.8	(30.85)	(117.15)		2.9	Cadoux area	3
	30	21 55 02.7	(30.90)	(117.15)		2.4	Cadoux area	3
	31	12 19 01	19.51	120.96		4.3	220 km SW Broome	8
	31	17 43 44.3	(30.85)	(117.15)		2.5	Cadoux area	3
	31	19 53 53.2	(30.90)	(117.15)		2.6	Cadoux aea	3

TABLE 9

Date 1980	Origin Time U.T.	Lat. °S	Long. °E	Dept km	ML(MUN)	MB(MUN)	Remarks	No. of Stations
Aug	01 18 24 10.8	16.44	128.71	37	2.7		78 km S Kununurra	3
	01 20 19 27.5	17.03	119.36	37	4.0		320 km WNW Broome	6
	02 05 31 57	29.41	124.82		3.3		355 km ENE Kalgoorlie	4
	02 19 10 22.1	16.71	120.35	37	4.3		240 km NW Broome	7
	03 09 59 34.4	(30.95)	(117.20)		2.3		Cadoux area	3
	03 10 12 12.5	(30.85)	(117.15)		2.3		Cadoux area	3
	07 16 29 16.8	(30.85)	(117.15)		2.1		Cadoux area	3
	07 20 48 00	29.39	123.58		4.2		250 km NE Kalgoorlie	8
	08 02 27 38	27.22	112.83	(19)	3.3		140 km WNW Kalbarri	3
	08 05 29 53.8	(30.85)	(117.15)		2.5		Cadoux area	3
	10 02 41 06.7	(30.75)	(117.20)		2.2		Cadoux area	2
	11 00 20 30.3	29.85	116.51		2.6		30 km NW Wubin	5
	13 03 12 12.4	33.40	117.73	8	2.3		8 km S Dumbleyung	3
	13 23 49 04	33.36	117.74	10	2.1		4 km S Dumbleyung	3
	17 18 51 02.2	27.46	115.58	37	3.3		70 km SW Meebeere	8
	21 15 08 33.0	31.65	117.08		2.2		7 km ESE Meckering	4
	21 15 16 39	17.44	121.17	37	3.1		125 km WNW Broome	6
	24 07 03 41.5	31.29	117.28	(10)	2.0		15 km SW Wyalkatchem	3
	24 07 16 01.4	31.30	117.28	(10)	2.0		16 km SW Wyalkatchem	3
	24 08 30 19.3	30.82	117.12	15	3.0		6 km S Cadoux	4
	25 13 11 42.3	31.33	117.31	(0)	2.0		18 km SSW Wyalkatchem	3
	25 19 34 18.3	(30.80)	(117.15)		2.1		Cadoux area	3
	26 01 09 58.6	(30.80)	(117.15)		2.2		Cadoux area	3
	26 01 26 02.6	(30.80)	(117.15)		2.5		Cadoux area	3
	27 09 55 06.3	31.29	117.27	(10)	2.0		17 km SW Wyalkatchem	3
Sep	01 12 48 24.2	30.75	117.18	9	3.0		5 km E Cadoux	6
	01 16 59 24.6	(30.75)	(117.20)		2.3		Cadoux area	3
	02 17 47 24.2	(30.80)	(117.20)		2.7		Cadoux area	3
	14 12 25 50.7	(30.90)	(117.20)		2.3		Cadoux area	3
	20 03 39 08.0	(30.95)	(117.15)		2.1		Cadoux area	3
	20 13 53 26.0				2.0		49 km From Marble Bar	1
	23 03 18 08.5	(30.95)	(117.15)		2.7		Cadoux area	3

TABLE 9

Date 1980	Origin Time U.T.	Lat. °S	Long. °E	Dept km	ML(MUN)	MB(MUN)	Remarks	No. of Stations
Sep	28	01 50 22.0	(30.90)	(117.15)	2.2		Cadoux area	2
	30	04 50 05.9	(30.75)	(117.20)	2.3		Cadoux area	3
Oct	02	00 50 42.9	(30.90)	(117.15)	2.3		Cadoux area	3
	05	01 32 37.2	(30.85)	(117.15)	2.1		Cadoux area	3
	05	19 26 06.0	33.33	117.76	3.0		Dumbleyung	3
	08	22 58 59.0	(30.95)	(117.15)	2.1		Cadoux area	3
	11	12 3 30.4	(31.70)	(117.00)	2.3		Meckering area	3
	31	04 17 38.7	(30.75)	(117.20)	2.1		Cadoux area	3
	31	13 03 13.1	(30.80)	(117.15)	2.4		Cadoux area	3
	31	20 13 58.6	(30.75)	(117.20)	2.0		Cadoux area	2
Nov	02	18 27 00.9	23.86	113.32	(10)	3.3	120 km NNW Carnarvon	5
	05	19 50 07.6	(30.85)	(117.15)	2.3		Cadoux area	3
	05	22 16 06.3	(30.85)	(117.15)	2.0		Cadoux area	3
	17	14 58 17.9	(30.75)	(117.20)	2.2		Cadoux area	3
	20	13 30 31.4	33.11	118.97	(10)	2.1	4 km W Newdegate	4
	22	15 30 44	38.38	120.21	(10)	3.3	420 km SSE Albany	5
	23	19 32 31.5	30.00	123.36	(10)	3.5	200 km NE Kalgoorlie	7
	24	19 54 53	15.72	123.88	(37)	4.0	170 km N Derby	6
	29	13 38 33.0	18.19	125.04	(37)	3.3	55 km W Fitzroy	
							Crossing	6
Dec	01	22 34 40.5	(30.85)	(117.15)	2.4		Cadoux area	3
	02	14 51 15.4	17.03	119.95	(37)	3.9	Rowley Shoals	5
	04	20 00 41.9			(37)	2.0	60 km From Marble Bar	1
	05	08 41 15.8	16.65	128.37		2.8	102 km SSW Kununurra	2
	08	00 12 07.8	32.12	114.11	(37)	5.2	150 km W Fremantle	
							felt MM V	9
	10	02 44 00.1	(30.75)	(117.20)	2.4		Cadoux area	3
	10	04 22 46.0	(30.79)	(117.20)	2.8		Cadoux area	3
	10	04 35 05.6	30.73	117.15	13	5.0	4 km NNE Cadoux,	
							felt MM V1	9
	10	06 26 20.9	(30.75)	(117.20)	2.2		Cadoux area	3
	13	16 30 00.2	(30.75)	(117.20)	2.0		Cadoux area	3

TABLE 9

Date 1980	Origin Time U.T.	Lat. °S	Long. °E	Dept km	ML(MUN)	MB(MUN)	Remarks	No, of Stations
Dec 17	18 12 08.5	(30.75)	(117.20)		2.4		Cadoux area	3
17	23 21 20.4	(30.75)	(117.20)		2.6		Cadoux area	3
18	23 24 50.2	(30.85)	(117.15)		2.9		Cadoux area	3
19	14 07 41	21.95	126.54	13	3.9		Lake Tobin	7
20	19 23 29	22.00	126.64	10	3.9		Lake Tobin	7
21	13 20 49	22.00	126.57	30	4.0		Lake Tobin	7
Dec 23	14 25 00	21.20	114.55	(10)	3.0		70 km NW Onslow	2
24	03 20 00.0	(30.75)	(117.20)		2.2		Cadoux area	3
24	06 26 34.2	34.69	116.67		3.2		30 km N Walpole	3

TABLE 10

REQUEST FOR DATA

Institution	Type of data	No.
Aerodata Services	Magnetogram copies	6
Lands & Surveys, Perth	Declination map	
Geosearch Pty Ltd	Magnetogram copies	8
Geophysical services	Magnetogram copies	18
International Tsunami Information Centre	Tide data WA	
French National Centre for Exploration of Oceans	Seismogram copies	5
D.S.I.R. New Zealand	Seismogram copies	1
Stanford University	Seismogram copies	2
Insurance Company	Earthquake lists 1978-79	
Bhabha Atomic Research Centre	Seismogram copies	4
Lamont University	Seismogram copies	3
Lumney & Co	List of publications on WA Seismicity	
Californian Institute of Technology	Seismogram copies	6
Kunming Seismological Brigade	Seismogram copies	20
McDonald Insurance Co.	Earthquake lists 1979	
Earthquake Research Institute, Tokyo	Seismogram copies	12
Geological Survey of WA	Cadoux isoseismal map	
Lamont-Doherty Geological Observatory	Seismogram copies	3
Insurance Co.	Earthquake Data list 1967-80	
U.S. Geological Survey	Seismogram copies	6
National Geophysical Research Institute, India	Seismogram copies	9
Institute of Meteorology, Germany	Seismogram copies	3
US Geological Survey	Seismogram copies	10
MBL Loss adjustors	WA earthquake list Jan-Sep 1980	
Geophysical Laboratory, Grenoble	Seismogram copies	3
Californian Institute of Technology	Seismogram copies	9
Insurance co.	Earthquake risk map	1

Institution	Type of data	No.
National Geophysical Research Institute, India	Seismogram copies	7
World Data Centre	Seismogram copies	6
CSIRO, Melbourne	WA earthquake lists 1980	
Institute of Meteorology & Geophysics, Germany	Seismogram copies	3
Monsel Engineering	Isoseismal map (Cadoux)	
Northam Police	Earthquake risk map	
WA Lands & Survey Dept	Earthquake lists 1976-80	

TABLE 11

ACCELERATION

Date 1980	Time UT	ML	Site	Distance km	Comp.	Period s	Peak Acceleration m/s ²
Jan 21	(1716	2.7	Morrell's	5)	Z	0.01	4.9×10^{-1}
	or	or		or)			
	(1720	2.9		8)	N	0.01	9.1×10^{-1}
					E	0.01	5.0×10^{-1}
Aug 21	1508	2.2	Kelly's	5	Z	0.01	3.4×10^{-2}
					N	0.01	6.8×10^{-2}
					E	0.01	7.3×10^{-2}
Oct 11	1213	2.3	Kelly's	6	Z	0.012	0.8×10^{-2}
					N	0.012	2.6×10^{-2}
					E	0.012	1.2×10^{-2}