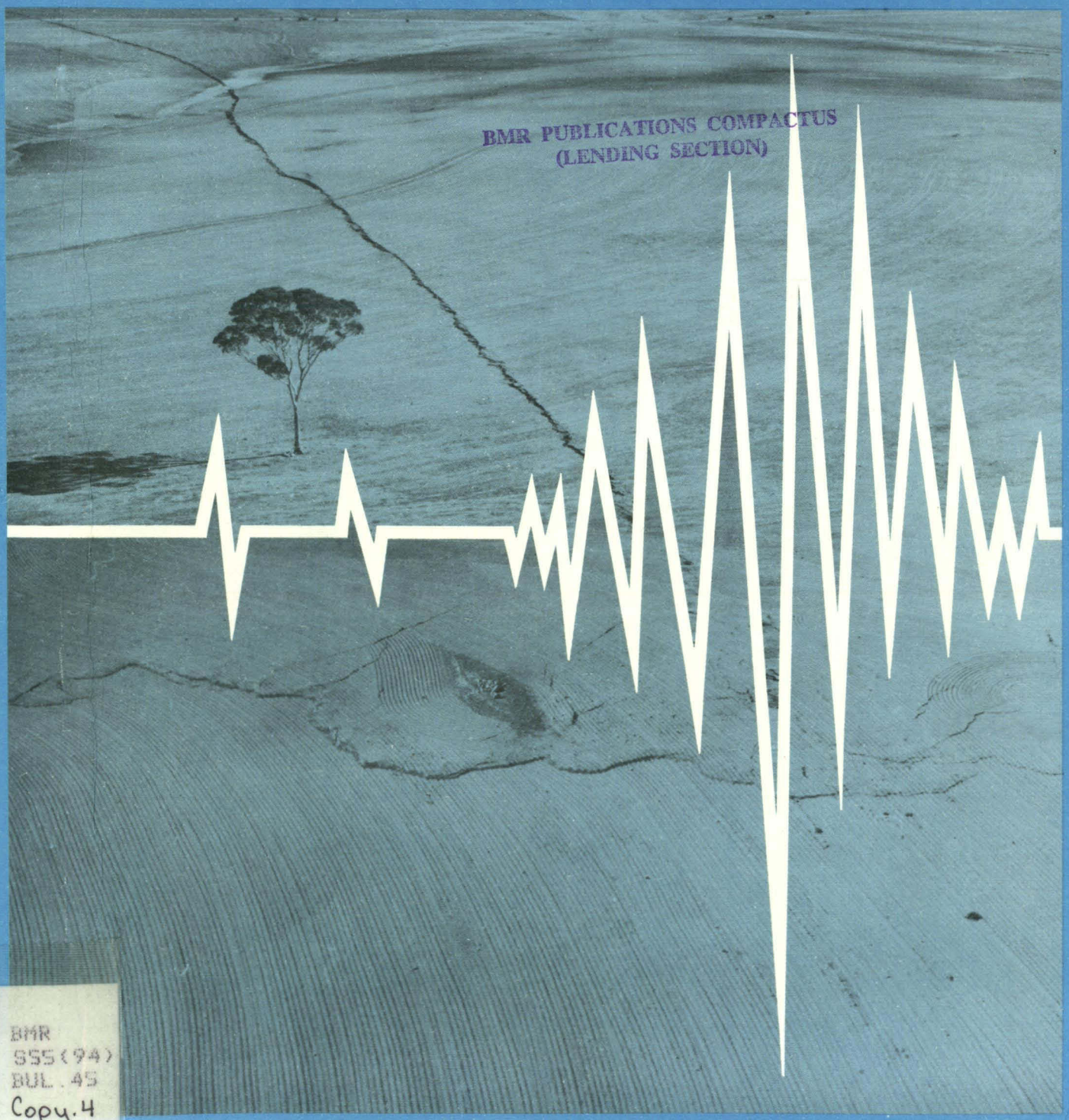
AUSTRALIA

Atlas of isoseismal maps of Australian earthquakes

BMR Bulletin
214

I.B. Everingham A.J. McEwin D. Denham



DEPARTMENT OF NATIONAL DEVELOPMENT & ENERGY
BUREAU OF MINERAL RESOURCES, GEOLOGY
AND GEOPHYSICS

BULLETIN 214

Atlas of Isoseismal Maps of Australian Earthquakes

Compiled by

I. B. EVERINGHAM, A. J. MCEWIN, & D. DENHAM

AUSTRALIAN GOVERNMENT PUBLISHING SERVICE
CANBERRA 1982

DEPARTMENT OF NATIONAL DEVELOPMENT & ENERGY

MINISTER: SENATOR THE HON. SIR JOHN CARRICK, K.C.M.G.

SECRETARY: A. J. WOODS

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

DIRECTOR: R. W. R. RUTLAND

Published for the Bureau of Mineral Resources, Geology and Geophysics by the Australian Government Publishing Service

ISBN 0 644 0189 6 8
ISSN 0084-7089

This Bulletin was edited by J. S. Adkins

Printed by Graphic Services Pty Ltd, 516-518 Grand Junction Road, Northfield, SA 5085

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ABSTRACT

This Atlas of isoseismal maps of Australian earthquakes contains the results of the ground intensity effects from all known Australian earthquakes for which adequate documentation is available. A total of 83 isoseismal maps are presented for 70 Australian earthquakes. The Atlas is arranged with each isoseismal map presented in chronological order, facing a page containing a brief description of the earthquake and the methods used to obtain the intensity data. References to the source of the map and to other publications that contain information on the earthquake's intensity are also given. The earliest map is from the July 1883 Mount Barker (SA) earthquake and the most recent from the November 1981 Suggan Buggan (NSW) earthquake.

The largest recorded earthquakes from the Australian continent have occurred in Western Australia. These were the 1941 Meeberrie and 1968 Meckering events, which have magnitudes of about ML 7, and were felt at distances of about 900 and 800 kilometres from their respective epicentres. In South Australia, the 1897 Beachport earthquake (magnitude 6.5) produced the greatest shaking and was felt about 600 kilometres from the epicentre; in eastern Australia, the 1935 Gayndah (Qld), 1961 Robertson-Bowral (NSW), and 1973 Picton (NSW) earthquakes were felt out to about 400 kilometres and the 1918 Bundaberg (Qld) earthquake was felt at distances of about 650 km.

The 1968 Meckering and June 1979 Cadoux earthquakes produced the highest observed ground shaking. Intensities of MM IX were experienced, and fault scarps, with throws of about a metre, extended over several kilometres for each earthquake. Intensities of MM VIII were recorded for the 1897 Beachport, 1902 Warooka, 1941 Meeberrie, 1949 Dalton-Gunning, and 1954 Adelaide earthquakes.

Total damage caused by the June 1979 Cadoux earthquake was 3.8 million dollars (1979 prices) and the 1968 Meckering earthquake, 2.2 million dollars (1968 prices). The 1954 Adelaide earthquake caused 4 million pounds damage at 1954 prices.

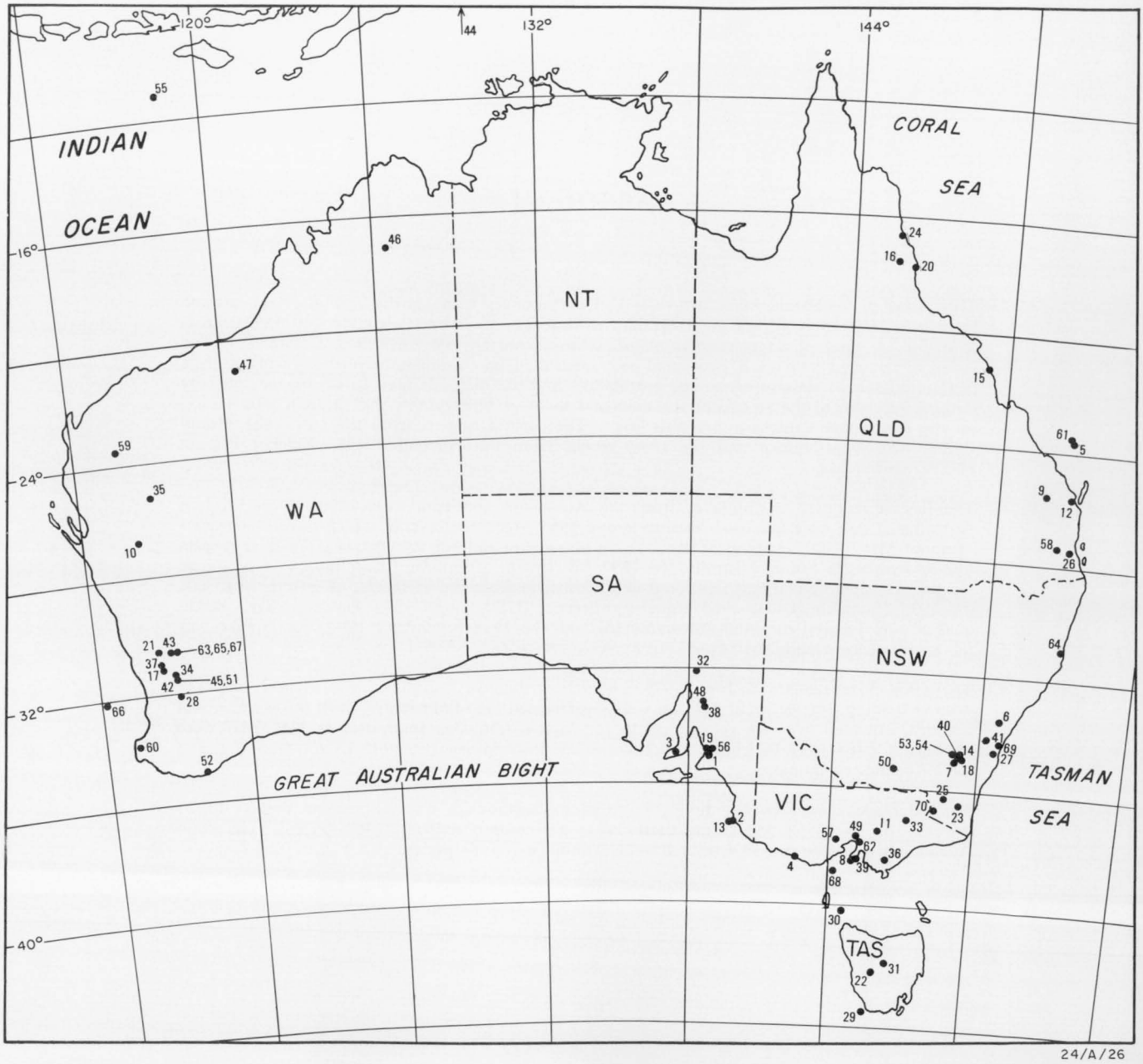


Fig. 1. Index map of Atlas earthquakes (see Table 1).

1. INTRODUCTION

Isoseismal maps show the distribution of the shaking effects of earthquakes and provide valuable information for estimates of earthquake risk. They are of particular significance in Australia where strong-motion instrumental data are scarce and difficult to obtain.

Isoseismal maps for Australian earthquakes have appeared in a large variety of publications, and some maps have been republished in small groups when used in specific earthquake risk studies (e.g. Everingham & Parkes, 1971; Bubb, 1971; McCue, 1973, 1975). However, the data as a whole are scatttered and not readily accessible, and as more macroseismic data are obtained, the problem of accessibility will be compounded.

The purpose of the Isoseismal Atlas is to provide a convenient medium for the assembly of intensity maps for Australian earthquakes i.e. a basic macroseismic data source. No attempt has been made to analyse the results in terms of attenuation studies or earthquake risk assessment. However, any such analyses must be consistent with the records presented here.

Terminology used in the text, maps, table, and map descriptions is defined in Appendix 1.

The Modified Mercalli (MM) scale, the basis of modern intensity estimates, is described in Appendix 2.

In the text, reference is frequently made to 'BMR' although 'BMR' does not appear in the References. In these instances the results have been obtained from the unpublished files and computer data lists of the Bureau of Mineral Resources, Geology and Geophysics, Canberra. BMR maintains the Australian National Earthquake Data Centre, where information on all located earthquakes occurring in the Australian region is recorded and updated.

2. EARTHQUAKE DATA

Table 1 lists details of earthquakes for which isoseismal maps are shown—the location of each earthquake is shown in Figure 1. The BMR earthquake computer file lists earthquake details from all sources, giving a preferred solution for each earthquake. In selecting hypocentres and magnitudes for the Atlas earthquakes, all solutions were examined carefully along with published information on the earthquakes.

Hypocentres

For earthquakes that occurred prior to 1958, instrumentally-determined hypocentres are either not available or have been inaccurately determined because instrumental recordings were rare and timing was inaccurate by modern standards. In fact, until the mid-1950s only five recording stations were in continuous operation on the Australian continent (Brisbane, Adelaide, Perth, Melbourne, and Sydney). Hence, most of the early earthquake maps show epicentres that have been determined from macroseismic observations; the epicentres are plotted in the zones of highest intensities. Exceptions are the 1941 Meeberrie and 1954 Adelaide earthquakes, for which hypocentres were redetermined during special studies—see Bolt (1959); McCue (1975).

Determinations of epicentres and depths for earthquakes after the late-1950s are more accurate than for earlier earthquakes but their accuracy can vary within this set. By the end of 1981 many more seismograph stations had been installed but there are still significant gaps in the coverage of Queensland, Western Australia, and northern New South Wales (see Fig. 2). The most accurate results have been obtained for those earthquakes with epicentres located within networks of stations and those which have been closely studied because they were felt over a wide area.

The focal depths of some earthquakes have been determined by using local network results or reliable depth phases recorded as teleseisms; these focal depths have been included in Table 1.

Magnitudes

For each earthquake, the magnitude determinations and the source of each determination are indicated in Table 1 and defined in Appendixes 1 & 3. Each magnitude was investigated to ensure that it was reliably determined from instrumental data because earthquake lists frequently give magnitudes that have been determined from intensity data (e.g. those of McCue, 1980) or have been determined by non-standard methods. Local magnitude (ML) was the most commonly determined magnitude and therefore will generally be referred to by researchers when analysing results. If more than one value of ML was available for any given earthquake then the ML determinations listed by Drake (1976) or McCue (1975) were preferred for eastern and southern Australian earthquakes respectively. In Western Australia, all ML values given were determined by BMR Mundaring Geophysical Observatory.

Reliable magnitude values for several earthquakes could not be determined instrumentally (from seismograms), therefore magnitudes calculated from macroseismic data are listed to give an idea of the size of the earthquakes. McCue's (1980) magnitude estimates derived from macroseismic information are listed wherever they are applicable; however, magnitudes found by this method should be treated as approximate values which may be revised as a result of further research.

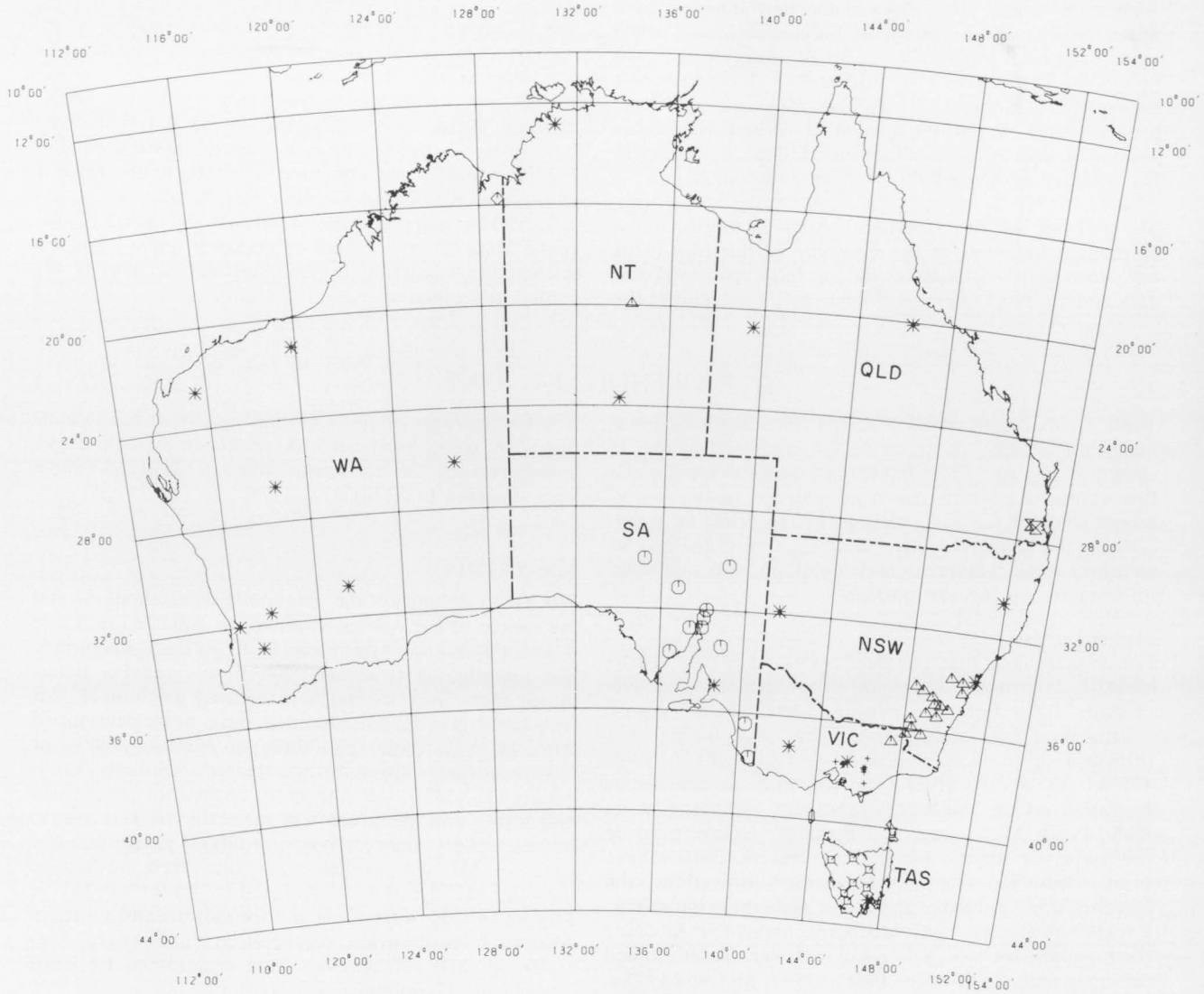


Fig. 2. Australian seismograph stations 1981.

3. ISOSEISMAL MAPS

Maps that have been published elsewhere are reproduced here without major modifications to the overall shape of the isoseismals; however, some minor modifications have been made to standardise the presentation. Isoseismals drawn over the sea have been eliminated but their trend is indicated by a single dash. A reference to each map is given in Table 1. Two maps are shown for some earthquakes because the maps were drawn by different authors, or because a detailed map was drawn for the epicentral area.

Most of the original maps used in the Atlas show intensities on the Modified Mercalli (MM) scale. Those maps for which the Rossi-Forel (RF) scale was originally used are presented here, and/or another map has been drawn by either converting the RF intensities to MM intensities using the correspondence of the two scales given by Richter (1958, p.651) or, if possible, by reassessing the felt reports. Hence, for each earthquake an isoseimal map is available with intensities shown on the MM scale.

Many of the original maps showed the isoseismals but not the basic information from which their shapes were established, namely the position and intensity for each observation point. These data have been added to published maps wherever they could be recovered. They should be included on every isoseismal map to permit future reinterpretation of the data and to provide a measure of the quality of the map. Because the Atlas maps were drawn by a large number of investigators, their methods of preparation are likely to be inconsistent. For example, it is well known that people experiencing their first earth tremor tend to exaggerate the felt effects; experienced investigators would allow for this when compiling data from observers reports, completed questionnaires etc.

The isoseismals on each map are drawn to enclose all intensity observations equal to or greater than a given intensity, ignoring isolated intensity reports which do not fit the general pattern. Thus, the isoseismals are smoothed to some extent. In recent surveys, observed intensities are sometimes given values of I^+ (where the intensity is estimated to be at least I but possibly greater), or I^- (where the intensity is thought to be lower than I but greater than I–1). The intensity I isoseismal is drawn to include I and I^+ observations and exclude I^- observations.

4. THE FUTURE

Because of the sparseness of instruments to record strong ground motion in Australia we will have to rely for many years on the careful analysis of felt intensities to assess earthquake risk. Therefore it is essential that a comprehensive and reliable source of these data is maintained. New isoseismal maps, of past and future earthquakes and possible revisions of existing isoseismal maps, will be covered by supplements to this Bulletin, to be issued as the need arises.

It is hoped that this Atlas will encourage earthquake seismologists throughout Australia to compile and maintain comprehensive records of the effects of future earthquakes so that the data set of earthquake effects can be enhanced.

5. ACKNOWLEDGEMENTS

The Atlas was finally compiled by the authors after the project had been initially worked on by several past and present members of the BMR Geomagnetism and Seismology Sub-section, notably J. Petkovich and P. Gidley. Their results, and those of others referred to in the text who made their maps available, are greatly appreciated.

We thank the staff of the BMR Cartographic Section who contributed to the drawing of the Atlas illustrations (in particular, I. Hartig), and S. Fereday, who designed the cover illustration.

TABLE 1. AUSTRALIAN ISOSEISMAL MAPS

No.	Locality	Origin time						Epicentre		Focal depth (km)	Magnitude						Map reference
		Yr	M	D	UT			Lat.°S	Long.°E		ML		MS		MB		
					H	M	S										
1	Mount Barker (SA)	1883	JUL	07	13	58		35.1	138.7	10	4.7	I					McCue (1975)
2A	Beachport (SA)	1897	MAY	10	05	26		37.33	139.75	14	6.5	I					Dodwell (1910)
2B	Beachport (SA)	1897	MAY	10	05	26		37.33	139.75	14	6.5	I					McCue (1975)
3A	Warooka (SA)	1902	SEP	19	10	35		35.0	137.4	14	6.0	I					Howchin (1917)
3B	Warooka (SA)	1902	SEP	19	10	35		35.0	137.4	14	6.0	I					Dodwell (1910)
4	Warrnambool (Vic.)	1903	JUL	14	10	29		38.43	142.53	10	5.3	I					McCue (1978)
5A	Bundaberg (Qld)	1918	JUN	06	18	14	24	23.5	152.5		6.0	RIV	5.8	BMR			Hedley (1925)
5B	Bundaberg (Qld)	1918	JUN	06	18	14	24	23.5	152.5		6.0	RIV	5.8	BMR			Rynn (1981)
6	Kurrajong (NSW)	1919	AUG	15	10	21	21	33.5	150.7		4.6	RIV					Cotton (1921)
7	Murrumbateman (NSW)	1924	MAR	06	23	45	00	34.9	149.0		4.0	I					Cotton (1925)
8	Mornington (Vic.)	1932	SEP	02	18	22	32	38.3	145.0		4.5	MEL	4.2	BMR			Holmes (1933)
9	Gayndah (Qld)	1935	APR	12	01	32	22	25.5	151.7		5.2	I	5.4	BMR			Bryan & Whitehouse (1938)
10A	Meeberrie (WA)	1941	APR	29	01	35	41	26.8	116.1	33	7.2	MUN	6.8	GR	7.3	MUN	Clarke & others (1955)
10B	Meeberrie (WA)	1941	APR	29	01	35	41	26.8	116.1	33	7.2	MUN	6.8	GR	7.3	MUN	Denham (1979)
11	Marysville (Vic.)	1944	NOV	02	14	05	43	37.5	145.9		4.0	I					Gaskin (1947)
12	Maryborough (Qld)	1947	JUN	11	10	03	13	25.5	152.7	33	4.0	I					Jones (1948)
13	Robe (SA)	1948	AUG	06	03	29	23	37.36	139.68		5.6	I	5.4	BMR			McCue (1975)
14A	Dalton-Gunning (NSW)	1949	MAR	10	22	30	33	34.74	149.20		5.5	RIV	4.6	BMR			Joklik (1950)
14B	Dalton-Gunning (NSW)	1949	MAR	10	22	30	33	34.74	149.20		5.5	RIV	4.6	BMR			Joklik (1950)
15	Mackay (Qld)	1950	APR	05	19	50	52	21.1	149.2		4.4	I					Webb & others (in prep.)
16	Atherton (Qld)	1950	JUN	19	09	00	00	17.5	145.5		4.0	I					Webb & others (in prep.)
17	Bolgart (WA)	1952	MAR	11	06	09		31.3	116.5		5.1	I					BMR
18	Gunning (NSW)	1952	NOV	19	01	59	16	34.8	149.25		4.9	RIV	3.6	BMR			Joklik & Casey (1952)
19A	Adelaide (SA)	1954	FEB	28	18	09	52	34.93	138.69	4	5.4	I	4.9	BMR			Kerr-Grant (1956)
19B	Adelaide (SA)	1954	FEB	28	18	09	52	34.93	138.69	4	5.4	I	4.9	BMR			Kerr-Grant (1956)
20	Mourilyan (Qld)	1954	MAY	04	07	05	00	17.7	146.0		4.4	I					Webb & others (in prep.)
21	Gabalong (WA)	1955	AUG	30	13	52		30.7	116.4		5.8	I					BMR
22	Queenstown (Tas.)	1958	JAN	01	00	07	00	42.2	146.1		5.3	RIV					Ripper (1963)
23	Rock Flat (NSW)	1958	SEP	01	11	18	32	36.40	149.24	11	4.0	CAN					Cleary & others (1964)
24	Cairns (Qld)	1958	DEC	01	10	38	33	16.5	145.5		4.4	I					Webb & others (in prep.)
25	Berridale (NSW)	1959	MAY	18	06	13	00	36.22	148.64	15	5.3	RIV	3.8	BMR			Cleary & others (1964)
26A	Mount Glorious (Qld)	1960	NOV	17	05	00	17	27.33	152.85		4.4	BRS					Bauer (1972)
26B	Mount Glorious (Qld)	1960	NOV	17	05	00	17	27.33	152.85		4.4	BRS					Bauer (1972)
27A	Robertson-Bowral (NSW)	1961	MAY	21	21	40	02	34.55	150.50	19	5.6	RIV					Cooney (1962)
27B	Robertson-Bowral (NSW)	1961	MAY	21	21	40	02	34.55	150.50	19	5.6	RIV					Cleary & Doyle (1962)
28	Nourning Spring (WA)	1963	JAN	18	05	49	16	32.25	117.17	18	4.9	MUN	4.1	MUN	5.4	MUN	Everingham (1968)
29	Port Davey (Tas.)	1963	NOV	03	12	00	40	43.49	145.80	10	4.4	BMR	3.9	BMR			Ripper (1963)
30	Bass Strait (Tas.)	1964	NOV	14	10	53	04	40.22	144.60		4.5	TAU					Green & others (1965)
31	Great Lake (Tas.)	1964	DEC	09	16	38	41	41.80	146.63		3.4	TAU					Green & others (1965)
32	Quorn (SA)	1965	AUG	28	00	26	39	32.23	138.30	16	5.0	ADE			4.9	GS	Sutton & White (1968)
33	Mount Hotham (Vic.)	1966	MAY	03	19	07	54	37.04	147.13	8	5.0	RIV			4.3	ISC	Underwood (1967)
34A	Meckering (WA)	1968	OCT	14	02	58	50	31.60	117.00	5	6.9	MUN	6.8	GS	6.0	GS	Everingham & Gregson (197(
34B	Meckering (WA)	1968	OCT	14	02	58	50	31.60	117.00	5	6.9	MUN	6.8	GS	6.0	GS	Everingham & Gregson (197(
35	Landor (WA)	1969	JUN	17	19	54	32	25.26	116.73		5.6	MUN	5.1	MUN	5.7	MUN	Everingham & Parkes (1971)
36	South Gippsland (Vic.)	1969	JUN	20	11	15	28	38.47	146.30	19	5.3	RIV	4.8	PMG			Wilkie (1970)
37A	Calingiri (WA)	1970	MAR	10	17	15	11	31.11	116.47	1	5.1	MUN	5.1	MUN	5.7	GS	Everingham & Parkes (1971)
37B	Calingiri (WA)	1970	MAR	10	17	15	11	31.11	116.47	1	5.1	MUN	5.1	MUN	5.7	GS	Everingham & Parkes (1971)
38	Spalding (SA)	1971	JAN	06	23	54	30	33.46	138.56	12	4.6	ADE					Stewart & Sutton (1971)
39	Western Port (Vic.)	1971	JUL	06	21	55	01	38.42	145.11	23	5.0	ADE	4.9	GS			Bishop & Cresswell (1972)
40	Dalton (NSW)	1971	NOV	03	20	05	37	34.78	149.17	3	4.2	RIV					BMR
41A	Picton (NSW)	1973	MAR	09	19	09	14	34.14	150.29	20	5.5	RIV	5.3	BMR	5.5	GS	Denham (1976)
41B	Picton (NSW)	1973	MAR	09	19	09	14	34.14	150.29	20	5.5	RIV	5.3	BMR	5.5	GS	Denham (1976)
42	Meckering (WA)	1974	JUL	09	10	46	47	31.65	117.00		4.3	MUN			5.3	MUN	Gregson & Smith (1975)
43	Manmanning (WA)	1974	SEP	04	23	17	42	30.79	116.97		4.5	MUN			5.8	MUN	Gregson & Smith (1975)
44	Banda Sea	1974	OCT	29	03	14	15	6.88	129.46	117			6.6	PAS	6.5	GS	BMR
45	Meckering (WA)	1974	NOV	19	09	30	23	31.63	117.03		4.0	MUN					Gregson & Smith (1975)
46	Kimberley (WA)	1975	MAR	06	23	51	26	17.08	126.38						5.2	MUN	Gregson & Smith (1976)
47	Marble Bar (WA)	1975	JUL	24	22	23	42	21.09	120.47	33					5.1	MUN	Gregson & Smith (1976)
48	Gladstone (SA)	1976	FEB	27	11	44	51	33.30	138.45	8	3.6	ADE					McCue (pers. comm., 1980)
49	Preston (Vic.)	1976	JUL	09	08	27	40	37.73	145.03		1.3	PIT					Gibson & others (1981)
50	Lockhart (NSW)	1976	AUG	23	19	14	51	35.30	146.47	4	4.2	RIV					BMR
51	Meckering (WA)	1976	OCT	29	06	04	48	31.64	117.00		4.7	MUN					Gregson (1977)
52	Albany (WA)	1977	MAY	15	19	16	08	35.00	117.95		4.5	MUN			3.9	GS	Gregson (1978)
53	Bowning (NSW)	1977	JUN	30	12	48	22	34.67	148.87	12	4.5	CAN					Smith & McEwin (1980)
54	Bowning (NSW)	1977	JUL	04	20	05	20	34.65	148.89	13	5.0	CAN			4.2	GS	Smith & McEwin (1980)
55	Indonesia	1977	AUG	19	06	08	51	11.16	118.41	33			7.9	GS	7.0	GS	Gregson & others (1979)
56	Adelaide (SA)	1977	AUG	20	21	55	20	34.91	138.89	22	3.4	ADE					McCue & Sutton (1979)
57	Balliang (Vic.)	1977	DEC	02	13	32	33	37.86	144.26	15	4.5	CAN					Gibson & others (1981)
58	Esk (Qld)	1978	APR	26	11	53	14	27.23	152.31		3.5	BRS					Rynn & Webb (in press)
59	Maroonah Homestead (WA)	1978	MAY	01	03	42	53	23.64	115.59		5.7	MUN					Gregson (1980a)
60	Margaret River (WA)	1978	JUN	09	12	31	18	33.93	115.20		3.0	MUN					Gregson (1980a)
61	Heron Island (Qld)	1978	NOV	28	17	33	36	23.36	152.43	12	5.0	UNQ			4.8	UNQ	Rynn & others (in press)
62	Scoresby (Vic.)	1979	APR	16	23	24	47	37.89	145.25	2	2.6	PIT					Gibson & others (1981)
63A	Cadoux (WA)	1979	JUN	02	09	48	01	30.79	117.16	15	6.2	MUN	6.2	BMR	6.0	GS	Gregson (1980b)
63B	Cadoux (WA)	1979	JUN	02	09	48	01	30.79	117.16	15	6.2	MUN	6.2	BMR	6.0	GS	Lewis (in press)
64	Kempsey (NSW)	1979	SEP	06	13	07	59	30.87	152.98		3.1	BMR					Rynn (pers. comm., 1980)
65	Cadoux (WA)	1979	OCT	11	04	04	12	30.79	117.15	15	4.8	MUN			5.0	GS	Gregson (1980b)
66	Offshore Fremantle (WA)	1980	DEC	08	00	12	08	32.12	114.11	37	5.2	MUN			4.6	GS	Gregson (1982)
67	Cadoux (WA)	1980	DEC	10	04	35	06	30.73	117.15	13	5.0	MUN			4.0	GS	Gregson (1982)
68A	Bass Strait (Vic.)	1981	JUN	16	21	35	56	38.90	144.20	15	4.9	BMR	4.2	BMR			BMR
68B	Bass Strait (Vic.)	1981	JUN	16	21	35	56	38.90	144.20	15	4.9	BMR	4.2	BMR			BMR
69	Appin (NSW)	1981	NOV	15	16	58	10	34.25	150.90	14	4.6	BMR	3.9	BMR	4.3	BMR	Denham & others (in prep.)
70	Suggan Buggan (NSW)	1981	NOV	30	02	09	08	36.69	148.33	7	3.7	BMR					BMR

Note: 1. Appendix 3 lists the sources of magnitude determinations.
2. Figure 1 shows the location of each earthquake listed in Table 1.

6. REFERENCES

BÅTH, M., 1981—Earthquake magnitude—recent research and current trends. *Earth-Science Reviews*, 17, 315-398.

BAUER, J. A., 1972—The earthquake of 17 November 1960, in the Mount Glorious region, southeastern Queensland. *B.Sc. Thesis; University of Queensland, Department of Geology and Mineralogy, Brisbane* (unpublished).

BISHOP, I. D., & CRESSWELL, L. A., 1972—The Western Port earthquake of 6 July 1971. *Proceedings of the Royal Society of Victoria*, 85, 70-71

BOLT, B. A., 1959—Seismic travel times in Australia. *Journal of the Proceedings of the Royal Society of New South Wales*, 92, 64-72.

BRYAN, W. H., & WHITEHOUSE, F. W., 1938—The Gayndah earthquake of 1935. *Royal Society of Queensland Proceedings*, 49(10), 106-119.

BUBB, C. T. J., 1971—On the seismicity of Australia. *DIC Dissertation, Imperial College, London* (unpublished).

CLARKE, E. DE C., PRIDER, R. T., & TEICHERT, C., 1955—ELEMENTS OF GEOLOGY FOR WESTERN AUSTRALIAN STUDENTS, 3rd Edition. *University of Western Australia Press, Perth.*

CLEARY, J., & DOYLE, H. A., 1962—Application of a seismograph network and electronic computer in near earthquake studies. *Bulletin of the Seismological Society of America*, 52, 673-682.

CLEARY, J. R., DOYLE, H. A., & MOYE, D. G., 1964—Seismic activity in the Snowy Mountains region and its relationship to geological structures. *Journal of the Geological Society of Australia*, 11, 89-106.

COONEY, G. H., 1962—The New South Wales earthquake of May 22, 1961. *Australian Journal of Physics*, 15, 536-548.

COTTON, L. A., 1921—The Kurrajong earthquake of August 15, 1919. *Journal of the Proceedings of the Royal Society of New South Wales*, 55, 83-104

COTTON, L. A., 1925—Note on the earthquakes at Murrumbateman during March and April, 1924, and January to April, 1925. *Journal of the Proceedings of the Royal Society of New South Wales*, 59, 325-328.

DAYEH, R. J., 1976—Some structural damage caused by the 1973 Picton earthquake. *In* DENHAM, D. (Editor)—Seismicity and earthquake risk in eastern Australia *Bureau of Mineral Resources, Australia, Bulletin* 164, 33-39,

DENHAM, D., 1976—Effects of the 1973 Picton and other earthquakes in eastern Australia. *In* DENHAM, D. (Editor)—Seismicity and earthquake risk in eastern Australia. *Bureau of Mineral Resources, Australia, Bulletin* 164, 15-28.

DENHAM, D., 1979—Earthquake hazard in Australia. *In* HEATHCOTE, R. L., & THOM, B. G. (Editors)—NATURAL HAZARDS IN AUSTRALIA. *Australian Academy of Science, Canberra*, 94-118.

DENHAM, D., BOCK, G., & SMITH, R. S., in preparation—The Appin (New Souh Wales) earthquake of 15 November, 1981. *BMR Journal of Australian Geology & Geophysics.*

DODWELL, G. F., 1910—South Australian earthquakes. *Report of the Australian Association for the Advancement of Science*, 12, 416-423.

DRAKE, L., 1976—Seismic risk in Australia. *Journal of the Proceedings of the Royal Society of New South Wales*, 109, 115-121.

EIBY, G. A., 1966—The Modified Mercalli Scale of earthquake intensity and its use in New Zealand. *New Zealand Journal of Geology and Geophysics*, 9, 1-2,

EVERINGHAM, I. B., 1968—Seismicity of Western Australia. *Bureau of Mineral Resources, Australia, Report* 132.

EVERINGHAM, I. B., & GREGSON, P. J., 1970—Meckering earthquake intensities and notes on earthquake risk in Western Australia. *Bureau of Mineral Resources, Australia, Record* 1970/97 (unpublished).

EVERINGHAM, I. B., & PARKES, A. A., 1971—Intensity data for earthquakes at Landor (17 June 1969) and Calingiri (10 March 1970) and their relationship to previous Western Australian earthquakes. *Bureau of Mineral Resources, Australia, Record* 1971/80 (unpublished).

EVERINGHAM, I. B., & TILBURY, L., 1972—Information on Western Australia earthquakes 1849-1960. *Journal of the Royal Society of Western Australia*, 55(3), 90-96.

EVERINGHAM, I. B., GREGSON, P. J., & DOYLE, H. A., 1969—Thrust fault scarp in the Western Australian Shield. *Nature*, 223, 701-703.

GASKIN, A. J., 1947—The Victorian earth tremor of 3rd November, 1944. *Proceedings of the Royal Society of Victoria*, 58, 66-69.

GIBSON, G., WESSON, V., & CUTHBERTSON. R., 1981—Seismicity of Victoria to 1980. *Journal of the Geological Society of Australia*, 28(3/), 341-356.

GORDON, F. R., & LEWIS, J. D., 1980—The Meckering and Calingiri earthquakes, October 1968 and March 1970. *Geological Survey of Western Australia, Bulletin* 126.

GREEN, R., DAFENEY, C., NEWSTEAD, G. H., WATT, P., & MUIRHEAD, K., 1965—Seismological investigations in Tasmania. *In* RINGWOOD. A. E. (Compiler)—International Council of Scientific Unions Upper Mantle Project. Australian Progress Report 1960-65. *Australian Academy of Science, Canberra*, 7-18.

GREGSON, P. J., 1977—Mundaring Geophysical Observatory Annual Report, 1976. *Bureau of Mineral Resources, Australia, Record* 1977/7 (unpublished).

GREGSON, P. J., 1978—Mundaring Geophysical Observatory Annual Report, 1977. *Bureau of Mineral Resources, Australia, Record* 1978/73 (unpublished).

GREGSON, P. J., 1980a—Mundaring Geophysical Observatory Annual Report, 1978. *Bureau of Mineral Resources, Australia, Record* 1980/40 (unpublished).

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

GREGSON, P. J., 1982—Mundaring Geophysical Observatory Annual Report, 1980. *Bureau of Mineral Resources, Australia, Record* 1982/9 (unpublished).

GREGSON, P. J., & PAULL, E. P., 1979—Preliminary report on the Cadoux earthquake, W. A., 2 June 1979. *Bureau of Mineral Resources, Australia, Report* 215.

GREGSON, P. J., & SMITH, R. S., 1975—Mundaring Geophysical Observatory Annual Report, 1974. *Bureau of Mineral Resources, Australia, Record* 1975/143 (unpublished).

GREGSON, P. J., & SMITH, R. S., 1976—Mundaring Geophysical Observatory Annual Report, 1975. *Bureau of Mineral Resources, Australia, Record* 1976/48 (unpublished).

GREGSON, P. J., PAULL, E. P., & GAULL, B. A., 1979—The effects in Western Australia of a major earthquake in Indonesia on 19 August 1977. *BMR Journal of Australian Geology & Geophysics*, 4, 135-140.

GUTENBERG, B., & RICHTER, C. F., 1954—SEISMICITY OF THE EARTH, 2nd Edition. *Princeton University Press, Princeton, New Jersey.*

HEDLEY, C., 1925—The Queensland earthquake of 1918. *Transactions of the Royal Geographical Society of Australasia, Queensland*, No. 16, 151-156.

HOLMES, W. M., 1933—The Mornington earth tremor of 3rd September, 1932. *Transactions of the Royal Society of Victoria*, 45(2), 150-151.

HOWCHIN, W., 1917—THE GEOGRAPHY OF SOUTH AUSTRALIA. Revised Edition. *Whitcombe & Tombs, Christchurch, New Zealand.*

HOWCHIN, W., 1918—THE GEOLOGY OF SOUTH AUSTRALIA. *Publication of the Education Department, Adelaide, South Australia.*

JOKLIK, G. F., 1950—Dalton-Gunning area, N.S.W., earth tremors of March 1949. *Journal of the Proceedings of the Royal Society of New South Wales*, 84, 17-27.

JOKLIK, G. F., & CASEY, J. N., 1952—Gunning district N.S.W.—Earth tremors November, 1952. *Bureau of Mineral Resources, Australia, Record* 1952/91 (unpublished).

JONES, O. A., 1948—The Maryborough earthquake of 1947. *University of Queensland Papers, Department of Geology,* 3(6).

KERR-GRANT, C., 1956—The Adelaide earthquake of 1st March 1954. *Transactions of the Royal Society of South Australia,* 59, 177-185.

LEWIS, J. D., in press—The Cadoux earthquake, June 1979. *Western Australian Geological Survey Report,* 11.

McCUE, K. F., 1973—On the seismicity of Western Australia, Parts 1 and 2. *Report of the Commonwealth Department of Works, Australia.*

McCUE, K. F., 1975—Seismicity and seismic risk in South Australia. *University of Adelaide Report,* ADP 137.

McCUE, K. F., 1978—The value of historical records—the Warrnambool earthquake of July 1903. *Proceedings of the Royal Society of Victoria,* 90, 245-250.

McCUE, K. F., 1980—Magnitudes of some early earthquakes in southeastern Australia. *Search,* 11(3), 78-80.

McCUE, K. F., & SUTTON, D. J., 1979—South Australian earthquakes during 1976 and 1977. *Journal of the Geological Society of Australia,* 26, 231-236.

McGREGOR, P. M., & RIPPER, I. D., 1976—Notes on magnitude scales. *Bureau of Mineral Resources, Australia, Record* 1976/56 (unpublished).

RICHTER, C. F., 1935—An instrumental earthquake magnitude scale. *Bulletin of the Seismological Society of America,* 25, 1-32.

RICHTER, C. F., 1958—ELEMENTARY SEISMOLOGY. *Freeman and Company, San Francisco.*

RIPPER, I. D., 1963—Local and regional events recorded by the Tasmania seismic net. *Honours Thesis, University of Tasmania, Hobart* (unpublished).

RYNN, J. M. W., 1981—A reappraisal of Queensland's largest earthquake—the 'Queensland' earthquake of 6 June 1918 (magnitude about 6). *Papers of the Department of Geology, University of Queensland.*

RYNN, J. M. W., & WEBB, J. P., in press—The Esk, southeast Queensland earthquake of 26 April, 1978. *Papers of the Department of Geology, University of Queensland.*

RYNN, J. M. W., WEBB, J. P., & FLOOD, P. G., in preparation—The Capricornia (Heron Is) earthquakes of 28 November 1978—An initial study of the seismicity and tectonics along the passive continental margin of Central Eastern Queensland, Australia.

SMITH, R. S., & McEWIN, A. J., 1980—Earthquake accelerograms and attenuation of seismic waves at Oolong, NSW. *BMR Journal of Australian Geology & Geophysics,* 5, 63-67.

STEWART, I. C. F., & SUTTON, D. J., 1971—The South Australian earthquake of January 7, 1971, and aftershocks. *Journal of the Geological Society of Australia,* 18, 201-205.

SUTTON, D. J., & WHITE, R. E., 1968—The seismcity of South Australia. *Journal of the Geological Society of Australia,* 15, 25-32.

SUTTON, D. J., McCUE, K. F., & BUGEJA, A., 1977—Seismicity of the southwest of South Australia. *Journal of the Geological Society of Australia,* 25, 357-364.

UNDERWOOD, R., 1967—The seismic network and its applications. *Ph.D. Thesis, Australian National University, Canberra* (unpublished).

UNDERWOOD, R., 1973—Studies in Victorian seismicity. *Proceedings of the Royal Society of Victoria,* 85, 27-48.

WEBB, J. P., RYNN, J. M. W., LYNAM, C. J., & MILLICAN, J. M., in preparation—The Seismicity of Queensland—1875 to 1981.

WILKIE, J. R., 1970—The south Gippsland earthquake of 20 June, 1969. *Bureau of Mineral Resources, Australia, Record* 1970/91 (unpublished).

APPENDIX 1: TERMINOLOGY

ACCELEROMETER. A seismograph for measuring ground acceleration as a function of time.

ACTIVE FAULT. A fault along which slip has occurred in historical (or Holocene) time, or on which earthquake foci are located.

AFTERSHOCKS. Smaller earthquakes following the largest earthquake of a series concentrated in a restricted crustal volume.

EARTHQUAKE. The vibrations of the Earth caused by the passage of seismic waves radiating from some source of elastic energy.

EPICENTRE. The point on the Earth's surface directly above the focus (or hypocentre) of an earthquake.

FAULT. A fracture or zone of fractures in rock along which the two sides have been displaced relative to each other parallel to the fracture. The total fault offset may range from one millimetre for very small earthquakes to ten metres for the Earth's largest shocks.

FOCAL DEPTH (OF EARTHQUAKES). The depth of the focus (hypocentre) below the surface of the Earth.

FOCUS (HYPOCENTRE). The place at which rupture commences.

FORESHOCKS. Smaller earthquakes preceding the largest earthquake of a series concentrated in a restricted crustal volume.

HYPOCENTRE (FOCUS). The place at which rupture commences.

INTENSITY (OF EARTHQUAKES). A measure of ground shaking obtained from the damage done to structures built by man, changes in the Earth's surface, and felt reports (see Appendix 2).

INTENSITY QUESTIONNAIRE. Special form or card listing questions designed about the Modified Mercalli scale of intensity to which simple answers indicate the intensity of an earthquake. The answers to these questionnaires gathered from an area around a felt earthquake can be integrated with field observations and other reports in drawing isoseismal maps (see Appendix 4).

ISOSEISMALS. Contour lines drawn to separate one level of seismic intensity from another.

MACROSEISMIC EFFECTS (OF EARTHQUAKES). Those effects that can be observed on a large scale in the field without instrumental aid.

MAGNITUDE. A quantity that is characteristic of the total energy released by an earthquake, in contrast to 'intensity' which subjectively describes earthquake effects at a particular place. Richter (1935) devised the logarithmic magnitude scale in current use to define local magnitude (ML) in terms of the motion that would be measured by a standard type of seismograph located 100 km from the epicentre of an earthquake. Several other magnitude scales are also in use, for example body-wave magnitude (MB) and surface-wave magnitude (MS), which use body waves and surface waves respectively. The scale is open-ended, but the largest known earthquake magnitudes are about MS 8.5. For magnitude relations see McGregor & Ripper (1976) or Båth (1981).

MAGNITUDE SOURCE. The seismological centre whose methods or results are used for the magnitude determination listed in Table 1 and on each isoseismal map. A list of magnitude sources is given in Appendix 3.

MEIZOSEISMAL REGION. The area of strong shaking and significant damage in an earthquake.

MODIFIED MERCALLI (MM) SCALE. A numerical index describing the effects of an earthquake. The scale in common use today is the Modified Mercalli scale of 1931, with intensity values indicated by capital Roman numerals from I to XII. The narrative descriptions of each intensity value are given in Appendix 2.

RISK (SEISMIC). The relative risk is the comparative earthquake hazard from one site to another. The probabilistic risk is the odds of earthquake occurrence within a given time interval and region.

ROSSI-FOREL (RF) SCALE. A numerical index describing the effects of an earthquake (in common use before the adoption of the MM scale in about 1931).

SCARP (FAULT). A cliff or steep slope formed by displacement of the ground surface.

SEICHE OSCILLATION. Resonant oscillation in closed or semiclosed bodies of water.

SEISMICITY. The distribution of earthquakes in space and time.

SEISMOGRAPH. An instrument for recording, as a function of time, the motions of the Earth's surface that are caused by seismic waves.

SEISMOLOGY. The study of earthquakes, seismic sources, and wave propagation through the Earth.

STRONG GROUND MOTION. The shaking of the ground near an earthquake source made up of large amplitude seismic waves of various types.

TELESEISM. An earthquake recorded by a seismograph at a great distance from the source, i.e. over 1000 km.

APPENDIX 2: MODIFIED MERCALLI (MM) SCALE OF EARTHQUAKE INTENSITY

(New Zealand version, 1965, after Eiby, 1966)

MM I Not felt by humans, except in especially favourable circumstances, but birds and animals may be disturbed. Reported mainly from the upper floors of buildings more than ten storeys high. Dizziness or nausea may be experienced. Branches of trees, chandeliers, doors, and other suspended systems of long natural period may be seen to move slowly. Water in ponds, lakes, reservoirs, etc., may be set into seiche oscillation.

MM II Felt by a few persons at rest indoors, especially by those on upper floors or otherwise favourably placed. The long-period effects listed under MM I may be more noticeable.

MM III Felt indoors, but not identified as an earthquake by everyone. Vibrations may be likened to the passing of light traffic. It may be possible to estimate the duration, but not the direction. Hanging objects may swing slightly. Standing motorcars may rock slightly.

MM IV Generally noticed indoors, but not outside. Very light sleepers may be awakened. Vibration may be likened to the passing of heavy traffic, or to the jolt of a heavy object falling or striking the building. Walls and frame of building are heard to creak. Doors and windows rattle. Glassware and crockery rattles. Liquids in open vessels may be slightly disturbed. Standing motorcars may rock, and the shock can be felt by their occupants.

MM V Generally felt outside, and by almost everyone indoors. Most sleepers awakened. A few people frightened. Direction of motion can be estimated. Small unstable objects are displaced or upset. Some glassware and crockery may be broken. Some windows cracked. A few earthware toilet fixtures cracked. Hanging pictures move. Doors and shutters swing. Pendulum clocks stop, start, or change rate.

MM VI Felt by all. People and animals alarmed. Many run outside. Difficulty experienced in walking steadily. Slight damage to Masonry D. Some plaster cracks or falls. Isolated cases of chimney damage. Windows, glassware, and crockery broken. Objects fall from shelves, and pictures from walls. Heavy furniture moved. Unstable furniture overturned. Small church and school bells ring. Trees and bushes shake, or are heard to rustle. Loose material may be dislodged from existing slips, talus slopes, or shingle slides.

MM VII General alarm. Difficulty experienced in standing. Noticed by drivers of motorcars. Trees and bushes strongly shaken. Large bells ring. Masonry D cracked and damaged. A few instances of damage to Masonry C. Loose brickwork and tiles dislodged. Unbraced parapets and architectural ornaments may fall. Stone walls cracked. Weak chimneys broken, usually at the roof-line. Domestic water tanks burst. Concrete irrigation ditches damaged. Waves seen on ponds and lakes. Water made turbid by stirred-up mud. Small slips, and caving-in of sand and gravel banks.

MM VIII Alarm may approach panic. Steering of motorcars affected. Masonry C damaged, with partial collapse. Masonry B damaged in some cases. Masonry A undamaged. Chimneys, factory stacks, monuments, towers, and elevated tanks twisted or brought down. Panel walls thrown out of frame structures. Some brick veneers damaged. Decayed wooden piles broken. Frame houses not secured to the foundation may move. Cracks appear on steep slopes and in wet ground. Landslips in roadside cuttings and unsupported excavations. Some tree branches may be broken off.

MM IX General panic. Masonry D destroyed. Masonry C heavily damaged, sometimes collapsing completely. Masonry B seriously damaged. Frame structures racked and distorted. Damage to foundations general. Frame houses not secured to the foundations shifted off. Brick veneer fall and expose frames. Cracking of the ground conspicuous. Minor damage to paths and roadways. Sand and mud ejected in alluviated areas, with the formation of earthquake fountains and sand craters. Underground pipes broken. Serious damage to reservoirs.

MM X Most masonry structures destroyed, together with their foundations. Some well-built wooden buildings and bridges seriously damaged. Dams, dykes, and embankments seriously damaged. Railway lines slightly bent. Cement and asphalt roads and pavements badly cracked or thrown into waves. Large landslides on river banks and steep coasts. Sand and mud on beaches and flat land moved horizontally. Large and spectacular sand and mud fountains. Water from rivers, lakes, and canals thrown up on the banks.

MM XI Wooden frame structures destroyed. Great damage to railway lines. Great damage to underground pipes.

MM XII Damage virtually total. Practically all works of construction destroyed or greatly damaged. Large rock masses displaced. Lines of slight and level distorted. Visible wave-motion of the ground surface reported. Objects thrown upwards into the air.

Categories of non-wooden construction

Masonry A. Structures designed to resist lateral forces of about 0.1 g, such as those satisfying the New Zealand Model Building Bylaw, 1955. Typical buildings of this kind are well reinforced by means of steel or ferro-concrete bands, or are wholly of ferro-concrete construction. All mortar is of good quality and the design and workmanship is good. Few buildings erected prior to 1935 can be regarded as Masonry A.

Masonry B. Reinforced buildings of good workmanship and with some mortar, but not designed in detail to resist lateral forces.

Masonry C. Buildings of ordinary workmanship, with mortar of average quality. No extreme weakness, such as inadequate bonding of the corners, but neither designed nor reinforced to resist lateral forces.

Masonry D. Building with low standards of workmanship, poor mortar, or constructed of weak materials like mud brick and rammed earth. Weak horizontally.

Windows Window breakage depends greatly upon the nature of the frame and its orientation with respect to the earthquake source. Windows cracked at MM V are usually either large display windows, or windows tightly fitted to metal frames.

Chimneys The 'weak chimneys' listed under MM VII are unreinforced domestic chimneys of brick, concrete block, or poured concrete.

Water tanks The 'domestic water tanks' listed under MM VII are of the cylindrical corrugated-iron type common in New Zealand rural areas. If these are only partly full, movement of the water may burst soldered and riveted seams. Hot-water cylinders constrained only by supply and delivery pipes may move sufficiently to break pipes at about the same intensity.

APPENDIX 3: MAGNITUDE SOURCES

Estimates of earthquake magnitudes have been obtained from several sources. The table below identifies the agencies that provided the estimates from the codes on the Atlas maps. 'I' indicates that the magnitude has been estimated from intensity results as per McCue (1980).

ADE — University of Adelaide, Adelaide (SA)
BMR — Bureau of Mineral Resources, Geology and Geophysics, Canberra (ACT)
BRS — University of Queensland, Brisbane (Qld)
CAN — Australian National University, Canberra (ACT)
GR — Gutenberg & Richter (1954)
GS — United States Geological Survey—National Earthquake Information Service (NEIS) (USA)
I — Magnitude determined from intensity data
ISC — International Seismological Centre (UK)
MEL — BMR Melbourne Ovservatory Group, Melbourne (Vic.)
MUN — BMR Mundaring Geophysical Observatory, Perth (WA)
PIT — Preston Institute of Technology, Melbourne (Vic.) (now Phillip Institute of Technology).
RIV — Riverview Observatory, Sydney (NSW)
TAU — University of Tasmania, Hobart (Tas.)
UNQ — University of Queensland, Brisbane (Qld)

APPENDIX 4: EARTHQUAKE QUESTIONNAIRE FORM

GEOPHYSICAL OBSERVATORY GROUP,
BUREAU OF MINERAL RESOURCES,
P.O. BOX 378,
CANBERRA CITY, A.C.T. 2601

EARTHQUAKE REPORT

We are investigating the effects of the earthquake that took place on , and would be grateful if you would complete this report and return it in the pre-paid envelope.

If you did not feel the earthquake, please complete section 1 of the report, because this will help to fix limits of the area affected by the shock.

Please underline appropriate words or fill in spaces.

Name of Person reporting (block letters)	An earthquake was felt ☐ Not felt ☐	Time.....a.m. .....p.m.

1. YOUR LOCATION DURING EARTHQUAKE

(a) Address at time of earthquake.....
and nearest large town.....

(b) Ground: Rocky, gravelly, loose, compact, marshy, filled-in or.....
Level, sloping, steep or.....

(c) If indoors, type of building construction: Wood, brick, brick veneer, masonry, concrete or.....

(d) Quality of construction: New, old, well built, poorly built, or.....

(e) No. of floors in building.....

(f) Observer's floor.....

(g) Activity when earthquake occurred: Walking, sitting, lying down, sleeping, or.....

(h) If out of doors, you, others were: Quiet, active, or.....

2. EFFECTS ON POPULATION

(a) Felt by: Very few, several, many, all (in your home) (in community)

(b) Awakened: No one, few, many, all (in your home) (in community)

(c) Frightened: No one, few, many, all (in your home) (in community); general panic

3. RELATED SOUNDS

(a) Rattling of windows, doors, dishes, etc. .....

(b) Creaking of building (describe).....

(c) Earth noises: Faint, moderate, loud.....

4. PHYSICAL EFFECTS AND DAMAGE

(a) Outside:

1. Trees and bushes shaken, vehicles rocked, etc. .....
2. Ground cracked, landslides, water disturbed, etc. .....
3. Columns, monuments, elevated water tanks, etc., cracked, twisted, overturned.....
4. Other effects.....

(b) Buildings:

1. Hanging objects swung moderately, violently.
Direction of movement.....
2. Small objects shifted, overturned, fell.....
3. Furniture shifted, overturned, broken.....
4. Plaster cracked, broken, fell.....
5. Windows cracked.....
6. Structural elements of brick, wood, or.....
were damaged slightly, moderately, greatly.....

Additional information will be appreciated. Use space on reverse side.

G82/4-124A

ISOSEISMAL MAPS

(in chronological order)

ISOSEISMAL MAP OF THE MOUNT BARKER EARTHQUAKE, SOUTH AUSTRALIA— 7 JULY 1883

'Adelaide and its suburbs experienced "tremors" on several occasions after 1837, notably: 1840, 1848, 1856, 1882, 1883, 1886, 1887 and 1889, the most severe of which appeared from the reports to be that of 1883. Accordingly a thorough search was made of local newspapers in the South Australian Public Library and an isoseismal map drawn up from the data collected to assess its relative size and approximate location. This confirmed that it was a low magnitude event (ML less than $4\frac{1}{2}$ . . .) centred in the Mt Lofty ranges east of the city and it may be concluded, from their short duration and the lack of simultaneous reports of nearby towns, that the others were, similarly, small very local events with one exception: that of 17 April 1887.' (McCue, 1975).

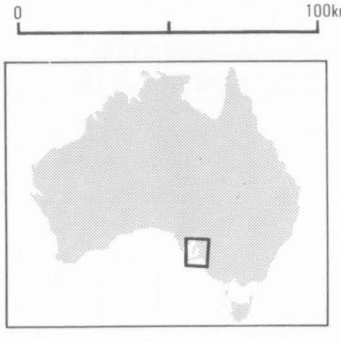
The event was subsequently re-estimated to be ML 4.7 by McCue (1980).

REFERENCES

McCUE, K. F., 1975—Seismicity and seismic risk in South Australia. *University of Adelaide Report,* ADP 137.

McCUE, K. F., 1980—Magnitudes of some early earthquakes in southeastern Australia. *Search,* 11(3), 78-80.

ISOSEISMAL MAP OF THE MOUNT BARKER EARTHQUAKE, SOUTH AUSTRALIA 7 JULY 1883



DATE : 7 JULY 1883
TIME : 13:58 UT
MAGNITUDE : 4.7 ML (I)
EPICENTRE : 35.1°S 138.7°E
DEPTH : 10km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/SA/1

ISOSEISMAL MAP OF THE BEACHPORT EARTHQUAKE, SOUTH AUSTRALIA— 10 MAY 1897

'. . . earthquakes were felt in 1897 and 1902, not only in Adelaide but throughout the southern part of South Australia. These were approximately located from the isoseismal maps constructed then, the first occurring on 10 May 1897 near Kingston and the second on Yorke Peninsula on 19 September, 1902 near Warooka.

'From the rapid attentuation of intensity, it may be inferred that both shocks were quite shallow and further, that in view of the considerably wider felt area, the Kingston earthquake was the larger—in fact the largest to have occurred in South Australia between 1837 and 1974.

'The main shock on Monday afternoon was followed by about 30 aftershocks in the first five hours and a total of about 90 aftershocks were felt at Kingston in the first two days (Adelaide Advertiser, 14 May 1897). Fewer aftershocks were felt at Robe but one of these on 18 May was reported to have stopped clocks. An earthquake in the same area about two years later (2 May 1899) was felt in Warrnambool (Underwood, 1973). Extensive liquefaction was observed at Robe, Beachport and Kingston with the formation of water spouts and sand volcanoes. The shock was apparently recorded on the Port Adelaide tide gauge but there was no accompanying tsunami as experienced on the NW coast of Western Australia following the Krakatoa eruption. This indicates the absence of any major vertical tectonic displacement or widespread slumping of the sea floor.' (McCue, 1975).

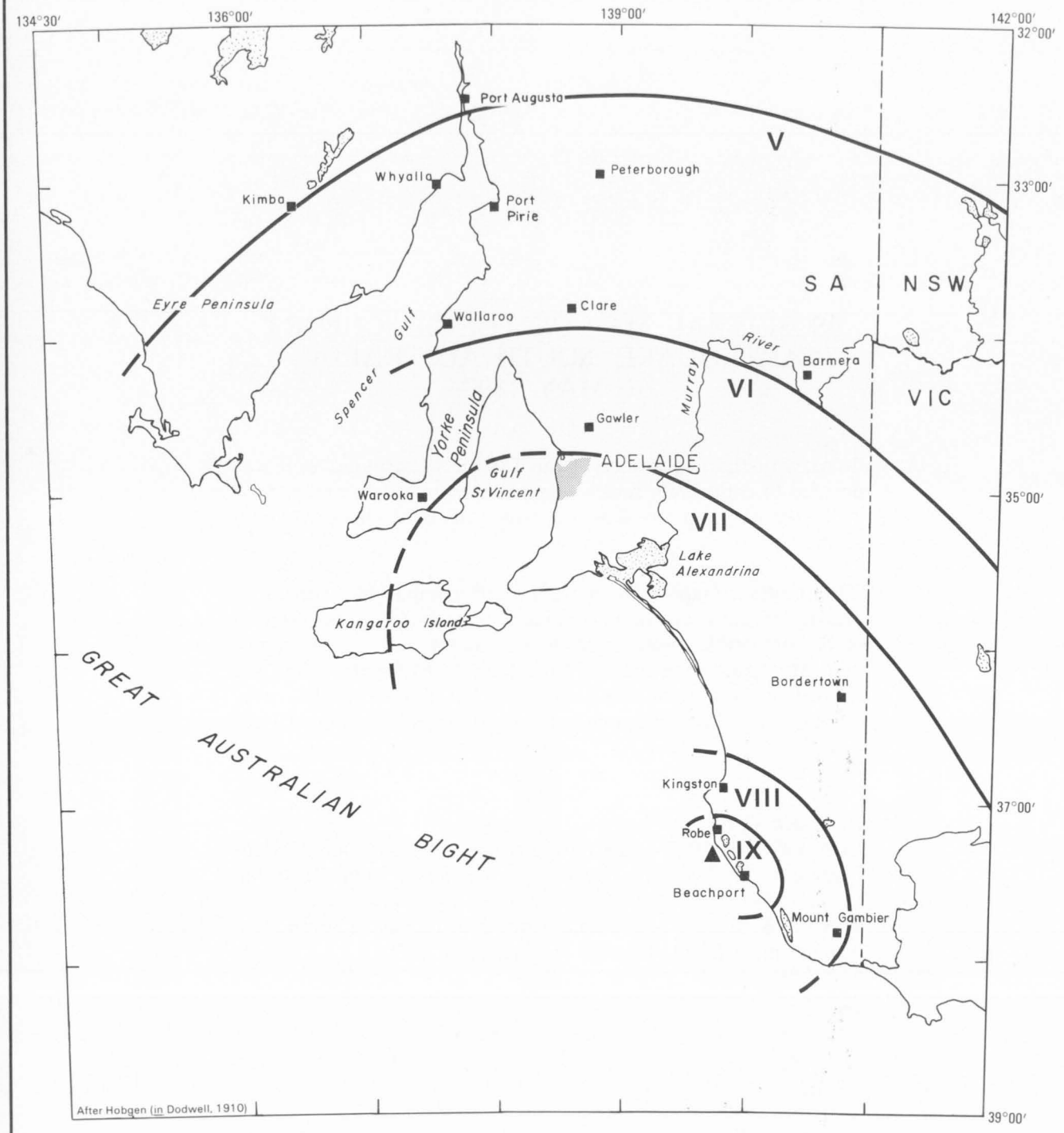
REFERENCES

DODWELL, G. F., 1910—South Australian earthquakes. *Report of the Australian Association for the Advancement of Science,* 12, 416-423.

MCCUE, K. F., 1975—Seismicity and seismic risk in South Australia. *University of Adelaide Report,* ADP 137.

UNDERWOOD, R., 1973—Studies in Victorian seismicity. *Proceedings of the Royal Society of Victoria,* 85, 27-48.

ISOSEISMAL MAP OF THE BEACHPORT EARTHQUAKE, SOUTH AUSTRALIA 10 MAY 1897



DATE : 10 MAY 1897
TIME : 05:26 UT
MAGNITUDE : 6.5 ML (I)
EPICENTRE : 37.33°S 139.75°E
DEPTH : 14km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (RF)

24/SA/2

ISOSEISMAL MAP OF THE BEACHPORT EARTHQUAKE, SOUTH AUSTRALIA— 10 MAY 1897

'In view of the importance of the 1897 . . . earthquake, it was decided to completely review the macroseismic data and redraw an isoseismal map based on the widely used Modified Mercalli scale'.

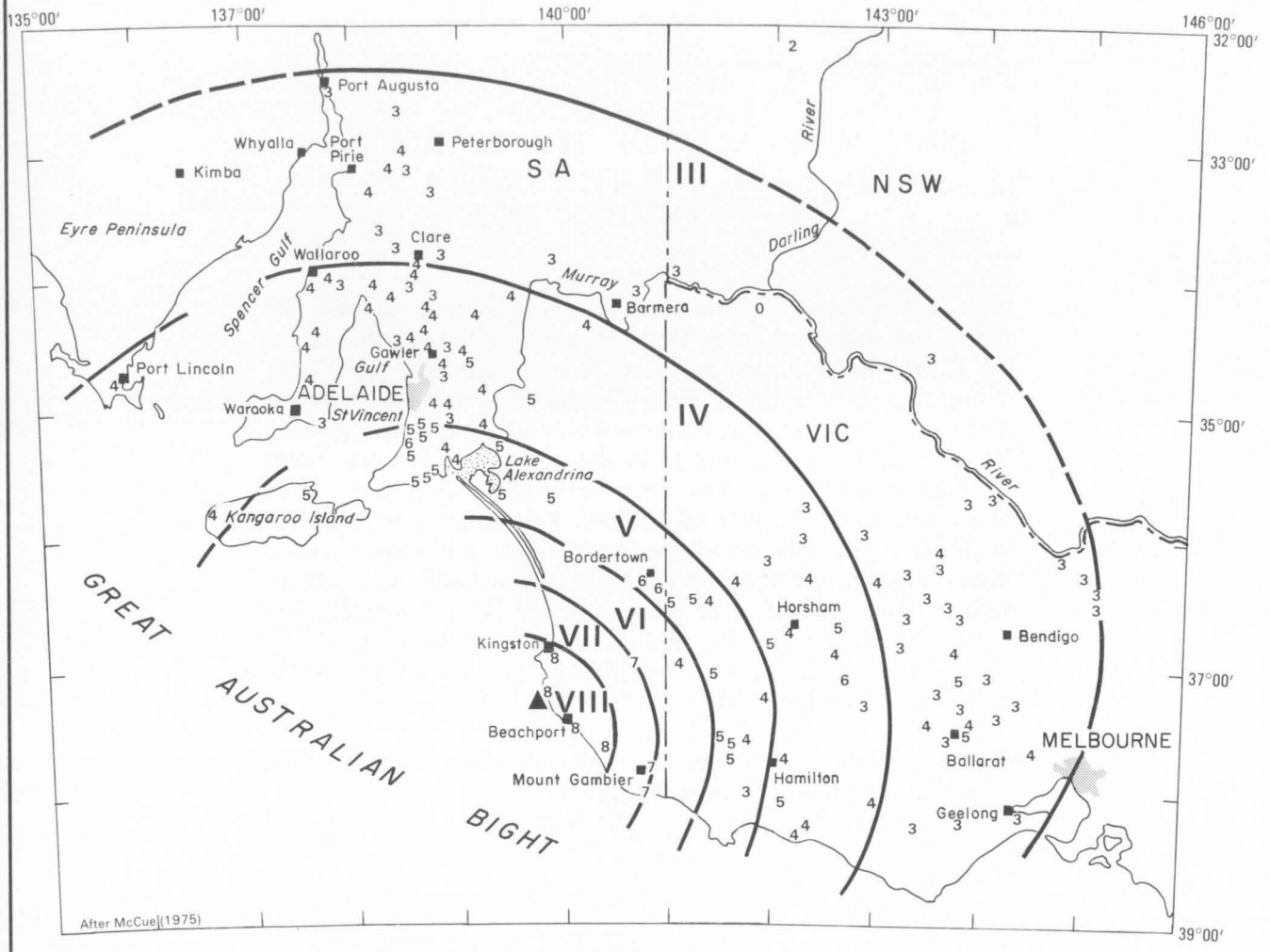
'The resultant map . . . is more directly comparable with those drawn for more recent earthquakes and thus can be used to make compatible estimates of its focal depth and size or magnitude. Hogben's intensities (*in* Howchin, 1918) for this event are equivalent in the meizoseismal area but appear to be overestimated by about one unit at large distances.' (McCue, 1975).

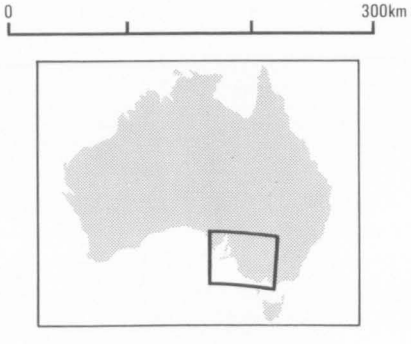
REFERENCES

HOWCHIN, W., 1918—THE GEOLOGY OF SOUTH AUSTRALIA. *Publication of the Education Department, Adelaide, South Australia.*

MCCUE, K. F., 1975—Seismicity and seismic risk in South Australia. *University of Adelaide Report,* ADP 137.

ISOSEISMAL MAP OF THE BEACHPORT EARTHQUAKE, SOUTH AUSTRALIA
10 MAY 1897





DATE : 10 MAY 1897
TIME : 05:26 UT
MAGNITUDE : 6.5 ML (I)
EPICENTRE : 37.33°S 139.75°E
DEPTH : 14 km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/A/23

ISOSEISMAL MAP OF THE WAROOKA EARTHQUAKE, SOUTH AUSTRALIA— 19 SEPTEMBER 1902

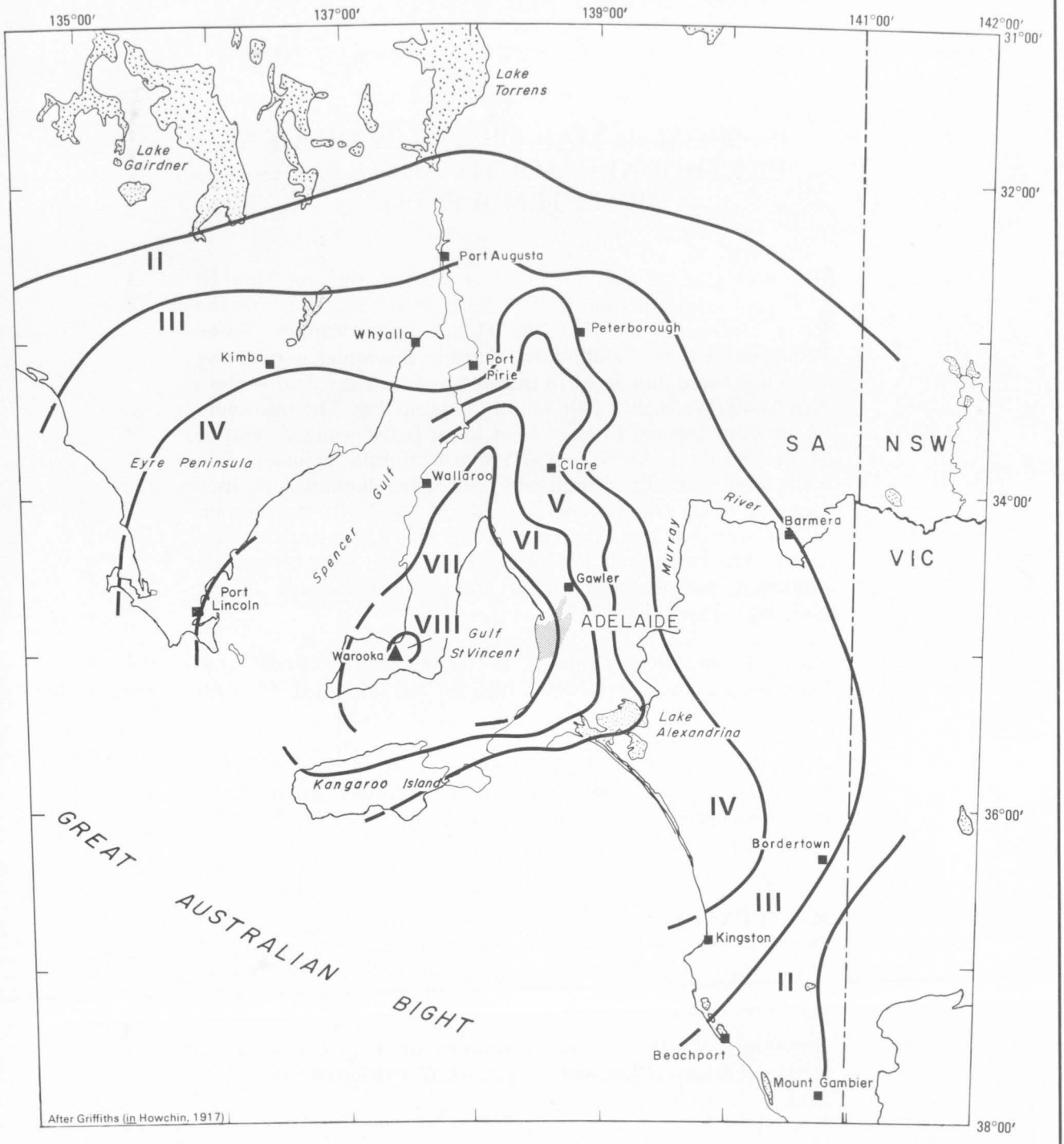
'The area affected was not quite so great as that on May 10 1897, but extended from Port Augusta in the north, across the River Murray in the east, the Mount Lofty Ranges, Yorke Peninsula, and the South East. Outside the State, a rumbling noise was heard and an earth tremor was felt at Jareena, western New South Wales at 8.10 p.m. on the same day. The maximum of intensity appears to have been towards the southern end of St Vincent Gulf. At Warooka, Yorke Peninsula, chimneys fell, walls were partially demolished, while few buildings escaped minor injuries. On the opposite side of the Gulf, at Normanville, Clarendon and other places, the shock was scarcely less severe. The lanterns of Troubridge Lighthouse were completely destroyed, and the spilt oil set fire to the woodwork of the building.' (Howchin, 1917).

The isoseismal map shows Griffith's intensities (*in* Howchin, 1917) on the Rossi-Forel scale.

REFERENCE

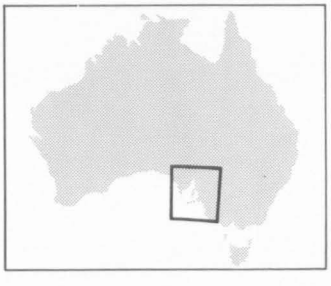
HOWCHIN, W., 1917—THE GEOGRAPHY OF SOUTH AUSTRALIA, Revised Edition. *Whitcombe & Tombs, Christchurch, New Zealand.*

ISOSEISMAL MAP OF THE WAROOKA EARTHQUAKE, SOUTH AUSTRALIA 19 SEPTEMBER 1902



DATE : 19 SEPTEMBER 1902
TIME : 10:35 UT
MAGNITUDE : 6.0 ML (I)
EPICENTRE : 35.0°S 137.4°E
DEPTH : 14km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (RF)



24/SA/4

ISOSEISMAL MAP OF THE WAROOKA EARTHQUAKE, SOUTH AUSTRALIA— 19 SEPTEMBER 1902

'The area affected was not quite so great as that on May 10 1897, but extended from Port Augusta in the north, across the River Murray in the east, the Mount Lofty Ranges, Yorke Peninsula, and the South East. Outside the State, a rumbling noise was heard and an earth tremor was felt at Jareena, western New South Wales at 8.10 p.m. on the same day. The maximum of intensity appears to have been towards the southern end of St Vincent Gulf. At Warooka, Yorke Peninsula, chimneys fell, walls were partially demolished, while few buildings escaped minor injuries. On the opposite side of the Gulf, at Normanville, Clarendon and other places, the shock was scarcely less severe. The lanterns of Troubridge Lighthouse were completely destroyed, and the spilt oil set fire to the woodwork of the building.' (Howchin, 1917).

Todd's intensities (*in* Dodwell, 1910) on the Rossi-Forel scale have been converted to intensities on the Modified Mercalli scale.

Griffith's intensities (*in* Howchin, 1917) are equivalent to Todd's in the meizoseismal area but Todd's intensities are probably overestimated by one at large distances (McCue, 1975).

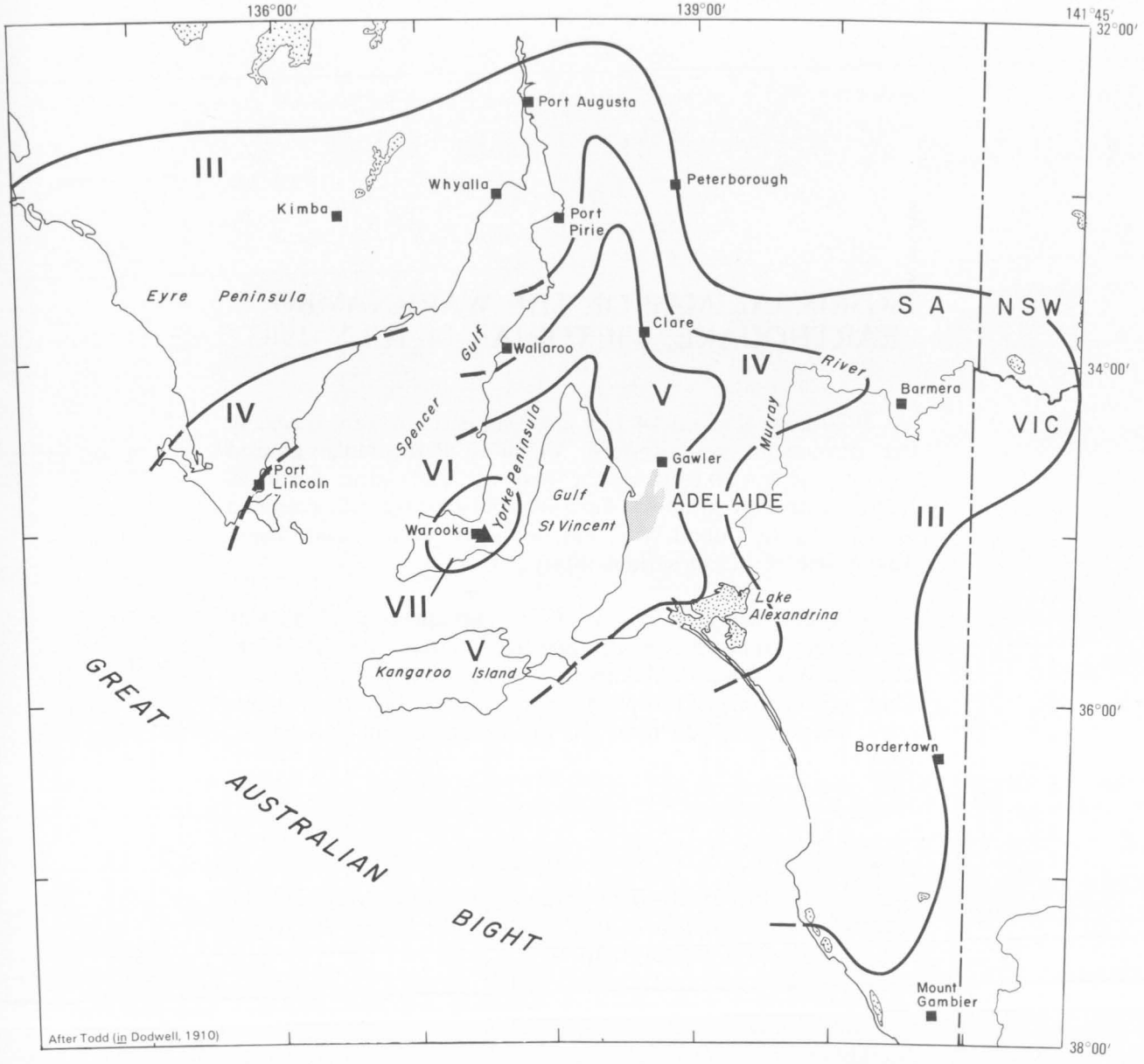
REFERENCES

DODWELL, G. F., 1910—South Australian earthquakes. *Report of the Australian Association for the Advancement of Science,* 12, 416-423.

HOWCHIN, W., 1917—THE GEOGRAPHY OF SOUTH AUSTRALIA, Revised Edition. *Whitcombe & Tombs, Christchurch, New Zealand.*

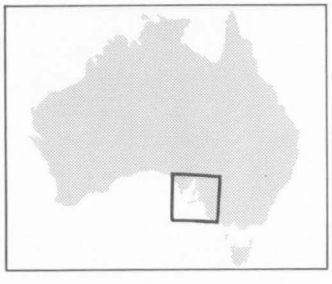
MCCUE, K. F., 1975—Seismicity and seismic risk in South Australia. *University of Adelaide Report,* ADP 137.

ISOSEISMAL MAP OF THE WAROOKA EARTHQUAKE, SOUTH AUSTRALIA 19 SEPTEMBER 1902



DATE : 19 SEPTEMBER 1902
TIME : 10:35 UT
MAGNITUDE : 6.0 ML (I)
EPICENTRE : 35.0°S 137.4°E
DEPTH : 14 km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)



24/SA/3

ISOSEISMAL MAP OF THE WARRNAMBOOL EARTHQUAKE, VICTORIA—14 JULY 1903

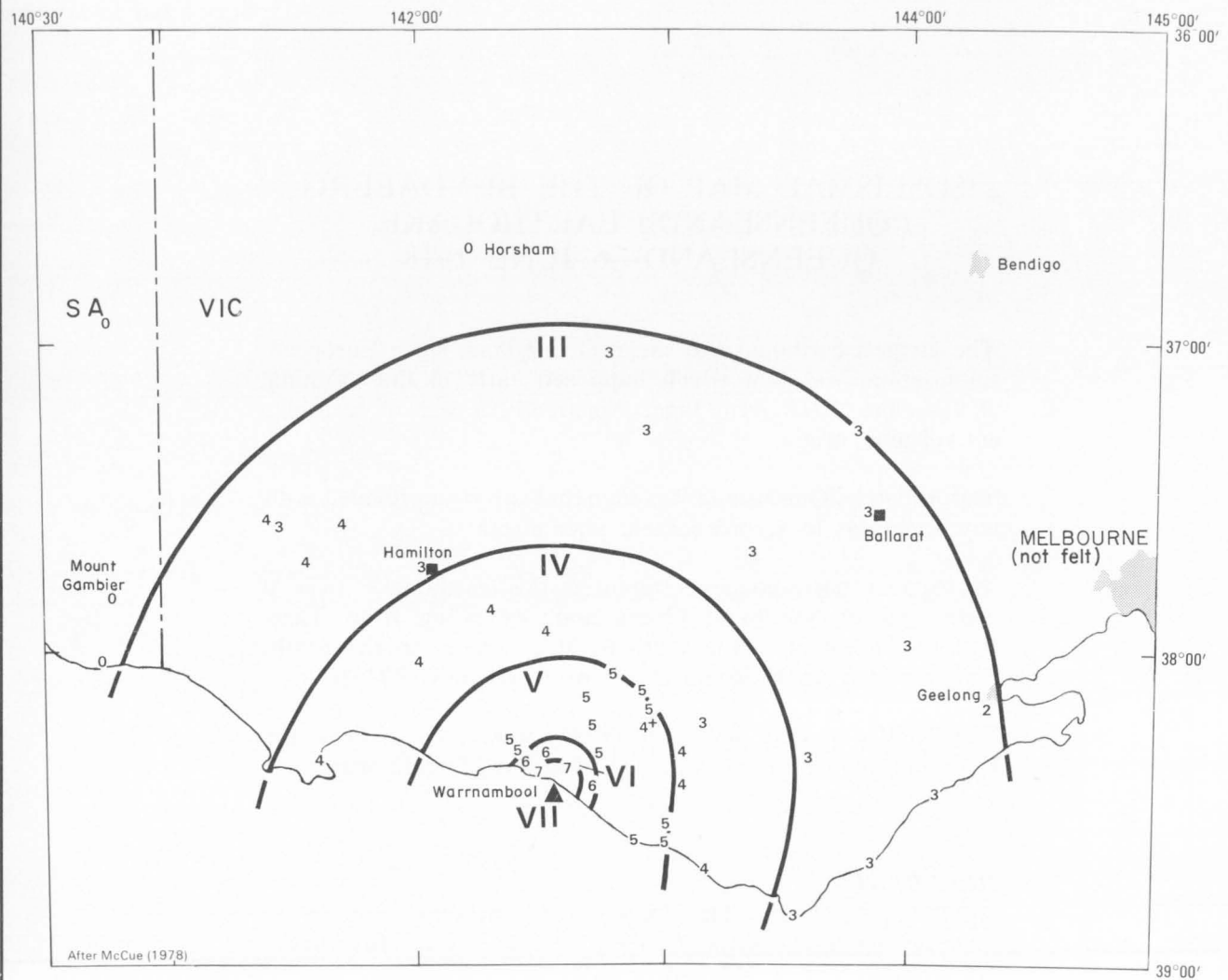
'At 2029 local time on 14 July 1903 an earthquake was widely felt throughout southwestern Victoria. Perceptable ground motion did not extend as far east as Melbourne north as Horsham or west to South Australia and damage was confined to a small area around Warrnambool on the south coast. There was no loss of life or serious injury.

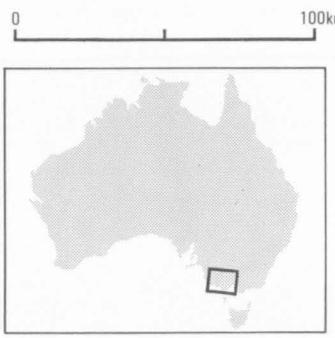
'A more detailed examination of the earthquake's effects was made using contemporary newspapers, in particular the Warrnambool *Standard,* Melbourne *Age* and Geelong *Advertiser.* This information was supplemented with entries from lighthouse keepers' logs to draw up the isoseismal map' (McCue, 1978).

REFERENCE

McCue, K. F., 1978—The value of historical records—the Warrnambool earthquake of July 1903. *Proceedings of the Royal Society of Victoria,* 90, 245-250.

ISOSEISMAL MAP OF THE WARRNAMBOOL EARTHQUAKE, VICTORIA 14 JULY 1903





DATE : 14 JULY 1903
TIME : 10:29 UT
MAGNITUDE : 5.3 ML (I)
EPICENTRE : 38.43°S 142.53°E
DEPTH : 10 km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/V/4

ISOSEISMAL MAP OF THE BUNDABERG ('QUEENSLAND') EARTHQUAKE, QUEENSLAND—6 JUNE 1918

'The greatest earthquake to shake Queensland, since European colonisation, was that which happened early in the morning of 7th June, 1918 local time. Apparently it was of tectonic, not volcanic, origin.

'Unforunately, Queensland was then and still is unprovided with any apparatus to record seismic phenomena.

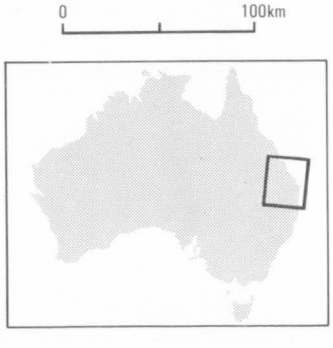
'Newspaper correspondents reported this earthquake over a wide area of South-east Queensland, extending from Tambourine Mountain in the south to St Lawrence in the north, and from the sea to Roma in the west.' (Hedley, 1925).

The detailed reports in Hedley (1925) were used to draw the isoseismal map (intensities on the Modified Mercalli scale).

REFERENCE

HEDLEY, C., 1925—The Queensland earthquake of 1918. *Transactions of the Royal Geographical Society of Australasia, Queensland,* No. 16, 151-156.

ISOSEISMAL MAP OF THE BUNDABERG ('QUEENSLAND') EARTHQUAKE, QUEENSLAND 6 JUNE 1918



DATE : 6 JUNE 1918
TIME : 18:14:24 UT
MAGNITUDE : 6.0 ML (RIV), 5.8 MS (BMR)
EPICENTRE : 23.5°S 152.5°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/Q/4

ISOSEISMAL MAP OF THE BUNDABERG ('QUEENSLAND') EARTHQUAKE, QUEENSLAND—6 JUNE 1918

At about 18:15 UT on 6 June 1918 (04:15 local time on 7 June 1918) an earthquake of magnitude ML 6.0 occurred about 100 km off the central Queensland coast.

This earthquake was felt over an area in excess of 300 000 km^2, extending from Mackay to Grafton and west to Charleville. Some damage occurred in Rockhampton and Bundaberg where a maximum intensity of MM VI was reported. Over 100 towns reported felt effects associated with the earthquake. Some damage was reported from Rockhampton when chimney stacks fell down, cracks appeared in buildings, windows were broken, and many items on shelves in private homes and stores were knocked to the ground. Other specific incidents included those reports of the event being felt on trains in the Rockhampton and Toowoomba areas, many clocks stopped including the one on the Pile Light in Brisbane, an abnormal ocean swell experienced by the steamer 'The Clyde' off Mackay, and several instances of 'very loud, rushing noises' from coastal towns. All newspaper reports strongly indicate a general fear by many people with two reports of people being 'thrown out of bed' in Rockhampton and Toowoomba. The event was widely felt in most suburbs of the city of Brisbane, the most severe effects being reported from the bayside suburbs.

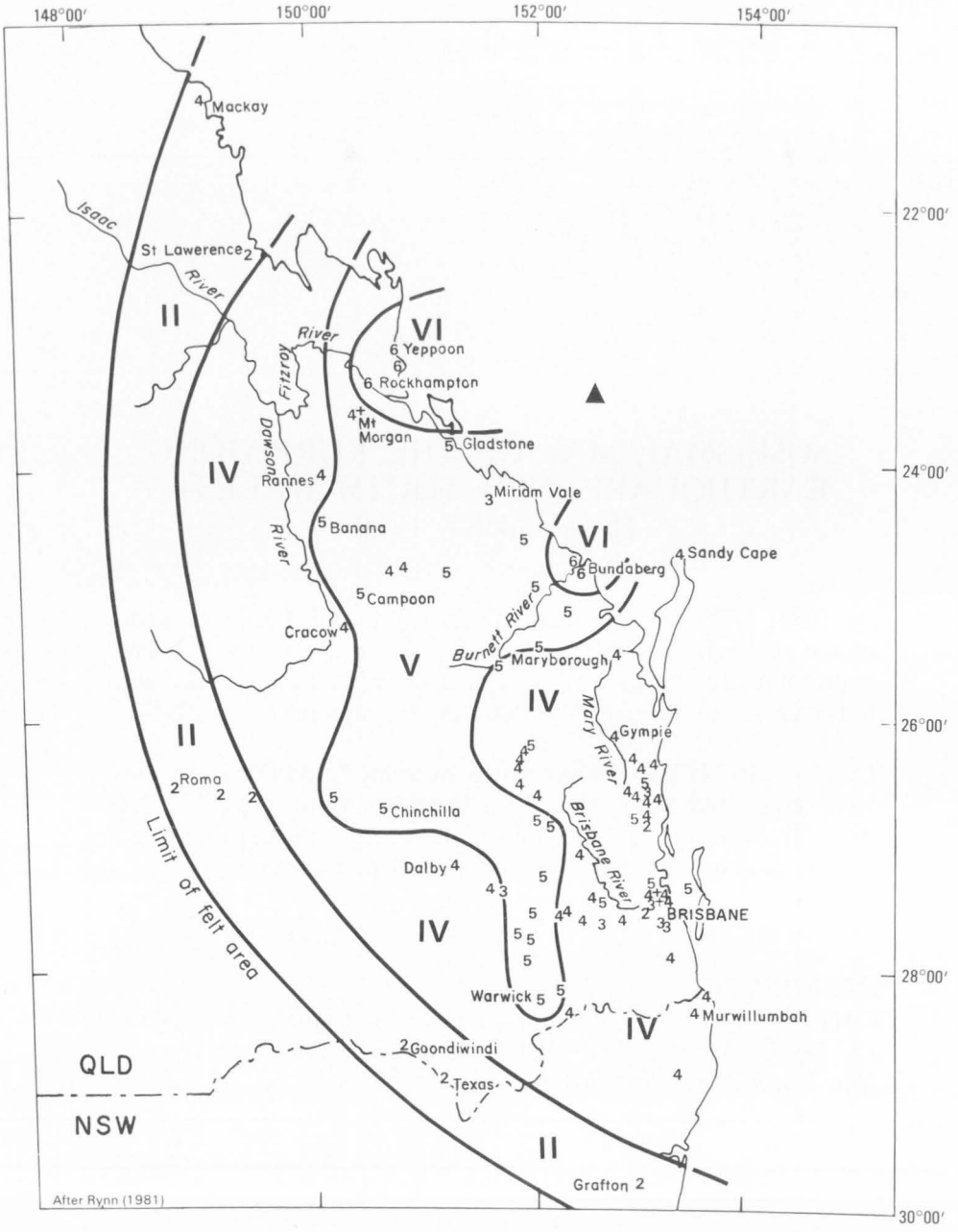
Several aftershocks were reported as felt in the six hours following the main shock.

The location of the epicentre is uncertain because neither instrumental nor macroseismic results are available to improve the accuracy of its determination.

REFERENCE

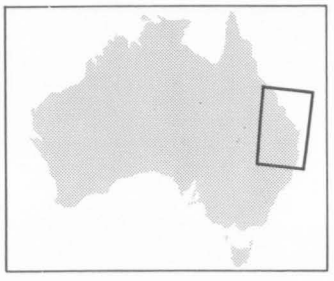
RYNN, J. M. W., 1981—A reappraisal of Queensland's largest earthquake—the 'Queensland' earthquake of 6 June 1918 (magnitude about 6). *Papers of the Department of Geology, University of Queensland.*

ISOSEISMAL MAP OF THE BUNDABERG ('QUEENSLAND') EARTHQUAKE, QUEENSLAND 6 JUNE 1918



DATE : 6 JUNE 1918
TIME : 18:14:24 UT
MAGNITUDE : 6.0 ML (RIV), 5.8 MS (BMR)
EPICENTRE : 23.5°S 152.5°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/Q/2

ISOSEISMAL MAP OF THE KURRAJONG EARTHQUAKE, NEW SOUTH WALES— 15 AUGUST 1919

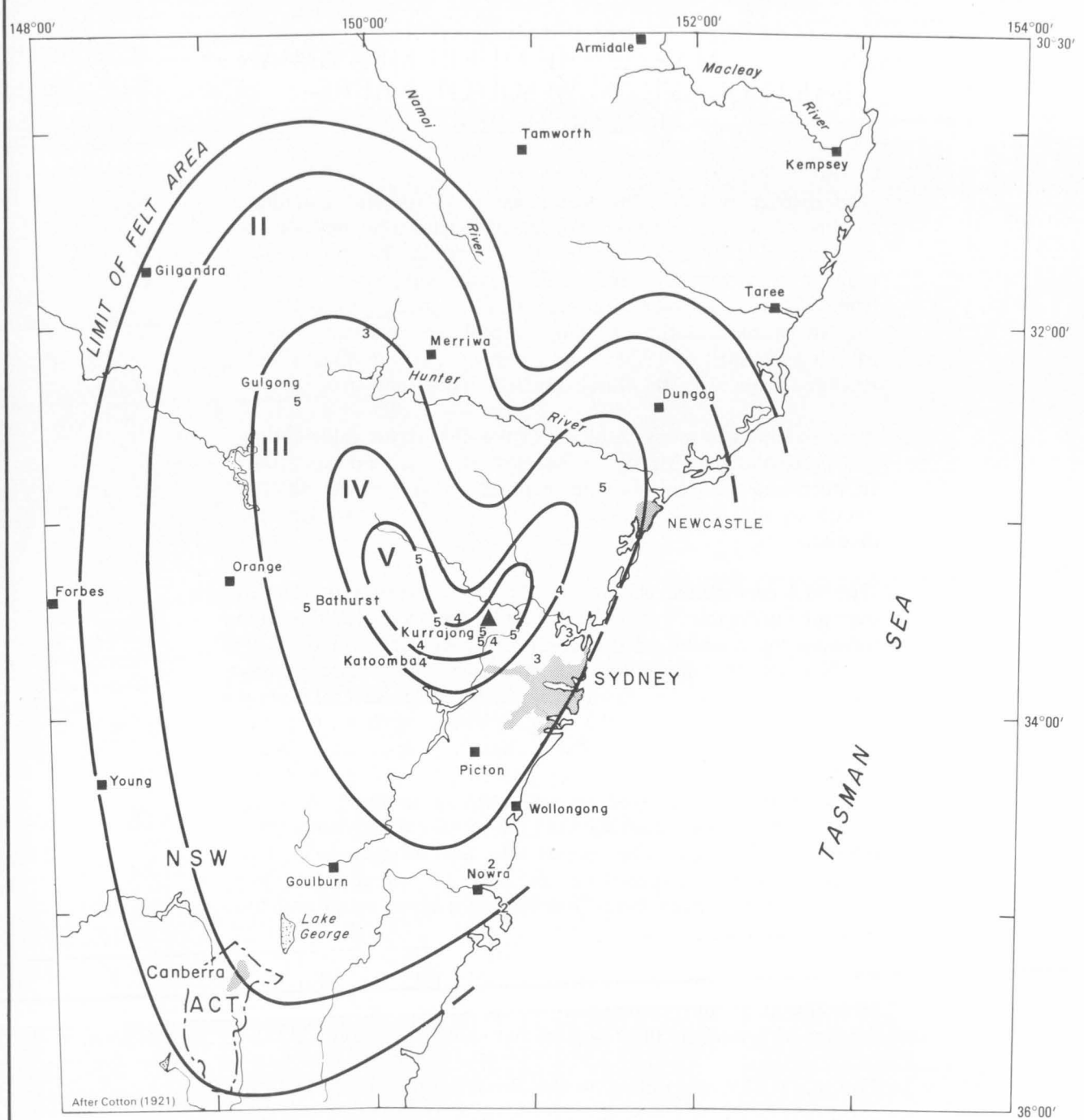
At 10:21 UT (20:21 local time) on 15 August 1919 an earthquake of magnitude ML 4.6 occurred near Kurrajong, NSW, approximately 50 km northwest of Sydney. The earthquake was felt over an area of over 100 000 km^2 throughout eastern NSW.

Cotton's (1921) list of reports was examined and the intensities were converted from the Rossi-Forel scale to the Modified Mercalli scale for the drawing of the isoseismal map. Cotton's (1921) isoseismal trends are maintained in this map.

REFERENCE

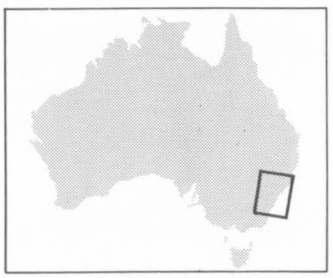
COTTON, L. A., 1921—The Kurrajong earthquake of August 15, 1919. *Journal of the Proceedings of the Royal Society of New South Wales,* 55, 83-104.

ISOSEISMAL MAP OF THE KURRAJONG EARTHQUAKE, NEW SOUTH WALES 15 AUGUST 1919



DATE : 15 AUGUST 1919
TIME : 10:21:21 UT
MAGNITUDE : 4.6 ML (RIV)
EPICENTRE : 33.5°S 150.7°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/N/1

ISOSEISMAL MAP OF THE MURRUMBATEMAN EARTHQUAKE, NEW SOUTH WALES— 6 MARCH 1924

'The district lying to the south-east of Yass and extending southward to the northern border of Victoria is one of the most unstable areas of continental Australia. A considerable number of earthquakes and earth tremors have been recorded from this area, but there is no record of so many shocks occurring in so short a time as those recently experienced during March and April of 1924. Altogether, nine or ten shocks were recorded from the 7th March to 26th April inclusive.

'I am indebted to many residents of the district for information, and particularly to Mr A. J. Shearsby of Yass, who has kindly supplied me with all the information which he was able to obtain as the result of his personal enquiries throughout the district.

'The first earthquake was by far the most severe and was felt over a considerable area, as indicated by the accompanying map showing the position of the isoseismals. At the town of Murrumbateman the shock was exceptionally severe; articles were thrown down from shelves, and the plaster fell in several houses, being thrown right across the room from the north west wall to the south east in one case. The ground was observed to heave and wave, and fences and trees rocked perceptibly. A 1000-gallon water tank swayed in an alarming manner. A study of the accompanying map showing the isoseismals presents some interesting features. The isoseismals are elongated in two directions, and this suggests that the earth movement took place along two intersecting faults, one having a north-south and the other an east-west trend.

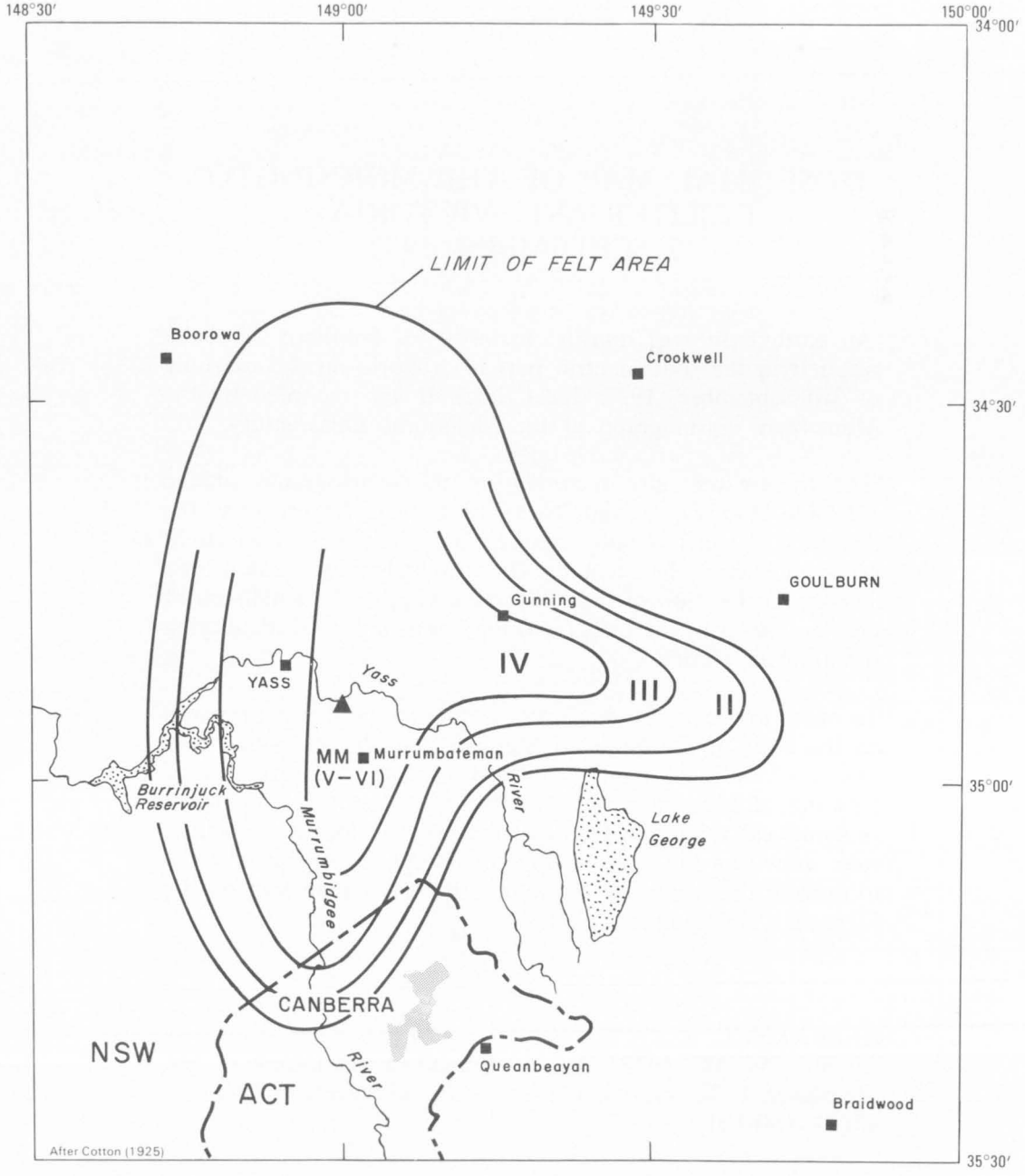
'The second earthquake (8 March 0603 UT) was also most pronounced at Murrumbateman, where water was thrown over the top of a tank as the result of the shock.' (Cotton, 1925).

Cotton's (1925) intensities on the Rossi-Forel scale have been converted to the Modified Mercalli scale.

REFERENCE

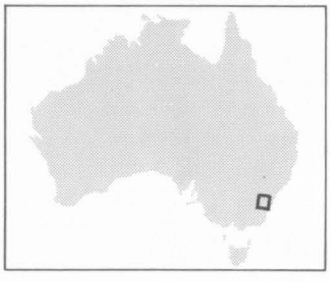
COTTON, L. A., 1925—Note on the earthquakes at Murrumbateman during March and April, 1924, and January to April, 1925. *Journal of the Proceedings of the Royal Society of New South Wales,* 59, 325-328.

ISOSEISMAL MAP OF THE MURRUMBATEMAN EARTHQUAKE, NEW SOUTH WALES 6 MARCH 1924



DATE : 6 MARCH 1924
TIME : 23:45:00 UT
MAGNITUDE : 4.0 ML (I)
EPICENTRE : 34.9°S 149.0°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)



24/155/1

ISOSEISMAL MAP OF THE MORNINGTON EARTHQUAKE, VICTORIA— 2 SEPTEMBER 1932

'An earth tremor of unusual intensity for Southern Australia was felt in the south-central part of Victoria on the morning of 3rd September, 1932 (local time). It was recorded by the Milne-Shaw seismograph at the Melbourne Observatory.

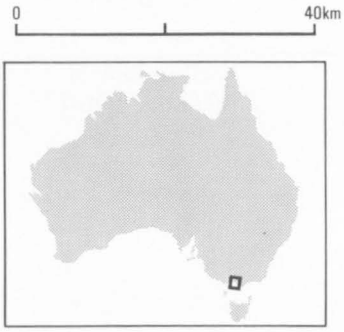
'The tremor was also recorded on the seismographs at the Adelaide Observatory and Riverview College Observatory, the directors of which kindly supplied such information as could be obtained from their records. Unfortunately these yielded little help in the location of the epicentre owing to the smallness of the amplitudes of the traces and the impossibility of identifying the different phases.

'In order to locate the epicentre, a questionnaire was prepared on the basis of the modified Mercalli scale of intensities, and this was published by the courtesy of the Melbourne press. Upwards of 200 replies were received from about 110 localities. A numerical value was then assigned to each locality and lines were drawn on the map. It was not thought to be worth while to draw in the boundaries for intensities lower than four on the Mercalli scale' (Holmes, 1933).

REFERENCE

HOLMES, W. M., 1933—The Mornington earth tremor of 3rd September, 1932. *Transactions of the Royal Society of Victoria,* 45(2), 150-151.

ISOSEISMAL MAP OF THE MORNINGTON EARTHQUAKE, VICTORIA 2 SEPTEMBER 1932



DATE : 2 SEPTEMBER 1932
TIME : 18:22:32 UT
MAGNITUDE : 4.5 ML (MEL), 4.2 MS (BMR)
EPICENTRE : 38.3°S 145.0°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)

24/J55/1

ISOSEISMAL MAP OF THE GAYNDAH EARTHQUAKE, QUEENSLAND— 12 APRIL 1935

'The authors early realised the possibility of obtaining some light on the nature and origin of the earthquake if a sufficient number of reliable reports could be gathered from the personal experience of people situated within the area perceptibly affected. In view of this possibility, an immediate appeal for information was made through the Brisbane Press and by means of the Australian Broadcasting Stations at Brisbane (4QG) and Rockhampton (4RK).

'These appeals brought forth a most gratifying response in the shape of numerous replies. Most of these appeared to be thoroughly reliable, while very few were worthless. Some contained information collected by the sender from a number of different sources, and several were prepared with a scientific precision and exactitude that must have involved a great deal of patient work.

'In addition to these replies, there were available the numerous messages sent in to the Brisbane newspapers by country correspondents and the more localised details set out in those country newspapers published in the affected area.

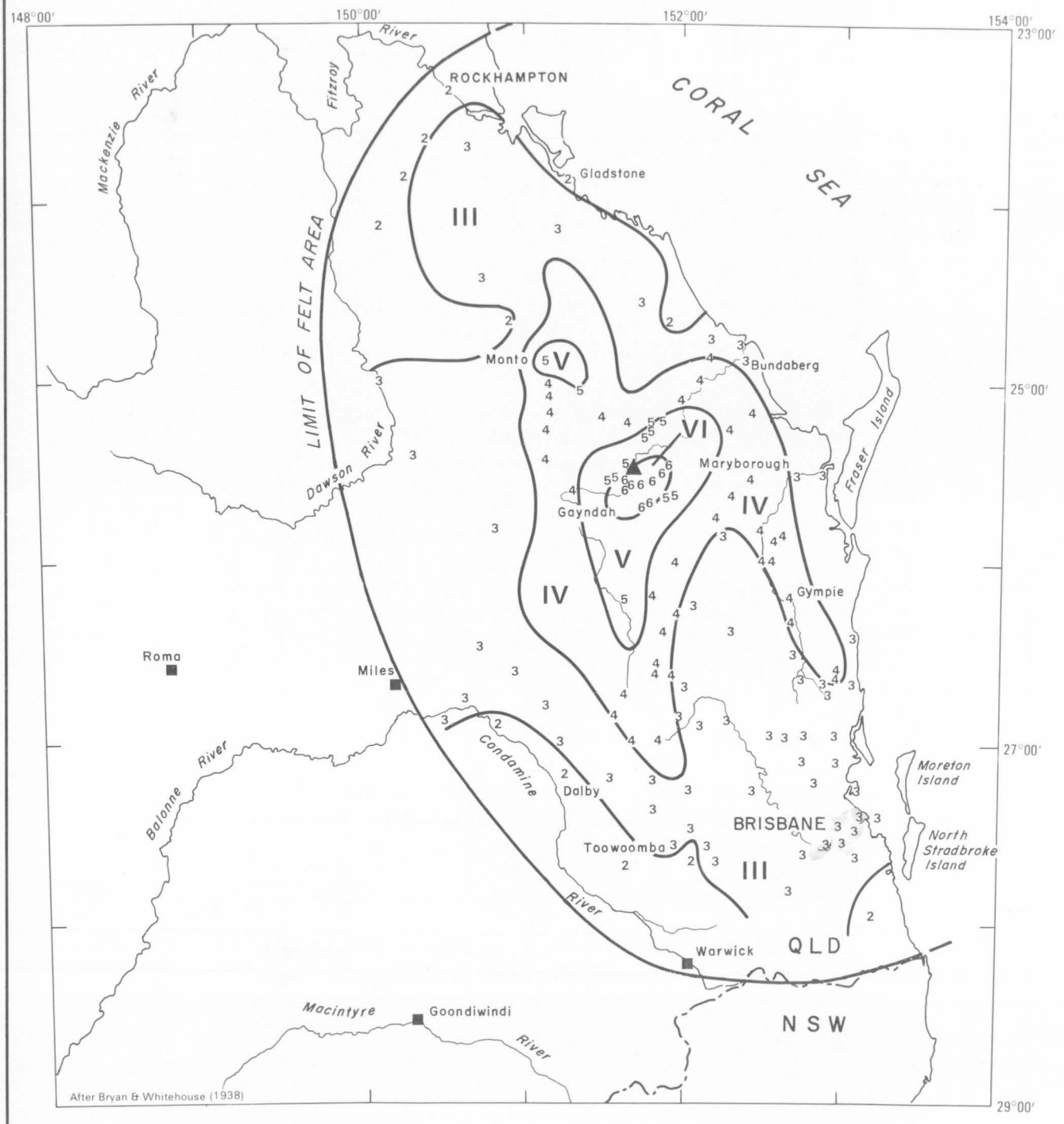
'In order to fill the numerous gaps in our knowledge that remained after these replies have been received, a questionnaire was drawn up based on the Rossi-Forel Scale and despatched to school masters and others likely to be in a position to help. Nearly all of the forms were completed and returned, thus affording a great deal of additional information. As a result of these various methods reports have been collected from nearly 200 localities' (Bryan & Whitehouse, 1938).

Bryan & Whitehouse's (1938) intensities on the Rossi-Forel scale have been converted to the Modified Mercalli scale.

REFERENCE

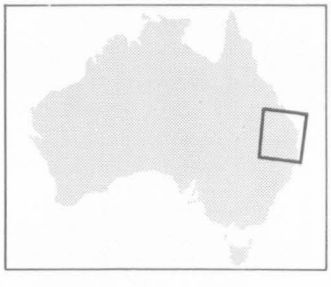
BRYAN, W. H., & WHITEHOUSE, F. W., 1938—The Gayndah earthquake of 1935. *Royal Society of Queensland Proceedings,* 49(10), 106-119.

ISOSEISMAL MAP OF THE GAYNDAH EARTHQUAKE, QUEENSLAND
12 APRIL 1935



DATE : 12 APRIL 1935
TIME : 01:32:22.4 UT
MAGNITUDE : 5.2 ML (I), 5.4 MS (BMR)
EPICENTRE : 25.5°S 151.7°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/Q/3

ISOSEISMAL MAP OF THE MEEBERRIE EARTHQUAKE, WESTERN AUSTRALIA—29 APRIL 1941

The Meeberrie earthquake was one of the largest to have occurred in Australia. Its magnitude was ML 7.2 and it was felt over a wide area of Western Australia. The isoseismal map shown here, by Clarke & others (1955), is based on intensities on the Rossi-Forel scale at about 25 points and is significantly different from that compiled in BMR from about 50 observations. The Meeberrie homestead's report of the effects there is reproduced by Everingham (1968). Intensity/distance results given by Everingham & Parkes (1971) include those of Clarke & others (1955) and should be revised.

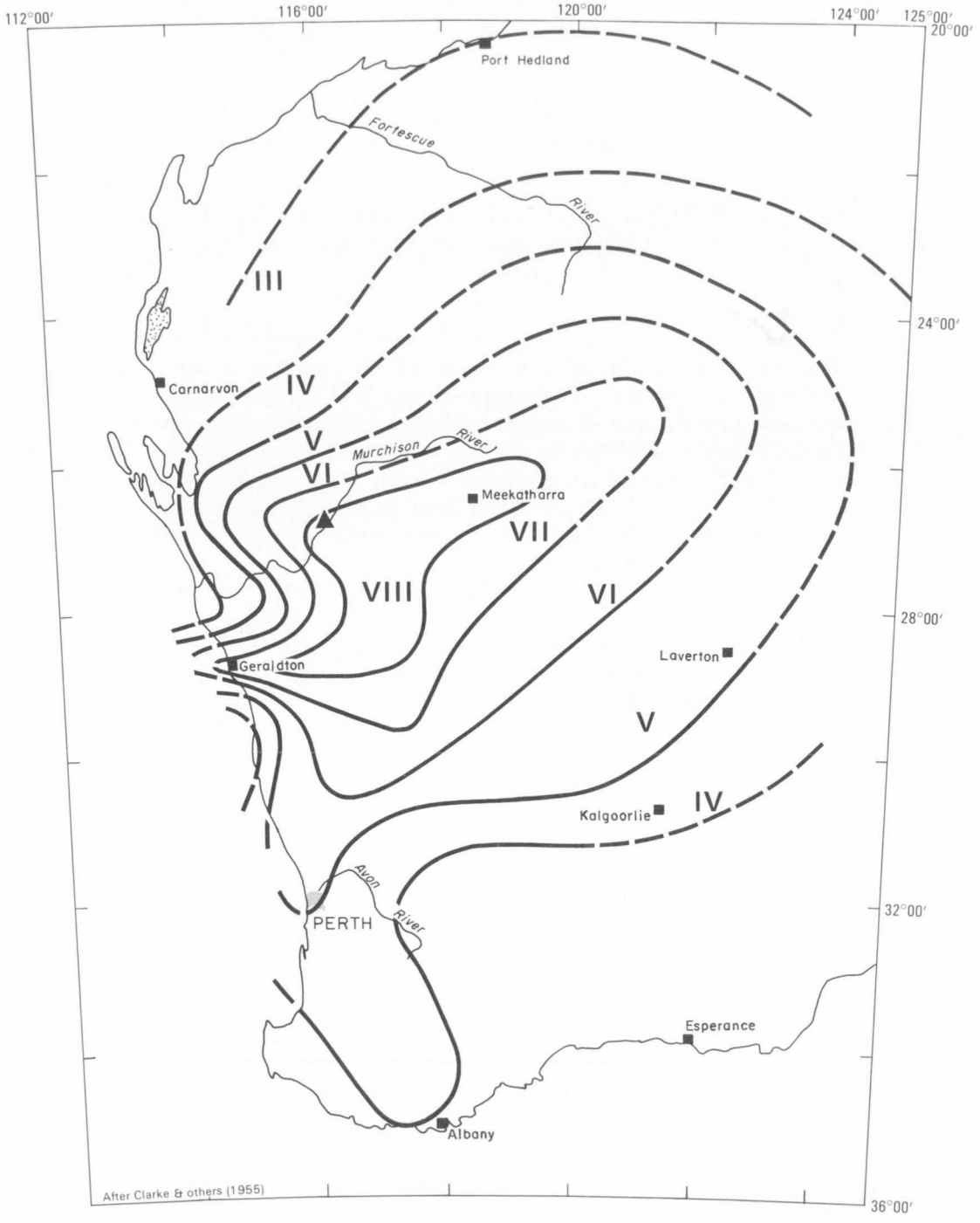
REFERENCES

CLARKE, E. DE C., PRIDER, R. T., & TEICHERT, C., 1955—ELEMENTS OF GEOLOGY FOR WESTERN AUSTRALIAN STUDENTS, 3rd Edition. *University of Western Australia Press, Perth.*

EVERINGHAM, I. B., 1968—Seismicity of Western Australia. *Bureau of Mineral Resources, Australia, Report* 132, 38-39.

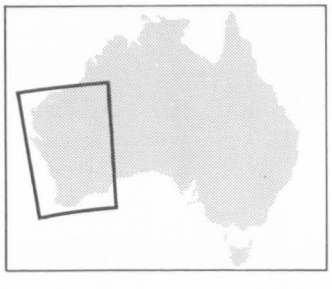
EVERINGHAM, I. B., & PARKES, A. A., 1971—Intensity data for earthquakes at Landor (17 June 1969) and Calingiri (10 March 1970) and their relationship to previous Western Australian earthquakes. *Bureau of Mineral Resources, Australia, Record* 1971/80 (unpublished).

ISOSEISMAL MAP OF THE MEEBERRIE EARTHQUAKE, WESTERN AUSTRALIA
29 APRIL 1941



DATE : 29 APRIL 1941
TIME : 01:35:41 UT
MAGNITUDE : 7.2 ML(MUN), 6.8 MS(GR), 7.3 MB(MUN)
EPICENTRE : 26.8°S 116.1°E
DEPTH : 33km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (RF)



24/WA/7

ISOSEISMAL MAP OF THE MEEBERRIE EARTHQUAKE, WESTERN AUSTRALIA—29 APRIL 1941

The Meeberrie earthquake was one of the largest to have occurred in Australia. Its magnitude was ML 7.2 and it was felt over a wide area of Western Australia. Damage from the earthquake was small because of the low population in the epicentral region, but the shaking at Meeberrie homstead was very severe; all the walls of the homestead were cracked, several rainwater tanks burst, and widespread cracking of the ground occurred. Although questionnaires were distributed by the Western Australian Government Astronomer, these have not been traced to date and, consequently, our knowledge of this earthquake is restricted to reports in local newspapers and to a report from Meeberrie homestead. The Meeberrie homestead report is given by Everingham (1968).

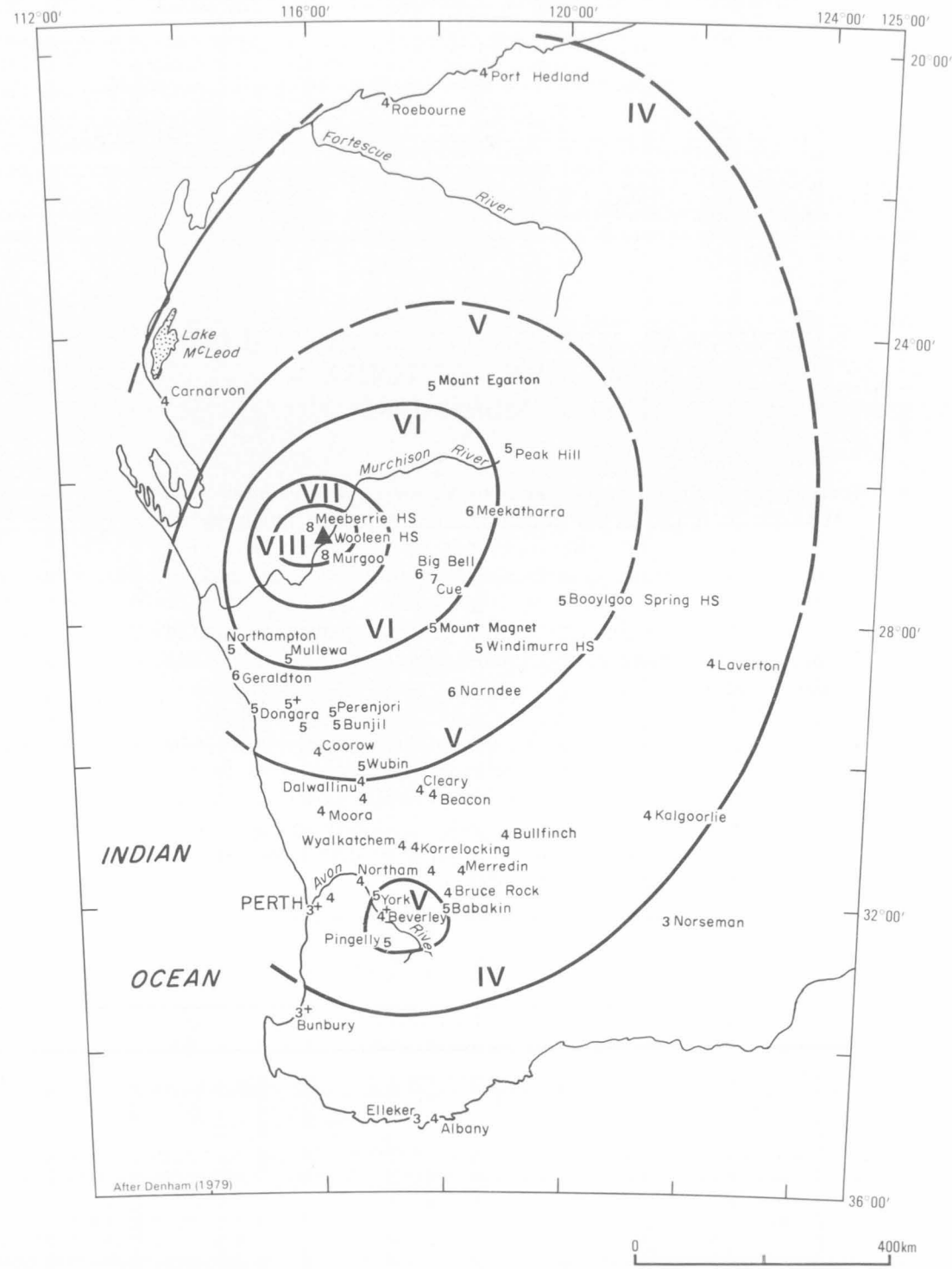
Denham (1979) published a BMR map using 50 reports but the data have subsequently been reinterpreted and the map redrawn because the intensities around Perth given by Denham (1979) were too high. The main difference is that, in the revised map shown here, the area enclosed by the MM V isoseismal is smaller than in Denham's (1979) map.

REFERENCES

DENHAM, D., 1979—Earthquake hazard in Australia. *In* HEATHCOTE, R. L., & THOM, B. G. (Editors)—NATURAL HAZARDS IN AUSTRALIA. *Australian Academy of Science, Canberra,* 94-118.

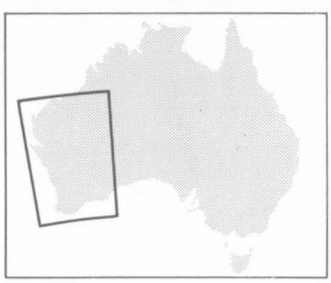
EVERINGHAM, I. B., 1968—Seismicity of Western Australia. *Bureau of Mineral Resources, Australia, Report* 132, 38-39.

ISOSEISMAL MAP OF THE MEEBERRIE EARTHQUAKE, WESTERN AUSTRALIA
29 APRIL 1941



DATE : 29 APRIL 1941
TIME : 01:35:41 UT
MAGNITUDE : 7.2 ML(MUN), 6.8 MS(GR), 7.3 MB(MUN)
EPICENTRE : 26.8°S 116.1°E
DEPTH : 33km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/WA/8

ISOSEISMAL MAP OF THE MARYSVILLE EARTHQUAKE, VICTORIA— 2 NOVEMBER 1944

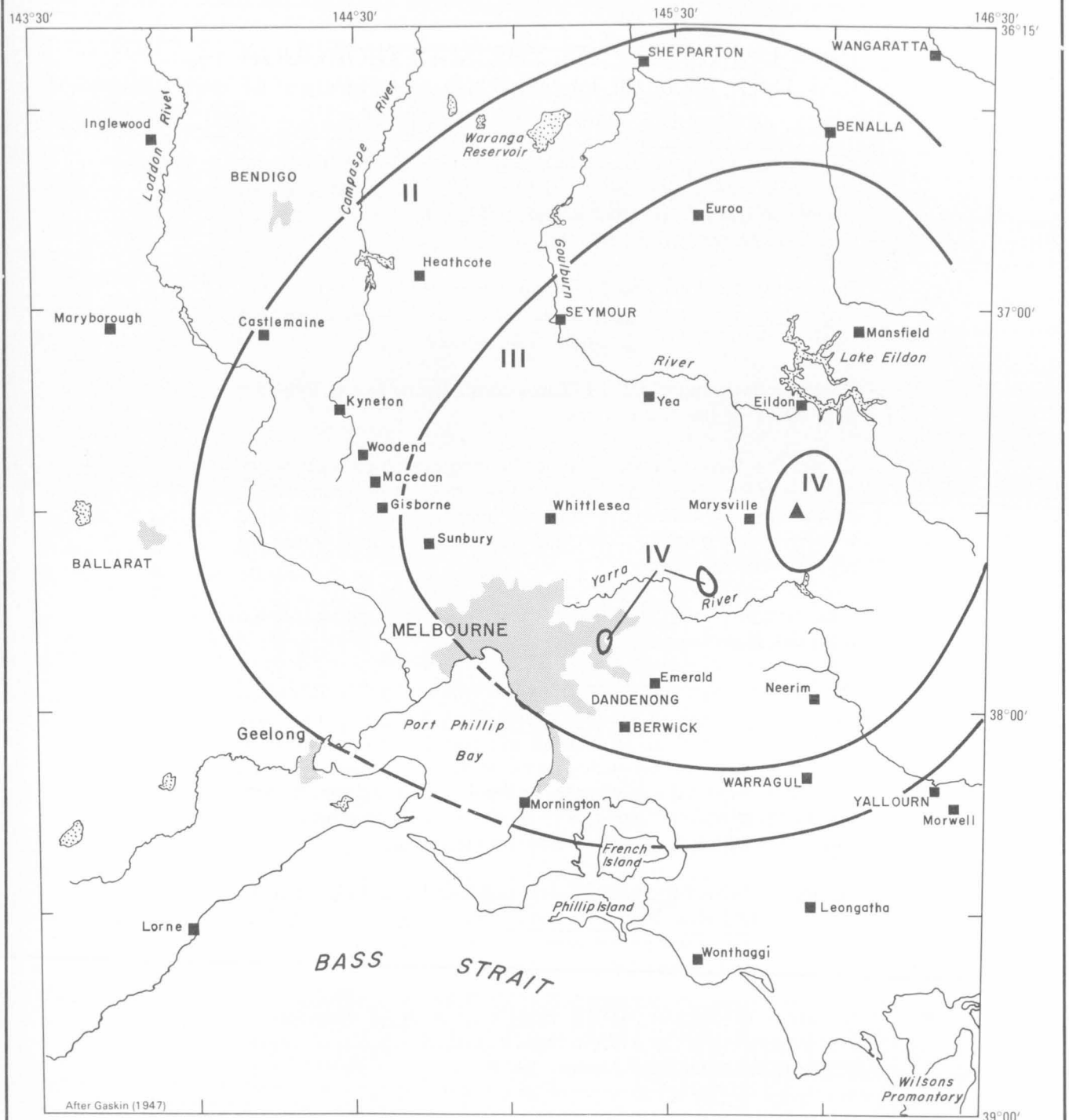
'A strong earth tremor occurred in Victoria on November 3rd, 1944 (local time). In the Melbourne area, it was felt between five and six minutes after midnight of November 2nd. The tremor was generally described as beginning with an audible phase, which varied, according to the locality, from a loud crack to a low rumbling sound, followed or accompanied by one or more phases of more or less intense vibration lasting from one to four seconds.'

'Following a public request for information, about 100 reports concerning the tremor were received from observers in the Melbourne area, and about 75 from country observers. Intensities on the Modified Mercalli scale . . . were assessed from these reports, and mapped in an attempt to determine the epicentre of the shock.' (Gaskin, 1947).

REFERENCE

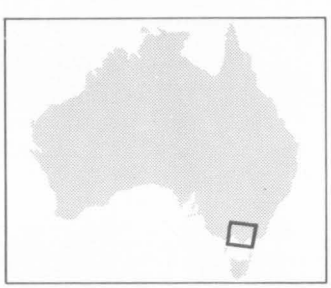
GASKIN, A. J., 1947—The Victorian earth tremor of 3rd November, 1944. *Proceedings of the Royal Society of Victoria,* 58, 66-69.

ISOSEISMAL MAP OF THE MARYSVILLE EARTHQUAKE, VICTORIA
2 NOVEMBER 1944



DATE : 2 NOVEMBER 1944
TIME : 14:05:43 UT
MAGNITUDE : 4.0 ML (I)
EPICENTRE : 37.5°S 145.9°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)



24/V/5

ISOSEISMAL MAP OF THE MARYBOROUGH EARTHQUAKE, QUEENSLAND—11 JUNE 1947

'Shortly after 8 p.m. (Eastern Australian Standard Time) on June 11th 1947, there occurred the third earthquake shock of notable magnitude in Queensland and the first to be recorded by seismographs within the State.

'The only previous shocks of sufficient magnitude to cause widespread comment were those of June 7th 1918, and of April 12th 1935, The Gayndah Earthquake.'

'The tremor of June 11th 1947 was considerably less in intensity than either of the earlier ones.

'In the two days following the earthquake copies of a questionnaire were sent to over 150 post-masters, railway station-masters, headmasters of schools, lighthouse keepers, etc., in the area which reports indicated were affected by the tremor. Over 80 replies were received.

'The intensity was assessed for each before looking at the localities from which they came.

'No real damage was caused by the tremor. In Nambour a wireless aerial pole (a sapling) broke off at the stay about thirty feet above the ground. In areas of intensity IV or over, mirrors, blinds, curtains and kerosene lamp chimneys were dislodged and fell, windows and doors vibrated violently, crockery, etc. rattled, and hanging objects swung. The most common description was that it was like a heavy truck striking the building.

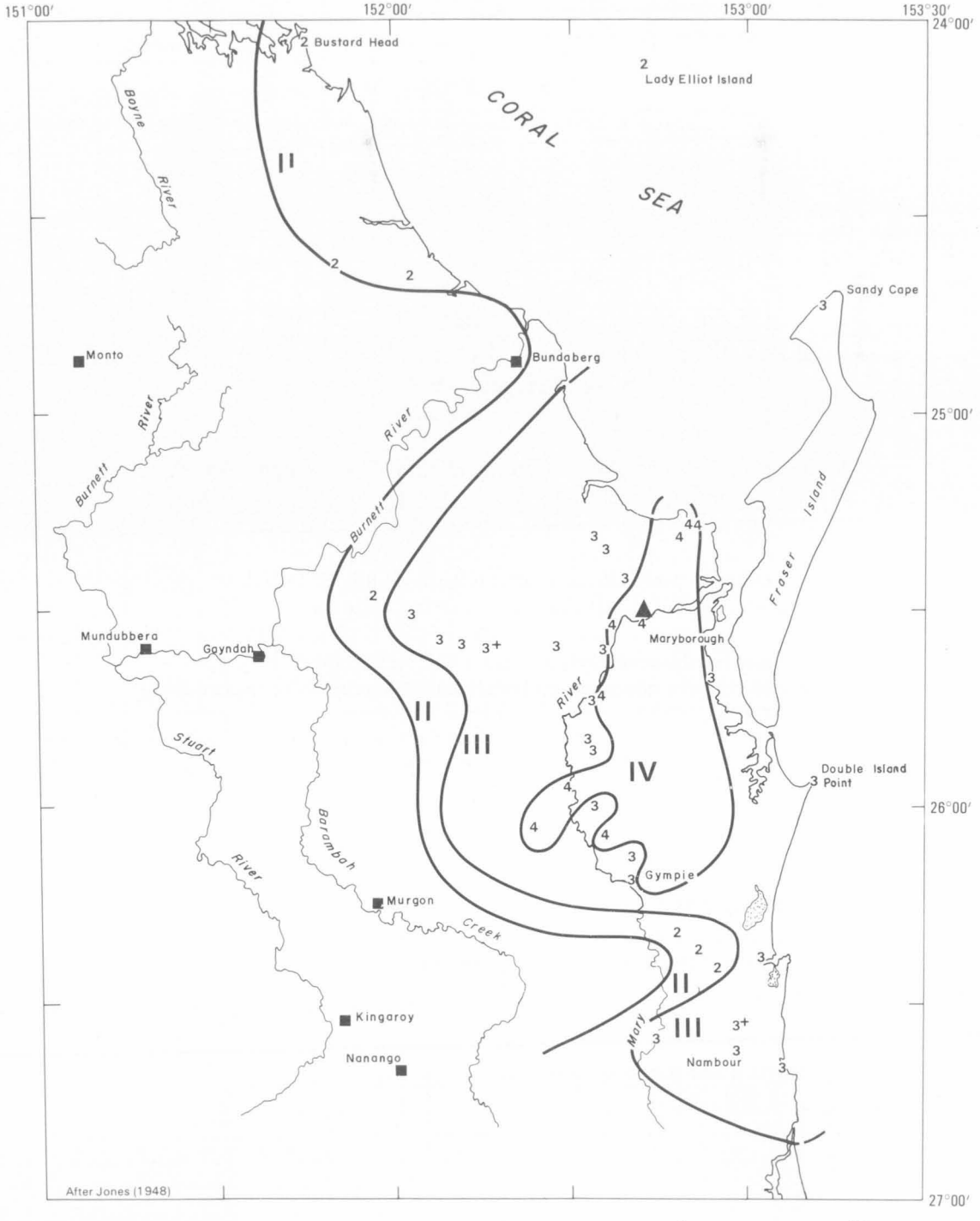
'In areas in which the intensity was between III and IV, hanging objects swung slightly and in some cases crockery rattled. The most common descriptions were "like a heavy truck passing", or "like a train going by".

'In areas of intensity II-III, there was a slight vibration of crockery etc., and the sensation was described either as trembling or a distant rumbling.' (Jones, 1948).

REFERENCE

JONES, O. A., 1948—The Maryborough earthquake of 1947. *University of Queensland Papers, Department of Geology*, 3(6).

ISOSEISMAL MAP OF THE MARYBOROUGH EARTHQUAKE, QUEENSLAND
11 JUNE 1947



DATE : 11 JUNE 1947
TIME : 10:03:13 UT
MAGNITUDE : 4.0 ML (I)
EPICENTRE : 25.5°S 152.7°E
DEPTH : 33km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/G56/2

ISOSEISMAL MAP OF THE ROBE EARTHQUAKE, SOUTH AUSTRALIA—6 AUGUST 1948

At about 03:29 UT (about 1 pm local time) on 6 August 1948 an earthquake of magnitude ML 5.6 occurred about 20 km off the South Australian coast, approximately 300 km south-southeast of Adelaide. Although the earthquake was not felt in Adelaide, it was felt over an area of about 55 000 km^2 in southeastern South Australia and western Victoria.

'Macroseismic data extracted from local newspapers and lighthouse records was adequate to construct the "smooth" isoseismal map' (McCue, 1975).

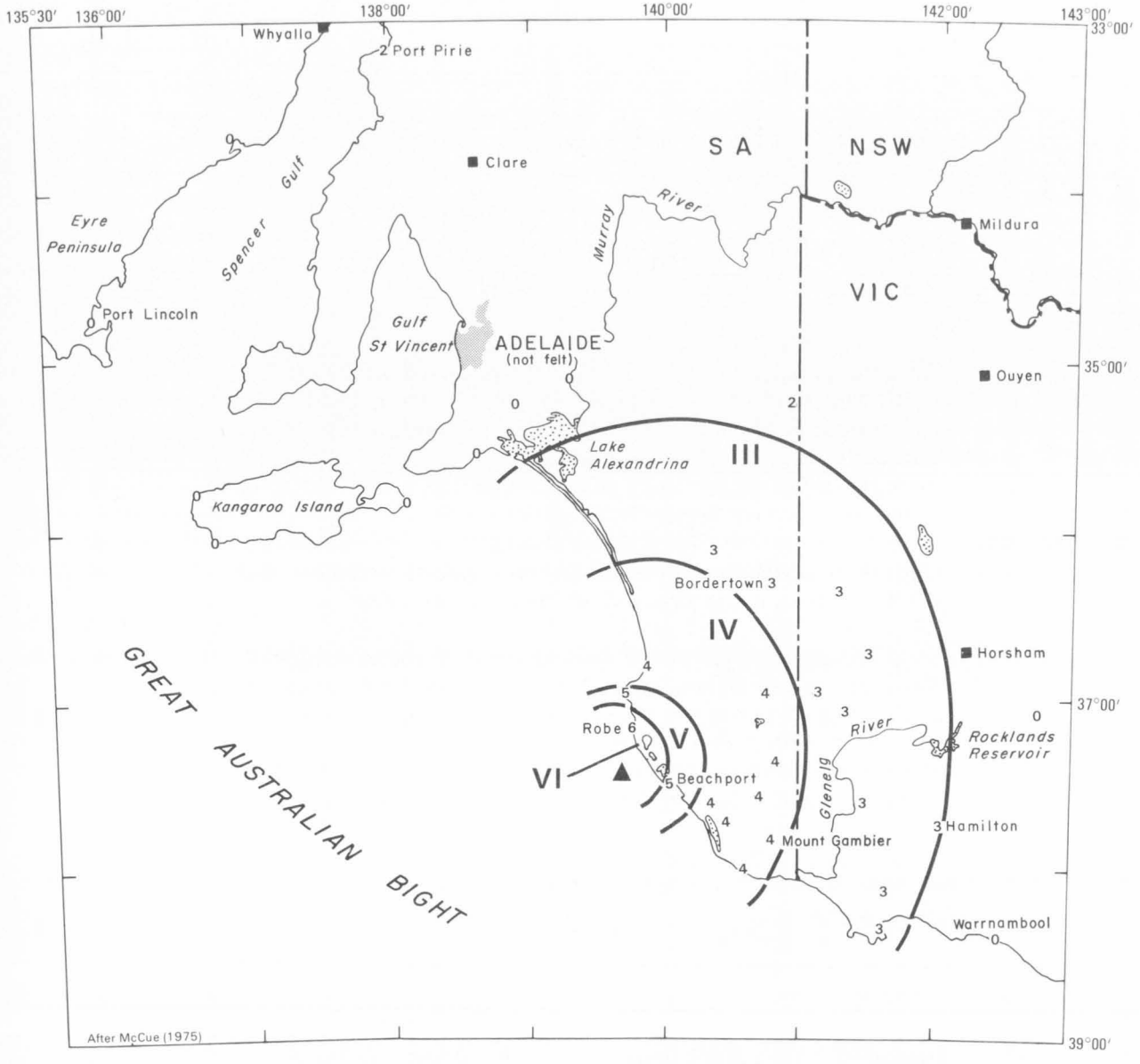
Other earthquakes felt in this area are discussed by Sutton & others (1977).

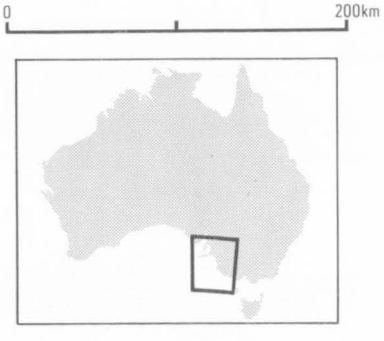
REFERENCES

McCue, K. F., 1975—Seismicity and seismic risk in South Australia. *University of Adelaide Report,* ADP 137.

Sutton, D. J., McCue, K. F., & Bugeja, A., 1977—Seismicity of the southwest of South Australia. *Journal of the Geological Society of Australia,* 25, 357-364.

ISOSEISMAL MAP OF THE ROBE EARTHQUAKE, SOUTH AUSTRALIA
6 AUGUST 1948





DATE : 6 AUGUST 1948
TIME : 03:29:23 UT
MAGNITUDE : 5.6 ML (I), 5.4 MS (BMR)
EPICENTRE : 37.36°S 139.68°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/A/24

ISOSEISMAL MAP OF THE DALTON-GUNNING EARTHQUAKE, NEW SOUTH WALES—10 MARCH 1949

An earthquake of magnitude ML 5.5 occurred at 22:30 UT on 10 March 1949 (08:30 local time on 11 March 1949) near the townships of Dalton and Gunning in southeastern NSW. The earthquake was felt over an area of about 65 000 km^2, from Jindabyne in the south to Oberon in the north and from as far west as Gundagai.

Officers of BMR were detailed to investigate the tremors and left Canberra on the first day of their occurrence.

'. . . The greater part of the week devoted to the investigation was spent in the Dalton area. A reconnaissance embracing an area within a radius of about 40 miles of Dalton was also carried out with a view to determining the regional distribution of intensities, and the Chief Government Geologist circularised post offices and police officers stationed at 14 NSW towns.

'In all some 150 people were interviewed and the properties of most of these inspected.' (Joklik, 1950).

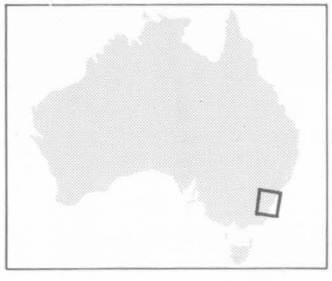
REFERENCE

JOKLIK, G. F., 1950—Dalton-Gunning area, N.S.W., earth tremors of March 1949. *Journal of the Proceedings of the Royal Society of New South Wales,* 84, 17-27.

ISOSEISMAL MAP OF THE DALTON-GUNNING EARTHQUAKE, NEW SOUTH WALES 10 MARCH 1949

DATE : 10 MARCH 1949
TIME : 22:30:33 UT
MAGNITUDE : 5.5 ML (RIV), 4.6 MS (BMR)
EPICENTRE : 34.74°S 149.20°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT
INSET MEIZOSEISMAL ZONE SHOWN IN FOLLOWING MAP



24/N/2

ISOSEISMAL MAP OF THE DALTON-GUNNING EARTHQUAKE, NEW SOUTH WALES, NEAR EPICENTRE—10 MARCH 1949

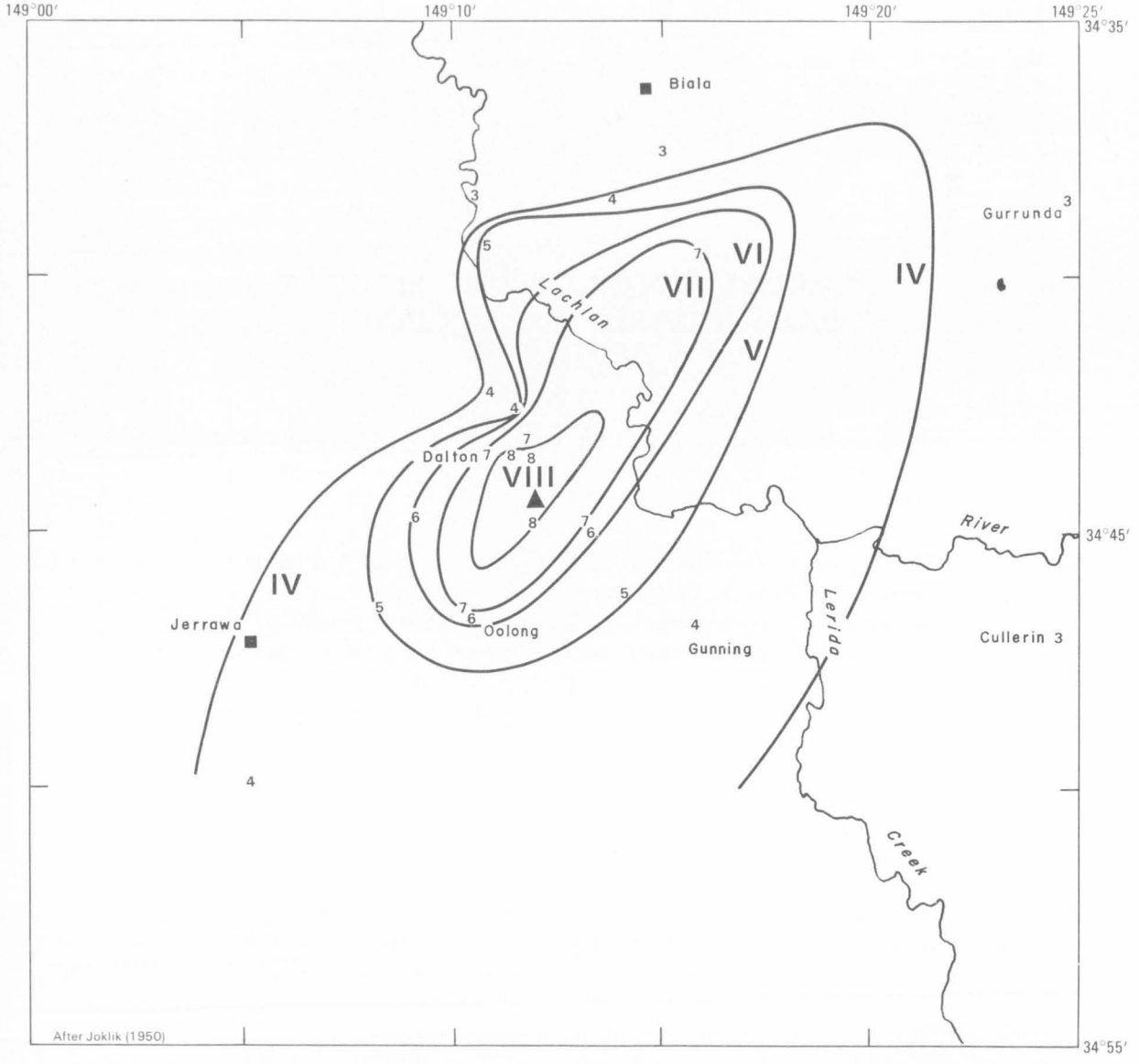
'In all, some 150 persons were interviewed, and the properties of most of these were inspected. Press reports drew attention to damage in the township of Dalton itself, but it was found that landholders to the immediate east suffered more heavily.

'Damage in the epicentral area included such items as heavily cracked walls, collapse of chimneys, collapse of timber stacks, shifting of heavy machinery, collapse of poorly constructed walls, destruction of parapets, bursting of concrete water-tanks, breakage of pictures and property stacked on shelves, etc. The most spectacular damage was of course caused in the most poorly built structures. In the township of Dalton all the more modern buildings with the exception of one concrete edifice escaped serious damage. The Royal Hotel, which had previously been condemned, and the two churches, both very old buildings, received the greater publicity. In these three it was found, upon removal of the plaster, that the walls were built of irregular granite and sandstone blocks the interstices between which had been filled with mortar, wood and even paper. Numerous chimneys collapsed in the township, but here again it was found that the cement in most cases had crumbled.' Joklik (1950).

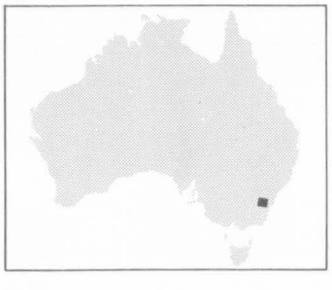
REFERENCE

JOKLIK, G. F., 1950—Dalton-Gunning area, N.S.W., earth tremors of March 1949. *Journal of the Proceedings of the Royal Society of New South Wales,* 84, 17-27.

ISOSEISMAL MAP OF THE DALTON-GUNNING EARTHQUAKE, NEW SOUTH WALES NEAR EPICENTRE, 10 MARCH 1949



0 10km



DATE : 10 MARCH 1949
TIME : 22:30:33 UT
MAGNITUDE : 5.5 ML (RIV), 4.6 MS (BMR)
EPICENTRE : 34.74°S 149.20°E

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

24/155-12/1

ISOSEISMAL MAP OF THE MACKAY EARTHQUAKE, QUEENSLAND— 5 APRIL 1950

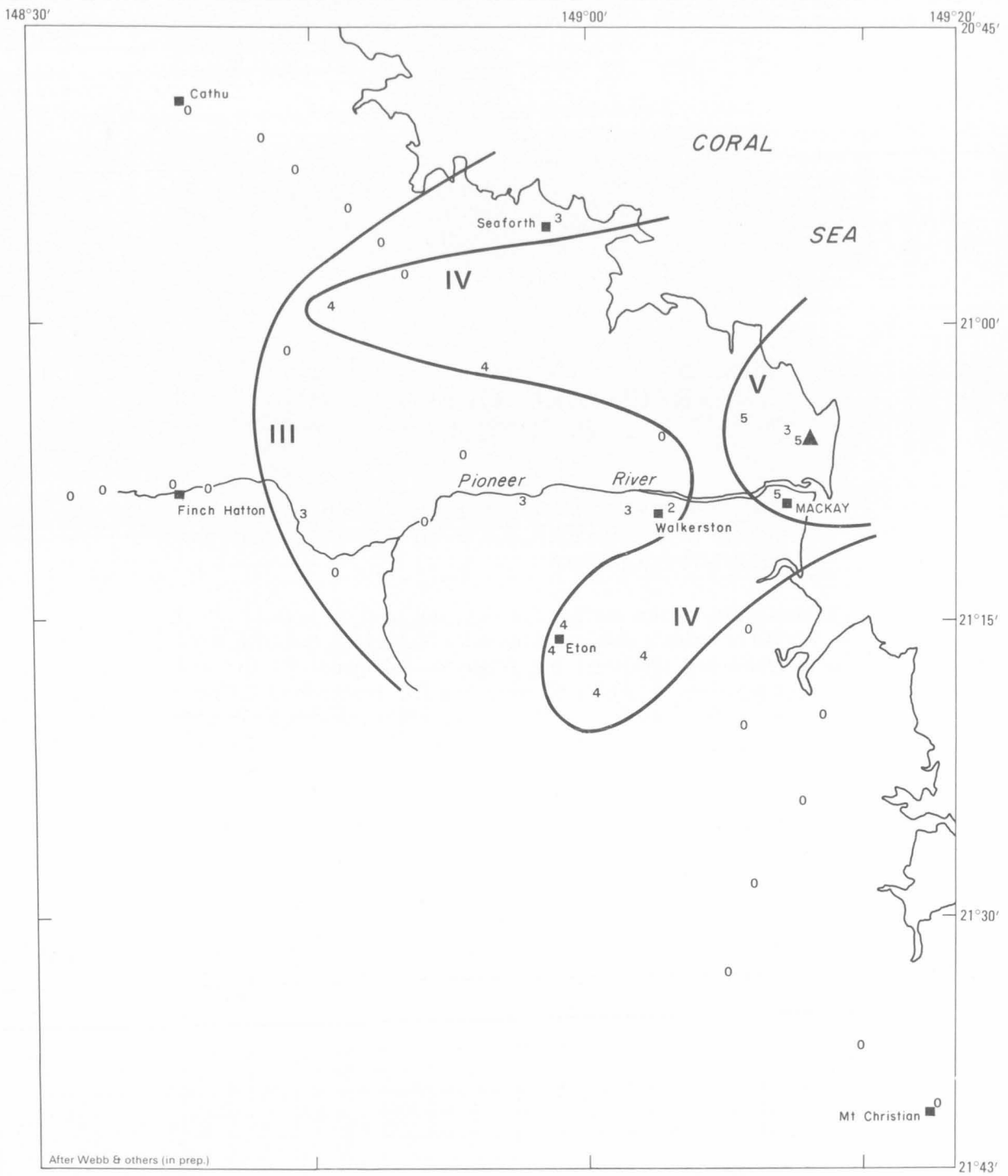
On 5 April 1950 at 19:50 UT (05:50 local time on 6 April 1950) an earthquake of magnitude ML 4.4 occurred in the Mackay area.

The felt area extended over about 3000 km^2 with a maximum intensity of MM V being experienced in the Mackay region. No damage was reported. Of 72 questionnaires returned, 34 were 'not felt' reports and 17 were returned from addresses that did not exist (railway sidings, discontinued post offices). The original data were collected by the late Dr O. A. Jones (University of Queensland) who compiled an isoseismal map but did not publish it. Webb & others (in preparation) redrew the map from these original data.

REFERENCE

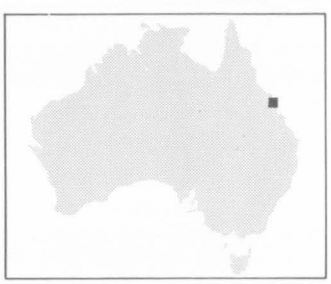
WEBB, J. P., RYNN, J. M. W., LYNAM, C. J., & MILLICAN, J. M., in preparation—The seismicity of Queensland—1875 to 1981.

ISOSEISMAL MAP OF THE MACKAY EARTHQUAKE, QUEENSLAND
5 APRIL 1950



DATE : 5 APRIL 1950
TIME : 19:50:52 UT
MAGNITUDE : 4.4 ML(I)
EPICENTRE : 21.1°S 149.2°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/F55/1

ISOSEISMAL MAP OF THE ATHERTON EARTHQUAKE, QUEENSLAND— 19 JUNE 1950

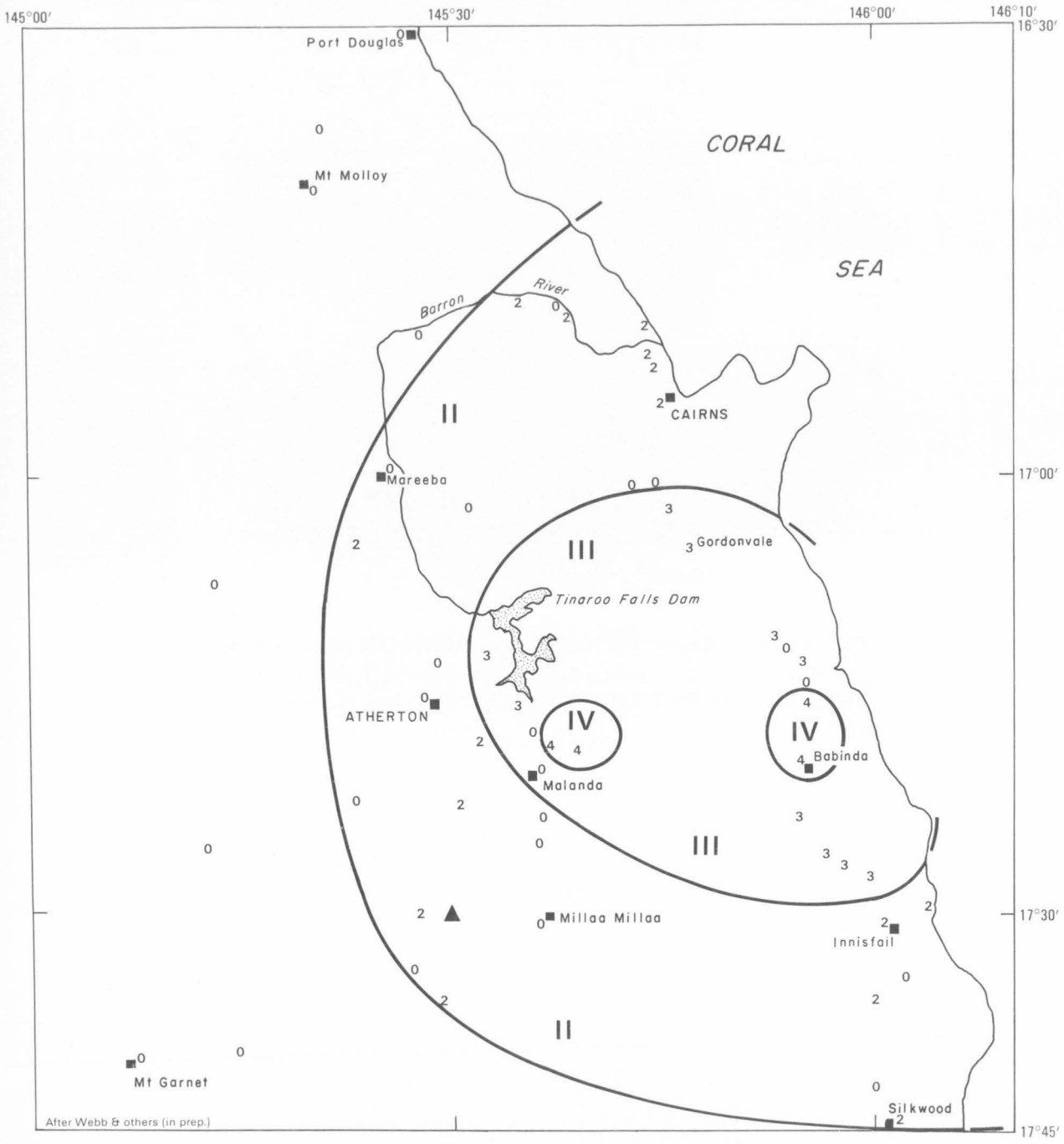
At about 09:00 UT (19:00 local time) on 19 June, 1950 an earthquake of magnitude ML 4.0 occurred in the southern part of the Atherton Tableland.

The effects of this earthquake were felt over an area of about 8000 km^2 with a maximum intensity of MM IV recorded from several small towns on the Atherton Tableland. Of the 124 questionnaires returned, 52 were 'not-felt' reports and 22 were returned from railway stations, post offices, and schools that had been closed. The late Dr O. A. Jones (University of Queensland) collected the data and drew an isoseismal map, but did not publish either. The map presented here was drawn by Webb & others (in preparation) and was based on the original data and map.

REFERENCE

WEBB, J. P., RYNN, J. M. W., LYNAM, C. J., & MILLICAN, J. M., in preparation—The seismicity of Queensland—1875 to 1981.

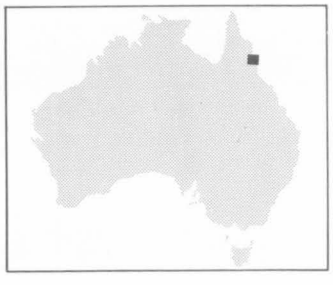
ISOSEISMAL MAP OF THE ATHERTON EARTHQUAKE, QUEENSLAND
19 JUNE 1950



0 40km

DATE : 19 JUNE 1950
TIME : 09:00:00 UT
MAGNITUDE : 4.0 ML (I)
EPICENTRE : 17.5°S 145.5°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/E55/1

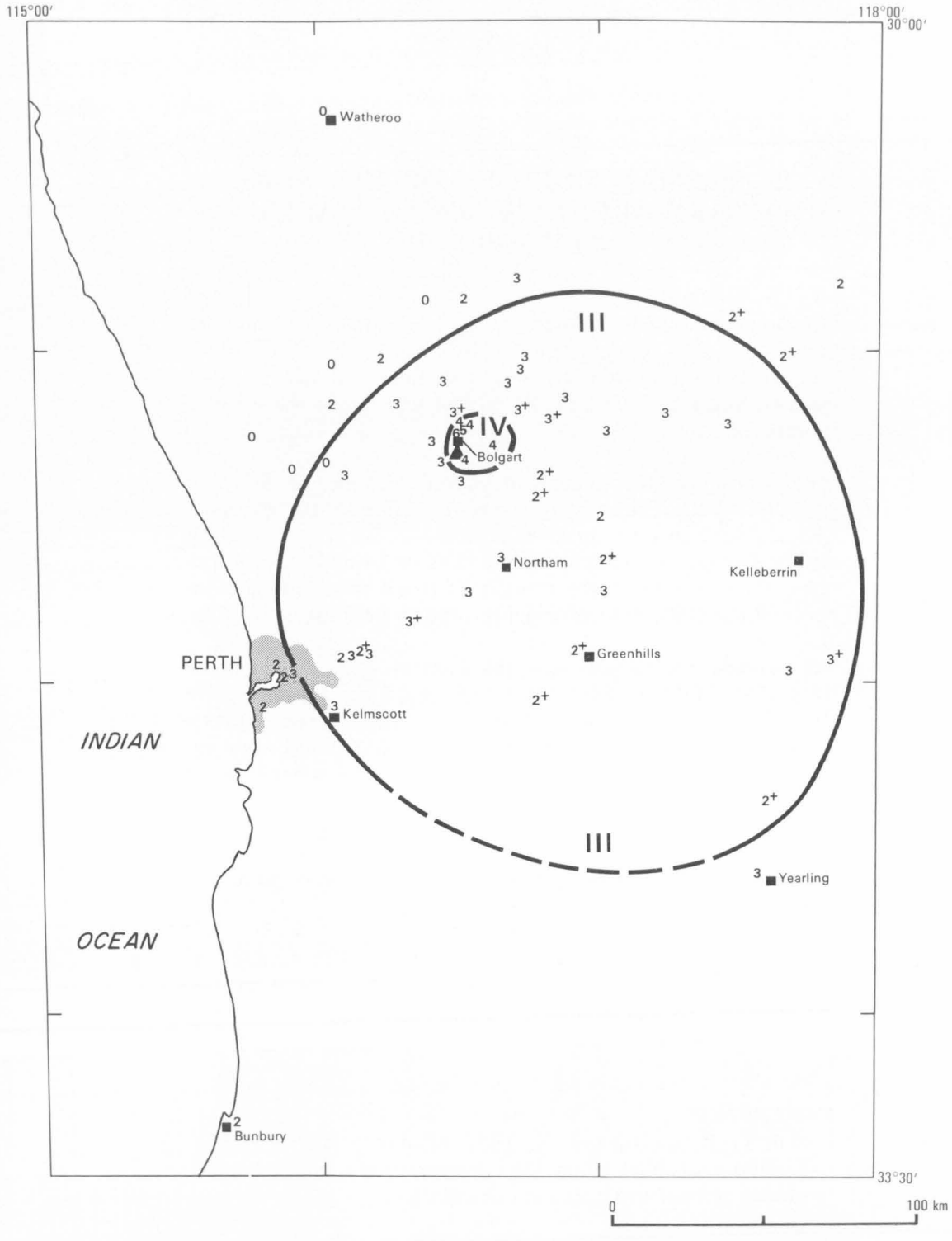
ISOSEISMAL MAP OF THE BOLGART EARTHQUAKE, WESTERN AUSTRALIA— 11 MARCH 1952

The map was drawn by staff of the BMR's Mundaring Geophysical Observatory using newspapers reports and felt reports collected by the Perth Observatory. The map has not been published before.

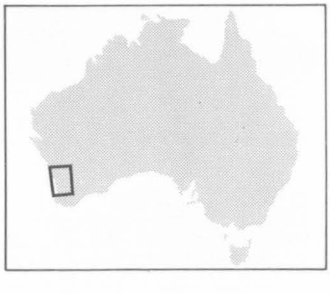
REFERENCE

EVERINGHAM, I. B., & TILBURY, L., 1972—Information on Western Australian earthquakes 1849-1960. *Journal of the Royal Society of Western Australia,* 55(3), 90-96.

ISOSEISMAL MAP OF THE BOLGART EARTHQUAKE, WESTERN AUSTRALIA
11 MARCH 1952



DATE : 11 MARCH 1952
TIME : 06:09 UT
MAGNITUDE : 5.1 ML (I)
EPICENTRE : 31.3°S 116.5°E



▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/WA/19

ISOSEISMAL MAP OF THE GUNNING EARTHQUAKE, NEW SOUTH WALES—19 NOVEMBER 1952

'The tremors were felt most severely in the town of Gunning and in the area to the west. Their intensity decreased more gradually outwards from the epicentre than that of the 1949 tremors. Slight trembling of the ground was felt in the western suburbs of Sydney.

'The intensity of the tremors at various localities in the area surrounding the epicentre is shown in terms of the modified Mercalli Scale of Earthquake Intensities . . . As no permanently visible damage was caused to buildings or to any other structures, the intensity of the tremors is based in every case on personal accounts, most of which proved to be fairly unreliable.

'At Gunning, the tremors were felt as severe jolts accompanied by a loud rumbling noise which was heard for approximately thirty seconds in the case of the three most severe shocks. Windows rattled, a little plaster fell from ceilings, but no objects were dislodged. The general opinion of the town's people was that these tremors were felt as severely in Gunning as were the tremors of March, 1949 . . .'

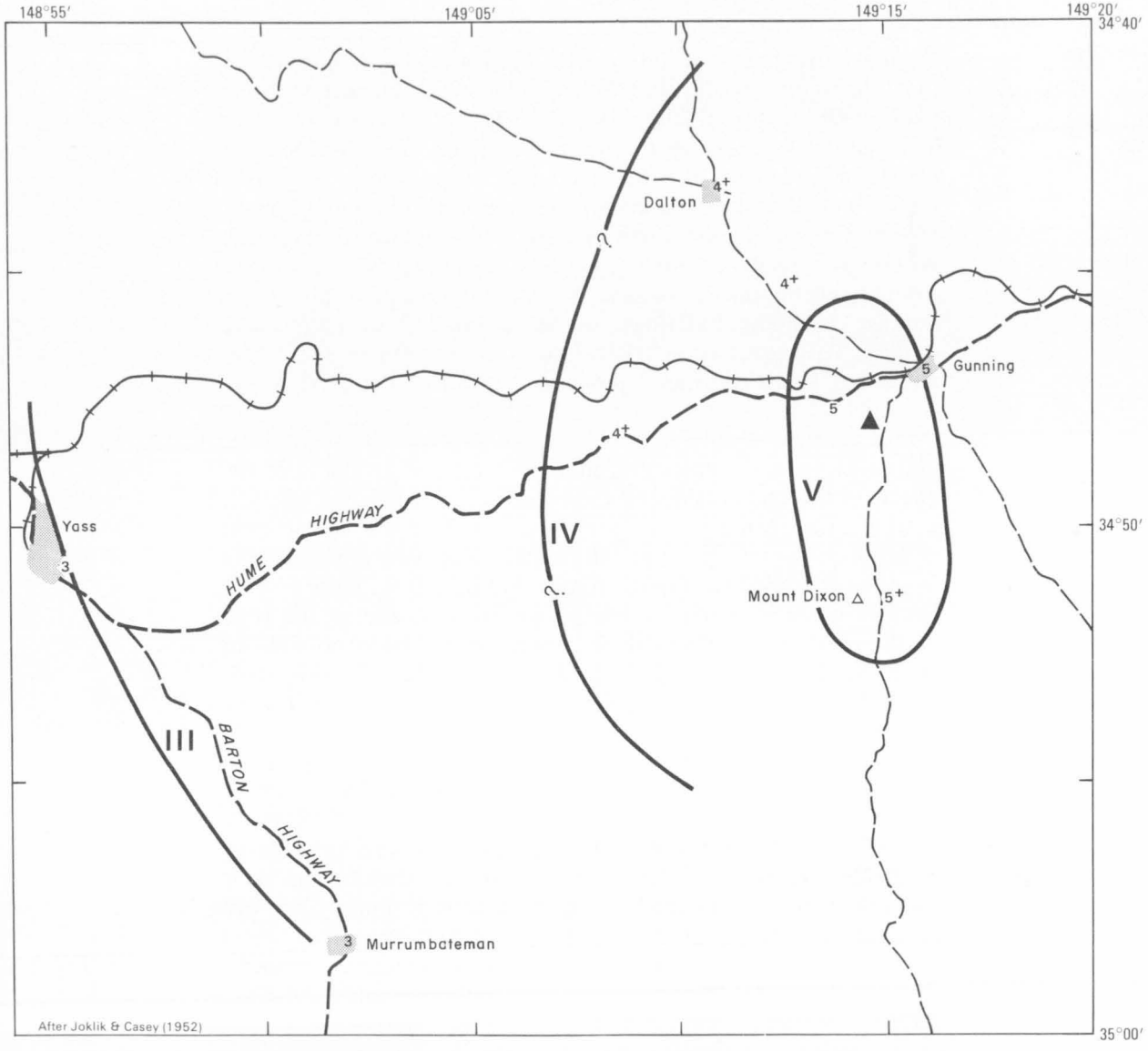
'Residents of Dalton [felt] that the recent tremors were not nearly as severe as those of 1949 . . .'

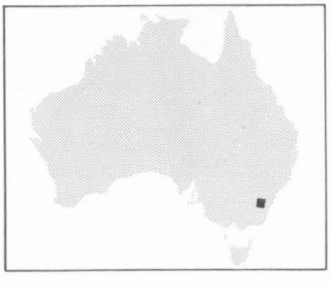
'No damage to property resulted from the earth tremors of November, 1952. Newspaper reports of them were grossly exaggerated.' (Joklik & Casey, 1952).

REFERENCE

JOKLIK, G. F., & CASEY, J. N., 1952—Gunning district, N.S.W. —Earth tremors November, 1952. *Bureau of Mineral Resources, Australia, Record* 1952/91 (unpublished).

ISOSEISMAL MAP OF THE GUNNING EARTHQUAKE, NEW SOUTH WALES
19 NOVEMBER 1952





DATE : 19 NOVEMBER 1952
TIME : 01:59:16 UT
MAGNITUDE : 4.9 ML (RIV), 3.6 MS (BMR)
EPICENTRE : 34.8°S 149.25°E
DEPTH : NEAR SURFACE

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/155-12/2

ISOSEISMAL MAP OF THE ADELAIDE EARTHQUAKE, SOUTH AUSTRALIA— 28 FEBRUARY 1954

'In the early hours of 1st March 1954 (local time), most of the inhabitants of the city of Adelaide were awakened by a loud rumbling noise followed by a shaking severe enough to crack the walls and loosen plaster from many houses. For most persons in Adelaide, this was their first experience of an earthquake, and it is the first record in almost a hundred years of any movements in the earth's crust in the vicinity of the city. Although a relatively minor one by the standards of countries prone to earthquakes, it was sufficiently severe to cause material damage to many buildings, as the possibility of earthquake damage had never been taken into consideration in their construction. There were no injuries as a result of the earthquake.

'In the absence of any instrumental records from distances under 400 miles from the epicentre, numerous reports available of the effects of the earthquake and the experiences of persons who felt it were investigated by the geophysical staff of the Department of Mines. An abundance of information was naturally available from the Adelaide metropolitan area, but data from more remote country areas is sparse as few people were awake at the time of the earthquake. From these reports it has been possible to draw isoseismal lines and establish the approximate position of the epicentre . . . The maximum intensity of the earthquake has been established as Intensity 8 on the Modified Mercalli scale. A second or minor epicentre with Intensity 7 appears to occur in the vincity of Beaumont' (Kerr-Grant, 1956).

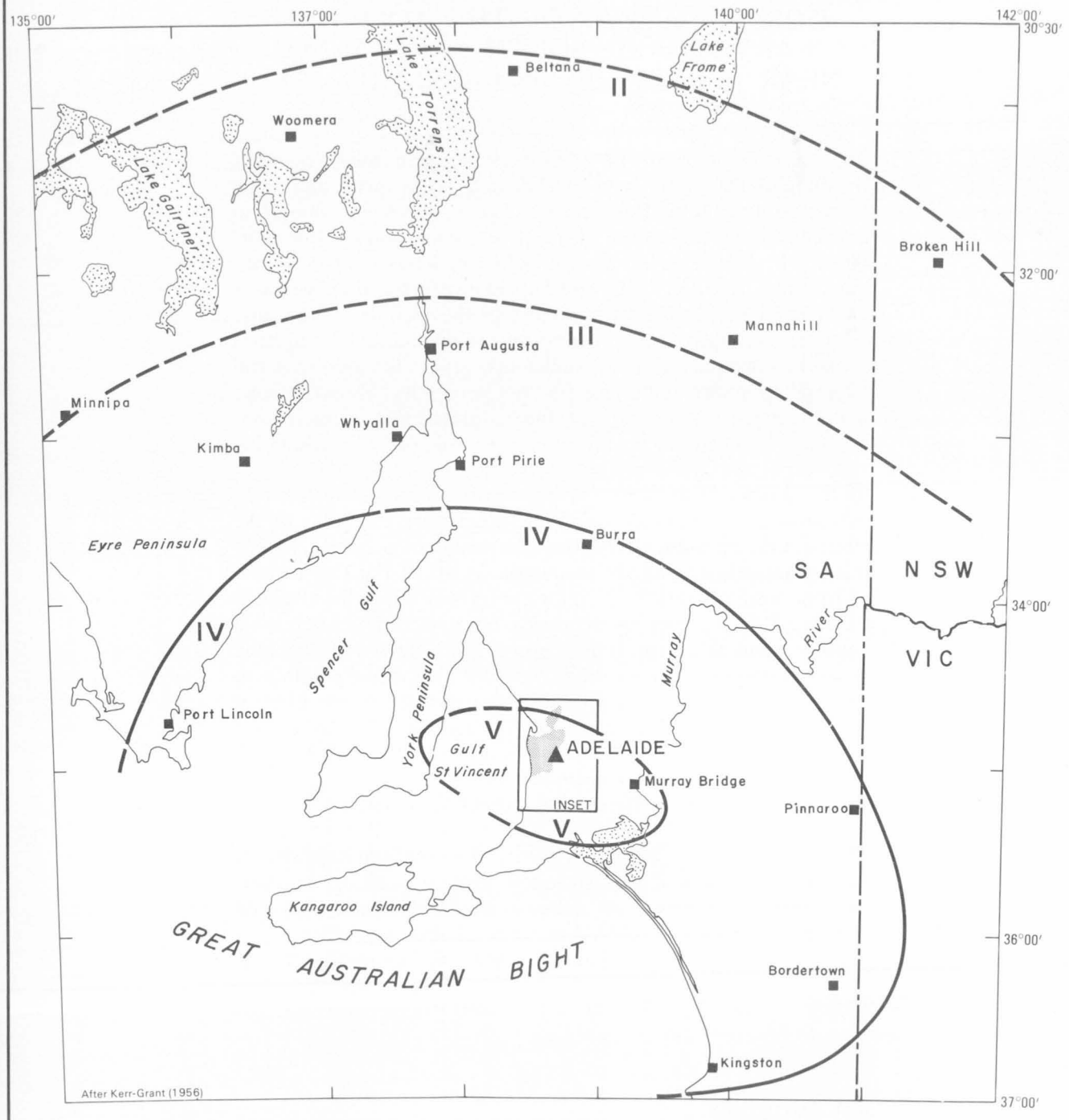
'On the 1st March 1954 (LT) . . . the southern suburbs of Adelaide experienced the strongest ground shaking in their short history. Widespread damage occurred, mainly to old domestic dwellings (30,000 insurance claims were filed . . .) and whilst the average claim was only one hundred pounds, the estimated total loss was about four million pounds' (McCue, 1975).

REFERENCES

KERR-GRANT, C., 1956—The Adelaide earthquake of 1st March 1954. *Transactions of the Royal Society of South Australia,* 59, 177-185.

MCCUE, K. F., 1975—Seismicity and seismic risk in South Australia. *University of Adelaide Report,* ADP 137.

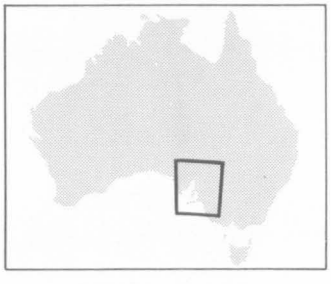
ISOSEISMAL MAP OF THE ADELAIDE EARTHQUAKE, SOUTH AUSTRALIA
28 FEBRUARY 1954



0 150km

DATE : 28 FEBRUARY 1954
TIME : 18:09:52 UT
MAGNITUDE : 5.4 ML (I), 4.9 MS (BMR)
EPICENTRE : 34.93°S 138.69°E
DEPTH : 4km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
INSET MEIZOSEISMAL ZONE SHOWN IN FOLLOWING MAP



24/SA/5

ISOSEISMAL MAP OF THE ADELAIDE EARTHQUAKE, SOUTH AUSTRALIA, NEAR EPICENTRE—28 FEBRUARY 1954

'In the early hours of 1st March 1954 (local time), most of the inhabitants of the city of Adelaide were awakened by a loud rumbling noise followed by a shaking severe enough to crack the walls and loosen plaster from many houses. For most persons in Adelaide, this was their first experience of an earthquake, and it is the first record in almost a hundred years of any movements in the earth's crust in the vicinity of the city. Although a relatively minor one by the standards of countries prone to earthquakes, it was sufficiently severe to cause material damage to many buildings, as the possibility of earthquake damage had never been taken into consideration in their construction. There were no injuries as a result of the earthquake.

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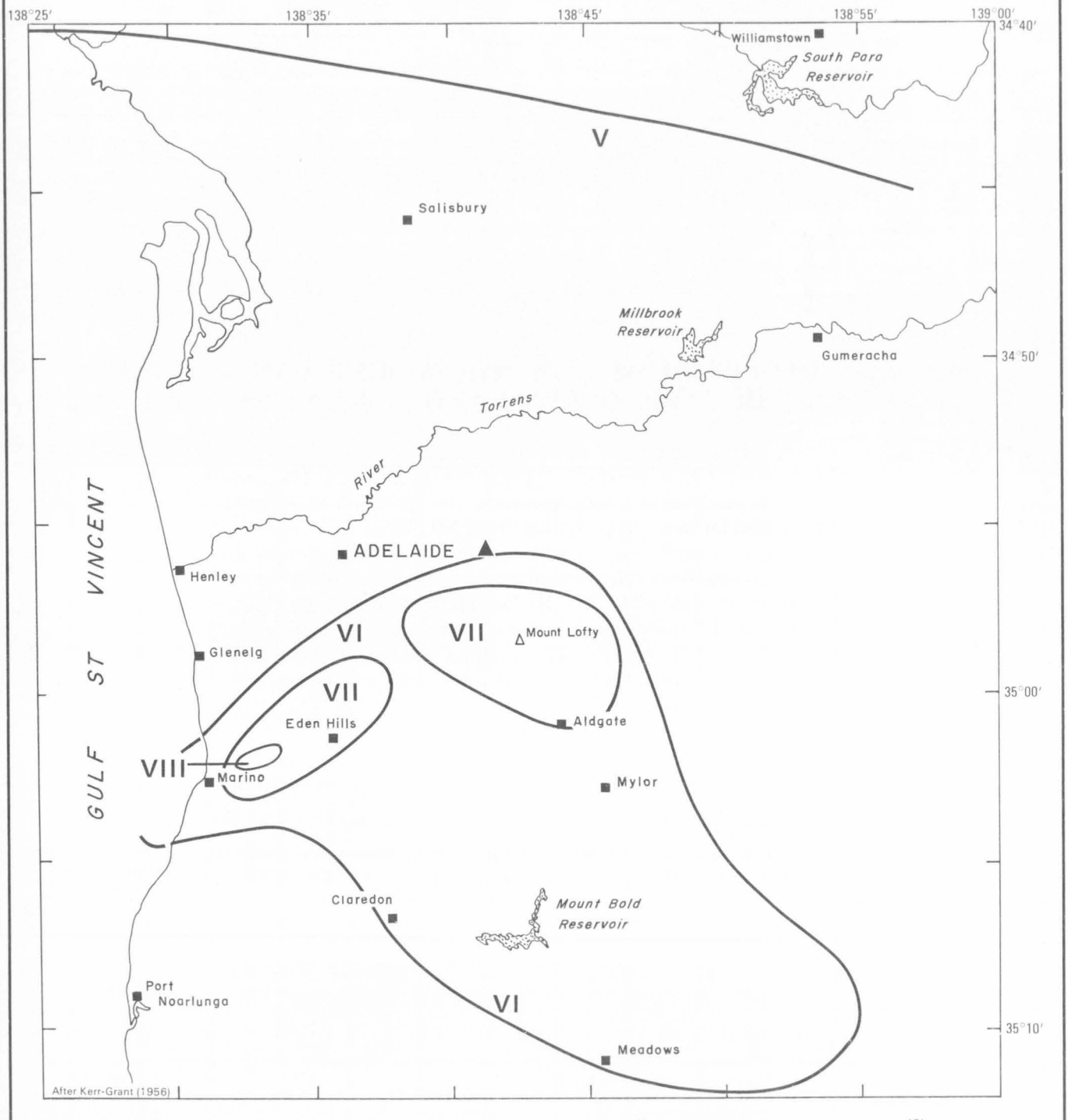
REFERENCES

KERR-GRANT, C., 1956—The Adelaide earthquake of 1st March 1954. *Transactions of the Royal Society of South Australia,* 59, 177-185.

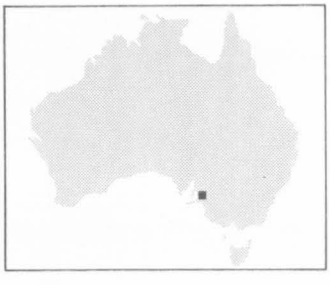
MCCUE, K. F., 1975—Seismicity and seismic risk in South Australia. *University of Adelaide Report,* ADP 137.

ISOSEISMAL MAP OF THE ADELAIDE EARTHQUAKE, SOUTH AUSTRALIA
NEAR EPICENTRE, 28 FEBRUARY 1954



DATE : 28 FEBRUARY 1954
TIME : 18:09:52 UT
MAGNITUDE : 5.4 ML (I), 4.9 MS (BMR)
EPICENTRE : 34.93°S 138.69°E
DEPTH : 4km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)



24/154/1

ISOSEISMAL MAP OF THE MOURILYAN EARTHQUAKE, QUEENSLAND—4 MAY 1954

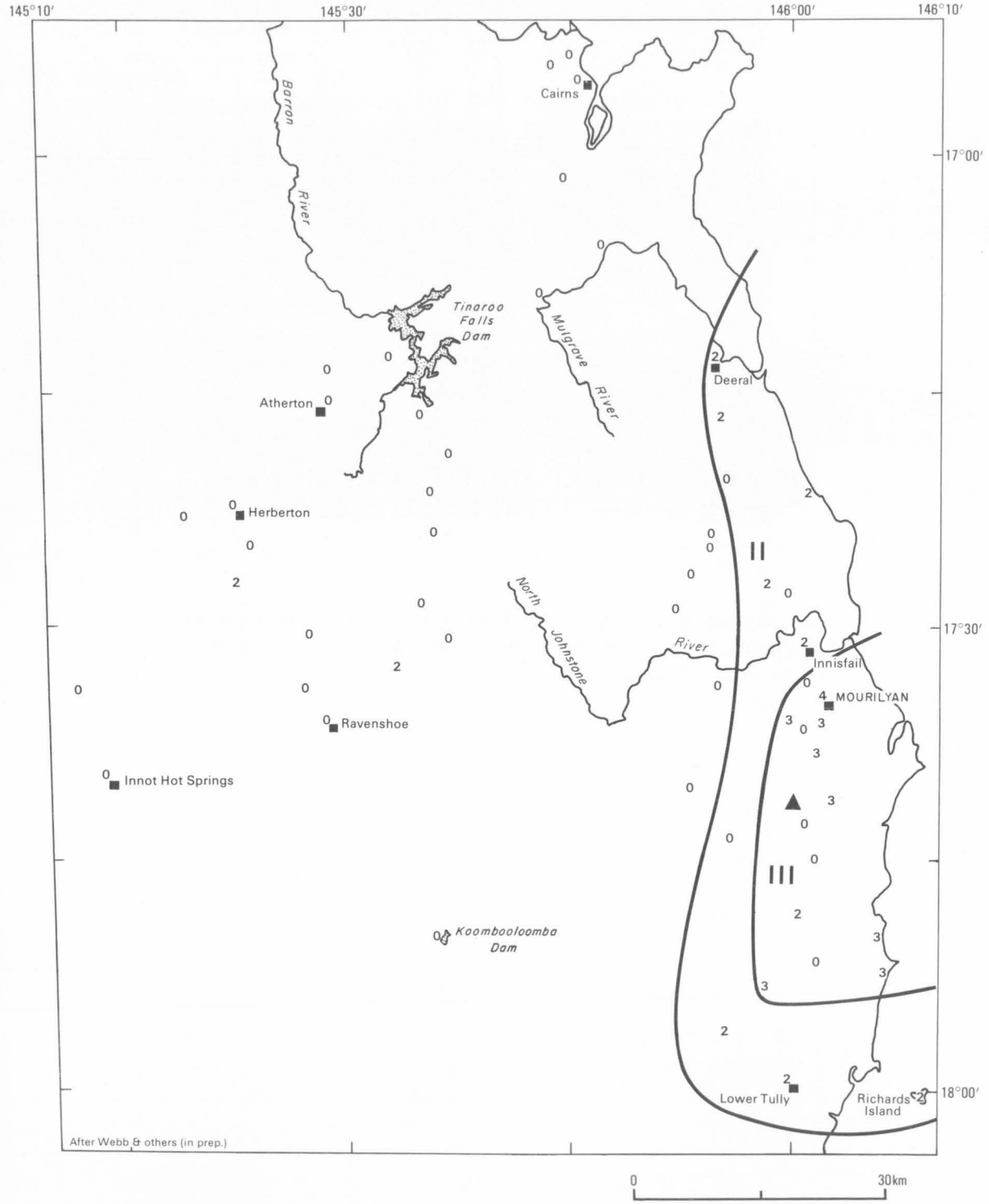
On 4 May, 1954 at 07:05 UT (17:05 local time) the area around Mourilyan at South Johnstone (to the south of Cairns) experienced an earthquake of magnitude ML 4.4.

The earthquake was felt over an area of about 1500 km^2 with the maximum intensity MM III-IV reported from Mourilyan. A total of 80 questionnaires were completed, of which 58 recorded 'non-felt' reports. The original isoseismal data were collected by the late Dr O. A. Jones (University of Queensland) but were not published. The map presented here was drawn by Webb & others (in preparation) based on these data.

REFERENCE

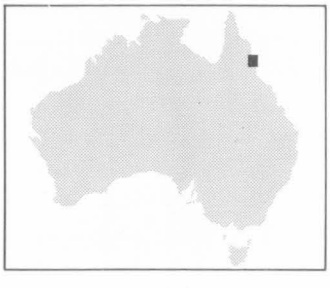
WEBB, J. P., RYNN, J. M. W., LYNAM, C. J., & MILLICAN, J. M., in preparation—The seismicity of Queensland—1875 to 1981.

ISOSEISMAL MAP OF THE MOURILYAN EARTHQUAKE, QUEENSLAND
4 MAY 1954



DATE : 4 MAY 1954
TIME : 07:05:00 UT
MAGNITUDE : 4.4 ML (I)
EPICENTRE : 17.7°S 146.0°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/E55/2

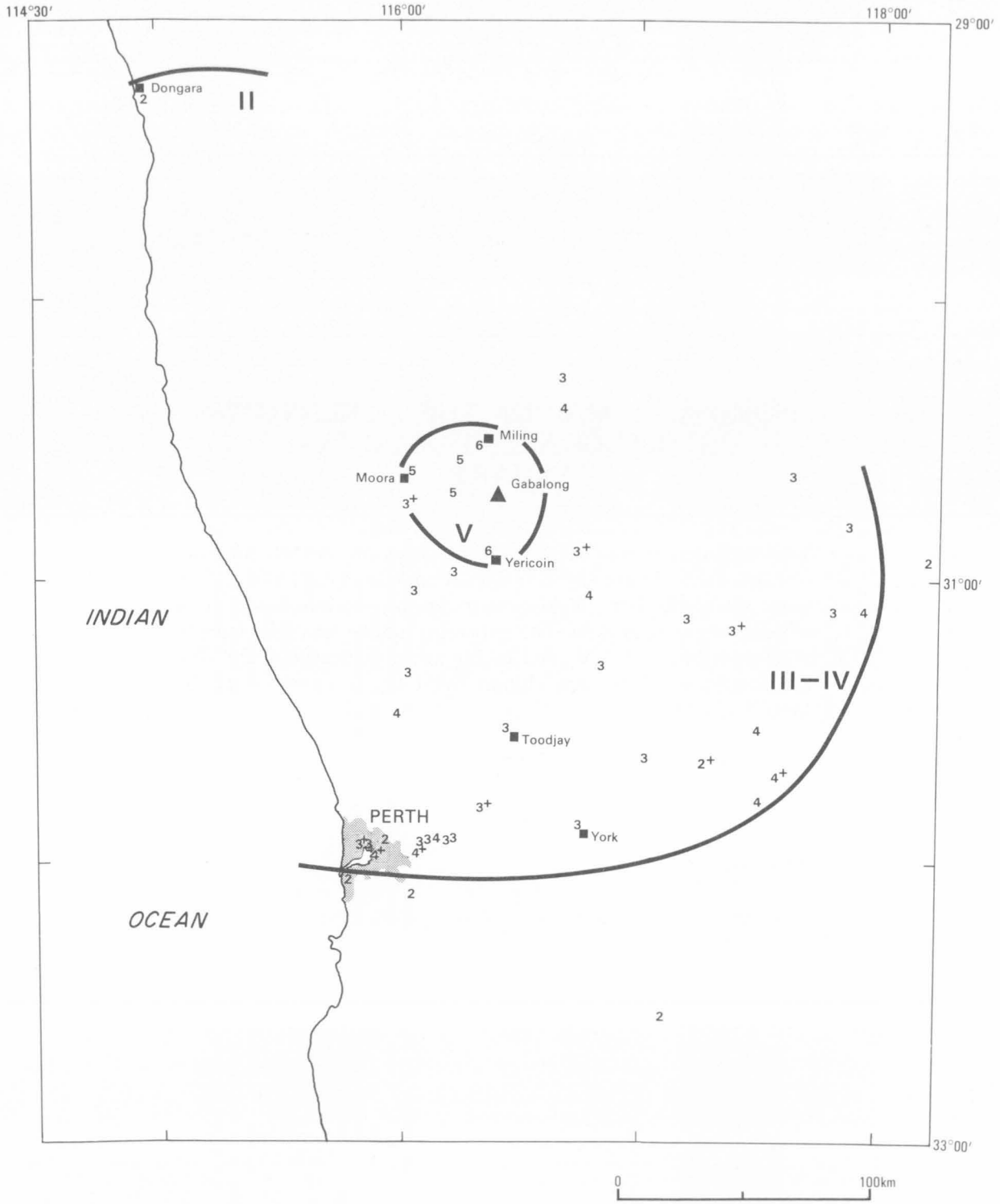
ISOSEISMAL MAP OF THE GABALONG EARTHQUAKE, WESTERN AUSTRALIA— 30 AUGUST 1955

The map was drawn by staff of BMR's Mundaring Geophysical Observatory using newspaper reports and felt reports collected by the Perth Observatory.

REFERENCE

EVERINGHAM, I. B., & TILBURY, L., 1972—Information on Western Australian earthquakes 1849-1960. *Journal of the Royal Society of Western Australia,* 55(3), 90-96.

ISOSEISMAL MAP OF THE GABALONG EARTHQUAKE, WESTERN AUSTRALIA
30 AUGUST 1955



DATE : 30 AUGUST 1955
TIME : 13:52 UT
MAGNITUDE : 5.8 ML (I)
EPICENTRE : 30.7°S 116.4°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/WA/18

ISOSEISMAL MAP OF THE QUEENSTOWN EARTHQUAKE, TASMANIA— 1 JANUARY 1958

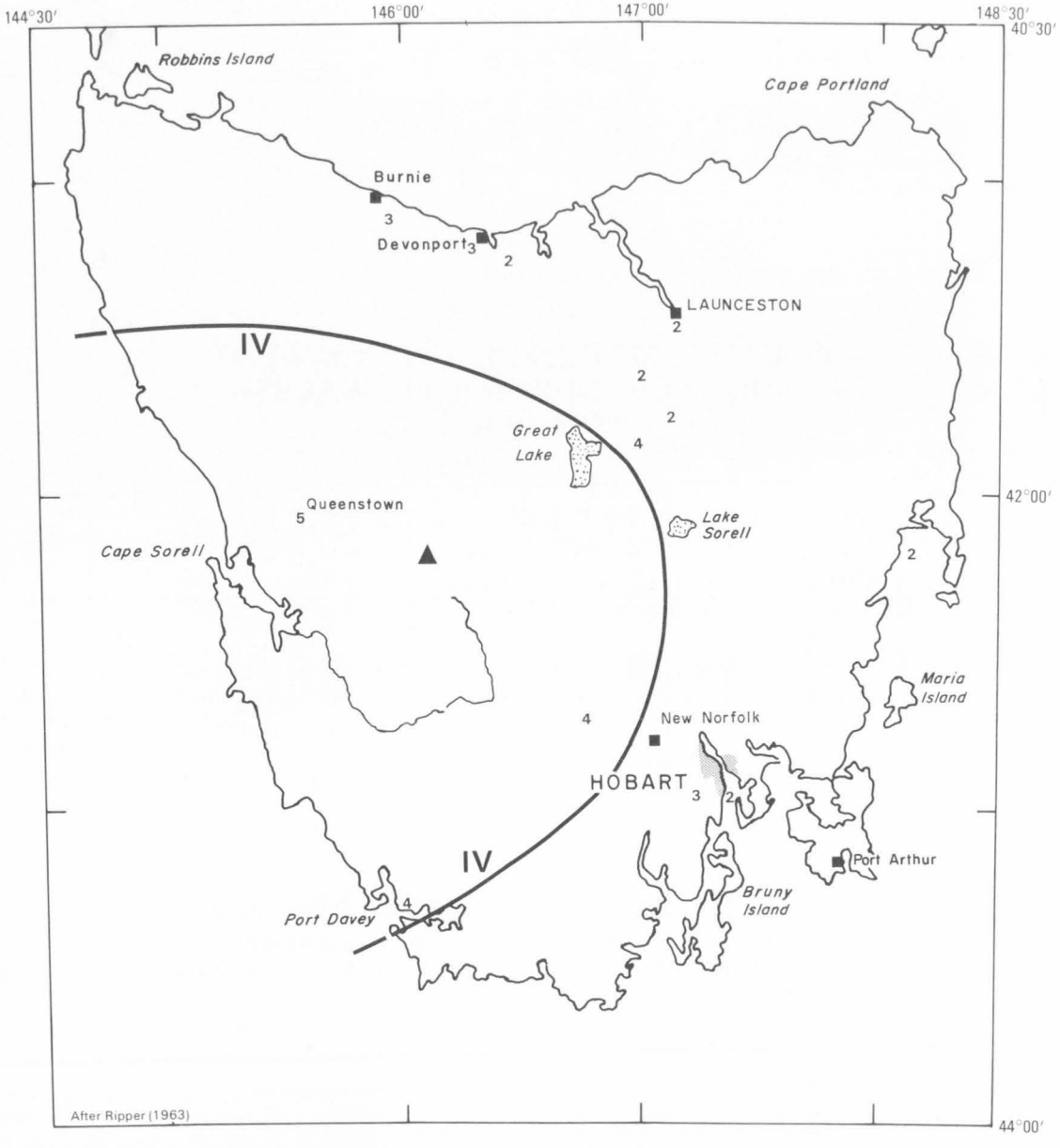
This earthquake was the first local shock to be recorded by instruments in Tasmania. It occurred on New Year's Day, 1958 soon after the Fort Nelson seismograph station, sited near Hobart, began operation. The main earthquake was felt strongly at Queenstown (MM V) and as far away as Burnie (MM III), Launceston (MM II), and Hobart (MM II). It was followed by several aftershocks.

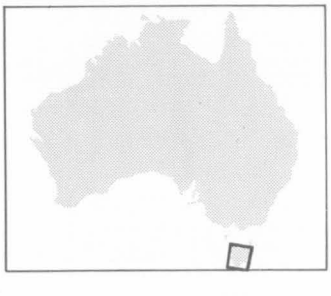
The map was drawn by Ripper (1963).

REFERENCE

RIPPER, I. D., 1963—Local and regional events recorded by the Tasmania seismic net. *Honours Thesis, University of Tasmania, Hobart* (unpublished).

ISOSEISMAL MAP OF THE QUEENSTOWN EARTHQUAKE, TASMANIA
1 JANUARY 1958





DATE : 1 JANUARY 1958
TIME : 00:07:00 UT
MAGNITUDE : 5.0 ML (I), 5.3 ML (RIV)
EPICENTRE : 42.2°S 146.1°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/K55/1

ISOSEISMAL MAP OF THE ROCK FLAT EARTHQUAKE, NEW SOUTH WALES— 1 SEPTEMBER 1958

At 11:18 UT (21:18 local time) on 1 September 1958 an earthquake of magnitude ML 4.0 occurred near Rock Flat, approximately 20 km southeast of Cooma. The earthquake was felt over an area in excess of 15 000 km^2 of southeastern NSW.

'Following the Rock Flat earthquake, questionnaires based on the USCGS questionnaire cards were circulated to many people over a wide area.' (Cleary & others, 1964). The number of replies was not stipulated.

REFERENCE

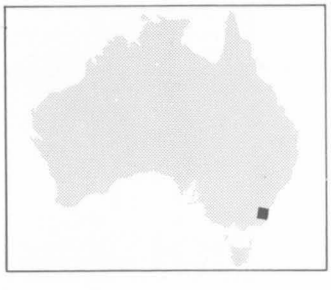
CLEARY, J. R., DOYLE, H. A., & MOYE, D. G., 1964—Seismic acivity in the Snowy Mountains region and its relationship to geological structures. *Journal of the Geological Society of Australia,* 11, 89-106.

ISOSEISMAL MAP OF THE ROCK FLAT EARTHQUAKE, NEW SOUTH WALES
1 SEPTEMBER 1958

0 40km

DATE : 1 SEPTEMBER 1958
TIME : 11:18:32:3 UT
MAGNITUDE : 4.0 ML (CAN)
EPICENTRE : 36.40°S 149.24°E
DEPTH : 11km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)



24/N/3

ISOSEISMAL MAP OF THE CAIRNS EARTHQUAKE, QUEENSLAND— 1 DECEMBER 1958

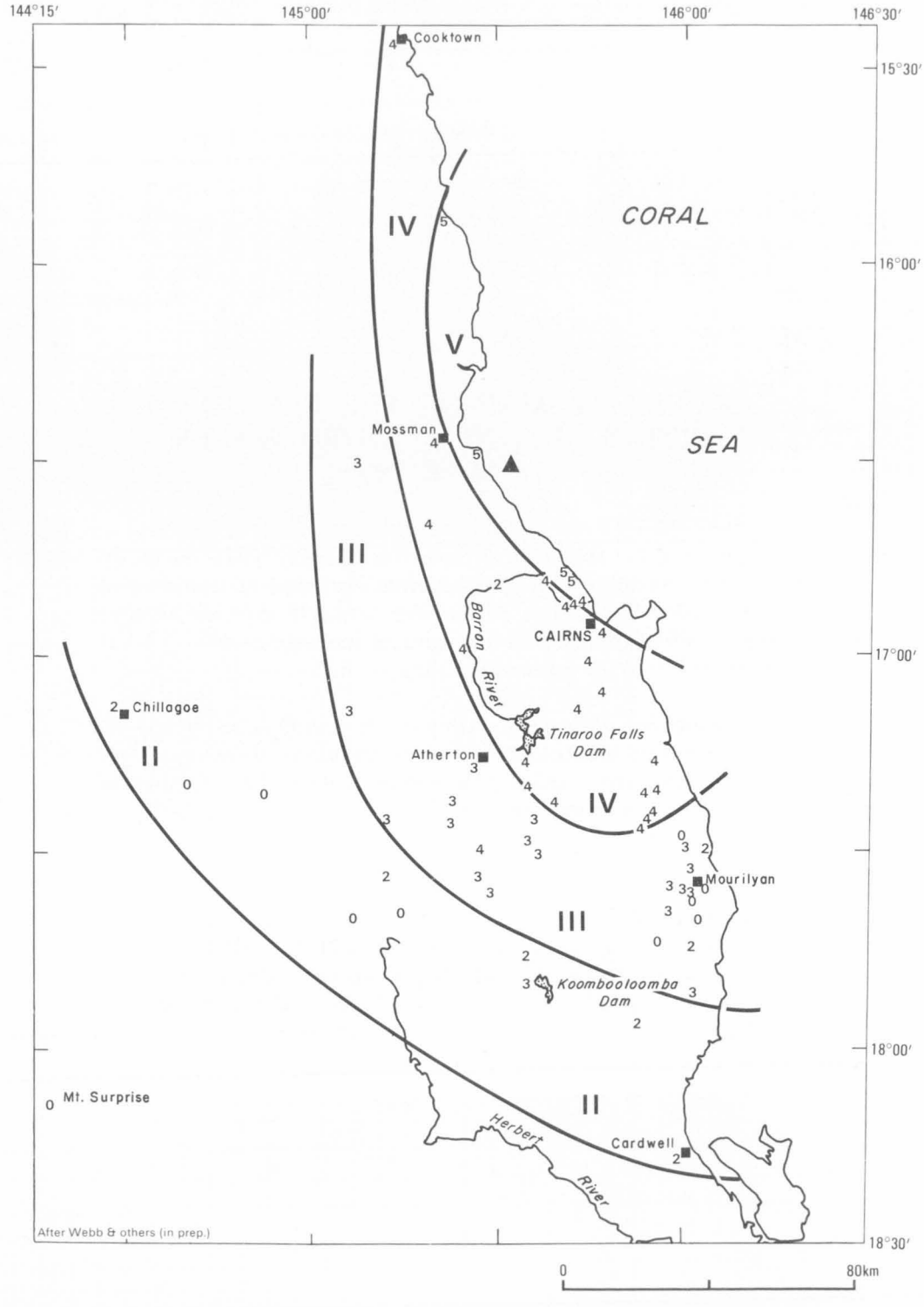
At 10:38 UT (20:38 local time) on 1 December 1958 a fairly severe earthquake was experienced in the Cairns region. Its magnitude was estimated at ML 4.4.

This earthquake was felt over an area of about 23 000 km^2 with a maximum intensity of MM V being reported from Cairns and Mossman. Of 85 questionaires returned, 14 were 'non-felt' reports and 4 were returned from schools and post offices that had been closed. From the isoseismal map, it is apparent that the epicentre was indeed off the coast. The original isoseismal data were collected by the late Dr O. A. Jones (University of Queensland), who did not draw an isoseismal map nor publish the data. The isoseismal map presented here was drawn by Webb & others (in preparation) from the original data. Several aftershocks, one of which was felt in Cairns, were noted as being associated with this earthquake.

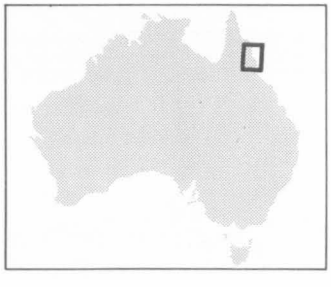
REFERENCE

WEBB, J. P., RYNN, J. M. W., LYNAM, C. J., & MILLICAN, J. M., in preparation—The seismicity of Queensland—1875 to 1981.

ISOSEISMAL MAP OF THE CAIRNS EARTHQUAKE, QUEENSLAND
1 DECEMBER 1958



DATE : 1 DECEMBER 1958
TIME : 10:38:33 UT
MAGNITUDE : 4.4 ML (I)
EPICENTRE : 16.5°S 145.5°E



▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/E55/3

ISOSEISMAL MAP OF THE BERRIDALE EARTHQUAKE, NEW SOUTH WALES— 18 MAY 1959

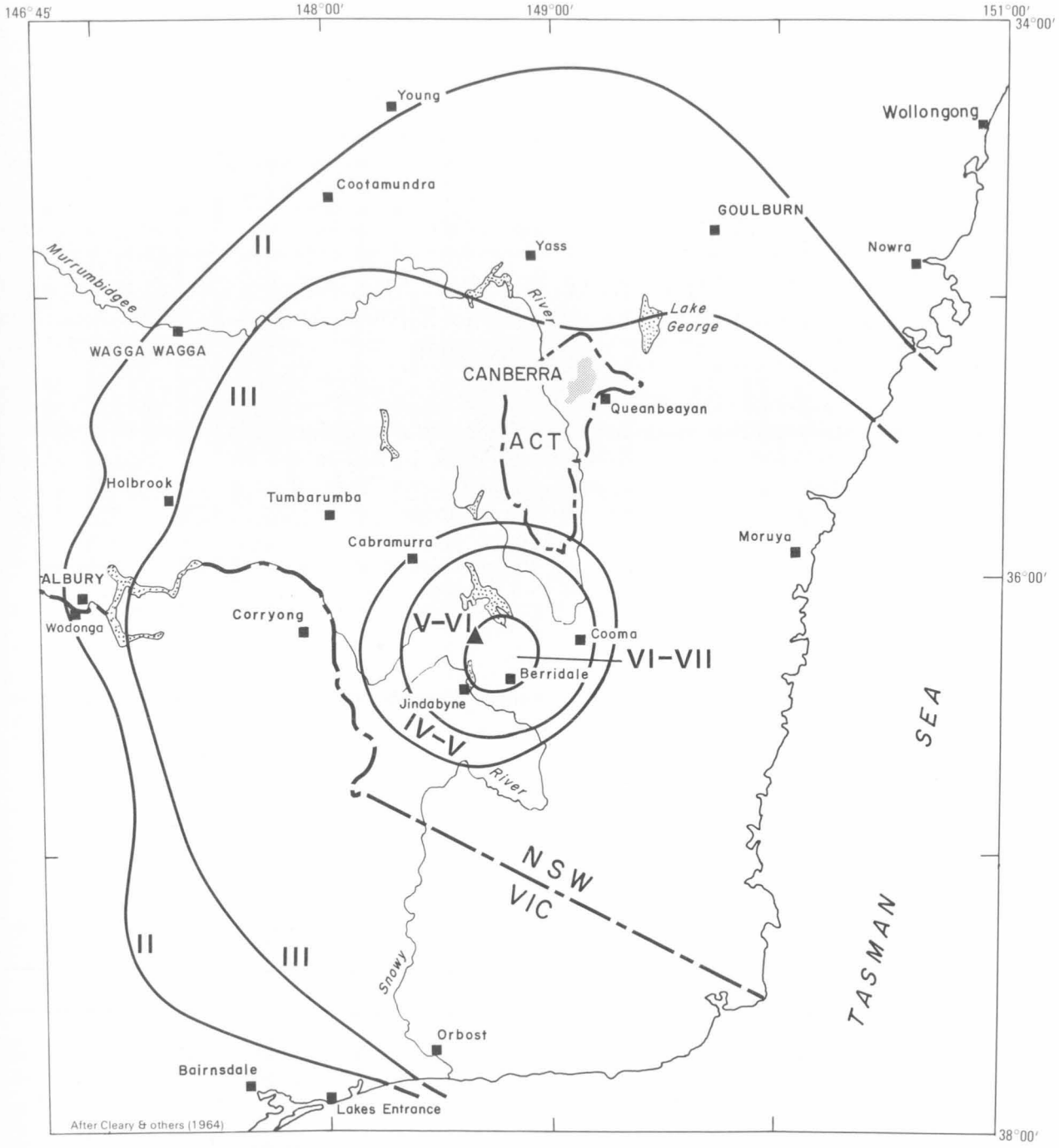
At 06:13 UT (16:13 local time) on 18 May 1959 an earthquake of magnitude ML 5.3 occurred northeast of Berridale in southeastern NSW. The earthquake was felt over an area of almost 100 000 km^2 with a maximum intensity of MM VI-VII observed just to the southeast of the epicentre.

'Following the Berridale earthquake questionnaires based on the USCGS questionnaire cards were circulated to many people over a wide area.' (Cleary & others, 1964). The number of replies was not stipulated.

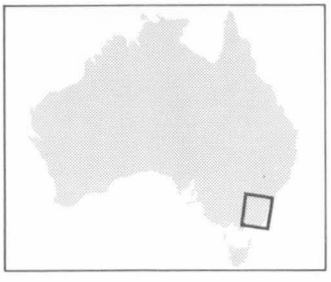
REFERENCE

CLEARY, J. R., DOYLE, H. A., & MOYE, D. G., 1964—Seismic acivity in the Snowy Mountains region and its relationship to geological structures. *Journal of the Geological Society of Australia,* 11, 89-106.

ISOSEISMAL MAP OF THE BERRIDALE EARTHQUAKE, NEW SOUTH WALES
18 MAY 1959



0 100km



DATE : 18 MAY 1959
TIME : 06:13:00.2 UT
MAGNITUDE : 5.3 ML (RIV), 3.8 MS (BMR)
EPICENTRE : 36.22°S 148.64°E
DEPTH : 15 km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)

24/N/4

ISOSEISMAL MAP OF THE MOUNT GLORIOUS EARTHQUAKE, QUEENSLAND—17 NOVEMBER 1960

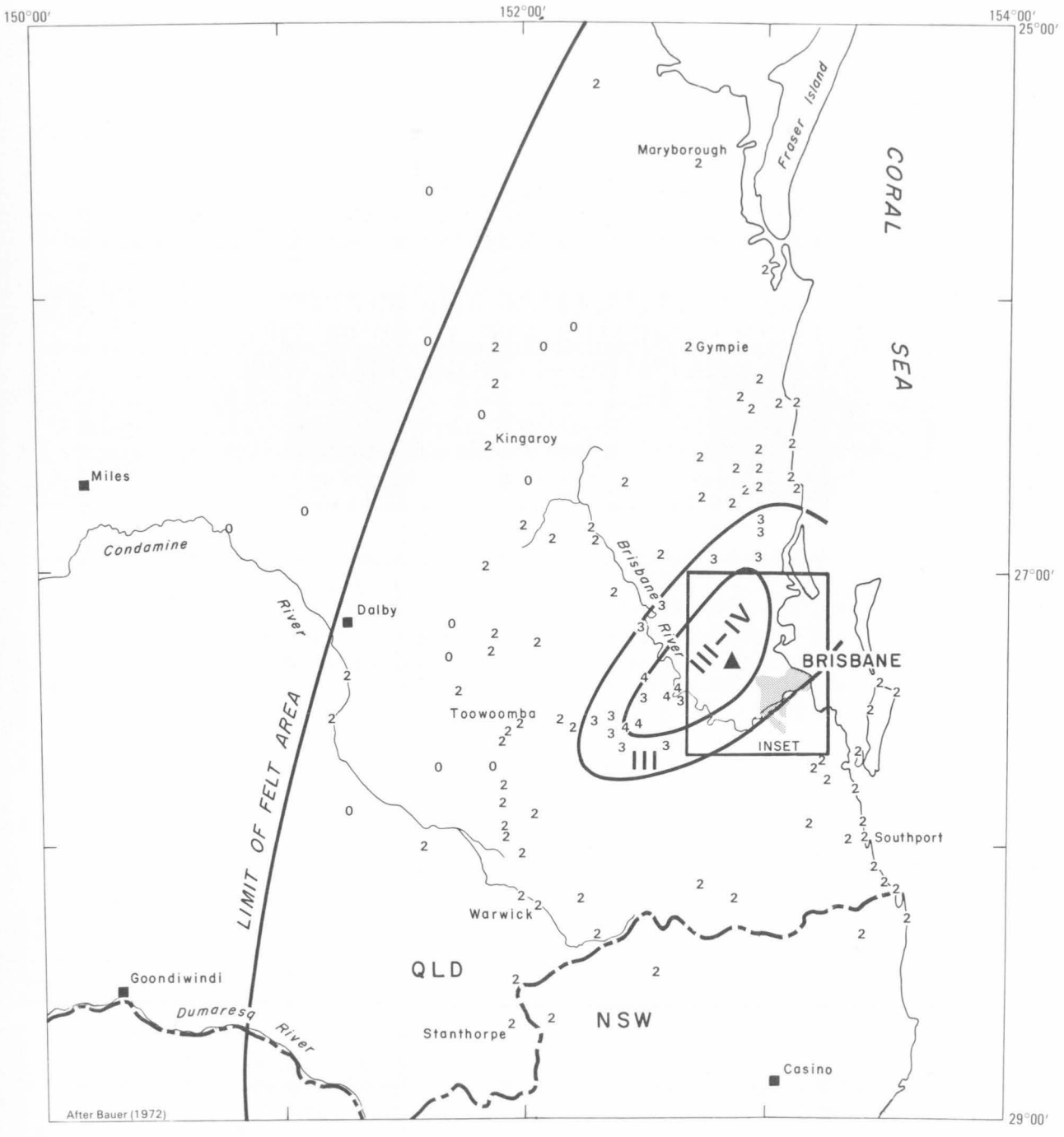
'A study has been made of macroseismic and instrumental data for the earthquake of 17 November 1960, located in the Mt Glorious region of southeast Queensland. Seven hundred questionnaires received from a felt area of about 100,000 square kilometres have provided data for the preparation of an isoseismal map and an estimate of the position of the epicentral region. This has been compared with a redefined epicentre based on the very inadequate instrumental observations of the earthquake.'

'For MM intensities within the range II to IV, there are no obvious correlations of observed intensity patterns with either regional geological trends or detailed near-surface geology.' (Bauer, 1972).

REFERENCE

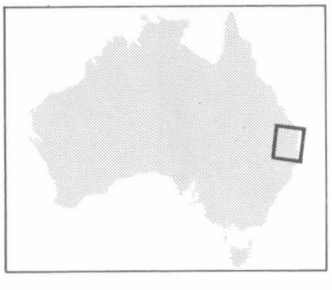
BAUER, J. A., 1972—The earthquake of 17 November 1960, in the Mt Glorious region, southeastern Queensland. *B.Sc. Thesis, University of Queensland, Department of Geology and Mineralogy, Brisbane* (unpublished).

ISOSEISMAL MAP OF THE MOUNT GLORIOUS EARTHQUAKE, QUEENSLAND
17 NOVEMBER 1960



DATE : 17 NOVEMBER 1960
TIME : 05:00:17 UT
MAGNITUDE : 4.4 ML (BRS)
EPICENTRE : 27.33°S 152.85°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT
INSET INTENSITIES SHOWN IN FOLLOWING MAP



24/G56/3

ISOSEISMAL MAP OF THE MOUNT GLORIOUS EARTHQUAKE, QUEENSLAND, NEAR EPICENTRE—17 NOVEMBER 1960

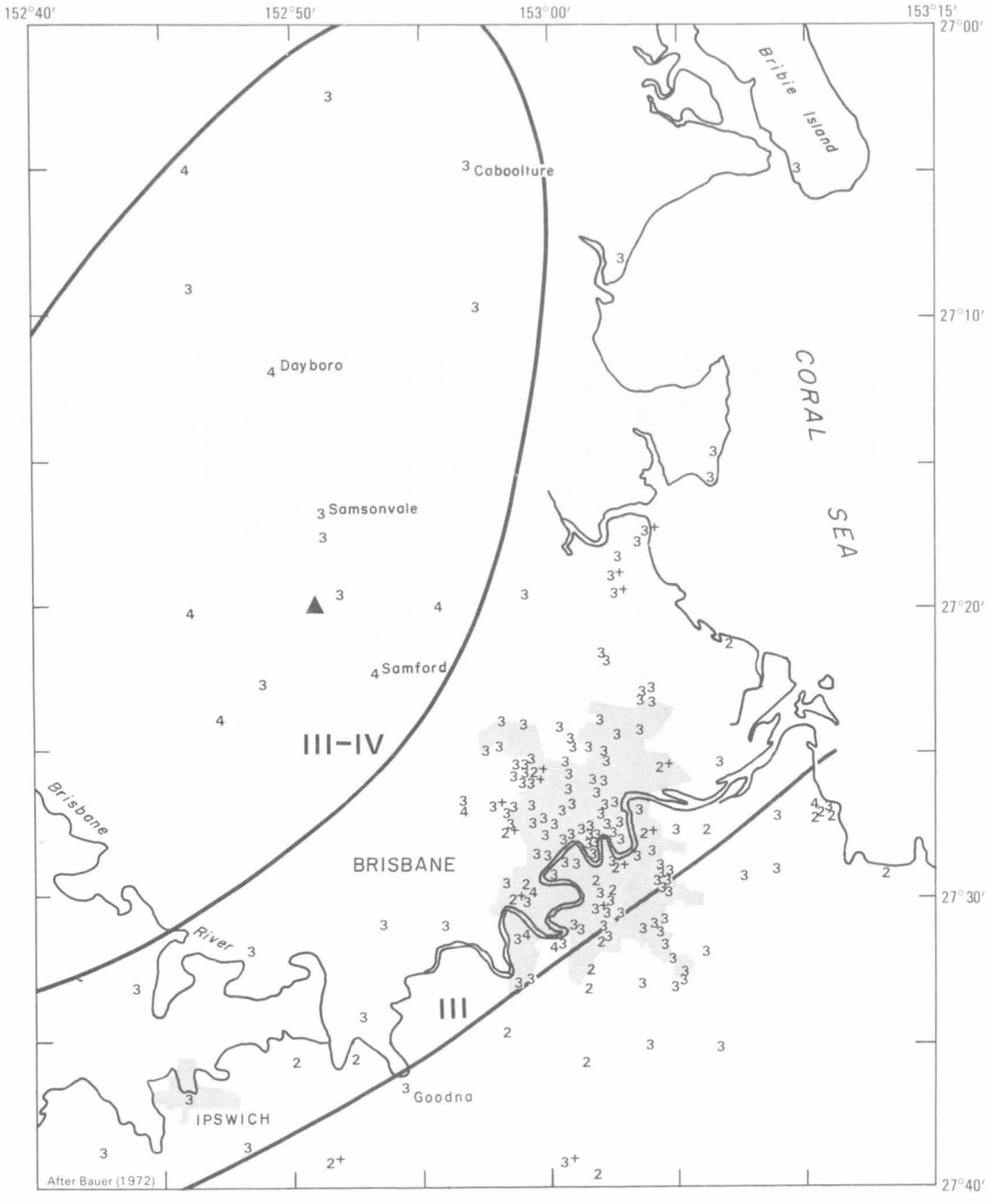
'A study has been made of macroseismic and instrumental data for the earthquake of 17 November 1960, located in the Mt Glorious region of southeast Queensland. Seven hundred questionnaires received from a felt area of about 100,000 square kilometres have provided data for the preparation of an isoseismal map and an estimate of the position of the epicentral region. This has been compared with a redefined epicentre based on the very inadequate instrumental observations of the earthquake.'

'For MM intensities within the range II to IV, there are no obvious correlations of observed intensity patterns with either regional geological trends or detailed near-surface geology.' (Bauer, 1972).

REFERENCE

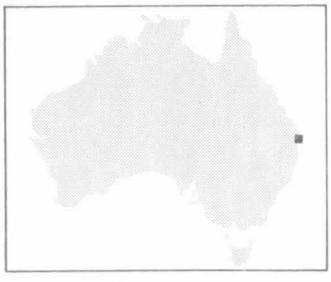
BAUER, J. A., 1972—The earthquake of 17 November 1960, in the Mt Glorious region, southeastern Queensland. *B.Sc. Thesis, University of Queensland, Department of Geology and Mineralogy, Brisbane* (unpublished).

ISOSEISMAL MAP OF THE MOUNT GLORIOUS EARTHQUAKE, QUEENSLAND
NEAR EPICENTRE, 17 NOVEMBER 1960



DATE : 17 NOVEMBER 1960
TIME : 05:00:17 UT
MAGNITUDE : 4.4 ML (BRS)
EPICENTRE : 27.33°S 152.85°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/G56-14/2

ISOSEISMAL MAP OF THE ROBERTSON-BOWRAL EARTHQUAKE, NEW SOUTH WALES—21 MAY 1961

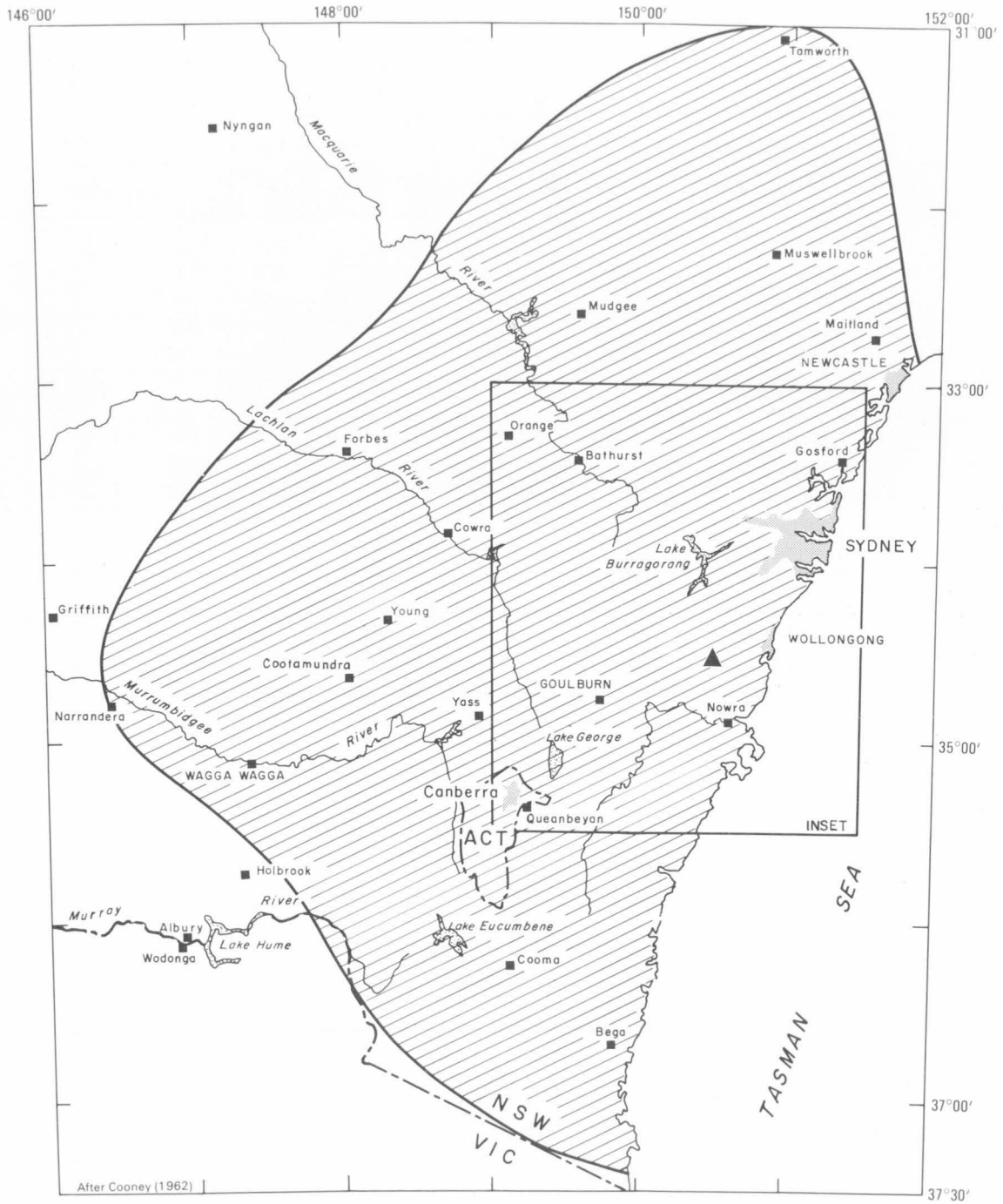
'On 1961 May 22^{d} 7^{h} 40^{m} local time, New South Wales was visited by an earthquake which, according to press reports, was felt over a region of some 50 000 square miles [130 000 km^2], extending from the Snowy Mountains to Newcastle and inland to Dubbo and Narrandera. The earthquake caused significant damage to buildings in the Moss Vale-Robertson-Bowral area, blockage of the Macquarie Pass road through rockfalls, and some power failures; it was noted for the sharpness with which it was felt in Sydney, where minor damage was done and considerable alarm caused.' (Cooney, 1962).

The isoseismal map was drawn by Cooney (1962). Details of the information used to compile the map were not given.

REFERENCE

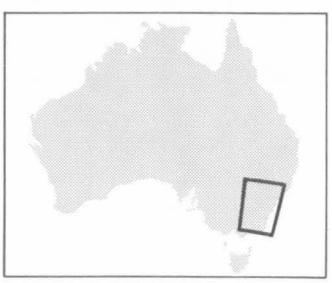
COONEY, G. H., 1962—The New South Wales earthquake of May 22, 1961. *Australian Journal of Physics,* 15, 536-548.

ISOSEISMAL MAP OF THE ROBERTSON–BOWRAL EARTHQUAKE, NEW SOUTH WALES 21 MAY 1961



DATE : 21 MAY 1961
TIME : 21:40:02 UT
MAGNITUDE : 5.6 ML (RIV)
EPICENTRE : 34.55°S 150.50°E
DEPTH : 19km

▲ EPICENTRE
AREA IN WHICH SHOCK WAS FELT
INSET INTENSITIES SHOWN IN FOLLOWING MAP



24/N/5

ISOSEISMAL MAP OF THE ROBERTSON-BOWRAL EARTHQUAKE, NEW SOUTH WALES, NEAR EPICENTRE—21 MAY 1961

'On the morning of the 22nd May (local time) south-eastern N.S.W. was shaken by a moderate sized earthquake, magnitude 5½ on the Richter scale. The intensity was greatest in the Robertson-Bowral area sixty miles south-west of Sydney.'

'The maximum intensity in the epicentral area was VII on the Modified Mercalli (M.M.) scale. Intensities of order III were experienced in Sydney, the strongest in that city since 1919 when an earth tremor occurred near Kurrajong [see Cotton's (1921) map]. On that occasion the maximum intensity near Kurrajong was V, and III in Sydney. Historical records show that several other earth tremors have been felt near Sydney.'

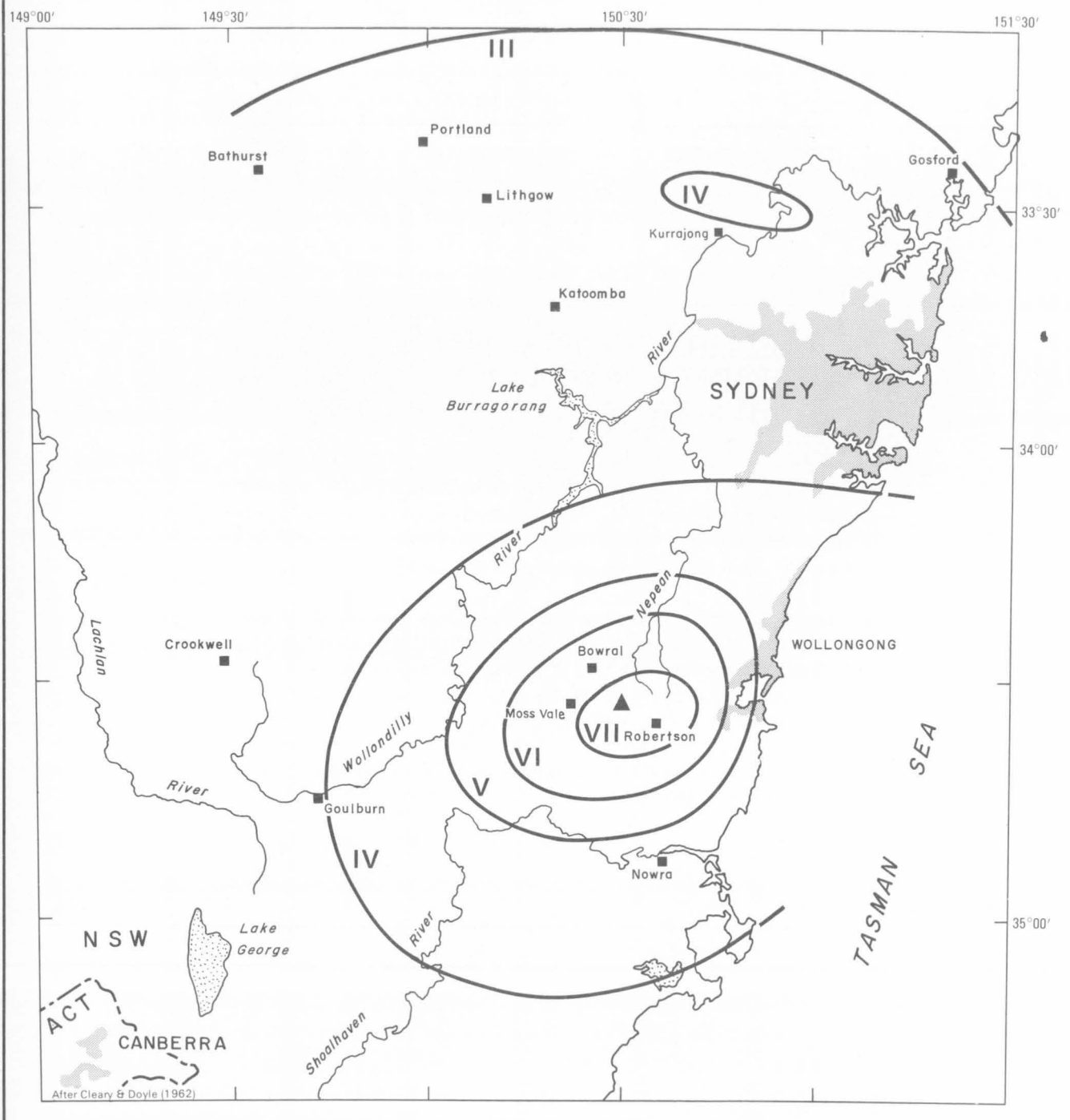
'Approximately 100 special questionnaire forms were promptly sent to police stations, post offices etc. in the towns distributed over the affected area, from Newcastle in the north to Orange in the central west and Nowra to the south. These questionnaires had previously been prepared for such an occasion to aid the preparation of isoseismal maps. Meanwhile, I visited the most disturbed area with a colleague.' (H. A. Doyle, RSES/ANU, personal communication, 1970).

REFERENCES

CLEARY, J., & DOYLE, H. A., 1962—Application of a seismograph network and electronic computer in near earthquake studies. *Bulletin of the Seismological Society of America,* 52, 673-682.

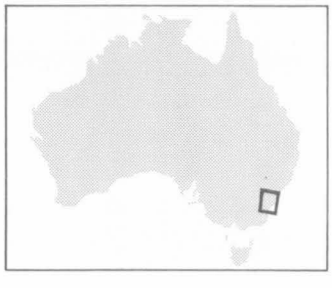
COTTON, L. A., 1921—The Kurrajong earthquake of August 15, 1919. *Journal of the Proceedings of the Royal Society of New South Wales,* 55, 83-104.

ISOSEISMAL MAP OF THE ROBERTSON–BOWRAL EARTHQUAKE, NEW SOUTH WALES, NEAR EPICENTRE, 21 MAY 1961



DATE : 21 MAY 1961
TIME : 21:40:02 UT
MAGNITUDE : 5.6 ML (RIV)
EPICENTRE : 34.55°S 150.50°E
DEPTH : 19km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)



24/N/6

ISOSEISMAL MAP OF THE NOURNING SPRING EARTHQUAKE, WESTERN AUSTRALIA—18 JANUARY 1963

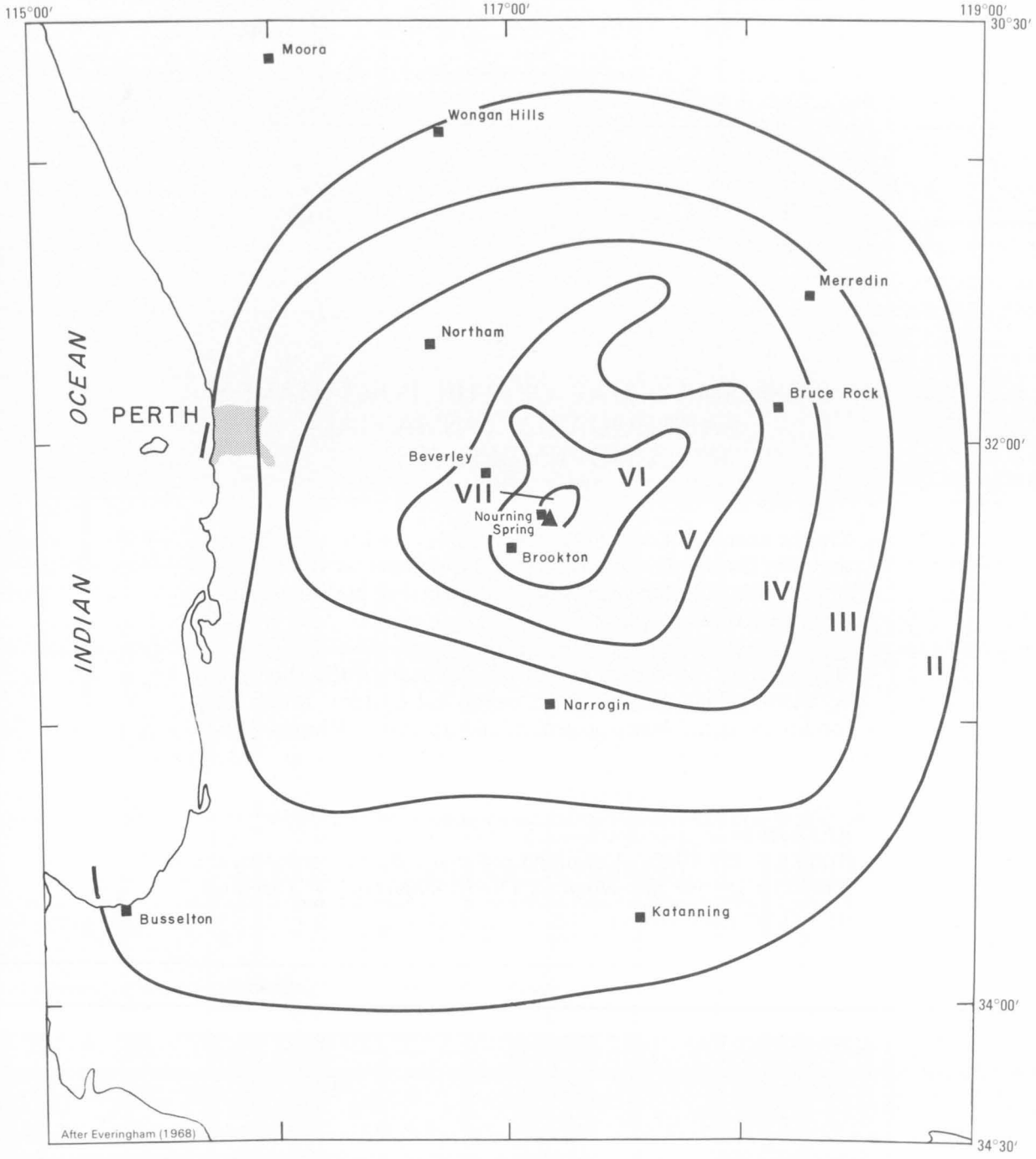
At 05:49 UT (13:49 local time) on 18 January 1963 an earthquake of magnitude ML 4.9 occurred near Nourning Spring, approximately 130 km east-southeast of Perth. The earthquake was felt over an area of about 100 000 km^2.

'In order to study the macroseismic effects two hundred questionnaires on earthquake intensity were distributed from Mundaring; replies were received from about three-quarters of these. The isoseismal map is based on these data. The point of maximum intensity, MM VII, at a farm at Nourning Spring is coincident with the epicentre determined from Mundaring instrumental data and in the centre of the aftershock zone.' (Everingham, 1968, p. 8).

REFERENCE

EVERINGHAM, I. B., 1968—Seismicity of Western Australia. *Bureau of Mineral Resources, Australia, Report* 132.

ISOSEISMAL MAP OF THE NOURNING SPRING EARTHQUAKE, WESTERN AUSTRALIA 18 JANUARY 1963



0 100km

DATE : 18 JANUARY 1963
TIME : 05:49:15.9 UT
MAGNITUDE :4.9 ML(MUN),4.1 MS(MUN),5.4 MB(MUN)
EPICENTRE : 32.25°S 117.17°E
DEPTH : 18km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)

24/WA/9

ISOSEISMAL MAP OF THE PORT DAVEY EARTHQUAKE, TASMANIA— 3 NOVEMBER 1963

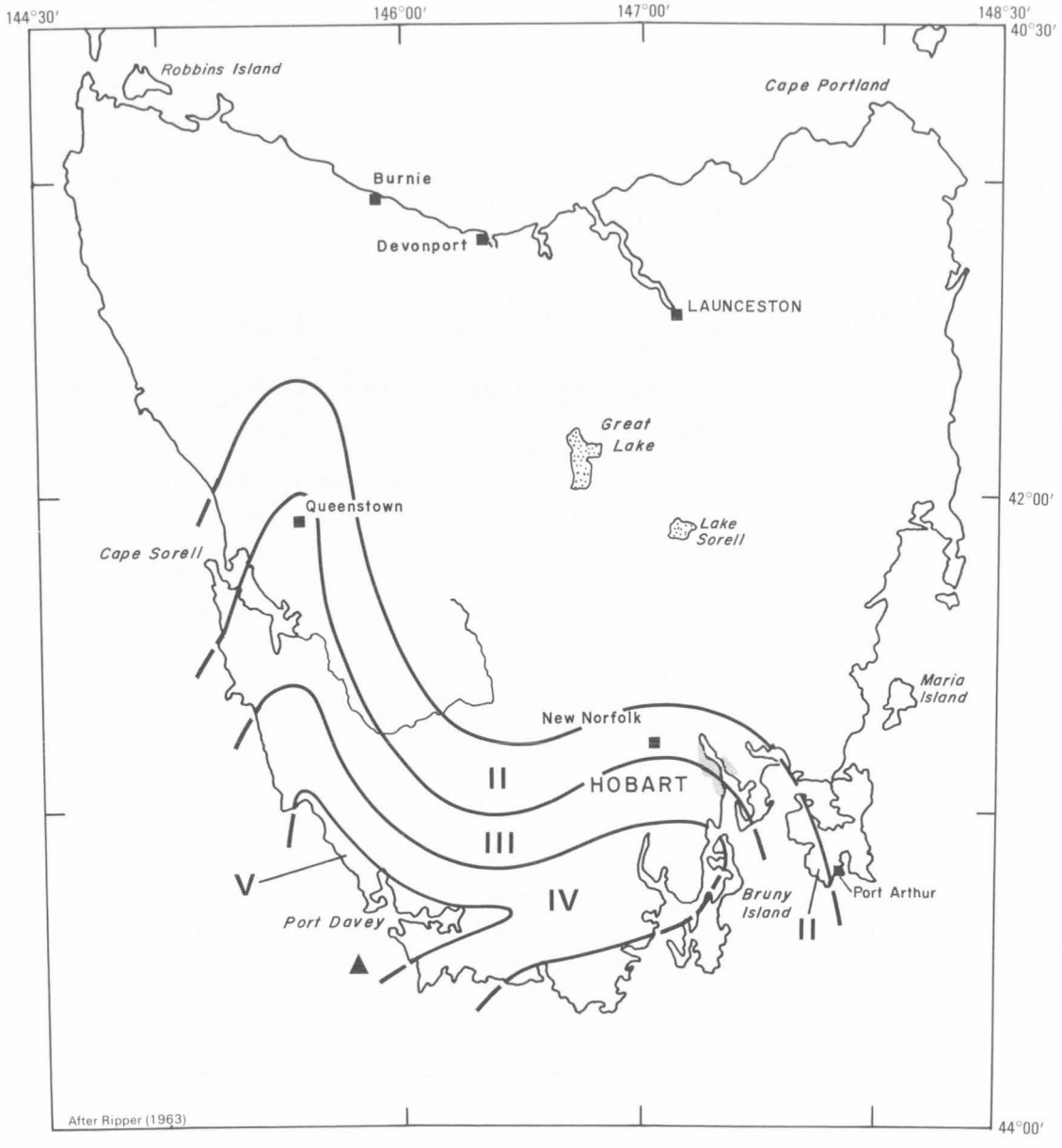
'On the evening of 3rd November, 1963, an earth tremor shook southern Tasmania. Unfortunately the weather at the time was stormy, with blustery winds and rain, so that the shock passed unnoticed in many places.'

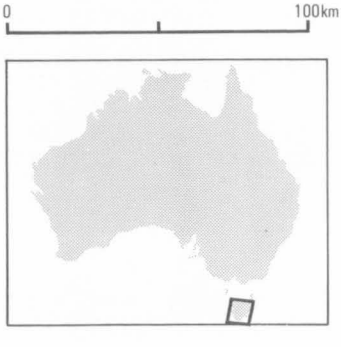
'The weather, or wind force at the moment of the shock may be a controlling factor of the isoseismal pattern, rather than conditions at the focus or geological structure.' (Ripper, 1963).

REFERENCE

RIPPER, I. D., 1963—Local and regional events recorded by the Tasmania seismic net. *Honours Thesis, University of Tasmania, Hobart* (unpublished).

ISOSEISMAL MAP OF THE PORT DAVEY EARTHQUAKE, TASMANIA
3 NOVEMBER 1963





DATE : 3 NOVEMBER 1963
TIME : 12:00:40 UT
MAGNITUDE : 4.4 ML (BMR), 3.7ML(TAU), 3.9MS (BMR)
EPICENTRE : 43.49°S 145.80°E
DEPTH : 10km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)

24/K55/2

ISOSEISMAL MAP OF THE BASS STRAIT EARTHQUAKE, TASMANIA— 14 NOVEMBER 1964

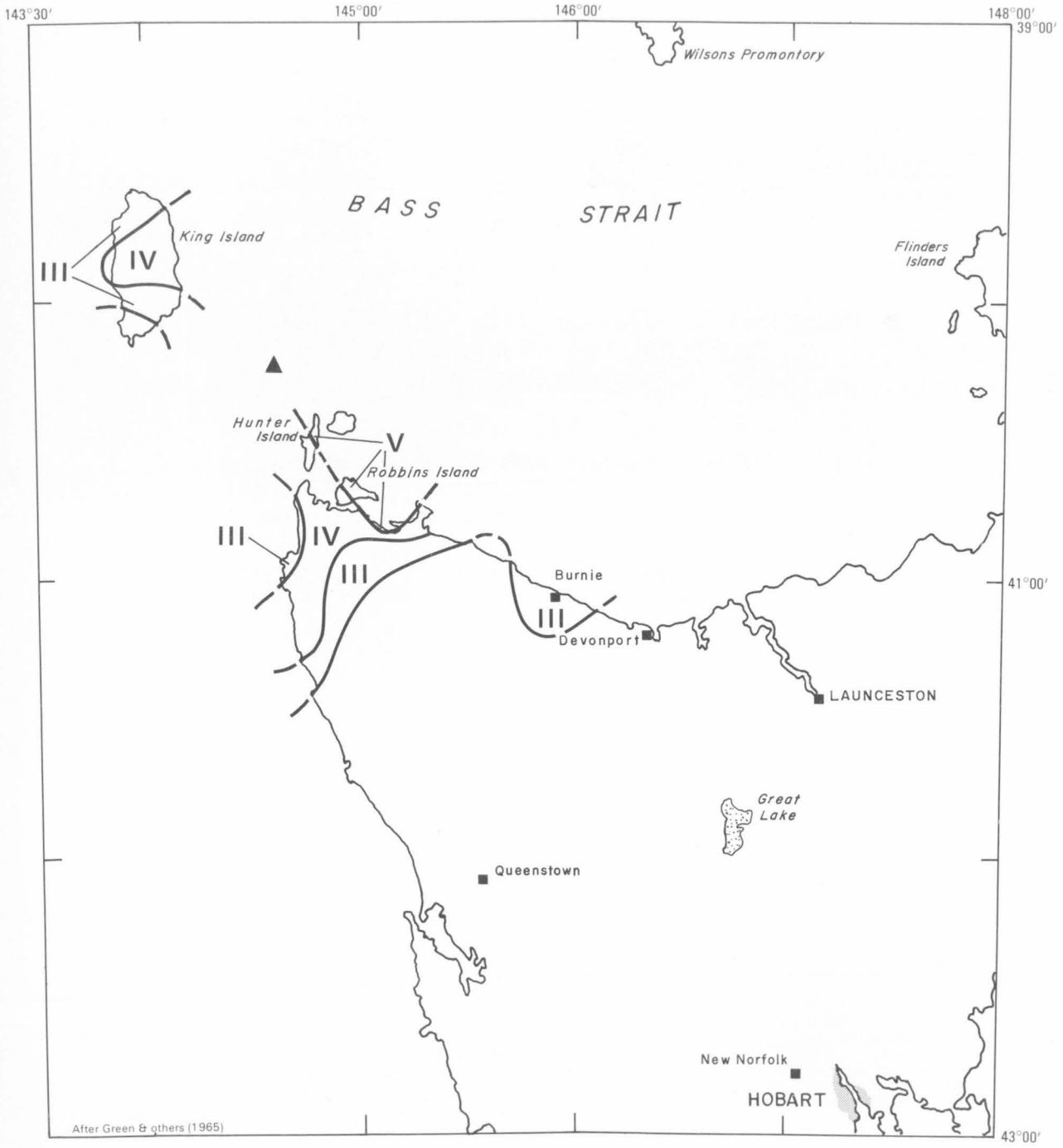
At 10:53 UT (20:53 local time) on 14 November 1964 an earthquake of magnitude ML 4.5 was felt in northwestern Tasmania and on King, Hunter, and Robbins Islands. The earthquake's epicentre was located approximately midway between King and Hunter Islands. An intensity of MM V was recorded at several locations.

The isoseismal map was drawn by the Department of Geology, University of Tasmania (Green & others, 1965). Details of the information used to compile the map were not given.

REFERENCE

GREEN, R., DAFENEY, C., NEWSTEAD, G. H., WATT, P., & MUIRHEAD, K., 1965—Seismological investigations in Tasmania. *In* RINGWOOD, A. E. (Compiler)—International Council of Scientific Unions Upper Mantle Project, Australian Progress Report 1960-65. *Australian Academy of Science, Canberra,* 7-18.

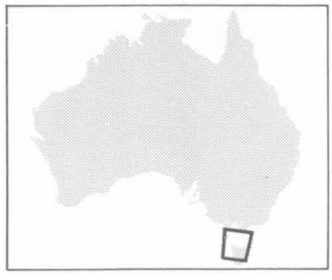
ISOSEISMAL MAP OF THE BASS STRAIT EARTHQUAKE, TASMANIA
14 NOVEMBER 1964



0 100km

DATE : 14 NOVEMBER 1964
TIME : 10:53:04 UT
MAGNITUDE : 4.5 ML (TAU)
EPICENTRE : 40.22°S 144.60°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)



24/K55/3

ISOSEISMAL MAP OF THE GREAT LAKE EARTHQUAKE, TASMANIA— 9 DECEMBER 1964

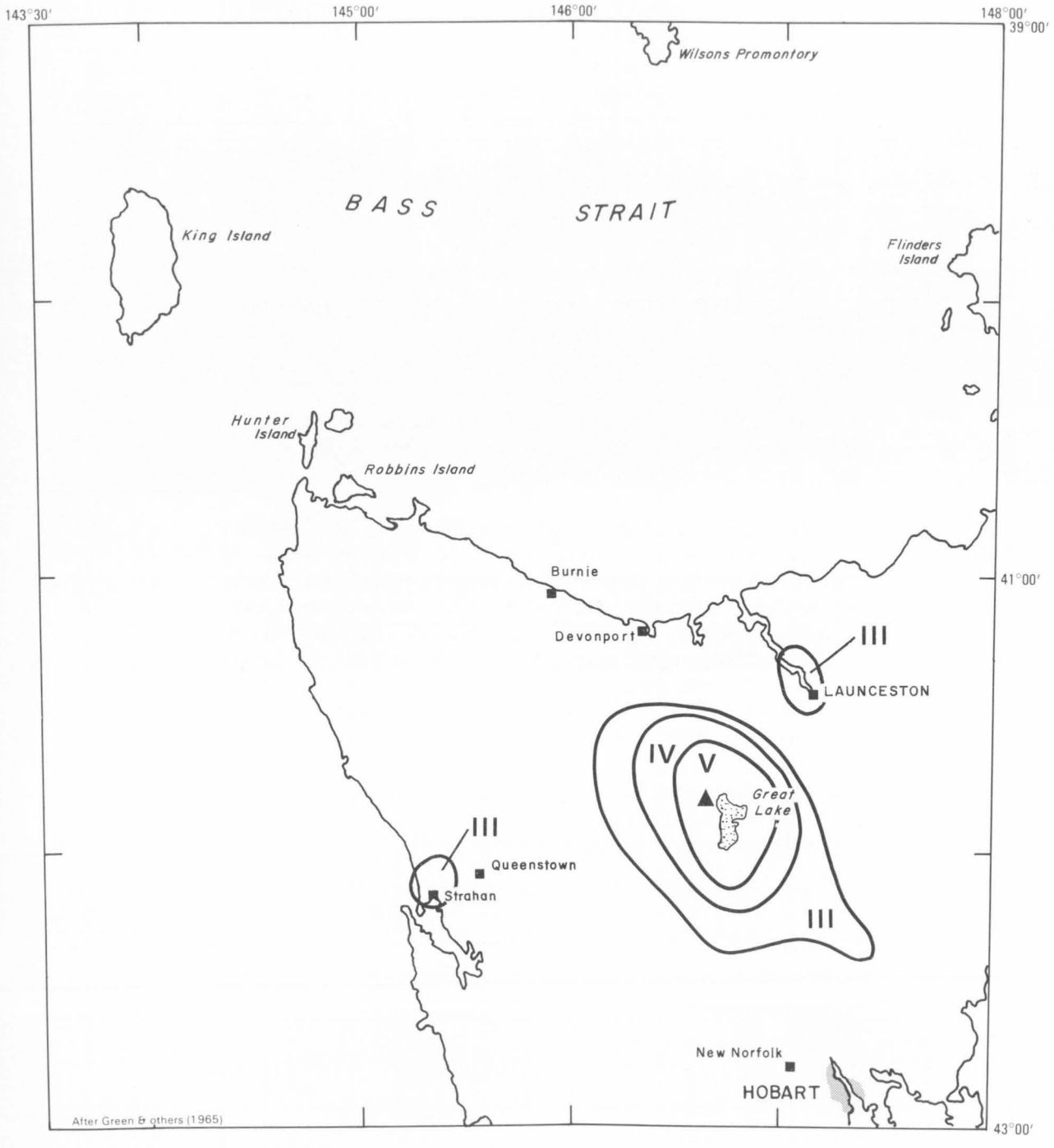
At 16:38 UT on 9 December 1964 (02:38 local time on 10 December 1964) an earthquake of magnitude ML 3.4 occurred in central northern Tasmania, about 125 km north-northwest of Hobart. The earthquake was principally felt in a small area centred on Great Lake (intensity MM III-V) but intensities of MM III were reported from Launceston in the north and Strahan in the west.

The isoseismal map was drawn by Department of Geology, University of Tasmania (Green & others, 1965). Details of the information used to compile the map were not given.

REFERENCE

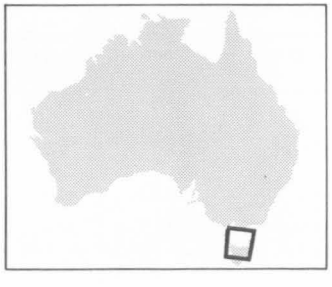
GREEN, R., DAFENEY, C., NEWSTEAD, G. H., WATT, P., & MUIRHEAD, K., 1965—Seismological investigations in Tasmania. *In* RINGWOOD, A. E. (Compiler)—International Council of Scientific Unions Upper Mantle Project, Australian Progress Report 1960-65. *Australian Academy of Science, Canberra,* 7-18.

ISOSEISMAL MAP OF THE GREAT LAKE EARTHQUAKE, TASMANIA
9 DECEMBER 1964



DATE : 9 DECEMBER 1964
TIME : 16:38:41 UT
MAGNITUDE : 3.4 ML (TAU)
EPICENTRE : 41.80°S 146.63°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)



24/K55/4

ISOSEISMAL MAP OF THE QUORN EARTHQUAKE, SOUTH AUSTRALIA— 28 AUGUST 1965

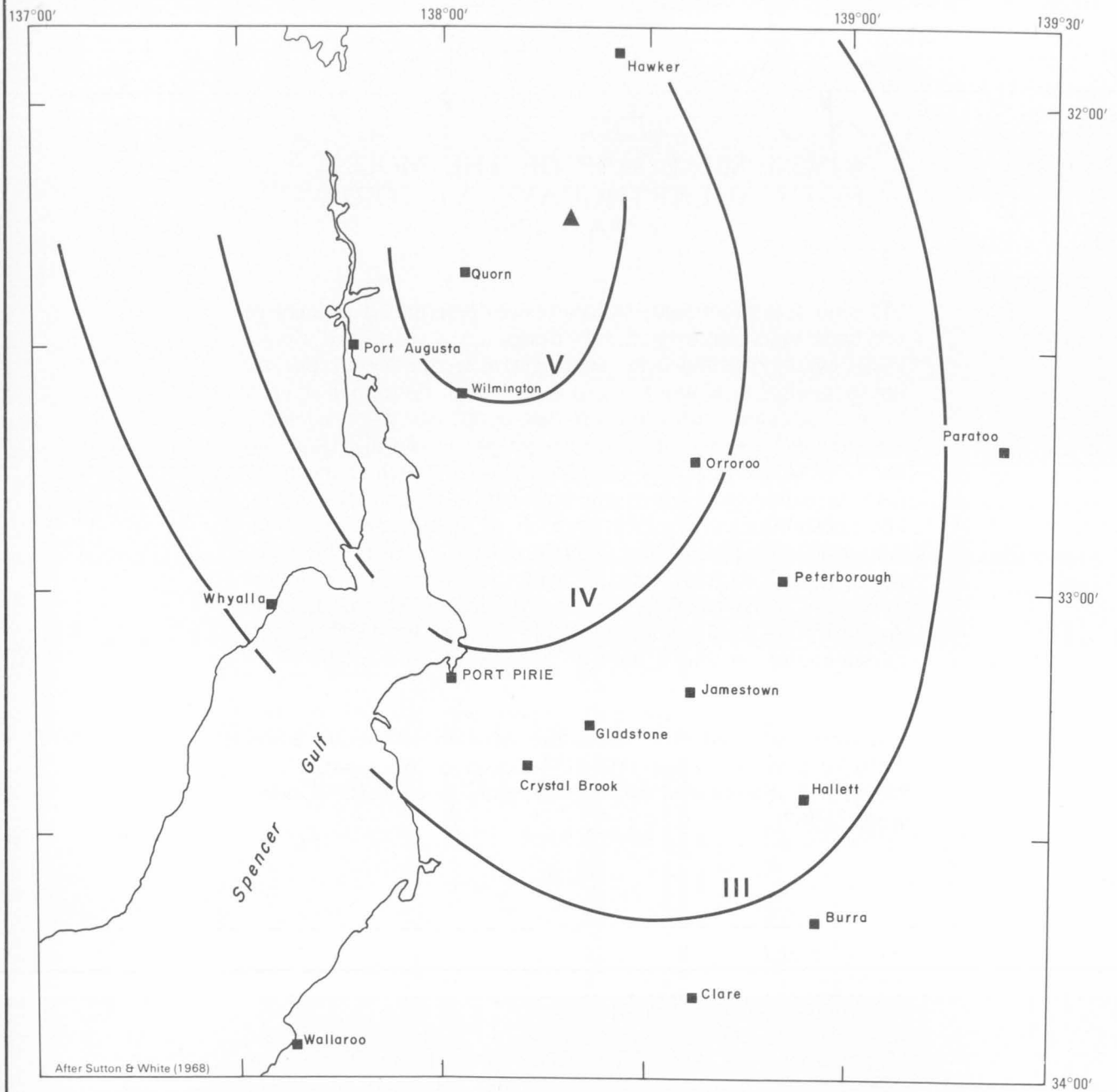
An earthquake of magnitude ML 5.0 occurred at 00:26 UT (about 10:00 local time) on 28 August 1965 about 30 km northeast of Quorn, South Australia.

'In spite of the fact that the macroseismic effects produced by the main shock under investigation were relatively small, an attempt was made to collect information on felt effects. Eighty questionnaires were sent out, of which 67 were returned. Approximate isoseismal regions determined on this basis are shown [on the accompanying map]. There were reports of minor damage at Quorn, Port Augusta and Wilmington. Part of a chimney fell at Quorn and older residents said that it was the most severe earthquake in their memory. Reports seem to indicate that this earthquake was felt at greater distances to the south than the north. However, this may be an apparent effect, due to the sudden decrease in the density of the population to the north of Quorn.' (Sutton & White, 1968).

REFERENCE

SUTTON, D. J., & WHITE, R. E., 1968—The seismicity of South Australia. *Journal of the Geological Society of Australia,* 15, 25-32.

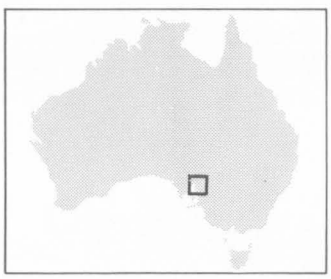
ISOSEISMAL MAP OF THE QUORN EARTHQUAKE, SOUTH AUSTRALIA
28 AUGUST 1965



0 60km

DATE : 28 AUGUST 1965
TIME : 00:26:38.8 UT
MAGNITUDE : 5.0 ML (ADE), 4.9 MB (GS)
EPICENTRE : 32.23°S 138.30°E
DEPTH : 16km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)



24/SA/6

ISOSEISMAL MAP OF THE MOUNT HOTHAM EARTHQUAKE, VICTORIA—3 MAY 1966

'As soon as a preliminary epicentre was determined a series of ten lines radiating from it was drawn on a map, and twelve towns evenly distributed in each segment were selected. Several questionnaires were sent to the post master or policeman in each town so selected, with a request that he fill one of these in for himself, and ask one or two other people in the district to do the same. A list of people interested enough to telephone radio 2AY in Albury was sent to the writer by Mr A. A. B. Martin, and questionnaires were sent to each of these persons as well. About a dozen people were interviewed by the writer in settlements around Mount Hotham, while a few unsolicited letters were also received. The Snowy Mountains Hydro Electric Authority has kindly made available the answers to their own questionnaire, so that a total of 211 reports is available.

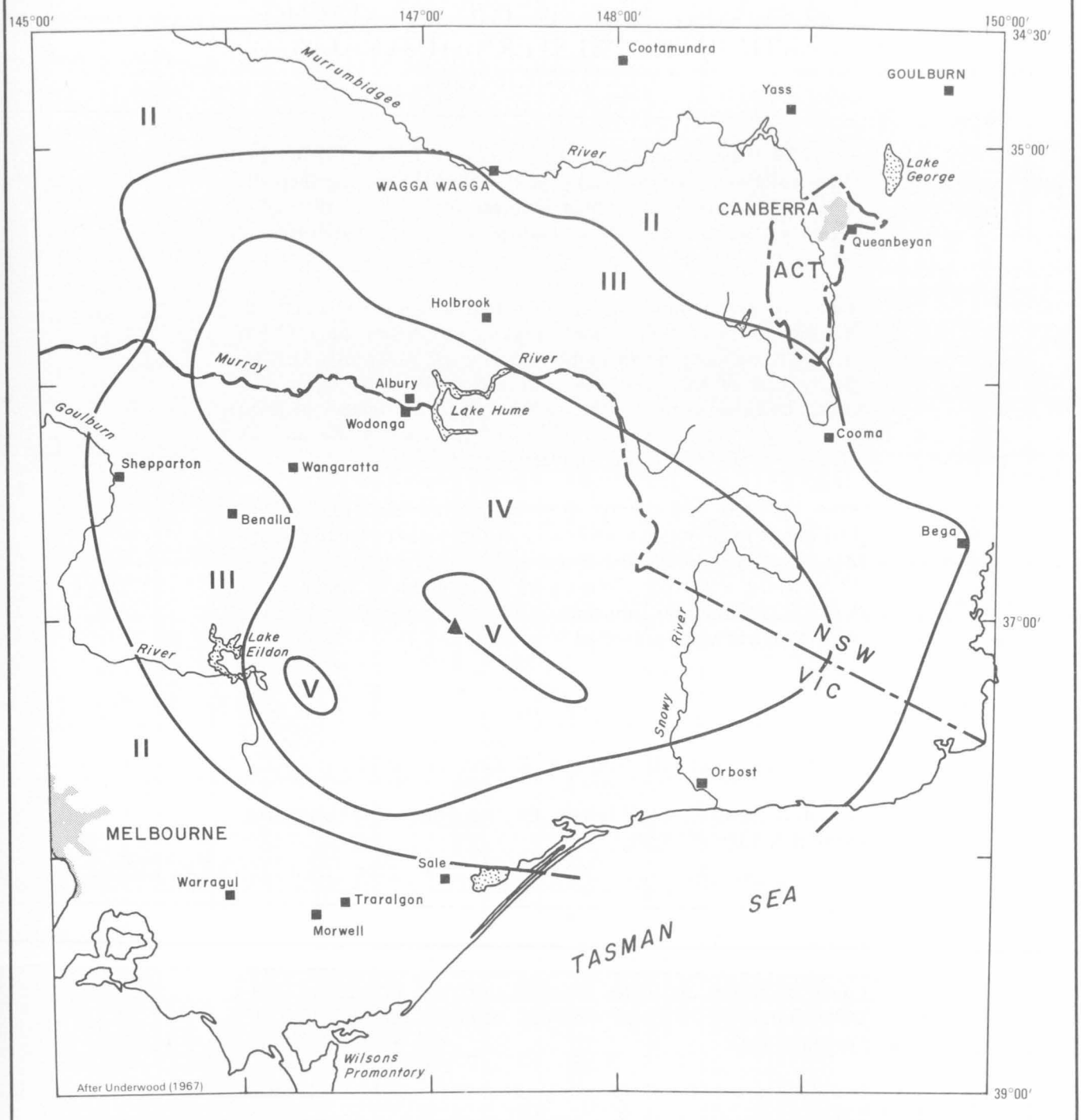
'The intensity value for each report was assessed by two observers independently, using the Modified Mercalli Scale, 1956 version of Richter (1958). In cases of discrepancy, the report was re-examined by both assessors in concert.' (Underwood, 1967).

REFERENCES

RICHTER, C. F., 1958—ELEMENTARY SEISMOLOGY. *Freeman and Company, San Francisco.*

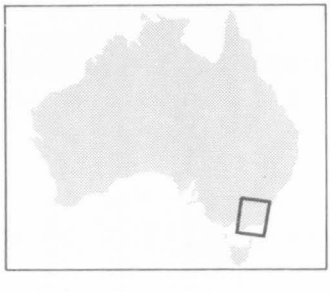
UNDERWOOD, R., 1967—The seismic network and its applications. *Ph.D. Thesis, Australian National University, Canberra* (unpublished).

ISOSEISMAL MAP OF THE MOUNT HOTHAM EARTHQUAKE, VICTORIA
3 MAY 1966



DATE : 3 MAY 1966
TIME : 19:07:54 UT
MAGNITUDE : 5.0 ML (RIV), 4.3 MB (ISC)
EPICENTRE : 37.04°S 147.13°E
DEPTH : 8km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)



24/J55/2

ISOSEISMAL MAP OF THE MECKERING EARTHQUAKE, WESTERN AUSTRALIA—14 OCTOBER 1968

'At 1059 Western Standard Time (0259 UT) on 14 October 1968 a shallow earthquake of magnitude (MS) 6.8 wrecked the town of Meckering . . . which is in the eastern area of a zone of known seismic activity extending across the southwestern part of the Shield.'

'The earthquake was remarkable in that it was associated with faulting clearly seen at the surface along an arcuate zone 32 km in length trending north-south and convex westwards. Immediately east of this fault the land was uplifted by up to 1.5 metres and over-thrust to the west by up to 2.0 metres to form a scarp. A preliminary description of the earthquake and its effects is given by Everingham & others (1969).'

'Four hundred and twenty intensity questionnaire forms were distributed to about five observers in the region of each township in a network selected to cover the State south of latitude 22°S, whilst a further eighty were distributed to residents of Perth, Fremantle and suburban areas . . . eighty precent of the questionnaires were answered.'

'Each town or centre (from which there were up to five replies) was allotted an intensity rating and field visits were made in the region of Meckering in order to assess the higher intensities near the epicentre' (Everingham & Gregson, 1970).

A comprehensive account of the earthquake is given by Gordon & Lewis (1980).

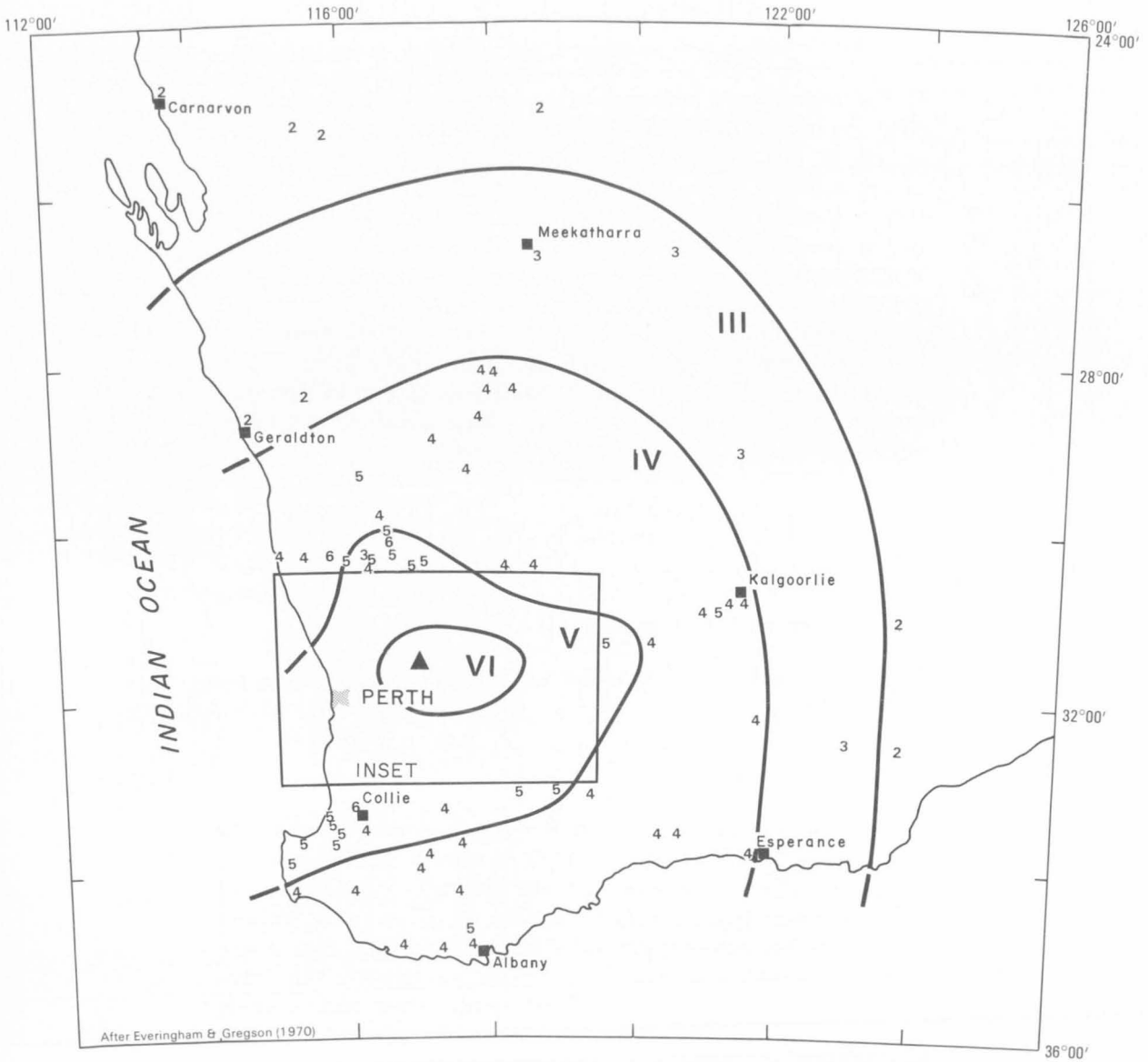
REFERENCES

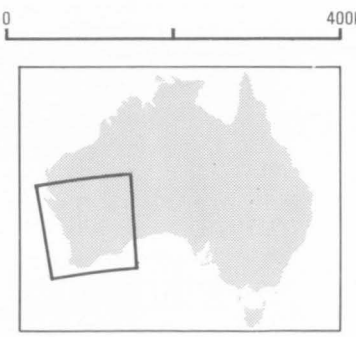
EVERINGHAM, I. B., & GREGSON, P. J., 1970—Meckering earthquake intensities and notes on earthquake risk in Western Australia. *Bureau of Mineral Resources, Australia, Record* 1970/97 (unpublished).

EVERINGHAM, I. B., GREGSON, P. J., & DOYLE, H. A., 1969—Thrust fault scarp in the Western Australian Shield. *Nature*, 223, 701-703.

GORDON, F. R., & LEWIS, J. D., 1980—The Meckering and Calingiri earthquakes, October 1968 and March 1970. *Geological Survey of Western Australia, Bulletin* 126.

ISOSEISMAL MAP OF THE MECKERING EARTHQUAKE, WESTERN AUSTRALIA
14 OCTOBER 1968





DATE : 14 OCTOBER 1968
TIME : 02:58:50.3 UT
MAGNITUDE : 6.9 ML (MUN), 6.8 MS (GS), 6.0 MB (GS)
EPICENTRE : 31.60°S 117.00°E
DEPTH : 5km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT
INSET INTENSITIES SHOWN IN FOLLOWING MAP

24/WA/10

ISOSEISMAL MAP OF THE MECKERING EARTHQUAKE, WESTERN AUSTRALIA, NEAR EPICENTRE—14 OCTOBER 1968

'In the region with intensity VII or greater most old brick or stone buildings were unsafe after the earthquake. Car passengers in this region at the time of the earthquake reported feeling that the tyres were flat and that wind was unusually strong. Ground waves were reported to have been seen by several people in the open during the earthquake. Railway-lines, pipe-lines and roads were all fractured at the fault zone, and extensive cracking of the ground occurred in its immediate vicinity. Old brick houses within 100 metres of the fault were flattened but timber framed sheds and open or closed verandahs remained upright. Away from the fault, cracks due to slumping were common, particularly along river banks, around salt lakes, and where roads run along embankments.'

'In Meckering (MM IX) a bank, hotel, shire hall, three churches and sixty of about seventy-five houses were wrecked. Few of the remaining buildings were habitable, fibro and galvanised iron clad timber-framed structures being outstanding because of the comparative lack of damage to them.'

'The region of intensity MM VI was characterised by notable cracking of oldest brick and masonry buildings, and alarm caused to many residents. Changes of water flow in wells and springs were noted at several localities.'

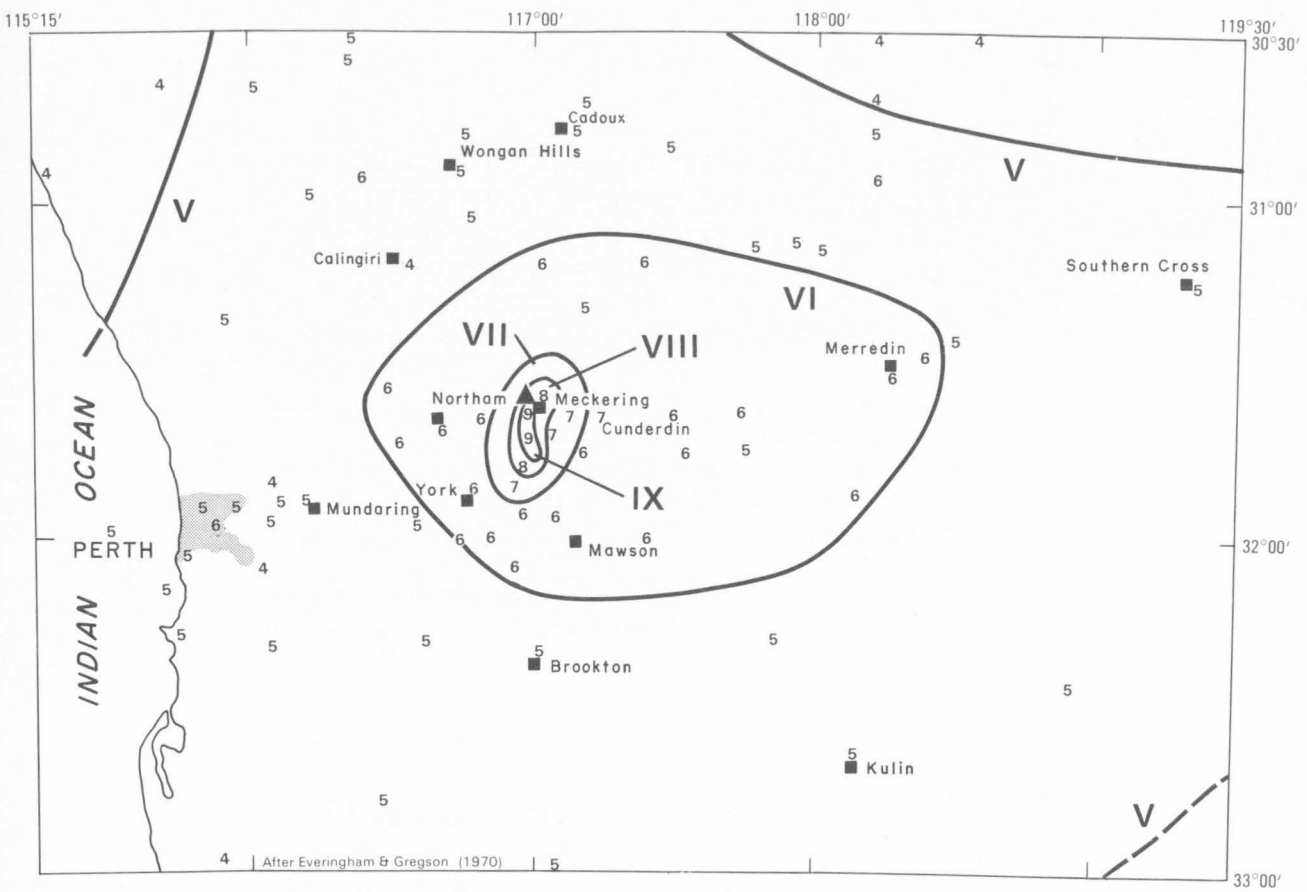
'It is of interest to examine an independent assessment of an intensity level made by the W.A. Government Relief Advisory Committee when examining damage claims . . . the areas of proven damage (which were drawn by the Committee without reference to the authors) generally coincide with the area where the intensity rated was MM VI or more and confirm the shape of the MM V-VI isoseismal. Their results show that notable damage would not be expected where the intensity was less than MM VI.' (Everingham & Gregson, 1970).

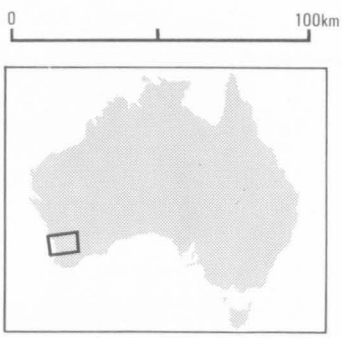
Damage is estimated to have cost approximately 2.2 million dollars (1968 prices).

REFERENCE

EVERINGHAM, I. B., & GREGSON, P. J., 1970—Meckering earthquake intensities and notes on earthquake risk in Western Australia. *Bureau of Mineral Resources, Australia, Record* 1970/97 (unpublished).

ISOSEISMAL MAP OF THE MECKERING EARTHQUAKE, WESTERN AUSTRALIA
NEAR EPICENTRE, 14 OCTOBER 1968





DATE : 14 OCTOBER 1968
TIME : 02:58:50.3 UT
MAGNITUDE : 6.9 ML (MUN), 6.8 MS (GS), 6.0 MB (GS)
EPICENTRE : 31.60°S 117.00°E
DEPTH : 5km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/H50/3

ISOSEISMAL MAP OF THE LANDOR EARTHQUAKE, WESTERN AUSTRALIA—17 JUNE 1969

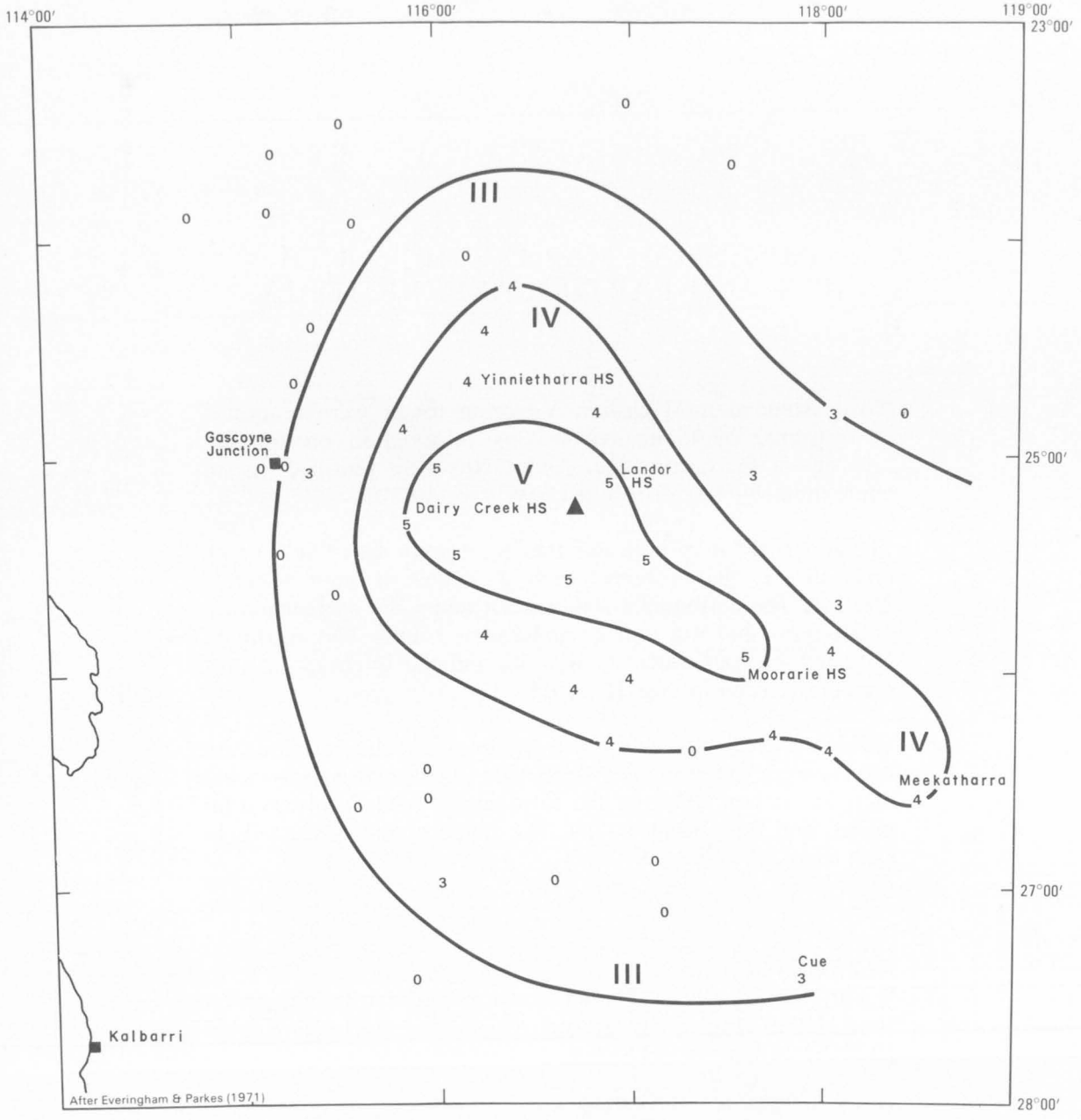
At 19:54 UT on 17 June 1969 (03:54 local time on 18 June 1969) an earthquake of magnitude ML 5.6 occurred near Landor homestead in central-western Western Australia, about 860 km north-northeast of Perth. An intensity of MM V was recorded over an area of about 120 000 km^2 and reports of MM IV were recorded at Meekatharra township, about 240 km southeast of the epicentre.

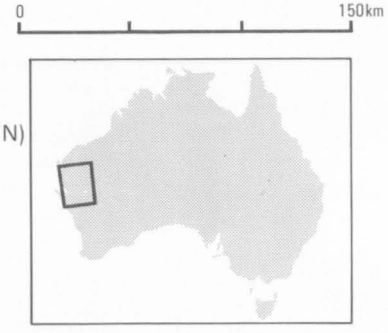
'Fifty-two replies were received from about seventy questionnaires sent to every homestead and township within a 300 km radius of the epicentre.' (Everingham & Parkes, 1971).

REFERENCE

EVERINGHAM, I. B., & PARKES, A. A., 1971—Intensity data for earthquakes at Landor (17 June 1969) and Calingiri (10 March 1970) and their relationship to previous Western Australian earthquakes. *Bureau of Mineral Resources, Australia, Record* 1971/80 (unpublished).

ISOSEISMAL MAP OF THE LANDOR EARTHQUAKE, WESTERN AUSTRALIA
17 JUNE 1969





DATE : 17 JUNE 1969
TIME : 19:54:32.1 UT
MAGNITUDE : 5.6 ML(MUN), 5.1 MS(MUN), 5.7 MB(MUN)
EPICENTRE : 25.26°S 116.73°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/G50/1

ISOSEISMAL MAP OF THE SOUTH GIPPSLAND EARTHQUAKE, VICTORIA—20 JUNE 1969

'Postmasters in most eastern Victorian towns were requested to distribute questionnaires seeking information on the felt intensity of the earthquake. About 200 were returned out of approximately 480 distributed.' (Wilkie, 1970).

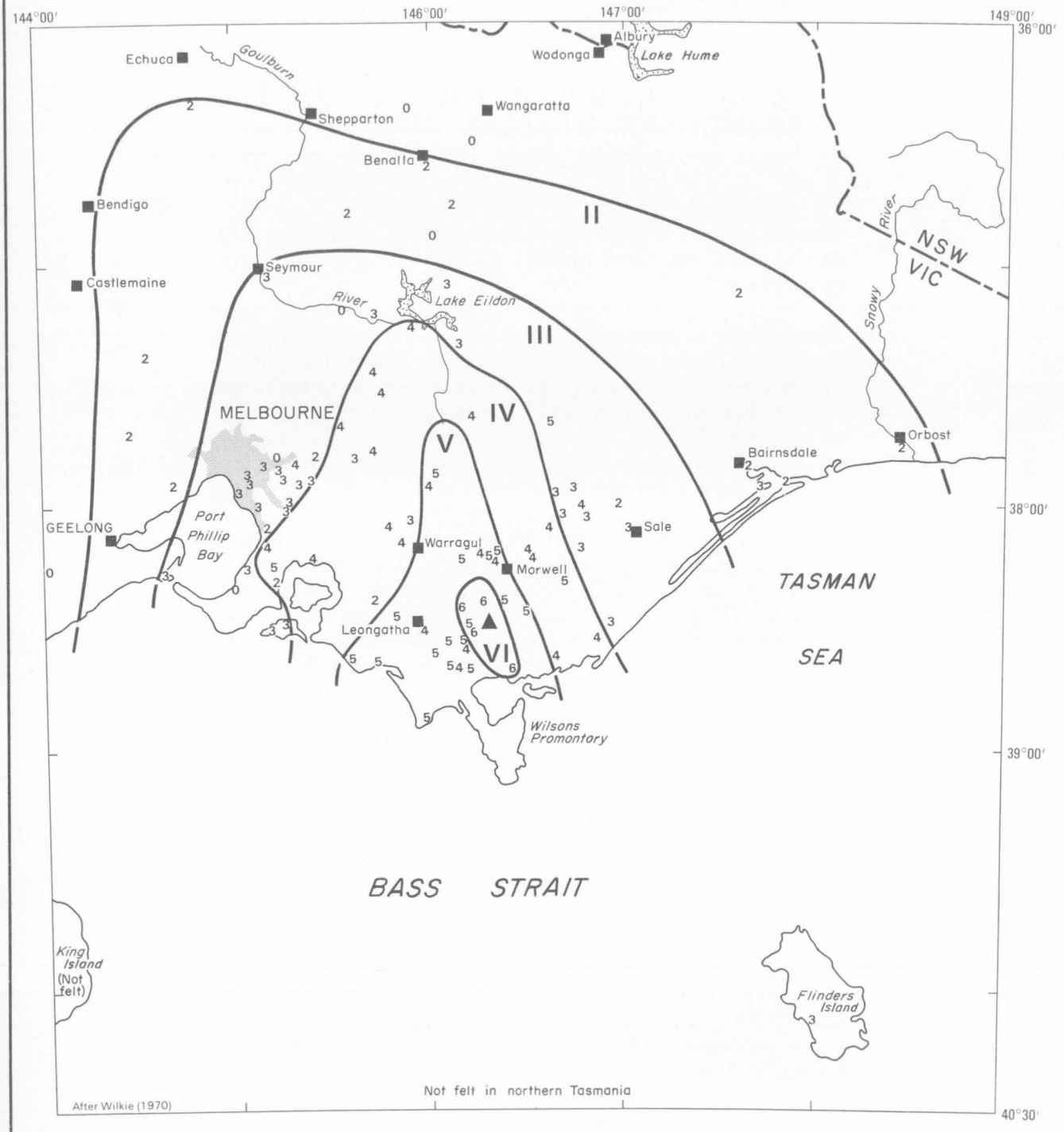
The isoseismal map indicates that the tremor was felt over an area around the epicentre with a radius of approximately 250 km. The earthquake was not felt along the northern coast of Tasmania but was noticed at Flinders Island. The maximum Modified Mercalli intensity was VI and the intensity in most Melbourne suburbs was II or III.

Wilkie's (1970) information and the results of the questionnaire survey, were independently reassessed and a revised isoseismal map was drawn, showing the isoseismals, intensity observation points, and Bass Strait results. The shape of the isoseismals in each map are similar.

REFERENCE

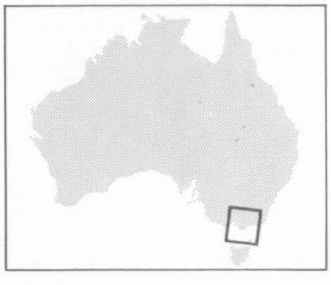
WILKIE, J. R., 1970—The south Gippsland earthquake of 20 June, 1969. *Bureau of Mineral Resources, Australia, Record* 1970/91 (unpublished).

ISOSEISMAL MAP OF THE SOUTH GIPPSLAND EARTHQUAKE, VICTORIA
20 JUNE 1969



DATE : 20 JUNE 1969
TIME : 11:15:28.3 UT
MAGNITUDE : 5.3 ML (RIV), 4.8 MS (PMG)
EPICENTRE : 38.47°S 146.30°E
DEPTH : 19km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/J55/3

ISOSEISMAL MAP OF THE CALINGIRI EARTHQUAKE, WESTERN AUSTRALIA—10 MARCH 1970

'Three hundred and sixty replies were received from about 420 questionnaires circulated within a 300 km radius of the earthquake epicentre.'

'Although the earthquake caused an arcuate shallow east-dipping thrust fault over a distance of about 5 km, where the surface was uplifted by as much as 30 cm, major damage to buildings did not occur at Calingiri only 3 km from the fault. No building straddled the fault, where the only damage was the shortening and misalignment of wire fences and a bump in a road where the fault scarp crossed it.'

'Here it should be noted that the authors' rating of intensity (MM6) is based largely on cracking of walls in older homes, which because of their age, were considered to be in the "Masonry D" group as defined by Richter. However, G. A. Eiby (DSIR, NZ, personal communication) considered that, because the local standard of buildings was generally higher than in areas described by Richter, these types of building could be classified as "Masonry C", and that accordingly the authors' rating would tend to be too low.' (Everingham & Parkes, 1971).

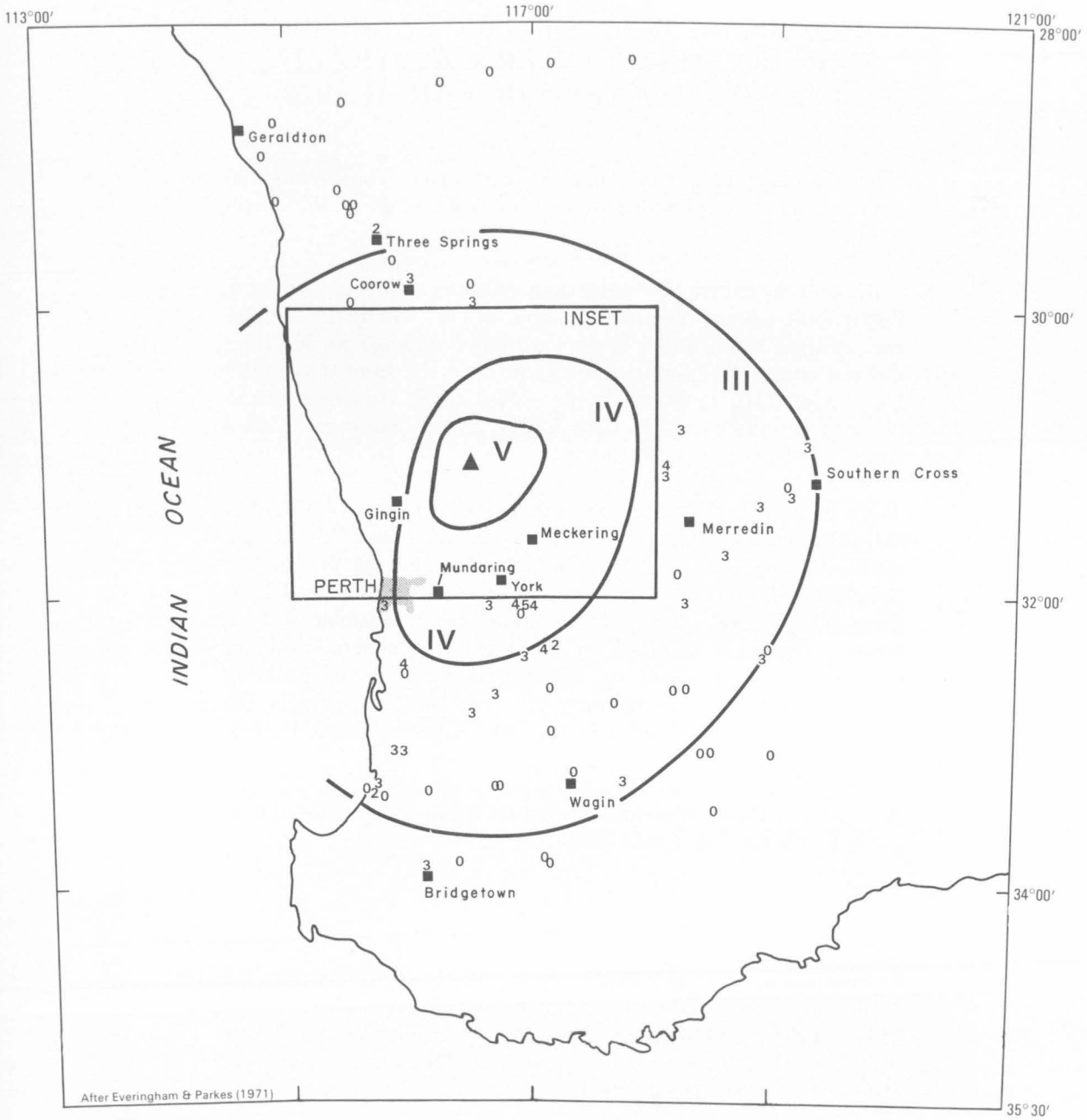
A comprehensive description of the Calingiri earthquake is given by Gordon & Lewis (1980).

REFERENCES

EVERINGHAM, I. B., & PARKES, A. A., 1971—Intensity data for earthquakes at Landor (17 June 1969) and Calingiri (10 March 1970) and their relationship to previous Western Australian earthquakes. *Bureau of Mineral Resources, Australia, Record* 1971/80 (unpublished).

GORDON, F. R., & LEWIS, J. D., 1980—The Meckering and Calingiri earthquakes, October 1968 and March 1970. *Geological Survey of Western Australia, Bulletin* 126.

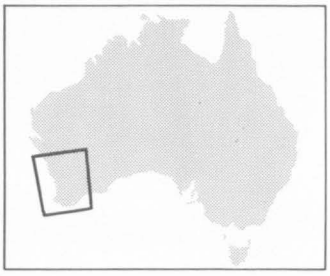
ISOSEISMAL MAP OF THE CALINGIRI EARTHQUAKE, WESTERN AUSTRALIA
10 MARCH 1970



0 200km

DATE : 10 MARCH 1970
TIME : 17:15:11.2 UT
MAGNITUDE :5.1 ML (MUN), 5.1 MS (MUN), 5.7 MB (GS)
EPICENTRE : 31.11°S 116.47°E
DEPTH : 1km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT
INSET INTENSITIES SHOWN IN FOLLOWING MAP



ISOSEISMAL MAP OF THE CALINGIRI EARTHQUAKE, WESTERN AUSTRALIA, NEAR EPICENTRE—10 MARCH 1970

'Three hundred and sixty replies were received from about 420 questionnaires circulated within a 300 km radius of the earthquake epicentre.'

'Although the earthquake caused an arcuate shallow east-dipping thrust fault over a distance of about 5 km, where the surface was uplifted by as much as 30 cm, major damage to buildings did not occur at Calingiri only 3 km from the fault. No building straddled the fault, where the only damage was the shortening and misalignment of wire fences and a bump in a road where the fault scarp crossed it.'

'Here it should be noted that the authors' rating of intensity (MM6) is based largely on cracking of walls in older homes, which because of their age, were considered to be in the "Masonry D" group as defined by Richter. However, G. A. Eiby (DSIR, NZ, personal communication) considered that, because the local standard of buildings was generally higher than in areas described by Richter, these types of building could be classified as "Masonry C", and that accordingly the authors' rating would tend to be too low.' (Everingham & Parkes, 1971).

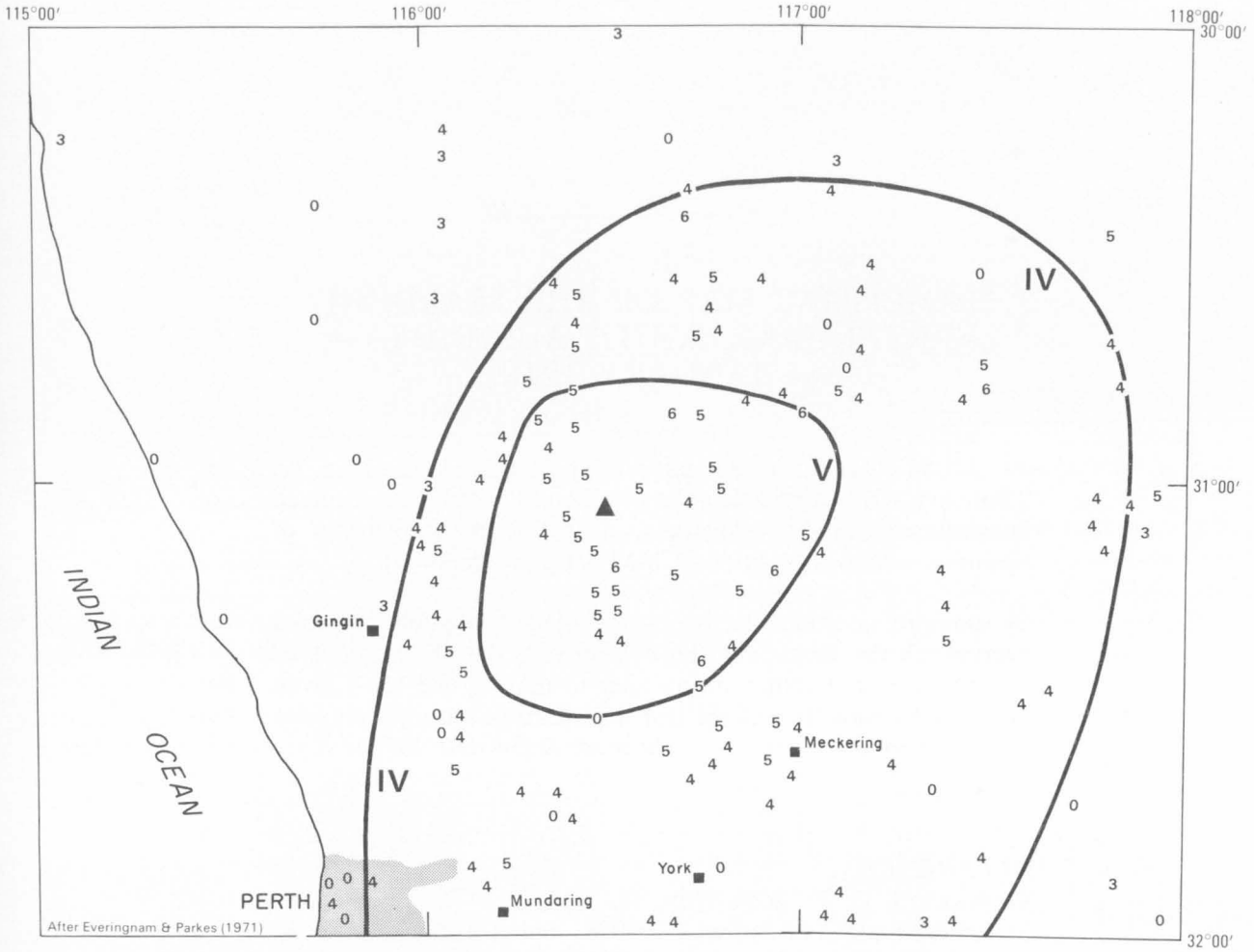
A comprehensive description of the Calingiri earthquake is given by Gordon & Lewis (1980).

REFERENCES

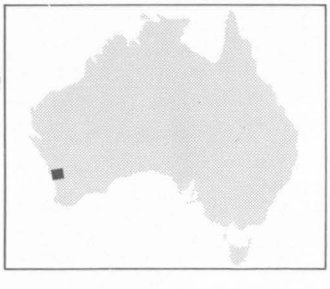
EVERINGHAM, I. B., & PARKES, A. A., 1971—Intensity data for earthquakes at Landor (17 June 1969) and Calingiri (10 March 1970) and their relationship to previous Western Australian earthquakes. *Bureau of Mineral Resources, Australia, Record* 1971/80 (unpublished).

GORDON, F. R., & LEWIS, J. D., 1980—The Meckering and Calingiri earthquakes, October 1968 and March 1970. *Geological Survey of Western Australia, Bulletin* 126.

ISOSEISMAL MAP OF THE CALINGIRI EARTHQUAKE, WESTERN AUSTRALIA NEAR EPICENTRE, 10 MARCH 1970



0 80km



DATE : 10 MARCH 1970
TIME : 17:15:11.2 UT
MAGNITUDE : 5.1 ML (MUN), 5.1 MS (MUN), 5.7 MB (GS)
EPICENTRE : 31.11°S 116.47°E
DEPTH : 1km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/150/3

ISOSEISMAL MAP OF THE SPALDING EARTHQUAKE, SOUTH AUSTRALIA— 6 JANUARY 1971

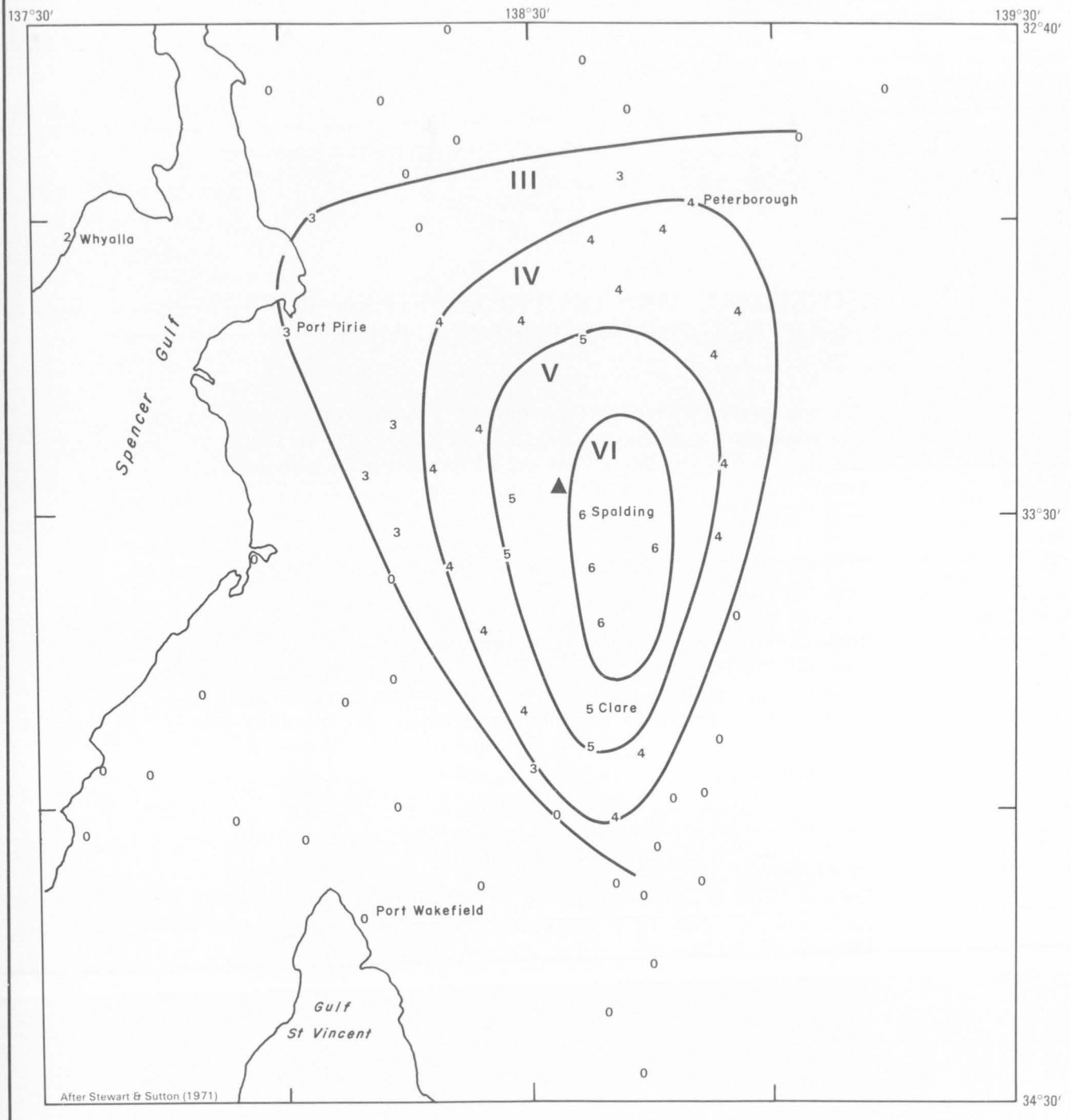
At 23: 54 UT on 6 January 1971 (09:24 local time on 7 January 1971) an earthquake of magnitude ML 4.6 occurred in southeastern South Australia, near the small township of Spalding, where intensities of MM VI were reported.

'A standard questionnaire was distributed throughout the area over which the shock may have been felt, the observations of the inhabitants enabling an intensity to be assigned for a given location. Reports of damage (for insurance purposes) were also used in estimating intensity.' (Stewart & Sutton, 1971).

REFERENCE

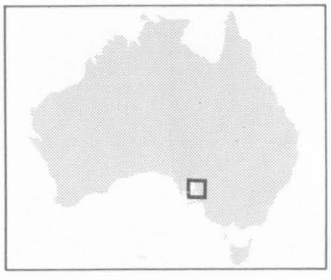
STEWART, I. C. F., & SUTTON, D. J., 1971—The South Australian earthquake of January 7, 1971, and aftershocks. *Journal of the Geological Society of Australia,* 18, 201-205.

ISOSEISMAL MAP OF THE SPALDING EARTHQUAKE, SOUTH AUSTRALIA
6 JANUARY 1971



DATE : 6 JANUARY 1971
TIME : 23:54:30.3 UT
MAGNITUDE : 4.6 ML (ADE)
EPICENTRE : 33.46°S 138.56°E
DEPTH : 12km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/154/2

ISOSEISMAL MAP OF THE WESTERN PORT EARTHQUAKE, VICTORIA—6 JULY 1971

'An earthquake occurred in the region of Western Port Bay at approximately 8 a.m. Australian E.S.T. on 7 July 1971 (6 July, G.M.T.). It was felt throughout the Melbourne area, a major part of West Gippsland, and reports were received from 136 km away.'

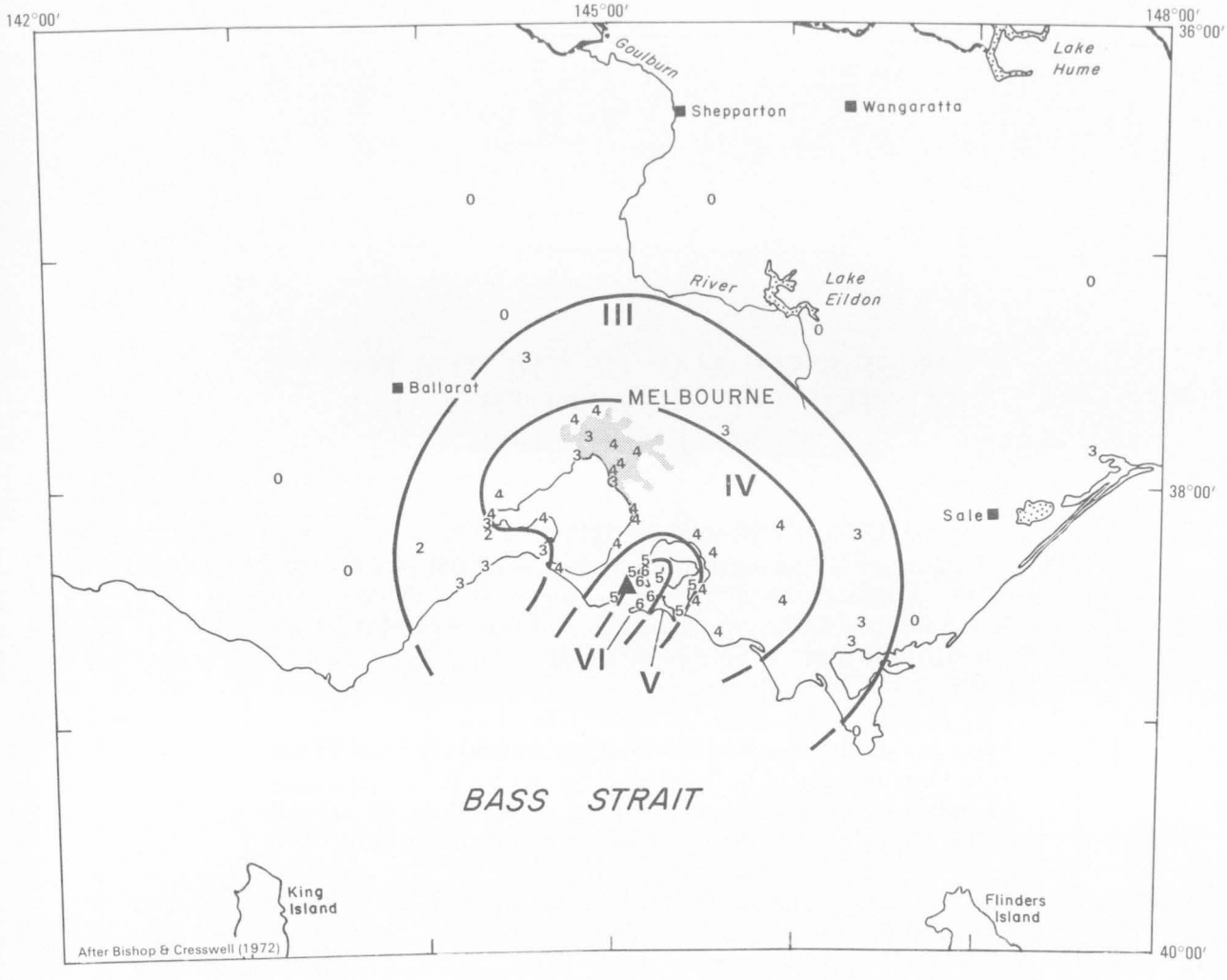
'Damage resulting from the quake was minor and no injuries were reported.'

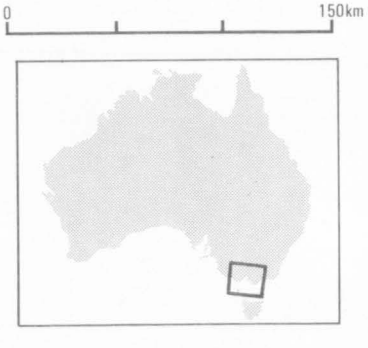
'Immediately after the earthquake, questionnaires seeking information on felt intensity were distributed throughout Central Victoria and residents near the epicentre were interviewed. About 150 reports were collected for analysis and a similar number collected by the BMR were also studied.' (Bishop & Cresswell, 1972).

REFERENCE

BISHOP, I. D., & CRESSWELL, L. A., 1972—The Western Port earthquake of 6 July 1971. *Proceedings of the Royal Society of Victoria,* 85, 70-71.

ISOSEISMAL MAP OF THE WESTERN PORT EARTHQUAKE, VICTORIA
6 JULY 1971





DATE : 6 JULY 1971
TIME : 21:55:01.3 UT
MAGNITUDE : 5.0 ML (ADE), 4.9 MS (GS)
EPICENTRE : 38.42°S 145.11°E
DEPTH : 23km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/155/4

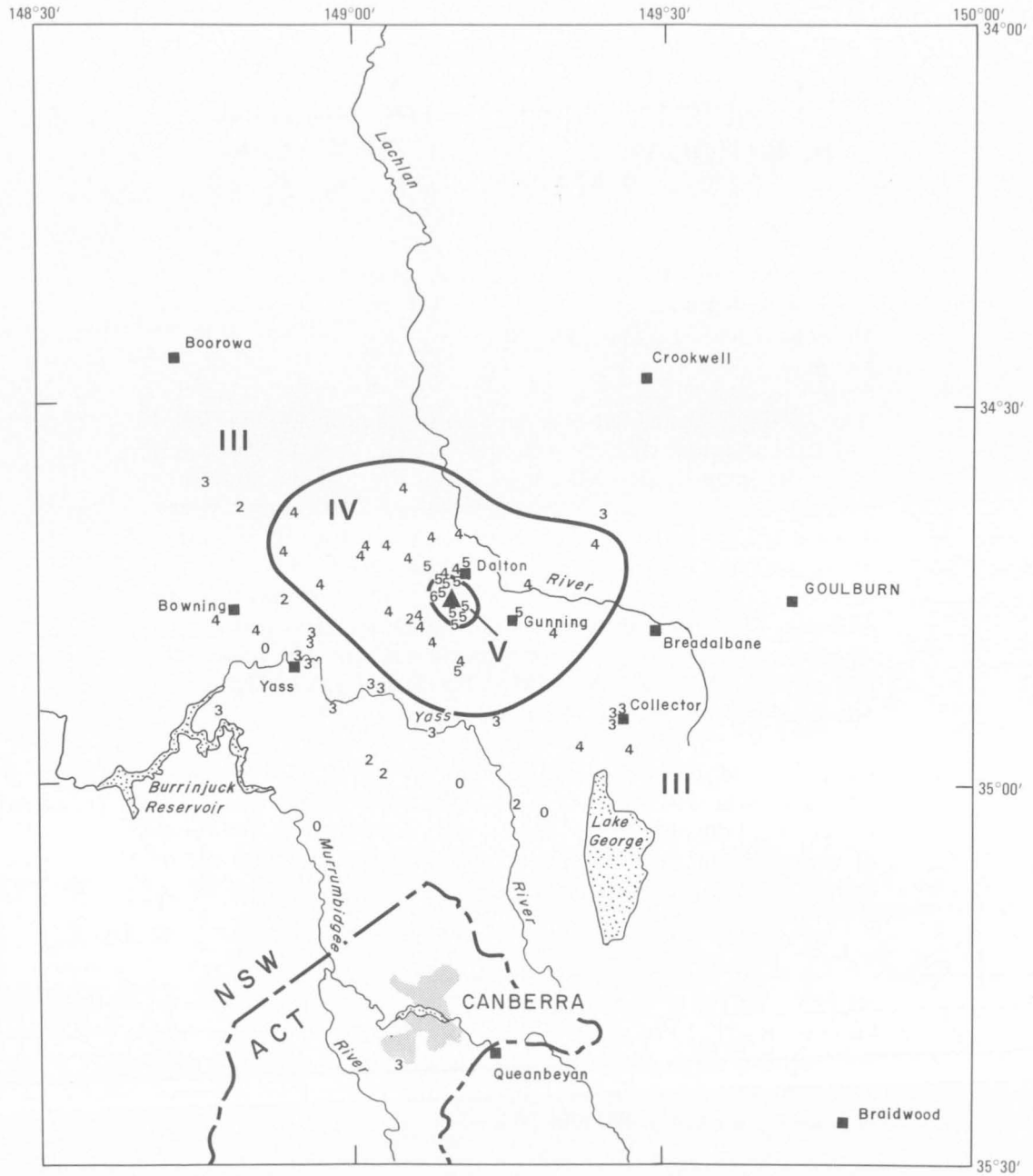
ISOSEISMAL MAP OF THE DALTON EARTHQUAKE, NEW SOUTH WALES— 3 NOVEMBER 1971

At 20:05 UT on 3 November 1971 (06:05 local time on 4 November 1971) an earthquake of magnitude ML 4.2 occurred in the Dalton-Gunning region of southeastern NSW, about 60 km north of Canberra. A maximum intensity of MM VI was reported just west of the epicentre and an intensity of MM III was reported in Canberra.

The main earthquake was followed by over 40 aftershocks that were large enough to be located—the pattern of epicentres extended over a distance of about 16 km, mostly along the azimuth of the main Dalton-Gunning seismic zone (approximately 135°).

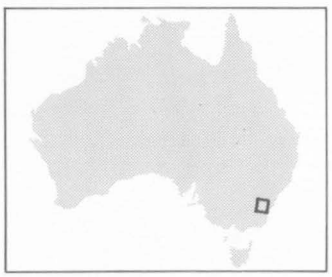
The map was compiled by BMR, Canberra and has not been published previously.

ISOSEISMAL MAP OF THE DALTON EARTHQUAKE, NEW SOUTH WALES
3 NOVEMBER 1971



DATE : 3 NOVEMBER 1971
TIME : 20:05:37.3 UT
MAGNITUDE : 4.2 ML (RIV)
EPICENTRE : 34.78°S 149.17°E
DEPTH : 3km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/155-12/3

ISOSEISMAL MAP OF THE PICTON EARTHQUAKE, NEW SOUTH WALES— 9 MARCH 1973

'An earthquake of magnitude 5.5 ML occurred on 9 March 1973 at a depth of 20 km at 1909 UT (0509 local time on 10 March 1973). The epicentre was about 30 km west of Picton.'

'This earthquake was felt over an area of [almost 200 000 km^2] and light damage was caused over a wide area (4,000 km^2) where the intensity was MM V or more. Most of the structures affected were very old, some more than 100 years. Minor damage was caused to plaster, brickwork and tops of chimneys where heat had destroyed the adhesive properties of plaster. No reports of complete chimneys breaking at roof levels were received. Only one instance (at Wollongong glass works) of significant damage to goods or stores is known. The maximum intensity experienced was MM VI-VII and total damage is estimated to be about $500 000.' (Denham, 1976).

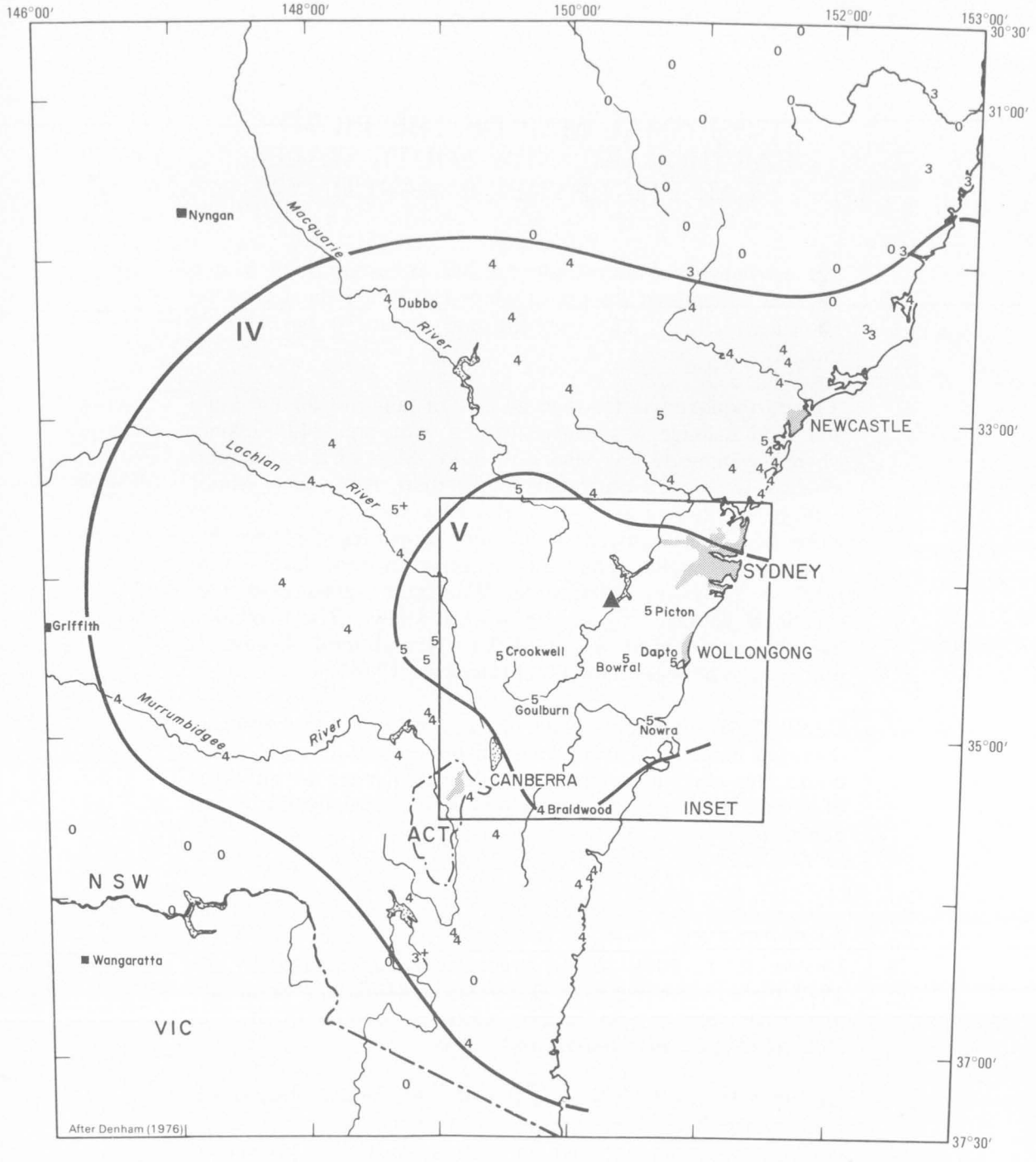
Dayeh (1976) describes details of damage to the most seriously damaged buildings which he visited three days after the earthquake. He concluded that only minimal damage to buildings of normal standard of construction was caused by the earthquake.

REFERENCES

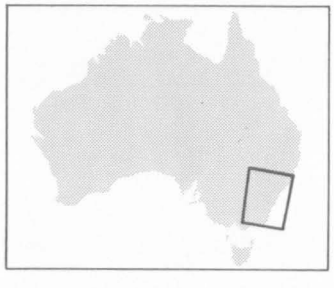
DAYEH, R. J., 1976—Some structural damage caused by the 1973 Picton earthquake. *In* DENHAM, D. (Editor)—Seismicity and earthquake risk in eastern Australia. *Bureau of Mineral Resources, Australia, Bulletin* 164, 33-39.

DENHAM, D., 1976—Effects of the 1973 Picton and other earthquakes in eastern Australia. *In* DENHAM, D. (Editor)— Seismicity and earthquake risk in eastern Australia. *Bureau of Mineral Resources, Australia, Bulletin* 164, 15-28.

ISOSEISMAL MAP OF THE PICTON EARTHQUAKE, NEW SOUTH WALES
9 MARCH 1973



DATE : 9 MARCH 1973
TIME : 19:09:14 UT
MAGNITUDE : 5.5 ML (RIV), 5.3 MS (BMR), 5.5 MB (GS)
EPICENTRE : 34.14°S 150.29°E
DEPTH : 20km



▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT
INSET MEIZOSEISMAL ZONE SHOWN IN FOLLOWING MAP

24/N/7

ISOSEISMAL MAP OF THE PICTON EARTHQUAKE, NEW SOUTH WALES, NEAR EPICENTRE—9 MARCH 1973

'An earthquake of magnitude 5.5 ML occurred on 9 March 1973 at a depth of 20 km at 1909 UT (0509 local time on 10 March 1973). The epicentre was about 30 km west of Picton.'

'This earthquake was felt over an area of [almost 200 000 km^2] and light damage was caused over a wide area (4,000 km^2) where the intensity was MM V or more. Most of the structures affected were very old, some more than 100 years. Minor damage was caused to plaster, brickwork and tops of chimneys where heat had destroyed the adhesive properties of plaster. No reports of complete chimneys breaking at roof levels were received. Only one instance (at Wollongong glass works) of significant damage to goods or stores is known. The maximum intensity experienced was MM VI-VII and total damage is estimated to be about $500 000.' (Denham, 1976).

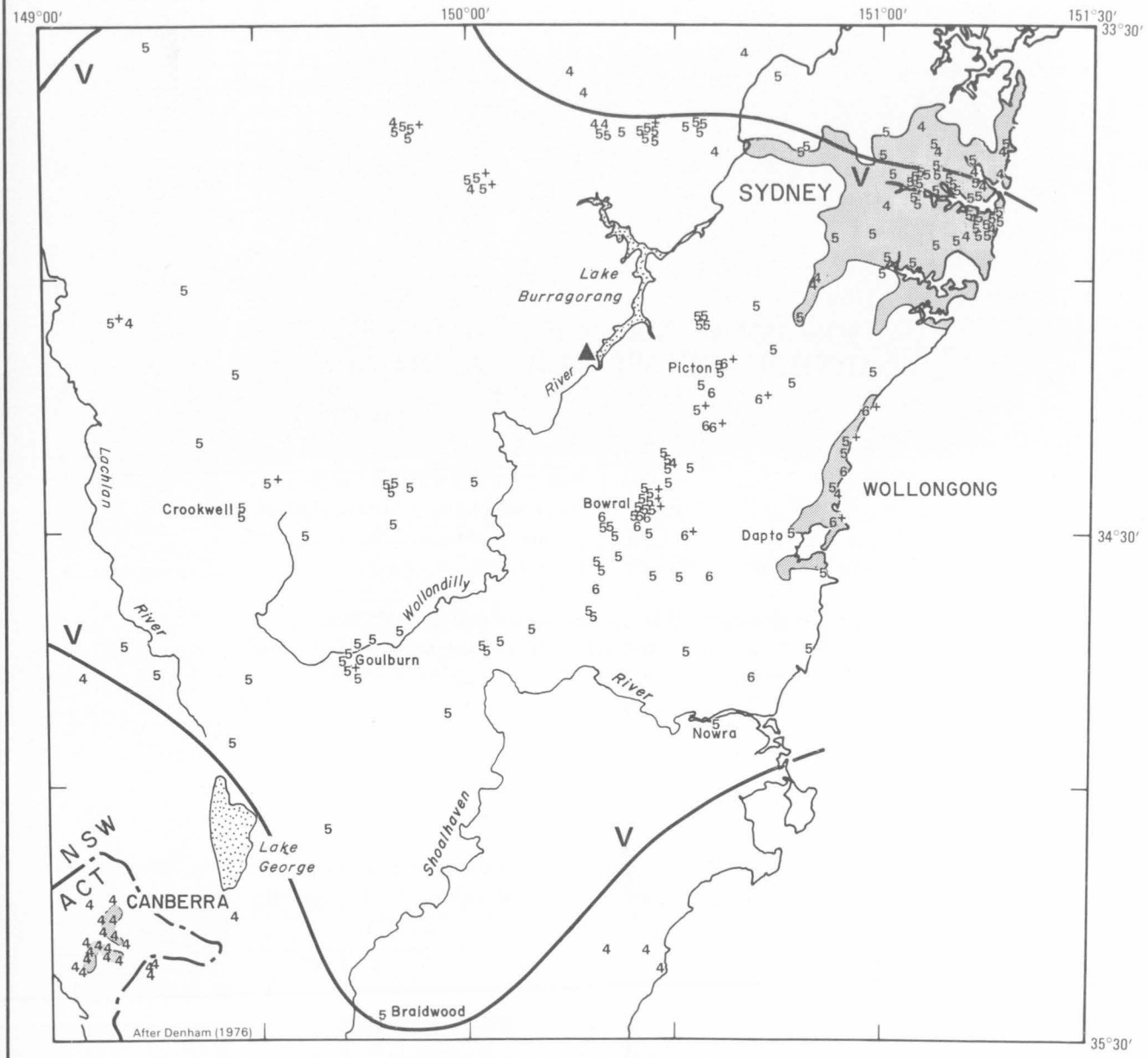
Dayeh (1976) describes details of damage to the most seriously damaged buildings which he visited three days after the earthquake. He concluded that only minimal damage to buildings of normal standard of construction was caused by the earthquake.

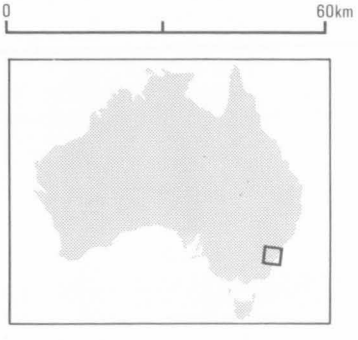
REFERENCES

DAYEH, R. J., 1976—Some structural damage caused by the 1973 Picton earthquake. *In* DENHAM, D. (Editor)—Seismicity and earthquake risk in eastern Australia. *Bureau of Mineral Resources, Australia, Bulletin* 164, 33-39.

DENHAM, D., 1976—Effects of the 1973 Picton and other earthquakes in eastern Australia. *In* DENHAM, D. (Editor)— Seismicity and earthquake risk in eastern Australia. *Bureau of Mineral Resources, Australia, Bulletin* 164, 15-28.

ISOSEISMAL MAP OF THE PICTON EARTHQUAKE, NEW SOUTH WALES
NEAR EPICENTRE, 9 MARCH 1973





DATE : 9 MARCH 1973
TIME : 19:09:14 UT
MAGNITUDE : 5.5 ML (RIV), 5.3 MS (BMR), 5.5 MB (GS)
EPICENTRE : 34.14°S 150.29°E
DEPTH : 20km

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

ISOSEISMAL MAP OF A MECKERING EARTHQUAKE, WESTERN AUSTRALIA— 9 JULY 1974

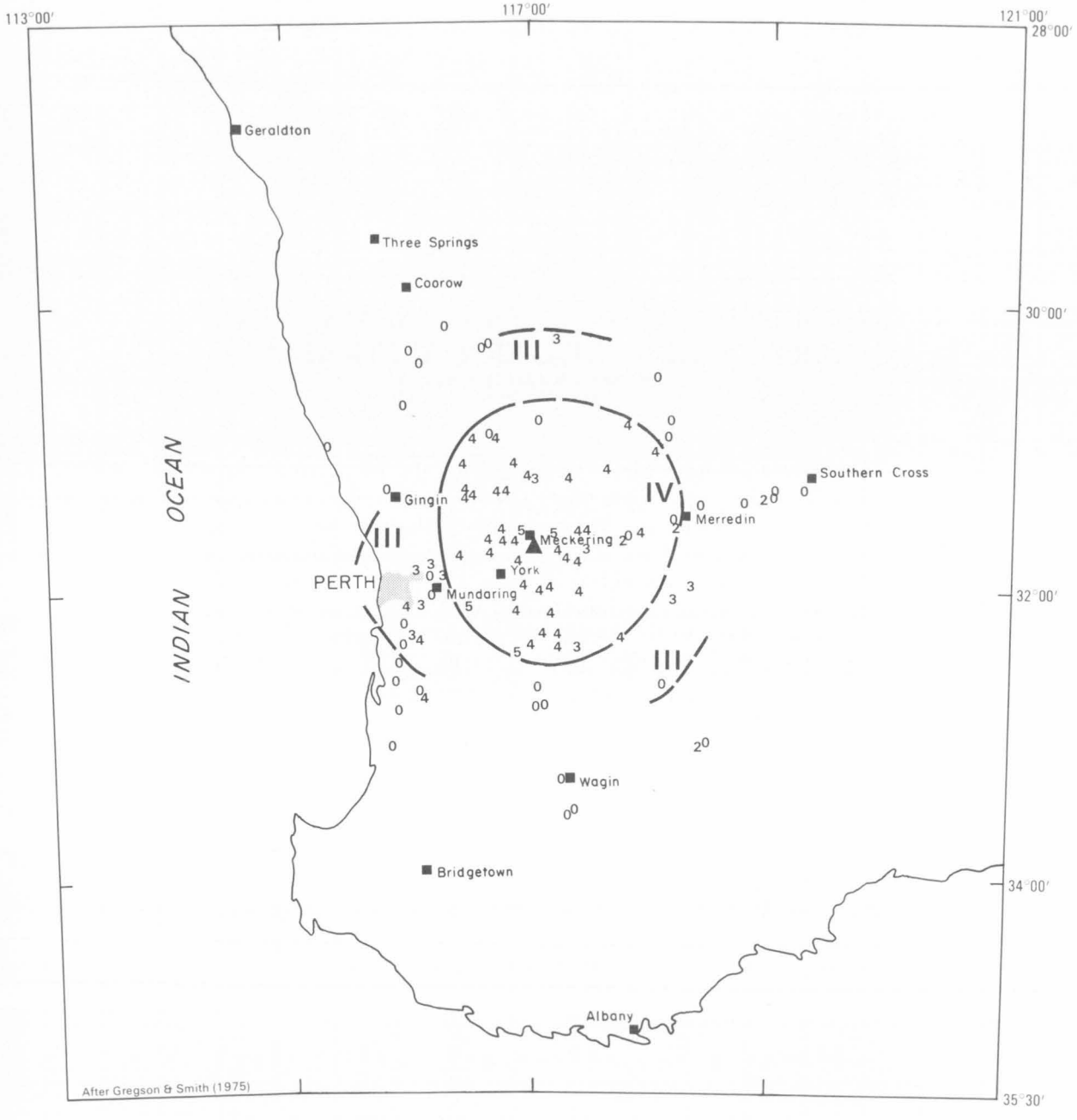
At 10.46 UT (18:46 local time) on 9 July 1974 an earthquake of magnitude ML 4.3 occurred near Meckering, approximately 120 km east-northeast of Perth, in the southwest seismic zone of Western Australia.

Earthquake questionnaire forms were distributed throughout the southwest, and the isoseismal map was compiled by staff of BMR's Mundaring Geophysical Observatory from the results of the survey. The earthquake was reported felt up to a maximum distance of 200 km from the epicentre.

REFERENCE

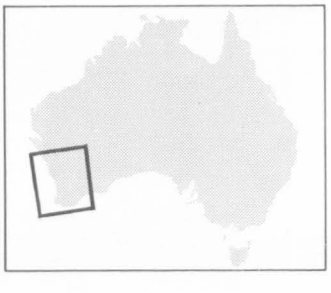
GREGSON, P. J., & SMITH, R. S., 1975—Mundaring Geophysical Observatory Annual Report, 1974. *Bureau of Mineral Resources, Australia, Record* 1975/143 (unpublished).

ISOSEISMAL MAP OF A MECKERING EARTHQUAKE, WESTERN AUSTRALIA
9 JULY 1974



DATE : 9 JULY 1974
TIME : 10:46:47.4 UT
MAGNITUDE : 4.3 ML (MUN), 5.3 MB (MUN)
EPICENTRE : 31.65°S 117.00°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/WA/12

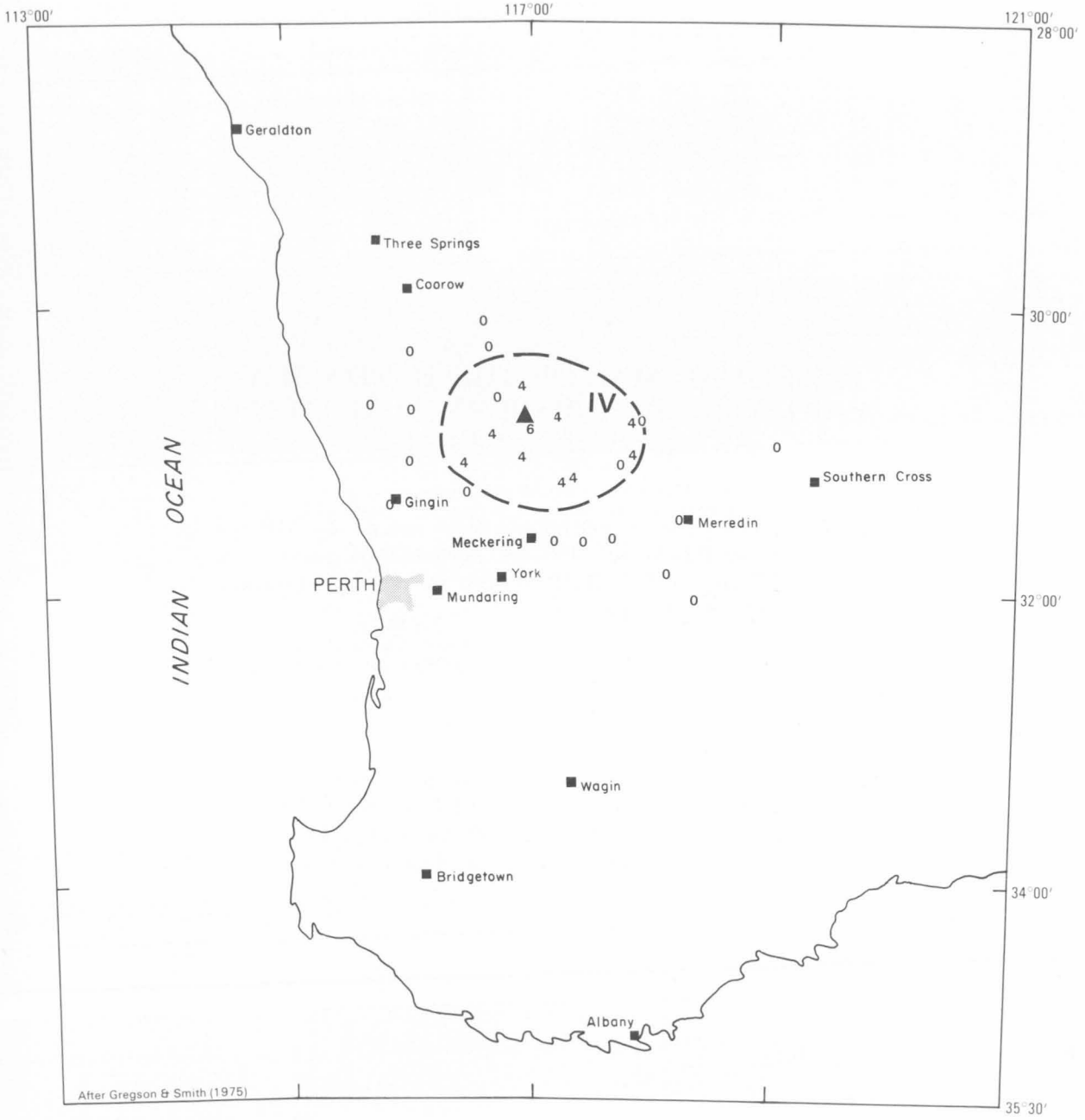
ISOSEISMAL MAP OF THE MANMANNING EARTHQUAKE, WESTERN AUSTRALIA—4 SEPTEMBER 1974

'The extent of the MM IV isoseismal for the Meckering earthquakes [in July and November] is comparable. By comparison the area over which the Manmanning earthquake was felt was surprisingly small. This small area and maximum intensity of MM VI near the [epicentre] suggests that the event was very shallow. Mr Shankland reported—"At 7.17 a.m. a very loud explosion—right under the kitchen table—vibrations and rumbling, so much so that the six of us at breakfast ran for it. At 7.20 a.m. as before, we ran outside—have experienced tremors before but never as terrifying as this experience." Mr Shankland also felt tremors at 8.40 a.m. and 2.20 p.m.' Gregson & Smith (1975).

REFERENCE

GREGSON, P. J., & SMITH, R. S., 1975—Mundaring Geophysical Observatory Annual Report, 1974. *Bureau of Mineral Resources, Australia, Record* 1975/143 (unpublished).

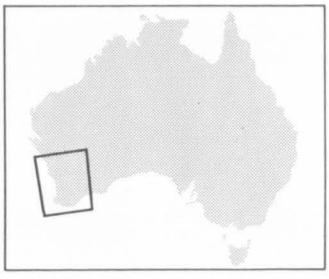
ISOSEISMAL MAP OF A MANMANNING EARTHQUAKE, WESTERN AUSTRALIA
4 SEPTEMBER 1974



0 200km

DATE : 4 SEPTEMBER 1974
TIME : 23:17:42.4 UT
MAGNITUDE : 4.5 ML (MUN), 5.8 MB (MUN)
EPICENTRE : 30.79°S 116.97°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



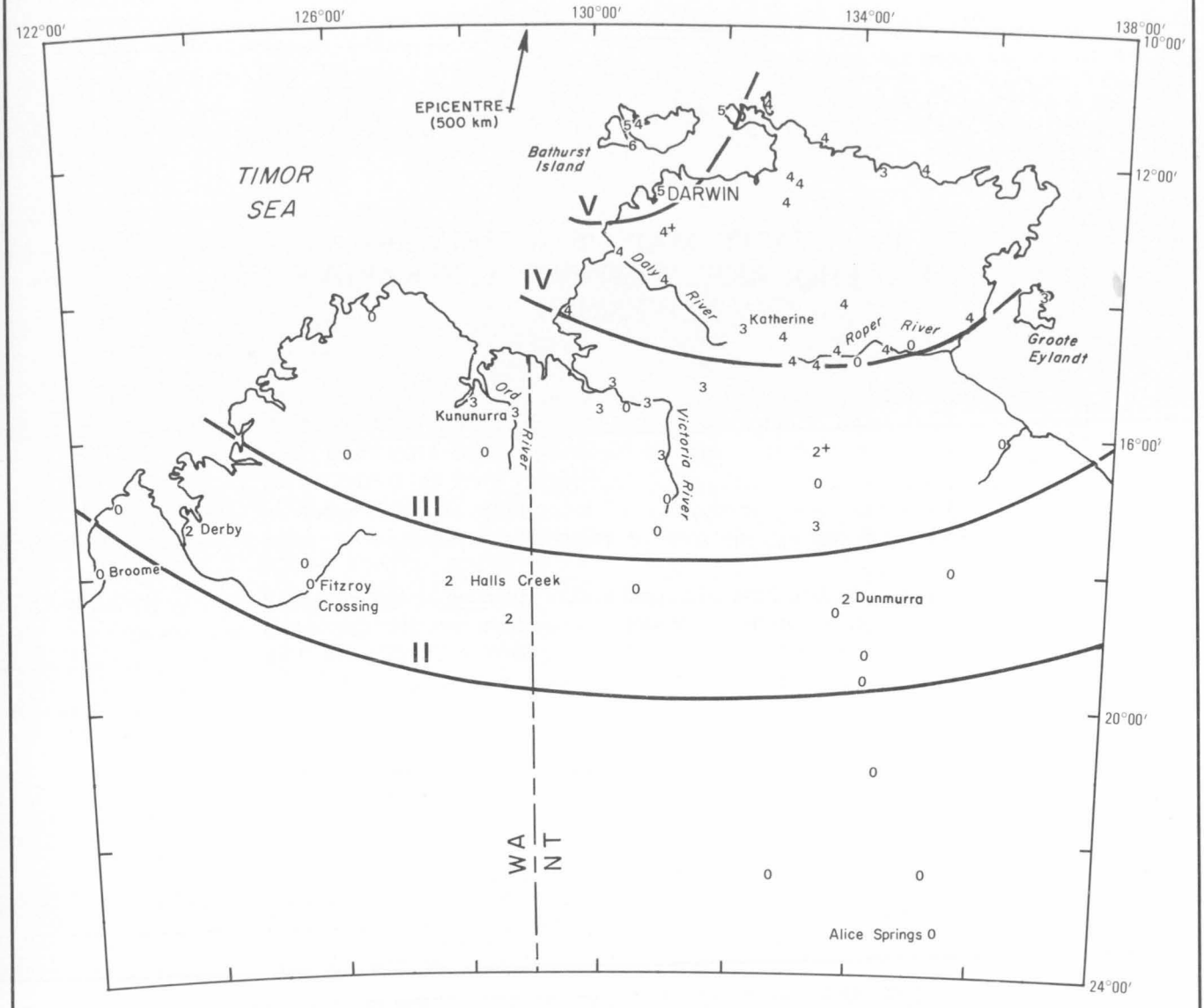
24/H50/4

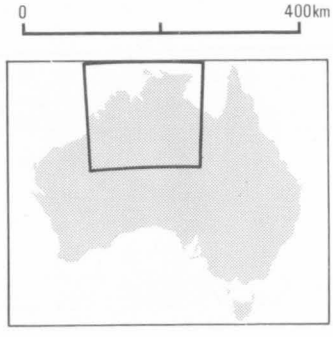
ISOSEISMAL MAP OF THE BANDA SEA EARTHQUAKE, NORTHERN AUSTRALIA AREA—29 OCTOBER 1974

On 29 October 1974 an earthquake with magnitude MB 6.5 occurred in the Banda Sea 300 km northeast of Timor at a depth of 117 km. Staff of BMR studied its effects in northern Australia, and compiled the map.

At Darwin, 650 km to the south, the earthquake was felt with an intensity of MM V. Damage to concrete fixtures, toilet fixtures, and walls was reported. The earthquake was felt as far afield as Derby in the west, Groote Eylandt in the east, and Dunmarra in the south. The maximum felt intensity in Australia was a single report of VI on Bathurst Island. No felt reports from Indonesia were received although the USGS PDE sheet (E9-74) listed the earthquake as felt in Timor and Kupang.

ISOSEISMAL MAP OF THE BANDA SEA EARTHQUAKE, 29 OCTOBER 1974





DATE : 29 OCTOBER 1974
TIME : 03:14:14.6 UT
MAGNITUDE : 6.6 MS (PAS), 6.5 MB (GS)
EPICENTRE : 6.88°S 129.46°E
DEPTH : 117km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/A/25

ISOSEISMAL MAP OF A MECKERING EARTHQUAKE, WESTERN AUSTRALIA— 19 NOVEMBER 1974

At 09:30 UT (17:30 local time) on 19 November 1974 an earthquake of magnitude ML 4.0 occurred about 120 km east-northeast of Perth, close to the township of Meckering. The epicentre of this earthquake was virtually identical to the 9 July 1974 Meckering earthquake of magnitude ML 4.3, again in the southwest seismic zone of Western Australia.

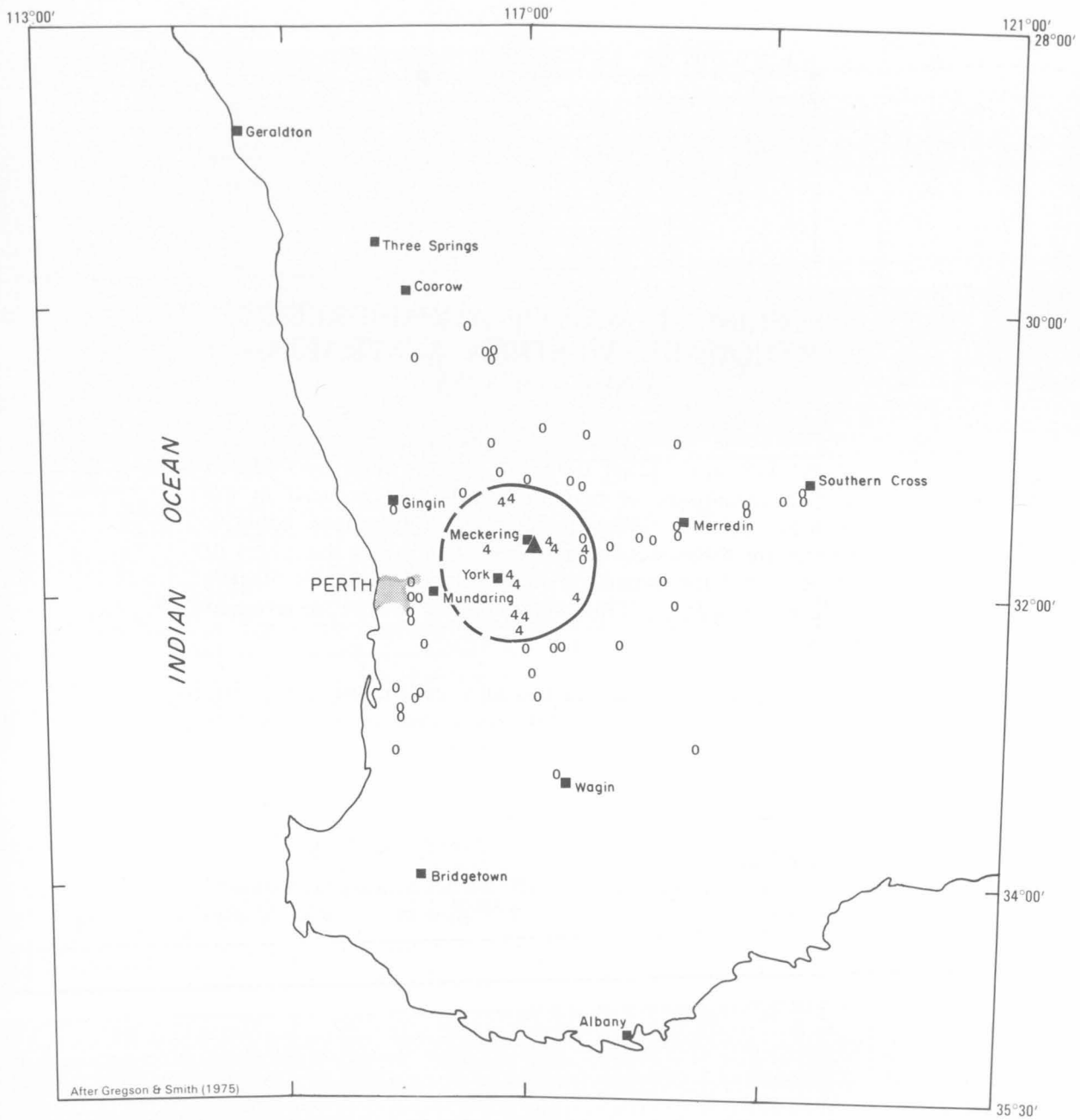
Earthquake questionnaire forms were distributed throughout a wide area of southern Western Australian and the isoseismal map drawn up by staff of BMR's Mundaring Geophysical Observatory from the questionnaire survey results.

Unlike the 9 July 1974 shock, which was felt up to 200 km from the epicentre, the 19 November 1974 earthquake was reported felt over only a small area (about 10 000 km^2).

REFERENCE

GREGSON, P. J., & SMITH, R. S., 1975—Mundaring Geophysical Observatory Annual Report, 1974. *Bureau of Mineral Resources, Australia, Record* 1975/143 (unpublished).

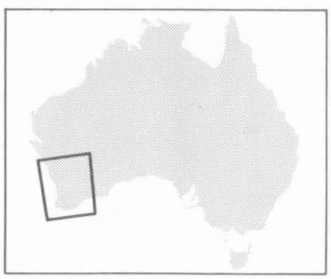
ISOSEISMAL MAP OF A MECKERING EARTHQUAKE, WESTERN AUSTRALIA
19 NOVEMBER 1974



0 200km

DATE : 19 NOVEMBER 1974
TIME : 09:30:22.6 UT
MAGNITUDE : 4.0 ML (MUN)
EPICENTRE : 31.63°S 117.03°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/WA/13

ISOSEISMAL MAP OF A KIMBERLEY EARTHQUAKE, WESTERN AUSTRALIA—6 MARCH 1975

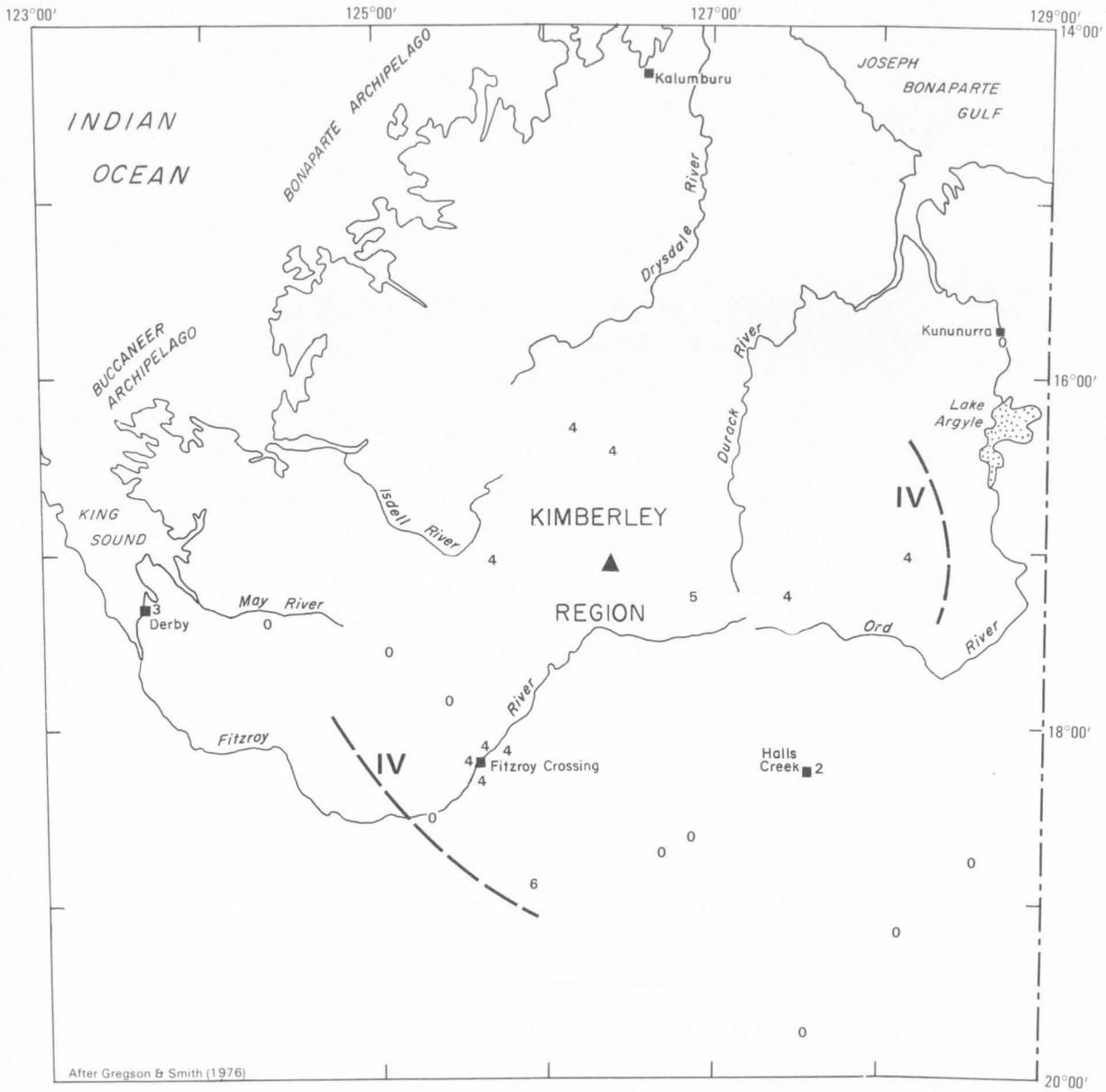
At 23:51 UT on 6 March 1975 (07:51 local time on 7 March 1975) an earthquake of magnitude MB 5.2 occurred in the Kimberley region of Western Australia. Earthquake intensity questionnaire forms were sent to homesteads and townships in the region and the isoseismal map drawn by staff of BMR's Mundaring Geophysical Observatory on the basis of the returned questionnaires.

'The scarcity of population in this area limited the availability of data, however, the results gave some idea of the extent of the intensity MM IV.' (Gregson & Smith, 1976).

REFERENCE

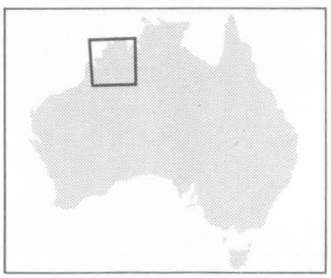
GREGSON, P. J., & SMITH, R. S., 1976—Mundaring Geophysical Observatory Annual Report, 1975. *Bureau of Mineral Resources, Australia, Record* 1976/48 (unpublished).

ISOSEISMAL MAP OF A KIMBERLEY EARTHQUAKE, WESTERN AUSTRALIA
6 MARCH 1975



DATE : 6 MARCH 1975
TIME : 23:51:26.3 UT
MAGNITUDE : 5.2 MB (MUN)
EPICENTRE : 17.08°S 126.38°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/WA/14

ISOSEISMAL MAP OF A MARBLE BAR EARTHQUAKE, WESTERN AUSTRALIA—24 JULY 1975

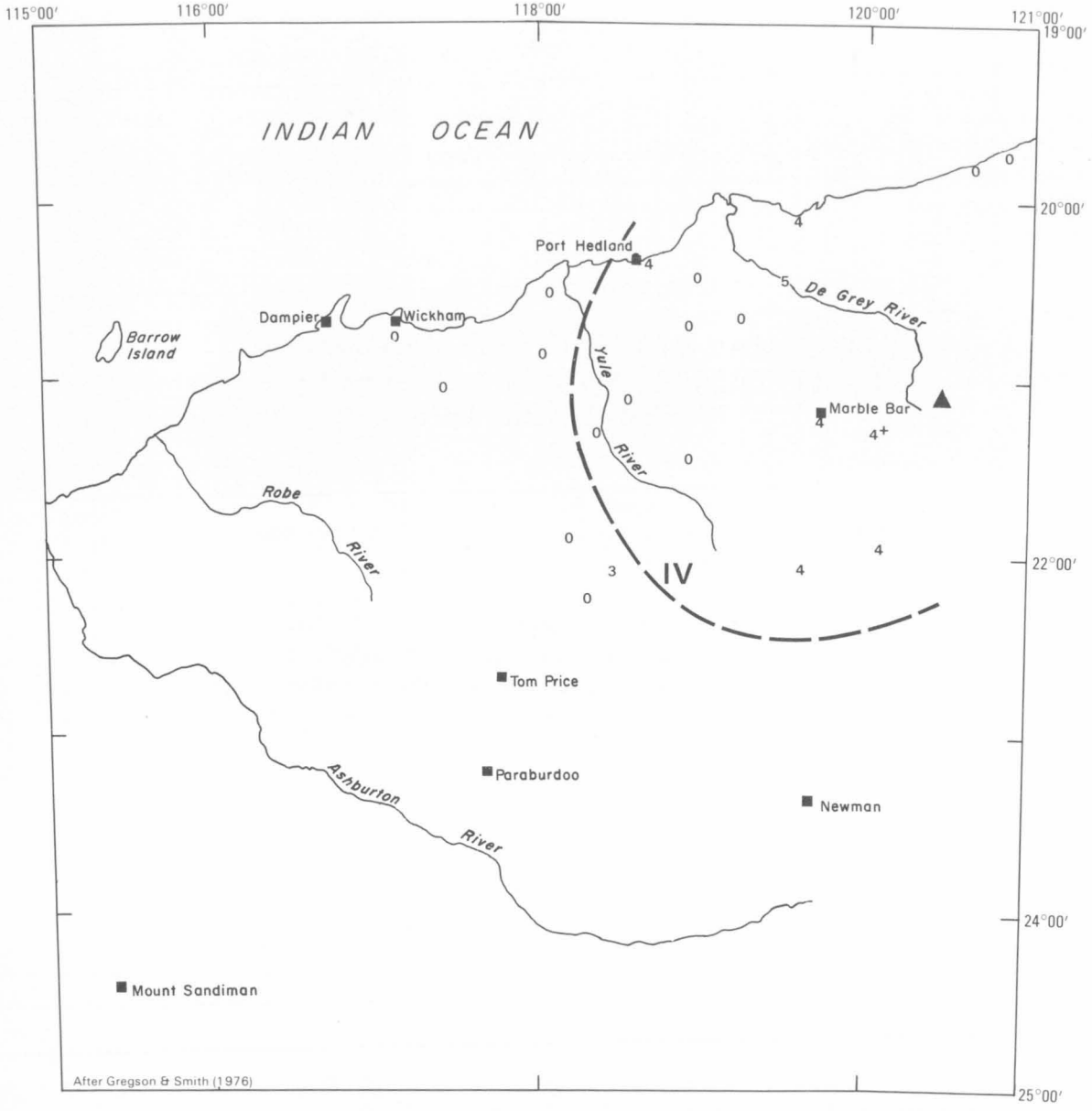
At 22:23 UT on 24 July 1975 (06:23 local time on 25 July 1975) an earthquake of magnitude MB 5.1 occurred approximately 75 km east of Marble Bar in northwestern Western Australia. Earthquake intensity questionnaire forms were sent out to homesteads and townships in the region and the isoseismal map drawn by staff of BMR's Mundaring Geophysical Observatory on the basis of the returned intensity questionnaires.

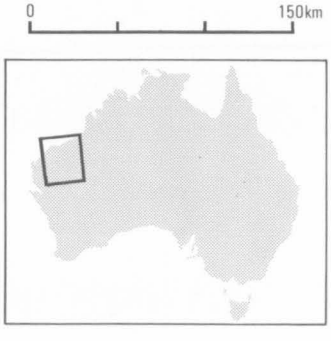
'The scarcity of population in this area limited the availability of data, however, the results gave some idea of the extent of the intensity MM IV.' (Gregson & Smith, 1976).

REFERENCE

GREGSON, P. J., & SMITH, R. S., 1976—Mundaring Geophysical Observatory Annual Report, 1975. *Bureau of Mineral Resources, Australia, Record* 1976/48 (unpublished).

ISOSEISMAL MAP OF A MARBLE BAR EARTHQUAKE, WESTERN AUSTRALIA
24 JULY 1975





DATE : 24 JULY 1975
TIME : 22:23:41.7 UT
MAGNITUDE : 5.1 MB (MUN)
EPICENTRE : 21.09°S 120.47°E
DEPTH : 33km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

ISOSEISMAL MAP OF THE GLADSTONE EARTHQUAKE, SOUTH AUSTRALIA— 27 FEBRUARY 1976

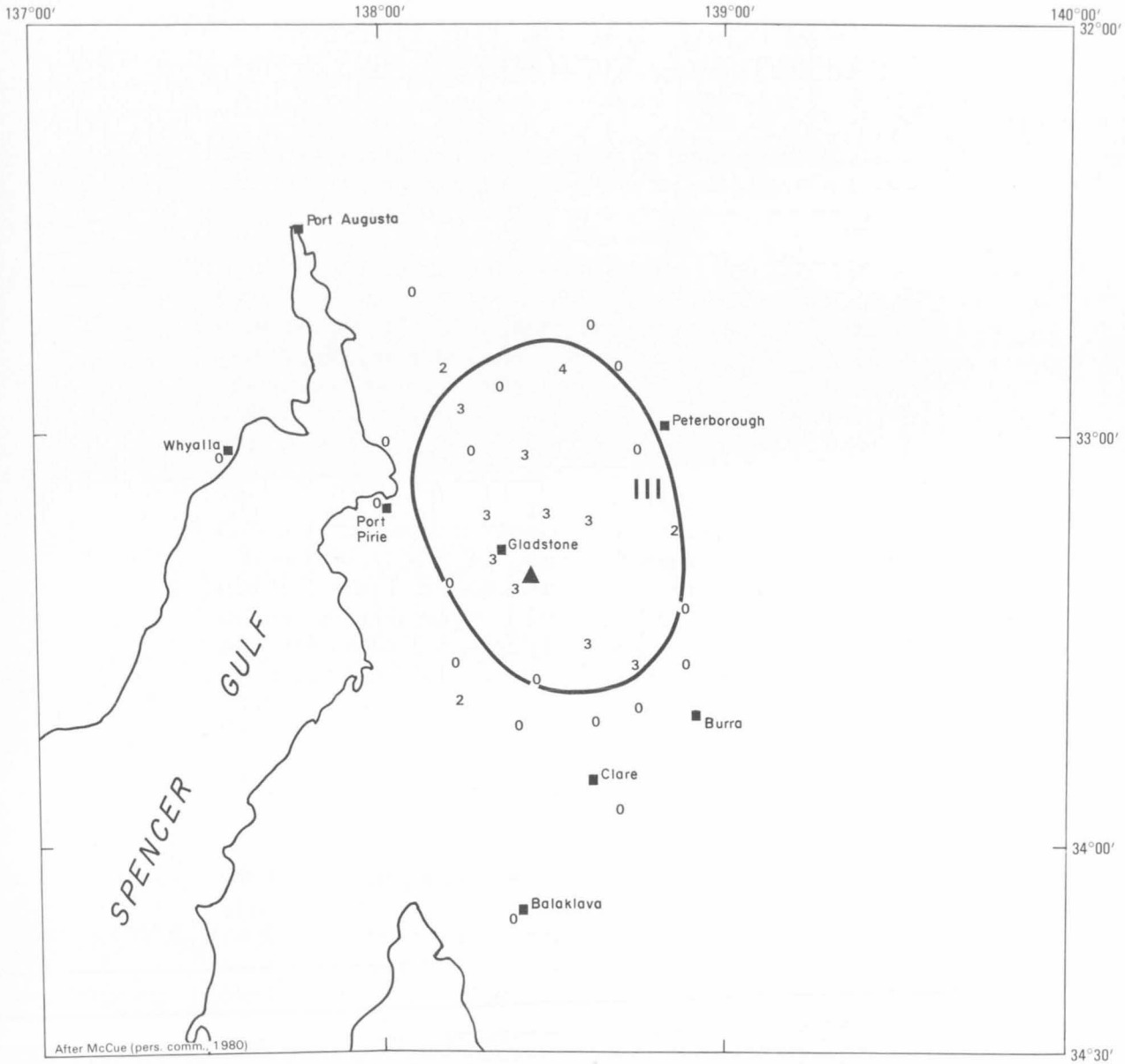
An earthquake of magnitude ML 3.6 occurred at 11:45 UT, 27 February 1976 about 10 km southeast of the township of Gladstone, South Australia.

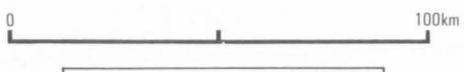
Hypocentral details of the earthquake are given by McCue & Sutton (1979) but no accounts of damage are given. The isoseismal map was drawn by K. F. McCue (Port Moresby Geophysical Observatory, personal communication, 1980) from data that he collected whilst at the University of Adelaide, South Australia.

REFERENCE

McCue, K. F., & Sutton, D. J., 1979—South Australian earthquakes during 1976 and 1977. *Journal of the Geological Society of Australia,* 26, 231-236.

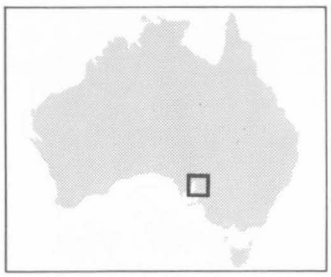
ISOSEISMAL MAP OF THE GLADSTONE EARTHQUAKE, SOUTH AUSTRALIA
27 FEBRUARY 1976





DATE : 27 FEBRUARY 1976
TIME : 11:44:51 UT
MAGNITUDE : 3.6 ML(ADE)
EPICENTRE : 33.30°S 138.45°E
DEPTH : 8 km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/154/3

ISOSEISMAL MAP OF THE PRESTON EARTHQUAKE, VICTORIA—9 JULY 1976

(Note: Although small in magnitude, this earthquake has been included in the Atlas because it took place in an urban environment and was reported by a large number of observers).

'At 0827 UT (0627 pm EST) on 9 July 1976, a small earthquake with magnitude ML 1.3 was felt in the Melbourne suburb of Preston. A foreshock of magnitude ML 0.3 occurred 8 minutes earlier, but was not felt. The high population density provided an opportunity to study intensities from a small but very shallow earthquake. The intensity survey covered an area of about 30 square kilometres, and yielded over 140 intensity estimates.

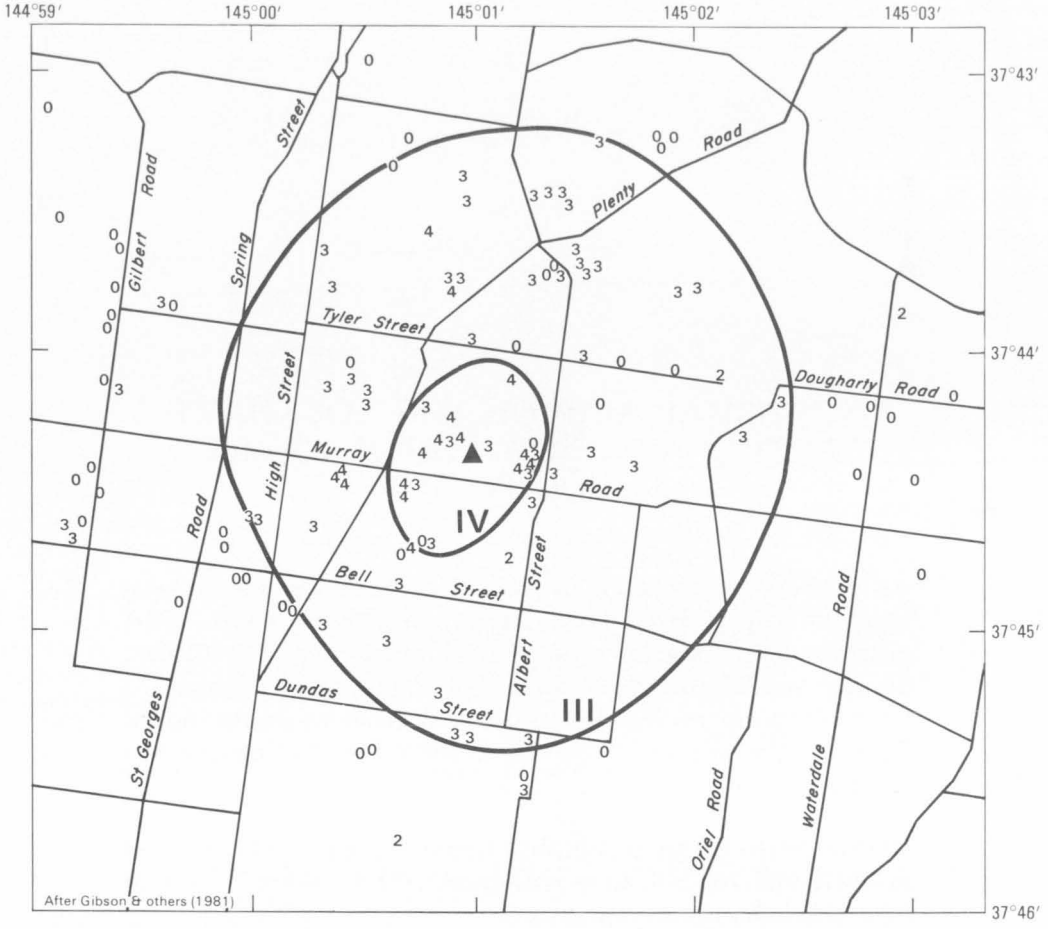
'. . . By good fortune, a new seismograph was being tested at a temporary location just 9 kilometres west of the earthquake, so a good instrumental location was obtained. This was at latitude 37.731°S, longitude 145.033°E [approximately 200 m northeast of the intersection of Tyler St and Albert St], with an uncertainty of about 0.8 kilometres. This was about one kilometre north-east of the [plotted] isoseismal map epicentre, which was just north of Murray Road, between Plenty Road and Albert Street, Preston. The difference is almost certainly due to inadequacy in the lithospheric model at such shallow depths.

'The fact that an event of such small magnitude, about the size of a typical quarry blast, was felt at all indicates a very shallow depth. Intensity-distance-depth relationships derived for large earthquakes and extrapolated down yield depths of between 0.5 and 1.5 kilometres. The instrumental location gives a depth of 0.1 ± 1.2 kilometres.' (Gibson & others, 1981).

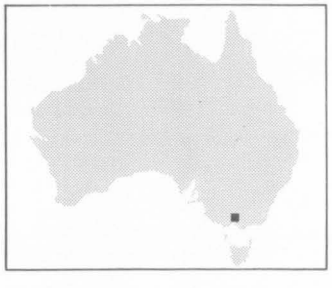
REFERENCE

GIBSON, G., WESSON, V., & CUTHBERTSON, R., 1981—Seismicity of Victoria to 1980. *Journal of the Geological Society of Australia,* 28(3/4), 341-356.

ISOSEISMAL MAP OF THE PRESTON EARTHQUAKE, VICTORIA
9 JULY 1976



0 1 km



DATE : 09 JULY 1976
TIME : 08:27:40 UT
MAGNITUDE : 1.3 ML(PIT)
EPICENTRE : 37.73°S 145.03°E

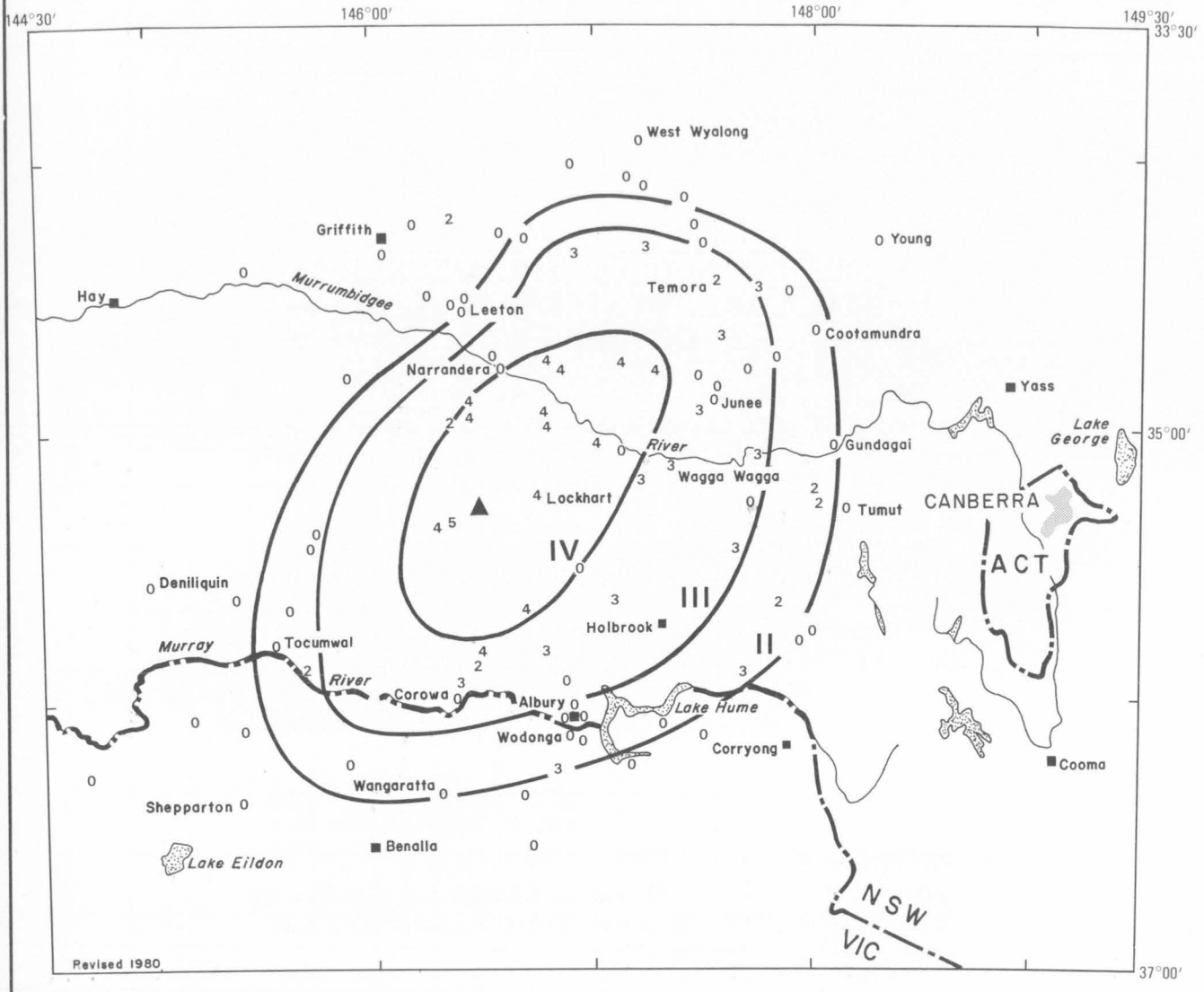
▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

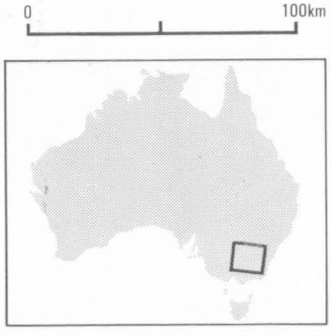
ISOSEISMAL MAP OF THE LOCKHART EARTHQUAKE, NEW SOUTH WALES— 23 AUGUST 1976

An earthquake of magnitude ML 3.8 occurred at 05:15 local time, 24 August 1976, about 20 km west of Lockhart. BMR distributed questionnaires; of the 94 questionnaires returned, 56 were 'not-felt' reports. A total of 38 felt reports were received from places up to 250 km away, near Temora in the north, Tumut in the east, and Wodonga in the south. No damage was reported.

Data collected for an unpublished isoseismal map, and contained in BMR File 76/759, were reassessed, and a revised version of this earlier map is shown here.

ISOSEISMAL MAP OF THE LOCKHART EARTHQUAKE, NEW SOUTH WALES
23 AUGUST 1976





DATE : 23 AUGUST 1976
TIME : 19:14:50.9 UT
MAGNITUDE : 3.8 ML(BMR) 4.2 ML(RIV)
EPICENTRE : 35.30°S 146.47°E
DEPTH : 4km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/155/2

ISOSEISMAL MAP OF THE MECKERING EARTHQUAKE, WESTERN AUSTRALIA—29 OCTOBER 1976

At 06:04 UT (14:04 local time) on 29 October 1976 an earthquake of magnitude ML 4.7 occurred near the township of Meckering, about 120 km east-northeast of Perth.

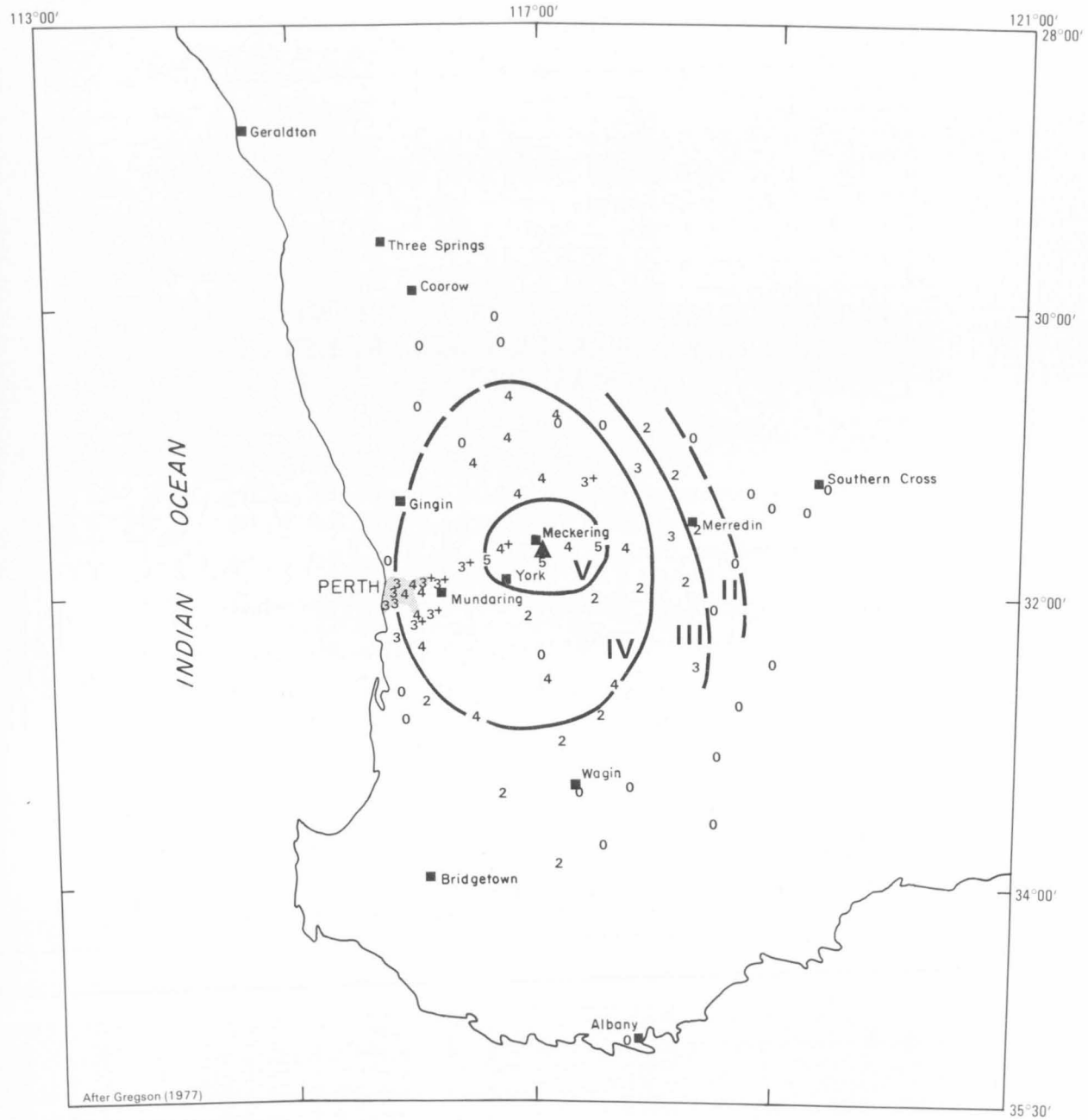
'One hundred and eighty questionnaires were distributed for the Meckering earthquake . . . 75 percent of them were returned.'

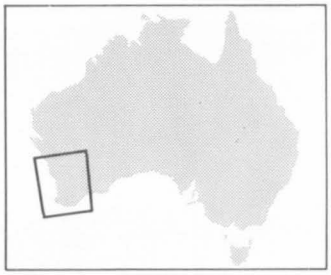
'It is difficult to fit smooth isoseismals but the data indicate that the maximum intensity was upper V at Meckering, the radius of the isoseismal for intensity IV was approximately 120 km, and the earthquake was felt up to 240 km from the epicentre.' (Gregson, 1977).

REFERENCE

GREGSON, P. J., 1977—Mundaring Geophysical Observatory Annual Report, 1976. *Bureau of Mineral Resources, Australia, Record* 1977/7 (unpublished).

ISOSEISMAL MAP OF A MECKERING EARTHQUAKE, WESTERN AUSTRALIA
29 OCTOBER 1976





DATE : 29 OCTOBER 1976
TIME : 06:04:48.2 UT
MAGNITUDE : 4.7 ML (MUN)
EPICENTRE : 31.64°S 117.00°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/WA/15

ISOSEISMAL MAP OF THE ALBANY EARTHQUAKE, WESTERN AUSTRALIA—15 MAY 1977

At 19:16 UT on 15 May 1977 (03:16 local time on 16 May 1977) an earthquake of magnitude ML 4.5 occurred on the extreme southern coastline of Western Australia, close to the township of Albany.

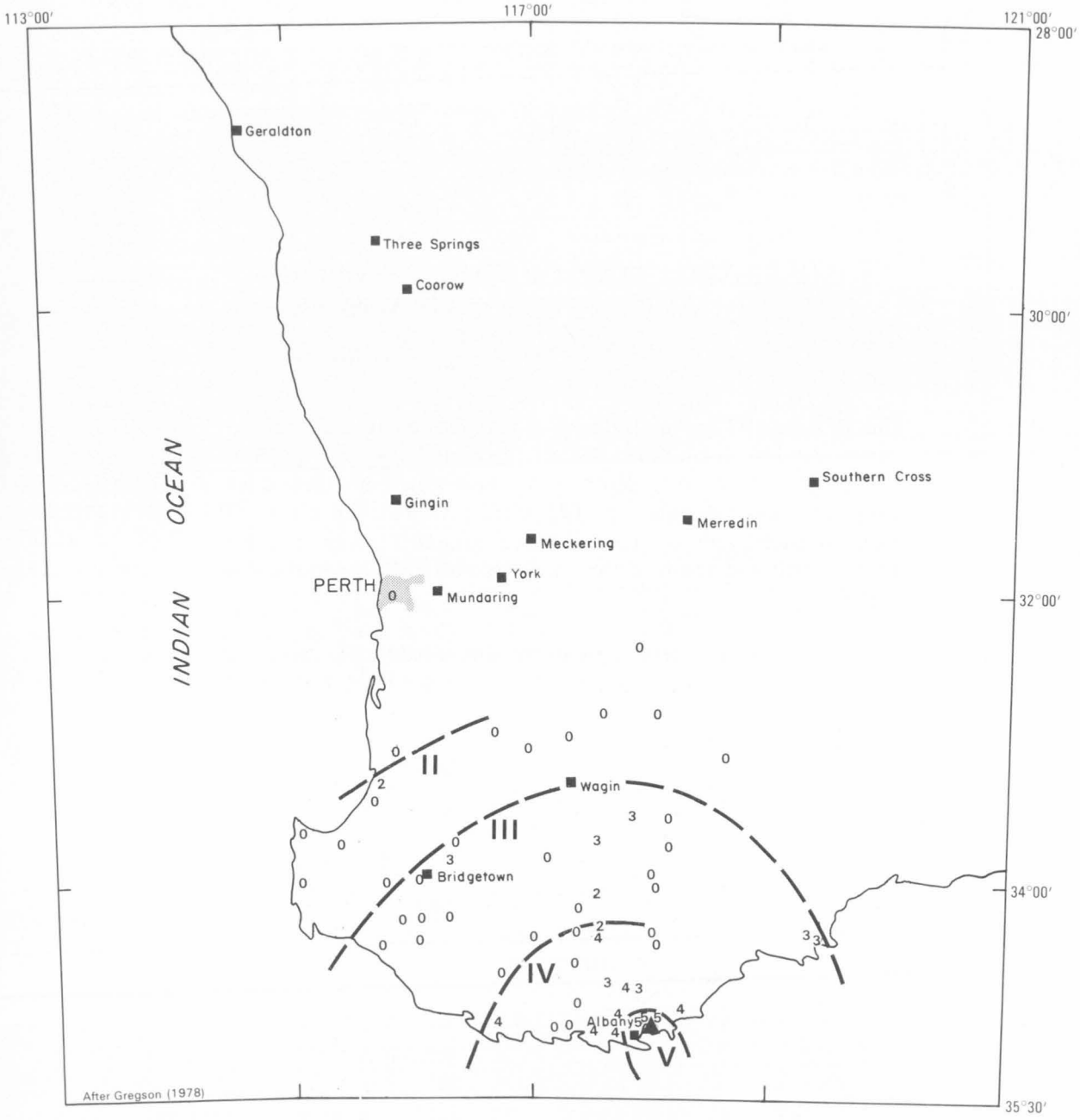
'About two hundred questionnaires were distributed, of which about 75 percent were returned.'

'The maximum intensity was MM V at Albany, the radius of the isoseismal for intensity IV was 85 km, and the earthquake was felt up to 300 km from the epicentre.' (Gregson, 1978).

REFERENCE

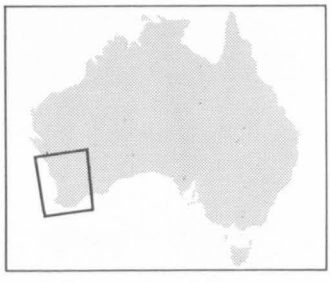
GREGSON, P. J., 1978—Mundaring Geophysical Observatory Annual Report, 1977. *Bureau of Mineral Resources, Australia, Record* 1978/73 (unpublished).

ISOSEISMAL MAP OF THE ALBANY EARTHQUAKE, WESTERN AUSTRALIA
15 MAY 1977



DATE : 15 MAY 1977
TIME : 19:16:07.6 UT
MAGNITUDE : 4.5 ML (MUN), 3.9 MB (GS)
EPICENTRE : 35.00°S 117.95°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/150/1

ISOSEISMAL MAP OF THE BOWNING EARTHQUAKE, NEW SOUTH WALES— 30 JUNE 1977

On 30 June 1977 an earthquake of magnitude ML 4.5 occurred about 20 km north-northwest of Yass and 14 km north of Bowning in NSW at a depth of 12 km. Three hundred questionnaires were distributed: 143 were returned, of which 69 were 'not-felt' reports. The felt area extended about 150 km to the north and south of the epicentre and 100 km to the east and west.

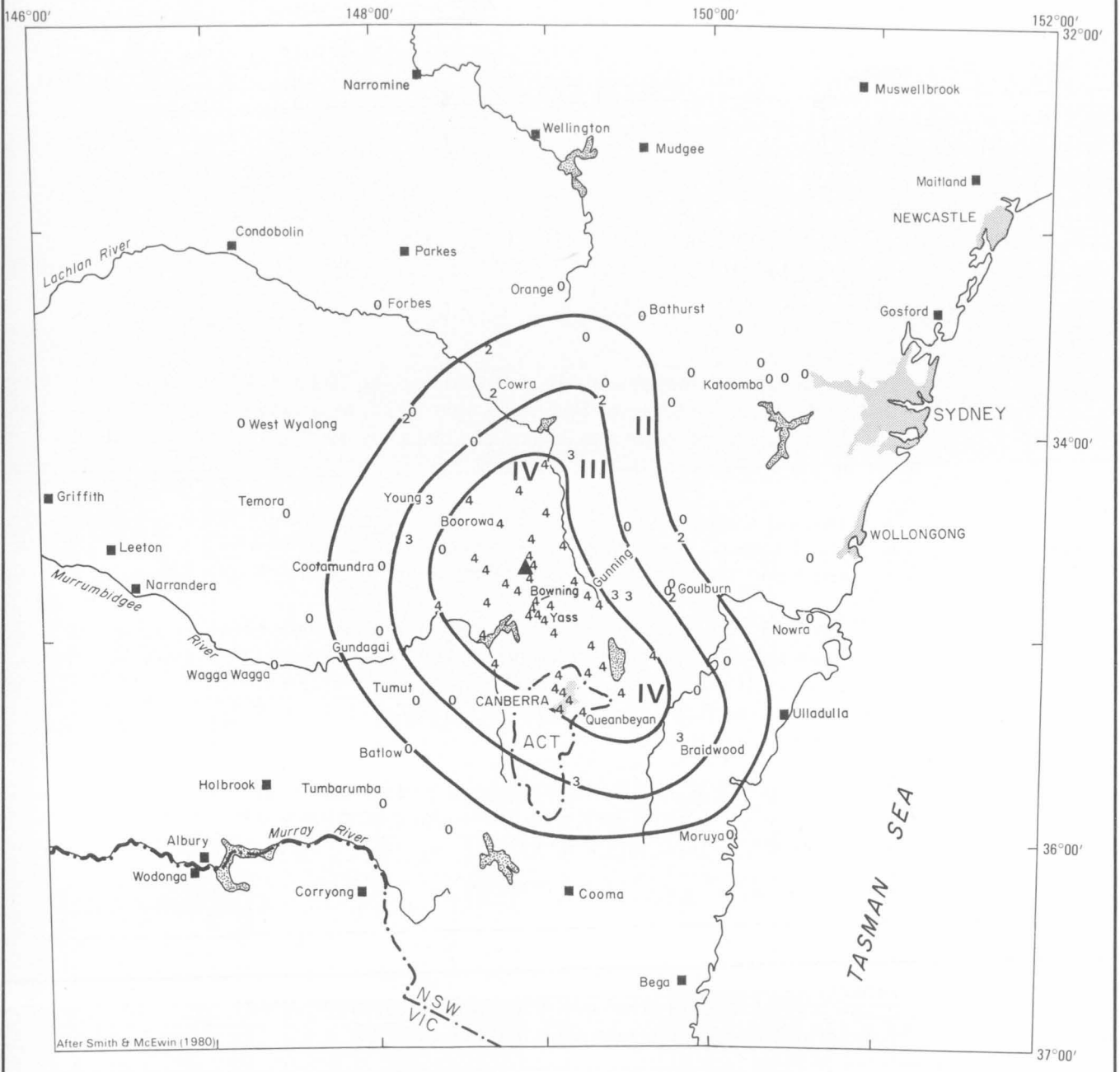
No major damage was caused by this earthquake which is regarded as a foreshock to a larger earthquake on 4 July 1977.

The earthquake triggered the accelerograph at Oolong, 10 km east of Bowning, where a maximum acceleration of 0.21 $m.s^{-2}$ was recorded (Smith & McEwin, 1980).

REFERENCE

SMITH, R. S., & MCEWIN, A. J., 1980—Earthquake accelerograms and attenuation of seismic waves at Oolong, NSW. *BMR Journal of Australian Geology & Geophysics*, 5, 63-67.

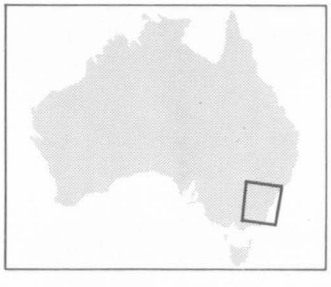
ISOSEISMAL MAP OF THE BOWNING EARTHQUAKE, NEW SOUTH WALES
30 JUNE 1977



0 150km

DATE : 30 JUNE 1977
TIME : 12:48:22.3 UT
MAGNITUDE : 4.5 ML (CAN)
EPICENTRE : 34.67°S 148.87°E
DEPTH : 12km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/155/3

ISOSEISMAL MAP OF THE BOWNING EARTHQUAKE, NEW SOUTH WALES— 4 JULY 1977

An earthquake of magnitude ML 5.0 occurred at 20:05 UT on 4 July 1977 (06:05 local time on 5 July 1977) at a depth of 13 km (the hypocentre was essentially the same as that of the 30 June 1977 earthquake).

A maximum intensity of MM V caused minor damage locally. Reports of cracked masonry, plaster, and concrete fixtures were received from Yass, Bowning, and surrounding farms.

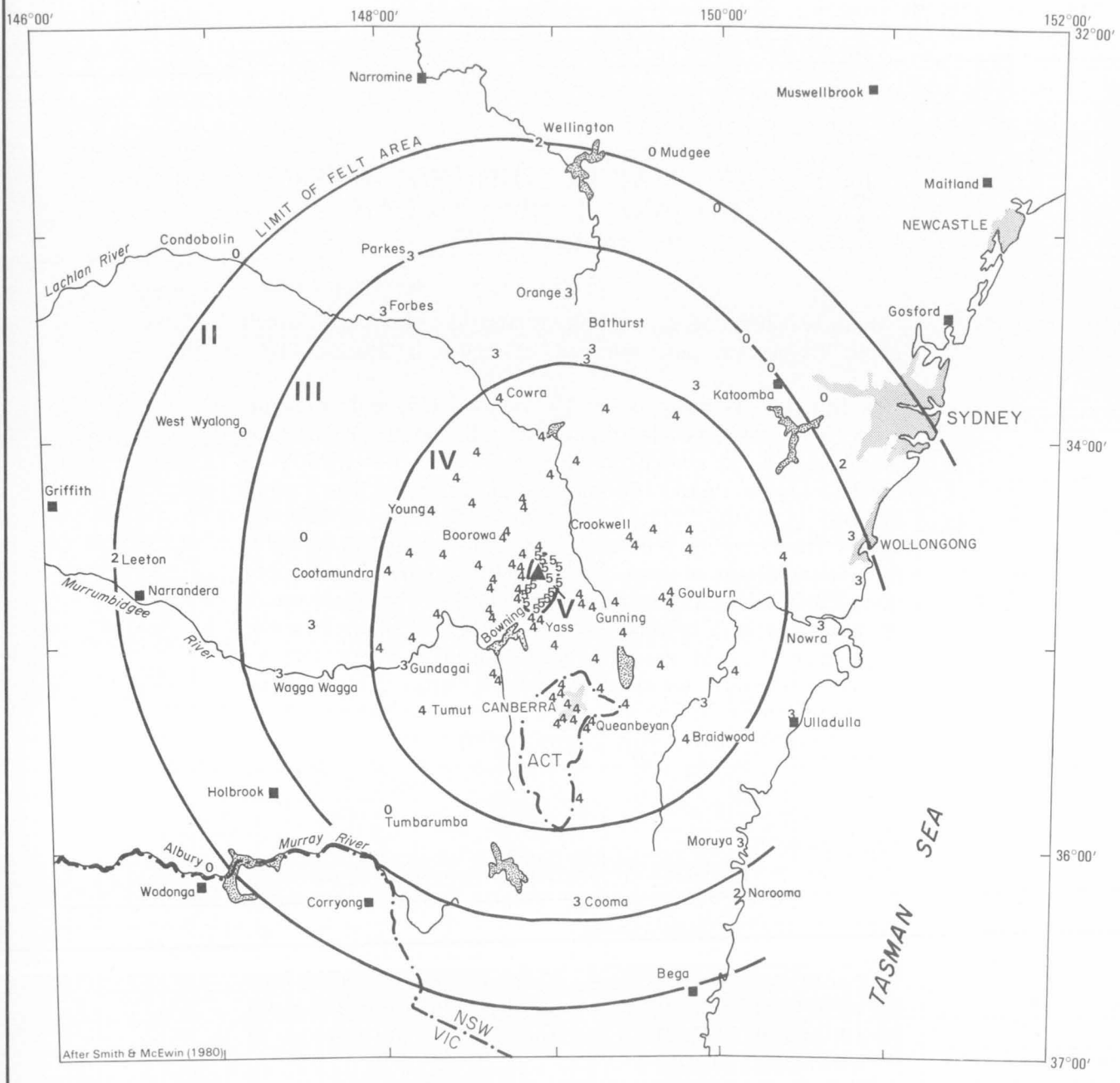
One hundred and fourteen felt-reports were returned, and 16 interviews were carried out in the epicentral area to determine the boundary at zone V. The earthquake was felt over a 220 km radius, as far as Wellington to the north, Leeton to the west, and Narooma in the south.

The earthquake triggered the accelerograph at Oolong, 10 km east of Bowning, where a maximum acceleration of 0.95 $m.s^{-2}$ was recorded (Smith & McEwin, 1980).

REFERENCE

SMITH, R. S., & MCEWIN, A. J., 1980—Earthquake accelerograms and attenuation of seismic waves at Oolong, NSW. *BMR Journal of Australian Geology & Geophysics*, 5, 63-67.

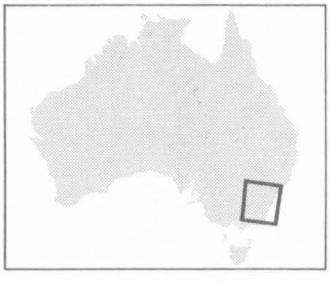
ISOSEISMAL MAP OF THE BOWNING EARTHQUAKE, NEW SOUTH WALES
4 JULY 1977



0 150km

DATE : 4 JULY 1977
TIME : 20:05:20.4 UT
MAGNITUDE : 5.0 ML (CAN), 4.2 MB (GS)
EPICENTRE : 34.65°S 148.89°E
DEPTH : 13km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/N/8

ISOSEISMAL MAP OF THE INDONESIAN EARTHQUAKE, INDIAN OCEAN— 19 AUGUST 1977

'About two hundred questionnaires were distributed, of which about 75 percent were returned.' (Gregson, 1978).

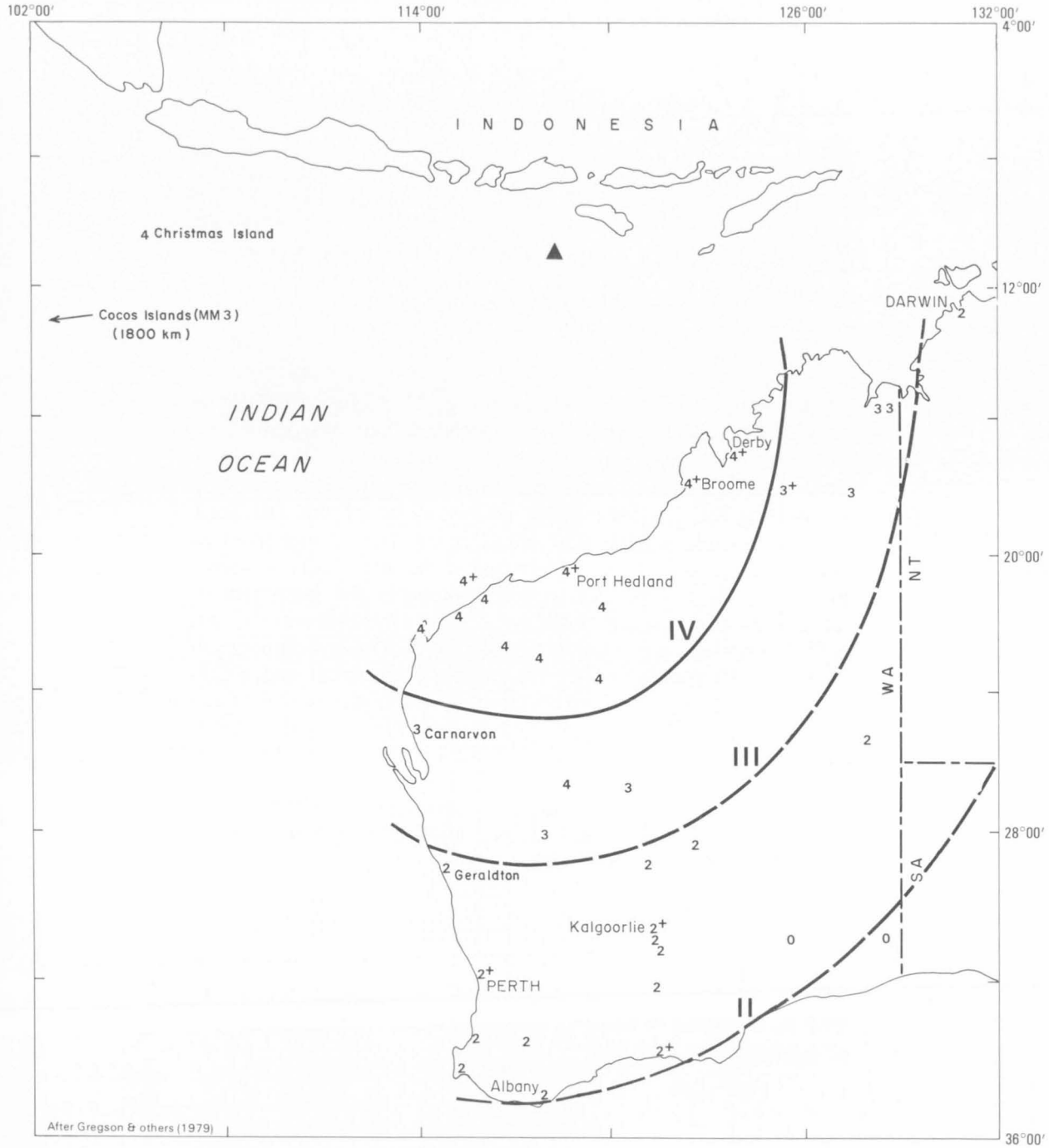
'The Indonesian earthquake of 19 August 1977, with a magnitude (M)8, was felt in Western Australia up to distances of 2600 km. The maximum ground intensity felt was MM V in northwest towns up to 1100 km from the epicentre. The ground intensity in Perth, 2300 km from the epicentre, was MM III or less. Resonance of multi-storey buildings resulted in an eight-fold amplification of peak ground acceleration on the upper floors. Only minor damage occurred in Perth. Seismic sea waves up to six metres in height were reported several hours after the earthquake at towns along the northwest coast. There were no reports of damage associated with these waves. They arrived along the coast near low tide, otherwise there could have been some flooding.' (Gregson & others, 1979).

REFERENCES

GREGSON, P. J., 1978—Mundaring Geophysical Observatory Annual Report, 1977. *Bureau of Mineral Resources, Australia, Record* 1978/73 (unpublished).

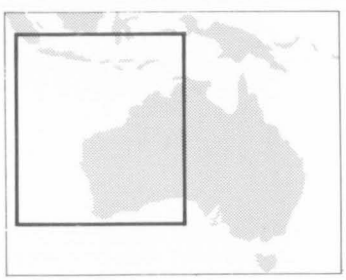
GREGSON, P. J., PAULL, E. P., & GAULL, B. A., 1979—The effects in Western Australia of a major earthquake in Indonesia on 19 August 1977. *BMR Journal of Australian Geology & Geophysics,* 4, 135-140.

ISOSEISMAL MAP OF THE INDONESIAN EARTHQUAKE
19 AUGUST 1977



DATE : 19 AUGUST 1977
TIME : 06:08:51 UT
MAGNITUDE : 7.9 MS (GS), 7.0 MB (GS)
EFICENTRE : 11.16°S 118.41°E
DEPTH : 33km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/OA/1

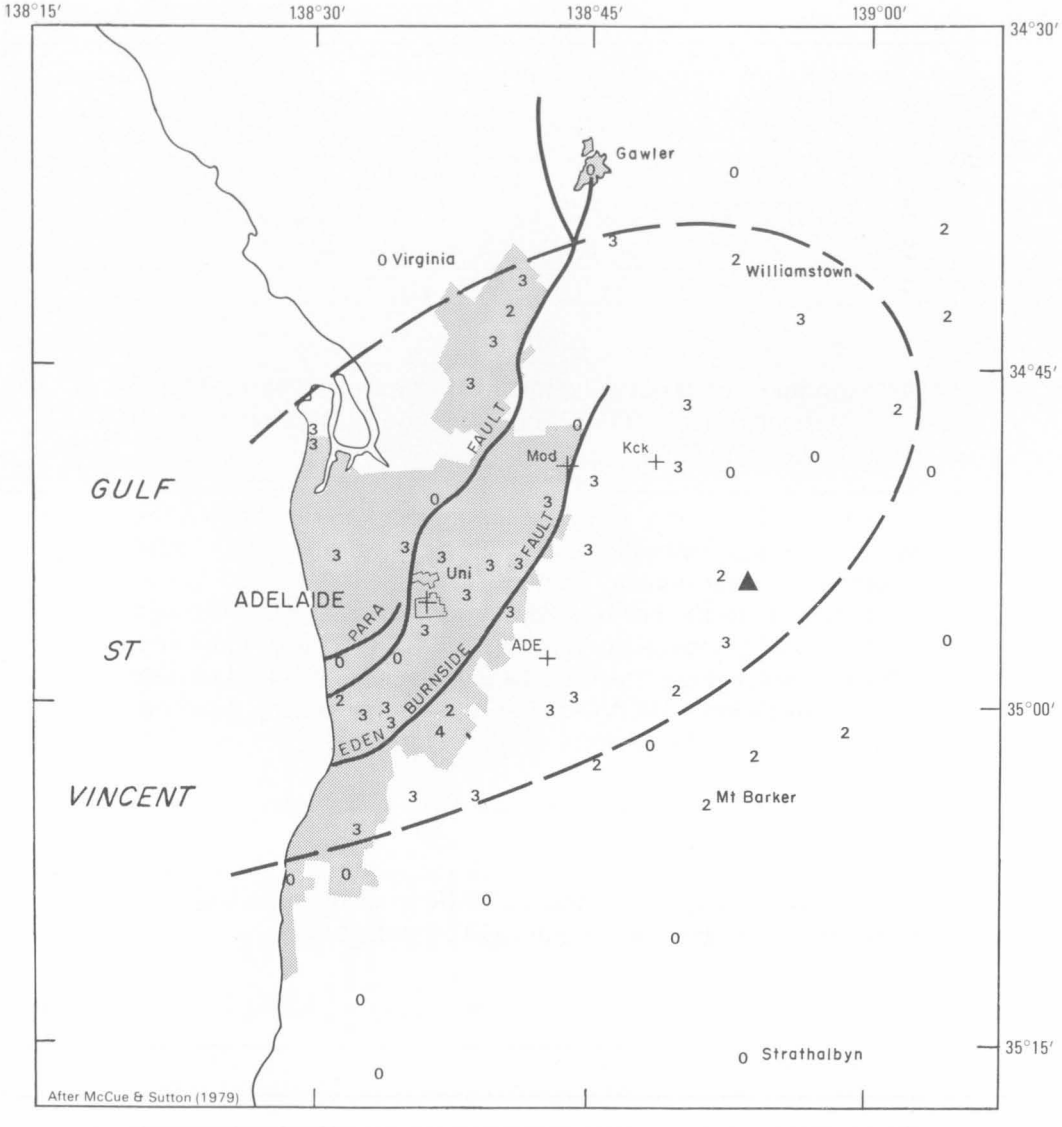
ISOSEISMAL MAP OF THE ADELAIDE EARTHQUAKE, SOUTH AUSTRALIA— 20 AUGUST 1977

'In the early hours of Sunday morning, 21 August 1977 [local time] a distinctive earthquake was either felt or heard throughout the Adelaide Metropolitan area and surrounding towns. Sufficient telephone queries were made to construct the map delineating the felt area. Even in the centre of this felt area, several "not felt" reports were received: this lack of higher intensities, coupled with the fact that none of the three MO2 accelerographs in the region was triggered supports the greater-than-normal focal depth computed as 22 km. The epicentre is not well determined, since the University of Adelaide Seismograph on Mount Bonython (ADE) was the only one south and within 150 km of the epicentre. An epicentre nearer the centre of the MM Intensity III isoseismal, and at the correct focal distance from ADE, would be close to the Modbury accelerograph (Mod) and near the Eden-Burnside fault. However, neither the location nor supplementary information is sufficient to attribute the earthquake to the Eden-Burnside or any other fault unequivocably.' McCue & Sutton (1979).

REFERENCE

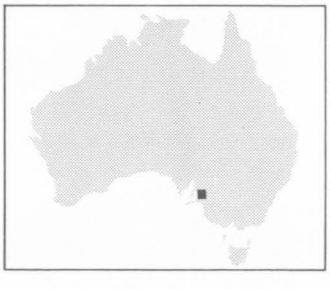
McCue, K. F., & Sutton, D. J., 1979—South Australian earthquakes during 1976 and 1977. *Journal of the Geological Society of Australia,* 26, 231-236.

ISOSEISMAL MAP OF THE ADELAIDE EARTHQUAKE, SOUTH AUSTRALIA
20 AUGUST 1977



DATE : 20 AUGUST 1977
TIME : 21:55:20 UT
MAGNITUDE : 3.4 ML (ADE)
EPICENTRE : 34.91°S 138.89°E
DEPTH : 22km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT
\+ SEISMOGRAPH OR ACCELEROGRAPH



24/154-9/1

ISOSEISMAL MAP OF THE BALLIANG EARTHQUAKE, VICTORIA— 2 DECEMBER 1977

An earthquake of about magnitude ML 5 occurred at 13:32 UT on 2 December 1977 (00:32 local time on 3 December 1977) near Balliang, Victoria.

Two hundred and sixty-three questionnaires were distributed (50 by the Preston Institute of Technology); nearly 70% were returned. The earthquake was felt over a radius of 230 km as far as Kerang to the north, Hamilton to the west, and Warragul to the east. A maximum intensity of MM V was indicated. Although isolated reports of minor damage were received outside the 20 km radius MM V zone (e.g. from Werribee) these are attributed to a higher density of population.

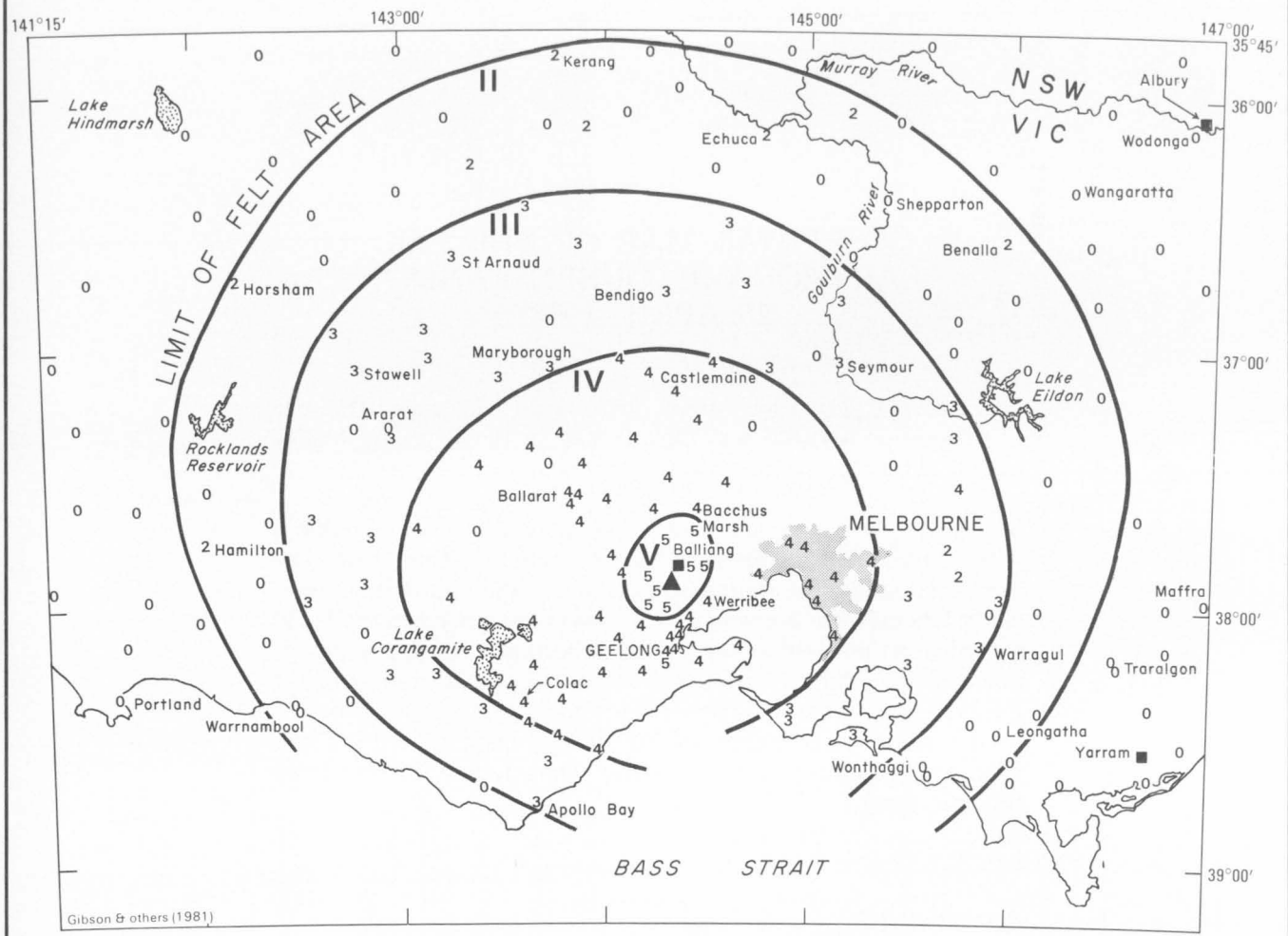
A number of aftershocks were recorded but no damage from these was reported.

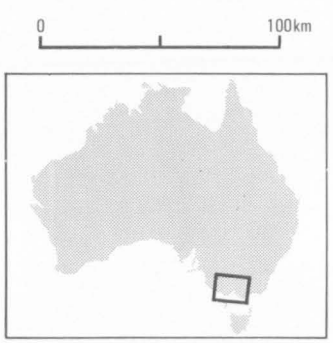
The isoseismal map was drawn by BMR from the data collected by BMR and the Preston Institute of Technology.

REFERENCE

GIBSON, G., WESSON, V., & CUTHBERTSON, R., 1981—Seismicity of Victoria to 1980. *Journal of the Geological Society of Australia,* 28(3/4), 341-356.

ISOSEISMAL MAP OF THE BALLIANG EARTHQUAKE, VICTORIA
2 DECEMBER 1977





DATE : 2 DECEMBER 1977
TIME : 13:32:33.2 UT
MAGNITUDE : 4.5 ML (TOO, CAN) 5.0 ML (PIT)
EPICENTRE : 37.86°S 144.26°E
DEPTH : 15 km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

ISOSEISMAL MAP OF THE ESK EARTHQUAKE, QUEENSLAND— 26 APRIL 1978

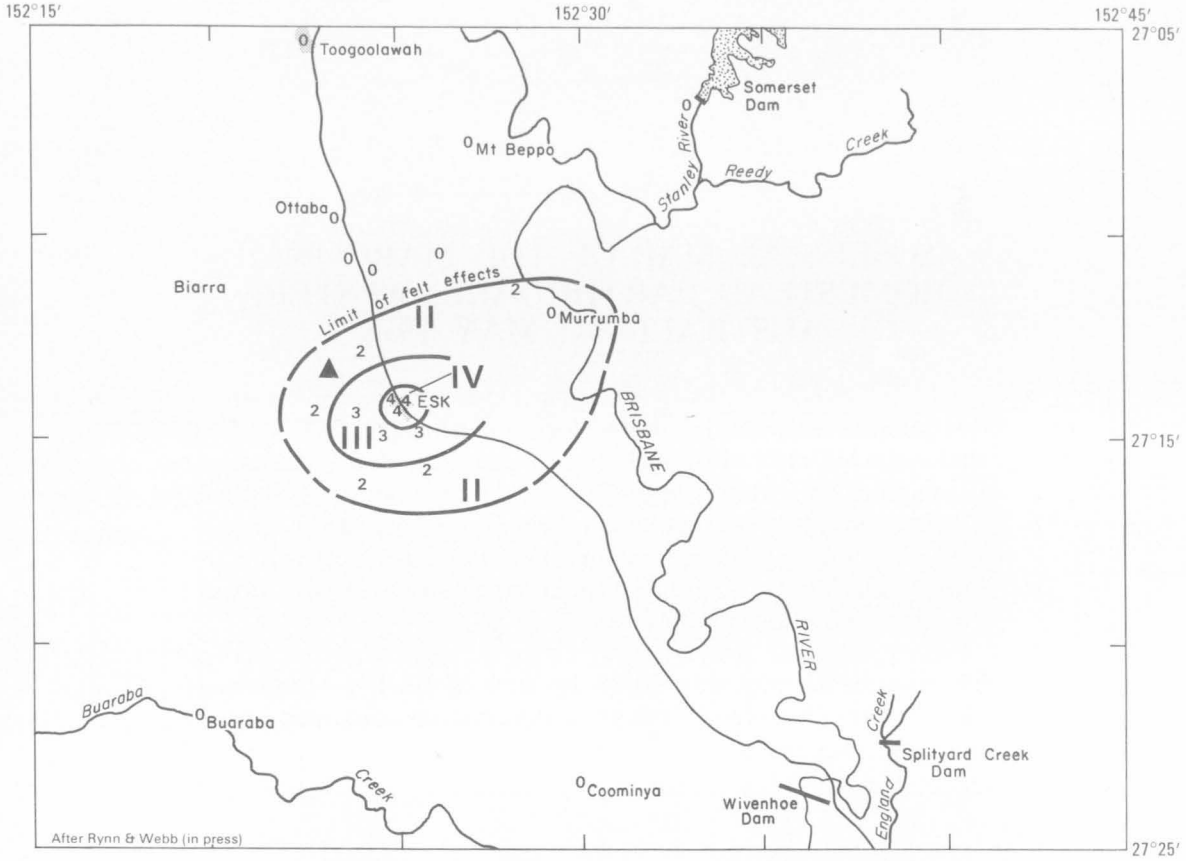
At 11:35 UT (21:53 local time) on 26 April 1981 an earthquake of magnitude ML 3.5 was experienced in the Brisbane Valley region about 65 km northwest of Brisbane.

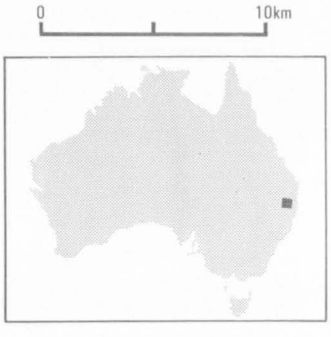
The earthquake was felt over an area of less than 200 km^2; with a maximum intensity of MM IV reported from Esk. The isoseismal study was initiated immediately the approximate epicentral zone was known. Of 50 questionnaires returned, 24 recorded a 'not-felt' report. The importance of this event is noted as it occurred within the seismic surveillance region for the Wivenhoe Dam. It is noted that the earthquake was not felt in the vicinities of either the Wivenhoe Dam (about 35 km from the epicentre) or the Somerset Dam (about 30 km from the epicentre).

REFERENCE

RYNN, J. M. W., & WEBB, J. P., in press—The Esk, southeast Queensland earthquake of 26 April, 1978. *Papers of the Department of Geology, University of Queensland.*

ISOSEISMAL MAP OF THE ESK EARTHQUAKE, QUEENSLAND
26 APRIL 1978





DATE : 26 APRIL 1978
TIME : 11:53:13.6 UT
MAGNITUDE : 3.5 ML (BRS)
EPICENTRE : 27.23°S 152.31°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

ISOSEISMAL MAP OF THE MAROONAH HOMESTEAD EARTHQUAKE, WESTERN AUSTRALIA—1 MAY 1978

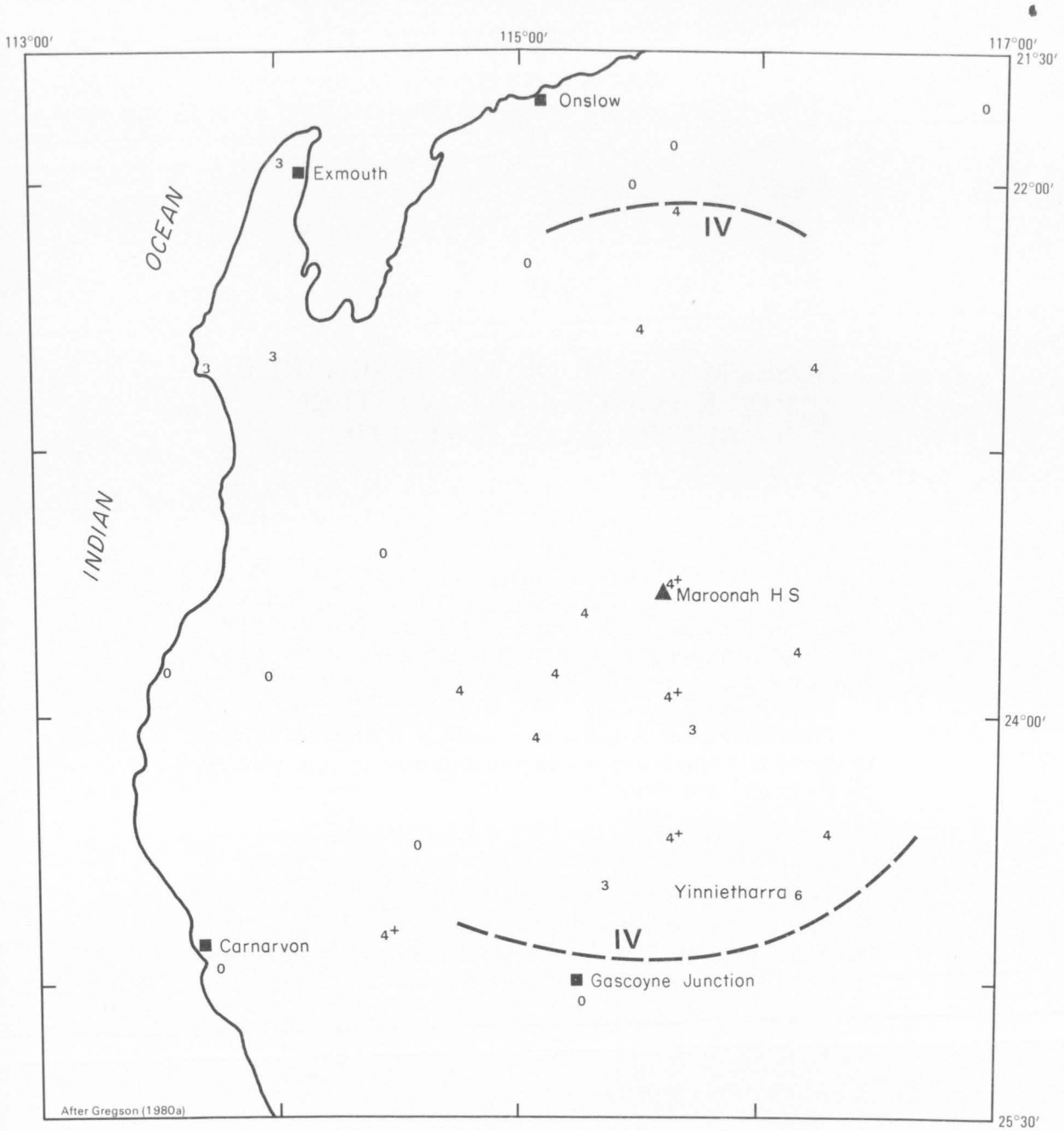
'Questionnaires were distributed for an earthquake (ML = 5.7) that occurred near Maroonah Homestead (250 km northeast of Carnarvon) on 1 May. About 40 questionnaires were distributed, of which about 75 percent were returned. Because of the sparseness of population, a maximum intensity could not be determined. The radius of the isoseismal for intensity IV was about 160 km.' (Gregson, 1980a).

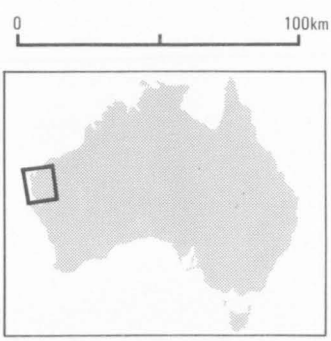
The isoseismal map was drawn by staff of BMR's Mundaring Geophysical Observatory based on information contained in the returned questionnaires.

REFERENCE

GREGSON, P. J., 1980a—Mundaring Geophysical Observatory Annual Report, 1978. *Bureau of Mineral Resources, Australia, Record* 1980/40 (unpublished).

ISOSEISMAL MAP OF THE MAROONAH HOMESTEAD EARTHQUAKE, WESTERN AUSTRALIA 1 MAY 1978





DATE : 1 MAY 1978
TIME : 03:42:52.5 UT
MAGNITUDE : 5.7 ML (MUN)
EPICENTRE : 23.64°S 115.59°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/WA/16

ISOSEISMAL MAP OF THE MARGARET RIVER EARTHQUAKE, WESTERN AUSTRALIA—9 JUNE 1978

The earthquake took place about 14 km east of Margaret River.

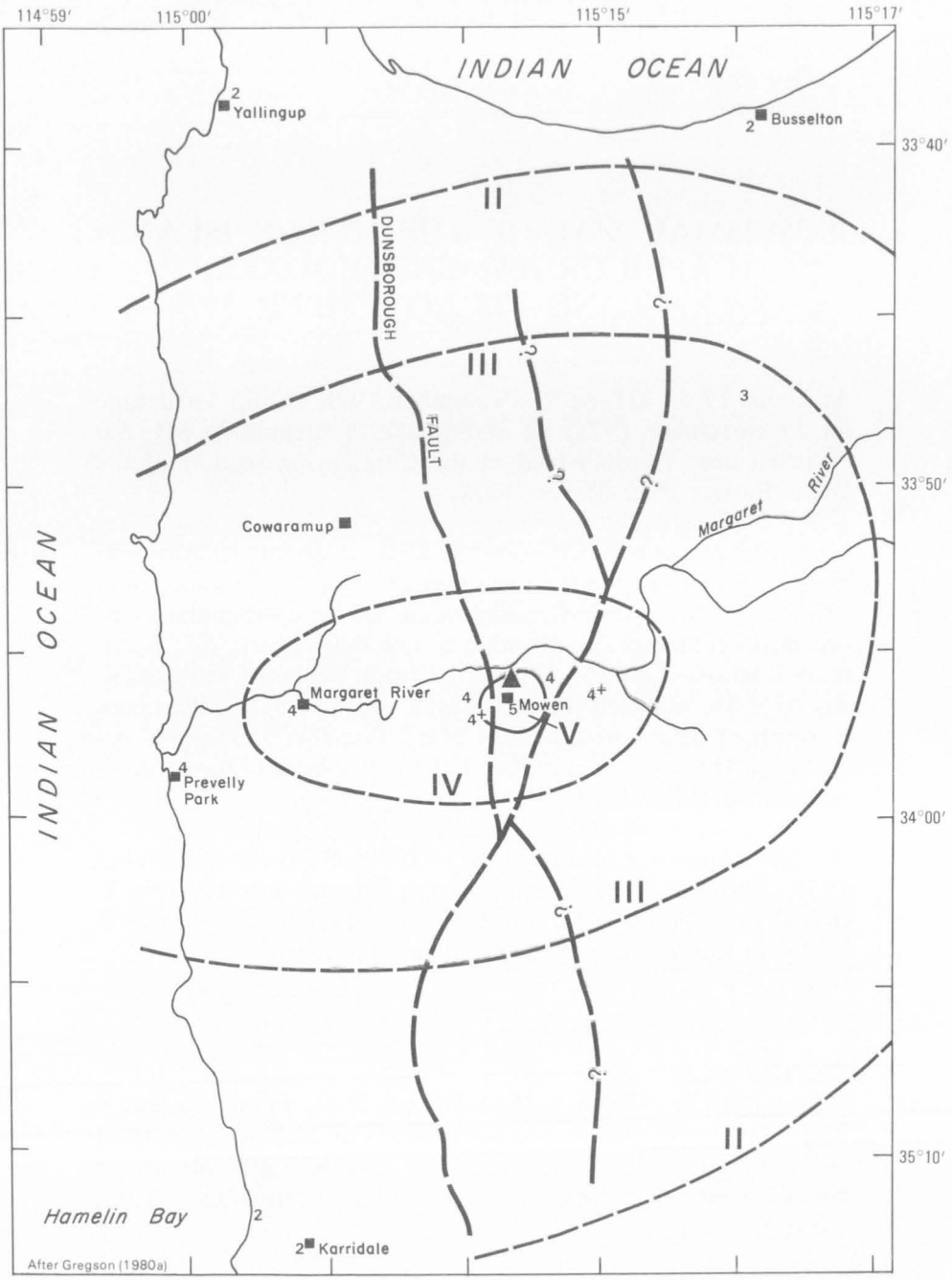
'Information was obtained from reports from residents in the area. The earthquake was felt up to distances of 30 km, with a maximum intensity of V near the epicentre. The earthquake is of particular interest because it is located near the Dunsborough Fault.' (Gregson, 1980a).

The isoseismal map was drawn by staff of BMR's Mundaring Geophysical Observatory based on information contained in the returned questionnaires.

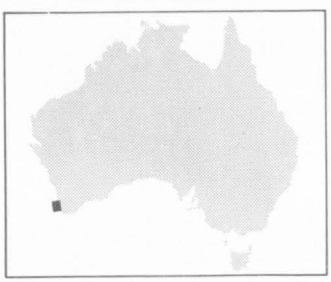
REFERENCE

GREGSON, P. J., 1980a—Mundaring Geophysical Observatory Annual Report, 1978. *Bureau of Mineral Resources, Australia, Record* 1980/40 (unpublished).

ISOSEISMAL MAP OF THE MARGARET RIVER EARTHQUAKE, WESTERN AUSTRALIA 9 JUNE 1978



DATE : 9 JUNE 1978
TIME : 12:31:17.8 UT
MAGNITUDE : 3.0 ML(MUN)
EPICENTRE : 33.93°S 115.20°E



▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT
—— FAULT, ? BURIED FAULT

ISOSEISMAL MAP OF THE HERON ISLAND (CAPRICORNIA) EARTHQUAKE, QUEENSLAND—28 NOVEMBER 1978

At about 17:33 UT on 28 November 1978 (03:33 local time on 29 November 1978) an earthquake of magnitude ML 5.0 occurred near Heron Island in the Capricornia section of the Great Barrier Reef Marine Park.

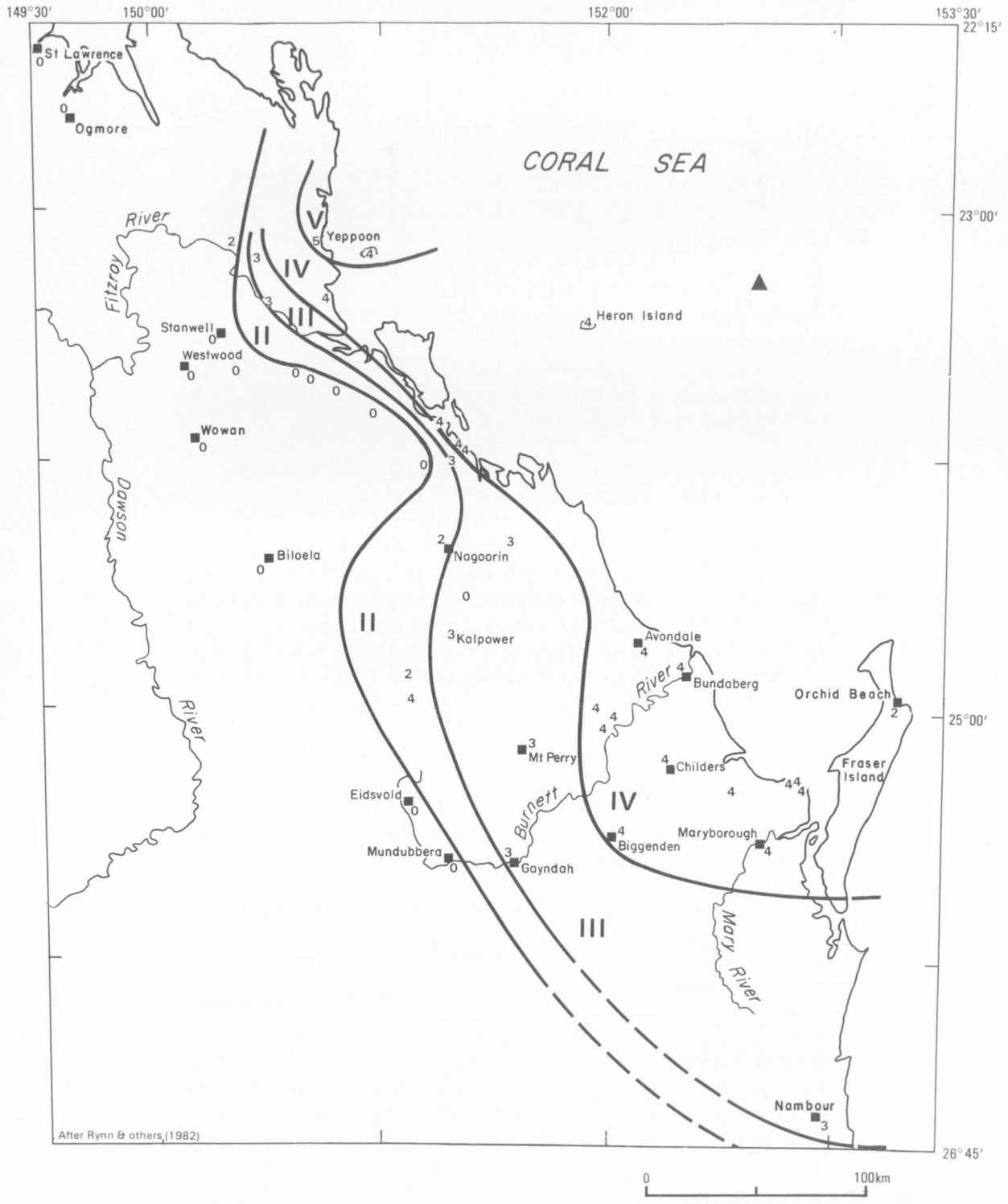
The earthquake was felt over an area of about 40 000 km^2 extending from Yeppoon in the north to Nambour in the south and west to the Monto-Gayndah area. Of 85 earthquake questionnaires returned, 36 recorded a 'not felt' report. The maximum intensity was MM V reported from Yeppoon, with intensity MM IV reported for the coastal strip from Rockhampton to south of Maryborough. It is noted that this earthquake occurred in the same area as the 1918 Bundaberg ('Queensland') earthquake (ML about 6.0).

One aftershock was also recorded at 18:44 UT on 28 November 1978. This was located about 20 km west of the main shock. It had a magnitude ML 4.5 and was reported felt with MM III-IV in the Yeppoon and Rockhampton areas.

REFERENCE

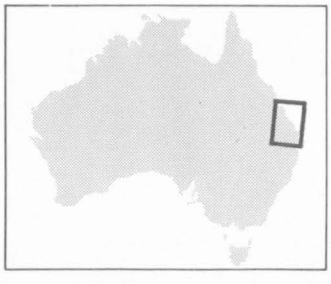
RYNN, J. M. W., WEBB, J. P., & FLOOD, P. G., in preparation—The Capricornia (Heron Is.) earthquakes of 28 November 1978—An initial study of the seismicity and tectonics along the passive continental margin of Central Eastern Queensland, Australia.

ISOSEISMAL MAP OF THE HERON ISLAND EARTHQUAKE, QUEENSLAND
28 NOVEMBER 1978



DATE : 28 NOVEMBER 1978
TIME : 17:33:36 UT
MAGNITUDE : 5.0 ML (UNQ), 4.8 MB (UNQ)
EPICENTRE : 23.36°S 152.43°E
DEPTH : 12km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/F56/1

ISOSEISMAL MAP OF THE SCORESBY EARTHQUAKE, VICTORIA—16 APRIL 1979

'In 1979 April 16 at 2324 UT (1979 April 17, 0924 am EST), a small earthquake of magnitude ML 2.6 was felt over the south-eastern suburbs of Melbourne. Although a considerable number of damage reports were received, it is unlikely that any structural damage could be directly attributed to vibratory motion from the earthquake.'

'The isoseismal map shows obvious elongation in the east-west direction, with few felt reports south of the epicentre, and very few to the north.

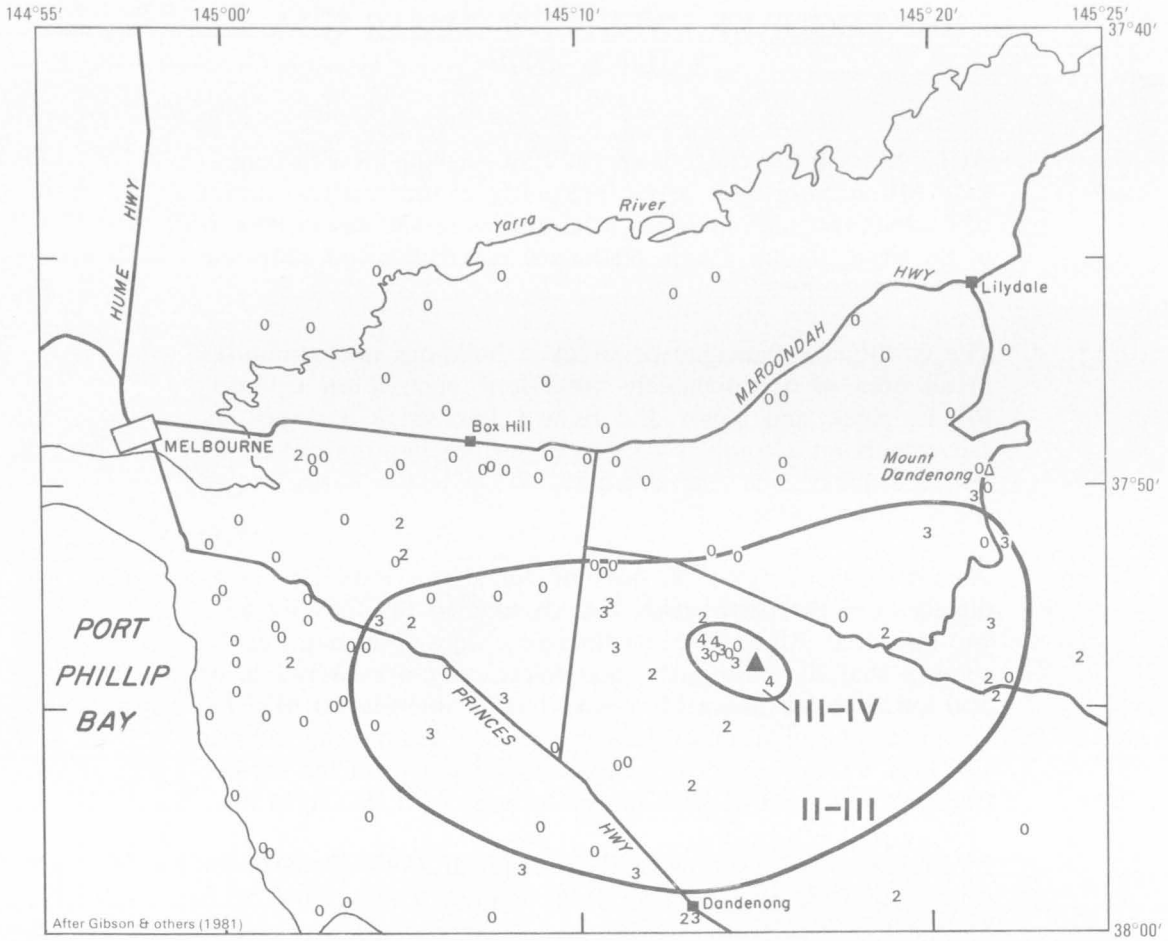
'The map was derived from 134 replies to a standard questionnaire circulated to local postmasters, a number of telephone interviews, and a detailed survey in the epicentral area. The usual scatter due to variations in local conditions was observed. Isolated intensities of 4 on the Modified Mercalli intensity scale were noted in the Scoresby area, with all of the people within a home feeling the event, and some claiming to have been frightened by it. Hanging pictures rattled but did not shift in position, and no confirmed cases of overturned objects were reported. The intensities were much lower than those required to cause damage in even poorly built structures.' (Gibson & Wesson, personal communication, 1980).

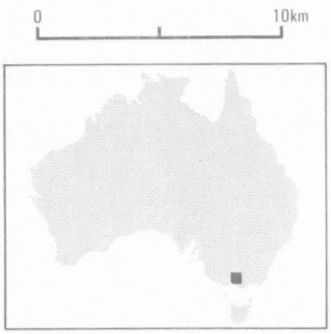
Gibson & others (1981) show the epicentre to be 37.919°S, 145.271°E but we believe the plotted epicentre is a better estimate because of the control provided by the felt reports.

REFERENCE

GIBSON, G., WESSON, V., & CUTHBERTSON, R., 1981—Seismicity of Victoria to 1980. *Journal of the Geological Society of Australia*, 28(3/4), 341-356.

ISOSEISMAL MAP OF THE SCORESBY EARTHQUAKE, VICTORIA
16 APRIL 1979





DATE : 16 APRIL 1979
TIME : 23:24:47 UT
MAGNITUDE : 2.6 ML (PIT)
EPICENTRE : 37.89°S 145.25°E
DEPTH : 2km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/J55/5

ISOSEISMAL MAP OF THE CADOUX EARTHQUAKE, WESTERN AUSTRALIA—2 JUNE 1979

At 17:48 local time on 2 June 1979 an earthquake with magnitude ML 6.2 occurred in the proximity of the small township of Cadoux (population 36) in a farming area 180 km northwest of the State capital, Perth. Cadoux was wrecked but only one person was injured.

The earthquake damaged or wrecked buildings and structures in an area of approximately 4000 km^2 centred on Cadoux. Roads, pipes, and power and railway lines were damaged by movements on a complex pattern of surface faulting caused by the earthquake in a zone extending 7 km to the north and to the south of Cadoux.

An isoseismal survey (700 questionnaires) was initiated immediately after the earthquake, and damage in the Cadoux area was inspected. About 500 questionnaires were answered. Results showed that the earthquake was felt clearly over a radius of 500 km. The maximum Modified Mercalli intensity of MM IX was observed adjacent to the earthquake fracture, and intensities MM VII or greater occurred up to 5 km from the surface fracture. Intensities in Perth ranged between MM IV and MM V.

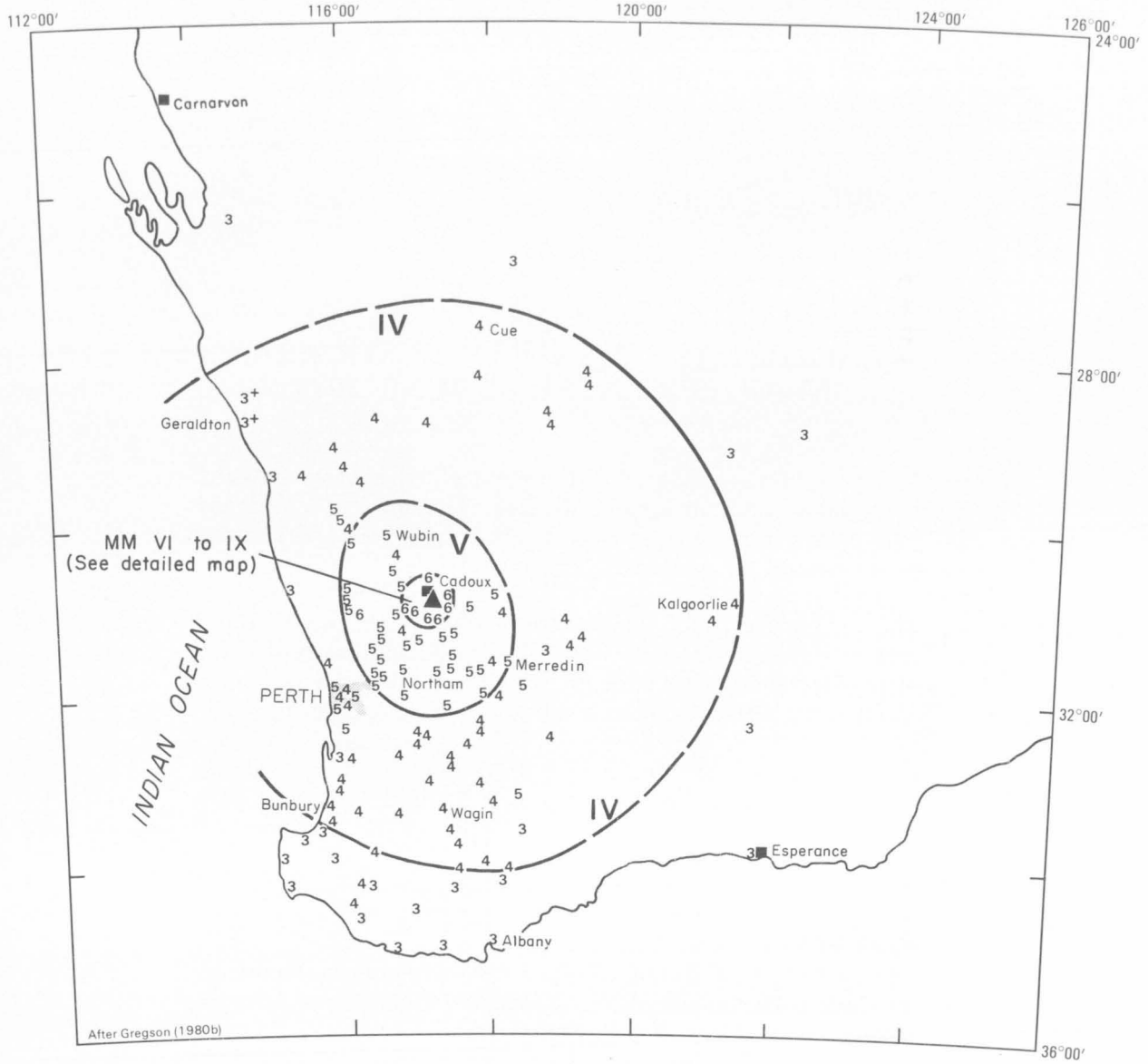
Information from insurance and Government Works Department sources indicate that damage costs amounted to around $3.8 million (1979 prices).

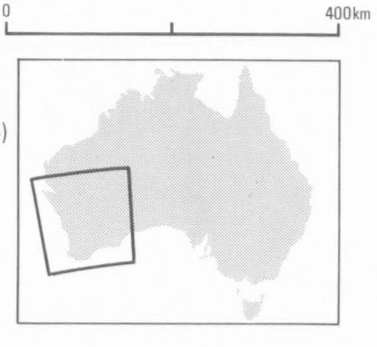
Four accelerographs in the Meckering area, 90 km from Cadoux, recorded maximum accelerations of approximately 0.1 $m.s^{-2}$. At Mundaring Weir, 120 km from Cadoux, the accelerograph recorded maximum east, vertical, and north component accelerations of 0.4, 0.2, and 0.1 $m.s^{-2}$ respectively (Gregson, 1980b).

REFERENCE

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

ISOSEISMAL MAP OF THE CADOUX EARTHQUAKE, WESTERN AUSTRALIA
2 JUNE 1979





DATE : 2 JUNE 1979
TIME : 09:48:01.1 UT
MAGNITUDE : 6.2 ML (MUN), 6.2 MS (BMR), 6.0 MB (GS)
EPICENTRE : 30.79°S 117.16°E
DEPTH : 15km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

ISOSEISMAL MAP OF THE CADOUX EARTHQUAKE, WESTERN AUSTRALIA, NEAR EPICENTRE—2 JUNE 1979

Members of the Mundaring Geophysical Observatory visited the Cadoux area to inspect damage. The area of damaging intensities of MM VII or more is about 300 km^2 and centred to the west of the earthquake's fault trace.

The earthquake's fault plane determination indicates that the area of maximum intensity is possible on the surface projection of an east-dipping fault at depth, which contains the hypocentre, and that the surface faulting is subsidiary to this deeper faulting.

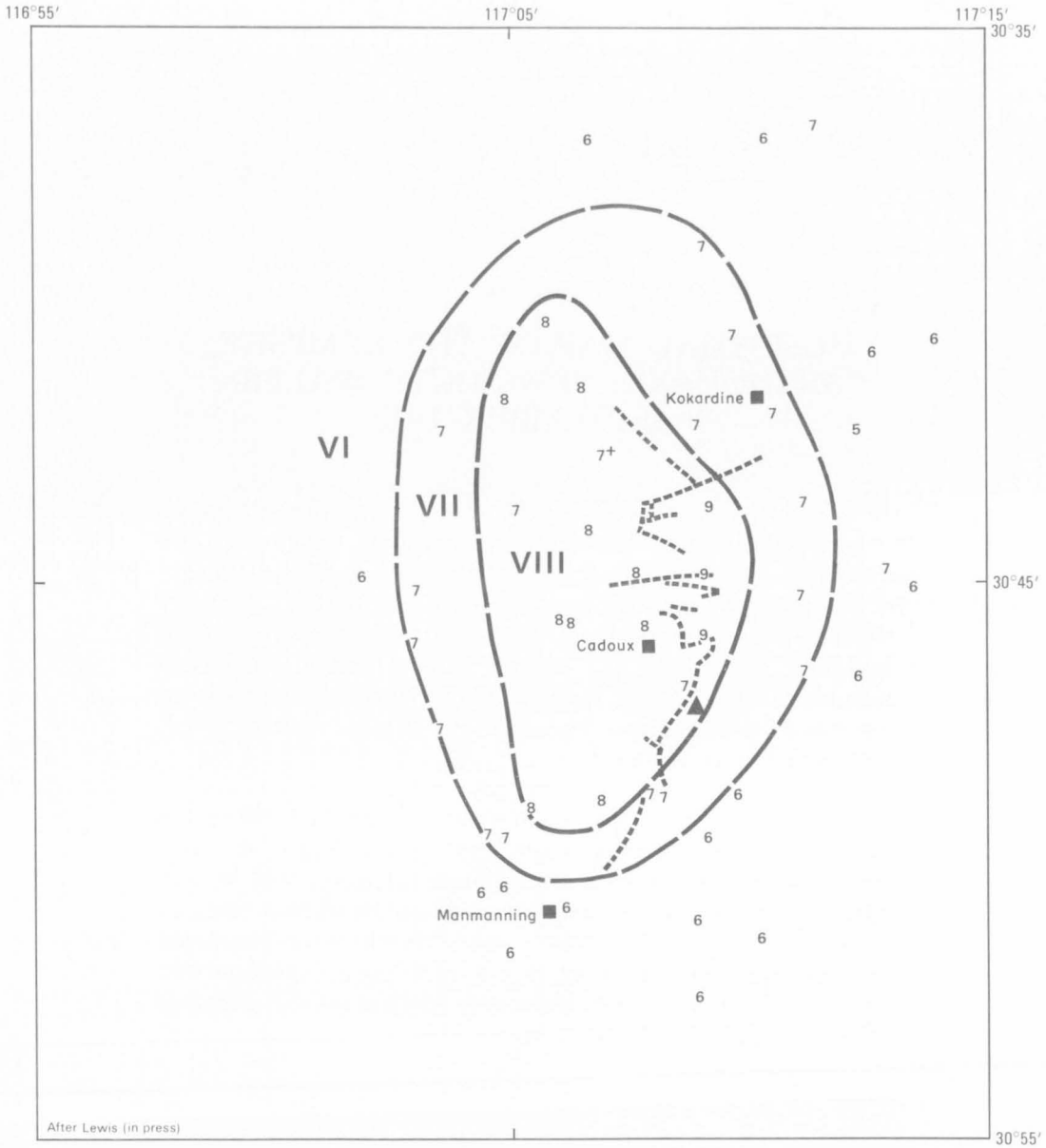
Features of the earthquake and its foreshock and aftershock sequences are described by Gregson & Paull (1979) and Lewis (in press).

REFERENCES

GREGSON, P. J., & PAULL, E. P., 1979—Preliminary report on the Cadoux earthquake W.A., 2 June 1979. *Bureau of Mineral Resources, Australia, Report* 215.

LEWIS, J. D., in press—The Cadoux earthquake, June 1979. *Western Australia Geological Survey Report*, 11.

ISOSEISMAL MAP OF THE CADOUX EARTHQUAKE, WESTERN AUSTRALIA
NEAR EPICENTRE 2 JUNE 1979



0 10km

DATE : 2 JUNE 1979
TIME : 09:48:01.1 UT
MAGNITUDE : 6.2 ML(MUN), 6.2 MS(BMR), 6.0 MB (GS)
EPICENTRE : 30.79°S 117.16°E
DEPTH : 15 km

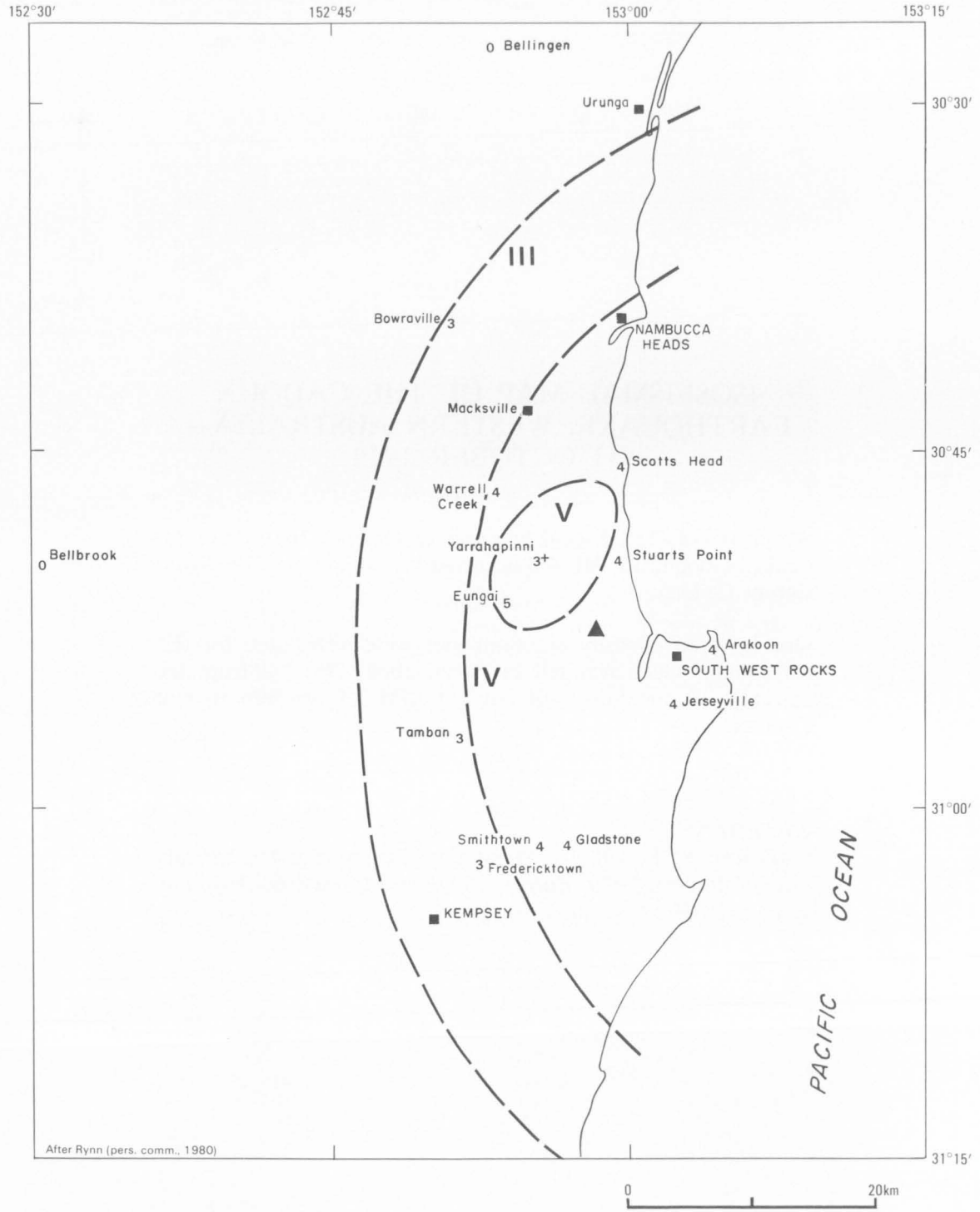
▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
o EARTHQUAKE NOT FELT
---- EARTHQUAKE FAULTING

ISOSEISMAL MAP OF THE KEMPSEY EARTHQUAKE, NEW SOUTH WALES— 6 SEPTEMBER 1979

'The University of Queensland seismology group initiated an isoseismal study immediately the approximate location of the earthquake was determined. With the assistance of local media in Kempsey viz Kempsey ABC radio and the Kempsey "Macleay-Argus" newspaper, earthquake questionnaires were distributed throughout the central coastal region and New England tableland from Taree to Coffs Harbour and west to Glen Innes, Armidale and Tamworth. 90 reports were received, 25 of which were negative.'

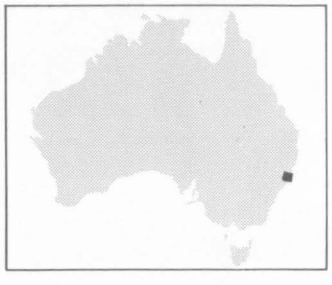
'The region of felt reports covered an area of about 1000 sq km extending 30 km to the north and south and 20 km to the west of the epicentre. The region of maximum intensity, MM V, was centred on the region of Eungai and Scotts Head. No cases of damage were reported. In many cases people were awakened and were frightened thinking that a very large explosion had occurred.' (J. M. W. Rynn, University of Queensland, personal communication, 1980).

ISOSEISMAL MAP OF THE KEMPSEY EARTHQUAKE, NEW SOUTH WALES
6 SEPTEMBER 1979



DATE : 6 SEPTEMBER 1979
TIME : 13:07:59 UT
MAGNITUDE : 3.1 ML (BMR)
EPICENTRE : 30.87°S 152.98°E

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/H56-10/1

ISOSEISMAL MAP OF THE CADOUX EARTHQUAKE, WESTERN AUSTRALIA— 11 OCTOBER 1979

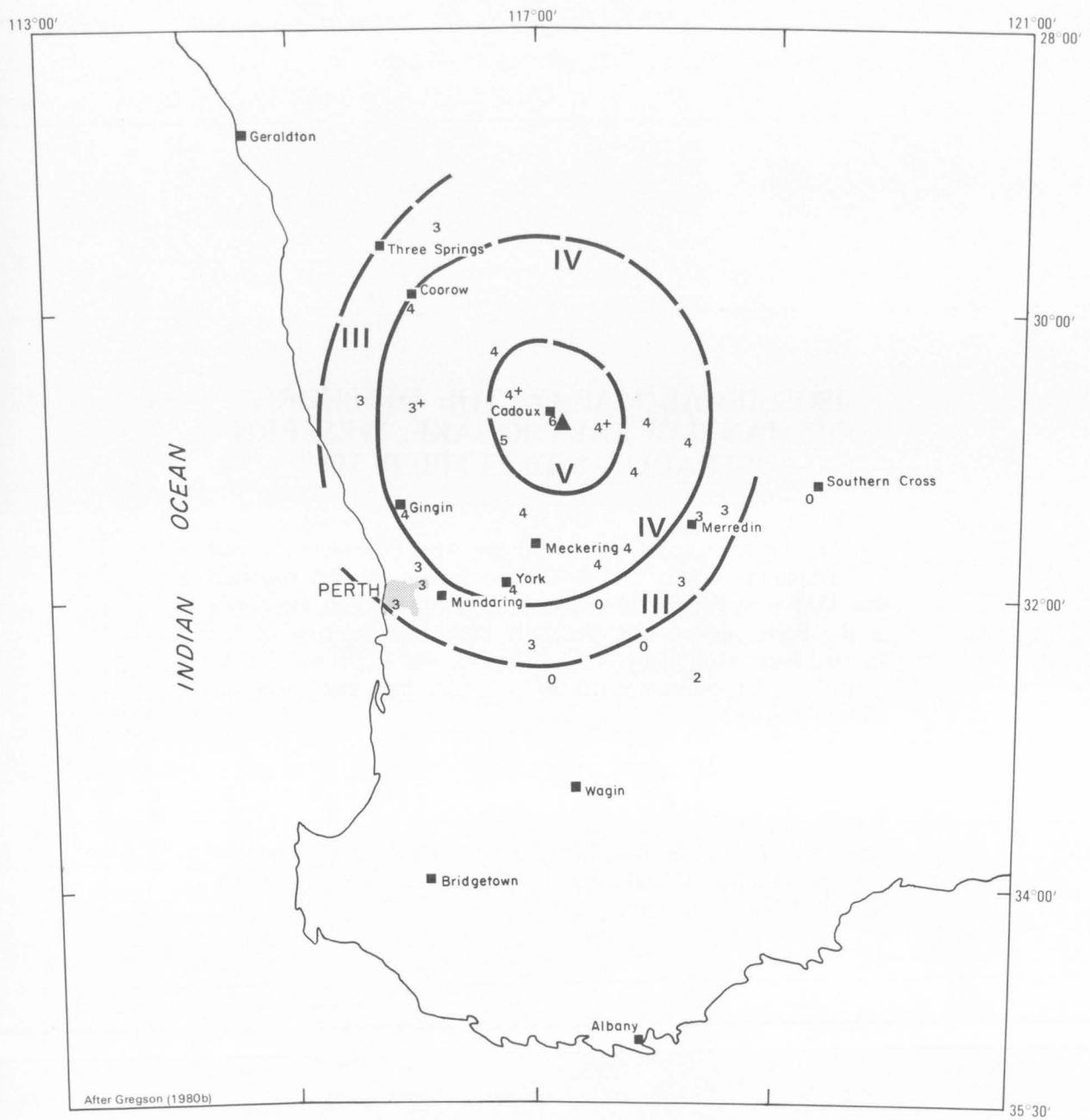
At 04:04 UT (12:04 local time) on 11 October 1979 an earthquake of magnitude ML 4.8 occurred just southeast of the township of Cadoux.

One hundred intensity questionnaires were distributed for this earthquake which was felt in Perth, about 200 km from the epicentre. A maximum intensity of MM VI was reported at Cadoux.

REFERENCE

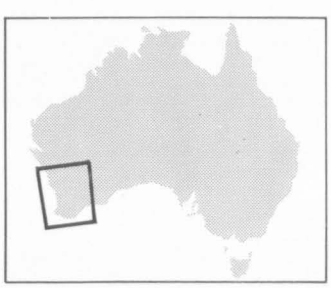
GREGSON, P. J., 1980b—Mundaring Geophysical Observatory Annual Report, 1979. *Bureau of Mineral Resources, Australia, Record* 1980/51 (unpublished).

ISOSEISMAL MAP OF THE CADOUX EARTHQUAKE, WESTERN AUSTRALIA
11 OCTOBER 1979



DATE : 11 OCTOBER 1979
TIME : 04:04:11.7 UT
MAGNITUDE : 4.8 ML (MUN), 5.0 MB (GS)
EPICENTRE : 30.79°S 117.15°E
DEPTH : 15km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/H50/5

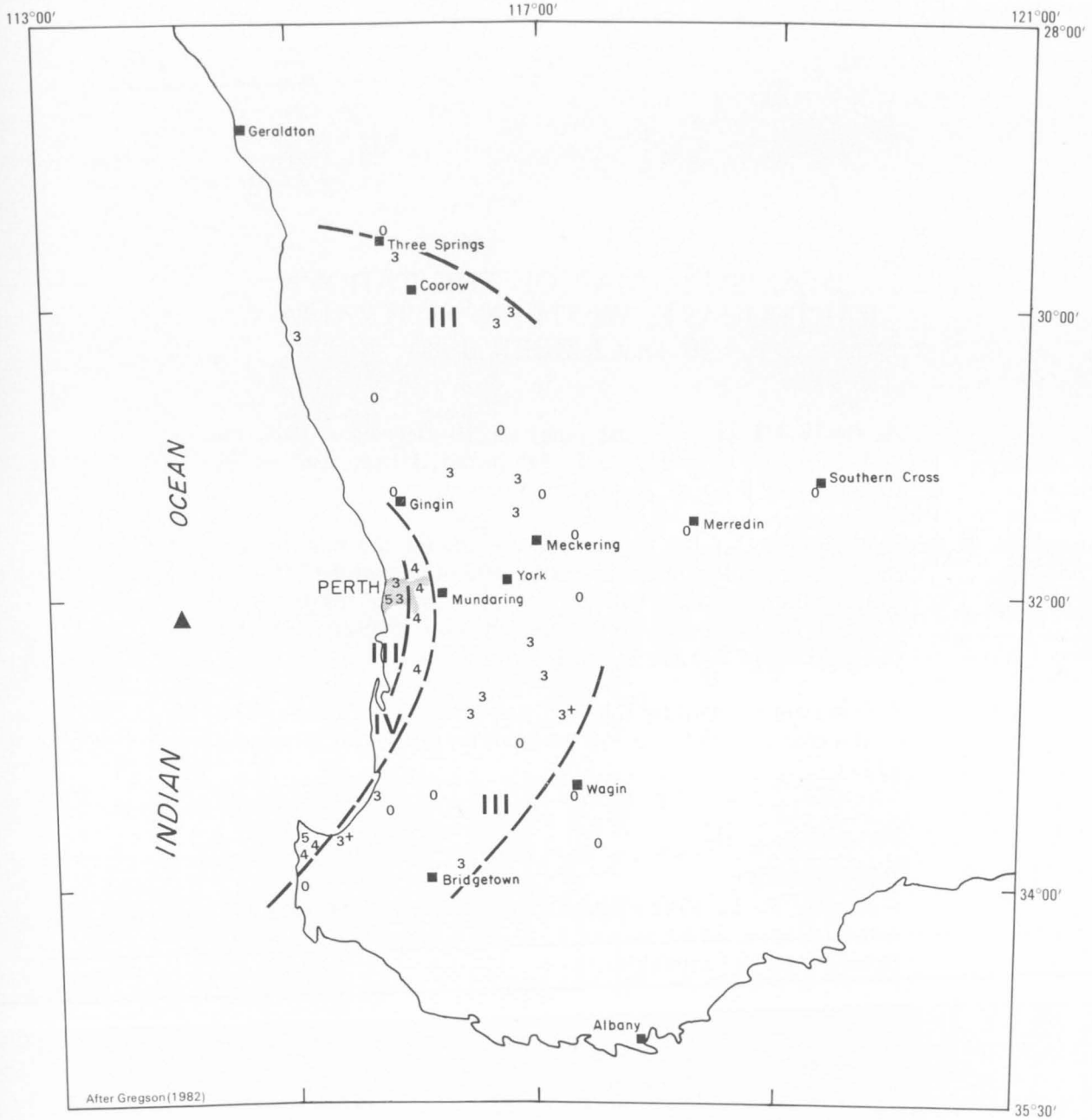
ISOSEISMAL MAP OF THE OFFSHORE (FREMANTLE) EARTHQUAKE, WESTERN AUSTRALIA—8 DECEMBER 1980

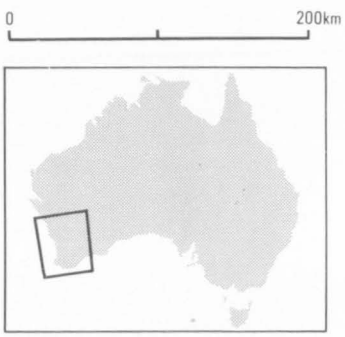
'This earthquake was located 150 km west of Fremantle and had a magnitude ML = 5.2. The maximum intensity reported was MM V at Fremantle and Cape Naturaliste. Felt intensities in the Perth region were generally higher to the east of the Darling Fault even though the earthquake was to the west of the fault. The earthquake was felt up to 350 km from the epicentre.' (Gregson, 1982).

REFERENCE

GREGSON, P. J., 1982—Mundaring Geophysical Observatory Annual Report, 1980. *Bureau of Mineral Resources, Australia, Record* 1982/9 (unpublished).

ISOSEISMAL MAP OF THE OFFSHORE (FREMANTLE) EARTHQUAKE, WESTERN AUSTRALIA 8 DECEMBER 1980





DATE : 8 DECEMBER 1980
TIME : 00:12:07.8 UT
MAGNITUDE : 5.2 ML (MUN), 4.6 MB (GS)
EPICENTRE : 32.12°S 114.11°E
DEPTH : 37km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

ISOSEISMAL MAP OF THE CADOUX EARTHQUAKE, WESTERN AUSTRALIA—10 DECEMBER 1980

At 04:35 UT (12:35 local time) on 10 December 1980 an earthquake of magnitude ML 5.0 occurred near Cadoux in southwestern Western Australia.

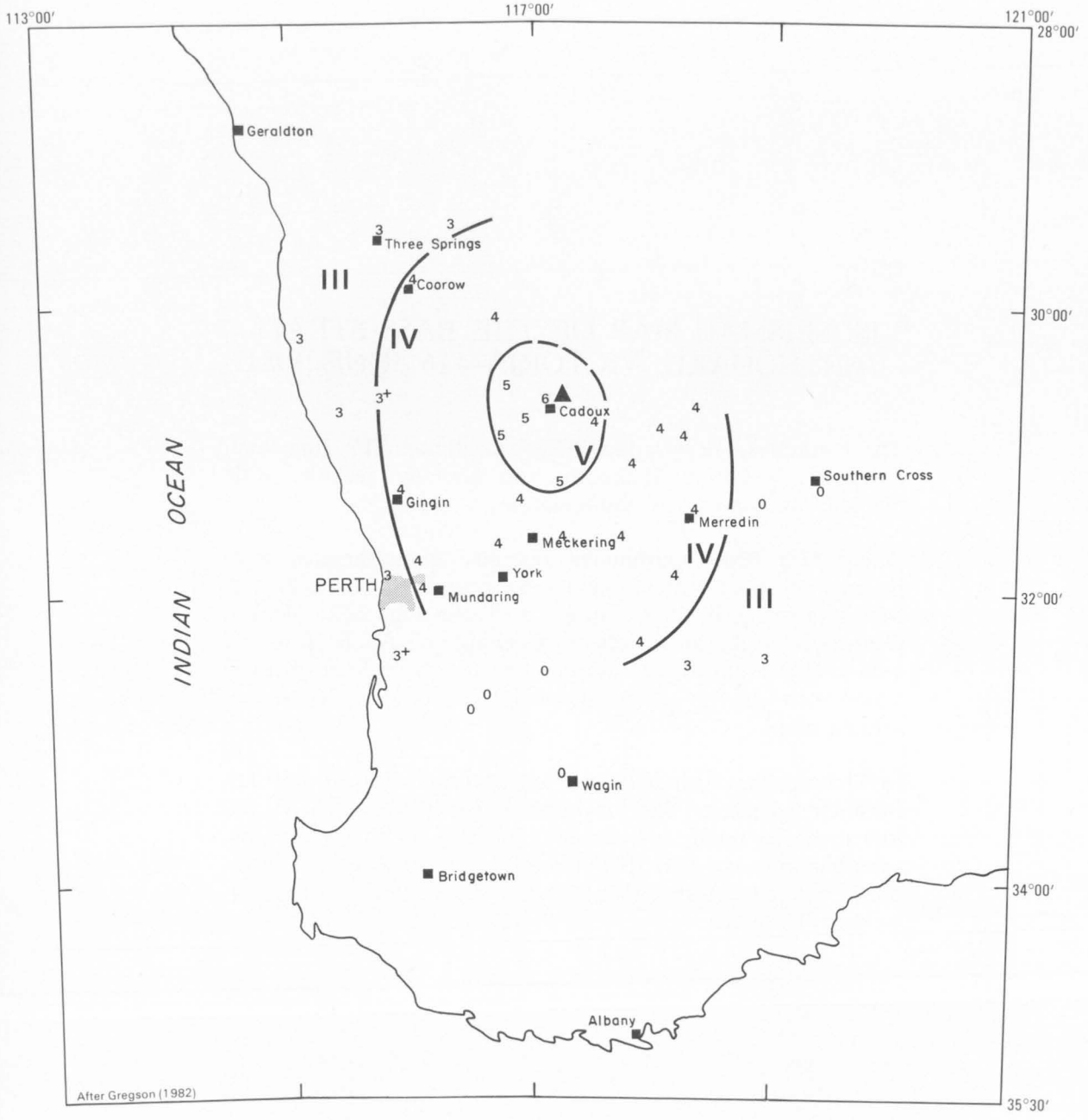
The epicentre for this earthquake was almost the same as for the 11 October 1979 Cadoux earthquake of magnitude ML 4.8. Both earthquakes were felt over a similar area of southwestern Western Australia and both were felt with intensity MM III in Perth, some 200 km to the southwest.

'The maximum intensity reported was MM VI at Cadoux. The earthquake was felt up to 250 km from the epicentre.' (Gregson, 1982).

REFERENCE

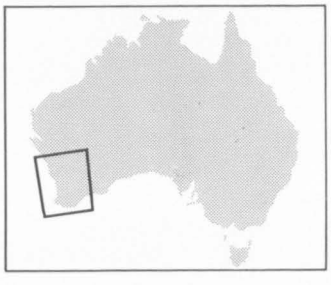
GREGSON, P. J., 1982—Mundaring Geophysical Observatory Annual Report, 1980. *Bureau of Mineral Resources, Australia, Record* 1982/9 (unpublished).

ISOSEISMAL MAP OF THE CADOUX EARTHQUAKE, WESTERN AUSTRALIA
10 DECEMBER 1980



DATE : 10 DECEMBER 1980
TIME : 04:35:05.6 UT
MAGNITUDE : 5.0 ML (MUN), 4.0 MB (GS)
EPICENTRE : 30.73°S 117.15°E
DEPTH : 13km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



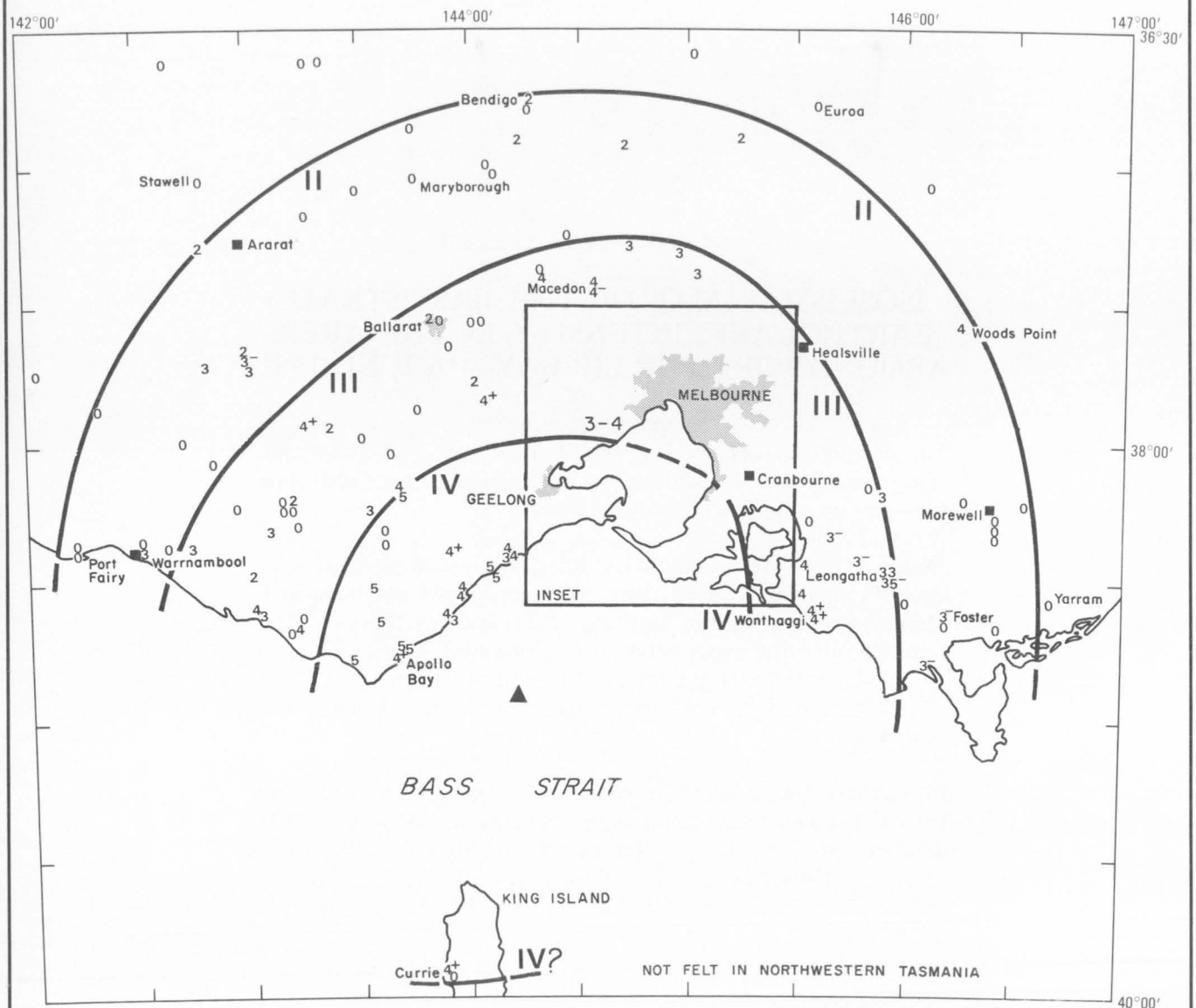
ISOSEISMAL MAP OF THE BASS STRAIT EARTHQUAKE, VICTORIA—16 JUNE 1981

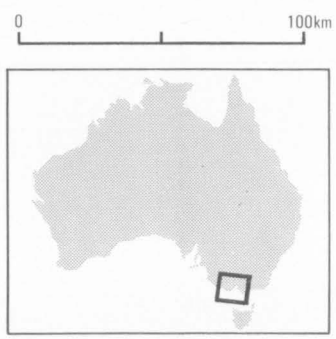
The earthquake occurred at 07:34 local time, 17 June and, being clearly felt in Melbourne and Geelong, received wide publicity on commercial radio stations.

About 500 BMR earthquake intensity questionnaires were issued and about half of these were completed and returned. Members of the Preston Institute of Technology Seismological Centre visited the areas between Geelong and Apollo Bay and around Port Philip Bay to assess intensities there. Staff of BMR added these data to the questionnaire results to draw the isoseismal maps.

In Victoria, the earthquake was felt at distances up to 250 km from the epicentre. The maximum intensity was MM V, too low to cause significant damage. Intensity in the Melbourne suburban area was MM III-IV. South of the epicentre the earthquake was felt at Currie (King Island) but was not felt in northwestern Tasmania.

ISOSEISMAL MAP OF THE BASS STRAIT EARTHQUAKE, VICTORIA
16 JUNE 1981





DATE : 16 JUNE 1981
TIME : 21:33:55.9 UT
MAGNITUDE : 4.9 ML (BMR), 4.2 MS (BMR)
EPICENTRE : 38.90°S 144.20°E
DEPTH : 15km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT
INSET DETAILS SHOW IN FOLLOWING MAP

24/J55/6

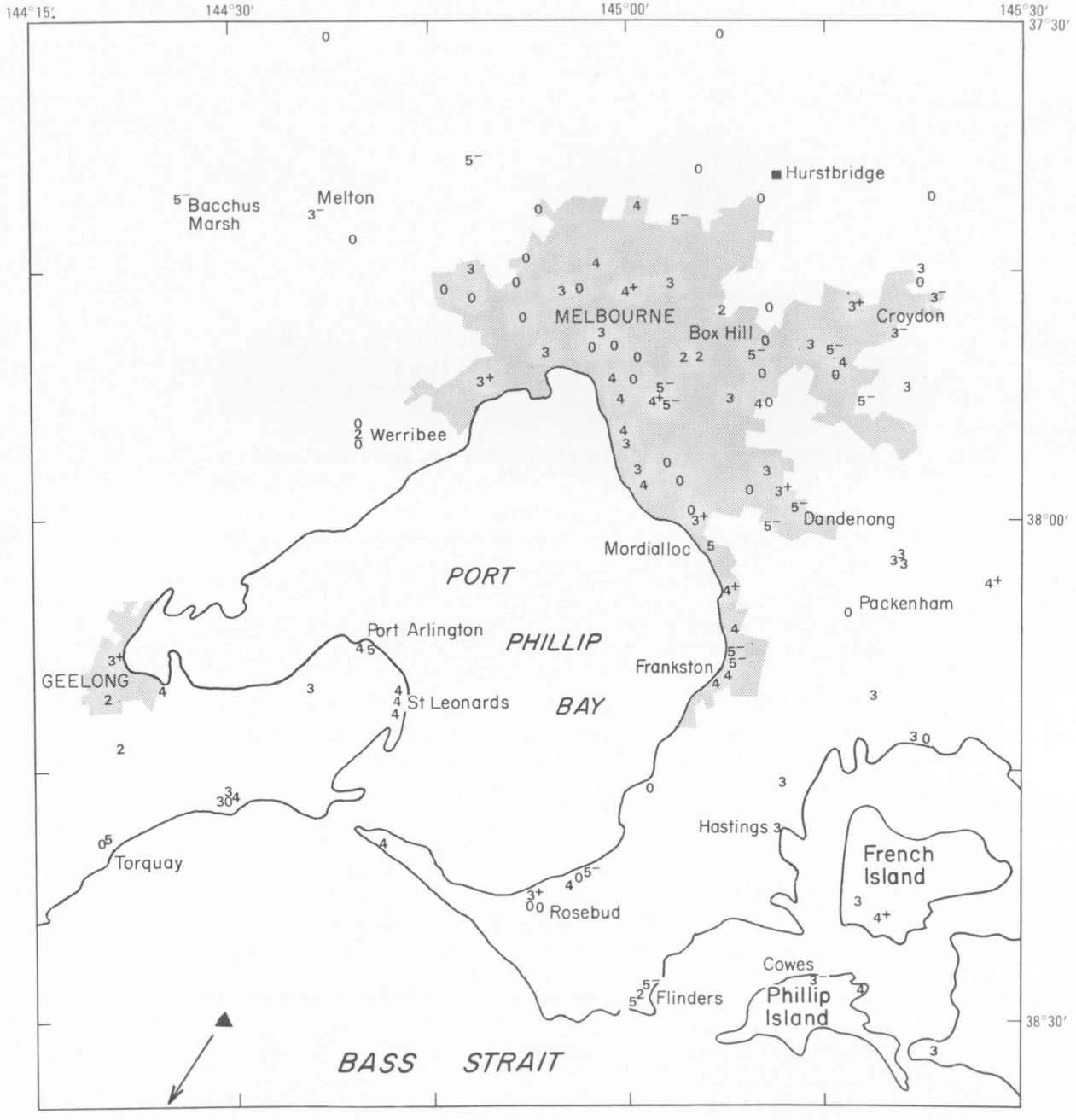
ISOSEISMAL MAP OF THE BASS STRAIT EARTHQUAKE, INTENSITY IN THE AREA AROUND PORT PHILLIP BAY—16 JUNE 1981

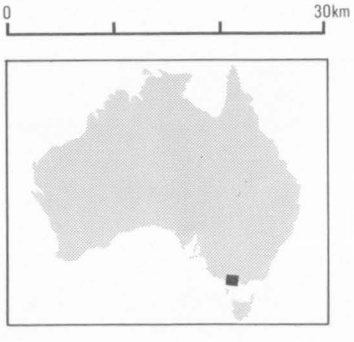
The earthquake occurred at 07:34 local time, 17 June and, being clearly felt in Melbourne and Geelong, received wide publicity on commercial radio stations.

About 500 BMR earthquake intensity questionnaires were issued and about half of these were completed and returned. Members of the Preston Institute of Technology Seismological Centre visited the areas between Geelong and Apollo Bay and around Port Philip Bay to assess intensities there. Staff of BMR added these data to the questionnaire results to draw the isoseismal maps.

In Victoria, the earthquake was felt at distances up to 250 km from the epicentre. The maximum intensity was MMV, too low to cause significant damage. Intensity in the Melbourne suburban area was MM III-IV. South of the epicentre the earthquake was felt at Currie (King Island) but was not felt in northwestern Tasmania.

INSET MAP OF THE BASS STRAIT EARTHQUAKE, PORT PHILLIP BAY AREA 16 JUNE 1981





DATE : 16 JUNE 1981
TIME : 21:33:55.9 UT
MAGNITUDE : 4.9 ML (BMR), 4.2 MS (BMR)
EPICENTRE : 38.90°S 144.20°E
DEPTH : 15km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT

24/J55/7

ISOSEISMAL MAP OF THE APPIN EARTHQUAKE, NEW SOUTH WALES— 15 NOVEMBER 1981

This earthquake took place at about 4 am local time and was felt over an area in excess of 50 000 km^2 although no damage was reported. The highest intensity was MM V, which was experienced along the coastal plain between Wollongong and Nowra, and at a few places in the epicentral area.

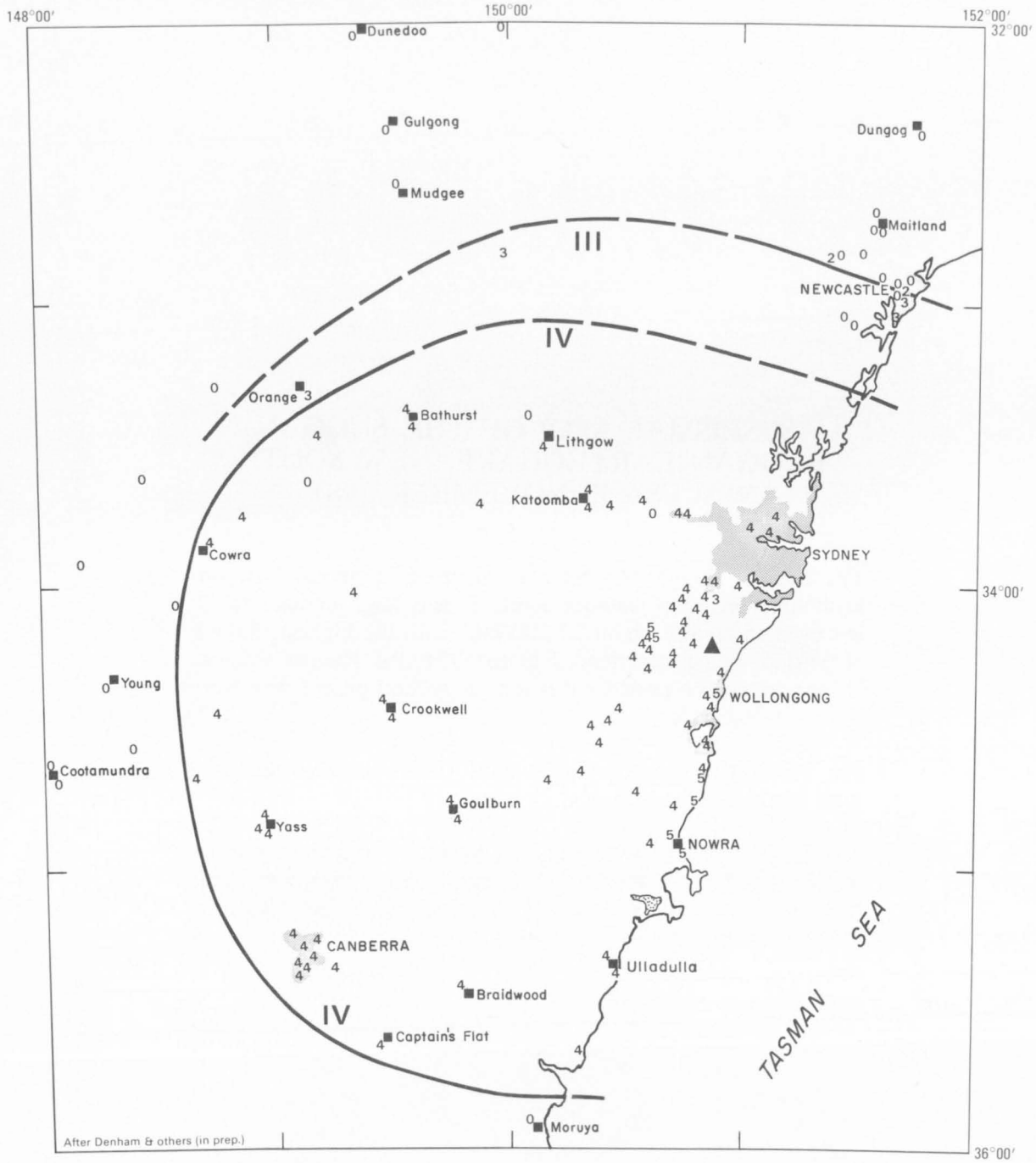
The map is based on 135 returns from BMR felt-report questionnaires which were distributed after the earthquake.

The earthquake was associated with thrust faulting caused by east-west compressive forces and had a similar mechanism to the 1961 Robertson and 1973 Picton earthquakes, which also took place beneath the Sydney Basin.

REFERENCE

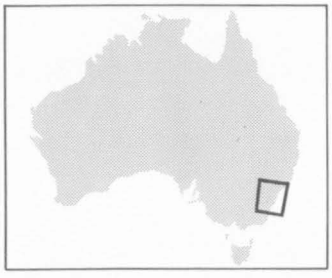
DENHAM, D., BOCK, G., & SMITH, R. S., in preparation—The Appin (New South Wales) Earthquake of 15 November 1981. *BMR Journal of Australian Geology & Geophysics.*

ISOSEISMAL MAP OF THE APPIN EARTHQUAKE, NEW SOUTH WALES
15 NOVEMBER 1981



DATE : 15 NOVEMBER 1981
TIME : 16:58:10 UT
MAGNITUDE : 4.6 ML(BMR),3.9 MS(BMR),4.3 MB(BMR)
EPICENTRE : 34.25°S 150.90°E
DEPTH : 14km

▲ EPICENTRE
IV ZONE INTENSITY DESIGNATION (MM)
4 EARTHQUAKE FELT (MM)
0 EARTHQUAKE NOT FELT



24/N/9

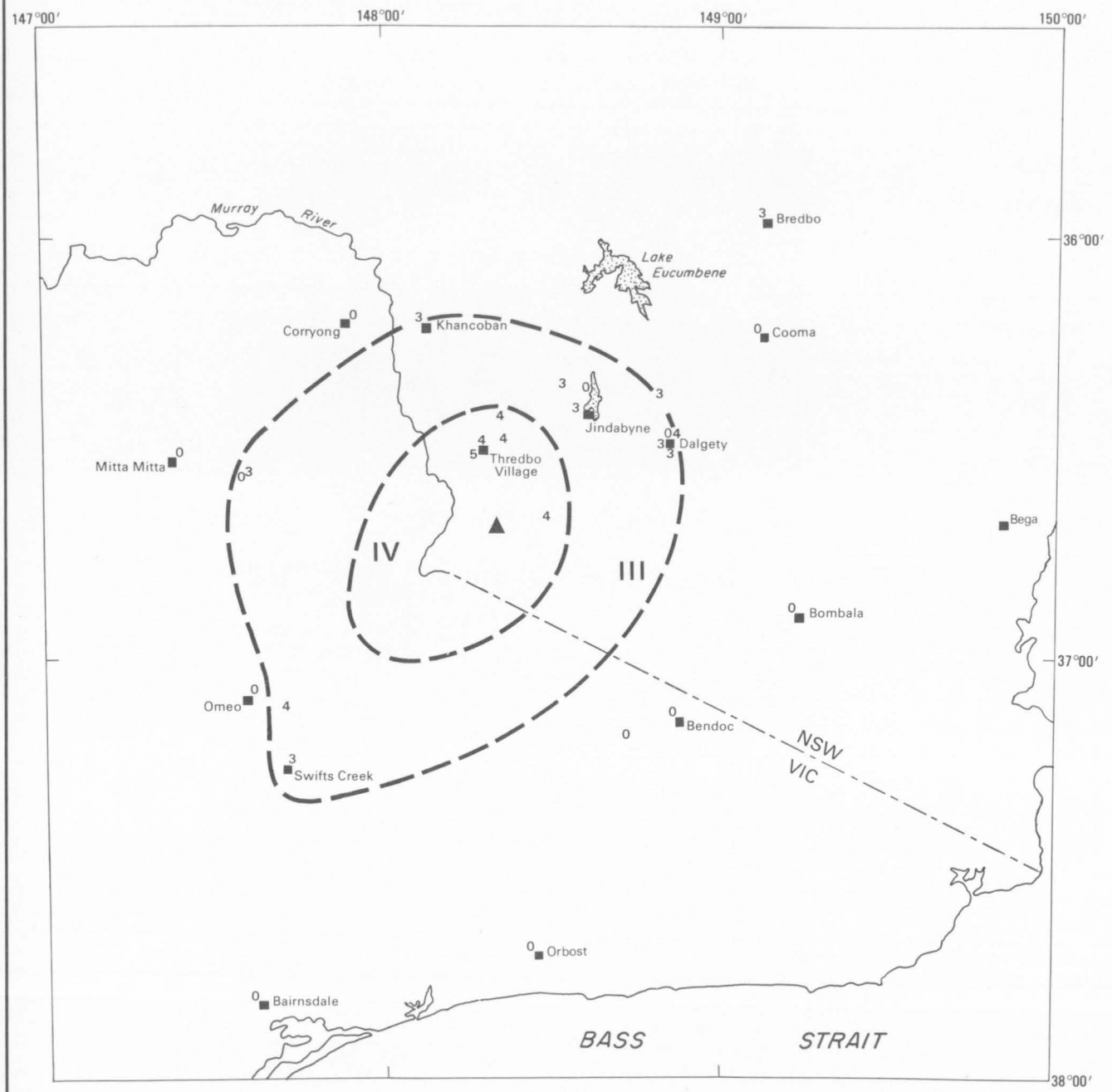
ISOSEISMAL MAP OF THE SUGGAN BUGGAN EARTHQUAKE, NEW SOUTH WALES—30 NOVEMBER 1981

The Suggan Buggan earthquake occurred at about 1.10 pm local time on 30 November 1981. It was large enough to be felt over an area of about 15 000 km^2 with the highest shaking of MM V being experienced at the Thredbo Ranger Station. No damage was reported but it startled several people who were near the epicentre.

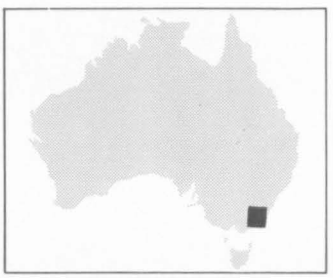
The earthquake occurred at shallow depth but the causative fault could not be identified.

The isoseismal map was compiled by BMR from 60 returned questionnaires (a total of 130 questionnaires were sent out); however, because the epicentral region is almost uninhabited, the shape of the isoseismals is not well controlled.

ISOSEISMAL MAP OF THE SUGGAN BUGGAN EARTHQUAKE, NEW SOUTH WALES 30 NOVEMBER 1981



0 60 km



DATE : 30 NOVEMBER 1981
TIME : 02:09:08 UT
MAGNITUDE : 3.7 ML (BMR, PIT)
EPICENTRE : 36.69S, 148.33E
DEPTH : 7 km

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

24/J55/12