

# Historical Earthquakes in NSW : a Revised List

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**ABSTRACT** Several hundred earthquakes felt in Australia have been documented in three volumes of the Isoleismal Atlas of Australia but sources have not yet been exhausted as we demonstrate with new information on interesting earthquakes in New South Wales thanks to the Australian National Library program Trove, that makes scanned, searchable newspapers publicly available. Studies of the newspapers may well help us recompile Clarke's (1869) unpublished lost list.

This study tabulates more than 280 earthquakes between 1788 and 1954, few of which had magnitudes and so are not in modern catalogues. Magnitude 5 earthquakes in 1860 that caused minor damage in Yass, and in 1886 near Lithgow have been re-discovered along with other previously unclassified earthquakes of interest, including one near Canberra in 1940 and another under Sydney inner suburbs in 1948. Strong temporal clustering of earthquakes is noted in NSW in 1870, 1886 and the three decades, 1933 to 1952 in the Gunning region. Earthquake swarms have been designated a 'magnitude' depending on the largest event of the swarm: "small swarms" occurred in Newcastle, three of them in 1951 and near Macleay in 1870 and Young in 1902, "medium swarms" near Gunning in 1933-1952, a "large swarm" struck NE Tasmania in 1883-1892, the large events of the swarm felt in southeastern NSW.

The largest known NSW earthquakes were those at Gunning in 1934 and Newcastle in 1989, magnitude 5.6, but several others were almost as large. More than 20 earthquake of magnitude 5 or more are known since 1788, a 'large' earthquake of magnitude 6 or more is surely overdue.

This new data and its interpretation is important for better hazard assessments by improving early earthquake details or extending the earthquake database backwards, to better define source zones and lower the magnitude threshold of completeness intervals. It also serves to remind us that even relatively small earthquakes have the potential to cause structural damage to non-engineered structures as they have done in the past. This is a work in progress.

## INTRODUCTION

The seismicity of New South Wales (including the ACT) has received considerable attention since the first earthquake was felt at Sydney Cove within six months of the founding of the new British colony there in January 1788 (see below). Factors for maintaining the interest included that the Rev. W.B. Clarke, recognised as the father of Australian Geology, took up residence in Sydney in 1839 (died 1878) where he wrote the first paper about Australian earthquakes in 1869 and compiled a list of Australian and New Zealand earthquakes which he never published.

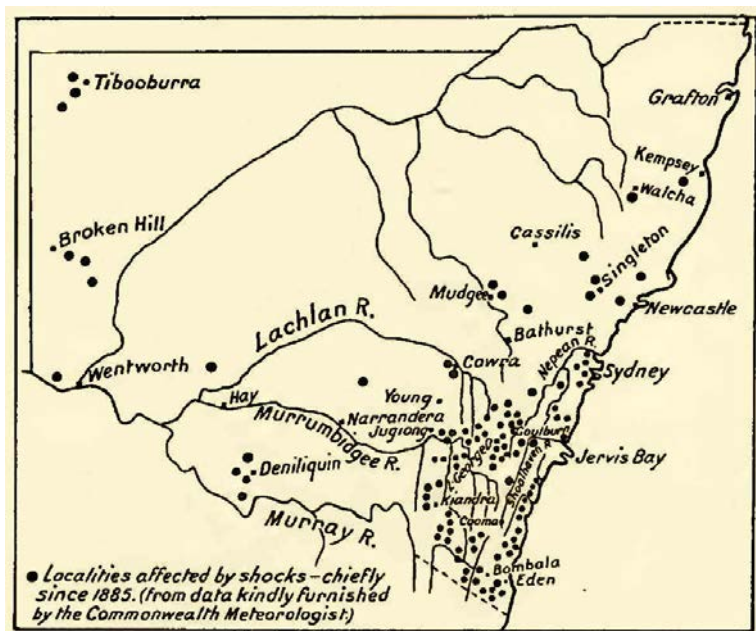
The first Observatory in NSW equipped with short period seismographs was established at St Ignatius College Riverview in 1909, and is still operating today. Directors of the Observatory, Pigot [the founding Jesuit observer], O'Connell Burke-Gaffney and Drake [the last Jesuit observer] all contributed greatly to our understanding of NSW earthquakes and were regular consulted by the media, newspapers in particular.

Others discussed earthquakes in the state of NSW including Griffith Taylor (in Jose and others, 1912) who included an interesting map of places where earthquakes were reported felt according to the Commonwealth Meteorologist. These would have included the large earthquakes originating in north-east Tasmania in the 1880-90s.

Later publications included those of Burke-Gaffney (1952), Doyle, Everingham and Sutton (1968), Drake (1974), Cleary (1967), Doyle and others (1968) and Hunter (1991), the former two dealt with the whole continent, Drake focussed on NSW, Cleary instrumented the Gunning region, Doyle and others limited their scope to the Sydney Basin while Hunter, appropriately, studied the Hunter region.

Many other papers have been written about specific areas like the Snowy Mountains, Dalton-Gunning, or Newcastle (Hunter, 1991), or about specific earthquakes. Iseismal maps for Australian earthquakes are compiled in three atlases by Everingham and others (1982), Rynn and others (1987) and McCue (1997). Included are maps of 15, 18 and 25 NSW earthquakes respectively. A number of additional maps have been compiled since the year 2000. It might be assumed there was not much more to add about early earthquakes in NSW.

**Figure 1** Seismicity of NSW since 1885 (Jose and others, 1912); places where earthquakes were felt as compiled by the Commonwealth Meteorologist.



**Figure 2** Seismicity of NSW, 1788 – 2009 (Payne, 2010); compare the pattern of felt reports in Figure 1 with this pattern of later epicentres.

However more information was elicited from previously unavailable newspapers with the recent publishing on-line, by the Australian National Library, of their scanned collection of early Australian Newspapers. The site TROVE allows users to correct the OCR of the scanned images which makes the collection even more valuable as this corrected text can be searched online by all. Examples of two newspaper that included lists of earthquakes, are included in an appendix.

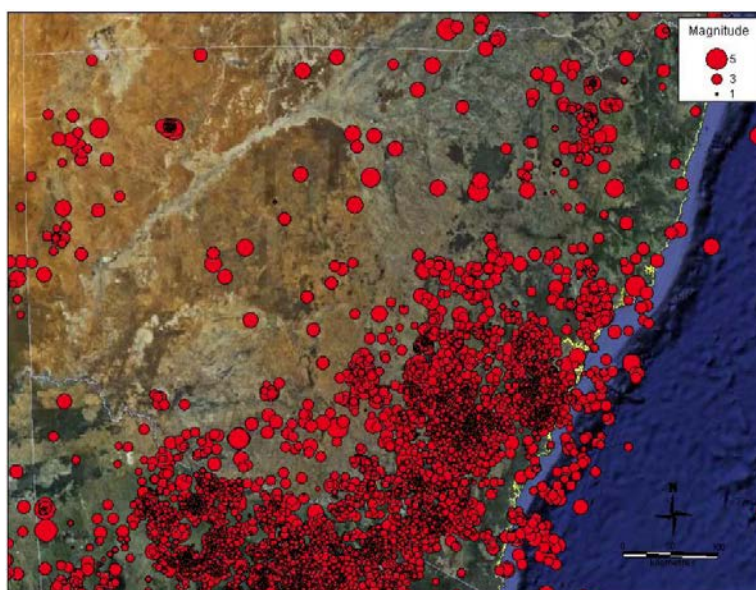


Figure 9: ES&S Earthquake Catalogue for New South Wales and surrounding region

So much additional information was found about Gunning region earthquakes for the three decades of the 1940s, '50s and '60s, prior to the establishment by the ANU of the local area seismograph network, that a separate report will be issued. The information is harder to extract due to a serious decline in the quality of newspapers in the 1950s.

It has been suggested for two centuries that earthquakes don't pose a threat to human life or structures in Australia, that somehow Australia's earthquakes aren't like, say, New Zealand earthquakes. Geologist Professor Edgeworth-David at Sydney University championed this view (*The Riverine Grazier (Hay)* Friday 21 April 1905, page 4):

*" There is no likelihood, however, of this mountain-building force in New South Wales becoming so accentuated in the near future as to cause earthquakes, such as would shatter buildings, and so endanger life."*

What can we do to dispel the Christchurch syndrome – 'it won't happen here'?

On the other side of the ledger, a Cooma newspaper in January 1924 found newsworthy, the fact that no earthquakes were felt there in 1923!

## **ON TIME**

The term Universal Coordinated Time (UTC) is used here even though it wasn't adopted until 1 January 1972, replacing Greenwich Mean Time that was introduced in Australia in February 1895. Before that, local time was measured from noon; when the sun was at its highest.

## **ON MAGNITUDE**

Magnitude is usually quoted to one decimal place but the range of measurements from seismograms is large. For example, the magnitude assessed by various world agencies for the last large Australian earthquake at Collier Bay WA on 10 August 1997 ranged from 5.6 to 6.6 (as reported by the ISC). Recently, on 19 November 2014, a small earthquake occurred near Gundagai NSW, the magnitudes assessed by monitoring agencies ranged from 2.8 to 4.2.

The magnitudes reported here should have a similar uncertainty; a range of  $\pm 0.5$ , corresponding to a perceptibility range ratio of 2.7. Any bias is probably on the low magnitude side because of the lack of 'not-felt' reports and non-reporting of low intensities, either at night or from people outside a building at the time.

## **NOTES ON REPORTED EARTHQUAKES**

The following notes on individual earthquakes listed chronologically were selectively compiled from newspapers, with comments where appropriate on the magnitude and location or explanations as to decisions made in arriving at a solution. The task is not complete as further newspapers are scanned and made available on-line.

### **1788 06 22 at 01:00 UTC, Sydney**

*Australian Town and Country Journal* Saturday 19 October 1878, page 17.

### **THE FIRST EARTHQUAKE RECORDED IN NEW SOUTH WALES.**

The following interesting extract is from Governor Phillip's " Voyage to New South Wales ":-

*1788—June 22. Slight shock of earthquake in the newly formed settlement of Sydney Cove. It did not last more than two or three seconds. It was felt by most people in camp, and by the Governor himself, who heard at the same time a noise to the south, and which he took at first to be the report of guns fired at a great distance."*

### **1800 01 17 time ?, Sydney and interior**

*The Sydney Herald* Monday 2 July 1832, page 2 mentions the second noted earthquake in New South Wales but with no details:

*A " Subscriber" enquires what were the particulars attending the earthquake in this Country in the year 1800 ? We have to state that no serious damage was done, and that it was more felt in the interior than in Sydney, but as no paper was published at that period, the only accounts of it existing, are those drawn from tradition, and perhaps from Collins' account.*

The 'interior' mentioned was still coastal as Blaxland, Lawson and Wentworth didn't cross the Blue Mountains until 1813. *The Sydney Gazette and New South Wales Advertiser* Tuesday 14 January 1834, page 2 mentions an earthquake in the 'Calendar for the Ensuing Week' Friday 17 - Earthquake at Sydney, 1800.

### **1801 02 12 at 13:00 UTC, Penrith**

Nostalgia is a wonderful thing: *The Cumberland Argus and Fruitgrowers Advocate* Wednesday 26 October 1938, page 68 recalls:

#### **WHEN P'MATTA HAD AN EARTHQUAKE**

*Many things have happened in Paramatta including an earthquake. Writing from Parramatta on August 25, 1801, George Caley, the botanist, mentioned it in a letter to Sir Joseph Banks:—*

*"About 11 o'clock at night on 12th February last I was awoke by an earthquake, which gave repeated shocks for about three minutes, though in other places not far from me it was said not to last above a few seconds. At Sydney I believe it was but little felt, but at the Hawkesbury it was felt as severe as with me. "It came from the east and proceeded to the west— that is, it began at the eastern end of the house and went off at the western. It first began like thunder at a distance, and shortly after the floor began to move under me with such violence as I think would have thrown me down had I been standing up or walking.*

*"Fortunately no further damage was done than a few brick houses a little shattered, where it was felt with less violence than with me. Had the like happened in England, the consequence must have been fatal, for the buildings would have been very much shattered and many thrown down.*

*"At this time the weather was hot and close, and the clouds very large. Thunder and lightning is very common but of late we have not had any. I lament that I was asleep, as at first when it waked me I was like as if I was stupified."*

Hawkesbury is taken to be present-day Pitt Town on the Hawkesbury River; we estimate the size as magnitude 4 and located near present-day Penrith. This should be the first entry in modern earthquake catalogues of NSW.

### **1804 05 07 at 11:30 UTC, Hawkesbury and Parramatta**

*The Sydney Gazette and New South Wales Advertiser* Sunday 13 May 1804, page 1 describes this, the third earthquake:

*On Tuesday last the 7th Instant, between nine and ten o'clock at night, the shock of an Earthquake was sensibly felt by all the Inhabitants and Settlers at and about Hawkesbury, Parramatta, and Prospect Hill. The motion appeared to be an undulation of the earth moving in the direction of N. E. to S. W. and lasted about six seconds. The night was remarkably fine and serene.*

*It may be remembered that a very violent shock was felt about two years ago, which occasioned much damage to several Buildings at Parramatta.*

It must have been a small local event or it would have been felt at Sydney and more widely. The 'violent shock' is presumably the February 1801 event mentioned above.

### **1806 09 24 morning local time, Richmond Hill**

*The Sydney Gazette and New South Wales Advertiser* Sunday 28 September 1806, page 2.

*On Wednesday morning last a shock of an earthquake was felt at Richmond Hill, of from 28 to 30 seconds duration, the undulation as nearly as could be described, from N.E. to S.W.*

### **1826 04 21 at 10:00 UTC, Parramatta**

*The Sydney Gazette and New South Wales Advertiser* Wednesday 26 April 1826, page 2 says:

*On the evening of Friday night, about eight o'clock, a slight shock of an earthquake was felt in the town and neighbourhood of Parramatta; and the shock was experienced, much about the same moment, in the district and vicinity of Bunbury Curran (Author: 30 km WSW Sydney). It is now about 26 years since this part of Australia was visited with such a phenomenon, and then it went off in a similar way without producing injury.*

We assume this was a small local event for the listing in Table 1. The journalist remembered the 1800 or 1801 events but not the intervening earthquakes in 1804 and 1806.

### **1832 03 15 at 02:00 UTC, Hawkesbury**

The Australian Friday 23 March 1832, page 3 reports:

*On the 15th instant, about noon, several slight shocks of an earthquake it is rumored, " were felt in different places on the south side of the Hawkesbury, from Pitt Town, downwards."*

### **1837 08 02 at 12:20 UTC, Newcastle**

The following extract from the letter of the Rev. Wilton was taken from *The Sydney Herald* 10 August 1837, page 2. At the end he lists the previous known earthquakes in the colony. This was the first of seven magnitude 5 or greater earthquakes in or near Newcastle to 2014. Earthquakes occurred in 1837 in Hobart, Adelaide and Port Phillip.

#### *EARTHQUAKE AT NEWCASTLE.*

*To the Editor of the Sydney Herald.*

*SIR.—The town of Newcastle, on the Hunter, upon the night of Wednesday the 2nd ultimo, at about twenty minutes past ten, was shaken by an earthquake, which occasioned a general consternation amongst the inhabitants. I was at the time sitting in my bedroom, when on a sudden I was alarmed by a cracking noise, which seemed to come from the eastern end of the parsonage, and the chair on which I was sitting was up-heaved; the walls of the house appeared to move; the timbers of the roof to strain like those of a ship at sea; and the windows were violently shaken. This continued for about the space of two or three seconds..... One of my servants who had retired to rest, describes the sensation as if the bed was raised upwards; while another, whose bed was laid upon the floor in another room, thought the floor was being moved from underneath, and that the walls were about to fall. In the kitchen, several utensils of tin were thrown down from the wall, and the plates in the plate rack were struck against each other; while the man who was in that part of the house states that there was a noise on the shingles as if hailstones were falling upon them, and he ran out to see if such was the case, but there was not a cloud in the sky. In one instance, where a person was sitting at a table, the table seemed to move away, and then to return to its former position. One of the men employed at the signal-station, on the Telegraph-hill, was at the time in the act of stirring up the beacon-fire, situate nearly on the verge of the cliff over the sea, and he states, that the earth appeared to quiver beneath him, so that he hardly knew whether he was upon his feet or not; while the walls of the windmill on the opposite heights, above the church, are described by the night-watchman within them, as if about to tumble, to such a degree did they tremble. The shock in short was generally felt by those who had not gone to their night's rest, and many who were asleep at the time were awakened by it, and rose up to inquire the cause. The men who were at work in the coal mines, twenty-three fathoms below the surface, experienced nothing of the shock, while those of their companions who were above ground were greatly terrified by it; and it would seem that it was felt with the greatest severity on the more elevated situations.....*

*On reference to the " Chronology of the most remarkable occurrences from the first establishment of Australia down to 1829." in the Australian Almanack, we find notices of four shocks of earthquake in this Colony, and of one in Van Diemen's Lad, viz —on the*

*22nd of June, 1788; 17th of January, 1801; 7th May, 1804; 24th September, 1806, and at Launceston on the 28th of November, 1823. These are, I believe, all the shocks upon record as having been felt in these Colonies; and whether they were greater than, or inferior to the one I have now endeavoured to describe, we have now no opportunity probably of ascertaining: .....*

*I remain, Sir,*

*Your obedient Servant,*

*C. PLEYDELL N. WILTON. Parsonage, Newcastle,*

*August 4, 1837.*

*The Sydney Monitor* Monday 14 August 1837 page 2 mentions that this earthquake was felt (slight) in Sydney but that it did not awake the sleeping reporter.

#### **1839 08 17 at ~01:00 UTC, Sydney?**

*The Sydney Gazette and New South Wales Advertiser* Saturday 7 September 1839, page 2 comments:

*EARTHQUAKE. -The Herald states, on the authority of a correspondent at St. Vincent's, that on the 17th August, in the forenoon, he experienced something like the shock of an earthquake.*

There is not enough information to estimate a location or magnitude, or even verify its origin in Australia.

#### **1841 01 27 at 21:15 UTC, Newcastle**

*The Sydney Herald*, Friday 19 February 1841, page 2.

To the Editor of the *Sydney Herald*.

Sir,—The Rev. W. B. Clarke, in your paper of the 9th instant, in his account of the shock of the Earthquake on the 28th of last month, as felt at Parramatta, mentions the state of the weather, and the many beautiful meteors which he had recently observed..... I have now before me the account of the shock of an Earthquake, which, with many other persons, I felt at Newcastle on the night of the 2nd of August, 1837, and of which I gave a description in the *Sydney Herald* the 10th of that month. From that it must appear that the shock came in a similar direction to that of the 28th of last month (which however was not felt at Newcastle) and it was preceded also by extraordinary atmospheric phenomena. The shock on the 28th was felt very strongly on the William and Patterson Rivers (as was also that of the 2nd of August, 1837) at Morpeth, East and West Maitland, and at Patrick's Plains. At West Maitland the labourers employed in erecting the Church thought that the building was coming down, as did also a man at work within the lately consecrated Church of St. James's, Morpeth, with respect to that building, out of which he ran upon feeling the strong vibrations accompanied by a rumbling noise. A resident upon the banks of the Hunter at Morpeth, likens the noise which he heard to that made by the paddle-wheels of a steam-boat in the first instance (so much so that he looked up to see if the steamer were coming) and then to that occasioned by the motion of a waggon laden with iron rods over a hard road. In each instance it would appear that the vibration seemed to come from about the north. From the information already obtained respecting this shock on the 28th instant, we perceive that it extended over a greater line of country and was attended by more violent effects than that to which I have alluded in 1837.....

I remain, Sir,

Your obedient servant,

C. PLEYDELL N. WILTON.

Parsonage, Newcastle,

February 13, 1841



P. S.—A report has just reached me that Mount Wingen has "tumbled in," and there are some who account for the late earthquake from this circumstance. The shock, if it reached that spot, may have caused such a change as reported in our Burning Mountain — but nothing more.

An isoseismal map was published by McCue (1996 but with a typo in the time), showing strong shaking in the Newcastle area as reported also by Hunter (1990) in contradiction with Wilton's comment above. Several other points can now be added to the map but do not change the general shape.

#### **1842 03 02 at 22:45 UTC, Bathurst**

The *Sydney Gazette and New South Wales Advertiser* of Tuesday 8 March 1842 page 2 recounts the following: *BATHURST, EARTHQUAKE. – We have been informed by a gentleman who arrived here on Saturday from Bathurst, that on Thursday last, the inhabitants of that township were thrown into a state of great alarm by several awful shocks of an earthquake, which continued to be felt at intervals during a great portion of the day. Several houses have sustained considerable injury, amongst others the store of Mr. Lord, which has been laid in ruins. We have not heard the extent of property destroyed, or whether any lives have been lost. On Friday our informant experienced the shock of an earthquake as he was descending the Mountains. In our next publication we shall probably have it in our power to lay the full particulars before our readers. The public are doubtless aware that shocks of earthquakes are of frequent occurrence in the interior, but fortunately hitherto they have neither been violent nor of long duration.*

The *Sydney Morning Herald* report of the same day page 2 is far less dramatic, the shock occurred at ¼ before 9 A.M. on Thursday, did cause several parties to rush outdoors and lime was shaken off the front of two or three houses (the extent of damage), and bottles jingled together in the dispensary. From this description we glean that an earthquake and aftershock did occur near Bathurst causing minor damage but it was not reported felt elsewhere, perhaps magnitude 3.5 to 4.0.

#### **1842 10 27 at 19:30 UTC, Newcastle**

Two earthquakes were reported felt that morning at Newcastle, Patrick's Plains and Paterson, the first one was only slight. The larger one was felt widely; sharp at Port Macquarie, Maitland, Dunmore, Raymond-terrace Singleton and Kempsey, distinct at Windsor and Stroud, and slight at Parramatta. Hunter (1991) catalogued the earthquake and an isoseismal map was published (McCue, 1996) yielding a magnitude of 5.3. *The Sydney Morning Herald* Tuesday, November 1, 1842, page 2.

##### *THE EARTHQUAKE.*

*AMONG our news from the interior will be found notices from Windsor, Newcastle, and Port Stephens, of the earthquake which occurred on Friday morning, and the course of which is thus traced for upwards of a hundred miles. We shall feel obliged by well-authenticated notices from other parts of the colony where it may have been felt, with reports of attendant phenomena, as **we are anxious that full particulars of all such occurrences should be recorded in the Herald for future reference.***

##### *NEWCASTLE-EARTHQUAKE.*

*On Friday morning last, the 28th instant, two shocks of earthquake were felt at Newcastle, by many of its inhabitants, who were awoke thereby out of their sleep, and who describe their beds as if tilted on one side, and on regaining their original position being violently shaken under them, while the walls of their chamber seemed to be falling down. Those persons who had risen from their beds when the second shock occurred, about half past five, state the earth as quivering beneath them, and themselves shaken, and as if lifted off the ground. Extraordinary atmospheric changes had taken place previous to this phenomenon; particularly on the Monday preceding, during the*

whole of which day a thick haze prevailed, accompanied by a death-like stillness, the wind suddenly veering from W. to E. in the afternoon, the same stillness continuing. On Tuesday evening, there was incessant lightning to the E., while on Thursday there was thunder and rain from the S. W. **The present instance makes the fourth shock of earthquake felt on the Hunter since the commencement of the month of August, 1837.** I trust that this notice of these tremblements de terre which occurred at Newcastle yesterday morning, may be the means of inducing other individuals who may have experienced their effects in other localities, to make known their observations through the medium of your journal.

#### **1849 12 12 at 09:00 UTC, first reported earthquake at Yass**

*The Goulburn Herald and County of Argyle Advertiser* Sunday 22 December 1849, Page 5.

*EARTHQUAKE AT YASS. —Some of our friends at Yass have denied that a shock of an earthquake was felt in their township on Thursday sen'night. They must be well aware that it is not fault of ours that they were not sensible of the vibration. That there was a shock is beyond all doubt; and we regret that those who never experienced the singular sensation produced by these freaks of nature, were not gratified on the late occasion. A youth, who knew nothing about earthquakes, went down to the river to water a horse. When he arrived near the brink, the stream was flowing steadily along, within its usual bounds. In a moment afterwards the earth trembled, and the water rushed over the bank and passed under his feet. Several of the townspeople felt the shock also whilst sitting in their houses.*

It was not reported felt at Goulburn or anywhere other than Yass so we assume it was a small local near Yass. The description is compatible with a seiche in the river which is unusual.

#### **1850 09 23 at 17:20, Good Hope, on the Murrumbidgee**

A postscript on a letter by the Rev W. B. Clarke to *The Sydney Morning Herald* Tuesday 1 October 1850 page 2 alerts us to a small earthquake near Yass.

*EARTHQUAKE. I have also to-day received information that a smart shock of earthquake was felt at Good Hope, on the Murrumbidgee, on the morning of Tuesday last, at 20 minutes past three o'clock A M. It was preceded by a loud rumbling noise from the south-ward, and the shock was felt also 20 miles to the north-west. Till the house shook, the sound was taken for thunder.*

W. B. C.

*St. Leonard's, September 30.*

#### **1850 11 30 at 02:30 UTC, Abercrombie River**

*SHOCK OF AN EARTHQUAKE. —The following letter from Mr. Armstrong, of Flowerdale, contains a detailed account of a shock of an earthquake felt near the Abercrombie River :—"I beg to inform you that between twelve and one o'clock of the 30th ultimo, a smart shock of an earthquake was felt in this neighbourhood. The day was very warm, not a cloud to be seen, nor a breath of wind stirring. The shock was accompanied by a rumbling noise like distant thunder. One of my sons was out walking at the time, and was nearly thrown to the ground; a neighbour was at dinner at the time, when his ducks and fowls flew up from the ground, making a sharp noise, which brought the family out to see what had frightened them; they also heard the rumbling noise, but considered it was thunder. The Maitland Mercury and Hunter River General Advertiser Saturday 14 December 1850, page 1.*

#### **1852 03 06 at ~18:45 UTC, near Lake George**

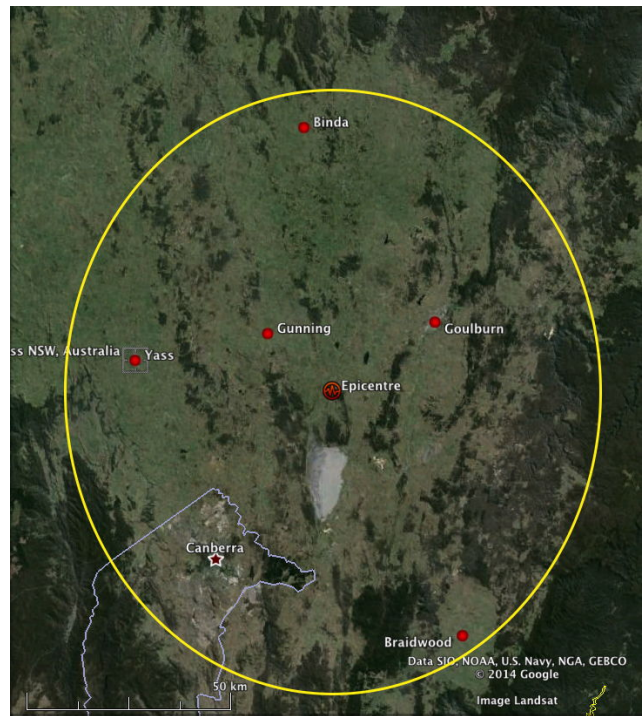
The felt area shown in Figure 3 is compatible with an earthquake of at least magnitude 4.4, the epicentre near present-day Collector, at the mapped northern end of the Lake George Fault.



**Figure 3** Lake George earthquake, 6 March 1852. The yellow ellipse encompasses those places where shaking was reported. This earthquake would have been strongly felt at Collector and Canberra had they existed, details below.

*Bathurst Free Press and Mining Journal*  
Wednesday 17 March 1852, Page 2.

*Earthquake.*—On Sunday morning the 7th instant, about a quarter to five o'clock, a.m., a great number of the inhabitants of this district were aroused from their slumber by the shock of an earthquake, which lasted several seconds ; it was felt at Binda, forty-six miles to the north-west; at Lake George, at Gunning, at Braidwood, and at Yass; at the latter place, according to report, it was more violent than at Goulburn, when some of the people thought it violent enough, it having shaken the rings of their bed curtains and the crockery of their wash-stands till they rung again. Those who had visited the countries subject to those convulsions, were at no great loss to tell what was the name of the disturber of their rest; some take upon them to affirm that there were two shocks, and that one of these lasted from six to eight seconds, and was preceded by a sound like distant thunder, which was closely followed by the shock.—Goulburn Correspondent of the Herald.



### 1857 12 10 at 00:00 and 04:00 UTC, First earthquakes to be observed at Gunning

*Empire* Saturday 12 December 1857, Page 2

*SHOCKS of AN EARTHQUAKE.*—On Thursday last about 10 o'clock, a.m., the shock of an earthquake was felt at Gunning, and a second one was experienced about 2 o'clock on the same afternoon. It was felt at the west of Gunning and southward as far as Ben Barker's at the Run of Water. Persons residing about two miles on the other side of Lodge's state that their hut appeared to sway from side to side. The direction the earthquake took was east to west. The atmosphere was sultry and not a breath of wind stirring.

*Empire* Tuesday 15 December 1857, Page 5.

*EARTHQUAKE.*—The shocks of an earthquake felt at Gunning on Thursday, were also perceptible at Collector, on that day. In several houses the crockery-ware was violently shaken, and much alarm was experienced by the occupiers. Shortly after 12 o'clock a.m., on Wednesday the shock of an earthquake was felt in Goulburn by several persons. The houses occupied by them shook to their foundations. This is the third shock that has been felt in town during the last five years. The weather on the night we allude to was very boisterous, the wind blowing violently in gusts, accompanied by thunder, lightning, and rain.

The Goulburn event on Wednesday may well have been thunder but the two earthquakes on Thursday could not be confused with thunder. We assume they originated near Gunning and were each about magnitude 3.

### 1858 06 24 at ~09:00 UTC, Murray River near Echuca

The following story about an earthquake near Pyramid Hill or Echuca, both well known for their

recent earthquakes, was extracted from *The Sydney Morning Herald* Saturday 17 July 1858, page 8:

*SHOCK OF EARTHQUAKE ON THE MURRAY. — We lately extracted from the Argus an account, by a correspondent of that journal, of the shock of an earthquake felt at Rest Down Plains, the station of Dr. Rowe, on the Campaspe, on the 24th June last. We now learn from Mr. Maiden that the shock was not confined to that locality, and that it was very perceptibly felt for a long distance along the valley of the Murray. At his own station, at Barracouta, the sensation experienced by several persons was that of a vessel being suddenly struck by a heavy wave, and so severe was the shock that it almost threw them down. Mr. Maiden, who was himself crossing the river at the time, states that his attention was first arrested by a noise as of a very heavy vehicle approaching on a hard road, or of a distant but distinct clap of thunder. At the same moment there was a heavy swell in the river, which lasted for several seconds. Two men who were engaged in splitting in the bush, on being asked if they had noticed anything remarkable, replied that they had thought a steamer had arrived in the vicinity, and that her boiler had burst. The shock was felt for thirty miles below Barracouta, to Mr. Maiden's knowledge, and he thinks it must have been observed at Swan Hill. At Mr. Bagot's station, the doors of the hut were violently thrown open, and considerable alarm was occasioned. At Moama and at Mount Hope, the shock and the subterraneous noises were also distinctly perceptible. They seem, Mr. Maiden observes, to have run along the valley of the river. What, if a concussion should some day take place, sufficient to throw the Murray out of its present course? — Bendigo Advertiser.*

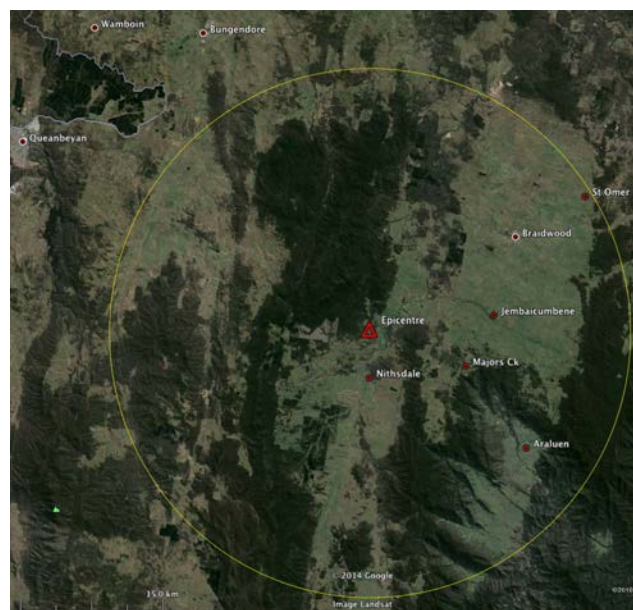
The *South Australian Register* Saturday 3 July 1858 page 2 added a few details (eg time):

*Shock of an Earthquake at the Rest-Down Plains.— A correspondent forwards us (Argus) the following particulars of one of these phenomena, which happened a few days back in this neighbourhood:— ' Terrick Terrick, 24th June, 1858. About 7 o'clock this evening there was felt here a very smart shock of an earthquake. It was preceded by a noise resembling thunder, or I should describe it better by comparing it to that which would be caused by the rush of a large flock of sheep in your immediate proximity. Before I could rise from my chair I felt a sensation under my feet like that I have felt upon the deck of a ship when she suddenly grounded. It was repeated in a very slight degree about a quarter of an hour afterwards, but unaccompanied by any noise. The sky was almost unclouded, and the wind scarcely perceptible. The motion came from the north-west, which is the direction of the highest peak of this volcanic hill.*

Depending on whether it was felt at Swan Hill or not, the magnitude varies from 4.5 down to 3.5.

**1859 03 05 at 00:30 UTC, Braidwood**

**Figure 4** Known felt area of the 1859 Braidwood earthquake with preferred epicentre near Nithsdale.



*The Star* (Ballarat) Wednesday 23 March 1859, page 2 reports:

*EARTHQUAKE AT BRAIDWOOD.—A shock of an earthquake is rather an important feature in the news of a week. It is reported that a slight shock of an earthquake was*

felt on last Saturday morning, between ten and eleven o'clock, all over this district. We are informed, by persons of undoubted veracity, that they distinctly felt the shock. The trembling of the earth was perceptible at Araluen, Major's Creek, Jembaicumbene, St Omers, and other places. Many persons say that they did not feel the shock at all..... The earthquake was heard at the Upper Araluen as a loud report. ....It was also felt at various places simultaneously, and has excited no little surprise and excitement throughout the district—Braidwood Dispatch.

In a similar vein, *The Goulburn Herald and Country of Argyle Advertiser*, Saturday 12 March 1859, page 2 makes a fuss about the earthquake, implying they are a rare phenomenon:

**THE EARTHQUAKE.**—This is no hoax, and the fact of their having been a veritable earthquake, is testified to by a large number of most respectable parties in the district. The shock was severe at Nithsdale: a person living there describes it "as if a dray had run against the chimney," and then went out of doors, expecting its immediate downfall. Also, at St. Omers, a slight trembling was noticed. Earthquakes are of frequent occurrence in New Zealand, but in this colony the phenomenon is so rare as to cause considerable excitement.—Braidwood Daily News.

Using the felt area from the map, the magnitude has been calculated at 3.6 which may be an underestimate though the lack of felt reports from nearby Queanbeyan and Bungendore cap the value at 3.7.

**1860 03 04 at 10:08 UTC, Yass**

This earthquake is not in known catalogues.

The *Yass Courier* of Saturday March 10, 1860 reported the earthquake, the story was then picked up by *The Argus* on Monday 19<sup>th</sup> March as shown in the accompanying figure.

**Figure 4** Extract from the *Argus* of Monday March 19, 1860, itself an extract from the *Yass Courier* of Saturday March 10, 1860.

Four aftershocks were felt at Yass where the strongest shaking was reported in the mainshock on Sunday evening indicating that the epicenter was nearby (34.8°S, 148.9°E). The effects were widely felt, from Bathurst in the north to Queanbeyan in the south, and from Shoalhaven in the east to Gundagai in the west. Other places reporting the earthquake included Gunning, Goulburn, Collector, Wheeo, Burrowa and Reid's Flat. Perhaps it was felt south of Queanbeyan but the 1860 Cooma newspaper is yet to be digitized.

Minor damage was caused in Yass, mortar falling from stonework on the Church of England and a timber roof support in another building was split.

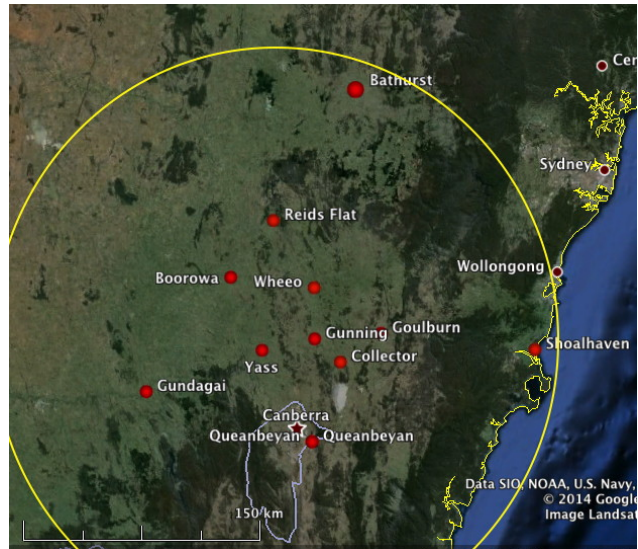
## NEW SOUTH WALES.

**EARTHQUAKE.**—On Sunday evening last several shocks of earthquake occurred in this district. A double shock took place exactly at 10 minutes past 8 o'clock p.m., and the concussion caused very considerable alarm. A number of those attending service in the Church of England, and in the Wesleyan Chapel, rushed towards the doors, and in the former church the excitement was so great that the services were soon after terminated; in the latter church, however, the religious services were resumed. Exactly at 9.45 p.m., a more slight shock was felt, and at midnight it again occurred. The earthquake seemed to proceed from south to north. No injury was done to property. On Monday and Tuesday nights a repetition of the shocks was distinctly felt, but not nearly so violently as on Sunday evening. At Queanbeyan the earthquake was slightly felt at a quarter past 8 o'clock on Sunday evening; and at Gundagai and Goulburn it occurred at about the same hour. From this it would appear that the district around Yass received the shock more violently than elsewhere, and some few seconds earlier than it occurred at the other places named. In Yass on Sunday evening the earthquake occasioned a report not unlike a double discharge from a large sized cannon, and the ground seemed to move from under the feet. A stove at Mr. Myer's, Cricketers' Arms, which weighs about 16cwt., was removed two inches from where it was fixed; an upright post supporting the roof of another place was split from end to end; some of the mortar was forced from between the stonework of the English Church; and the tinware, earthenware, and glassware, jingled in most houses. Many persons were in great terror at the unusual visitation, and several females who happened to be on the street at the time ran shrieking towards their homes.—*Yass Courier*, March 10.



The magnitude adopted here, ML5.2, is a minimum value, the maximum value, ML 5.5, is limited by the fact the earthquake doesn't appear to have been felt in Sydney.

**Figure 5** Locations where the earthquake on 5th March 1860 (EST) near Yass was felt. The ellipse delineates the felt area and its radius of perceptibility is used to compute the magnitude.



### 1860 08 16 at 16:30 UTC, Araluen

**EARTHQUAKE AT ARALUEN.**—This district has again been visited with an earthquake. Between two and three o'clock Friday morning, the inhabitants of Araluen (our informant states) were turned out of their beds in a state of great confusion, the shocks being very severe. The ground, with but short intervals, trembled for fifteen minutes (*The Sydney Morning Herald* Tuesday 21 August 1860, page 9).

### 1862 04 23 at 17:45 UTC, Tambaroora, near Sofala

*The Maitland Mercury and Hunter River General Advertiser* Tuesday 29 April 1862, page 2 mentions an earthquake was felt in the goldfields:

#### *SHOCK OF EARTHQUAKE.*

**SOFALA** — *Thursday, 12.30p.m.*—At 3.45 this morning the shock of an earthquake was felt in Sofala, almost every resident being sensible of it. The vibrations lasted for about one minute, causing glasses and bottles to jingle. The noise, like modulated thunder, was prolonged for about four minutes, becoming gradually feebler to its close. The direction of sound seemed to be from east to west.

**MUDGEES.** — *Thursday, 1 p.m.*—About four this morning the inhabitants of Mudgee were considerably alarmed by hearing a rumbling noise, and at the same time feeling a severe shock which caused the earth to vibrate, so much so that it shook the crockery from off the dressers in more than one house, and persons attempting to leap out of bed found that they could hardly retain their feet, but had to cling to the first thing within reach for support. The shock did not last more than one minute, and appeared to travel from south-east to north-west. This morning the weather is sultry and calm.

**BATHURST**—*Thursday, 2 p.m.*—Between three and four o'clock this morning several of the inhabitants of Bathurst experienced a slight shock of an earthquake, but as far as I can learn, no damage has been done.

Telegrams to the *Ovens and Murray Advertiser* of Tuesday 6 May 1862, page 2 reported it felt at Orange and the *Bathurst Free Press and Mining Journal* mentions it was distinctly felt at Windeyer and slightly at Clarke's Ck Merroo.

*Bathurst Free Press and Mining Journal* of Wednesday 30 April 1862, page 2 reports:

#### *TAMBAROORA.*

**EARTHQUAKE.** — *On Thursday 24th April instant, about the hour of 3 o'clock a.m., this locality was visited by a fearful shock of an earthquake. The oldest travellers, now residing here, who have spent the greater part of their early days in other countries subject to volcanic eruptions &c., say they have never experienced anything like it. The first sensation felt by those who were awake at the time was like the deep and awful growl of a coming thunderstorm close at hand which increased in its portentous sound. The bed on which the writer lay appeared as if about to be shaken from under him; and*

*the doors and windows to be torn from their hinges. The house, a substantial one built of wood, was so frightfully shaken that the inmates who had all waked up were fearfully terrified.*

To have been felt so widely, and at Sofala and Mudgee sufficiently to wake people, the magnitude had to be at least ML4 with an epicentre WNW of Sofala near 33°S, 149.6°E.

**Figure 6** The epicentral region is near Tambaroora, WNW of Sofala, where the shaking was very pronounced. Strong north-south oriented geological structure is visible on the satellite photo but associating the earthquake with any mapped faults would be imaginative.



#### **1862 12 19 at 19:00 UTC, Yass**

*Burrowa Times* Saturday Dec. 27, reports: *A slight shock of an earthquake was felt in Burrowa and along the road as far as Yass about five o'clock on the morning of Saturday last. How much farther off the shock was felt we have not yet been able to ascertain.*

The distance between Yass and Burrowa is about 48km, an epicentre midway yields a magnitude of 3.3, the minimum size of this earthquake, especially one at 5am local time.

#### **1865 02 13 evening local time, Burrowa**

*The Queanbeyan Age* Thursday 2 March 1865, page 2 briefly reported that on Monday evening, 13th instant, an earthquake was distinctly felt in several parts of the Burrowa district.

#### **1865 10 09 ?? time, Armidale**

*The Illustrated Sydney News* Monday 16 October 1865 mentions that an earthquake was felt for two seconds at Armidale on the 9<sup>th</sup>.

#### **1866 11 27 at 11:45 UTC, Bega and neighbourhood**

*The Illawarra Mercury* Tuesday 11 December 1866, page 3 mentions:

*Shock of an Earthquake. — On Tuesday evening last, the 27th, a slight shock of an earthquake was distinctly felt, not only by the inhabitants of the township, but, from information we have received it would appear that at Kamaruka and as far as Ma Hill's, the Accommodation House at Yellow Pinch, a similar vibration was noticed by many people. As near as we can judge the occurrence took place within a few minutes of 10 o'clock, and traversed in the direction of north-west and south-east. The atmosphere was thick and oppressive, and the first general impression seemed to have been that the singular sound was that of distant thunder. The shock lasted five or six seconds. — 'Bega Gazette.'*

This earthquake seems to have been very local to the Bega area and of short duration, so the assigned magnitude is 3.0.

### **1868 06 18 at 14:00 UTC, Maitland**

An isoseismal map of this magnitude 5.3 earthquake was compiled by McCue (1996) with supportive information from Hunter (1991). Rev. W.B. Clarke felt this earthquake and wrote widely in the newspapers about it without, as far as we know, drawing an isoseismal map. The ready access to newspapers through TROVE has made much more information available e.g. for the metropolitan area of Sydney that is useful for microzonation. What better way to estimate potential ground motion amplification than using a real earthquake!

The felt area is similar to that of 1842 and both are assigned magnitudes of 5.3, the largest earthquakes at Newcastle before 1989.

### **1870 03 26 at 09:45 UTC, Wallangra**

The Maitland Mercury and Hunter River General Advertiser 12 April 1870, page 4.

*WALLANGRA.*

(From the Armidale Express, April 9.)

*On the evening of Saturday, the 26th, there was distinctly felt a smart shock of an earthquake, the vibration lasting, I should imagine, about twenty-five seconds. It happened about a quarter to eight. Just previously myself and another gentleman were remarking on the sudden and extraordinary oppressiveness of the atmosphere.*

The duration is longer than for a close (smart) magnitude 3 event, the two bits of information leading to an assessment of magnitude of 3.5 in this sparsely populated region near the Queensland border.

### **April and June 1870, Swarm in North-eastern NSW**

#### **1870 04 10 at 11:20 UTC, Lower Macleay**

*The Maitland Mercury and Hunter River General Advertiser of Thursday 28 April 1870 page 3:*

*Shock of Earthquake at Macleay River Heads. —On the night of last Sunday, at twenty minutes past nine, a smart shock of an earthquake was experienced at the pilot station, at the heads of this river. The vibration was sufficiently great to cause the crockery to rattle on the shelves, and to stop a clock. A shock was also felt on Tuesday, the 5th instant, but it was of so slight a character that it was doubted whether it was a shock. The one on Sunday night, however, gave such distinct proof, that there can be no doubt as to its having been the shock of an earthquake. —S M. Herald, April 25.*

This event seems to have spawned a swarm of small earthquakes in the region.

#### **1870 04 18 at 08:00 UTC, Lower Macleay**

*Evening News Tuesday 3 May 1870, page 3.*

*Shock of an Earthquake on the Lower Macleay.*

*(From the Correspondent of the Macleay Herald.)*

*We have had another shock of an earthquake here. This makes the third one this month— viz., one on the 5th, another on the 10th, and the last on Monday the 18th, at about 6 p.m. The second one was felt at Warrell and Freshwater creeks and at Gumma Gumma. I have not heard how far this one has been felt from here. The shock came from the S.E., and there was a great deal of thunder and lightning at the time. The earthquake has raised a very heavy sea. I cannot account for the heavy sea now rolling in in any other way. On Sunday night, previous to the shock, the sea was smooth, but on Monday morning, although Sunday night was very calm and fine, there was an unusually heavy sea.*

*Since writing the above I hear that the shock on Monday was felt on the Nambuccra and Deep Creek. This morning, Friday, April 22, at a little before 6 a. m., just as it was getting daylight, we had two more shocks— one was pretty sharp, the other faint. They seemed to come from the S.W. The Messrs. Oakes who were down the river at the time felt the shock very plainly. The shock was also felt at Mr. Stewart's ship-building yard, the men running out of the house, imagining from the vibration and noise that one of the vessels had fallen off the ways.*

It was reported felt at Long Flat in the *Empire* Thursday 12 May 1870, page 3.

**1870 05 28 at 12:00 UTC, Crookwell**

*Australian Town and Country Journal* Saturday 7 May 1870, page 7.

*EARTHQUAKE AT CROOKWELL.—A correspondent of the Goulburn Herald, under date 2nd instant, says— We felt a shock of an earthquake on Thursday evening last, about ten o'clock. It was accompanied with a noise resembling very heavy distant thunder. The vibration lasted about thirty seconds; it shook the crockeryware on the shelves, and several persons who had gone to bed jumped up in amazement, not knowing what to make of it. It proceeded from the west.*

**1870 06 18 at least 22 small earthquakes, Lower Macleay**

*Empire* Thursday 7 July 1870, page 3.

*NINE SHOCKS OF EARTHQUAKE AT THE MACLEAY HEADS.*

*Mr. J. B. GARRARD, pilot station, Macleay River, reports : On Saturday, the 18th June, we had three shocks of earthquake ; the first and second shocks were pretty sharp. The first shock occurred at 11.30 a.m., the second about twenty minutes past 1 p.m., and the third about 5 p.m.*

*On Sunday, the 12th June, I was not on the pilot station, but my men told me they felt four shocks that day.*

*To-day, June 23rd, we had a severe shock at ten minutes past 6 p.m., by my time; it stopped my clock, and I think if my house had been a brick one some part of it would have fallen. There was another slight shock at 7 p.m.*

*The shocks on the 18th were felt on the Nambuccra, Warrel Creek, and other places. A young man named Smith, living on the Nambuccra, stated that the week before last he felt nineteen different shocks during that week.*

*I don't know whether you feel anything of them; they seem to be confined to this vicinity. I am inclined to think they have their origin in the Yarrahappini mountains, and living as we do at the foot of these mountains, we feel them most. And the same at the Nambuccra and Warrel Creek, as they lay only at the foot of these mountains. I should not be surprised if we feel more of them before the night is out.*

*All the fore and middle part of this day has been very cold, with a strong southerly wind blowing. Immediately after the first shock, the wind died away nearly calm, and it became quite warm. Another shock of earthquake, very severe, was experienced at ten minutes to two on Tuesday morning, the 28<sup>th</sup> instant.*

**1870 07 08 at 02:00 UTC, Markdale (between Crookwell, Oberon and Cowra)**

*The Sydney Morning Herald* Tuesday 26 July 1870, page 2.

*The Markdale correspondent of the Goulburn Herald says: —..... About noon of the 8th instant, a smart shock of an earthquake was felt here. It lasted several seconds, and apparently travelled from S.W. to N.E.*

This was a small local earthquake, assigned magnitude 3.0.



### **1870 08 03 at 20:30 UTC, Bellinger**

Newspapers report this shock was felt on the Bellinger River (several people), at Macleay Heads and Nambuccra River on 4<sup>th</sup> at various times (5a.m. sunrise or 6.30a.m.) but we accept this version from *The Maitland Mercury and Hunter River General Advertiser* Thursday 18 August 1870, page 3 (From a correspondent of the *Macleay Herald*):

#### **NAMBUCCRA RIVER.**

*Three very severe shocks of earthquake were felt here on the 4th instant. The first, which took place at 6.30 a.m., was particularly heavy, and in some residences shook the lamps and other articles off the tables, which were left on from the previous evening.*

### **1870 08 06 at 20:00 UTC, Eurobodalla**

The *Empire* Thursday 11 August 1870 carried an earthquake story:

*EARTHQUAKE SHOCK AT EUROBODALLA.—On Sunday morning, 7th August, just before break of day, we experienced a pretty smart shock of earthquake. The rumbling was such as might be occasioned by the passage of a heavily laden dray over a very rough metallic road. A continuous rattle of crockery, tin-ware, &c, &c., was kept up for thirty seconds at least. One violent jerk seemed, for an instant, to put our habitation in jeopardy. My eldest son and I, in different rooms, were awake some time before the occurrence; but the rest of the family were startled from sleep, and their exclamations and questionings some-what prevented the note I would otherwise have taken. However, its course appeared to be from the south-west.*

### **1870 08 24 at 16:55 UTC, Lower Macleay**

Apparently this swarm began in April, missed May and July but continued into August with severe shocks on 4<sup>th</sup> and the most severe of the sequence on the night of 24th August 1870 at 2.55a.m. and felt at Nambuccra and Bellinger (*Newcastle Chronicle*, Tuesday 13 September 1870, page 3). The swarm seemed to have petered out in October but a later shock was felt at Kempsey, Arakoon and Smithtown and on 4 October 1889.

An interesting discussion of the swarm appeared in *The Kiama and Shoalhaven Advertiser* Thursday 15 September, 1870, Page 4:

*SHOCKS OF EARTHQUAKE ON THE BELLINGER AND NAMBUCCRA RIVERS. Mr. JOHN BRAZIER, corresponding member of the Zoological Society of London, writes to the Macleay Herald, and states that a severe shock of earthquake was felt at Manarm Creek, Bellinger River, on the 24th August, at 2.55 a.m. The house worked, he says, and everything in it rattled. " The vibration was quick the few seconds it lasted, and the sound was like the passing of a railway train from east to west. At the time the weather was rather cloudy to the eastward, with faint flashes of lightning and wind from the south-east. .... If I remember rightly, there were nine or ten shocks felt at the Macleay Heads in July." .... The Nambuccra correspondent of the paper referred to reports four very severe shocks on the night of Tuesday, the 23rd August. They were by far the most severe that have been felt on that river, and they seemed to come from the north-west.*

### **1870 09 ??, Lower Macleay**

The *Sydney Morning Herald* Friday 16 September 1870, page 3 mentions:

*From Nambuccra River, on the 6th. instant, it is reported that..... We have lately had several shocks of earthquake. They commenced about 11 o'clock at night, and continued with slight shocks until 3 o'clock in the morning—when the final one made the house I was in violently tremble. When we are to be free from these visitations I do not know, or what their ultimatum will be I cannot surmise. They are certainly very unpleasant, to say the least.*

### **1870 10 no time, Lower Macleay**

The *Evening News* of Thursday 13 October 1870 page 2 reports another slight shock at the heads in the last few days but no details.

### **1871 05 01 at 20:55 UTC, Braidwood**

The Newcastle Chronicle (from the Braidwood Monitor) records an earthquake felt at Braidwood:

*Between four and five minutes to 7 o'clock on Monday morning, we experienced a rather strong shock of an earthquake here. We were at the time sitting in our office, and distinctly heard the rumbling noise which accompanied the shock ; it resembled to us that of a coach passing over a wooden bridge, situated at a little distance. The vibration was perfectly distinguishable, though not violent, causing a good tremulous motion to the table at which we were, also to the chair which we were occupying. We should say it did not last over a second. From the inquiries we have made, we find that it was generally felt and noticed by the inhabitants, and many versions are given as to the effect of the sound and shock upon different people in different situations. It appears that it was felt much stronger at the southern end of the town. At Mr. Walsham's dwelling, on the Araluen road, the vibration was so strong that it not only shook the house but every thing inside of it, making all the glasses fairly rattle again. It was also felt very forcibly at Bedervale, the residence of R. Maddrell, Esq. Some who were in bed at the time felt the bed shake under them. Some describe the noise as if something had fallen down in the store ; others, as if someone was shaking the front door violently ; those who were out of doors state the sound to have been something like distant thunder. A man who was standing on a ladder at the time, felt the vibration very perceptibly. The shock was felt by the patients in the hospital, one of whom stated that it was similar to those he had felt in New Zealand. Another informant also corroborates the statement, he having been in Wellington when several severe shocks took place. It was also felt at Mr. Steward's, Farrington, Elrington, and at Jembaicumbene. We give time by our clock, which we looked at immediately after the occurrence.*

The strong but short duration of shaking indicates that the earthquake was local and small, perhaps magnitude about 3.5.

### **1871 06 08 at 04:40 UTC, Tumut**

Dr Dirk Spennemann, Charles Sturt University, investigated a number of earthquakes in the Tumut, Albury, Adelong area, including this one and four of its aftershocks for which he compiled isoseismal maps, redrawn by GA to their standard format. The mainshock, magnitude about 5.3 based on the felt area, is interesting; it damaged the local public school, was felt strongly underground and was followed by aftershocks till at least September and ultimately another magnitude 5 earthquake on 3 January 1972. There are no reports in the Manaro paper of the mainshock being felt in Cooma or further to the southeast.

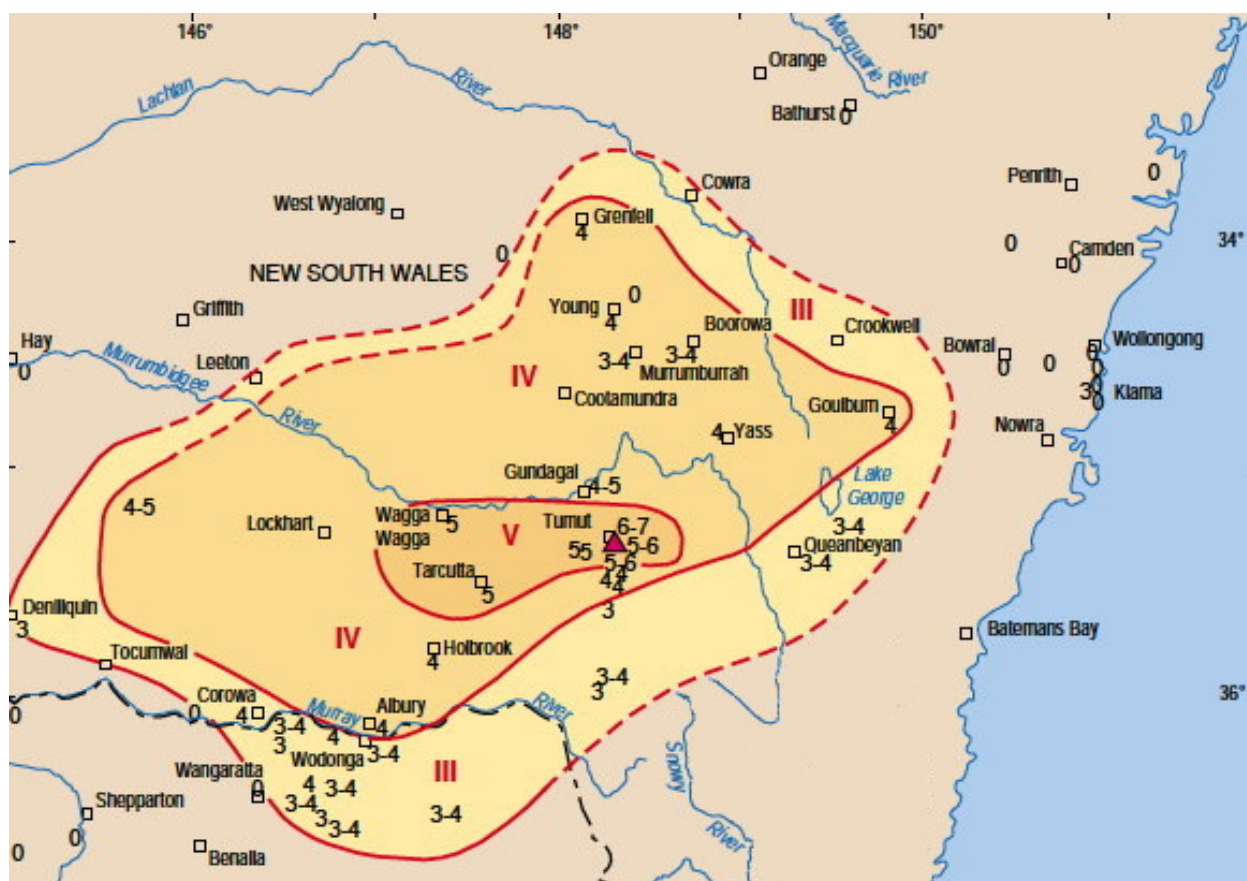
*The Manaro Mercury, and Cooma and Bombala Advertiser, Saturday 17 June 1871, page 3.*

*We have just experienced a very heavy shock of earthquake. Our townspeople all ran out of their houses, thinking they were coming down. I (the correspondent) was, with others, standing on the Camp Reef at the time, where the shock was so severe that it displaced an anvil from a log of wood. The men working in each ride of the deep shaft thought its sides would come-in on them. In Messrs. Henwood and Co.'s shaft, the deepest on this reef, Mr. W. Long was in the act of bailing water with a dipper, when the tools in the shaft began to dance, and the dipper to strike against the wall. In a short time, Long, thinking every thing had given way at top, made his ascent to grass. On gaining the open air, he found his mates as much surprised as he was, and those of the next claim, who had also come to earth, as greatly alarmed as he himself had been. In*

many of the houses in the township, plates, glasses, &c, were thrown down or shaken out of their places; and at the Public School, I believe, the books were thrown from their shelves, the master at once dismissing the children for the day.

From the manner in which horses and cattle ran about during the time the shock lasted, I fancy they were as much astonished and alarmed as their owners.— June 8th. At the Adelong Crossing-Place, we understand the shock was more severe than at Gundagai.

A portion of the gable end of a strongly-built stone kitchen attached to the Home Hotel was cracked, and the rafters, with some planks on them, forming a kind of loft, were displaced. In the bar of this hotel, bottles and glasses on the shelves tumbled to the floor. It may be surmised that the inmates of the house were considerably alarmed. We believe the shock also did damage to Mr. Walsh's smithy. A new stone house, built by Mr. Neaves, has been so disturbed that its chimneys will probably have to be pulled down. The Public School building has been slightly canted to one side, and its chimney much injured. All the crockeryware in this educational establishment was, we believe, broken; and a large desk fairly danced on the floor, to the great alarm of the scholars, who thereupon rushed out of doors, somewhat fearful that the suddenly-animated piece of school furniture would follow them.



**Figure 7** Isoseismal map of the ML 5.3 Adelong earthquake of June 8, 1871 (after Spennemann, 1991).

#### 1871 07 13 at 16:00 UTC, Adelong – another possible aftershock

*The Manaro Mercury, and Cooma and Bombala Advertiser* Saturday 15 July 1871, page 3.

**EARTHQUAKE.** — Another shock of earthquake, accompanied by the usual rumbling noise, was, we have been informed, distinctly perceptible at Snowball Creek, at 2 o'clock on Friday morning; it seemed to pass off towards Adelong. A fainter vibration of the earth was also experienced in the same locality on Wednesday morning last.

Snowball Creek is about 17km north of Adelong, and this event may well highlight the epicentral region of the earlier, much larger earthquake on 8<sup>th</sup> June 1871, north of Talbingo reservoir.

### **1872 01 03 at 13:30 UTC, Kiandra NSW earthquake**

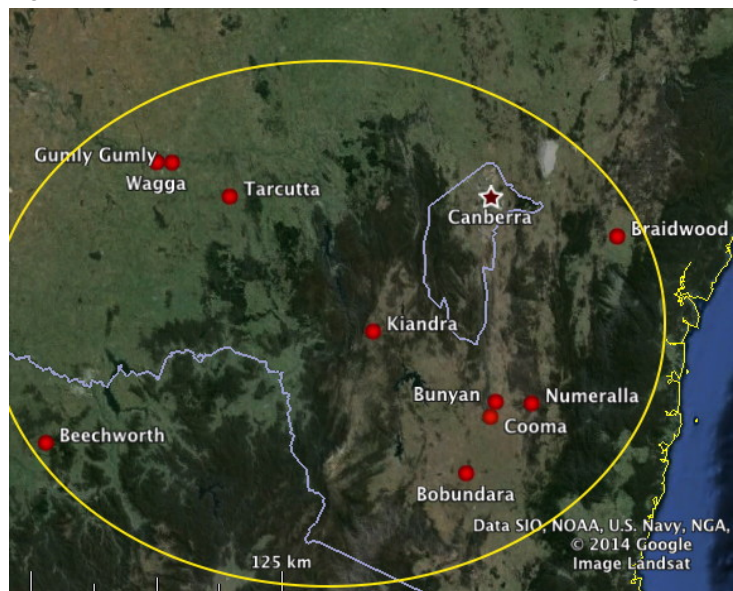
*Evening News Tuesday 9 January 1872, Page 3.*

#### *Shock of an Earthquake*

*At twenty-five minutes to 12, or about midnight on Wednesday last, says the Monaro Mercury, a violent shock of earthquake was experienced in Cooma, causing no little alarm to our townspeople. The vibration of the earth was most distinctly felt, and housewives and others perceived that crockery, glassware, bottles, and other things had for a few moments become possessed of vitality. The earthquake seemed to pass from north to south, and lasted but a few seconds. A gentleman, writing to us on Thursday last, says: — 'I was writing at the time, and heard it in all its solemnity, as did equally the servants in the kitchen, who were in no small degree alarmed. The shock, according to the clock in the kitchen, must have occurred within about five minutes to 12 o'clock. At the Cooma Hotel, and other places in Massie-street, the shock was surprising; in the former place, a person walking across one of the rooms at the time of the subterranean commotion grasped the table; a legal gentleman, who was then engaged in writing, formed some strange hieroglyphics on the sheet of paper before him. Messrs. Carey and Benke, of the Criterion Stores, describe the sensation as being a most unpleasant one, and the rumbling noise accompanying the shock as if a number of heavy articles had been rolled over the roof of the premises.*

**Figure 8** Felt area of the 3 January 1872 earthquake near Kiandra NSW. The felt area is consistent with a magnitude of 5.2.

*In the Monaro Mercury office, some of the printing material was shifted out of its place, and the position in which it laid indicates that the shock came from the north. Teamsters who camped on the plains say they were lifted up from the ground and laid down after a gentle rocking motion by the earthquake. Of course, there are various opinions as to the direction of*



*the underground traveller, and as to the exact time of the visitation; we believe the time was twenty-five minutes to 12 p.m. The vibration was very forcible at Bunyan. A private telegram from Kiandra speaks of the shock of earthquake there as having been very alarming. We are informed that the shock was felt by the residents of Seymour. At Umaralla, the shock was also distinct, and it is said that it resembled a number of horses galloping towards the river. At Cottage Creek, near Bobundarah, the shock was severely felt; the inmates of Mrs Pendergast's house expected the building, which is a large stone one, to fall, so great was the vibration At Riverslee, the residence of Mr. W. Gosgrove, the effects of the earthquake were visible by the oscillating motion causing everything in the house to tremble. We have no doubt the earthquake was felt throughout the whole district.*

*On Wednesday night last, at about half-past 11 o'clock, the people of Wagga Wagga says the Express were, for the sixth or seventh time within the last half year, startled in their shaking houses by the shock of an earthquake. The shock consisted of a series of sharp quivering vibrations, with the unpleasant sensations of which we are becoming by far too familiar, and was certainly the most violent yet experienced in the district It lasted, as nearly as could be judged, about fifteen seconds, and so violently agitated the houses that in very many instances*

*they could be seen to move. Suspended pictures and lamps, light ornaments, and household effects, swayed rapidly backwards and forwards, while weighty articles of furniture bumped heavily against the walls, and created, for the time, a very general alarm. The shock was accompanied with the usual rumbling noise, but, as far as we have learnt, does not appear to have caused any damage to buildings. At Berambula, the family of Donnelly, who had all retired to rest, were so alarmed by the shaking of the house that several of them jumped out of bed and were preparing to make a rush for the open air when the motion ceased and calmed their fears. At Tarcutta, Ten-mile Creek, and other places in the neighbourhood shocks were also felt.*

#### **1872 10 18 at 09:50 UTC, Jenolan Caves**

This earthquake just before 7 pm was widely felt in Sydney, Newcastle and central-east NSW, from Queanbeyan in the south to Stroud in the north and as far west as Orange. At Bathurst, chairs were overturned and dishes smashed but no building were damaged. The location and magnitude, derived from the isoseismal map, are given by McCue (1996) where the time is incorrectly given as 18:50 GMT.

#### **1872 11 16 at 18:50 UTC, Queanbeyan**

The most severe earthquake ever experienced in Queanbeyan is how it was described in the *Australian Town and Country Journal* of Saturday 23 November 1872. At Gundaroo, only 35 km away it was described as slight so its epicentre must have been near Queanbeyan and at least magnitude 3.5.

#### **1873 05 19 at 08:20 UTC, Lithgow - Portland area**

This earthquake was felt slightly in Sydney and as far away as Bathurst (smart) but not as strongly as the earthquake of 16 October 1872 in a similar location.

*A SHOCK of earthquake was distinctly felt at various places in the colony on Monday evening last. The vibration was felt by several persons in Station-street, Newtown, about a quarter past 6, while our Sofala correspondent states there was a slight shock there accompanied by a rumbling kind of noise about ten minute to 6, which lasted about a minute, the wave seeming to come from the south-west. Telegrams from North Richmond announce that a shock was felt there at twenty minutes after 6, the direction apparently from north to south. A similar telegram was received from Bathurst and the Times of Wednesday observes:—" On Monday evening last, about twenty minutes past 6, the shock of an earthquake was felt by the residents of Bathurst. As on the last occasion, the shock, though not nearly so violent, was accompanied by a low rumbling sound, which came from the north-west, and died away towards the south-east, and while it lasted a trembling sensation was felt throughout the city. The weather during the day was extremely dull and cold, but as the sun descended, the sky along the western horizon was covered with a fiery red colour." The Hill End Times, of the same day, said two or three small shocks were felt there on Monday, especially one at sixteen minutes past 6 p.m., passing from north to south, which lasted about eleven seconds. The Rev W. B. Clarke says the shock felt at North Richmond about twenty minutes past 6 o'clock on the evening in question, was also felt at the North Shore." "It was accompanied," says the rev. gentleman, " by a noise very similar to that which attended the last shock felt in Sydney on the 18th October, 1872, and by shaking of windows. It was preceded by a slight shock on Sunday morning. I happened to be awake, and found the time by my watch to be four minutes past 3. It was not accompanied by any noise, but the whole house (which is strongly built of stone) trembled, much like a ship struck by a heavy sea during two seconds.*

A note in a contemporary SMH (21 May 1873, page 3) says it was felt in the suburbs. In his remarks on the weather for May 1873, Mr. H. C. Russell commented that it was felt at Mudgee,



Mount Victoria, Woodford and South Head while the Empire says it was felt (slight) at Chambers Creek. The approximate magnitude, based on the felt area is 4.5.

METEOROLOGICAL OBSERVATIONS.  
GOVERNMENT OBSERVATORY, SYDNEY.  
Latitude, 33° 51' 41". Longitude 10h. 4m. 46s.  
Magnetic variation, 9° 32' 22" East.  
MAY, 1873.

**1873 07 22 at 06:55 UTC, Marulan (Morowollen)**

*The Goulburn Herald and Chronicle Wednesday 30 July 1873, page 2. MOROWOLLEN. A shock of earthquake was felt here on Tuesday last, at 4.55 p.m., by many of the inhabitants of this town and also the district. There are different accounts prevalent as to the effect it had. One person says that his table was shaken from one side of the room to the other but I rather think he was jesting. The shock in my opinion was not a very severe one. The first symptoms were a rumbling noise as of distant thunder, and then a slight vibration, scarcely discernible to any one unacquainted with the like. July 28th.*

**1873 09 23 at 16:45 UTC, Goulburn**

According to the *Herald* and other newspapers, a shock of earthquake was generally felt in Goulburn at a quarter to 3 o'clock in the morning of Wednesday 24 September 1873. *The Maitland Mercury and Hunter River General Advertiser* says many persons in Goulburn were awakened and that it was felt throughout the district surrounding Goulburn so it warrants at least magnitude 3.

**1874 01 22 at 12:00 UTC, Tumut**

The *Sydney Evening News* of Friday 23 January page 2 blandly reports an earthquake was felt in Tumut at 10pm last night – no other details. *The Gundagai Times and Tumut, Adelong and Murrumbidgee District Advertiser* Saturday 31 January 1874, Page 3: The 'Tumut Times' reports that on Thursday week last a violent shock of earthquake was felt by some of the townspeople both at Tumut and Adelong (Ed. ~15km apart.).

**1874 12 14 at 01:00 UTC, Goulburn**

Slight shock of earthquake at Goulburn at 6am on the 11<sup>th</sup> (December 1874) according to the *Abstract from Meteorological Stations* for December 1874 published in *The Sydney Morning Herald* on Thursday 18 February 1875, page 6.

**1875 01 25 at 00 UTC, Cooma**

This was obviously a small local earthquake at Cooma judging by the description in *The Manaro Mercury, and Cooma and Bombala Advertiser* Saturday 30 January 1875, page 2.

*EARTHQUAKE.— A shock, vibrating from north to south, was perceptible in Cooma about 10 o'clock on Monday morning, the earthquake lasting nearly a second, and being preceded by a rumbling sound like thunder.*

**1875 04 13 at 15:00 UTC, Albury - Meteor**

The *Evening News* reported this an earthquake but then mentioned a meteor passing overhead almost simultaneously at 1 a.m. so we can suppose the sound and shake can be attributed to the shock wave from the meteor.

**1875 06 03 at 10:00 UTC, Cobar and aftershocks**

The following account (by T.J. Knight Kohn) of an earthquake in western NSW is perhaps exaggerated, but, given the felt area, it was obviously quite a strong event.

*The Riverine Grazier*, Wednesday 16 June 1875, page 2 reports:

*The writer, travelling from Bourke to Hay via Cobar, on Thursday evening, 3rd inst., was at Corilla, 80 miles north of Cobar, about 8 o'clock p.m. Heard a long rumbling sound, beginning slow, gradually swelling, and then decreasing until lost in the distance. Though he had never heard or felt an earthquake, the impression made on his mind was that a shock had been felt, and, as he thought, in the direction of Cobar. Proceeding on his journey he found that, at Tindara, distance 40 miles from Cobar, a shock of earthquake had had been felt causing great excitement; the people rushing out of their house expecting it to fall. At Cobar the excitement was intense, on the evening in question; the first sound heard was as though empty iron tanks were being beaten, followed in two or three minutes by a terrific shock as if an explosion had taken place immediately underneath. People rushed out of the houses with their hands over their heads, expecting the walls to fall; women were screaming in all directions, and some were frightened into hysterics. The men down in the Cobar mine rushed up, (and it is stated they got up in a fourth of the time the usually take). The commotion extended to the blacks, who cleared out of their camp, screaming and shaking. Their idea of the occurrence was, " that blackfellow jump up in some other country."*

*On Sunday morning, about 10 a.m., another shock was felt by myself and others, not so violent as the first, but still of considerable force, having split a chimney and caused a crack two inches wide. Proceeding on my journey I found as I got further south from Cobar, the shock was also felt, until near the Willandra; about 150 miles south, only a faint rumble was heard like a distant roll of thunder.*

*Altogether between the evening of Thursday and Sunday morning over 20 distinct shocks were counted. The writer requested a resident to give his version which is annexed hereto.*

*Cobar, June 7th. — On Thursday night, the 3rd inst, about 8 o'clock, the whole of Cobar was thrown into great commotion by a frightful shock of an earthquake. The shock appeared to come from the north, and lasted about three minutes. [The foregoing writer thinks the direction of the shock was from west to east.] The nearest description I can give of it is, that some great explosion had taken place near at hand, the vibration being so great that every board in my house trembled to such an extent that those standing kept their feet going, as though they were on a treadmill. I have often heard of people's hair standing on end, but never witnessed it until the night in question. Children were awoke from their slumbers, their little hearts beating like the tick of a watch. Mothers' screaming and falling off into hysterics, miners rushed from their work below, fearing the whole mine was falling upon them. Parties out burning charcoal saw their kiln rise in front of them, the fright of which threw them off their equilibrium. Horses and cattle galloped about like mad. People knelt down and prayed, in fact many thought their last hour had come. I have felt two shocks before in Victoria, but nothing to equal the one felt here. Another heavy shock occurred about 3 o'clock on the morning of the 4th inst, causing the sleepers to roll from their beds; that is those that were in bed, many being too frightened to take their usual rest. We have had a succession of shocks up to Sunday, (6th inst) 10 a.m. At Tindara the shock was also great causing the water to over-flow from the bank, and throwing glasses and crockery from the shelves.*

*The South Australian Register* Thursday 17 June 1875, page 7 briefly mentions the earthquake in its "River District Notes":

*Brewarrina. — The river is rising at the rate of 1 foot in twenty-four hours. A shock of earthquake was experienced here yesterday ..... It is mentioned that a shock of earthquake was experienced in Bourke on the 3rd.*

This region of western NSW was not densely populated but the felt area is very large. With an epicentre near Cobar where the intensity was high, the felt distance north and south of about



150km indicates a magnitude in excess of 5, though there are no reports from Nyngan about 120km to the east.

#### **1875 07 04 at 20:40 UTC, Watson's Bay - American Independence Day**

Given the date, and the location, it is possible that this was some sort of maritime tribute to American Independence Day, rather than a genuine earthquake. The *Evening News* Tuesday 6 July 1875, page 2 reports it as an earthquake:

*Earthquake at Watson's Bay.*

*Yesterday morning an earthquake shock was felt at Watson's Bay. Captain Jack, one of the pilots stationed at the bay, states that he felt the shock, that it caused his house to vibrate, and that the time was about twenty minutes to 7. The shaking of the earth lasted for a few seconds only, but it was felt by people in all parts of the bay, and more distinctly on the upper portion of the ridge. At the Signal Hotel the lamps and the crockery on the shelves were shaken, and similar signs were noticed in other houses. Some people say that they felt a second shock, but this is doubtful. No extraordinary rise of the tide in the bay was noticed. Mr. Sayers, cashier in the General Post Office, and living near the Signal Station, felt the shock distinctly, and noticed the bedsteads and other things in his house vibrate. He believes the course of the earthquake was from north to south. The shock does not appear to have been felt nearer Sydney than Watson's Bay.*

#### **1875 07 11 at 06:00 UTC, Bega and Eden**

The *Newcastle Chronicle* Thursday 15 July 1875, page 4 itemised an earthquake:

**EARTHQUAKE AT EDEN AND BEGA**

*Herald's Telegram.*

*EDEN, Monday. — An earthquake, accompanied by a loud rumbling sound like the rolling of thunder, occurred here yesterday, at 3.40 p.m. The shocks were sufficiently severe to rattle the windows of the houses and of the church. They lasted five seconds. The direction of the wave was from north-west to south-east.*

*Bega, Monday. — A shock of an earthquake was felt here on Sunday afternoon, at four o'clock. It was accompanied by a heavy rumbling noise, and lasted several seconds. The direction was apparently from south-east.*

A minimum magnitude, assuming an epicentre midway between Eden and Bega where the intensity was similar, would be ML3.5, subject to further information. Other townsfolk at Candelo and Pambula should also have felt the earthquake.

#### **1875 07 16 at 01:12 UTC, Southern Monaro – Bega and Eden**

*Another Earthquake at Bega Friday.*

*Another shock of earthquake was felt here at eleven minutes past 11 this morning. There was a heavy rumbling noise as the wave passed north-wards. Crockery, windows, and chairs rattled. It lasted about four seconds.*

The *Sydney Morning Herald* Saturday 17 July 1875 page 9 (3 different stories) noted this earthquake was felt at Bega, Eden, Burnima, Maharatta (station near the site of modern Bombala) and Bombala though not as strong at Bega and Eden as the Sunday earthquake. The magnitude had to be at least 4.0.

#### **1875 08 05 morning local time, Albury**

The *Evening News* of Saturday 14 August 1875 page 4 mentioned this earthquake, *distinctly perceptible to several persons* but without details of time or whether felt elsewhere.

#### **1875 09 25 at 12:00 UTC, Bowral**

The *Australian Town and Country Journal* Saturday 2 October 1875, page 9 reported this earthquake:

*EARTHQUAKE. —On Saturday evening last a slight shock of earthquake was felt by the residents of Nattai, Bowral, Kangaloon, and Burrawang. I happened to be stopping at Burrawang for the night, and was sitting at the table engaged in conversation with my host, when the shock came. We first heard a rumbling, like the noise of distant thunder, or like the rushing of a herd of cattle when frightened from the camp; and this was almost directly followed by the vibration, which seemed to strike the house with considerable force. The door of the room in which we sat faced the south, and it shook in its frame as if it were severed and violently shaken by the hand of man. The dogs were lying quietly at the back or north side of the house, but they ran, evidently alarmed and barking, in a southerly direction. The sound and the shock must have lasted eight or ten seconds; and, on looking at my watch, which I did within a few seconds after the vibration had ceased, I found that it wanted twenty-two minutes to 10 p.m.*

*I could not be sure as to the direction of the wave, but the sound seemed to be travelling from north to south. I shall be glad to get your issue of to-day, which will reach us at 9 this evening; for I think it not unlikely that some places further north received a greater shock than we did.*

On the same page it was also reported felt at Kiama, Shellharbour and Albion Park. Yet other papers say it was felt at Berrima and Mittagong. The felt area is consistent with an earthquake of magnitude 4.0.

#### **1876 01 21 at 04:30 UTC, between Bathurst and Hillend**

Evening News Thursday 27 January 1876, page 2.

*Shock of Earthquake at Bathurst.*

*On Friday last about 2 o'clock, reports the Bathurst Free Press, a distinct shock of earthquake was felt in several parts of the district, although we have not heard that any one in Bathurst noticed it. At Brucedale the trembling was very perceptible, the shock being preceded by the usual rumbling noise. At O'Connell Plains it was also felt, and the crockery and other goods on the shelves of Mr. Thompson's store were considerably shaken and disturbed.*

The shock was also distinctly felt at 2:00pm at Hillend where buildings shook severely according to a Hillend paper. This was obviously a small local earthquake between Bathurst and Hillend, magnitude 3.2.

#### **1876 02 08 at 07:15 UTC, Lithgow**

*LITHGOW. On Tuesday, the 8th instant, a slight shock of earthquake was felt here, which lasted for about two minutes. It occurred about a quarter past 5 o'clock in the evening, and seemed to travel in a north-westerly direction. The noise resembled the rumbling of a heavy coach over a new road. Some thought it was blasting in the mines, others that it was a train (SMH Saturday 26 February 1876, page 6).*

This seems a long duration for a small local earthquake but that's how we will categorise this one unless more information becomes available.

#### **1876 08 03 at 01:20 UTC, Yass and Gunning**

*The Sydney Morning Herald* of Friday 4 August 1876 page 5 reported an earthquake:

*YASS.*

*THURSDAY.*

*A sharp shock of earthquake occurred at twenty minutes after 11, and was distinctly felt in the court and all over the town. The direction was apparently from north-east to north-west. A second slighter shock took place a few minutes afterwards.*

*The weather has completely changed since the earthquake. A steady warm rain has fallen. The shock was felt at Gunning.*

*The Goulburn Herald and Chronicle* of Wednesday 9 August, page 2 commented that it was also felt slightly at Collector. The most likely location is near Dalton, north of Gunning about

equidistant between Collector and Gunning because of the report at Gunning of the aftershock, the magnitude is ~3.5.

**1877 02 27 at 08:00 UTC, Carcoar**

An 'explosion' was heard by some persons in Carcoar about six o'clock on Tuesday 27 February 1877 and at Trunkey Creek and Mandurama (*Evening News*, Wednesday 28 February 1877, page 2). This must have been a very close small local earthquake at Carcoar.

**1877 11 28 at 02:30 UTC, Bombala**

This earthquake was described in the *Evening News* Tuesday 4 December 1877, page 2.

*On Wednesday morning between 12 and 1 o'clock, says the Bombala Times, a slight shock of earthquake was felt at Maharatta station, also at Bombala, the noise resembling that of distant thunder, and at the time the sky was beautifully clear, not a cloud visible. The wave was travelling from south to north. Mr. James Hayden, informs us that he was conversing with some friends at Delegate, at about 11.30 a.m., when they distinctly felt a severe shock, and at the same time heard a great noise. The day being very fine, they looked round to see where the noise came from, and in the direction of the Buldah Mountains, distant about 15 miles, they perceived an immense cloud of dust towering up towards the sky.*

The 'great noise' and 'immense cloud of dust' surely signifies a landslide triggered by a nearby earthquake and at the distance from Bombala would signify a magnitude of about 4, any larger and it would have been felt more widely, any smaller and it should not have triggered a landslide.

**1878 02 03 at 02:00 UTC, Berridale**

*Queanbeyan Age* Wednesday 6 February 1878, page 1.

*COOMA. Tuesday 5.15 p.m. A shock of an earthquake which lasted some moments was felt at noon on Sunday. The Roman Catholic Church shook and the lamps clattered. It was also felt at Buckley's Crossing (now called Dalgety) and Adaminaby.*

The absolute minimum magnitude is 3.5. The location is between Berridale and Eucumbene Dam near the epicentre of the May 1959 magnitude 5.3 earthquake that has been incorrectly associated with the filling of the Eucumbene Reservoir.

**1878 06 08 at 05:08 UTC, Yass – shaking probably caused by a meteorite**

The *Evening News*, Saturday 15 June 1878, page 5 reports on an earthquake felt in Yass and Breadalbane: *On the Murrumbidgee, at Mr. P. Molloy's, a meteor was seen travelling along the horizon, and after it burst a great volume of smoke was left behind. Immediately following this the rumbling noise and shaking of the earth were felt and heard.*

**1880 07 31 at 07:00 UTC, Coonamble**

The *Evening News*, Saturday 6 February 1892, page 3S lists earthquake reports collated by Mr. H. C. Russell (Government Astronomer) starting with:

*1880 — In the Coonamble report of July 31 it appears that at 5 p.m. a peculiar noise was heard for 250 miles along the Castlereagh River, and for a range of 50 miles wide. It was like the discharge of rifle and cannon, or as if a large iron tank was bumping on the ground. Mr. Steuglin heard it, and said the blackfellow with him got off his horse and went down on the ground in terror, saying, " Devil devil coming " and even the horses shook with fear. It was heard by many persons all over the area specified, and seems to have been confined to these limits.*

This is a very eccentric area representing an earthquake of at least magnitude 5.4 (I assume it was an earthquake). The location is very uncertain, the Castlereagh River flows downstream through or near the towns of Coonabarabran, Binnaway, Mendooran, Gilgandra and Coonamble, but is taken here to be near Coonamble. This stretch of the river around

Coonamble is remarkably straight and oriented SSE, or more nearly NS, and looks to be strongly fault controlled.

#### **1880 11 26 at 03:15 Walcha**

*The Sydney Morning Herald* Saturday 4 December 1880, page 5 reports a small local earthquake:

*A SLIGHT shock of earthquake was experienced in Walcha on Friday, October 26th (the correspondent of the Times reports), when, at a few minutes past 1 o'clock p.m., the people were startled with a slight report as of blasting, seemingly proceeding from underneath. The noise was accompanied by a distinct vibration of the earth, which lasted from three to four seconds, as near as I can determine, though the sensation caused by the shock continued for perhaps a quarter of a minute. The explosion died away in the distance with a low rumbling sound resembling the gradual decadence in the sound of very distant thunder. In some houses, glassware, &c, jingled on the shelves, while the rattle of the walls and roofs was easily perceptible. This was more especially the case with buildings built of brick, wooden ones seeming to "give" with the subterranean motion. From information gathered from various sources, I am led to believe that the shock was much more severe at Europambela, four miles away to the east, than in town.*

October 26, 1880 was a Tuesday, but November 26 was indeed a Friday. Other newspapers such as the *Australian Town and Country Journal* 4 December 1880, page 9 reported the earthquake occurring in November 1880.

#### **1881 05 10 at 07:00 UTC, Nulla Nulla/Macleay**

*The Sydney Morning Herald* Wednesday 11 May 1881, page 5 and Friday 13 May 1881 Page 5 mention an earthquake:

*NULLA NULLA.*

*TUESDAY.*

*A distinct shock of earthquake was felt here at twenty minutes past 5 this evening.*

and

*CENTRAL KEMPSEY.*

*THURSDAY.*

*Several distinct shocks of an earthquake are reported to have been felt on Tuesday afternoon, at Bellinger and Macleay Heads.*

The Macleay District was certainly turned-on in the years 1870 to 1910 but quiet thereafter.

#### **1881 09 23 at 00 UTC, Tenterfield**

The *Southern Argus* of Friday 30 September 1881 page 2 labels it a supposed earthquake: *Supposed Earthquake.*

*On Friday week last (the Tenterfield Star relates) a strange sensation was experienced in this locality which has led to the belief that the district was visited by an earthquake. About 10 o'clock in the morning a loud report, or rather it is described as a dull, heavy thud as of blasting, was heard, which was followed by a rumbling reverberation as of thunder, accompanied in some places by a trembling of the earth. At the time it was heard the sky was very clear, with no sign of any disturbances by thunder. From the intelligence that has reached us the shock seems to have been felt in the immediate neighbourhood of the town, at Bryan's Gap, the Ten-mile, Boonoo Boonoo, Wilson's Downfall, and we hear also at Stanthorpe. At a settler's homestead at the Ten-mile the house was visibly shaken and the crockery rattled on the shelves, while those about the place were much alarmed.*

Felt over this area centred on the NSW/Qld border, the magnitude had to be at least ML3.5. A quite spectacular fault system, less than 20km east of Tenterfield, can be seen on Google Earth imagery.

### 1881 09 30 at 11:30 UTC, Adelong and Tumut

#### *An Earthquake.*

*On Friday evening last at about half-past nine o'clock a most unearthly sound was heard, which frightened, not the people of Tumut so much as our outside neighbours. It passed like the "bang" of a huge drum and could not have been alone local in its operation, for not only did our neighbours apprise us at once of their experience, but our reporter who happened to be in Adelong at the same time, heard the mysterious sound, and questioned others to corroborate him in his auricular testimony. The noise was not dissimilar to the kind of slow crash which accompanies an earthquake but there was no sense of surface disturbance in any way. No windows were broken, and no crockery disturbed; nevertheless the detonation was very distinct. Since experiencing this remarkable disturbance, we have questioned others who reside 'twixt here and Adelong, and find that they also were 'surprised' about the same time. We are no strangers to earthquakes in this district, and therefore it may be reasonably presumed that the loud and almost unearthly report heard on Friday night had some affinity to an earthquake. — T. and A. Times.*

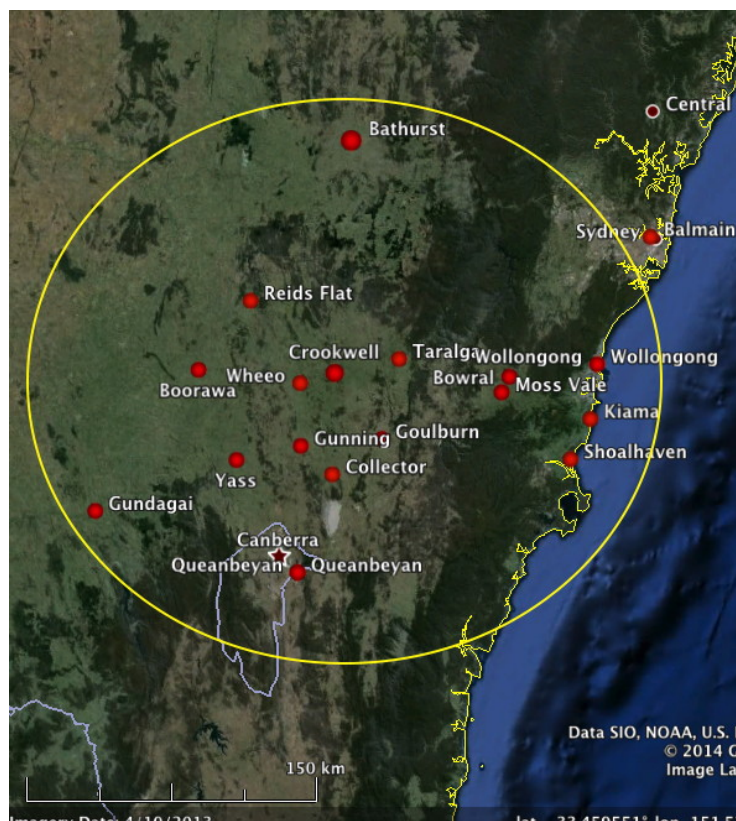
There can be little doubt as to the cause of this bang – a shallow, close but small earthquake.

### 1883 08 29 at 14:00 UTC, Crookwell

*The Sydney Morning Herald* of Friday 31 August 1883 (page 5) reported that an earthquake had been felt in Goulburn, Kiama and Taralga about midnight on Wednesday 29 August 1883. The *South Australian Advertiser* says the shock was also felt at Collector, Bowral and Crookwell.

*Morning Bulletin* (Rockhampton, Qld), Saturday 1 September 1883, page 3 reports: *Shocks of earthquake are reported to have been felt at Burrowa, Mossvale, and Balmain, and at Bundaroo, near Mossvale, a loud report like the discharge of a cannon was followed by a rumbling noise, which lasted for several seconds. The iron roofs on the house rattled briskly, and houses were shaken.*

**Figure 9** The ellipse encompasses places where shaking was reported felt during the 29 August 1883 Crookwell quake.



THE *Goulburn Herald* says:—A strong shock of earthquake was felt in Goulburn and surrounding districts on Wednesday night about 12 o'clock. It was accompanied by a rumbling noise, and was sufficiently powerful to cause windows and doors to shake, and articles of crockery and glassware to rattle. In the upper floor of a three-story house the vibration was strong enough to overturn a jug which was standing on the floor. Many persons were awakened by the shock, and some not a little alarmed. The duration of the shock was estimated by persons who were up at from 10 to 30 seconds, the former period being probably nearest the mark. The direction of the wave has been stated variously according to the locality and the observer, some saying from north to south, others from west to east, and others from south-west to north-east. It was felt very strongly towards the Shoalhaven, and at Reevesdale, near

*Bungonia, was powerful enough to shake over a small pile of firewood stacked against the house. It was slight at Bowral, and strong in the direction of Crookwell and Taralga.*

This felt area corresponds to an earthquake of magnitude about ML 5.2, with an epicenter between Crookwell and Goulburn at (34.5°S, 149.7°E).

Coincidentally, this earthquake occurred within 24 hours of the earlier magnitude 5.9 Gayndah earthquake in Queensland, and a month after a large earthquake off NE Tasmania, to say nothing of disastrous earthquakes in New Zealand and Italy in August 1883. Krakatoa also erupted the same month.

#### **1883 09 20 at 11:50 UTC, Bungendore**

The *Bendigo Advertiser* Saturday 22 September 1883, page 2 mentions a felt earthquake :

*A severe shock of earthquake was felt at 9.50 p.m. yesterday at Bungendore, which lasted about 10 seconds, and passed in a south-westerly direction. A shock of earthquake was also felt at Braidwood at ten o'clock, lasting about 20 seconds. It shook several houses. There was a clear sky at the time. Considerable alarm was occasioned.*

The earthquake was also felt in Queanbeyan according to the *Goulburn Evening Penny Post* Thursday 27 September, page 4.

*On Thursday night last, about 10 o'clock, Queanbeyan experienced a second earthquake shock, of sufficient force to shake moveables in several of the houses. The shock was accompanied with a loud rumbling sound of some seconds' duration.*

#### **1885 01 18 at about 01:57 UTC, Sydney**

The *Sydney Morning Herald* Wednesday 21 January 1885, page 9:

*Referring to a paragraph which appeared in our issue of yesterday, relative to a shock of earthquake having been experienced at Waverley at 12.58 p.m. on Sunday, a correspondent writes from Woollahra as follows: —" A distinct shock of an earthquake was felt here on Sunday, 18th instant, at 12.56 p.m., the wave travelling from north-east to south-west, causing a vibration throughout the house."*

This event was report felt at Manly, obviously small and very localised under Sydney suburbs and, of necessity, quite shallow.

#### **1885 01 21 at 01:00 UTC, Berridale**

Further newspaper felt reports will allow an upgrade to the isoseismal map by McCue, published in the 2<sup>nd</sup> volume of the *Isoseismal Atlas* (Rynn and others, 1987). The time should perhaps be changed to 01:00 UTC (11am local time). The *SMH* of Saturday 27 February, page 9, mentions that it was felt severely in Bombala. It was reported felt at Cobargo, Queanbeyan and Gagedzerick (Berridale) extending the isoseismal line north and south and increasing the inferred magnitude slightly, from 4.6 to 4.7.

The *Evening News* Saturday 6 February 1892, page 3S reminisced about earthquakes felt in Tasmania and Australia in general and included the following:

*Mr. W. E. Hepburn wrote in January, 1885: A slight shock of earthquake occurred at Coolamatong (near Cooma) at 11.15 a.m., January 21, lasting about 3sec or 4sec; motion from east to west; shaking the house, outbuildings, &c. Bega reported slight shock on same day at 11 a.m., direction south-west to north-east. Cooma, at 11 a.m., had a most distinct shock which shook the whole office (telegraph); it seemed to come from north travelling to south, and lasted about ½min. It was also felt at Aaminaby, 30 miles west, and at Kiandra, 52 miles west of Cooma; also at Nimitybelle at 11.5 a.m., travelling in an easterly direction.*



### 1886 02 08 at 02:00 UTC, Cobar

The first reported earthquake of the year in NSW was at Cobar, according to the South Australian Register of Tuesday 9 February 1886, page 6:

*NEW SOUTH WALES.*

*Sydney, February 8.*

*Two shocks of earthquake were felt at Cobar to-day shortly after noon. The first shock was light, but the second, which followed immediately afterwards, was very severe. It appeared to be travelling from north to south.*

The year turned out to be a very active one for NSW with activity reported across the state, the largest, in late November near Gunning, a magnitude 5.5 earthquake.

### 1886 03 25 at 21:02 UTC, Mulgoa?

In 1933 Edgeworth David recalled, during an interview, previous earthquakes in NSW including a 'notable' earthquake at Mulgoa near Penrith reported by Mr. Collins in March 1868, the year of the widely felt earthquake near Yass.

The earlier *Australian Town and Country Journal* of Saturday 6 February 1892 published a record of Earthquakes in Australia and mentioned: *Daniel Collins, of Mulgoa, 30 miles east of Sydney, reported a shock on March 26 7.2 a.m.; it passed under the house from north to south, and lasted 4sec.*

This earthquake does not seem to have been felt in Sydney, nor in Penrith. It is quite possible that the month is reported incorrectly and should be April, not March. (see details below).

### 1886 04 14 at 00 UTC, Carcoar

The Thursday edition of the *South Australian Register*, 15 April 1886, page 5 reports:

*Sydney, April 14.*

*At Carcoar on Wednesday a very distinct shock of earthquake took place at 10 a.m., and was felt in various parts of the district. The shock seemed to travel from a south-easterly direction. In many parts the vibration was felt in the houses, especially in the town of Sydney.*

### 1886 04 25 at 21:02 UTC, Lithgow vicinity

This earthquake was widely reported, for example *The Sydney Morning Herald* of Tuesday 27 April 1886, page 7 and Thursday 29 April page 12 reported:

*SHOCK OF EARTHQUAKE.*

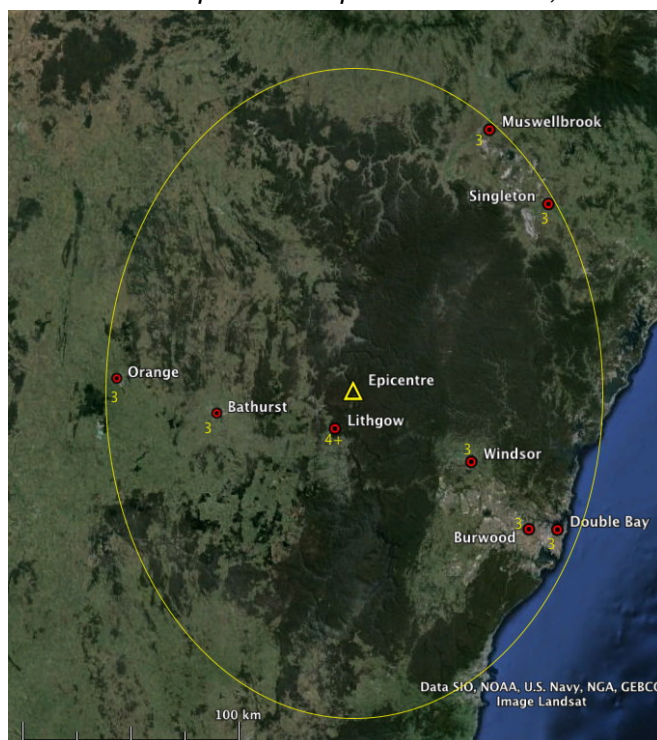
*LITHGOW, MONDAY.*

*A severe shock of earthquake was felt here this morning at two minutes past 7, lasting several seconds. The direction of the wave was from east to west.*

**Figure 10** Isoseismal map of the 25 April 1886 earthquake near Lithgow.

*SINGLETON, MONDAY.*

*A slight shock of earthquake was felt here at 7 o'clock this morning, lasting about 15 seconds. The vibration appeared to travel from south-east to north.*





A few residents of Bathurst also felt the earthquake at about 7 a.m. and it is quite probable that it was felt at Mulgoa; April not March as mentioned above.

*The Maitland Mercury and Hunter River General Advertiser*, Saturday 1 May 1886, page 16S

*The Recent Earthquake.*— Concerning the earthquake reported in the *Herald* of Tuesday, the Government Astronomer, Mr. H. C. Russell, writes —"In addition to the places mentioned in your columns at which the earthquake was felt on Monday morning, I have a letter from J. H. Cox, Esq., of Negoa, near Muswellbrook, stating that the earth tremor was felt there at 7 a.m., and lasted four or five seconds, during which the house was felt to shake.

At Burwood, also, the shock was sufficient to rattle the crockeryware. I did not feel the shock, nor was it sufficient at the Observatory to record itself upon any of the instruments." Writing from Windsor on Tuesday, Mr. John Tebbutt says:-- " The earthquake shock referred to in your issue of to-day was distinctly felt here at half a minute past 7 o'clock on Monday morning. It lasted about three seconds. It shook everything in my bedroom, and likewise the window sashes and shutters. It was impossible to determine satisfactorily the direction of the shock, but it appeared to me to be vertical."

The SMH of Friday 30 April 1886, page 8 mentioned that several people in Orange also felt the earthquake. Obviously the epicentre must be nearer Lithgow than any other place reporting the earthquake, the uncertainty is high. All the same the felt area is large corresponding to a magnitude of ML5.

#### **1886 06 10 at 13:50 UTC, Eruption of Mt Tarawera, New Zealand – heard Sydney?**

The *Globe* Friday 11 June 1886 Page 3 attributes shaking and sounds heard in Sydney to the eruption of Mt Tarawera volcano, NZ. It is possible that the blast was heard given that the Krakatoa eruption was heard as far away as Alice Springs but there are no other reports confirming it than those in the article.

#### **THE EARTHQUAKE HEARD IN SYDNEY.**

*Last, night at ten minutes to twelve o'clock as Mr. Macgregor, of the firm of Macgregor, and Foy, was about to enter his residence in Phillip-street, in company with Mr. F. Fligg, of the stamp office, the attention of both gentlemen was attracted by a deep, low, moaning sound, coming from due east. Presently the sound was repeated with equal force and a third time they heard it, but it was much fainter. They were greatly impressed, and on entering the house went to the room of Mr. Arthur Logan to arouse him and tell him of it. They found that gentleman awake, and he had not only heard the sound, but had attributed it to an earthquake, and averred that it woke him, and that his windows shook and rattled. This morning the story was very generally scouted by those to whom these gentlemen told it, but when the first intelligence of the earthquake was published in the *Globe*, they called at this office and told us the above particulars. At that time the hour at which the earthquake took place had not been ascertained. It now appears that it was ten minutes past two, and as the scene of the calamity is about twenty-four degrees east of Sydney, there is no doubt of the exact coincidence of time. There is every reason to believe that the effects of the earthquake which occurred at that moment were actually felt, although faintly, at this distance, at least fourteen hundred miles (Ed. 2340km by Google Earth).*

#### **1886 08 02 at 10:50 UTC, near Bombala**

*Goulburn Evening Penny Post* Tuesday 3 August 1886, page 2 mentions an earthquake near Bega:

*A smart shock of earthquake was felt at Bega yesternight, lasting for thirty seconds. Another slight shock was experienced early this morning.*

The Meteorological Report in *The Sydney Morning Herald* Wednesday 4 August 1886, page 9 mentions that shocks of earthquake were felt at: Bodalla, shock of earthquake last night at 8.50 p.m. travelling N. to S.; Bega, shock of earthquake last night at 8.54 travelling S.E. to N.W.; Cape St George shock of earthquake last night at 9.50.

*The Sydney Morning Herald* on Tuesday 10 August 1886, page 8 quotes the *Bombala Times*:

*The Bombala Times of Friday last says that on Monday evening, at about 10 minutes to 9, a severe shock of earthquake was felt to pass through Bombala. There are various opinions as to the direction it took, the majority thinking it travelled from N.E. to S.W. It was about as strong a shock as we have experienced for a long time; windows and doors rattled, bottles danced a fandango, and the inhabitants were considerably startled. It lasted for several seconds, and was accompanied by a deep rumbling noise, distinctly heard as it rolled away in the distance.*

Ignoring the Cape St George report, this earthquake was widely felt and warrants magnitude ML4. There was a report of another earthquake the next morning between 5 and 6 am.

#### **1886 08 29 at 19:15 UTC, Young**

*The Gundagai Times and Tumut, Adelong and Murrumbidgee District Advertiser* of Tuesday 31 August 1886, page 3 reports an earthquake at Young:

*Monday, 8 p.m. An alarming shock of an earthquake was felt at Young early this morning, and caused considerable alarm, every resident being awakened by the report.*

The *Clarence and Richmond Examiner and New England Advertiser* (Grafton), Saturday 4 September 1886, page 4 also mentions the earthquake:

*SHOCK OF EARTHQUAKE AT YOUNG. — An alarming shock of earthquake occurred at Young on Monday morning at 5.15, travelling from west to east. The governor of the gaol was awakened by the report, and rushed into the prison yard, thinking the wall had fallen. The warder on guard was in great alarm, and says he distinctly heard the western wall vibrate. Nearly every resident was awakened by the shocks which caused windows to rattle most unmistakably.*

Nearly everyone awakened, goods thrown off shelves, the shaking was strong but there are no felt reports from other towns so the earthquake cannot have been much bigger than magnitude 3.5 so it was virtually under Young.

#### **1886 09 06 at 18:30 UTC, Newcastle**

According to the *Evening News* of Tuesday 7 September 1886, Page 6, an earthquake rattled Newcastle early on Monday morning:

*Earthquake in Newcastle. — A shock of earthquake was felt in Newcastle on Monday morning, at half-past 4 o'clock. The vibration was very distinct, and rattled loose articles about. The duration of the shock was about 5sec.*

*The Maitland Mercury and Hunter River General Advertiser* Tuesday 14 September 1886, p 5.

#### **1886 09 12 night local time, Bombala**

Several newspapers including the *Sydney Morning Herald* of Wednesday 15 September page 10 mentioned an earthquake at Bombala, but no time:

*BOMBALA, TUESDAY.*

*It rained heavily here on Friday night and Saturday morning. A few light showers have fallen since. At present the weather is dry and warm.*

*There was a slight shock of earthquake on Sunday night.*

This event is possibly an aftershock of last month's earthquake. The same evening an earthquake was felt more than 400km away near Newcastle at West Maitland.

#### **1886 09 12 at 09:30 UTC, West Maitland**

*The Maitland Mercury and Hunter River General Advertiser* of Tuesday 14 September 1886, page 5 suggests an earthquake was felt in West Maitland:

*EARTHQUAKE.—A shock of earthquake is said to have been distinctly felt by several residents of West Maitland on Sunday evening, between 7 and 8 o'clock, Mr. William Filmer, who was sitting in a backroom at his residence, heard a rumbling noise, and is confident that it was produced by earthquake. Occupants of another house in town also assert that the shock was very distinct.*

With no further information we assign this a magnitude of 3.0 and a location at West Maitland.

#### **1886 11 29 at 16:57 UTC, Gunning**

An isoseismal map was published for this earthquake (Rynn and others, 1987) that they rated magnitude 5.5 from the felt area, and their location was near Yass where minor damage was reported though they counsel that the location was very poorly determined. The information presented here would change the shape of the inner isoseismal and shift the epicentre nearer Gunning and Dalton. At Dalton the earthquake was rated a severe shock but no details (*Goulburn Evening Penny Post* Saturday 4 December 1886, page 6) whilst at Gunning it was the most severe ever experienced, and much alarmed many of the residents whose houses seemed to rock to and fro (*Goulburn Herald* Thursday 2 December 1886, page 2). It was not felt in Sydney.

An interesting postscript appeared in the *Goulburn Penny Post* on Thursday 9 December page 4:

*The Recent Earthquake. We (Echo) are informed by Mr. C. H. Russell, the Government Astronomer, that the record at Lake George shows no sign of the earthquake, although the observer felt it; and the Newcastle tide sheet is also without mark of the earthquake. It would seem, therefore, that the vibration must have been so momentary that it did not set the water in motion.*

The *Goulburn Evening Penny Post* Tuesday 30 November 1886, page 2 commented in a light-hearted manner on the effect of the earthquake at the Goulburn Hospital. The shaking was sufficiently pronounced that Mrs. Guille, the matron of the hospital, got up and did a ward round to check on the patients. The newspaper summarized the effects of the earthquake in a previous paragraph:

*EARTHQUAKE SHOCKS. Two distinct shocks of earthquake were experienced in Goulburn this morning at about 3 o'clock. They were accompanied by a loud rumbling sound, and were so severe that the majority of persons were awakened. Houses shook, beds oscillated, crockery and windows rattled, and dogs barked excitedly. Different accounts are given as to the duration of the shocks; but each appears to have lasted several seconds, and there was only a slight intermission between the two. The rumbling sound died away gradually at the close. The shocks were experienced at Bathurst, Yass, Bungendore, Michelago, and Gunning, and doubtless through the whole colony. Opinions vary as to the direction of the current; but the majority believe that it travelled from west to east. They were undoubtedly the most severe shocks ever experienced in Goulburn—at all events, within the memory of most of the inhabitants; and no little excitement has been caused, the occurrence being the principal topic of conversation to-day. A correspondent writes as follows:— " About 3 a.m. this morning two very severe shocks of earthquake running north and south were experienced, the first shock lasting about seven seconds and the last about ten seconds, about five seconds elapsing between the two shocks, the last being accompanied with a heaving sensation and a*

*rumbling like distant artillery. The shocks were severe enough to cause all the glassware and crockery in the room to rattle and the bedsteads to heave to and fro in the direction of the shocks, the vibration lasting fully three minutes after the shocks. The sky was clear at the time, excepting a bank of dark clouds running north and south, the stars having a particularly bright appearance.*

*Yours obdtly., Fred. H. Wedd, Salford House, Sloane-street."*

*Gunning, Tuesday. A severe earthquake shock occurred this morning at 2.55, lasting fully a minute. It appeared to travel west to east, followed by a slight shock.*

*Burrowa, Tuesday. A severe shock of earthquake was felt here this morning at about 3 o'clock. It lasted several seconds, and shook houses very much, frightening several of the inhabitants. Several things in different houses were shaken from the shelves and other places. No serious damage was done. About half-an-hour afterwards another light shock was felt. The first shock was the heaviest ever felt in Burrowa.*

#### **1887 07 28 at 07:23 UTC (5:20 pm local time), felt Nyngan and district**

*Smart earthquake shock occurred at Wilgar Downs about 5 p.m. on July 28. Heavy rumbling noise toward the south-east, lasting nearly a minute, and appeared to travel toward the west; another slight shock was felt on 29th. The shock of the 28th was severely felt at Booroomugga. At Girilambone the station-master rushed out of his room, thinking the floor was rising. At Nyngan houses were shaken. It was sharply felt at Cannonbar, and caused the waters of Duck Creek to rise over the knees of a man fishing on the bank and threw fish out of the water. (Australian Town and Country Journal (Sydney), Saturday 6 February 1892, page 28).*

A more contemporary account appears in the *Evening News* of Friday 29 July 1887, page 5:  
*Shock of Earthquake.*

*Nyngan, Thursday evening. — A shock of earthquake occurred here at about 5.20 p.m. this afternoon. The vibration lasted for nearly 20sec. and caused no little excitement among the residents. The shock was first felt at the railway station, where it caused a number of the officials to feel considerably alarmed. The telegraph operator rushed out of the office. Barrett's Hotel was also shaken heavily. Old residents of Nyngan affirm that this is the first shock of earthquake experienced at Nyngan within their memory.*

*Canonbar, Thursday evening. — Two sharp shocks of earthquake, accompanied by a rumbling noise, were felt here about 23min past 5 this evening. Each shock lasted about 5sec. No damage was done.*

The known felt area corresponds to a magnitude of 4.0, but it was probably larger than this.

#### **1888 01 12 early morning, Congewai near Ellalong**

*The Sydney Morning Herald* Friday 27 January 1888, page 7 mentions an earthquake but it was rather a massive collapse, interesting because of the nearby earthquake in 1994 at Ellalong.

*A REMARKABLE occurrence, which is looked upon by those residing in the neighbourhood to have been an earthquake, took place early on the morning of the 12th instant on the grazing estate known as Congewai the property of Messrs. F. and W. Dodds, in the Wollombi district, near the township of Ellalong. At the time mentioned two or three of the people living thereabouts declare they felt a tremor and shock of the ground as of an earthquake, and immediately there was a cave-in of about 150 acres on the estate referred to. The ground sank to a depth of 10ft. and in some places 15ft, with a width of 8ft., carrying trees, rocks, &c., with it, and was split up and crossed in all directions by cracks and fissures of various shapes and sizes, the main fissure surrounding the whole almost in the form of a circle, being about a mile in circumference. Inside this line the ground was all broken up; in some places it was depressed into holes*

*and fissures ; in others it was raised up, so that here and there the surface looked liked waves of the sea, so far as mere conformation went. A line of fencing running across the land was thrown completely down. It is impossible to drive even cattle across it, so much is it broken up. Many of the roots of trees have been snapped asunder as if cut with a crosscut saw. Most of the crevices and depressions became filled with water, which has a very strong, mineral taste and a cloudy or milky colour. The country in which the miniature earthquake took place is of a very mountainous character. It might be worth the while of the Government Geologist to take a trip to the scene to ascertain its exact character, with a view to enlightening the scientific world, at least, upon the subject.*

**1888 02 06 at 12:30 UTC, Goulburn**

GOULBURN, Tuesday. (*SMH* Wednesday 8 February, 1888, page 10).

*Sydney, 7<sup>th</sup> February. A very slight shock of earthquake was experienced here last night at about half-past 10. It lasted several seconds, but was so slight that the majority of people did not feel it.*

**1888 07 05 at 20:10 UTC, Gurrundah**

When Burke-Gaffney (1952) tabulated this earthquake he assigned it to the Bowral region but McCue (1996) thought that the isoseismal map showed it to have struck the Dalton-Gunning region, neither was convincing. Reports such as that from Camden and Picton – slight, and Bowral – awakened a number of people, indicate that it wasn't near Bowral, but the Yass report – distinct and rattled windows and doors was not too dissimilar. By contrast, at Crookwell, it was called the worst shock ever felt there, and the Goulburn experience was similar. There is no mention of it being felt in Gundagai, though the effects of the earthquake elsewhere were reported.

The centre of the felt area is between Crookwell, Goulburn and Gunning, east of Gurrundah so that is where we will locate it for now.

**1888 10 26 at 13:00 UTC, Narrandera**

The *Evening News* Monday 29 October 1888 page 4 reported the barest details of this earthquake about 11pm Friday, which we can only assume was a small local event.

**1888 12 27 at 22:45 UTC, Adelong**

*Australian Town and Country Journal* Saturday 5 January 1889, Page 10.

An Earthquake.

ADELONG, Dec. 28.—A slight, but distinct shock of earthquake was felt here this morning about a quarter to 9 o'clock. It seemed to be travelling in a northerly direction.

**1889 10 04 at 03:40 UTC, Smithtown (on the Macleay River)**

*Evening News* Saturday 5 October 1889, Page 6.

*Earthquake in the North.*

*Smithtown, Friday. — A heavy shock of earthquake was felt here to-day at 1.40 p.m., the shock lasting about ten seconds, and caused houses, &c., to shake considerably. It travelled from south to north-east.*

*The Sydney Mail and New South Wales Advertiser* Saturday 12 October 1889, Page 841.

*Shock of Earthquake in the Macleay District.*

*Our Beachport correspondent telegraphed on the 4th inst.: — A severe shock of earthquake was felt here about 1.40 p.m. to-day. It appeared to come from the S.W. and to travel N.E. A very loud rumbling, resembling a stampede of horses, was heard some seconds before the shock was felt. It lasted about 20 seconds. It violently shook the*

*crockery and glasses in the houses. The weather during the day has been very sultry. A slight shower with thunder fell early this morning. The shock was also felt at Macleay Heads and Nambucca Heads, and at Arakoon.*

(note: This Beachport may now be a suburb of Port Macquarie).

**1890 04 25 at 16:10 UTC, Tuena (southeast of Cowra)**

*Evening News* Monday 28 April 1890, Page 5.

*Earthquake in the South.*

*Tuena, Saturday. — A shock of earthquake was distinctly felt here this morning at ten minutes past 4, giving some of the buildings a severe shaking. It seemed to be travelling from south east to north west.*

**1891 03 14 at 15:00 UTC, Kempsey Lower Macleay District**

*The Sydney Morning Herald* Monday 16 March 1891, Page 5.

*SHOCK OF EARTHQUAKE AT KEMPSEY.*

*KEMPSEY, SUNDAY.*

*A distinct shock of earthquake was felt throughout the district, moving from north to south, about one this morning. Numbers of persons were aroused by a rumbling sound, followed by the rattling of crockery and windows. Some wooden houses gave decided wave effects.*

**1891 06 14 at 22:40 UTC, Morpeth swarm or ?**

*A rather remarkable incident was observed by Mr. C. F. Wakely, the postmaster at Morpeth, on Monday last, both in the morning and during the afternoon, which was no doubt a slight form of earthquake. It was first noticed at 20 minutes to nine in the morning, when attention was drawn to the circumstance by the vibration of the windows and the rattling of the bolts in the doors. The movements lasted till 9.32, so that there was ample opportunity of verifying the phenomenon. A similar disturbance was observed at 5.31 p.m. lasting till 6.27. As soon as the movements were observed, Mr. Wakely placed a glass vessel filled with water on the floor of the verandah, a cement one, and the water could be distinctly observed to be agitated, the waves motion being from N.W. to S.E. There was a slight trembling felt and also a slight rumbling proceeding as from the ground. Several other people felt the movements. Mr. Wakely has informed Mr. Russell, the Government Astronomer, of the event.*

Such long duration would suggest something other than an earthquake unless it was a swarm. These events were mentioned by Hunter (1991) but dates were not then known.

**1892 08 22 at 09:30 UTC, Gundagai**

*The Sydney Morning Herald* Wednesday 24 August 1892, Page 6.

*GUNDAGAI, Tuesday.*

*During the past 24 hours nearly 3in. of rain fell here. A very heavy thunderstorm raged for fully an hour last night, the lightning being very vivid. About 7.30 last evening a slight shock of earthquake was felt.*

Difficult to say whether the cause of the shock was an earthquake or thunder.

**1892 08 27 at 20:30 UTC, Cooma**

*The Adelaide Advertiser* Tuesday 30 August 1892, page 5 mentions an earthquake experienced at Cooma:

*A distinct shock of earthquake was felt at Cooma and other portions of the Monaro district at 6.30 on Sunday morning. The vibration was considerable, and in a few cases disturbed householders. The tremor lasted about 15 seconds, and travelled from east to the north-west.*

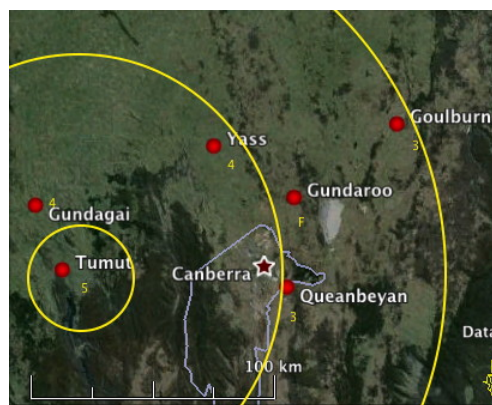
#### **1893 07 31 at 16:00 UTC, Goulburn**

Two shocks were experienced half an hour apart at Goulburn, at about 2 am local time on Tuesday morning 1 August 1893. They don't appear to have been felt elsewhere.

#### **1893 09 25 at 08:45 UTC, Tumut**

This earthquake was widely felt, at Yass (distinct), Gundagai (smart), Tumut (severe) and Queanbeyan (slight) according to the *Australian Town and Country Journal* of Saturday 30th September 1893. Goulburn newspapers indicate it was also felt at Goulburn (slight) and Gundaroo.

**Figure 11** An attempt to define the epicentre and magnitude of the 25 September 1893 Tumut earthquake, with few data.



It is possible that the epicenter was in the Brindabella Mountains west of Canberra but closest to Tumut where it was most strongly felt. This is probably a late aftershock of a magnitude 5.3 earthquake near Tumut on 8<sup>th</sup> June 1871 at 04:15 UTC and a series of aftershocks that lasted until early 1872 (Spennemann, 1998).

#### **1894 05 27 at 11:30 UTC, Cooma**

According to the *Sydney Morning Herald* of Tuesday 29<sup>th</sup> May 1894, a slight shock of earthquake passed over Cooma and the district last evening at half nine, lasting only a few seconds. Again we assign a magnitude of 3.5 and a location at Cooma, though what 'district' refers to we don't know. A similar report 22 years earlier mentions a distinct shock of earthquake at Cooma in early January 1872 which may be the last of the Tumut aftershocks mentioned in the previous paragraph.

#### **1896 10 26 at 02:00 UTC, Coonabarabran**

*The Sydney Morning Herald* Friday 30 October 1896, Page 5.

*SUPPOSED EARTHQUAKE SHOCK.*

*COONABARABRAN, Thursday.*

*A remarkable phenomenon occurred in the neighbourhood of Coonabarabran on Monday about midday. A loud rumbling noise resembling distant thunder was heard for several seconds. The atmosphere was calm at the time, and not a cloud was to be seen. The cause appeared to be in the air immediately surrounding the neighbourhood of the sound and apparently travelling north and south. No vibration or tremor was noticeable. Farmers working in the fields were very much alarmed. Reports from various parts of the district confirm the authenticity of the noise. It is supposed to be the shock of an earthquake.*

If it wasn't an earthquake, what was it? perhaps a distant thunderstorm or a meteorite or ??

#### **1897 05 05 at 18:55 UTC, Queanbeyan**

The shock shortly before 5am awoke many persons according to the *Sydney Morning Herald* of Friday 7 May 1897. There were no reports from other urban centres. Again we assign a magnitude of 3.5 and a location near Queanbeyan.



**1897 06 12 at 07:50 UTC, Moss Vale**

*The Sydney Morning Herald* Monday 14 June 1897, Page 6.

*MOSS VALE, Saturday.*

*A distinct shock of earthquake was experienced here about 5.50 this evening. It lasted about five seconds, travelling in an easterly direction. Windows rattled, and a rolling sensation was felt under foot.*

*MOSS VALE, Tuesday.*

*The earthquake shock experienced here last Saturday was felt in many places around the district. At Bundanoon, Exeter, and Yarrunga the shock was more distinct than here.*

**1897 08 16 at 19:30 UTC, Cooma**

*The Sydney Morning Herald* of Wednesday 18 August 1897 page 7 notes an earthquake felt at Cooma at 5:30am on Tuesday morning without further details.

**1897 10 20 at 12:22 UTC, Goulburn**

The ground shook for about 6 seconds at 10:22pm, the sound like rolling thunder, windows and doors vibrated (*Goulburn Herald*, Friday 22 October 1897 page 2).

**1898 02 21 at 14:40 UTC, Young**

This was the first of two earthquakes (description in that of the following event).

**1898 02 24 at 11:40 UTC, Young**

*It is reported that a slight earth tremor occurred at Young on February 22 at 12.40, a.m., and again, with increased force, on February 24, at 9.40 p.m. Buildings were shaken, and crockery and glass in several houses were broken. Australian Town and Country Journal, Saturday 5 March 1898, page 14.*

**1898 11 13 at 15:00 UTC, Queanbeyan**

A brief mention is made of this earthquake in the following description of the Cooma earthquakes.

**1898 11 16 at 12:05 UTC to 1898 11 18, Cooma series**

*The Manaro Mercury, and Cooma and Bombala Advertiser* Friday 18 November 1898, page 2 had the following story:

*A slight shock of earthquake was noticed at Cooma a few minutes past 10 o'clock on Wednesday night, by several residents. Other slight shocks are also reported last night and early this morning. An earthquake shock was felt at 1 o'clock on Monday morning at Queanbeyan.*

**1899 03 15 at 10:30 UTC, Goulburn**

The *Goulburn Herald* Friday 17 March 1899 page 3 reported an earthquake, two shocks heard like a cannon or quarry blast at 8:30pm local time.

**1900 08 07 at 23:05 UTC, Oberon**

The *Bathurst Free Press and Mining Journal* of Thursday 9<sup>th</sup> August 1900 mentions that a slight earthquake, enough to rattle crockery and windows, was felt in Oberon and at Tunkey. Yet other reports mention it was felt at Rockley, Crookwell, Eglinton, Burruga, and Mount Victoria. This wide area indicates a magnitude of 4 or more.

Other earthquakes in 1900 were felt at Bungendore and Braidwood on Saturday 21<sup>st</sup> July about noon, and two at Cooma on Saturday 6<sup>th</sup> October at 3pm and 11:30pm.

**1901 03 07 at 10:00 UTC, Cooma**

*The Manaro Mercury, and Cooma and Bombala Advertiser* Friday 8 March 1901, page 2.

*A loud rumbling noise was noticed in Cooma at eight o'clock last evening, which proved to be an earthquake, the tremor lasting about a minute. The direction was north-west to south-east. Lesser shocks were noticed at 8.40 (lasting three quarters of a minute), 10.10p.m., 11 p.m. and 12.30 p.m. The first shock caused the windows of several houses in town to shake, and the continued earth tremor caused some slight consternation.*

**1902 02 27 at 18:00 UTC, Greta**

*Newcastle Morning Herald and Miners' Advocate* Monday 3 March 1902, Page 6.

**GRETA. AN EARTHQUAKE TREMOR.**

*On Friday morning, about 4 o'clock, most of the inhabitants felt an earthquake tremor. The shock was very distinct for some seconds. The post and telegraph buildings, vibrated to such an extent that the plaster on the inside walls was cracked in several places, and Mrs. Galloway, whose room was immediately over the office and against the brick chimney, was under the impression the latter was falling down, so severe was the effects in this part of the building.*

**REPAIRS TO THE POST-OFFICE.**

*It has been decided to call tenders during this week for the repair and renovation of the post office buildings, a work which is decidedly necessary.*

*WEST MAITLAND, Sunday. (The Sydney Morning Herald Monday 3 March 1902, p8.)*

*On Saturday morning a distinct earthquake tremor was felt in West Maitland. There was a low, rumbling noise, and the vibration was strong enough to shake houses and cause windows and doors to rattle.*

*ALLANDALE (The Maitland Daily Mercury Monday 3 March 1902, Page 4.)*

*An earthquake gave two shocks shortly before 4 a.m. on Saturday, and was accompanied by a long, rumbling noise, that many mistook for thunder. About six years ago a similar vibration, that shook glass and crockery on the shelves, took place, although we are well out of the earthquake belt.*

Without other reports it is difficult to assess the magnitude except that, given the damage, it could hardly be less than 3.8.

**1902 02 28 at 12:30 UTC, Camden**

*The Sydney Morning Herald* Monday 3 March 1902, Page 8.

**EARTHQUAKE SHOCKS.**

**SOME REMARKABLE EXPERIENCES. MILES OF COUNTRY AFFECTED. DWELLINGS SEVERELY SHAKEN.**

*On Friday night last, somewhere between 10 and 11 o'clock, the inhabitants throughout a considerable area in the coastal district of this State were startled by the sudden rocking of their dwellings and by earth tremors, which varied in intensity from slight to heavy shock accompanied by rumbling noises not unlike distant thunder. Our correspondents send the sub-joined particulars of what happened in the several localities. Upon inquiring of the Government Astronomer, Mr Russell said last night that he received by telephone the following reports :—*

*" 10.25 p.m. Friday — A decided earthquake shock occurred at Bexley, near Rockdale." " Bellevue Hill, 10.40 p.m. — Many felt earthquake shocks here. They seemed to come from below, striking upwards."*

*Other telephones were:—" Earthquake 10.10 p.m. Shock seemed to come upwards."*

*Mr. Russell said that earthquakes were remarkable about Sydney. They had not felt these shocks at the Observatory, and at the time that the telephone messages were sent through to him he concluded that they referred to light earth tremors but he felt convinced now that these referred to a genuine earthquake. There had never occurred in New South Wales any disastrous upheaval such as had happened in New Zealand, for instance, and it was very rare indeed to hear of an earthquake on this part of the continent.*

*BULLI, Saturday.*

*A sharp shock of earthquake was experienced in this district shortly after 10 o'clock last night. The shock was preceded by a low rumbling similar to distant thunder followed by a dull explosive sound. Persons in houses at the time describe it as resembling some ponderous weight being precipitated against a building. The tremor appeared to cross from the south-west to the east. Old residents state that it must be 30 years since there was a similar experience in this district.*

*CAMPBELLTOWN, Saturday.*

*An earthquake shock was felt here last night at 10.20 o'clock.*

*CAMDEN, Saturday.*

*A sharp shock of earthquake occurred last evening lasting 3 seconds.*

*MITTAGONG, Saturday.*

*A shock of earthquake was felt at 10.30 p.m. yesterday at Bargo. The tremors were felt at the railway crossing, Mittagong at 11.45, and were accompanied with a low rumbling sound.*

**Figure 12** Felt area of the 28 February 1902 earthquake. Epicentre near Camden where walls were cracked. The felt area is as expected for a magnitude 4.3 earthquake.



*MOSS VALE, Saturday.*

*A slight shock of earthquake was felt here last night about 10.30.*

*PICTON, Saturday.*

*Last night, a little after 10 o'clock, a distinct shock of earthquake was felt. Buildings for miles around were noticed to tremble. Windows and casements shook like leaves. It is many years since anything of the same nature was felt here.*

*SUTHERLAND, Saturday.*

*A distinct shock of earthquake was felt here about 10 p.m. yesterday, and was accompanied by a rumbling sound.*

*WOLLONGONG, Saturday. A shock of earthquake was felt here last night.*

*The Evening News Tuesday 4 March 1902, Page 4 has considerable coverage about the earthquake:*

## *SHOCKS IN THE SUBURBS. EXTEND INTO THE COUNTRY.*

*Sydney, the nesting-place recently of so many and diverse forms of alarm — including fears of drought, inadequate water supply, the spread of bush fires, and the plague — has experienced a new sensation by the visitation of earthquake shock. Reports of 'shakes' have been received from such near-at-hand suburbs as Dulwich Hill and Burwood, while Rose Bay has also been visited. Moss Vale, Cobbity, and Wentworth Falls also send word of quakes and tremors felt on Friday night last, and the times at which the shakes are reported to have been felt agree very well. A lady resident at Rose Bay states that on Friday night, after she had retired, and when she had, presumably, just dozed off, she was awakened by her bed rocking. She was told next morning by her maid that the time was about a quarter to 11. The maid was at that time cutting out a pattern, and the table at which she was standing rocked, while the floor seemed to give way under her feet. Other residents of this waterside suburb also report having felt a shock at the time named. A very old resident of Burwood, who says it is thirty years since anything of the same nature occurred in the locality, reports that on Friday night, at the time already given, a sharp, distinct shock of earthquake was felt. He says it lasted for 5 seconds, and was accompanied by a loud, rumbling noise, familiar to explosions, and which shook the place. The windows and doors rattled violently. Some people in the vicinity, he says, were very much alarmed at the occurrence, and did not sleep at all that night. From Dulwich Hill comes a report that a resident, while seated quietly at about half-past 10 on Friday night, a distinct shock was felt. The glass on the sideboard rattled; also the windows. An occupant of a bed in an adjoining room called out to learn what was the cause of the shaking. A resident of Cobbity, while seated on a couch reading, was disturbed by a sudden shock. It was similar to the shock caused by a door being heavily slammed. There was, he says, only one shock. There being no apparent cause for the occurrence, it was attributed to earthquake. A shock of earthquake was distinctly felt on Friday night at Wentworth Falls, at about 20 minutes to 11. The shock was distinctly felt in several houses. The gentleman reporting the occurrence said the sensation was as though the foundations of the house had been violently struck. It so jarred things in the room that the pendulum clock on the mantelpiece nearly stopped.*

*The Wagga Wagga Advertiser Tuesday 4 March 1902, page 2 mentions:*

*Earthquake Shocks.*

*SOME REMARKABLE EXPERIENCES. MILES OF COUNTRY AFFECTED.*

*DWELLINGS SEVERELY SHAKEN.*

*On Friday night last, somewhere between 10 and 11 o'clock, the inhabitants throughout a considerable area in the coastal district of this State were (the "S. M. Herald" says) startled by the sudden rocking of their dwellings and by earth tremors, which varied in intensity from slight to heavy shocks, accompanied by rumbling noises not unlike distant thunder. Our correspondents send the subjoined particulars of what happened in the several localities. Upon inquiries of the Government Astronomer, Mr. Russell said on Sunday night that he had received by telephone the following reports :*

*"10.25 p.m., Friday. —A decided earthquake shock occurred at Bexley, near Rockdale."*

*"Bellevue Hill, 10 40 p m.—Many felt earthquake shocks here. They seemed to come from below, striking upwards."*

*Other telephones were:—" Earthquake 10.10 p.m. Shock seemed to come upwards."*

*Shocks of greater or less intensity also occurred at Bulli, Campbelltown, Camden, Greta, Mittagong, Mossvale, Picton, Sutherland, Wollongong and West Maitland.*

*The tremor was felt in Rockdale, Helensburgh, Menangle and in a seaside suburb of Sydney according to the *Clarence and Richmond Examiner* Saturday 8 March 1902, Page 3:*

## AN EARTHQUAKE IN SYDNEY.

"Ares" writes:—Between 10 and 11 o'clock on the night of the 28th ultimo, a short but decided earth tremor was felt in Sydney. Being a New Zealander, the experience was not altogether unfamiliar, therefore not so startling to me as to many others. However, when you are suddenly and unexpectedly brought face to face with an old friend, it does give you rather a peculiar feeling, so I must confess that when I was rudely aroused last night by a very apparent trembling under foot and a violent rattling of doors and windows, I felt rather as though I had seen a ghost! The tremor was so soon over that it left me in doubt whether it was an earthquake or not, and it was not until I had discussed the matter with a friend (who has a very keen "ear" for the like) that I became fully convinced that it was the real thing. Close upon this slight shock the sound of the waves increased considerably, and I was secretly afraid that our night was going to have an unpleasant ending. We looked out upon the water (being in one of the sea-side suburbs at the time), it appeared to be unusually calm and unruffled. Yet, one dark ridge, extending the whole length of the bay, rose high but foamless, and crept gradually towards the shore. We watched its approach with interest. It was more like a heavy swell than a wave. However, it subsided as mysteriously as it had risen, and Father Cecear quieted down again, and we heard only the low, monotonous sound of waves lapping the sandy beach.

The *Cootamundra Herald* Wednesday 5 March, Page 2 had a fuller account of the effects in Campbelltown:

*CAMPBELLTOWN, Monday.*

*Friday night at 10.28 we had a sharp shock of earthquake, causing buildings to vibrate, windows and crockery to clatter. The tremor lasted for a few seconds only. In the Camden district it is said persons were much scared, and the walls of some buildings were cracked. The sound appeared to come from a northerly direction and was travelling south.*

The quake reportedly caused minor damage at Camden, cracks in walls, and was distinctly felt at Branxton while at Wollongong, residents heard the gradual approach like thunder then were 'shaken rather roughly'. There seem to have been two events; one near Greta and West Maitland; the other south of Sydney near Camden that was widely felt, the area corresponding to a magnitude of 4.3.

### **1902 05 27 at 02:00 UTC, Lithgow**

*The Maitland Daily Mercury* Thursday 29 May 1902, Page 2.

*A shock of earthquake, which was sufficiently pronounced to cause people to run out of their homes, occurred at Lithgow on Tuesday.*

### **1902 07 08 at 07:23 UTC, three events at Young**

The *Sydney Morning Herald*, Wednesday 9 July 1902, page 7 mentions:

**EARTHQUAKE SHOCKS. BUILDINGS SHAKEN AT YOUNG.**

*YOUNG, Tuesday.*

*Three shocks of earthquake were felt at Young to-day—one at 7 a.m., another an hour later, but at 5.20 there was a very palpable quake. Buildings were shaken, and the people came out in wonderment.*

*Mr. Russell, the Government Astronomer, last night received the following telegram from the telegraph master at Young:—"A distinct shock of earthquake was felt at Young at 5.23 p.m. It appeared to come from west to east."*



### **1902 08 13 at 10:20 UTC, Young**

The *Australian Town and Country Journal* Saturday 23 August 1902 page 13 states:

*A severe shock of earthquake was experienced at Young about 9 o'clock on August 13, while, another, though less distinct one, took place previously. Altogether about five or six shocks have been felt here within the last two months.*

*The Manaro Mercury, and Cooma and Bombala Advertiser and Sydney Morning Herald* Friday 15 August 1902, page 2 and 7 respectively mention this earthquake at Young at twenty minutes past eight on Wednesday night. It caused the residents to run outside into the streets.

### **1902 08 25 at 18:10 UTC, Young**

The *Singleton Argus* Tuesday 28 October 1902, page 2.

*ANOTHER EARTHQUAKE AT YOUNG. Alarm of the Inhabitants.*

*The Government Astronomer (Mr. H. C. Russell) last Sunday evening received a telegram from Young intimating that another earthquake was felt in that town at 4.10 a.m. on Sunday. It is only a week ago since the inhabitants were alarmed by two distinct shocks.*

### **1902 09 13 at 18:15 UTC, Young - possibly the largest of swarm**

Minor damage occasioned by these two local events in Young but there were no other town reports in the *Sydney Morning Herald* Tuesday 16 September page 3.

YOUNG, Monday.

*On Sunday last, at 4.15 a.m., two violent shocks of earthquake startled the sleeping residents of the town. There was only about a minute's interval between the two shocks. The first resembled in sound the falling of a huge tree, and caused buildings to vibrate, cracking the plaster on brick buildings, including the City Bank.*

This sequence seems to have continued into October.

### **1902 10 15 at 11:14 UTC, Cooma**

The *Sydney Morning Herald* Friday 17 October 1902, page 5.

*The Government Astronomer, Mr. H. C. Russell, yesterday received the following telegram from Cooma:-" A severe shock of earthquake occurred at 9.14 p.m. on Wednesday."*

COOMA, Thursday.

*A distinct shock of earthquake, lasting for three quarters of a minute, was felt here at a quarter past 9 o'clock last night.*

This earthquake was also reported distinctly felt 40km away at Adaminaby about ten past nine so the magnitude is at least 3.2.

### **1902 10 18 at 15:10 and 20:25 UTC, Young**

The *Sydney Morning Herald* Tuesday 21 October 1902, page 5.

*SHOCKS OF EARTHQUAKE.*

*EXPERIENCES AT YOUNG. PEOPLE SHAKEN IN THEIR BEDS.*

YOUNG, Monday.

*At 1.10 a.m on Sunday a heavy earth tremor or earthquake, extending north and east, was experienced. People were shaken in their beds and the contents of houses rattled. This was followed by a milder shock later on, and about 6 o'clock there was another visitation, when it appeared as if the earth was rolling from north-east to south-west.*

There is a discrepancy between reports about the times of these two earthquakes.

### **1902 10 25 at 18:10 UTC, Young**

The *Singleton Argus*, Tuesday 28 October 1902, page 2.

ANOTHER EARTHQUAKE AT YOUNG. Alarm of the Inhabitants.

*The Government Astronomer (Mr. H. C. Russell) last Sunday evening received a telegram from Young intimating that another earthquake was felt in that town at 4.10 a.m. on Sunday. It is only a week ago since the inhabitants were alarmed by two distinct shocks.*

### **1903 02 26 at 12:30 UTC, Lithgow**

The *Sydney Morning Herald* Saturday 28 February 1903, Page 9, and Tuesday 3 March 1903, Page 6.

SHOCK OF EARTHQUAKE.

LITHGOW, Friday.

*About half-past 10 last night a very distinct shock of earthquake was experienced at South Bowenfels. One of those who felt the shock declares that the rumble was most unmistakeable, and lasted about a third of a minute. The sound was like distant heavy thunder or that produced by a travelling omnibus, in addition to which there was a very perceptible tremor of the earth.*

*The earthquake shock already reported at South Bowenfels affected also several of the neighbouring centres. It was felt at Marrangaroo, Wallerawang, and Piper's Flat.*

### **1903 03 26 at 07:00 UTC, Bingara**

SMH Saturday 28 March 1903, page 8 by relay:

*Earthquake at Bingara.—The Government Astronomer (Mr. H. C. Russell) yesterday received a telegram from Bingara to the effect that a slight earth tremor had been felt at that centre at 5 p.m on Thursday. The earthquake travelled from the direction of east towards the west, and was followed by a rumbling noise resembling thunder.*

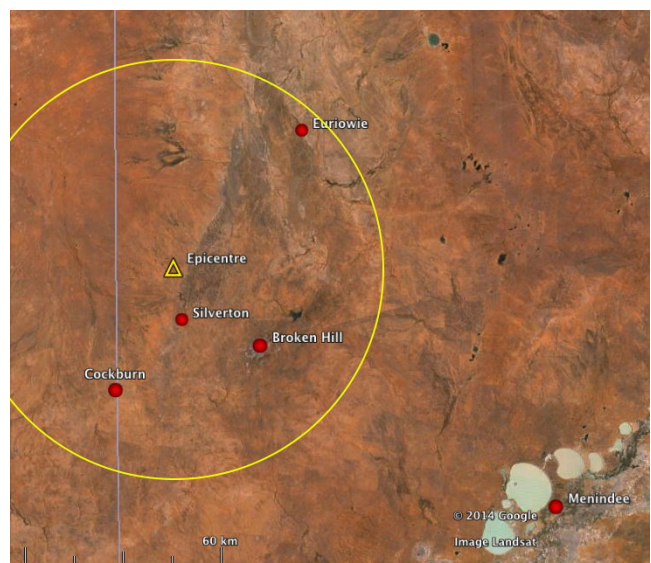
### **1903 04 30 at 08:20 UTC, Broken Hill – first known earthquake there**

The *Evening News* Saturday 2 May 1903, page 6.

*BROKEN HILL, Friday.— The first earthquake shock, last night, was followed by a much lighter tremor about 7.55. The shocks fortunately did no damage underground at the mines, but numerous cases of broken crockery, and a couple of overturned lamps are reported. One house at North Broken Hill was cracked from ceiling to floor.*

**Figure 13** Felt area of the 1903 Broken Hill earthquake, the first ever recorded there. The epicentre is most uncertain but is near the centre of the felt area and closest to Silverton, where the intensity was highest.

*The shock was felt severely at Cockburn, and Silverton. At the latter*



*place the walls of the old gaol were badly cracked. Apparently, the tremor was not felt down the line beyond Cockburn, but all stations to the north, and in a north-east direction, up to Euriowie, experienced the shock. It was not felt, however, at Wilcannia, or Menindie. Much alarm was felt everywhere, but the only physical ill effects following was a slight headache in numerous instances.*

The *Barrier Miner* Wednesday 6 May 1903 page 2 reports that the earthquake was also felt at Avondale, at 6.18pm. It shook the house without causing damage. Avondale is 30km east of Broken Hill.

#### **1903 06 02 at 12:00 and 1903 07 16 at 11:00 UTC, Silverton**

An aftershock (?) was felt at Broken Hill on 2 June 1903 at 10pm local time, lasting about 10 seconds. In July there was another aftershock at 9pm on 16 July (local time) according to the local newspaper.

#### **1903 06 11 at 07:57 UTC, Cooma and Berridale**

The *Dubbo Liberal and Macquarie Advocate* and *Goulburn Evening Penny Post* Saturday 13 June 1903, page 3 & 4 respectively, reported an earthquake in the Cooma region:

*EARTHQUAKE SHOCKS.*

*Sydney, Friday.*

*A slight shock of earthquake was felt yesterday evening at Cooma and Berridale.*

#### **1904 03 06 at 11:55 UTC, Goulburn earthquake swarm**

The *Australian Town and Country Journal* Wednesday 12 March 1904 page 17 has an interesting story about a swarm of local earthquakes:

*Earthquake Shocks near Goulburn.*

*Mr. C. A. Middleton, Postmaster of Goulburn, sends the following description of the above to the Acting Government Astronomer:—"Distinct shocks of earthquake were felt in Goulburn and the surrounding district on Sunday, 6th instant, and early next morning. The first shock was a few minutes before 10 p.m. In Goulburn the shock was very slight, and unnoticed by many; but a few miles from town was of a more serious nature, shaking houses. A second disturbance, at 3.20 a.m. of the 7th. At that time two sharp shocks followed in quick succession. A loud rumbling noise, followed by a crash and rattling of windows and crockery. The path apparently was from west to east.*

*Mr. John A. Harris, of 'Grena Mumorell', about, 10 miles west of Goulburn, writes: On Sunday, about 10 p.m., we were greatly alarmed at two distinct reports like the sound of cannon fired at close quarters, and a slight trembling of the earth, and between 3 and 4 o'clock next morning two reports even greater than the first two, which seemed to shake the house to its very foundation, occurred. And between this second occurrence and 6 o'clock there were other minor reports, which seemed at a great distance away. In all I counted twenty-two reports. These reports came in twos, about a second between each. The night was beautifully calm and cool, and moonlight, and there was no appearance of anything out of the common.*

Obviously the swarm was at or under *Grena Mumorell*, west of Goulburn where 22 events were noted within a few kilometres (presumed S-P time of 1 sec). The largest seem to have been the pair at 3:30 am on 7<sup>th</sup> local time (17:30 on 6<sup>th</sup> UTC).

#### **1904 07 27 at 17:07 UTC, Cooma earthquake?**

The following is the weather report issued by Mr. H. Gunning, Cooma:— Tuesday, On 28th instant a distinct shock of earthquake occurred at 3.7 a.m. lasting about 1½ minutes (Ed. !).

### **1905 10 20 at 05:00 UTC, Tweed River**

The *Australian Town and Country Journal*, Wednesday 25<sup>th</sup> October 1905 reports: Sydney Observatory authorities report:-"Mr. Coles, of Cudgen, on the Tweed River, reports that a slight shock of earthquake was felt there a little after 3 p.m. on Friday, with a loud explosion. Buildings were shaken, and horses frightened. The shock came from the sea. As this district has hitherto been considered immune from earthquakes it has been suggested that the effects experienced may have resulted from the explosion of a meteor."

More likely the result of a small magnitude 3 local earthquake we think.

### **1906 05 15 at 06:30 UTC, Newcastle 'Creep'**

*The effect was like that of an earthquake. Houses rocked, walls cracked, gas mains burst, and the guns at the fort moved 11in. The area affected by the 'creep' is about 300 acres. The front of the cliffs cracked for some distance, and boulders loosened and fell into the sea.*

*The West Australian*, Wednesday May 16, 1906 page 7.

There can be no doubt this event, and many like it reported in the newspapers, is a mining induced event, and not a tectonic earthquake.

### **1906 08 24 at 02:20 UTC, Carcoar**

*Albury Banner and Wodonga Express* Friday 31 August 1906, Page 30.

*Earthquake at Carcoar.*

*A Carcoar (N.S.W.) correspondent wired to the metropolitan press on Friday last as follows: — Residents of Carcoar felt distinct shocks of earthquake at about 20 minutes past 12 o'clock to-day. The shocks, though faint, were sufficiently strong to rattle the crockery on the sideboards, and sounded like distant thunder. The shocks were almost simultaneous, lasting for about a couple of seconds. Mr. Neville, a resident of the town, while travelling over Back Mount, on the Macquarie Ridge, about four miles from here, felt the shock very distinctly. The mountain is a rocky backbone, which, owing to its rigidity of structure, registers seismic vibrations to a greater extent than the neighbouring town, which is built on a covering of alluvial soil. The sound and shake which accompanied it appeared to him as if a huge body of soft earth had been lifted under a heavy blast of powder. The shock was also felt at Lyndhurst, Neville, and other places in the district. Further reports to hand show that the shock of earthquake covered a large extent of the surrounding district, and that the strongest tremors were felt in the hilly and mountainous country. A slight earth tremor was felt at Mandurama. There was a more distinct shock at Gallymont, seven miles distant. The seismograph at the Sydney Observatory was examined on Saturday morning to see whether it registered any sign of the shock reported to have occurred at Carcoar. There was no trace of any earth tremor. Mr. Hunt stated that if anything of the kind occurred, it must have been of a very local and superficial character. The seismograph is so delicately adjusted that the slightest disturbances in the earth's crust are recorded. He is, however, of the opinion that a surface shock would need to be of a violent character to be communicated to the instrument. Movement at greater depths would be more speedily and definitely felt. The seismograph is sensible to heavy blasts in quarries about Sydney, and to atmospheric storms sufficiently severe to shake buildings. Mr. Hunt, however, ventured no decided opinion as to whether there was or was not an earthquake at Carcoar.*

*The felt area mentioned in the papers is small but the effects are commensurate with a magnitude 3.5 earthquake, at least 3.5.*

### **1907 01 30 at 08:30 UTC, Lithgow**

*The Dubbo Liberal and Macquarie Advocate* Saturday 2 February 1907, Page 4.

*Lithgow. Friday.*

*Somewhat of a sensation was caused in Lithgow at about half-past 6 o'clock on Wednesday night by a distinct and heavy shock of earthquake, lasting about a second. The shock is said to have shaken the railway tracks in the loco. yard. Shocks were also felt at Wallerawang and Rydal at about the same time.*

*Sydney, Friday.*

*No trace of the Wallerawang or Lithgow earthquake is recorded by the seismograph at the Sydney Observatory.*

The SMH Friday 1 February mentions, without giving the time, that it was felt at Bowenfels, Wallerawang, Piper's Flat, Rydal and Portland. The *Evening New* Thursday 31 January 1907 page 5 has the same story but mentions it was the first earthquake felt at Lithgow. The paper follows up with a long list of earthquakes felt in NSW and the reporter mentions that they were all plotted on charts (at the Observatory, see Figure 1). Another paper reports that people rushed to the doors and into the streets and that it was felt underground, the miners got to the surface as quickly as possible.

The minimum magnitude for this earthquake was 3.2, based on the felt area.

#### **1907 02 01 at 07:55 UTC, Bombala**

*Albury Banner and Wodonga Express* Friday 8 February 1907, Page 34.

*A slight shock of earthquake was felt at Bombala, at five minutes to 6 on Friday night.*

#### **1907 04 05 at 02:00 UTC, Cullenbone (near Mudgee)**

*Morning Post* Friday 12 April 1907, Page 5.

*EARTHQUAKE SHOCK.*

*SYDNEY, Thursday.*

*The residents of Cullenbone report a slight shock of earthquake on Friday last. About noon, a loud noise resembling the boom of a cannon, was heard, followed by a rumbling sound and an earth tremor which lasted for several seconds.*

No other reports have been found so this was a very small local event.

#### **1908 02 15 at 03:50 UTC, Adelong**

*The Tumut Advocate and Farmers and Settlers' Adviser* Tuesday 18 February 1908, Page 3.  
*ADELONG.*

*On Saturday afternoon between 15 and 10 minutes to 2 the shock of an earthquake was experienced at Adelong. The first indication of the disturbance was a noise resembling the passing of the ambulance waggon, the noise growing rapidly louder and louder until it sounded like the rumbling of distant thunder as the earth tremor passed through the town. The noise was heard distinctly for over half a minute. At the time of its loudest the buildings and their contents shook and rattled. The visitation came from the N.E and travelled towards the S.W. So far as we can ascertain no damage to life or property was occasioned; though many people sustained a great fright, and as the houses shook some ran out not knowing what might come next. At the time the sky was perfectly cloudless, and a light cool wind was blowing.*

Bushwalkers on nearby Mt. Adrah also reported feeling the shock at 2pm.

#### **1908 05 08 at 20:10 UTC, Cooma earthquake?**

*The Manaro Mercury, and Cooma and Bombala Advertiser* Monday 11 May 1908, page 2.

*THE following is the weather report issued by Mr. H. Gunning, Cooma: Saturday, 62 max. 24 min. Fine, frosty and pleasant. Sunday, 66—23; fine, frosty and pleasant. Monday, 69—31; fine, dull, threatening. Barometer high but falling steadily, tendency for fresh westerly winds with snow upon mountains. On 9th, distinct shock of earthquake 6.10 a.m. duration about one minute.*

#### **1909 05 08 at 15:00 UTC, Lochinvar**

*Western Star and Roma Advertiser* Wednesday 12 May 1909, Page 2.



*Earth Tremors.*

*Sydney, May 11.*

*A report received from Lochinvar, N.S.W., states that earth tremors were felt there shortly before 1 o'clock on Sunday morning. The people were so frightened that they left their houses.*

**1909 07 28 at 11:10 UTC, Gundagai**

*The Argus* Friday 30 July 1909 Page 4.

*EARTHQUAKE SHOCKS.*

*SYDNEY, Thursday. — Two distinct shocks of earthquake occurred at Gundagai last night, the first at 10 minutes past 9, and the second half an hour later. The residents were considerably alarmed by the rattling of windows and the falling of glassware and crockery.*

**1909 07 28 at 11:40 UTC, Gundagai**

(see previous article)

**1910 01 17 at 00:45 UTC, Young**

*The Wollondilly Press* Saturday 22 January 1910, page 3, noted a small local earthquake:

*A sharp shock of earthquake was experienced at Young at 10.45 a.m. on Monday. It did not last more than a minute.*

**1910 01 20 at 13:30 UTC, Brewarrina**

The *Sydney Morning Herald* of Friday 21 January 1910 reported a distinct shock of earthquake at 11:30 last night (local time). We assign it a magnitude of 3.5 and a location at Brewarrina for lack of other reports.

**1910 02 25 at 17:00 UTC, Armidale**

*Singleton Argus.* Tuesday 1<sup>st</sup> March 1910 page 3.

*Some excitement was occasioned at Armidale at 3 o'clock on Saturday morning when residents were awakened from their slumbers by a rumbling sound, slight vibrations at the same time occurring in houses. Windows, crockery and other articles rattled violently for some seconds, and many sleepers rushed from their rooms into the street, fearing that the buildings were about to collapse, but no serious damage has yet been reported. The disturbance is supposed to have been a slight earthquake.*

These reports indicate a magnitude of at least 3.5, even assuming the epicenter was very close to Armidale.

**1910 04 24 at ?time , Burragorang Valley**

*The Northern Star* of 7<sup>th</sup> May 1910 reports: *The shock of earthquake in the Burragorang Valley caused damage to a church and several buildings. Windows and crockery were smashed and walls cracked.*

*The Register* Tuesday 26 April mentions two distinct tremors at Yerranderie on Sunday which are probably the same event(s). Magnitude at least 4 but more reports needed.

**1910 06 01 01:59 UTC, Yaouk**

This noon earthquake was felt from Kosciuszko to Queanbeyan corresponding to a magnitude of about 4.5. The epicentre was nearer Adaminaby than Cooma, judging by the report although three separate events were felt at Cooma including the first one at noon. Another shock was felt at Cooma on Wednesday 17 August 1910 at 10:35pm.

The epicentre, at the centre of the felt area northeast of Adaminaby near Yaouk (36.0, 148.8), is

just south of the current ACT/NSW border.

SMH Thursday 2 June 1910

#### EARTHQUAKE IN THE SNOWY MOUNTAINS NOISE RESEMBLES ARTILLERY.

*A correspondent at Adaminaby telegraphs:- "This (Wednesday) morning at 11.59 a severe shock of earthquake was experienced here, and from information to hand it appears to have traversed the whole of the Snowy Mountains district, from Kosciusko to Rhine Falls. The shock resembled an immense field of artillery fired simultaneously, with distant rumblings of thunder lasting about, in all, five seconds. It was a very still, bitterly cold morning, with heavy mists."*

**Figure 14** The yellow ellipse encompasses places where the shaking was reported felt during the 01 June 1910 earthquake.

*Cooma, Wednesday. Three distinct shocks of earthquake were felt here today between noon and half-past 3 o'clock. None of the tremors was violent but the vibration was distinctly felt, accompanied by a rumbling noise, on each occasion.*

*Queanbeyan Age Friday 3<sup>rd</sup> June 1910 page 5.*

*A heavy shook of earthquake occurred at Adaminaby on Wednesday. The shook lasted ten seconds. A slight tremor was felt locally.*

**1910 07 02 at 13:15 UTC, Macleay District**  
*Clarence and Richmond Examiner, Saturday 9 July 1910, Page 2.*

*A slight earthquake tremor was distinctly felt at Macksville about 11.15 on Saturday night, accompanied by subterranean rumblings, which were plainly heard by the residents.*

*The earthquake shock on Saturday night was felt right throughout the Macleay district. It travelled from seawards inwards, east to west, and was most pronounced near the coast. For several nights before the shock brilliant lightning showed, and there were rumblings of thunder eastward of Smoky Cape.*

*The river steamer Olga, which leaves Kempsey late at night, distinctly felt the shock. While between Gladstone and Smithtown, at Jerseyville, close to the sea coast, the crockery tumbled from the shelves. It is about 20 years ago since a similar shock was experienced in the Kempsey district. A fissure appeared at the rear of a residence at West Kempsey on Saturday.*

The Macleay District was rocked by a swarm of earthquakes from April to October 1870 while the earthquake about 20 years ago referred to in the newspaper is probably that of March 1891.

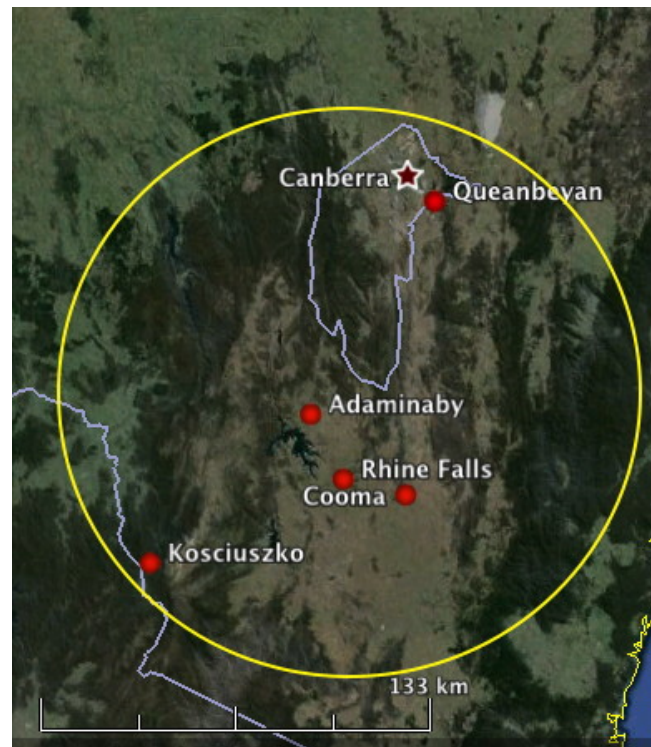
**1910 08 03 at 02:02 UTC, Cooma earthquake?**

The following news item was contributed to the local newspaper by the Cooma weather observer, Mr H. Gunning:

*August 3, shock of earthquake at 12.2 p.m. (midday) duration one minute.*

**1910 08 16 at 12:35 UTC, Cooma**

*The Sydney Morning Herald Thursday 18 August 1910, Page 3.*



*COOMA, Wednesday*

*A distinct shock of earthquake occurred last night at 10.35, lasting several seconds. This is the third shock experienced during the past few weeks.*

**1910 10 29 at 11:20 UTC, Goulburn**

The *Goulburn Evening Penny Post* 1 November 1910 page 4 carried a report of a pronounced earthquake that rattled windows on Saturday night. This is a similar report to another at 'Bronte', 20 miles from Goulburn on 9 May 1906 at 08:30 UTC.

**1912 01 17 at 20:09 UTC, Bega**

*The Border Morning Mail and Riverina Times* Friday 19 January 1912, Page 3.

*EARTHQUAKE AT PAMBULA.*

*AN ALARMING SHOCK. PAMBULA, Thursday.*

*The residents of this town were greatly alarmed this morning by a severe earthquake which lasted for half a minute. Houses rocked and furniture and crockery rattled in a manner that gave people a great shock. (Pambula, in the electorate of Bega, is situated on the River Pambula, 275 miles south from Sydney, four miles from Merimbula, and 12 miles from Eden, Twofold Bay. It has a charming climate, and is the centre of a dairy and mixed farming and mining district. The population of the town is 43 and of the district 1440.)*

An isoseismal map was drawn up by McCue (1996) from which a magnitude of  $4.9 \pm 0.3$  was determined. On the map, the intensity at Pambula was rated only MMIV. The earthquake was not included in Drake's list (1974) of post-1909 earthquakes.

**1913 02 09 time?, Windorah ~30km N of Wellington**

This local earthquake was intense enough to knock books off shelves and be mistaken for something striking the house. It was slightly felt at Wellington implying a magnitude of about 3.5.

**1913 06 16 at 20:30 UTC, Goulburn**

*The Wollondilly Press* Saturday 21 June 1913 page 4 mentions an earthquake felt in Goulburn:

*Earthquake in Goulburn*

*At about half-past six on Tuesday morning a sharp shock of earthquake was felt distinctly by a number of local residents. An Auburn-street butcher was working in his shop and was amazed to see the joints hanging against the walls swaying outwards, a moment later the building was jarred perceptibly, and a low rumble was heard. Several other residents report having had a similar experience, though in most cases, the observer being in bed, not so much attention was paid to it.*

**1915 11 08 at 08:30 UTC, Euriowie**

*The postmaster at Euriowie, which is 50 miles north of Broken Hill, during a telephone conversation with a "Miner" reporter this afternoon, stated that a severe earth tremor had been experienced at Euriowie on Monday at 6.30 p.m.*

*The shock lasted four or five minutes, and all movable articles in the houses in the township were shifted. There was no serious damage done and nothing in the nature of a panic.*

*The postmaster, added that the tremor seemed to be moving in a southerly direction, and was even more pronounced at the Sturt Meadows station, which is eight miles distant, than at Euriowie.*

*Barrier Miner* Wednesday 10 November 1915, page 4. There was no report of it being felt at Broken Hill so the magnitude must have been less than about 4.2.

**1916 06 10 at 17:51 UTC, Seal Rocks**

Father Pigot SJ, founder of the Riverview Observatory near Sydney, declared that this early morning earthquake was the largest to have occurred in NSW since its establishment in 1909.

Contemporary newspapers stated that it was felt from Taree to Bulli and, with more information available, the isoseismal map published in McCue (1996) is due for an update.

During this review it became obvious that a quite independent earthquake had occurred near Cootamundra (see next report) hours after the Seal Rocks earthquake, the felt reports mixed in with those from the Seal Rocks event. It is surprising how often this happens.

#### **1916 06 11 at 09:50 UTC, Cootamundra**

E.A.B. wrote to the *SMH* on 14 June 1916 to report that a short earthquake shock was felt there at 7:50p.m., by residents all over the town, the rumbling audible for several seconds. We can assume the epicentre was near Cootamundra (34.64°S, 148.0°E) and the magnitude at least ML 3.0.

#### **1916 06 13 at 11:30 UTC, Goulburn**

According to the Goulburn Penny Post Thursday 15 June 1916, page 2 an earthquake was felt there on Tuesday evening:

*EARTHQUAKE SHOCK IN GOULBURN. On Tuesday night at about half-past nine o'clock a distinct shock of earthquake was felt in portion of Goulburn. Doors and windows rattled alarmingly in some cases. Though the tremor was not violent it was remarkable for the length of time over which it extended. It was intermittent. In some parts of the city there was no indication of the shock.*

#### **1916 09 17 at 12:30 UTC, Goulburn**

The *Goulburn Evening Penny Post* Thursday 21 September 1916, page 2:

*EARTHQUAKE SHOCKS IN GOULBURN. Two earthquake shocks were felt in parts of Goulburn on Sunday night, the first being at half-past 10 and the second shortly afterwards. According to the statements of residents, the tremor was pronounced. Houses seemed to shake, and furniture and windows rattled. In one case it is said that a bed swayed. The visitation was distinctly felt in Bradley-street and Cowper-street. Earthquake shocks are reported from Cooma and other parts of the State.*

The *Scrutineer and Berrima District Press* Sunday 23 September 1916 page 2:

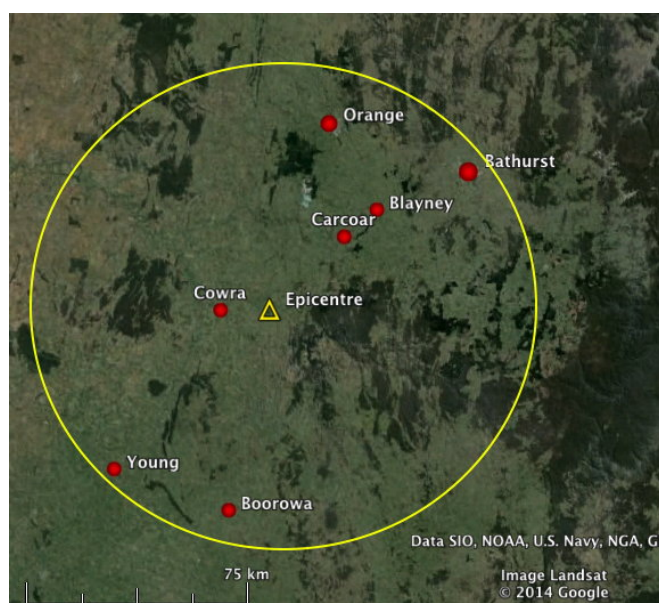
*Earthquake in Goulburn. — Two shocks of earthquake were experienced in Goulburn on Sunday night last, several residents of Bradley-street being aroused from their sleep. The first occurred at 10 50 p m, houses being jarred to their foundations and furniture shaken violently, the second shock following a few moments later. At a boarding establishment near Cowper-street every occupant was awakened, one gentleman stating that his bed was being swayed from side to side, while the window of the room rattled for several minutes.*

#### **1916 12 31 at 15:02 UTC, Cowra and Carcoar**

**Figure 15** The 1916 Cowra earthquake (New Year's Day 1917), recorded RIV. There was slight damage in Cowra and pictures were dislodged from walls.

The *Forbes Times* Friday 5 January 1917, page 4 details the earthquake:

*It was reported at the Commonwealth Weather Bureau that an earth tremor, lasting for a couple of seconds, and travelling from west to north-west, occurred at Carcoar, on the west*



*central tablelands, at 12.52 on Monday morning....This coincides with the report of a tremor felt in Bathurst, Blayney, Orange, and Cowra.*

The *Cowra Free Press* Wednesday 3 January 1917, page 2 adds that the tremor did minor damage in Cowra and that the shaking was more widely felt:

*Those who followed the time honored custom of seeing the Old Year out and the New Year in were somewhat startled on Monday morning to notice their dwellings commence to rock just as they were retiring about 1 o'clock. There were two distinct shocks lasting only a few seconds each. In several houses pictures were knocked from the walls and crockery, glasses, etc., were heard to rattle. The only sufferer we have learned of to date by the occurrence is Mr. T. Bonser, whose brick baker's oven was badly cracked. Carcoar Blayney and Young are the only other centres to report the disturbance so far.*

The *Bathurst Times* Wednesday 10 January, front page quotes Father Pigot:

*Father Edward F. Pigot (Riverview College), reports:— "On more detailed examination of the Riverview seismic tracings for the early morning of the 1st inst. a minute, but perfectly distinct record was found of the sharp earth tremor felt by many persons on that morning in the Orange, Carcoar, and Bathurst districts. It was recorded at Riverview at 1h. 2m. 29s. (Sydney standard time — less than an hour before the change to the new legal time), and is clearly visible on four out of five recording sheets. The wave-periods were very short — less than 1sec. A considerable number of the so-called "earth-tremors" stated from time to time as having been felt by isolated individuals in country districts of New South Wales, are of doubtful seismic origin. In the present case this is not so, as is confirmed by the Riverview records, which indicate a true earthquake shock, but happily of very low intensity, scarcely No. 3 of the Rossi-Forel scale. Two other seismic shocks originating in this State within the last five years, and recorded by those seismographs, have quite surpassed in intensity that of Monday last, viz., those of January 17, 1912 (Bega-Cooma district), and June 11 last (Seal Rocks, Taree, &c.).*

This event was recorded at Riverview but was not included in Drake's (1974) list.

#### **1917 03 23 at 21:15, 21:30, 21:50 and 22:10, North of Jindabyne**

Four earthquakes were reported felt at Cooma, Adaminaby and Kosciuszko on Friday morning. The epicentral region is poorly defined but must have been near present-day Jindabyne.

*The Manaro Mercury, and Cooma and Bombala Advertiser* Friday 23 March 1917, Page 2:

*Several shocks of earthquake were felt in Cooma and surroundings this morning. Two of a light nature at 7.15 and 7.30 lasted a few seconds but others at 7.50 and 8.10 were of two and three minutes duration. All were travelling from a direction east, to south west. The heavier shocks caused vibration in several buildings in the town. Mr. H. Gunning recalls similar shocks in 1897 which were followed by heavy rains.*

#### **1917 04 02 at 19:55 UTC, Holbrook**

The *Northern Times* Tuesday 3 April 1917 mentions that an earthquake was felt in Albury (crockery and furniture broken) early Tuesday morning and it was also felt in Wagga. The *Young Witness* Thursday 5 April 1917, page 1 reports an earthquake at Adelong early Tuesday morning, something the residents were used to 50 years ago, so it should not have been a 'novelty':

*The town of Adelong was startled at Daylight on Tuesday by a strong rumbling noise, which evidently was due to a severe shock of earthquake. Crockery was rattled on kitchen dressers. The novelty of an earthquake was quite disconcerting in the town during the day.*



The *Daily Herald* Wednesday 4 April 1917, page 5 extends the information:

*SYDNEY, April 3.*

*At Adelong a strong rumbling was heralded by a somewhat severe earth tremor. The Sydney Weather Bureau has received reports from Wagga and Holbrook residents of a similar happening, as well as Albury and Adelong.*

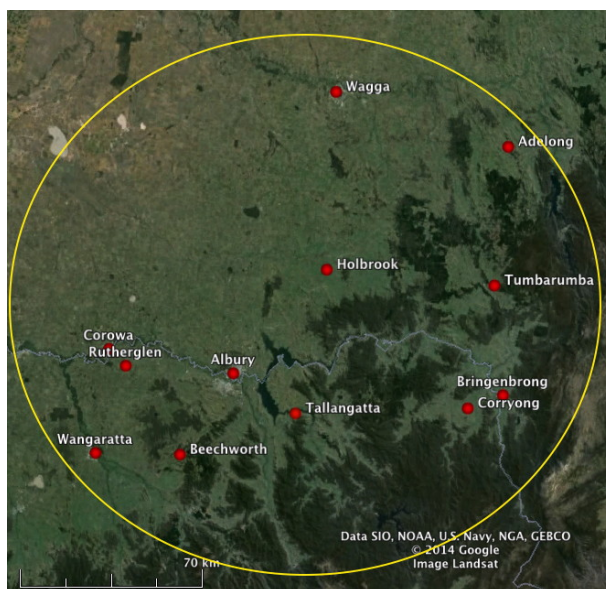
*At Albury crockery and furniture were broken. At Wagga rumbling noises were heard. As the districts affected are a considerable distance apart, the disturbance must have been of some intensity.*

**Figure 16** Felt area of the earthquake near the NSW/Vic border east of Albury on 2 April 1917. The derived magnitude of 4.7 is a minimum value given the early morning occurrence, and the epicentre may be nearer Albury where the shaking was strongest.

Beechworth too reported an earth tremor before 6 a.m., especially in the PO building but all over town, likewise Rutherglen, Corryong, Corowa, Tumbarumba, Wangaratta and Bringenbrong felt the shaking.

The *Daily Advertiser* Thursday 5 April 1917 page 3 quotes Father Pigot's observation:

*Father Pigot said on Tuesday that the seismograph at Riverview College had recorded the disturbances, although they were only slight ones. "They were," he said, "distinctly registered on no fewer than four recording sheets. The waves lasted about half a minute, and commenced at 5.57 a.m. The earthquake shocks were," he concluded, "the two smallest ever recorded at Riverview."*



#### **1917 06 09 at 15:00 & 16:00UTC and 1917 06 11 at 17:00 UTC, Tumut sequence**

*Young Witness* Friday 15 June 1917, Page 3.

*Two distinct earthquake shocks were felt in Tumut at 1 and 2 a.m. respectively on Sunday. On Tuesday morning three violent shocks were experienced in five minutes, commencing at 3 o'clock. Houses shook and windows rattled. The earth tremor was from west to east, and in each instance was preceded by a loud rumbling noise resembling thunder, which gradually died away as the disturbance proceeded on its eastward course.*

#### **1918 06 06 at 18:14 UTC, Bundaberg Q'ld earthquake felt widely in northern NSW**

#### **1918 07 25 at 09:25 UTC, Milong**

*Young Witness* Friday 26 July 1918, Page 5.

**EARTH TREMOR. WINDOWS RATTLE AT MILONG.**

*A distinct shock of earthquake was felt in portions of the Young district last evening. Mr. R. J. Young, of Milong, reports that at 7.25 p.m. a loud rumbling noise resembling that of a heavy thunder clap was heard, causing the windows to rattle. The shock was felt at Mr. Lamb's residence, near Tubbul.*

#### **1919 08 15 at 10:21 UTC, Kurrajong**

This earthquake was felt throughout Sydney and more widely. It has been attributed to the Kurrajong Fault though there was no surface faulting, nor was the focus well enough

determined. Cotton's isoseismal map was converted from RF to MM scale (Everingham and others, 1982). The *Mudgee Guardian and North-Western Representative* Thursday 21 August 1919, Page 19.

*A phenomenal disturbance took place in the district about 9 o'clock on Friday night last. At the hour stated there was a slight earth tremor, which was felt by many people. At Goolma and other places the crockery rattled in the shelves. The tremor was also felt at Mudgee.*

*Windsor and Richmond Gazette* Friday 22 August 1919, Page 2.

#### **THE EARTHQUAKE.**

##### ***Severe Shock in Hawkesbury District.***

*A distinct earthquake was felt throughout the Hawkesbury district between 8.15 and 8.30 p.m. on Friday night. The shock was also severe around Sydney and suburbs, and in the Parramatta district. In Windsor the shock was severe in some places, while the Kurrajong distinct, Lower Portland, Wiseman's Ferry and other places felt the tremor. Many people report that the shock resembled a severe bump, as if some heavy body had fallen against their houses. Bedsteads, tables and chairs danced and rocked, pictures rattled against the wall, and in some places fell, while articles fell from shelves and tables. Floors quivered, windows rattled, and walls and roofs groaned, and the whole earth seemed to tremble. Many people thought the walls of their houses had fallen, so severe was the bump, and there was great perturbation, especially among the women folk. At Riverview College, Hunter's Hill, which is specially equipped with apparatus for recording earthquake shocks, a seismograph record was obtained. This gave the time of the disturbance as 8.23 p.m.*

#### **1919 12 18 night, NSW/SA border region**

*The Register* Monday 22 December 1919, Page 8 reports:

##### ***EARTH TREMOR AT THE BARRIER.***

##### ***BROKEN HILL, DECEMBER 21.***

*Residents of Cockburn SA, Mutooroo SA, and Thackaringa NSW report that a slight, but very distinct, earth tremor was experienced on Thursday night.*

Either a small local or rather larger regional earthquake could explain this report.

#### **1919 12 26 at 02:27 UTC, South of Cadia mine near Carcoar**

*The Maitland Daily Mercury*, Tuesday 30 December 1919, Page 2.

*On Boxing Day at 12.27 an earth tremor occurred at Errowanbang, 11 miles from Carcoar. It appeared to travel in a southerly east, to north-east direction, and was of about five seconds duration. Crockery and furniture rattled, and a slight twist of the earth was noticed, the twist seemingly being from north to south. Flyers Creek, Somers, Gallimont, Mandurama, and Millpost Creek all report having felt the tremor, which was accompanied by a noise like thunder. At Gallimont, the shock was the most severe, crockery rattling on the shelves.*

#### **1920 03 23 Tuesday night local time, Goulburn**

A tremor was reported felt in north Goulburn on Tuesday night. It rattled crockery but was not recorded at Riverview.

A distinct shock of earthquake was reported felt in Goulburn on Wednesday morning according to the *Canowindra Star and Eugowra News* Friday 26 March 1920, page 2. These are probably the same event.

### 1921 04 23 at 10:00 UTC, A mining creep in Lithgow

*The Northern Daily Leader* Tuesday 26 April 1921, Page 2.

*Earthquake at Lithgow.*

*HOUSE DESTROYED. Earth Tremors Common Lately. SYDNEY, Monday.*

*The home of Mrs. W. Hodge was wrecked by an earth tremor at Lithgow about 8 o'clock Saturday night. The first intimation of the danger was a rumbling sound under the house. This was immediately followed by a shower of mortar. Miss Hodge and a friend, the only occupants of the cottage, rushed out and gave the alarm. Neighbours helped to carry the furniture out of the wrecked building; and other residents, fearing a further earthquake, also removed the valuable furniture from their homes. The creep extended about 200 yards along the west side of Macaulay-street. Residents stated that they have felt earth tremors along the street for the past six week.*

Obviously this was a man-made, mining-related event and not a tectonic earthquake.

### 1921 May date/time? Edith near Oberon

*Wellington Times* Thursday 2 June 1921, Page 6.

*A distant earth tremor was felt at Edith in the Oberon district, during the week. Crockery and windows were shaken, and the visitation was accompanied by a dull, booming sound.*

### 1921 Mid-June, multiple tremors Sydney

SYDNEY EARTH TREMORS.

SYDNEY, June 18.— The scientific experts, who have for the past few days been investigating the mysterious earth tremors, which have been frightening many Sydney people, and for which the Pons-Winnecke comet has been thought responsible by the public and certain sections of the Press, have now discovered that they were simply caused by the destruction by explosion of condemned cordite at Holdsworthy. The neurotic section of the community who had been much alarmed, are now reassured by this discovery.

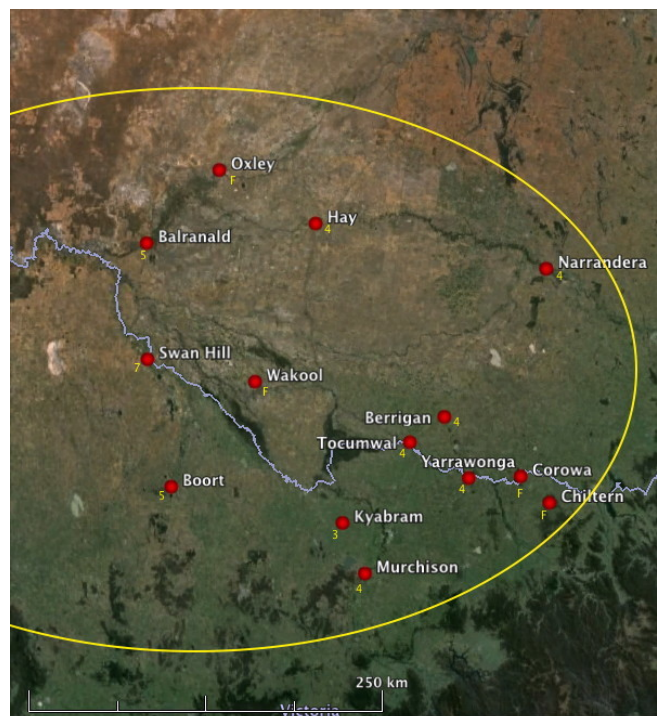
### 1921 05 30 at 15:00 UTC, Swan Hill

**Figure 17** This earthquake on 30 May 1921 was widely felt in south-central NSW and Victoria. The felt area shown in the figure has been skewed to an epicentre near Swan Hill commensurate with the intensity there. The derived magnitude is the same as Drake's (1974) measured magnitude of 5.5 at RIV.

*Albury Banner and Wodonga Express*  
Friday 3 June 1921, Page 23

**EARTH TREMOR IN RIVERINA.**

*Hay, Tuesday. — A very distinct earth tremor was experienced here just before 1 o'clock this morning. The buildings seemed to heave, and the walls rattle. The shock was of brief duration. Shortly afterwards a rainstorm, with heavy thunder and lightning, took place.*



*Berrigan, Tuesday. — A sharp and distinct earth tremor was felt about 1 o'clock this morning. Buildings shook, and furniture and crockery rattled. Many residents were awakened by the noise.*

*Tocumwal, Tuesday. — An earth tremor was felt here early this morning, the buildings being shaken.*

*Balranald, Tuesday. — A violet earth tremor occurred at Balranald, Oxley and Wakool about 1 o'clock this morning. Wooden buildings strained, creaked, and swayed under the influence. No damage is reported.*

The Victorian newspapers relate the felt effects in towns south of the border.

*Boort to Balranald Affected.*

*BOORT Tuesday. — A sharp, earth tremour was felt at 1 o'clock this morning. It lasted about two minutes, and appeared to travel, from east to west. Beds were bumped against walls, crockery rattled, and furniture rocked. Many people were considerably alarmed by the swaying motion. When the tremor passed, heavy rain fell for nearly an hour. The tremor was felt in many parts of the district.*

*KYABRAM, Tuesday. — A slight earth tremor was felt this morning at 20 minutes to 1 o'clock.*

*MURCHISON, Tuesday. — An earth tremor was felt here early this morning. A number of people got out of bed to find out what had happened, as their doors and windows were shaking.*

*SWAN HILL, Tuesday. — At seven minutes to 1 o'clock this morning, a violent earth tremor shook the houses. The roofs rattled, plaster walls cracked, and water tanks were thrown off their stands. A red glow was observed in the northern sky while the shock lasted.*

*YARRAWONGA, Tuesday. — A distinct earth tremor was felt in the town early this morning. It lasted only a few seconds, but houses shook. No damage was done.*

*TOCUMWAL (N.S.W.), Tuesday. Early this morning an earth tremor shook buildings, but caused no damage.*

The shaking was also felt at Finley, just north of Tocumwal, at Corowa 30km east of Yarrawonga and Chiltern, 20km south-east of Corowa.

### **1921 November and December, Cooma but no other reports**

Slight shocks of earthquake were reported felt in Cooma in November and December 1921. Mr Gunning was the reporter.

### **1922 05 17 at 18:45 UTC, Cooma**

A slight earthquake was reported by Mr Gunning, felt Cooma and nowhere else.

### **1923 04 15 at 23:30 UTC, Manilla**

*The Sydney Morning Herald* Wednesday 18 April 1923, Page 14.

*EARTH TREMOR.*

*MANILLA, Tuesday.*

*An earth tremor was felt here yesterday morning, about 9.30 o'clock. Two rumbling sounds were heard, and large windows shook.*

### **1924 11 04 time?, Canowindra and Cargo**

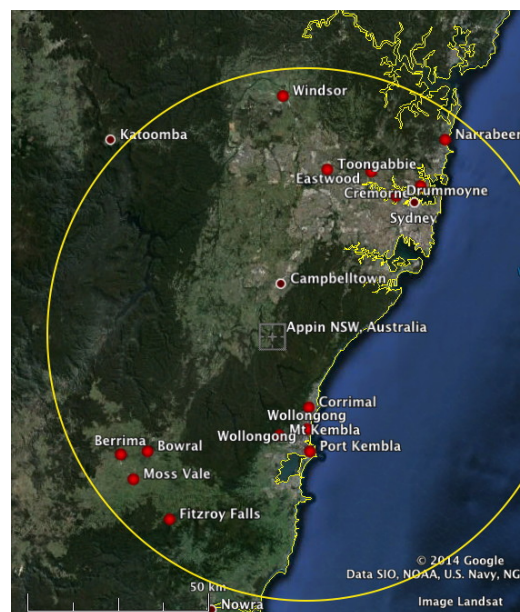
*The Gundagai Times and Tumut, Adelong and Murrumbidgee District Advertiser* Tuesday 11 November 1924, page 2:



*A distinct earth tremor was felt about three miles from Canowindra on Wednesday morning last. It was accompanied by rumblings like thunder. Several brick houses were cracked and utensils dislodged from shelves. At Cargo, 14 miles away, the hotel walls were cracked and bottles shaken from the counters and shelves.*

#### **1925 01 07 10:23 UTC, South of Sydney**

An earth tremor at 8.23 on Wednesday night was felt in many houses in Sydney suburbs, Coogee, Woolahra, Manly, Cremorne, Eastwood, Drummoyne, Wollongong, Narrabeen, Windsor and in the western suburbs. In some cases doors and windows rattled, and many people were unable to understand the cause of these happenings. The *Sydney Morning Herald* Friday 9<sup>th</sup> January 1925 page 11 and Saturday 10 January 1925 reports that the shock was also felt at Moss Vale, where a house quivered for a few seconds. The *Adelaide Advertiser* of that day reports that Port Kembla was strongly shaken, people rushing out into the street and houses shaken, crockery damaged.



**Figure 18** Felt area of the 7 January 1925 earthquake felt in many Sydney suburbs. The felt reports look like two events.

The earthquake was felt at Coogee, Corrimal, Berrima, Fitzroy Falls (pictures shaking on walls), Toongabbie and Bowral. At Mount Kembla: *crockery on shelves rattled and houses shook*, hardly a near-epicentre report. The most likely epicentre is one near Appin with a magnitude of about 4.3.

#### **1925 01 15 at 11:30 UTC, Gundagai**

An earthquake, lasting several seconds, affected the district at 9.30 last night. In places crockery was knocked off the shelves and windows rattled. Father Pigot, of Riverview College, said last night that the instruments in his observatory at Riverview had distinctly recorded the tremor. It was of no significance. "It was really so trifling," said Father Pigot, "that it is not worth offering any comment upon."

This earthquake was also felt at Cootamundra and Binalong.

#### **1925 03 15 at 08:00 UTC, Bungendore**

*The Scrutineer and Berrima District Press*, Saturday 21 March 1925, page 2.

*At six o'clock on Sunday afternoon a distinct shock of earthquake was felt in Goulburn, at least two citizens reporting that the tremor was sufficient to jar buildings and cause windows to rattle. Braidwood felt the shock severely, while our Bungendore correspondent states that every house in the town was shaken. The tremor appeared to travel from west to east. Fortunately no damage was done.*

The epicentre was probably nearer Bungendore than Braidwood and furthest from Goulburn. It was felt at Queanbeyan and could have occurred on the Lake George Fault, its magnitude was about 4.3.

#### **1925 12 18 at 10:47:10 UTC, Newcastle**

This magnitude 5.3 earthquake (McCue in Rynn and others, 1987; Drake, 1974 measured it at ML5.2 from the RIV recording) was felt from Wollongong in the south to Taree in the north.

*PANIC IN PICTURE THEATRE.*



*A few minutes before 9 o'clock this evening Newcastle and its environs were shaken by two severe earth tremors, which were felt in all parts of the district. Thousands of citizens rushed out of doors to ascertain what had happened.*

*At Betts' Union Picture Theatre, in Hunter-street West, the tremor caused a panic amongst a large section of the audience. The manager (Mr Fenton) states that when the first tremor was experienced, numbers of the audience shifted uneasily in their seats, and when, almost immediately, the building was again shaken to its foundations, there was a wild stampede for the exits. For a few minutes hopeless pandemonium reigned, and had it not been for the efforts of the theatre attendants, many people would undoubtedly have been severely injured. As it was, many women fainted and had to be carried into the foyer, where restoratives were applied.*

*At the Strand Picture Theatre, in Hunter-street, Newcastle, the tremor also caused considerable alarm amongst the audience, although those who left the building, did so in a calm and orderly manner.*

Coincidentally, the welcoming function for the first bulk oil tanker to visit Newcastle, the Vacuum Oil Company's tanker Pulpit Point, was being held at the Great Northern Hotel that evening and the earthquake caused consternation there. (*The Muswellbrook Chronicle* Wednesday 23 December 1925, page 3.)

*The Bombala Times* of Friday 25 December 1925 page 1 printed an interesting quote after the earthquake: *Rev. Father Pigot, of Riverview College, who is the recognised authority in Australia on earthquakes, declared that there was nothing to be alarmed about, and that a similar shock would not occur for another 20 or 25 years.*

History shows that the wait was just short of 7 years, when a similar sized earthquake struck near Gunning. Newcastle had to wait another 64 years.

#### **1926 06 13 at 20:00 UTC, Cowra**

*The Riverine Grazier* Tuesday 15 June 1926 page 2.

*EARTH TREMOR AT COWRA. At Cowra, the local residents were alarmed at 6 o'clock this morning, when heavy rumblings were heard. An earth tremor immediately followed, which caused houses to shake and crockery to rattle. Two distinct noises were heard. Apparently no damage was done to property.*

There were no reports from surrounding towns that this event was felt anywhere but Cowra.

#### **1926 07 05 at 6:15 UTC, Goulburn**

*The Tumut and Adelong Times* Tuesday 13 July 1926, page 2 says:

*Goulburn experienced a heavy earthquake shock at 4.15 p.m. last Wednesday. Houses shook and windows rattled and a long low rumble passed from west to east. At North Goulburn the wall of one house was split from top to bottom. A lot of crockery was broken.*

This earthquake must have occurred under North Goulburn to explain the very localised strong shaking and damage. Was it recorded at RIV? The time given by the *Great Southern Herald* (Katanning WA) was 4:35 pm and the journalist suggests this was a meteorite, not an earthquake.

#### **1927 12 31 at 09:22 UTC, Armidale**

*The Singleton Argus* Tuesday 3 January 1928, Page 2 reported:

*EARTH TREMOR*

*ARMIDALE WINDOWS RATTLED*

Sydney, Monday.

*An earth tremor was felt in Armidale and district at 7.22 p.m. on Saturday. It lasted for only a second or two, but shook houses, rattling windows and other objects. When Dr. Pigot, of the Riverview Observatory, was interviewed concerning the earth tremor, he said the records on the Observatory seismograph showed the tremor lasted two minutes, but it was of a very slight nature.*

This event was further from RIV, where it was recorded, than the following earthquake at Wellington that was not recorded at RIV, so it must have been the bigger of the two.

#### **1928 02 03 at 07:30 UTC, first earthquake recorded Wellington**

The *Wellington Times* Monday 6 February 1928, Page 3 devoted nearly a column to the story.

##### **SEVERE EARTH TREMOR.**

##### ***Buildings Shaken. TOWNSPEOPLE SCARED***

*At about 5.30 on Friday afternoon, Wellington residents had their first experience of a short and severe earthquake. At the hour mentioned, people were suddenly startled by a muffled roar, like an explosion in the distance. This was immediately followed by two distinct quakes, which shook buildings. Brick houses shook and weatherboard buildings creaked, bottles and crockery rattled, and, in some places, plaster fell from walls. So severe was the quake that people thought that buildings were collapsing, and in a short space of time the streets were full of inquiring and scared residents. Never before in the history of Wellington has such an occurrence, happened. The quake was also recorded in several parts of the district, indicating a severe eruption or earthquake somewhere. The quake was felt within a radius of twenty miles, and out as far as Stuart Town and Burrandong. In town a pile of empty boxes was hurled to the ground. From information received, the quake was not felt outside the Wellington area, and is the first ever recorded here..... As may be expected residents were thoroughly scared by the sudden visitation, for in some case's it appeared as if buildings were collapsing. So great was the fear of some of the womenfolk that they burst into tears..... The disturbance appears to have been purely local, as there were no reports of earth tremors in any other parts of the State during Friday, although there were reports that a quake had occurred in New Zealand. Cr. Edwards, who was in town on Saturday, stated that the tremor was not felt at Stuart Town (Ed. 30km away). Mr. Brennan, Senr., who resides at Montefiores, states that his house shook and crockery rattled, whilst the piano was seen to rock to and fro. One man was ploughing in a garden along the Bell river flats, when he suddenly felt the earth shake and wondered what was happening. Reports from all parts of the town show that the shock was felt in every dwelling, and by people working in the fields. The centre of the disturbance appeared to be in the vicinity of Mount Arthur. Strange to relate, no reports have been received from any other district in the State reporting any disturbance or quake..... The incident will go down in the town's history as the first 'quake' in the Wellington Valley since settlement became established.*

It was felt in Dubbo by a few people at rest and at Arthurville, but was not recorded at RIV. The felt area and intensity are consistent with a magnitude of 3.7.

#### **1928 02 13 at 08:45 UTC, Bredbo**

The *Manaro Mercury*, and *Cooma and Bombala Advertiser* Friday 20 April 1928, page 2.

##### ***Local and General News***

*A distinct shock of earthquake was noticed at the residence of Mr. J. J. Harnett, of Bredbo, on Friday last at about 6.45 p.m. The quake was travelling from South-East to North-West, and lasted a few seconds.*

### **1928 05 06 at 12:00 UTC, Between Goulburn and Crookwell**

The *Goulburn Evening Post* Wednesday 7 and 9 May 1928, Pages 2 and 4 report a slight earth tremor was felt in West Goulburn and Yarra, 7 miles south-west of Goulburn. It was felt at Crookwell on Sunday night, about 10pm and Taralga at 10.15pm.

### **1928 08 27 at 01:55 UTC, White Cliffs**

The *Barrier Miner* Wednesday 5 September 1928 Page 3 reports:

#### *EARTH TREMOR FELT IN WHITE CLIFFS DISTRICT*

*A distinct, earth shock was experienced at White Cliffs and in that district on Monday, August 27 (says the "Western Grazier"). Just before noon a rumbling noise, like the approach of a heavily laden motor lorry was heard, and almost immediately the earth became tremulous and many buildings in the town were shaken, the vibration being very noticeable at the White Cliffs hotel. It had all the signs of an earthquake shock: an occurrence not previously heard of in these parts. A slight shock was felt by some residents in Wilcannia about the same time.*

Obviously the event was closer to White Cliffs than Wilcannia, 85 km away, so at the very least the magnitude was 4.5.

### **1929 02 08 at 14:08 UTC, Bowning damage**

#### **SHOCKS! TWO TREMORS YASS EXCITED**

*Two severe earth tremors shook Yass at 12.8 a.m. on Saturday last. The roof of an old house at Bowning fell through, while a wall was cracked in another home nearby.*

*The tremors were excitedly discussed by residents of the district, and though some were so sound asleep that they did not feel them, they were soon convinced that Yass had been shaken. The manager of the Bank of New South Wales, which is in the main street, was working in his office, and when he heard the window rattle he thought it was somebody trying to break into the bank. But after listening for a few minutes he heard no further disturbance, and concluded that he had been mistaken.*

### **1929 05 22 Vale Rev. Dr. Edward Francis Pigot S.J., Riverview Observatory, 1858-1929.**

### **1929 05 26 at 09:00 UTC, Binalong**

*The Grenfell Record and Lachlan District Advertiser* Thursday 30 May 1929, Page 2.

#### **EARTH TREMOR.**

There was a slight earth tremor at Binalong, about 7 o'clock on Sunday night. It was felt in town and parts of the district. No damage was done.

### **1929 10 ?? at 18:00 UTC, Gunning**

*The Gundagai Times and Tumut, Adelong and Murrumbidgee District Advertiser* Tuesday 29 October 1929, Page 2.

*Had All 'Quake Symptoms.*

*Tricked Hens, But it Wasn't a Quake.*

*Up at Gunning there have been subterranean rumblings and earth tremors so violent that at 4 o'clock one morning last week a particularly violent 'shake' woke people in the town and at Dalton. Hen cackled, roosters crowed, and cows bellowed. Local prophets, who have forecasted such a happening, seemed to have come into their own. Nature provided adequate river-beds for the waters of the Murrumbidgee, Snowy and Cotter Rivers, but man, 'unnaturally,' had built the huge Burrinjuck Dam and burdened the earth's surface overmuch they had argued. The weight of the water causing these*

disturbances. 'Terraneous settlement,' said the prophets. But science confounds the prophets, 'The tremors are the outcome of the fracturing of rocks far beneath the surface of the earth,' says Professor A. Leo Cotton, of Sydney University.

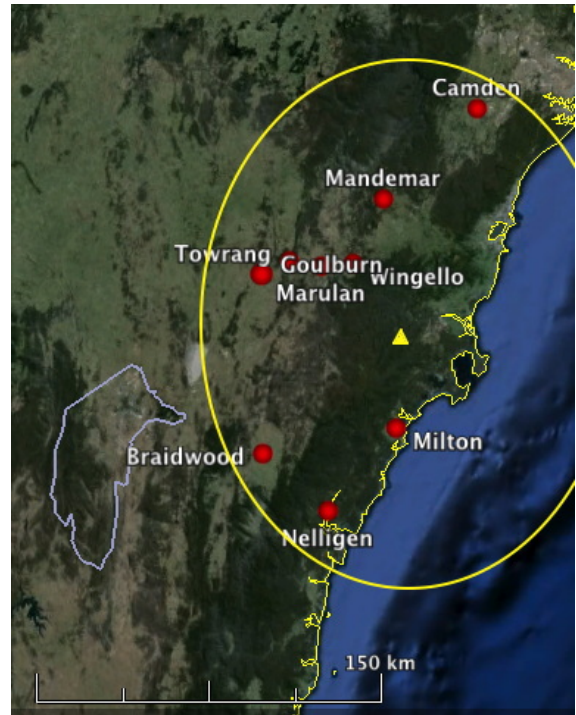
ONE SECTION SLIPS. 'One section slip's over another, setting up a vibration.' The movements lead to readjustments in the earth, but the exact nature of this is a puzzle to geologists. 'Some people believe the earth is growing colder and shrinking; others that it is warming up again. 'The Yass-Gunnung district,' said Professor Cotton, 'is very much broken by these fractures, known as faults. The movements which cause them might take place miles below the earth.' But the Burrinjuck Dam is not the cause.

#### 1930 05 22 03:10 UTC, Milton South Coast

Felt from Towrang to Wingello and at Goulburn, Milton and Nelligen, this event was obviously reasonably large and in an unusual location.

**Figure 19** Places where the earthquake of 22 May 1930 reported feeling the shaking, and a minimalist ellipsoid outlining the probable felt area.

Milton on the South Coast seems to have borne the brunt of the shaking though no damage was reported. The newspapers say that Sydney Observatory reports that it was 150 to 170 miles (240 – 270 km) from Sydney. The felt area was plotted and corresponds to a magnitude of ML4.8, the epicenter at (35 °S, 150°E) which is 175km (not miles) from Sydney.



It was also felt for 6sec at Camden and was distinct at Braidwood.

*The Scrutineer and Berrima District Press* Saturday 31 May 1930, Page 4:

*Earth Tremors.*

#### **BUILDINGS SHAKEN AT MARULAN**

*Distinct earth tremors were felt at various centres on the southern line from Towrang to below Wingello last week. Marulan especially felt tremors, which shook many buildings to such extent that residents became alarmed. At Wingello rail fences were shaken loose. Slight tremors were noticed in some parts of Goulburn. A message from Milton also states that a sharp earth tremor was experienced in the town. It was preceded by a long, heavy rumble, which seemed to come from a south-easterly direction. Buildings were violently shaken. Mandemar also report tremors.*

#### 1930 10 27 at 02:03 UTC, Boorowa

*The Sydney Morning Herald* Tuesday 28 October 1930, Page 9.

#### **EARTH TREMORS**

**OVER LARGE AREA. No Damage Reported.**

*Two distinct earth tremors were experienced over a large area of the State shortly after noon yesterday and, from reports which have been received at Sydney, it is calculated that a slight movement of the earth's surface occurred somewhere more than 100 miles from Sydney in a west-south-westerly direction. No damage was done*

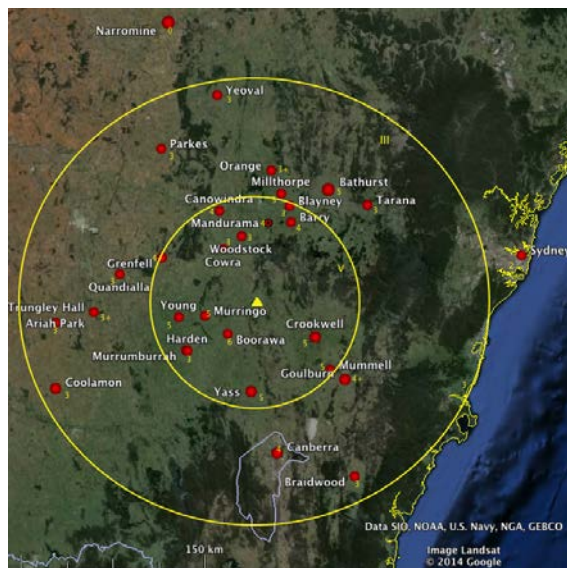
*The exact site of the occurrence has not yet been determined but is thought to have been centred in an irregular area approximately oval in shape extending from Goulburn*

to Coolamon in the south (approximately 180 miles) and to Canowindra in the west (approximately 120 miles). At many places the shock was so great that residents were under the impression that a large object had struck their houses whilst at others windows were shaken violently and crockery was thrown from shelves. At Canowindra a heavy anvil swayed perceptibly. A slight shock was felt in several of the suburbs of Sydney.

Accounts of the occurrence agree that there were two phases of the disturbance and that the first tremor was preceded by a low rumbling not unlike the sound of an explosion at a distance.

The seismographs at Sydney and Riverview observatories recorded the shocks which scientifically were neither large nor important.

**Figure 20** Isoseismal map of the 27 October 1930 Boorowa NSW earthquake. The epicentre (yellow triangle) is about 25 km NW Boorowa, within about 30km of the Drake (1974) epicentre. The felt area is consistent with a magnitude of 5.3. Below is a plot of the felt area published in a contemporary newspaper.



### COUNTRY REPORTS

From Bathurst, Woodstock, Cowra, Canowindra, Blayney, Millthorpe, Grenfell, Goulburn, Canberra, Coolamon, Boorowa, Arian Park, Quandialla, Harden and Murrumburrah came reports of the phenomenon. In all cases the time given was between noon and 12.40 p.m. Riverview Observatory recorded it as 40 seconds after 12.40 p.m. Each tremor lasted only a few seconds and there was less than a minute's interval between them.

Father O'Leary of the Riverview Observatory said that slight movements of the earth's crust had been fairly frequent in the past few months. As far as Australia was concerned there was absolutely no cause for alarm.

The Canberra Times Tuesday 28 October 1930, page 1.

ALARM IN THE WEST SYDNEY, Monday.

Considerable alarm was occasioned in parts of the Western Districts by severe earth-tremors shortly after midday to-day.

At Bathurst almost every building was shaken for about ten seconds, and operators of the local telephone exchange feared that the building would collapse.

At Mandurama the shock was not so serious, but at Murrumbidgee two shocks shook the houses and dislodged crockery from the shelves and pictures from the walls.

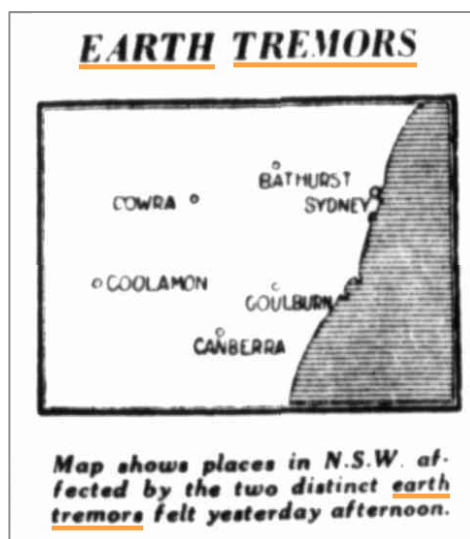
Many people left their homes at Crookwell where the shock was severe but no serious damage was done.

Shocks were also felt in some suburbs of Sydney, but they were very slight. Both Riverview and Sydney Observatories recorded tremors, but they were very slight.

Evening News Monday 27 October 1930, Page 7.

STARTLING SHOCKS

Widespread Earth Tremors N.S.W. SHAKEN





*EARTH tremors, startling in their intensity, and causing slight damage in a number of cases, occurred about midday to-day in different parts of the State.*

*THE shock was recorded at Riverview Observatory to-day. The main shock took place about half a minute after the disturbance started. 'It was quite a close shock, and seemed to be located about 100 miles from Sydney,' said an official of the Observatory. Buildings Trembled CANBERRA, Monday. A strong earth tremor lasting 12 seconds, was felt in Canberra at 12.5 p.m. to-day, but no scientific instruments are installed here by which a record can be made. Buildings trembled. Members of Cabinet at No. 2 Sectariat, who were preparing the financial proposals for caucus, were anxious for information. Apparently they regard the occurrence as an augury of coming events when caucus meets.*

*Walls Cracked BOOROWA, Monday.*

*An earthquake shock at midday today startled the residents. There were two shocks, the first being the more severe. Buildings were badly shaken, and the walls of many houses were cracked. At the school a large picture fell and just missed the head of a boy. The blackboard also fell, and the school wall was badly cracked from the ceiling to floor. Pupils were ordered from the building.*

*Safe Moved YASS, Monday.*

*About noon to-day a severe tremor was experienced in the town and parts of the district. At the courthouse the floor shook. The showroom of one store trembled, crockery and glassware rattled, and the safe was moved from one side of the room to the other. The tremors lasted about five seconds. Residents say they were the worst ever experienced at Yass.*

*Rush for Safety BATHURST, Monday.*

*About 12.15 p.m. to-day residents of Bathurst were startled by a severe earth tremor. Practically every building in Bathurst was shaken for a few seconds. Girls working in the telephone exchange and operators at the telegraph office experienced an exciting few seconds and the girls raced into the street, fearing the building would collapse. The shock was also felt in many adjoining districts. It was the heaviest ever experienced here.*

*Buildings Shaken CANOWINDRA, Monday.*

*An earth tremor felt here about noon to-day caused much excitement. The disturbance which lasted for a few seconds, was felt by practically every resident of the town area, and buildings received a severe shaking. No damage was reported.*

It was severe at Grenfell at 12:15 distinct at the David Berry Hospital where tiles were heard to crack.

### **1931 03 13 at 21:13 UTC, Neriga**

Burke-Gaffney (1951) reports this event but no mention could be found in the newspapers digitised to December 2014.

### **1931 05 12 at 21:55 UTC, Cooma**

Alarm in some houses, slight shock in others but described by some as an explosion followed by a series of bumps shortly before 8 am Wednesday (*Sydney Morning Herald*, Thursday 14<sup>th</sup> May 1931. The Braidwood newspaper described it as the heaviest shock for many years at Cooma.

### **1931 06 05 Time unknown, Mt. Bobbra Landslip**

This is an interesting event though not an earthquake, possibly the effect of an earlier earthquake as claimed.

*Advocate* Saturday 6 June 1931 Page 2

*BIG LANDSLIDE IN N.S.W.*

*Effect of 'Quake Shock*



*SYDNEY, Friday-Two acres of land at Mt. Bobbra, seven miles from Binalong, fell into the valley below. The landslide carried with it thousands of tons of rocks and many trees, but the only damage done was to a fence.*

*Three months ago an earthquake shook the Yass and Binalong districts and left a huge crack right through Mt. Bobbra on property owned by J. Hordon. Week by week the crack widened until, following recent heavy rain, the crash came. A further fall is probable.*

According to Burke-Gaffney (1952) there was an earthquake three months previously, on 13<sup>th</sup> March 1931 its magnitude 3½, surely far too small to have caused the effects noted in the report above. The relevant newspapers have not yet been digitised so it doesn't appear in a Trove search. Perhaps the earlier 27<sup>th</sup> October 1930 earthquake was the culprit, Drake (1974) rated its magnitude 5.0 whilst McCue (2001) computed the magnitude at 5.3 from the isoseismal map. Both gave an epicenter near Boorawa.

### **1932 05 22 at 10:45 UTC, Narromine**

A decade long sequence of earthquakes at Narromine has been documented by (McCue, 2014b), the first of them on 19 March 1930, the last on 13 May 1938. The largest earthquake by far occurred on 22 May 1932, its magnitude between 4.5 and 5.0 (Drake, 1974 assigned it ML 4.5). Minor damage was reported in Narromine. They started on 18<sup>th</sup> May as follows:

*The Sydney Morning Herald Saturday 21 May 1932, Page 13.*

*EARTH TREMORS In Country Towns. NARROMINE, Friday.*

*What are presumed to have been a series of earth tremors have been experienced at Narromine during the past 24 hours. There were two very strong tremors and two mild ones. The first was at 3 a.m. yesterday. A light shake occurred about 11 a.m., and a particularly heavy one was felt this morning at 3.45. There was a further light tremor at 4 a.m.*

*The main shock this morning was heralded by an explosion similar to that of a land mine, well underground. Then buildings shook and rattled and a heavy rumbling noise travelled underground apparently from the south-west to the north-east. It wakened practically everybody in the town.*

This earthquake on Friday was not the mainshock, the worst was still to come, on Sunday.

### **1932 05 22 at 10:46 UTC, Narromine houses damaged**

*Narromine News and Trangie Advocate Friday 27 May 1932, Page 5.*

*Narromine's Night of Horror*

*Severe Earth Tremor, Terrifies Residents. Loud Rumbling Noise And Violent Shaking.*

*NOTHING SO TERRIFYING EVER PREVIOUSLY EXPERIENCED.*

*Sunday night last was a terrifying time for Narromine people, and many residents are still panicky from the effects of the unusual and severe fright they received.*

*In last issue the 'News' reported that the town was again being disturbed by earth tremors, and up till Friday afternoon quite a number of mild shocks, and a couple of fairly severe ones, had been felt. But there was worse to follow. At about a quarter to nine o'clock on Sunday night easily the worst tremor so far experienced passed through the town and adjacent district, and left the residents in a state of panic. Sunday night was beautifully calm, without a breath of wind, or a cloud in the sky. At the time stated a very loud rumbling noise suddenly filled the air, followed immediately by violent trembling and shaking which rocked houses, shook furniture, crockery and pictures, and left the inmates in a state of terror. The shock only lasted a few seconds,*

*but it was quite long enough to thoroughly scare every resident in the town. Children were aroused from their sleep, and cried loudly, and in some homes women went into hysterics. Many people rushed from their houses and very shortly after the shock groups of thoroughly scared men and women could be seen in every street discussing the violence of the 'quake. It was Narromine's evening of horror, and an experience that will never be forgotten. That night many people had but little sleep, the dread of another tremor being constantly before their minds. Nothing else was discussed in Narromine on Monday, and inquiries made elicited the information that in many homes the tremor had not only scared the people, but did damage to property. The brick wall in the dining room of Mr. B. J. Mooney's home was split through in two places and plaster thrown to the floor. Mr. J. Tancred had the plaster knocked from the walls in three rooms and damage done to a brick chimney. At the Imperial Hotel damage was done to a window and plaster came down on a boarder who was in bed, but who quickly pulled on a pair of trousers and ran into Burroway street. Mr. A. B. Dundas and Mr. W. P. O'Neill had not long returned from a visit to Peak Hill and were standing in front of a warm fire at Mr. Dundas' home, when the house rocked violently and a shower of plaster fell to the floor. Plaster also fell at the Presbytery, Mr. W. Elder's home, and many other places. In the main streets, cool drink shops emptied quickly and in Burroway Street many people congregated from nearby places. Many people who were returning from church, received the shock in the streets, and in all cases hurried home as quickly as possible. For the first time the tremor was felt at Trangie and Dubbo, but neither towns received anything like the severe shock that was experienced at Narromine. Local residents are still wondering what is the cause of so many tremors occurring at Narromine, and the fact that the last few have been so severe is causing much uneasiness. During this week several mild shocks have been felt, the worst occurring at a quarter past four o'clock this Friday morning, when many people were again aroused from their sleep.*

#### **1933 01 11 at 20:11 UTC, Dalton-Gunning**

An earthquake on Thursday 12<sup>th</sup> January 1933 seems to have heralded the start of a 50 year period of unusually high seismic activity in the Dalton/Gunning region of NSW, apparently dormant since the storm of 1886 to 1888. The earthquake was felt in Sydney suburbs and therefore warranted further investigation. Riverview Observatory had been in operation since 1909 and recorded the earthquake but there were no other seismographs in the state outside Sydney at that time, the epicenter based on the place reporting the highest intensity, compatible with the distance from Riverview. It was also recorded at Melbourne Observatory.

*According to the Central Queensland Herald of 19 January 1933: The tremor left a trail of broken rock and an earth fissure across paddocks. [Ed. Faulting?] Rocks, some of them weighing 20 tons, were split and shattered.*

Drake (1974) listed the earthquake as the first of magnitude 4 or more in Gunning since 1909 when the Riverview Observatory opened, its magnitude ML4.8. It is worth repeating part of a contemporary newspaper article about the earthquake, noting the damage:

The *Sydney Morning Herald* (NSW: 1842 - 1954), Friday 13 January 1933, page 9, and note the comment about damage caused by a previous tremor (perhaps 1886 or 1888?).

*Damage at Gunning.*

*A severe shock of earthquake was experienced over a wide area between Yass and Goulburn early yesterday morning. Considerable damage was done at Gunning, which appears to have received the full force of the tremor.*

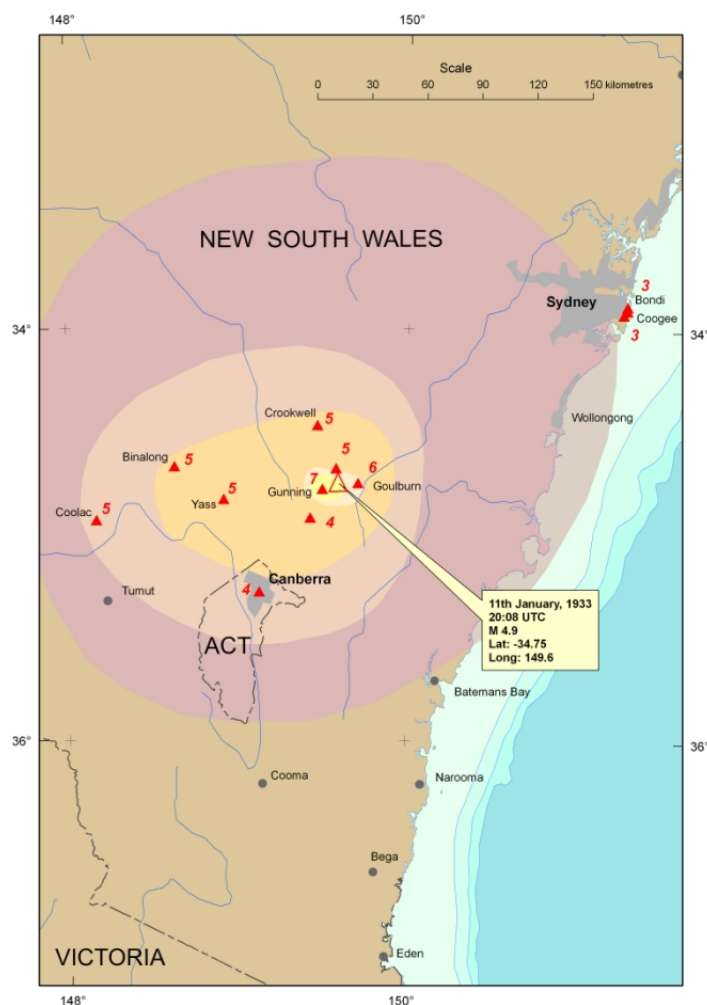
*The shock was felt distinctly at Coogee, Bondi, and other seaside suburbs, and was recorded on seismographs at Sydney and Riverview observatories.*

*At Gunning the concrete dwelling of E. Hallam was badly damaged chimneys being broken walls cracked, and a verandah broken away from the house. The concrete walls of a neighbouring house, occupied by T Johnson developed cracks that would admit a hand. Olivet, the residence of Mr G E Ardill, MLA, had its walls cracked. In nearly every room plaster was scattered about. The walls of the Public school, which had been cracked by a previous tremor, and which had been recently repaired were again opened up. The walls and ceilings of many other buildings were damaged and articles were shaken off shelves. At one house a 1000-gallon tank full of water was shifted almost off its stand.*

**Figure 21** Isoseismal map of the damaging Gunning earthquake on 11 January 1933.

*After the first shock which occurred at 6.8a.m. tremors of varying intensity continued at short intervals until 6.50a.m. when another severe shock was experienced. Between 6.8a.m., and 7.10a.m., 12 distinct tremors occurred and these were followed by others at 8.40 a.m., 9.40 a.m., and 10.15 a.m.*

*A resident on the outskirts of the town stated that nothing could be seen distinctly in the town. Everything seemed to be in a haze caused by the shaking of the earth and the buildings.*



In Canberra pronounced shaking was reported by residents of Red Hill, Forrest and Gungahleen (now Gungahlin). Dr. W.G. Woolnough, Geological Adviser to the Commonwealth Government, made a request for felt reports via the *Canberra Times* newspaper but received only six responses. Unfortunately these do not seem to have been left for posterity. The newspapers reported it was felt in Crookwell (people thrown from beds) and Coolac (many sleepers awakened).

More than 21 aftershocks were felt in the first thirty hours and 100 aftershocks had been reported felt up to 20 February 1933.

This and many other examples show that old un-reinforced masonry buildings behave poorly in earthquakes. The 1954 Adelaide and 2010/12 Christchurch earthquakes have shown that such buildings are very vulnerable to strong shaking but they can be successfully strengthened by retrofitting with steel (or fibre) bands.

### **1933 06 07 06:00 UTC Broken Hill 'Bump'**

This seismic event was felt over an area of a square mile 'along the mines' according to the *Barrier Miner* of Thursday 8<sup>th</sup> June 1933. One experienced resident said: *the shock yesterday was a distinct bump and was entirely different from an earthquake.*

### **1934 01 30 at 20:30, Gunning swarm and foreshocks**

*The Braidwood Dispatch and Mining Journal* Friday 2 February 1934 page 2.

*Gunning was awake practically all Tuesday night owing to the continuous tremors there. Altogether there were some 50 or 60 recorded, the most marked one being that which occurred shortly before 8.30 on Wednesday morning. This shock was felt in Goulburn and Crookwell. At Braidwood and throughout the district a distinct tremor was felt at 6.30 a.m., while at 10.30 or 11 o'clock the previous night a minor shake was experienced. The 6.30 shock, was preceded by a particularly terrific noise like an explosion. 'It gave one the impression that the bottom had fallen out of everything,' said one Gunning resident. Plaster was cracked in many homes, the walls in particular suffering. Crockery was knocked from the dressers and smashed, while floor and window frames were thrown out of alignment. Considerable damage was done at the residence of Mr. A. J. Sumner, on the Dalton road, about two miles from Gunning. The building of concrete and brick suffered badly, practically every wall being cracked from the ceiling to the floor. A room recently added to the main building, which was only completed last week, was torn away from the main building. The walls were cracked, and the doorframes were knocked out of position. The dining-room chimney was cut in two vertically, and the kitchen fireplace was cracked in two places. Mr. Sumner said that during the worst tremors the house seemed to rock backwards and forwards, and the noise was nerve racking. At the residence of Mr. Lawliss, a neighbor, plaster fell in the rooms, and portion of the chimney fell, one of the bricks falling through the roof and landing on the breakfast-room table. The shocks in Gunning are still continuing at frequent intervals, and two or three severe shakes occurred between 1 and 2 o'clock. An underground tank at the residence of Mrs. J. Clancy burst, and 1000 gallons of water escaped. An earth tremor which set beds creaking and crockery rattling was felt in Goulburn at about 6.30 a.m. Residents in different parts of the city reported feeling the tremor with varying degrees of intensity. At Crookwell three shocks were experienced. The first was at about 11 o'clock on Tuesday night, the next at about 2 a.m., and the third, which was most marked, at about 6.30 a.m. This one lasted about a minute.*

This swarm is part of a remarkable sequence of earthquakes that commenced in 1930 and culminated in a damaging M5.6 earthquake in November 1934.

### **1934 07 02 at 14:30 UTC, Bathurst**

*The Grenfell Record and Lachlan District Advertiser* Thursday 5 July 1934, Page 2.

*TWO SHOCKS. EARTH SHUDDERS. BATHURST RESIDENTS ALARMED. WINDOWS, DOORS RATTLE.*

*Following an earth tremor which was experienced throughout the city and in parts of the district at 12.25 o'clock on Tuesday morning, a further tremor occurred before 3 p.m. on Tuesday, being particularly severe at Freemantle, and in the neighbourhood. People living in Stewart, Russell and Rocket streets report that the first tremor could be heard very plainly; windows and doors rattled, while some state a slight rumbling was heard. Most people were sound asleep in bed at the time, but the tremor was distinctly experienced at the Bathurst telephone exchange, one of the telephonists stating that the disturbance lasted some ten seconds, during which time the windows rattled loudly while the switchboard was also affected. A number of residents who felt the shock reported it to the telephonist. At 3 p.m. on Tuesday residents of the Freemantle area were startled by another tremor, not as severe as that experienced during the night. Mr.*

*A. McIntosh, of Freemantle, said that the tremor caused the iron sheets on roofs to rattle for a brief space. Residents were alarmed by the occurrence. A similar phenomenon was experienced at Gowan, five miles away, while there were reports of its being felt at Bathurst. Mrs. McIntosh described the first tremor as like the sound of a fire burning, and the first impression was that of one of the homes in the neighborhood was on fire.*

*SEVERE AT ORANGE. A report from Orange says the most severe shock for 30 years was that experienced about 12.30 a.m., which lasted 20 seconds. Many people rushed from their houses. The second tremor was felt at 2.10 p.m. At Molong two distinct tremors were felt, each lasting several seconds. In many instances crockery was shaken from the shelves and smashed. The tremors were not recorded on the seismograph at Riverview Observatory, Father O'Leary saying the shocks must have been very slight.*

### **1934 08 26 at 15:00 UTC, Dorrigo**

*Singleton Argus Wednesday 29 August 1934, page 2.*

#### **SEVERE EARTH TREMOR**

*A severe earth tremor is reported from the Dorrigo district. Many centres report having heard and felt a severe earth movement about 1 o'clock on Monday morning. Buildings shook, and windows and crockery rattled. There was a similar occurrence about two years ago, but it was never solved.*

### **1934 11 10 at 23:47 UTC, and various other earthquakes near Gunning/Goulburn**

*The earthquakes reported over the weekend may well be foreshocks of Sunday week's quake.*

*Goulburn Evening Penny Post Monday 12 November 1934, Page 3.*

#### **EARTH TREMOR . Shakes at Week-end**

*A severe earth tremor was felt in Goulburn at about 9 o'clock last night, when windows rattled and furniture moved in an alarming manner. The 'quake was one of several felt over the week-end, several people reporting a tremor on Saturday morning, while others felt a severe shock on Sunday morning at about 10.30. The shakes were apparently felt in waves with varying intensity, but none appears to have been of such severity as to cause any damage.*

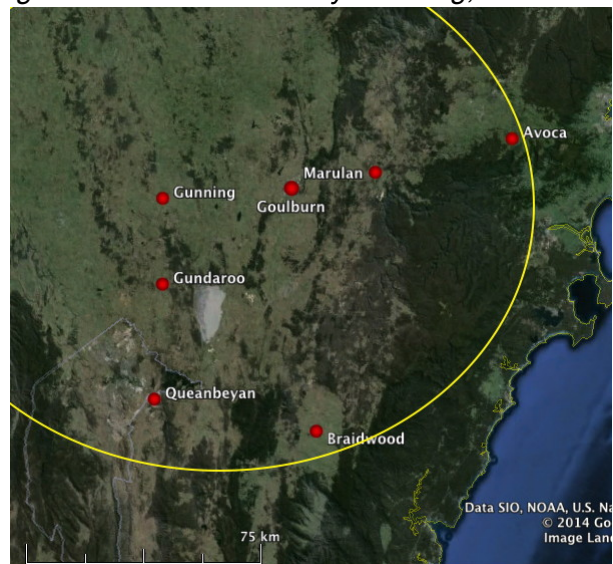
**Figure 22** Felt area of the 10 November 1934 Gunning foreshock, magnitude 4.8

*The Braidwood Dispatch and Mining Journal Friday 16 November 1934 Page 2 says:*

#### **EARTH TREMORS**

*On Sunday morning Braidwood residents experienced a severe earth tremor, which shook houses and rattled windows. A dull rumble accompanied the shock.*

*At Gunning the disturbance commenced at 9.50 a.m. with a severe shock that lasted for about half a minute. Houses were shaken and plaster fell from the walls. Minor vibrations occurred at frequent intervals throughout the day, and at 9 p.m. people in the town were startled by a strong tremor which appeared to move the ground right under the town. Further light shocks continued until early on Monday morning. Houses were shaken, and residents rushed hastily into the open at Avoca, 10 miles from Moss Vale,*



*when a severe shock was felt at 9.35 a.m. on Sunday. Cracks two inches wide appeared on the Hume Highway about 15 miles south of Moss Vale. Goulburn also experienced two slight tremors. The tremor was also felt at Queanbeyan and Gundaroo, where a crack developed in the wall of the Presbyterian Church.*

The felt area and intensity indicate a magnitude of at least 4.7, virtually the same as Drake's (1974) estimate of 4.8.

#### **1934 11 18 at 21:58 UTC, Dalton-Gunning – damage to water supply at Goulburn**

This earthquake was studied by McCue and others (1989) who drew an isoseismal map. *The Sydney Morning Herald* Wednesday 21 November 1934, Page 13 reports:

*EARTH TREMORS. Continue in Gunning District. FURTHER REPORTS OF DAMAGE.*

*GUNNING, Tuesday.*

*Earth tremors of varying intensity continued at Gunning throughout last night and at intervals to-day.*

*Reports are still being received from outlying parts of the district of damage caused by yesterday's shock. At the residence of J. McCabe, about six miles from Gunning, on the same granite ridge as Mr. Sumner's house, which was wrecked, the chimneys were broken off, one crashing to the roof. Outbuildings swayed and twisted in an alarming manner.*

*A thousand-gallon tank was burst by the force of the shocks.*

*In the steep and rugged hills to the north-west of the town, the violent shaking started a landslide, and tons of earth and rock crashed down the hillsides, blocking water courses. A cloud of dust from this avalanche could be seen for miles.*

*At Dalton the damage was fairly extensive. The residence of J. E. Stone was damaged almost as badly as Sumner's and the home of W. N. Brown suffered in a similar manner. At the Dalton Hotel bottles were thrown from shelves in the bar. A new general store erected by L. S. Martin, owner of the trotting champion, Walla Walla, was cracked from the floor to the ceiling, and a quantity of stock was hurled to the floor. Men working underground in the Dalton gold mines hurriedly vacated the shafts, being unable to continue operations owing to the continued shaking and the danger of falling earth.*

A phenomenon witnessed after yesterday's tremor was a dust haze which rose from the hills surrounding Gunning. This and the 1989 Newcastle earthquake are the two largest NSW earthquakes that have occurred since 1788, their magnitude 5.6. The TROVE project has unearthed new information such as the following from *The Sydney Morning Herald* Friday 23 November 1934, page 10:

*GOULBURN, Thursday.*

*The earthquake yesterday afternoon was responsible for the holding up of portion of the Goulburn water supply. A large iron buoy in the settling tank at the waterworks was lifted up, automatically closing the valve regulating the low-level supply. The water was cut off for about two hours. The hold-up was not as serious as it might have been, as most of the Goulburn residents, owing to the hardness of the water through the supply, have rain tanks. Cracks have appeared in the mixing trough and filter tank at the pumping station, and it is estimated that it will cost £15 to repair the damage.*

It was reported that the banks of Spring Creek, five miles south-west of Gunning, collapsed and hundreds of tons of rock and earth fell into the water, temporarily blocking the creek.

Mr. H. B. Curlewis at the Perth Observatory, noted that the seismograph at the Perth Observatory registered slight tremors at 6.14a.m., which would correspond with the Gunning tremors, because the surface waves would take about that time, 15 minutes, to travel to Perth.



**1934 11 21 at 06: 32, Gunning, More chimneys damaged and one injury**

*Singleton Argus Friday 23 November 1934, Page 6.***MORE EARTH TREMORS**

**CLERGYMAN STRUCK ON HEAD.**

*Six more earth tremors were experienced at Gunning yesterday, the first at 1 a.m., and the others at various intervals up till 1.5 p.m. Several chimneys were damaged. Plaster fell at the Church of England rectory, and Rev. Canon C. E. Burgess suffered severe shock when struck on the head by a piece of plaster.*

It was separately reported that a number of visitors left the district because of the continual tremors, and even residents who had been living at Gunning for years became anxious.

**1935 05 02, night time, Guyra**

*The Maitland Daily Mercury Friday 3 May 1935, Page 7 notes:*

**STOP PRESS**

**EARTH TREMORS INVERELL, Friday.**

*Loud rumblings, accompanied by earth tremors, startled residents between Bundarra and Inverell last night. The tremors were felt over a radius of 10 miles and lasted several minutes. A mountain near George's Creek appeared to be the centre of the disturbance and residents state that, during the last few years rumblings have been heard on several occasions. Some people fear that the mountain may burst into eruption and are urging that the Government Geologist should make investigations. Referring to the matter to-day, the Government Geologist, Mr. Harper, declared that a slight geological fault might be responsible for a small displacement in the strata, and this would cause rumblings. As the district was not of volcanic depth there was no necessity for him to carry out investigations.*

**1935 05 27 at 21:00 and 05 28 at 01:00, Narromine**

*The Dubbo Liberal and Macquarie Advocate Saturday 1 June 1935, Page 4 mentions that two earth tremors were felt to the west of Narromine, especially at Ceres Siding, on Tuesday about 7 and 11 am.*

**1935 06 01 at 21:00 UTC, Harden**

*The Sydney Morning Herald of Tuesday 4<sup>th</sup> June 1935 carried a news item about an earth tremor at Harden about 7 o'clock, that rattled crockery and houses.*

**1935 06 18 10:20 UTC, Gunning aftershock**

*Sydney Morning Herald Thursday 20 June 1935*

**SEARCH FOR "SAFE-BLOWERS."**

*Earth tremors, which apparently did no damage, but which set windows and crockery rattling in many homes, were reported on Tuesday night and yesterday morning in southern parts of New South Wales..... The first tremor was reported at. 8.20 o'clock on Tuesday night, and was felt distinctly in Goulburn, Yass and other towns on the southern tablelands. At Gunning the shock was accompanied by a low rumbling sound, but it was so slight that residents took little notice of it. There was a less pronounced tremor at Yass at 9 p.m.*

*The seismograph at Riverview Observatory recorded the first tremor, but the indication on the instrument was so slight that it was barely perceptible.*

The magnitude from the felt area corresponds to about ML 4.3. People reported 15 aftershocks between 6am and 11am. Many more aftershocks in this sequence could probably be documented, such as the event mentioned at 9pm the same night.

**Figure 23** Felt area of the June 18, 1935 earthquake near Gunning, an aftershock of the magnitude 5.6 mainshock on 18 November 1934 (McCue and others, 1989).

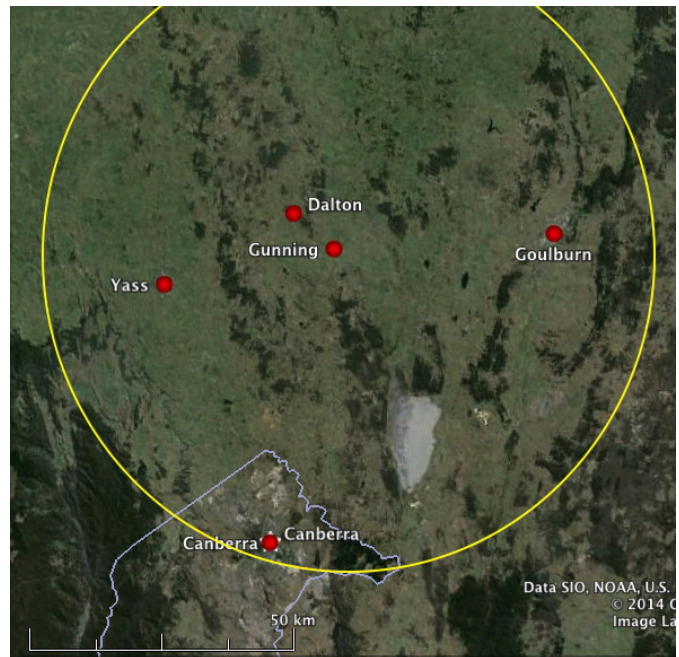
More felt reports would undoubtedly improve this map.

**1935 07 05 at 06:00 UTC, Nevertire, north-west of Narromine**

A distinct earth tremor was felt in the Nevertire district accompanied by loud rumbling noises, according to a very brief note in the *Sydney Morning Herald* of Monday 8<sup>th</sup> July 1935.

**1935 07 09 at 14:05 UTC, Gunning aftershock**

*The Canberra Times* of Thursday 11 July page 11 reported that this earthquake was more severe than any other that occurred last November! Crockery was broken and walls cracked in Gunning. The earthquake was felt in Bondi and Coogee, as well as Kiama, Goulburn, Queanbeyan, Braidwood and Yass, almost the same area as the 1933 earthquake warranting a magnitude of at least 4.8 though it is not in Drake's (1974) list. This seems to have been the largest aftershock in the sequence following the magnitude 5.6 mainshock on 18<sup>th</sup> November 1934. It was also felt at Cootamundra, Burrowa and Wagga.



**1936 06 13 at 03:05 UTC, Mount Canobalas**

*The Tumut and Adelong Times* Tuesday 16 June 1936, Page 6.

**ORANGE SHAKEN BY EARTH TREMOR**

**ALARMED RUSH BY RESIDENTS**

*Shuddering floors, shaking walls and dancing crockery alarmed Orange people a few minutes after 1 p.m. on Saturday, and there was a rush of frightened householders into the streets. Many children, were tearful in their terror. Worse than the only other earth tremor in the history of the district, the shock quickly passed over, after rumbling sounds like thunder. The other visitation was about a year ago, when there were two shocks in the one day. Saturday's tremor was even more violent at Canoblas, six or seven miles south of the town, at March, a village about 10 miles away, and at Borenore, 10 miles out.*

**GLOBES DANCED**

*Constable Muller said that while he was at work in the police station the electric light globes commenced to dance about. Then the building commenced to shudder and he ran out to join the crowd which had rushed from adjoining buildings. He said that the tremor seemed to proceed from south-west to north west. It appeared to start on one side of the building and work across to the other. No damage was reported, probably because the 'quake lasted only about two seconds.*

This slight damage warrants a magnitude of at least 3.6, it was also felt at Manildra where the inhabitants were 'startled', and at Carcoar.

**1937 03 28 at 11:45 UTC, Mudgee and Dunedoo**

*Mudgee Guardian and North-Western Representative* Thursday 1 April 1937, Pages 2 and 4.

**EARTH TREMOR**

### *Dunedoo Shakes*

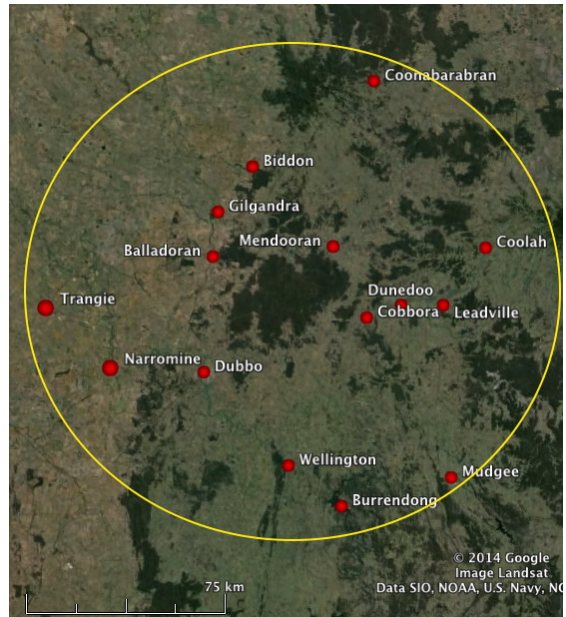
*DUNEDOO experienced a slight, but very distinct earth tremor at approximately 9.45 p.m. last Sunday evening.*

**Figure 24** Felt area of the 28 March 1937 earthquake west of Dunedoo in northern NSW.

*In the quiet of the evening there was a sudden movement of the earth, houses shook and fixtures rattled. There was a distinct rumbling noise which, together with the quake, lasted perhaps 30 seconds. It is understood that the tremor was felt at Coolah, Leadville, Cobbora, Mendooran and other surrounding portions of the district.*

### *Earth Tremor*

*THE earth tremor experienced at Dunedoo on Sunday evening last was also felt by many Mudgee folk, who tell us that their houses fairly shook. The sensation was a peculiar one, and people hurried out of doors in an endeavor to ascertain the cause of the disturbance.*



The following week a report of the shock came from Coonabarabran. The felt area is commensurate with a magnitude 4.6 earthquake.

### **1937 06 17 at 14:45 UTC, Cracks to silos in Tullamore**

*The Argus* Wednesday 23 June 1937 Page 12.

### *Sleepers Awakened by Earth Tremor*

*SYDNEY, Tuesday. — A severe earth tremor occurred in the Tullamore district at 2.45 am. on Monday. It lasted for fully 15 seconds. Many residents were awakened by the rattling and shaking of their homes and beds. Slight cracks are showing in the silos close to those caused by a tremor about two and a half years ago.*

The shaking was not reported felt elsewhere but on the basis of the cracking in the silos a magnitude of 3.5 has been assigned. The earthquake was not recorded at Sydney Observatory. The event 2½ years ago was probably the November 1934 Gunning earthquake.

### **1938 03 24 at 20:03 UTC, Riverina**

The *Daily Advertiser* Saturday 26 March 1938, page 6 reports:

### **Earth Tremor**

### **FELT IN RIVERINA, NO DAMAGE TO PROPERTY**

*Awakened from their slumber shortly after 6 o'clock yesterday morning, residents of Riverina were alarmed to find themselves in the throes of a severe earth tremor which lasted more than a minute. No damage to property or loss of life resulted, but the effect was startling and by no means pleasant. Houses were shaken, windows rattled, crockery was dislodged from shelves, timbers creaked, beds were moved, and water in tanks and cisterns was ejected. The tremor was remarkable in that it was confined solely to Southern Riverina and a portion of the North East of Victoria. Reports of the tremor show that it was felt from the plains at Lockhart and Milbrulong, south-west of*



Wagga, right to Batlow, more than 100 miles east of Wagga among the hills, south to Albury on the border and Wangaratta in the north-east of Victoria. Reports as to the exact nature of the tremor vary but all are substantiated, showing that it had different effects. In portions of Wagga it was like a heavy deluge of water pouring on the roofs of houses. At other places it was like a heavy vehicle passing over a paved road. In country districts it resembled a shower of rain, but this was ironical in view of the urgent necessity for rain, and elsewhere it was said to appear like the noise of an empty water tank being carted over a road.

The tremor appeared to move, from west to east and was of about two minutes' duration. Its approach was like the rolling of distant thunder, and the actual tremor lasted about eight seconds. Considerable excitement was caused at Euberta, The Gap, Mangoplah, Brucedale, Lockhart, Milbrulong, Forest Hill, Oura, Ganmurra, Moorong, Young, and other district centres. Mr. A. A. Beck, of The Gap, said that the tremor caused the house to shiver like an aspen leaf, and when it was at its height fears were held that considerable damage would be done. Mr. P. Reid, of Ganmurra, declared that the noise was formidable, the crockery in the house rattled, and the house was badly shaken. In one household in the Borambola district the tremor caused much alarm. The occupants were about to rush out of the building, taking with them as much furniture as they could manage when the tremor gradually lessened in intensity and passed away. At the Wagga telephone exchange, the subscribers' shutters dropped, but no damage was occasioned any of the mechanism at the post office.

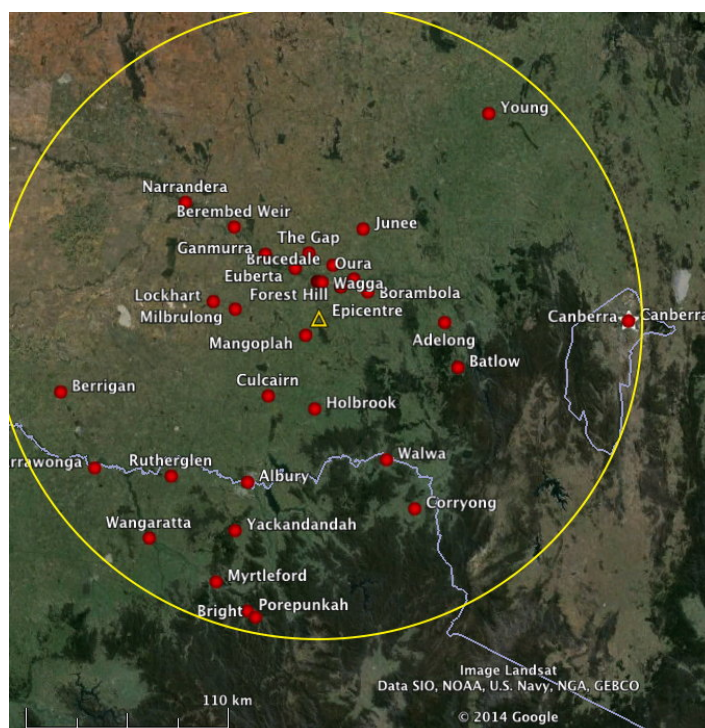
.... At The Gap, Mr. Glen Hancock was awakened by the rumbling, simultaneously to his friend, Mr. W. Robinson. .... A delay in printing operations was caused by the tremor at the office of 'The Dally Advertiser' when the paper web on the rotary printing machine was broken. The tremor was noticeably felt at the Wagga Base Hospital, both in the building proper and in the nurses' quarters. Most patients were awake at this time, but those who had been sleeping were soon aroused from their slumber by the tremor. The vibration lasted for two minutes, but no damage was done to property, and no one suffered any ill effects. No ill effects were felt at Lewisham Hospital, where the sisters and patients just realised that a tremor had occurred.

**Figure 25** Felt area of the 1938 Riverina NSW earthquake, 24 March 1938. No damage was done which is surprising given the inferred magnitude is at least 5.2. Drake (1974) measured 5.5 at RIV.

*BATLOW, Friday. Batlow residents were awakened about 6 o'clock this morning by the earth tremor which shook houses, rattling crockery, etc. People jumped out of their beds to see what was the matter. This is the second occasion on which an earth tremor has been felt at Batlow, the first one being only very slight in November, 1934 (Ed. Gunning).*

**1938 05 12 at 18:00 UTC, Narromine**

*The Dubbo Liberal and Macquarie Advocate Tuesday 17 May 1938, Page 1.*



### *Earth Tremor Felt at Narromine*

*A severe earth tremor was felt at Narromine about 4 a.m. on Friday. It was accompanied by a low rumble, and awakened many residents. It is believed by some people that the shock had some connection with the earthquake at Salamaua, in New Guinea, the same day.*

Discounting the Salamaua connection, we can assign a magnitude 3.5 to this event, subject to other reports surfacing.

### **1938 06 04 at 17:05 UTC, Tumut**

*The Tumut and Adelong Times Tuesday 7 June 1938, page 2:*

*Another earth tremor, on Sunday morning last, awakened many sleepers with a shock. The tremor came along just after 3 a.m. A deep rumbling could be heard some seconds before it was felt. It came from the north and when the full force was felt, houses rattled and many thought the iron was tearing off the roof. It gradually appeared to go away to the south, just a few minutes later there was a second tremor, though not nearly as severe as the first one. Some say there was a third, but few people noticed it. This is the second one within a few months that has been felt here.*

This short series of earthquakes must have been very near Tumut for the two subsequent aftershocks to be felt.

### **1938 06 27 at 22:55 UTC, Guyra**

**Figure 26** Felt area of the Guyra earthquake, 27 June 1938. The corresponding magnitude is 4.3 c.f. 4.7 at RIV (Rynn and others, 1987).

Crockery and windows rattled in Guyra shortly before 9a.m. on Tuesday 28 June 1938, according to *The Dubbo Liberal and Macquarie Advocate*, of that day. This is a large felt area in a sparsely populated (then) part of NSW.

### **1938 08 07 at 09:15, Walcha**

*Singleton Argus Wednesday 9 August 1939, Page 2.*

#### **EARTH TREMOR AT WALCHA**

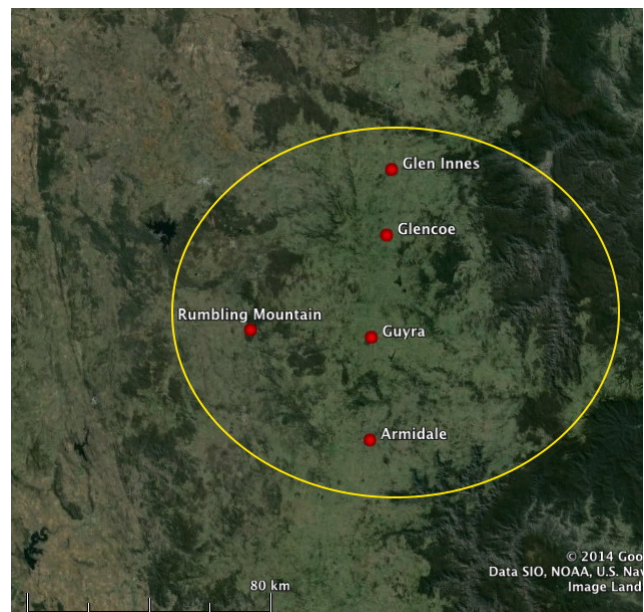
*At a quarter past seven on Monday night a severe earth tremor was felt at Mayfield, the homestead of Mr R. Seccomb, near Walcha. The tremor lasted for several seconds and was severe enough to startle members of the household. Crockery and other movable objects in the house rattled for some time, and there was a rumbling noise with the disturbance, which appeared to have been purely local in character.*

### **1938 09 02 at 21:45 UTC, Grenfell**

*The Grenfell Record and Lachlan District Advertiser Monday 5 September 1938, page 3:*

#### **Severe Shock at Grenfell.**

*A very distinct earth tremor was felt at Grenfell at about 7.45 on Saturday morning, the quake coming in time to wake up several who otherwise would have been late for work. The quake was preceded by a deep rumbling noise like thunder; this was*





*followed by a tremor which rattled the crockery, and also some who wondered 'what was up.'*

#### **1938 09 23 at 04:00 UTC, Cowra**

*The Newcastle Herald and Miners' Advocate* Saturday 24 September 1938, Page 11 mentions that goods were shaken off shelves in some shops. No other reports have been found.

#### **1939 11 20 at 05:30 UTC, off Redhead Newcastle**

**Figure 27** Limit of felt area onshore during the 20 November 1939 Newcastle earthquake, epicentre seemingly offshore Redhead.

*Newcastle Morning Herald and Miners' Advocate* Tuesday 21 November 1939, page 7.

##### **MINOR EARTH TREMOR**

##### ***Felt in Newcastle RUMBLINGS HEARD AT REDHEAD.***

*A minor earth tremor was felt in Newcastle and nearby districts yesterday afternoon. Riverview Observatory had no record of the tremor, which it said, must have been extremely small. The disturbance lasted for about four minutes.*

*The tremor, which happened shortly after 3.30, was accompanied by dull rumblings, as though guns were being fired at a distance. Windows rattled in many Newcastle houses, but in other homes the disturbance was not noticed. The tremor was apparently most pronounced at Redhead and at Blacksmiths, near Swansea.*

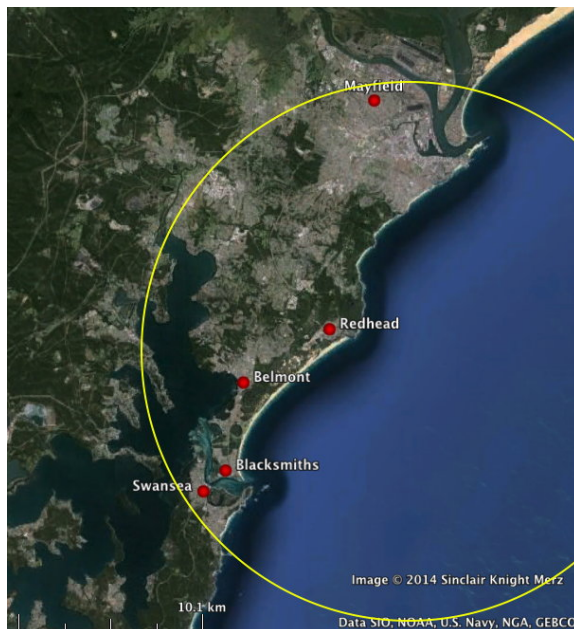
##### **Three Dull Explosions**

*At Blacksmiths, the tremor was preceded by three dull explosions. Then houses and windows shivered. Mrs. J. McLaren, fearful that the house would fall, ran into the street with her baby. Mrs. I. Barrass said she thought that a thunderstorm was coming, but was puzzled to see no cloud in the sky. The Postmaster (Mr. C. Means) said last night that the tremor came quite suddenly, and was over quickly. The postal official at Redhead told how windows rattled. The rumbling sound increased in volume as though some thing was gaining speed, he said. Then it would ease off. This occurred seven times. At first, he mistook the sound for dull gunfire. The seven reports fell into three sections, with the second and third less violent than the first. "It was as though there was a violent thunderstorm south," he added. The tremor was not strong enough to shake the ground or buildings, but the windows moved. Mr. S. Flowers, Manager of the John Darling colliery, Belmont, said that no earth movement had been noticed in the mine, although he had noticed the tremor at his house and heard the dull rumbling.*

The most likely epicentre was offshore although reports are sparse compared with the later earthquake in 1951, perhaps there were other distractions in 1939. The felt area is larger than that in 1951 so the apparent magnitude of 3.0 is also larger. Hunter (1991) lists and plots the felt reports during this earthquake and was the source for this search.

#### **1940 09 21 at 15:00 UTC, Canberra**

Federal election day with war looming, it is perhaps not surprising that this earthquake didn't rate much of a mention in national or local newspapers. The shaking was strong in Canberra



where houses shook violently and woke residents there and in Queanbeyan and Tumut. It was also felt in Gundagai.

The Goulburn Evening Post Tuesday 24 and 25 September 1940, Pages 1 and 2 respectively.

*BUILDINGS ROCKED Heavy Earth Tremors Goulburn was shaken early on Sunday morning by an earth tremor lasting a quarter of a minute. Although most householders had retired for the night, people living in various parts of the city experienced the tremor, which was of sufficient violence to send a vibration through buildings. Superintendent A. J. Wingate, who was on duty at the ambulance station, said that the quake started at 12.56 a.m. and continued for from 15 to 20 seconds. The whole building was shaken but no damage resulted. Mr. Wingate said that for a moment he thought that the rumbling noise was made by a train passing through the nearby railway yards, but he soon realised that he had been mistaken.*

*A Montague Street resident said that the wardrobe in her bedroom was severely shaken, while in a house at South Goulburn crockery in the kitchen cabinet rattled in uncanny fashion. At a Bourke Street home a fireplace grate was rocked by the vibration. Employees of the Evening Post who were working on late election returns also experienced the tremor, which caused the front doors of the building to rattle so loudly that it was thought that a caller was knocking. So far there are no reports of damage to buildings, some of which have been badly cracked by similar occurrences in the past.*

#### FELT AT GUNDAROO

*A report from the Post's Gundaroo correspondent states that the tremor was experienced there shortly before 1 am. It lasted several seconds and set up a loud rumbling that resembled thunder. Buildings were shaken and many people were awakened from their sleep.*

*Tremor Widespread. The earth tremor experienced in Goulburn shortly before 1 a.m. on Sunday was felt over an extremely wide area of the Southern Tablelands. Centres which felt the shock also included Canberra, Queanbeyan and Braidwood.*

138	"	21	eNE iNE F	14 55 53 55 56 14 56.6	<1					A few very small waves superposed on microseisms. Felt at Queanbeyan, N.S.W. Houses shaken, people awakened. Very little damage. Distance about 160 miles.
(Concluded on next sheet)										

**Figure 28** Extract from RIV Bulletin 9/1940 by D.J.K. O'Connell SJ, Director RIV (provided by Hugh Granville, Geoscience Australia). No reports of damage have been unearthed.

More reports are needed to tie down this elusive magnitude 4.7 earthquake, with an epicentre possibly to the west of Canberra in the ACT which would make it the largest known earthquake in the ACT.

#### 1941 04 24 at 09:35 UTC, Goulburn

The *Goulburn Evening Post* Monday 28 April 1941, Page 2 mentions that three earthquake were felt in Goulburn on Thursday last at 5 p.m., 6.50 p.m. and 7.35 pm. The later shock was the strongest and it was felt at Kingsdale where the guttering and spouting rattled loudly.

#### 1941 06 12 at 16:56 UTC, Goulburn - four events

*Goulburn Rocked Severe Earth Tremor*

*Goulburn was shaken by a violent earth tremor shortly before 3 o'clock this morning, the disturbance awakening sleepers in all parts of the city.*

*From reports gathered to-day by the Evening Post, it appears that the damage was slight, but it was ascertained that two houses in Gold-Smith Street had their walls cracked, while at several homes crockery was knocked to the floor and broken. Several people who were roused by the disturbance said to-day that at 2.55 a.m. they heard a noise resembling a heavy explosion lasting up to two seconds and several minutes later there were two tremors of lesser intensity. Doors and windows rattled in eerie fashion, and the noise of falling household effects in many homes added to the alarm of the occupants. Actually there were several separate "quakes," the first being a mild tremor at 10.18 last night. The second and most severe occurred at about 2.55 a.m., and was followed some minutes later by two others. The shock experienced at 10.18 p.m., although it rattled doors and windows and was accompanied by a slight rumbling sound, lasted four or five seconds and passed practically unnoticed.*

#### **OVER WHOLE CITY**

*Shortly before 3 a.m., however, a violent shock, which was felt in slightly varying degrees of intensity in every quarter of the city, awakened hundreds of people. Many were so startled that they left their beds to investigate. Some people, still barely awake at the time, said to-day that they attributed the noise to thunder and even to blasting operations in the district, and went back to sleep. Others, fearing that the heavy shock felt by them had been caused by a motor vehicle crashing into some obstruction, opened doors and windows before they had fully realised what had occurred. The latter report a curious phenomenon. While looking into the darkness and listening to the rumbling noises fade into the darkness, they saw the sky light up briefly as though by a distant gun-fire flash. Most people who were awake at the time report a severe concussion, followed almost immediately by two sharp explosive noises and then a heavy rumble which, over a period of minutes, gradually faded away. To some the noise immediately following the shock resembled a heavy cask falling from a height of several feet and then rolling over a rough, uneven surface. Reports from Mundy, Cowper, Montague, Clifford, Bourke, Ottiwell, Bradley, Kinghorne and Park Streets and other areas are almost identical. All state that houses were shaken as though, in the grip of a violent wind. Doors, windows and furniture rattled and shook, while in many instances crockery was thrown from the shelves and broken.*

#### **CHAIRS UPSET**

*At one house in South Goulburn two light chairs were upset. At two houses in Park and Opal Streets occupants were awakened by the shock, which knocked several articles, including a picture, off bedroom dressing tables. "It did one good thing—it shook Goulburn's weather back to normal," declared one Sloane Street resident, who said that when first awakened he thought the explosions were being caused by detonators on the railway line. As his house commenced to shake and the shelves to rattle, however, he quickly realised his mistake. He said later that to his recollection the shook was the worst he had experienced in Goulburn for over 20 years. Others said that it was the heaviest in the last 15 or 16 years. Apart from broken crockery, no great damage has so far been revealed, although it was reported late to-day that plaster which had been freshly placed on a new house near Victoria Park had been cracked.*

#### **SUSPECTED CRACKSMEN**

*Mr. F. Funnell, Auburn Street nightwatchman, who was on his rounds, fixed the time of the main tremor as within one minute of 3 o'clock. He said he was inspecting the rear of premises in the Evening Post block when he was startled by what he described as a "heavy crash," which caused iron roofs and the doors of buildings to rattle*

*violently. His first impression was that safe blowers were at work in Auburn Street, and he reported the matter to the police, who later toured the city, but found nothing to arouse suspicion. Two youths working on the telephone exchange also heard the noise and notified the police that they believed there had been a safe robbery in the adjoining bank building, while a similar telephone call reached the police from another agitated resident. A South Goulburn man said that the noise was so loud that his first thought was that a bomb had struck his house. Another householder, living in Faithfull Street, estimated that the main tremor lasted for at least two seconds and was followed by two others four or five minutes later. He said that the house seemed to vibrate and a small portmanteau in the bedroom was knocked over. He said that the disturbance set the dogs in the neighbourhood barking wildly. Gunning, where several severe tremors have been experienced in recent years, reported that this morning's were not felt there. Kingsdale reports that the tremours were experienced there but no damage was caused.*

The damage was slight but the shaking was obviously strong in Goulburn worse than in the 1934 earthquake, but it was not felt over a wide area – not even at Gunning only 40km east of Goulburn so we have assigned it a magnitude of 3.8.

#### **1942 11 07 at 16:00 UTC, Gundaroo**

*Goulburn Evening Post* Wednesday 11 November 1942, Page 1.

*EARTH TREMOR On Sunday morning, about 2 o'clock, writes our Gundaroo correspondent, a slight earth tremor took place. Windows rattled and houses shivered, the quake lasting only a few seconds. The tremor was also noted in Goulburn by several residents.*

#### **1943 02 22 at 14:45, 20:00, 20:30, 21:00 and 21:45 UTC, Gunning**

*Goulburn Evening Post* Wednesday 24 February 1943, Page 1.

*EARTH TREMORS AT GUNNING Gunning was visited again yesterday Tuesday by a few earth tremors. The first occurred about a quarter to one a.m. and was fairly heavy, accompanied by a distant rumbling. Somewhere about 6 a.m. another tremor came not so severe as the first. Then at 6.30 a.m. a sharp and fairly heavy one occurred and was followed by two more, one at 7 a.m. and another at 7.45. It is some time now since we have had a visit of these earth settlements writes our correspondent, and it was thought that we were done with them.*

(The newspaper print is almost indecipherable so these times might not be correct.)

*The Canberra Times* Wednesday 24 February 1943, Page 3.

#### **EARTH TREMORS AT CANBERRA**

*A slight earth tremor was experienced in Canberra yesterday morning.*

*The tremor, which occurred at about 6.35 a.m. and lasted for about six seconds was felt by a number of residents. Rooms shook with a light but steady vibration followed by a faint underground ticking. Inquiries at Mt. Stromlo Observatory revealed that recordings of such phenomena are not kept there.*

*Similar tremors have occurred intermittently in the A.C.T. over a period of years and are believed to originate around the Lake George District.*

The lack of a seismograph at the Observatory on Mt Stromlo was not remedied for another 20 years, and the fixation of geologists that because the largest fault in the region was along the western edge of Lake George therefore it must be the source of the earthquakes, hasn't changed much.

### 1944 01 17 time??, Sydney Suburbs

National Advocate Tuesday 18 January 1944, Page 1.

#### EARTH TREMORS IN SUBURBS

#### CEILINGS OF HOUSES DAMAGED

*SYDNEY Monday: Residents of South Coogee, Clovelly and Bondi to-day reported earth tremors which lasted several seconds but the official seismograph did not record any. Some of the residents declared their homes shook and in one or two instances ceilings cracked.*

This event was explained in Army News Wednesday 19 January 1944, Page 2 as follows:

*Fish Up In Air On Navy Depth Charges SYDNEY, Monday.—Hundreds of fish were killed and others stunned when a Naval vessel dropped depth charges between Maroubra and Coogee beaches yesterday. The explosion shook houses at Coogee, Clovelly and Maroubra. Some people thought the concussions were earth tremors.*

### 1944 04 25 between 3 and 4 pm local time, Sydney Suburbs – military exercises

News Wednesday 26 April 1944, Page 4.

*Explosions In Army Exercises Rock Sydney SYDNEY.—Police and Army officers who today investigated explosions which rocked Sydney suburbs 35 miles apart yesterday, found they occurred during special military manoeuvres at Liverpool. It is believed more than 200 tons of gelignite were used. Puzzling feature of the explosions is that the main force was felt in the Gladesville-Ryde area, 15 miles away, where buildings shook.*

### 1944 05 03 at 20:30, 21:00, 21:40, 22:20, 24:00, Goulburn

The Picton Post Thursday 11 May 1944, Page 4.

#### EARTH TREMORS AT GOULBURN

*Goulburn had a shock this morning:— several of them says the Goulburn Penny Post of last Thursday. Only heavy sleepers failed to hear the preliminary shocks which occurred at 7 o'clock.*

*What seemed like a heavy explosion, followed almost immediately by a violent explosion, accompanied by rumblings of the earth, which shook most of the houses in the city, occurred at that hour.*

*This was preceded, some state, by a preliminary minor affair at 6.30. It was followed, ten minutes later, by a repetition on a smaller scale and again at 20 minutes to 8, while at 8.20 there was another minor occurrence. A number of people also noticed a tremor at 10 o'clock. It did not seem to have the features of a genuine earthquake, but gave the impression, in the first case, of a huge shell exploding, or of a mountain peak slipping and rolling down the sides. It was not felt in the country south of Goulburn, and Gunning, generally looked to as the source of these earth tremors, reported no disturbance in that area this morning. Even at Joppa and Breadalbane the 'earthquake' was not felt. On the other hand, north of Goulburn reports were received which gave support to the theory that it occurred in the mountains to the north or north-east. Mrs. T. B. Fenwick, of Kingsdale, for instance, said it was particularly noticeable out there, while Mrs. G. M. Young, of Murray's Flats, said it was most marked there and seemed to come from a north-easterly direction. She said it resembled the explosion which she heard some time ago when gelignite was set off. There was a rumbling first as of thunder, then came a violent explosion which shook the house, and this was followed by other minor occurrences as in Goulburn.*



The earthquakes were also felt at Mummel, about 12 km NW of Goulburn according to the *Goulburn Post* of 10<sup>th</sup> May. The epicentre was obviously near Murrays Flat so the magnitude from the felt area, constrained by not-felt reports, was small.

**1944 06 14 at 09:30 UTC, Goulburn**

*Goulburn Evening Post* Thursday 15 June 1944, Page 3.

*EARTH TREMOR*

*A marked earth tremor occurred in Goulburn at 7.30 last night. Windows rattled, water in the bath rippled, and in one case a heavy suitcase was dislodged from a wardrobe.*

The epicentre was most likely in the same spot as that of May, the magnitude similar.

**1945 01 15 at 18:00 UTC, Bega**

*The Canberra Times*, Wednesday 17 January 1945, Page 2.

*EARTH TREMOR AT BEGA*

*BEGA, Tuesday.—An earth tremor was felt at Bega and Tathra at about 4 o'clock this morning. The tremor shook houses in both towns.*

This earthquake could have been onshore between the towns or offshore, in the latter case of course the magnitude would be larger than in our assumed case.

**1945 01 21/22 at ?UTC, small swarm at Gunning**

*Goulburn Evening Post* Thursday 25 January 1945, Page 2.

*EARTH TREMORS AT GUNNING GUNNING: On Sunday and Monday earth tremors occurred here. One or two were fairly severe, but not heavy enough to cause any damage to buildings.*

**1945 02 27 at 05:10 UTC, Canberra**

*The Canberra Times* Wednesday 28 February 1945, Page 2.

*Earth Tremor Felt in Canberra*

*An earth tremor was experienced in Canberra about 3.10 yesterday afternoon, but was of brief duration. It resembled a distant detonation, a low rumbling sound being followed by a tremor lasting about 12 seconds.*

*The occurrence was noticed by householders in some parts of the city and was also experienced in the Commonwealth offices. One of those who noticed the tremor in the Commonwealth offices was Mrs. Fisher who formerly resided at Rabaul, where her husband (Dr. Fisher) was attached to the observatory where seismic disturbances were recorded frequently. "I knew I was not mistaken that it was an earth tremor," said Mrs. Fisher when she rang "The Canberra Times" later to enquire if any other reports of the tremor had been received. "It almost made me feel homesick," she added.*

*Earth tremors have been experienced at Canberra on several occasions during the last 20 years and are believed, to originate from subterranean settlement which is taking place in the Gunning-Gundaroo district along the northern end of the Lake George fault.*

There are no reports that this earthquake was felt locally elsewhere, like Queanbeyan, Sutton, Gundaroo, Murrumbateman, Gunning or Royalla, so we suppose it was an ACT event to the southwest of the city, magnitude about 3.

**1945 10 08 at 13:00 UTC, Goulburn**

*Goulburn Post* Tuesday 9 October 1945, Page 3

*EARTH TREMOR* An earth tremor was experienced at about 11 o'clock last night by Mr. S. Wheeldon, fruiterer. Mr. Wheeldon stated that at about that hour last night he heard and felt a tremor in the foundations of his home at 476 Auburn Street. It felt to him as though a heavily-laden waggon was moving down the drive at the side of his premises and the windows rattled. Mrs. Wheeldon awoke with a start as a result of the tremor. Others report noticing the tremor.

The last sentence gives a bit more credibility to the story, especially given the previous activity near Goulburn.

#### **1945 10 15/16 ?time, small swarm near Trangie**

*The Sydney Morning Herald* Wednesday 17 October 1945, Page 3.

##### **TRANGIE HAS EARTH TREMORS**

*NARROMINE, Tuesday.* Earth tremors in the Trangie district are disturbing residents, some of whom think that an earthquake may follow. When similar tremors occurred previously it was surmised that they were due to subsidence at the eastern edge of the old inland sea which is now the Trangie district.

*The tremors are now becoming more frequent. Mrs. Ron Gibson of Somerlea Park near the Macquarie River, heard a rushing noise near her home followed by a "bump." She was flung to the ground. The earth then trembled three times.*

#### **1946 01 06 at 03:10 UTC, Four events near Murringo in the Boorowa District**

*The Burrowa News* Friday 18 January 1946, Page 2.

##### **EARTH TREMORS IN BOOROWA DISTRICT**

*Sunday, January 6, a sharp earth tremor was felt at Geegullalong, Gungewalla and Narra Allen, in the Boorowa district. The tremor took place at 1.10 p.m., and, although of short duration, it was very distinct. Two subsequent shocks were experienced at 4.10 a.m. on Monday, January 14, and another movement of the earth took place at 9 p.m. on Thursday, January 10. The shocks on Monday were severe, but the one on Thursday night was very slight. Mr. Keith McPherson, at Geegulalong, advised the 'News' of this phenomena this week.*

None of these could have exceeded magnitude 3.2 or they would have been felt in Burrowa, Cowra or Young.

#### **1946 05 10 at 16:00 UTC, Gunning**

*Goulburn Evening Post* Thursday 16 May 1946, Page 1

*GUNNING SHAKEN by Earth Tremor Gunning: Residents were awakened at two a.m. on Saturday last, when the town experienced a recurrence of the earth tremors so prevalent a few years ago. The first shock was sharp and sudden, lasting about three seconds. This was followed by three tremors of lesser intensity, but accompanied by a sustained rumbling noise. .... No damage to property has been reported.*

This was obviously a small but close earthquake.

#### **1946 08 10 at 15:45 UTC, Goulburn and Gunning**

*Goulburn Evening Post* Monday 12 August 1946, Page 7.

*EARTH TREMOR At Goulburn and Gunning* A sharp earth tremor was felt at Goulburn and Gunning between 1.30 am. and 2 a.m. yesterday. At Gunning the tremor was preceded by a deep rumbling sound. This was followed by a loud report and a distinct tremor, which shook houses and rattled iron roofs. A minor tremor occurred a few

*minutes later, followed by more deep rumbling. The tremor travelled in a south-easterly direction. During the past fortnight there have been several minor tremors at Gunning.*

With an epicentre between Goulburn and Gunning but closer to Gunning the magnitude would have to be at least 3.4.

#### **1947 05 05 at 04:43 UTC, damage in Gunning**

*FOUR HEAVY TREMORS. CANBERRA ALSO SHAKEN.*

*SYDNEY, May 5.—Earth tremors were felt at several towns in New South Wales this afternoon. At Canberra there were also two shocks. The worst quake was at Gunning, between Goulburn and Yass, where buildings were shaken, and people became alarmed. There were four tremors described as "heavy" within 15 minutes. Three shocks were recorded at Riverview Observatory, where an official said that the first of the three shocks was the heaviest recorded in Gunning district since 1934.*

Two of these earthquakes had to be around magnitude 4 to have been felt in Canberra, indeed the largest was measured at 4.5 by Drake (1974). They were felt in Parliament House, Goulburn and Burrowa, the largest also felt Tumut. Plaster reportedly fell from the wall of a bank in Gunning.

#### **1947 05 16 at 05:55, Lithgow mine collapse – not an earthquake**

*WIDE DAMAGE BY MINE "CAVE-IN" SYDNEY.— Thousands of pounds worth of damage has been caused to homes, public utilities, and roads by the "creep," which began in the old workings of the Vale of Clwydd mine at East Lithgow late yesterday.*

*Many residents whose houses had been rocked and damaged by the subsidences spent last night with friends living in safe areas, while others, less fortunate, spent a night of fear in their threatened homes. No further "cave-ins" had occurred up to this morning, but everybody in the affected area was on the alert. It was just before 4 p.m. yesterday when 30 homes in East Lithgow were rocked by what residents thought was an earthquake. Walls bulged away from roofs, and huge gaps appeared in the homes. In others ceilings partially collapsed. Four-inch wide cracks appeared in roadways, and residents, now certain about an earthquake, ran into the open for shelter. Water and gas mains burst when roadways "opened up," and Lithgow Council officers immediately cut off all water and power supplies. Fearing further subsidences, a number of residents will not return to their own homes until the area has been declared safe. The danger is not yet past, according to local experts. Sergeant Bardman, of the Lithgow Police, said today council employees had made attempts to make the damaged houses safe. Most homes in the area were weather-board, otherwise greater damage, perhaps injury, would have resulted.*

#### **1947 09 25 at 10:57 UTC, Cowra**

##### **TREMORS FELT AT COWRA**

*The Canberra Times* of Saturday 27 September 1947 carried the following story.

*SYDNEY, Friday.—Two earth tremors were felt over a radius of 20 miles at Cowra last night. Each lasted only a few seconds but they caused cracks in plaster. Father O'Connell, of the Riverview Observatory, said they were merely a settling of the earth's crust. There was no reason to expect an earthquake.*

The *Goulburn Evening Post* Friday 26 September 1947 page 5 states that it was slightly felt in some sections of Goulburn, but not in Gunning. The *Dubbo Liberal and Macquarie Advocate* mentioned it was felt at Bathurst at about 9pm and recorded on the Riverview seismograph at 8.57 pm. The felt area, rough as it is, corresponds to a magnitude of about 4.5, large enough to cause non-structural damage.

This brief report is very similar to a report dated 12 March 1896 when Cowra experienced a double earthquake shock at 10:45 pm local time (*Sydney Morning Herald*, Friday 13 March 1896).

**1948 02 02 at 07:26 UTC, Sydney suburbs**

*Newcastle Morning Herald and Miners' Advocate* Tuesday 3 February 1948, Page 1.

*Earth Tremor in Sydney Suburbs*

*SYDNEY, Monday.—An earth tremor felt in several suburbs at 5.26 p.m. to-day shook houses and rattled windows. Father O'Connell, of Riverview Observatory, said there was a distinct recording on the seismograph. The Weather Bureau was flooded with telephone calls from people inquiring about the tremor. The shake was felt at Arncliffe, Bexley and Eastwood. One man at Arncliffe said his house shook alarmingly, but the shake was not sufficient to cause damage. Police at Kogarah said they did not feel the tremor, but heard what sounded like a dull explosion in the distance. Mrs. F. Day, of Halley-avenue, Bexley, said: "I heard what I thought to be an explosion. It shook the house, and, thinking it was an explosion, I ran outside. People were running from their homes asking each other what had happened." Mr. R. A. Burt, of Victoria-street, Arncliffe, said there was an explosion like a big gun going off, and his house shook slightly.*

*The Newcastle Sun* Tuesday 3 February 1948, Page 3 adds:

**EARTH TREMORS IN SYDNEY**

*SYDNEY. — A three-second earth tremor which shook the St. George district and parts of the western suburbs early last night startled residents, who rushed into the streets.*

*Radio programmes were interrupted by static and electric lights flickered in many homes. All areas affected are on solid rock formations. Director of Riverview Observatory (Father O'Connell) said: "First indication I had was when the seismograph recorded slight local tremors." He emphasised there was no danger and said occasional tremors are usual in Sydney.*

Earthquakes under Sydney suburbs are fairly rare and this one, felt over a radius of 16km (reported as 10 miles) was smaller than magnitude 3.0.

**1948 04 08 at 11:45 UTC, Gloucester**

*The Gloucester Advocate*, Friday 16 April 1948, Page 2.

**EARTH TREMOR.**

*The residents of Cundle Flat, Knorritt Flat, Connolly's Creek and Kitty Kitty were startled on Thursday night of last week by a decided earth tremor. It shook roofs and crockery, and lasted five or ten seconds. A number of residents of Gloucester have also reported having felt the shock, which occurred between 9.30 and 10 o'clock.*

**1948 08 15 early afternoon, Boorowa**

*The Burrowa News* Friday 20 August 1948, Page 1.

*Earth tremor Felt At Boorowa*

*Residents of Boorowa district felt a heavy earth tremor early last Sunday afternoon. There was a loud rumble, followed by a rattle of windows and groaning of walls in buildings. An unusual feature of the occurrence was that there was only one tremor, whereas there are usually at least two, due to the earth settling in position.*

**1948 08 21 at 14:30 UTC, Armidale, Scone and Karamea (60km NW Gloucester on Barnard River)**

**EARTH TREMOR**

*The Scone Advocate* Tuesday 24 August 1948, Page 1

*Felt at Armidale and Scone*

*A report from Armidale says a slight earth tremor was experienced in that centre about 12.30 a.m. on Sunday when windows and furniture were shaken and crockery rattled, but no damage was reported. At exactly, the same time, several Scone residents had a similar experience, with two tremors within the space of seconds. Beds occupied at the time were shaken.*

The issue of the same newspaper on 7 September 1948 mentions that it was also felt at Krambach on the near North Coast. The earthquake would have to have been about magnitude 4.5 but there are no reports from Port Macquarie or Tamworth.

**1949 03 10-16, damage to cemetery in Dalton and many aftershocks**

Joklik (1951) wrote up the field survey conducted by BMR soon after the mainshock on 10 March 1949 at 8:31am EST, and included an isoseismal map for the source area. He commented that the attenuation was very rapid. Very usefully he tabulated the RIV amplitudes measured by Burke-Gaffney for the mainshock and main aftershocks, for both the 1934 and 1949 earthquakes. This enables the magnitudes of those aftershocks to be computed and confirms the difference in size of the two mainshocks as 0.1 (5.6 and 5.5).

The earthquake caused considerable damage in Dalton and Gunning estimated at £2000; collapsed parapets, ceilings, cracked walls; overburden failure at the Goulburn quarry; rockfalls behind Towrang and dislodgment of tombstones at the Dalton cemetery - the headstones inclining at all angles.

**1949 07 17 at 14:59 UTC, Stroud and Bulladelah**

*Newcastle Morning Herald and Miners' Advocate* Tuesday 19 July 1949, page 2.

*Earth Tremor at Bulahdelah An earth tremor lasting about a minute shook Bulahdelah about 1 am. yesterday. Houses trembled, but no damage was done. Sergeant Casey, of Bulahdelah, said he was awakened by the violent shaking of the police station. He thought it had been caused by an explosion. When he went into the street he found that the occupants of houses in the vicinity had also been awakened. An alum mine is the only one operating in the Bulahdelah area. The tremor was felt at Stroud, 30 miles west of Bulahdelah, and at Coolongolook, 16 miles north.*

Many Tea Gardens residents got up and had a look around when their sleep was disturbed shortly after 1 a.m. on Monday morning. It was like a dull explosion and houses and crockery shook almost immediately. The Riverview Observatory recorded a shock at 12.59 a.m., whereas locals timed it at 1.9 a.m.

It woke a few people at Bulahdelah. A magnitude of 3.5 is consistent with the felt reports and its detection at RIV (Thanks to Cynthia Hunter, 1991 for finding this event).

**1950 04 05 at 10:50 UTC, Yass**

*Cootamundra Herald* Wednesday 12 April 1950, page 2.

*A severe earth tremor was felt and heard at Yass at 8.50 last Wednesday night.*

**1950 05 07 at 17:30 UTC, Molong and Manildra**

The *National Advocate* Tuesday 9 May 1950, Page 4 mentions:

## EARTH TREMOR AT MANILDRA

*MANILDRA. Monday: An earth tremor early this morning dislodged plaster on the ceilings of a few houses but did not cause any serious damage. Between 3 and 4 a.m. people in the town were awakened by two muffled explosions, followed by noises similar to distant thunder. The tremor lasted about 10 seconds.*

The damage is a concern, maybe a consequence of construction quality rather than intensity of shaking, but the lack of reports from other places leads us to conclude this was a small, very local event.

## 1950 05 23 at 20:15 UTC, Manilla north of Tamworth

On the evidence available (*Courier Mail* Thursday 25 May 1950, Page 5 and *The Dubbo and Macquarie Advocate* Saturday 27 May 1950, Page 1), this too was a small close earthquake. People ran from homes, roofs and beds rattled, some walls cracked.

## 1950 08 10 at 06:00 UTC, Quirindi

*The Sydney Morning Herald* Saturday 12 August 1950, Page 3.

### *Earth Shock At Quirindi*

*QUIRINDI, Friday.—There was a sharp earth tremor in Quirindi about 4 p.m. yesterday.*

*Mrs. Arthur Lowe, of Railway Avenue, said the couch on which she was lying rocked and that windows and crockery rattled.*

*Mr. J. J. Reilly, of Hill Street, said he felt a distinct tremor pass under the house, giving a sensation like standing on a wooden bridge when a car passes over.*

## 1951 02 11 at 07:30 UTC, Katoomba

*Illawarra Daily Mercury, Monday 12 February 1951, Page 3.*

*EARTH TREMOR AT KATOOMBA Sydney, Monday. — Homes were shaken by a short, sharp earth tremor at Katoomba, Blue Mountains, late yesterday. Scores of people ran outside.*

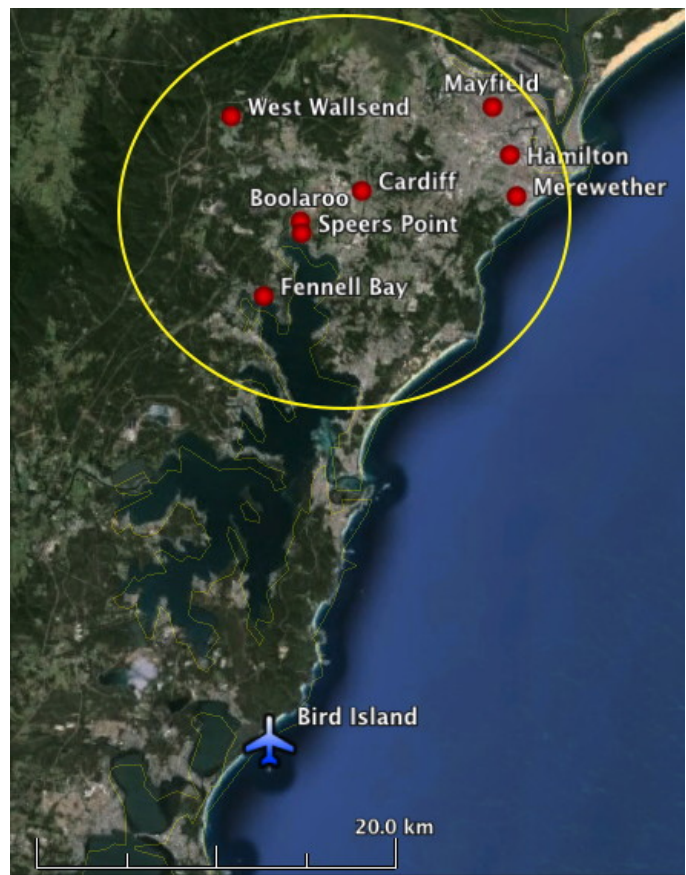
There are no other reports.

## 1951 07 09 at 04:45 UTC, small swarm Newcastle

**Figure 29** This plot of the 1951 07 09 event felt reports is intriguing, the centre is near the epicentre of the 1989 Newcastle earthquake and aftershock. The timing rules out the bombing exercise as the cause as does the location of Bird Island, nearly 40 km south-southwest of the city. Hunter (1991) discussed this event, plotted the felt reports and concluded it was an earthquake.

*The Newcastle Morning Herald and Miners' Advocate* Tuesday 10 July 1951, page 1.

*Earth Tremors Shake Homes In Newcastle District.*





*Earth tremors shook houses over a wide area in the Newcastle district between 2.45 and 3 p.m. yesterday.*

*In the absence of official information, Mr. Mark Howarth, of Grange Mount Observatory, Mayfield, said the tremors might have been caused by the collapse of a cliff or shelf under the sea. On 23 September 1938 a similar phenomenon occurred at sea between Norah Head and Redhead.*

*Mr. Howarth was working in his garden when he heard a sound he had believed to be thunder. He did not take much notice of it till his wife, who was in the house, said the building had trembled. Men at the lighthouse at Norah Head, which is within sight of Bird Island, said planes were dropping practice rockets or bombs on the island between 1.30 and 2 p.m. yesterday. They heard explosions and saw earth thrown up, but the ground did not tremble nor the lighthouse shake.*

*The tremors were felt in Newcastle and suburbs. They were pronounced in the Lake Macquarie area and at West Wallsend. A number of shocks were felt about 2.45. They were followed about five minutes later by a single tremor. Mr. A. Connor, of Speers Point, said his house shook and windows rattled. Believing it was an explosion, he went into the street, where a lot of people had assembled. Mr. Joe Walters, of Fourth-street, Boolaroo, said he felt six or seven tremors in his house. People in the area congregated in the street. Some believed there had been an explosion in a mine or that blasting was taking place nearby.*

*People working in offices in Telford-street, City, were startled when windows shook and a noise like an explosion seemed to strike the premises. Householders at Hamilton, Merewether West, Mayfield and Merewether proper noticed that the windows in their properties rattled. A sound like thunder accompanied the rattles. A group of tennis players at a Merewether court put the noise and tremors down to thunder—there were heavy cloudbanks in the south and rain had been falling. Tremors were felt at Argenton and Fennell's Bay. At West Wallsend a miner who heard the noise said it sounded much like a shot echo followed by vibration. Two members of Lake Macquarie Ambulance, Messrs. Ken Avery and George Barnier, who were in an ambulance car at Warner's Bay, said they felt the concussion just as the car had stopped at a house.*

Cynthia Hunter (1991) mentions this series of tremors on page 81 of her book. Even if the bombing runs over Bird Island had somehow been the cause of this apparent swarm, there was more to follow.

#### **1951 11 14 at 05:00, Newcastle – a second small swarm**

A second small swarm has puzzled if not frightened residents and 'experts' 26 years after the last strong earthquake in Newcastle. *Newcastle Morning Herald and Miners' Advocate* Thursday 15 November 1951, Page 1 reported the tremors:

##### *Rumbling Was NOT Thunder*

*A series of rumbles, like distant explosions, about 3 o'clock yesterday afternoon shook houses and rattled windows in Newcastle extending from the eastern end of the city to beyond Hamilton. The rumbles were heard from the eastern end of the city to beyond Hamilton. The cause of the disturbance is not known, but Mr. Mark Howarth, of Grange Mount Observatory, Mayfield, said that if the tremors were felt in areas near the sea they might have been caused by a submarine subsidence, several of which had occurred in the past 20 years. Mr. Howarth said about 25 years ago a severe submarine subsidence off the coast shook houses and shops in Hunter-street, Newcastle, and extended as far as Mayfield. Yesterday's tremor was not felt at Mr. Howarth's home. No Bombing Mr. Cyril Griffiths, of Bar Beach, said there were seven*

*or eight sharp cracks in about 18 minutes. The first occurred about 2.57 and was very severe. It was not thunder. Officers at Fort Scratchley felt the tremors and heard faint explosions. They thought they might have been coming from the R.A.A.F. bombing area near Morna Point, but R.A.A.F. officers said there was no bombing there yesterday. Coastal guns were not fired. Tremors accompanied by rumblings, believed to have been thunder, were heard in offices in King street, Newcastle, and in houses in Church-street. In lower Beaumont street, Hamilton, near the race course, people in houses heard a rumble and looked out to see if it was raining. A woman in Lawson-street, Hamilton, said the sound was like heavy weights being dropped.*

Again the centre of felt reports is consistent with an epicentre near Boolaroo.

### **1951 12 05 at 00 UTC, Newcastle – a third small swarm**

*The Newcastle Sun* Wednesday 5 December 1951, Page 2.

#### *More Rumblings Underground*

*Newcastle homes bordering the sea were shaken again today by a prolonged series of subterranean explosions similar to those which rattled windows and doors over a wide area of the district several weeks ago.*

*Today's explosions and resulting earth tremors were not as severe as last month's, but they continued without a break for nearly half an hour between 9.40 and 10.10 a.m. Homes nearest the sea in the Bar Beach-Merewether area were most affected by the disturbance, but residents of Hamilton South reported that the explosions could be heard quite distinctly inside their homes. Mr. Gordon Campbell of Parkway-ave, described the explosions as "like a series of heavy blasting charges." Bar Beach council inspector, Reg. Gazzard, said the beach seemed to rock slightly as the explosions occurred. Mr. Mark Howarth of the Mount Grange Observatory, still favors the theory that the last two disturbances have been due to the subsidence of old mine workings under the sea-bed and says the heavy detonations were probably caused by a terrific rush of water and the ejection of air from the mine passages. An old Newcastle sea captain, who served for many years on a survey ship off Newcastle, advanced the theory today that this morning's tremor was due to the cave-in of an under-water cliff face. He said precipice-like cliffs 300 feet high existed off the coast south-east of Newcastle, and heavy falls could easily occur.*

These three remarkable swarms of 1951 occurred between the strong earthquakes of 1925 and 1989 – is there some connection?

### **1952 05 19 at 11:10 UTC, Western NSW**

This earthquake was very widely felt according to the *Barrier Miner* Tuesday 20 May 1952, page 4.

*Broken Hill last night was affected by an earth tremor centred mainly south of the city. Most of the several thousand square miles of the West Darling district felt the shock. Reports today disclosed that most parts of the city were affected. The tremor lasted up to about ten seconds. It was felt about 9a.m.*

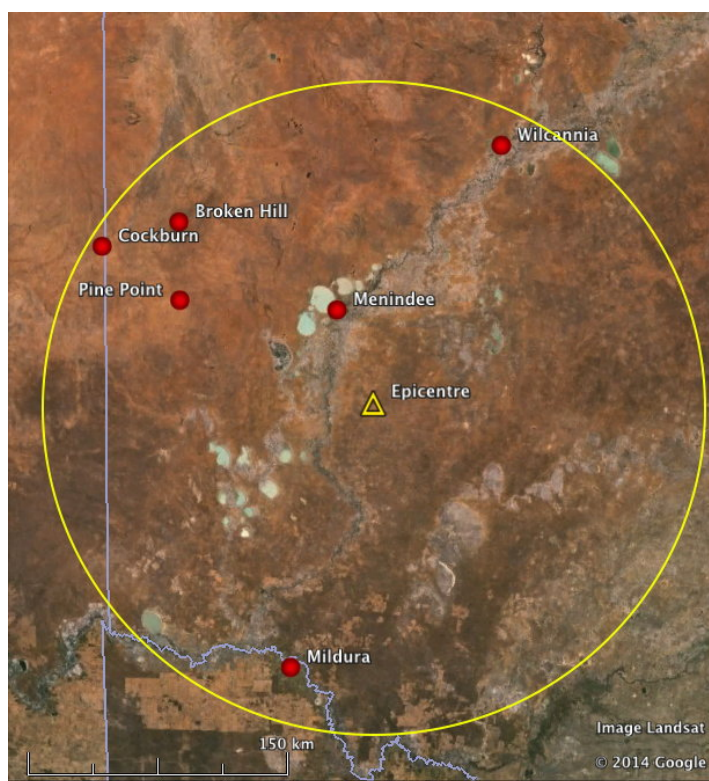
*Many residents said that glass in windows and glassware in the house rattled. They said the tremor was accompanied by a low rumble. It resembled the noise of a 20-ton truck passing on the roadway. It is believed the tremor was more severe in the southern portion of the city. No reports of damage or actual earth movement were received. The tremor did not interrupt work on the mines. Many people slept through the tremor and were told about the happenings this morning.*

*Outback stations disclosed that the shocks were more severe there. They were felt at Menindee, Wilcannia and to a lesser degree in the Cockburn area.*

*Station hands were awakened by the rumble and shaking of their quarters. Station property south of the city seemed to get full force of the tremor.*

**Figure 30** Felt area of the Western NSW earthquake of 19 May 1952. The epicentre (compatible with the felt reports) is very approximate.

*A report from Pine Point station showed that when the tremor occurred, the walls and roof shook, and a bed rocked sideways. Other stations also reported similar experiences. Although party telephone lines in the outback were kept busy last night, the Broken Hill exchange did not experience any noticeable increase in phone calls. There was no undue panic as the result of the tremor.*



*Broken Hill experienced a more severe shaking about 50 years ago when windows, furniture and crockery rattled. A local resident said today he recalled a tremor about 8 o'clock at night in May 1903 (Author - good memory: 1 May 1903 at 6:20pm local time). He remembered men going underground to check workings.*

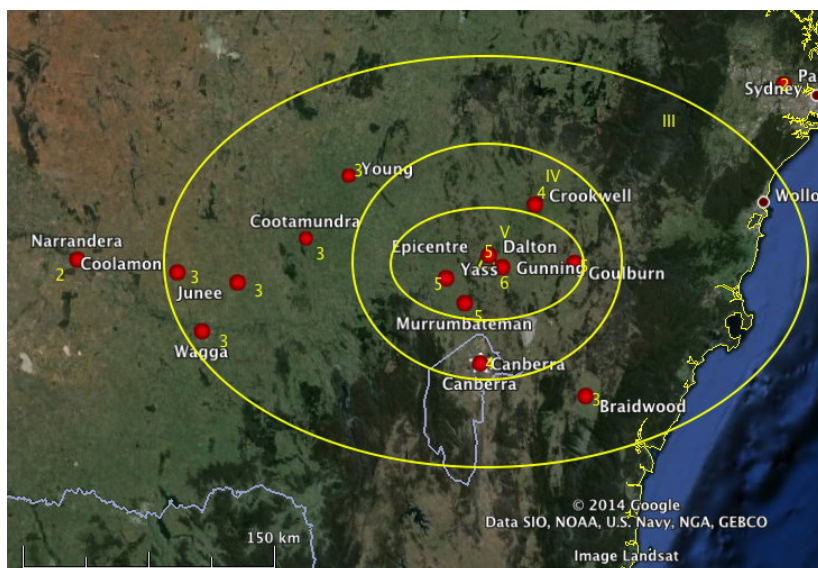
### 1952 09 07/08, Gunning, old cracks reopened

*The Sydney Morning Herald Tuesday 9 September 1952, Page 3 reports:*

*The little town of Gunning (pop. 700), half-way between Goulburn and Yass, may be a mild earthquake centre. The director of the Riverview Observatory, Father N. Bourke-Gaffney, said yesterday that the town appears to lie on a "fault" in the earth's crust.*

**Figure 31** Isoseismal Map of the Gunning earthquake of 19 November 1952 at 01:59 UTC. The felt area indicates a magnitude of 5.2, higher than Drake's (1974) estimate of 4.9, but it was felt as far as Parramatta (200km away MM2) and Narrandera. This map may change as more newspapers are scanned by ANL.

*It is in such areas that earth tremors are most likely. The "fault" would explain why Gunning feels tremors so often. The latest occurred yesterday and on Sunday. There were 15*



altogether. "We recorded our first tremor on Sunday at 3.42 p.m.," said Father Bourke-Gaffney. "It is likely that the shocks to-day were only 'after shocks'."

Older residents say the tremors are commonplace. Mr. Bill Lyell, a grazier, of Byalla Street, who is a lifelong resident, can, like many other people, point to cracked walls in nearly every room. "Yesterday's tremors opened cracks we had sealed and shook the roof back a couple of inches," he said. "We are used to these things now. We try to fix up the cracks, but each year they open up again."

*Tremors May Last Centuries* CANBERRA, Sunday.—The earth tremors which continue to shake Gunning may recur intermittently for thousands of years. The Chief Geologist of the Bureau of Mineral Resources (Dr. N. H. Fisher) said this to night. Ultimately they would result probably in a change in the terrain, which may take the form even of a new range of hills. Dr. Fisher said there was nothing to indicate any likelihood of a major earthquake at Gunning. Severe earthquakes usually occurred suddenly. The Gunning tremors were known to be reasonably deep and were probably associated with movements of a fault in the earth's surface, which were associated with the formation of Lake George, near Goulburn. A severe tremor last night shook Gunning, Yass, Dalton and Crookwell. It rumbled like thunder beneath Parliament House, Canberra, 40 miles away. It dislodged plaster from walls and ceilings but did no other damage. Sergeant V. D. Daley, of Gunning police, said the earth shook at half-hourly intervals to-day, with the most distinct tremor at 3 p.m. Sergeant Daley said he was in the station woodshed when the big shake occurred. "It sounded like thunder in a big tank and I felt the floor move under me," he said.

There was an earlier earthquake at Gunning on 18 August, no details in the *Goulburn Evening Post* of Thursday 1 January 1953, page 2.

#### **1953 01 03 at 14:03 UTC and 1953 01 04 at 07:00 UTC, events of Gunning swarm**

*The Sydney Morning Herald*, Monday 5 January 1953, Page 1.

##### *Severe Earth Tremor Rocks Gunning*

CANBERRA, Sunday. A sharp earth tremor rocked buildings in Gunning early this morning but did no serious damage. A Gunning resident said it was one of the severest jolts the district had experienced.

The tremor was felt at about 12.30 a.m. and continued for a few minutes, rattling windows and slamming open door. It widened chimney cracks caused by past tremors.

Less violent tremors occurred at frequent intervals during the morning until about midday. The first tremor and another at about 5 p.m. were felt in Canberra.

Earth tremors are fairly common in Gunning. Geologists say that the town is standing on a fault in the earth's crust. To-day's tremors were the first for four or five weeks.

Two of the swarm were felt Canberra so must have been about magnitude 4 which also explains the slight damage observed near the epicentre. The postulated fault is unknown.

#### **1953 02 11 at 00:30 UTC, Milparinka and Mt Browne**

*Barrier Daily Truth* Thursday 12 February 1953, page 2.

A severe earth tremor was felt yesterday morning at Milparinka and Mt. Browne at 10.30 o'clock. Three quarters of an hour earlier a party travelling towards Milparinka felt a shock 25 miles south of that centre. At 11 a.m. Mt Browne radioed the Flying Doctor Base that half an hour earlier a tremor had rattled windows and caused the

wireless masts to shake. Mr. N. Wheeler, who gave the report, said there was a low rumbling sound rising into a severe vibration, and the earth shook for a minute at the peak of the tremor.

About nine miles away, Milparinka was also affected by the tremor. Here the postmistress first noticed the disturbance when the clock on her desk started to dance about. She picked up the clock and ran into the street. Homes were shaken.

Three-quarters of an hour earlier, when 25 miles south of Milparinka, a group of workmen going from Broken Hill by motor felt the shock, which rocked the vehicle. They had arrived at Milparinka just as that centre received the big tremor.

Later at Mt Browne the owner found a fibro cement store had been cracked from top to bottom in four places by the tremor.

#### **1953 05 20 at 07:00 UTC, Collector**

*Goulburn Evening Post* Thursday 21 May 1953, Page 8 reports:

*Earth Tremor* A severe earth tremor was experienced at Collector at about 5 p.m. yesterday. Although only the one quake occurred, it was severe enough to cause cracks in the walls of one or two homes and rattle windows and crockery in others. Mr. W. Dyball, of Collector, said the tremor cracked the chimney of his kitchen fireplace. He said the quake was the severest experienced at Collector for some time.

#### **1954 05 28, daytime, Newcastle**

*Newcastle Morning Herald and Miners' Advocate* Saturday 29 May 1954, page 3:

*The cause of earth tremors which rattled windows and shook wall fixtures in many Newcastle homes yesterday remains a mystery. The R.A.A.F. at Williamtown did some bombing, strafing and rocket firing at Morna Point yesterday (author: 33km NE Newcastle city), but the blast from those operations is not likely to have reached Newcastle. Suggestions that the tremors were caused by subterranean upheavals were not supported last night by a report that Sydney observatory had no record of any earth tremor near Newcastle during the day. Riverview Observatory also had no record of an earth tremor.*

From many similar experiences and discussions with colleague Andre Phillips, the author is reasonably confident in attributing this incident to the nearby RAAF exercise but has some reservations due to the 1951 swarms discussed above.

#### **1954 06 09 at 16:26 UTC, Crookwell**

Crookwell seems to have borne the brunt of the shaking at 2:26 a.m., where the 3000 residents are reported to have spent a sleepless night (*Argus*, Friday June 11, 1954 page 3). At Gunning the shaking was also rated severe. The *Canberra Times* mentions that it was slightly felt in Canberra, (author - not one I remember). It has been assigned magnitude 4.5 subject to more information. It was recorded at Riverview but not mentioned by Drake (1974).

#### **1954 09 19 at 10:30 UTC, Brewarrina**

*The Newcastle Sun* Monday 20 September 1954, Page 4.

*Earth Tremor*

*BREWARRINA: An earth tremor shattered windows in several homes in the town last night. The tremor, believed to be the first in the town's history, lasted about 30 seconds at about 8.30 p.m. Residents ran into the street.*

Indications are that this was a close small earthquake but at least magnitude 3.5.

Note: The ANL may not scan newspapers after 1954, except for *The Canberra Times*.



### **1956 08 15 at 16:47 UTC, Orange**

*The Canberra Times* Friday 17 August 1956, page 3:

*SYDNEY, Thursday. — Severe earth tremors to-day shook Newcastle and Orange districts, rattling doors and windows.*

*At Orange, where the tremor occurred at 2.47 a.m., residents ran outside their homes in night attire to see what had happened. Police thought the "crack" of the tremor was the noise of a safe being blown. They patrolled the main streets in an attempt to find the cause of the tremor. Mrs. Noel Wheatley, of Kite Street, Orange, said she was drinking coffee with her husband and friends when she heard a loud rumbling noise. "It came close, and then the windows and doors rattled," she said. Other residents said the tremor made a noise like an express train. In a grocery shop in Price Street goods were thrown to the floor.*

Police said no damage had been reported. It was the third tremor Orange has had in five years.

### **1956 08 16 at 01:00 UTC, Newcastle**

*The Canberra Times* Friday 17 August 1956, page 3:

*The first tremor in Newcastle was reported from the police station and later from Merewether and Mayfield. Police said they felt the tremor soon after 11 a.m. It shook the building and caused lights to sway. It was followed shortly after by another distinct tremor, similar to the first.*

*Mr. M. Howarth, of the Grange Mount Observatory, said the tremors could have been caused by the collapse of a marine shelf some miles from the coast. This has happened before. The last time I can recall that tremors were felt in Newcastle was about 28 years ago," he said (Ed. Actually December 1925, 31 years ago).*

### **1956 11 28 at 00:30 and 04:55 UTC, Sydney**

*The Canberra Times* Thursday 29 November 1956, Page 3 reports:

#### **EARTH TREMORS IN SYDNEY**

*SYDNEY, Wednesday. — Two earth tremors which to-day shook buildings in the city startled thousands of office workers. The first tremor, which occurred at 10.30 a.m. was recorded at Riverview College Observatory. It lasted about 15 seconds. The second was felt at 2.55 p.m. and lasted only a few seconds. The Director of Riverview College Observatory, Father Burke-Gaffney, said the disturbances were "very minor".*

These and earlier 'tremors' indicate that earthquakes can and do happen under Sydney.

### **TSUNAMI ON THE NSW COAST**

A secondary effect of major earthquakes, tsunami too are a threat to cities along the NSW coast, as history shows, and should be considered by engineers, architects and local governments when developing low lying coastal areas.

### **1886 09 05 17:00 UTC Sydney and Newcastle – Tsunami**

*The Sydney Morning Herald* Thursday 14 October 1886, Page 10.

#### **TO THE EDITOR OF THE HERALD.**

*Sir,—Some of the recent earthquakes and eruptions and the phenomena here which have been supposed to be connected with them, seem worthy of record. In the past we have so frequently been able to connect the small periodic waves which reach our*



*coast with earthquake shocks that I was rather surprised to find no record of any such waves on our tide gauges about the times of the great earthquake in America, August 31, or that in Greece, August 27. There was, however, at 5.15 a.m., of August 30, a rather alarming earthquake shock at Young, and like the harbour the waters of Lake George did not show any disturbance on these dates, but at 3 a.m. of September 6 a series of small tidal waves began on this coast at Sydney and Newcastle, and continued for two days. About 9 p.m. of the 6th also the level of the water in Lake George suddenly changed, and rose three inches at the south end, and after remaining so for nearly six hours gradually recovered their former level, the usual wave motion going on all the time, independently of the change of level. On September 26 the volcano on the island of Niufu, in the Tongan Group, was in violent eruption; but, again any sign of sympathy with it is wanting in our tidal register.*

*The remarkable absence of connection between the periodic waves which have been recorded here recently is noteworthy, the more so since we learn that during the American earthquake, Sullivan's Island, near Charleston, was submerged by a tidal wave. Such waves would seem, therefore, to have been caused only on the Atlantic, and not on the Pacific side. When the great eruption took place in New Zealand and destroyed the Pink Terraces no sea disturbance was caused, and it seems certain that many eruptions and earth tremors take place without corresponding phenomena in the sea.*

*H. C. RUSSELL.*

*Observatory, October 13.*

The source of this tsunami is not recorded.

#### **1960 05 24, Sydney and Newcastle – Tsunami from Chile**

*The Canberra Times* Wednesday 25 May 1960, page 1.

*NEW YORK, Tuesday (A.A.P.).—Tidal waves generated by Chilean earthquakes have smashed at Pacific coastlines, within the past few hours, leaving widespread death, destruction and panic in their wake.*

*As three wave pounded on Hawaii, Japan, the U.S. mainland, Alaska, New Zealand and Australia, Chile itself was subjected to new tremors, volcanic eruptions, landslides and floods. The toll in the week-end earthquakes and associated disasters which ravaged Southern Chile stood this morning at an estimated 900 dead, 15,000 hurt and hundreds of thousands homeless.*

*The tidal surge reached the eastern Australian coastline early this morning. Tides along the coast rose and fell with freakish, alarming rapidity, tearing adrift hundreds of small craft. The inrush of water sank three fishing boats at Newcastle, and residents at Lake Macquarie were startled from their beds by the water's roar.*

*Fort Denison, in Sydney Harbour, reported that the water level was still surging up to nine inches above normal, but was steadily decreasing. Most damage occurred in Sydney about 6.30 a.m. The heavy surge of water rushing through the Heads sliced off land from harbour reserves and beaches. In Middle Harbour, near The Spit, scores of launches were torn from their moorings and caught in a huge whirlpool. Two police launches, Osiris and Adastrea, battled for more than three hours helping to recover the drifting boats, scattered for miles down the Harbour.*

*A barge propelled by the swiftly running tide smashed into the Spit Bridge. Police said this section of the Harbour was worst hit, although the tidal surges extended up the Harbour to Balmain, where 900 logs were set adrift from their moorings at shipping yards.*

*The Krakatoa explosion of Monday, August 27, 1883.*

*Extracts from an article by Alan Stephens in the Sunday Times, Perth Sunday 22 June 1952, page 5S.*

*This explosion, the largest of a series of several dozen, occurred at 2 minutes past 10 in the morning, with the results that it killed 36,380 people, wiped out cities, towns and villages, steamers and schooners, for hundreds of miles, was heard nearly 3,000 miles away, affected tides across the oceans of the globe, and sent a red dust pall 3 times round the world!*

*Prior to the explosion Krakatoa was an island 18 square miles in area, and rising from narrow sandy beaches to a height of 1,500 feet. It was located in the Sunda Strait, between Java and Sumatra.*

*After the explosion two thirds of the island was gone, literally blown up. Of the northern side the only thing which showed was a block of stone some 30 feet square, standing up forlornly above the waves. The once threatening crater was buried 1000 feet below the surface.*

*The instantaneous release of such terrific energy threw up waves over 70 feet high. This merciless irresistible death swept away, and screaming townspeople drowned along all the areas along the strait. If they lived in more substantial buildings they were crushed to death by collapsing ruins, and died even more horrible deaths.*

*Daly Waters and Alice Springs, N.T., residents (more than 2,030 miles) reported distant gunfire,*

*The earth tremors resulting from the eruption were recorded from wide areas also, and no less than a dozen towns on the eastern coast of Australia advised that the tremors had been felt.*

*The waves which had caused such devastation and death in the Sunda Straits radiated outwards over the oceans. Three days after the explosion, waves 8 feet high dashed themselves onto the coast of Western Australia, and walkers on the beach at Geraldton were almost trapped by their onrush.*

*In Newcastle Harbor all ships at anchor suddenly swung about momentarily as if the tide was ebbing instead of flowing. Harbors on the east coast of Tasmania and New Zealand were flooded by miniature tidal waves.*

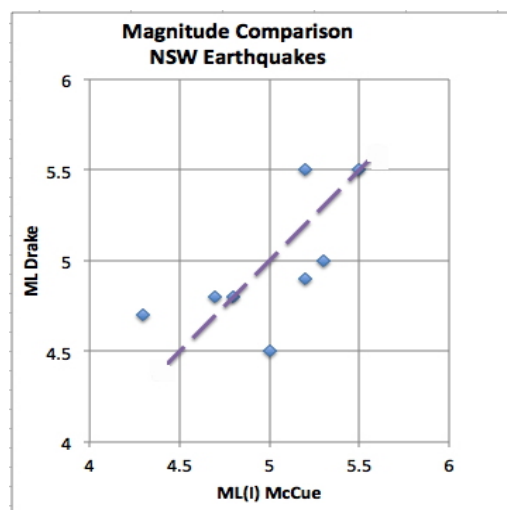
## **MAGNITUDE REVISITED**

Drake (1974) revised the magnitudes of significant NSW earthquakes to 1973. This allows us to calibrate our relationship between the magnitude derived from the felt areas of pre-1955 earthquakes mapped in this report (from McCue, 1980) against Drake's magnitude measured from the RIV seismogram.

**Figure 32** Magnitude comparison between Doyle's measurement of ML from the RIV seismogram with McCue's estimate of ML(I) from the felt area of earthquakes tabulated in this study. The dashed line is not the line of best fit but the line of equality in the scales. Only eight values were jointly determined (the small blue diamonds).

A simplified relationship McCue (1980) derived from earthquakes throughout Australia is

$$ML(I) = 1.01 \ln R_p + 0.13$$



where  $ML(I)$  is the magnitude determined from the felt area and  $R_p$  is the radius of perceptibility (the radius in km of a circle with the same area as the felt area). Undoubtedly the uncertainty is large but probably not larger than half the range of magnitudes for any earthquake measured in 2014 from seismograms.

This equation seems to be a reasonable fit for NSW earthquakes.

## DISCUSSION

There are some big unknowns in modeling earthquake occurrence in Australia:

- Why do large intraplate earthquakes occur in Australia, and so frequently?
- Is the pattern of earthquakes during the short period of seismograph coverage of the continent, down to say magnitude 3, stationary? If so why?
- Will the pattern of future earthquakes mirror the pattern of past earthquakes?
- Why did none of the ~20 observed large ( $M > 5.9$ ) earthquakes of the last 100 years occur on a known large fault? Are faults in Australia relevant in this context? ie can they be labeled active without seismicity?
- Where might the next large earthquake occur?
- When will a large earthquake strike a major Australian city (~10 of them); or a critical facility such as the Lucas Heights nuclear reactor, the Geelong Animal Health Laboratory; or one of the many (~500 according to ANCOLD) 'large' dams? With so many 'targets', the joint probability is non-negligible.
- Why are there Recent volcanoes in continental Australia, far from the plate boundaries?

This study aimed at recreating the earthquake history of NSW since European settlement to help address some of these questions. Further additions and improvements in the epicentral locations and magnitudes will be made as more newspapers and other historical documents are scanned and made publicly available by the ANL.

For example, the 1933 Gunning NSW earthquake should have been felt at Wollongong, Picton, Bowral and Crookwell, unless its location reported here is incorrect.

The study shows that we can be reasonably confident that no large ( $M > 5.9$ ) earthquake has occurred in NSW since ~1850 by which time Europeans had spread out across the state. We note that there have been 20 earthquakes over magnitude 5 in that time, four of them  $M5.5$  or more. Paleo-seismological studies confirm that large earthquakes have struck NSW in Recent geological time. Extrapolation of the recurrence relation suggests that large earthquakes, of magnitude 6 or more, can be expected in NSW on average every 70 years or so. History therefore suggests that a large earthquake is overdue.

Only Newcastle and Bowral have suffered a direct hit from a moderate earthquake but small earthquakes under Sydney, Canberra and Wollongong show that other cities are vulnerable.

It is also obvious that there are at least three different types of earthquake behavior (i) a standard foreshock, mainshock, aftershock pattern (type case Gunning), (ii) an isolated magnitude 5 or greater earthquake (type case Newcastle) and (iii) swarm activity which seems to occur in both Newcastle and Gunning, and other places.

The area around Dalton and Gunning is one of the most seismically active in NSW yet a study of the geology shows little relationship between earthquake epicentres and major faults such as the Lake George Fault or the complex set of surface faults that define the northern boundary of the Gunning Batholith in the region (Figure 32 and 33 from Simpson, 1974). The foci of those earthquakes that are well constrained are quite shallow. The Lake George Fault is almost aseismic unless it dips to the west at less than  $10^\circ$ , a typical thrust fault dips at  $30-45^\circ$ . Simpson also states: *During the investigation, no conclusive evidence was seen of earth displacements attributable to the recent seismic activity monitored by Cleary (1967).*

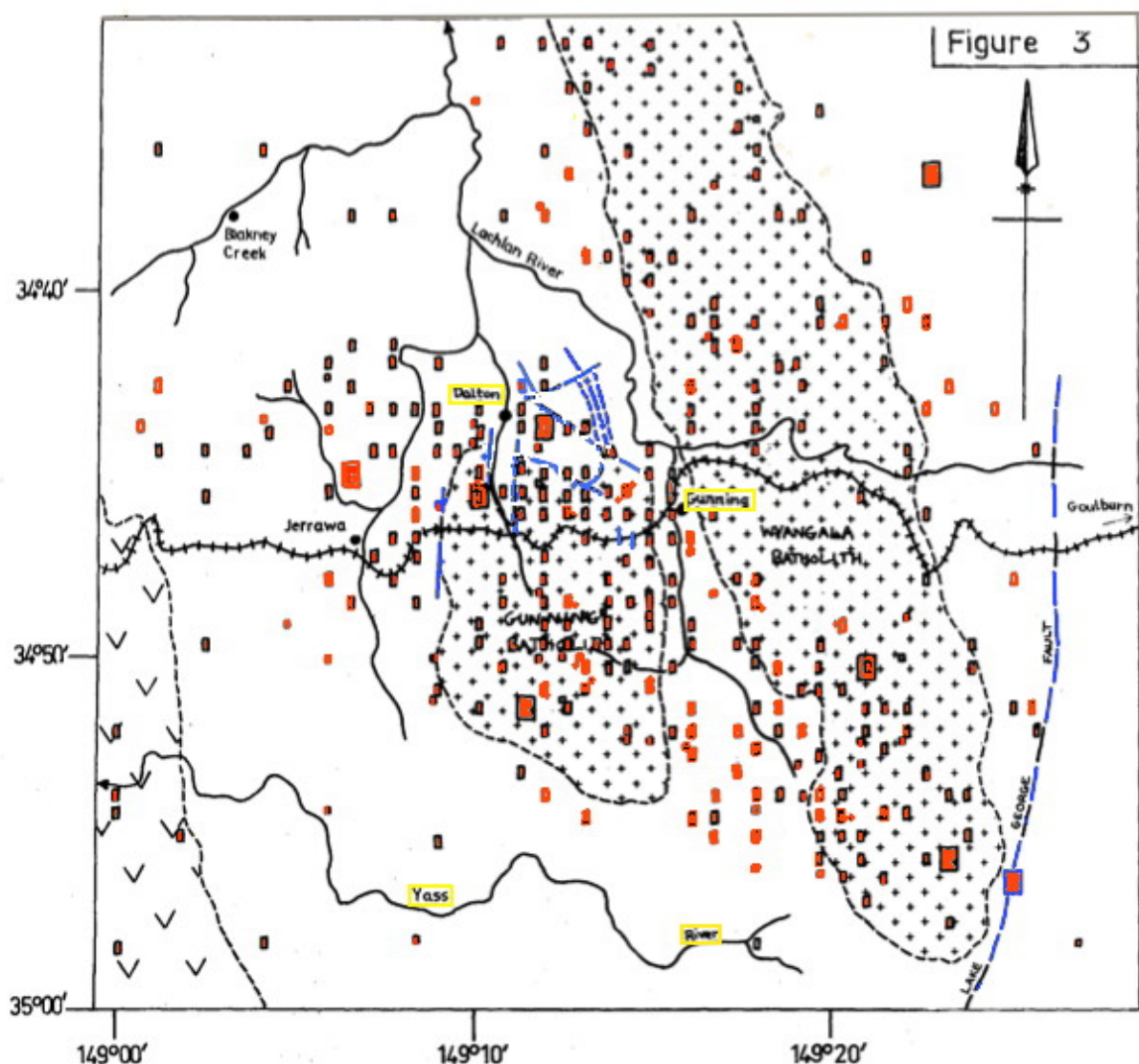
The mapped granite outcrop does not tell us much about the geometry of the subsurface batholiths so it is difficult to assert that this is the attractant. We can only surmise that earthquakes tell us little about the state of faults and the geology tells us little about the likelihood of earthquakes, at least in this region. We can only suggest that future earthquakes are more likely to occur where past earthquakes have happened.

More data will improve all of the events studied in this paper (summarised in Table 1 below) and no doubt this information will come to light in the future, there is always scope for improvement as Underwood (1972) pointed out 40 years ago. Many of the earthquakes mentioned in the Appendix have not yet been investigated. Additional historical events will be found and further study of some of the events mentioned in new newspaper extracts will enable their magnitudes to be estimated so that they can be added to databases, pushing the completeness interval to a lower magnitude and an earlier starting date.






The issue of completeness was the subject of a paper delivered by McCue (2014a) at the annual AEES conference in Lorne in November 2014. This is necessary to compute a recurrence relation for NSW for the period of European settlement, most of the state was inadequately monitored with seismographs until the 1960s.








Burke-Gaffney (1951) made the following observation about completeness: *It is probable that the whole area considered is covered down to magnitude 6; for smaller magnitudes, those areas around the recording stations are best covered — within 10° of them for magnitudes of about 5. New South Wales is probably covered for magnitudes, of little more than 4. Smaller tremors at distances greater than 10° from any station are not likely to have been recorded at all.*

Human activities are increasingly leading to earthquakes, whether pumping fluids underground for waste disposal or geothermal reservoir production, filling large reservoirs or mining. Historically, mining has shown a capacity to induce earthquakes, the coalmines of NSW and Queensland as well as the hard rock mines in NSW, SA and WA and more recently fracking operations in coal rich areas. All such operations should be monitored closely with local networks of seismographs, and it is essential that the data be made publicly available even if it has to be undertaken by governments to achieve this. A national publicly-accessible database of induced seismic events should be created both to prevent such man-made events corrupting earthquake databases and for more robust study of the underlying stress and the relationship of earthquakes with faults.



**Regional Geology of the Gunning Area, NSW**  
 with locations and magnitudes of earth tremors occurring  
 between 1958 and 1970  
 (after Cleary 1967)  
 Scale 1 : 250000

-  Granite— Siluro-Devonian
-  Volcanics— Middle Silurian
-  Metasediments—Upper Ordovician
-  Geological boundary, position approximate
-  Fault, position approximate

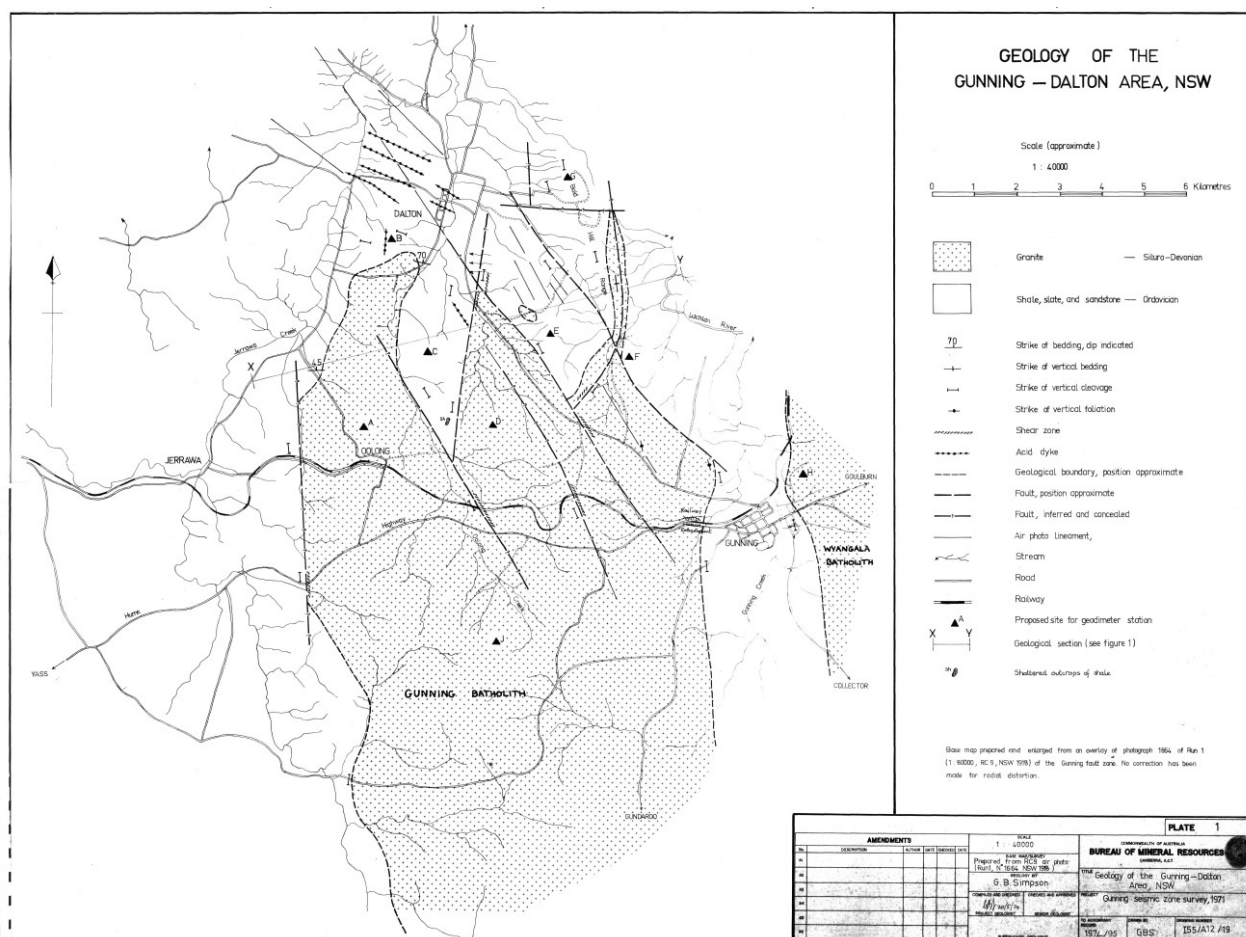
- Earth tremor epicentre magnitudes**
  -  <1.5
  -  1.5–3.0
  -  3.0–4.5
  -  No magnitude given
  -  Town
  -  Railway
  -  River

155/A12/20

To accompany record 1974/95

**Figure 33** Geology of the Gunning area with earthquake epicentres from 1958-1970 (ANU data), after Simpson (1974).





**Figure 34** Geology of the Gunning/Dalton area (from Simpson, 1974).

**Table 1** Earthquakes discussed in this paper; magnitudes were derived from the felt area

Date	Time (UTC)	Lat°S	Long°E	Mag	Location
1788 06 22	01:00			-	Sydney
1800 01 17	-			-	Parramatta (?)
1801 02 12	13:00	33.8	150.7	4.0	Penrith
1804 05 07	11:30	33.7	150.9	3.3	Parramatta
1806 09 24	-			-	Richmond (Hill), 12km N Penrith
1826 04 21	10:00	33.9	150.9	3.3	Parramatta
1832 03 15	02:00	33.8	150.7	3.0	Hawkesbury
1837 08 02	12:20	32.7	151.6	5.0	Newcastle
1841 01 27	21:15	32.8	151.6	5.0	Newcastle
1842 03 02	22:45	33.4	149.6	3.8	Bathurst
1842 10 27	19:30	32.6	151.6	5.3	Newcastle
1850 09 23	17:20	34.9	148.8	3.0	Good Hope (near Yass)
1850 11 30	02:30	34.0	149.4	3.0	Abercrombie River (N Crookwell)
1852 03 06	18:45	34.9	149.7	4.5	Collector
1857 12 10	00:00	34.75	149.25	3.0	Gunning
1857 12 10	04:00	34.75	149.25	3.0	Gunning
1858 06 24	09:00	35.9	144.3	4.0	Murray River near Echuca
1859 03 05	00:30	35.53	149.63	3.6	Braidwood
1860 03 04	10:08	34.8	148.9	5.2	Yass
1860 08 16	16:30	35.6	149.8	3.5	Araluen
1862 04 23	17:45	33.0	149.6	4.0	WNW Sofala
1862 12 19	19:00	34.6	148.8	3.3	Yass/Boorawa
1865 02 13	-	34.5	148.8	3.0	Boorawa (evening)
1865 10 09	-	30.5	151.7	3.0	Armidale
1866 11 27	11:45	36.7	149.8	3.0	Bega
1868 06 18	14:00	32.8	151.6	5.3	Maitland/Newcastle
1870 03 26	09:45	29.3	151.0	3.5	Wallangra
1870 04 05	-	30.5	152.9	3.0	Lower Macleay
1870 04 10	11:20	30.5	152.9	3.5	Lower Macleay
1870 04 18	08:00	30.5	152.9	3.5	Lower Macleay, the 3 <sup>rd</sup> and largest, to 22 <sup>nd</sup>
1870 04 21	19:55	30.5	152.9	3.0	Lower Macleay
1870 05 28	12:00	34.5	149.5	3.5	Crookwell
1870 06 18	01:30	30.5	152.9	3.5	Lower Macleay, 1st of many to 23 <sup>rd</sup>
1870 06 18	03:20	30.5	152.9	3.5	Lower MacLeay
1870 06 18	06:00	30.5	152.9	3.0	Lower Macleay
1870 06 23	08:10	30.5	152.9	3.8	Lower Macleay
1870 06 27	15:50	30.5	152.9	3.0	Lower Macleay
1870 07 08	02:00	34.1	149.2	3.0	Markdale
1870 08 03	20:30	30.5	152.9	3.5	Lower Macleay (largest of 3 shocks)
1870 08 06	20:00	36.1	150.0	3.5	Eurobodalla
1870 08 24	16:55	30.5	152.9	4.0	Lower Macleay, largest earthquake of swarm
1870 08 06	20:00	36.1	152.9	3.5	Eurobodalla
1870 08 27	15:50	30.5	152.9	3.5	Lower Macleay
1870 10 ??	-	30.5	152.9	3	Lower Macleay
1871 05 01	20:55	35.3	149.7	3.5	Braidwood
1871 06 08	04:40	35.4	148.1	5.3	Tumut/Adelong
1871 07 13	16:00	35.2	148.0	3.0	Tumut/Adelong
1872 01 03	13:30	35.9	148.5	5.2	Kiandra
1872 10 18	09:50	33.7	150.0	5.3	Jenolan Caves
1872 11 16	18:50	35.35	149.25	3.5	Queanbeyan
1873 05 19	08:20	33.7	150.0	4.5	Near Lithgow/Portland
1873 07 22	06:55	34.7	150.0	3.0	Marulan (Morowollen)
1873 09 23	16:45	34.75	149.7	3.0	Goulburn

1874 01 22	12:00	35.3	148.2	3.0	Tumut
1874 12 14	01:00	34.75	149.7	3.0	Goulburn
1875 01 25	00	36.2	149.1	3.0	Cooma
1875 06 03	10:00	31.7	145.6	5.2	Cobar
1875 07 11	06:00	36.9	149.8	3.8	Bega and Eden
1875 07 16	01:12	36.9	149.8	4.0	Southern Monaro, Bega and Eden
1875 08 05	-	36.0	146.9	3.0	Felt Albury
1875 09 25	12:00	34.4	150.7	4.0	NE Bowral
1876 01 21	04:30	33.2	145.9	3.2	Bathurst/Hillend
1876 02 08	07:15	33.5	150.1	3.0	Lithgow
1876 08 03	01:20	34.8	149.1	3.5	Yass and Gunning
1877 02 27	08:00	33.6	149.1	3.2	Carcoar
1877 11 28	02:30	37.1	148.9	4.0	Bombala
1878 02 03	02:00	36.25	148.75	3.5	Berridale
1880 07 31	07:00	31.0	148.4	5.4	Coonamble region
1880 11 26	03:15	31.0	151.65	3.5	Walcha
1881 05 10	07:00	30.9	153.0	3.0	Macleay District
1881 09 23	00:00	28.9	152.0	3.5	Tenterfield
1881 09 30	11:30	35.3	148.15	3.0	Adelong and Tumut
1883 08 29	14:00	34.5	149.7	5.2	Crookwell
1883 09 20	11:50	35.45	149.45	4.0	Bungendore/Braidwood/Queanbeyan
1885 01 18	01:57	33.89	151.24	2.0	Sydney Eastern Suburbs
1885 01 21	01:00	36.3	149.1	4.7	Berridale
1886 02 08	02:00	31.5	146.0	3.5	Near Cobar
1886 04 14	00:00	33.6	149.1	3.5	Carcoar and district
1886 04 25	21:02	33.34	150.24	5.0	Near Lithgow
1886 08 02	10:50	36.5	149.8	4.0	Bombala
1886 08 29	20:15	34.3	148.3	3.5	Young, goods off shelves
1886 09 06	18:30	32.9	151.7	3.0	Newcastle
1886 09 12	-	36.5	149.8	3.0	Bombala
1886 09 12	09:30	32.7	151.5	3.0	West Maitland
1886 11 29	16:57	34.7	149.1	5.5	Gunning
1887 07 28	07:23	31.4	146.9	4.0	Nyngan
1888 02 06	12:30	34.75	149.7	3.0	Goulburn
1888 07 05	20:10	34.65	149.5	5.3	East of Gurrundah
1888 10 26	13:00	34.7	146.5	3.0	Narrandera
1888 12 27	22:45	35.3	148.0	3.0	Adelong
1889 10 04	03:40	31.0	152.9	3.2	Smithtown, Macleay River
1890 04 25	16:10	34.0	149.3	3.0	Tuena
1891 03 14	15:00	30.9	153.0	3.5	Kempsey Macleay District
1891 06 14	22:40	32.7	151.6	3.0	Morpeth, many small events
1892 08 22	09:30	35.1	148.1	3.0	Gundagai
1892 08 27	20:30	36.25	149.1	3.0	Cooma
1893 07 31	16:00	34.7	149.7	3.0	Goulburn two shocks
1893 09 25	08:45	35.2	148.5	5.0	Tumut
1894 05 27	11:30	36.25	149.1	3.5	Cooma
1896 03 12	12:45	30.8	148.7	3.5	Cowra, double shock like explosion
1896 10 26	02:00	31.25	149.3	3.0	Coonabarabran, quake or thunder?
1897 05 05	18:55	35.35	149.25	3.5	Queanbeyan
1897 06 12	07:50	34.65	150.35	3.0	Moss Vale
1897 08 16	19:30	36.25	149.1	3.5	Cooma
1897 10 20	12:22	34.6	149.7	3.5	Goulburn
1898 02 21	14:40	34.3	148.3	3.0	Young
1898 02 24	11:40	34.3	148.3	3.5	Young
1898 11 13	15:00	35.4	149.3	3.0	Queanbeyan
1898 11 16	-	36.3	149.1	3.0	Series at Cooma

1899 03 15	10:30	34.65	149.65	3.0	Goulburn
1900 07 21	02:00	35.3	149.7	3.5	Braidwood
1900 08 07	23:05	34.0	149.7	4.0	Oberon, Crookwell etc
1900 10 06	05:00	36.25	149.1	3.0	Cooma
1900 10 06	13:30	36.25	149.1	3.0	Cooma
1901 03 07	10:00	36.2	149.1	3.5	Cooma, 5 events
1902 02 27	18:00	32.65	151.4	3.8	Greta
1902 02 28	12:30	34.07	150.65	4.3	Camden minor damage, not felt Observatory
1902 05 27	02:00	33.5	150.1	3.0	Lithgow, people fled houses
1902 07 07	21:00	34.25	148.25	3.0	Young
1902 07 07	22:00	34.35	148.35	3.0	Young
1902 07 08	07:23	34.3	148.3	3.5	Young 3 events, largest at 5:23pm local time
1902 08 13	10:20	34.3	148.3	3.0	Young
1902 08 25	18:10	34.3	148.3	3.0	Young
1902 09 13	18:15	34.3	148.3	3.5	Young, possibly the largest of the swarm
1902 10 15	11:14	36.1	149.0	3.2	Cooma and Adaminaby
1902 10 18	15:10	34.3	148.3	3.2	Young
1902 10 18	20:25	34.3	148.3	3.0	Young
1902 10 25	18:10	34.3	148.3	3.0	Young
1903 02 26	12:30	33.5	150.1	3.0	South Bowenfels, Lithgow
1903 03 26	07:00	29.9	150.6	3.0	Bingara
1903 04 30	08:20	31.75	141.2	4.3	Western NSW near Broken Hill
1903 06 02	12:00	31.8	141.2	3.0	Silverton, Broken Hill
1903 06 11	07:57	32.3	148.9	3.0	Cooma and Berridale
1903 07 16	11:00	31.8	141.2	3.0	Broken Hill
1904 03 06	11:55	34.7	149.55	3.0	Goulburn, start of swarm
1905 10 20	05:00	28.3	153.5	3.5	Tweed River
1906 05 15	17:00	33.0	151.6	–	Newcastle – a damaging ‘creep’*
1906 08 24	02:20	33.65	149.15	3.5	Carcoar
1907 01 30	08:30	33.5	150.1	3.2	Lithgow
1907 02 01	07:55	36.9	149.2	2.5	Bombala
1907 04 05	02:00	32.5	149.5	2.5	Cullenbone
1908 02 15	03:50	35.3	148.0	3.0	Adelong
1909 05 08	15:00	32.7	151.5	3.0	Lochinvar
1909 07 28	11:10	35.0	148.1	3.0	Gundagai
1909 07 28	11:40	35.0	148.1	3.0	Gundagai
1910 01 17	00:45	34.3	148.3	3.0	Young NSW
1910 01 20	13:30	30.0	146.8	3.5	Brewarrina, unusual location
1910 02 25	17:00	30.5	151.7	3.5	Armidale
1910 04 24	-	34.1	150.3	4.0	Burraborang Valley
1910 06 01	01:59	36.0	148.8	4.5	Yaouk
1910 07 02	13:15	30.9	153.0	3.5	Macleay District
1910 08 16	12:35	36	148.8	3	Cooma
1910 10 29	11:20	34.7	149.6	3.0	Goulburn
1912 01 17	20:09	36.5	150.0	4.9	Bega Cooma
1913 02 09	-	32.3	148.9	3.0	Windorah north of Wellington
1913 06 16	20:30	34.7	149.6	3.0	Goulburn
1915 11 08	08:30	31.4	141.6	4.2	Euriowie
1916 06 10	17:51	32.25	152.5	4.6	Seal Rocks
1916 06 11	09:50	34.64	148.0	3.0	Cootamundra
1916 06 13	11:30	34.7	149.55	3.0	Goulburn
1916 09 17	12:30	34.7	149.5	3.0	Goulburn
1916 12 31	15:02	33.8	149.0	4.5	Near Cowra (damage), Carcoar
1917 03 23	21:15	36.25	148.6	3.0	North of Jindabyne
1917 03 23	21.30	36.2	148.55	3.0	Jindabyne
1917 03 23	21:50	36.3	148.7	3.5	Jindabyne

1917 03 23	22:10	36.2	148.65	3.5	Jindabyne
1917 04 02	19:55	35.9	147.2	4.8	Albury - Holbrook
1917 06 09	15:00	35.3	148.2	3.0	Tumut, two earthquakes
1917 06 09	16:00	35.25	148.2	3.0	Tumut
1917 06 11	17:00	35.3	148.15	3.2	Tumut, three distinct shocks
1917 06 11	17:02	35.3	148.25	3.0	Tumut
1917 06 11	17:05	35.35	148.15	3.0	Tumut
1918 07 25	09:25	34.3	148.1	3.0	Tubbul-Young
1919 08 15	10:21:21	33.5	150.7	4.6	Kurrajong
1919 12 18	-	32.1	141.0	3.0	NSW/SA Border
1919 12 26	02:27	33.6	149.0	3.0	Errowanbang near Carcoar
1920 03 23	-	34.7	149.5	3.0	Goulburn night time
1921 05 30	14:51:59	35.3	143.7	5.5	East of Swan Hill
1922 02 28n	15:03:53	35	150	3.5	Nerriga
1923 04 15	23:30	30.7	150.7	3.0	Manilla
1924 11 04	-	33.4	148.8	3.0	Cargo, near Canowindra - morning
1925 01 07	10:23	34.1	150.8	4.3	Appin
1925 01 15	11:30	35.1	148.1	3.5	Gundagai and Cootamundra
1925 03 15	08:00	35.2	149.4	4.3	Bungendore
1925 12 18	10:47:10	33.0	151.6	5.3	Newcastle
1926 06 13	20:00	34.1	148.5	3.5	Cowra
1926 07 05	06:15	34.74	149.72	3.6	Goulburn, broken crockery, cracked wall
1927 12 31	09:22	30.5	151.6	3.9	Armidale
1928 02 03	07:30	32.6	148.9	3.7	Wellington, first ever
1928 02 13	08:45	36.0	149.1	3.0	Bredbo
1928 05 06	12:10	34.6	149.7	3.5	North of Goulburn
1928 08 27	01:55	31.0	143.0	4.5	White Cliffs
1929 02 08	14:08	34.75	148.8	3.8	Bowning
1929 05 26	09:00	34.6	148.6	3.0	Binalong
1929 10 2?	18:00	34.75	149.2	3.0	Gunning
1930 03 19	09:30	32.3	148.4	3.6	Narromine – first event.
1930 05 22	03:10	35.0	150.4	4.8	West of Milton
1930 10 27	02:03:51	34.1	149.0	5.3	Boorowa (Reids Flat)
1931 03 13	21:13:56	35	150	3.5	Neriga
1931 05 12	21:55	36.25	149.1	3.5	Cooma
1932 03 02	09:45	32.3	148.4	2.8	Narromine
1932 05 18	17:00	32.3	148.4	3.2	Narromine
1932 05 19	01:00	32.3	148.4	2.5	Narromine
1932 05 19	17:45	32.3	148.4	3.8	Narromine
1932 05 19	18:00	32.3	148.4	2.5	Narromine
1932 05 22	10:46:28	32.3	148.4	5.0	Damage in Narromine, strong in Dubbo
1932 05 26	18:15	32.3	148.4	3.0	Narromine aftershock
1932 06 04	18:00	32.3	148.4	3.0	Narromine aftershock
1932 06 07n	09:59:36	32.3	148.4	3.5	Narromine aftershock
1932 06 30	21:00	32.3	148.4	3.0	Narromine aftershock
1932 07 24	09:00	32.3	148.4	2.5	Narromine aftershock
1932 07 25	10:40	32.3	148.4	2.5	Narromine aftershock
1932 09 13	-	32.3	148.4	3.5	Narromine aftershock
1933 02 12	20:40	32.3	148.4	3.0	Narromine aftershock
1933 01 11	20:10:51	34.75	149.5	4.8	Gunning, possible start of a 50 year cycle
1933 06 07*	06:00	32.0	141.5	-	South Broken Hill 'bump'
1934 01 30	20:27:54	34.8	149.2	4.3	Gunning earthquake swarm, 50-60 events
1934 07 02	14:30	33.2	149.2	4.0	Orange
1934 08 26	15:00	30.3	152.7	3.5	Dorrigo
1934 11 10f	23:47:40	34.8	149.2	4.8	Gunning, felt Avoca, Goulburn and Marulan
1934 11 11f	00:30	34.8	149.3	3.0	Gunning/Goulburn



1934 11 11f	10:46:32	34.9	150.0	4.7	Gunning
1934 11 18	21:58:41	34.8	149.2	5.6	Gunning - damage to Goulburn water supply
1934 11 19a	06:56:18	34.5	149.5	3.0	Gunning
1934 11 19a	07:10:16	34.8	149.2	4.3	Gunning
1934 11 21a	06:32:07	34.8	149.2	5.2	Gunning
1935 05 02	-	30.3	151.5	4.2	Guyra Armidale Inverell
1935 05 27	21:00	32.2	148.2	3.0	West of Narromine
1935 05 28	21:00	32.2	148.2	3.0	West of Narromine
1935 06 01	21:00	34.6	148.4	3.0	Harden
1935 06 18a	10:20	34.75	149.5	4.3	Gunning aftershock of the 1934 earthquake
1935 07 05	06:00	31.8	147.7	3.0	Nevetire NW Narromine
1935 07 09	14:05	34.75	149.5	4.8	Another aftershock of the 1934 earthquake
1935 12 08n	03:08:07	34.5	150.5	3.0	Gunning
1936 01 08	21:55	32.3	148.4	2.5	Narromine aftershock
1936 03 01	12:00	32.3	148.4	3.0	Narromine aftershock
1936 06 13	03:05	33.3	149.0	3.6	Mount Canobalas
1937 03 28	11:45	32.0	149.0	4.7	Dunedoo
1937 06 17	14:45	32.6	147.5	3.5	Tullamore
1938 03 24	20:03:33	35.3	147.3	5.2	Riverina
1938 05 12	18:00	32.3	148.4	3.5	Narromine
1938 06 04	17:05	35.3	148.2	3.5	Tumut, three small events
1938 06 27	22:55	30.2	151.7	4.3	Guyra
1938 08 07	09:15	31.0	151.6	3.0	Walcha
1938 09 02	21:45	33.9	148.1	3.0	Grenfell
1938 09 23	04:00	33.8	148.7	3.2	Cowra
1939 11 20	05:30	33.0	151.75	3.0	Newcastle, off Redhead
1940 09 21	13:00	35.3	149.0	4.7	Canberra region
1941 04 28	09:35	34.7	149.8	3.5	Goulburn
1941 06 12	16:56	34.75	149.8	3.8	Goulburn, not Gunning, 4 events
1942 11 07	16:00	35.0	149.4	3.0	Gundaroo and Goulburn
1943 02 22	14:45	34.8	149.2	3.5	Gunning
1943 02 22	20:35	34.8	149.2	4.0	Gunning
1944 05 03	21:00	34.7	149.8	3.2	North Goulburn
1944 06 14	09:30	34.75	149.8	3.2	Goulburn
1945 01 15	18:00	36.7	149.9	3.0	Bega and Tathra
1945 01 21	-	34.8	149.2	2.5	Small swarm at Gunning
1945 02 27	05:10	35.4	148.8	3.0	Canberra
1945 10 08	13:00	34.75	149.8	2.5	Goulburn
1945 10 15	-	32.03	148.0	2.5	Trangie small swarm
1946 01 06	03:10	34.1	148.5	2.5	Murringo district
1946 01 10	11:00	34.05	148.45	3.0	Murringo district
1946 01 13	18:10	34.15	148.55	3.2	Murringo district
1946 05 10	16:00	32.0	149.2	3.2	Gunning
1946 08 10	15:45	32.0	149.2	3.4	Gunning
1947 05 05	04:43:48	34.75	149.2	4.5	Gunning, 4 events, worst since 1934
1947 05 05	04:46	34.75	149.2	3.5	Gunning felt Canberra Boorowa on RIV
1947 05 05	04:57	34.75	149.2	3.5	Gunning felt Canberra Boorowa on RIV
1947 09 25	10:56:27	34.0	148.6	4.6	Cowra, also felt Goulburn and Bathurst
1948 02 02	07:26	34.9	151.1	2.5	Sydney inner suburbs
1948 04 08	11:45	31.9	152.0	3.0	Gloucester
1948 08 15	04:00	34.4	148.7	2.5	Boorowa
1948 08 21	14:30	31.5	152.0	4.5	Armidale and Scone
1949 03 10	22:31:36	34.8	149.2	5.5	Gunning damage many aftershocks
1949 03 11a	05:33:54	34.8	149.2	4.8	Gunning
1949 03 16a	15:25:24	34.8	149.2	4.2	Gunning
1949 07 17	14:59	32.4	152.2	3.0	Bulahdelah/Stroud/Coolongolook

1950 04 05	10:50	34.8	149.0	3.0	Yass
1950 05 07	17:30	33.18	148.7	3.5	Manildra
1950 05 23	20:15	30.8	150.7	3.5	Manilla north of Tamworth
1950 08 10	06:00	31.5	150.7	3.0	Quirindi
1951 02 11	07:30	33.7	150.3	2.5	Katoomba
1951 07 09	04:45	32.95	151.65	3.0	Newcastle swarm 1
1951 11 14	05:00	32.95	151.65	3.0	Newcastle swarm 2
1951 12 06	00:00	32.95	151.8	3.5	Newcastle swarm 3
1952 05 19	11:10	32.9	142.6	5.3	Western NSW, felt in 3 states
1952 09 07	05:41:46	34.8	149.2	5.2	Gunning
1952 11 18	18:03:42a	34.8	149.2	4.7	Gunning
1952 11 19	01:59	34.8	149.25	5.0	Gunning, damage in town, recorded RIV
1952 11 22	07:57:56a	34.8	149.2	4.8	Gunning
1953 01 03	14:03	34.8	149.2	4.0	Gunning
1953 01 04	07:00	34.8	149.2	4.0	Gunning
1953 02 11	00:30	29.8	141.9	3.5	Milparinka and Mt Browne
1953 05 20	07:00	34.9	149.4	3.5	Collector
1954 06 09	16:26	34.6	149.7	4.6	Crookwell
1954 09 19	10:30	29.95	146.8	3.5	Brewarrina
1956 08 15	16:47	33.3	149.1	3.5	Orange
1956 08 16	01:00	32.95	151.75	3.0	Newcastle
1956 11 28	00:30	33.85	151.2	2.5	Sydney
1956 11 28	04:55	33.85	151.2	2.0	Sydney

a = aftershock, \* = a mining 'creep' or 'bump' not an earthquake, n = from Burke-Gaffney (1951). Some of the Burke-Gaffney solutions have been changed to fit the felt reports.

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## APPENDIX 1 Special Newspaper Issue Summarising Felt Earthquakes In Australia

*The Sydney Morning Herald* Wednesday 1 December 1886 page 10.

### EXTENSIVE EARTHQUAKES IN NEW SOUTH WALES.

*An interesting record of about 300 distinct colonial (including NZ) earthquake shocks was collated by the late Rev. W. B. Clarke, dating from the year 1839 until the time of his death; but unfortunately the list has not been made public (the list was destroyed in a fire).*

*Mr. Russell, F.R.S., the Government Astronomer informs us that no systematic record of similar disturbances in New South Wales has been kept. During the past few years, however, the vibrations which have been felt in this colony have chiefly been the results of earthquakes in Tasmania. It would appear from the information which has been acquired in connection with these, that the recurrent shocks have been extending northwards throughout New South Wales.*

*The first earthquake recorded in Australia is thus described by Governor Phillip:-"Slight shock of earthquake in the newly formed settlement of Sydney Cove. It did not last more than two or three seconds. It was felt by most people in camp, and by the Governor himself, who heard at the same time a noise to the south, and which he took at first to be the report of guns fired at a distance. The earth teemed with sulphurous odour for some time after."- June 22, 1788 (The last sentence is included in some but not all the quoted historical records).*

*Earthquakes were also felt in Sydney on January 17, 1800; January 17, 1801; February 7, 1801; Parramatta, Prospect, and Hawkesbury, May 7, 1804; strongly at Richmond, September 24, 1806; Launceston (Tasmania), January 28, 1823; Melbourne, August 21, 1841; Windsor, Newcastle, Port Stephens, Macleay River, and Patrick's Plains; October 28, 1842; Wellington (New Zealand), October 16 and 17, 1848; Melbourne, September 17, 1852; Christchurch (New Zealand), January 23, 1855; Melbourne, January 10, 1867; New Zealand, October 19, 1868; Bombala, 1869; Braidwood, January 3, 1871; Goulburn, Yass, Albury, Wagga Wagga, &c., June 8 and 12, 1871; Braidwood (severe), June 2, 1872; Sydney and other parts, October 18, 1872; Queanbeyan, November 18, 1872; Buman (South Australia), January 23, 1873; Maryborough, Avoca, &c. (sharp), 1873; Wellington, March 13, 1875; Bega and Eden, July, 1875; Warurill (Queensland), November 24, 1875; Port Darwin, December 7, 1876; Castlemaine (Victoria) and vicinity, January 21, 1877; and Melbourne, June 23, 1877.*

*Australian Town and Country Journal* Saturday 6 February 1892, page 28  
Seismic Disturbances. A RECORD OF EARTHQUAKES IN AUSTRALIA.

*The shocks of earthquake, which were felt in this colony, Melbourne, and Launceston (Tas.), on the 27th ultimo were reported as sufficiently heavy and lengthy to inspire the greatest alarm. At Launceston the shock was felt at 2.48 a.m., and was the heaviest ever experienced in the colony of Tasmania.*

*These shocks of earthquake revive an interest in the phenomena of underground natural disturbances. The exact and earnest investigation of the phenomena, from a scientific standpoint, was only commenced, strange to say, between 30 and 40 years ago, which must be accounted remarkable when it is remembered that earthquakes, with their terrible consequences, have forced themselves on the peoples of nearly all ages and countries. Since this scientific investigation was first inaugurated, a technical name for the study of natural underground disturbances or upheavals has been given to the world - seismology. Various are the causes given by seismologists in accounting for earthquakes. .... Whatever the cause, however, it is matter for regret that so little should be known as to the origin of earthquakes.*

## **APPENDIX 2 A RECORD OF EARTHQUAKES IN AUSTRALIA.**

from: Australian Town and Country Journal (Sydney), Saturday 6 February 1892, page 28.

The shocks of earthquake, which were felt in this colony, Melbourne, and Launceston (Tas.), on the 27th ultimo were reported as sufficiently heavy and lengthy to inspire the greatest alarm. At Launceston the shock was felt at 2.48 a.m., and was the heaviest ever experienced in the colony of Tasmania. A loud rumbling noise preceded the shock, which lasted fully 1min. Houses were shaken, chimney tops knocked down, and people aroused from their beds in a state of panic. The vibration was from north to south. At Kiama and Gerringong the shocks were equally severe, occurring at 3.8 a.m., and lasting about 20sec. In the Calligull Ranges (Vic), about 14 miles from Taralford, the vibrations were felt for a distance of 35 miles. It shook the houses, awoke the inmates who were in bed, and generally caused alarm. The light tower on Wilson's Promontory vibrated violently, and at Foster the chimney of a hotel was shaken off. The shock lasted from 15sec to 20sec. At Jervis Bay a violent shock was felt at 3.30 a.m.; at Cooma a slight vibration was felt at 3.15 a.m.; two shocks following closely upon one another were felt at Pambula at about 3 a.m., and two severe shocks were experienced at Bega at about the same hour.

These shocks of earthquake revive an interest in the phenomena of underground natural disturbances. The exact and earnest investigation of the phenomena, from a scientific standpoint, was only commenced, strange to say, between 30 and 40 years ago, which must be accounted remarkable when it is remembered that earthquakes, with their terrible consequences, have forced themselves on the peoples of nearly all ages and countries. Since this scientific investigation was first inaugurated, a technical name for the study of natural underground disturbances or upheavals has been given to the world-seismology. Various are the causes given by seismologists in accounting for earthquakes. One of the earliest is that the earth possesses a liquid interior, covered by a comparatively thin crust. Waves are afterward generated in the subterraneous fluid, which on striking the flexible earth-crust produce the shocks. Modern thinkers "believe that an earthquake is a vibratory motion propagated through the solid materials of the earth, much in the same way that sound is propagated by vibrations in the atmosphere." Whatever the cause, however, it is matter for regret that so little should be known as to the origin of earthquakes.

In an interview with Mr. H. C. Russell (Government astronomer), a representative of the TOWN AND COUNTRY JOURNAL gathered the following interesting record of earthquakes in the colony since 1880 :-

- 1880 - In the Coonamble report of July 31 it appears that at 5 p.m. a peculiar noise was heard for 250 miles along the Castlereagh River, and for a range of 50 miles wide. It was like the discharge of rifle and cannon, or as if a large iron tank was bumping on the ground. Mr. Steuglin heard it, and said the blackfellow with him got off his horse and went down on the ground in terror, saying, "Devil devil coming !" and even the horses shook with fear. It was heard by many persons all over the area specified, and seems to have been confined to these limits. A slight shock of earthquake was experienced in Walcha at a few minutes past 1 p.m. on October 26, 1880; there was a slight report as of blasting seemingly proceeding from underneath, accompanied by a distinct vibration lasting from 3sec to 4sec. The rattle of walls and roofs was easily perceptible. It appears to have been much more severe at Europambela, four miles to the east of Walcha.
- 1884 - A distinct shock of earthquake was felt at Eden on July 13, 1884, at 2.10 p.m.; deviation 30sec; motion apparently from south to north. This was also felt at Gabo very severely at 2.20 p.m., lasting 10sec, direction south to north. Bega reported on same day at 1.26 p.m. shock lasting few seconds, travelling west to east. Green Cape reported in September, 1884, several shocks of earthquake - one on September 19, at 8.40 p.m. shook the buildings (telegraph office.) Mr. J. H. Cardew, of Woollahra (Sydney), wrote : On Sunday, January 18, at 12.56 p.m., I felt a distinct shock of earthquake. The wave

appeared to be travelling from north-east to south-west, causing vibration throughout the house. Mr. E. E. Palser, of Darlington-road (Sydney), wrote: I distinctly felt the trembling of the wood in back of the sofa. It was a gentle but decided shaking.

- 1885 - Mr. W. R. Hepburn wrote in January, 1885: A slight shock of earthquake occurred at Coolamatong (near Cooma) at 11.15 a.m., January 21, lasting about 3sec or 4sec; motion from east to west; shaking the house, outbuildings, &c. Bega reported slight shock on same day at 11a.m., direction south-west to north-east. Cooma, at 11 a.m., had a most distinct shock which shook the whole office (telegraph); it seemed to come from north travelling to south, and lasted about ½min. It was also felt at Adaminaby, 30 miles west, and at Kiandra, 52 miles west of Cooma; also at Nimitybelle at 11.5 a.m., travelling in an easterly direction. Green Cape reported a sharp shock at 10.4 p.m. on February 27, 1885, lasting about 50sec, and travelling from south to north. Gabo: A very severe shock of earthquake was felt at Gabo on March 21, 1885, at 9.25 a.m. ; duration, 1 min 13sec ; direction, south to north. Gabo reported on May 13, 1885, at 9.50 a.m., a very severe shock, lasting 1 min, direction south to north. "The most severe shock yet felt." Green Cape reports shock on same day at 9.50 a. m., lasting 2min, direction south to north. And Bega reported, at 9.45 a.m. same day, a severe shock, lasting 1 min, direction west to east. It was also severely felt at Cooma, May 27, 1885, at 7.30 p.m., direction north to south, lasting some seconds.
- 1886 - Mr. Daniel Collins, of Mulgoa, 30 miles east of Sydney, reported a shock on March (Ed - April) 26 7.2 a.m.; it passed under the house from north to south, and lasted 4sec. An alarming shock and earthquake occurred at Young at 5.15 a.m., August 30, 1886; direction west to east; for some seconds after the shock a rumbling noise was audible; the warder on guard at the gaol said that he " distinctly heard the western wall vibrate." A slight shock was felt at Mount Poole and Milparinka at about 10 p.m. 1 September 1886, lasting about 3sec, accompanied by a rumbling noise of about 30sec duration; reported by Mr. C. M.A. King. 1886- On November 30, about 3 a.m., a sharp shock of earthquake was felt over a strip of country, 150 miles east to west, and 240 miles north and south, forming the south-east corner of New South Wales. The reports are as follow: At Adelong, smart shock at 2.55 a.m., lasting about 30sec. At Bathurst, smart shock felt about 3 a.m. Bodalla district, smart shock felt little before 3 a.m. Mr. B. F. Glennie reported two shocks at Bungonia, at about 2.50 a.m. local time; the first lasted about ½min, and after an interval of 10sec was succeeded by another lasting fully 1min ; direction, north to south. At Broughton Creek, Mr. John W. Clinch reported earthquake at 2.59 a.m., lasting 40sec; direction, north to south; the post office, E.S. and A.C. Bank and Commercial Bank were much shaken. A very distinct shock was felt at Cooma at about 3 a.m., lasting some seconds; direction, north to south. Mr. Robert G. Pockley reported that windows of his residence at Gordon were shaken by the earthquake, of November 30. At Gininderra: Sharp earthquake at 3 a.m., heavy rumbling and severe vibration, shaking stone house; direction, north to south; duration about 35sec. At Cape St. George: Severe shock at 3 a.m., lasting few seconds. At Goulburn: Two exceedingly severe shocks were experienced about 3 a.m., lasting 15sec; direction, west to east. The most severe earth tremor experienced in Goulburn. At Grenfell: Smart shock at 3 a.m., followed by a lesser one. At Gundagai : A very severe shock at 3 a.m. lasted 10sec or 12sec ; direction, north-east to south-west. The sound was heard for some seconds before the heavy shock came. At Gundaroo, severe shock at 3 a.m., travelling west to east; houses were shaken. At Gunning, a very severe shock at 3 a.m. ; the sensation was like that of riding in a luggage train; the vibration lasted fully 1min. At Jervis Bay, severe shock at 3.5 a.m., lasting a few seconds. At Junee, a distinct shock at 3 a.m.; direction east to west, accompanied by rumbling noises lasting about 9sec. At Kyamba, Mr. R.J. Barr reported shock of earthquake at a few minutes after 3 a.m.; the furniture in his room vibrating for about a dozen seconds, followed by a noise like a rush of wind. At Marulan, a sharp shock at 3 a.m.; direction east to west. At Moss Vale, slight shock at 3 a.m. At Murrumburrah, severe shock at 3 a.m. At Nowra, strong shock in all parts of district at 3 a.m., lasting 7sec. At



Orange, a sharp shock was felt at 3 a.m. At Penrith, a severe shock at 3 a.m., lasting some seconds. At Picton, a slight shock felt at 2.55 a.m. At Queanbeyan, severe earthquake shock at 3.5 a.m., travelling west to east, lasting 1min. At Tumut, a smart earthquake wave passed under at 3 a.m., accompanied by a long rolling subterranean rumbling; direction, north-east to south-west; brick houses were violently shaken. At Wagga, a severe shock was felt, lasting 9sec. At Wild Meadows, Mr. C. A. Moule reported two earthquake shocks at 3 a.m., accompanied with rumbling noise. At Yass, two distinct shocks at about 2.54 a.m.; direction west to east, duration 12sec. Houses were violently shaken, the walls being cracked and ceilings shaken down in several; the vibration lasted over 2min.

1887 - Smart earthquake shock occurred at Wilgar Downs about 5 p.m. on July 28. Heavy rumbling noise toward the south-east, lasting nearly a minute, and appeared to travel toward the west; another slight shock was felt on 29th. The shock of the 28th was severely felt at Booroomugga. At Girilambone the station-master rushed out of his room, thinking the floor was rising. At Nyngan houses were shaken. It was sharply felt at Cannonbar, and caused the waters of Duck Creek to rise over the knees of a man fishing on the bank and threw fish out of the water.

1888 - On July 6 a shock of earthquake was felt at Sydney and at various places to 60 miles south and 50 miles south-west. Reports as follow:- Baw Baw, Mr. Murray L. Allen reported : I was aroused by a low rumbling sound which drew nearer and increased in loudness. This was succeeded by a great rumbling of the ground at precisely 6.15 a.m., and lasted from 3sec to 5sec It caused my watch, which was hanging on the looking glass (facing north and south), not only to oscillate, but to tap against the frame several times. When this shock had subsided there was a slighter tremulous motion perfectly distinct from the first. At 6.35 a.m. I observed another slight tremulous motion accompanied by a noise resembling distant thunder. The direction of the waves seemed to be from north-west to south-east. Many neighbors felt it at the same time, and towards Mummel, four miles north-west of Baw Baw, it was still more severely felt. At Berrima a sharp shock of earthquake was felt at 6.10 a.m. July 6, preceded and followed at intervals of about 20min by much lighter shocks. Broughton Creek reported shock as having occurred at 6.30 a.m., lasting 5sec. At Collector, Lake George, Mr. A. Ranger reported severe shock of earthquake at 6.20 a.m., travelling direct south. At Double Bay, Sydney, Mr. E. E. Boissier reported that distant shock of earthquake occurred at 6.15 a.m., duration 15sec. At Darlinghurst, Sydney, a shock was reported at 6.10 a.m., lasting 10sec or 12sec. Goulburn reported shock at 6.10 a.m. ; Moss Vale reported shock at 6.15 a.m. At Mount Costigan an earthquake occurred about 6.30 a.m. on July 6. The shock was preceded for a few seconds by a low rumbling noise, apparently from E.N.E. to W.S.W.; then followed shock, causing timbers of houses to creak. Mr. C. L. Lorden, of Orange, writing in August of same year (1888), says that he felt the shock at Orange on July 6, but gives no details. Picton reported slight shock, lasting few seconds, about 6 a.m., July 6. At Randwick the Rev. J. Woodhouse reported a shock on morning of July 6; no details. An earthquake at Wollongong on morning of July 6, about 6.15; direction, north to south. Also felt at Dapto, 10 miles distant, travelling in same direction. 1888-At Orange, Mr. C. L. Lorden reported shock of earthquake at 2.32 a.m. on August 13, 1888, causing windows to rattle. The sensation was as if a large door was suddenly slammed.

1889-At Arakoon, a sharp shock experienced at 1.30 p.m., October 4, 1889, travelling south-west to north-east. 1890-At Orange, Mr. C. L. Lorden reported two slight shocks of earthquake at 3.16 a.m. on March 27, 1890 (within 10sec), causing furniture to rattle in his house. At Double Bay, Sydney, Mr. J. C. Ellis reported slight earthquake towards morning of June 4, 1890, rattling the bedsteads, and lasted several seconds. Another shock was experienced shortly after.

1890- At Werrina a severe earthquake shock was felt at 1 a.m. on August 22, 1890, reported by Mr. J. F. Clode. This shock was also felt at Mr. Scott's station, on opposite side of the Macintyre; also at Mungindi, 35 miles below on same river.

1891- At Morpeth, on June 15, 1891, a slight earthquake was felt. Mr. C. F. Wakely reported that from 8.40 a.m. to 9.32 a.m. there were slight vibrations, shaking windows and doors, and that the same phenomena were repeated from 5.31 p.m. to 6.27 p.m. A 12in glass globe was placed on a cement verandah with water in it, and the vibrations made a surface ripple similar to that produced by blowing gently on it.

### **Appendix 3 PAST EARTH TREMORS**

Evening News Thursday 31 January 1907, Page 5.

Mr. A. Noble, the Acting-Government Meteorologist. "there have been shocks practically all over this State at various times, and the records have all been plotted upon charts." A glance at a chart shown by Mr. Noble revealed the fact that there had been tremors as far north and north-west at Tibooburra and Milparinka. At the former place, there were disturbances in September and November, 1899, and at the latter a shock was felt on September 6, 1886. "There was a tremor at Broken Hill in April, 1903," said Mr. Noble. "Do you refer to all these past shocks merely as tremors?" asked the reporter. "Yes, the shocks that have been experienced in this State up to the present time have been tremors, but earthquake is the term generally used."

He continued to refer only to earthquakes. Getting away from the Western area, it was shown that in the coastal districts shocks had been recorded as far North as Bellingen and Nambucca River. In the north-western country it is interesting to note that shocks have been recorded as far north as Bingara, where there was a tremor on March 26, 1903. Mr. Noble thought this morning that the shock at Lithgow may have been due to an explosion at one of the mines, in connection with blasting operations, but the information that came from Wallerawang helped to confirm the news from the former station. Looking over a chart supplied from the Meteorological Department, it may be noted that the country in which the majority of earthquakes which occurred in this State is on, and in the vicinity of the southern tableland. It is in this part of the State that Dalgety, the site chosen by the Federal Parliament, for the capital, and other suggested sites, are located, a fact that has apparently escaped public attention.

WHERE SHOCKS HAVE OCCURRED. Following is a complete list of earthquakes recorded at the Sydney Observatory since 1800:—

1800— June 17: Shock of earthquake (probably at Sydney). 1806— September 24: A shock of earthquake was felt at Richmond Hill. 1837— August 2: Shock of earthquake perceptibly felt in various parts of Sydney between 10 and 11 p.m. 1841 — January 28: Shock of earthquake on Paterson River, at 8 a.m. 1868— June 19: Shock at Lochinvar, at 2 a.m. 1871 — June 8: At Cooma, at 2.30 p.m.; Queanbeyan, 2.37 p.m.; and at Kiandra, 2.40 p.m. 1872— January 3: Bombala, 11.30 a.m.; also heard at Kiandra, Cooma, and Beechworth (Vic), lasting about 30sec. October 18: Smart shock, generally in coast and mountain districts between parallels 32deg and 35deg south latitude. 1873—May 19: Shock at Mudgee, also at Mount Victoria, at 6.24 p.m., and Woodford, 5.30 p.m. The lighthouse-keeper, Sydney Harbor, felt three distinct shocks at 6.19 p.m., each lasting 30sec. September 24: Shock (3sec), at Goulburn. 1874 — December 14: At Goulburn, at 6 a.m., apparently from north-east to south-west. 1875 — July 11 and 16: Shock at Eden, from north-east to south-west; first one at 3.30 p.m., second 11.30 a.m. 1876— May 28: At Orange, at 9.44 a.m., apparently from south-east. August 3: Slight shock at Queanbeyan, at 11.30 a.m. 1880 — November 26: Shock at Walcha. 1882— March 19: Shock at Buddigower, from east to west. 1883 — January 22: Slight shock at Jindabyne, at 8.30 p.m. February 19; Slight shock at Jindabyne, from south to north. February 12: At Raymond Terrace, from east to west. August 8: At Jindabyne, two distinct shocks, about 7.45 a.m. August 29: About 11.45 p.m., shocks heard at Moss Vale, Goulburn, Queanbeyan, and Braidwood. 1884 — February 28: At Queanbeyan, at 9.33 p.m. July 13: At Bega, at 2.26 p.m. September 26; At Eden and Bukalong, at 8.45 p.m. 1885— January

23: At Bega. 1886— April 26: At about 1 a.m., at Lue, Morpeth, Mulgoa, Muswellbrook, and Singleton. June 10: Shock at Nowra. August 2: Shock at Bega. August 23: Shock at Moss Vale, at 4.55 p. m. August 22: Slight shock at Nowra, at 10.15 p.m. August 30: Young, at 5.15 p.m. September 6: At Milparinka, at 10 p.m. September 24: At Mittagong, at 6.30 p.m. November 30: Generally in southern half of colony, at 3 a.m. December 1: At Yass, at 4.15 p.m. 1887— July 28: Shock at Girilambone, Wilgar Downs, Booroomugga, Nyngan, and Cannonbar, about 5.20 p.m. September 2: At Dungog, at 1 p.m. 1888— July 5: At Sydney and Lake George. 1888— July 6: An earthquake from Sydney to Yass. December 29: An earthquake felt at Adelong. 1889— July 30: Sharp shock at Gabo Island, from north to south, at 6.20 p.m. October 30: Slight shock at Nambucca. 1891— March 16: Slight shock at Bellbrook. 1892—January 25: At Bega, from south-east to south. January 27: At Delegate and Nungaita, at 3 a.m. 1893 — August 13: Earth tremor, at 2 a.m. September 25: Shocks at Collector, Sutton, Rosemount, Dubbo Creek, Gobarralong, and Lake George, about 6.50 p.m., 15 seconds, east to west. 1894 — May 2: Collector, at 6.50 p.m., south-east to north-west. May 9: Bedooba, earth tremor, about 4 pm., lasting half-a-minute May 9: Brotherong, earthquake, south to north, at 3.45 pm May 9: Eremeran, earthquake, at 4 pm. May 9. Dine Dine, earthquake, at 3.10 p.m. May 9: Hillston, earthquake, at 4 p.m., south-west to north-east. May 9: Hillston, earthquake, 4 p.m, south-west to north-east. May 9. Mount Hope Tank, earthquake, 3.45 p.m. May 27: At Boloco and Jindabyne, at 9.45 p.m. July 27: At Jindabyne. at 7.30 p.m., east to west. November 3: At Cavan, 3 seconds, east to west. November 3: At Douglas, 8.24 p.m., and at Queanbeyan, 8.40 p.m. 1895— February 24: Samares, at 9.30 a.m., south and north. July 21: Bega, at 10.30 p.m., east to west. July 21: Bodalla, 11.45 p.m., south to north. July 21: Cobargo, violent shock, south-east to south-west. July 21: Collector, slight shock at 11.20 a.m., 6sec, south-east to north-west. July 21: Maxton. July 21: Moruya Heads, severest shock ever felt. July 27: Collector at 5 a.m., from south-east, 10 to 12 seconds. 1896—March 11: Cowra, slight shock at 10.45 p.m., rattled windows etc; and at Mudgee, 10 p.m. September 25: Jimenbuen, slight shock, at 9.30p.m. 1897—February 25: At Bobundara, Bolero, Boloco, Bombala, Delegate, Green Hills, Thornleigh, Kiandra (north-west to south-east), and Lake Wambrook, reported at various stations between 11.45 p.m. and midnight. 1898— November 14: Distinct shock at Gobarralong, 8.35 a.m., south-west to north-east. 1899—January 27: At Homeleigh, at 1.30 a.m. September 5: At Tibooburra, at 10.10 a.m., north west to south-east. November 30: At Tibooburra, 10.30 p.m.; south-west to north-east; also at Moolpa, 10.30 p.m. 1900—January 19: Dubbo Creek, at 8 a.m., Gobarralong 8.35 a.m., south-west to north-east. July 8: Cowra, at 6.20 p.m. August 8: At Rockley, Oberon, Burruga, Jenolan, Crookwell, Forest Creek, Kippilaw, Maxton, Samares, Taralga; reported variously between 8.35 and 9.8 a.m. September 24: Kippilaw, shock at 5.10 a.m. 1901— March 27: Bobundara, two shocks, 7.58 p.m. and 8.40 p.m. April 22: Bobundara, shock at 1.50 p.m. July 27: Green Hills, severe shock at 4.45 a.m. 1902—February 28: At Albion Park, 10.30 p.m., accompanied by a rumbling noise; at Picton, east to west; about 10.15. May 27: Jenolan Caves 10.40 a.m. Oberon 11.45 a.m., travelling north-east, 5sec. September 19: Severe shock at Tareena, at 8.40 p.m. 1903—March 26: Slight shock at Bingara, 5 p.m., east to west, succeeded by a rumbling noise. April 30: Severe tremor at Broken Hill (south to north, lasting 15 seconds), and Silverton, at 6.20 p.m., and at Ascot Vale at 6.25 p.m. July 7: Earthquake at Umaralla. 1904— March 6: Cavan, at 3 a.m., south to north. March 6: Goulburn and Gunning, slight shock, at 10 p.m. March 7: Goulburn and Gunning, two sharp shocks, at 3.20 a.m. April 25: Shock at 4.30, at Bodalla (east to west, lasting 5 or 6 seconds), and at Norrimundah (accompanied by a rumbling noise, which lasted about 30 seconds). 1905— June 16: At Cooma, 7.20 p.m., east to west, lasting 1½ minute. August 28: At Tumut, at 6 p.m., lasting several seconds. August 29: At Adelong, and Grahamstown, in afternoon.