

Clustered seismicity at Narromine NSW

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Abstract

A tabulation of 17 earthquakes at Narromine during the decade of the 1930s has been compiled from valuable contemporary newspaper reports. This seismic sequence appears to be a standard foreshock-mainshock-aftershocks type. An isoseismal map for the mainshock is presented, from which a location just southwest of Narromine and a magnitude of 5.0 have been determined. These parameters are almost identical to the single-station location and magnitude determined by Riverview Observatory seismologists for the mainshock and one aftershock that are the only events that appear in modern earthquake catalogues.

Such episodic activity appears to be typical of the southeast of Australia, moderate earthquakes migrate from place to place over decades but the pattern of their occurrence is not always, like this one, a typical foreshock-mainshock-aftershock pattern.

Keywords: seismicity, cluster, aftershock, Narromine

1 INTRODUCTION

There are several earthquake 'hotspots' in NSW, places where clusters of earthquake are known to have occurred on and off over the last 200 years of written history. Newcastle is one such place, Dalton/Gunning another.

Hardly in the news for its earthquakes over the last 50 years, Narromine, a town in central western NSW about 330 km northwest of Sydney (Figure 1) was, in the 1930s, squarely on the earthquake map.

2 THE EARTHQUAKE SEQUENCE

The first documented tremor near the town was on Wednesday 19th March 1930, between 7 and 8 pm local time. Not everyone in town felt or heard the short-lived rumble including the skeptical editor of the *Narromine News and Trangie Advocate* but he was won over by the weight of prominent towns people who contacted him about it. The local doctor reportedly evacuated his surgery; such was his concern at the tremor though it was all over 'in an instant.'

A tornado hit the town on 1st February 1932 and then a month later about 7:45 pm on Wednesday 2nd March 1932 the town was shaken by another, stronger earthquake, this one more widely felt although only within a small radius of the town, crockery rattled and houses shook. The editor of the *Narromine News and Trangie Advocate* of Friday 4th March 1932 writing about the earthquake would soon learn to regret his final politically-motivated words: "to many harrassed business people a good earthquake would be welcome."

Twelve weeks later on Friday 20th May 1932 the newspaper ran the headline "Local people scared" after early-morning earthquakes woke people on Thursday and Friday 19th and 20th May. The Friday morning earthquake was the stronger of the two, the shake and noise like thunder woke many people in town. On this occasion the editor was rather prophetic stating: "perhaps the worst have not yet been experienced."

The mainshock struck at 8:45pm on Sunday night scaring people into evacuating their homes and again lasted only a few seconds. On inspection, considerable damage was done in Narromine; cracks in brick walls and a brick chimney, and collapse of plaster walls and ceilings. The headline in the newspaper called it 'Narromine's night of Horror'. Few residents slept that night for fear of further shocks. When classes resumed at the Narromine School after the holidays, a large crack in a brick wall was found, extending from ceiling to floor, and this was attributed to the earthquake.

The Catholic Press Thursday 2 June 1931 page 13 ran an appeal for funds to repair the damage from the tornado and subsequent earthquake, a selection from the appeal reads:

As a result of the tornado Narromine Catholics lost a very fine brick church, and of the inside fittings and furniture nothing was saved. As well, the convent and presbytery, two very fine buildings were seriously damaged.

In their present condition the convent and presbytery are in a grave danger, as a result of the severe earth tremors that have been prevalent in Narromine recently, In the 'quake of last Sunday night plaster was dislodged from the already damaged walls of the presbytery, and the Sisters of Mercy were greatly frightened when the damaged walls of the convent were moved considerably as a result of the tremor.

On this occasion the earthquake was felt in neighbouring towns Dubbo, Trangie, and Peak Hill and even as far southeast as Orange and Bathurst. At Dubbo, plaster was reported to have fallen

in one house. The earthquake was recorded at Riverview Observatory (RIV), the only sensitive seismograph in NSW, and this event was the only earthquake of the sequence mentioned in RIV Bulletins. With only a single station, the seismologist, quite reasonably, assigned the location to near Narromine where the earthquake effects were strongest.

The earthquake was not tabulated by Doyle and others (1968). Drake (1974), then Director of the Riverview Observatory, re-analysed the seismogram to ascertain its magnitude. He applied several corrections to the standard procedure to account for the different attenuation in NSW and California, and also to allow for the incorrect magnification of the Wood-Anderson seismometer. Drake arrived at a magnitude of 4.5.

Several aftershocks were reported and are listed in Table 1. **Only two of the events in Table 1 are found in the GA catalogue.** The local newspaper reported on 10 June that: *Narromine is still experiencing earth tremors, and although we have not had one nearly so bad as the shock that disturbed and frightened people on Sunday night, May 22, nevertheless they are quite severe enough. In addition to a lot of small tremors, very distinct quakes occurred about 4 o'clock last Sunday morning and again at 8 o'clock on Tuesday night.*

Table 1 Notable earthquakes in the Narromine sequence (local time used = UTC +10h)

Date	Local time	~Mag	Imax	Comment
1930 March 19	7:30 pm	3.6	4	Probably the first earthquake of the sequence, recorded RIV
1931	?	2	3	Several shocks?
1932 March 2	7.45 pm	2.8	3+	Felt only in Narromine and by only half the population.
1932 May 19	Early am	3	4	Felt by many but not all awoken.
1932 May 20	3.50am	3.5	5	Whole town trembled, sound like burst of thunder, most awakened. Locals scared.
1932 May 22	8.45pm	5.0	6	A loud rumbling was followed by a violent trembling. Residents were terrified and vacated their homes. Some brick walls and a chimney were damaged and plaster fell. Lasted only seconds. Recorded RIV. Felt in surrounding towns such as Trangie (MM3) and Dubbo (MM5).
1932 May 27	4.15am	3	4	Woke many people
1932 June 05	4 am	3	4	Distinct
1932 June 07	8pm	3	4	Distinct
1932 July 01	7am	3	4	Pronounced
1932 July 24	7pm	2.5	3+	Felt
1932 July 25	8.40pm	2.5	3+	Felt
1932 Sep 14	Early morning	3.5	5	Two shocks, many awakened by violent shaking
1933 Feb 13	6:40am	3	4	Distinct but not severe, people aroused and felt that nasty trembling.
1936 Jan 09	7.55am	2.5	3	Slight
1936 Mar 01	10pm	3	4	Rather severe
1938 May 13	4am	3	4	Many awakened

* The mainshock location 32.3°S, 148.4°E is assigned to all the events.

Both O'Leary, the then Director of Riverview, and eminent geologist Edgeworth David were asked to write about the earthquake in the next week's edition of the local newspaper (a weekly paper). Both experts played down the earthquake and the risk of a larger one, David began his letter: *With a view to allaying possible fears for the stability of the earth's crust under Narromine* and finished: *It may be mentioned that the whole of our mountain ranges south of the Western railway line are subject, from time to time, to more or less strong earth tremors, or even mild earthquake shocks. These mean that the main Dividing Range of the Bathurst-Monaro region, and beyond, has still some vitality in it. These mountains are growing. Earth tremors are the 'growing pains' of mountains, a little disquieting, but not harmful to health. In my opinion there is no cause for alarm in these Narromine earth tremors. The earth's crust there should be reasonably stable for many generations to come.*

Father O'Leary said: *I can easily understand the anxiety that they have caused, but I think I can very safely say that there is not the least cause for alarm. Unlike most parts of the world Australia is very nearly dead in the matter of earth adjustment."* He mentioned that the amplitude of the signal was less than $1/8^{\text{th}}$ of an inch and the coda lasted a minute. He further went on to say: *"You need have no fear. The big movements in Australia happened something like a million years ago. These are only the twitches that come to tell us, that Australia has had its history of crustal movement, just like any other part of the world. But we are not going to have anything spectacular, nothing that would be worth recording. I rather feel that I should like to live in Narromine to have your interesting experience.*

3 THE ISOSEISMAL MAP

An isoseismal map was compiled using information extracted from the scattered Narromine newspaper reports, all of the observations but Trangie and Willydah are from the southeast quadrant as shown in Figure 1. Despite a serious search, no report could be found that the earthquake was felt at Nyngan 125 km to the northwest, nor was there mention it was felt at Parkes, 110km south though Orange and Bathurst, further away, did report it felt. A magnitude of 5.0 was computed from the felt area though there is quite large uncertainty with such a wide azimuthal gap in the observations. It was felt (MM2 assigned) at Bathurst ~170km away which gives some indication of its size.

The Sydney Morning Herald Tuesday 24 May 1932, page 9 reports:

EARTH TREMORS In Western Districts.

HOUSES SHAKEN AT NARROMINE.

Earth tremors continue to scare residents of Narromine. During the week-end four additional shocks were felt. The heaviest yet felt occurred at 8.50 o'clock last night. The rumbling continued for a considerable time and was felt over a much wider area than before. People rushed out in the streets and stood about in groups for an hour or so before going into their homes again.

Buildings shook, crockery rattled, pictures swung out from the walls, and in the case of a number of brick houses certain damage was done. Plaster fell from the walls, chimneys crashed, and in one case the bricks were split in the walls.

WELLINGTON, Monday.

Earth tremors were felt here between 8 and 9 o'clock last night. Tremors were also felt in various parts of the district. Several years ago severe tremors occurred

PREVIOUS RECORDS.

Earth tremors were also reported from Narromine on March 2 and May 20 last.....

Authorities are agreed that there is little cause for alarm in Australia, although tremors have occurred rather frequently in recent years, along lines of weakness which are now fairly well defined.

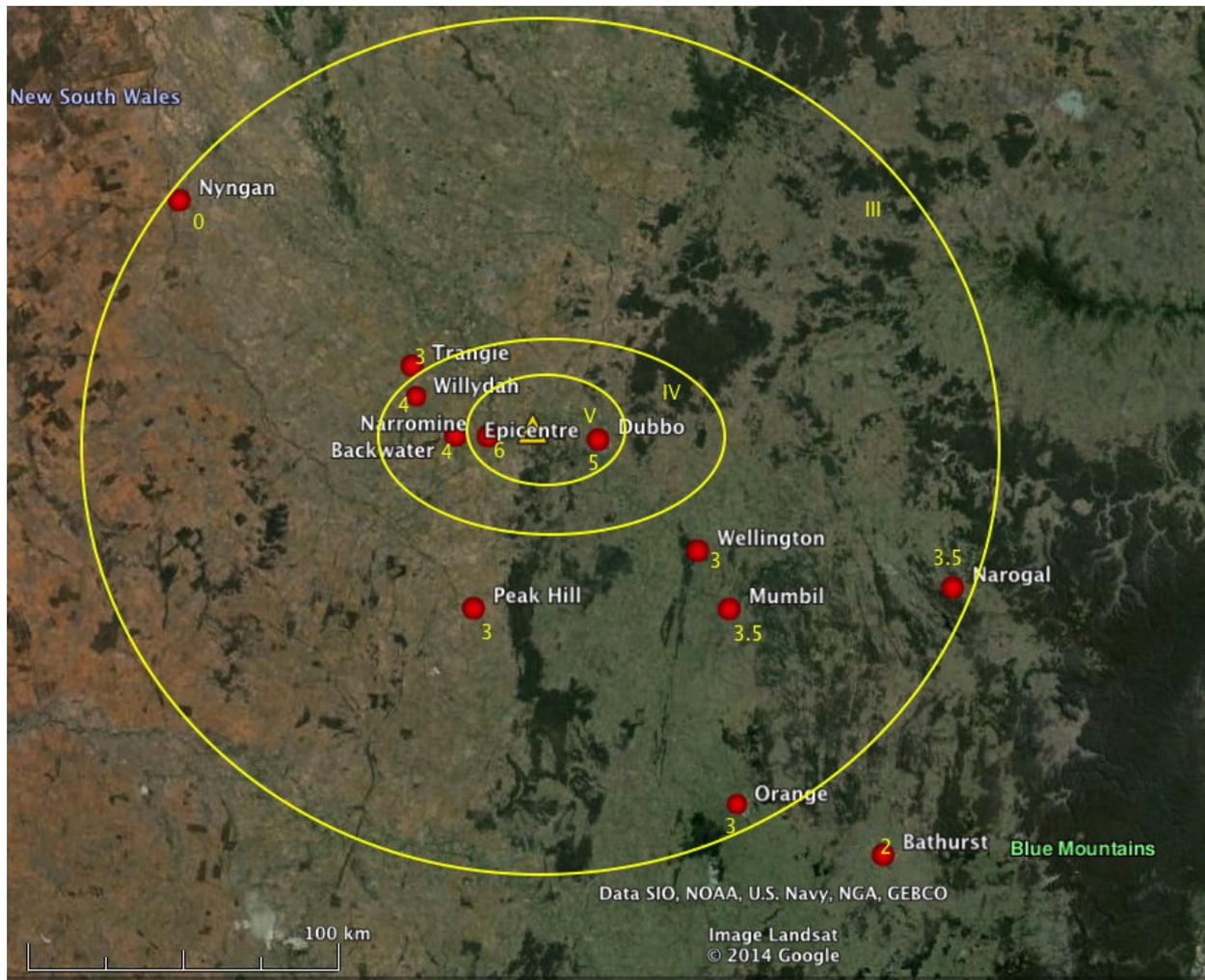


Figure 1 Isoseismal Map of the 22 May 1932 Narrromine mainshock. The red dots indicate where the earthquake was reported felt, with the rated intensity in yellow.

In Dubbo people thought that something heavy had hit the house, pictures and walls rattled and crockery shook on the shelves.

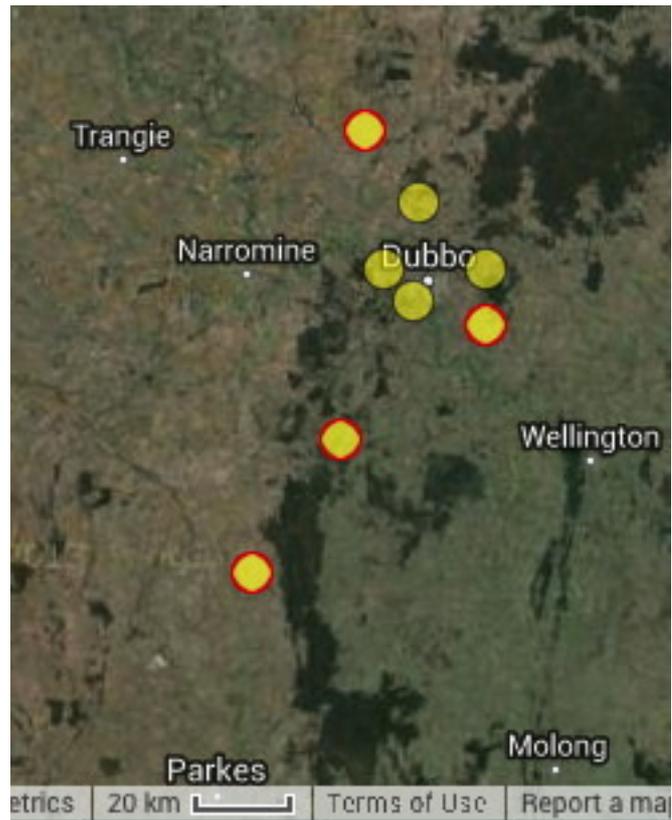
4 EVENT MAGNITUDES

The nearest towns, Trangie and Dubbo, are almost equidistant from Narrromine, 33 and 35 km away. The magnitude corresponding to an earthquake just felt at this distance is about 3.5. The smallest magnitude that would be reported felt is about magnitude 2 if it occurred right under the town. Allowing for the fact that people who are asleep won't feel anything below intensity MM4 and likewise in the daytime unless they are resting. I have assigned approximate magnitudes to as many of the earthquakes in the sequence as possible, assuming they all occurred a few kilometres southeast of the Narrromine town centre towards Dubbo, but further from Trangie. This location is virtually identical to the epicentre reported by Burke-Gaffney (1952) from the distance from RIV and the felt reports though he did not compile a map.

5 THE POST-1940 SEISMICITY

The GA earthquake database lists 10 earthquakes above magnitude 2.9 near Narromine, the closest 25 km to the east near Dubbo, the largest magnitude ML 3.9 in 1974, all of them post-1969. These are plotted here and listed below. The two earthquakes of 1932 are in both tables, the aftershock on 7 June was presumably the 2nd largest recorded at Riverview, its magnitude larger than the assigned magnitude based on the felt reports.

Figure 1 Post-1940 earthquakes within 50km of the 22 May 1932 earthquake epicentre.



The pattern is interesting, could it be fault controlled? One branch of epicentres is oriented NW/SE parallel to the drainage (seen on Figure 1), the other branch oriented NE/SW is approximately at right angles to the drainage. There are too few earthquakes and their location not so accurate to warrant such a proposition but superficially the proposition is attractive.

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Table 2 All earthquakes in the GA database within 50km of the 22 May 1932 epicentre.

UTC Date	UTC Time	Latitude	Longitude	Magnitude
22/05/1932	10:46:28	-32.3	148.3	4.5
7/06/1932	9:59:00	-32.3	148.3	3.5
4/01/1969	6:23:39	-32.75	148.25	3.5
2/06/1972	7:37:46	-32.22	148.73	3.1
7/01/1973	23:29:42	-32.28	148.58	3.4
14/02/1973	7:36:20	-32.22	148.52	3.4
9/03/1973	0:47:01	-32.32	148.73	3.5
21/09/1974	6:16:15	-31.98	148.48	3.9
1/03/1996	1:00:03	-32.11	148.59	3.0
18/03/2008	1:02:32	-32.52	148.43	3.7

6 DISCUSSION

Drake (1974) determined the mainshock magnitude from the RIV record. From the isoseismal

map presented here, the magnitude corresponding to the radius of perceptibility is slightly larger at 5.0 but felt reports are limited. The RIV amplitude according to O'Leary was about 3/8th inch or ~9mm (1932 newspaper report). The resolution on the seismogram is probably about 1mm corresponding to a smallest magnitude of about 3.5 at this distance. The magnitudes of foreshock and aftershocks, most of them too small to be recorded at RIV, ie less than 3.5, have been assessed intuitively from their felt effects assuming a common location with the mainshock, a very subjective assessment but probably reasonable as a way of getting the events into modern catalogues.

Narromine on the Macquarie River was founded about 1882 soon after the railway was extended there and the Newspaper presses began rolling in 1896. There are no reports of earthquakes until the town was subject to a remarkable attack by a long sequence of earthquakes from 1930 to 1938, then reverting seemingly to their pre-1930 aseismic behaviour. The Dalton-Gunning sequence fired up again in October 1930 (McCue and others, 1989), the shaking not felt in Narromine according to the local newspaper, after a quiescent period of about 3 decades, the sequence there continuing until about 1985. Since then the seismicity has been widely distributed in NSW rather than focused in a single region.

Other hotspots are known; the Snowy Mountains (Bock and others, 1983), the Echuca region on the NSW and Victoria border (Bowler, 1966; Clark, 2012), perhaps West Wyalong (Denham and others, 1982) and Eugowra (Gibson and others, 1994). Why they turn on and off again is not known. The stress drop is a small fraction of the in-situ stress and very localized, so these small earthquakes do not reduce the stress much, even near the source and do not influence the location of future earthquakes in the region.

7 ACKNOWLEDGMENT

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9 APPENDIX Newspaper extracts

EVENT 1

Narromine News and Trangie Advocate Friday 28 March 1930 page 3.

On Wednesday night, March 19, between 7 and 8 o'clock, a number of Narromine people experienced an earth tremor which was preceded by a loud rumbling noise. In last issue the 'News' reported the occurrence, but did not attach much importance to the happening. However, a number of prominent people spoken to during the week are all emphatic that the occurrence was serious and quite a large number of residents received a severe shock. At Dr. Sutherland's residence the tremor was very pronounced and scared the doctor from his surgery. Mr. G. H. R. Barlow, Mr. Hennessy, Mr. McWilliam, Mr. Stockham, Mr. Armstrong, Mr. Louche, Mr. J. Tancred, Mr. J. Klintworth, Mrs Pullen and numerous other residents also felt the shock and heard the rumbling noise. In many instances homes trembled and an uncanny feeling was experienced, but it was all over in an instant. As the late Father Piggott's seismograph at Riverview, recorded an earthquake on the night the shock was felt in Narromine, it is evident the local sensation was not imagination. The 'News' scribe did not experience the tremor, but in these times of drought, desolation, ruination, starvation, privation, expectation, very little consolation, and long-winded subscribers, the delicate skin of any newspaper proprietor is likely to become hardened to earthquakes, earth tremors, or any old kind of shock.

EVENT 2

Narromine News and Trangie Advocate Friday 4 March 1932 page 5

On February 1st, Narromine was devastated by a raging tornado, and on March 2, more than half of our population were startled by a distinct earth tremor. The shock was plainly felt in town and at several adjacent country homes, and in some places crockery rattled, houses shook and caused an unpleasant and uncanny feeling for residents. The vibration hit Narromine about a quarter to eight on Wednesday night, and appeared to travel in a north-easterly direction. This tremor, following on the several similar shocks experienced in Narromine last year, has some of the people thinking, but why worry? If an earthquake did swallow the lot of us at the present time, we would be no worse off, and it would be one sure way of escaping Jack Lang and his ruinous and unfair taxation. In fact to many harrassed business people a good earthquake would be welcome.

Narromine News and Trangie Advocate Friday 20 May 1932 page 4

NARROMINE AGAIN FEELS SHOCKS. Local People Scared.

Earth tremors have again been felt at Narromine, and on Wednesday and Thursday nights many people in the town were aroused from slumber and greatly scared. On several occasions within the last couple of years earth tremors have been felt in Narromine, and within a small radius of the town, but never before has the noise and involuntary trembling been so severe as on the two nights mentioned of this week. The vibratory motions and noise occurred in the early hours of Thursday morning and although the uncanny feeling was felt by many residents, it did not arouse people from their sleep like the tremor that occurred on Friday morning. At exactly 10 minutes to four o'clock this morning (Friday) the whole town trembled, and the noise, in some ways resembled a loud burst of thunder. The night, however, was perfectly calm and many people disturbed from their beds can testify that there was no indication whatever of an approaching storm. Although the 'News' proprietor was one of the many to be aroused from peaceful slumber by the tremor it is impossible to describe the uncanny feeling. But perfectly true it is to say that houses shook, crockery rattled, and an indescribable quivering passed

through the homes, that, in many cases greatly startled the inmates, especially the womenfolk and children. Just what causes these tremors it is impossible to say, and some time ago when the 'News' forwarded details to the seismologist at Riverview, little importance was attached to the shocks, and the information given that there was nothing to be alarmed about. This opinion might be alright, but it does not quite satisfy the curiosity of local residents, who are anxious to find out why Narromine, and apparently no other town, receives the tremors. The shocks this week, like all the previous tremors, were felt by country residents within a small radius of the town, and at 'Highland View,' a 'phone message from Mr. Robertson stated the main shock on Thursday morning to be most severe. Narromine residents, as a whole, are not greatly alarmed, but the fact that this week's 'quakes were the worst so far experienced, proves that the tremors are increasing in velocity, and perhaps, the worst have not yet been experienced. Narromine is already famous for wheat, wool, fat stock, dairy cattle, fat lambs, stud sheep farms and citrus fruit growing, but residents are not eager to have the town famous for earthquake shocks.

MAIN SHOCK

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.

WHAT A NEW ZEALANDER THINKS.

At present residing in Narromine is a New Zealand gentleman, who has experienced numerous earthquakes, and at the request of the "News," he penned the following information:— The people of Narromine on Saturday last were somewhat alarmed at the earthquake, but if they lived in New Zealand they would not take the slightest notice of such a mild shake. It will be time enough for them to be afraid when they see the chimneys tumble over, and hear the kitchen delph crash. I suppose you have often heard the town sage say, 'We will have rain; my corns are pretty bad.' Well, in New Zealand, you hear the same gentleman say, 'I think we will soon have an earthquake; I feel very heady and drowsy.' There is no doubt about it, but there is some kind of an uncanny feeling comes over a person before an earthquake. I am no scientist, so I cannot even try to explain earthquakes, but I can say this that the earthquakes which I experienced in Narromine the other day were nothing more than a rumble when compared with the shakes in N.Z. The last severe earthquake we had in Maoriland— I am referring to the one we had in February, 1931 — was the worst one I experienced. Though I was living about 60 miles from where the great damage occurred, I must say I was much too near it for my liking. I was sitting on a verandah in an arm-chair, talking to an old lady when the first shake came. She said, 'I think that is an earthquake. There was no doubt about it; because in a few seconds there was another shake, and we were both thrown on the floor. I did my best to help the lady, but the earth was so shaky and appeared like rolling waves that I had to lay prostrate on the ground. There was not much harm done where I was living; but as you have read in the papers, the towns of Napier and Hastings were very much damaged. The shakes in themselves were bad enough in those towns, as many buildings were destroyed, but it was the fire which caused the destruction of the business portion of the towns. Narromine was again visited on Sunday night by a much more severe shake; but it was not near as severe as the ones I have experienced in N.Z. The shake on Sunday night was peculiar insofar as the rumble was more prolonged than one of the same intensity in New Zealand. The shake is much sharper and the buildings would rock a great deal more. In Maoriland the building sways backwards and forwards, but in Narromine, a person only felt the forward shake. Though the one on Sunday night was fairly severe, yet the people have nothing to fear, as the noise and rumble were so loud and prolonged that really they caused a greater scare than the shake itself.'

AT DUBBO. The Dubbo 'Liberal' reports:— 'Proceeded by heavy underground rumblings, an earth tremor shook houses in Dubbo at 8.55 p.m. on Sunday. Although no damage has been reported, many residents received a severe shock, for the majority of them had never experienced such a weird sensation.

'Weatherboard houses shook and crockery rattled, while even in the more substantial brick residences, windows and doors shivered violently. 'It was a most uncanny feeling. For half a minute the whirr as of a distant plane could be heard. Then came a rush as of a powerful wind through a gigantic funnel. As it neared, the velocity lessened, and the locality trembled as if it had just escaped a rude shock. At first the tremor rolled the foundations, and then the

superstructures, windows, roofs and contents of the houses shared the sensation. At Mr. Ogner's home, slabs of plaster were splintered from the walls, but that is the nearest approach to any damage.'

AT WELLINGTON. Monday's issue of the Wellington 'Times' reports as follows:— 'Many residents state that between 8.30 and 9 o'clock on Sunday night a slight earth tremor was felt, and the same news has been received from different centres in the district. Mr. Eric Lowe, of Mumbil, rang the 'Times' office on Monday morning to inquire if any tremor had been felt, as he stated was quite distinct at his place. It was even more so at Mr. Geoff Smith's place at Narrogal, where a distinct rumble was heard. 'The question again arises as to the actual cause of the tremor in the earth. It will be remembered that some few years ago, a very distinct tremor was recorded in Wellington and district, when crockery was disturbed on the dressers of homes. However, no record was received of any earthquake at the Government Observatory or at any other stations, and the opinion of professors was that it was the result of some tremendous fall of earth in a large underground cave or passage. It is well known that most of the country from the Wellington caves to the areas of Mumbil and Narrogal are of limestone formation, and probably there are huge subterranean passages, which may have caved in, thus causing the rumbling and tremor of the earth which took place last night. "The tremor was also felt severely in Dubbo, and seemed to come from Narromine way."

FATHER O'LEARY'S OPINION.

"Tremors Something To Be Proud Of."

On Monday last the 'News' proprietor wrote a description of the earth tremors to Father O'Leary, S.J., Director of Riverview College Observatory, Sydney, and Friday's mail brought the following reply:— 'I received your very clear and interesting description of the tremors that have been troubling Narromine. I can easily understand the anxiety that they have caused, but I think I can very safely say that there is not the least cause for alarm. "Unlike most parts of the world Australia is very nearly dead in the matter of earth adjustment. Small adjustments of the crust happen everywhere. There are well defined belts along which the main readjustments occur, and the nearest we can get to such a belt is out along the belt through New Guinea, the New Hebrides and New Zealand. That belt takes up all the big strain and keeps Australia untouched by dangerous movements. But in every large world area there are continually small adjustments to keep the crust in equilibrium. Such are the very small and unimportant movements you experience from time to time. To show you how very insignificant these movements are I have just measured our record for your severest shock. It is a trace of less than one-eighth of an inch and lasted for about a minute, When we get the record of a destructive shock even some thousands of miles away, the instrument swings 3, 4, 7 inches and the subsequent movement lasts for hours.

'You need have no fear. The big movements in Australia happened something like a million years ago. These are only the twitches that come to tell us, that Australia has had its history of crustal movement, just like any other part of the world. But we are not going to have anything spectacular, nothing that would be worth recording. I rather feel that I should like to live in Narromine to have your interesting experience. "I have been speaking with Professor Sir Edgeworth David, who knows Australia as a doctor knows every fibre and nerve in the human body, and he gave me a most interesting account of the whole geological formation including the Narromine district. In his opinion there is no cause for the least anxiety. These are just the last twitches of a body not quite dead. "I hope your people will be rather proud of being able to say that they have actually felt an earth tremor. But they will not be able to boast of much. You can be quite certain of that."

PROFESSOR EDGEWORTH DAVID'S OPINION.

The Great Walloon Lake.

Professor Edgeworth David, Geology Department, Sydney University, writes as follows this week to the 'News:' 'Sir.— With a view to allaying possible fears for the stability of the earth's crust under Narromine, I trust you will kindly find space in your valuable columns for these notes. 'To understand the probable reason for the recent sharp earth tremors which have visited Narromine, one has to go a long way back in its past geological history. Many millions of years ago the Western Plains, north of a line from Dubbo to Bourke, and west of a line from Dubbo to Narrabri, formed part of a vast freshwater lake, known to geologists as the Walloon Lake. It was far greater than all the great lakes of North America put together. It extended westwards to near Tarcoola in South Australia and northwards perhaps to the Gulf of Carpentaria. The present site of Narromine was close to the eastern shore of this gigantic lake. The shores at this period of geological time, the Jurassic, were tenanted by the earliest reptiles, the Dinosaurs, from the site of a sheep up to that of the monster Rhaetosaurus, 40 feet long, the skeleton of which, now in the Queensland Museum at Brisbane, was found in old lake sediments at Durham Downs in South-eastern Queensland. A little later, in the Cretaceous period of geological time, Lake Walloon subsided to such an extent that the sea swept in from the north, converting most of Lake Walloon into a great mediterranean, which extended from Carpentaria to the great Australian Bight, and thus divided Australia into two large islands. The eastern shore of this sea reached an area between Warren and Narromine. Still later, in early Tertiary time, the sea was driven out through a slow elevation of Central Australia. Shallow lakes replaced the inland sea. Again Narromine was close to the shoreline of this Tertiary Lake. It was about then that volcanic eruptions broke out on a grand scale, pouring forth the volcanic lavas just north of Dubbo, building the majestic Warrumbungle Mountains over 4000 feet in height, and the rugged ranges of the Nandewars, near Narrabri, which in Mount Kapputar attain an elevation of 5,000 feet. These eruptions followed the line of the old lake shorelines. Shorelines are frequently zones of weakness in the earth's crust, where the earth's crust has been bent, or even fractured by earthquake cracks. Probably a zone of slight weakness in the earth's crust runs from near Narromine to Narrabri, and possibly it is joined by another line of weakness approximately following the railway line from Dubbo to Bourke. It should be remembered that probably several millions of years have elapsed since the old volcanoes to the north of Dubbo and in the Warrumbungle Mountains were in eruption, and in this vast period of time, the old earthquake cracks have been securely mended through the rocks at a depth coming into a state of stable equilibrium. It may be mentioned that the whole of our mountain ranges south of the Western railway line are subject, from time to time, to more or less strong earth tremors, or even mild earthquake shocks. These mean that the main Dividing Range of the Bathurst-Monaro region, and beyond, has still some vitality in it. These mountains are growing. Earth tremors are the 'growing pains' of mountains, a little disquieting, but not harmful to health. In my opinion there is no cause for alarm in these Narromine earth tremors. The earth's crust there should be reasonably stable for many generations to come.'

T. W. EDGEWORTH DAVID. Sydney University. May 25, 1932.

Narromine News and Trangie Advocate Friday 27 May 1932 Page 8.
Trangie Topics.

Earth Tremor. On Sunday evening, between 8 and 9 p.m., a slight shock was felt by several residents in both town and district, but no excitement was caused, as it only lasted for a very short time.

Narromine News and Trangie Advocate Friday 27 May 1932 page 1.

An earth tremor disturbed the equanimity of Willydah and Backwater residents at 8.45 p.m. on Sunday last.

Narromine News and Trangie Advocate Friday 10 June 1932 page 5.

Narromine is still experiencing earth tremors, and although we have not had one nearly so bad as the shock that disturbed and frightened people on Sunday night, May 22, nevertheless they are quite severe enough. In addition to a lot of small tremors, very distinct quakes occurred about 4 o'clock last Sunday morning and again at 8 o'clock on Tuesday night Narromine and district residents are still wondering why the tremors are so frequent in this locality and nowhere else in the West.

On the re-opening of the Narromine School after the recent holidays a large crack was found in the brick wall, extending from ceiling to floor. It is thought that the recent severe earth tremor did the damage.

Narromine News and Trangie Advocate Friday 1 July 1932 page 5.

Narromine experienced another pronounced earth tremor at 7 o'clock this Friday morning. This is the first quake felt for about three weeks and local residents were just beginning to hope that the shock season had passed.

Narromine News and Trangie Advocate Friday 29 July 1932 page 5.

Earth tremors were again felt in Narromine on Sunday night shortly after 7 o'clock and on Monday night about 20 minutes to 9 o'clock.

Narromine News and Trangie Advocate Friday 16 September 1932 Page 3.

For some months Narromine has been free from earth tremors, and residents were just beginning to rejoice in the knowledge that the unwelcome visitations had passed away. However at an early hour on Wednesday morning, many persons were rudely disturbed from slumber by two distinct shocks one of which was very severe and made a loud rumbling noise, and violently shook houses. If the tremors are to again occur at frequent intervals, and Increase to such an extent in violence as this town experienced some months ago, well, there will be no need for certain pious politicians to urge us to 'Observe Sunday.'

Narromine News and Trangie Advocate Friday 17 February 1933 page 5.

Last Monday Narromine experienced another earth tremor; not a severe one, but yet distinct enough to arouse people and cause that nasty trembling feeling. It hit the town at 6.40 a.m., and was all over in a few seconds.

Narromine News and Trangie Advocate Friday 10 January 1936 page 4.

Earth tremors are about again. A slight one occurred yesterday morning at about five minutes to eight.

Narromine News and Trangie Advocate Friday 6 March 1936 page 4.

Earth tremors are again becoming prevalent. A rather severe one occurred last Saturday evening about 10 p.m.

Narromine News and Trangie Advocate Thursday 19 May 1938 Page 4.

An unpleasant reminder of past experiences arrived in Narromine last Friday morning in the shape of an earth tremor. Many people were awakened by the rumble, which was felt at about four o'clock in the morning. It is possible that it was a reaction from the earthquake at Salamaua, New Guinea, the same day.