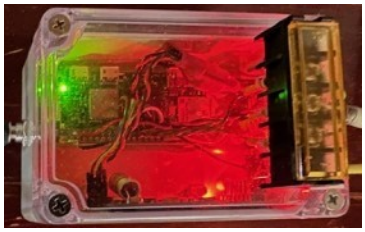
SAA Newsletter



The Peismo
#1/2025

From the Editor - Members are urged to submit articles with an earthquake connection of interest to members but accepting they may be edited or not published, at the discretion of the editors. Contributions to: mccue.kevin@gmail.com

Contents

Major Earthquakes Worldwide, October - December 2024

Two major earthquakes occurred in this quarter of 2024, the first offshore Cape Mendocino California, the second in Vanuatu. The USGS issued a tsunami warning from Oregon to the San Francisco Bay Area but it was soon cancelled, as was that following the Vanuatu earthquake.

In California, windows were damaged and water pipes burst. The shaking knocked items off store shelves. Hundreds of small aftershocks were recorded. In San Francisco, about 450 km away, residents reported a rolling motion for several seconds.

The epicentre of the Vanuatu earthquake was just 30km west of Port Vila. One building near the central market pancaked, several other buildings and two bridges were damaged. Many aftershocks were reportedly felt in the city, the largest M6.1 two days later.

Building collapse and landslides caused 14 fatalities and more than 200 injuries in Port Vila where strong shaking was observed. Lack of water and power and the general uncertainty as to what might happen next motivated the Australian government to fly Australian residents back home by RAAF Hercules.

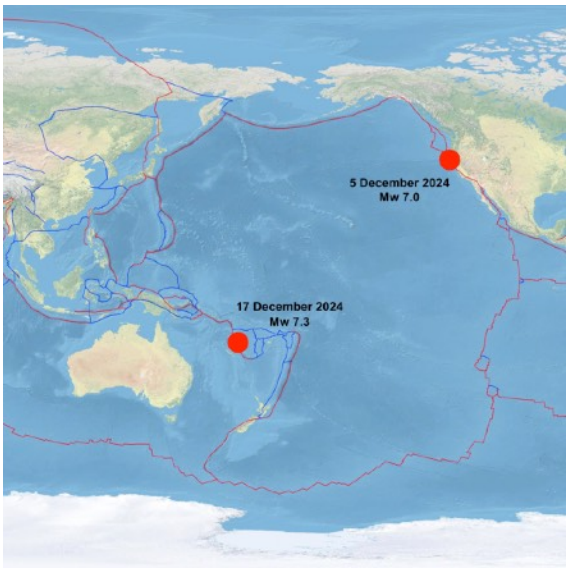


Figure 1. *Major M≥7 World earthquakes, from the USGS.*

Major earthquakes Worldwide, October to December 2024

Date UTC	Time UTC	Latitude	Longitude	Depth km	Mww	Place
2024-12-05	18:44:21	40.37	125.02	10	7.0	Offshore Cape Mendocino, Ca.
2024-12-17	01:47:26	17.69	168.03	57	7.3	30 km W of Port Vila, Vanuatu

Destructive Vanuatu Earthquake

Information extracted from the USGS, and ABC and Guardian reports.

As of writing this report, rescuers in Vanuatu's capital were still trying to extricate victims trapped under rubble as others spoke of their escape from the 7.3 magnitude earthquake that struck the Pacific nation at lunch time on Tuesday, killing at least 14 and injuring about 200 more.

Fourteen people are confirmed dead according to a Red Cross official. Two Chinese nationals were among the fatalities. One building damaged contained the UK, French and New Zealand high commissions, and the US embassy, which was located on the ground floor. Another 2-story building was "pancaked" (Photo).

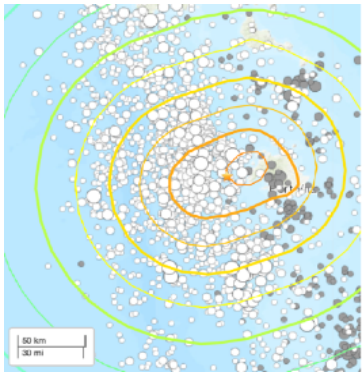


Figure 2. *Epicentre and modelled isoseismal map of the Vanuatu mainshock M7.3*

Aftershocks followed. Power and communications remained disrupted on Wednesday, while the airport was also closed to commercial flights for 72 hours for repairs to be made. Emergency services were attempting to recover people from collapsed buildings and landslides around Port Vila, and authorities were scrambling to reconnect electricity, water and telecommunications. International aid arrived on Friday.

Vanuatu's tourism infrastructure seems to have been largely undamaged. At one resort offshore from Port Vila, the destruction was confined to some broken windows. The resort, deemed safe by engineers after the quake, is now looking after guests and has electricity available on about three-quarters of the property via its solar system.

Photo 1*: The building housing the American embassy and UK, French and NZ high commissions. At the time, many embassy staff had been outside the building having lunch. Note the missing ground floor level in the end section - arrows) as the storey collapsed.*

Tectonics West of Vanuatu

The Australian plate subducts eastwards beneath the Pacific Plate, marked by a trench, at the rate of about 85 mm/yr. Large earthquakes are common along the trench, their mechanisms mainly thrusts, though occasional strike slip earthquakes occur to the north. Within the subduction zone 34 M7.5+ earthquakes have been recorded since 1900. Since 1962, however, the USGS and ISC have located only 10 major (M>6.9) shallow earthquakes within about 125km of this epicentre, none of them between 1962 and 1981 (Table below).

This recent earthquake is noticeably different from a thrust, the nodal planes near vertical and horizontal, typical of tsunamigenic earthquakes but there seems to have been no tsunami generated by the earthquake. It was also one of the closest major earthquakes to Port Vila, the exception a nearly identical earthquake, location and size, occurred in 2010.

Photo 2: *Pancaked building*

Discussion

Strong shaking, lasting less than 10 seconds, did quite a lot of damage but mainly in Port Vila where the taller (up to 6 storeys), more modern buildings exist. This can be put down to at least three factors, the large magnitude, shallow depth and very close proximity of the mainshock.

As with all earthquakes there are puzzles, why was there no tsunami? why did only one building pancake (obviously a structural problem)? and why was there not similar damage back in 2010 when a very similar earthquake occurred? Why was there such a long gap between 1962 and 1981 with no major earthquakes?

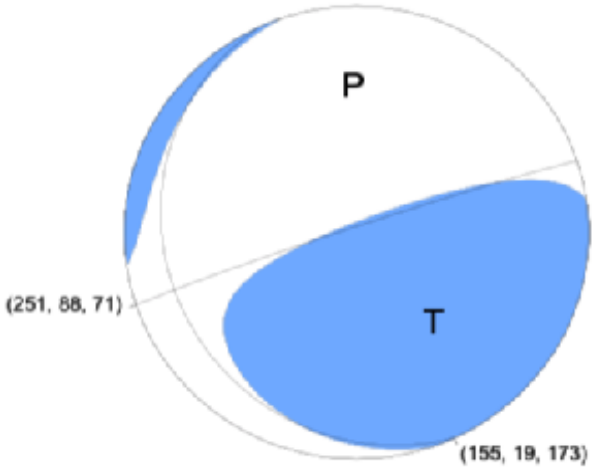


Figure 3. *Focal mechanism of the mainshock, nodal planes vertical and horizontal, one of them the fault plane, most probably the horizontal since there was no tsunami.*

Why are Vanuatu and some of its buildings not instrumented to measure the shaking as recommended at a joint AEES/NZSEE conference in 2015. The Australian, NZ, UK and US diplomats should have seen to this a decade ago. It is one thing for engineers to recommend an action but politicians have to stump up the money. There will inevitably be much larger earthquakes along this section of the Australian/Pacific Plate boundary, perhaps as large as M 9.2, resulting in much worse damage and loss of life, most probably compounded by a tsunami. Are politicians capable of acting to ensure this loss of life and economic destruction doesn't happen?

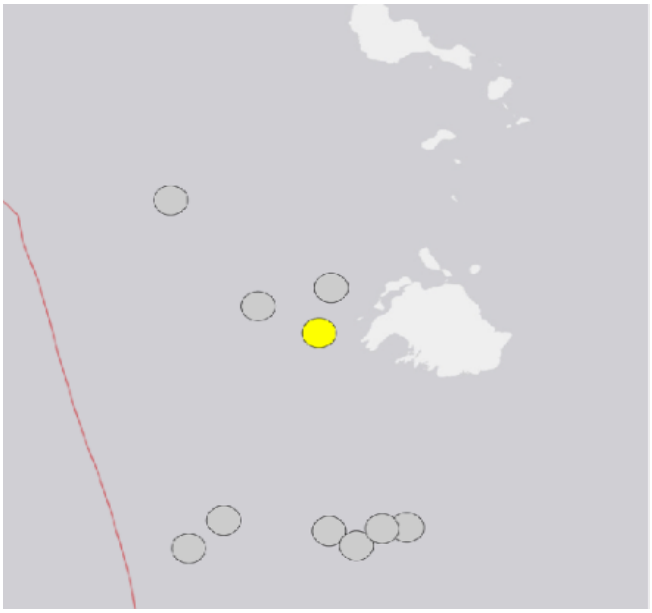


Figure 4. *Epicentres of major earthquakes (M>6.9) from 1962 on the subduction zone west of Vanuatu. The red line marks the trench, the surface manifestation of the subducting plate at the subduction zone (from the USGS).*

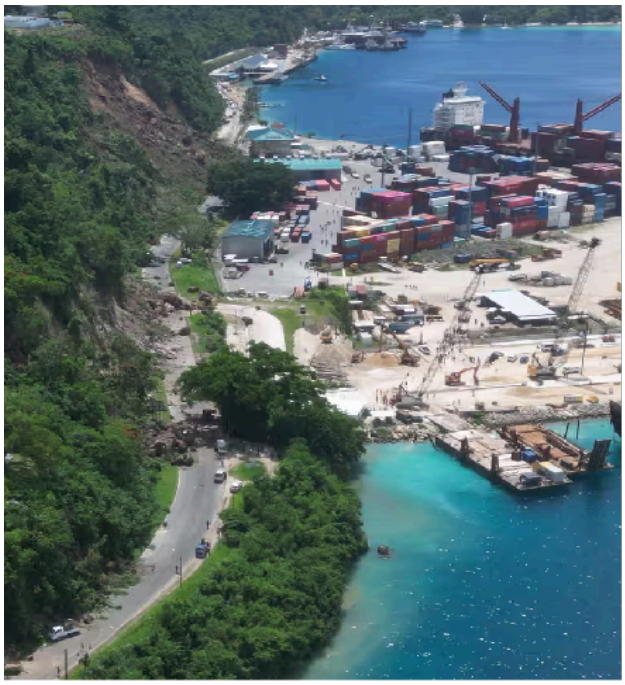


Photo 3. *Access to the main port was cut off by several shallow landslides.*

Table Major earthquakes since 1962 within about 125km of the recent earthquake (USGS)

Date/time	Latitude	Longitude	Depth (km)	M	M Type	Place
1981-07-15T07:59:08.470	-17.260	167.601	30	7.0	ms	92 km NW of Port-Vila, Vanuatu
1990-03-05T16:38:Z	-18.318	168.063	20	7.1	mw	69 km SSW of Port-Vila, Vanuatu
1994-07-13T02:35:56.020	-16.620	167.518	33	7.2	mw	58 km S of Lakatoro, Vanuatu
1999-11-26T13:21:15.570	-16.423	168.214	33	7.5	mwc	92 km ESE of Lakatoro, Vanuatu
2002-01-02T17:22:48.760	-17.600	167.856	21	7.2	mwc	50 km WNW of Port-Vila, Vanuatu
2010-08-10T05:23:44.980	-17.541	168.069	25	7.3	mwc	33 km NW of Port-Vila, Vanuatu
2011-08-20T16:55:02.810	-18.365	168.143	32	7.2	mww	71 km SSW of Port-Vila, Vanuatu
2011-08-20T18:19:23.550	-18.311	168.218	28	7.1	mww	64 km S of Port-Vila, Vanuatu
2012-02-02T13:34:40.650	-17.827	167.133	23	7.1	mww	125 km W of Port-Vila, Vanuatu
2024-12-17T01:47:26.347	-17.686	168.034	57	7.3	mww	30 km W of Port-Vila, Vanuatu

Note the USGS has used four magnitude scales

PEISMO Network expands

The fifth SAA Peismo, designed by Colin Love, and Eric and David Love, and constructed by John Millard, was set up on 21 August near Bredbo NSW, PFLO, between Canberra and Cooma. A sixth was installed at Sandon Victoria, S88P on 19 November, a seventh on 7th December at McKellar ACT, CLIL.

They join the first Adelaide stations LILH and PLYP on the Melbourne University server:

https://meiproc.earthsci.unimelb.edu.au/eqserver/ Follow the project https://github.com/colinlove/peismo

Maps of Earthquakes October to December 2024

The first map shows continental Australia in its plate tectonic setting. The plate boundaries are the thin red solid lines (USGS version). We have plotted everything above ~M4.5 on the plate boundary but above M3 intraplate. These limits are about what is practicable with the existing seismograph network.

Note the large gap in the interplate earthquakes north of Australia. A tsunami generated by a major or megathrust earthquake here would cause serious consequences along the NW coast of Australia.

The South Island of NZ to Macquarie Island is quiet but has experienced several major earthquakes in recent decades. The southern boundary of the Australian Plate is also quiet but not threatening because of the limited magnitudes and style of faulting. Seems the plate has stalled its northern march.

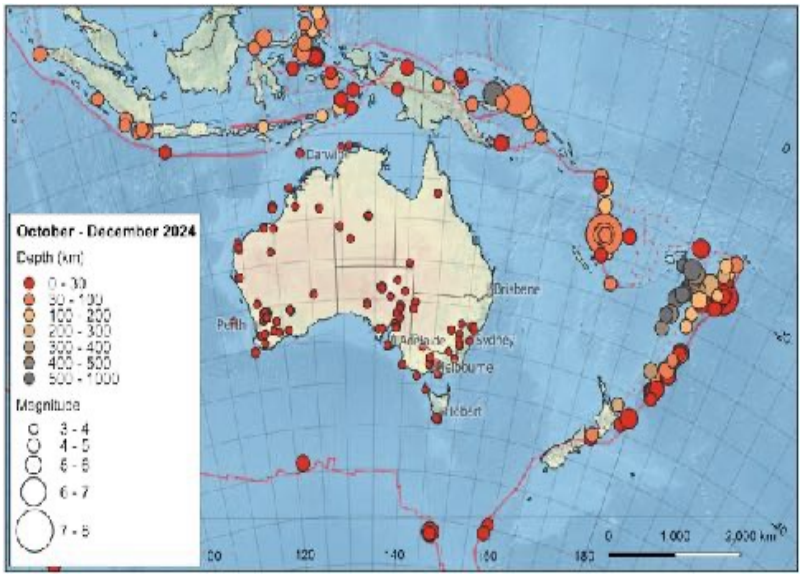


Figure 5. *Australian Plate region earthquakes, October to December 2024 (maps by Clive Collins).*

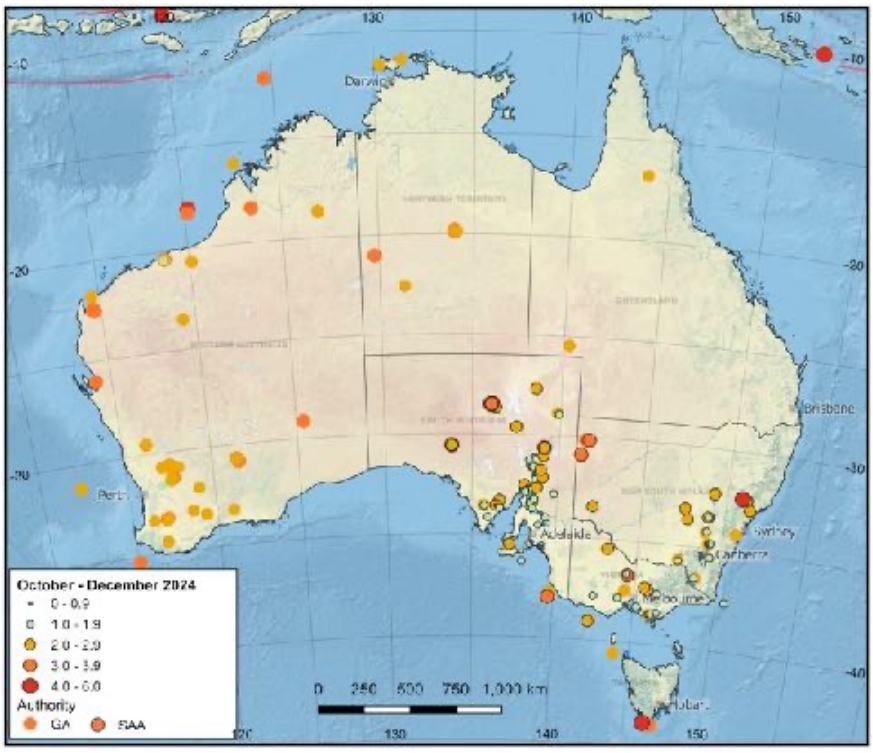


Figure 6. *Australian earthquakes (October to December 2024).*

There were no surprises in the Australian epicentral locations, Tasmania and Queensland remain very quiet, a single ML4 earthquake offshore SW Tasmania solicited 41 reports to the GA online query form. In continental Australia, the largest earthquake in the quarter was the mainshock ML5.0 of the sequence near Muswellbrook NSW (see last SAA Newsletter for a discussion of this sequence), a mine induced earthquake. Four of the 15 earthquakes of magnitude 4 or greater in the quarter were in NSW, at Muswellbrook, all felt in Sydney but apparently causing no alarm in the city, unlike locally.

GA reported that all but one of the 15 earthquakes of magnitude 4 or more were reported felt, the offshore Broome WA event, ML 4.3 on 4 October, was not felt ashore. None of the earthquakes in Queensland or the Northern Territory exceeded magnitude M3.9 in the quarter.

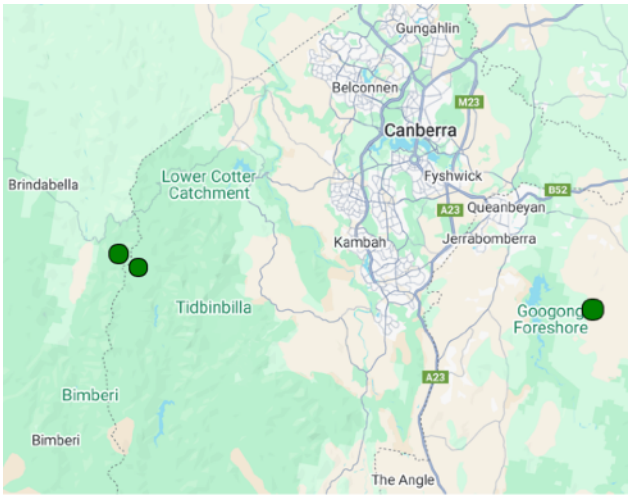


Figure 6(a) Three small earthquakes were located near the ACT, two straddling the border west of the city, another southeast of the city near Googong Dam.

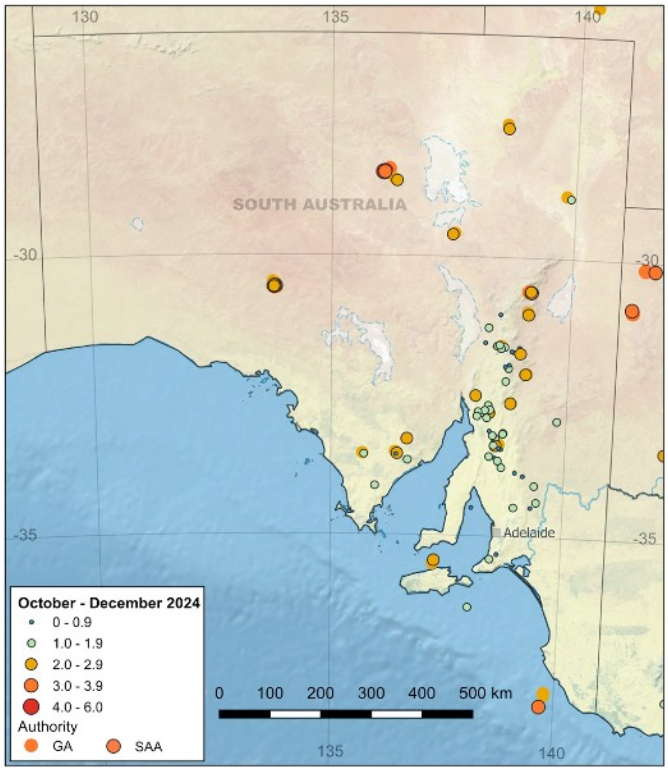


Figure 7. *South Australian earthquakes (October to December 2024).*

The region within 100km of Adelaide experienced just a single small event, most of the earthquakes were in the Flinders rangers as usual, a couple in the South-east and likewise the Eyre Peninsula zones. Jamestown and the northwest of William Creek bore the brunt of the two ML4+ earthquakes. The Jamestown sequence is continuing (see the last Newsletter). SAA seismologists removed their temporary seismograph network around Jamestown in May.

The pattern of earthquakes in South Australia, at least in the southern half of the State, has remained stationary both in the historical and post-1959 instrumental periods apart from a singular event west of the Eyre Peninsula.

There were no earthquakes in the northwest of the State.

New report outlines what a major earthquake could do to Vancouver, Canada

Digital Writers, The Weather Network (Published 9 November 2024)

The report suggests small actions can go a long way to reducing earthquake risk. Over a thousand casualties, billions of dollars in damages, and widespread property destruction. Those could be some of the effects of a M 7.2 earthquake in Vancouver, according to a new report scheduled to be discussed with the city council on 12 November.

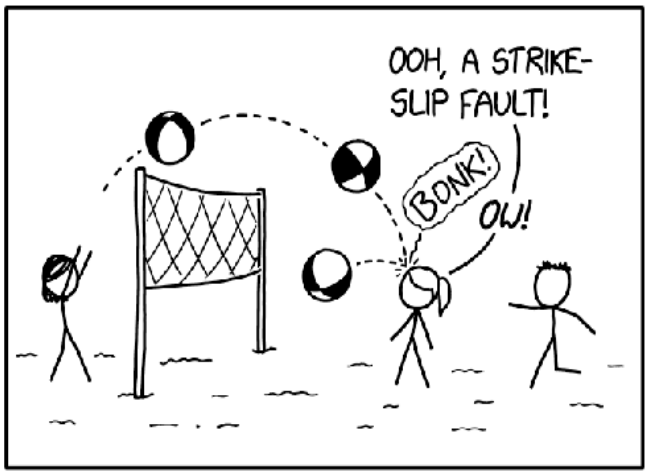
Other findings from the report suggest a M 7.2 earthquake could lead to:

- Approximately 1,350 casualties.
- Significant damage to 6,100 private buildings.
- Financial losses of around $17 billion.
- Displacement of more than one-third of residents and workers.

It is suggested that buildings built before 1990, and especially those built before 1973, are at the highest risk of sustaining damage. Nearly 70 per cent of at-risk populations are renters, and of that percentage, many are low-income, seniors, visible minorities, and/or Indigenous. “Even a less intense earthquake, like the one used in the city’s 2019 VanSlam earthquake exercise, could leave as many as 25,000 residents and workers disrupted and displaced for more than three months, and cause as many as 200 severe injuries and fatalities,” reads an excerpt from the report.

The report's authors formed their conclusions using earthquake simulation software. The research is intended to be used as a guide to put seismic risk reduction strategies in place before a major event takes place. The report argues that small, targeted actions can support long-term recovery. Research predicts where the next 'big one' will occur. A study published this past summer has predicted the next major earthquake, often referred to as a "big one" is likely to occur close to Vancouver Island and Washington, but it's unclear when that event will occur.

"There's a huge range," John Cassidy, a seismologist with Natural Resources Canada, told Global News in June. "We've had 19 [large earthquakes] during the past 10,000 years, so roughly every 4 or 500 [years]." The last major earthquake along the fault line off the west coast happened roughly 324 years ago, in January 1700 with an estimated strength of magnitude 9.2.



WHY SEISMOLOGISTS ARE BAD AT BEACH BALL VOLLEYBALL

From: https://xkcd.com/3021/ by Eric Love

Blasting at Fosterville Gold Mine causes 3.6-magnitude earthquake in Central Victoria

By Philippe Perez ABC Central Victoria

A gold mine in Central Victoria (photo above) has confirmed its activities induced a 3.6-magnitude earthquake felt in multiple towns near Bendigo. The earthquake occurred at 6:40am with 22 felt reports submitted to Geoscience Australia.

Fosterville Gold Mine, located 25 kilometres north-east of Bendigo, said it recorded a mine-induced seismic event. The mine's environment and community manager Will Wettenhall said staff were working at the site when it happened. "It occurred soon after a production firing [or] blasting event," he said. "Our people are safe. "The mechanisms are similar to an earthquake, however they are related to our mining activities."

Photo 4. *Fosterville Gold Mine, Central Victoria*

Local resident Ange Maree, from Goornong, said there was a loud bang when the earthquake hit. "I thought something had crashed into the house," she said. "The whole house shook." She was concerned a crack in an archway inside her house was larger after the quake. "It has increased in size and there are extra cracks that weren't there before," she said. "It's a concern if this type of thing is going to be ongoing."

Fellow Goornong resident Julie Dunlop-Harty said she had "never felt anything quite like that before". "You could feel yourself jolt." Ms Dunlop-Harty said many residents were concerned that the quake was mine-induced, and was worried about further impacts. She planned to attend a community meeting to find out more. "Maybe it'll put our minds at rest or maybe it'll make us more worried," she said. "What are they doing out there that is reaching so far to our homes?" A resident in Echuca, 45km away from the epicentre, also reported feeling the quake.

Mine investigating

Mr Wettenhall said an investigation was underway, and representatives had spoken to locals at a community marquee set up in Axedale Park."We have protocols in place to respond to these events underground, which we are currently working through, and we've mobilised our community engagement team to be available to talk to our neighbours or landholders who may have concerns," Mr Wettenhall said. "We have a team of geotechnical engineers who investigate these mine-induced events. "As that additional information comes to hand we provide regular updates on our website."

On November 1, a spokesperson from Fosterville Gold Mine said a smaller seismic event registering a 2.3 magnitude had occurred about 1:30pm. That event was recorded about 1 kilometre below the surface in the Phoenix area of the mine. A 2.5-magnitude seismic event was also recorded at the mine in 2022.

Such admissions are welcome but rare in the mining sector. This coming soon after a similar admission from Muswellbrook where coal mining has triggered an extensive and damaging 'earthquake' sequence (see the previous SAA Newsletter).

East Coast Gets A Rattle From The East!

David Love

Occasionally the southeast coast of Australia is affected by earthquakes in the 'East Islands'. One such case happened recently, on 15 December at 1623UT. Two earthquakes, magnitude 5.1 and 5.0, occurred about 6 minutes apart at the south end of New Zealand near the tectonic plate boundary.

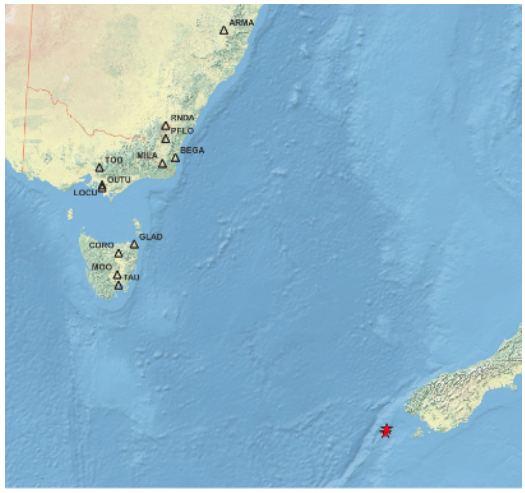


Figure 8. *Event epicentres and recording stations.*

The recordings of these events by Australian stations near the coast show both P phases clearly, along with even bigger T phases about 15 minutes later. The T phase occurs when the earthquake is fairly shallow under the ocean. The P phase enters the SOFAR ocean channel at the NZ continental shelf. SOFAR acts as a wave guide so that the vibrations, travelling at about 1.5km/s, the speed of sound in the ocean can travel great distances. Then they may be transformed back into a P phase at the Australian continental shelf.

The P and T phases are clearest on the closer stations. The first S phase is also visible on a few stations between the two P phases. The later T phase can be seen on the ARMA Armidale and RNDA Canberra records, about 170 and 180 km from the continental shelf. It was also recorded at Macquarie Island but the record is noisy.

The depths of the earthquakes are uncertain as the nearest recorders are about 150 km away. Geonet (NZ) nominated depths of 5 km (first) and 33 km (second). The USGS nominated 10 km deep for the first event, but did not list the second. Geoscience Australia did not list either event. The amplitudes of the T phases indicates that the earthquakes must have been fairly shallow.

Earthquakes GNSNZ

Date Time UTC	Long	Lat	M	Type	Depth (km)
2024-12-15 T16:29:29.951Z	165.834	-47.371	5.0	MLv	33
2024-12-15 T16:23:41.242Z	165.843	-47.176	5.1	M	5

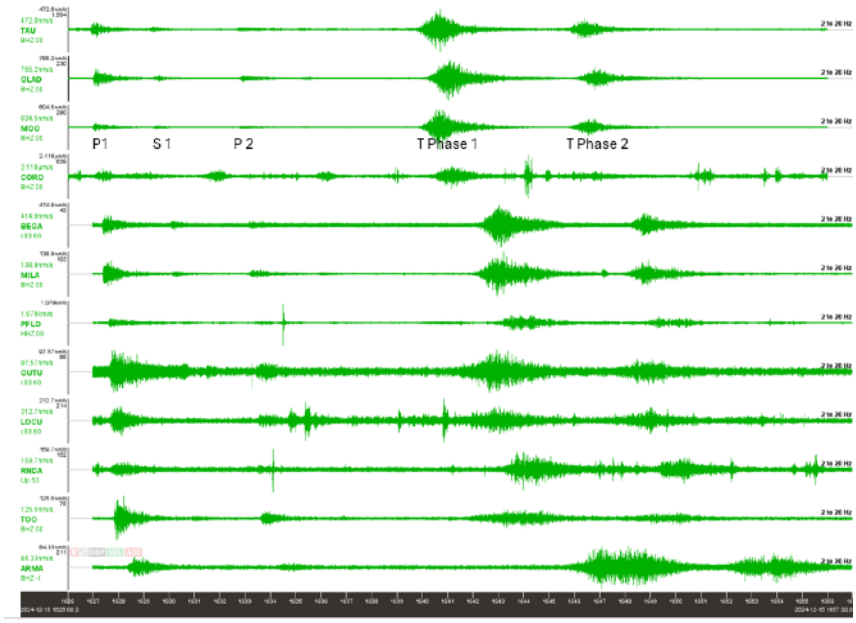


Figure 9. *Seismic waves P, S and T recorded by some Australian stations.*

AEES 2024 Annual Conference Adelaide

The 2024 meeting was held in Adelaide to mark the 70th anniversary of the March 1954 Adelaide SA earthquake, the most destructive earthquake in Australia until the Newcastle NSW earthquake in December 1989 (35th anniversary). The conference was held in the up-market Eos by Skycity in central Adelaide, South Australia from Thursday afternoon to Saturday afternoon, 21-23 November 2024. A welcome reception was held on Thursday night and the conference dinner on Friday night.

Forty two presenters including three invited keynote speakers from NZ, Europe and the USA addressed the audience in a single room over the three days, a very successful format, designed by AEES founding fathers to get engineers and seismologists talking together. Topics ranged from recent earthquakes to earthquake resistant design, rapid media communication to building codes. Students and teachers, practitioners and researchers, citizen scientists all contributed. The Charles Bubb medal was presented to Prof Nelson Lam, MelbUni for a lifetime of contributions to earthquake engineering. An award for the best student paper was presented to PhD candidate Eric Wang (UTS) for his paper on reevaluating the mechanisms of SE Australian earthquakes through a semi-automatic process. This award was strongly contested, so many excellent presentations, the students so well prepared and enthusiastic.

The audience counted six former Presidents of AEES. John Wilson, Mike Griffith and Peter McBean are seated in the photograph, with the current President Scott Menegon and AEES member #1 George Walker, still contributing at a high level. Immediate past-president Trevor Allen was there and Kevin McCue took the photo. David Love, Kathryn Dix, Vic Dent and Kevin McCue doubled up as SAA members and presenters. Notably absent were politicians and media.

The conference was declared a great success by the eighty odd registrants present. Papers will be available on-line soon via the AEES homepage. Next year's AEES meeting will be held in Melbourne.

Newcastle 1989 revisited

https://www.nbnnews.com.au/2024/12/29/35-years-since-newcastle-was-rocked-by-australias-deadliest-earthquake/

As briefly mentioned in the report of the AEES 2024 conference above, the year 2024 marks the 50th anniversary of the 1 March 1954 earthquake near Adelaide and the 35th anniversary of the 28 December 1989 Newcastle NSW earthquake. These two relatively small earthquakes, even for Australia M6 (revised) and M5.6, are notable as being the two most destructive earthquake in terms of financial cost. In Newcastle 13 lives were lost and another 160 were injured, mostly in the collapse or partial collapse of URM buildings.

In both cases, most of the damage sustained was to old, low rise URM buildings. The undoubtedly strong shaking was magnified by the sedimentary soils in places but it lasted just a few seconds. The lack of ties and poor or degraded mortar due to the cities' proximity to the ocean and a blast furnace further contributed to the damage.

In both cases there were few aftershocks, two felt under Adelaide and just one recorded under Newcastle. In the latter case the location of the aftershock recorded on instruments installed in the previous 24 hours by SRC and GA seismologists was crucial evidence in subsequent discussions of the mainshock location and focal depth.

Many of the current generation are oblivious to these earthquakes and their effects and that goes for engineers, architects and builders.

That was the situation in Adelaide too in 1954. The city had been damaged by earthquakes in 1897 and 1902. It was strongly shaken by an earthquake in September 1953 and asked at the time, noted geologist Sir Douglas Mawson reassured Adelaidians that their city would not be damaged in future earthquakes. He didn't have long to wait to be proven wrong.

Newcastle has an interesting history of close local M~5 earthquakes, in 1841, 1842, 1868 and 1925. Feted German explorer Ludwig Leichhardt even wrote to colleagues in Germany about the impact of the 1842 earthquake. You would have thought they would be firmly in the memory of politicians and engineers, alas not.

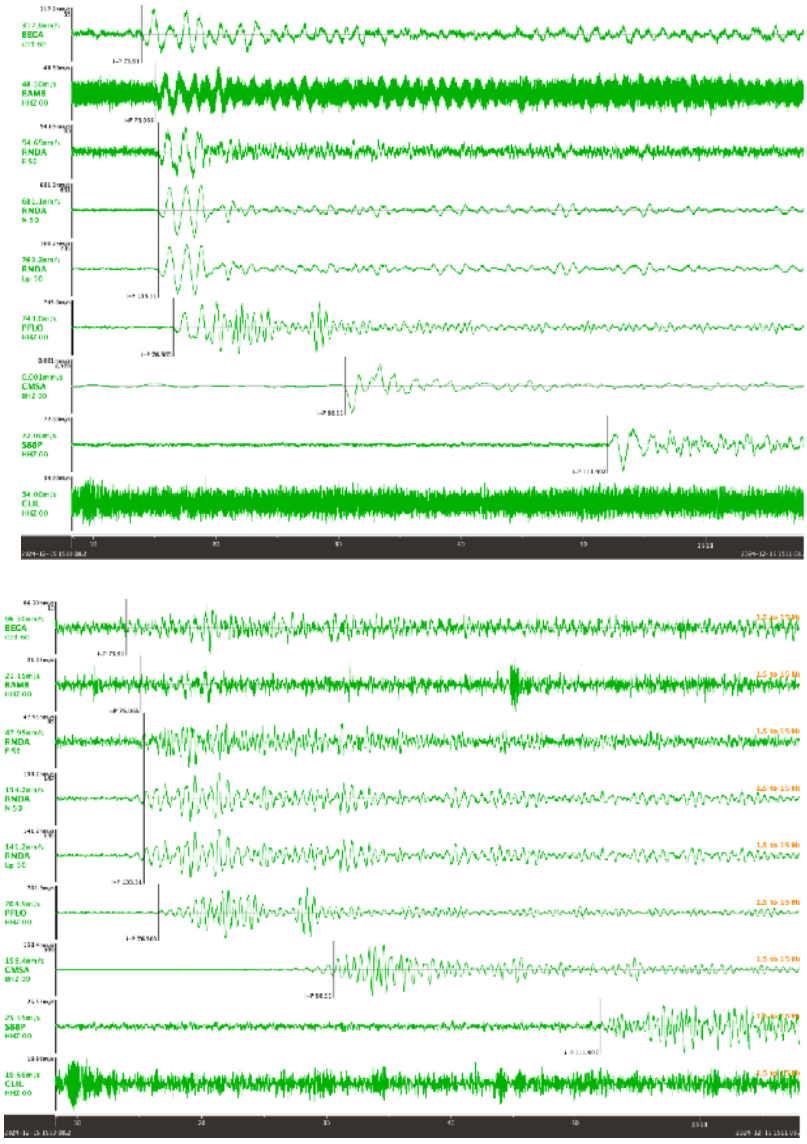
Recent digital data collected by SAA's high grade seismograph network run by very capable citizen scientists has reduced the uncertainties in locations and focal depths and surprised many of us by the greater depth range than previously acknowledged, earthquake foci down to 20km not uncommon in SA.

Earthquake hazard studies that ignore historical earthquakes follow in Mawson's tracks downplaying the hazard with inevitable consequences. But who would be held accountable for the lack of earthquake engineering design provisions should engineers choose to use such downgraded results obtained with only the short instrumental period data?

It is up to organisations like SAA and AEES to continue to address the earthquake problems in Australia and keep the population informed of what they are doing, and why. Anniversaries like Adelaide's 50th are a good opportunity to front the media so the lack of such attention during the AEES conference was a missed opportunity.

Stations, Seismometers and Filtering

The two screen dumps following are from the SAA's southeast Australia network plus GA's station Cobar CMSA. The earthquake was deep under Tonga, 136 km W of Neiafu, Tonga M 5.9
2024-12-15 15:03:37 (UTC)18.565°S 175.273°W 213.5 km depth



Using SRC's software *Waves*, the top panel is unfiltered data, the lower panel is filtered using a 1.5 to 15Hz filter. So, compared to CMSA, third trace from the bottom, how did the urban stations go? Apart from CLIL not yet operational, you'd have to say pretty well. Take BAMB, a Willmore Mk3A on the house and garage concrete slab overlying thick weathered sedimentary rock. Unfiltered despite the obvious 50Hz noise the first motion is quite clear. The station at Bega BEGA on unweathered volcanics under a house and garage is again, quite remarkable. Station marked RNDA is actually a Willmore Mk3 (top Trace) and the next two also marked RNDA are Willmore Mk3A verticals under test, sitting on the low inner brick wall of a house in suburban Aranda. I was surprised at how faithfully the 2 identical Mk3A seismometers are, but obviously different from the Mk3. The PFLO trace indicates it does as well as CMSA even though the seismometer is on a concrete slab over shallow volcanics of a rural shed near Bredbo NSW. S88P is in a rural shed near Newstead, Victoria, its polarity reversed (a tradition).

The filtered records apart from that at S88P, show just how difficult it would be to pick a P first arrival; the arrival times for the unfiltered record are marked. The phase shift depends on the filter and the filter parameters are chosen by the analyst to enhance some part of the signal. BEGA and RNDA are Echo recorders, BAMB, PFLO and S88P are Peismos

SAA Social, Adelaide

Front row L to R: Katherine Dix, David Love, Chris Anderson, Heather Love

Back row L to R: Vic Dent, Sonja Lenz, Jim Deer, Kevin McCue, John Millard, Lyn Grida, Joe Grida, Ian Anderson, Luke Van Den Bos, Colin Love (photographer) and Eric Love

Following the AEES meeting in Adelaide, David Love took the opportunity to convene a social gathering for interstate visitors Vic, Kevin and Sonja (Gary and Saide had to return to Melbourne) to meet local members. This was the first in-person meeting since before Covid. Also present was Katherine Dix whose Masters Thesis at Adelaide University was awarded in 2013, some time after the majority of her research on South Australia's historical earthquakes was completed. Free discussion flowed around the usual meal of Chinese takeaway and Bakers Delight. John Millard brought some Peismos for Kevin. Old timers probably didn't notice that the wobbly round table has had its third seismic retrofit, and no longer shakes.

Though the holiday period is fast coming to a close we thought we would all benefit from the **IASPEI** greeting to members and share Johannes's hope for a better 2025.

A MERRY HOLIDAY SEASON
and a
HAPPY and HEALTHY NEW YEAR 2025
to
ALL OF YOU!

IASPEI Newsletter

(http://download.iaspei.org/newsletters/2020-029/2024-Dec.pdf)

Dear Readers,

I hope this Newsletter finds you all well. In this last Newsletter in 2024, we have some information about the forthcoming Assembly in Lisbon, Portugal, a call for an IASPEI Medal awardee 2025, followed by some updates regarding the AfSC Assembly in Namibia in 2025. Further, we have two meeting reports and two new conference announcements. Then, I must inform you with great sadness that three of our colleagues passed away. We remember them with obituaries.

All the best for a hopefully more peaceful 2025,

Johannes Schweitzer
Secretary General.

The Seismological Association of Australia Inc.

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website: https://earthquake.net.au/

Membership of the SAA is open to anyone interested in earthquakes and applies for the calendar year (January through to December)

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