Seismological Association of Australia

SAA Newsletter

#1/2024

From the Editor We encourage members 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 editor. Contributions to: mccue.kevin@gmail.com

Contents

Major Earthquakes Worldwide, October - December 2023

There were three earthquakes worldwide of magnitude 7 or more in the last quarter of the year, all on the Pacific Plate boundary in the Australian quadrant. The major earthquake under the Banda Sea (Table 1) was felt in Darwin, one of 4 to shake the top end in 2024.

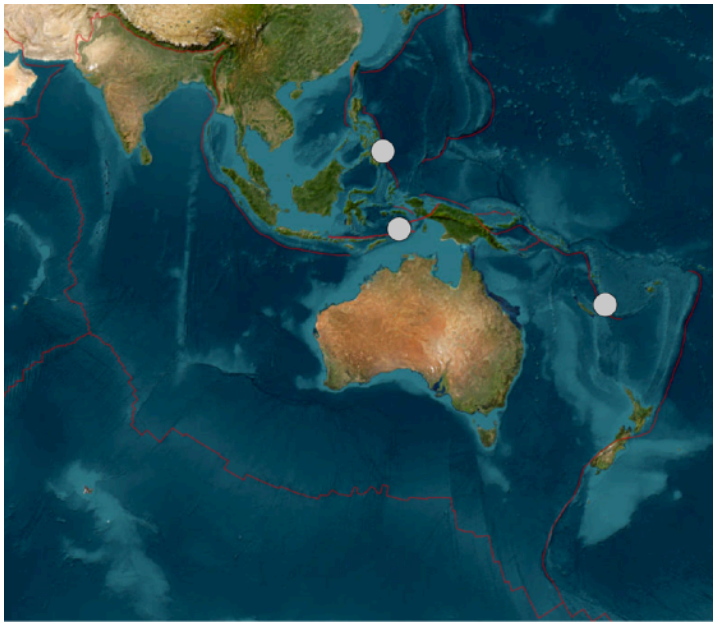


Figure 1 $M7^{+}$ earthquakes worldwide in the fourth quarter of 2023.

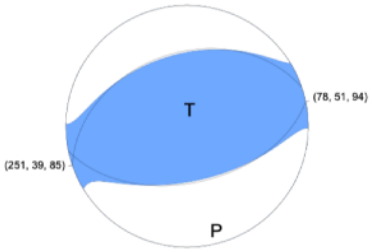
Three other regional earthquakes in the quarter were especially interesting for the editor. On 26 October an intermediate depth earthquake of magnitude 5.6 originating 150 km under the Banda Sea east of Timor Leste. It shook residents of Darwin, more than 300

Table Major earthquakes Worldwide, Oct - Dec 2023

Date UTC	Time UTC	Latitude	Longitude	Depth km	Mww	place
2023-12-07	12:56:31.0	-20.596	169.289	54	7.1	116 km S of Isangel, Vanuatu
2023-12-02	14:37:04.4	8.5258	126.417	40	7.6	19 km NNE Hinatuan, Philippines
2023-11-08	04:53:50.3	-6.4194	129.547	10	7.1	Banda Sea

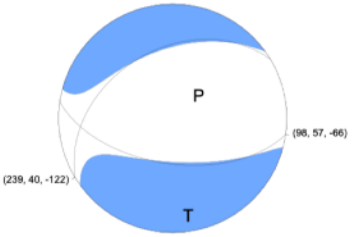
of them reporting it to Geoscience Australia. It was also felt in Timor Leste and the Malaku Islands.

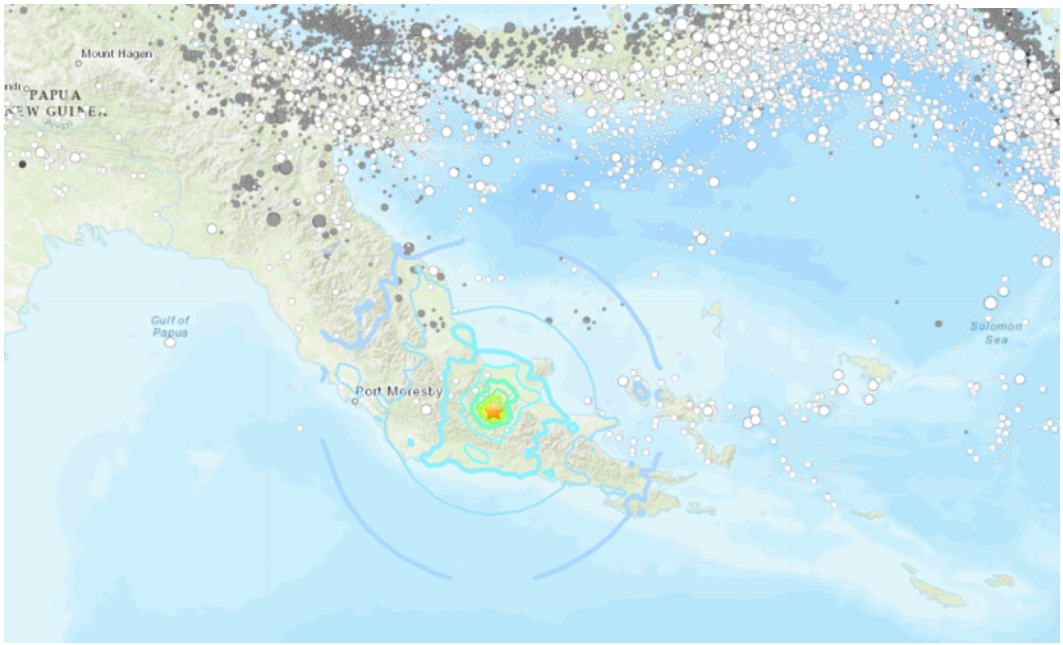
Indian Ocean
USGS Location
2023-11-14 07:00:56 (UTC)
4.039°S
87.082°E,13.5 km
depth, Mww 6.1



A large shallow intraplate earthquake near the 90^0 East Ridge in the Indian Ocean was well recorded across the SAA network. There are competing theories about the origin of the ridge, somehow generated as the Indian continent drifted north after separating from Antarctica and Australia.

Papua New Guinea, Papuan Peninsula
USGS Location
2023-11-21 07:10:15 (UTC)
9.565°S 148.674°E, 10 km depth Mww 5.5

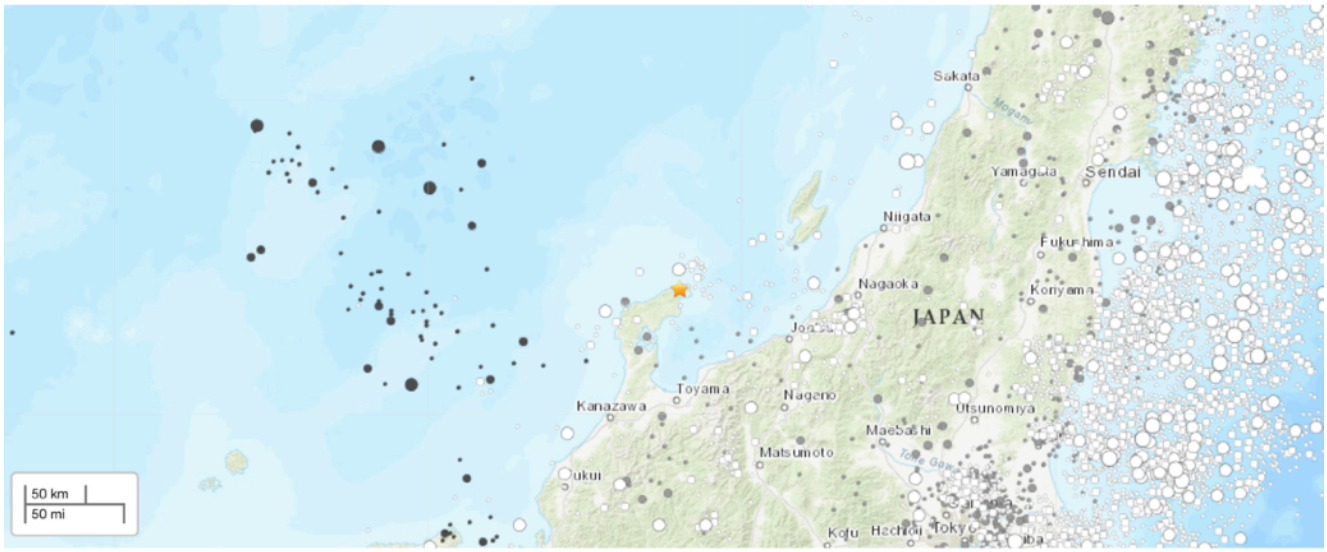




The second, another shallow event was interplate on the Papuan Peninsula east of Port Moresby in Papua New Guinea. This is a diffuse slowly moving boundary with separation of the Australian and Solomon Sea plates.

The two earthquakes had similarly oriented nodal planes but opposite mechanisms, their P and T axes reversed.

Japan's West Coast earthquake, 2024



The shallow January 1, 2024, magnitude 7.5 earthquake off the west coast of Honshu, Japan caused enormous damage to traditional homes and some modern buildings, killing more than 200 people and generating a 1m high tsunami, fire and landslides.

Thousands of aftershocks followed, the largest a magnitude 6.2 aftershock just eight minutes after the mainshock.

Photo A modern 7-storey building in Wajima toppled over.

The last similar sized earthquake on the west coast occurred on June 16, 1964, near Niigata 205 km ENE of the January 1 event (see map from the USGS), resulting in 36 fatalities and the destruction of about 3,500 homes. Extensive liquefaction caused several buildings to topple. Both earthquakes are notable for the extent of foundation failure and damage yet relatively few fatalities. But why after liquefaction during the Niigata and Christchurch (2011) earthquakes is liquefaction still an issue causing modern buildings to topple?

It is fair to wonder what Japanese earthquake codes have learned since 1964, particularly about liquefaction. One blog claimed this 2024 earthquake was a success of engineering based on the low fatality rate, but the financial cost will be enormous. Earthquake engineering needs to do more, not just save lives but reduce their economic impact on society.

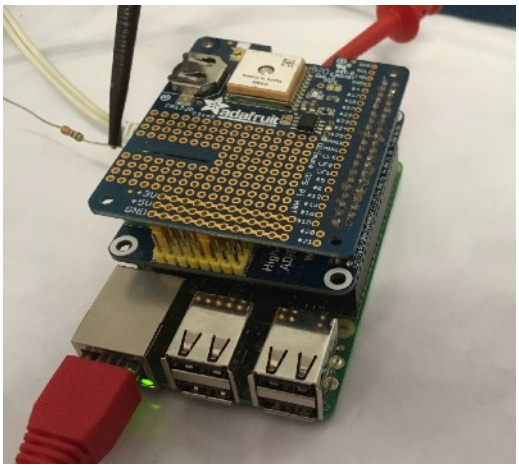
PEISMO – A cheap locally designed and built digital seismograph

By David Love

Colin Love has developed another cheap seismograph on a Raspberry Pi.

In 2016 Colin, David & Eric Love presented a paper at the Asian Seismological Commission, showing a cheap seismograph built around a Raspberry Pi2 with an A/D chip and GPS. This successfully operating as LILH (Littlehampton, SA) for about 2 years before failing with breadboard connection problems.

Colin recently decided to revive the project, but with off-the-shelf boards, and with timing using existing freeware (Photo). The instrument uses a Rpi 2, with an A/D expansion board by Waveshare and a GPS board by Adafruit. Timing by GPS or NTP is handled by freeware with setup instructions from https://austinsnerdythings.com/2021/04/19/microsecond-accurate-ntp-with-a-raspberry-pi-and-pps-gps/.



The new instrument is running as station LILH on the Melbourne University server

https://meiproc.earthsci.unimelb.edu.au/eqserver/

Beginning on 27th December 2023, it has been undergoing various tests.

On 3rd January at 0624UTC it recorded a small earthquake nearby, Magnitude 1.1, and about 20km deep. The figure below shows LILH with an L4C seismometer, compared to station MBKR nearby, using a PSN plus WinSDR system with an S6000 seismometer. Both sites are in towns and are quite noisy.

Photo showing Rpi3B with Waveshare A/D and Adafruit GPS boards.

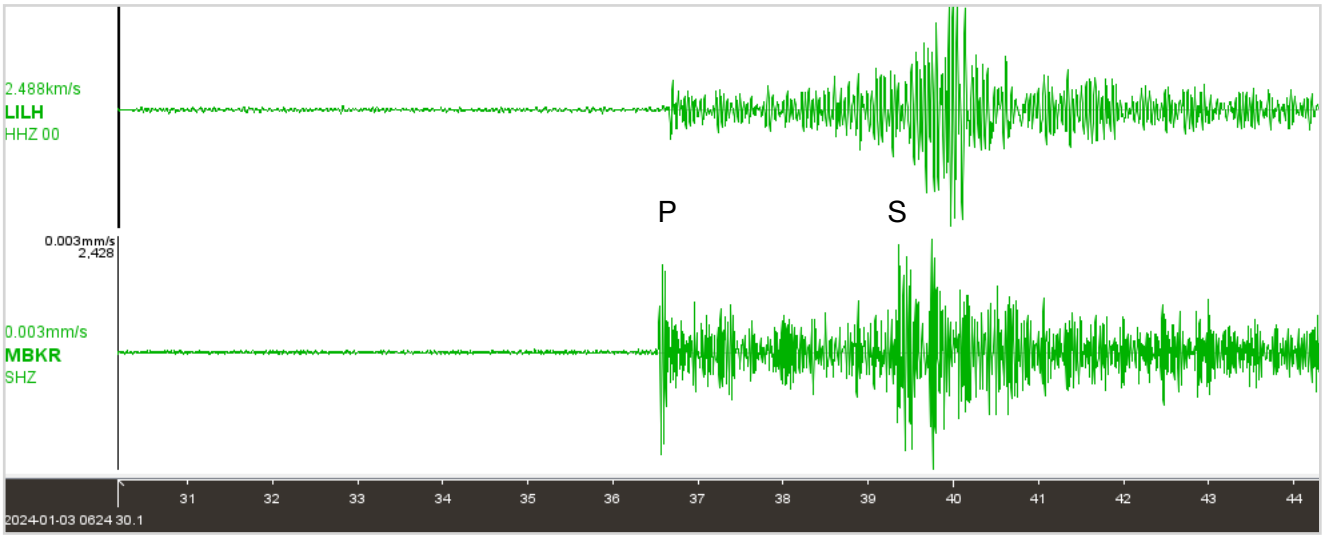


Figure Seismogram of a small local earthquake recorded on LILH with an L4C vertical seismometer compared with the vertical component of a nearby seismograph MBKR with an S-6000 seismometer. The P and S phase arrivals are indicated.

Follow the project on https://github.com/colinlove/peismo

History – for members of the SAA

The first reported earthquake in Darwin, NT

from: The Surveyors The Story of the Founding of Darwin by Margaret Goyder Kerr. Rigby Ltd. 1971.

George Goyder was the Surveyor-General of South Australia in 1869 when he led an expedition to survey the town of Palmerston (renamed Darwin from 1911) in the Northern Territory, then part of South Australia.

One of his team, William Hoare kept a diary in which he mentioned that on 16 July 1869 a slight shock of an earthquake occurred which he thought was coffee grinding. Goyder described it thus:

> *A slight shock of an earthquake occurred between 5 and 6 a.m. The sound like a gong harshly struck at some distance gradually decreasing and more rumbling as it died away. The house shook or trembled slightly. The sound decreased towards the south.*

Not much to go on. Was it a local earthquake or one on the plate-boundary more than 500km away?

How did I become a seismologist?

David Love

I was 32 and working in the then SA Mines Department when my boss Reg Nelson called me in one day. "We are taking over an earthquake network from Flinders University. Could you and Graham look after it for 3 months while we set up an institute and employ a seismologist." Seemed OK; a short diversion from geophysics: gravity, magnetics, seismic and data management. This was August 1986 and I had just missed the Marryat Creek earthquakes.

I was in no hurry to knuckle down and learn, because it wasn't going to be for long. Alison McArdle (now Wallace) and Jennette Brown came with the network, and they could keep on locating the earthquakes. But I learnt a bit about the data management from Roy McDougall. Two Department technicians Russell Job and Kym Gaard had to learn the ropes more quickly because they had to keep the instruments running. There was not a long time for them to learn from Bob Nation, the University technical officer.

The Seismological Association of Australia Inc.

PO Box 682, Mylor SA 5153

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).

Committee

Chair - Blair Lade
m: 0407 189 061
e: blairl@bettanet.net.au

Chief Seismologist - David Love
p: 08 8336 8003
e: david@earthquake.net.au

Public Officer - Paul Hutchinson
m: 0419 829 216
e: windfarmer@bigpond.com

Treasurer - Joe Grida
m: 0407 558 036
e: joe.grida@internode.on.net

Newsletter Editor - Kevin McCue
m: 0405 082 306
e: mccue.kevin@gmail.com

Committee member - Gary Gibson
m: 0457 699 277
e: gary@earthquake.net.au

On 16th October, in the lead-up to the Grand Prix, a plane broke the sound barrier west of Adelaide. It was reported as an earthquake in the paper the next morning. Phones ran hot. We had to work on a response plan to handle the media and public. (Our first plan said nothing about measuring aftershocks.) My managers heard that one normally distributes a questionnaire to gauge the effects. I was told to run off 3,500 questionnaires! The replies and telephone reports soon made it clear that it was not an earthquake, even before the outlying seismograph records came in. A bit awkward.

Somewhere along the way, I learned from Alison and Jennette how to locate an earthquake. I did have 12 lectures on 'earthquakes and planetary interiors' from Dr David Sutton in 1975 as a third year unit while doing my degree in Physics at Adelaide University. I was more interested in mining exploration and completed Honours in Geophysics the following year. The unit with Dr Sutton was just an extra and I soon threw away my notes. Our first big earthquake came on 16th December 1986, off the end of Kangaroo Island. I think it took 36 hours to get our first epicentre, and it was at the wrong end of Kangaroo Island.

I met Gary Gibson in 1987 (a rare interstate work trip) and we bought some of his equipment and software. I remember March 1988 when he walked in with a new computer, and had Alison and Jennette locating earthquakes within 2 hours.

Fortunately, I had continuing help from Dr Stewart Greenhalgh, who also brought in Cvetan Sinadinovski. Cvetan and I converted the old data sets to the new format, and also converted the old magnitudes to a better one developed by Stewart.

It was in 1988 that I went to my first earthquake building code meeting, because my boss was not available. I sat between Kevin McCue and Gary and kept my mouth well zipped. Following that, with help from some really good programming by Roy, I did my first hazard analysis.

1988 was the Tennant Creek sequence, but crossing the border was rare, so I didn't go there. I did manage to get to Uluru following a big event there in 1989, but we recorded no aftershocks; very disappointing. The Newcastle Earthquake happened in December 1989. Things suddenly went from interesting to deadly serious. I was hooked.

Maps of Earthquakes Oct to Dec 2023

Clive Collins has again created interesting epicentre maps for the Newsletter covering the last quarter of 2023 (LHS) and the whole of 2023 (RHS).

The first shows continental Australia in its plate tectonic setting, the plate boundaries are the thin red solid lines (USGS version). The intraplate earthquakes are mainly in the old, cold continental crust and smaller and less frequent, whereas the interplate earthquakes are larger and more frequent and in younger oceanic crust.

We have mentioned the larger M7+ earthquakes but plotted here is everything above ~M4.5 on the plate boundary but down to M3 intraplate. These limits are about what is practicable with the existing seismograph networks.

In this quarter, the least active States are Queensland and Tasmania but it hasn't always been so and hazard practitioners need to look at a longer time period (see also Mike Turnbull's article below). More earthquakes occurred in WA than in the other states or territories, comparable though with central Australia; South Australia and the Northern Territory combined.

Interestingly New Zealand had a quiet year not a single epicentre blots the islands, and there is a large gap in the plate boudary through the Southern Ocean south of SA and WA.

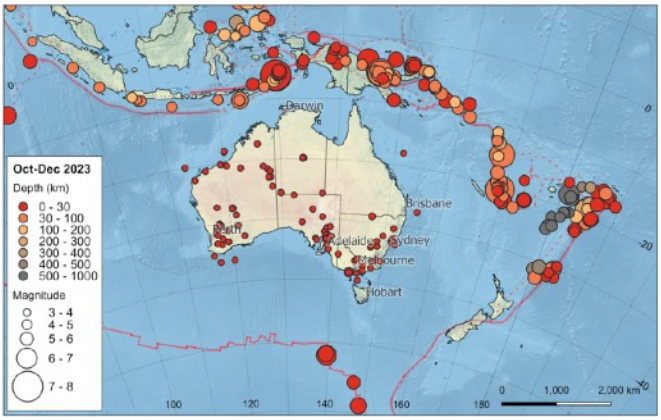
We decided to add epicentre plots for the whole year in addition to those for the last quarter. None of the 9 potentially damaging earthquakes in Australia during the year, magnitude 4 or more, was close to a populous urban area.The year's largest earthquake, magnitude 5.0 to 5.6 occurred near Gnowangerup, WA. It did minor non-structural damage locally (ceilings down, cracked walls) and shook some residents of highrise buildings in Perth. See article in SAA Newsletter #4 2023).

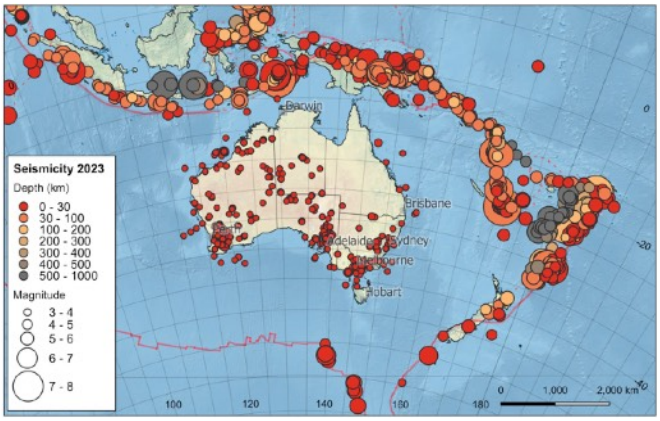
https://earthquake.net.au/index.php/2023/08/10/gnowangerup-earthquake/

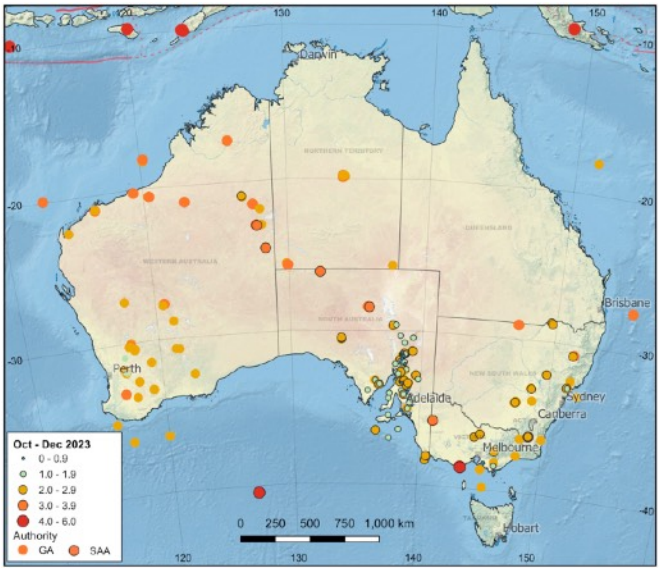
SE Queensland earthquakes - more seismographs needed to clarify the situation

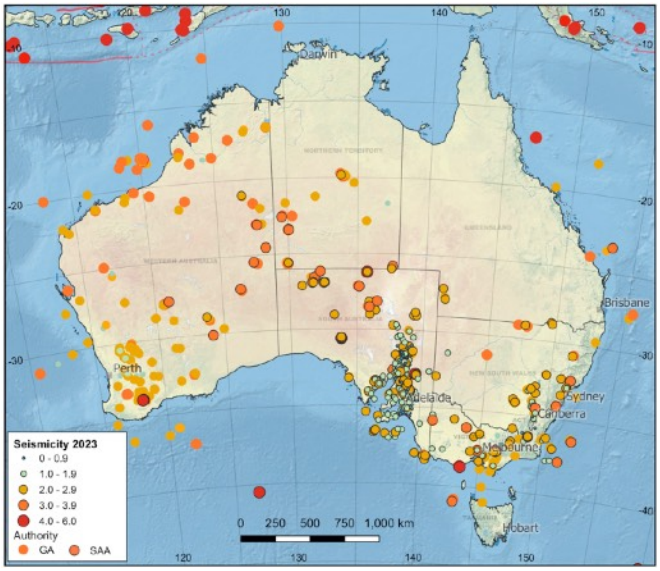
Mike Turnbull

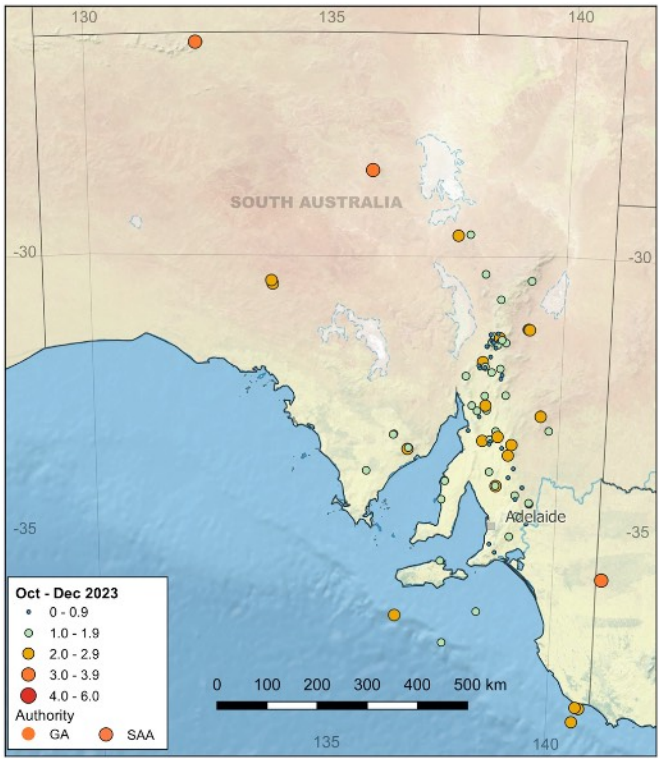
I have attached a map showing all the earthquake events that I have detected and located associated with the Bowen 2011 ML5.4 sequence, the Whitsunday Passage 2016 ML5.8 and 2020 ML5.0 events, and other events that have occurred since those main events.

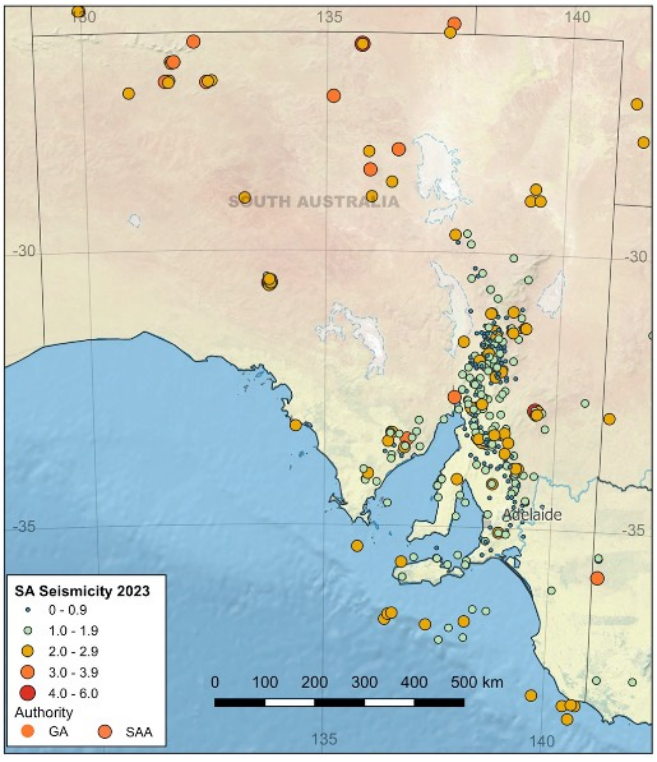

Oct-Dec 2023
Depth (km)
0 - 30
30 - 100
100 - 200
200 - 300
300 - 400
400 - 500
500 - 1000
Magnitude
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
Darwin
Brisbane
Perth
Adelaide
Sydney
Melbourne
Hobart
0 1,000 2,000 km


Seismicity 2023
Depth (km)
0 - 30
30 - 100
100 - 200
200 - 300
300 - 400
400 - 500
500 - 1000
Magnitude
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
Darwin
Brisbane
Adelaide
Sydney
Melbourne
Hobart
0 1,000 2,000 km


Oct - Dec 2023
0 - 0.9
1.0 - 1.9
2.0 - 2.9
3.0 - 3.9
4.0 - 6.0
Authority
GA
SAA
Darwin
Perth
Adelaide
Brisbane
Sydney
Canberra
Melbourne
Hobart
0 250 500 750 1,000 km


Seismicity 2023
0 - 0.9
1.0 - 1.9
2.0 - 2.9
3.0 - 3.9
4.0 - 6.0
Authority
GA
SAA
Darwin
Perth
Adelaide
Brisbane
Sydney
Canberra
Melbourne
Hobart
0 250 500 750 1,000 km


SOUTH AUSTRALIA
Adelaide
Oct - Dec 2023
0 - 0.9
1.0 - 1.9
2.0 - 2.9
3.0 - 3.9
4.0 - 6.0
Authority
GA
SAA
0 100 200 300 400 500 km


SOUTH AUSTRALIA
Adelaide
SA Seismicity 2023
0 - 0.9
1.0 - 1.9
2.0 - 2.9
3.0 - 3.9
4.0 - 6.0
Authority
GA
SAA
0 100 200 300 400 500 km

This includes a few (pink dots) of the 1,377 events that were only recorded on the BW stations, that I did not previously attempt to locate but have now started to do so (using the first motions of BW1H and the relative arrival times at the two stations to glean an azimuth). Clearly the locations are forming an eastward arc suggesting an overall annular aspect – however, this appearance is likely an artefact produced by the available monitoring station geometry (BW1H, BW2S, AUAYR, TV1H, TV2S, AND CTAO).

annular feature, and this provides some evidence that the overall feature may be an artefact.

Given the fact that this whole area is currently generating the majority of detectable Queensland earthquakes (about 60 in 2023), more than any other region of Queensland, and given the economic importance of the Bowen/Whitsunday/ Mackay region, it would seem to make good sense both economically and scientifically, to deploy an extra number of temporary stations along the coast between where BOW2 was located down to Proserpine, and southwest of

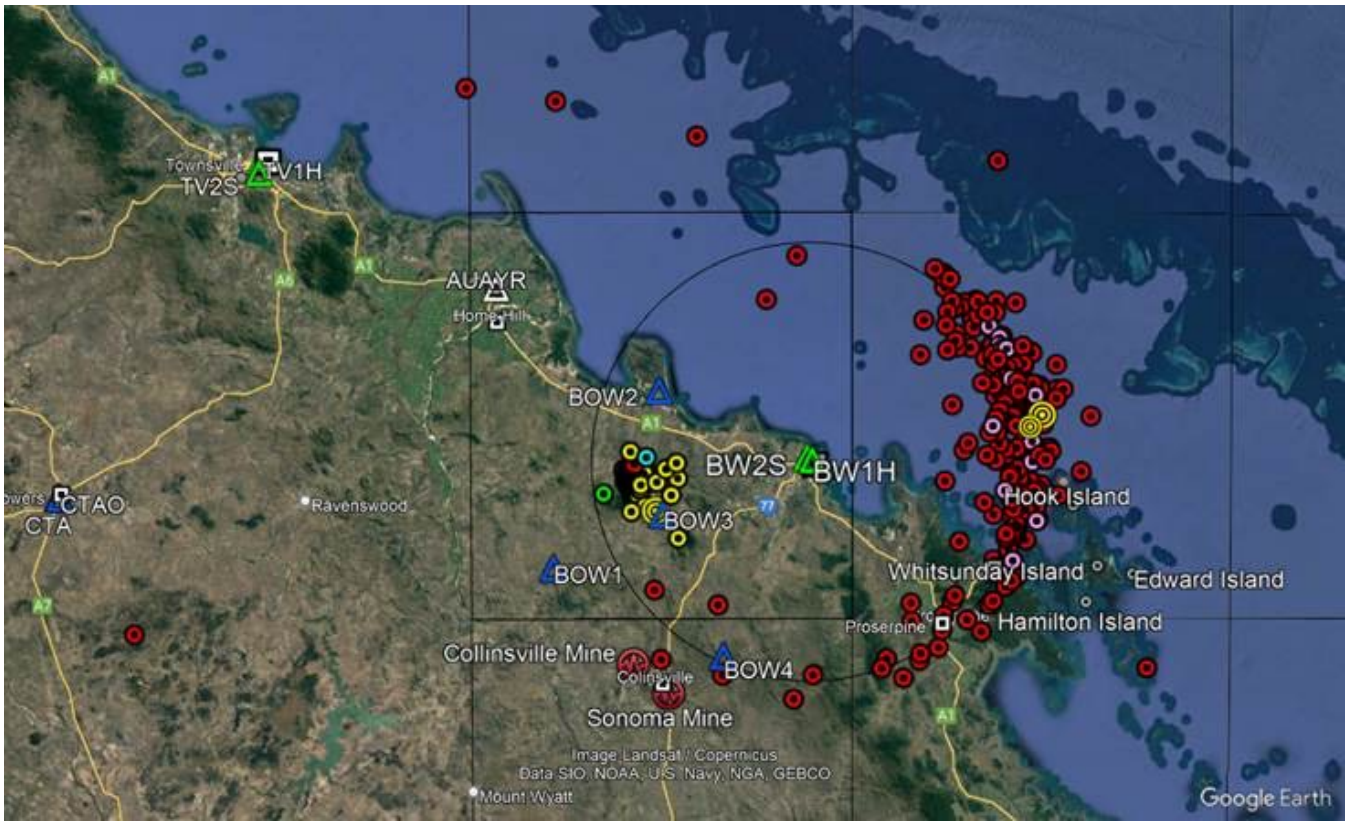


Figure Earthquake associated with the Bowen 2011 ML5.4 sequence, the Whitsunday Passage 2016 ML5.8 and 2020 ML5.0 events, and other events that have occurred since those main events.

The yellow dots are the aftershocks of the 2011 ML5.4, to the west of Bowen. Most of those events were located using the additional GA aftershock deployment of BOW1, 2, 3, and 4. Those event locations do not conform to the Bowen out to near Collinsville, so that a better picture can be formed of just where the earthquake events are actually occurring.

It would be useful for GA to deploy a temporary network of (say) five or six stations in that area, for 2024 – or at least for a few months. The data from those stations would clarify the situation. The temporary stations could be recovered after a suitable time. I would be happy to assist with deployment and ongoing maintenance issues.