Newsletter of the Seismological Association of Australia Inc. Quarter 2, 2022

Seismological Association of Australia Inc.

Welcome to the Newsletter of the
Seismological Association of Australia Inc.
PO Box 682, Mylor SA 5153

Membership of the SAA is open to all, with the only prerequisite being an interest in seismology. Membership applies for the calendar year. (January through to December)

Membership fees are: Full member $50

A Membership application form can be obtained from the Treasurer by email or you may download it here.

Member Submissions

Submissions for inclusion in the Newsletter are welcome from all members; please note that submissions may be held over for later editions. Wherever possible, text submissions should be sent via email in almost any word processing format. Images should be high resolution and uncompressed, although high resolution JPEGs are acceptable. Your name may be withheld only if requested at the time of submitting.

All enquiries and submissions should be addressed to the Editor and preferably sent by email to weaksignals@iinet.net.au

Your Committee

Chairperson - Blair Lade

mobile: 0407 189 061 email: blairl@bettanet.net.au

Chief Seismologist - David Love

phone: 08 8336 8003 email: david@earthquake.net.au

Public Officer - Paul Hutchinson

mobile: 0419 829 216 email: windfarmer@bigpond.com

Secretary / Treasurer - Joe Grida

mobile: 0407 558 036 email: joe.grida1@bigpond.com.net

Committee Member - Kevin McCue

email: mccue.kevin@gmail.com

Committee Member - Col Lynam

email: col.lynam@gmail.com

Editor - Peter Gray

mobile: 0418 829 632 email: weaksignals@iinet.net.au

The SAA can be contacted by post to the address above, or by email to any member of the Committee.

SAA News

2022 SAA Member Meeting Schedule - Please note the following dates for Member's meetings which will continue to be held via ZOOM for the foreseeable future, we'll let you know if this situation changes as the year progresses. Monday, June 13th and Monday, August 8th. The AGM will be held on Monday, October 10th at 7:30pm ACST, 8:00pm AEST and 10:00 UT. via ZOOM. All members should receive an invitation and link to attend prior to each meeting.

The first two Members' meetings for the year went well. In February, Kevin McCue and Blair Lade presented some more detailed seismic and barometric information on the Tonga eruption and David Love presented additional data and images of the Murrayville aftershocks and some preliminary work on Arthur River. Much of the second meeting held in early April was a short presentation on the wobbly building project at Adelaide Uni. Jerry Vaculik from Engineering outlined the process that three of his engineering student would be following in their pursuit of the vibration characteristics of the Schulz building. The SAA has offered a small grant to encourage these students to crunch the numbers for us. The Mount Barker quake and aftershocks were discussed at length by David and an enthusiastic collection of members directly involved in capturing the data at close range. Col Lynam informed members of a new "heritiage" copy of the QLD Earthquake Database that he has been involved with, along with the Royal Society of Queensland. The link will take you to this important historical resource.

2022 SAA Committee Meeting Schedule - Should members wish to propose an initiative, make a suggestion or just have a whine about something we've done, or plan to do, please note the following dates for Committee Meetings. Monday, May 9th : Monday, July 11th : Monday, September 12th and Monday, November 14th.

Site Updates - Winter is looming fast and as usual, we had to have at least one battery go down the tubes at the worst possible moment. **UTT** required a new battery and the EchoPro needed a new GPS for the ongoing Week Number Roll Over problem which Blair carried out in early March. **THS** required another battery change, right in the middle of the Mt Barker events, so Blair & Peter recently ventured out to Sampson Flat to sort it out. In late March, **ROBE** went offline unexpectedly with a suspect 3G modem. Peter and Mr Paul Bedford from Broken Hill visited the site while caravanning around SA but by the time we had arrived onsite with a replacement modem, everything was back to normal. It seems the problem was with Telstra but we went and checked out things just in case, the last visit was back in 2019. David recently did a quick trip out to Strathalbyn (**STR2**) to reinstall the Guralp CMG 5 Triaxial Accelerometer that was used for the wobbly building project, in time to provide some strong motion data during the Mount Barker aftershock events. Another PSN station out along the western side of the Murray River (Mannum, SA) took a step closer to completion with a new code being issued by Paul Harris at the Aust. Centre for Geomechanics in WA.

SAA News is continued on Page 18

Mount Barker M3.8 earthquake 6th March 2022

Kindly submitted by David Love, SAA Chief Seismologist

On Sunday morning 6th March at 7:20 am (5th March 2050 UT) a number of our members noticed the earthquake. There was some extra excitement for our seismologists and supporters, knowing that this was what we were running instruments for. As an association we were ready, and quickly into action. Within minutes I was contacted by a few members to check that I was aware of the event, which was appreciated. We had a location and depth that we could report to police, Geoscience Australia and the media in less than 30 minutes. We had coverage on two TV channels later in the day. Fortunately this was not a damaging earthquake; just a little above what I call the 'cute' range.

Our network performed well, thanks to all our members and supporters. This meant there was good coverage. The PSN recorders at Mount Barker (MBKR), Lobethal (LBTL) and Aberfoyle Park (ABFP) were among the closest stations. They all went off-scale, but the addition of these P waves helped confirm the depth of this event as being over 20km deep. The first estimate we reported was 26 km. The south-east direction from the event had the least seismograph coverage, but fortunately the ANU recorder at Murray Bridge High School (AMBR) is reliable.
Blair installed two extra portables in that direction, as well as another one in Mount Barker. A portable was installed in Elizabeth (ELZ5) on the Saturday night before the earthquake, at the home of Luke Van Den Bos. He was thrilled to record an earthquake the next morning.
Figure 1 shows stations in the region. Of these only Marden (AUMAR), Peake (PEA2) and Modbury Heights (THS) were not running. The three extra portables are shown as CAL1-3.

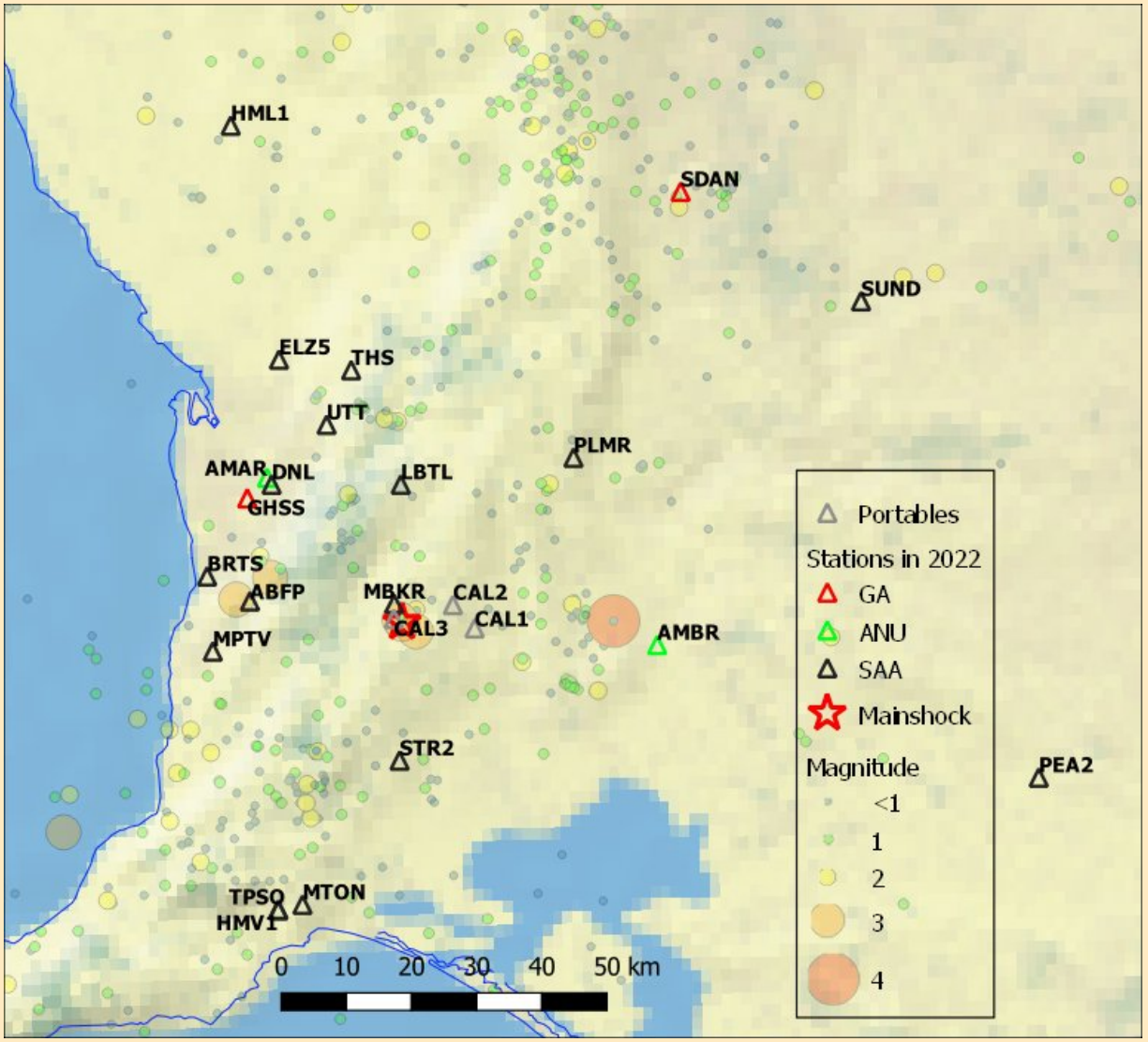


Figure 1: Red star is mainshock. Triangles are recording stations. Portables are grey triangles. Earthquakes since 2006 in background.

Mount Barker M3.8 earthquake
6th March 2022

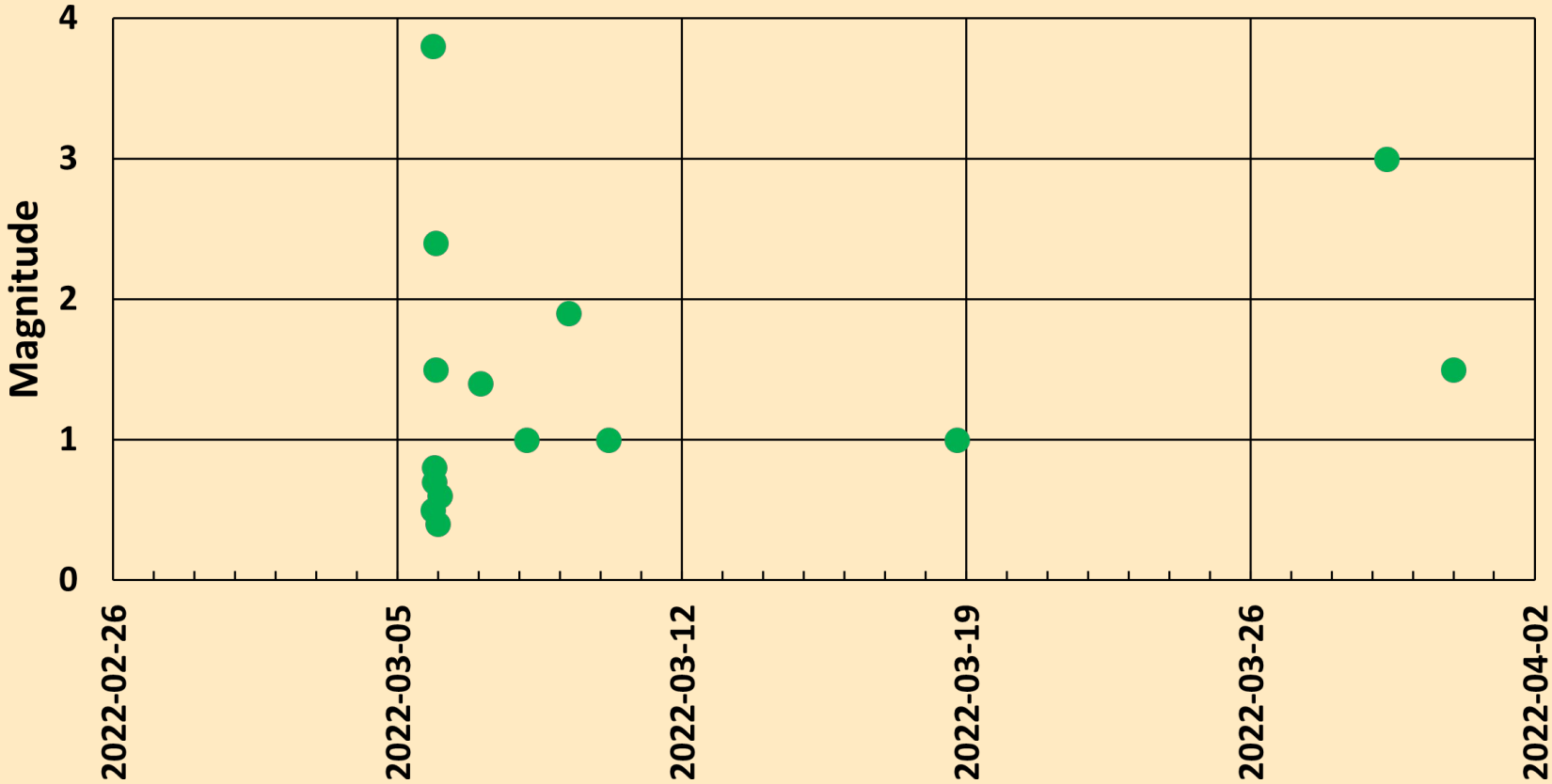


Figure 2:

Mount Barker mainshock and aftershocks.

Probably complete above magnitude 0.7.

Aftershocks were noticed in the following hours, and to date 14 aftershocks have been recorded. I expected there would be none, or just a few. I was wrong. The sequence is shown in Figure 2. The magnitude 2.4 aftershock at 9:00 am was felt, but most of the others were not, due to the depth. All aftershocks greater than magnitude 0.7 are likely to have been recorded. I suggested that Blair retrieve the portables after about 10 days, which happened on 17th, only to be followed by another on the 18th. However the hidden surprise came on 29th March, with a magnitude 3.0 at 7:04 in the evening. I did not feel it, but had a call in very short order, before the data was visible on the Melbourne Uni server! We had more good media coverage from this, but it left us wondering "what next?". As a result, we have installed an extra accelerometer in Littlehampton, reinstalled one of the portables, reinstated the accelerometer at Strathalbyn, and are reviewing other options.

Mount Barker M3.8 earthquake
6th March 2022

Figure 3 shows the epicentral area in more detail, with aftershocks as well as past activity. A magnitude 4 earthquake will rupture roughly a 1 sq km area, and magnitude 3.7 about half of this. Most of the aftershocks are within 1.5 km of each-other, showing that our locations are quite accurate and reliable. Two of the smaller ones have slightly greater uncertainty. Changing the velocity model made almost no difference to epicentres, and only minor changes to depths. The 2019 events are particularly close, along with the 2010 event. In 2010 a number of the current stations were not running, and the epicentre less accurate. Thus it is possible that the 2010 event was at nearly the same location as the current activity.

Past History

McCue (1975) produced a map for an 1883 earthquake estimated around magnitude 4.5. This was in the region of Mount Barker, and is the largest event known close-by. Love (2010) reported on the 2010 event of about the same size and location as the recent one. It did not have any aftershocks, which leads to the obvious question - why did the latest one have aftershocks?

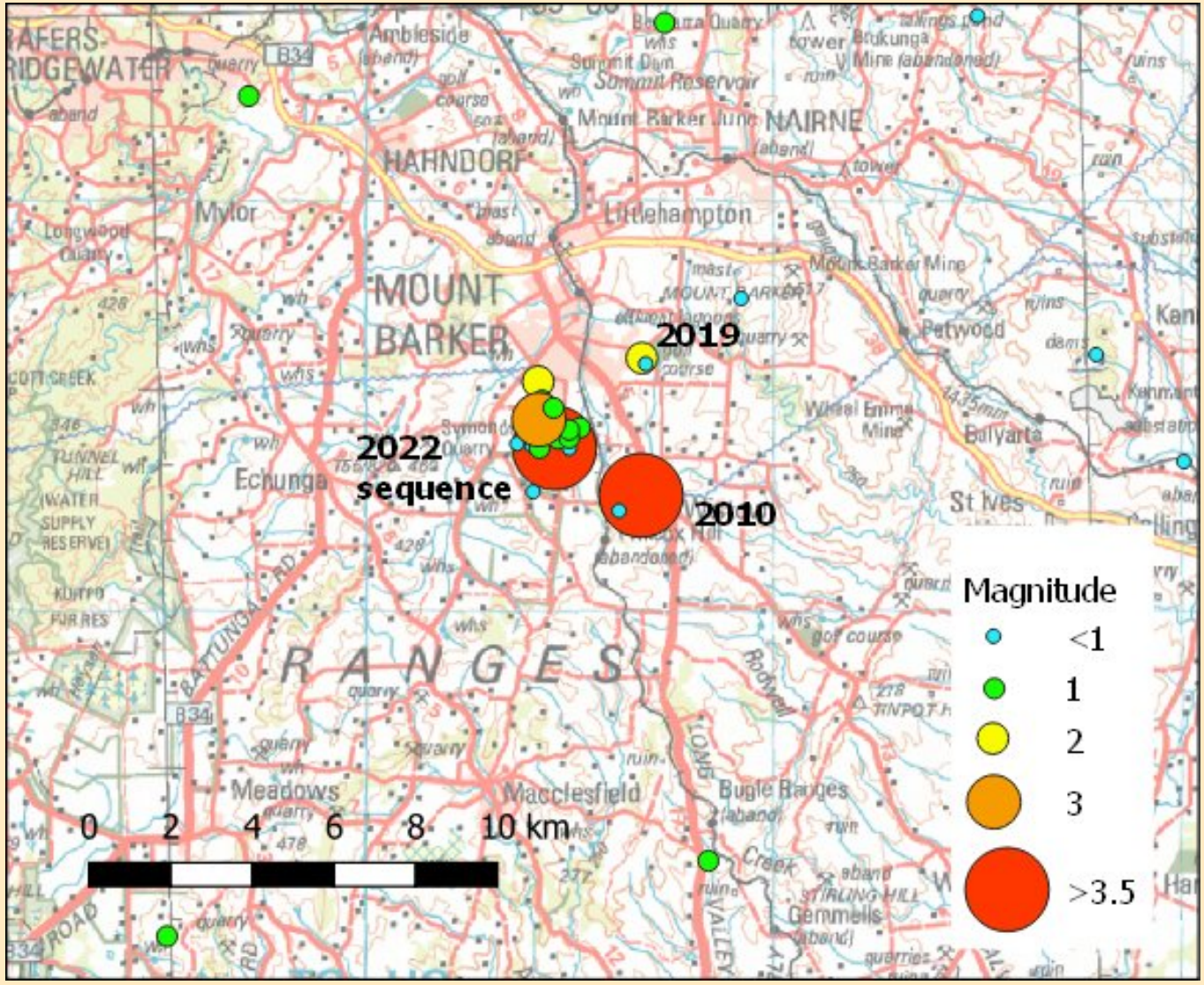
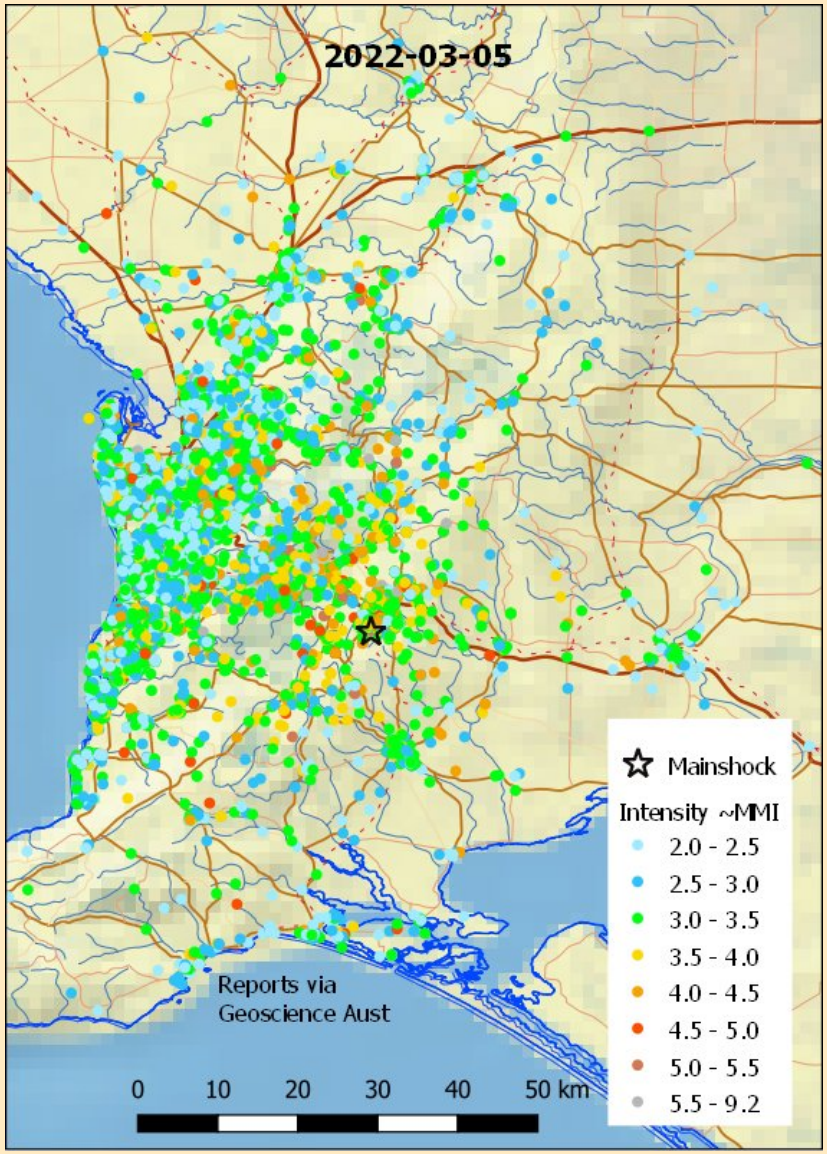


Figure 3: Earthquakes since 2006 near Mount Barker. The small event over the 2010 event is an inaccurate aftershock of the 2022 sequence. There were 2 small events nearby in 2019.

Mount Barker M3.8 earthquake
6th March 2022



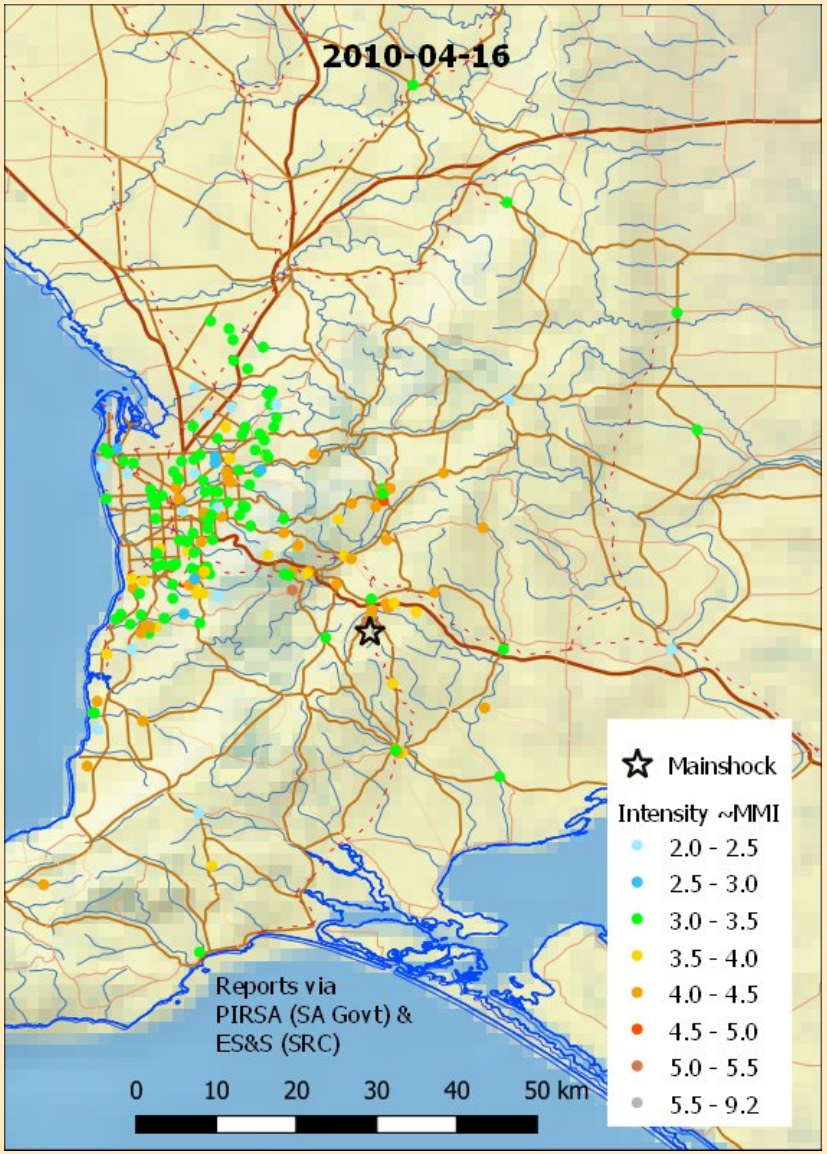


Figure 4: Felt reports

2022 earthquake
4a (left)

2010 earthquake
4b (right)

Mount Barker M3.8 earthquake
6th March 2022

Felt reports

The Geoscience Australia felt report service received over 12,000 reports, mostly within the first hour, and these are shown in Figure 4a. Given the depth, it is not surprising that the epicentral area does not show a big intensity difference. Further work is being done on this data to see if any areas of increased intensity can be demonstrated. In areas closer to the epicentre, over 4% of the population put in a felt report. In 2010, felt reports came from various directions. GA and ES&S (Seismology Research Centre) had questionnaires on their websites, and PIRSA (SA Govt operating network) mailed out forms. The USGS already had an automatic website to collect and display this data. They received about 700 reports which were amalgamated into readings at 6 towns. This was more than the combined reports for the Australian groups. Also in 2010, the GA and PIRSA websites crashed due to heavy traffic, although neither had information for the event at that time! Results from ES&S and PIRSA for 2022 are shown in Figure 4b.

Depth

Prior to the network upgrade around 2006, it was not possible to calculate reliable depths over most of South Australia, particularly near Adelaide. Events around 20 km deep were being pondered on when the 2010 event came along. Since then it has been found that many events are quite deep, and the increased station density has improved the situation still further. The 2010, 2019 and 2022 events all appear to be deeper than 20 km. The actual depths are difficult to tie down, as the P and S velocities and depth to Moho are not accurately known. For the larger events, if more distant stations are included, the depth tends to be greater. My present best estimate is in the range 22 to 24 km. To calculate a reliable depth requires stations around the event so that the largest gap is less than 180 degrees, as well as a close station, preferably with an epicentral distance of less than the depth. GA uses their own stations plus the Seismometers in Schools, therefore they are not able to produce reliable depths over most of the region around Adelaide. The default depth of 10 km is broadcast without explanation!

Magnitude

Geoscience Australia is using the Greenhalgh equation developed for South Australia. At present, the magnitudes shown on the SAA website are all using a standard formula from California. We hope to convert this at a later stage.

Focal mechanisms

Focal mechanisms have been produced for 2010, 2019 (mag 2.2) and 2022 (mag 3.8 and 3.0). These are shown in figure 5. They all show compression with the dominant direction being WNW - ESE. Either of the 2 planes in a focal mechanism may be the one that ruptured. The planes for each of the events are slightly different, suggesting that the breakages were not on any single fault surface. These mechanisms use only the up/down direction of the first P arrival. It is hoped to improve these with S wave information at a later date.

Mount Barker M3.8 earthquake
6th March 2022

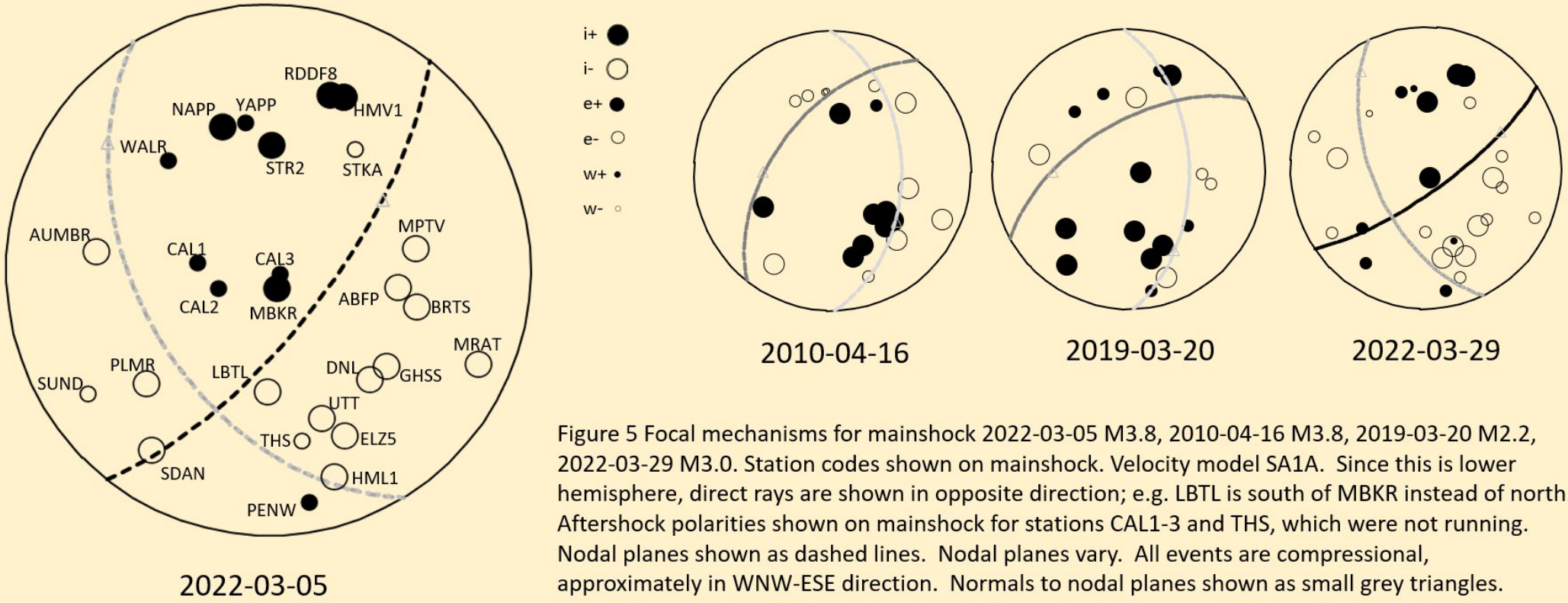


Figure 5 Focal mechanisms for mainshock 2022-03-05 M3.8, 2010-04-16 M3.8, 2019-03-20 M2.2, 2022-03-29 M3.0. Station codes shown on mainshock. Velocity model SA1A. Since this is lower hemisphere, direct rays are shown in opposite direction; e.g. LBTL is south of MBKR instead of north. Aftershock polarities shown on mainshock for stations CAL1-3 and THS, which were not running. Nodal planes shown as dashed lines. Nodal planes vary. All events are compressional, approximately in WNW-ESE direction. Normals to nodal planes shown as small grey triangles.

References

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

Love, D 2010. The Mount Barker Earthquake - 16th April 2010, Magnitude 3.7. https://aees.org.au/wp-content/uploads/2013/11/31-Love.pdf

Arthur River Earthquake Swarm

Contributions have been made by many people, all acknowledged in the text. This article has been compiled & submitted by David Love, SAA Chief Seismologist

Introduction

At the SAA's Members meeting via Zoom in February, I gave a summary of seismic event activity and investigations to that point. More activity and research has happened since then.

A brief history of installations and activity

In 2020, ANU (Dr Miller) installed a temporary network of seismographs (called SWAN) in the South-West Seismic Zone (SWSZ). Figure 1 shows these sites, along with the permanent Geoscience Australia network, the Seismometers in Schools project (ANU) and PSN recorders installed by Vic Dent.

In January 2022 activity began at Arthur River. There was a little warning from a few events over the previous 5 months. The activity, similar to other cases in the SWSZ was lively with vast numbers of events being felt by locals.

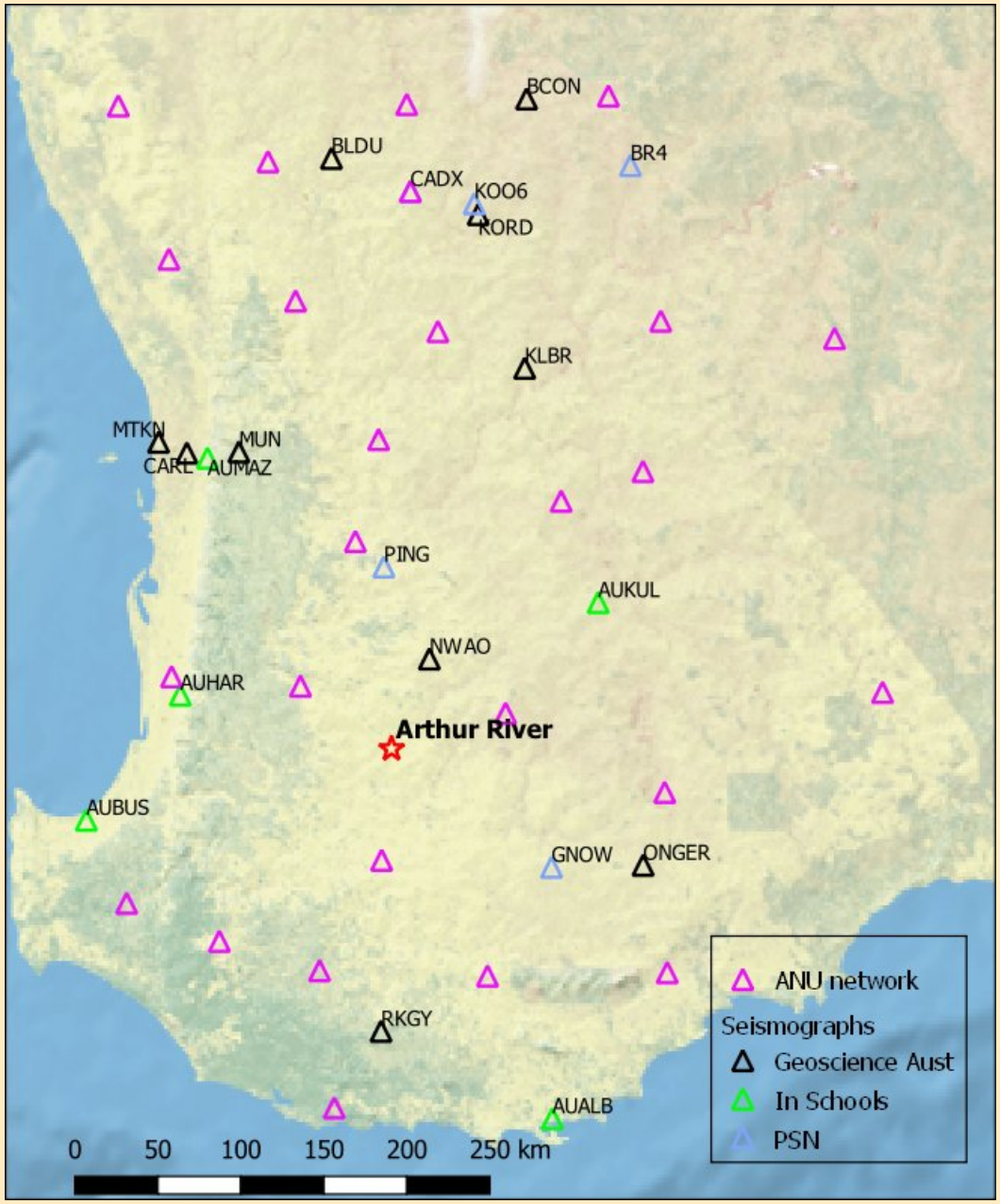


Figure 1: Regional monitoring status in January prior to activity

Arthur River Earthquake Swarm

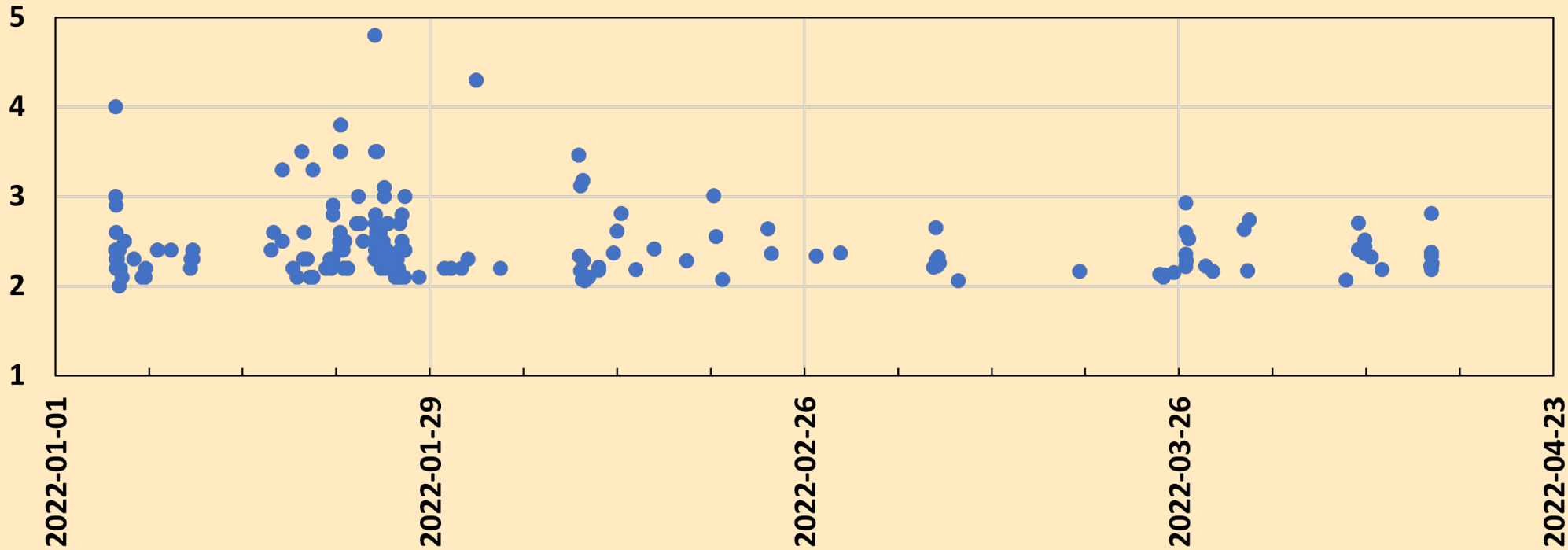


Figure 2: The Arthur River sequence to 18th April. Data from Geoscience Australia

The sequence is shown in figure 2, using data from Geoscience Australia (GA). Early in the sequence a magnitude 4.0 event occurred (4th Jan) followed by many smaller shocks. Following this, Dr Huaiyu Yuan (Macquarie Uni) and Ruth Murdie (Geological Survey of WA - GSWA) installed six recorders moderately close and surrounding the epicentral area (10th Jan). They were Smartsolo recorders with 5 second seismometers. This was apparently a test run before the equipment went to the Pilbara.

Two weeks later a magnitude 4.8 shook a wide area, and rattled locals with hundreds of aftershocks being felt. Figure 3 shows the data for January from the SWAN and Smartsolo recorders. This data was provided by Dr Robert Pickle (ANU).

Arthur River Earthquake Swarm

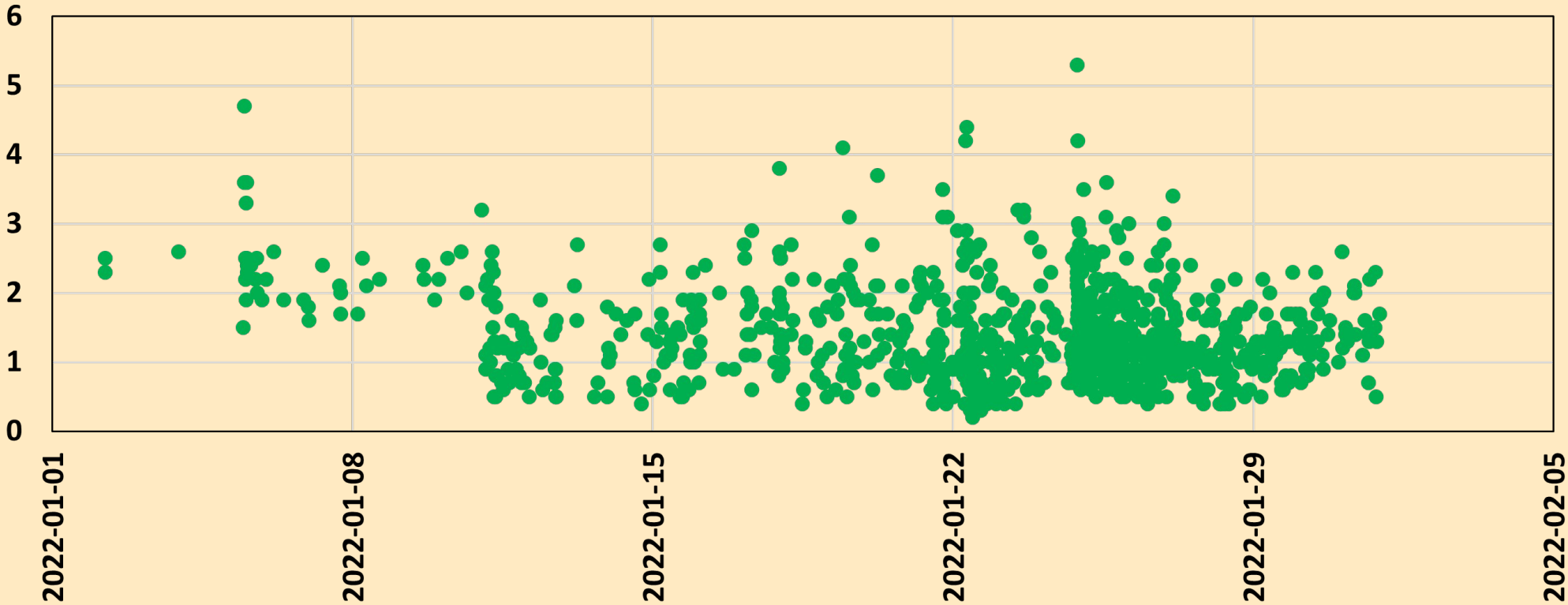


Figure 3: The sequence during January. Data from SWAN and Smartsolo recorders. Note that magnitudes are preliminary

The detection improvement of the close-in recorders over the SWAN and GA networks is clear. Note that magnitudes are preliminary, and use different stations. Following the magnitude 4.8, Alby Judge installed a PSN recorder right in the active area. This was moved about and later expanded to 3 recorders with help from Vic Dent. Figure 4 shows where Smartsolo and PSN recorders were installed.

Arthur River Earthquake Swarm

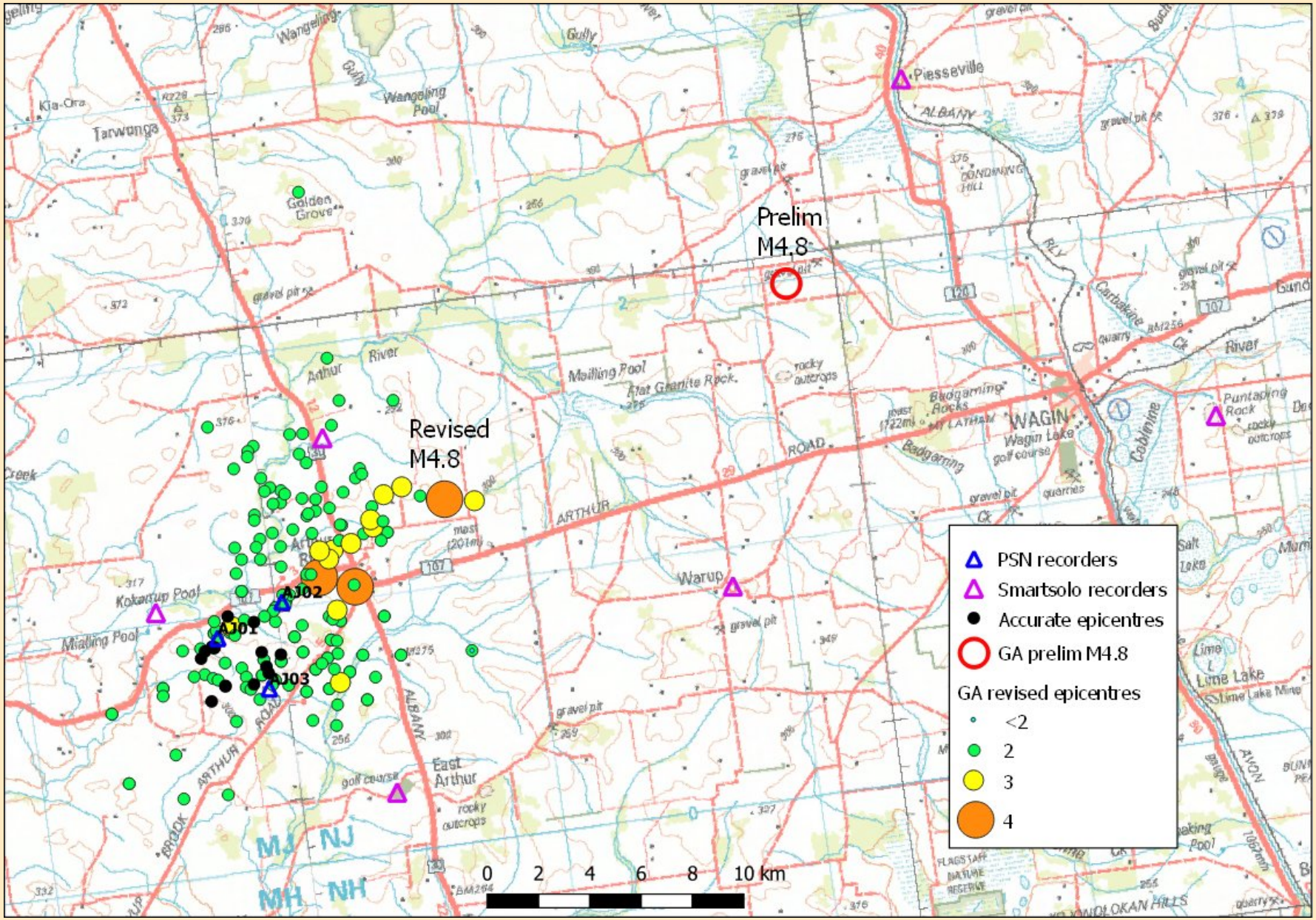


Figure 4:

GA preliminary mainshock location, revised epicentres, and accurate epicentres using Smartsolo data only

Arthur River Earthquake Swarm

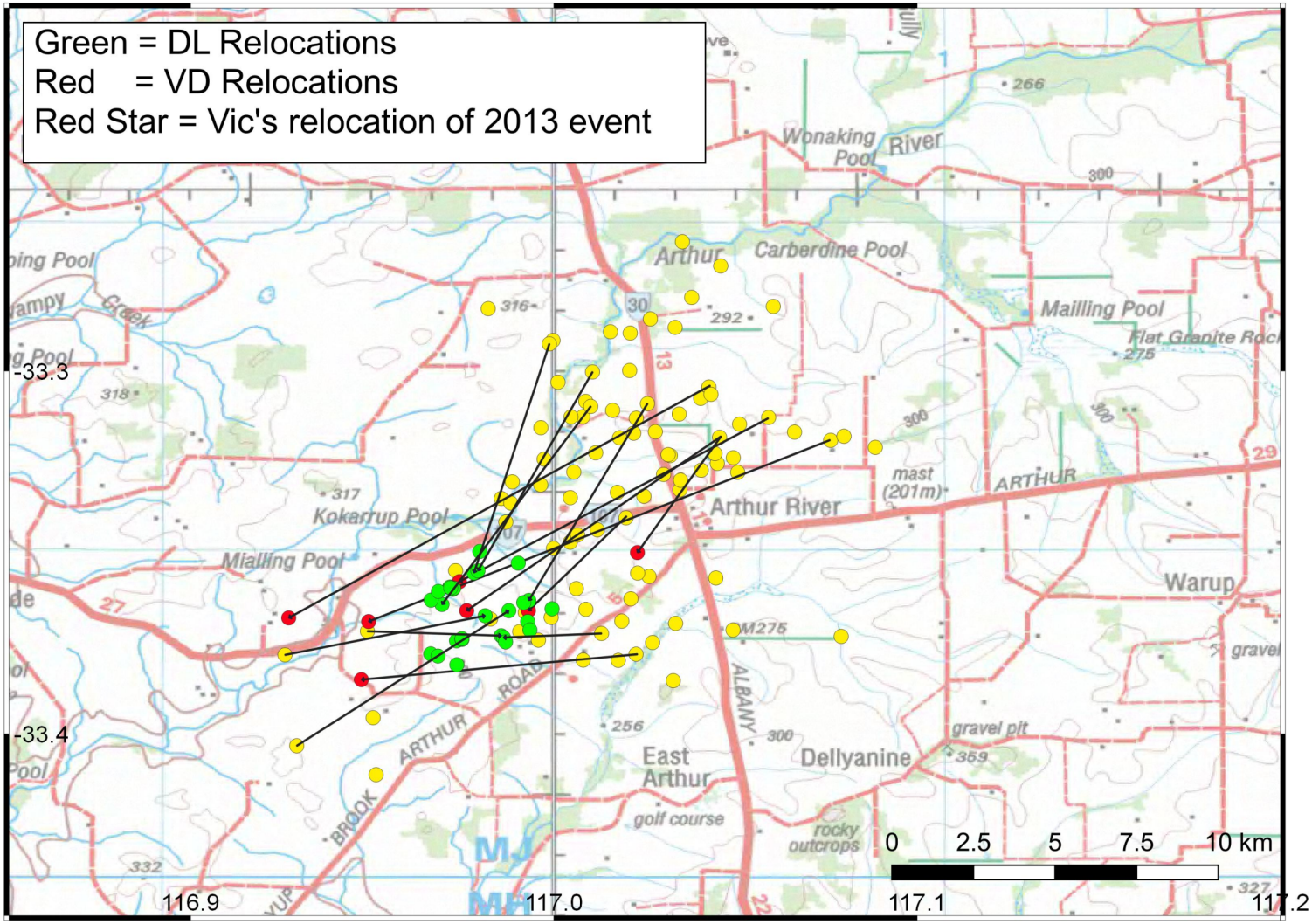


Figure 5:

Relocation of some GA epicentres by David Love and Vic Dent.

Some red points are obscured by green points.

Diagram by Clive Collins

Arthur River Earthquake Swarm

Locating the earthquakes.
Vic Dent has been working on relocations of Geoscience Australia epicentres for many years. Figure 5 (produced by Clive Collins) shows some of these relocations (follow the line from the yellow original to the improved). Most early epicentres were to the north-east of the true locations. If distant stations are used in locations, the result is often inaccurate.
The GA preliminary and revised estimates for the M4.8 event can be seen in Figure 4. Using data from the Smartsolo recorders, I accurately located a few events manually. These all clustered in a small area, just south-west of Arthur River (black points in Figure 4). When all the Smartsolo and PSN data are available, it is hoped that automatic processing by Dr Pickle may give us an interesting picture of the development of this swarm. It will be a rare case where most of the instrumentation was in place before the mainshock. It is also hoped that manual processing of events near the three PSN stations will give enough accurate depths to show what the main rupture plane is.

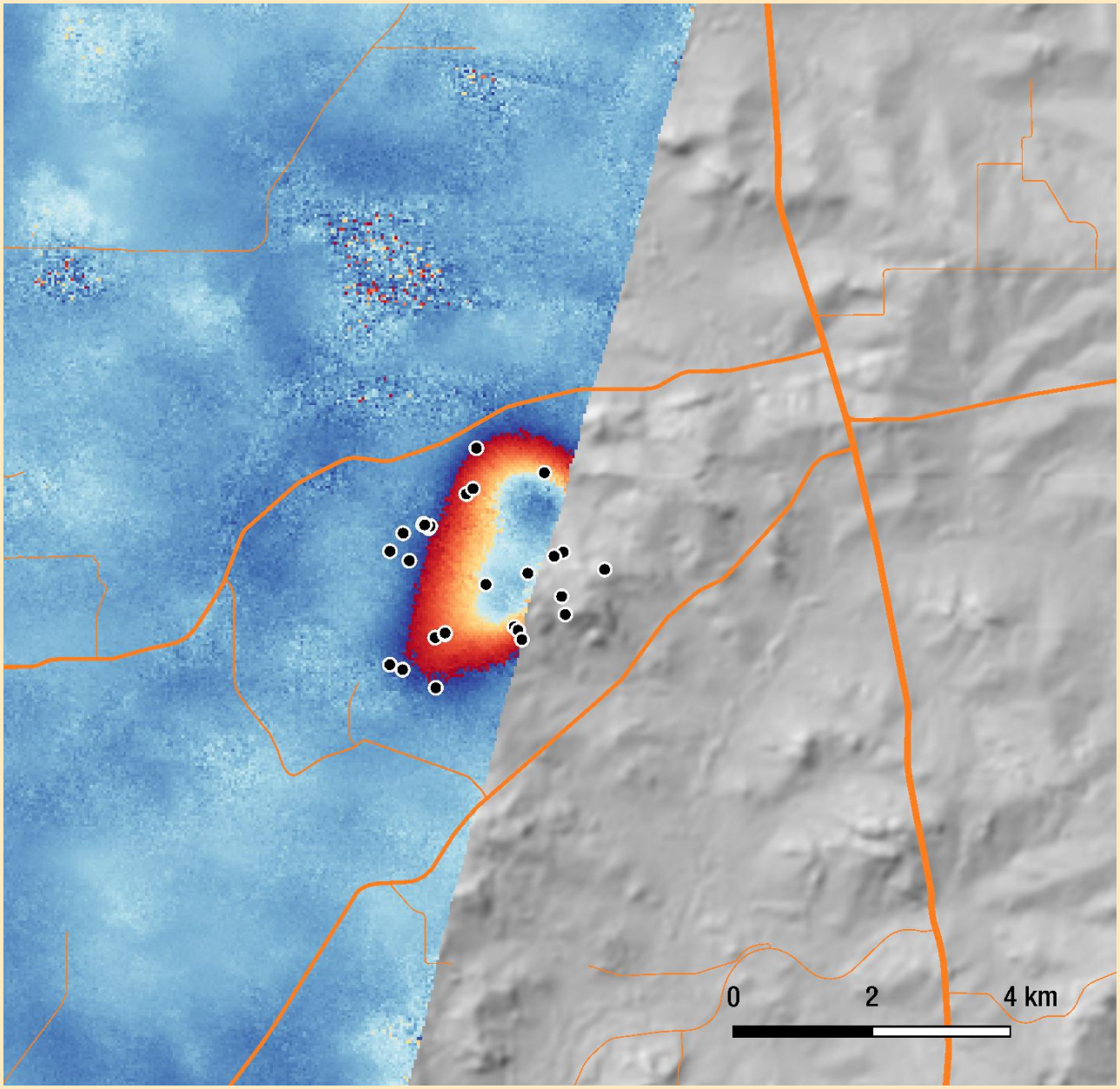


Figure 6:

InSAR image over part of Arthur River with accurate epicentres. The match is very good. Diagram from Dr Valkaniotis

Arthur River Earthquake Swarm

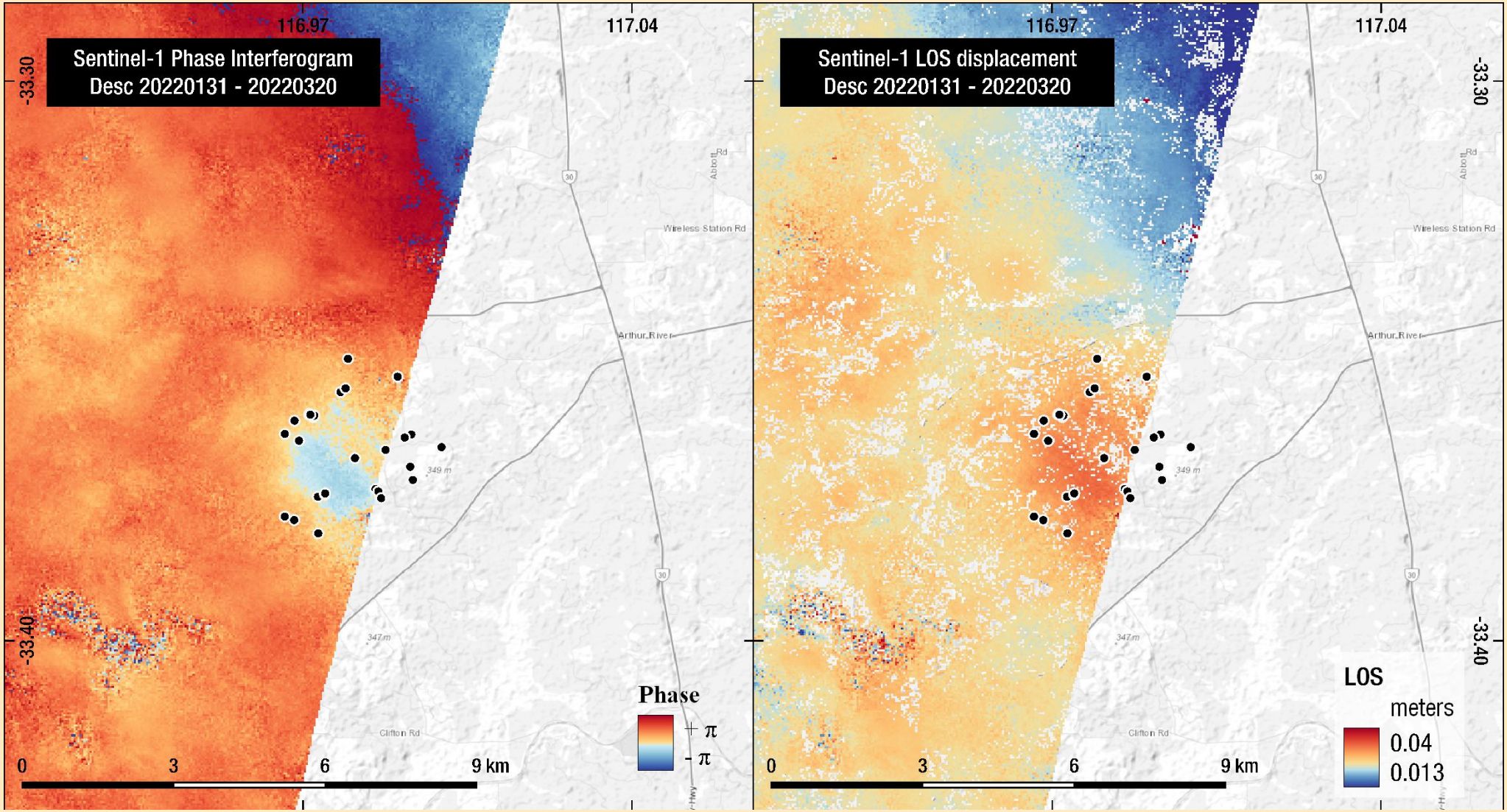


Figure 7: Later InSAR images possibly caused by magnitude 4.3 earthquake on 1st February. Diagram from Dr Valkaniotis

Arthur River Earthquake Swarm

It is unlikely that first motion focal mechanisms will be possible in this case. With very shallow earthquakes, reliable departure angles are not possible.

InSAR results

Interferometric Synthetic Aperture Radar (InSAR) is now commonly used to locate ground movements from many sources, including earthquakes. This is done by determining the difference between two passes of the satellite. Data from the Sentinel 1B satellite has been used for a number of years, however this failed late last year. Thus it was thought that no data would be available. However Dr Valkaniotis (Greece) noticed that Sentinel 1A data over part of the area showed an anomaly. This is shown in Figure 6 with the accurate epicentres plotted. The anomaly occurred during the time interval when the magnitude 4.8 event occurred. He also found a later but much smaller anomaly from two later passes of the satellite. This may have been caused by the magnitude 4.3 shock on 1st February. This is shown in Figure 7.

Figure 8: Photo - Vic Dent. Water seep found by John Pascoe

On the basis of Figure 6, Dr Valkaniotis considers that the rupture has not reached the surface, however he considers that other secondary cracks may have reached the surface. John Pascoe at Arthur River has found an area where a water seep has occurred. He originally thought it was caused by leakage from a tank, however he now believes it is coming from the ground. Figure 8 shows the area. It also indicates where Vic Dent found some fresh jointing nearby.

Arthur River Earthquake Swarm

What next?
Vic Dent has been showing that activity in the SWSZ mostly clusters at particular centres. It is hoped the SWAN project will show this more clearly. Recently data from online stations suggest an area to the north-east is now becoming active. Will it emerge as Arthur River dies out?

Recent (14th April) email snippets make interesting reading:
David: Is Arthur River hotting up again?
Vic: Based on previous large swarms, this activity could easily last a year or more.
Martina: Oh that's great news!!! Certainly felt a few last night!

Being very close (0 - 4 km) to small events does not help sleep patterns.

Stay tuned for the next instalment.

Some more SAA News

Note the new bits - A new addition to the newsletter are some comprehensive maps of seismic activity for Australia and South Australia (for this issue). These maps will eventually replace the Recent Seismic Activity images that have been a regular inclusion for the past year or so. The team of collaborators to this resouce is impressive and their work should be a valuable contribution to the seismic record in Australia**.**

CQSRG 2021 Annual Seismological Report - Mike Turnbull recently announced that the latest Annual Report is now available for download at the link provided.

What is Geoscience Australia's role in reducing risk to Australians from earthquakes? -
Col Lynham recently noticed this question on the GA website and has offered some commentary as points of discussion for members to ponder upon and perhaps provide some answers to.

This is somewhat different catechism to what I listened to while working at UQ, when BMR (now GA) used to say they had "no mandate to monitor Australian seismology" and thus evolved "the great Resignation" by State's and Universities from seismological monitoring and eventually teaching geophysics at all. Because their meagre BMR operational subsidy for seismic data was terminated. Was there a Parliamentary Act that changed the role of GA?
Can anyone point to where this change happened and when?
Does this mean GA should control a definitive Australian earthquake catalog ?

The editor will keep some space in the next newsletter for this, should responses be submitted**.**

On the Cover - Despite the many images submitted for this issue, there was nothing that I could really use as a large spread image for the cover page.
I have updated and recycled the Kangaroo Island "Kingscote Cluster" image created using Google Earth. All the small quakes from the start of this year are shown with date and magnitude, along with some of the more significant events from previous years. This image shows all quakes back to May 2017.

Recent Seismic Activity - Australia

Australian Earthquakes

January - March 2022

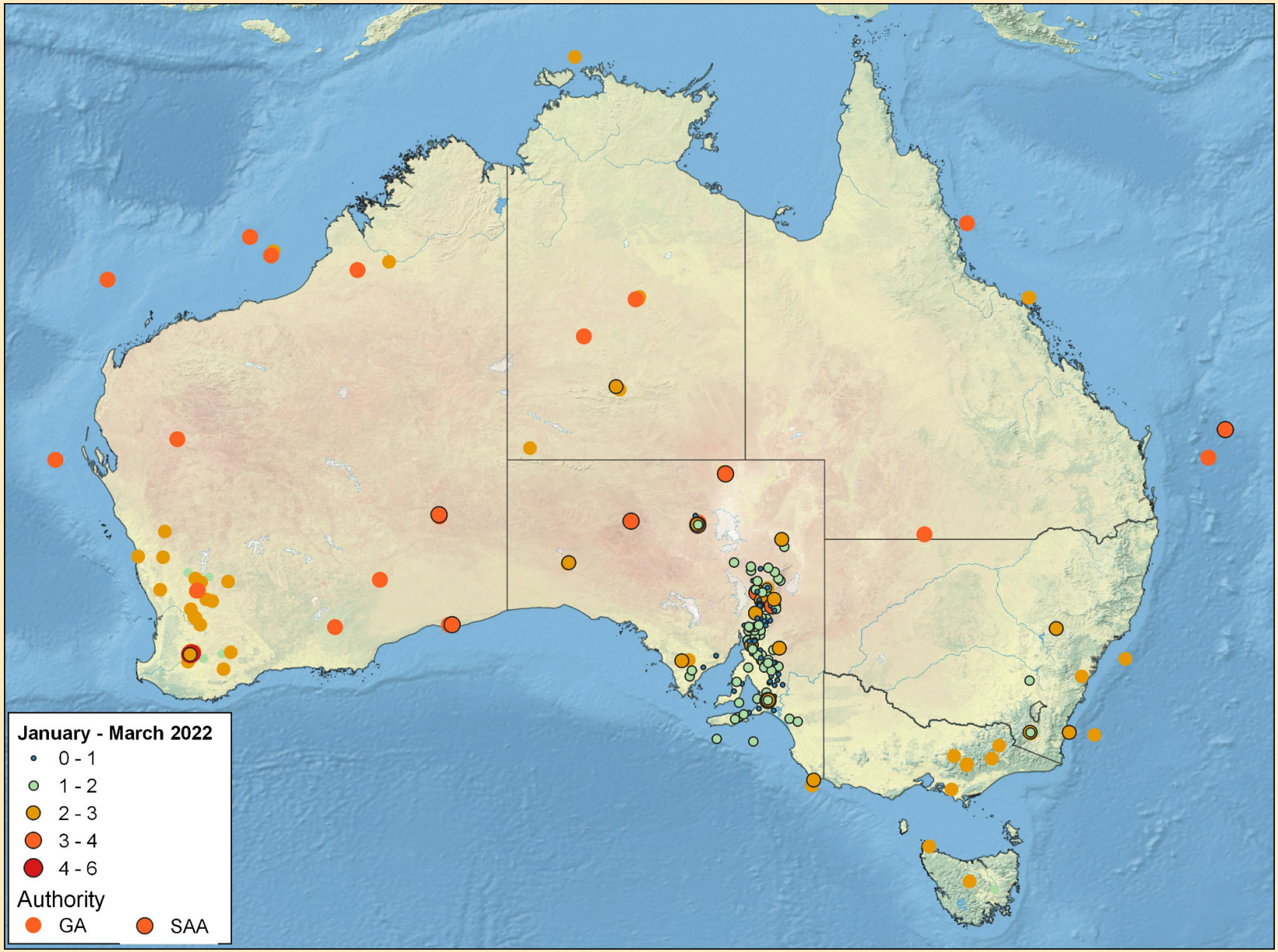
Map produced by Clive Collins

Epicentres from:

Geoscience Australia &
Seismological Assoc.
of Australia Inc.

SAA contributions from:

Kevin McCue (NSW)
Mike Turnbull (CQSRG, Qld)
Alison Wallace
David Love



continued next page...

Recent Seismic Activity - South Australia

SAA computations make use of all data we can readily access including:

PSN recorders
Raspberry shakes
SAA stations
Seismology Research Centre stations
Seismometers in Schools
Geoscience Australia network & occasionally more.

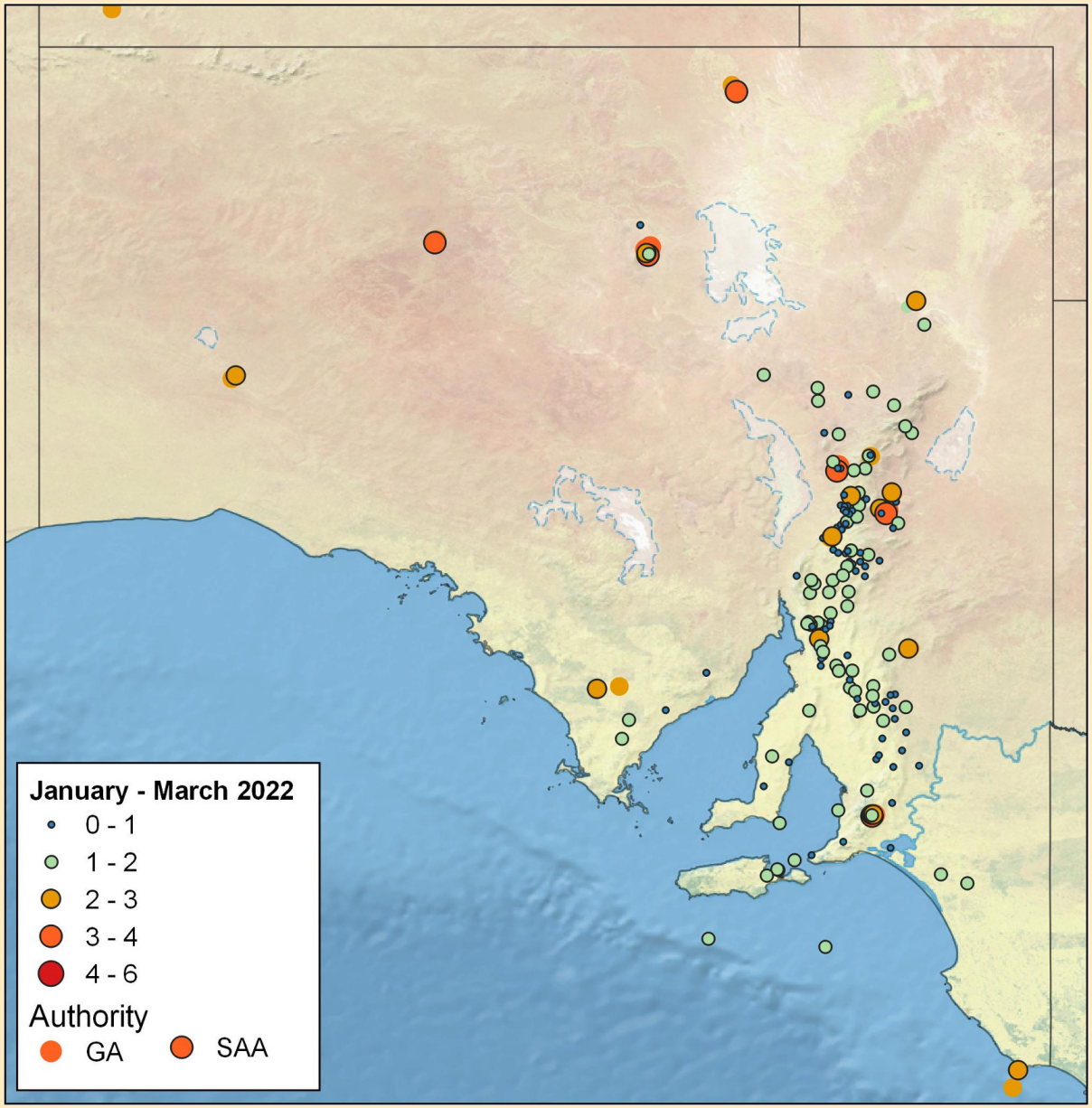
Many thanks to all who keep their instruments running and organisations who keep collecting and making the data available including:

IRIS (Incorporated Research Institutions in Seismology)
University of Melbourne
Australian Centre for Geomechanics - UWA, collecting PSN data
Central Queensland Seismology Research Group, displaying PSN daily plots
Australian National University

South Australian Earthquakes

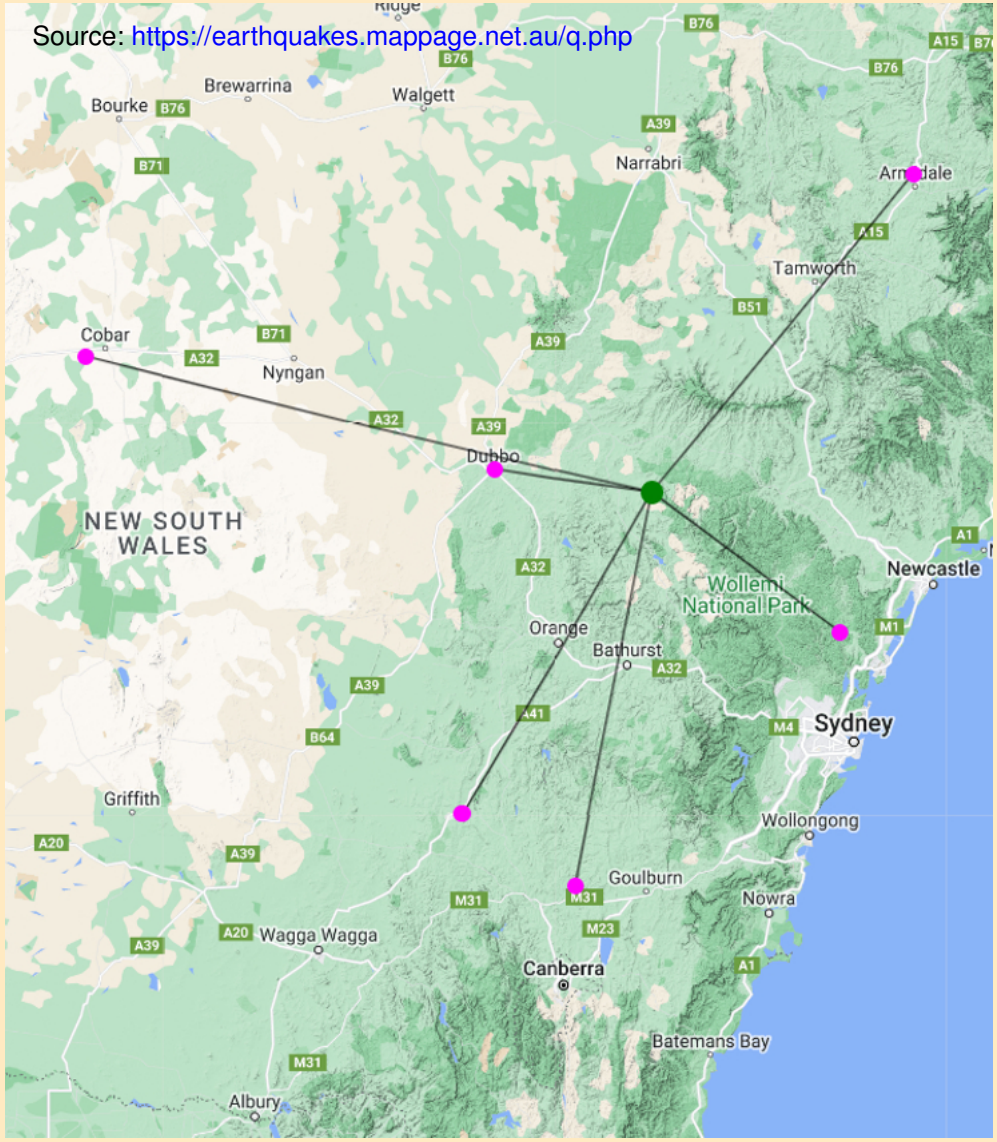
January - March 2022

Map produced by Clive Collins

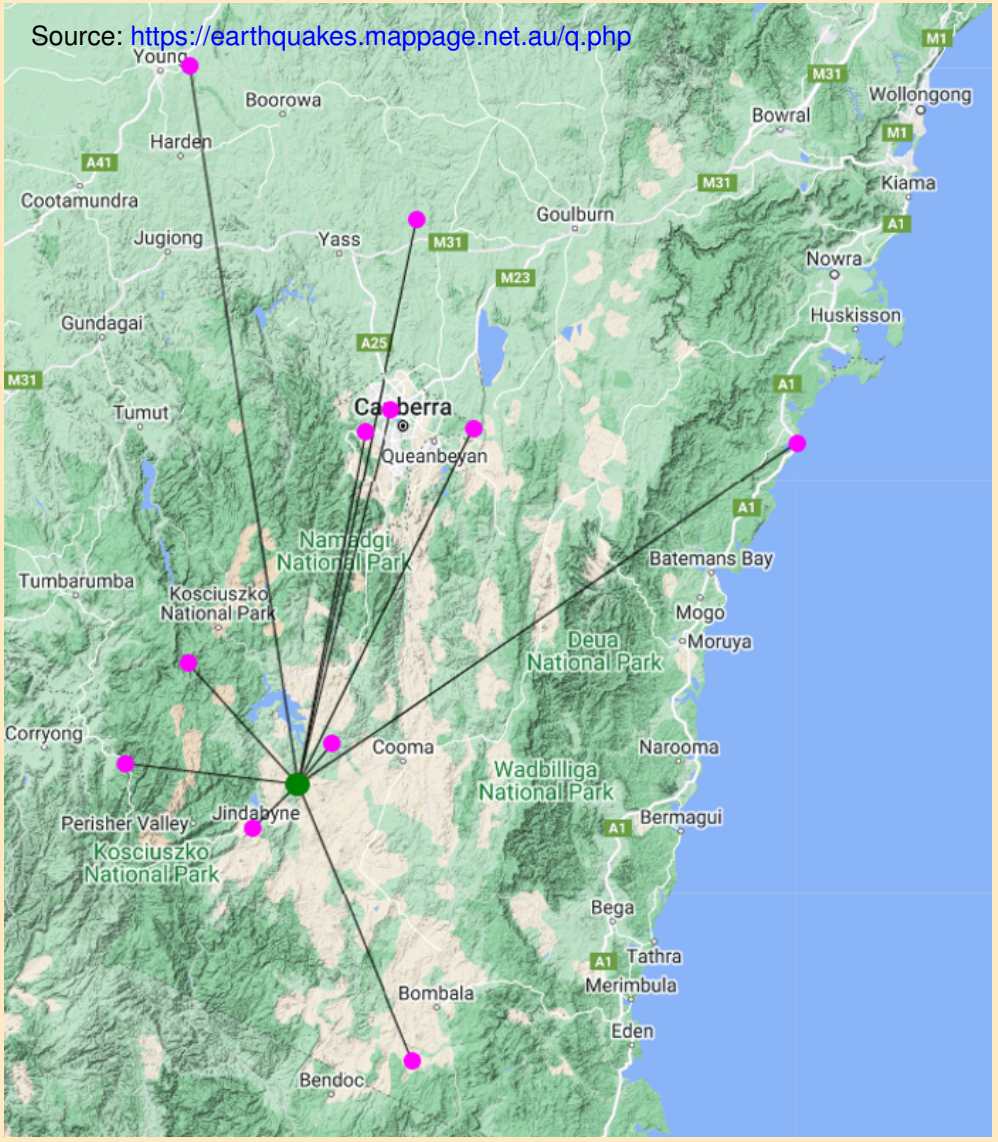


Recent Seismic Activity - New South Wales

2022-01-25 05:20 S of Ulan -32.3751, 149.756 2.8MLv

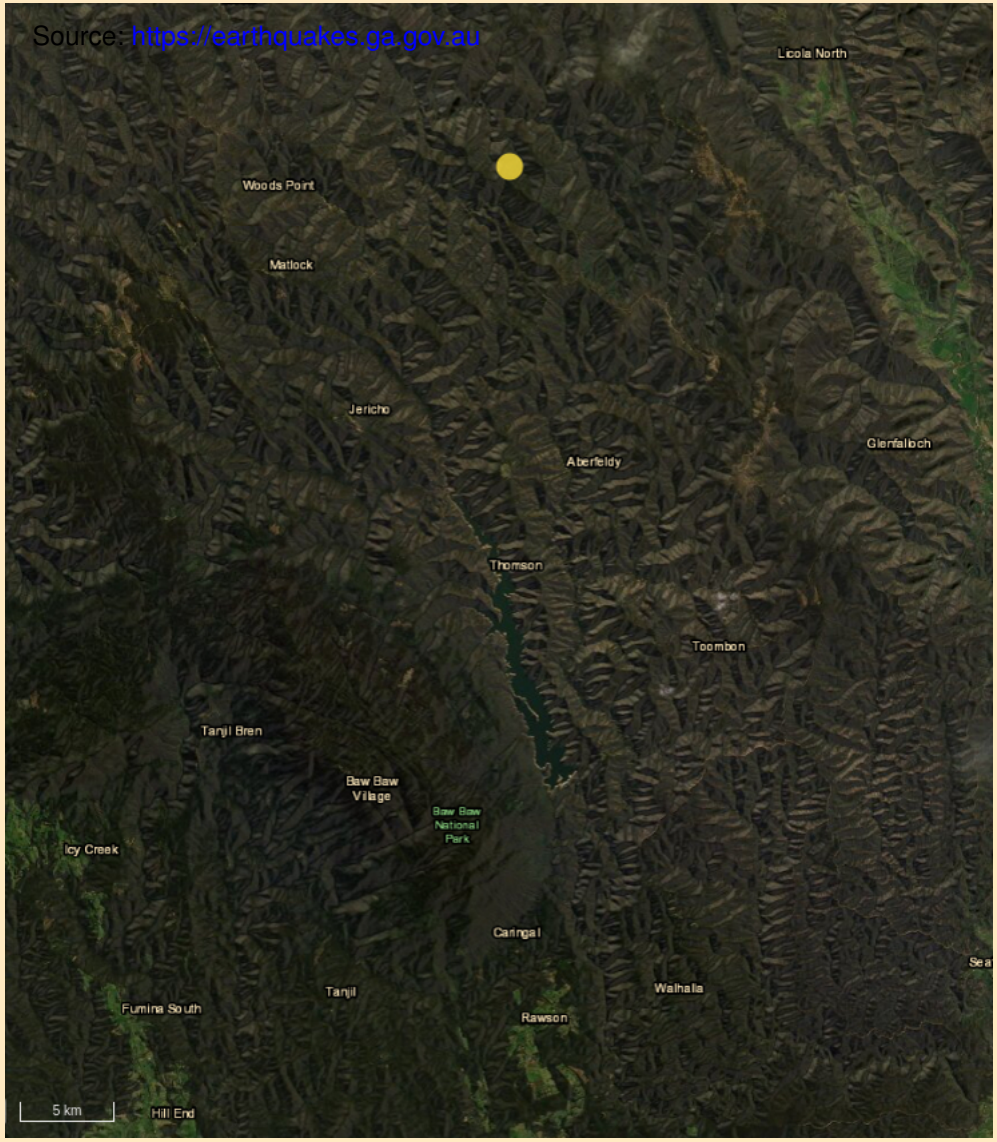


2022-03-13 22:19 NW of Berridale -36.2983, 148.768 2.4MLv



Recent Seismic Activity - Victoria

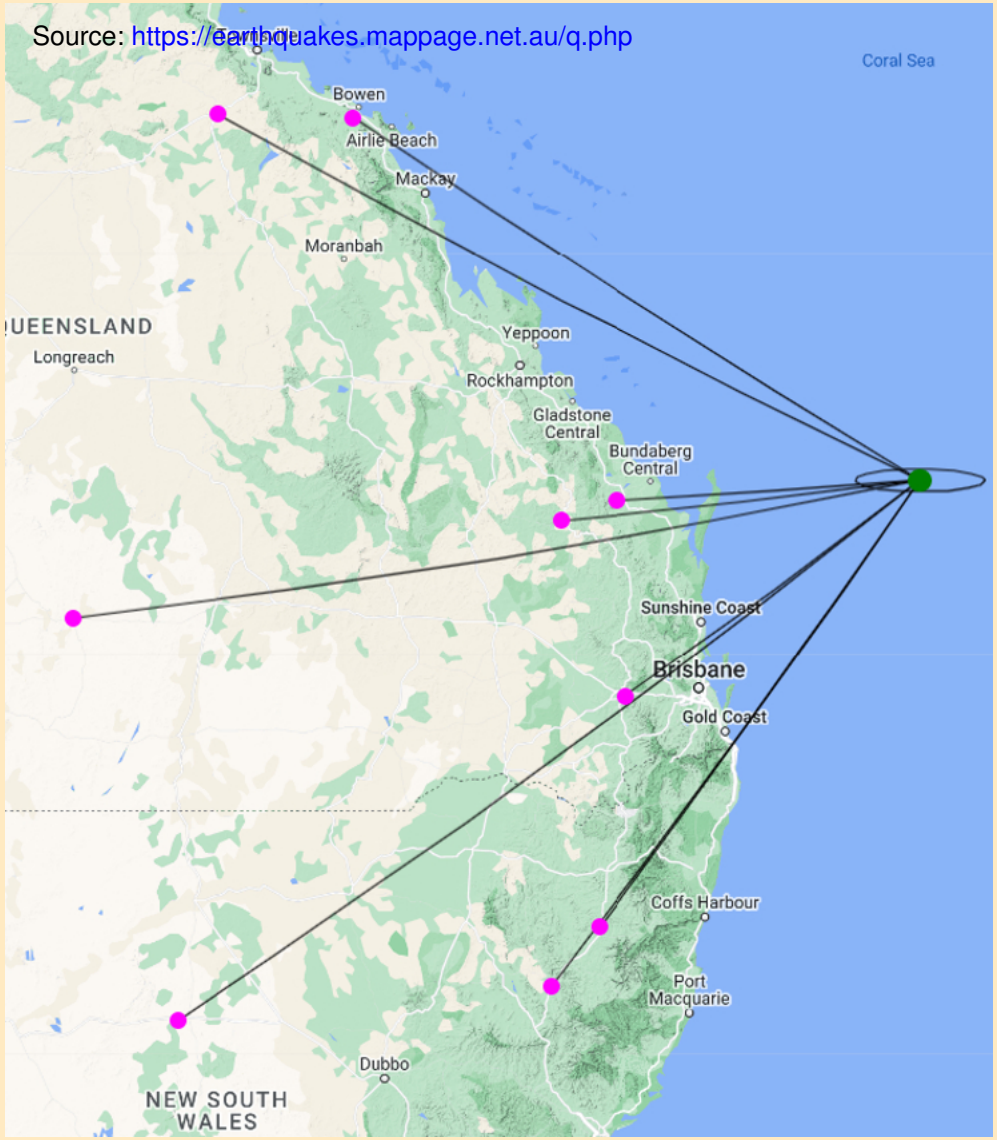
2022-02-02 16:15 N of Rawson -37.55, 146.36 3.0ML



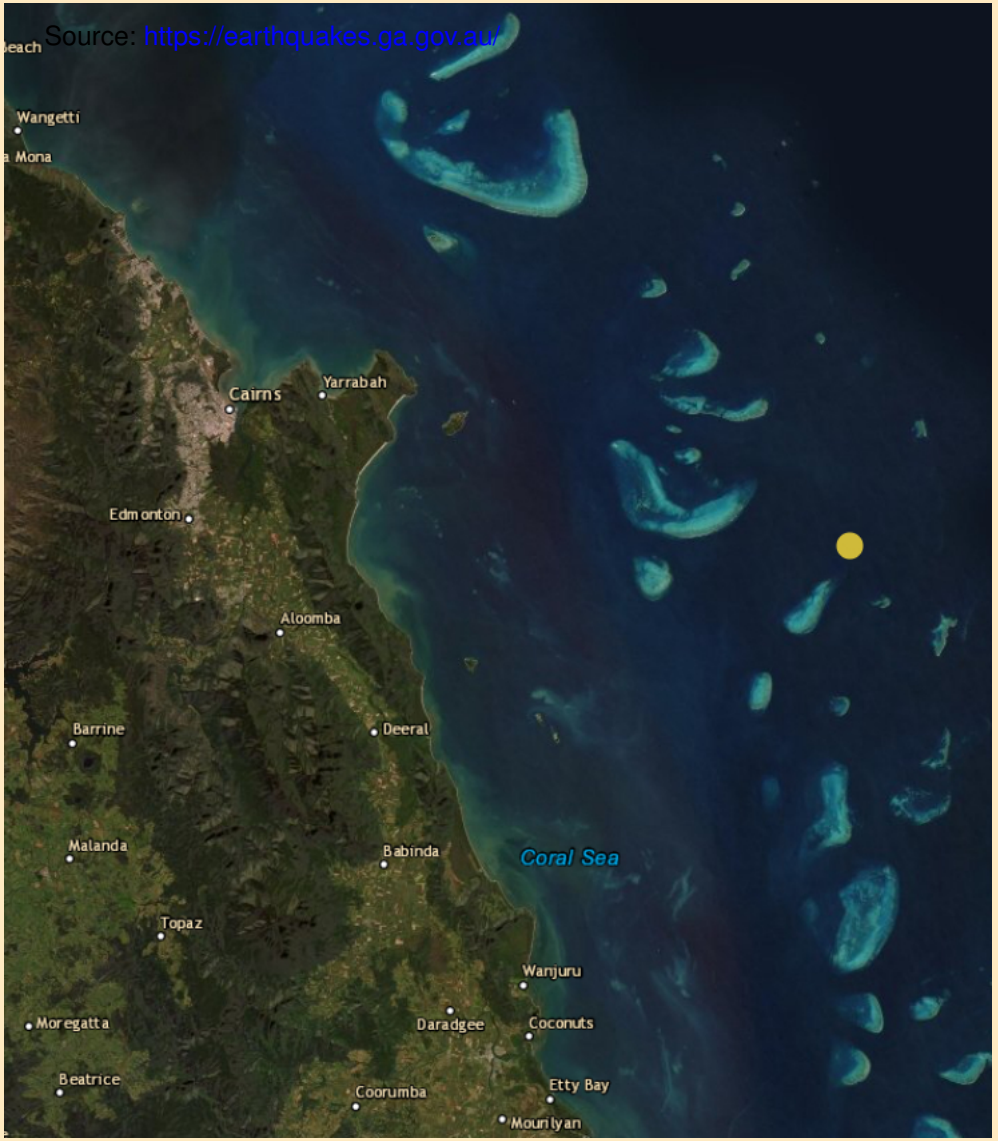
2022-02-26 10:45 Korumburra -38.46, 145.80 3.0ML

Recent Seismic Activity - Queensland

2022-03-26 19:14 Coral Sea -24.8492, 156.148 3.9ML



2022-02-06 02:17 Offshore NE of Innisfail -17.05, 146.38 3.8ML



Recent Seismic Activity - Western Australia

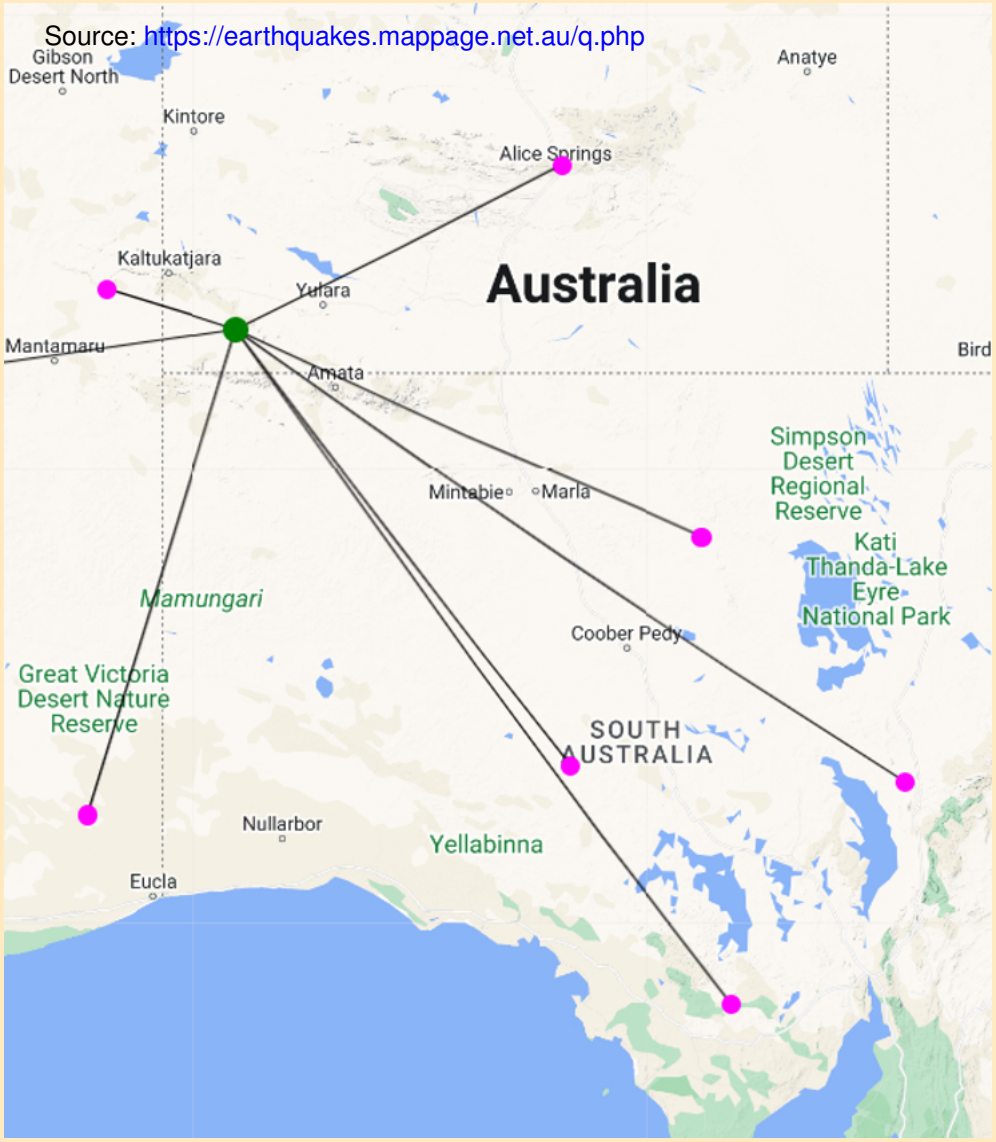
2022-03-30 23:227 NW of Quairading -31.93, 117.17 2.2ML

2022-03-31 10:22 Carnamah -29.68, 115.99 2.2ML

Recent Seismic Activity - Northern Territory

2022-02-27 14:11 Coastal Melville Island -10.76, 131.55 2.8ML

2022-04-04 06:21 SW of Yulara -25.5018, 129.908 2.7MLv



Resources & useful links

Description	URL / Webpage	Notes
SAA Membership Application	https://www.assa.org.au/media/74629/saa-membership-	Join up with the SAA using this form
SAA Flier	https://www.assa.org.au/media/74629/saa-membership-	Our current brochure - flier, saying what we do
SAA Newsletters at Trove	https://nla.gov.au/nla.obj-1685315562	View any SAA Newsletter at Trove
SAA EqServer	http://ade-eqserver.dyndns.org:8080/eqserver/	South Australian miniseed seismometers
Melbourne University EqServer	http://meiproc.earthsci.unimelb.edu.au/eqserver/	Australian miniseed seismometers
Regional Seismic Network	http://www.regional-seismic.net/	PSN seismometers - Aust. Centre for Geomechanics
Australian Public Seismic Network	http://cqsrg.org/psn/stations/	Australian PSN seismometers
Recent SA Earthquakes	https://earthquakes.mappage.net.au/q.php	Data & summaries of recent SA quakes
Central QLD Seismology Research Group	http://www.cqsrg.org/	CQSRG - Kevin McCue
Geoscience Australia	http://www.ga.gov.au/earthquakes/initRecentQuakes.do	Our national authority on seismic events
Earthquake Services	https://www.researchgate.net/profile/Colin_Lynam	Citizen Science Consultant - Col Lynam
Seismic Research Centre	https://www.src.com.au/	OEM of seismic instruments & software
symCDC	http://symcdc.com/	OEM of seismic instruments & software
IRIS Seismic Monitor	http://ds.iris.edu/seismon/	Global seismic events
Joint Australian Tsunami Warning Centre	http://www.bom.gov.au/tsunami/	Bureau of Meteorology site
Australian Earthquake Engineers Society	https://aees.org.au/	An organisation with similar interests
Atlas of the Underworld	http://www.atlas-of-the-underworld.org/	Mapping the Earth's mantle
Atlas of Living Australia	https://www.ala.org.au/	A Citizen Science initiative