Seismological Association of Australia

SAA Newsletter

#2/2023

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 in 2023

It is only a quarter of the way through the year but it is already shaping to be an active year compared with average over the last century.

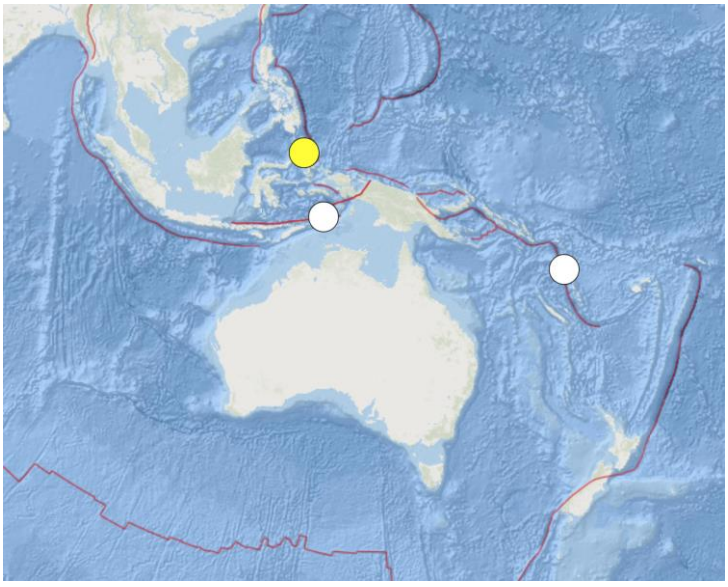


Figure 1 Location of the World's major earthquakes, M>6.9, January to March 2023, from the USGS.

We have been kept busy with international earthquakes, especially the shockingly destructive earthquake sequence in eastern Turkey. It's all very well to say that earthquakes don't kill people, it's the collapsing buildings that are to blame, but who accepts responsibility for them collapsing? Not so long ago they were called acts of God in both the west and east and were not covered by insurance. Even when the East Anatolian Fault Zone was a recognised hazardous earthquake zone and plate boundary.

Now modern earthquake engineering can prevent building collapse, if owners agree to pay for the detailing in design and construction (building may survive but be a write off) or base isolation (building may suffer little damage and remain useable) or do nothing and take the risk of being forewarned (and so survive) as in Italy and hope for an insurance pay out to rebuild.

As these issues play out in Türkiye and Syria there is a clamour to rebuild and this pressure to rebuild will all but guarantee that the new building will use the same design and materials as those that

collapsed. I travelled through this region in 1975, four years after the destructive magnitude 6.9 Bingol earthquake on the East Anatolian Fault, and that's what happened then. You can't suddenly find skilled earthquake engineers to provide advice let alone inspections at the time of rebuild so far from Ankara or Istanbul. Who will train the local builders in new methods and materials?

(Extract from the Australian Government Media Release 25 February 2023) *The team of 72 personnel making up the Disaster Assistance Response Team comprised representatives from Fire and Rescue NSW, Queensland Fire and Emergency Services, ACT Fire and Rescue, New South Wales Departments of Health and Public Works, NSW Ambulance, NSW Police, representatives from the National Emergency Management Agency and the Department of Foreign Affairs and Trade.* The Australian Defence Force also made a valuable contribution by transporting personnel and equipment to and from Türkiye.

Deployment of the DART was part of Australia's $18 million humanitarian assistance package.
So what did the 72 person DART team achieve in Türkiye apart from relearning how destructive earthquakes can be and *provided comfort and support to affected communities and local authorities in Türkiye*. They arrived too late to save lives. Were any of them experienced earthquake engineers or seismologists to teach the local how to rebuild to mitigate damage or educate them about earthquake risk and the need for monitoring?

Post-strengthening Homes against Earthquakes in Australia

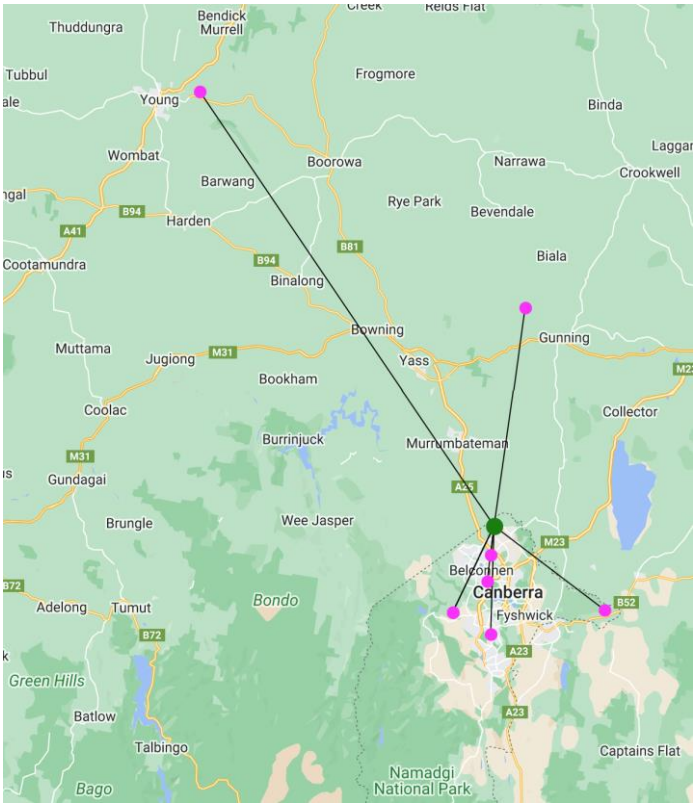
It would be good to hear from Australian engineers/seismologists who have modified their own homes to make them more earthquake resistant.
Let me kick off the discussion. I live in Canberra and 30yr ago moved into a 3-br brick veneer home with concrete tiled roof. It sits on concrete brick footings on weathered sedimentary rock. The house was built in ca 1967. The block is sloping so one corner had 2-storey high single clay-brick walls. Over the years we have

- built a garage and deck to strengthen the 2 storey-high walls against buckling and out-of-plane failure, the floor of the garage is a reinforced concrete slab
- replaced the concrete roof tiles with colorbond corrugated steel screwed to steel battens which themselves are screwed to the hardwood timber trusses
- rebuilt the weathered brick chimney 1m high above the roofline and cemented a steel plate with steel insert on the chimney top
- installed an angled (30^0 to horizontal) welded angle-steel frame housing solar panels between the 2-storey high wall and the garage timber roof frame.

When I admitted that we had adopted these measures to minimise earthquake damage most people including the builders suggested I was crazy, we get earthquake insurance included in the fire insurance in Canberra. My double-brick family home in the suburb of Griffith built ca 1947 suffered minor damage in a magnitude 5.6 earthquake in Picton in 1973 but survived intact similar-sized earthquakes in Bowral in 1961 and Gunning in 1949. Earthquake hazard in Canberra is not negligible, only marginally lower than that in Adelaide and Newcastle, so why not plan for it. Any insurance payout and remedial work may take several years and cover only part of the damage if our experience after the January 2020 hailstorm is any guide.

Rare earthquake under northern Canberra

Citizens of the Canberra suburb of Casey were rudely awakened on Saturday morning 18th March at 4:05 ESST by a small earthquake – except they weren't. The earthquake was widely recorded on seismographs across the ACT and into NSW at 6 to 115km distance and would normally have been quickly reported to police and news agencies even with magnitudes in the



lowly range of 0.9 to 1.6.

Figure 1 shows the epicentre (green dot) and the seismographs that David Love and I used to locate the earthquake (pink dots).

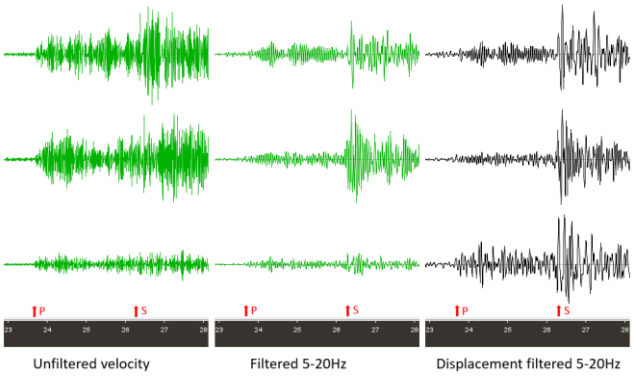
Seismographs in the Canberra region are operated by a growing number of citizen scientists, some by the ANU and schools, and others by Geoscience Australia and the Seismology Research Centre.

Why wasn't it felt? Too early in the morning? More likely because it was unusually deep, 19±2km below the surface, the deepest reported ACT earthquake to date. Most local events were thought to be in the range 1 to 10km deep but new seismographs around Canberra are helping us dramatically improve focal depth estimates.

Locating Earthquakes - Tips

David Love

Picking S waves A small earthquake, magnitude 0.6 occurred south-east of Adelaide on 2023-03-22 at 1213UT. It was about 10km deep, with 12 stations used in the location. The MBKR station at Mount Barker consists of a 3 component seismometer and PSN recorder (200sps) in a garage on the edge of town. It has a resonant frequency around 35 Hz.



The figure shows on the left the unfiltered velocity record. The S wave is quite difficult to pick in this. Filtering from 5-20Hz brings out the S quite strongly in the middle panel. The S should be picked from the horizontals (top and middle traces). Converting to displacement and again filtering from 5-20Hz produces the right panel. The S wave has more energy in the lower frequencies, and this is accentuated in the integration. This is often the best way to pick the S wave, again from the horizontals.

The P wave is probably best picked from the vertical (bottom trace) on the left panel.
Actual picks: P 23.67, S 26.28

More Monitoring in the Schulz Building

David Love & Blair Lade

On Saturday morning, 4th March, Blair and David installed 9 recorders in the Schulz Building at the University of Adelaide. Approvals, passes and permits were organised by the Infrastructure group at the University, positioning of the instruments was guided by Jerry Vaculik, eight accelerometers were provided by the University of Melbourne and remaining equipment was supplied by our association.

Accelerometers were installed at the east and west ends of floors 3, 6, 9 and 12. A broadband seismometer was installed on the ground floor, and another accelerometer was already running in the middle of the 12th floor. It took over 3 hours to install all the instruments, do tilt checks to confirm all axes were working, and stamp tests to check that timing was correct. About half of the instruments were powered by chargers, and cables in walkways needed to be taped down. The sensors at the east and west ends were outside the lift wells, but over the weekend, when access is by special pass only, there was significantly less lift activity. On early Monday morning a stamp test was applied before removing all the equipment.

The particular target of this experiment is detecting any torsion in this elongated building. A group of three Honours students have elected to tackle this data, and the association is offering $1000 support.

Photo Eight recorders and sensors being checked prior to installation.

During the weekend an earthquake of about magnitude 6.9 (USGS) occurred in the Kermadec area north of New Zealand. The shaking from this was visible at the GHSS recorder operated by Geoscience Australia. This is about 150m west of the Schulz Building. The shaking can be

seen on all recorders in the building after suitable filtering has been applied.

Photo Recorder and accelerometer installed outside lift well.

Historic earthquakes

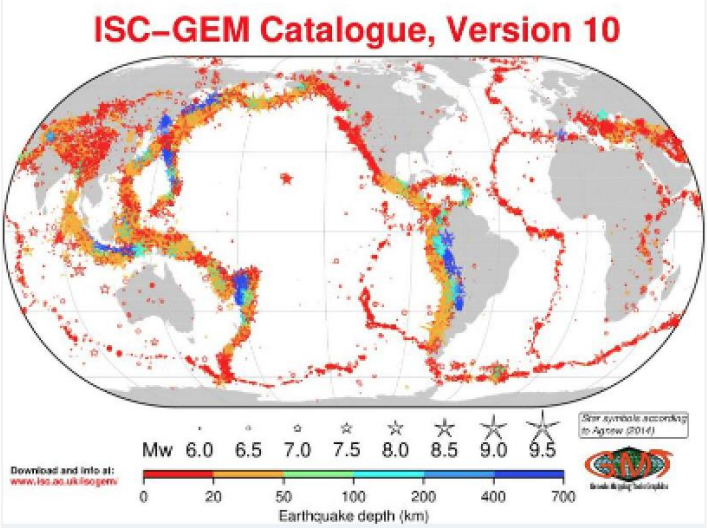
The study of historic earthquakes never ends. New information can always help refine the location and or size of previous estimates. Recently a visiting friend with an a shared interest in lighthouses related a story told her by a friend whose father was a lighthouse keeper on Tasman Island, Australia's highest lighthouse on a small island off the Tasman Peninsula, Tasmania. When she was about 11 or 12 years old she helped sweep up the mercury that had spilled down the stairs of the lighthouse following a strong earthquake. In those days the light mechanism was floated on a bed of mercury. A quick look at the first Isoseismal Atlas of Australian Earthquakes by Everingham and others (1982) turned up the most likely candidate earthquake off the southwest coast of Tasmania on 3 November 1963. I rang Ian Ripper who had drawn the isoseismal map in the Atlas (Ripper, 1963) and he renewed his comment of the time that the stormy weather had probably cloaked many of the felt effects so the earthquake probably had a higher magnitude than predicted from his map.

The same is true of the 1897 Kingston SA earthquake. I thought I had just about exhausted all newspaper and lighthouse keepers reports but Peter Gray found amongst these stories an anecdote that the shaking was slightly felt in Melbourne. I remember reading that it was also slightly felt on King Island in Bass Strait but I have been unable so far to rediscover that reference. Again this new information will slightly increase the computed felt area, hence

the magnitude of this, South Australia's largest earthquake in the post-European era.

ISC-GEM (from Col Lynam)

Dr. Domenico Di Giacomo, Senior Seismologist at the International Seismological Centre (ISC), announced the release of Version 10 of the ISC-GEM Catalogue. It covers the period 1904-2019 and is available for download at



http://www.isc.ac.uk/iscgem/download.php

What's new:

Version 10.0 of the ISC-GEM Catalogue is the result of the 1st Year of the *Further Improvement Project* that began in 2022. It adds 18,576 globally distributed earthquakes that occurred between 1976 and 2018 with direct Mw from GCMT between 5.0 and 5.5 (complementing continental earthquakes down to magnitude 5 added in previous versions).

Furthermore, the catalogue has been extended to the end of 2019, which now includes 1663 earthquakes with Mw down to 5.0 globally. Full details of the Catalogue updates are available at: www.isc.ac.uk/iscgem/update_log/

A Note on Earthquake Magnitude

I have just re-read a paper by Charles Richter *Historical Background of the Magnitude Scale* a must for all budding seismologists or those wanting to understand this important but imprecise number. His primary purpose for introducing the term *magnitude* was to clarify the statistics of earthquake occurrence, not just for anxious news reporters. In the process he:

- discusses the confusion often seen between intensity and magnitude, still common to this day
- debunks earthquake prediction
- examines the contradiction of earthquake size and the size of the resulting disaster and
- points out that earthquake statistics based on just the historical record are gravely deficient
- stresses that magnitude could not be replaced with energy release but foresaw the coming digital revolution which would make energy calculation possible and the conversion to magnitude only necessary to investigate the magnitude scale itself
- points out that magnitude scales necessarily deal only with energy radiated as seismic waves and so
- considers it erroneous to calculate the energy from fault displacements and then use this with the measured magnitude to determine the magnitude-energy relationship. One is measured from shaking, the other from final displacement.

We know ourselves how much variation one can get measuring magnitudes for any event on a number of seismographs. Take two recent examples:

- the magnitude 4.8 event south of Yunta SA on 22 March which was felt as far as Adelaide. Measured magnitudes ranged from 4.4 to 5.5.
- A microearthquake 9km SE of Adelaide, also on 22 March but which was not felt. Measured magnitudes ranged from 0.3 to 1.1.

The magnitude scale is relatively crude, as Richter said.

Measuring seismic moment and then converting this to a magnitude through some linear conversion scale between moment and magnitude across the whole 100 million range of energy values to an implied precision of 0.01 begs belief.

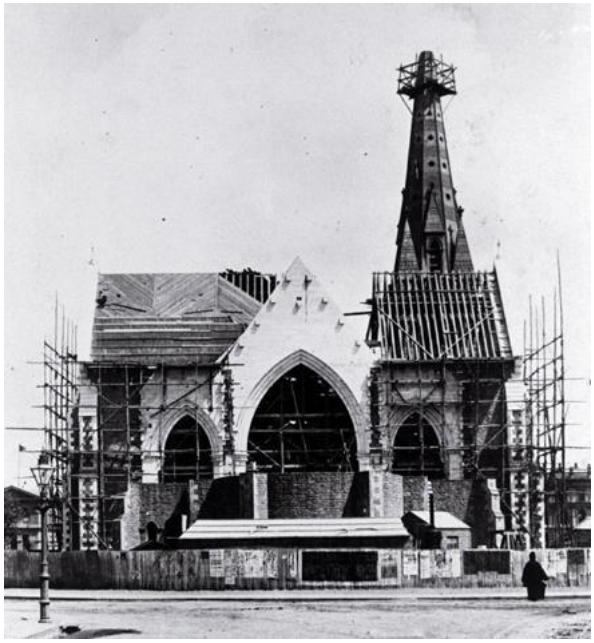
Replacing the Monumental Cathedrals of Christchurch New Zealand

The Anglican Christchurch Cathedral

Christchurch Cathedral is the focal point of Cathedral Square in the heart of Christchurch.

The Cathedral was damaged by earthquakes on 5 December 1881, 1 September 1888 and

16 November 1901. Each time the spire was damaged. After the 1901 earthquake, the top of the tower was replaced by hardwood sheathed in copper. The Cathedral again suffered minor damage in the earthquakes of September and December 2010, but was devastated by the 22 February 2011 earthquake. No one was killed and only one person was injured, rescued from a room in



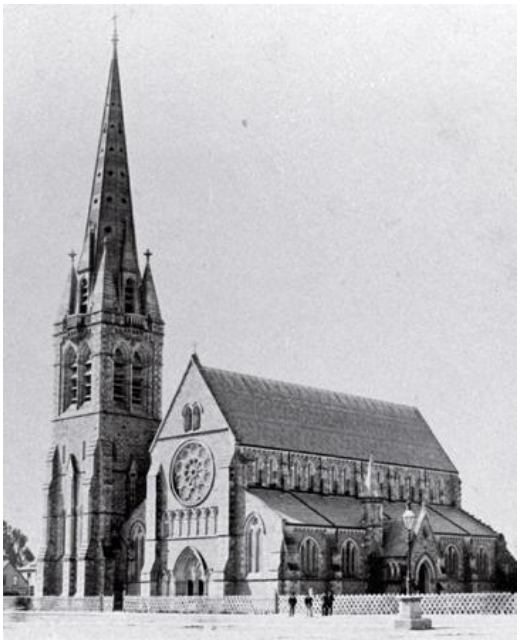
the belltower.

Photos 1 and 2 show the cathedral under construction in 1880 and completed in ca 1888 (photo by Frank Coxhead)

In the aftermath of the February 2011 earthquakes, a decision was made to partially demolish the Cathedral. The deconsecration ceremony took place on 9 November 2011.

The Anglican Church built a temporary‘ cardboard cathedral’ on the site of St John’s Anglican Church in Latimer Square which itself was badly damaged in the February 2011 earthquake and later demolished.

Post-quake Restoration In September 2017 after a vote by the Anglican Synod, the decision was made to restore the Cathedral - restoration to be funded from a combination of insurance, donations, and money gifted by the Great Christchurch Buildings Trust, Government, and Christchurch City Council. The first physical work to restore the Cathedral was begun in May 2020 and is expected to take between 7 and 10 years.



The Catholic Cathedral This cathedral, also known as the Christchurch Catholic Basilica, was opened on 12 February 1905. *Seismic strengthening was undertaken in 2004*. Following the earthquakes of 2010 and February 2011, the Cathedral was severely damaged, the two bell towers collapsed and the main 41m diameter dome was tilted off vertical. Its demolition concluded in 2021

with plans for a new one to be built closer to the city centre.

Photo 3 Cathedral of the Blessed Sacrament, Barbadoes Street, Christchurch [ca. 1905]. CCL PhotoCD 4, IMG0042

However the Vatican's supreme court has stepped in halting plans that include a new Cathedral in the central city. The Supreme Tribunal of the Apostolic Signatura – the Vatican's highest court – has agreed to hear a legal case from a group of Catholic parishioners from around Christchurch who oppose the $100 million building plan.

Maps of Earthquakes January to March 2023

Clive Collins has created three interesting epicentre maps for the Newsletter covering the first quarter of 2023. Naturally this period is too short on which to base hazard and risk assessments but how long is long enough? This three month period is as Richter pointed out gravely deficient (see article on magnitude on page 5). The last 50 off years of instrumental data equally deficient.

Take the first map showing those earthquakes that were locatable in South Australia. It shows clearly that earthquake coverage of the State is not homogenous. Small earthquakes can be detected in the South-east that are not even detected in the North-west.

Earthquakes occurred in the usual places, the Flinders and Mt Lofty Ranges, Eyre Peninsula, the Kingston-Beachport area of the South-east and Olary spur heading towards Broken Hill in NSW.

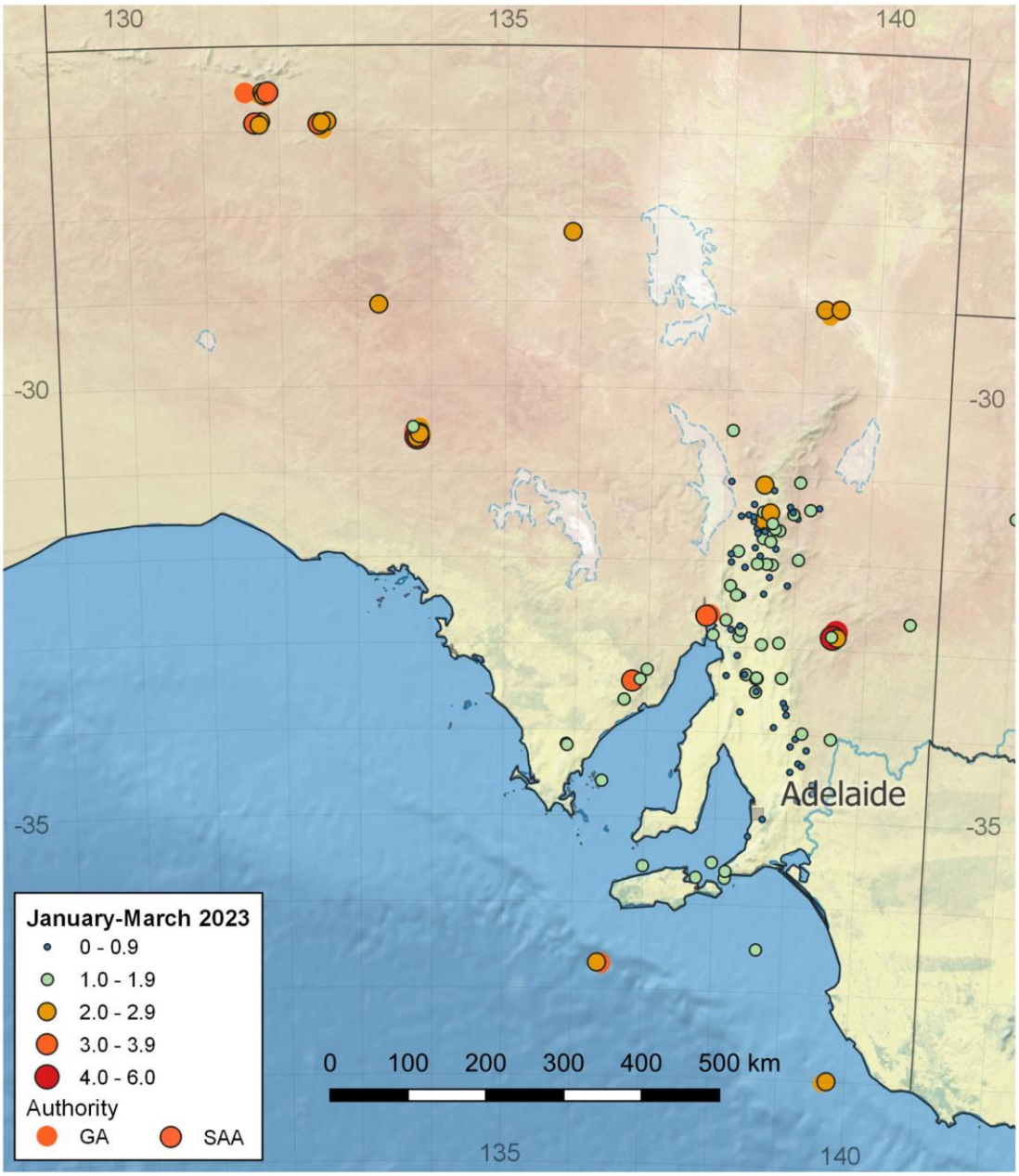
Earthquakes also occurred in unusual places; that in the very centre of the State in February, magnitude 3.4 and aftershocks, others of magnitude 3.1 in the far north-east of the State in the Strezlecki dunes north of Lake Blanche and in the far North-west in the Great Victoria Desert.

The most important area for risk assessment, the vicinity of Adelaide, is problematic. Only two tiny earthquakes were located in an area that is an obvious link between the Mt Lofty and Flinders Ranges in the north to those events around Kangaroo Island to the southwest. One of the two largest earthquakes in the historic record occurred in 1902 in this link area as did the damaging 1954 Adelaide earthquake. Modern data does not reflect the reality of the hazard in this area.

The largest earthquake in this quarter, magnitude 4.8, is not in the Flinders Ranges and not in one of the high hazard zones in anyone's model.

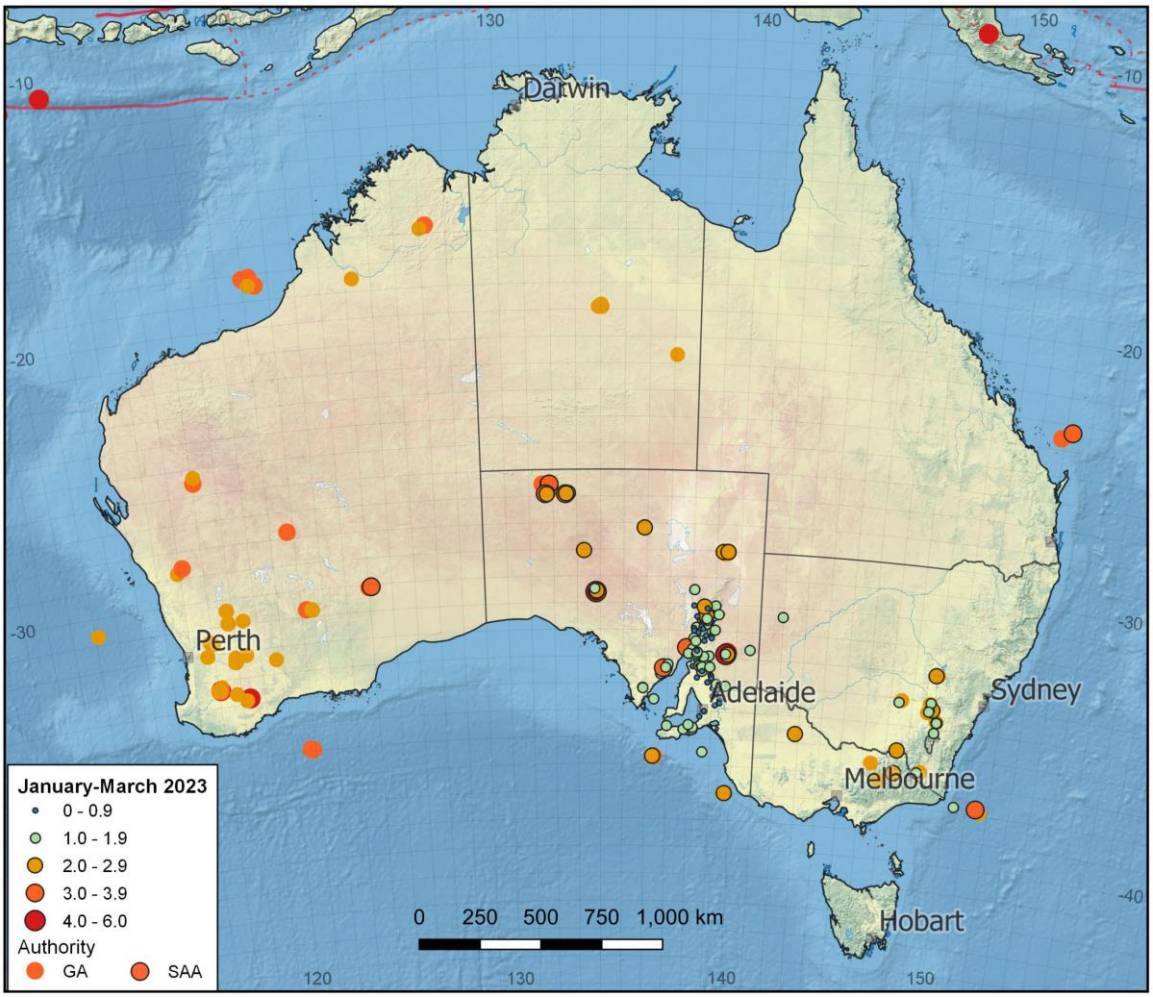
The second map, of Australia, shows that no earthquakes were recorded onshore in either Queensland or Tasmania. Until recently these were the only two states in Eastern Australia that had been struck by large earthquakes in the European historical period. To get any meaningful understanding of the hazard in the eastern states you obviously need a longer observation period - but how long is enough?

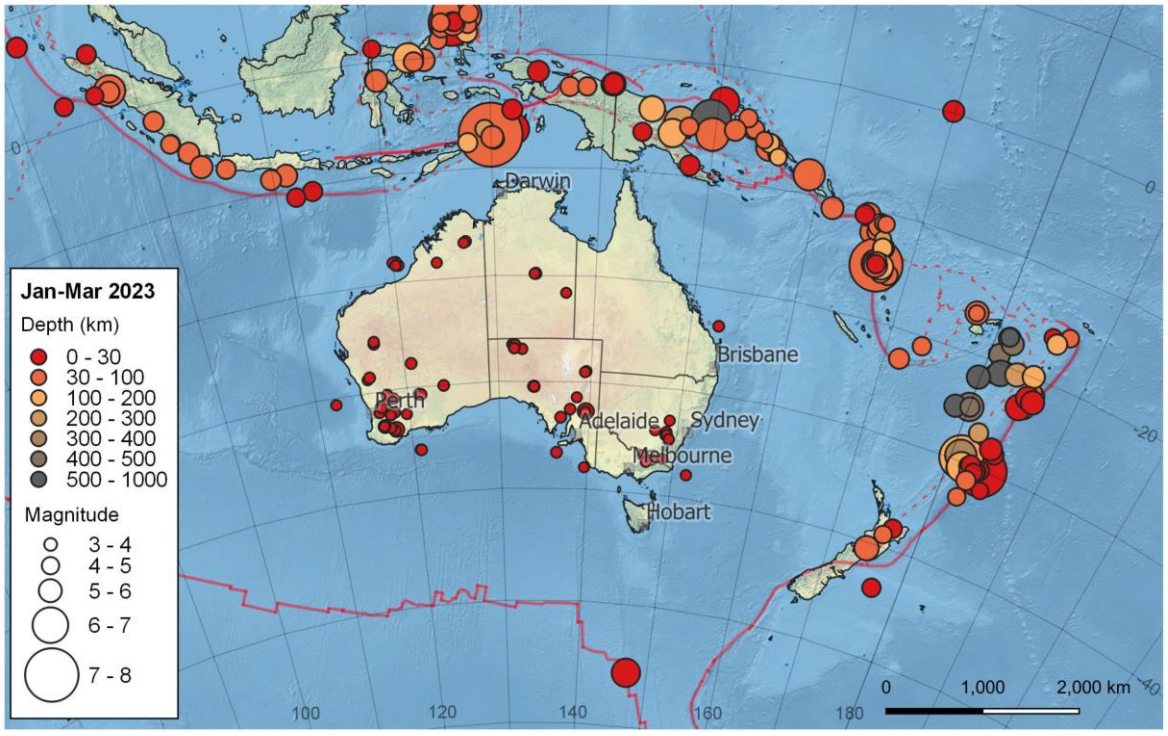
The final map of Clive's the Australian Plate boundary earthquakes shows clearly the relative hazard between inter-plate and intra-plate regions in our area. One might conclude from this map that the South Island of New Zealand has the same lack of earthquakes as Tasmania and Queensland but that would be wrong, grossly wrong. The map masks the



problem for hazard analysts in New Zealand; how to design for earthquakes in Christchurch compared with towns along the west coast of the South Island. What difference in the earthquake design forces is appropriate and acceptable (see article on page 6)?

Take it further then, what design is appropriate and practicable for regions of Papua New Guinea where the plates are colliding at twice to three times the rate the same two plates are interacting in New Zealand.


Darwin
Perth
Adelaide
Sydney
Melbourne
Hobart
January-March 2023
0 - 0.9
1.0 - 1.9
2.0 - 2.9
3.0 - 3.9
4.0 - 6.0
Authority
GA
SAA
0 250 500 750 1,000 km
120
130
140
150
-10
-20
-30
-40


Darwin
Brisbane
Perth
Adelaide
Sydney
Melbourne
Hobart
Jan-Mar 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
0 1,000 2,000 km
100
120
140
160
180
0
-20
-40