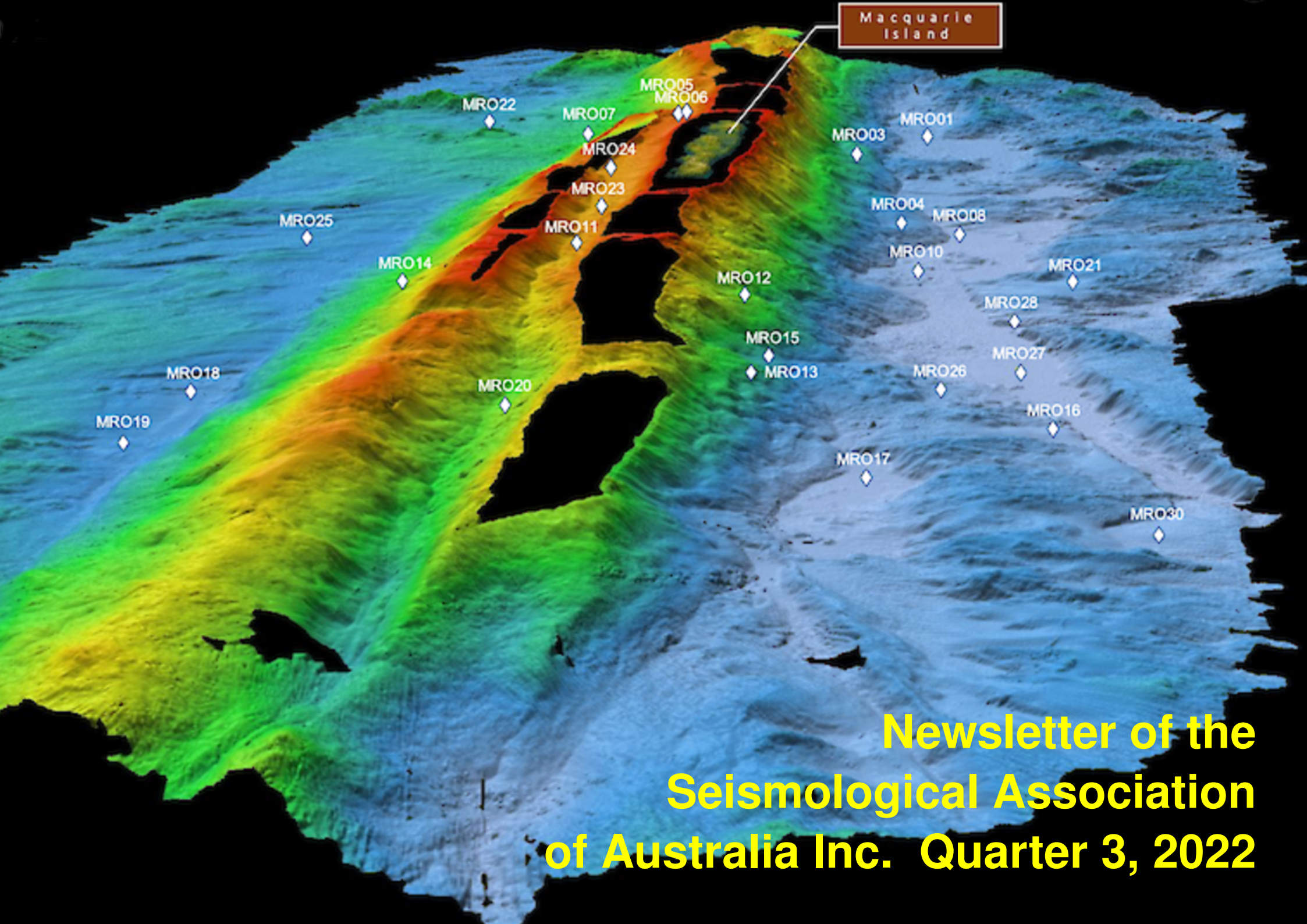

Newsletter of the Seismological Association of Australia Inc. Quarter 3, 2022

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

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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. Monday, August 8th will be the final members meeting before the AGM. Our main speaker for the evening is Gabor Papp, Geodesy research group leader from the Institute of Earth Physics and Space Sciences, Hungary. The SAA's TPSO is right by the coast, and offers the opportunity for Gabor's team to investigate crustal loading from the ocean tides. More importantly to Gabor's team, to test their solid earth tidal predictions against the reality of their tiltmeter located within TPSO. Our location by the sea and in the opposite hemisphere to where they usually test their predictive models against provides a unique research opportunity.
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.

Science Alive! 2022 - This year's Science Alive event will be held over the weekend of August 6th and 7th at the Adelaide Showgrounds, Wayville. Preparations for the event are well underway and a healthy list of volunteers to be onsite for the three days has been drawn up. If you are available to attend for a couple of hours on either the Friday, Saturday or Sunday, please give Blair or David a call to schedule in your generous and welcome assistance.

Changes to the CQSRG Website - The bad news is that Mike Turnbull recently closed down the bulk of the content available at the Central Queensland Seismic Research Group website. This represents a significant loss of a good source of seismic information in Australia and it will be missed. The good news is that Mike it was has decided to maintain the Australian Public Seismic Network (PSN) seismogram page for the next couple of years. The better news is that Mike Turnbull's Seismogram Download Form has recently been added, another great resource for both professional and amatuer seismomologist to use. If you have a functional PSN station lurking around and want to add it to Mike's PSN page, you can use this link to contact Mike.

Elsewhere in this issue you may find an update on the humidity problem within TPSO. We recently lost the ability to monitor the temperature/humidity within the vault due to battery failure on the weather station. We decided not to further risk disruption to the operation of any of the instruments by entering the facility until it became an absolute neccessity. The last time the vault was opened, another long period instrument was installed on the seismic pier. Back in 2019, Colin Stuart donated an Inyo Force-Balance Vertical seismometer to the SAA, one the six(?) that Colin and Dale Hardy made some years before Dale's passing in 2019. This LP seismometer is connected to RJAM RA7E6 and can be seen here, if you're interested in some of the capabilities of this instrument and the Raspberry Shake network.

Macquarie Island Earthquake
19 May 2022 at 1013 UTC, Mw6.9

Kindly submitted by Kevin McCue and Dr Cvetan Sinadinovski

On the Cover The cover image is the subsurface area surrounding Maquarie Island in 3D. The Maritime National Facility's IN2020_V06 voyage produced this 3-D structure of the oceanic crust along the central Macquarie Ridge Complex (MRC) using novel lithospheric seismic imaging. The marker sites indicate Ocean Bottom Seismograph deployments in the vicinity of Macquarie Island along the central MRC.

At 20:10 local time on the 19th of May, a small quake was felt by expeditioners at the base on the northern end on the island. Three minutes later a magnitude 6.9 quake struck. This triggered the tsunami warning alarm, people grabbed their survival bags and made for higher ground.

Some time later the tsunami warning was cancelled. The station hadn't suffered any structural damage, however the shaking had caused quite a mess in many buildings, minor landslips and a rockfall (see photos attached from the Australian Antarctic Division).
The location is in a seismic gap postulated by McCue (2013).

The red line represents the boundary between the Australian, Pacific and Antarctic Plates.

The epicentre (orange dot) is on the Pacific-Australian Plate boundary south of NZ and only 40km north of Macquarie Island.
This is the largest close earthquake to Macquarie Island since the Mw8 earthquake on 23 May 1989.

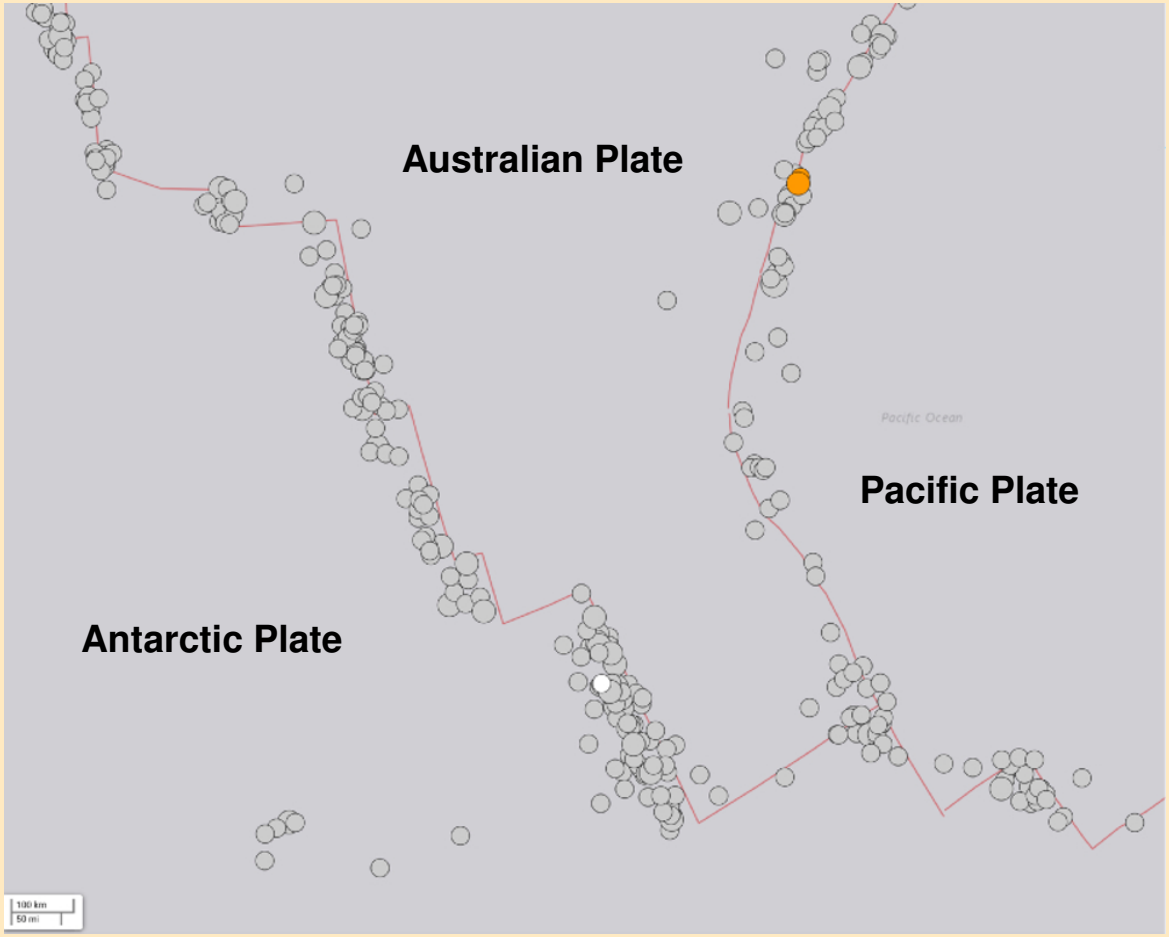

Figure 1: The plot from the USGS shows epicentres since the year 2000 with magnitude of 5 or more.

Macquarie Island Earthquake

19 May 2022 at 1013 UTC, Mw6.9

Uncertainty in magnitude and depth

The magnitude and focal depth estimates from various agencies are tabulated below. Magnitude is supposed to be a measure of the earthquake's size but the widely different estimates shown give one no confidence that the magnitude problem has been solved. There is now a bewildering array of different scales, more than 20 of them, all purporting to measure this one important source parameter.

The crustal thickness under the central ridge has been measured to be about 15km so how can one explain the various focal depth estimates other than that agencies used different ways of estimating it, or they just said it was shallow and allocated a depth of 10km. They can't all be right if it is the depth at which rupture commenced. There are depth phases that can be used (pP, sP, PcP for example) but these days machines and analysts rarely use them, if they are instructed or know how.

Magnitude	M	mww	Mww	Mi	Mwb	mb	Mwp	Mw
USGS	6.9	6.9	6.9	7.3	6.7			
EMSC								6.9
GFZ								6.8
GA			6.9			6.0	6.5	

Agency	Focal Depth				
USGS	10 km	29.0 km	29.3 km	25.5 km	14 km
EMSC	15 km				
GFZ	10 km				
GA	10 km				

Macquarie Island Earthquake

19 May 2022 at 1013 UTC, Mw6.9

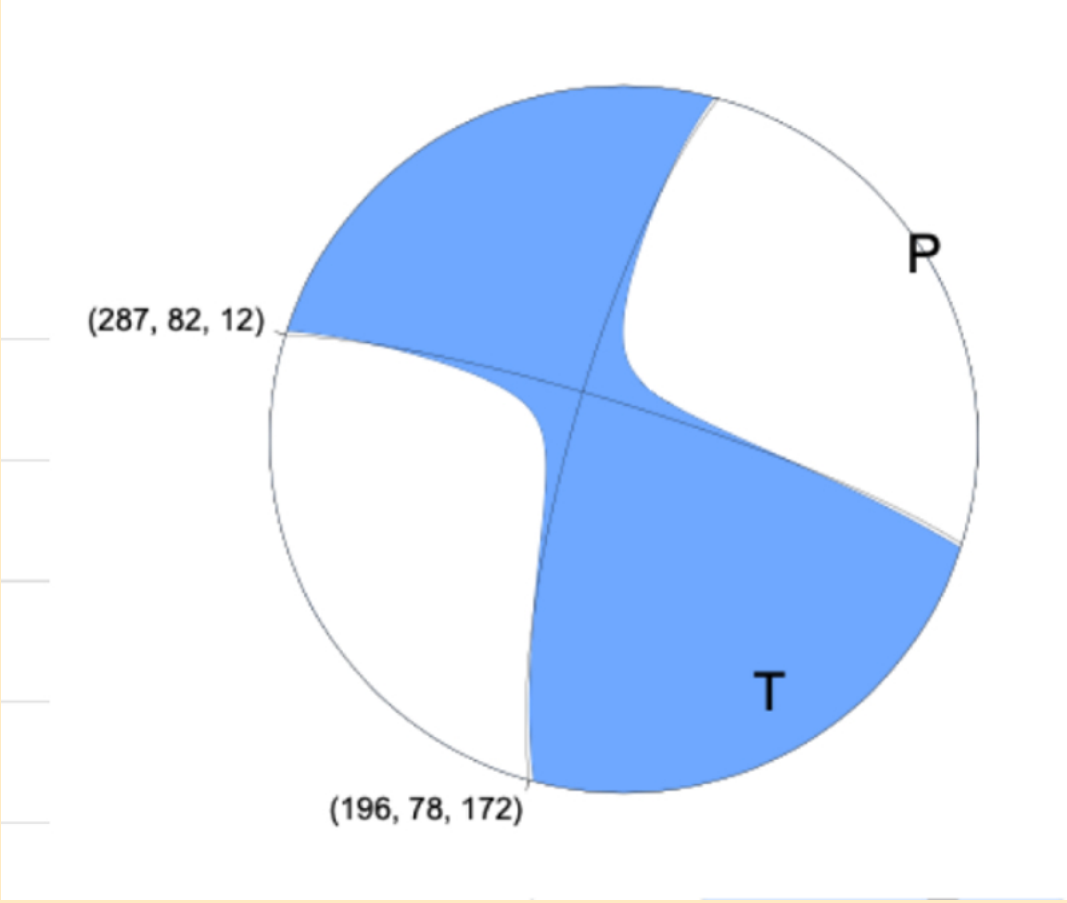

Figure 2: Body-wave Moment Tensor (Mwb) (USGS)

The focal mechanism shown in Figure 2 is that of a strike-slip or transfom faulting earthquake. The right lateral plane striking at 16° (196°) is along the strike of the plate boundary in the region.

The acceleration response spectra shown in Figure 3 on the next page, 5% damping, were computed by Sinadinovski and Skopje Seismological Observatory, using the GA data recorded on Macquarie Island and show the foreshock on the left and mainshock on the right. The pink line is the vertical component and the two horizontals are orange and blue. The EW component is the stronger of the horizontals with a peak in the range 0.1 to 0.2 sec. The mainshock amplitudes are all in the range 0.34g to 0.53g, strong shaking. These data will be useful for design purposes on any of Australia's offshore islands on oceanic crust where strike-slip earthquakes are likely to occur.

References

https://aees.org.au/wp-content/uploads/2013/11/37-McCue.pdf

https://eprints.utas.edu.au/13863/4/1988_Williamson_origin.pdf

https://www.antarctica.gov.au/news/stations/macquarie-island/2022/shaking-things-up-on-macca/

Geoscience Australia provided the strong motion records of the foreshock and mainshock. The remainder of the data are from the USGS. The final two pages are images from the Australian Antarctic Division.

Macquarie Island Earthquake

19 May 2022 at 1013 UTC, Mw6.9

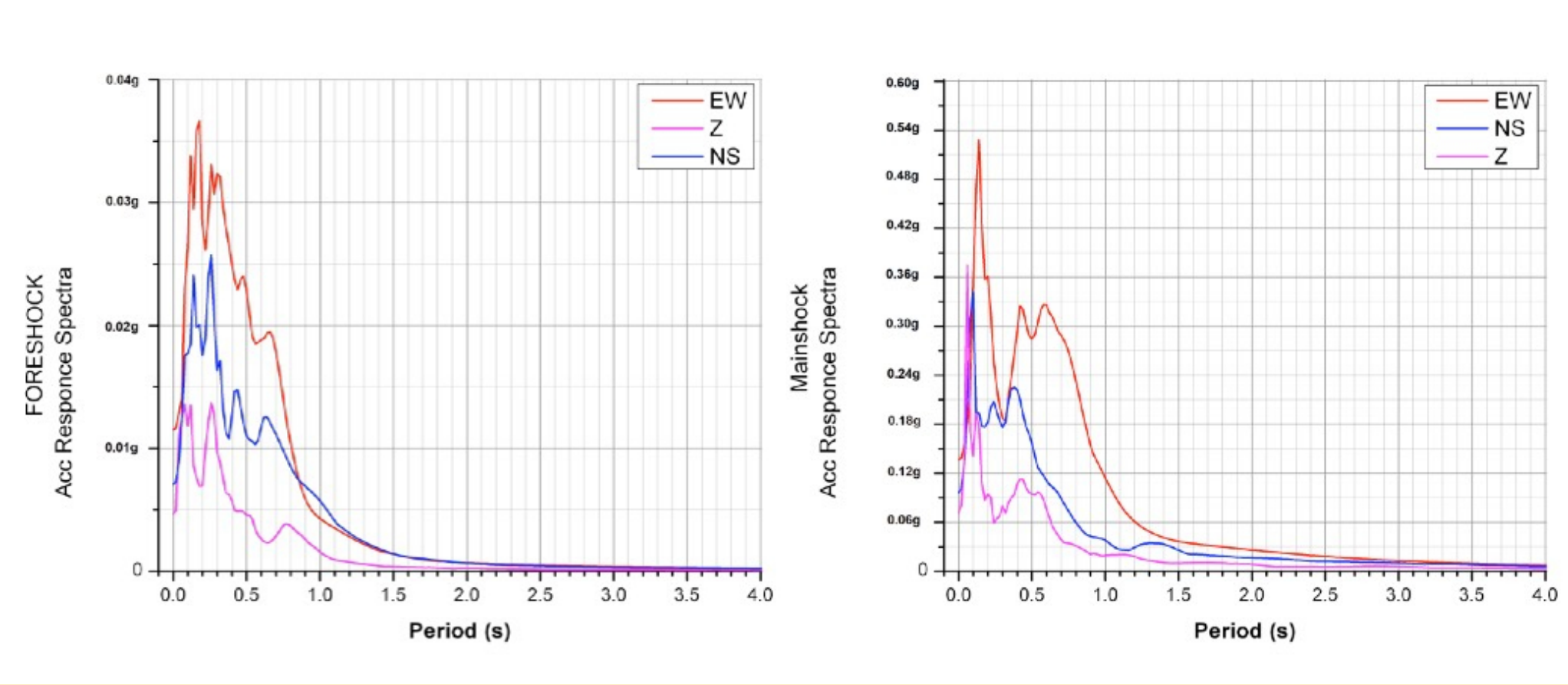

Figure 3: Foreshock M5.6 on the left and mainshock M6.9 on the right.
The pink line is the vertical component and the two horizontals are orange and blue.
The EW component is the stronger of the horizontals with a peak in the range 0.1 to 0.2 sec.
The mainshock amplitudes are all in the range 0.34g to 0.53g

Macquarie Island Earthquake

19 May 2022 at 1013 UTC, Mw6.9

Macquarie Island Earthquake

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Macquarie Island Earthquake

19 May 2022 at 1013 UTC, Mw6.9

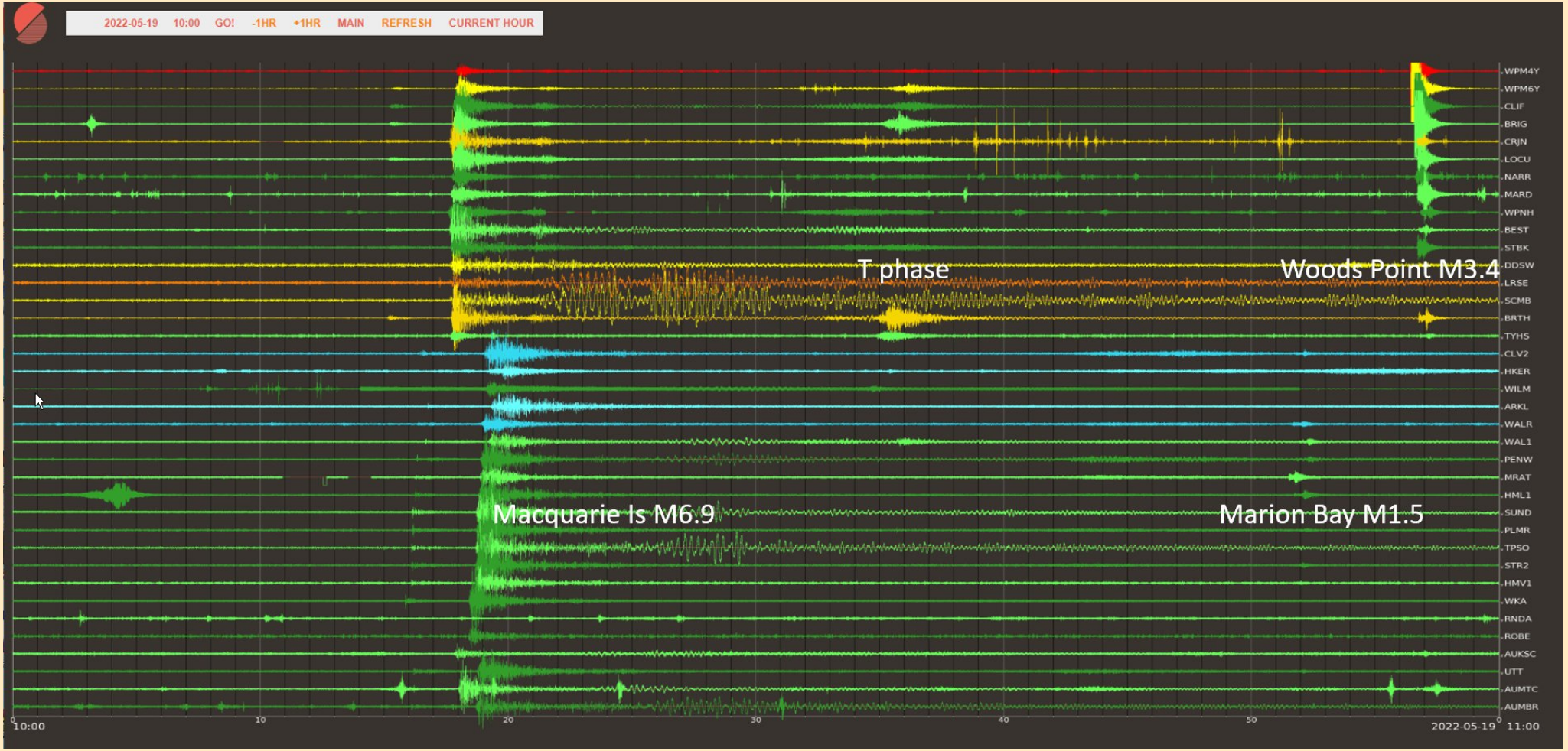


Figure 8: A snapshot of the Melbourne Uni eqServer (Main) on May 19th from 10:00UT, quite a busy evening. Several seismic events from different sources can be seen in this image spanning one hour, identification courtesy of David Love.

KUKLICI STONE DOLLS
A PRECARIOUSLY BALANCED ROCKS PLACE

Kindly submitted by
Dr Cvetan Sinadinovski

Kuklici Stone Dolls is a site in northeastern Macedonia about 100 km from the capital Skopje (Figure 1) and 8 km from Kratovo, a small town located in the crater of an extinct volcano. The place covers a small area of around half a km^2 at an altitude of 420 meters. It consists of many naturally occurring rock formations shaped by erosion processes.

Kuklici's peculiar pyramids and pillars were created between the Eocene and Pliocene as a result of volcanic activity. Soft tuffs are overlain by solid, sturdy andesites and ignimbrites which are many millions of years old. The differences in the erodibility of the volcanic rocks of the area are the main factor for the shape and sizes of their remains. Scientific investigations suggest erosion in the last 10,000 years, during the Holocene epoch, leaving them in a precariously balanced state.

The probability of toppling these formations, the precariously balanced rocks (PBR), is of importance for Seismic Hazard Assessment (SHA) models, since contemporary hazard and risk estimates are mainly driven by the historical records of earthquakes.
Thus, the characterisation of PBRs in terms of their preservation and stability can assist in reducing uncertainties in the calculated SHA models. There are more than 120 such PBRs in the locality of Kuklici, a few reaching 9m high. The stone formations are situated on the right bank of the Kriva River valley.

Figure 2 shows a panoramic view of the site from the hill top.

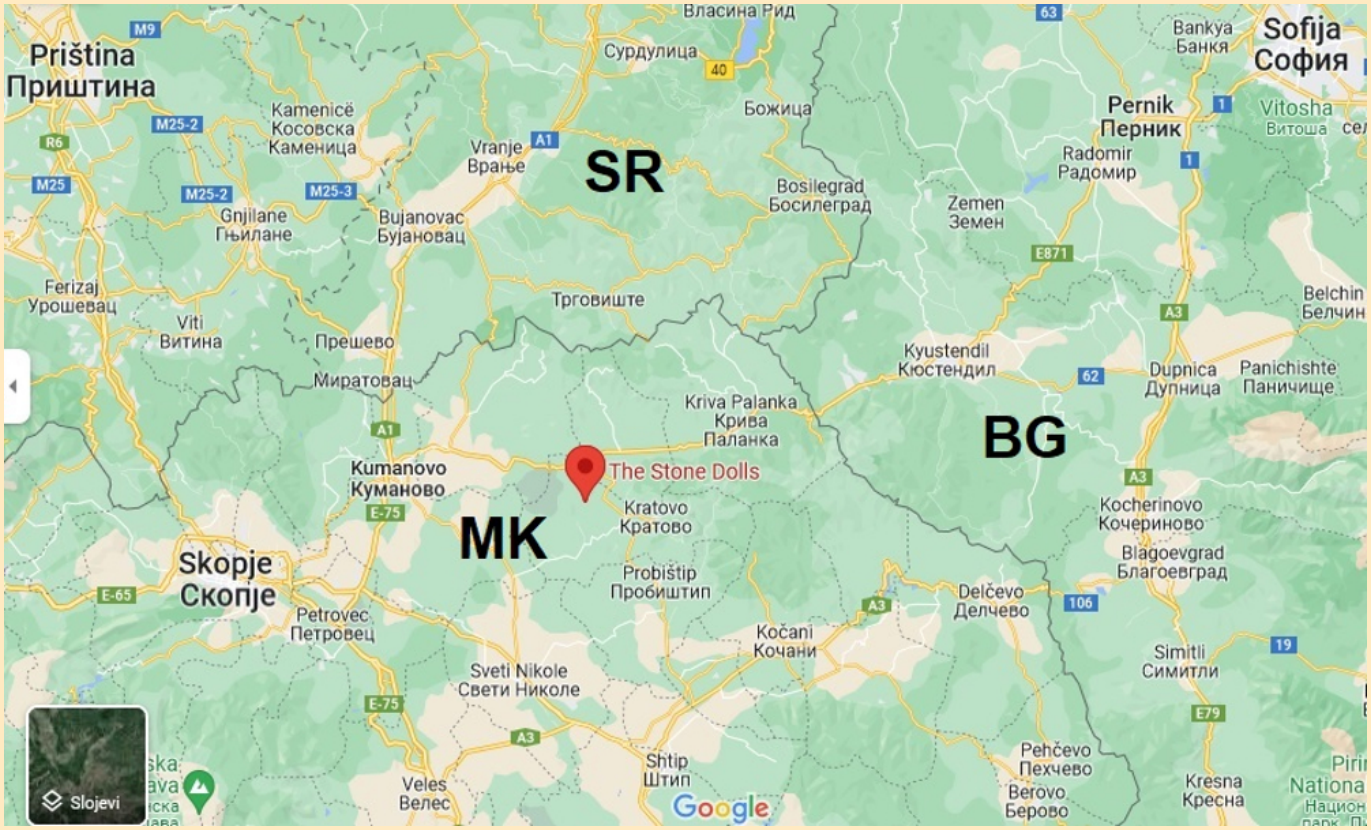


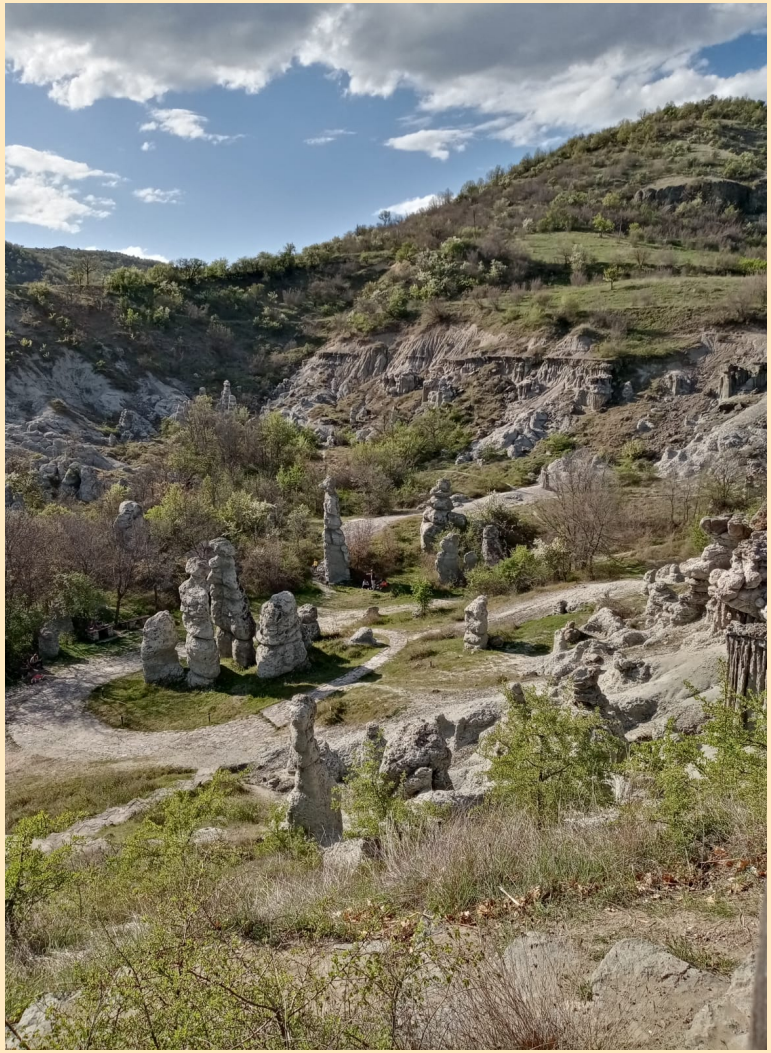
Figure 1: Google map of the region near Kuklici.

KUKLICI STONE DOLLS
A PRECARIOUSLY BALANCED ROCKS PLACE

Figure 2: Kuklici site viewed from the top.

From closer range (Figure 3), numerous formations of stone pillars and columns can be seen. The rocky figures show interesting features, many resembling humans, which became a subject of mystic stories and legends by the local population. In fact, the word “kuklici” in the Macedonian language means “dolls”. There are two main legends about the formation of the stone pillars and columns in Kuklici.
One legend according to the local villagers, is that there was once a forest in the area, but due to battles, it was burned down and the whole place became a wasteland. The temperatures were very low and when an army passed through the wasteland, all of the soldiers turned into rocks. Another famous legend, is that of a man who could not choose which of two women to marry. So, the man decided to marry each woman on the same day, but at different times. While the first wedding was in progress, the woman to be married second went to see who was also getting married on the same day. When she saw her future husband marrying another woman, she cursed the groom, the bride and all in attendance at the wedding party and turned them into stones..

KUKLICI STONE DOLLS
A PRECARIOUSLY BALANCED ROCKS PLACE



Figures 3a & 3b: Rock formations at Kuklici site

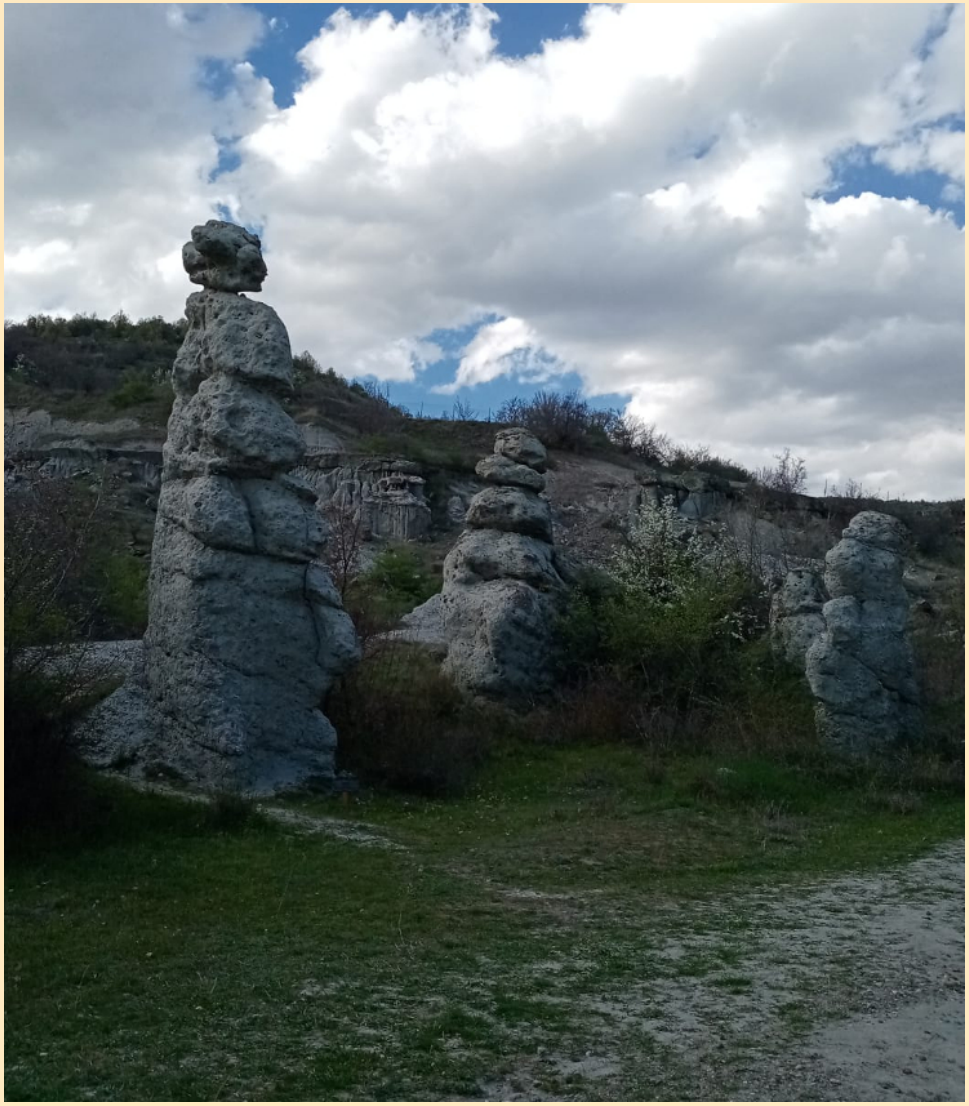
KUKLICI STONE DOLLS
A PRECARIOUSLY BALANCED ROCKS PLACE

Figures 4a & 4b: Stone Dolls of the bride and the groom

KUKLICI STONE DOLLS
A PRECARIOUSLY BALANCED ROCKS PLACE

Figures 5a & 5b: Stone Dolls of the godfather and the godmother

KUKLICI STONE DOLLS
A PRECARIOUSLY BALANCED ROCKS PLACE



Figures 6a & 6b: Stone Dolls of the guests at the wedding party

KUKLICI STONE DOLLS
A PRECARIOUSLY BALANCED ROCKS PLACE

Figure 7: Close-up of a Stone Doll

Figure 4 displays pictures of the stone dolls - the bride and the groom, from various angles and distances and relative to the size of humans. Similarly, figures 5 and 6 display the stone dolls of the godfather, the godmother and the guests at the wedding party. Figure 7 is a close-up photo of one of the stone figures to show the visible features on the surface of the material. The stone dolls occurred as a result of strong erosion and scientists think that the Kuklici area was once under the sea. That is supported by samples taken from the rocks, which contain traces of salt. Further mass spectroscopy analysis should reveal more details about the age and composition of the rocks.

More investigations in the Kuklici area are planned in conjunction with the Skopje Seismological Observatory. It is expected that the results of the spectral analysis and dating will shed light on the age of the rocks and assist in better understanding of the geological settings. Testing the PBRs models with different levels of vibration could reveal the upper limits for the size of the regional earthquakes, corresponding to peak ground acceleration (PGA) with a rate of exceedance for given return periods.

For example, the maximum intensity experienced at Kuklici in the last century was VII MCS, equivalent to PGA of 0.2g. The maximum probable PGA for a 10,000-years return period is theoretically computed to about 1g and might be of special interest to engineers in the design of critical structures. Thus, this kind of studies will demonstrate how knowledge about seismic shaking from geological past can be used to improve the seismic hazard estimates for the present and future too.

KUKLICI STONE DOLLS
A PRECARIOUSLY BALANCED ROCKS PLACE

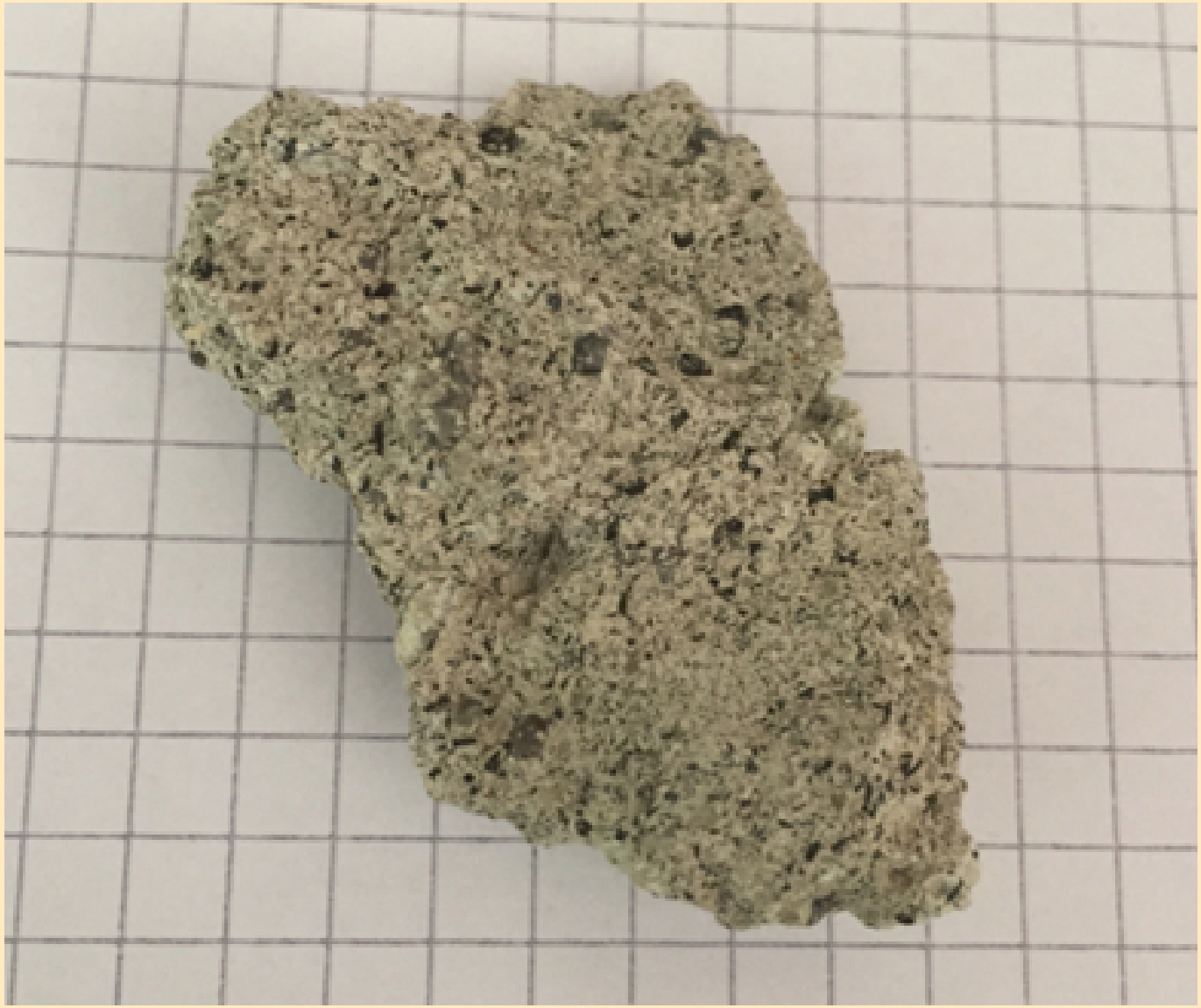


Figure 8: A sample piece taken for analysis.

ACKNOWLWDGEMENT

Here, I wish to express gratitude to my family, especially to my late parents Radmila and Gjorgji Sinadinovski, for their constant encouragement in everything.
Also, I acknowledge my cousin Emilija Jankovska for sharing her experience and original photos of the joint field trip.

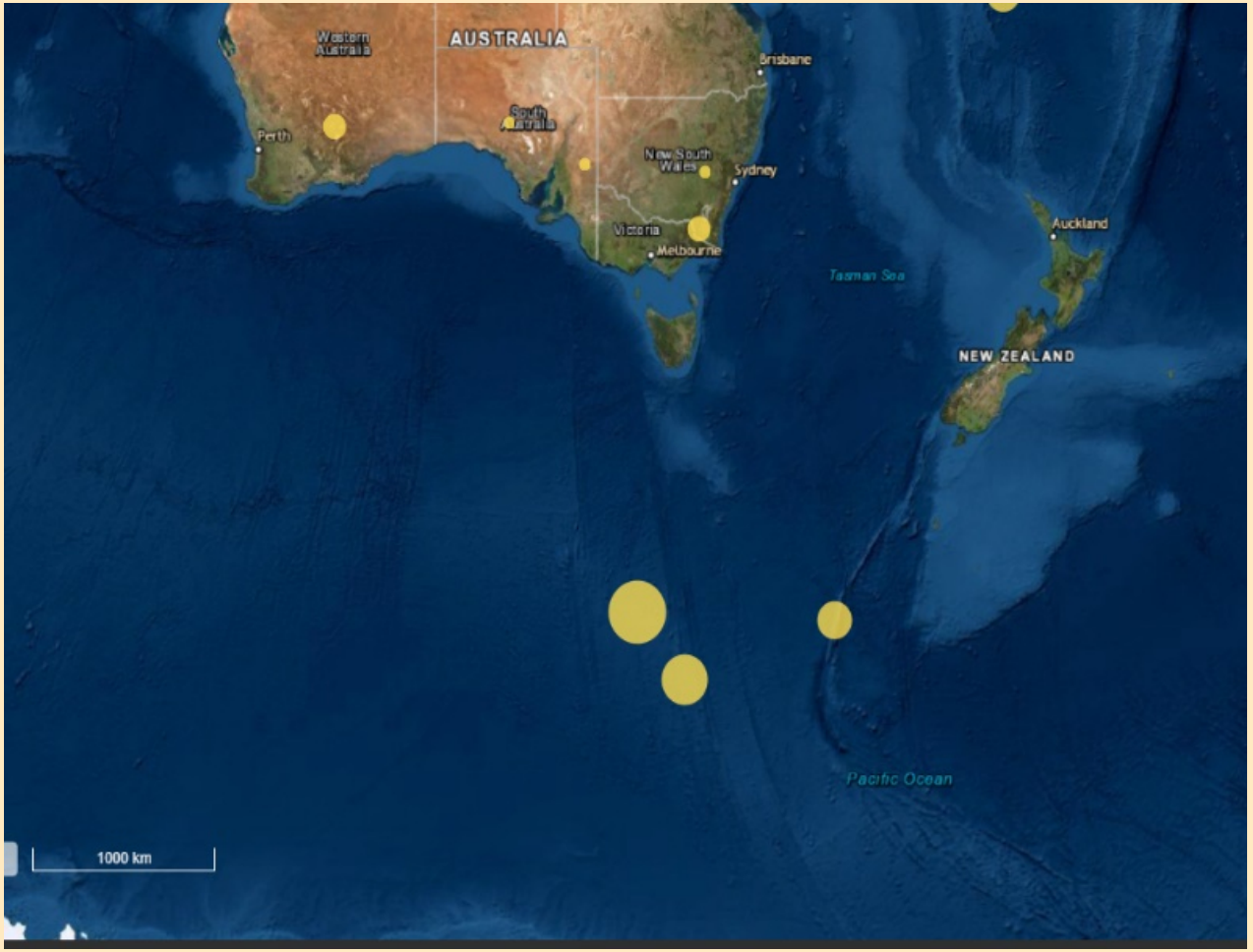
The Antarctic Circumpolar Current
- from little quakes, big currents grow

Kindly submitted by Colin Lynam (retired seismologist)

On the creation of the Antarctic Circumpolar Current (ACC) – from little quakes, big currents grow.
Earthquakes are faulting fracture-bursts of energy, releasing the stress build-up, by the constantly sliding tectonic plates, that we live upon. In Australia, we are moving N-NW at about 7-10 cm per year, as we are pushing away from Antarctica. The geology beneath becomes compressed and sporadically fractures. On Friday, May 7th 2021, an unusual magnitude 6 earthquake occurred south-west of Tasmania, near the spreading seafloor rift that oozes the newest lava rocks, beneath the Southern Ocean. It was detected by seismographs across the globe and reported by a Russian science journal.

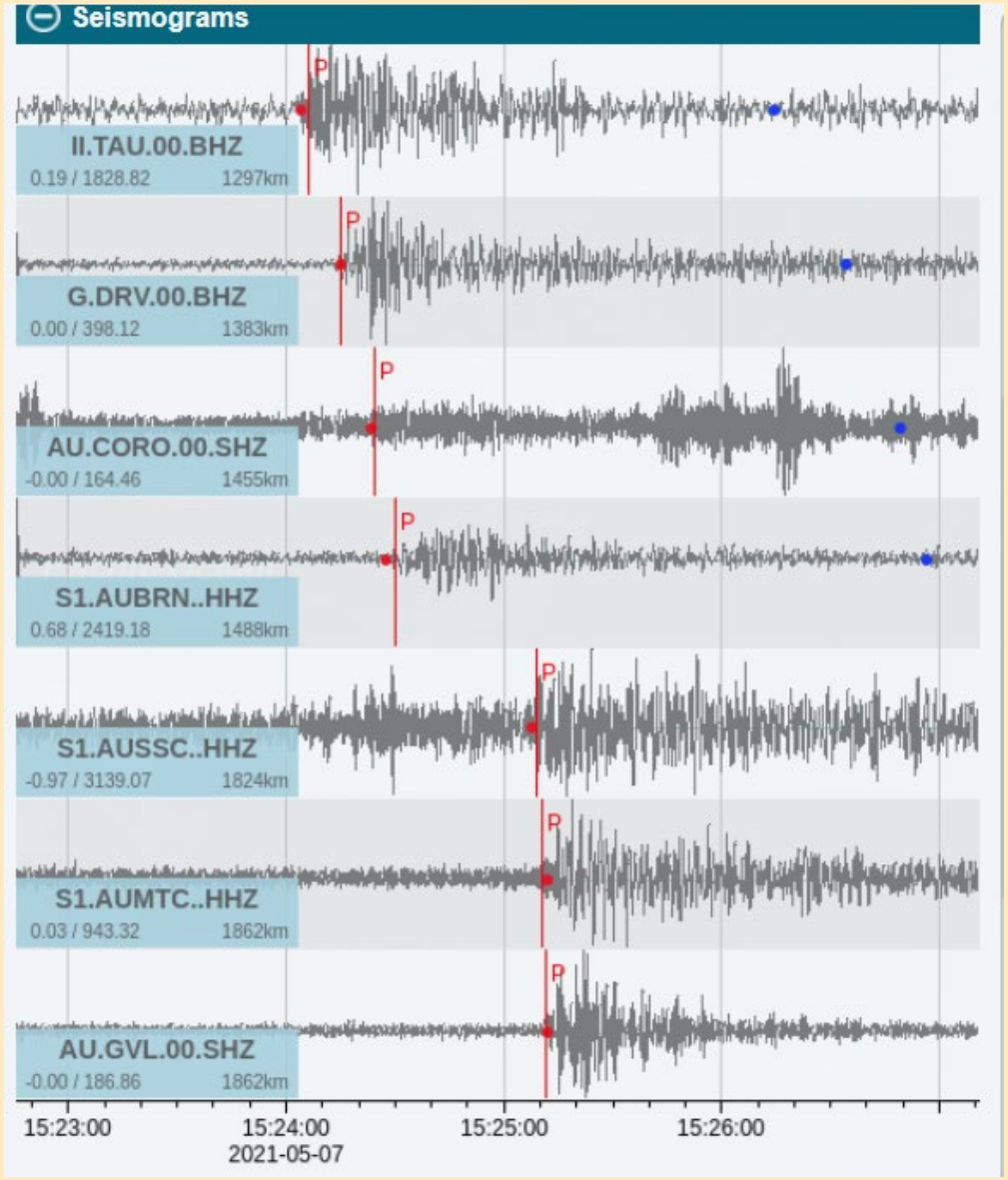
It is evidence of the ongoing tectonic escalator system, further separating the Australian continent from the Antarctic continent. Thirty million years ago, this process created the world's largest ocean current - the Antarctic Circumpolar Current (ACC).

Let's investigate it further.
On the next page we see some of the seismogram records that enabled the earthquake epicentre to be located, as shown on this map. (Courtesy of GA)



Earthquake Epicentre information
Date : 2021-05-07 15:21:13 (UTC)
Location : 54.407°S 144.195°E
Depth : 10.0 km depth and distanced from -
- 1262.7 km (782.9 mi) S of Geeveston, Australia
- 1287.9 km (798.5 mi) SSW of Kingston, Australia
- 1297.1 km (804.2 mi) SSW of Sandy Bay, Australia
- 1298.9 km (805.3 mi) SSW of Hobart, Australia
- 1303.2 km (808.0 mi) S of Glenorchy, Australia

The Antarctic Circumpolar Current
- from little quakes, big currents grow



But this event leads us to a bigger tectonic story.
Recent research shows us that "Tasmania (while) separating from Antarctica about 35 million years ago created the Tasmanian Seaway and for a long time scientist have thought that the opening of this seaway enabled the onset of the ACC, but we've found out this is not the case." Said Dr Joanne Whittaker from University of Tasmania's Institute for Marine and Antarctic Studies. (Whittaker 2021)

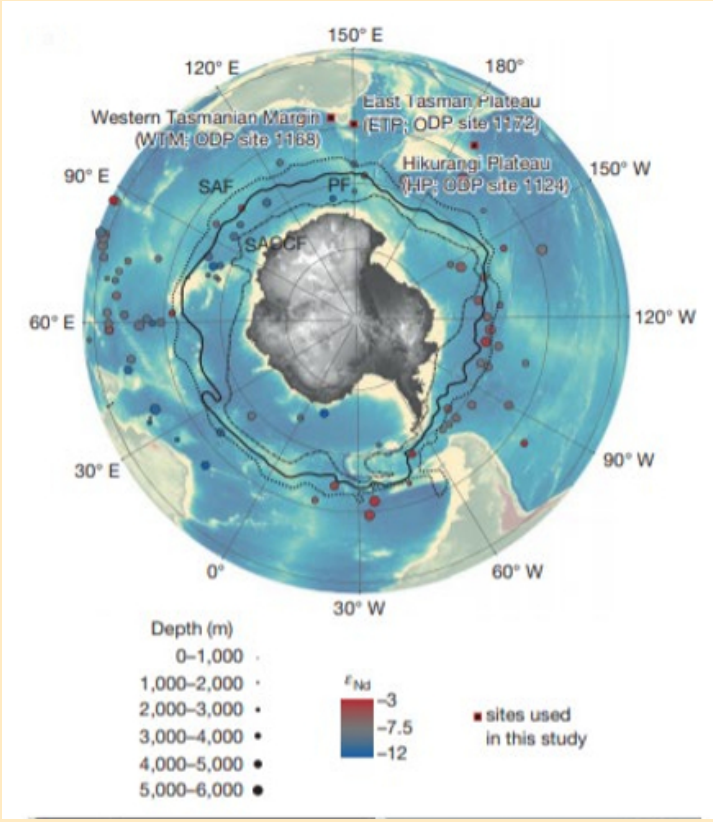
"We discovered that opening the Tasmanian Seaway on its own wasn't enough. It needed to move far enough north to be in the westerly wind band. When the seaway first opened it was too far south. Once it moved further north, the westerly winds were able to drive water through the seaway, and the Earth's biggest ocean current began," Dr Whittaker said. See the sequence of tectonic plate shifts in diagram below.

"The Antarctic Circumpolar Current (ACC) is the world's largest ocean current. It flows clockwise around Antarctica because there are no land masses in the way and it plays a role in maintaining the large ice sheets on Antarctica because it keeps warmer ocean waters away," Dr Whittaker explained.

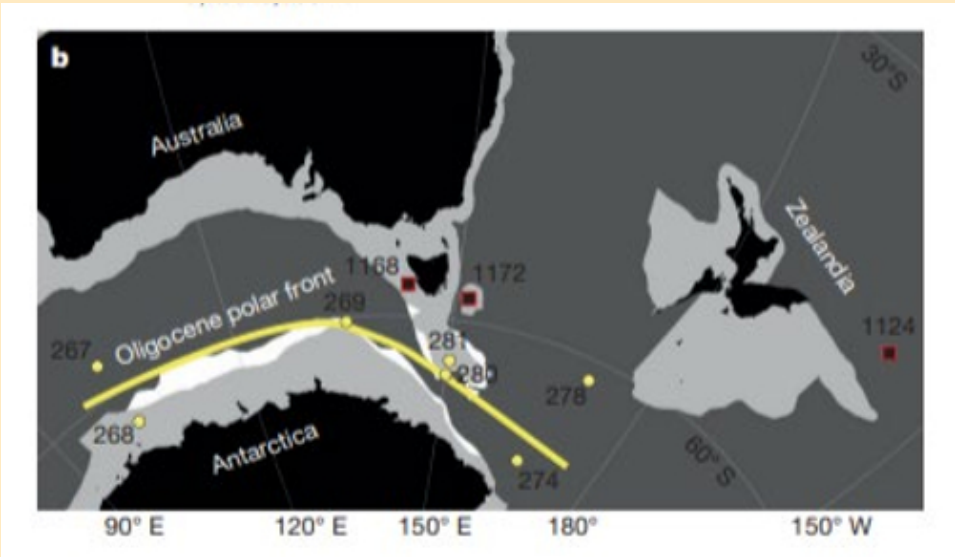
The following maps show the present-day Southern Ocean and relevant study sites.

The Antarctic Circumpolar Current
- from little quakes, big currents grow

The map to the right shows the study sites, present-day zonal eNd distribution, and major frontal zones. Black squares with red borders show the present-day locations of the sediment cores used in this study. Black lines show the meridional extent of the major frontal zones associated with the ACC30. Circles show the locations of Southern Ocean ferromanganese (Fe-Mn) nodules found on the seafloor 7. The colour of the circles shows the eNd values of the surface layers; these surface layers are in equilibrium with overlying bottom water. The size of the circles reflects water depth. SAF, Sub-Antarctic Front; PF, Polar Front; SACCF, Southern Antarctic Circumpolar Current Front**.**



The map below shows a reconstruction of the early Oligocene (30 Ma) tectonic plates around the Tasmanian Gateway (the narrow gap between Antarctica and Australia). Continents with present-day shorelines are in black. Light grey indicates the continental shelf; dark grey denotes ocean basin/oceanic crust. White bands along the outer continental shelf illustrate the range between the outermost and innermost geophysical expression of the COB on the South Tasman Rise (light grey and white lobe south of Tasmania) and Antarctic conjugate margins 8.



Yellow circles indicate the reconstructed position of Deep-Sea Drilling Program (DSDP) sediment cores, with microfossil assemblage data19 used to reconstruct the Oligocene position of the polar front (yellow band). Red squares indicate the reconstructed positions of Ocean Drilling Program (ODP) sediment cores, used to obtain fossil fish tooth eNd records in this study. (The plate reconstruction was made using GPlates (http:// www.gplates.org)). (Sher et al 2015)

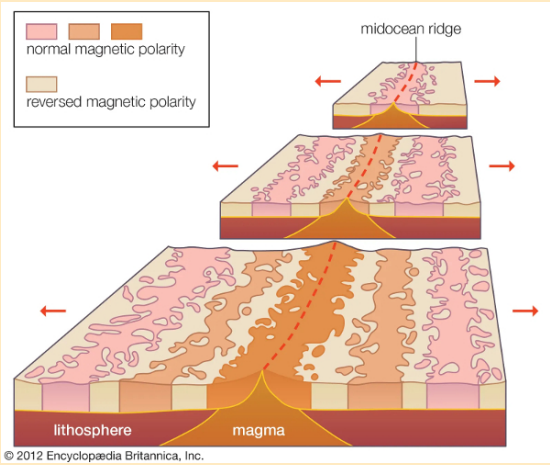
The Antarctic Circumpolar Current
- from little quakes, big currents grow

By studying to be a geologist or geophysicist we can learn to create tectonic reconstructions of how the earth looked millions of years ago. Earth is always changing the shape of continents, forming new mountain chains and erupting new volcanic lava, dust and gas and depositing those under lakes and seas. Tasmania and southern Australia once had glaciers and ice fields. In this sequence of diagrams, we see a collage of tectonic reconstructions, starting from the present day and going backwards in time to (21 M years bp), then to (45 M years bp), then (65 M years bp) and finally (75 M years bp). Australia began separating from Antarctica around 83 M years bp. (Weissel et al 1977)

Through dating measurements of subsea sediments, it is estimated that the East Tasman Plateau subsided constantly after separation from Antarctica. How could they create those reconstructions? Well, they measured the remnant magnetism of each sample taken from the sea-floor. When magma oozes from the volcanic rift chain, the iron molecules align to the earth's magnetic field, present at the time of occurrence.

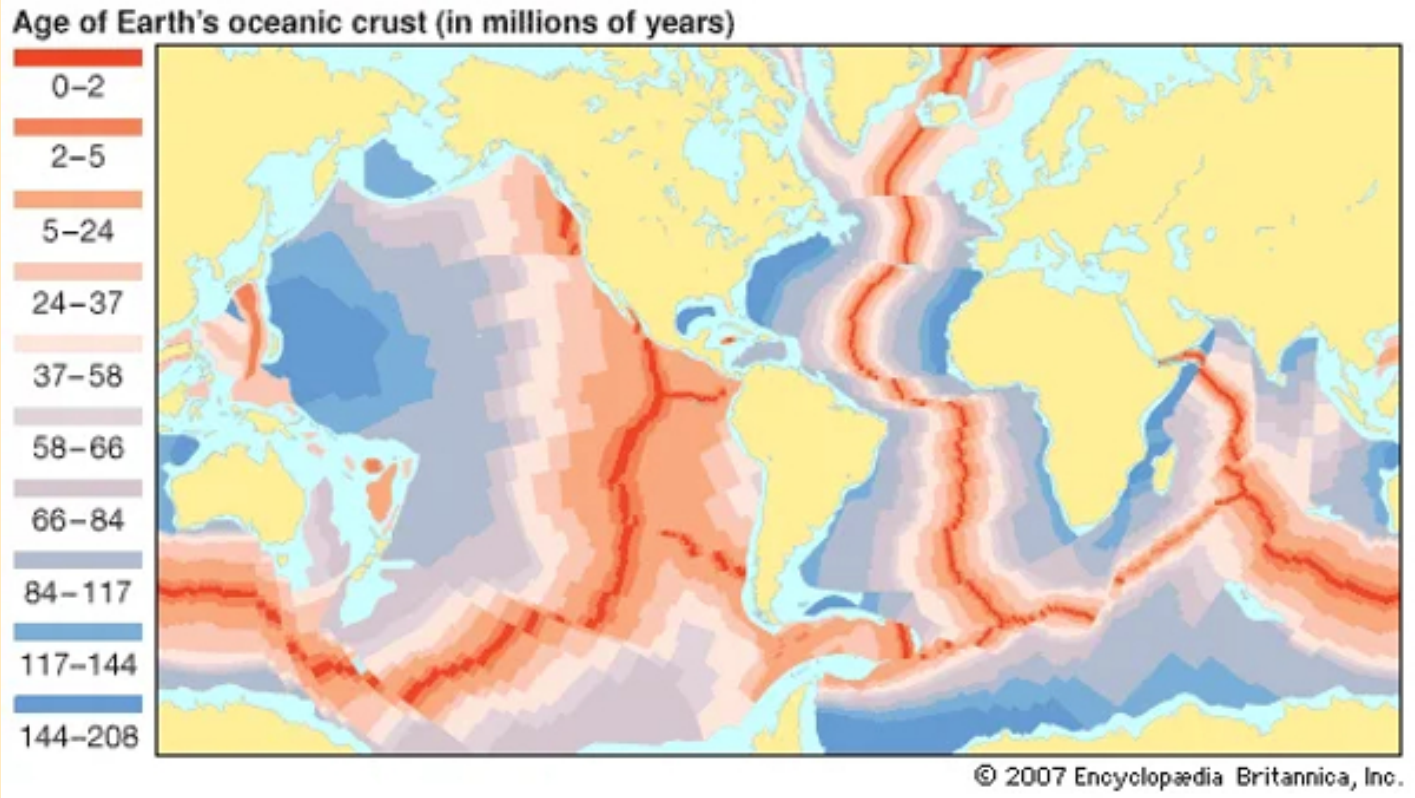
The earth periodically changes magnetic poles and new rocks take on a different alignment, as we see in the diagram on the right. A marine magnetic anomaly is a variation in strength of Earth's magnetic field caused by magnetism in rocks of the ocean floor.

Marine magnetic anomalies typically represent 1 percent of the total geomagnetic field strength. They can be stronger ("positive") or weaker ("negative") than the average total field. Also, the magnetic anomalies occur in long bands that run parallel to spreading centres for hundreds of kilometres and may reach up to a few tens of kilometres in width.



The Antarctic Circumpolar Current
- from little quakes, big currents grow

In this diagram, we can see that the earth exudes the newest rock formations (red) along the constantly upwelling of sea-floor spreading and then pushes the oldest sea-floor rocks down underneath overriding continents (light blue), in a process called subduction. (Luyendyk 2016)



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Weissel, J.K., Hayes, D.E. and Herron, E.M., (1977). Plate tectonics synthesis: the displacements between Australia, New Zealand, and Antarctica since the Late Cretaceous. Mar. Geol., 25: 231--277, Whittaker J., Williams S., (2021 April)

FISH TEETH AND TECTONIC PLATES TELL A NEW STORY ABOUT WORLD'S LARGEST OCEAN CURRENT (https://www.utas.edu.au/profiles/staff/imas/joanne-whittaker)

Scher, H., Whittaker, J., Williams, S. et al. 2015, July 15) Onset of Antarctic Circumpolar Current 30 million years ago, as Tasmanian Gateway aligned with westerlies. Nature 523, 580–583 (2015). https://doi.org/10.1038/nature14598

Dealing with the high humidity inside the TPSO seismic vault

Kindly submitted by
Paul Hutchinson - Director,
The Peters Seismological Observatory

The Seismological Association of Australia's (SAA) underground seismological observatory TPSO, located close to Victor Harbor in South Australia provides a stable temperature of +21°C, with approximately ±0.5°C variation throughout the whole year. This temperature stable environment allows the Lippmann High Resolution tiltmeter on the seismic pier of TPSO to produce high quality solid Earth tidal data, which SAA provides under a joint cooperation agreement with the Institute of Earth Physics & Space Science, Hungary (EPSS). European researchers at four institutions in three countries continue to analyse this data and conduct ongoing refinement to current solid Earth tidal models. But in order to maintain such temperature stability, the TPSO seismic vault must be kept closed.

Having been closed for the past eight years, has meant dampness on the exposed bedrock located inside the seismic vault has evaporated into the air inside the vault. The result of this is 93% Relative Humidity (RH) in the sealed seismic vault, a condition which is detrimental to the longevity of the sensitive instruments on the seismic pier, their electronics and the plugs and cables these instruments use to connect to the outside world. Some 2½ months ago, the exposed bedrock in the vault was covered with a waterproof layer, which hopefully will prevent any moisture from the damp bedrock from evaporating into the sealed airspace of the vault.

A de-humidifier was used for a period of nine days to dry out the water-based bitumen rubber which was placed over the exposed bedrock. The de-humidifier removed some 20 litres of water from inside the vault. But this hot air de-humidifier resulted in an increase of almost 11°C inside the vault, and drove the RH down as low as 44%. It took two weeks for the temperature to then drop 8°C. Then for the month of June 2022, the temperature dropped another half a degree to now stabilise at +21.1°C. This changing temperature had a detrimental effect upon the quality of the tilt data. In June on two separate occasions we placed desiccant inside the vault, and each time observed a drop of some 3% RH within a few hours, only to see after a week, the RH back up again to some 92%. Now with the temperature inside TPSO again stable we have decided to leave the vault closed for the foreseeable future, recognising the need for a stable temperature environment for the tiltmeter to do its job.

However, the need to reduce the humidity inside TPSO still remains. But it is of interest to consider that at 92% RH and +21°C, at about sea level, the total amount of moisture in all the some 10m3 of air inside the shut up vault is only some 145ml of water. This 145ml of water would be easily absorbed by either of the two lots of desiccant placed inside the vault during June. So where is the moisture coming from?

The obvious answer is that the impermeable layer we placed over the exposed moist bedrock in the vault, at the end of April 2022, is not effective in keeping moisture from entering the vault.

Dealing with the high humidity inside the TPSO seismic vault

That said, the less obvious answer is that it is being emitted from the concrete walls and roof that make the seismic vault.

Concrete, that is dry, cured and mature concrete can,

- Emit moisture from out of the concrete into the air if the humidity is below about 70% RH, and,
- Absorb moisture from out of the air into the concrete if the humidity is above about 70% RH.

But for a 300mm thick slab of concrete sealed one side and exposed to air on the other side, it takes some three years for the “free” moisture in the concrete to reach stabilisation with air of a new RH. The concrete making up the 300mm thick walls and 500mm thick ceiling of the TPSO seismic vault are sealed on the outside under the some 9 metres of earth.

Over the past 6 years, this concrete has been exposed to 93% RH air inside the vault, and using Chart 1, would have absorbed an amount of moisture equal to about 5.8% of its total weight. With concrete walls and ceiling of the vault weighing about 30 tonnes, and having been exposed to 93% RH for some five years, then the concrete of the vault could be presently holding some 5.8% of its weight in “free” water, or some 1,750 litres. So just to reduce the RH in the vault to a stable 85%, will require the concrete to only hold some 5.0% of its weight in “free” water, or 1,500 litres.
That is if we are to have a stable 85% RH in the seismic vault, we need to extract some 250 litres of moisture from out of the concrete walls and ceiling of the vault.

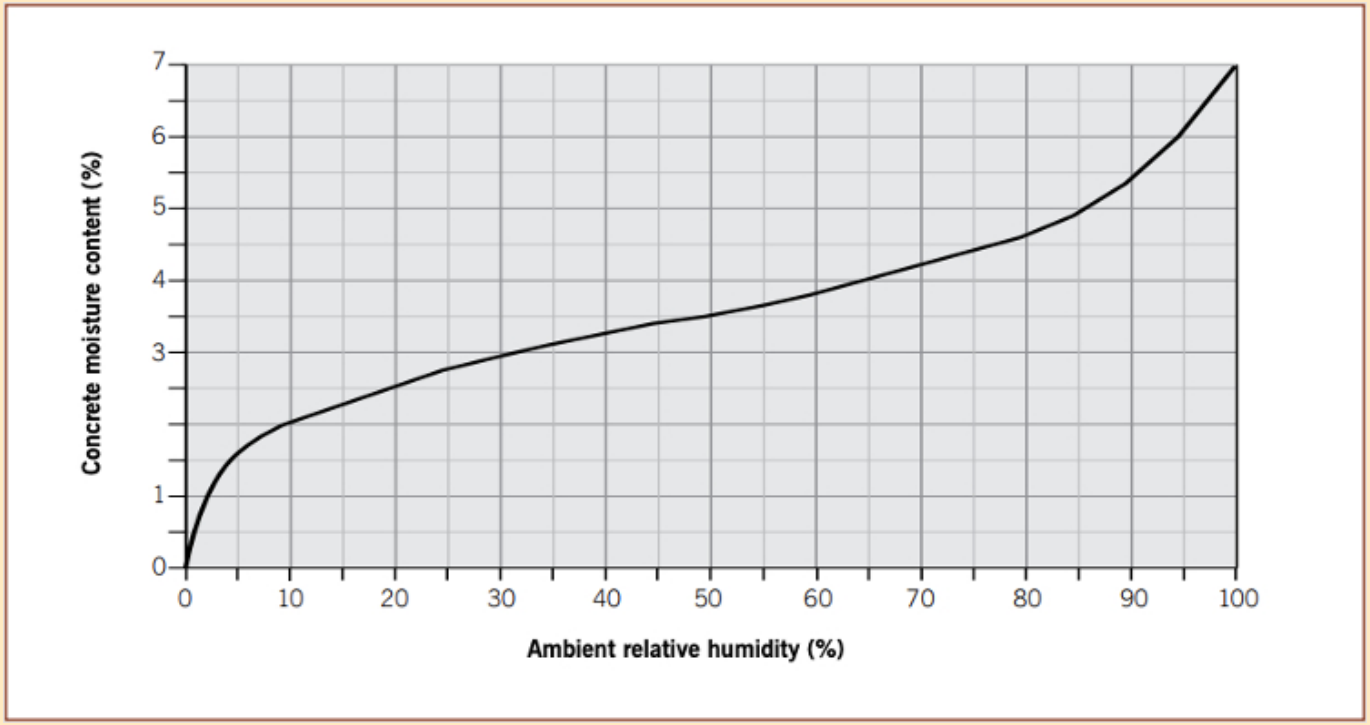


Chart 1: Sorption curve for concrete

Dealing with the high humidity inside the TPSO seismic vault

To do this in a conventional manner would be to run a hot air dehumidifier which would heat the vault up to some +35°C, and have a RH of some 30 to 40%. And run the dehumidifier for a year or more.

This is obviously not an option for the seismic vault of TPSO with the priority of a stable vault temperature. So one option we are looking at is that we may in the future, pump into the seismic vault fresh outside air thru a 60mm diameter pipe. But only when the outside RH is say below 40%, and the temperature is close to +21°C. As occurs often during summer. The 60mm diameter pipe, being some 15 metres long, and running the full length of the observatory tunnel, and having a small airflow of just some approximately 35m^3 per day, would allow the fresh air temperature entering the vault to be very close to the same temperature as that in the last sections of the tunnel. And 35m^3 per day of low humidity air, being enough [in theory] to absorb some 300 litres water over a three year period. A three year period, seeing as the emittance of free moisture from the 300mm thick concrete is a very slow process.

So we could expect after three years of periodically admitting fresh air, (and removing some 250 litres of moisture from out of the concrete) then with the vault then sealed and no fresh air entering the sealed vault, to have a stable 5% “free” moisture content in the concrete with a stable 85% RH of the sealed air inside the vault.

We would also need to determine what effect would the low flow of air into the vault have on the tiltmeter, even if the temperature of the incoming air was almost exactly the same as that in the vault. Even if the tiltmeter was sealed underneath a foam box on the seismic pier.

As an aside, the Conrad Observatory in Austria (COBS) with a 145 meter long tunnel, has a year round temperature of +6.9°C and 100% RH. The operators of scientific instruments in the COBS seismic vaults, have dealt with their RH issues, by way of placing each instrument on the seismic pier, under a thick foam box. The tiny amount of heat generated by each instrument raises the temperature of the air inside the thick foam box a small amount, resulting in the RH of the air inside the foam box dropping below 100%. Obviously, it takes some many days even weeks, for the temperature inside the foam box, to reach stability. But that is how COBS deals with their 100% relative humidity problem.

If you want to follow the progress of the High Resolution Tiltmeter at TPSO, you can see the daily (24hr) measurement cycle at this link. The images (lower left and right) on the webpage cycle at a regular rate or you can select an image to view. The LTS_HRTM1_X_TPSO and LTS_HRTM1_Y_TPSO tabs, along with the LTS_HRTM1_temp_TPSO tab (lower left hand image) show the state of the instrument's primary outputs.

Recent Seismic Activity - Australia

Australian Earthquakes

April - June 2022

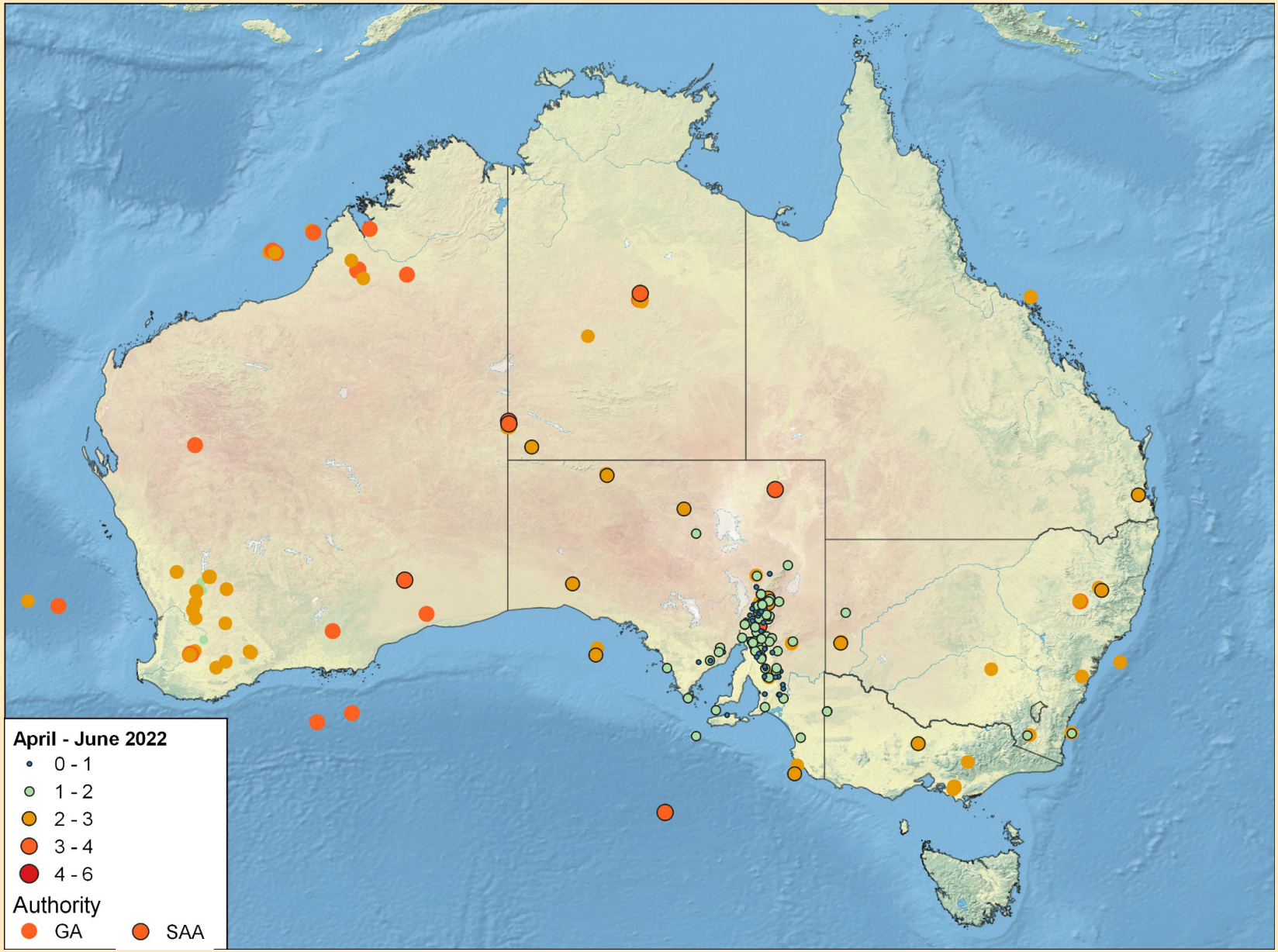
Map produced by Clive Collins

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.

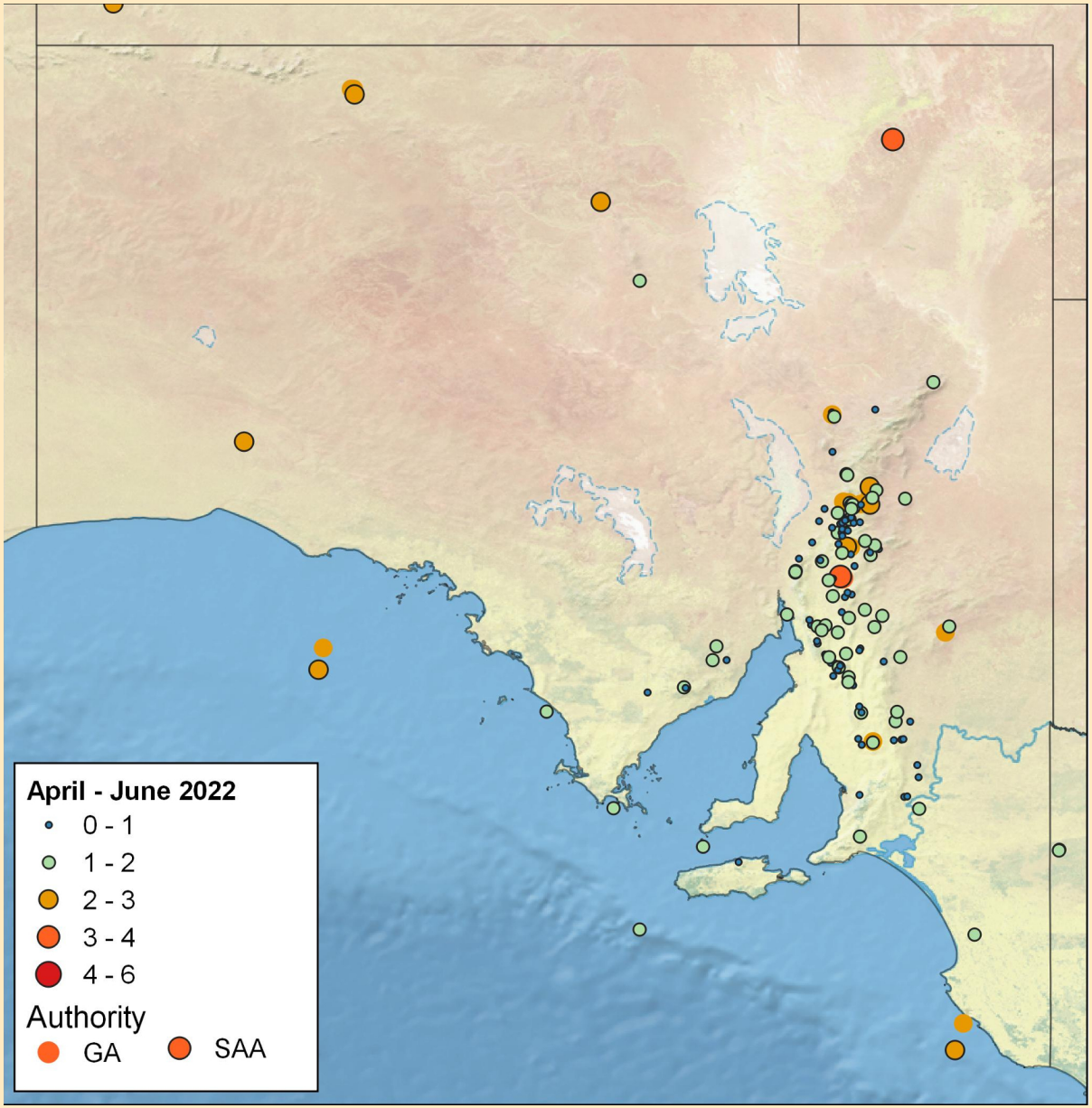
Many thanks to all who keep their instruments running and organisations who keep collecting and making the data available including:

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

April - June 2022

Map produced by Clive Collins



Recent Seismic Activity - Queensland

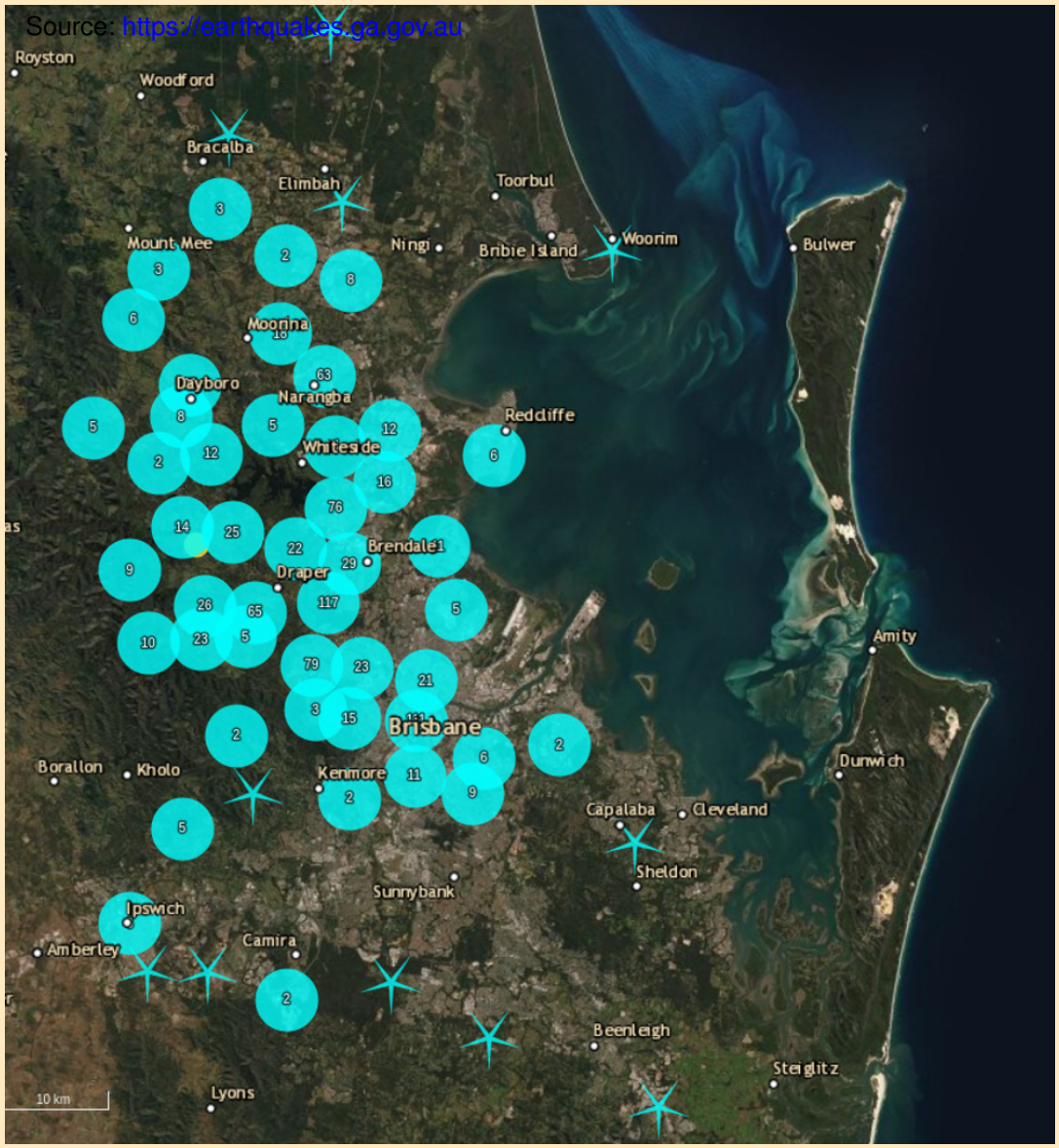
Kindly submitted by Col Lynham

The map shows the number of Felt Reports registered by people (chatting in social media), who felt the earthquake that occurred at 1:25PM on Tuesday 31 May 2022. Geoscience Australia has a web app that collects that social media data continuously. The tremor was widely felt across the Samford Valley, Narrangba and into Brisbane suburbs of New Farm, Chermside, and Ferny Grove.

RSQ member Dr Mike Turbull (citizen seismologist at Gin Gin) said that “Despite being widely felt and heard in the mesoseismic area the available seismographic records are relatively poor quality. This suggests that this ML3.0 event was relatively shallow. The occurrence of this event in this location is not unusual. There have been several such events here in the past ten years. It is a possible indicator that larger and potentially damaging events can occur close to Brisbane, and that the Queensland State Government cannot afford to be complacent when it comes to monitoring for small earthquake events throughout the State.”

He also points out “This author argues that funded in-house (i.e., a formal departmental agency, not second- or third-party agencies) seismological research would be of benefit to the Queensland Government, Queensland industry and commerce and Queensland society in general. Knowledge of where and when small earthquake events occur is an indicator of where future larger and potentially damaging events may occur and is therefore crucial information to inform emergency response and hazard mitigation plans.”

2022-05-31 03:25 Brendale -27.31, 152.83 3.0ML

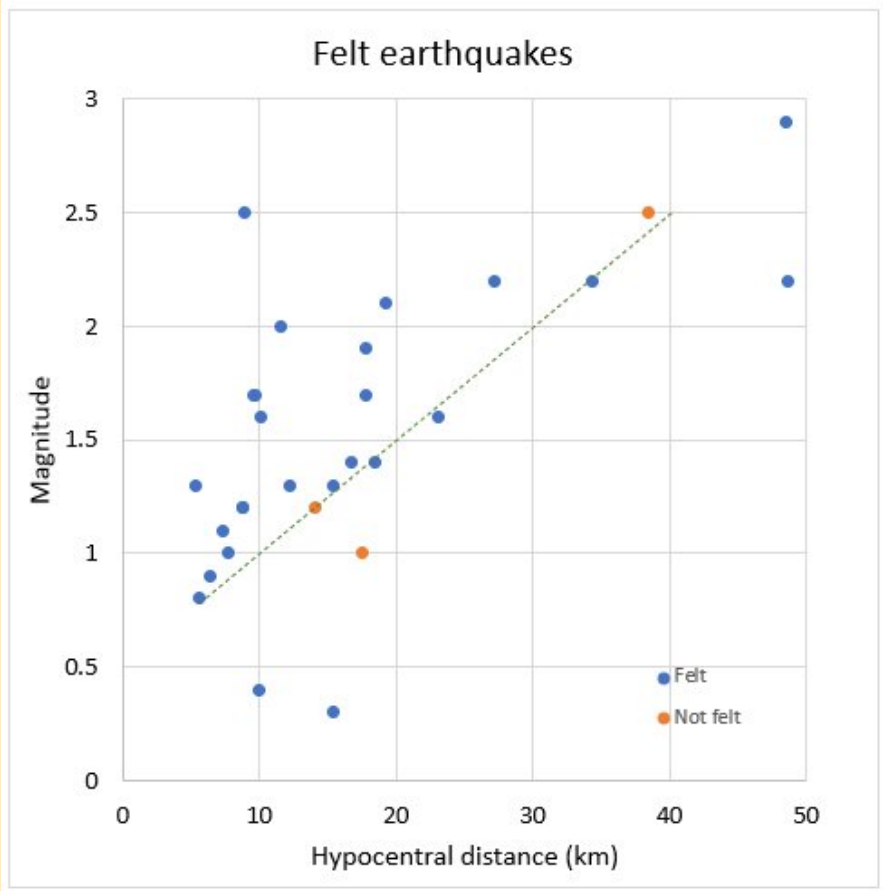


Recent Seismic Activity - How small can you feel them?

Kindly submitted by David Love, SAA Chief Seismologist

A tiny earthquake of magnitude 0.7 occurred near Hope Valley, SA on 2022-05-18 at 1748UT. There were 2 felt reports (blue stars) on the GA website. Our nearest station UTT was 3 km to the north-east. It was shallow, but unclear how shallow. A depth on 1 km is listed on our website. It was recorded on 11 stations. We record very few events this small near Adelaide.

The couple who operated the station at Gladstone, QLD (2015-17) regularly felt small earthquakes. A number are plotted on the graph below, showing hypocentral distance against magnitude. It suggests that a magnitude 1 at 10 km or a magnitude 1.5 at 20 km was commonly felt.



Resources & useful links

Description	URL / Webpage	Notes
SAA Membership Application	https://www.assa.org.au/media/74936/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	https://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/	PSN seismometers & some Raspberry Shakes
Recent SA Earthquakes	https://earthquakes.mappage.net.au/q.php	Data & summaries of recent SA quakes
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