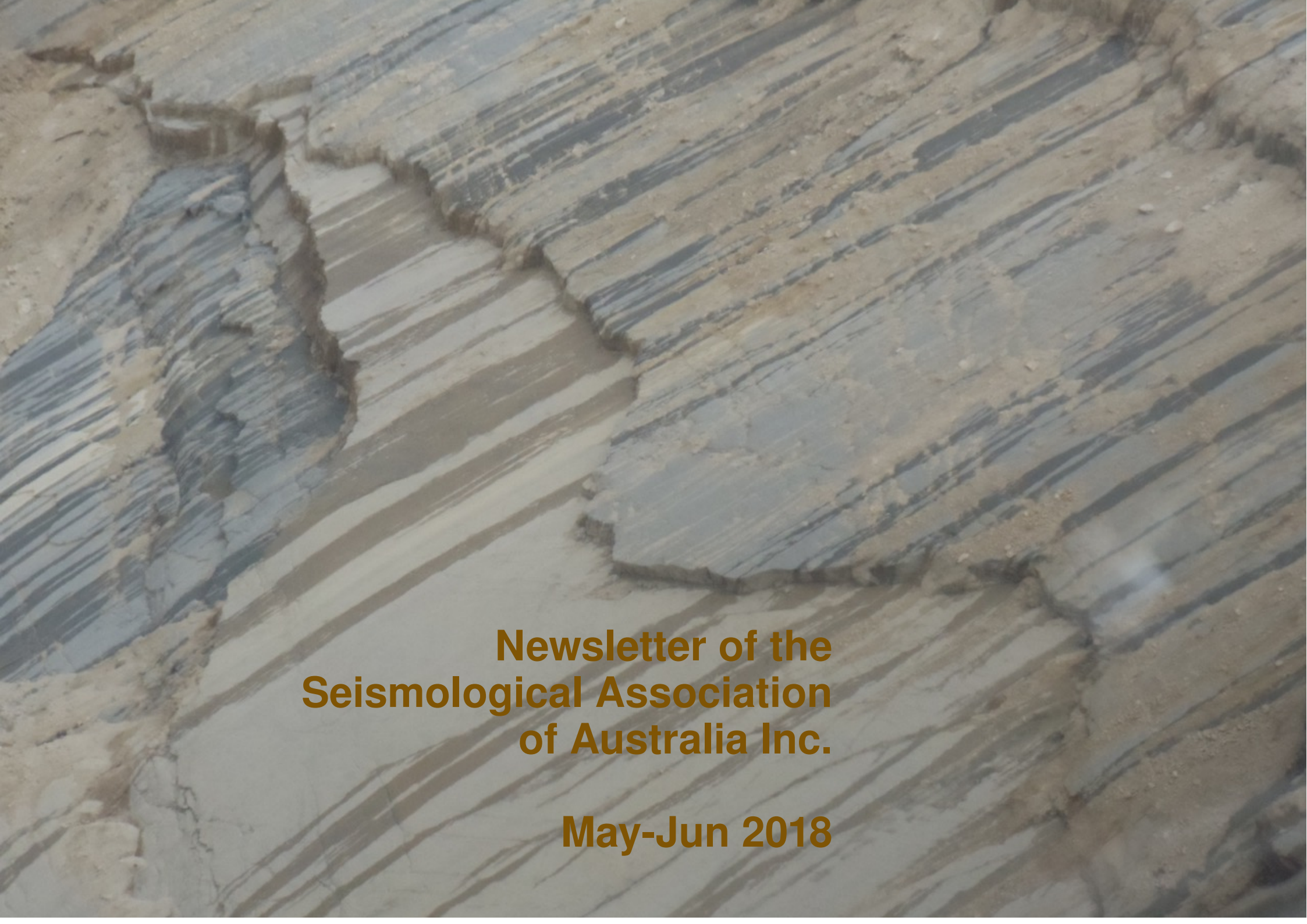
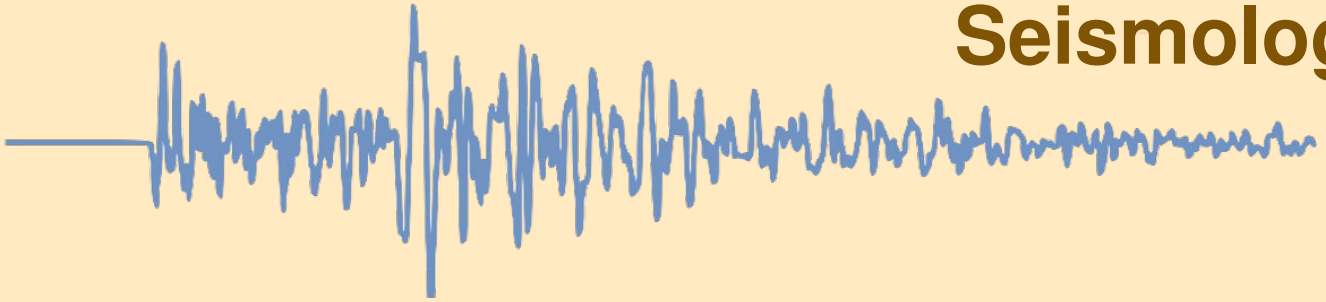


Newsletter of the Seismological Association of Australia Inc.

May-Jun 2018



Seismological Association of Australia Inc.

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

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

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.

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. Your name may be withheld only if requested at the time of submitting. Images should be high resolution and uncompressed, although high resolution JPEGs are acceptable.

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

A word from the Editor

Sadly, the Chairman has asked me to fill in for him for this edition, please excuse my manners if **I** offend anyone. This edition features some updates on the state of the SAA seismic network as several of the existing stations finally transition into the hands of Geoscience Australia. This is a good thing for a number of reasons, probably the most important being that it frees up some serviceable assets to be redeployed at sites which need replacement equipment or upgrades. It also allows the SAA to consolidate the network and look for opportunities to enhance coverage in areas underserviced at present. You will see the benefit of this on Page 5, in the results obtained from the small Ashton quake recorded in April.

I prefer to present a balance of the past, present and future within this newsletter but I think we've been leaning a little toward the past recently. I am really pleased to include an insight into the work being done by Eric Daine in the USA, using innovative technologies to provide sensitivity and resolution enhancements to instruments we use on a regular basis. Enjoy.

Peter Gray

SAA member activities

PALMER SEISMOGRAPH WORKING BEE

On Saturday 12th May, four SAA members converged at Kitticoola, south of Palmer, to modify PLMR to send continuous data to the 'net. John Duffield and Blair Lade were hard at work adding an extra 80 watts of solar power to the site before I arrived. Jim Deer arrived soon after. Netgear wireless access points with small yagi aerials were used to make a link from the current site to a house on the property that has an NBN satellite service. Squeezing low loss coax through existing conduit turned out to be one of the most difficult exercises. The seismometer pit, a piece of 12 inch (30cm) PVC pipe, was extended to include 6 inches (15cm) of styrofoam insulation to reduce condensation.

Unfortunately we were not able to solve the internet issues before the end of the day. This will have to wait for another visit.

PLMR was an early continuous digital station in the Adelaide network, established in 2006. The site was the second to use a continuous dial-up phone system. No ADSL, wireless broadband or mobile phone connection is possible at this site, nestled in the quiet heart of the valley. It has been recording on-site (Echo recorder and Guralp 6T-1 seismometer) for most of the time since SAA took over management in 2017.

David Love, Chief Seismologist

Left to Right: Jim Deer, John Duffield and Blair Lade - David is on the camera

SAA member activities

Jim Deer, ready to fend off the next ladybird swarm - David is on the camera

STATION CHANGES IN SA

As part of the Geological Survey of South Australia restructure, an agreement was made for Geoscience Australia to take over the operation of three stations and upgrade the equipment. The three stations are Mount Gambier, Sedan and Kelly Hill Caves. In the interim, SAA has been operating the sites with GA covering the phone costs.

Jim Deer and I travelled to Mount Gambier on 21 May to remove the existing equipment. The weather is usually the biggest problem at The Bluff. It is nearly always windy, and often wet and cold. We were fortunate to have only light winds, but were constantly getting in and out of the car between showers. When the sun comes out, the view is quite stunning. However the greatest problem this time was the plague of ladybirds. We had to sweep them off everything, not just once, but two or three times.

On the same trip, we also visited the Robe station where a malfunctioning recorder was replaced, and the Willalooka station.

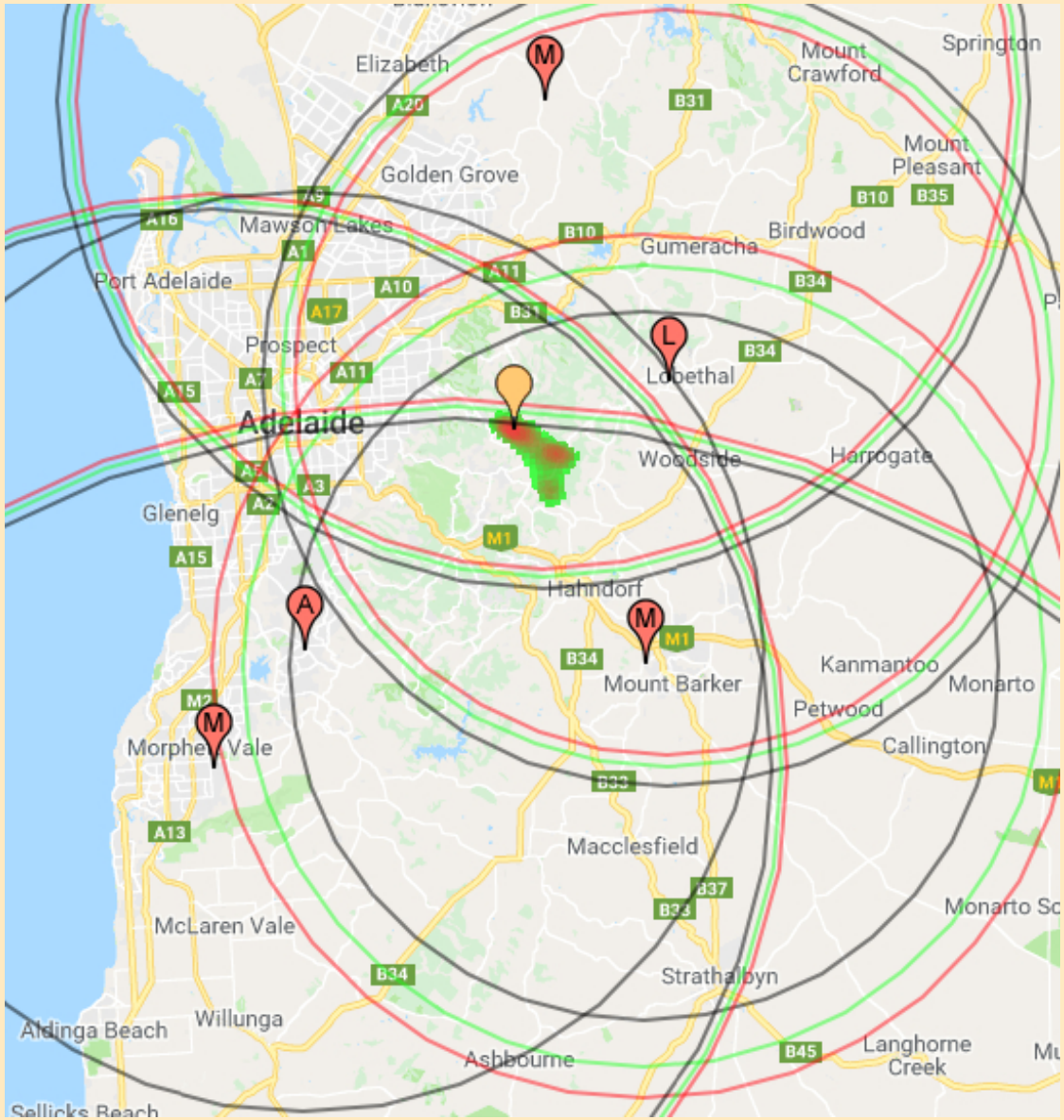
The Sedan station north-east of Adelaide is now turned off, as GA begin installing their new equipment.

It is expected that the stations will be available via Seedlink within a few weeks.

The Kelly Hill Caves station will change over soon.

David Love, Chief Seismologist

SAA member activities



ACG website figure showing location as a probability cloud (orange arrow).

RECENT EARTHQUAKES NEAR ADELAIDE

In the last month four earthquakes have been located relatively close to Adelaide. Two of these are within our network where denser station spacing has allowed much more accurate location including depth. This is where the less used stations have significant value to add.

The Ashton earthquake (2018-04-28 2049UT) was 15km east of Adelaide, and at magnitude 1.0 was too small to be felt. There were 14 operating seismographs within 50km, completely circling the event. This includes two Geoscience Australia stations and one school station. There was no significant angular gap in any direction. The location program (eqFocus) suggested that the solution was accurate to better than 1 km in east, north and vertical directions - depth 23km

http://earthquakes.mappage.net.au/q.htm

This is a vast improvement on 15 years ago when there would have been only 2 recordings within 50km. The Australian Centre for Geomechanics (ACG) website, using only the PSN seismographs, was able to produce the figure below, showing the epicentral area as a green to red probability function (orange pointer). Their calculated depth was 22km. Surprisingly, although this was a very low magnitude event, most stations had moderately clear first arrivals. As a result, a focal mechanism will be produced when all data has been collected.

David Love, Chief Seismologist

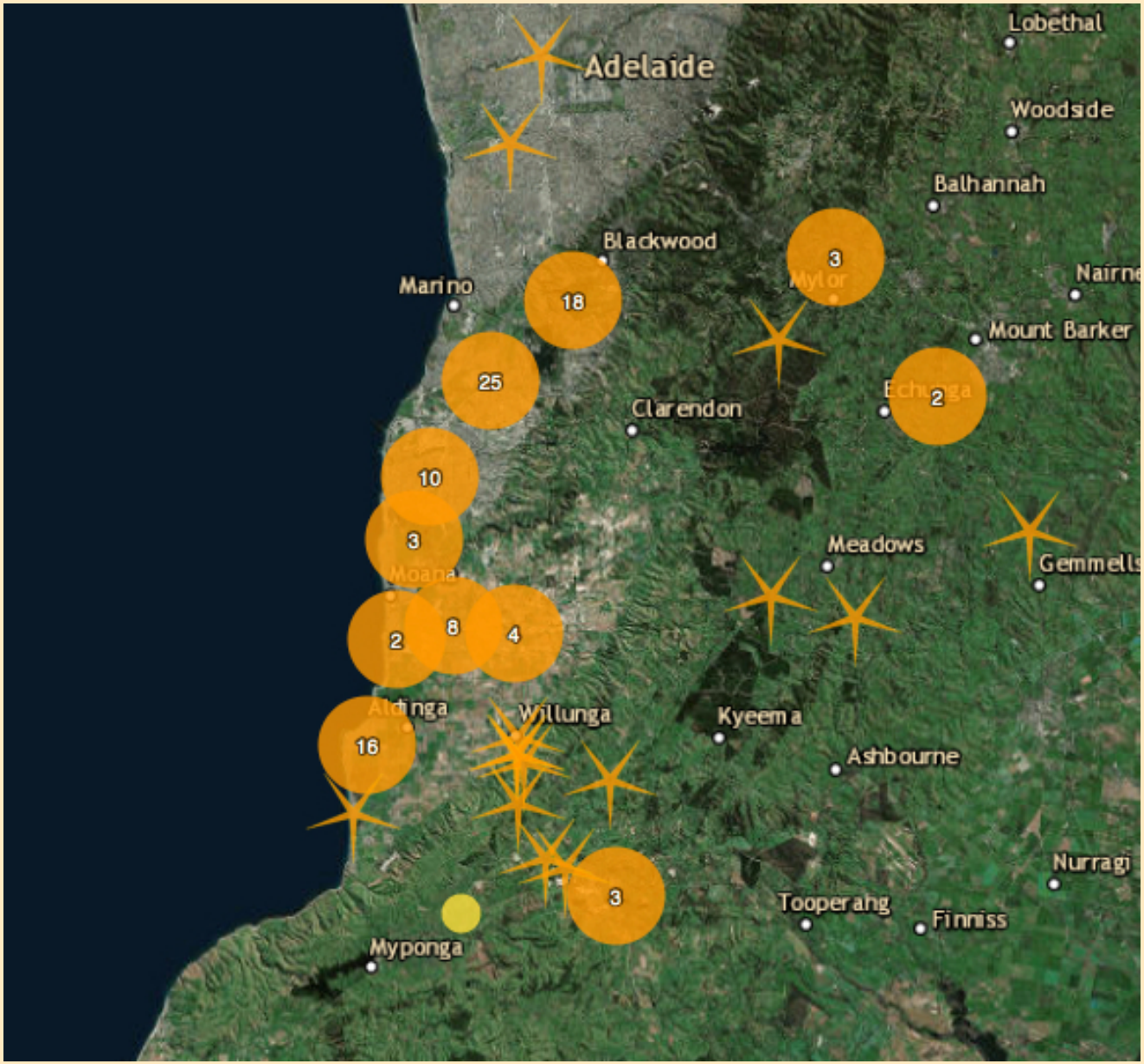
SAA member activities

RECENT EARTHQUAKES NEAR ADELAIDE

The Aldinga earthquake (2018-05-28 0243UT) was 40km south of Adelaide. Its magnitude of 2.8 meant that it was felt by a considerable number of people. This time there were about 11 seismographs within 50km of the epicentre. The distribution of recorders around the epicentre was not as good as the previous event, with most being to the north. The nearest recorder was at Morphett Vale, 15km to the north. The initial location using most local stations was between Aldinga and Willunga and 16km deep. This is about 10km north of the initial GA location. A focal mechanism may be possible for this event also.

Geoscience Australia had only a few days previously launched a major upgrade of their website https://earthquakes.ga.gov.au so that more details, particularly felt reports, could be seen. The figure below shows the distribution of the reports. As expected this is heavily affected by where computer users are placed!

David Love, Chief Seismologist



Felt reports on the new GA website.
GA epicentre – yellow dot.

AEES Seismologists (they're SAA members too) return to PNG Southern Highlands

Following their initial visit in March, Kevin McCue continues the story

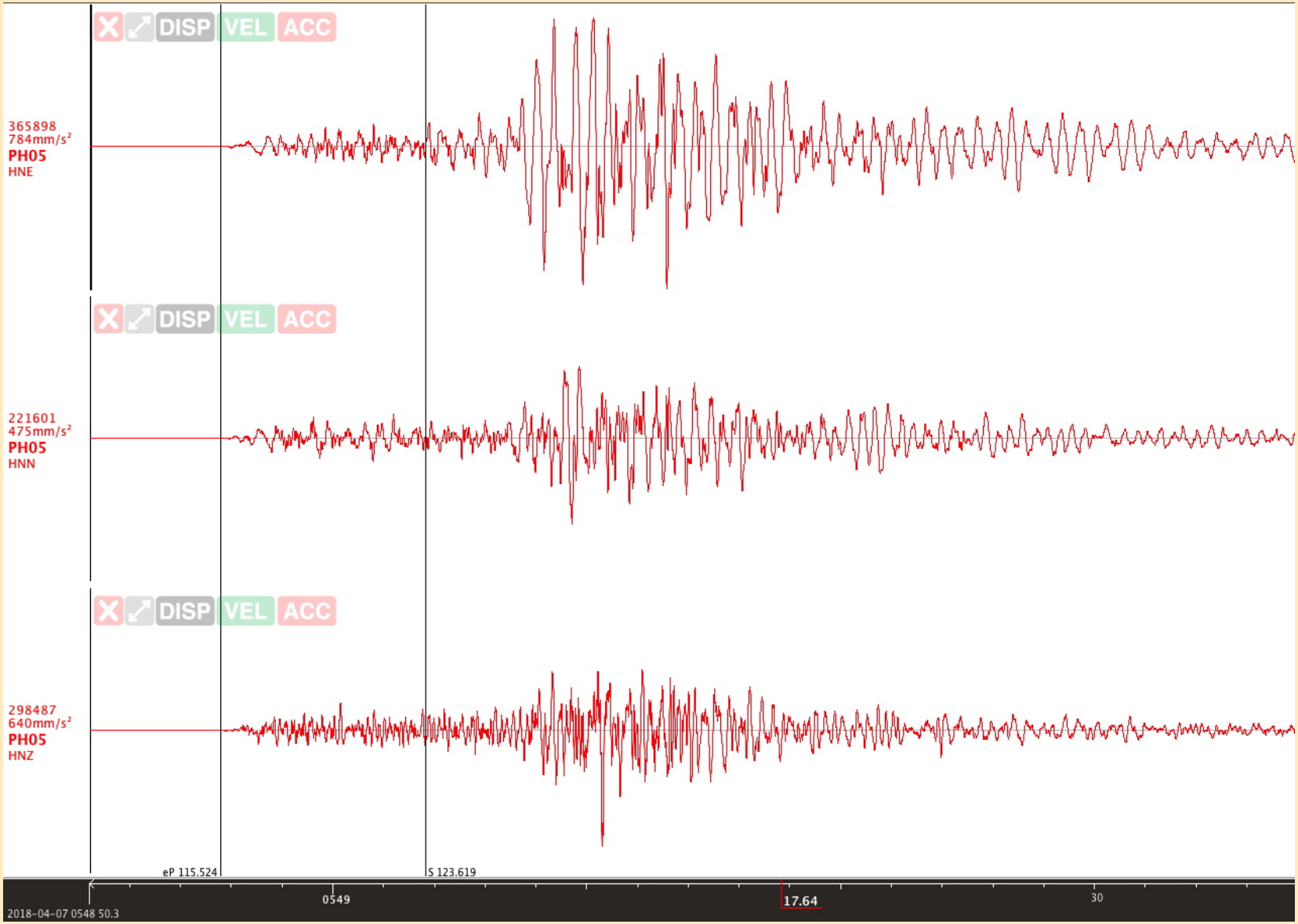
AEES members Gary Gibson and Kevin McCue returned to Moro much earlier than expected to secure any data recorded following the large magnitude 6.3 aftershock on 7 April, shortly after they left PNG at the end of the installation field trip. We arrived at Moro airfield late Monday evening on 23 April and boarded the bus for the half hour trip to Oil Search's Moro Camp where we were accommodated. The rough gravel mountainous road through tropical rainforest with overhanging landslides awaiting the next tropical downpour or earthquake was a small price to pay, twice a day. Our helicopter flights from the airfield were fitted into a busy schedule of post-disaster aid deliveries, medical emergencies and normal operational requirements so we spent a bit of time hanging out at the departure gate for our flights and where we met many interesting passengers including the Director of the Tari Hospital where one of our recorders was based and whom we would be calling in on in a few days. At camp meal times we met up with Mark Herriot from WGA Adelaide, and Dick Beetham from Coffey NZ who generously shared his office and we discussed the impact of the earthquake and aftershocks.

It is always both a relief and a surprise to find all the equipment still operating. The sd cards were replaced while the helicopter waited - no pressure and the great volume of data, 3 channels at 200 s/s continuous recording meant we couldn't really look at events until we returned to Australia. We noted with dismay that most of the battery capacity had been used at all sites so we arranged re-charging or replacing batteries necessitating doubling up on station visits, some we left to Yapi Akore, a liaison officer with Oil Search and a self proclaimed bush mechanic, to sort out after we left, following a rapid training program.

On Friday morning 27 April we met up with Oil Search Chief Geoscientist Dr Shane Schofield back in Port Moresby to discuss the future of monitoring in the Southern Highlands and then the three of us visited the Port Moresby Geophysical Observatory where Chris McKee and Mathew Moihoi showed us around. They have a sophisticated data acquisition system, digital data telemetered from 13 field stations into the PMGO office and then to a server in the SW Pacific, but not to the USGS or any other site where it might be made public.

An oil/gas pipeline bridge apparently unscathed after a mag 7.5 earthquake and 6 aftershocks of mag 6 or more. Landslides near abutments were no problem.

AEES Seismologists (they're SAA members too) return to PNG Southern Highlands



The top trace shows the pga about 0.8g horizontal - that is huge. Engineers can't design for that level of shaking, especially over a 10 sec duration.
No wonder there were landslides, no wonder there was damage.
That is about the size of a design earthquake for important structures in Australia, our one in ten year event.
We saw what happened to Christchurch in a slightly smaller event in February 2010 and they claim to have designed buildings to withstand the 500 year event.
Nobody would imagine such high acceleration in PNG where the stress drops are thought to be lower than those in Australia.

AEES Seismologists (they're SAA members too) return to PNG Southern Highlands

A fault controlled river in the Southern Highlands apparently blocked by faulting and landslide debris.

These meetings were very productive. Kevin flew out at 3pm whilst Gary stayed on to analyse some of the data before leaving on Sunday 29 April.

The Australian Earthquake Engineering Society funded Kevin and Gary's airfares to and from PNG. Oil Search again provided the essential logistical support in PNG including flights between Port Moresby and Moro, helicopter access to accelerograph sites and food and accommodation. A third and final visit will be made before the batteries expire in a few weeks, Gary and a young seismologist will pull out the equipment.

Newsletter Front Cover Image

The rock is Darai Limestone that was lain down in thin layers (coloured bands) in a shallow sea and is from 500m to >1000m thick. It was then uplifted and tilted to its present altitude of ~1500m, the tectonic process continuing today. The M7.5 earthquake triggered massive landslides and in this picture, a detail of a much larger landslide failure surface, the limestone layers are clear and the jagged fractures mark the head scarps of the individual sliding surfaces.

SAA Member Sites and interests

Eric modeling his vintage Western Electric Headphones

Hello fellow SAA members, my name is Eric Daine,
I am an electronics technician and embedded systems programmer, passionate about electronics. I enjoy learning about fabrication and small scale manufacturing. My professional career has given me practical experience in many lab environments. I have also maintained a home electronics lab and general workshop for the past 17 years. I love combining different materials to create a final product. I am fascinated with digital machining like CNC and 3D printing. I love designing a 'Thing' using a computer and seeing it turn into object using machines.

I am cofounder of a small organization called symCDC. It's a collaborative effort between myself and Dr. Randall Peters. We started symCDC in 2012 with a focus on developing scientific instruments and publishing articles related to those instruments. The name symCDC stands for symmetric differential capacitive to digital converter. All the devices we have built use the same type of differential capacitance transducers. Patented by Randall, these sensors use cross coupled conductive plates that form equipotential capacitive pairs. Configured as a transducer the plates are stationary while a conductive material moves between the plates producing a change in capacitance that is measured electronically.

In the beginning Randall approached me with the idea of building a control system for a very special chip, the Analog Devices AD7745 capacitive to digital converter. This chip can resolve changes in capacitance down into the attofarad range, thats 10^{-18} Farads. I accepted the challenge and set about designing a control system and printed circuit board layout for this target chip. A microcontroller was chosen that would configure the CDC chip and relay the data back to a computer via a USB to serial converter.

The first transducer we tried with the capture card was a capacitive pressure transducer. We used it to make a precision microbarometer. Randall designed these transducers some years earlier. I inherited some

SAA Member Sites and interests

of the older units and with a little rehab was able to get one functioning again. The transducer is made from two disc's of PCB laminate. The top and bottom discs have copper plates wired as differential pairs that form the sense capacitor. One set of plates gets the excitation voltage from the AD7745 while the other set are measured for capacitance change. Stretched between the plates leaving a small air gap on each side is a thin membrane of silvered mylar. Each side has an opening to allow interaction with the outside atmosphere. We attached one side of the transducer to a sealed plastic jar and left the other side open. Air pressure on the outside of the jar changes at a different rate then the air pressure inside the jar. The pressure changes deflect the mylar and the counts from the CDC chip on the CapTure card.

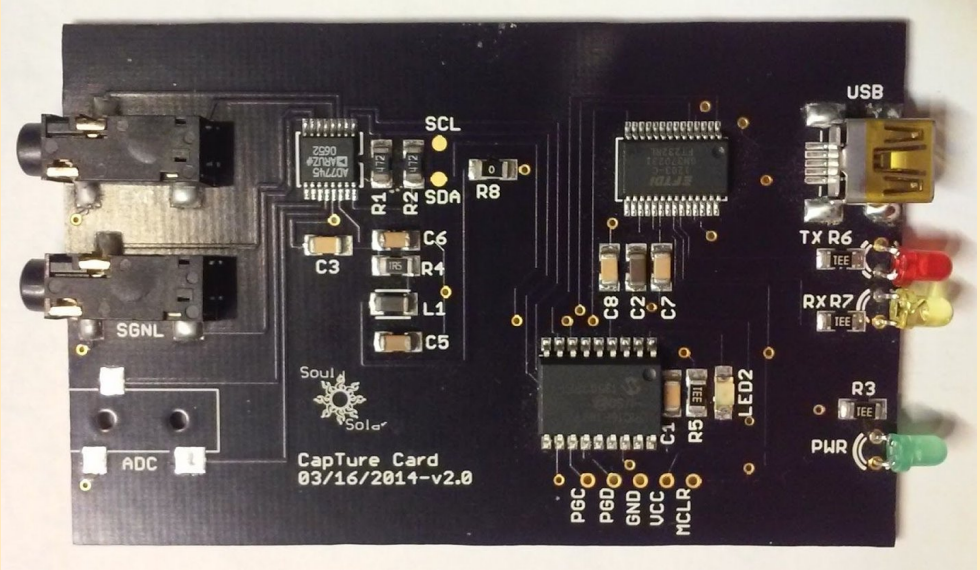
The data was plotted with a real time graphing program and suddenly I could observe lots of interesting phenomenon. In the two story University building where I had the instrument set up I saw sharp changes in the graph line caused by building pressure changes when doors to the outside were opened. I could tell when the buildings air handlers turned on long before you could feel or hear a change in the room. It was easy to resolve different pressure levels by moving the bottle up or down a few feet.

We tried putting a small piece of black cardstock inside the bottle. If you shown a flashlight on the card an instant spike would occur in the graphline as the photons were absorbed, heating the air, causing a pressure change. This instrument was a barometer, it was a bolometer, it was an accelerometer, it was simple and amazing. I was hooked.

As time went on we tried the CapTure card with several different instruments that Randall had installed capacitive sense plates on in the past. Until then he only had the ability to resolve capacitance changes using an analog amplifying circuit and a 24bit ADC. This new CDC gave intriguing levels of resolution and precision with each instrument we tried. Along the way we published our findings on the symCDC website to share with others.

Eventually I built an entire system designed to perform a physics experiment allowing students to measure the acceleration of gravity. The experiment was based on Captain Kater's classic pendulum experiments. The instrument, included PCB sense plates mounted on 3D printed towers and a shielded metal enclosure with PCB silk screened end plates. A GUI written in Python allows the student to setup the experiment and displays the data in realtime.

For the new board layout I tried to reduce any spurious noise caused by ground loops. I utilized an interesting style of ground plane known as "Bridge and Moat". All the analog circuitry is on one side of the moat and



CapTure Card V2.0

SAA Member Sites and interests

all the digital is on the other side. The communication between the two go over the bridge forcing the ground returns to come back under the bridge helping to cancel noise. I also isolated the CDC chip with its own 'T' filtered power supply. The PCB was designed to use all surface mount components for manufacturing and was finally dubbed the CapTure Card.

I am still dreaming of producing more instruments. I would love to release a Barometer, Tiltmeter, Magnetometer and yes hopefully someday an affordable Seismometer. Each instrument opens new possibilities for discovery. For instance, with the help of Paul Hutchinson and TPSO large datasets are being collected from an instrument using the same type of capacitive sensors. After these records were recently processed by Randall they revealed interesting phenomena related to "Tidal Force Complexity" and together they published a paper which we hosted on the symCDC website.

Here you can see a picture of this prototype Barometer. Yes that's a milled circuit board taped to the side of a Peanut Butter Jar the capacitive pressure transducer is mounted to the top.

SAA Member Sites and interests

Each of these instruments present constraints and design challenges not to mention software hurdles. I am always on the lookout for new tools that will help make these instruments possible. Lately I have been exploring real time graphing software like Grafana and InfluxDB for data visualization and time series database storage. Currently, I have these software tools running on a Raspberry Pi and taking data from the CapTure card. Recent experiments with LoRa radios suggest the possibilities of remote sensor nodes that can relay thier data back to a central repository for post processing and historical collection.

What I envision is a system where it is easy for all the measurement devices to share, save, and visualize data. Quantifying the data is not as interesting to me as collecting and using it to discover new phenomena but I realize its importance. Tying these data sources together opens new possibilities for discovery. Correlating the data could be important for gaining new levels of understanding and perspective about many complex systems.

What I would love to produce are instruments that instill a sense of wonder and amazement. That way I felt when I first hooked the CapTure Card to the pressure transducer. The idea that I might discover something new. That somehow my perception is enhanced so that I am aware of my surroundings in a way that I was not before.

I'd love to connect with people interested in incorporating these capacitive sensors into other measuring devices. If you have any suggestions or ideas please don't hesitate to get in touch. Check out symCDC.com for more photos of the instruments we have created and be sure to check out the publications. Scroll to the bottom to see the latest articles.

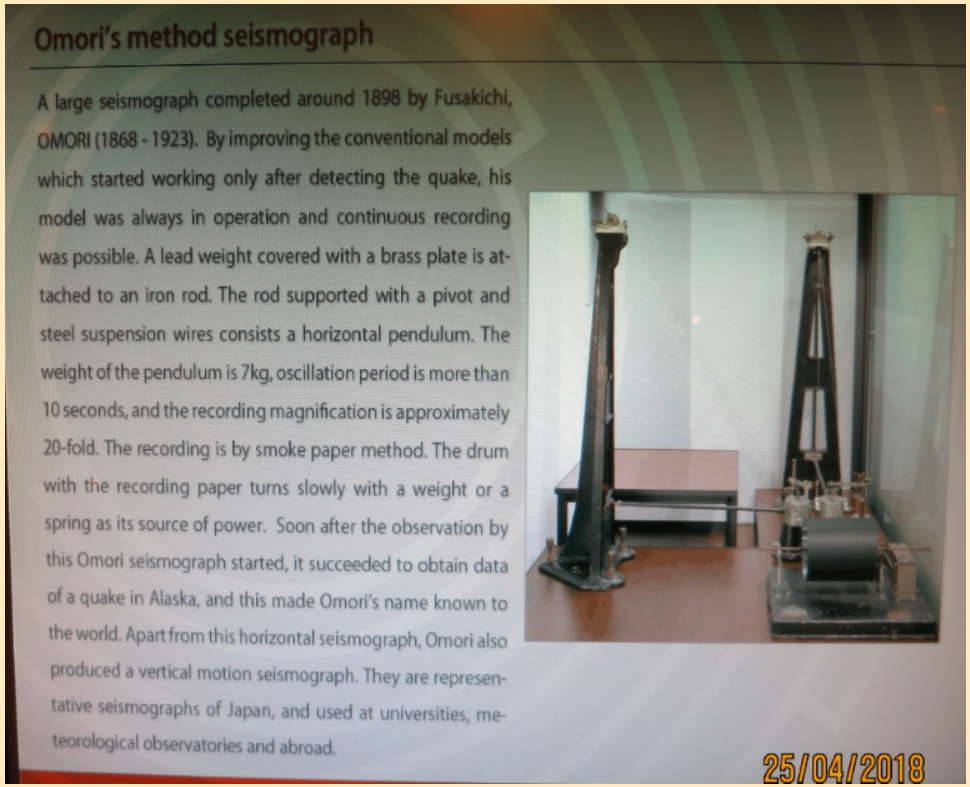
Thanks for the opportunity to share my story with you all.

Eric Daine - Micaville, North Carolina USA - ednspace@gmail.com

A recent project, my Kater Pendulum

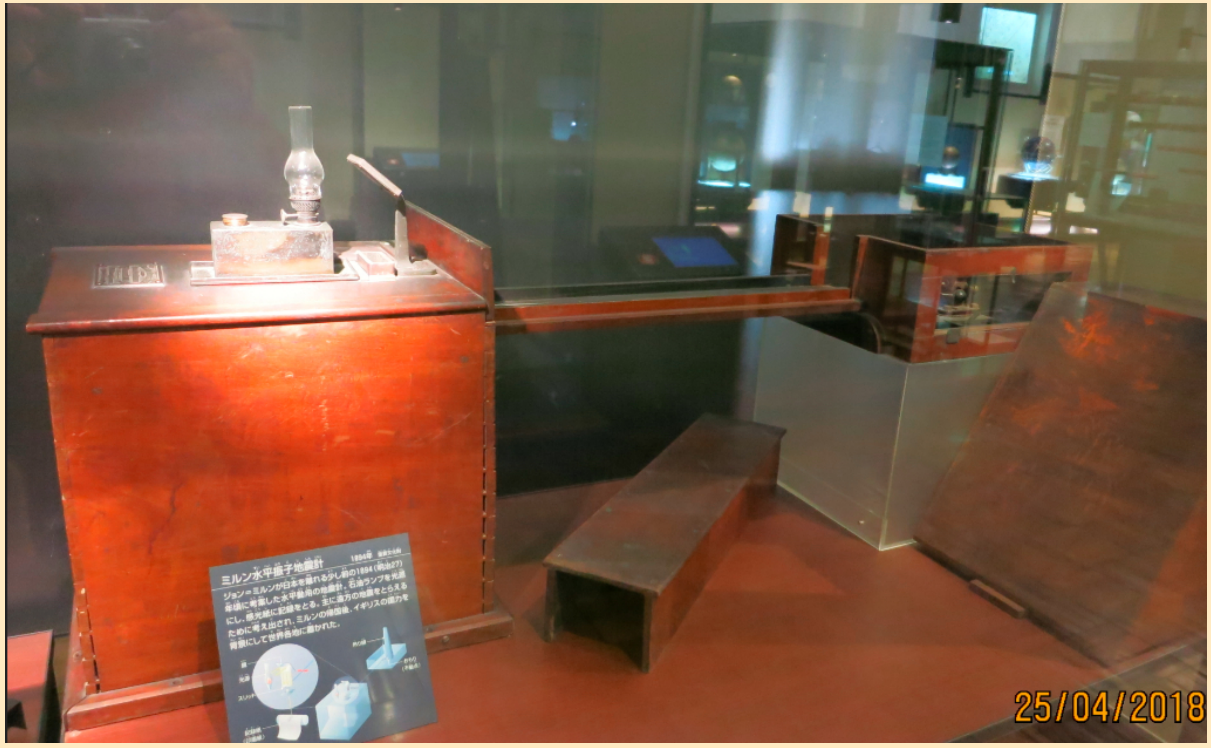
A collage of slides from my recent visit to earthquake engineering and museums in Japan

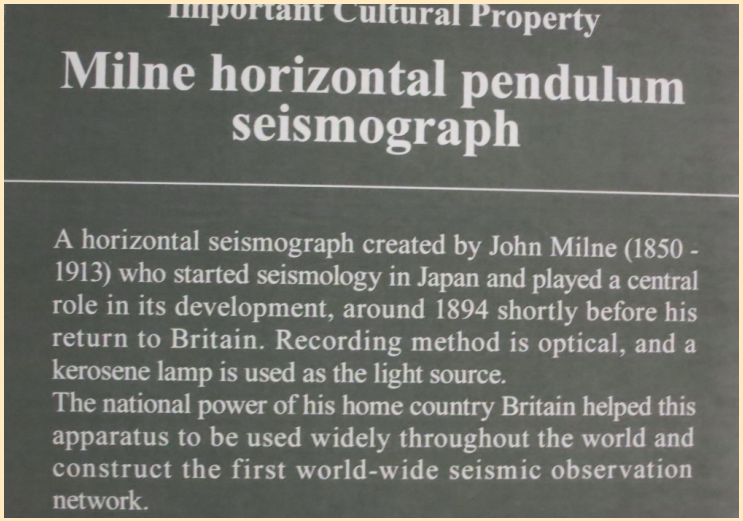
Dear SAA colleagues,
I wanted to share with you some slides of scientific equipment that I saw on my recent visit to Japan.



The first image is an historical seismograph developed by Fusakichi Omori in 1898. Kevin McCue tells me there is one of these in the Rabaul Observatory (active?).

A collage of slides from my recent visit to earthquake engineering and museums in Japan





The second image is the prototype developed by geophysicist John Milne in 1894.
The University has 2 later developed seismographs purchased and operated here in 1937.
John Milne visited Australia to install them.

A collage of slides from my recent visit to earthquake engineering and museums in Japan

"After Milne returned to England, he refined his measurements of the world's seismic regions, coming to Melbourne to install his Gray-Milne seismograph at the Melbourne Observatory in 1887. It is now on display at the Melbourne Museum.

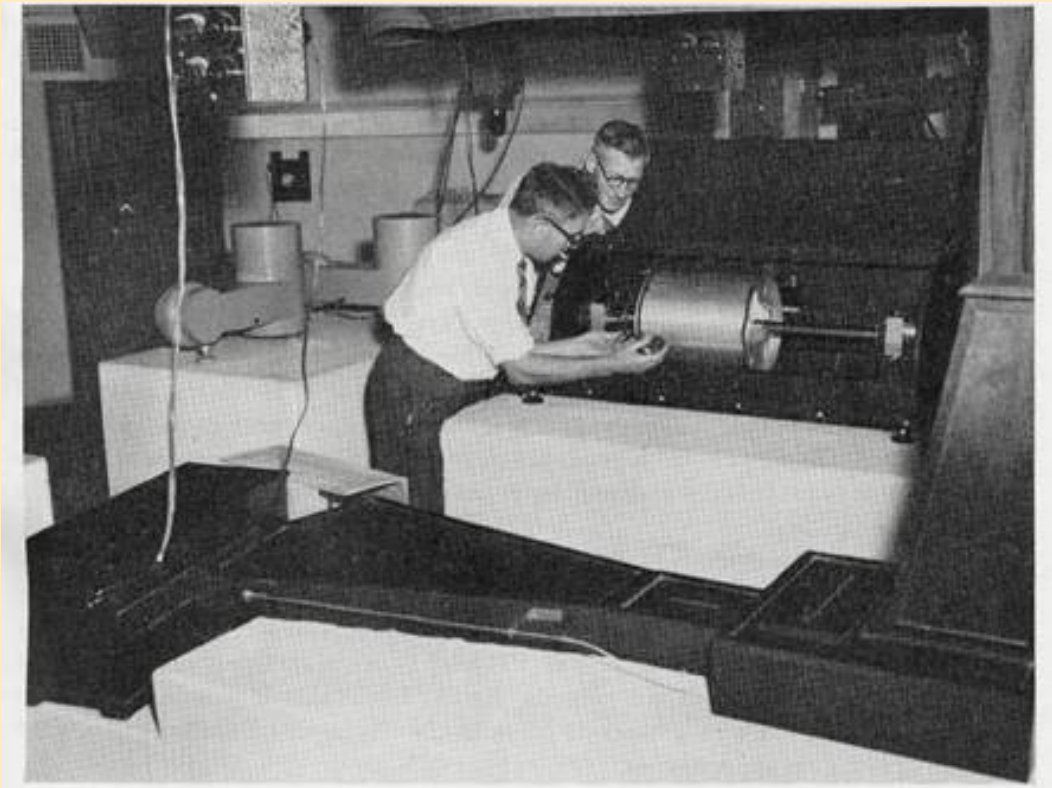


Fig. 3. View of part of main vault, with Benioffs on left, Milne-Shaw in foreground, and microseismic recorder on right.

In 1895, Milne and his Japanese wife, Tone Harikawa, had an audience with the emperor, who conferred on him the honour of the Third Order of the Rising Sun, for his contribution to the understanding of the quakes that have littered Japan's history."

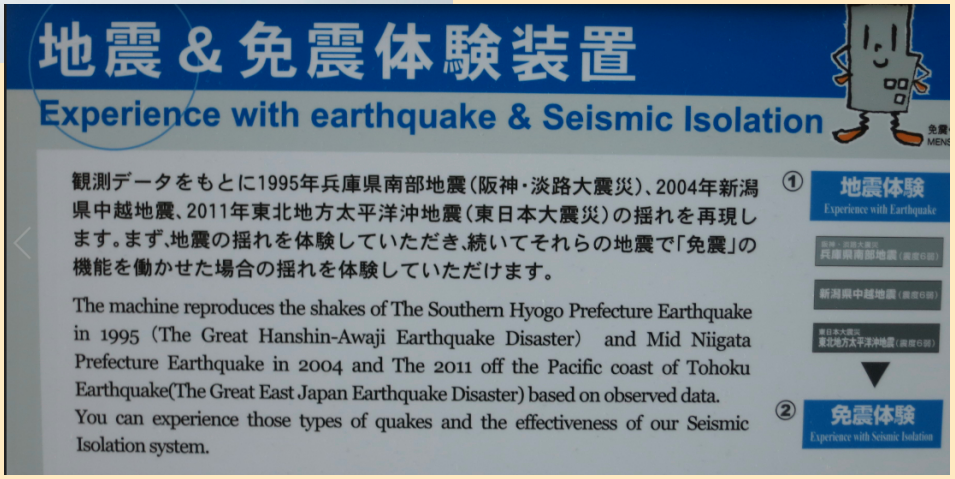
(Interview with Dr William Twycross, Mansfield, Vic. Published Rafael Epstein, The Melbourne Age, March 18, 2011, The Father of Seismology)

Photo of Milne Shaw instrument (foreground) in BRS station (1937)

OA Jones 1953, The New University of Queensland Seismograph Station BSSA (Vol43, No 3) (pp247-253)

A collage of slides from my recent visit to earthquake engineering and museums in Japan

This third slide is of interest to earthquake engineers, architects and planners. It is the model of the isolation device used to squelch the effect of large earthquakes in tall buildings.



Even though todays seismometer sensors fit into the back of your mobile phone, the accuracy of these old mechanical instruments are quite accurate and their records are preserved for comparative calibration.

Col Lynam, Brisbane