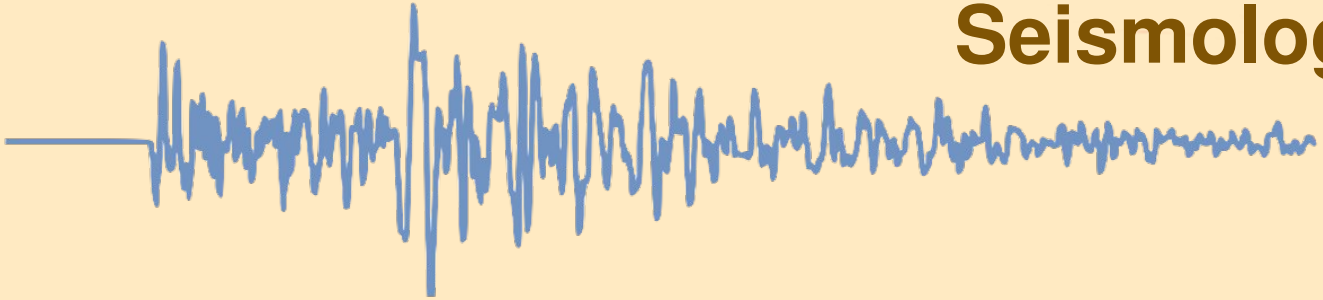
Newsletter of the Seismological Association of Australia Inc.
Nov-Dec 2018



Seismological Association of Australia Inc.

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

Your Committee

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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
The cover image for this edition of our newsletter was taken from Google Maps. To the Northwest is Lake Torrens, partially obscured by the title text, to the Northeast is Wilpena Pound and to the Southeast is the town of Hawker. Nestled close to and east of the Hookina Creek railway bridge is the site(s) for the proposed Nuclear Waste Dump. Barndioota is currently top of the short list of suitable sites being considered by the Australian Government. Without being too pessimistic, it may be too late to change the tide of vested interests and machinations of government bureaucracy to alter what may be inevitable. Rightly or wrongly, when Australia began to sell uranium, we joined the nuclear fuel cycle and the waste was likely to be "return to sender". What is in question here is site suitability. Of the choices available, immediately downstream from one of the most seismically active areas on the continent is questionable, amongst better options. I urge all members to review Vic Gostin's PowerPoint presentation, review the alternatives and form an opinion. Should I still have the Editor's position for the next edition of the SAA Newsletter, you will be hearing more about this issue and how we, as a bipartisan association with limited resources, could make a contribution to this situation, should it come to pass.

Peter Gray

SAA Annual General Meeting 2018

THE SAA AGM WAS HELD AT THE OFFICES OF NOVA SYSTEMS, MILE END SA ON SATURDAY, NOVEMBER 10TH AT 7.30PM

The meeting was opened by the Chairman, Blair Lade with sufficient members present to form a quorum. Michael Andre Phillips in NSW attended via Skype but we were unable to contact Chris Chapman in the UK via Skype as originally planned. Apologies were accepted from Judy Carter, Joe & Lyn Grida, Joan Harris, Colin Lynam, Kevin McCue, David Miller and Paul Hutchinson.

The Chairman delivered his annual report, you can find it here at Dropbox.
The Treasurer delivered his annual report, you can find it here at Dropbox.
The Chief Seismologist presented a talk on Dent Cluster Centres, you can find it here at Dropbox.
Vic Gostin presented a talk on a proposal for Barndioota, you can find it here at Dropbox.

The meeting concluded after the election of the 2019 Committee. The current encumbents were re-elected unopposed and the only change was for Joe Grida to formally accept the job of Secretary in addition to his role of Treasurer.
Supper followed, along with the obligatory group photo, taken by our gracious host, Peter Nikoloff of Nova Systems.

Rear - David Wallace, Peter Gray, Ian Anderson, Alison Wallace, Blair Lade & John Duffield. Middle - Victor Gostin, Jim Deer & Eric Love. Seated - David Love & Nina Stansfield

Dent Cluster Centres

AN ABBREVIATED VERSION OF A PRESENTATION BY DAVID LOVE AT THE SAA AGM, 2018

Vic Dent has been beavering away for more than a decade, trying to improve earthquake locations in the South-west seismic zone in WA. It has been clear for a long time that many of these events come from the same places, often with no clear main shock, but a number of events of similar size (a swarm). Vic has made use of the PSN stations that he has set up in the area. The GA stations are quite widely separated (see map), and given the emergent P and S arrivals (common for distant stations in WA), it is not difficult to improve epicentres. In 2016 Vic produced a list of these activity points, that he has termed cluster centres. Some of these appear to have been active over decades. Various authors have suggested that 60% to 90% of activity may occur at these points. If that is the case, then we have a possibility of forecasting locations of future large events, but not the times. This is different from most other active areas of Australia, where swarms are much less common, and single events, or mainshock – aftershocks are usual.

Another interesting fact in the South-west seismic zone is that most events appear to be shallow, but we do not know really how shallow.

This leads to other interesting opportunities. Recorders could be placed at cluster centres, with a fair expectation of getting an occasional strong recording. Earthquakes near clusters could be located much more accurately, including in depth. Currently that is not possible. It may be possible to do detailed elevation models before and after events to measure the surface changes. If the event is very shallow, it may be possible to drill and measure stress before and after an event. If a sustained swarm occurs, it should be relatively easy to install many more recorders and get focal mechanisms.

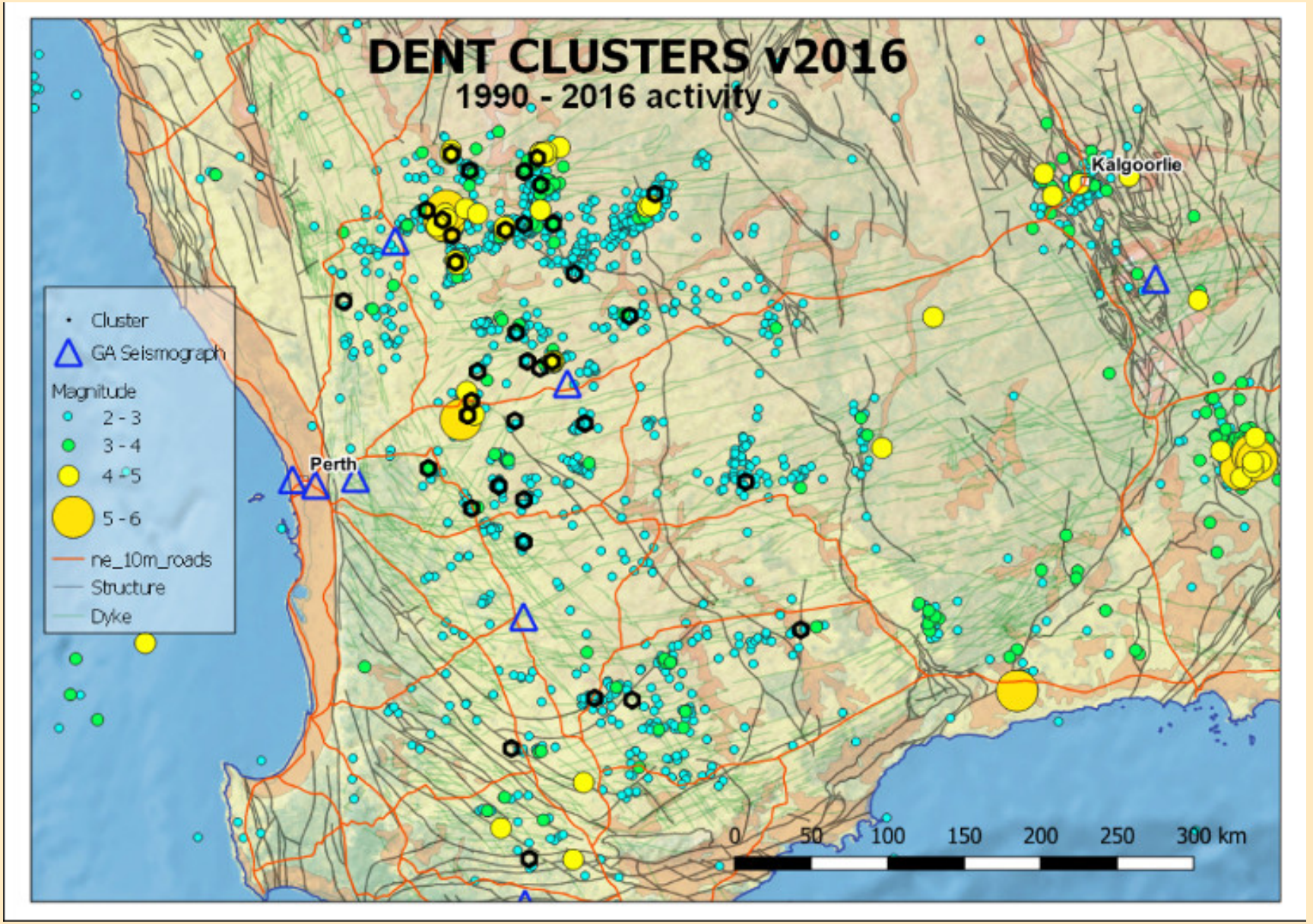
The recent Lake Muir sequence has been interesting. A magnitude 5.7 occurred on Sunday 16th September, followed by many aftershocks. Geoscience Australia was able to mobilise quickly, sending a team with 5 portable recorders, and 2 geodetic GPS recorders on Monday. The first instruments were installed on Tuesday, with the central recorder being very close to the centre of activity. One key reason for the good position of the first station was because GA had worked hard on the mainshock location, including two nearby schools sites and a nearby infrasound stations. All portable recorders streamed data back to Canberra in real-time, and the data was made available via Seedlink. This was an important first for GA, allowing the action to be closely monitored. Aftershocks were posted to the GA recent earthquakes page as they occurred, and phases were listed.

InSAR is a technique that uses satellite radar images before and after to measure elevation variations. The first image produced after the earthquake suggested a ground rupture striking approximately NNE-SSW and dipping to the east. A geologist from UWA, Sean Standen, travelled to the site looking for the scarp. He found some indications of rupture at the expected location, with the east side being raised, as expected. However, a later image with more processing suggested that the fault was in a different position and that the east side would be lower. Sean searched in the revised area, but was unable to find another scarp. So questions remain.

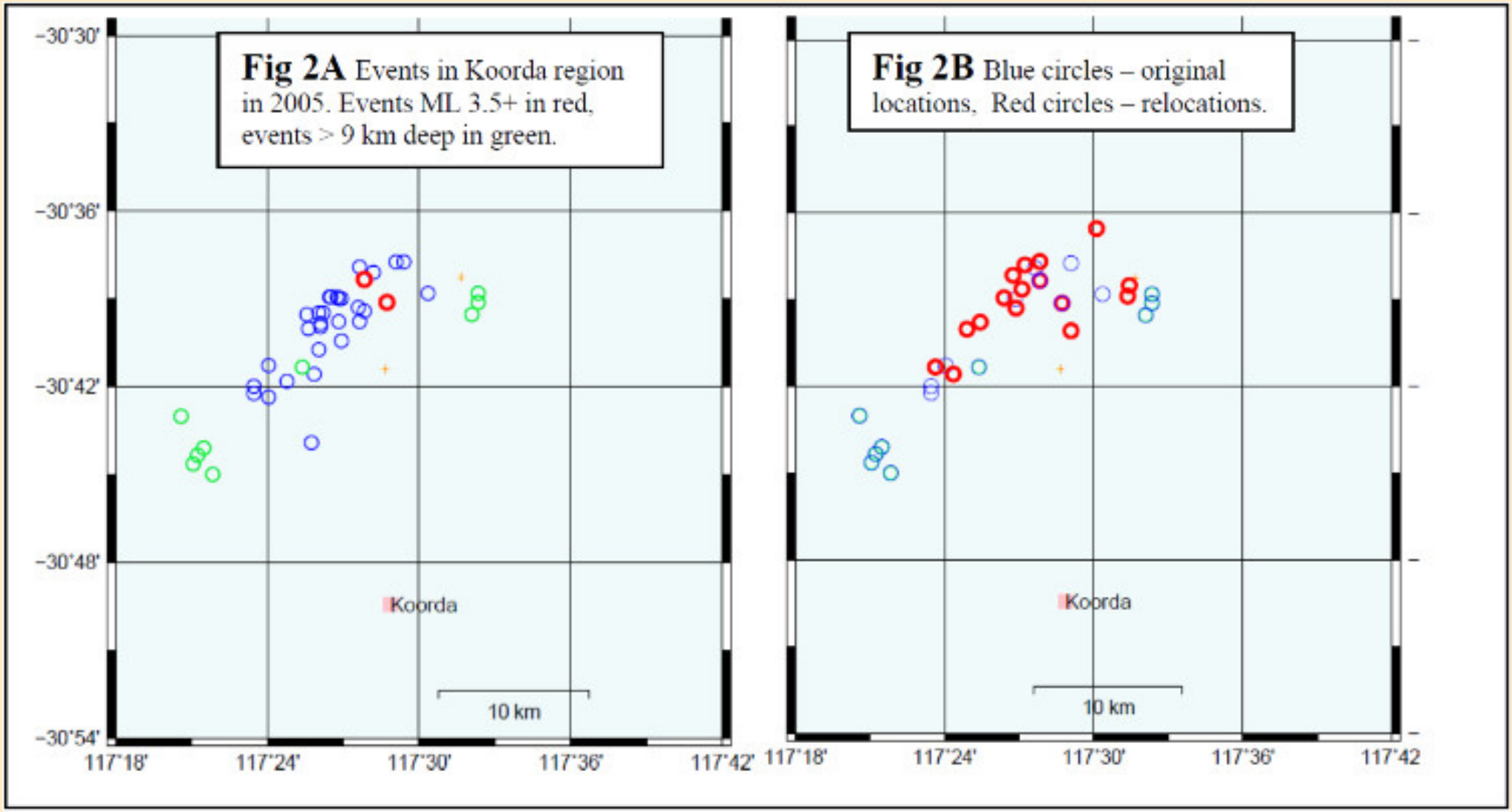
Unfortunately, while GA managed to get one recorder right near the action, the others were too far away to get accurate depths for most aftershocks. Vic Dent will be trying to improve some of the aftershock locations. David published an early location on our SAA recent earthquakes page, and also attempted a one station location, using the GA station RKGY. The latest Waves software (v3) has rotation of horizontal axes (and dip also), and this produced a reasonable result. Further investigation of the fault scarp area is expected.

Dent Cluster Centres

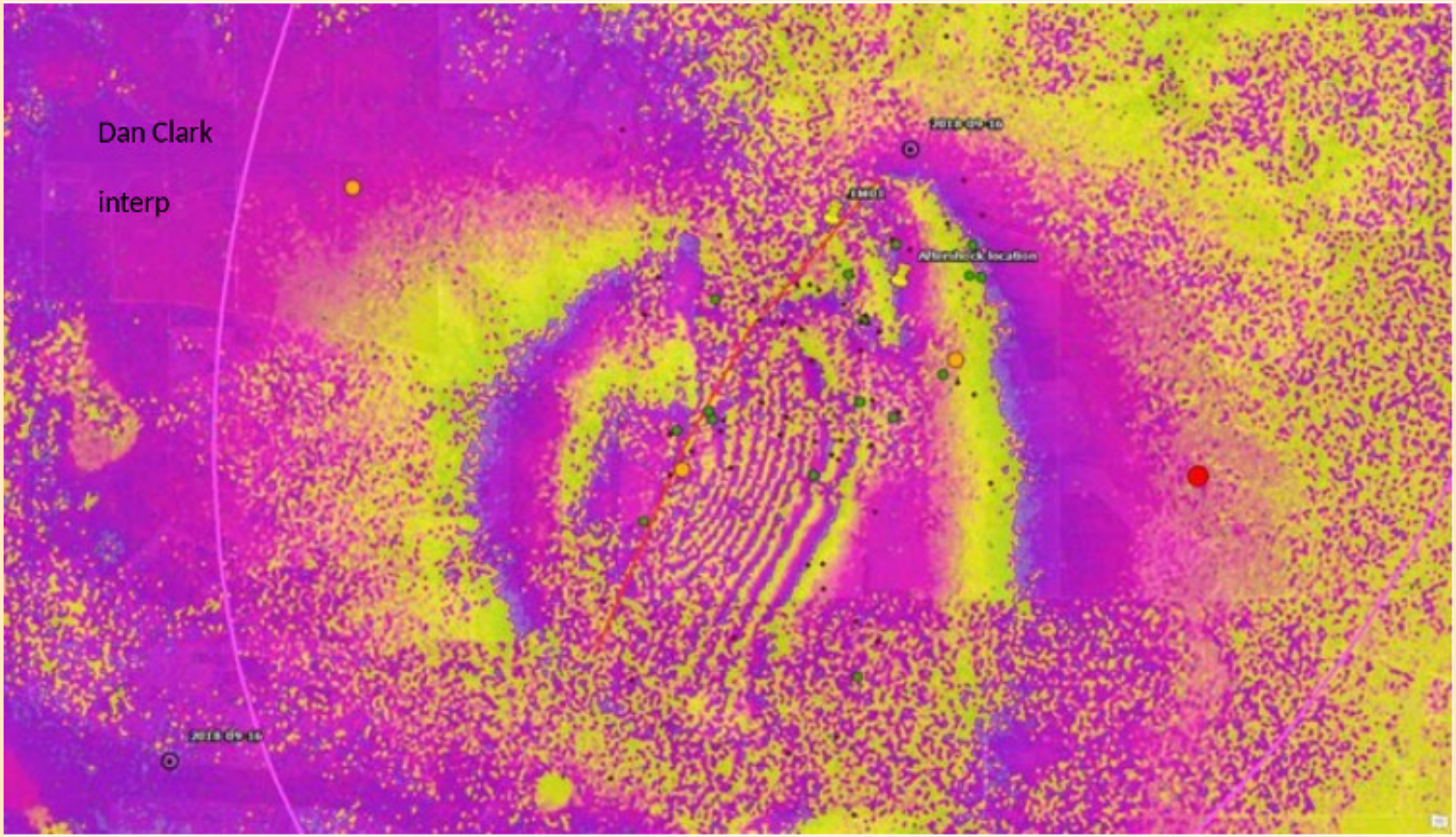
Area of interest - Southwest Western Australia



Dent Cluster Centres



Dent Cluster Centres



Dent Cluster Centres

AUSTRALIAN EARTHQUAKES [List] [Upload New]

Location: 2018-09-16 04:56 Rocky Gully 19km NW
General Phases Magnitudes **Text solution** Files Merge
Locations : **DL**

```
EARTHQUAKE LOCATION                                  Printed

EQ Date:    2018-09-16 0456 24.49 ±  0.29
Place:      Rocky Gully 19km NW
Magnitude:  ML 5.6

Longitude:  116.8213  ±    2.84 km
Latitude:   -34.4275  ±    2.25 km
Depth:        5.00    ±    3.85 km
 (Constrained)

Arrivals:  11/13                  StdDev:  0.396     Sit
Nearest:     24.9 km (RKGY)       Gap:     158.1°    Qua
SemiMajor:  1.3360 km             SemiMinor: 0.7003 km

Run:       ADE   1                Run by:   DL        Ru
Program:    eqFocus 4.5.1   Earth Model: WA2

ARRIVAL DATA
Active Arrivals:
site  phase      time            wt   calc  residual
 RKGY   i-P  0456 28.25 ±  0.0  3.3  28.63    -0.38
 RKGY    eS  0456 31.78 ±  0.0  1.9  31.66     0.12
AUALB   i-P  0456 43.82 ±  0.0  3.1  43.72     0.11
AUALB    eS  0456 58.54 ±  0.0  1.8  57.80     0.75
AUBUS   i-P  0456 49.46 ±  0.0  3.1  49.29     0.17
AUBUS    eS  0457 08.26 ±  0.0  1.8  67.86     0.41
 SWAO   e-P  0456 50.78 ±  0.0  1.8  51.13    -0.35
 SWAO    eS  0457 11.33 ±  0.0  1.8  71.10     0.24
 PINC    eP  0456 56.87 ±  0.0  1.8  56.75     0.12
  MUN    eP  0457 03.75 ±  0.0  1.7  64.62    -0.86
 KLBR    eP  0457 10.57 ±  0.0  1.7  70.65    -0.08

Deferred Arrivals:
site  phase      time            wt   calc  residual
  MUN    eS  0457 38.17 ±  0.0  1.7  94.88     3.30
 KMRL    eP  0457 42.03 ±  0.0  1.7  102.42   -0.38

MAGNITUDE DATA
Assign:  ML 5.6  ADE

Comment:

NEARBY PLACES
 3191 km SE (143°) of West Island, West Island, Cocos
  290 km  S (162°) of Perth, Western Australia, Austr
   65 km  E (108°) of Manjimup, Western Australia, Au
   72 km SW (205°) of Kojonup, Western Australia, Aust
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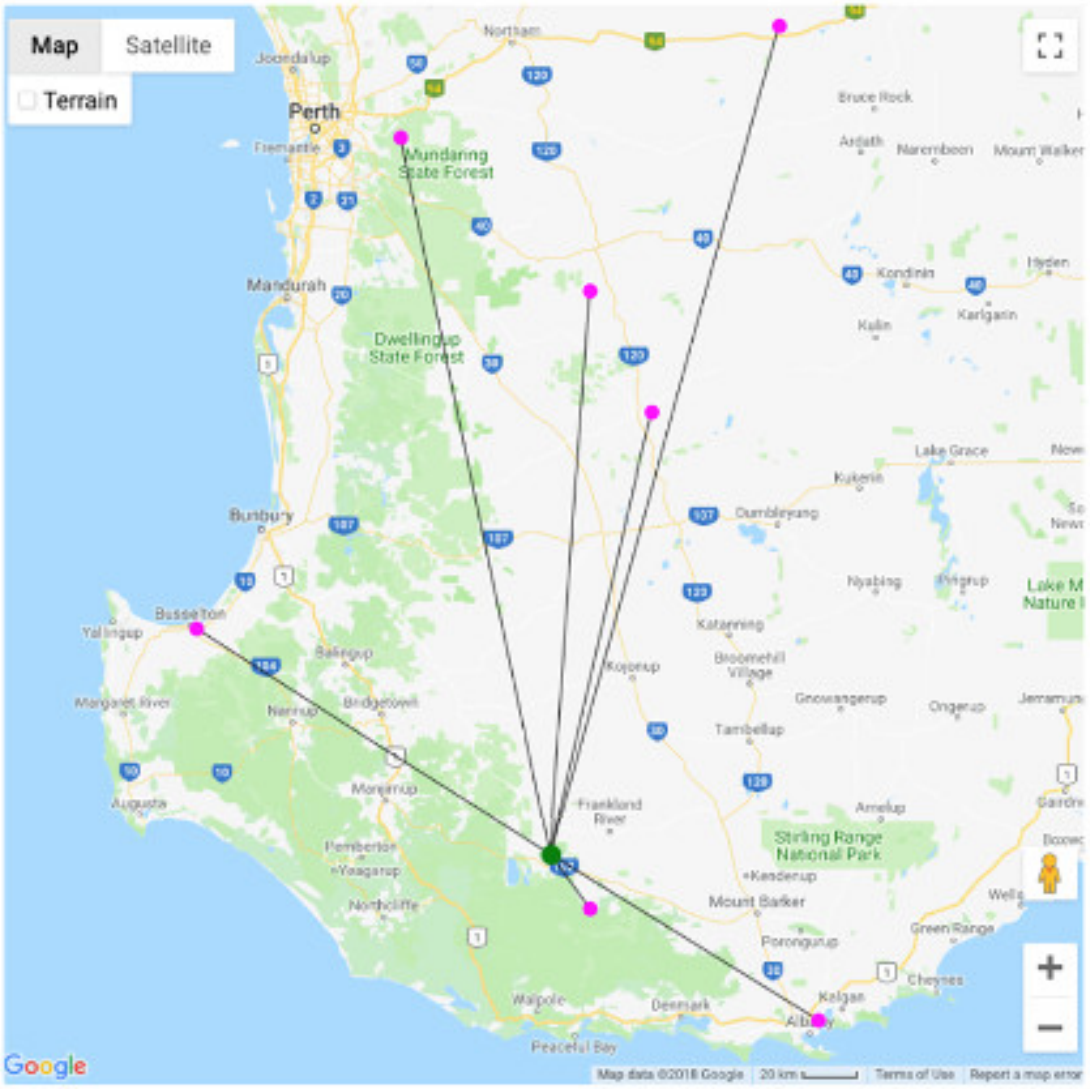
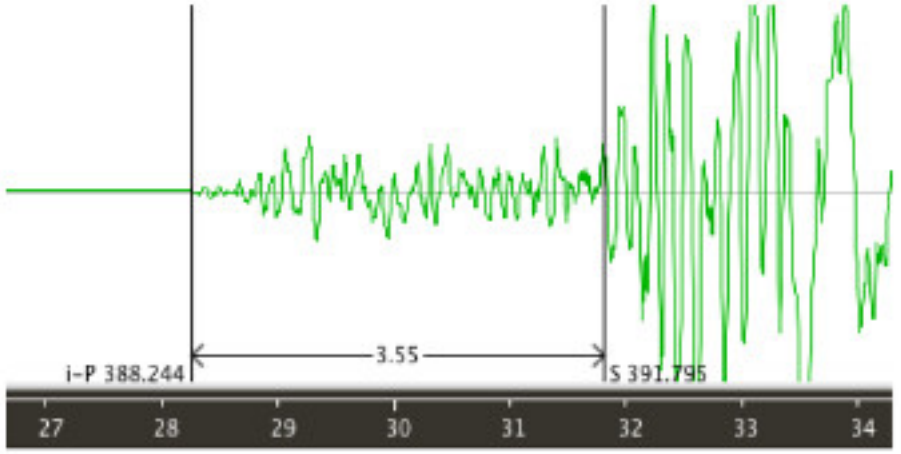


Dent Cluster Centres



PSN Reliability

So you would like to set-up a Public Seismic Network station on your property or perhaps you already have one and it's in need of some TLC. One of the primary objectives in running a PSN station is to run it reliably.

There is little point investing your time and money into a seismic station and not end up with something that delivers data 24/7, rain or shine, with some immunity to power outages and resistance to rodents, bugs and life generally. It might be fair to assume that your seismic hardware does not share your general living space with you, particularly if you have a partner who doesn't share your enthusiasim for this sort of thing. So it has been relegated to the garage, a shed, under the veranda, where environmental conditions are not so cosy. Modern electronics is capable of marvellous things but it does not survive for very long without some care, particularly from dust and moisture. I'd like to share with you one method of making life easier for your seismic set-up to live a long and productive life.

The core electronic items I'm referring to are (were) produced or sourced from Webtronics, prior to Larry Cochrane's retirement earlier this year. These probably remain the most capable ADC cards available to us at present, apart from their inability to send data in miniSEED format. I have included some useful ancillary items which will assist in their longevity and hopefully make your life easier too. Where possible, IP67 rated components and stainless steel fixing hardware have been used, most is available from Jaycar, eBay or even your local hardware store.

I have made up two variants, one based on the 16bit ADC digitiser and the other based on the 24bit ADC digitiser. Both share similar ancillary and hardware items but where they are not required in one or the other, they have been omitted.

In the larger enclosure (top) is the 16bit ADC and the 24bit ADC is in the smaller enclosure (bottom)

PSN Reliability

WEBTRONICS 16bit ADC BASED DIGITISER

Core electronics
16bit ADC Board: Webtronics P/N. PSN-ADC-SERIAL **or**
16bit ADC Board: Webtronics P/N. PSN-ADC-USB
Seismic Amplifier/Filter Board: Webtronics P/N. PSN-ADC-EQAMP
GPS Receiver: Garmin P/N. 010-00321-36 (GPS 18x-LVC OEM)
Garmin GPS are available from Johnny Appleseed GPS

Ancillary electronics
12V Battery Charger: CTEK P/N. 1047 (XS 0.8) (eBay)
12V 7.2AH SLA Battery: Diamec P/N. DM12-7.2 (Jaycar #SB2486)
Low Voltage Disconnect Module: CZH-LABS P/N. D-1077/12V (eBay)
Adj. DC-DC Step Up Module: P/N. 126106/STEPUP (eBay #LM2577)

Interconnects & Wiring
XLR Bulkhead Receptacle (Qty 4): Neutrik P/N. NC3FD-L-1
D-SUB 9 Line Connector, Plug (Qty 1): (Jaycar #PP0800)
D-SUB 9 Line Connector, Socket (Qty 1): (Jaycar #PS0804)
D-SUB 9 Backshell (Qty 2): (Jaycar #PM0808)
2.1mm DC Power Connector, 10mm Plug (Qty 1): (Jaycar #PP0509)
6.3mm Spade Terminal 14-16AWG (Qty 2): (Jaycar #PT4607)
18AWG, 2 Core DC Power Wire/metre (Qty 1): (Jaycar #WH3057)
6mm Balun Core (Qty 4): (Jaycar #LF1222)
Twin Screened Audio Cable/m (Qty 1): (Jaycar #WB1502)

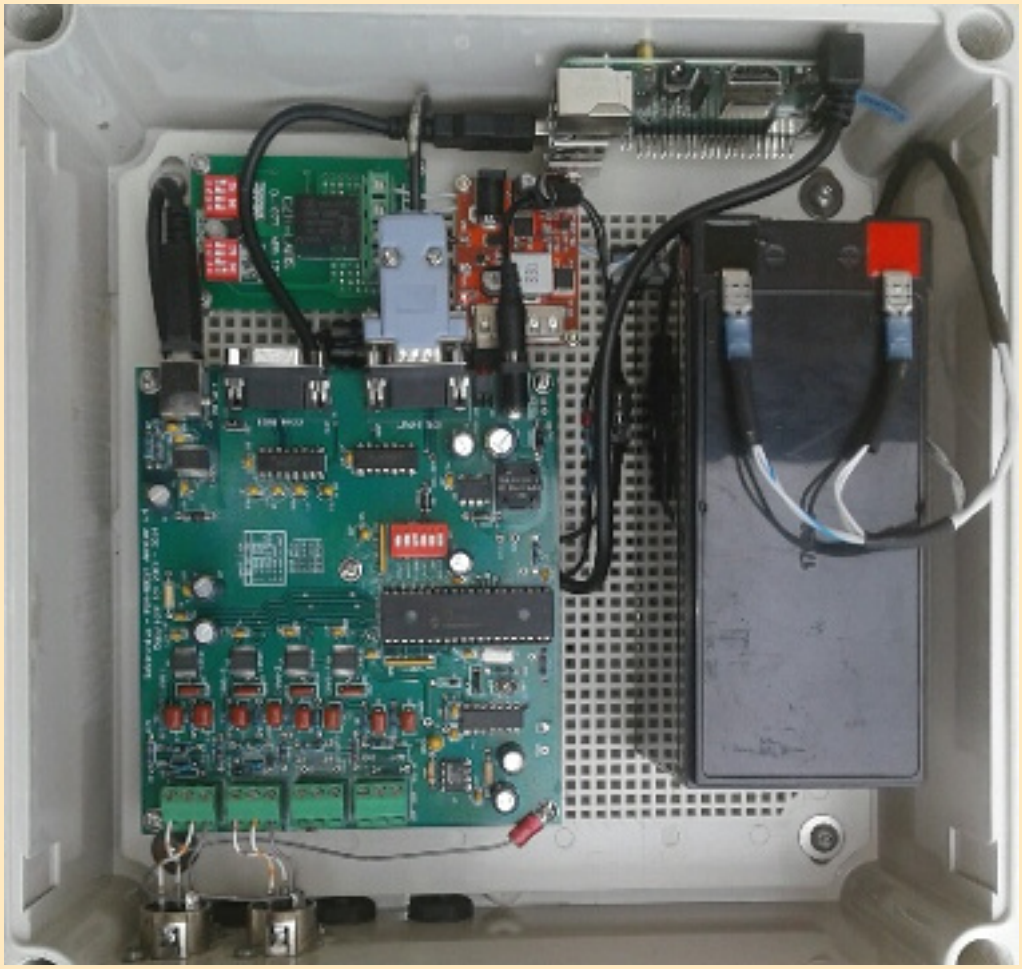
Hardware
Enclosure with lid: DSE HiBox P/N. DS-AG-2834 (280x340x130mm)
ABS Mounting Panel: DSE HiBox P/N. DS-2834P/L
DSE HiBox enclosures are available from Cookson Controls
Cable Gland, 3-6.5mm dia. (Qty 3): (Jaycar #HP0720)
M4x10mm Machine Screw, 304 S/S (Qty 4)
M4x50mm Machine Screw, 304 S/S (Qty 5)
M4 Nyloc Hex Nut, 304 S/S (Qty 15)
M3x25mm Machine Screw, 304 S/S (Qty 4)
M3 Nyloc Hex Nut, 304 S/S (Qty 12)
Metric stainless steel fixings are available from the FKO eBay store

16bit ADC Digitiser without optional integral computer

PSN Reliability

WEBTRONICS 24bit ADC BASED DIGITISER

Core electronics
24bit ADC Board: Webtronics P/N. PSN-ADC24
GPS Receiver: Garmin P/N. 010-00321-36 (GPS 18x-LVC OEM)
Garmin GPS are available from Johnny Appleseed GPS
Ancillary electronics
12V Battery Charger: CTEK P/N. 1047 (XS 0.8) (eBay)
12V 7.2AH SLA Battery: Diamec P/N. DM12-7.2 (Jaycar #SB2486)
Low Voltage Disconnect Module: CZH-LABS P/N. D-1077/12V (eBay)
Interconnects & Wiring
XLR Bulkhead Receptacle (Qty 2): Neutrik P/N. NC3FD-L-1
D-SUB 9 Line Connector, Plug (Qty 1): (Jaycar #PP0800)
D-SUB 9 Line Connector, Socket (Qty 1): (Jaycar #PS0804)
D-SUB 9 Backshell (Qty 2): (Jaycar #PM0808)
2.1mm DC Power Connector, 10mm Plug (Qty 1): (Jaycar #PP0509)
6.3mm Spade Terminal 14-16AWG (Qty 2): (Jaycar #PT4607)
18AWG, 2 Core DC Power Wire/metre (Qty 1): (Jaycar #WH3057)
6mm Balun Core (Qty 4): (Jaycar #LF1222)
Twin Screened Audio Cable/m (Qty 1): (Jaycar #WB1502)
Hardware
Enclosure with lid: DSE HiBox P/N. DS-AG-2828 (280x280x130mm)
ABS Mounting Panel: DSE HiBox P/N. DS-2828P/L
DSE HiBox enclosures are available from Cookson Controls
Cable Gland, 3-6.5mm dia. (Qty 3): (Jaycar #HP0720)
M3x25mm Machine Screw, 304 S/S (Qty 5)
M3 Nyloc Hex Nut, 304 S/S (Qty 15)
Metric stainless steel fixings are available from the FKO eBay store
2.1mm Cable Ties (Qty 6)



24bit ADC Digitiser with optional integral computer

PSN Reliability

SYSTEM COMPONENTS

ADC Board: The Analog to Digital Converter(s) process the seismic sensor output(s) into data streams that are timestamped and processed for a computer to send to a remote server for analysis.
GPS Receiver: Provides accurate positional and time information to the ADC board and the computer.
12V Battery Charger: Connects to AC mains power and regulates the charge state of the sealed lead acid (SLA) battery.
12V 7.2AH SLA Battery: Provides DC power to core and ancillary electronics within the enclosure.
Low Voltage Disconnect Module: An independent relay to protect the SLA battery from deep discharge during AC power failure. Switch selectable Disconnect (10.0V to **12.1V**) and Reconnect (10.7 to **12.8V**)
Adj. DC-DC Step Up Module: Regulates the variable DC voltage of the SLA Battery to a constant voltage (**+18.0V**). This voltage needs to be set prior to initial operation

This item is not required if the PSN-ADC24 board is used

Interconnects & Wiring

Cable Glands route RS-232 Data I/O, GPS data I/O and Battery Charger output wiring into each enclosure. The RS-232 and GPS terminate in D-SUB 9 connectors on the ADC Board. The Battery Charger connects directly to the SLA Battery using Spade Terminals.
XLR connectors are used for the analog inputs, twin screened cable connects to the ADC Board, depending on optional ADC Board input configuration.
A 2.1mm DC plug, centre pin + (positive) is used for the ADC Board Power input, soldered to the output of the DC-DC Step Up Module.
The 6mm Balun Cores are used on all lengths of DC Power wiring, routing the cable through one side of the core, back over the top and through the other side of the core.

Hardware

Rather than using spacers, I have chosen long machine screws and nyloc nuts to set the height of each assembly above the ABS Mounting Panel.

XLR Analog inputs, RS-232, GPS and Battery Charger

PSN Reliability

Integral Computer option

16bit ADC Digitiser with optional integral computer
In headless (normal) operation the HDMI cable, USB mouse & USB keyboard are disconnected, allowing the lid to be fitted and sealed.

If your installation is reasonably close to your Internet Access Point (within WI-Fi range) and you don't want to commit a PC or Notebook to your seismic system, consider an integral computer option. The Raspberry Pi SBC has been proven to be a competent tool for sending data to the Australian Centre for Geomechanics (ACG) Regional Seismic Network website in Direct Mode, perhaps a little less so in WinSDR mode.

Core electronics
Raspberry Pi3 Single Board Computer: Model B+
Raspberry Pi SBC is available from Little Bird Electronics
Ancillary electronics
MicroSDHC Card: Sandisk P/N. SDQUAR-016G-GN6MA
5V 3A USB DC-DC Step Down Module: P/N. HW-683
RS-232 to USB Converter (FTDI):
Required if using PSN-ADC-SERIAL board
USB-A to USB-B Cable
Required if using PSN-ADC-USB or PSN-ADC24 boards
MicroUSB Right Angle (Down) to USB-A Charge Cable:
Hardware
M2.5x5mm Brass Spacer (Qty 50) with M2.5 Hex Nut:
Ancillary items and Hardware are available from eBay

For the moment we'll consider the pros and cons of Direct Mode operation:

Advantages
low power consumption
AC Power failure immunity, >12 hours without data loss
Automatic start on power-up
Remote access available for maintenance
TeamViewer, VNC or SSH available

Disadvantages
no "local" realtime monitoring available
risk of system corruption after SLA battery is depleted *(a spare microSD card with copied image is required)*
Wi-Fi seems to work better on a 5GHz Network than a 2.4GHz Network *(possibly due to RFI effects*)

PSN Reliability

The image shows the Raspberry Pi screen in "Direct Mode". Direct Mode is available as a microSDcard image which can be copied easily and distributed by mail if need be. The image contains a basic GUI version of the Raspbian Stretch operating system and some scripts developed by Paul Harris at the ACG. There is no need for WinSDR or Exagear Desktop and WINE software that the Raspberry Pi needs to run it.

In Conclusion

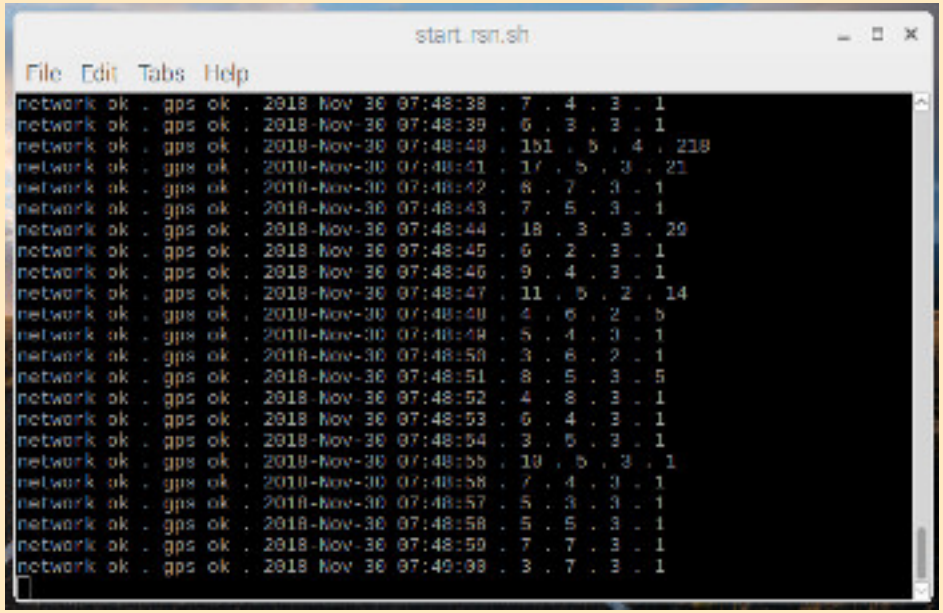
The reliability of this seismic system depends upon a couple of key factors:

a stable power supply system that can withstand outages for many hours
commercial-off-the-shelf sub-assemblies housed in weather resistant enclosures

My intention was to house everything in the one enclosure, located in close proximity of the seismic sensor. This included the integral computer so enclosure size and battery capacity was determined by these basic parameters. Where the distance to the Internet AP exceeds the distance required for a good Wi-Fi comms connection, it might be better to separate the computer from the sensor and digitiser. This would rely on a wired serial connection (RS-232) back to the computer or other options such as wired LAN or Wi-Fi extenders. The Raspberry Pi SBC does appear to create some electrical noise and the system may be better served by locating it away from the sensitive analog end. Time and emperical observation will tell.

I thought this might be a good oportunity to quantify a "typical" PSN set-up, so I have listed the component parts and their current costs just to see what it comes to. This may be useful to anyone contemplating such a system or perhaps just for insurance purposes.

For this exercise AU$1.00 = US$0.72



Direct Mode on the screen shows Comms and GPS status, date & time (UTC) and four channels of data each second

INTEGRAL COMPUTER OPTION

Core electronics	**Cost in AUD**
Raspberry Pi3 Single Board Computer: Model B+	$62.16
Ancillary electronics	
16Gb SD Card (Qty 2): P/N. SDQUAR-016G-GN6MA	$17.88
5V 3A USB DC-DC Step Down Module: P/N. HW-683	$6.92
RS-232 to USB Converter (FTDI):	$30.00
Required if using PSN-ADC-SERIAL board	
USB-A to USB-B Cable	$4.50
Required if using PSN-ADC-USB or PSN-ADC24	
MicroUSB Right Angle (Down) to USB-A Charge Cable	$5.40
Hardware	
M2.5x5mm Brass Spacer (Qty 50) with M2.5 Hex Nut	$11.00
M2.5x4mm Machine Screw (Qty 10)	$11.00
Total	**$144.36**

PSN Reliability

WEBTRONICS 16bit ADC BASED DIGITISER

Core electronics	Cost in AUD
16bit ADC Board: P/N. PSN-ADC-USB	$250.00
4Ch Amplifier/Filter Board: P/N. PSN-ADC-EQAMP	$257.00
GPS Receiver: Garmin P/N. 010-00321-36	$100.00
Ancillary electronics	
12V Battery Charger: P/N. 1047	$73.00
12V 7.2AH SLA Battery: Jaycar #SB2486	$34.95
Low Voltage Disconnect Module: P/N. D-1077/12V	$13.90
Adj. DC-DC Step Up Module: P/N. 126106/STEPUP	$7.95
Interconnects & Wiring	
XLR Bulkhead Receptacle (Qty 4): P/N. NC3FD-L-1	$40.00
D-SUB 9 Line Connector: Jaycar #PP0800	$1.45
D-SUB 9 Line Connector: Jaycar #PS0804	$1.95
D-SUB 9 Backshell (Qty 2): Jaycar #PM0808	$4.50
2.1mm DC Power Connector: Jaycar #PP0509	$1.95
6.3mm Spade Terminal (Qty 8): Jaycar #PT4607	$2.75
2 Core DC Power Wire/metre: Jaycar #WH3057	$1.40
6mm Balun Core (Qty 4): Jaycar #LF1222	$5.00
Twin Screened Audio Cable/m: Jaycar #WB1502	$1.00
Hardware	
Enclosure with lid: DSE HiBox P/N. DS-AG-2834	$38.21
ABS Mounting Panel: DSE HiBox P/N. DS-2834P/L	$10.50
Cable Gland (Qty 4): Jaycar #HP0720	$9.90
M3x25mm Machine Screw, 304 S/S (Qty 20)	$7.20
M3 Nyloc Hex Nut, 304 S/S (Qty 20)	$5.40
Total	**$868.00**

While it looks a bit scary on paper, it's still a bit cheaper than an EchoPro.

WEBTRONICS 24bit ADC BASED DIGITISER

Core electronics	Cost in AUD
24bit ADC Board: P/N. PSN-ADC24	$361.00
GPS Receiver: Garmin P/N. 010-00321-36	$100.00
Ancillary electronics	
12V Battery Charger: CTEK P/N. 1047	$73.00
12V 7.2AH SLA Battery: Jaycar #SB2486	$34.95
Low Voltage Disconnect Module: P/N. D-1077/12V	$13.90
Interconnects & Wiring	
XLR Bulkhead Receptacle (Qty 2): P/N. NC3FD-L-1	$20.00
D-SUB 9 Line Connector: Jaycar #PP0800	$1.45
D-SUB 9 Line Connector: Jaycar #PS0804	$1.95
D-SUB 9 Backshell (Qty 2): Jaycar #PM0808	$4.50
2.1mm DC Power Connector: Jaycar #PP0509	$1.95
6.3mm Spade Terminal (Qty 8): Jaycar #PT4607	$2.75
2 Core DC Power Wire/metre: Jaycar #WH3057	$1.40
6mm Balun Core (Qty 4): Jaycar #LF1222	$5.00
Twin Screened Audio Cable/m: Jaycar #WB1502	$1.00
Hardware	
Enclosure with lid: DSE HiBox P/N. DS-AG-2828	$45.00
ABS Mounting Panel: DSE HiBox P/N. DS-2828P/L	$10.50
Cable Gland (Qty 4): Jaycar #HP0720	$9.90
M4x10mm Machine Screw, 304 S/S (Qty 20)	$7.20
M4x50mm Machine Screw, 304 S/S (Qty 20)	$7.20
M4 Nyloc Hex Nut, 304 S/S (Qty 20)	$5.40
M3x25mm Machine Screw, 304 S/S (Qty 20)	$7.20
M3 Nyloc Hex Nut, 304 S/S (Qty 20)	$5.40
Total	**$715.30**

This article, "PSN Reliability" was submitted by Peter Gray, SAA Newsletter Editor

Period Extension for Geophones

A METHOD FOR EXTENDING THE FREQUENCY RESPONSE OF COMMON GEOPHONES

4.5Hz geophones used in the mining industry are produced in large quantities, which is reflected in both their price and availability. 2Hz and 1Hz geophones are much more expensive.

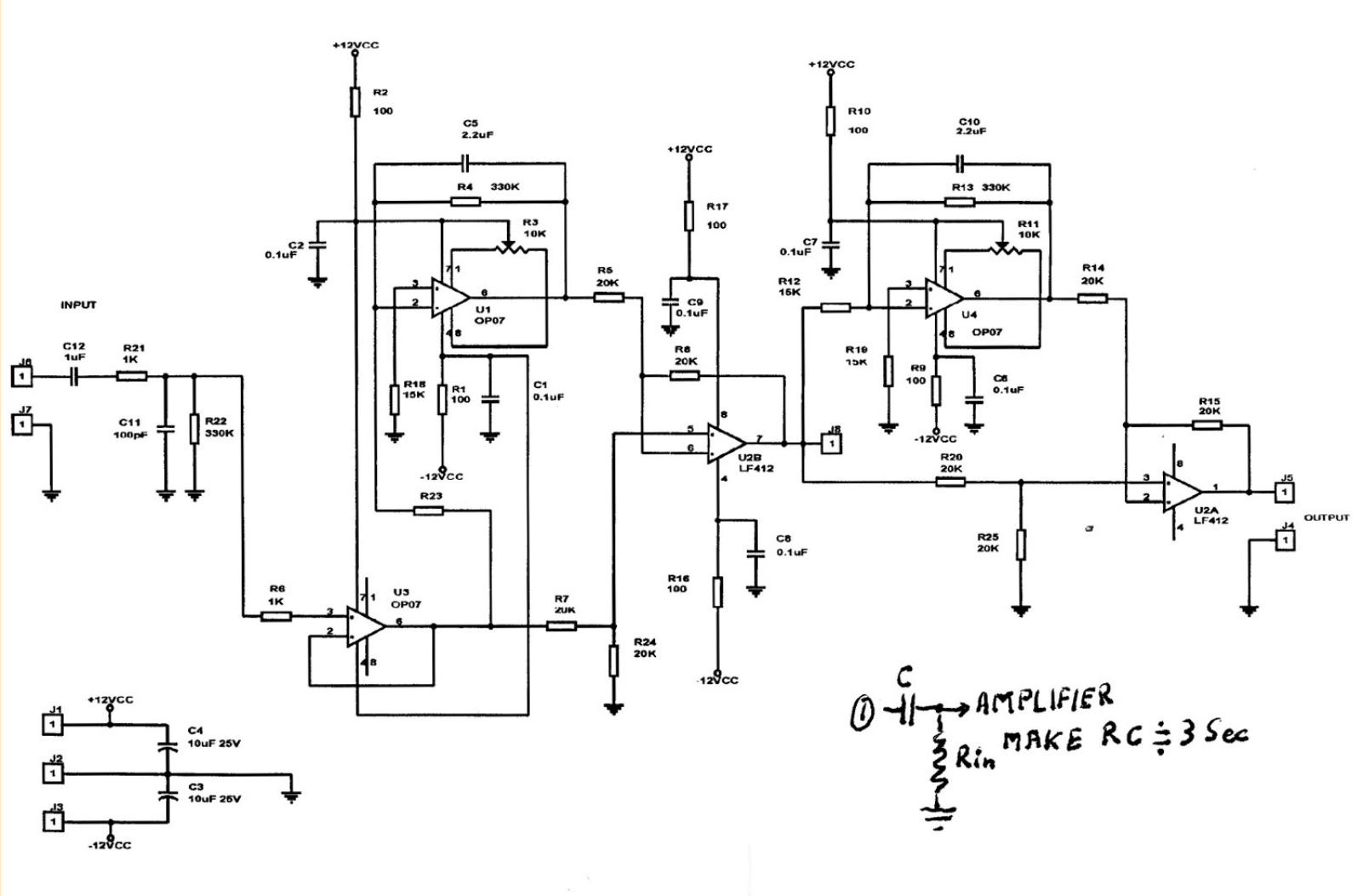
The problem with using 4.5Hz geophones for seismic recording, over most of Australia, will be that the majority of the quakes are teleseismic with frequencies of between 2 and 0.5Hz, so the amplitudes of the signals may be decreased by factors of up to 81. I find it much easier to analyse a trace when the response is ~flat with velocity from 10Hz down to 0.5Hz. I see up to 3 noise pulses per hour, but only ~3 quakes per fortnight! Sorting out the quake signals is a significant problem. I find it much easier to separate quakes from noise when there are some associated signals with known time or frequency differences. These can be S Waves, or Rayleigh Waves for vertical systems.

There are three methods of extending the period of a velocity sensing seismometer like a geophone. The output voltage falls as f^2 below resonance. You can add a pre-amplifier with a (1/f^2 + flat) characteristic and use either parallel or series compensation. Reichmann used a -ve input impedance amplifier to compensate for the resistance of a geophone and then converted the output current into a voltage. These circuits are ALL now out of patent.

Although (1/f^2 +flat) response is required, second order circuits have a phase null with the direct higher frequency signals at 'f', giving a ~0 sum output. Two sequential stages are required to add in the higher frequency signals. When extending the range, there is additional 1/f noise at lower frequencies. To get linear compensation, we need to extend the rather broad compensation roll off to frequencies well below the desired minimum and to then add a two stages of high pass filter to limit the response and reduce the noise.

An R.T. Clark 4.5Hz Vertical Geophone

Period Extension for Geophones



THE 4.5HZ GEOPHONE PERIOD EXTENSION CIRCUIT

The C12 and R22 input on the first U3 opamp form a LF noise filter and give a high input impedance.
The U1 opamp forms the first 1/f boost filter and this signal and the high frequency signal are summed by opamp U2B.

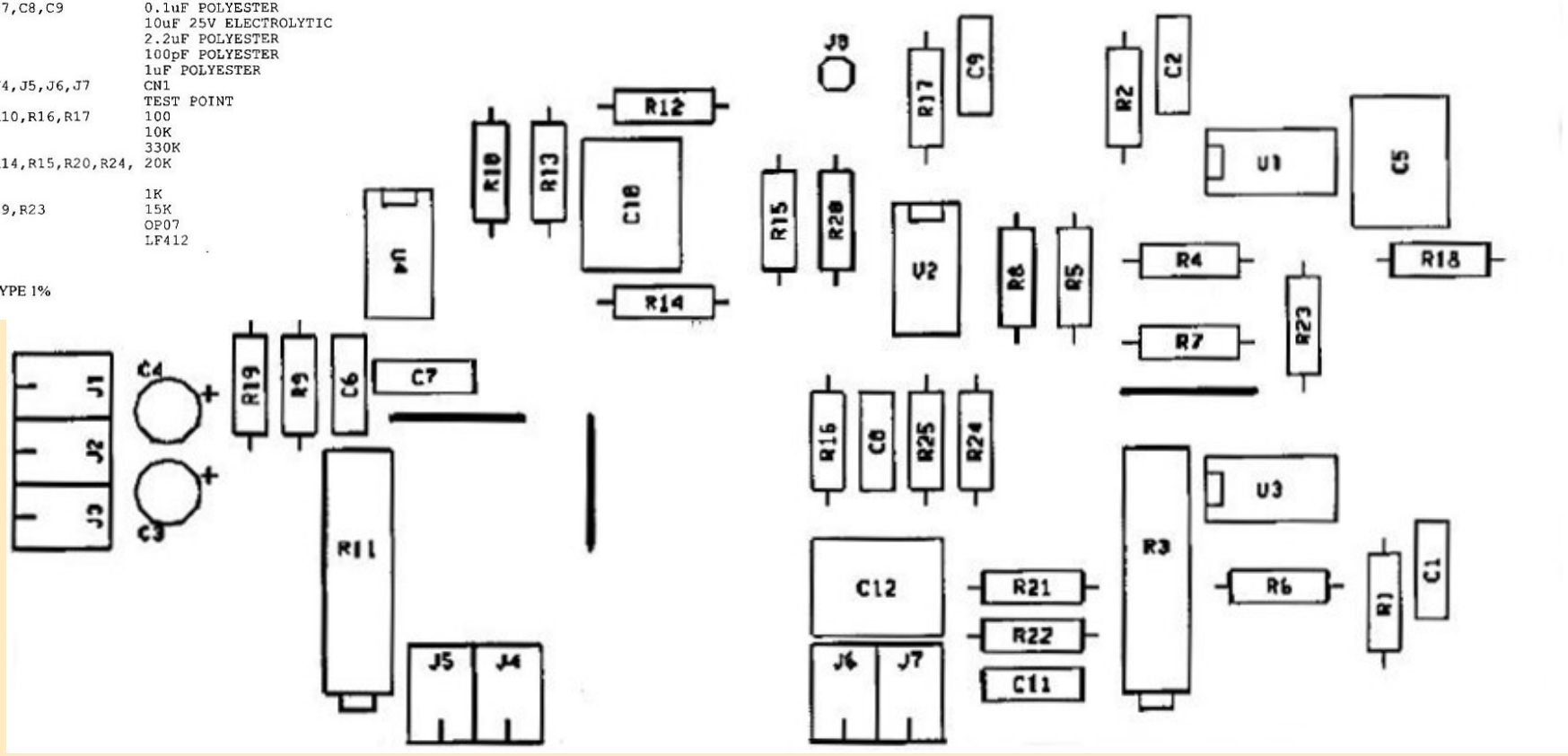
The U4 opamp forms the second 1/f boost filter and it's output and the direct U2B output are summed by opamp U2A.
I added a second LF noise filter to the output.
Non polarised electrolytic capacitors are produced for HiFi speaker filters.
The Rin may be the input resistor of the main amplifier, or of an intermediate stage.

Since the gain of the boost stages is high, both OP07 opamps need zero set potentiometers.
The amplifier was originally designed for +/- 12 V, but it works OK with +/- 5 V supplies.

Period Extension for Geophones

Item	Quantity	Reference	Part
1	6	C1,C2,C6,C7,C8,C9	0.1uF POLYESTER
2	2	C3,C4	10uF 25V ELECTROLYTIC
3	2	C5,C10	2.2uF POLYESTER
4	1	C11	100pF POLYESTER
5	1	C12	1uF POLYESTER
6	7	J1,J2,J3,J4,J5,J6,J7	CN1
7	1	J8	TEST POINT
8	6	R1,R2,R9,R10,R16,R17	100
9	2	R3,R11	10K
10	3	R4,R13,R22	330K
11	8	R5,R7,R8,R14,R15,R20,R24, R25	20K
12	2	R6,R21	1K
13	3	R12,R18,R19,R23	15K
14	3	U1,U3,U4	OP07
15	1	U2	LF412

ALL RESISTORS IN METAL FILM TYPE 1%



Parts List and Board layout diagram

This article, "Period Extension for Geophones" was kindly submitted by Chris Chapman

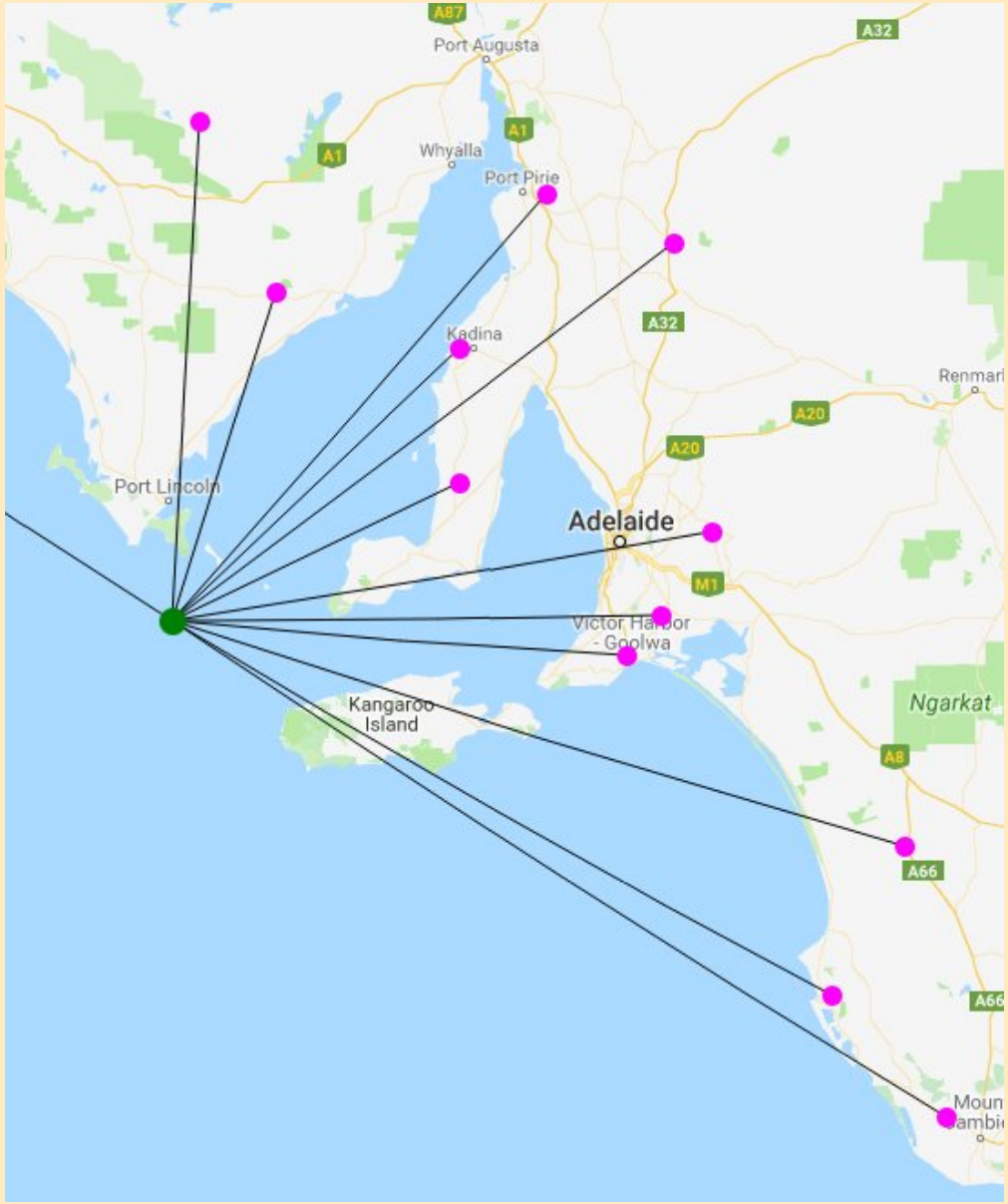
Recent Seismic Activity

PORT LINCOLN 2018-10-10 02:57

This earthquake occurred at 1:27 SA summer time, had a magnitude of about 3.6 and the epicentre was about 65km due south of Port Lincoln. It is not possible to calculate the depth as the nearest recorders were over 100km away. The earthquake was unlikely to have been felt on the mainland. It was well recorded at the Kelly Hill Caves seismograph (operated by Geoscience Australia) and the Cleve seismograph (operated by the SAA). It was even weakly recorded by some seismographs interstate.

There are a few other earthquakes that have occurred near that region, but this is the largest on our records. In 2002 there was one of magnitude 3.1, followed by another of magnitude 3.2 the next year. The event is about the same size as the magnitude 3.7 that occurred near Cleve on 1st July this year.

The accompanying image taken from our website shows the location of the earthquake and some of the stations that recorded it. The station to the north-west (not shown) is the GA station (FORT) at Forrest, WA.



SAA Member Sites

GUNDEROO Public Seismic Network Station is back online

On 11 Oct 2018, seismologists Vic Dent, Cvetan Sinadinovski and I drove out to Gundaroo NSW about an hour north of Canberra to restore the PSN seismograph there, a Raspberry Pi model (top right in photo). Property owners Nick and Fran were away but we had access to their seismometer shed. The Wilmore MkII seismometer was in a new shallow hole behind the shed with a very solid steel cover (thanks Nick).

After a short investigation, Vic changed the Webtronics 16bit Analog-Digital Converter and 2 Channel Filter printed circuit boards (behind the yellow multimeter). Life was restored, catch-up data from August began to flow to the Perth server immediately. So easy to revive a very useful citizen science project and a pleasant day was had by all.

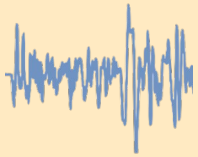
Kevin McCue

P.S. The fault was caused by corrosion due to moisture on the ADC board but was recently repaired successfully by Blair Lade.

The old Gundaroo School, now the public library

Cvetan and Vic, looking for signs of life

The Gunderool PSN station was originally located at the old Gundaroo School. Some years ago after many faults and issues, the equipment was moved to it's present location where it's operation, security and access has proven to be more reliable.



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	https://www.assa.org.au/resources/technical-special-	Download any SAA Newsletter from this site
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
Regional Seismic Users Website	http://www.rsuw.daleh.id.au/index.html	PSN seismometers - RSUW
Recent SA Earthquakes	http://earthquakes.mappage.net.au/q.htm	Data & summaries of recent SA quakes
Central QLD Seismology Research Group	http://www.cqsrg.org/	CQSRG - Kevin McCue
Astronomical Society of SA	https://www.assa.org.au/resources/technical-special-	ASSA - Seismology page
Geoscience Australia	http://www.ga.gov.au/earthquakes/initRecentQuakes.do	Our national authority on seismic events
QLD Uni Environmental & Earth Sciences	https://sees.uq.edu.au/	The University of Queensland - Col Lynham
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