Newsletter of the Seismological Association of Australia Inc. Sep-Oct 2019

Seismological Association of Australia Inc.

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

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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 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. 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
Dear reader, please accept my apologies as I have stuffed up yet again. Not only did I send everone the wrong date for the AGM, but a greater injustice has been presented in print.
I refer to Newsletter #10 and the location of the proposed National Radioactive Waste Management Facility at Wallerberdina Station (formerly referred to as Barndioota).
On a recent visit to the Flinders Ranges, I was made aware of this error. The cover image of Newsletter #10 shows the "facility" some 3km east of the Port Augusta-Leigh Creek railway line, when in fact the correct location is about 4km northwest of the railway crossing along Lake Torrens Road. This cover image is the railway looking north. When you get to the power line crossing above the road, you're there (on the northern side of the road). In the grand scheme of things, a difference of 7km away from the western range front could be considered by reviewing this document and drawing your own conclusions.
See NRWMF Site Characterisation-Technical Report Wallerberdina, Section 3.3, Subsurface Environment: Seismic Risks (Pages 140 through 172) for some interesting reading.

Peter Gray

SAA News and upcoming activities

2019 SAA AGM

Please be advised that the SAA Annual General Meeting has been scheduled for Tuesday, 22nd of October, 2019 at 7:30pm. The venue for the AGM will be at Hamilton College Space School, 815 Marion Road, Mitchell Park SA (enter via the 3rd entrance heading south).

Agenda items will include the Chairman's Report, the Treasurer's financial report and the Chief Seismologist's report. All committee positions will be declared vacant and elections will be held to fill the positions of:

Chairperson - Secretary - Treasurer - Chief Seismologist - Newsletter Editor

Nominations for any of these positions are welcome from financial members of the association, and should be submitted to the Secretary by e-mail prior to the meeting.

At the conclusion of the meeting, members in attendance will be able to tour the facility under the guidance of Space School Director Tony Virgo, including the Mars crater and other mission training areas.

TPSO goes global - well almost

Paul Hutchinson recently inquired about sending data from the Streckeisen STS-2 on the pier directly to the IRIS Data Management Centre for dissemination. As a result of Paul's action and some advice from IRIS on how it could be done, the SAA now has FDSN Network Code DU assigned, along with our own digital object identifier (DOI).
The next step will be to configure a PC with SeisComP3 software, having already been granted a licence to use the package. If any members are familiar with the SeisComP3 software, we would love to hear from you.
Another software package currently being considered for our seismic operations is Obspy. If any members are familiar with Obspy or Python programming in general, we would love to hear from you too.

Week Number Rollover issues continue...

Well it finally happened, a Trimble GPS module in one of our EchoPros (Strathalbyn STR2) flipped back to 1999 in late August 2019. Fortunately, the Melbourne Uni eqServer had been prepared for this and a patch provided by the Seismic Reasearch Centre corrected the date fault.
While we could continue to operate faulty recorders with the patch, our preferred solution is to replace the faulty GPS with a new model and have fully serviceable recorders. A visit back to STR2 is being arranged in October to 'swap out' the faulty unit with an already modified replacement recorder. As the other recorders fail, similar rescue operations will be carried out, as required.
Replacement GPS modules have already been purchased for the small number of Echo recorders still in operation, these will be delivered in the next week or so and installed ASAP.
Just in case you are curious, this WNRO activity has cost the association many hours of effort and around $2000 in cash to rectify, with many more hours of travel and effort still to come.
We'll be back to Bunnings at our earliest opportunity.

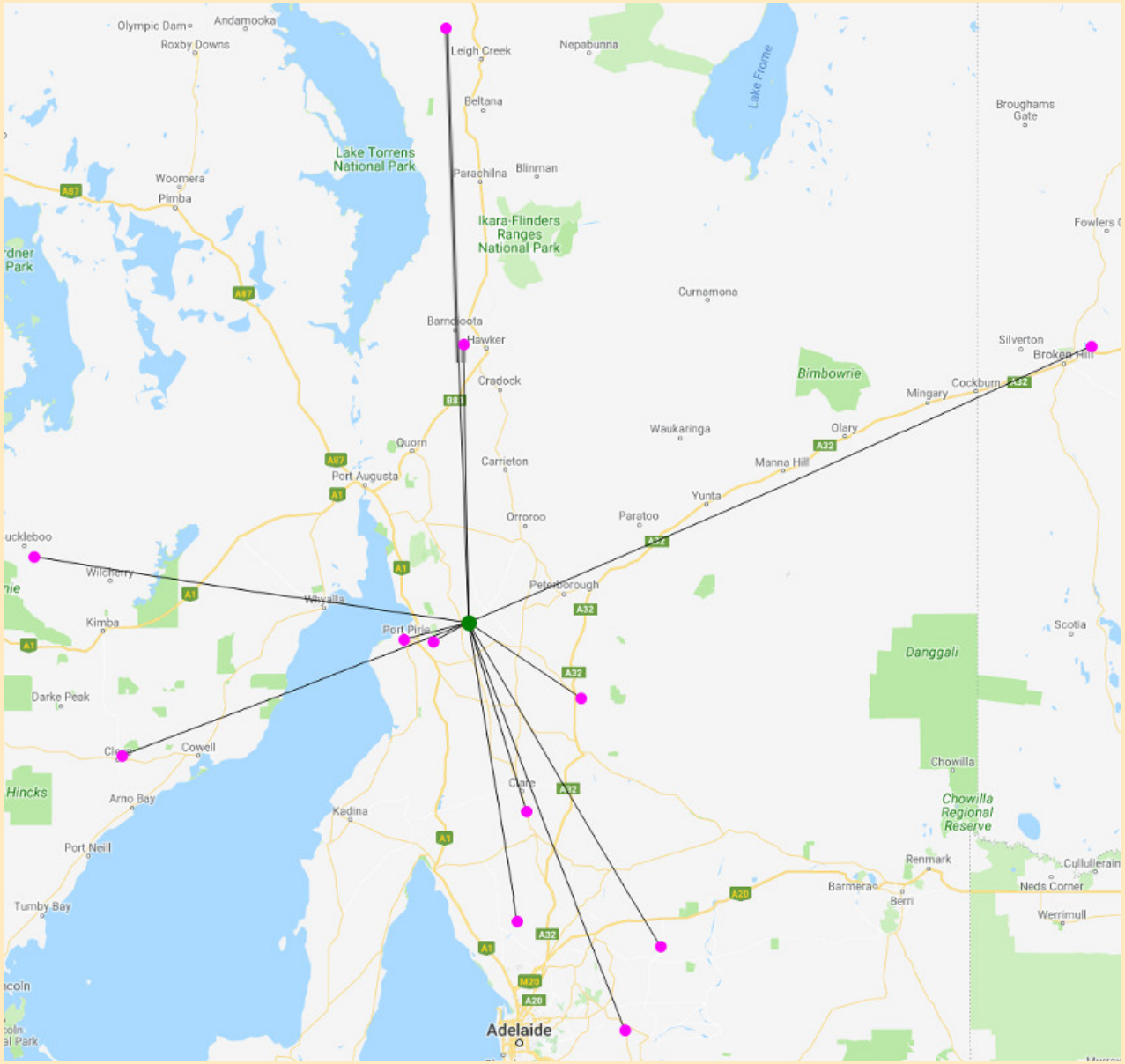
Site modifications for Willalooka

Further to the recent trip to Willalooka for a battery change, the situation with the trees shadowing the solar panel have become complicated. Due to restrictions to further clearance of native vegitation throughout the south east of SA, our remaining options are to move the existing solar panel to another location or add another panel at another location, or both. This makes the job somewhat larger than originally thought and will require additional resources, people and time onsite. Fortunately, the task is not urgent but it will have to be completed before next winter.

Recent Seismic Events

Gladstone 2019-09-05 02:21 ML3.3

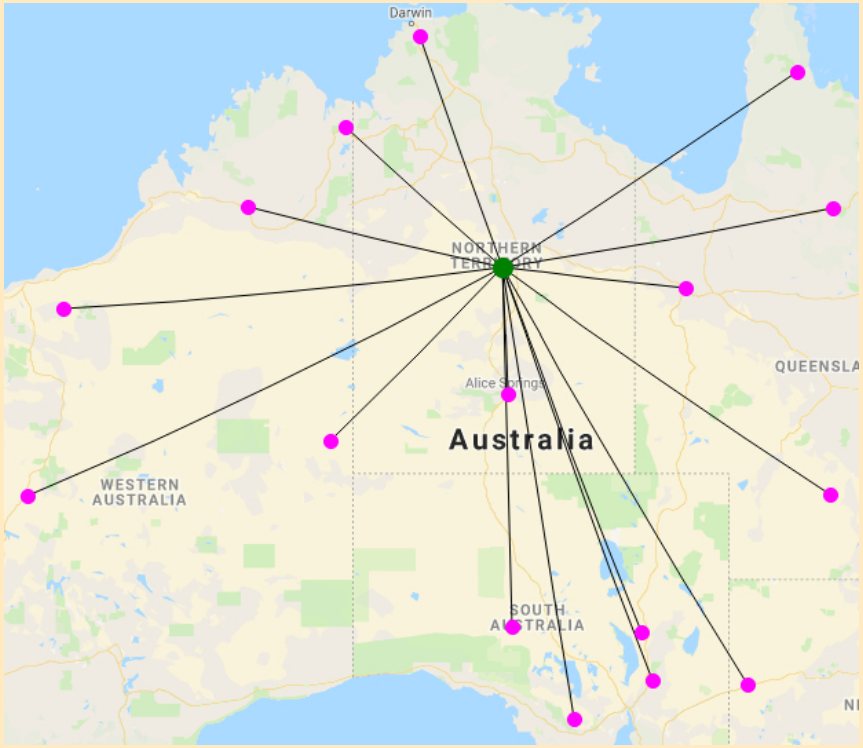
"I felt it" reports:
Laura / MMI IV (Light shaking):
A deep rumbling vibration that lasted about 10 seconds making windows rattle
Laura / MMI IV (Light shaking):
Distant deep short rumbling boom - felt the vibration through the thin concrete slurry floor of the kitchen, (cottage is 119 years old), kitchen pendant light moved, water in the clear bottle atop of the ceramic dispenser sloshed back and forth quite vigorously. Momentarily had a sinking feeling thought it may have been a truck accident north of Laura. Also photograph hanging on the wall in the lounge had moved.
Laura / MMI III (Weak shaking)
Belalie North / MMI II (Very weak shaking):
Thought it was a truck coming at first, but soon realised it was an earth tremor.
Bangor / MMI IV (Light shaking)
Tarcowie / MMI V (Moderate shaking):
Sounded like dynamite going off underground for about 20 seconds.

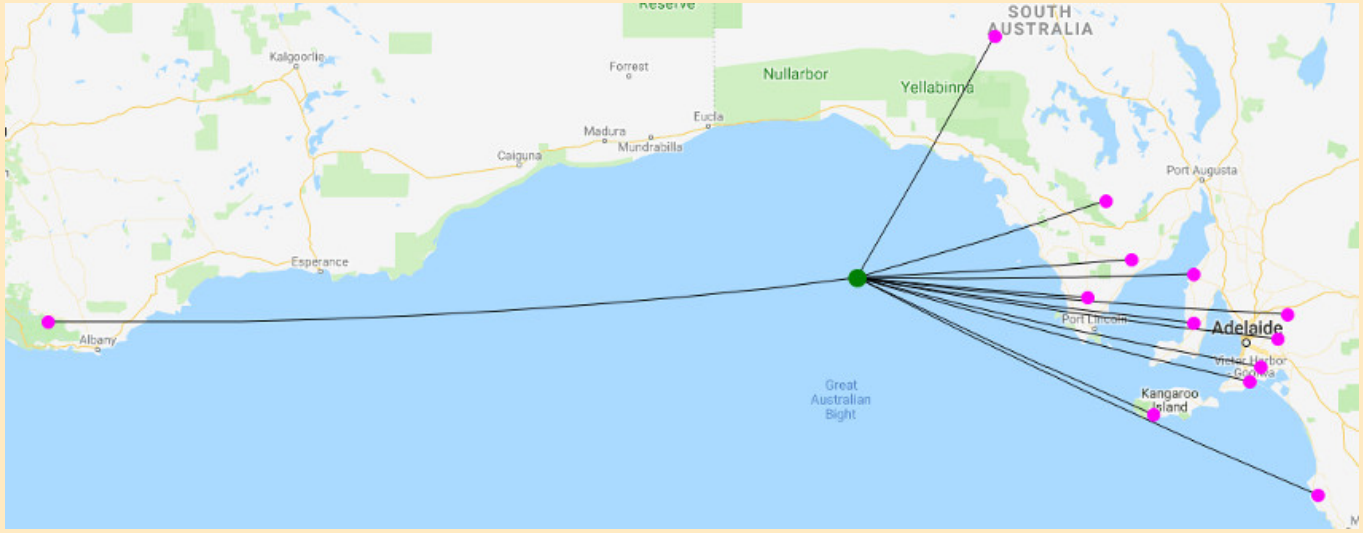


Recent Seismic Events

Tennant Creek 2019-08-01 01:22 ML5.5

The largest earthquake recorded on mainland Australia since the last newsletter was published. The image shows the many seismic stations used across the continent to determine the hypocentre. The ANU operates one of the most sensitive seismic sites in the country, not far from the epicentre of this quake. The Warramunga Seismic and Infrasound Research Station near Tennant Creek in the Northern Territory comprises a 24-element broad-band seismic array and an 8-element infrasound array. Both arrays are certified primary stations under the Comprehensive Nuclear Test Ban Treaty and data is provided by satellite link to the International Data Centre in Vienna, Austria and to Geoscience Australia, in real time. You may remember from earlier newsletters that our Chairperson, Blair Lade spent some time there in his younger years.





Offshore Streaky Bay

280km SW 2019-08-13 02:14 ML4.7
260km SW 2019-08-13 04:11 ML2.5
260km SW 2019-08-13 04:47 ML2.3
250km SW 2019-09-11 22:37 ML2.7

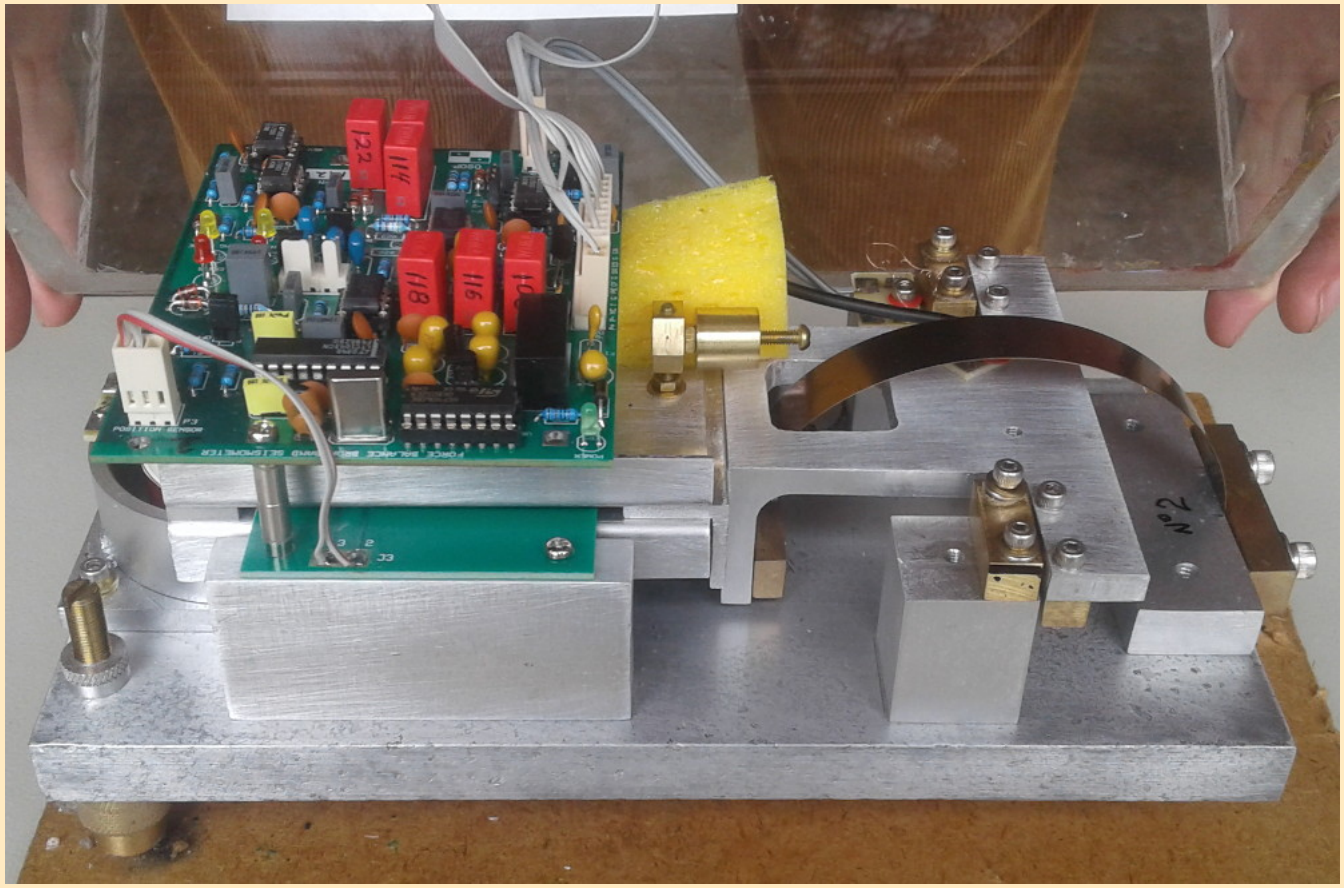
A moderate sized quake with a couple of aftershocks in August and another in September.

Colin Stuart donates an Inyo FBV

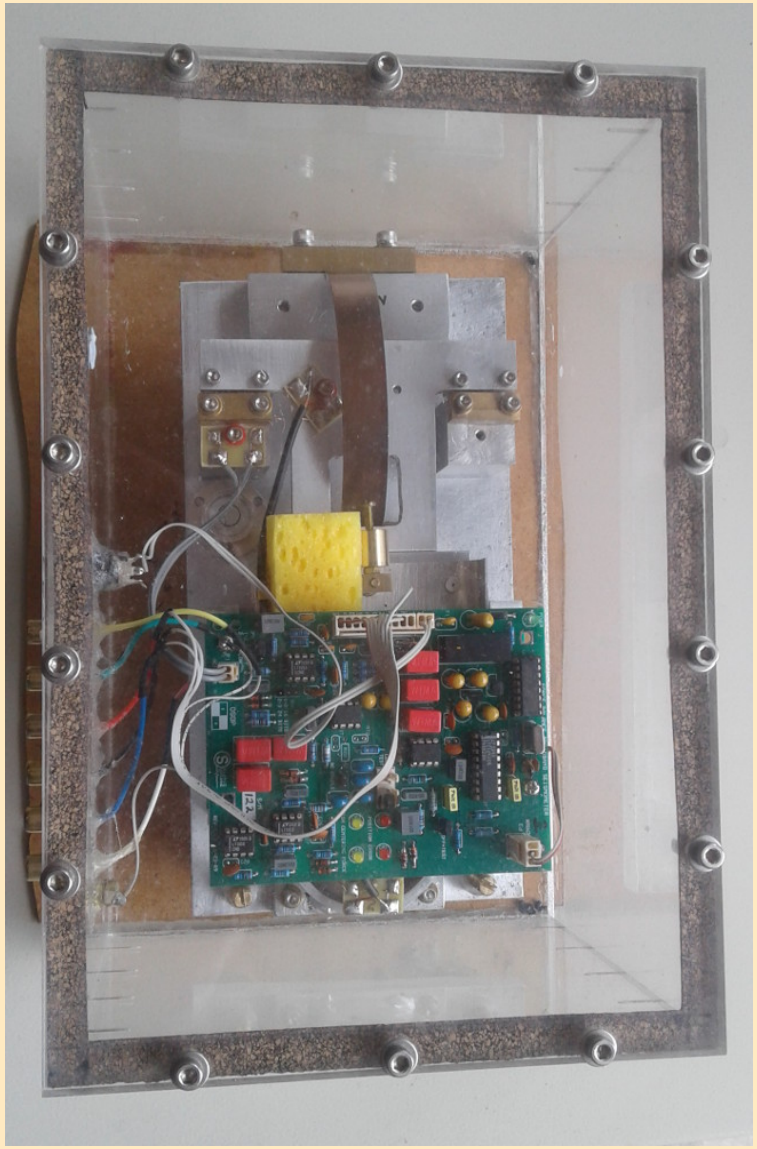
Article submitted by Peter Gray

SAA now has an Inyo Force Balance Vertical Seismometer

On a recent visit to South Australia, Colin Stuart contacted David Love and offered to donate his Inyo FBV to the association. This Inyo is the second of seven instruments Colin built in collaboration with Dale Hardy several years ago. The instrument adds considerable capability to our network and complements the Inyo FBV located at Morphett Vale (MPTV), operated by Joan Harris. The Inyo was the first of three designs based on the principal of an astatic leaf-spring suspension and broadband force balance electronics developed by Dave Nelson and Brett Nordgren in the USA.



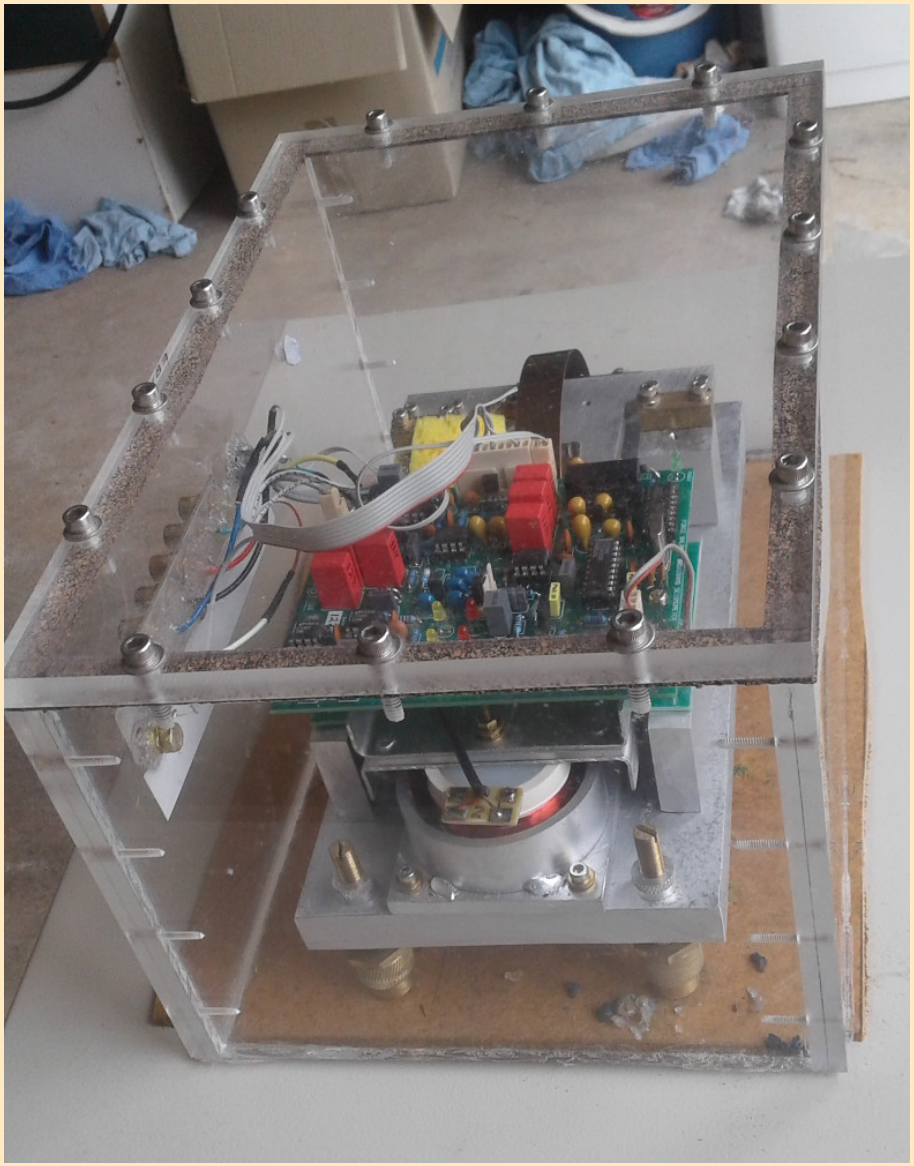
Colin Stuart donates an Inyo FBV

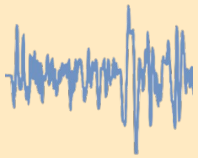


Some more images of the Inyo from different angles.

To stabilise the temperature and minimise air currents within the instrument, the perspex case is fixed to the vault floor using a silastic or similar compound.

The plywood base and yellow foam are there to help protect the instrument during transport.





The Use of Abscissas in Graphs

Article kindly submitted by Mike Turnbull, Central Queensland Seismology Research Group

Introduction

Discussed in this paper is an oft occurring academic debate concerning the correct usage of the abscissa when graphing data from any of the disciplines of mathematics, but in particular the physical sciences. The opinions are those of the author.

The central issue of the debate is whether the abscissa of a graph should always be used to represent the independent data. This is a view held by many. In order to approach the debate in a rational manner it is necessary to define the words "abscissa", and "independent", and then undertake a review of the traditional and current accepted usages.

Definition of "abscissa"

The Oxford English Dictionary (2005) provides the following definition of "abscissa" in relation to its geometric usage.

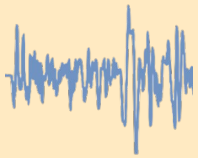
> **"Pl. -es; more commonly in the L. form abscissa (æb'sIs{schwa}), pl. abscissae; also Eng. abscissas**.
>
> 1. *Geom. Literally*, **a line or distance cut off**; *spec*. **the portion of a given line intercepted between a fixed point within it, and an ordinate drawn to it from a given point without it.**
>
> In *Conic Sections*: the segment (or segments) of a diameter (or in a hyperbola, a diameter produced), intercepted between the point where it is cut by an ordinate, and the bounding curve.
> In *Rectilineal Coördinates*, the segment of a given line, x, intercepted between the point where it is cut by another line, y, and that in which it is cut by a line parallel to the latter drawn from a given point without it, and called the *ordinate*."
>
> Emphasis is not the author's

The meaning of this definition is rather obscure, and requires some knowledge of geometry, and mathematics in general, in order to understand it. In common parlance this definition indicates that an abscissa is a line drawn in any general orientation, to represent any quantifiable data that is intercepted by another line (called the ordinate). A specific case of an abscissa being used to model the diameter of a conic section is referred to. The definition leaves open the possibility that more than one ordinate may be associated with any particular abscissa. Apart from the implication that the abscissa is somehow different from an ordinate, the definition ascribes no other importance to the role the abscissa plays in geometric representation of quantifiable data. Indeed, the definition implies that the role of the abscissa and the ordinate can be reversed, because, just as the ordinate is "drawn to" the abscissa "from a given point without it", so is the abscissa related to the ordinate.

What is an Independent Variable

There is an opinion amongst some scientists that an independent quantity is one that can be considered, in isolation, as being dependent on no other quantity for its intrinsic value. The author contends that there is no quantity that can be so defined. Nature is such that all physical quantities are necessarily interdependent on some other converse quantity. Indeed the Heisenberg Uncertainty Principle formally states this. There is no physical quantity that can be measured independent of some other converse quantity. It may be debated on a philosophical level that some quantity may exist that is intrinsically independent of the rest of the Universe, but this contention is not supported by scientific evidence.

As an example of what is currently (in 2005) understood by an independent mathematical variable, the Colorado State University Mathematics Department (2004), as part of its Mathematics Placement Examination Review, provides the following definition. (Emphasis added by the author.)



The Use of Abscissas in Graphs

> "**An independent variable is one that may be changed at will**, that controls a process, or **that determines the value of the other variables**. A variable which responds to or whose value is determined by the value(s) of the independent variable(s) is called the dependent variable."

The author accepts this definition as being valid. In particular the author accepts, and agrees, that an independent variable is any variable that, in the context of its usage, may be varied at the will of the practitioner to determine the value of some other variable that is pertinent to the physical situation under consideration.

StatSoft (2004) define an independent variable, in the statistical sense, as follows.

> "**Dependent vs. independent variables**. Independent variables are those that are manipulated whereas dependent variables are only measured or registered. This distinction appears terminologically confusing to many because, as some students say, 'all variables depend on something.' However, once you get used to this distinction, it becomes indispensable. The terms dependent and independent variable apply mostly to experimental research where some variables are manipulated, and in this sense they are 'independent' from the initial reaction patterns, features, intentions, etc. of the subjects. Some other variables are expected to be 'dependent' on the manipulation or experimental conditions. That is to say, they depend on 'what the subject will do' in response. Somewhat contrary to the nature of this distinction, these terms are also used in studies where we do not literally manipulate independent variables, but only assign subjects to 'experimental groups' based on some pre-existing properties of the subjects. For example, if in an experiment, males are compared with females regarding their white cell count (WCC), Gender could be called the independent variable and WCC the dependent variable."

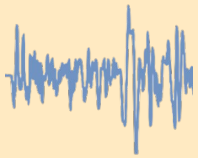
This definition supports the accepted concepts that an independent variable implies all of the following usages.

> A number representing the value of the variable quantity that is being manipulated by the practitioner during an experiment.
>
> A variable that the practitioner believes might influence the measured outcome of an experiment. (Simon, 2005).
>
> A variable in an equation that may have its value freely chosen without considering values of any other variable. For equations such as $y = 3x - 2$, the independent variable is x. The variable y is not independent since it depends on the number chosen for x. Formally, an independent variable is a variable which can be assigned any permissible value without any restriction imposed by any other variable. (Mathwords, 2004)

First Review

It is clear from available definitions of the words "abscissa" and "independent variable" that they each convey totally different meanings in mathematical terms, especially in the disciplines of geometry and statistics.

An abscissa is a line used to display geometric and statistical data in a graphical manner, in conjunction with other lines referred to as ordinates. This implies that the values on the ordinates may be derived from the values on the abscissae, either by means of well-defined transfer functions, or due to some relative causative effect - but this is not a necessary relation. Both the abscissa and the ordinate values may be obtained from experimental measurements, with no assumption of cause and effect relationship between the values.



The Use of Abscissas in Graphs

The values modelled by an independent variable (which may or may not be depicted on an abscissa) do not necessarily exist independently and in isolation of other variable quantities (which may or may not be depicted on an ordinate). The role of the independent variable has to be interpreted in the context of the universal data set being modelled. This role may be ambiguous, and can be determined by the practitioner.

Case Studies

Thermometer Calibration

The National Institute of Standards and Technology (2004) provides the following information concerning the procedure used to calibrate some commonly used thermometers.

Industrial Thermometer Calibration Laboratory

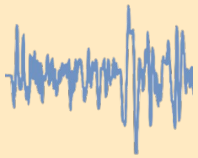
The Industrial Thermometer Calibration Laboratory calibrates liquid-in-glass thermometers, industrial platinum resistance thermometers, thermistors, and thermocouples in the temperature range -196°C to +550°C. Calibrations in this laboratory are made by comparison with a calibrated standard platinum resistance thermometer in stirred liquid baths. Fixed-point measurements at the Ga melting point (+29.7646°C) [for a thermometer with an outer diameter of less than 3.6 mm], the water triple point (+0.01°C) and the ice point (0.00°C) are available.

Thermometer	Temperature Range
Industrial PRT's	-196°C to +550°C
Thermistors	-196°C to +100°C
Thermocouples	-196°C to +550°C
Liquid-in-glass	-196°C to +400°C
Digital	-196°C to +550°C

The process requires that the measured quantity of the thermometer being calibrated (be it voltage, current, resistance, length, or whatever) be "compared" with the measured quantity of a standard platinum resistance thermometer under identical, controlled, thermodynamic environmental conditions; the standard thermometer having been previously calibrated by subjecting it to reproducible thermodynamic environmental conditions of known effect.

During the process of calibrating the standard thermometer the value representing the reproducible thermodynamic environmental conditions of known effect may be considered to be the independent variable in that process - after all, it is the reproducible thermodynamic environmental conditions of known effect that that number represents, that is causing the measured output value of the standard thermometer to change, not the other way around.

During the process of using the standard thermometer to calibrate a working thermometer, the two instruments are subjected to the same thermodynamic environmental conditions, with the standard instrument being used to quantify the environmental effect as the effect is changed. In practice the output of the standard thermometer is observed while the practitioner alters the environmental conditions to achieve the required output value. In this case it is the output of the standard thermometer that is being used to control the environmental condition, not the other way around. Therefore the output of the standard thermometer can be considered, in the context of usage at that time, to be the independent variable. It is also of interest to note that, as the environmental conditions are being changed in a controlled manner, the output value of the working thermometer is also being recorded, and compared to that of the standard thermometer. This comparison is generally depicted as a graph, with the measured values obtained from the standard thermometer displayed on the abscissa as temperature (directly traceable to the original calibration chart of the standard instrument), and the measured values obtained



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from the working thermometer displayed on the ordinate, in voltage, current, resistance, length, or whatever physical quality being exploited. So the values on the ordinate are not directly related to the values on the abscissa; and the values on the abscissa are not in fact the values being measured on the output of the standard instrument at all.

It is clear from this case study that in practical, everyday usage, the perceived independence of data obtained during the calibration and operation of a thermometer changes from process to process. As the perceived independence changes, the practitioner's choice as to whether the data is modelled on the abscissa or the ordinate of a display graph also changes.

As an epilogue to this case study, it is noted that, in using a working liquid-in-glass thermometer, it is the length of the liquid column that is measured to determine the current ambient temperature. The length of the column is the known quantity, and the temperature is the unknown quantity. When graphing this relation it is customary to put the known quantity on the abscissa and the unknown quantity on the ordinate - even though an adherence to the causative relation would require the converse on the grounds of the independency of data being attributed to the temperature.

Earthquake Epicentral Distance

When an earthquake occurs it generates two distinct energy waves that radiate out from the point where the earthquake occurred in all directions. These two waves are known as the P wave and the S wave. The P wave travels faster than the S wave. At a monitoring station some distance from the point on the surface beneath which the earthquake occurred (known as the epicentre) the P wave will arrive before the S wave. Therefore, as the distance from the epicentre to a monitoring station increases, the S-P delta time will also increase. In this sense it can be said that the S-P delta time depends on the epicentral distance, not the other way around.

By recording the measured S-P delta time and associated known epicentral distances of numerous earthquake events, a graph can be drawn to depict the relationship between the two sets of data. The purpose of drawing this graph is so that, when a given S-P delta time is observed for a particular future event, the epicentral distance to that event can be simply read off the graph. Consequently, even though during the calibration phase both the epicentral distance and the S-P times are known values, with the S-P delta time being dependent on the epicentral distance, during the usage phase, it is the epicentral distance that is the unknown quantity. Therefore, during the calibration phase it may be appropriate to model the epicentral distance on the abscissa. Later, during the usage phase, it may be more appropriate to model the epicentral distance on the ordinate.

Abstract Mathematical Relation

Consider the hypothetical functional relation defined by the equation:

d(s) = ms - k ... (Eq1)

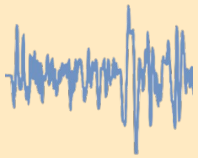
In the above equation **d** is the dependent variable, and **s** is the independent variable in the context of the function so defined.

By algebraic manipulation Eq1 can be transformed to Eq2.

s(d) = pd - q ... (Eq2)

In Eq2 it is **s** that is considered to be the dependent variable, with **d** being the independent variable in the context of the function so defined.

It is clear that, in this example, any concept of independency of data is a philosophical ideology imposed by the observer that is not factually supported by the underlying abstract nature of the problem.



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Second Review

In practical usage it is not always the data with perceived independence that is modelled on the abscissa. In the context of purpose it is usually the known data (that is, the data that can be readily measured) that is modelled on the abscissa. In such cases the unknown data (that is, the values that can be derived from the known data) are modelled on the ordinate or ordinates.

In the case of a working thermometer the length of the liquid column is the known quantity not the ambient temperature; even though the column length is physically dependent on the ambient temperature.

In the case of earthquake epicentral distance determination, it is the S-P delta time that is the known quantity; even though the S-P delta time is physically dependent on the epicentral distance.

If a relation is treated as a pure mathematical abstraction the independence of the variables may often be interchanged by mathematical transformation. It is only when an externally perceived reality is imposed on the abstract relation that any concept of independence emerges. This imposition may in some instances enable the observer to give physical meaning to the relation. On the other hand, such an imposition may cause the observer to become blind to the abstract potential of the relation.

Conclusion

It has been demonstrated that the concept of independence and dependence of related variables is imposed by an external concept of reality. That concept of reality is unique to the observer and is ambiguous depending on the observer's bias. Although it is an established custom to model the perceived independent data on the abscissa of a graph, the ambiguity imposed by different practitioners will necessarily result in conflicts of opinion.

In common practice it is the known values that are usually modelled on the abscissa, with the unknown values being modelled on associated ordinates; whether the value of a particular quality is known or unknown changes from process to process. Consequently, a quality that is modelled on the abscissa in a process may be modelled on the ordinate in the converse process.

If modelling your data set on the abscissa makes sense to you, then don't feel bad about it.

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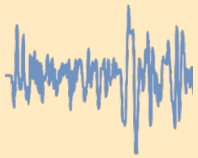
Simon, S., Steve's Attempt to Teach Statistics: Definition: Independent variable, Children's Mercy Hospitals & Clinics, http://myschoolonline.com/page/0,1871,2491-182599-2-56401,00.html, (Accessed Mar 01, 2005, no longer available online; however, Steve Simon currently maintains a web site where his work can be accessed at http://www.pmean.com/category/TeachingResources.html)

StatSoft, Inc. (2004). Electronic Statistics Textbook. Tulsa, OK http://www.statsoft.com/textbook/stathome.html, (Accessed Mar 01, 2005. No longer available online; however, you can access StatSoft online textbooks at http://www.statsoft.com/Textbook)



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(Accessed Mar 01, 2005, still available in 2019)

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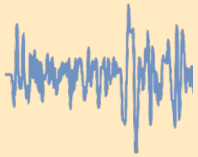

Resources & useful links

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
Australian Public Seismic Network	http://cqsrg.org/psn/stations/	Australian PSN seismometers
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