AMATEUR SEISMOLOGY

My venture into the world of seismology started prior to the Mt Barker earth-quake in 2010 when my recently constructed Lehman type horizontal sensor produced reasonable trace of the event.

******Mt Barker trace********

A day or so later I contacted the Seismology branch of PIRSA to report we felt the event and I had a trace from my recently constructed seismic sensor.
The head of PIRSA's seismology department is Dr. David Love who invited me to visit his workshops at Glenside, and at the same time put the public seismic network operators in touch with me via the e-mail. David also suggested I should consider constructing a vertical sensor as a vertical sensor would be an advantage to sense smaller events and obtain arrival times of events. Also I should consider an accurate time source, GPS is the source that is used generally by seismic stations.

Slide PIRSA display*

David also demonstrated the P.I.R.S.A. seismic network and how a comparison between sensors is an essential part of identifying and locate of events. David also advised that there were no seismic sensors in the South West of Adelaide and would be interested in results of my activities.
He also asked if I would like an e-mail advice from the system of events detected.
In the following days an exchange of e-mail occurred with Vic Dent from West Australia and Dale Hardy in N.S.W. resulting in the ordering of equipment from USA where there is a very large and active Public Seismic Network that has developed hardware and software of a very high standard at a reasonable price.
The amplifier and Analog to Digital cards and the GPS module and software arrived and was duly assembled, I also constructed a simple vertical sensor from drawings supplied by Dale.

****** Slide AS-1 Drawing ******

I constructed my AS-1 from steel that was on hand with the 1 inch square post welded to the base, the boom from 1"x1/8 steel, a round bar magnet glued to the boom that is positioned to move freely within the centre of a 240 volt contactor coil. Some-what different to the plans. Magnetic (eddy current) damping
The now 2 sensors and the electronics were installed on a concrete slab under the house where it was dry and out of the way. Seemed like a good idea at the time.

****Photo AS1****

A redundant Pentium 4 computer was loaded with the software and serial connection to the A-D card was installed. With assistance from Dale the software was configured with GIF images of the traces from the now 2 sensors being up-loaded to Dale's web site in NSW with my traces being placed adjacent to other traces from amateur seismic stations.

It was also suggested I should forward my data to Vic's site in Perth, however the file transfer protocol was a little more convoluted than the up-load of the GIF files.
I then realized that Vic's association with Regional Seismic Network was a little more than group of amateurs collecting seismic data, the RSN being part of the Australian Centre for Geomechanics, (A.C.G.) a consortium of CSIRO, University of W.A, Curtain University, with a number of schools and mine sites providing data to the site.
The A.C.G. has an association with mining companies (big mining companies) who are very sensitive to the association of seismic activity that is, or may, be induced by mining activity, in particular open cut mining. There are people who are convinced that some seismic events are mining induced.

My setup under the house while close to the computer was not a good seismic location, it became noticeable that the neighbors' back door slamming, us moving around in the house all created a lot of seismic noise, not to mention a stray cat bumping or investigating the slab.
This resulted in numerous "cat quakes" and "bug quakes" false alarms.
Then on Sunday morning 6th June, there was a genuine earth quake at Cleve, initially thought to be yet another "cat quake", the newly constructed AS1 vertical produced a magnificent trace of the event.

******* Cleve trace ****** 21:47:38 UTC 5/6/10

E-mails of congratulations came from many people, some I didn't know, about bagging my first quake after only being active for about a month. There were also requests for a copy of the recorded data files. A request for an image of the trace came from Kevin McCue in Canberra for a research project.

It became very evident that the site under the house was a far from satisfactory location for the seismic sensors, noise was a very significant problem, access to the sensors was difficult. I discussed the mater with Joan and the back of the shed seemed a reasonable compromise, a sketch was supplied that indicated that a 2 M deep 300 mm diameter hole, 1 M of cement, no aggregate (it makes noise), a smaller diameter riser isolated from the top 1 M of soil with a slab balanced on the top to be a bed for the sensors.

*****Photos Construction in shed******

It was then suggested I should obtain a 3 axis geophone for local events that generally produce higher frequency seismic signals as the ***AS1*** and ***Lehman*** are low frequency devices and the data from the geophone could be used to assist in the location of the origin of events. Second hand geophones are available from the PSN in the US but I also needed more input channels. More electronics and a geophone were obtained from the US and so the system expanded.

It was then suggested, I should "Register the Station" and obtain a "CALL SIGN", this had been researched by others and suggested that MPTV (abbreviation for Morphett Vale) be applied for from the registration organization in the U.K. and the web site

supplied in the e-mail. The process was started and about 3 weeks later advice came that MPTV was registered. At no cost!

The shift to the shed was made after more cables were run, the serial data run would now be just short of 50 Metres and I had tried extending the cable and it seemed to work OK but rise-times on the data were slowed significantly.
The other issue I have is the ABC, AM Transmitters site at Pimpala, earthing, bypassing and screening had to be given attention. The expanded system was installed in the shed and the system all worked.

I thought I had noise under the house, this new install, took about 4 weeks to become seismic quiet as the cement cured.
Teleseismic events (earth quakes with origins overseas) started to appear on the traces from the sensors with the ***AS1*** producing some impressive traces, some small local events also appeared.

At this point it is probably reasonable to look at what seismic sensors are required to detect. An example; a magnitude 3 event will produce ground movement within 100 metres from the event of 27 millimeters of vertical peak movement . At 300 km the motion is reduced to 0.04714 of a micron, at 600 km motion is 0.005339 of a micron.

*** Slide Table of motion***

A human hair has a diameter of nominally 0.02mm.

For some reason, this ***AS-1*** performs extremely well, all be it made from steel and not the non-ferrous material that is the accepted construction material for seismometers.

The performance of the AS1 apparently did not go un-noticed, the people in WA at RSN, became interested in taking data and requested remote access to the computer to install their software to collect data from the sensors, I had failed on several attempts to install and make operate the software.

With data now going both East and West all was well until a short power fail shut the computer down one night, it was not noticed by us for some hours, as the computer runs normally with the screen turned off, oops, a UPS was obtained and installed.

**** Slide change raw data****

At times it is difficult to determine seismic events from seismic noise or environmental noise, there is a M6.0 event hidden in the noise on this slide, digital filtering is amazing the manner noise can be filtered to reveal a very reasonable seismic event.

****Slide change filtered data****

This event was a M6.0 in Indonesia on 26/09/10 at 12:12:38 UTC 8 Km deep at position 5.314 S, 133.923E.

The main sources of noise I have is wind, particularly easterly gully winds, busses and trucks on States Road about 60 Meters to the west and the odd heavy vehicle that drives past in our street. There is also a nominal 10Hz signal that is continuous, I suspect from the water pipes .

Slide change USGS

It becomes very important to have advice of events, both local and over seas teleseismic events, this advice of events I receive in E-mails from the United States Geological Survey USGS. This advice is only an event has occurred at a time and location.

Primary Industries and Resources S. A.

Slide change PIRSA automation*

The PIRSA E-Mail advice is generated by their automation that detects an event and does the calculation to auto locate events, it sometimes gets the locations correct, other times it is less than accurate, particularly with some teleseismic events. It is still very good information with respect to arrival times of events at the various seismic stations.

***Slide change NZ event comparison ***

Christchurch New Zealand events were recorded by my sensors as well as other stations in the amateur seismic network, there is a phenomena that has been known to occur with earth quakes from New Zealand where multiple seismic wave fronts arrive with a significant delay.
This occurrence is thought to be caused by a fast seismic wave traveling through the earth's crust and a slower wave traveling through the water producing another seismic wave when it reaches the Australian coast. However it is my understanding the event in New Zealand probably needs to occur on the west coast to produce the rite conditions. This is one of the many research projects where data collected is valuable for research. As a result this slide is a comparison of my data for the 2 Christchurch events, the centre trace is from the event September 2010, the top trace has been filtered to look at low frequency content, while the bottom trace is of a broader bandwidth.

Slide photo overlooking Christchurch*

This photo was from an e-mail and was taken as the earth quake occurred, it is an indication of the energy expended by the event.

The Honshu Japan events;

****Slide change GIF of day before 9-3-11****

In hindsight, there were warnings as activity in that area started with a M7.2 on the 9th of March followed by 12, M5.0 or greater events over the following 9 hours, not visible on the GIF, the 18:27 event was a M6.0 off Honshu, the 21:33 event was a M6.6 in the New Britain region of P.N.G.
Just to confuse the system of prediction;

****Slide Change GIF of Bali Sea event****

This GIF is of the 24 hours of activity the day prior to the Honshu event. This Bali Sea event M6.2 occurred 17:08 took about 7 minutes to arrive in Adelaide.

****Slide change GIF of 11-3-11****

This GIF is an indication of the seismic activity that occurred on that day associated with the Honshu Japan event.

****Slide change Honshu event***

The very large Honshu Japan event Magnitude 8.9 that occurred 11/3/11 at 05:46:24 UTC took 11minues 31 seconds to arrive at Adelaide and my instruments.

****Slide change Honshu event with following events****

This trace is an expansion of the time line of the previous slide, numerous events that followed the main M8.9 event at 0557, 0617 a M6.4, 0618 a M6.4, 0626 a M6.8, 0636 a M7.1 on the right-hand side.

****Slide change animation of energy by the events****

This back projection animation of the event is a compressed time animation of the energy dissipated by the events that occurred off the coast of Honshu Island Japan. The seismic activity has continued and this animation was produced only days after the main earth quake and certainly graphically depicts the enormous energy that was released

****Slide change graphic and text *****

END, Questions.