

## Near surface passive seismic surveying for mineral exploration, environmental and engineering applications: Notes on the 2016 ASEG-AIG-PESA conference workshop

A one day workshop on 'Near surface passive seismic surveying for mineral exploration, environmental and engineering applications' was presented on the Saturday before the 2016 ASEG-AIG-PESA conference and was organised by Jayson Meyers and Chris Wijns. Despite a low conference turn-out the workshop was well attended with 50 participants from the minerals industry, academia and government, 13 of whom were presenters.

A small but growing number of geophysicists and geologists are starting to use near surface passive seismic methods for regolith and sedimentary cover mapping, either as a stand-alone survey method or in conjunction with other classical geophysical survey methods such as gravity, magnetics, EM, ERT, GPR and seismic reflection/refraction. While passive seismic surveying has been around for a long time, it has mainly been the subject of research and has only been utilised on a large scale by seismologists interested in earthquake hazard mapping. Passive seismic surveying is now starting to gain traction as a practical geophysical exploration method because the advantages of the technique are becoming increasingly apparent. Surveys can be done quickly using a single seismometer instrument or small array of seismometers, there is no need for an active seismic source, depth calibration can be easily and reliably done by taking readings at drillholes that intersect acoustic basement, the data are simple to process, and results can be quite robust. Despite these advantages there is still a lot of uncertainty and scepticism amongst geoscientists concerning the reliability of various passive seismic methods and their results. The workshop was designed to address some of these concerns.

The keynote address was given by Professor Michael Asten from Monash University, who has been a pioneer of shallow passive seismic research since the mid-1970s and has continued to be a leader in this field (Figure 1). He shared his global experience on passive seismic theory and methods, mainly Spectral Analysis of Surface Waves (SPAC) and Horizontal to Vertical Spectral Ratio

(HVSr) methods, showing key examples of the different types of survey systems, acquisition methods, ground responses, and data processing and modelling results; some of this from calibration test sites. This address set the stage for the remainder of the workshop.

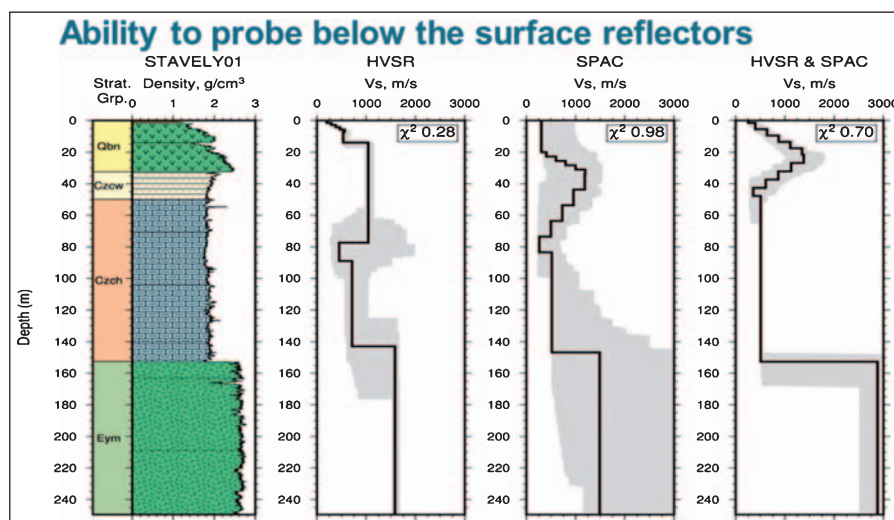
Jeremy Magnon from Moho SRL presented the basics of seismic theory, focussing on the vertically incident Sh-wave motions that produce the HVSr signal for detecting the thickness and S-wave velocity of poorly indurated sedimentary deposits and regolith overburden sitting above hard bedrock, where a strong acoustic

impedance contrast can be detected as a peak frequency. Moho developed the 'Tromino' seismometer, which has been miniaturised into a self-contained instrument that is becoming widely used for rapid geological and engineering sub-surface mapping applications.

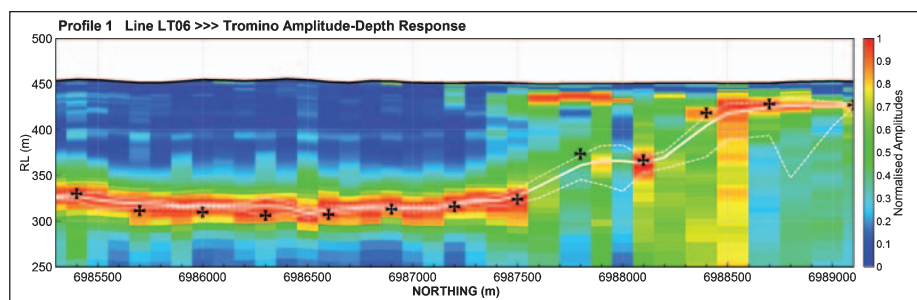
Nick Smith from PassiveX and Alexi Gorbato from GA both gave presentations on passive seismic theory and research at mineral exploration sites, where they used very sensitive seismometers in arrays for collecting SPAC and HVSr data. The data were used for determining velocity vs depth structure of geological layers in the



**Figure 1.** Michael Asten from Monash University presenting the keynote address at the shallow passive seismic workshop.



**Figure 2.** Passive seismic inversion results carried out on SPAC and HVSr data sets, and combined inversion results, compared to geological and density logs from a diamond drillhole (from Gorbato, Czarnota and Buckerfield, Geoscience Australia).



**Figure 3.** HVSR passive seismic cross-section showing high amplitude bedrock response (hot colours) defining the base of a palaeochannel sitting below a broad salt lake playa in WA, with depth estimations from a drillhole calibration equation (while line with dashed error bars) and 1D modelling results (black Xs); also note the lower amplitude horizons caused by calcrete layers within the channel deposit sequence (from Owers and Meyers, Resource Potentials).

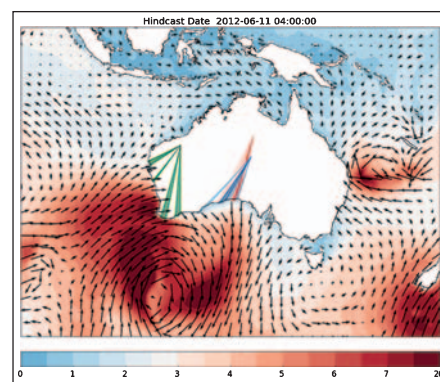
regolith, extending into the underlying hard rock layers by direct estimation and inversion methods (see Figure 2 for example).

Several industry presenters and one presenter from the GSWA then showed case histories of predominantly HVSR survey results from different types of geological, regolith and mineral deposit settings, where passive seismic results were also compared to drilling data and results from other geophysical survey methods. The HVSR method was clearly shown to be a valuable mapping tool for detecting thickness of cover and regolith, and for mapping some layering within the regolith where there is a sufficient acoustic impedance contrast. Passive seismic survey results were shown for layer thickness and velocity mapping in the following geological settings: Kalahari cover in Southern Africa, loess thickness in northern China, laterite and saprolite in Australia, palaeochannels in Australia for sulphate of potash brines (Figures 3 and 4), alluvial gold, calcrete uranium and channel iron deposits,

ironsand deposits in New Zealand, tundra and glacial cover thickness in Canada, mining waste dump and tailings dam embankments in Australia, and shallow intra-cratonic basin mapping in Australia. Other direct detection applications were also shown for: cementation zones and unconformities for sedimentary uranium deposits, detecting tops of high density ore bodies surrounded by host rocks with no HVSR response due to broad gradients in velocity and density, and using cover mapping results to remove the regolith anomaly response from gravity data.

Anya Reading presented research results obtained by her and her students at UTAS using 'big data' sets and high power computing to study how ocean storms that impact coastal areas generate microseisms that propagate across the Australian continent and contribute to the passive or ambient source signal (Figure 5).

The workshop finished off with a panel discussion, where Michael Asten, Anya Reading, Jeremy Magnon, Nick



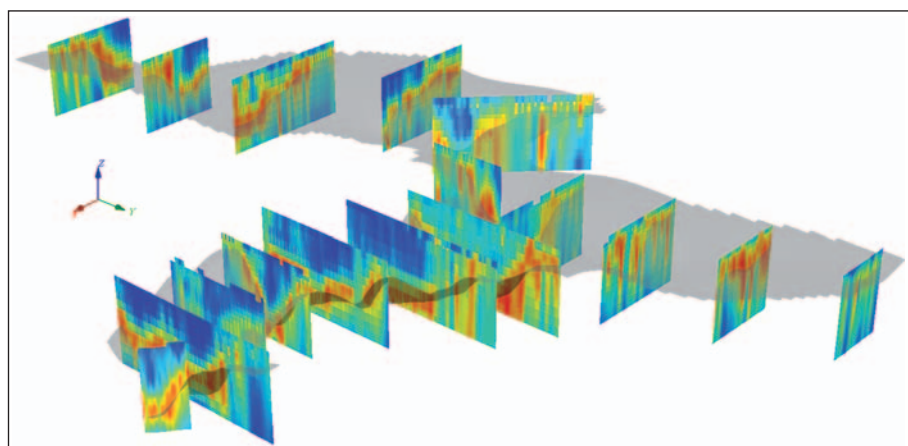
**Figure 5.** Passive seismic source vectors within the Australian continent from seismometer array data recorded well within the continent compared to coincident storm events impacting the Australian coastline. The results indicate that far-field storm wave and wind action along the coastline contributes to the microseismic signal for passive seismic surveying over a thousand kilometres inland (from Reading, Gal and others, University of Tasmania).

Smith and Alexi Gorbatov addressed fundamental questions posed by Chris and Jayson, and then fielded questions from the rest of the workshop participants.

Thanks to ASEG Webmaster David Annetts, the presentation PDF files from the workshop are freely available at: <https://www.aseg.org.au/workshop-proceedings>.

There was a 'buzz' going around the conference following the shallow passive seismic workshop and presentations given during the conference sessions, indicating that interest in this method will continue to grow. For those who could not attend the Adelaide conference and workshop, a similar shallow passive seismic workshop is being organised through the Australian Institute of Geoscientists (AIG) to be held in Perth on 2 May this year. For more information about this workshop, please contact the authors of this article or visit the AIG website at [www.aig.org.au](http://www.aig.org.au).

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**Figure 4.** 3D fence diagram of HVSR passive seismic cross-sections and a base of palaeochannel surface generated from the cross-sections (from Owers and Meyers, Resource Potentials).



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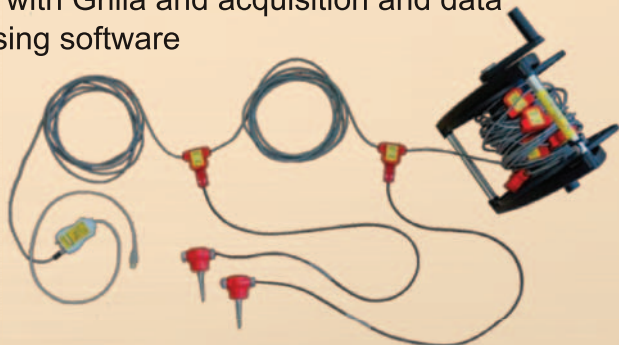
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## AEGC 2018: update from the Conference Organising Committee



The conference organisation is progressing well. The conference webpage is up and running (<http://www.aegc2018.com.au/>), and the venue has been confirmed (<http://www.iccsydney.com.au/>). The Sponsorship and Exhibition Prospectus has been released (<http://www.aegc2018.com.au/sponsorship-and-exhibition.php>) and we already have some confirmed sponsors and exhibitors.

The technical committee has been talking with prospective keynote speakers and discussing the technical programme. The focus of the conference will be exploration and the technical programme will have three overarching themes:

- Energy
- Mineral Geoscience
- Near Surface and Groundwater

Each of the main themes has five sub-themes, which will result in an exciting and dynamic technical programme:

### Energy

- Case Histories
- Petroleum Conventional
- Petroleum Non-conventional
- Coal
- Renewables

Table 1. AEGC Conference fees

Category	Early	Standard	Late
Member Full <sup>A</sup>	\$900	\$1100	\$1300
Non Member Full	\$1150	\$1350	\$1550
Member Retired <sup>B</sup>	\$550	\$750	\$950
Student <sup>B</sup>	\$150	\$150	\$150
Member Day	N/A	\$495	\$695
Non Member Day	N/A	\$645	\$845
Welcome Reception (guests)	\$85	\$85	\$85
Dinner	\$130	\$130	\$130

<sup>A</sup>Members of The Australian Society of Exploration Geophysicists (ASEG), The Petroleum Exploration Society of Australia (PESA) and the Australian Institute of Geoscientists (AIG).

<sup>B</sup>Retired and Student Members must provide confirmation from the associated society.

### Mineral Geoscience

- Case Histories
- Geology, Geochemistry, Geophysics
- Ore genesis
- New Technologies
- Strategic and Industrial

### Near Surface and Groundwater

- Case Histories
- Groundwater
- Environmental
- Geotechnical
- Archaeology and Forensics

Confirmed keynote speakers are:

Peter Baillie, CGG  
Katarina David, University of New South Wales  
Natasha Hendrick, Santos  
Kevin Hill, Oilsearch  
Jim Macnae, RMIT  
Graham Heinson, University of Adelaide

The **call for Abstracts is now open**, you can find the abstract template and submission portal on the conference website (<http://www.aegc2018.com.au/call-for-abstracts.php>), please do not forget to submit your 250 word initial abstract.

Registration for the conference will be available from late May 2017. The table above outlines the fees. Early bird registration closes 31 October 2017, standard registration closes 18 January 2018. The prices for conference registration (see Table 1) are in AU\$ and include GST.

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## First call for nominations for the 2017–18 ASEG Honours and awards



**To be presented in conjunction with the AEGC, 18–21 February 2018, Sydney, Australia.**

**Award categories requiring nominations from ASEG Members prior to the conference include:**

- Outstanding contributions to the geophysical profession
- Outstanding contributions and service to the ASEG
- Recognition of innovative technological developments
- Promotion of geophysics to the wider community

- Significant achievements by younger ASEG members

Lists of previous awardees, award criteria and nomination guidelines can be found on the ASEG website at <https://aseg.org.au/honours-and-awards>.

For further information, preliminary expressions of potential nominations, and submission of nominations, please contact:

Andrew Mutton  
ASEG Honours and Awards Committee Chair  
[awards@aseg.org.au](mailto:awards@aseg.org.au)



# CALL FOR ABSTRACTS IS NOW OPEN

## AEGC 2018

### FIRST AUSTRALASIAN EXPLORATION GEOSCIENCE CONFERENCE

18-21 FEBRUARY 2018 | SYDNEY AUSTRALIA **EXPLORATION • INNOVATION • INTEGRATION**

**W**e would like to invite you to join us at the First Australasian Exploration Geoscience Conference to be held in Sydney, Australia from 18-21 February 2018.

This Conference is jointly hosted by the Australian Society of Exploration Geophysicists, the Australian Institute of Geoscientists and the Petroleum Exploration Society of Australia and incorporates the 26th ASEG-PESA Geophysical Conference and Exhibition and the Eastern Australian Basin Symposium and will be home to the highest quality technical program with a focus on exploration.

The Conference will bring together geoscientists involved in energy exploration and exploitation and also exploration and mining of metals and industrial mineral as well as near surface and groundwater exploration. We expect a large number of delegates from Australia, New Zealand, and our Asia Pacific neighbours.

The theme of the conference is "Exploration, Innovation, Integration" emphasising that innovation and integration are critical in exploration for commodities. The technical program will be based around three overarching themes of Energy, Mineral Geoscience, Near Surface and Groundwater. The themes highlight the diverse nature of geoscience research and we invite you to join us in making this the highest quality program possible.

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Society of Australia

For further information on themes and subjects  
please visit <http://www.aegc2018.com.au/>

*Mark Lackie and Max Williamson*  
Co-Chairs, First Australasian Exploration Geoscience Conference



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