10.1071/PVv2014n172ASEGnews

The ASEG in a changing world

Nola and I are back from Iceland and I thoroughly recommend the country as a fascinating place to visit. Walking across the fractures of the mid-Atlantic Ridge, descending into an evacuated magma chamber, seeing the immensity of the glaciers – it all added up to an epic trip. The recent eruptions seem even more spectacular now that we have been there. The massive volcanic fields and recent rifts show how the earth is ever changing and will evolve eventually into something very different to what we see today. All this volcanic activity made me sit back and think hard about where the ASEG is going as a society. Are we an anachronism to be 'subducted' and will a new structure or organisation take our place? I hope not, but if the Society is to continue to prosper it must change in an ever changing world.

Every Member of the ASEG Federal executive is cognisant of the Society's objects, as set out in the Society's constitution. I would also encourage you to read the constitution. You will find it at: https://aseg.org.au/images/pages/ASEG%20Constitution%20and%20By%20Laws%20April%202014.pdf.

The constitution states that the ASEG is a learned society and its objects are:

> *... the promotion and advancement of geophysical sciences, especially the knowledge, and its application and continuous professional education, in the areas of exploration geophysics and related sciences.*

Are these objects still relevant? As we are all too well aware, the world is a very different place to what it was when the Society was formed more than 40 years ago. How will new technology and changing paradigms impact on our Society? How will we deliver on our objects in the future?

At the most basic level I am concerned that the future of geophysics is being damaged by a gradual decline in education standards, particularly in science. I find the increasing focus on environmental science over the basic sciences of physics, chemistry, geology and biology particularly worrying. I remember Lazlo Kevi a GSWA geophysicist saying to me that 'the only true science is physics; the rest are merely stamp collecting' but, it would seem that physics is the biggest loser in schools today. I have nothing against environmental science, but I find that too many graduates in environmental science lack basic training in scientific principles as well as in the basic sciences of physics and chemistry. There also appears to be a trend in environmental science towards adopting off-the-shelf solutions rather than towards designing solutions that are a thoughtful response to a problem that has been carefully characterised. I can illustrate the wasteful consequences of off-the-shelf solutions from my personal experience. Environmental scientists thought that planting more trees would fix dryland salinity and planted more trees without a proper understanding of landscape processes in individual catchments. The 'billion trees' program was a failure because trees were not planted in the right places. I understand the tree that Bob Hawke planted died.

How can we as a Society deal with a world where 'scientists' are focused on quick fixes and rush to implement off-the-shelf solutions? Do we sit on our hands or should we get involved? I believe that we should get involved and that we should promote good secondary education. Can we generate an enthusiasm about geophysics in secondary teachers? Adrian Noetzli, a former teacher himself, is planning a workshop for secondary teachers as part of the next ASEG–PESA Conference. It is clear that I am not alone in my concern for the future of our profession because every geophysicist I have asked to present at this workshop has given an instant YES. It would be great to replicate the workshop in other states or to deliver it online.

The lack of understanding of science at secondary level has flowed through to universities. Students are flocking to subjects that promote quick fixes without getting the basic training in science that they will need to properly understand and define the problems they will face in the real world. In addition, changes in the way that universities are funded have seen a decline in the numbers of geophysical staff. In some universities lecturers are merely part time teachers, and in others geoscience is taught with minimal or no geophysical input. I do wonder how useful geologists can be to exploration companies if they have no understanding of geophysics.

The old paradigm that universities were the repository of knowledge and their role was to carry out research and disseminate new ideas no longer applies. Students no longer go to university to 'read' in the classical sense, but to be taught and university staff numbers have been cut in geophysics to the point where academic staff have little time outside their teaching duties to carry out research.

Another issue facing the ASEG is the future of communication technology. From the outset our priorities have been publishing a technical journal (*Exploration Geophysics*), running conferences and publishing a newsletter (*Preview*). Older members like me still prefer hardcopy, but we must move forward. There are good reasons for abandoning the printed medium and moving towards on-line publication. The move will allow us to get copy out to members faster and cheaper. I believe it will also eventually allow us to include more diverse media in our communications to members. For example, we could include video or 3D content in an on-line publication. Printing of colour pages is also an issue for *Exploration Geophysics* contributors and, as a contributor who has just received an invoice of $1000 for colour pages, I believe that contributing to the cost of colour printing may be a significant hurdle for intending authors. We could also consider promoting e-conferences and e-workshops.

Standing in a rift in the mid-Atlantic Ridge in Iceland.

That brings me to a personal observation on the way the ASEG Federal Executive runs. As a group of volunteers we do not have enough time to deal with all the issues facing our Society. There's not enough time for the Federal Executive to focus on strategy, whilst managing core business, whilst struggling to excite and attract the next generation of members and enticing existing ones to stay. So, how do we make sure the ASEG is prepared to meet this and the many other challenges ahead? How do we make our society ready for the future?

We are interested in your views. We will be asking the members to give us feedback on what we should be doing. This may be a survey on-line or it may be a paper survey handed out at the conference. Please participate because we want to hear what you want. Tell us what the ASEG does well and what it does not do so well. If you have any concerns please tell us what is wrong and obviously avoid giving us a solution without defining the problem. The Society is yours as much as ours.

A further concern in geophysics is the move away from larger geophysics departments in large mining houses and government. These departments used to be places where young geophysicists could be mentored and educated into the exploration industry. This role is now taken up by consulting groups but only a small number are large enough to carry a junior workforce. Cost cutting at CSIRO has left so few geophysicists, one wonders if they can be really effective in research. This situation is compounded by cost recovery which forces CSIRO to compete for projects with the private sector.

The latest round of retrenchments at Geoscience Australia has left the organisation with no geophysicists in senior management positions. Can GA be truly effective without senior geophysicists in these times when geophysics is integral to understanding the Australian continent? The situation reminds me of my welcome interview with Alec Trendall when I joined the Geological Survey of Western Australia. The first thing he said was 'Welcome Greg, but we are a Geological Survey and frankly I don't know why we need a geophysicist.' I spent the next 5 years with little to no budget trying to show what geophysics could do for geologists. In that time we flew the first airborne geophysical survey, developed a database of surveys and pushed geophysics into regional geological mapping programs. The efforts of the geophysicists that followed me did dramatically change the Survey such that geophysics expenditure is a now major item in the GSWA annual budget. Is geophysics not one of the major expenditure items in the GA budget? If so, how can GA manage without geophysicists in senior management positions?

If the decline of geophysicists in our research and training organisations continues, then the ASEG will have an important role to play in fostering education and research in geophysical sciences. Perhaps this has always been the case in exploration geophysics because exploration has always about research but, an increasing emphasis on this role will require more resources so that we can develop more effective tools for disseminating and storing knowledge and information. The Society is taking over some of the roles previously held by universities, CSIRO and GA, without the resources and funding that these organisations had in the past. We are an organisation largely run by volunteers who contribute their own time and resources. We need more involvement. We need more members. We need you to get involved in some way if our profession is to grow and, if the Society is going to serve you well, then you need to be part of it. This can be in the smallest way by providing feedback and ideas or greater ways by taking up positions on standing committees, state branches, forming specialist groups or volunteering for the federal executive where strategies are developed. In particular we are looking for people on the education committee and as associate editors for *Exploration Geophysics*. Think about how you can help your profession. It all helps you in the end.

Our profession is expanding and contracting like the earth. New rifts appear, new ideas are formulated, while we move forward in an ever changing world.

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ASEG President
president@aseg.org.au

ASEG Federal Executive 2014–15

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Welcome to new members

The ASEG extends a warm welcome to the following thirty nine new Members. Their membership was approved at Federal Executive meetings in July and August 2014.

Name	Affiliation	State/Country	Grade
George Bernardel	Geoscience Australia	ACT	Active
David Caust	Geoscience Australia	ACT	Active
Dylan Cremasco	Santos	SA	Active
Victoria Gallagher	Santos	QLD	Active
Michael Hartley	CGG	VIC	Active
Josef Holzschuh	Geoscience Australia	ACT	Active
Ashley Howlett	Talisman Energy	QLD	Active
Ross Kleinschmidt	Radiation & Nuclear Sciences, Qld Dept of Health	QLD	Active
Ben Lewis	Geoscience Australia	ACT	Active
Sonia Maunder		QLD	Active
Sarlae McAlpine	Geoscience Australia	ACT	Active
Edith Miller	Chevron	WA	Active
Rory Murray	Fortescue Metals Group Ltd	VIC	Active
Nathan Palmer	Central Petroleum	QLD	Active
Jingbo Wang	Geoscience Australia	ACT	Active
Robert Howard	Case Consulting Pty Ltd	SA	Active
Noori Alavi		WA	Associate
Cameron Mitchell	Geoscience Australia	ACT	Associate
Robbie Morris	Geoscience Australia	ACT	Associate
Alastair Smart	Omnitron Technologies	VIC	Associate
Marcus Haynes	Geoscience Australia	NSW	Associate
Nicholas Badullovich	Australian National University	ACT	Student
Summer Barron	Macquarie University	NSW	Student
Andrey Budniy	Curtin University	WA	Student
Sarah Chamberlain	Curtin University	WA	Student
James Deeks	University of Western Australia	WA	Student
Andy Do	Macquarie University	NSW	Student
Michael Drane	Macquarie University	NSW	Student
Sarah Jayne Evans	Macquarie University	NSW	Student
Sanjay Govindan	Australian National University	NSW	Student
Madeleine Hearnden	Australian National University	ACT	Student
Samuel Henman	Macquarie University	NSW	Student
Anam Mazhar	University of Western Australia	WA	Student
Jarrod McDonald	Macquarie University	NSW	Student
Jack Muir	Australian National University	ACT	Student
Kate Robertson	University of Adelaide	SA	Student
Paul Ssali	Curtin University	WA	Student
Benjamin Stepin	Curtin University	WA	Student
Alexandrea Tuckett	Macquarie University	NSW	Student

New South Wales

In July, we held our annual dinner. Once again, it was held in a steakhouse; we ate lots of steak, drank lots of red, and discussed lots of geophysical and non-geophysical topics. We had a good turnout and a great time was had by all.

In August, **James Austin** from the CSIRO (Mineral Resources) gave a talk entitled 'Lightening, Diesel and Dust: Remanent Magnetism and the Search for Magmatic Nickel Sulphides in Central Australia'. James discussed the magnetic characteristics of the Giles Complex and how they are not fully understood. James then outlined his investigation of the magnetic properties of magmatic nickel sulphide systems and the complexities and problems in trying to understand them. Many questions about the science and the logistics of working in the Musgraves were asked.

An invitation to attend NSW Branch meetings is extended to interstate and international visitors who happen to be in town at the time. Meetings are held on the third Wednesday of each month from 5:30 pm at the Rugby Club in the Sydney CBD. Meeting notices, addresses and relevant contact details can be found at the NSW Branch website (aseg.org.au/nsw/).

Mark Lackie
(NSW Branch President)

Queensland

The Queensland Branch of the ASEG has had quite a social winter in Brisbane. We had the annual Zoeppritz night in July, which started modestly and gathered momentum as the night went on. We also enjoyed a joint ASEG–PESA trivia night in August. Both of these events were well attended by students from our local universities!

We also hosted our most attended event this year to date, with **Dave Hale** presenting his SEG DL '3D seismic image processing for interpretation of faults and horizons'. Dave's enthusiasm was contagious and there were many in the audience bursting with questions at the conclusion of his presentation.

Dave Hale presenting to the Queensland Branch of the ASEG. Note the XXXX beer on hand!

We are getting increasing interest from students attending the local branch meetings and to encourage continuing involvement we have sponsored five students to attend the **Brian Minty** OzSTEP course in September.

We invite any member who is visiting Brisbane to attend our technical meetings and we would welcome offers for technical presentations!

Fiona Duncan
(QLD Branch President)

South Australia and Northern Territory

Since the last edition of Preview, the SA Branch has hosted the annual SEG distinguished lecture. **Dave Hale**, from the Colorado School of Mines, had his audience strongly considering brushing up on their programming skills, with his talk '3D seismic image processing for interpretation of faults and horizons'.

Our annual wine tasting has been run and won. Details of the winning wines can be seen on the order form in this edition of *Preview*. As ever, we think this year's choices are worthy winners, and highlight the diversity and strength of some of SA's lesser-known wineries. Getting an invitation to the Wine Tasting event is quite easy – all you have to do is help out the local ASEG branch; become a sponsor, join the committee, or present a talk at one of our technical nights.

Speaking of sponsors, all of these events are made possible by our very generous group of sponsors for 2014, including Beach Energy, the Department of State Development, Geokinetics, Ikon Science, Minotaur Exploration, Petrosys, Santos, Schlumberger, Statoil and Zonge.

Upcoming events include our annual Industry Night, to be held in late October, and the SEG Near Surface Lecture, by **Dr Koichi Hayashi** whose talk 'Integrated geophysical methods applied to geotechnical and geohazard engineering: From qualitative to quantitative analysis and interpretation' will be held on the evening of Tuesday 7 October, at the Coopers Alehouse.

The Melbourne Cup Luncheon will be held on 4 November at the National Wine Centre, and promises to be another great day. Thanks to Beach for their ongoing exclusive sponsorship.

As ever, new members and other interested persons are always welcome to local events. For further details, please contact Luke at luke.gardiner@beachenergy.com.au or 8338 2833.

Luke Gardiner
(SA and NT Branch President)

Tasmania

The Tasmanian branch is looking forward to hosting the following events in late September and early October:

- **Brian Minty**'s OzSTEP one day course on radiometrics (30 September, CODES Conference Room, University of Tasmania)
- 2014 SEG Near Surface Honorary Lecturer **Koichi Hayashi** (12 noon, 6 October, same venue).

The Branch is also looking forward to a number of honours student presentations towards the end of the year.

Mark Duffett
(Tasmanian Branch President)

Victoria

On Wednesday 6 August the ASEG Victoria Branch enjoyed the *Annual Joint ASEG–PESA–SPE Mid-Winter Social*. As always a good time was had by all!

On Thursday 7 August we were lucky enough to host the SEG 2014 Distinguished Lecture: '3D seismic image processing for interpretation of faults and horizons', presented by **Dave Hale** from Colorado School of Mines. This was a lunch meeting at the Victoria Hotel and a great turn-out ensured many questions following Dave's excellent presentation.

On Thursday 18 September we hosted an ASEG Victoria branch technical evening with 'New developments in airborne gamma-ray spectrometry' presented by **Brian Minty** from Minty Geophysics. The evening meeting was held at the Kelvin Club, and a good sized crowd enjoyed the drinks, nibbles and Brian's well-crafted presentation.

For members who wanted to learn even more about radiometric methods, the opportunity came about the very next day (Friday 19 September) when we hosted the ASEG 2014 OzStep one-day course 'The Gamma-ray Spectrometric Method for Mineral Exploration and

Environmental Mapping', also presented by Brian Minty.

On Wednesday 8 October we will host an evening technical meeting with the SEG 2014 Near Surface Honorary Lecture: 'Integrated Geophysical Methods Applied to Geotechnical and Geohazard Engineering: From Qualitative to Quantitative Analysis and Interpretation', by **Koichi Hayashi** from Geometrics; and on Thursday 23 October we will have the Annual Student Night, where local geoscience students will be presenting their current research. Both meetings will be held at the Kelvin Club, Melbourne Place, off Russell Street in Melbourne's CBD.

We look forward to seeing many ASEG Victoria Branch members at the meetings in the coming months.

Asbjorn Norlund Christensen (Victorian Branch President)

Western Australia

The WA branch of ASEG has had another round of exciting activity during the first quarter of the new Financial Year.

On the 9 July **Dr Rie Kamei**, Assistant Professor at University of Western Australia, delivered an impressive talk on 'Applications of seismic full waveform inversion'. Dr Kamei briefly reviewed the fundamentals of Full Waveform Inversion (FWI) and illustrated the power of FWI with field examples from a variety of applications.

On 21 July the WA branches of ASEG and AIG participated in the annual Hale School/St Mary's Careers Expo. The night was well attended with exhibitors from local universities and various sectors including finance, hospitality, medicine, real estate, law, health, police and GEOSCIENCE! This year marked our third year at the event and although it was a stormy night, many students benefited from the displays and advice given by the exhibitors. We look forward to an ongoing presence at career events like these, which give us the opportunity to encourage students to study math and science! A total of 75 students and staff attended this Careers Expo.

We hosted **Dr Dave Hale**, Green Professor of Exploration Geophysics at the Colorado School of Mines, as Distinguished Lecturer in one of our regular monthly tech-nights on 12 August. The title of his talk, sponsored by CGG, was '3D seismic image processing for interpretation of faults and horizons'. The talk was attended by over 75 people.

*ASEG WA committee member **Javad Khoshnavaz** manning the ASEG-WA Stall at the Careers Expo.*

Another exciting event was the One-Day Workshop on Geophysical Inversion for Mineral Explorers. More details on this event are presented separately within this edition of *Preview*.

John Joseph on behalf of Kathlene Oliver (WA Branch President)

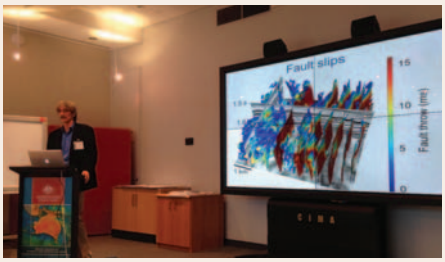
David Hale presenting to the WA branch of the ASEG. Note no beer anywhere within reach.

A large number of geoscientists/explorers attended David Hale's presentation to the WA branch.

Australian Capital Territory

The ACT branch of the ASEG ran a Geo-societies Student afternoon on 18 August at Geoscience Australia. Members of geo-societies spoke about the value of their society to their professional career and how the geo-societies expertise is inter-related. **Millie Crowe** represented the Australian Society of Exploration Geophysicists (ASEG), **Lisa Hall** represented the Petroleum Exploration Society of Australia (PESA), **Emma Mathews** represented the Geological Society of Australia (GSA), **Gabby Yates** represented the International Association of Hydrogeologists (IAH), **Jon Clarke** represented the Mars Society Australia (MSA), **Ian Roach** represented the Australian Regolith Geoscientists Association Inc. (ARGA), and **Paul Kay** represented The Australasian Institute of Mining and Metallurgy (AusIMM). Students were also given a tour of the Australian Tsunami Warning System and afternoon tea, kindly co-funded by PESA. The Geo-societies Student afternoon was a great success – special thanks to **Tegan Smith** (PESA) for MC-ing at short notice and **Millie Crowe** for speaking about the (ASEG) and for her help on the day. Approximately 30 students from the Australian National University and the University of Canberra attended the afternoon.

The 2014 Fall SEG/AAPG Distinguished Lecturer **Dr David Hale** visited on 5 August, his presentation '3D seismic image processing for interpretation of faults and horizons was engagingly presented to nearly 40 people. Dr Hale spoke about new software he is developing that highlights faults in 3D seismic data volumes. This generated a lot of positive discussion days after his talk.



David Hale presenting a faultless talk to the ACT Branch of the ASEG. Note no beer in the ACT either.

Dr Brian Minty kicked off his day long OZstep course in the ACT on 12 September with 16 attending his course:

'The Gamma-Ray Spectrometric Method for Mineral Exploration and Environmental Mapping'**.** The course offered a valuable insight into the elements of radiometric mapping that affect the interpretability of geophysical data. Brian's knowledge of this topic is second to none and no question was too easy or too hard to elicit a thoughtful answer.

Dr Brian Minty and OzSTEP participants from the Geological Survey of India, Geoscience Australia and ANU.

Sunday 14 September saw another Social Event with members and their families meeting at the National Arboretum Canberra. The Pod Playground proved a hit and I was reliably informed the coffee was great too. The tourist attraction is a must see when in Canberra, with a lovely café and fine dining – for more details see http://www.nationalarboretum.act.gov.au.

ASEG (ACT) SEG Special Lecturer; **Koichi Hayashi** will be speaking on Friday 3 October his talk: 'Integrated geophysical methods applied to geotechnical and geohazard engineering: From qualitative to quantitative analysis and interpretation', will start at 12:30, lunch will be provided for members from 12 noon.

In addition to all the other events and training our members have been busy writing abstracts for posters and oral presentations for the upcoming ASEG–PESA 2015 conference. A special thanks to **Chris Wijns**, **Mike Dentith** and the Conference Secretariat at EECW – the event coordinators, for their help.

Marina Costelloe
(ACT Branch President)
Millie Crowe
(ACT Branch Secretary)

Snapshots from the ACT ASEG Social Event at the National Arboretum in Canberra

Ned Stolz. Note beer in hand.

Bill Jones, Ross Costelloe, Carina Kemp and Phil Wynne.

Ted and Penny Lilley.

Harry Costelloe, Millie Crowe, Attilia Jones and Helena Jones.

Carina and Esmé Kemp.

Leonie Jones, Mille Crowe and Attilia Jones.

ASEG calendar: technical meetings, courses and events

Date	Branch	Event	Presenter	Time	Venue
2014					
15 Oct	NSW	Honours and Masters Students Research Presentations	Various	1800–1900	The Rugby Club, Off 31 Pitt Street, Sydney
20–24 Oct	WA	CET hosted short course on Magnetotellurics	Prof Alan Jones, Dublin Insitute of Advanced Studies		University of Western Australia, Crawley, Perth
19 Nov	NSW	Technical Presentation: Sub-bottom resistivity profiling	Jason Errey	1800–1900	The Rugby Club, Off 31 Pitt Street, Sydney
23 Nov	VIC	Annual Student Night	Various	1800–2000	The Kelvin Club, 24-30 Melbourne Place, Melbourne
04 Nov	SA	Melbourne Cup Luncheon		1200–1630	National Wine Centre, Adelaide
07 Nov	WA	ASEG-PESA WA 27th Annual Golf Classic			TBA
13 Nov	WA	Honours and Masters Students Research Presentations	Various	1730–1930	City West, Function Centre, Perth
Late Nov	SA	Student Honours Night	Various	1730–1930	Coopers Alehouse, Hurtle Sq, Adelaide
10 Dec	WA	WA Christmas Party and AGM		1730 till late	TBA

2014 SEG Honorary Lecturer Near Surface: 'Integrated geophysical methods applied to geotechnical and geohazard engineering: From qualitative to quantitative analysis and interpretation' Koichi Hayashi, Geometrics, San Jose, California. (http://www.seg.org/education/lectures-courses/honorary-lecturers/2014/hayashi/abstract)

Date	State Branch	Time	Venue
01 Oct	NSW	1730–1900	The Rugby Club, Off 31 Pitt Street,Sydney
03 Oct	ACT	1230–1400	Geoscience Australia, Canberra (Lunch at 1200)
06 Oct	TAS	1200–1300	CODES Conference Room, University of Tasmania, Hobart
07 Oct	SA	1730–1930	Coopers Alehouse, Hurtle Sq, Adelaide
08 Oct	VIC	1800–2000	The Kelvin Club, 24–30 Melbourne Place, Melbourne
10 Oct	WA	1730–1900	City West Function Centre, Perth
13 Oct	QLD	1730–1900	Metropolitan Motor Inn, Spring Hill, Brisbane

2014 OzSTEP: 'Interpreting Seismic Amplitudes' Dr Dennis Cooke, University of Adelaide, Australian School of Petroleum. (www.aseg.org.au)

Date	State Branch	Time	Venue
25 Nov	QLD	0830–1700	Watermark Hotel, 551 Wickham Terrace, Spring Hill

TBA, to be advised (please contact your state branch secretary for more information).

NOMINATIONS CLOSING SOON!

Nominate a colleague for an ASEG Honour or Award for 2014–15

The ASEG acknowledges the outstanding contributions of its individual members both to the profession of geophysics and to the ASEG, through the presentation of the Society's Honours and Awards across a range of categories. The next Awards are scheduled to be presented at the ASEG–PESA 24th International Geophysical Conference and Exhibition 15–18 February 2015 in Perth, WA.

The ASEG awards are made through nominations from the membership at large, as well as through State and Federal executives. The available awards are:

ASEG Gold Medal

For exceptional and highly significant distinguished contributions to the science and practice of geophysics, resulting in wide recognition within the geoscientific community.

Honorary Membership

For distinguished contributions by a member to the profession of exploration geophysics and to the ASEG over many years.

Grahame Sands Award

For innovation in applied geophysics through a significant practical development in the field of instrumentation, data acquisition, interpretation or theory.

Lindsay Ingall Memorial Award

For the promotion of geophysics to the wider community.

Early Achievement Award

For significant contributions to the profession by a member under 36 years of age.

ASEG Service Awards

For distinguished service by a member to the ASEG.

ASEG members are eligible for all award categories. Non-members also are eligible for the Lindsay Ingall and Grahame Sands awards. Under exceptional circumstances, the other awards may be offered to a non-member of the ASEG who has given appropriate service to the ASEG or to the profession of geoscience, and who has been duly nominated by the Federal Executive.

Nomination procedure

Any member of the Society may submit nominations for an award. These nominations are to be supported by a seconder, and in the case of the Lindsay Ingall Memorial Award by at least four geoscientists who are members of an Australian geoscience body (e.g. ASEG, GSA, AusIMM, AIG, PESA, or similar).

The awards carry considerable prestige within the ASEG and the geoscience profession. Therefore appropriate documentation is required to support the nomination. Nominations must be specific to a particular award and all aspects of the defined criteria should be addressed.

Further details of the award categories and nomination criteria were published in the August 2014 *Preview* and are also available on the ASEG website. *Proforma* nomination forms and further information on the nomination procedures can be obtained by contacting the Chair of the Honours and Awards Committee, Andrew Mutton. All correspondence and nominations will be treated confidentially.

Nominations including digital copies of all relevant supporting documentation are to be sent electronically to:

Andrew Mutton
ASEG Honours and Awards Committee Chair
awards@aseg.org.au or *andrew.mutton@bigpond.com*

Nominations must be received by Wednesday 10 December 2014.

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Geophysical Inversion for Mineral Explorers: A report on the workshop presented by the WA Branch of the ASEG on 2 September 2014

This workshop was the second in a series of minerals and near-surface geophysics one-day workshops targeting both geologists and geophysicists that the WA branch of the ASEG is trying to run on a more or less regular basis (the previous occurrence being a one-day workshop on airborne EM run in November 2012).

After throwing around a few ideas for topics, it seemed that geophysical inversion was a natural candidate. Even though it is often accompanied by dreadful formulas and fancy algorithm names, at the end of the day, geophysical inversion is one way (some may even say the only way) to represent large, complicated and sometimes messy geophysical datasets in a plausible geological sense. With available computing power increasing on a weekly basis, 3D environment software becoming more and more accessible to both geologists and geophysicists, and the growing need to compile multiple datasets in a single 3D exploration model, geophysical inversion is well and truly in the spotlight.

Some people asked us if it was worth attending the workshop because they do not usually perform inversions on their geophysical data, especially now their exploration budget has been cut anyway. Our response was simple. The attractiveness of geophysical inversion for an exploration geoscientist is that the cost of inverting old data with new inversion packages is almost insignificant compared with the cost of acquiring new data. And yet, new 'eye-opener' exploration ideas can still spring out of this relatively inexpensive exercise.

Over the course of the day, 90 registrants were shown a great selection of case studies where geophysical inversion demonstrably benefited the geoscientist at various stages of exploration – from terrane scale area selection to resource definition – for a wide range of techniques and commodities. The registrants were also able to spend some time between sessions visiting the sponsors' booths in an adjacent exhibition room. The abstracts for all of the 14 high quality presentations are appended below and the presentations are available for download by following this link http://goo.gl/deJu6o. As a bonus, Richard Lane has generously shared his notes on each of the presentations and these notes are posted on each of the abstracts.

The most positive feedback we received was the fact we managed to keep the registration cost extremely reasonable for this fully catered event ($200 for ASEG and AIG members, $50 for students and $300 for others). This was only possible thanks to our generous sponsors; namely CSIRO, Geosoft, Geotech Airborne, Intrepid Geophysics, Mira Geoscience and SkyTEM Australia. The topic for the next workshop is yet to be decided and we are open for suggestions!

Regis Neroni
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ABSTRACTS

SESSION 1 PRACTICAL THEORY

An introduction to geophysical modelling and inversion

James Reid, Mira Geoscience

This presentation will give a practical non-mathematical introduction to geophysical modelling and inversion. Forward modelling is the calculation of the expected geophysical response of a given distribution of subsurface physical properties (such as density, magnetic susceptibility or electrical conductivity) for particular measurement parameters (e.g. sensor type and position, component). Forward modelling is an integral part of geophysical inversion, but also has application to survey design, sensitivity analysis, validation of geological models and hypothesis testing. Geophysical inversion refers to the mathematical and statistical techniques for recovering information on subsurface physical properties from the observed geophysical data. Fundamental inversion concepts such as non-uniqueness, regularisation, sensitivity, and data and model norms will be introduced. An overview will be given of different inversion methods, including parameterised inversion, joint inversion, constrained inversion, and statistical (Monte Carlo) approaches. Common applications and pitfalls of inverse methods will also be introduced.

How do we overcome non-uniqueness? Through incorporation of prior knowledge i.e. by defining characteristics that we would like to see in the inverted model. Mira Geoscience Rock Property Database (RPDB). An impressive resource with more than 6 M measurements – including the GSC database and CRC Handbook values. In contrast to the GA database, which is fundamentally a spatial database, the RPDB is a lithological database. RL

Why different algorithms give different answers

Yusen Ley Cooper, CSIRO

Given the exploration conditions in Australia, where approximately 75% of the terrain is under cover and where outcrop is rare, geophysical exploration methods such as airborne electromagnetics (AEM) can provide us with important geological insights into the subsurface. Although AEM is a technology that emerged and was developed by the mineral exploration industry, for some time now we have witnessed its use in other areas such as groundwater and environmental management and as a tool for regolith mapping. These trends have been accompanied by a need to extract more quantitative information from the measured/observed data, particularly through numerical techniques like inversion. Inversion of geophysical data leads to non-singular solutions, therefore suggests there is the potential of

generating a variety of models which can fit the measured data. This ambiguity makes it clear that the choice of processes and algorithms used to interpret geophysical data requires more thought and understanding of the potential sources of these discrepancies. This talk aims to show the use of inversion not as a means of producing a model itself, but how inversion can be used to better understand and assess data, and lead to the optimal goal of gaining data driven geological knowledge.

Yusen asked us 'What is inversion?' It's a way of getting intimate with your data

It's a way of connecting what we measure (i.e. the data) with the essence of the situation (i.e. the model and the forward data transformation) to derive insight into the real world.

The question arose at the end of Yusen's presentation as to how we might define and communicate the degree of confidence that we have in the inversion results.

This was a recurring question through the day, and it is a very difficult ongoing problem. One thing to keep in mind is that the results of sensitivity analyses and probabilistic inversions are 'marginal' or conditional probabilities – i.e. they are conditional on the assumptions in the calculations. Also, they should only be treated as relative probabilities for different scenarios calculated using the same set of assumptions.

Another approach that can be investigated is to consider the 'robustness' of an outcome by inverting a variety of scenarios where we have tried to eliminate the feature through prior information (i.e. constraints such as a reference model that lacks the characteristic or feature in question). RL

Forward modelling and inversion for geophysical survey design

Kim Frankcombe, ExploreGeo

Modern geophysical survey equipment can provide the user with a range of choices regarding survey design. This complements explorers' desires to see deeper and with greater resolution than previously possible. However, these advances are buffered by shrinking exploration budgets which require that every survey offer the maximum return on investment.

In order to try and select the right tools for the problem and the configuration of those tools providing the best value for money, the problem can be modelled prior to the survey. For techniques which provide answers which are not always interpretable directly from the data, these forward models can be inverted to see how well the known starting point can be recovered from the data using the tools and configuration selected. By doing this prior to the survey various designs can be simulated and their effectiveness judged without the expense of trial surveys.

Induced polarisation equipment has advanced significantly in the past 20 years, perhaps more than any other weapon in the mineral geophysicists armoury. This has been coupled with similar advances in IP modelling and inversion software. Data can be acquired, processed and modelled in 3D. No longer are we restricted to acquiring data at a single dipole size or having the dipole size equal the electrode separation. The choices of electrode and dipole layout are infinite but not all choices are equal when it comes to resolution, depth of investigation and cost. Using a modelling and inversion process to test designs can result in surprises and lead to designs which had not previously been considered.

Kim expected more geologists to be attending so he had placed some of the presentation material into appendices. I'm not sure what this implies – perhaps that geologists can read whilst geophysicists need pictures?

I noted that Kim had quite high expectation from inversion in that he was looking for accurate delineation rather than simple detection of a feature. This is a reminder of how far we have come – from bump detection in data profiles, to feature detection through inversion, and now to feature delineation. RL

SESSION 2 CASE STUDIES 1 – PURE PROPERTY INVERSIONS

Magnetics – From the Arctic to the Andes

Michael Webb, Consultant

This presentation consists of three examples of magnetic inversions and forward modelling. The inversions and forward models were mostly performed using Geosoft's Voxi software. The first example is from Anglo American's Sakatti nickel and copper project in northern Finland. This example shows the results of unconstrained magnetic susceptibility and magnetisation inversions and compares these to inversions constrained by magnetic susceptibility measurements on drill core. The second example is from South Australia. It shows the results of magnetisation inversion on an area with strong magnetic remanence ($Q > 500$) and compares the magnetisation estimated from the inversion with magnetisation measured from oriented core samples. The final example, from Northern Chile, demonstrates the problems of working with magnetics in areas of rugged topography and low magnetic field inclination.

Mike showed examples of Geosoft's MVI results (i.e Magnetisation Vector Inversion). The message was that each program has limitations, and that we must be aware of these. As a consequence of non-uniqueness, a program that only modelled magnetic susceptibility would predict the observed data with more or less the same degree of accuracy as a full magnetisation inversion. However, constraints such as rock property prior knowledge would tell us that one or other of these scenarios was a more accurate reflection of our world. RL

Examples of 3D potential field inversions – low latitudes and remanence

Barry Bourne, Consultant

Recent advances in 3D inversion methods have led to the availability of techniques that look to address more complicated geological/geophysical problems and challenge conventional thinking. One of these techniques, the Magnetic Vector Inversion (MVI) method directly models the vector of magnetisation based only on anomalous TMI data. The method allows the interpreter to model features that may contain a combination of remanent magnetisation, demagnetisation or anisotropy of magnetic minerals. It is shown that at low latitudes the MVI technique appears to have benefits over conventional modelling for porphyry exploration. In addition, at a regional scale, geological features that appear to be normally magnetised may in fact have a remanent component and alternative modelling techniques should be trialled and all data considered before planning follow-up exploration.

Barry showed us some examples of using modelling and inversion to map geological features (i.e. a 3D geological mapping application). Rather than the direct detection of a target, multiple indirect criteria could be applied to the 3D geological map to derive targets. RL

Joint inversion of MT and DC data over Olympic Dam IOCG deposit

Peter Rowston, GRS

Geophysical Resources and Services have been running combined magnetotelluric and controlled source resistivity surveys as a standard service for over ten years. In the great majority of cases the models interpreted from each method are in good agreement. However, there are occasions when the models present systematic differences that cannot be easily explained. This talk illustrates such a case using data acquired over the Olympic Dam polymetallic deposit. The apparent contradiction is shown to be resolved by the use of joint inversion software that allows for electrical anisotropy.

Peter's biography indicated that he had experience on 5 of the continents. I wondered which of the 7 continents he had not worked on. A quick web search indicated that opinion was in fact divided on whether there were 5, 6 or 7 continents, let alone what their boundaries are. Non-uniqueness is not restricted to geophysics.

As with the previous presentation, Peter demonstrated the complexity of the real world (e.g. anisotropy in electrical conductivity) and how the assumptions in 'standard' modelling codes might gloss over the complexities leading to wildly erroneous results. RL

Two-dimensional joint inversion of ZTEM and MT plane-wave EM data for near surface applications

Keith Fisk, Geotech Airborne

ZTEM (Lo and Zang, 2008) is an airborne electromagnetic (EM) geophysical technique developed from AFMAG (Ward, 1959; Labson et al., 1985) where naturally propagated EM fields originating with regional and global lightning discharges (sferics) are measured as a means of inferring subsurface electrical resistivity structure. A helicopter-borne coil platform (bird) measuring the vertical component of magnetic (H) field variations along a flown profile is referenced to a pair of horizontal coils at a fixed location on the ground in order to estimate a tensor H-field transfer function.

The ZTEM method is distinct from the traditional magnetotelluric (MT) method in that the electric fields are not considered because of the technological challenge of measuring E-fields in the dielectric air medium. This can lend some non-uniqueness to ZTEM interpretation because a range of conductivity structures in the earth depending upon an assumed average or background earth resistivity model can fit ZTEM data to within tolerance. MT data do not suffer this particular problem, but they are cumbersome to acquire in their need for land-based transport often in near-roadless areas and for laying out and digging in E-field bipole sensors. The complementary nature of ZTEM and MT logistics and resolution has motivated development of schemes to acquire appropriate amounts of each data type in a single survey and to produce an earth image through joint inversion. In particular, consideration is given to surveys where only sparse MT soundings are needed to drastically reduce the non-uniqueness associated with background uncertainty while straining logistics minimally.

Algorithm ZTMT2DIV is a generalization from previous code AV2Dtopo (Legault et al., 2012) that inverted ZTEM and AirMt data allowing topographic variations and a variable bird height. ZTMT2DIV algorithm makes use of the public domain finite element forward problem and inversion parameter sensitivities using reciprocity developed at the University of Utah (Wannamaker et al., 1987; DeLugao and Wannamaker, 1996), together with the regularized Gauss-Newton non-linear parameter step estimate described by Tarantola (1987). The performance of two-dimensional (2-D) joint ZTEM/MT inversion by ZTMT2DIV is tested using synthetic brick structures below a hill and valley model, similar to AVERT2D-topo. Subsequently, separate and joint inversion of coincident ZTEM and Titan dense array MT data over the Johnston Lake district, Saskatchewan, are performed. A result of this effort is that only very few (e.g. three) MT stations may be needed to correct for background resistivity effects in a ZTEM survey provided the MT sites are appropriately spaced.

Keith presented another example of having multiple data types integrated within a modelling and inversion application. In this instance, ZTEM and MT data were inverted for a single rock property (i.e. electrical conductivity).

There was enough overlap in the rock volumes sampled by the observations that we could gain confidence in the calibration of both methods through the consistency of the predictions for both data sets from a single model.

I admired Keith's deft sidestep for a tricky question from the audience – 'That is a great question that deserves a great answer. You can look for this in the slide notes, but if it isn't there, I can put you in touch with someone who can give you an answer.' RL

SESSION 3 CASE STUDIES 2 – GEOLOGICALLY CONSTRAINED INVERSIONS

Inversion of SkyTEM data over an ultramafic hosted Ni-Cu deposit in Greenland

John Joseph, Consultant

The Maniitsoq nickel-copper-PGE license block in Greenland hosts numerous high-grade nickel-copper sulphide occurrences. North American Nickels Inc (NAN), a British Colombia based company obtained the exploration license of this block and utilized the traditional prospecting methods, modern ground and airborne geophysical techniques for delineating the target areas to be drilled. As a part of the geophysical exploration a large portion of the licence block was flown with a fixed wing TEM system in early 1990. The extremely rugged terrain and the mandated higher ground clearance severely hindered the ability of the survey to see prospective EM. NAN has further reviewed these data and concluded that nickel-copper bodies missed by the above survey might well be detected by modern helicopter-borne TEM systems such as SkyTEM.

Based on the compilation of historical exploration results, two blocks of ground were selected for helicopter-borne EM and magnetic survey using SkyTEM-304 system. Blocks A and B together covered 375 km2 and included the largest norite intrusions and most significant nickel occurrences in the larger licence block. The survey was flown with a nominal spacing of 200 metres. The line spacing was reduced to 100 metres when potentially significant conductors were detected. The EM data were processed and inverted using both SELMA based code and laterally constrained inversion scheme called Aarhus workbench, and detected significant EM anomalies which were not detected by previous geophysical surveys. It was observed that many of the prospective intrusions have a significant component of remnant magnetism giving them a distinctive magnetic signature. Mapping out the distribution of this signature suggests that there may be considerably more prospective noritic rock in this area than is exposed on surface. A detailed discussion of the survey, data processing, inversion and drilling results will be presented.

John opened with a confession – he wasn't presenting a constrained inversion despite being the first speaker in the constrained inversion session!

During John's talk, I was reminded of a quote from Terry Lee ... 'If you have seen one TEM decay, you've seen them all.' John showed us several TEM decays, and they certainly did all look the same. This was an excellent demonstration of just how useful modelling and inversion has been to extract the information that is present in EM data. EM has been a similar modelling and inversion success story to that of resistivity/IP, MT and magnetisation inversion in the sense that the model attributes are not always readily apparent from an inspection of the data. RL

Ways to integrate inversion in your interpretation

Tim Chalke, Mira Geoscience

The role of geophysics is necessarily evolving as modern exploration addresses the challenge of finding significant new deposits at depth, under cover, or in complex brownfields settings. This exploration activity can be driven by a fundamental understanding of mineralisation processes and the associated ore system signatures. This is therefore a step away from recognising anomalies in 'data space' but rather an interpretation in model space where the data informs components of this ore system signature. The aim of geophysical modelling can be to interpret the rock volume in terms of geometry, structure and rock properties associated with these components.

The interpretation of geophysical data can therefore be focused on informing geological objectives of understanding. This is done through interpreting how geophysical signatures relate to geology, and the geological meaning of rock properties. Interpretation of structure and geology leads to the modelling of key geological domains in 3D, attributed with best estimate rock properties. Inversion and forward modelling are utilised for quantitative reconciliation of geophysical data with the initial model followed adjustment of boundaries and physical properties where appropriate. The result is a model which honours the geophysical data, and which may be directly integrated with other multi-disciplinary data in 3D for exploration based around interpreted ore system signatures.

Happy birthday to Tim! What a birthday treat – to come along today to participate in this wonderful forum.

The day would not have been complete without a decent mention of the Common Earth Model concept that advocates for integration of model characteristics derived from multiple data types into a sub-surface mapping product to which different criteria can be applied to generate targets for different applications.

Another timely reminder from Tim was that so much more can be done than to just perform an unconstrained (default-setting) inversion. Yes, he recommended that we still do an inversion of this type, but he urged us to go further with input from rock properties and other forms of prior information.

When providing a second plug for the RPDB, Tim expressed the view that there are still issues with the reconciliation of rock property measurements with geophysical modelling results. RL

FALCON AGG inversion to constrain 3D geological models in the Glyde Sub-Basin, Northern Territory

Fabio Vergara, CGG

A high resolution FALCON® airborne gravity gradiometer (AGG) and magnetic survey was flown by CGG Airborne over the Glyde Sub-basin in the Northern Territory. Aim of the survey was the identification of the structural setting of the area to support Armour Energy's conventional and unconventional hydrocarbon exploration efforts.

A structural interpretation of the survey area was completed integrating the new AGG and magnetic data with historical geophysical information, regional and local geology (including two wells), remote sensing data and scientific papers. Advanced data processing was applied to improve the interpretation of the AGG data: pseudo-depth slices, to better understand the density variations at depth (Spector and Grant, 1970), and Shape Index, to define the geometry of the equipotential surface of the gravity field (Cevallos et al., 2013). The integrated interpretation was combined with 2.5D modelling on cross section and depth to magnetic basement to build a 3D Earth Model of the survey area. The $30 \times 40 \times 5$ km volume was discretised into a voxel with $200 \times 200 \times 100$ m cell size. The model was iteratively refined using homogeneous and heterogeneous 3D gravity gradient inversion (VPmg) to minimise misfit between calculated and observed data.

The interpretation and 3D modelling workflow applied in the Glyde Sub-basin project represents a solid approach to integrate available geological and geophysical data in a comprehensive 3D interpretation. 3D inversions proved valuable to refine the final model and as a quantitative tool to assess model reliability.

When integrated with a solid geological understanding, 3D inversions represent an additional tool for the geologists and the geophysicist to aid interpretation and improve 3D geological models.

Following on well from the previous talk, Fabio reminded us of the (never-ending) iterative nature of the Common Earth Model generation process. Around, around, around the loop we go – put forward an hypothesis, test it for compatibility with various observations, make adjustments to the hypothesis to improve the likelihood of this reflecting the world we live in, re-test the model, etc. RL

Use of geostatitically-constrained potential field inversion and downhole drilling to predict distribution of sulphide and uranium mineralisation

Matthew Zengerer, Intrepid Geophysics

This talk examines methods for generating geostatistically plausible 3D property values from downhole drilling logs, and how these property models can be used to both refine geological understanding and inform 3D property and lithology stochastic inversions. Examples are shown from a Copper deposit in the Northern Territory and a Uranium deposit in South Australia. Significance of the findings from forward modelling and inversion, as well as implications for exploration and inversion processes, are examined.

Matt drew our attention to many of the issues – a complete herd of elephants-in-the-room – that many of us would prefer to ignore ...

- sparse data,
- an imperfect understanding of the Earth and its processes,
- simplified models,
- under-determined mathematical problems, and
- non-uniqueness.

He then provided examples of the use of a statistical/probabilistic/Bayesian approach to inversion. This approach didn't overcome the issues, but certainly made them apparent through the generation of multiple satisfactory models. RL

SESSION 4 NEW APPLICATIONS AND RECENT DEVELOPMENTS

Pit-scale geological modelling with EM and magnetics inversion

Chris Wijns, First Quantum Minerals

The economics of mining low-grade deposits is very dependent on having good resource models to inform the mine plan. Resource models involve more than grade distribution – they include factors such as rock hardness, volume of pre-strip material, and oxide vs hypogene ore and waste zones. In such cases, diverse data sets are needed to help construct the best geologically constrained resource model possible. High-resolution airborne EM and magnetic data over the Cobre Panama porphyry deposits help to define structures and domains inside the pit volumes. The EM data map the depth of saprolite, which informs pre-strip and oxide ore volumes. The broad mineralisation envelope is also reflected in the EM via the response to clay (sericite) alteration. This same alteration results in demagnetisation of the host rock. Both magnetic and EM data define lithological contacts, but there is inconsistent correspondence with structures mapped in surface quarries and streams.

Chris took us on a journey to a different place and scale. He reminded us that geophysical modelling and inversion can prove beneficial not just during exploration, but during resource modelling and mine planning as well.

He also stated something that we all knew – that 'geophysics is never wrong.' Very true, but you were a brave man, Chris, to say it out aloud. RL

Advances in cooperative inversions of seismic and MT data; and comments on grids and super-computing

Brett Harris and Andrew Pethick, Curtin University

Cooperative or Joint inversion of data from co-located seismic and magnetotellurric surveys has potential benefits. We investigate the circumstances under which cooperative inversion makes sense. We highlight a range of cooperative inversion workflows based on structural and or petrophysical relationships with the aid of synthetic and field examples. These type of inversion strategies need to be coupled with fast computing. In the modern 3D geophysical world, the speed at which inversion and forward modelling can be undertaken becomes paramount. Computation speed will impact the final result that can be achieved, in particular when multiple datasets are inverted in a joint/co-operative inversion workflows. We present methods to parallelise electromagnetic modelling and inversion code and provide two scenarios showing the potential benefits of parallel computing.

Brett had the challenge of trying to explain to us how two (apparently) unrelated quantities can be inverted in a combined or cooperative manner. Of course, they are both reflections on a single 'Common Earth' as Tim Chalke would have said.

Andrew gave a very quick tour of parallel processing terminology (e.g. 'embarrassingly parallel') before illustrating how we can now take advantage of grid/cloud/remote/ supercomputing to expedite processing. RL

Meanwhile, at Geoscience Australia ... modelling and inversion related activities

Richard Lane, Geoscience Australia

Geoscience Australia is involved in geophysical modeling and inversion as a supplier of fundamental data, as an active practitioner, and for a certain group of clients, as a supplier of technical advice, and a supplier of computing services. The organisation is the custodian of national datasets that are often utilised for modelling, for example: gravity, magnetics, rock properties, surface topography, satellite imagery, and surface geology. In recent years, there has been an expansion of this role. Seismic reflection and magnetotelluric data acquired along traverses that cross key crustal features are made available to the public. A number of large regional AEM surveys have been flown, and the processed and modeled data are again made available to the public.

Modelling of geophysical data is carried out internally in support of groundwater, geohazard, petroleum, and minerals applications. Attendees at this forum would be most familiar with the work that is done for petroleum exploration via studies of frontier basins and the provision of supporting information for acerage release areas. In the minerals exploration arena, Geoscience Australia is focused on the UNCOVER agenda. The goal of this initiative is to achieve a step change in knowledge and methodologies in Earth Sciences that are relevant to mineral exploration beneath the cover. This change will be achieved through the four themes of the initiative: Characterising Australia's cover; Investigating Australia's lithospheric architecture; Resolving the 4D geodynamic and metallogenic evolution of Australia; and Characterising and detecting distal footprints of mineralisation.

Modelling of geophysical data is a key part of each of these themes, principally involving gravity, magnetic, AEM, MT, seismic reflection, seismic refraction, teleseismic, and thermal data.

Specific aspects of recent modelling-related work at Geoscience Australia that will be discussed in more detail include: regional gravity and magnetic modeling, AEM modeling, MT modeling, high performance computing, The Virtual Geophysics Laboratory, and the development and deployment of a second-generation Australian National Rock Properties Database.

How would you react to the challenge of performing gravity and magnetic data inversions to produce a model with 80 x 80 x 10 m cells from the surface to a depth of several kilometres, seamlessly across the entire continent?

After allowing the attendees to either pick themselves up off the floor or to stop laughing, Richard set out some of the initiatives that are underway at Geoscience Australia (GA) in geophysical modelling and inversion that would allow this goal to be met. It shall be exciting to follow the progress as GA marches towards this objective. RL

Student Events at ASEG–PESA 2015

The ASEG is organising two student events to be held in conjunction with the upcoming ASEG–PESA 2015 conference. One event is targeting high school students and the other is targeting university students (both undergraduate and post graduate). It is also planned to hold a 'Geophysics for Teachers' workshop on Sunday 15 February.

The High School Student Day will be held on Tuesday 17 February 2015 between 9:30 am and 2:30 pm at the Perth Exhibition and Conference Centre.

In summary:

- 50 free places are being offered for high school students and an accompanying teacher, kindly sponsored by Woodside and ASEG–PESA 2015.
- Invitations are being sent to 300 schools and 500 science teachers from across Western Australia asking them to nominate 5–10 students from each school to attend the day.
- The event aims to encourage Year 11 and 12 students to consider a career in geoscience.
- The day will consist of a talk by Koya Suto 'Hitchhikers Guide to Geophysics', followed by a series of hands on activities/experiments (magnetic survey, ground penetrating radar, micro-seismic).
- There will be a tour of the exhibition space.
- There will also be a short talk about education pathways into geoscience.
- More information can be found at http://www.conference.aseg.org.au/registration-social-functions/high-school-student-day.html

The University Student Social Function and EAGE GeoQuiz will be held on Tuesday 17 February 2015 between 6:00 pm–9:00 pm at Bob's Bar, The Print Hall, Brookfield Place, 25 St Georges Tce, Perth.

In summary:

- This is a free event for undergraduate and postgraduate students with 75 places available.
- Food and drinks will be provided.
- EAGE have kindly offered to put on their EAGE GeoQuiz and have donated a first prize for the winning team to attend the 77th EAGE Conference & Exhibition in Madrid, Spain 1–4 June 2015. The prize includes airfares, accommodation and entry to the conference. This is a great prize and the ASEG is very grateful to the EAGE for their generosity.
- To participate in the EAGE GeoQuiz, students must register their team of 2 or 3 at the EAGE booth at the conference hall.
- The event is kindly sponsored by ASEG–PESA 2015.

Some additional student oriented activities for university students are planned with full details to follow on the ASEG–PESA website http://www.conference.aseg.org.au/

These will include:

- An opportunity for university students to participate in a mock job interview
- An opportunity for interested students to partner up with an ASEG member who will spend a few hours introducing them to industry professionals and mentoring them on their career path
- A session where students can listen to some short talks on academic and industry career paths and have the opportunity to ask questions.

For more information about any of these events please contact Adrian Noetzli adrian.noetzli@gpxsurveys.com.au

Geophysical adventures: the Geomagnetic Repeat Station Survey 2014

Bill Jones, Andrew Lewis and Liejun Wang

Email: geomag@ga.gov.au
Web page: http://www.ga.gov.au/scientific-topics/positioning-navigation/geomagnetism

Geoscience Australia (GA) operates a network of ten permanent geomagnetic observatories in the Australian region and Australian Antarctic Territory. To supplement the geomagnetic secular variation data collected at these observatories, a network of fifteen geomagnetic repeat stations is also maintained in Australia and the south-west Pacific. These repeat stations are occupied once every three to five years to collect secular variation data for use in modelling the regional magnetic field.

New Caledonian repeat station.

Close up of a Norfolk Island repeat station.

The data collected from the observatory and repeat station network are also used by the wider community, including government agencies such as the Bureau of Meteorology's space weather service IPS to aid in space weather monitoring, and researchers studying the Earth and near Earth environment from the core through the crust and into the atmosphere, magnetosphere and space. Magnetic time-series data from the network are available as an alternate source for magnetic base station data for the mineral exploration and drilling industry. Regional and global field models derived from the data are useful for navigation and magnetic direction finding.

At each of the repeat station sites a magnetic variometer system is deployed over a three to four day period. The variometer system consists of a 3 axis fluxgate magnetometer and a total-field magnetometer. These instruments record the magnetic field constantly for the duration of the occupation. During the daylight hours absolute observations are carried out to calibrate the variometer system to geomagnetic observatory standards. These calibrations are conducted using a fluxgate magnetometer mounted on a non-magnetic theodolite and a proton precession magnetometer. The repeat stations are generally located at airports where the magnetic environment remains stable over the medium to long term so the repeat stations remain free from magnetic contamination.

During the first half of 2014 four repeat stations were occupied by geophysicists from GA. These stations were located in Tontouta (New Caledonia), Norfolk Island, Kavieng (PNG) and Vanimo (PNG). Mainland Australian stations were occupied over the previous two years.

Bill and Andrew got the first gig in New Caledonia. The repeat station in New Caledonia is located within the boundary of La Tontouta International airport which is approximately 40 km to the north of the capital Noumea. To gain entry each day we had to visit the local Gendarmerie and hand over our passports to collect a gate pass. Considering that we don't speak any meaningful French, these officers were always friendly whenever we visited. The weather was very

Liejun Wang making observations at a Kavieng repeat station.

pleasant, if a bit windy, but when is an airport not windy?! For the sake of convenience we stayed close to the airport rather than make an 80 km round trip each day. We were the last guests at the hotel before it shut down, however we don't think that we were the cause. Near the end of the occupation the variometer site also had a visit from a large excavator, which was removing trees from a drain. Needless to say, this visit resulted in some contamination which needed removing before processing.

Bill Jones making observations at a Vanimo repeat station.

The next repeat station was on Norfolk Island , which we flew to from New Caledonia via Australia.

Unfortunately the flight from Sydney only had one seat available, so Bill flew ahead to start setting up the variometer whilst Andrew had an overnight stay in Brisbane and arrived the next day. When Bill woke up on the third day he was not feeling very well and, after a quick trip to the doctor, he was diagnosed with Chicken Pox. This left Andrew to complete the occupation by himself as Bill was restricted to bed rest. To add to the discomfort for Andrew, a tropical cyclone passed to the east of the island which made things very windy and very wet. We then returned to Australia where Bill spent the next week in self-imposed isolation.

Six weeks later the Papua New Guinean leg of the survey was undertaken by Bill and Liejun. The PNG stations are located at the airports in Kavieng (New Ireland) and Vanimo (Sandaun Province). We spent one night in Port Moresby before heading off to New Ireland. We set off to the airport to catch the flight to Kavieng first thing in the morning. At the check-in counter Bill was able to lodge his share of the luggage but Liejun was left standing at the counter for quite some time. Eventually he was told that a seat was available for him but there was no room for his luggage. So, once again, the team had to split up, with Bill heading off with the variometer system. Once in Kavieng a location within the perimeter fence of the airport was found for the variometer system. As this spot was located on the airfield there was, of course, no easy access to mains power. So, to power the site, we needed to purchase two car batteries, with these being swapped in and out once a day. The next day the flight arrived with Liejun and the rest of the gear. A search for the repeat stations then began, but with several years' worth of vegetation laying on top this naturally took several hours to sort out. With the help of the airport staff we eventually found the first of the stations. Using this station, we were then able to set up the theodolite. Then, with lots of hand waving, the second station located on the opposite side of the runway was also found. This was the end of our sunny weather at Kavieng, as from that point on it proceeded to rain whenever we stepped out of the car.

Vanimo repeat station with airport worker visiting.

The next station was at Vanimo airport, where we had lots of lovely sunny but humid weather. In Vanimo the airport grounds are unfenced so a secure location for the variometer needed to be found. The airport safety officer came to the rescue when he allowed us to use his garden. At this site we also had access to the mains to supply power for the instruments, however, we were soon to discover that the power supply in Vanimo is not very reliable. Power outages lasting several hours occurred each day during our visit. Eventually a truck battery was purchased and connected via a battery charger to the mains to create a make shift UPS. During the day, whilst collecting the absolute observations with the theodolite/magnetometer system, we often played host to curious locals who were using the airport as a short cut into town. So, after five days of data collection we were finally confident that we had collected enough data and packed up to return to Port Moresby. At the airport another power outage had occurred so Bill had to 'duck back' into town to find a bank so that he could withdraw enough cash to pay for the excess baggage. Another quick overnight stay in Port Moresby and we then started leap frogging back to Canberra via Cairns and Sydney.

All the data that have been collected over the last five years from these repeat station surveys will be combined with the data from the permanent geomagnetic observatories. These data will form the basis for modelling the 2015 AGRF.