Australian Society of Exploration Geophysicists

OCTOBER 2021 • ISSUE 214
ABN 71 000 876 040 ISSN 1443-2471

PREVIEW

NEWS AND COMMENTARY

FEATURES

ASEG federal executive 2020–21

Kate Robertson: President (Communications Committee liaison)
Tel: +61 8 8429 2564
Email: president@aseg.org.au

Emma Brand: President Elect (Diversity Committee Chair)
Tel: +61 455 083 400
Email: president-elect@aseg.org.au

Leslie Atkinson: Secretary
Tel: +61 414 804 028
Email: fedsec@aseg.org.au

Yvette Poudjomi Djomani: Treasurer (Finance Committee Chair)
Tel: + 61 2 6249 9224
Email: treasurer@aseg.org.au

David Annetts: Past President (Conference Advisory Committee liaison, Near Surface Geophysics Specialist Group Chair)
Tel: + 61 411 756 129
Email: pastpresident@aseg.org.au

Ted Tyne (Publications Committee Chair)
Tel: +61 434 074 123
Email: publications@aseg.org.au

Mark Duffett (Technical Standards Committee liaison)
Tel: +61 3 6165 4720
Email: mark.duffett@stategrowth.tas.gov.au

Ian James (Web Committee Chair)
Tel: +61 488 497 117
Email: webmaster@aseg.org.au

Suzanne Haydon (Membership Committee Chair)
Tel: +61 417 882 788
Email: membership@aseg.org.au

Kate Selway (Education Committee Chair)
Tel: +61 491 237 572
Email: education@aseg.org.au

Janelle Simpson (Branch Liaison Committee Chair)
Tel: +61 7 3096 6138
Email: branch-rep@aseg.org.au

The ASEG Secretariat

The Association Specialists Pty Ltd (TAS)
PO Box 576, Crows Nest, NSW 1585
Tel: +61 2 9431 8622
Fax: +61 2 9431 8677
Email: secretary@aseg.org.au

Standing committee chairs

Finance Committee Chair: Yvette Poudjom Djomani
Tel: +61 2 6249 9224
Email: treasurer@aseg.org.au

Membership Committee Chair: Suzanne Haydon
Tel: +61 417 882 788
Email: membership@aseg.org.au

Branch Liaison: Janelle Simpson
Tel: +61 7 3096 6138
Email: branch-rep@aseg.org.au

Conference Advisory Committee Chair: Michael Hatch
Tel:
Email: cac@aseg.org.au

Honours and Awards Committee Chair: Andrew Mutton
Tel: +61 408 015 712
Email: awards@aseg.org.au

Publications Committee Chair: Ted Tyne
+61 434 074 123
Email: publications@aseg.org.au

Technical Standards Committee Chair: Tim Keeping
Tel: +61 8 8226 2376
Email: technical-standards@aseg.org.au

ASEG History Committee Chair: Roger Henderson
Tel: +61 406 204 809
Email: history@aseg.org.au

International Affairs Committee Chair: Vacant - enquires to fedsec@aseg.org.au
Email: international@aseg.org.au

Professional Development Committee Chair: Vacant - enquires to fedsec@aseg.org.au
Tel: +61 8 6436 8746
Email: continuingeducation@aseg.org.au

Education Committee Chair: Kate Selway
+61 491 237 572
Email: education@aseg.org.au

Web Committee Chair: Ian James
Tel: +61 488 497 117
Email: webmaster@aseg.org.au

Research Foundation Chair: Philip Harman
Tel: +61 409 709 125
Email: research-foundation@aseg.org.au

Communications Committee Chair: Mosayeb K. Zahedi
Tel: +61 421 874 597
Email: communications@aseg.org.au

Specialist groups

Near Surface Geophysics Specialist Group Chair: David Annetts
Tel: +61 411 756 129
Email: nsgadmin@aseg.org.au

Young Professionals Network Chair: Jarrod Dunne
Email: ypadmin@aseg.org.au

ASEG branches

Australian Capital Territory

President: Andandaroop Ray
Tel:
Email: actpresident@aseg.org.au

Secretary: Mike Barlow
Tel: +61 439 692 830
Email: actsecretary@aseg.org.au

New South Wales

President: James Austin
Tel: +61 2 9413 7876
Email: nswpresident@aseg.org.au

Secretary: Steph Kovach
Tel: +61 2 8960 8443
Email: nswsecretary@aseg.org.au

Queensland

President: James Alderman
Tel:
Email: qldpresident@aseg.org.au

Secretary: Nick Josephs
Email: qldsecretary@aseg.org.au

South Australia & Northern Territory

President: Ben Kay
Email: sa-ntpresident@aseg.org.au

Secretary: Carmine Wainman
Tel: +61 411 876 173
Email: sa-ntsecretary@aseg.org.au

NT Representative: Tania Dhu
Tel: +61 422 091 025
Email: nt-rep@aseg.org.au

Tasmania

President: Mark Duffett
Tel: +61 3 6165 4720
Email: taspresident@aseg.org.au

Secretary: Matt Cracknell
Tel: +61 409 438 924
Email: tassecretary@aseg.org.au

Victoria

President: Thong Huynh
Tel: +61 438 863 093
Email: vicpresident@aseg.org.au

Secretary: Nathan Gardiner
Tel: +61 431 680 488
Email: vicsecretary@aseg.org.au

Western Australia

President: Todd Mojesky
Tel: +61 450 898 751
Email: wapresident@aseg.org.au

Secretary: Partha Pratim Mandal
Tel: +61 415 998 380
Email: wasecretary@aseg.org.au

ASEG honorary editors

Exploration Geophysics: Editor in Chief
Mark Lackie
Email: eg-editor@aseg.org.au

Preview: Editor
Lisa Worrall
Tel: +61 409 128 666
Email: previeweditor@aseg.org.au

ADVERTISERS INDEX

ASEG CORPORATE PLUS MEMBERS

Velseis Pty Ltd
Tel: +61 7 3376 5544
Email: info@velseis.com
Web: https://www.velseis.com/

HiSeis Pty Ltd
Tel: +61 8 9470 9866
Email: admin@hiseis.com
Web: http://www.hiseis.com.au/

TOTAL SEISMIC
Tel: +61 (0)409 891 391
Email: info@totalseismic.com
Web: https://www.totalseismic.com/

ASEG CORPORATE MEMBERS

Santos Ltd
Tel: +61 8 8116 5000
Web: https://www.santos.com

Southern Geoscience Consultants Pty Ltd
Tel: +61 8 6254 5000
Email: geophysics@sgc.com.au
Web: http://sgc.com.au/

Transparent Earth Geophysics
Tel: +61 (0) 409 887 459 Wayne Hewison
or +61 (0) 412 844 216 Andy Gabell
Email: info@transparentearth.com.au
Web: http://www.transparentearth.com.au

DUG Technology
Tel: +61 8 9287 4100
Email: sales@dug.com support@dug.com
Web: https://dug.com/

Australian Geophysical Services
Tel: +61 (0) 410529992
Email: info@australiangeophysicalservices.com
Web: https://www.australiangeophysicalservices.com/

FRONT COVER

ASEG President Kate Robertson deploying a MT instrument by helicopter as part of the Curnamona Cube project (photo taken by Samuel Jennings).

Preview is available online at
https://www.tandfonline.com/toc/texp20/current

ISSN: 1443-2471 eISSN: 1836-084X

CONTENTS

Editor's desk

Like many of you, no doubt, I prepared for the first virtual AEGC with some trepidation. I read Kate Robertson's riding instructions and duly cleared my calendar, dressed in a suit (from the waist up) and pre-prepared snacks and lunch. Surprisingly, I really enjoyed the experience. It was a relief to be able to dash between sessions without so much as breaking a sweat (just a couple of mouse clicks) and, as there was the inevitable clash between presentations (why is that the two presentations you most want to see are always scheduled at the same time?), even more of a relief to realise that I could watch the second presentation at my leisure down the track. Actually, I could watch the entire suite of presentations at my leisure down the track should that be my pleasure – an astonishing thought. Netflix or AEGC ….hmmmm. I expected to miss the interaction with my fellows and I did, but then again, I was surprised to see AESG Members, in particular, rise to the challenge of interacting virtually in the Discussion Forum. Those interactions felt very real. Again, the format had a surprising advantage over live interactions in that one could engage in several "conversations" at once.

This advantage came to the fore during the AEGC *Diversity in geoscience* panel discussion chaired by Marina Costelloe. I struck me, as I listened to the speakers and watched the discussion, that many of the experiences being described were not so much about discrimination but about plain old bad behaviour.

As a young scientist I had a fantasy that workplaces in science would be highly collegiate with individuals unselfishly focused on common goals. It has happened, CRC AMET under the leadership of Andy Green and then Brian Spies was one such workplace. However, I have also encountered workplaces in which many individuals are selfishly focused on very personal goals: bigger salaries, better titles, greater glory. Some of these individuals will do whatever it takes to achieve their goals, including exploiting what they perceive to be the weaknesses of those around them. Where I have been "discriminated" against in those workplaces it has often been because being a younger woman, being a single parent or being an older woman has been viewed as a weakness that could be exploited. Sure, I have fallen foul of systemic discrimination against women (the lack of toilets, restrictive dress codes for women in the early days of BMR/AGSO/GA for example), but nowadays such discrimination is usually easy to identify and work around. Overcoming the seeds of doubt sown behind the scenes about one's ability to make a contribution because of gender, age, appearance, social or cultural circumstances is a trickier proposition. If our workplaces are to benefit by being diverse, as well as benefiting by being inclusive of diverse and divergent scientific ideas, then I think that we all need to be careful to model good behaviour by treating all of our colleagues with courtesy and respect - and to call out bad behaviour wherever and whenever we see it.

This issue of *Preview* features the AESG 2021 Honours and Awards. These Honours and Awards were presented to the recipients during the AEGC 2021 conference by the ASEG President. The citations remind us of the valuable skills and experience possessed by many of our older Members, and the potential of many of our younger Members. The ASEG is truly a remarkable community of scientific practitioners.

Our regular *Preview* contributors (community members that we should particularly treasure!) continue to keep us informed. David Denham (*Canberra observed*) brings us the latest statistics out of Canberra, including the latest stats on job losses in Australian universities – not a pretty picture. In this gloomy environment Marina Pervukhina (*Education matters*) kick-starts a new series of interviews with industry leaders about their expectations of the tertiary education system – an exciting initiative. Mike Hatch (*Environmental geophysics*) picks his AEGC favourites. Terry Harvey (*Mineral geophysics*) contemplates the choice between ground-based or airborne surveys – not always straightforward. Mick Micenko (*Seismic window*), marks the 100th anniversary of the seismic reflection method. Tim Keeping (*Data trends*) unveils the AESG Technical Standards Committee's draft guide to measuring magnetic susceptibility in the field, and Ian James (*Webwaves*) takes a walk on the dark side!

Enjoy!

Lisa Worrall
Preview Editor
previeweditor@aseg.org.au

The Editor in the Croydon goldfields on the exposed margin of the Proterozoic Georgetown Inlier in north-west Queensland.

President's piece

Kate Robertson

Here I am soldiering through post-AEGC fatigue to get some words down on paper - sounds like a sign of a successful conference, and that it was. I'm yet to hear the final attendance numbers, but the latest update I had was 460 attendees!! Like many others, I have been a little wary of virtual conferences. Of course, the continued lockdowns and travel restrictions leaves us with no doubt that the decision to switch to a fully virtual conference was the right one. In the past I had thought that it would be difficult to block out the time for a virtual conference and not let other work matters interfere - I am happy to say this was not the case. In fact, I found the conference incredibly interactive and engaging. I made new connections, learnt new things and came away with plenty of ideas.

Without a doubt, one of my highlights of being President so far was the chance to virtually present the ASEG Honours and Awards during the conference. You can find a recording of these awards on the ASEG YouTube channel (youtube.com/ASEGVideos). Reading out the citations I was in awe of the incredible achievements of our Members. I encourage you to check out the full citations later in this issue - you too will be awe-struck and inspired. Next year don't miss the opportunity to nominate your deserving colleagues (at aseg.org.au/about-aseg/honours-awards). Thank you to the Honours and Awards Committee for all their hard work, as well as to the nominators and seconders.

I would like to express my immense gratitude to the AEGC 2021 Conference Organising Committee. The conference programme was full to the brim with innovation and new ideas, and was a great opportunity for discussion of important issues in geoscience. I received various emails or communications through the conference portal from people wanting to help with these issues and volunteer. I became aware of the many people who were passionate to help in different areas. So, I thought I would use this *President's piece* to highlight how you can help.

Call to action

Geophysics education

The issue: The status of geophysics education in Australia, and in other countries overseas, is bleak. *Preview 213* contained a report on a survey of Australian universities carried out by the ASEG Education Committee. This survey is the first part of a long-term action plan being developed by the ASEG and the wider geoscience community with a view to improving the outlook. Options being considered are increased numbers of professional development courses, a geophysics field camp, an education webinar stream, and an outreach programme at schools and career fairs amongst others.

What can you do? Do you have a geophysics course that you could deliver? Would you like to be a presenter on a geophysics field camp, or help to design practical exercises? Do you have

A screen capture during the ASEG 2021 Honours and Awards ceremony.

skills that could be applied to help us design an outreach programme for schools and career fairs? If you would like to join the Education Committee, or know other ways you could help, please contact our Education Committee chair, Kate Selway (education@aseg.org.au).

Mentoring and young professionals

The issue: As discussed in the Diversity in Geoscience Panel session at the AEGC, having a mentor can make a huge difference to your career, and being a mentor is a rewarding opportunity.

What can you do? If you would like to join the ASEG mentor programme as a mentor or mentee, or if you would like to help with getting the programme re-established, please contact the Young Professionals Network chair, Jarrod Dunne (YP-rep@aseg.org.au).

Sustainability

The issue: In the move toward a Net-Zero future, the role of the geophysicist is critical (and we as geoscientists know that), but the image of a geophysicist is distorted; to many in the public, geophysics still seems like a dirty job. Of course, the reality is that the industries that are making positive changes toward a carbon neutral future already know they need to hire geophysicists but, the education sector, potential students and politicians, may not have got the message.

What can you do? This is a critical time in exploration geophysics for communication, for outreach, and for clear messaging. If you would like to volunteer your time toward helping this, either as a speaker, course presenter, science communicator, or for brainstorming sessions, please contact me (president@aseg.org.au).

Diversity

The issue: There are many layers to diversity and we only managed to touch on a handful of these in the Diversity in Geosciences panel that was run during the AEGC. Diversity is critical for ensuring that we can see our problems from multiple perspectives, and creating an inclusive environment for all our Members is important for the future of our Society.

What can you do? Join our ASEG Diversity Committee to help drive positive change. Contact Emma Brand (president-elect@aseg.org.au). Or, if you're time poor but want to contribute any ideas or thoughts without joining the committee, send Emma an email.

Future directions of the ASEG

The issue: The ASEG has been a successful geophysical society for more than 50 years. As we look forward to the next 50 years, we acknowledge that times are changing, as is the role of a professional society. We need to ensure that our Society adapts to these times.

What can you do? Join your local branch (aseg.org.au/branch/act) or one of our committees (aseg.org.au/about-aseg/committees). If you're not sure of the best fit for you, please contact me (president@aseg.org.au).

Finally, I am very excited to announce the release of the ASEG's special publication in conjunction with Geoscience Australia, "Measuring Terrestrial Magnetism – the evolution of the Airborne Magnetometer and the first anti-submarine and aeromagnetic survey operations – People, Planes, Places and Events 1100s –1949" by Doug Morrison, the 2021 ASEG's Lindsay Ingall Awardee. Purchase your copy here: aseg.org.au/measuring-terrestrial-magnetism. This book marks the culmination of many years of research and lots of copies have already walked out the door - jump online so you don't miss out on your copy from the first print run.

In the next President's piece, I look forward to reporting on the outcomes of the ASEG Council Meeting which will be held on 12 October, and the Federal Executive strategy sessions which will be held throughout the month of October.

My thoughts go out to all that are still in lockdown or affected in other ways by COVID-19. I have had some busy nights packaging lockdown gifts for ASEG Members in NSW, Victoria and ACT who have experienced lengthy lockdown and COVID-related restrictions. The Federal Executive hope that these small gifts will provide a brief pick-me-up for our Members during lockdown.

Kate Robertson
ASEG President
president@aseg.org.au

The ASEG in social media

Have you liked/followed/subscribed to our social media channels? We regularly share relevant geoscience articles, events, opportunities and lots more. Subscribe to our Youtube channel for recorded webinars and other content.

Email our Communications Chair Millicent Crowe at Communications@aseg.org.au for suggestions for our social media channels.

Facebook: https://www.facebook.com/AustralianSocietyOfExplorationGeophysicists

LinkedIn company page: https://www.linkedin.com/company/australian-society-of-exploration-geophysicists/

Twitter: https://twitter.com/ASEG_news

YouTube: https://www.youtube.com/channel/UCNvsVEu1pVw_BdYOyi2avLg

Instagram: https://www.instagram.com/aseg_news/

Executive brief

AGM

The Federal Executive of the ASEG is the governing body of the ASEG. It meets once a month via teleconference, to deal with the administration of the Society. This brief reports on the monthly meeting that was held in August 2021. If there is anything you wish to know more about, please contact Leslie at fedsec@aseg.org.au.

Finances

The Society's financial position at the end of July 2021 was:

Year to date income - $169 944

Year to date expenditure - $147 801

Net assets - $1 120 559

Membership

As of 3 August 2021, the Society had 813 financial Members, compared to 848 at this time in 2020. The ASEG currently has eight Corporate Members, including three Corporate Plus Members. A huge thanks to all our Corporate Members for your continued support into 2021. Don't forget to have a look for our Corporate Members on the contents page of *Preview* and support them as much as you can. Our state branches also have additional local sponsors, which are shown at all branch meetings and at the beginning of all webinars.

The membership renewal process for 2022 has begun, so please don't forget to renew early and take advantage of our early-bird pricing. Early-bird discounts also apply to the five-year membership options that are available to Active/Associate and Retired Members. Early and mid-career Members are also encouraged to join the ASEG Young Professionals Network at www.aseg.or.au/about-aseg/aseg-youngprofessionals.

Member survey results

Earlier this year you were asked to have your say on a range of issues around the running of our Society. Thank you to all those Members who took the time to participate, we had a 30% response rate. This year we had an added incentive in a $500 gift card to one lucky participant. The winner of the gift card is Ken Witherly from Colorado, USA. Congratulations Ken. Your gift will be coming your way very soon.

Some of the results of the survey are shown in Figures 1–8.

Social media

Stay up to date with all the happenings of your Society on social media. You can connect to us on in facebook for all the latest news and events.

Leslie Atkinson
ASEG Secretary
fedsec@aseg.org.au

Figure 1. *Member employment status since 2019.*

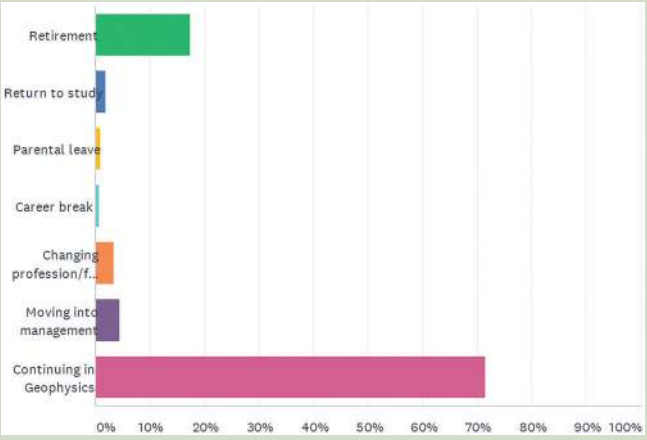


Figure 2. *Member employment intentions over the next 12 months.*

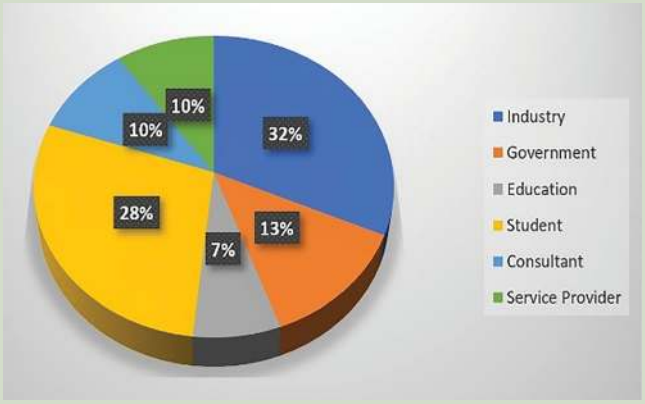


Figure 3. *Member employer.*

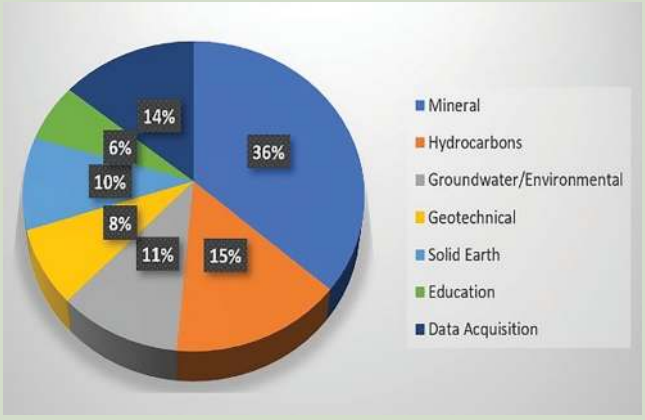


Figure 4. *Main Member professional interest area.*

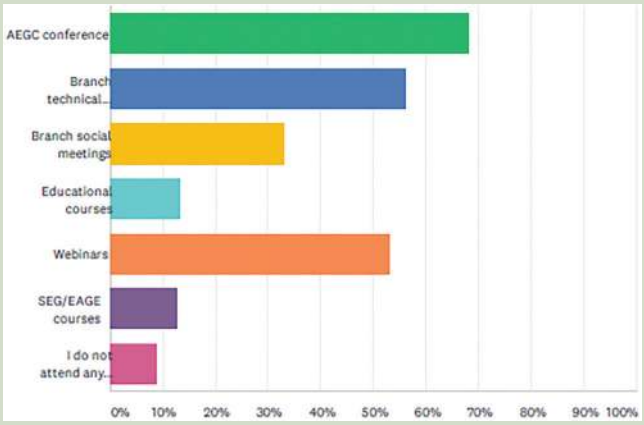


Figure 5. *ASEG events attended by Member.*

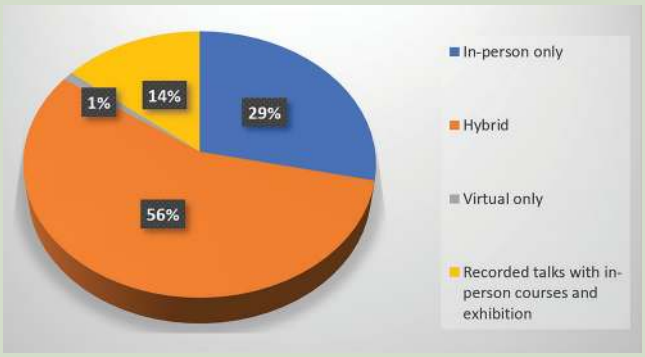


Figure 6. *Preferred conference format.*

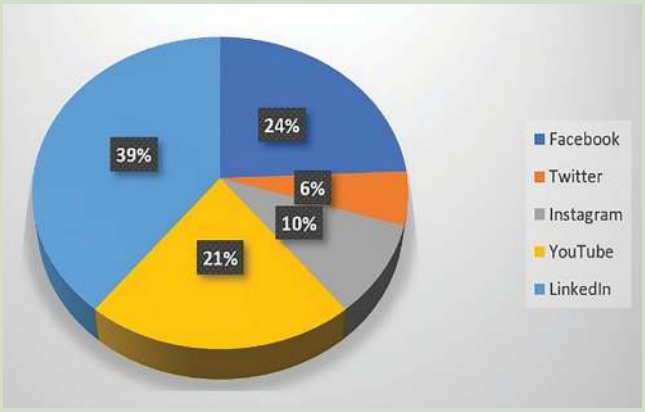


Figure 7. *Social media usage.*

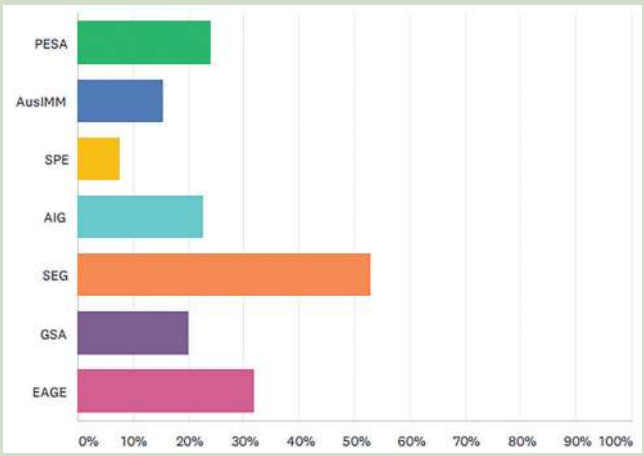


Figure 8. *Membership of other geoscience societies.*

Welcome to new Members

The ASEG extends a warm welcome to six new Members approved by the Federal Executive at its August and September meetings (see Table).

First name	Last name	Organisation	State	Country	Membership type
Lucy	Brisbout	Geological Survey of WA	WA	Australia	Associate
Steven	Hansen	Macquarie University	NSW	Australia	Associate
James	La Greca	The University of Melbourne	VIC	Australia	Student
Aidan	Loasby	Milsearch	SA	Australia	Associate
Guido	Staltari	Renaissance Capital Pty Limited	VIC	Australia	Active
Michelle	Thomas	BHP	WA	Australia	Active

ASEG Research Foundation: Meeting notes

The ASEG Research Foundation held its usual meeting in conjunction with the AEGC. The meeting was held via Zoom, which turned out to be quite a successful way to hold it, although it was a pity that the circumstances prevented at least some of us catching up in person.

All members of the committee expressed their heartfelt thanks for the continued support provided to the Foundation by the ASEG Federal Executive. The annual funding that the ASEG provides helps to make our work worthwhile and really makes a difference.

There was quite a lot of discussion about the falling number of applications over the past few years, and the relevance and quality of those applications. The two academic members of the committee, Steve Hearn of the University of Queensland and Mike Dentith of University of Western Australia made a useful contribution to this discussion. The current situation aside, the parlous nature of earth sciences and, in particular, geophysics education in the various universities around Australia is of great concern to us all. Maybe it reflects real changes in the community's attitudes to the earth sciences and the extractive industries that we rely so heavily upon, and a shift to attitudes that are more aligned to the "softer" professions. As a Society, we can't be guided by that. The world will always need the skills of earth scientists and, in particular, geophysicists to create a secure and worthwhile future for humanity. Ted Tyne indicated that the Federal Executive is more than aware of the issue, however the ASEG Research Foundation would like to formally express its concerns.

As a result of a membership drive after our meeting in Perth, we successfully welcomed a number of new members to the Research Foundation. They are Tania Dhu, Ian James, Mike Haederle, Roland Hill, Asmita Mahanta, Sharna Riley and Chris Wijn. We also welcomed Joe Cucuzza who re-joined the Foundation. This group changes the age profile and diversity of the group, and they all made valuable contributions to the meeting last week and to the earlier project selection process.

Finally, I thank Doug Roberts, Secretary, and Peter Priest, Treasurer, along with the committee convenors, for their on-going dedication to the ASEG Research Foundation.

Phil Harman
ASEG Research Foundation Chair
research-foundation@aseg.org.au

ASEG Technical Standards Committee: Meeting notes

The ASEG Technical Standards Committee met via Zoom on Monday 6 September 2021. Participants were: Kim Frankcombe, Mark Duffett, Dave Pratt, Des Fitzgerald, Phil Heath, Tim Keeping, Adrian Hitchman, Simge Ayfer, David Allen, Astrid Carlton, Richard Barnwell, Yvette Poudjom Djomani, Sam Matthews, Tania Dhu, Tim Leonard, Suzanne Haydon, Difu Wang, Matthew Roth, David Howard, Jeff Keetley, James Goodwin, Matt Zengerer and Shane Mulé.

Several issues were discussed. These were: JORC, new data formats, standard aliases, and geophysics techniques being overlooked in Australia. Discussion started with the current JORC review and where ASEG can assist with financial regulator demands that the Competent Person be recognised as qualified to practice in the methods reported. As a body created to promote science the ASEG cannot designate a Competent Person, but we can help guide the societies that are recognised by the investment regulators. David Pratt and Kim Frankcombe will take this topic to Fedex.

Adrian Hitchman gave an excellent overview of the move by MT practitioners to the IRIS HDF5 data format. The committee will convey its provisional acceptance of both the IRIS specifications and Des Fitzgerald's recommendations to Fedex.

It was noted that magnetic gradiometry was an underutilised technique in Australia, while it is apparently a norm in Africa. It is hoped that promoting gradiometry in government surveys and publicising the benefits of the technique will both bring down the acquisition price and improve exploration outcomes.

It was also noted that when Lidar and geophysical surveys are combined there can be a conflict between the requirement for lower altitudes for good geophysics, versus higher altitudes for good Lidar. Lidar usually suffers most in the compromise. It was suggested that the ASEG should assess and promote benefits of pre-survey Lidar flights for accurate surface models.

The lack of acquisition standards in geophysical drone surveying was discussed. Contractors are increasingly being asked to sort out the drone data that exploration companies have received. As it would seem that "every man and his dog" has a drone start up business, it was agreed that dialogue with surveyors would be futile. As alternative it was further agreed that the ASEG should create test range(s) for drone surveyors to draw them towards our standards, while promoting contracts setting out those standards. Des Fitzgerald remarked that Rainer Wackerlee rough-drafted drone magnetic surveying guidelines for the SEG and these could be resurrected for our purposes.

A new sub-committee headed by Astrid Carlton is tackling the problem of data naming conventions. This is a perennial topic in an industry with new data variants and now, expectations from AI/ML. David Pratt commented that we traditionally do not constrain column names but instead promote standard data aliases through formats like GDF2. This standard could grow to include other topics such as aliases to standardise the three major airborne gravity techniques, and expand to file naming conventions.

Many of the meeting participants were surprised to learn that GGIC automatically directs geophysics queries to ASEG. In this regard the ASEG website is an active resource for companies submitting data. As a consequence, we should consider the website functionality in relation to the National Submission Guidelines and ensure that it assists explorers with achieving compliance (FAQs, explanations, etc).

If readers have any questions at all, just email us at technical-standards@aseg.org.au.

Tim Keeping
ASEG Technical Standards Committee Chair
technical-standards@aseg.org.au

ASEG History Committee: Milestones in Australian exploration geophysics.

As reported in *Preview 212*, the History Committee, as one of its current projects, is compiling milestones by geophysical methods with an Australian focus. Lists are currently being developed for magnetics, electrical and electromagnetic, engineering and environmental and geophysical discoveries, with good input from the History Committee. Also, lists have been started for Seismic and Gravity but are, as yet, mostly instrumentation. What should also be included are milestones of relevant interpretation and applications and the Committee now invites the Preview readership to contribute entries to any of the above methods. Please contact history@aseg.org.au and your suggestions will be forwarded to the relevant compilers on the Committee.

For the electrical and electromagnetic milestones, a nomination process has been devised with a nomination form to be used (see below). You are invited to make nominations now. At least two geoscientists should make a nomination for a listing against this method, with one of the nominators being a current Member of the ASEG. Nominations may be submitted at any time of the year. Nominators are encouraged to apply the best combination of brevity and accuracy. Both individual recognition and group (or team) recognition is available for listing when multiple workers deserve inclusion.

A sample of some of the milestones already nominated are:

1972 - 74. CSIRO. SIROTEM. The fully digital microprocessor controlled TEM.

1975. B.R. Spies. Dual-loop for TEM.

1996+ R. Lane. Tempest airborne EM

2019. J Macnae. ARMIT. Magnetic field sensors.

Roger Henderson
ASEG History Committee Chair
history@aseg.org.au

NOMINATION FORM

The ASEG History Committee's record of electrical and electromagnetic milestones

The ASEG intends to compile a listing of significant milestones of Australian geophysical technological advances and innovations. The purpose of this Nomination Form is to provide information for the listing and recognition of a significant achievement in the field of electrical exploration geophysics or in the field of electromagnetic exploration geophysics applied within Australia. Submission of this form requires naming the key innovator, or team of innovators, stating the nature of the achievement, and the timing of the achievement.

This concept was stimulated by the receipt of a PDF compilation from Ken Witherly and Louise Pellerin entitled "Significant events electrical and electromagnetic methods", which covers an interval from 1830 to 1986 and focuses on North American events.

NOMINEE ……Provide name of person(s) nominated.

NOMINEE CONTACT……Provide name, phone and email contacts.

……

……

REASON FOR NOMINATION……State nature of contribution.

……

……

……

DATE OF ACHIEVEMENT ……Year(s) of achievement.

SUPPORTING DATA ……Attach a list of publications or presentations related to the nature of the nominee's contribution, and describe any forms of recognition relating to the nomination.

NOMINATOR 1……Provide name, phone and email contacts.

……

……

NOMINATOR 2……Provide name, phone and email contacts.

……

……

DATE OF NOMINATION SUBMISSION……

Note: A minimum of two nominators are required, and there may be more than two, with at least one nominator being a current Member of the Australian Society of Exploration Geophysicists. Please attach contact details of any additional nominators.

ASEG branch news

Western Australia

Hi, once again, from Perth. Yup, we've been fairly active since July and will keep carrying forward. I'll just try to list the things we're up to, and hopefully won't forget too many things that are going on. Way back on 22 July, **Paul Mutton**, a consulting geophysicist from Touchstone Geophysics, gave us a riveting Tech Night talk on his experiences in and about Kamchatka (Russia) Nickel Projects. Somehow he had some Russian core samples, which were on display during his live presentation at the Shoe Bar in the Perth CBD. Extremely well-attended and a tonne of questions and comments 😉.

A few days afterwards, on 26 July, two of our WA committee members (**Darren Hunt** and **Michel Nzikou**) attended and presented at the St Mary's Anglican Girls' School and Hale School Careers Expo 2021, impressing the heck out of the students and parents. Michel, BTW, is now our local representative on the new ASEG Communications Committee.

We managed to just squeak our August Tech Night into August … 32 August… **Jennifer Market**, Geophysics Manager from Epiroc's Kinetic Logging Services gave us a very interesting talk on the newer tech used to speed up and consolidate mineral assays: (almost real-time) downhole assays via elemental spectroscopy. Also, at the Shoe Bar and also very well-received.

Paul Mutton's Tech Night talk.

Paul's Russian core samples.

And, since COVID-19 seems to be holding off well in WA, the sponsored and scheduled AIG-ASEG-PESA YP Networking Evening went off without a hitch on 22 September. Yup, at the Shoe Bar again.

WA ASEG is also sponsoring what hopefully this year can be a face-to-face GSA Earth Science Student Symposium-WA (GESSS-WA) 2021, which will be held at Curtin University, tentatively on 25 November.

Inevitably, this year's AEGC was virtual, and so our four student award winners were not able to attend in person via our ASEG funding, but I'm sure their talks were well-received, and that universities and companies have taken notice of these local, sharp individuals.

Okay, and lastly, we've got a hard-working volunteer team from our WA committee and members working on putting together a late-November day-long (in-person) seminar for our Members (and potentially other organisations) tentatively titled "MAG21 – modern applications of geophysics: Case studies from minerals and mining". Sounds pretty flash to me.

Once again I'll say - stay safe and healthy, everyone!

Todd Mojesky
wapresident@aseg.org.au

Australian Capital Territory

The last few weeks have been busy for ACT geophysicists. On 2 September, **Jack Muir** from Caltech Seismolab gave an online talk on "Preconditioned compressive sensing for wavefield reconstruction: Applications to tomography, Helmholtz-Hodge decomposition and Distributed Acoustic Sensing". His lecture focused on methods which require spatial derivatives as part of the imaging process, but such derivatives are not easily obtained from conventional processing methods.

In other news, geophysicists at Geoscience Australia (GA) were busy preparing for the virtual AEGC 2021 conference, with one of the highlights being a GA organised workshop on the "Frontiers of AEM inversion and interpretation" with attendees from all over the world. The keynote talk was given by

Michel Nzikou and Darren Hunt at the Schools Career Expo.

Jennifer Market's Tech Night talk (on 1 September).

Dr **Lindsey Heagy** from the University of British Columbia, Vancouver. There up to 54 attendees for a full day's virtual workshop, and various topics from inversion uncertainty to the incorporation of induced polarisation or super-paramagnetism, and integration of seismic chronostratigraphy were vigorously discussed. Lastly, an interdisciplinary team from GA's Minerals, Energy and Groundwater Division won the best paper in near surface geophysics at the AEGC for their work on probabilistic classification of groundwater salinity in the Kimberley region of the Northern Territory.

Anandaroop Ray
actpresident@aseg.org.au

New South Wales

Oh 2021, you tumultuous year! We started the year in lockdown (remember those subdued New Year's Eve celebrations), enjoyed some months of freedom and now here we are. Sydney and now regional NSW have been in lockdown for 12 weeks at the time of writing. Now we can definitely empathise with our friends in Melbourne! The restrictions are ever so slightly easing and hopefully by the time you read this we will have some freedoms; but, in the meantime be sure to take care of yourselves.

ASEG NSW does not have any branch-specific activities to report; but, this is not where we will end our article, a very different AEGC just wrapped up. A huge thank you is extended to the AEGC organising committee for successfully coordinating an in-person event, which was then switched to hybrid, and finally a virtual conference. Despite it being virtual, many fun and engaging conference activities were available, and the sense of community amongst us was not lost.

A lot of interesting material was presented by NSW members and we congratulate these presenters for their hard work and pioneering research. In particular, PhD student, **Tom Zhao** (UNSW), 2020 winner of the student scholarship, presented at the fast-paced GeoPitch session with a fun talk titled "Serve farmers with geophysical data!". Also, our very own NSW President, **Jim Austin** (Mineral Resources, CSIRO), presented his research on "Geophysical proxies for redox gradients in IOGC systems: Cloncurry District, Qld, Australia". Many NSW members were also recognised during the ASEG Honours and Awards ceremony. **Blaire McKenzie** was highly commended for the Shanti Rajagoplalan Memorial Award, and **Joel Kumwenda** was the 2021 winner. **Doug Morrison** was the recipient of the Lindsay Ingall Memorial Award for his significant work on airborne geophysical surveying. And finally, **Mark Lackie** was awarded an ASEG 50th Anniversary Special Award for dedicated service over a long period for his many years of outstanding commitment to the geophysics community through teaching, research, mentoring students, and contributions to ASEG through his 14-year presidency, chairing major conferences and collaborations with other geoscientists. Further information about all the ASEG Honours and Awards including the full citations can be found elsewhere in this issue of *Preview*. A big congratulations to all the honours and award recipients, with an extra special round of applause to the NSW team!

An invitation to attend NSW Branch meetings is extended to interstate and international visitors who happen to be in town at that time. Most talks are livestreamed on zoom and uploaded to ASEG's YouTube page later, so you also have the option to join us online. Meetings are generally held on the third Wednesday of each month from 5:30 pm at Club York. News, meetings notices, addresses and relevant contact details can be found at the NSW Branch website. All are welcome.

Stephanie Kovach and Jim Austin
nswsecretary@aseg.org.au
nswpresident@aseg.org.au

Darren Hunt presenting Jennifer with a well-earned bottle of wine.

Queensland

In July we welcomed two recent graduate geophysicists; **Dale Harpley** and **Callum Kowalski** who presented on their theses. Dale's talk was titled "Attenuation of ice sheet reverberations in teleseismic P-wave receiver functions" and Callum's talk was titled "Compressive sensing: Key concepts in recently developed data acquisition". The talks were well attended and instigated a good technical discussion of the concepts presented. The talks were live-streamed, the first time the Qld ASEG has attempted live-streaming. We hope to live-stream more events in the future.

Our annual Zoepprittz night was held on 30 July and had a dozen revellers celebrating and socialising. Highlights included good beers, decadent burgers, fruity cocktails and/or smokey scotches. Thanks to those who attended.

Of course, September also brought the fully virtual AEGC conference. Whilst it was disappointing not to be able to host the geophysical and wider exploration geoscientific community in Brisbane, it was great to see so many at the virtual events. We were extremely proud to see Qld members receiving awards; congratulations to **Mal Cattach** for receiving the ASEG Gold Medal, to **Henk Van Paridon** for receiving an Honorary Membership and to **Fiona Duncan** for receiving the ASEG Service Certificate. The Qld committee hopes to hold a face-to-face event to further celebrate these achievements in the near future. In the interim we invite everyone to mark the 2023 Brisbane conference in their calendars.

We have several events planned leading up to the end of the year. In October we'll welcome **Randall Taylor** of Taylor Exploration Consulting to present "What happens when petroleum geoscientists go in search for minerals?" and in November, **Peter Fullagar** will present the second part of his talk from earlier in the year titled "Beyond plates – fast TEM inversion using conductive ellipsoids". Additionally, we're looking to repeat the success of previous Trivia nights hosted by Henk in mid-October, and will be again jointly hosting our Christmas event on 25 November with QUPEX, PESA and SPE. As always, we invite Queensland Members to send any feedback or suggestions to the committee.

James Alderman
qldpresident@aseg.org.au

South Australia & Northern Territory

The SA/NT Branch were happy to sponsor all of the six students that applied for grants to attend the virtual AEGC 2021 conference. We covered the cost of registration and up to two workshops for each applicant (provided the total cost was less than $1000). The six students were **Yi He** (University of Adelaide, Honours), **Oliver Hatswell** (Flinders University, Masters), **Mosayeb Khademi Zahedi** (University of SA, PhD), **Sam Jennings** (University of Adelaide, PhD), **Michael Everett** (Flinders University, PhD) and **Alex Hill** (University of Adelaide, Honours). It was great to see such a range of geophysical studies represented in the students' work, from broad scale crustal MT, near surface archaeology, petrophysics and thermal modelling.

On 5 October Sam Jennings (University of Adelaide) will be presenting a talk on work he has completed as part of his thesis "Nature of the lower crust" at the Coopers Alehouse. We've got our annual Spring Fling networking night hosted by the local ASEG, SPE, YPP and PESA branches on Thursday 21 October at the Havelock Hotel, which is sure to be another great night. If you're in SA on 26 November, the annual South Australian Exploration and Mining Conference (SAEMC) is always awesome to find out the latest mineral activities in the state which is proudly organised by the local ASEG branch and other geoscience professional associations.

Make sure to keep your eyes open for the annual ASEG wine offer, as we've got another great selection of wine on offer to all members again this year. Details can be found elsewhere in this issue of *Preview*.

We couldn't host any of our fantastic events without the valued support of our sponsors and we look forward to seeing as many of you as possible at the events the local branch committee is organising for the rest of the year. The SA/NT Branch is sponsored by **Beach Energy**, **Oz Minerals**, **Vintage Energy**, **Minotaur Exploration**, the **SA Department for Energy and Mining**, **Zonge**, **Santos** and **Heathgate**.

Ben Kay
sa-ntpresident@aseg.org.au

Tasmania

The Tasmanian Branch held its first hybrid (in person and online) technical meeting in the CODES conference room at the University of Tasmania on Thursday 26 August. **Richard Lynch** of Sisprobe delivered an excellent introduction to ambient noise interferometry for exploration, illustrated with applications in Canada (for PGM-Cu layered intrusions), South Africa (manganese) and Queensland (beneath sedimentary cover near the Mount Isa Inlier). The effectiveness and efficiency of this passive seismic technique as a low-cost method was amply demonstrated. A flurry of post-talk questions indicated a high level of interest from an audience numbering well in excess of 60, including both online and in-person attendees. Many of those lucky enough to be in the latter category subsequently adjourned to dinner at a nearby restaurant, where the proverbial good time was had by all, thanks not least to a contribution from the 2020 ASEG wine offer consignment.

Richard's presentation and subsequent Q&A are available at the ASEG's YouTube channel (https://youtu.be/El0uqYlrGGA).

Meeting notices, details about venues and relevant contact details can be found on the Tasmanian Branch page on the ASEG website. As always, we encourage Members to keep an eye on the seminar/webinar programme at the University of Tasmania / CODES, which routinely includes presentations of a geophysical and computational nature as well as on a broad range of earth sciences topics.

Mark Duffett
taspresident@aseg.org.au

Victoria

My oh my. That was certainly the biggest one I've ever succumbed to. It

Richard Lynch accepts a token of thanks and appreciation from Tasmania branch president ***Mark Duffett****. Photo courtesy of* ***Nick Direen****.*

was a pleasure like no other. My body swayed gently, my anxiety heightened and my walls literally rattled. It was a sensation I have been waiting to experience time and time again since the first time it happened. Admittedly, this time around, it was even better.

No, I am not talking dirty. It just so happened that the largest recorded earthquake to ever hit this state was felt as far as South Australia, New South Wales, Tasmania and even Queensland. And just to be politically correct, even the ACT 😊

It was a 5.8, possibly even a 6.0 on the famed Richter-scale with a calculated epicentre near Victoria's premier ski resort at Mount Buller. What a thrill it would have been for those lucky enough to experience some 'seismic skiing' this morning. Following the earthquake, I immediately jumped onto social media to discuss this significant event with fellow geoscientists. Everyone I chatted to was shocked! 😉 One person even made an untimely joke but it just fluorite over my head. I actually experienced an unusual side-effect from the earthquake – hunger pains – so I dashed down to my local café and ordered a tectonic plate to go. Unfortunately, it won't be here for a while. Ok, let's not talc about that bad quip because I've just lost my apatite.

In actual branch news, there is nothing to report. The annual ASEG-PESA-SPE winter social was planned for mid-August and then for mid-September, but COVID lockdown took care of that. Victoria Branch will be lucky to host any event by years' end. Fingers crossed. Anyway, earthquake or not you should go get yourself vaccinated if you haven't already. One thing's for certain - geology puns are great as they really draw pebble together. Of quartz it does!

Thong Huynh
vicpresident@aseg.org.au

ASEG national calendar

Date	Branch	Event	Presenter	Time	Venue
ASEG Branch face-to-face meetings have been suspended in many states due to COVID outbreaks. Some branches are still hosting webinars. Registration is open to Members and non-members alike, and corporate partners and sponsors of state branches are acknowledged before each session. Recorded webinars are uploaded to the ASEG's website (https://www.aseg.org.au/aseg-videos), as well as to the ASEG's YouTube channel (https://bit.ly/2ZNgIaZ). Please monitor the Events page on the ASEG website for the latest information about upcoming webinars and other on-line events					
Oct	QLD	Trivia night	Henk van Paridon	TBA	TBA
5 Oct	SA_NT	Tech talk	Sam Jennings	17:30	Coopers Alehouse, Adelaide
12 Oct		Tech talk	Randall Taylor	17:15	XXXX Ale House, Paten Street, Milton
20 Oct	NSW	Tech talk	Sam Matthews and Astrid Carlton	18:00	Webinar (https://us02web.zoom.us/webinar/register/WN_fWZnFRp1Q2q9wOapDGGHkA)
21 Oct	SA_NT		Spring Fling	TBA	Havelock Hotel, Adelaide
25 Nov	WA	Earth Science Student Symposium (GESSS-WA)	Various	TBA	Curtin University, Perth
Nov	MAG21	Various	TBA	TBA	
Nov	QLD	Tech talk	Peter Fullagar	17:15	XXXX Ale House, Paten Street, Milton
25 Nov	QLD	Christmas party	TBA	TBA	

The first magnetotelluric survey in Australia – as witnessed by Roger Henderson in 1968.

Roger Henderson
rogah@tpg.com.au

After receiving my MSc in deep resistivity from Sydney University and becoming the foundation lecturer in exploration geophysics at Macquarie University in 1968, my wish was to start a PhD in magnetotellurics.

Magnetotellurics (MT) is a passive electromagnetic method that uses natural time variations of the Earth's magnetic and electric fields to measure the electrical resistivity of the sub-surface.

The principles of MT are based on the theory expounded by Cagniard (1953). The method was in its infancy in 1968, and the only text book, just newly published, was Keller and Frischknecht (1966). I had also just read a paper on the subject by Vozoff (1963) and, in addition, an account of some Russian activity in Siberia (Alexeyev *et al.*, 1967). Keeva Vozoff subsequently became an expert in MT while Professor of Geophysics at Macquarie University from 1972-94.

As preparation for my studies I arranged to visit the first MT survey in Australia, which was taking place at that time. It was located in the Canning Basin, WA and operated by Societe Nationale des Petroles d'Aquitaine (SNPA) of Pau, France, for its affiliated company, Australian Aquitaine Petroleum P/L.

The field camp was 750 km WNW of Alice Springs in the northern Gibson Desert, and was reached by me in 1968 by flying from Sydney to Alice Springs, taking the 5-seater aircraft servicing Wilson Cliffs No. 1 oil well (at: 126.5° E, 22.3° S) and driving 150 km south over never-ending sand dunes to the camp

Figure 1. *Part of the featureless 150 km of track leading to the camp. Source: the author's 35mm slide.*

in the Terry Range[1] (see Figure 1). After a long, hot day, upon arrival at this most remote place. I was offered any amount of ice cream from the refrigerated van that also contained fresh lobsters flown in from Darwin. Being a French company, as well as the usual cook in the crew of seven, they also had a Chef.

As MT has now been practiced for over 50 years and is currently at a highly sophisticated level, I won't explain the technique any further except to highlight the differences between the 1968 and modern surveys. This may be of particular interest to current practitioners of the method. A webinar given recently by Wenping Jiang from Geoscience Australia, titled "Application of multi-scale MT data to mineral exploration" acquainted me with the latest developments in the method (https://www.aseg.org.au/search/node/Wenping%20Jiang).

The crew of seven included two engineers from SNPA. This meant that Pau, who had developed the equipment, were able to modify and maintain it. One of the engineers was Marcel Waeselynck who had published full details of the method internally (Waeselynck, 1967).

1 Another description of the survey location is; east of Well No. 27 of the Canning Stock route along which a magnetometer survey was conducted by Edward Kidson in 1914, as described by Doug Morrison (2005).

The following specifications are from notes that I made of the trip.

The telluric electrodes were 40 cm long lead rods with up to three placed in parallel. The magnetic measurements were made with 2 m long induction coils of 30 000 turns on a mu-metal core. Both electrodes were buried to avoid wind noise, as usual (see Figure 2). Measured components were filtered and recorded on a two-channel chart recorder and played

Figure 2. *An induction coil part buried. Source: the author's 35 mm slide.*

back on magnetic tapes in analogue and digital. Header information was placed on the tapes by voice registration.

Three overlapping ranges of frequencies were recorded in analogue and only the lowest and middle ranges in digital format. The lowest was recorded for 3 hours, the middle for 20 minutes and the highest for 5 minutes. Two soundings could be completed in each 24 hours and, as the station spacing was 10 km, the camp at the centre of 5 stations was moved 50 km every 3 days.

Preliminary calculations were conducted in the field using known empirical factors, and final reductions and interpretation were done 'on a computer' (!). I am not sure if the computer was held in the field or in Pau.

Preliminary results of the survey gave qualitative agreement with seismic results in the area, and suggested that new information could be obtained in places where seismic was unobtainable. I then recorded in my notes that the method would develop and be used further in Australia. I also postulated that when technical problems of remote control and sensing are solved, the method might well be applied offshore (!).

References

Alexeyev, A.M., *et al.*, 1967. Proceedings 7th World Petroleum Congress, Section I, 697-708.

Cagniard, L., 1953. Basic theory of the magneto-telluric method of geophysical prospecting, *Geophysics* **18** (3), 605-635.

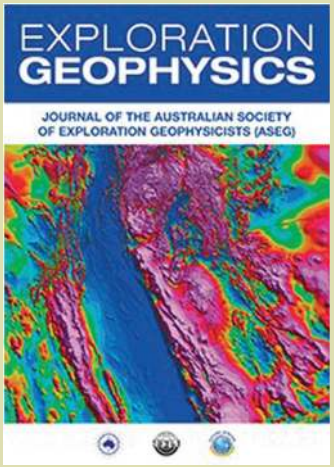
Keller, G.V. and Frischnecht, F.C., 1966. *Electrical Methods in Geophysical Prospecting*. Pergamon Press, 517 pp.

Morrison, D., 2005. 90 Years Ago – some pioneering field trips (Part 1), Kidson and his camels, *Preview*, **115**, 16-18.

Vozoff, K. *et al.*, 1963. Results and limitations of magneto-telluric surveys in simple geologic situations, *Geophysics* **28** (5), 778-792.

Waeselynck, M., 1967. *Bulletin of Centre of Research*, Pau, SNPA, v.1, 417-436.

Exploration Geophysics Special Issue: Call for papers



We are delighted to announce a special issue of the ASEG's technical journal *Exploration Geophysics,* entitled 'Lithospheric to deposit scale magnetotellurics advancements including AusLAMP in Australia'.

We invite you to submit your expressions of interest to the Special Editors by 31 August, 2021. Accepted expressions of interest will be due for submission to *Exploration Geophysics* by 31 March, 2022.

Scope of issue

Although the magnetotelluric (MT) technique was first used in Australia in the 1960s, it has only been widely adopted by academia, government, and industry over the last two decades, bolstered by the realisation of its important role in mineral and energy exploration undercover.

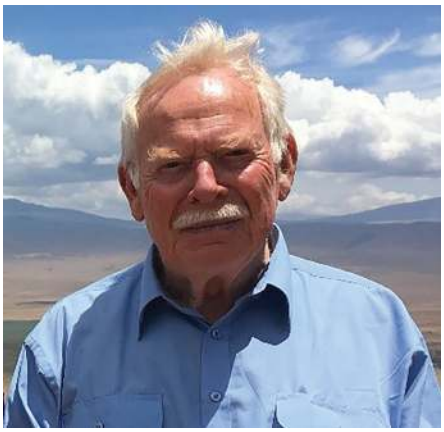
To date, there are many MT surveys and associated innovations across Australia. The national MT programme - Australian Lithospheric Architecture Magnetotelluric Project (AusLAMP), which is half way to covering the continent, has revealed major insights into the tectonic evolution and mineral systems of Australia, and inspired subsequent 'infill-surveys' for further investigations.

This special issue invites papers that focus on MT studies in Australia, including but not limited to applications in resource exploration, modelling/inversion, interpretation, innovations, and representative case studies.

Special editors

Kate Robertson Kate.Robertson2@sa.gov.au
Graham Heinson Graham.Heinson@adelaide.edu.au
Jingming Duan Jingming.Duan@ga.gov.au

Vale: John Henry Coggon (1944-2021)



John Coggan

It is with sadness that we record the death of John Henry Coggon on 7 August 2021 in Perth after a short period of illness. He is survived by four children Tula, Hunter, Peter and John together with eight grandchildren.

John will be remembered as a gentle man and a gentleman with a deep knowledge of geology and geophysics who always had time to lucidly explain the opaque world of geophysical interpretation to those who needed to look below the earth's surface.

He was born in Aldershot in the UK and moved with his family through Singapore and Malaysia before they settled in New Zealand. He obtained a BE (Hons) in mineral engineering and a BSc in mathematics at the University of Otago graduating in 1966. He then went on to study with the geophysical engineering group at Berkeley California graduating in 1971 with an MSc and DEng in geophysical engineering. John was part of a small group of students supervised by Dr Stan Ward who pioneered the use of numerical methods to model the electrical and electromagnetic responses of two-dimensional earth models.

During his time in the US he met Wendy Farley and they were subsequently married in New Zealand in 1972.

John returned to the University of Otago where he was lecturer in exploration and solid earth geophysics until 1976 when he was hired by Roy Woodall at Western Mining Corporation (WMC) to improve the effectiveness of geophysical exploration for nickel sulphide mineralisation, particularly electrical and electromagnetic methods in the Western Australian Archean. John's role was expanded from senior geophysicist to senior supervising scientist reflecting the depth and breadth of his contribution to the company.

He left WMC in 1982, wanting to remain in Kalgoorlie, and began a private consulting practice which he formalised as Mines Geophysical Services in 1991. From 1977 to 2010 John held various appointments at the WA School of Mines in Kalgoorlie from Lecturer to Senior Lecturer and Adjunct Professor.

John partially retired in 2013, moving with Wendy to their dream retirement location near Denmark on the south coast of WA, where he designed the house they built using heritage materials collected over many years. Wendy passed away in January 2018.

His quiet unassuming demeanour belied an intelligent, thoughtful and analytical approach that characterised his professional work. John's deep understanding of potential field and electrical/electromagnetic theory and practice informed his daily work. Few were aware of the original insights and techniques that underpinned his drill targets. He published original work in gravity and magnetics, drill hole EM, deep IP, EM and magnetic interpretation. He consulted on projects in 11 countries for many commodities and companies.

John was an active member of Rotary, hosting several exchange students over the years. He enjoyed restoring old houses and furniture, bushwalking and travelling.

Don Pridmore and Greg Hall
d.pridmore@hiseis.com
greghall06@hotmail.com

Free subscription to *Preview* online

Non-members of the ASEG can now subscribe to *Preview* online via the ASEG website. Subscription is free. Just go to https://www.aseg.org.au/publications/PVCurrent to sign up. You will receive an email alert as soon a new issue of *Preview* becomes available. Stay informed and keep up-to-date by subscribing now!!

NB: ASEG Members don't need to subscribe as they automatically receive an email alert whenever a new issue of Preview *is published.*

Kathy Ehrig receives inaugural AGC Roy Woodall Medal

After several failed attempts related to the pandemic, the Australian Geoscience Council (AGC) was finally able to make a formal presentation of its prestigious Roy Woodall Medal (https://www.agc.org.au/geoscience-in-australia/roy-woodall-medal) at the *Copper to the World Conference* in Adelaide on August 31 2021. A highlight of the presentation to inaugural winner, Dr Kathy Ehrig of BHP, was the presence of Roy's widow Barbara, who spoke about Roy's role in the inception of this award and his mentorship of Kathy. All in all, this was a very moving ceremony, coming as it did only a few months after Roy's death.

The Roy Woodall Medal seeks to recognise scientific excellence in both mineral exploration and the documentation of world-class mineral deposits. It honours the extensive contribution to scientific excellence in mineral geoscience that the late Roy Woodall AO made over his lifetime. Roy Woodall's high scientific standards, innovative approach to exploration and use of the latest geoscientific techniques have left an enormous and lasting legacy of improved scientific methodologies and exploration successes. The WMC team under Roy's leadership made many world class discoveries in Australia, several of which opened up entire new mineral provinces. The most notable of these include the Darling Range Bauxite Province, the Kambalda Nickel District, the Olympic Dam Copper-Gold-Uranium deposit and the St Ives Gold Camp. More importantly than even these discoveries, Roy's dedication to the training and mentorship of other geoscientists has advanced the capabilities of Australia's mining and exploration industries and the development of our nation.

The intention of this award is to recognise those individuals that seek to emulate Roy's contribution to the mineral industry by applying the best science to the endeavours of mineral exploration and the documentation of world-class mineral deposits. In addition, the award intends to encourage the ethos of scientific excellence that Roy so strongly advocated.

Dr Kathy Ehrig received a BSc in geology from California State University, Fresno in 1984 and a PhD in geology from the University of California, Berkeley in 1991. She began her career as a Geological Technician with the United States Navy in 1974, then went on to work with WMC and, later, BHP Billiton as Principal Geometallurgist at Olympic Dam. Her accomplishments at Olympic Dam have included leading the team that developed the geometallurgical models and metallurgical performance predictors for the entire Olympic Dam deposit, establishing the mineralogical relationship between sulphide mineralogy and concentrate grade, and developing quantitative relationships that predict mineral abundances based on drill core assays. Her work provided the conceptual framework that supported BHP's recent Oak Dam West discovery. At Yeelirrie Dr Ehrig developed the metallurgical performance predictors for a calcrete-hosted uranium deposit and built the world's first clay mineral model for an entire deposit, which involved innovative adaptation of existing technology.

Dr Ehrig is a particularly fitting inaugural winner of the Roy Woodall Medal because she was personally recruited by Roy Woodall to WMC Resources from University of California, Berkeley, and was mentored by Roy for many years.

Dr Kathy Ehrig receives her award from Barbara Woodall, the widow of Roy Woodall.

Ned Stolz joins Southern Geoscience Consultants

After holding a series of senior roles in government and industry, Ned Stolz is joining Southern Geoscience in the position of Principal Geophysicist.

Ned began his career with CRA on regional scale exploration for uranium and base metals before returning to university to complete a PhD in electromagnetic geophysics. After this he joined Western Mining to apply his electromagnetic knowledge to nickel sulphide exploration in the Agnew - Wiluna belt of WA. In 2001 Ned moved on to St Ives Gold Mine where he honed his potential-field skills and adapted reflection seismic methods for hard rock exploration. His interest in mineral systems targeting and databases led him to the role of Group Leader - Geophysics at Geoscience Australia in Canberra, responsible for all onshore and airborne geophysical acquisition.

Most recently Ned was Manager – Geophysics and Modelling at the Geological Survey of New South Wales. Highlights of his time at the Survey included delivery of all publicly available geophysics through the MinView web portal and completion of the AusLAMP long-period MT survey across New South Wales.

Ned is looking forward to returning to hands-on technical geophysics and says that "Southern Geoscience offers me the chance to work in a collaborative team assisting clients with exploration projects across a wide range of commodities and geological terrains. The ability to consult with other expert geophysicists and having access to the latest processing and modelling software ensures we can deliver the best solutions for our clients."

Ned's new contact details are: ned.stolz@sgc.com.au or phone 0429 055 321

Ned Stolz – one of the lucky ones on the ski slopes this winter.

Geoscience Australia: News

With the AEGC just behind us, I would like to acknowledge my colleagues at Geoscience Australia for their insightful, well-researched and impactful presentations. In all, we had eleven presenters covering stochastic inversion for AEM data, 3D potential field modelling, MT and passive seismic investigations, through to detailed basin studies (Table 1). Along with GA-facilitated and well-attended workshops on airborne EM and diversity in the geosciences, the value of our work was also communicated through key-note addresses focussed on the impacts of geophysical data releases by Minister Pitt and GA's Chief of Division, Dr Andrew Heap.

Many thanks to the ASEG AEGC team who made it all possible, and particular thanks for making the wise choice to transition the programme from a physical to virtual platform at short notice.

AEGC aside, a number of our 2020 - 2021 survey endeavours have recently been released, with details provided in Figure 1 and the tables in the following section. Key highlights for September are detailed below.

Exploring for the Future – Eastern Resources Corridor AEM survey

Just in case you missed it at the AEGC conference, the Eastern Resources Corridor AEM dataset was released in September. The 31 500 line km acquisition programme was completed in June and has been published with the full suite of contractor's products along with GA's own inversion routines. Spanning from Bedourie in Queensland to Cape Jervis in South Australia, and from Tibooburra in New South Wales to Warrnambool in Victoria (Figure 2), the data package is the first of many to be released as part of the extended Exploring for the Future programme (EFTF), with a focus on resource potential in southern Australia. Although a 100% Commonwealth-funded GA programme, it would not have been possible without land access assistance and other in-kind support from the Queensland, New South Wales, South Australian and Victorian Geological Surveys. The complete data package is available at: http://pid.geoscience.gov.au/dataset/ga/145744.

Exploring for the Future – Northern Australia AusLAMP model released

Between 2016 and 2019, Geoscience Australia acquired Australian Lithospheric Architecture Magnetotelluric Project (AusLAMP) long-period MT data as part of the Exploring for the Future programme in northern Australia. Geoscience Australia funded this project and the Northern Territory Geological Survey and the Geological Survey of Queensland assisted with land access clearances and other in-kind support.

Data modelling resolves the large-scale lithospheric architecture of most of the Northern Territory and western Queensland (Figure 3 and inset, Figure 3a). Strong spatial correlations between known iron oxide copper-gold (IOCG) and orogenic gold mineral deposits and good electrical conductors suggest these features may control the localisation of related mineral systems. On the other hand, base metal deposits that are broadly distributed on old resistive structures (~1800 Ma) suggest these deposits may be related to supercontinent assembly and have a

Table 1. Geoscience Australia presentations, AEGC September 2021. Numbers refer to AEGC listings.

Key Author / Presenter	Authors	Paper
James Goodwin	J Goodwin, and R Lane	80: The North Australian Craton 3D gravity and magnetic inversion models - A trial for first pass modelling of the entire continent
Anand Ray	D Blatter, A Ray and K Kerry	168: Nonlinear, 2D uncertainty estimation in magnetotelluric inversion using trans-dimensional Gaussian processes
Wenping Jiang	W Jiang, J Duan, Schofield, RC Brodie and A Clark	132: Multi-scale magnetotelluric surveys – mapping from the lithosphere to the near surface for mineral systems
Alexei Gorbatov	A Gorbatov, A Medlin, M Doublier, K Czarnota, T Fomin, P Henson and B L N Kennett	184: AusArray: uncovering major crustal features using passive seismic data
Jingming Duan	J Duan	228: Lithospheric resistivity structures and mineral prospectivity from AusLAMP data in northern Australia
Nadege Rollet	N Rollet, M Doublier, C Southby, C Carson, R Costelloe, T Fomin, Y LeyCooper, L Carr, M Bonnardot, J Wilford, S Wong, M Nicoll, K Czarnota, D Cathro and S Hostetler	81: Towards a 3D model of the South-Nicholson Basin region, Northern Australia, for mineral, energy and groundwater assessment
Tehani Palu	T Palu, A Jarrett, S MacFarlane, C Boreham and B Bradshaw	167: Northern Lawn Hill Platform – modelling the 'great-grandparent' emerging region
Adam Bailey	A Bailey, E Grosjean, A Jarrett, C Boreham, L Carr , D Edward , L Wang, S MacFarlane, C Carson, C Southby , J Anderson, K Khider and P Henson	158: Stratigraphic drilling in the era of EFTF: The Barnicarndy 1 and NDI Carrara 1 wells
Neil Symington	N Symington, A Ray, C H Pascal, K Piang Tan, Y LeyCooper Yusen, RC Brodie and R Taylor	197: Probabilistic modelling of groundwater salinity using borehole and AEM data
Yvette PoudjomDjomani	Y Poudjom Djomani and J Goodwin R Lane, Y Poudjom Djomani and P Wynne	206: Towards standard technical Deeds for (airborne) geophysical surveys in Australia 226: A new era for the Australian National Gravity Grids - adding airborne data to the mix
Matthew Gard	L Wang, A Lewis, B Jones, J Duan, A Hitchman and M Gard	91: Australian geomagnetic observatory network monitors space weather hazard – 180 years on

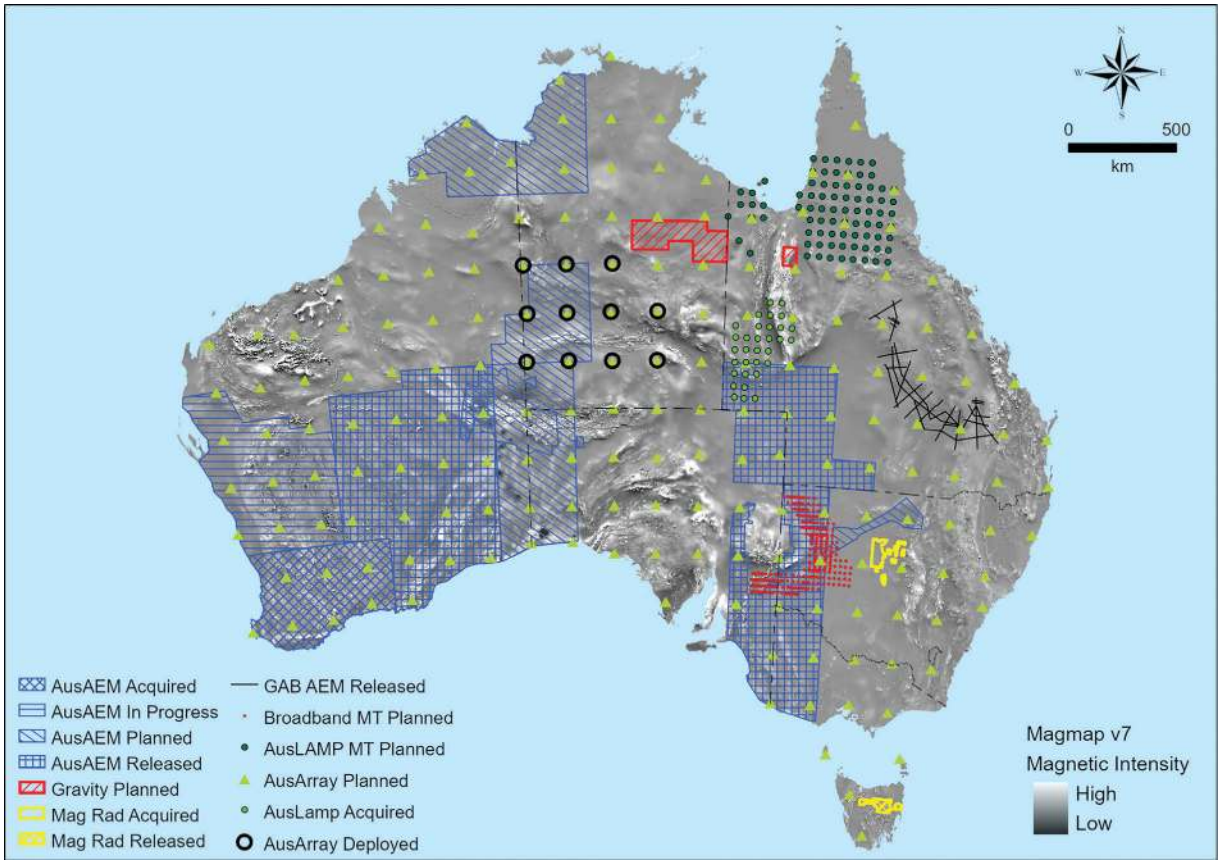


Figure 1. *2020 -2021 geophysical surveys – in progress, planned or still for release by Geoscience Australia in collaboration with State and Territory agencies.*

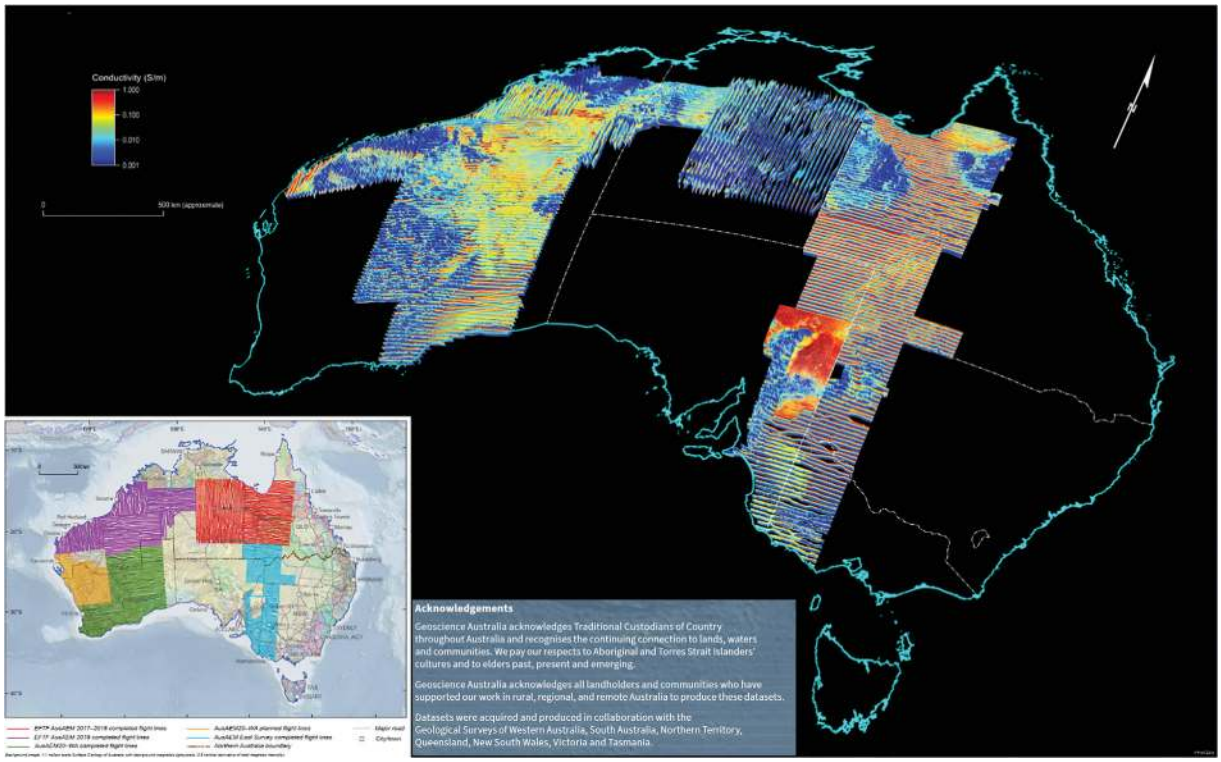


Figure 2. *National AEM survey coverage, September 2021. The recently completed Eastern Resources Corridor covers the 500 km wide band through Queensland, South Australia, New South Wales and Victoria. Shown here as electrical resistivity cross-sections (S/m), the entire compilation incorporates AusAEM1, AusAEM2, AusAEM20 and the South Australian Frome EM surveys. The new acquisition includes 31 500 line km, covers approximately 600 000 km^2 and was completed in less than three months by CGG (now XCalibur Multiphysics). AusAEM20 covering all of southern Western Australia will be completed before the end of 2021. The AusAEM programme has been expanded with funding from the Geological Surveys of Western Australia and Queensland, combined with valuable in-kind support from all Australian state and territory geological surveys.*

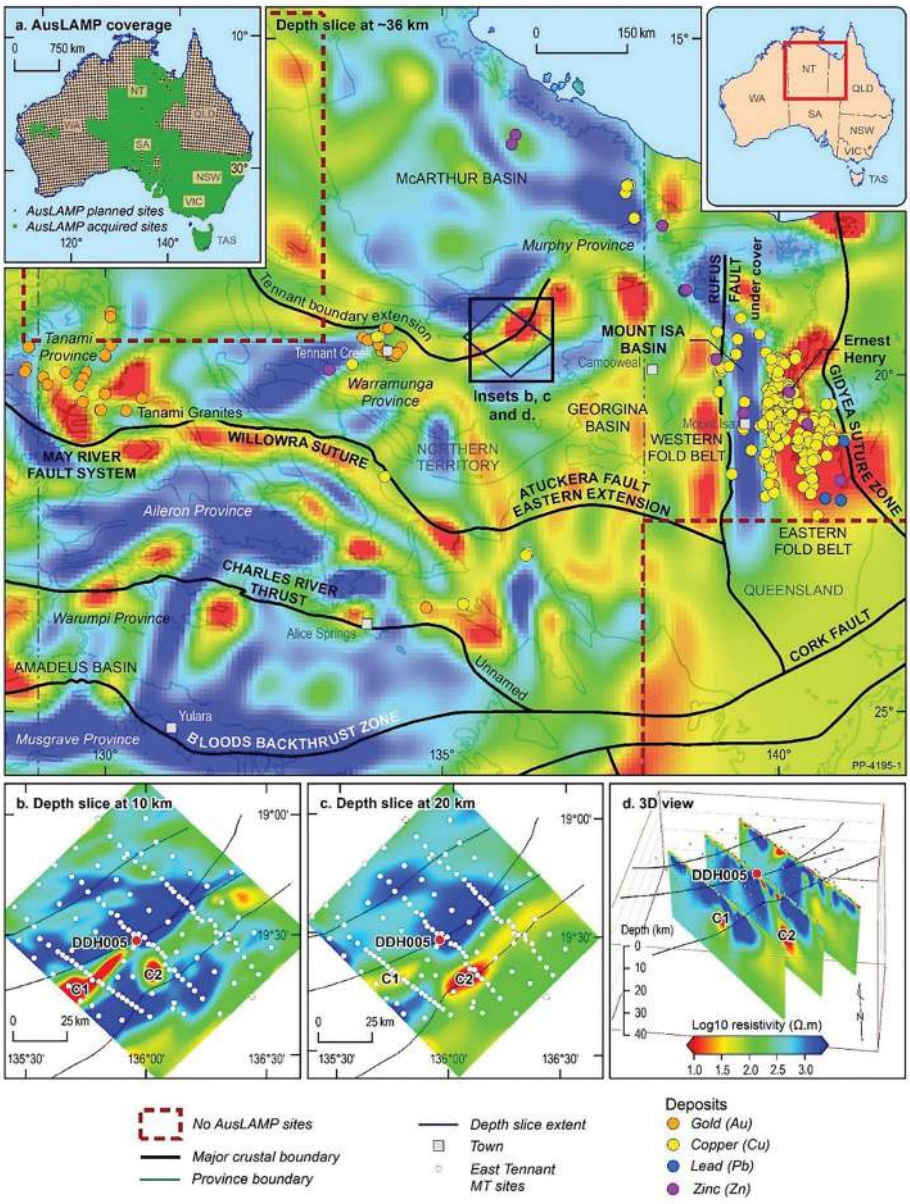


Figure 3. *Main map: AusLAMP resistivity model at ~36 km depth overlain by major geological provinces. Gold/yellow dots: gold/copper occurrences; black lines: major crustal boundaries (Doublier et al., 2016); dashed boxes: no AusLAMP stations. Inset maps: (a) AusLAMP sites. Green: data acquired; black: data acquisition planned. (b–c) East Tennant resistivity model ~10 km and ~20 km depth slices. (d) Vertical sections show conductors extending from lower crust to near surface. Black lines: major faults interpreted from seismic and potential-field data; white dots: MT stations; red dot: drillhole DDH005; C1, C2: conductors.*

different mineral-forming process from the IOCG and orogenic gold deposits. These results provide important first-order information for identifying the broad footprint of mineral systems.

In 2019, Geoscience Australia acquired higher-resolution infill broadband MT data to improve the constraints on geological architecture and understanding of mineral potential of the East Tennant region. Modelling of this data reveals two prominent conductors (Figure 3b–d, C1 and C2) that are interconnected with multiple conductive pathways linking fertile lower-crustal source regions to upper-crustal depositional sites near major faults. This finding suggests that major faults potentially acted as pathways for transporting metalliferous fluids to the upper crust to form mineral deposits.

Download more information about this AusLAMP work from:

- Data package and Exploring for the Future Extended Abstract – http://pid.geoscience.gov.au/dataset/ga/134997
- Model – http://pid.geoscience.gov.au/dataset/ga/145233
- Extended Abstract (Australian Exploration Geoscience Conference 2021)

And about the infill broadband MT work from:

- Data package – http://pid.geoscience.gov.au/dataset/ga/132016
- Model – http://pid.geoscience.gov.au/dataset/ga/135011
- Exploring for the Future extended abstract – http://pid.geoscience.gov.au/dataset/ga/133730

Geoscience Australia acknowledge all landholders and traditional custodians of the lands on which this work was undertaken; their cooperation and support allowed these data to be collected.

Reference

Doublier, M.P., Brennan, T., Korsch, R. and Nicoll, M.G., 2016, 3D Model of the Major Crustal Boundaries of Australia. Geoscience Australia, Canberra.

Mike Barlow
Geoscience Australia
Mike.Barlow@ga.gov.au

Update on geophysical survey progress from Geoscience Australia and the Geological Surveys of Western Australia, South Australia, Northern Territory, Queensland, New South Wales, Victoria and Tasmania (information current September 2021).

Further information about these surveys is available from Mike Barlow Mike.Barlow@ga.gov.au (02) 6249 9275 or Marina Costelloe Marina.Costelloe@ga.gov.au (02) 6249 9347.

Table 1. Airborne magnetic and radiometric surveys

Survey name	Client	Project management	Contractor	Start flying	Line km	Line spacing Terrain clearance Line direction	Area (km²)	End flying	Final data to GA	Locality diagram (*Preview*)	GADDS release
Tasmanian Tiers	MRT	GA	MAGSPEC	Mar 2021	Up to an estimated 25 000	200 m 60 m N–S or E–W	4300	Apr 2021	May 2021	See Figure 1 in previous section (GA News)	https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/145547
Cobar	GSNSW	GA	GPX	Jun 2021	53 000	200 m	11 600	Aug 2021	Sep 2021	See Figure 1 in previous section (GA News)	Oct 2021

TBA, to be advised.

Table 2. Ground and airborne gravity surveys

Survey name	Client	Project management	Contractor	Start survey	Line km/ no. of stations	Line spacing/ station spacing	Area (km²)	End survey	Final data to GA	Locality diagram (*Preview*)	GADDS release
Canobie	GSQ	GA	Xcalibur	Oct 2021	~5000	1–2 km	5300	Sep 2021	Dec 2021	See Figure 1 in previous section (GA news)	TBA
Brunette Downs Ground Gravity	NTGS	GA	Atlas Geophysics	Oct 2021	~ 12 000	2 x 2 km grid	55 000	TBA	TBA	TBA	TBA
Melbourne, Eastern Victoria, South Australia	AusScope GSV DEL WP	GA	Sander Geophysics	Jul 2021	137 000	0.5–5 km	146 000	TBA	TBA	See Figure 1 in previous section (GA news)	TBA
Kidson Sub-basin	GSWA	GA	CGG Aviation	14 Jul 2017	72 933	2500 m	155 000	3 May 2018	15 Oct 2018	See Figure 1 in previous section (GA news)	Set for release before Dec 2021
Little Sandy Desert W and E Blocks	GSWA	GA	Sander Geophysics	W Block: 27 Apr 2018 E Block: 18 Jul 2018	52 090	2500 m	129 400	W Block: 3 Jun 2018 E Block: 2 Sep 2018	Received by Jul 2019	195: Aug 2018 p. 17	Set for release before Dec 2021
Kimberley Basin	GSWA	GA	Sander Geophysics	4 Jun 2018	61 960	2500 m	153 400	15 Jul 2018	Received by Jul 2019	195: Aug 2018 p. 17	Set for release before Dec 2021
Warburton-Great Victoria Desert	GSWA	GA	Sander Geophysics	Warb: 14 Jul 2018 GVD: 22 Jul 2018	62 500	2500 m	153 300	Warb: 31 Jul 2018 GVD: 3 Oct 2018	Received by Jul 2019	195: Aug 2018 p. 17	Set for release before Dec 2021
Pilbara	GSWA	GA	Sander Geophysics	23 Apr 2019	69 019	2500 m	170 041	18 Jun 2019	Final data received Aug 2019	See Figure 1 in previous section (GA News)	Set for release before Dec 2021
SE Lachlan	GSNSW/ GSV	GA	Atlas Geophysics	May 2019	303.5 km with 762 stations	3 regional traverses	Traverses	Jun 2019	Jul 2019		Set for incorporation into the national database in 2021

TBA, to be advised

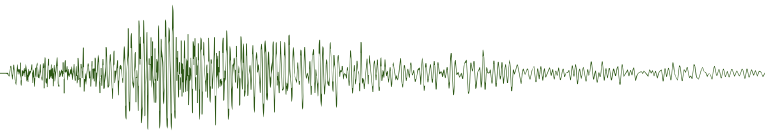


Table 3. Airborne electromagnetic surveys

Survey name	Client	Project management	Contractor	Start flying	Line km	Spacing AGL Dir	Area (km²)	End flying	Final data to GA	Locality diagram (*Preview*)	GADDS release
Western Resources Corridor	GA	GA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	See Figures 1 and 2 in previous section (GA News)	TBA
Eastern Resources Corridor	GA	GA	CGG	Apr 2021	32 000	20 km	640 000	Jun 2021	Dec 2021	See Figure 1 in previous section	http://pid.geoscience.gov.au/dataset/ga/145744
Mundi	GSNSW	GA	NRG	Mar 2021	1900	2.5	~ 5000	Apr 2021	Dec 2021	See Figure 1 in previous section (GA News)	Oct 2021
AusAEM20	GSWA	GA	CGG & SkyTEM	Aug 2020	62 000	20 km	1 240 000	Dec 21	Dec 2021	See Figure 1 in previous section (GA News)	TBA. Survey in production

TBA, to be advised

Table 4. Magnetotelluric (MT) surveys

Location	Client	State	Survey name	Total number of MT stations deployed	Spacing	Technique	Comments
Northern Australia	GA	QLD/ NT	Exploring for the Future – AusLAMP	366 stations deployed in 2016–19 32 stations deployed in 2021	50 km	Long period MT	The survey covers areas of NT and Qld. Data package: http://pid.geoscience.gov.au/dataset/ga/134997 Model: http://pid.geoscience.gov.au/dataset/ga/145233 Acquisition of 32 new sites in SW Qld completed mid-2021.
AusLAMP NSW	GSNSW/ GA	NSW	AusLAMP NSW	~300 stations deployed 2016-21	50 km	Long period MT	Covering the state of NSW. Acquisition and nearing completion.
Southeast Lachlan	GSV/GSNSW/ GA	VIC/ NSW	SE Lachlan	Deployment planned to commence early/mid-2021	~4 km	AMT and BBMT	~160 stations in the Southeast Lachlan. Acquisition delayed due to COVID-19 travel restrictions.
Spencer Gulf	GA/GSSA/ UofA/ AuScope	SA	Offshore marine MT	12 stations completed	10 km	BBMT	This is a pilot project for marine MT survey https://www.auscope.org.au/news-features/auslamp-marine-01

TBA, to be advised

Table 5. Seismic reflection surveys

Location	Client	State	Survey name	Line km	Geophone interval	VP/SP interval	Record length	Technique	Comments
Central Darling Basin	CINSW	NSW	Central Darling seismic survey	~208	10 m	10 m	6-16 sec	2D high resolution and deep crustal seismic	GA and CINSW signed MoU to acquire and process 2D high resolution and deep crustal seismic data in Central Darling Basin. New seismic data will be acquired, processed and interpreted to assist in proving up a geological resource in NSW for the safe and permanent storage of CO_2 emissions. The additional seismic data obtained will provide greater certainty in the future drilling exploration programme. The data acquisition was completed in May 2021 and processing is due to start in mid-Jul 2021, and aimed to be completed by Sep 2021.

(*Continued*)

Table 5. Seismic reflection surveys (*Continued*)

Location	Client	State	Survey name	Line km	Geophone interval	VP/SP interval	Record length	Technique	Comments
Officer Basin	GA	SA	Shallow legacy data	~2000	Varies	Varies	3-6 sec	2D shallow legacy data, explosive, vibroseis	GA commissioned reprocessing of selected legacy 2D seismic data in the Officer Basin, South Australia, as part of the Exploring for the Future programme. The objective is to produce a modern, industry-standard 2D land seismic reflection dataset to assist industry to better target areas likely to contain the next major oil, gas and mineral deposits. Reprocessing by Velseis is complete and data have been QC'ed. Release of the Velseis direct processed data package is planned for mid-Oct 2021. The data will be available on request to GA Client Services.
Officer Basin	GA	SA	L137 Officer Basin	550	40 m	240 m	20 sec	2D deep crustal seismic explosive reflection seismic	GA commissioned reprocessing of 2D legacy deep crustal seismic data in the Officer Basin, South Australia, as part of the Exploring for the Future programme. The objective is to produce a modern, industry-standard 2D land seismic reflection dataset to assist industry to better target areas likely to contain the next major oil, gas and mineral deposits. Reprocessing by Velseis is complete and data have been QCed. Release of two data packages is planned in mid-Oct 2021: GA website data package (images, segy and metadata); Velseis direct processed data package available on request to Client Services.
Pedirka Basin	GA	SA	Shallow legacy data	~2000	Varies	Varies	3-6 sec	2D shallow legacy data, explosive, vibroseis	GA commissioned reprocessing of selected legacy 2D seismic data in the Pedirka Basin, South Australia, as part of the Exploring for the Future programme. The objective is to produce a modern industry standard 2D land seismic reflection dataset to assist industry to better target areas likely to contain the next major oil, gas and mineral deposits. Reprocessing of these data by Geofizika started in May 2021 and is planned to be complete in Oct 2021
Eastern Goldfields	GSWA	WA	L132 1991 Eastern Goldfields Seismic	260	40 m	160 m	20 s	2D deep crustal seismic explosive reflection seismic	Project completed. GSWA/GA MoU covered reprocessing of legacy explosive data acquired by GA's predecessor agency, the Bureau of Mineral Resources in 1991. GSWA contracted Velseis Processing Pty Ltd. to reprocess these data set using modern processing techniques, which were unavailable at the time of the original data acquisition and initial processing. GA provided QC and monitoring of the reprocessing. The improved seismic data complements other geoscience datasets in GSWA's Eastern Goldfields Reinterpretation Project, and GSWA's Accelerated Geoscience Program. The work was funded by the WA Government's Exploration Incentive Scheme. Data release on GA website: http://pid.geoscience.gov.au/dataset/ga/74951

(*Continued*)

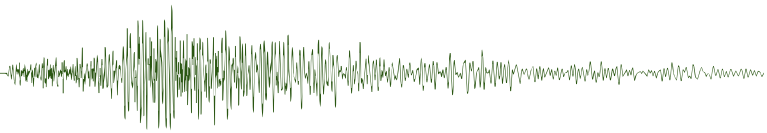


Table 5. Seismic reflection surveys (*Continued*)

Location	Client	State	Survey name	Line km	Geophone interval	VP/SP interval	Record length	Technique	Comments
Central Darling Basin	Coal Innovation NSW (CINSW)	NSW	Central Darling seismic survey	~208	10 m	10 m	6-16 sec	2D high resolution and deep crustal seismic	GA and CINSW signed an MoU to acquire and process 2D high resolution and deep crustal seismic data in the Central Darling Basin. New seismic data will be acquired, processed and interpreted to assist in proving up a geological resource in NSW for the safe and permanent storage of CO2. The new seismic data obtained will provide greater certainty in planning for future drilling. Data acquisition was completed in May 2021. Processing commenced in mid-Jul 2021 and is due for completion in Sep 2021. CINSW contracted Velseis to process the data and the GA seismic team is QC'ing the processing of this dataset.
2019 Camooweal 2D Seismic Survey Archiving Project	GSQ	Qld	Camooweal seismic survey	~300	30 m	10 m	20 s	2D deep crustal seismic	A Memorandum of Understanding has been signed with GSQ to prepare a standard GA Data Processing Package for the 300 line km 2019 Camooweal 2D seismic survey. This data package will support an interpretation project recently commenced by GSQ to produce new pre-competitive geoscience information that will boost exploration investment by assisting industry to better target areas likely to contain significant gas and sedimentary-hosted mineral deposits.

Table 6. Passive seismic surveys

Location	Client	State	Survey name	Total number of stations deployed	Spacing	Technique	Comments
Australia	GA	Various	AusArray	About 180 temporal seismic stations	~200 km spacing	Broad-band ~18 months of observations	The survey will cover all of Australia to establish continental-scale model of lithospheric structure and serve as a background framework for more dense (~50 km) movable seismic arrays. It started in NT as an initial 11 seismic stations deployment and will progress to other States and Territories depending on pace of land clearance processes and the status of COVID-19 travel restrictions.
Northern Australia	GA	QLD/NT	AusArray	About 265 broad-band seismic stations	50 km	Broad-band 1 year observations	The survey covers the area between Tanami, Tennant Creek, Uluru and the Western Australia border. The first public release of transportable array data was in 2020. See: http://www.ga.gov.au/eftf/minerals/nawa/ausarray Various applications of AusArray data are described in the following Exploring for the Future extended abstracts: http://pid.geoscience.gov.au/dataset/ga/135284 http://pid.geoscience.gov.au/dataset/ga/135130 http://pid.geoscience.gov.au/dataset/ga/135179 http://pid.geoscience.gov.au/dataset/ga/134501
Australia	GA	Various	AusArray, semi-permanent	12 high-sensitivity broad-band seismic stations	~1000 km	Broad-band 4 years observations	Semi-permanent seismic stations provide a back-bone for movable deployments and complement the Australian National Seismological Network (ANSN) operated by GA, ensuring continuity of seismic data for lithospheric imaging and quality control. Associated data can be accessed through http://www.iris.edu

Geological Survey of South Australia: Gravity database updated

Over the last couple of years the geophysicists at the Geological Survey of South Australia have been planning and implementing a series of changes to the existing gravity module on one of their primary geoscientific databases: SA Geodata. Data from SA Geodata feed directly into the South Australian Resources Information Gateway (SARIG), an online platform where users can access and download a variety of geoscientific information.

The gravity module on SA Geodata (an Oracle database) is the South Australian single point of truth for gravity data and metadata. The database calculates the Bouguer Anomaly from uploaded data: position and height information, observed gravity and point number, as well and information pertaining to all the datums used. The Bouguer Anomaly calculated is a simple Bouguer Anomaly, assuming a slab model of the Earth.

The updated module still requires this basic information, but also requires the user to upload additional height information: ellipsoidal heights in the GDA94 and GDA2020 datums. The Bouguer Anomaly calculated in the old module had used AHD heights - and the new module retains this - but it also calculates the Bouguer Anomaly as per the spherical cap equations using GDA94 ellipsoidal heights. The Bouguer Anomaly fields have been labelled as BAslab and BAscap to differentiate the two. The database also calculates the Free Air Anomaly.

As well as these new anomalies, the updated module has some other features. We've included a field titled grid_flag. This is simply a yes or no field and indicates whether individual stations have been used in the latest state grid. In cases where surveys of (say) different vintages are overlapping it often become necessary to filter out some points to ensure a coherent image. We do not undertake further levelling of individual gravity surveys on SA Geodata; the data on the database are as we received them.

The new module is also GDA2020 friendly. Coordinates of any datum and projection can be uploaded onto the database, and the database will calculate and store GDA94 and GDA2020 coordinates. It will then use the correct combinations to calculation the Bouguer Anomalies.

This is now viewable in SARIG (Figure 1). When a user undertakes a spatial search on the Gravity Stations layer, the pop-up table includes the usual columns of data, plus a selection of the new fields. Specifically, the new ellipsoidal heights, the Spherical Cap Bouguer Anomaly, the Grid Flag and the Free Air Anomaly. The next upload to Jetstream is scheduled for late November 2021 and will include an updated gravity station layer, making it easy to cookie-cut select portions of the gravity layer.

The geophysicists are now continuing their ongoing project of uploading more surveys onto the database. During the database development we paused this work but now the database is up and running we can recommence this work.

As always, for assistance with SARIG and accessing geophysical data, please contact Customer Services resources.customerservices@sa.gov.au.

Philip Heath
Geological Survey of South Australia
Philip.Heath@sa.gov.au

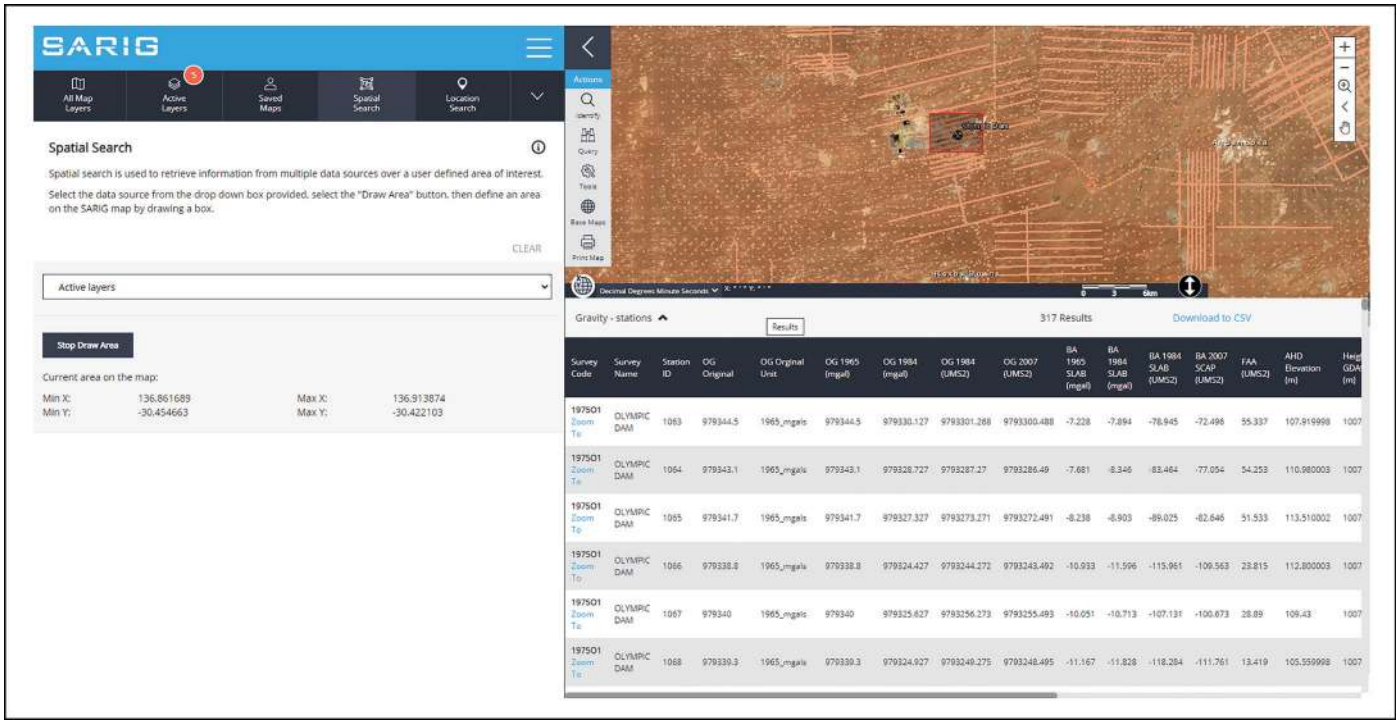


Figure 1. *The updated gravity table in SARIG includes new columns of data, including the Spherical Cap Bouguer Gravity.*

Geological Survey of Western Australia: Closing in on AusAEM–WA

In August 2021, data acquisition with the SkyTEM system began on the Murchison block in the mid-west of Western Australia. If the survey gods smile benignly upon us, by the time you are reading this in *Preview 214*, the acquisition will be complete, and the data from the already-flown SkyTEM Southwest block will be released (See *Preview 211*, April 2021).

Added to the AusAEM–WA TEMPEST surveys flown in 2020 that cover much of the south-eastern quadrant of the State, and with Geoscience Australia's 2019 AusAEM 02 data over the northern part of the State — both released earlier this year, only 10% of the area of Western Australia will remain to be surveyed in order to have complete AEM coverage at 20 km line spacing.

Geoscience Australia's AusAEM 01 and AusAEM 02 surveys have already demonstrated the coherence of the AEM data at these broad-acre scales.

However, when the datasets are juxtaposed to make images at a sub-continental scale, the coherence and impact are extraordinary, as can be observed in Figure 1, which shows stacked GA inversion 'curtains' compiled and displayed in the Geoscience Australia Portal. Images such as this, and the detail in the underlying datasets, provide explorers with the context needed to set optimum acquisition parameters for higher resolution AEM surveys at a tenement scale.

GSWA is currently planning to complete the remaining areas in the AusAEM–WA programme: in the East Kimberley in the far north; and a relatively narrow strip of country in the east along the border with South Australia and the Northern Territory (Figure 1, inset). GSWA is in dialogue with GA and with the Geological Surveys of South Australia and the Northern Territory to cover these areas as part of larger AusAEM surveys in GA's Exploring for the Future 2 'Western Corridor' programme, hopefully in 2022.

If you are in Perth in November, be sure to visit GSWA's 2021 Open Day (details elsewhere in this issue) to learn more about AusAEM–WA and other GSWA work programmes.

Funding for the AusAEM–WA is from the Western Australian government's Exploration Incentive Scheme. Data from the programme and from other government-funded regional surveys may be downloaded from GeoVIEW.WA — GSWA's interactive mapping, data discovery, and data delivery platform — or from the national Geophysical Archive Data Delivery System (GADDS) hosted by Geoscience Australia.

For more information, contact geophysics@dmirs.wa.gov.au.

David Howard
Geological Survey of Western Australia
David.HOWARD@dmirs.wa.gov.au

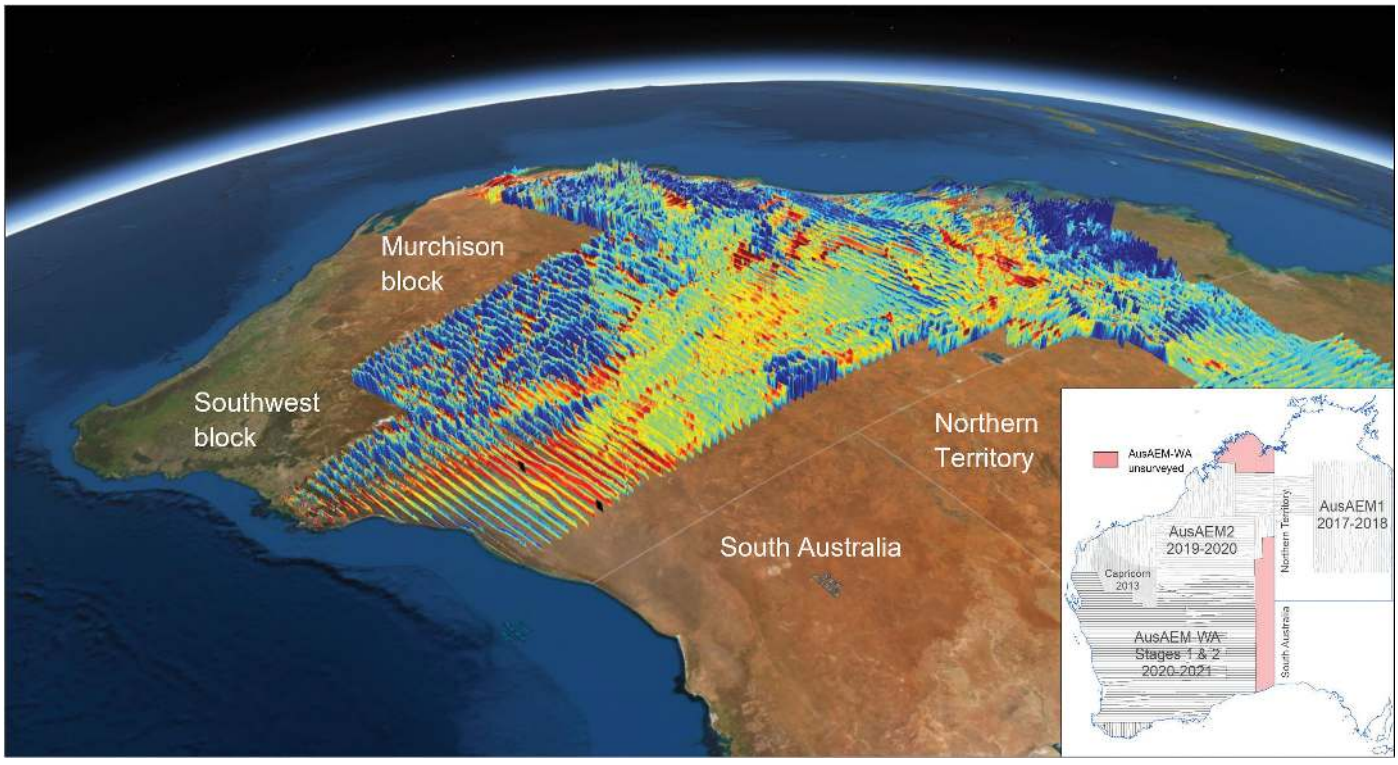


Figure 1. *Stacked 'AEM inversion curtains' from AusAEM and AusAEM–WA surveys compiled in the Geoscience Australia Portal. Inset: remaining areas of WA for 20 km AEM coverage as part of proposed 'Western Corridor' AusAEM surveys in 2022.*

AEGC 2021: Reflections

The Third Australasian Exploration Geoscience Conference (AEGC 2021), jointly hosted by the Australian Society of Exploration Geophysicists (ASEG), the Petroleum Exploration Society of Australia (PESA) and the Australian Institute of Geoscientists (AIG) was held from 15 – 17 September. Originally slated to take place in Brisbane, the decision was taken six weeks out from the conference to move to a fully virtual format due to the escalating COVID situation and the resultant border closures.

Despite this change in format, the Conference Organising Committee were delighted to welcome 449 total registrants to the event, including 29 international delegates from 22 countries. Sponsors were also supportive, with 78% sponsorship retained towards the AEGC 2023 event.

Delegates were able to enjoy a diverse technical programme coordinated by Binzhong Zhou and Alison Troup including eight keynotes, 130 concurrent session speakers and 20 digital posters. This programme was supplemented by an excellent virtual workshop programme, organised by Trent Retallick, that allowed 275 delegates to learn more about a wide range of topics from CO_2 storage to first nations engagement.

Forty-one exhibitors tried out the virtual exhibition platform, and were rewarded for their efforts with 3229 individual visits to exhibitors logged and 627 brochures downloaded. The meeting hub was also popular with 97 meetings scheduled across the 3 days.

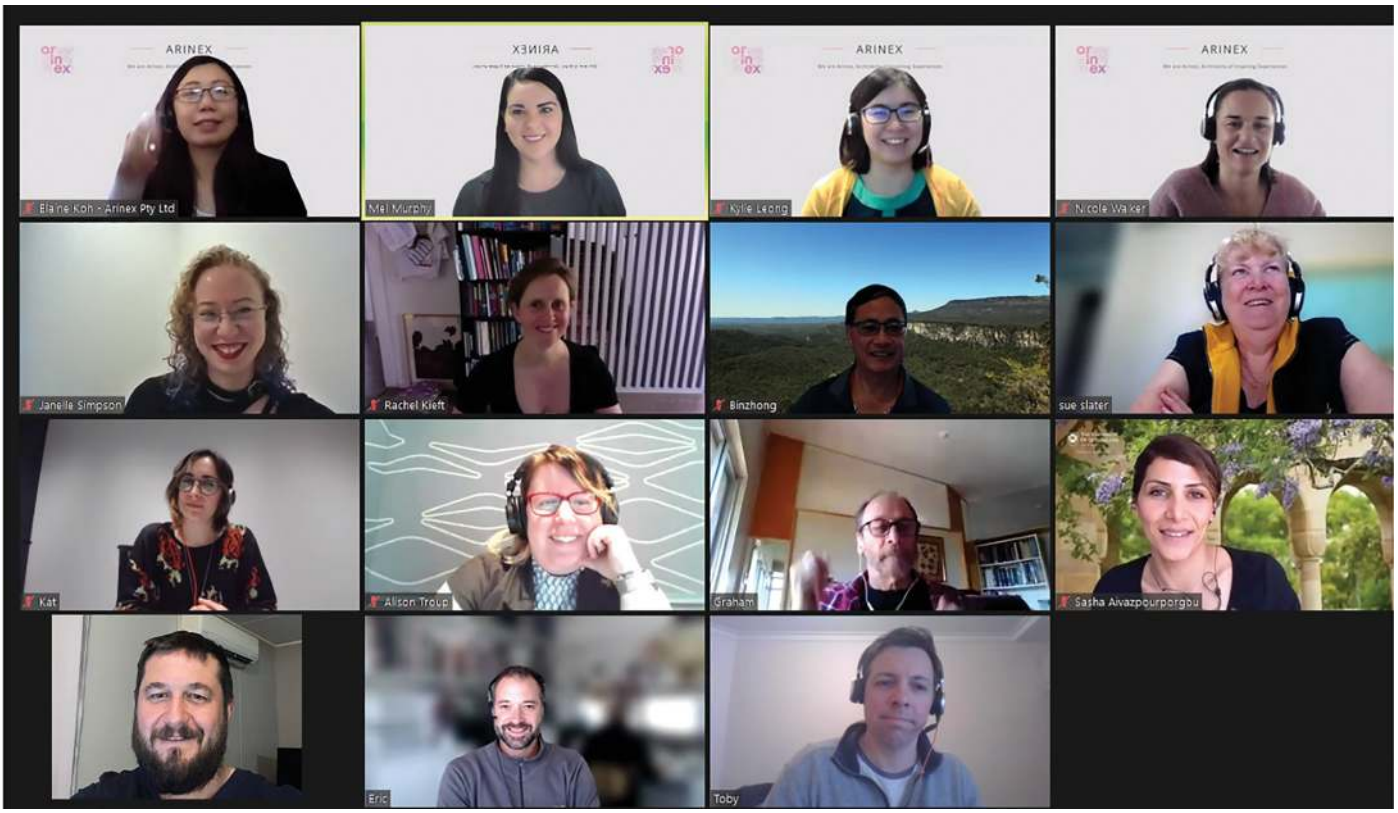
Students and early career geoscientists were well represented with 47 students registered (10% of delegates) and 35 early career geoscientists (or retired) registered! The student-focussed GeoPitch, organised by Kat Gioseffi, attracted 14 presentations for their 3-minute summaries.

Diversity in Geoscience, coordinated by Janelle Simpson, proved a popular topic with the five panellists and two moderators joined by over 160 delegates who actively engaged in a dynamic virtual chat and Q&A.

Many of the sponsors and exhibitors who committed for the original face to face (F2F) event stayed with us during the change to virtual, and have already affirmed a continued commitment for AEGC 2023 which is planned as a F2F event in Brisbane. This has enabled the AEGC 2021 virtual conference to be a success, and provides an excellent jumping off point for the incoming AEGC 2023 committee.

We feel a great sense of achievement to have provided such a successful virtual event – a first for all of the Conference Organising Committee and the host organisations.

AEGC 2021 Conference Organising Committee



The AEGC 2021 Conference Organising Committee Left to right and top to bottom, Elaine Koh (Arinex-PCO), Melissa Murphy (Arinex-PCO), Kylie Leong (Arinex-PCO), Nicole Walker (Arinex-PCO), Janelle Simpson, Rachel Kieft (Co-chair), Binzhong Zhou, Sue Slater, Kat Gioseffi, Alison Troup, Graham Pope (Treasurer), Sasha Aivapourporgou, Trent Retallick, Eric Battig (Co-chair) and Toby Colson.

AEGC 2021: Conference awards

Best paper - Minerals

95. Richard Smith: *Transformative geophysics: Alternatives to the reduction-to-pole transformation of magnetic data.*

Best paper - Regional

266. Vladimir Lisitsin, Courteney Dhnaram and Matthew Valetich: *Geochemical signatures and critical metal contents of key deposit types in the Mount Isa Province, Queensland, Australia.*

Best paper - Energy

151. Gregory Smith, William Rickard, Zhen Li and Svetlana Tessalina: *Petroleum source rocks, generation and primary migration: insights using new direct nano-scale Tof-Sims SEM analysis and Re-Os radiometric dating.*

Best paper – Near-surface and groundwater

197. Neil Symington, Anandaroop Ray, Chris Harris-Pascal, Kok Piang Tan, Ley-Cooper Yusen, Ross Brodie and Richard Taylor: *Probabilistic modelling of groundwater salinity using borehole and AEM data.*

Best student paper

66. Sasha Banaszczyk, Mike Dentith, Perla Piña-Varas and David Annetts: *Interpretation of magnetotelluric and airborne electromagnetic inversions from the Proterozoic basins of the Capricorn Orogen, WA.*

Best poster

156. Clive Foss, Keith Leslie and Phillip Schmidt: *If you can't go to a magnetic anomaly then let the anomaly come to you - Rubens cage surveys.*

Best Geopitch presentation

Lance Karlson: *Geological modelling with Measure-While-Drill data*

AEGC 2021: Workshop on frontiers of AEM inversion and interpretation for minerals, energy and groundwater applications

Alan Yusen Ley-Cooper and Anandaroop Ray
Geoscience Australia
Yusen.LeyCooper@ga.gov.au
Anandaroop.Ray@ga.gov.au

Summary

As part of the recent AEGC 2021 conference, we held a virtual workshop focusing on the state-of-the-art in airborne electromagnetics (AEM) and its uses, entitled "Frontiers of AEM inversion and interpretation for minerals, energy and groundwater". It was an all-day event held on Tuesday, 14 September 2021. With over 50 registrants, the workshop connected the theoretical background of electromagnetic geophysics and inversion to the interpretation of AEM imaging products.

The community got a comprehensive look at the current practices around AEM inversion methodologies and saw some practical applications through case studies and examples worldwide. Yusen Ley-Cooper and Anand Ray from Geoscience Australia (GA) chaired the workshop. The programme kicked off by welcoming people from five different continents and many time zones, with scene-setting by Yusen, in light of the expanding number of AEM end-product users and increasing number of line kilometres flown. The morning session touched on modern inversion, inference and uncertainty estimation methods presented by academia, industry, CSIRO and GA. The afternoon session focused mainly on interpretation and case studies.

Introduction

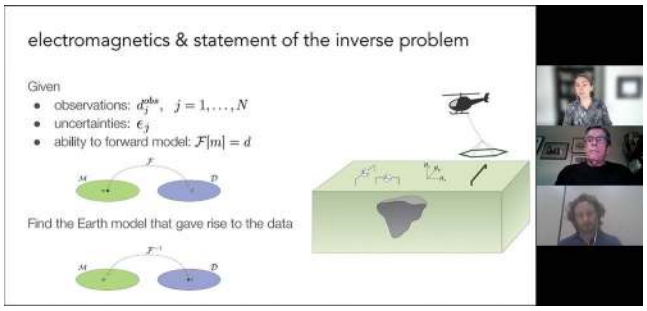
The workshops started with a casual conversation around the pertinence of distinguishing between AEM data and models of AEM data, what is actually resolvable from this kind of data, and the uncertainties associated with inverted models. How models are derived through the process of inversion and the assumptions involved were discussed in detail.

The benefits, limitations and future directions of various inversion techniques were also discussed, followed by a series of examples and case studies that described the speakers' experiences using AEM across regional, mineral and groundwater applications.

Dr Lindsey Heagy provided the keynote speech from the University of British Columbia, Vancouver. Rod Paterson (Intrepid) and Andrea Viezzoli (Aarhus Geophysics) presented on the state-of-the-art from their respective group's software developments - mainly focusing on 2.5D inversion, induced polarization (IP) and superparamagnetic (SPM) effects in the airborne data. A range of other speakers showcased their work, then the workshop closed with some lively but constructive discussion.

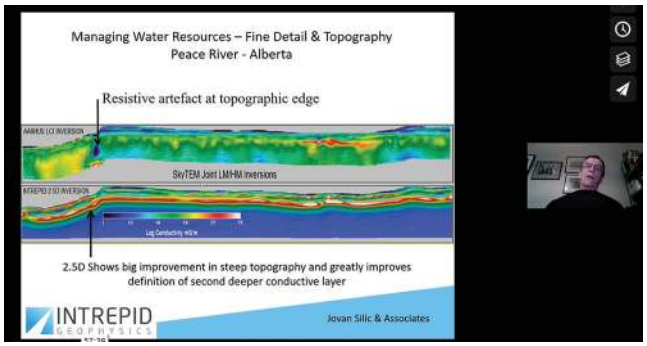
Quotes extracted from the speakers' talks are used to summarise their presentation.

Lindsey Heagy (University of British Columbia, Vancouver): *Electromagnetic modelling and inversion tools*



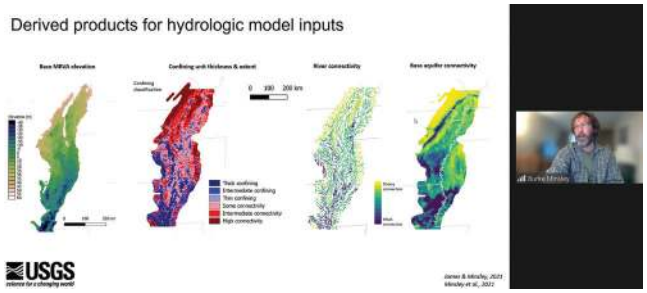
Lindsey spoke about the importance of communities developing open-source tools for modelling and inversion of electromagnetic data and the growth of an open-source ecosystem. She provided a comprehensive run-down on the formulation of the inversion difficulty, dealing with an ill-posed, non-unique problem and the theoretical framework to operate within. A) Tikhonov (deterministic) inversion in which a single "best" solution solving optimization is sought, or B) a Bayesian (probabilistic) inversion where an ensemble of thousands of models that fit the data is proposed. The talk showed some of her active research areas, such as sparse and compact norms for sharpening layer boundaries, including petrophysical information, joint inversions and progressing 3D inversions. She also provided several helpful links to educational material and software packages, which we have collated with others and included at the end of this manuscript.

Rod Paterson (Intrepid Geophysics): *2.5D inversion approaches and managing IP / SPM effects*



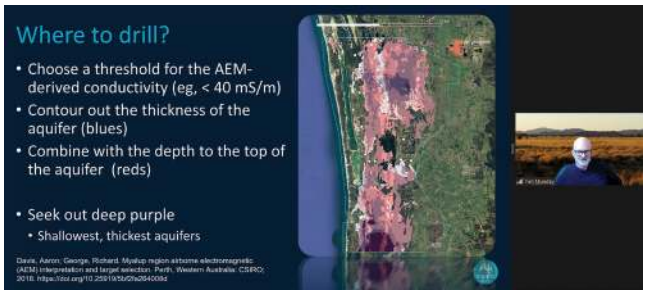
Rod presented on inverting AEM data with what is known as a 2.5D approach and dealing with what was termed as geo-electrical noise (induced polarization and superparamagnetic effects) in AEM data. The talk discussed the effects of topography, sharp boundaries and artefacts in 1D modelling. As part of Intrepid's latest developments, the presentation summarised including magnetic susceptibility as a term used to deal with so-called superparamagnetic effects in AEM data, a form of magnetization commonly attributed to ferrimagnetic nanoparticles. The talk showed a few case studies, including the widely studied Valen target in the Musgraves, showcasing modelling the AEM data with their in-house software and comparing the results against other models derived from different algorithms.

Burke Minsley (USGS): *Mississippi Valley AEM interpretation*



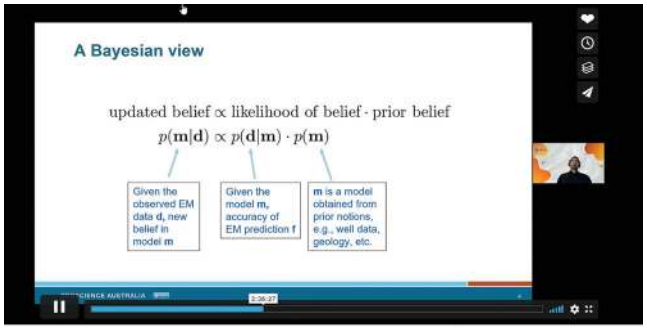
Burke's talk was on the Mississippi Alluvial Plain (MAP) project, the largest integrated AEM effort for groundwater resource mapping so far in the USA. An interesting survey was discussed where they used both a fixed-wing time-domain (TEMPEST) system and a frequency-domain (RESOLVE) AEM system. The acquisition was interwoven to allow the systems to complement each other. The derived conductivity models extracted from both instruments remarkably showed a seamless transition in their national hydrogeological grid. A 1 km x 1 km x 5 m vertical thicknesses mesh USGS national product was derived, from which maps and sections were presented. The presentation showed a remarkable correlation of subsurface images with known geology. The conclusion was that the results and data from this AEM survey will support several stakeholders and can be used in diverse scientific and societal applications such as geology, water, hazards, minerals, ecosystems, climate and infrastructure.

Aaron Davis, presented by **Tim Munday** (CSIRO): *AEM inversion with a hydrological perspective*



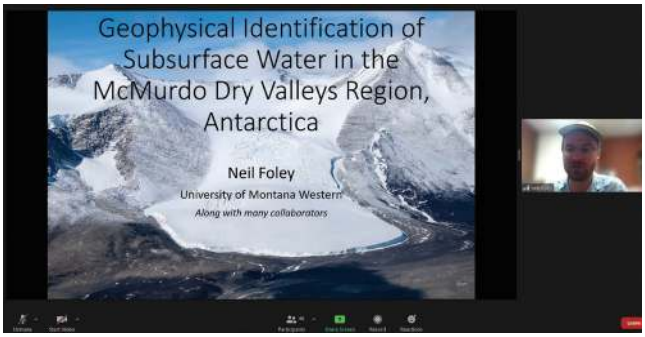
Tim gave an overview of CSIRO's current capabilities and presented work where CSIRO is engaged in the EM space. During the talk some case studies and examples were shown, ranging from larger-scale studies like the Perth basin to 'postage-stamp scale' smaller areas like a study in the South Goulburn Island in the Northern Territory, where the whole island's water supply is groundwater-dependent and is under constant threat of saltwater intrusion under changing sea levels. CSIRO also presented a portal for service provision and data delivery.

Anandaroop Ray (Geoscience Australia): *Incorporating uncertainty into electromagnetic inversion*



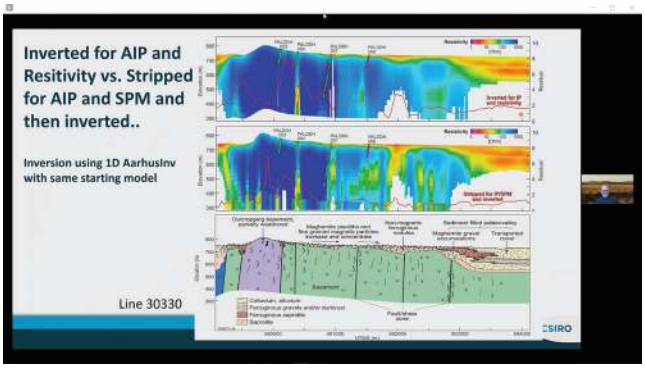
Anand talked about incorporating uncertainty into electromagnetic modelling and summarised discussions on the topic over the last decade. We were given an interesting rundown on Bayesian theory by starting with prior beliefs and ending with different beliefs, made different by the EM data. The difference (misfit) between measured and modelled data gives you the likelihood of your belief, and the smaller your misfit, the more likely is the model. With this, you update your prior belief to produce an updated posterior. Through the talk, we were also shown the importance of doing sensitivity tests and how these would help us assess if data are sensitive to the feature we are interested in. It is a good idea to carry out these tests before embarking on paying thousands of dollars for a survey, or burning thousands of CPU hours on an inversion product. An example of practical use was shown on two AEM datasets, a helicopter and a fixed-wing, acquired over the Menindee Lakes. The ensemble of conductivity models from both systems closely resembles the measured geo-electric layers measured via downhole conductivity logs.

Neil Foley (University of Montana): *Geophysical identification of subsurface water in the McMurdo Dry Valleys Region, Antarctica*



Neil took us on a field trip to Blood Falls in the Taylor Glacier in Antarctica and demonstrated how water (in its liquid form) is a particularly good target for AEM in the cryosphere, given that the presence of solute (salt) lowers the freezing point of water. In particular, this makes AEM the perfect tool for detecting intra-glacial-lake systems which harbour extremophile life forms, some of which are excellent proxies for life on Mars. The discovery of some of these waters in Antarctica are extensive and reflect the geologic history of the region.

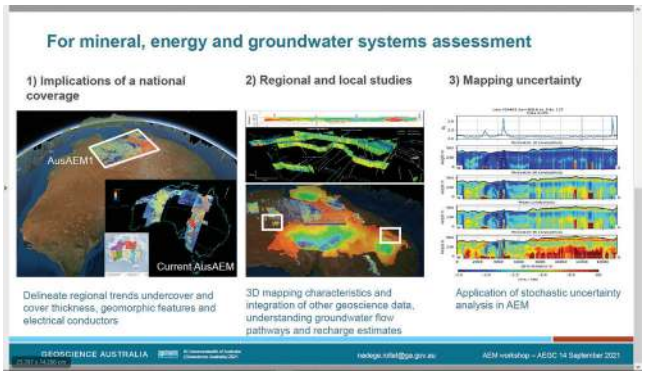
Tim Munday (CSIRO): *Inverting for and/or stripping of airborne IP and SPM - consequences for the geological interpretation of AEM data*.



Tim showed two approaches of dealing with what has been attributed to be a superparamagnetic effect (SPM) in AEM data, which appears to be more prevalent in the newer high-powered

systems. The SPM material that produces this effect was described as a cation deficient material partway between magnetite and maghemite, a product of tropical weathering of iron-rich basement rocks. One approach to dealing with these effects showed that incorporating three new variables in Ohm's law, using the Cole-Cole model and inverting for them in conjunction with conductivity (developed by AarhusInv). The second approach was stripping and reconstructing the AEM data and then modelling it with a thin sheet (developed by Macnae 2016).

Nadege Rollet, (Geoscience Australia)

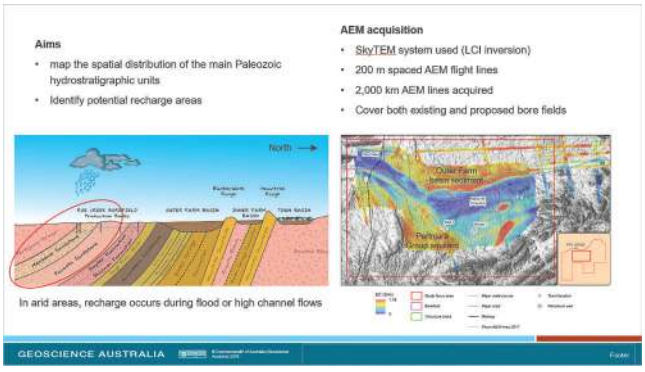


Nadege introduced GA's talks on AEM interpretation and presented the concept of scale reduction, going from continental, regional structures to very local features, all the way through to determining the uncertainty of thickness in potential aquifers.

Sebastian Wong, (Geoscience Australia): *Overview from national to local, interpretation of the AusAEM*

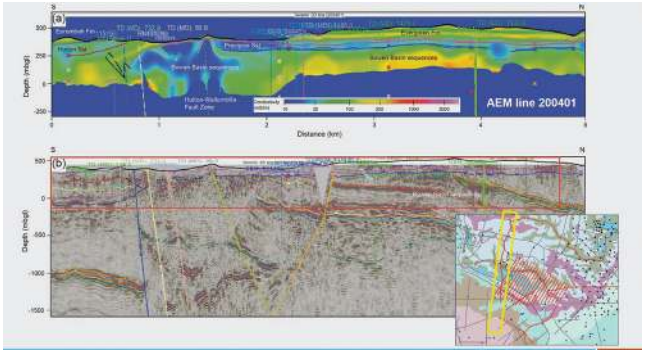
Seb presented on the mapping of the top few hundred meters of the subsurface from phase one of the AusAEM survey comprising some 200 000 sounding locations. He was also assisted in this endeavour by at least one child who shares his calendar.

Kok Piang Tan (Geoscience Australia): *AEM linking to Hydrogeological data in the Alice Springs area*



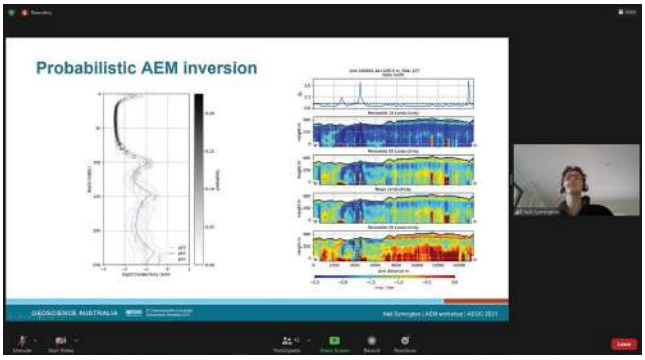
KP showed an example of using AEM for local scale aquifer mapping in the Alice Springs area. His subsurface mapping has changed the conceptual models around recharge in the area.

Andrew McPherson, (Geoscience Australia): *Characterising hydrogeology in the northern Surat Basin through integration of multi-disciplinary geoscience data sets*



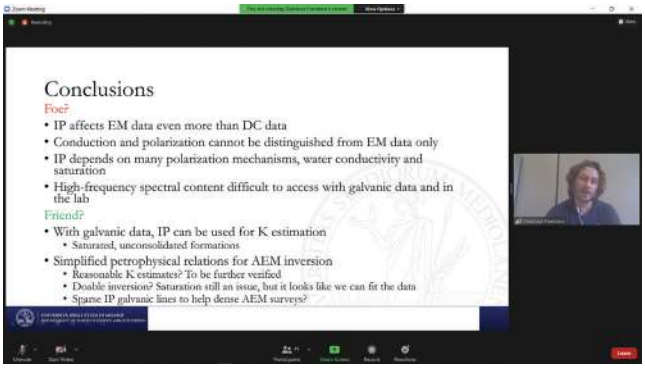
Andrew talked about the Great Artesian Basin work and showed some great examples of integrating seismic interpretation and chronostratigraphy with AEM models. He highlighted areas where the conductivity was more informative than the layering picked in the shallow seismic data.

Neil Symington (Geoscience Australia): *Probabilistic workflows for AEM interpretation*



Neil took us through a process of investigating the existence of specific features such as pinch-outs through a probabilistic inversion of AEM data and posterior quantiles of conductivity.

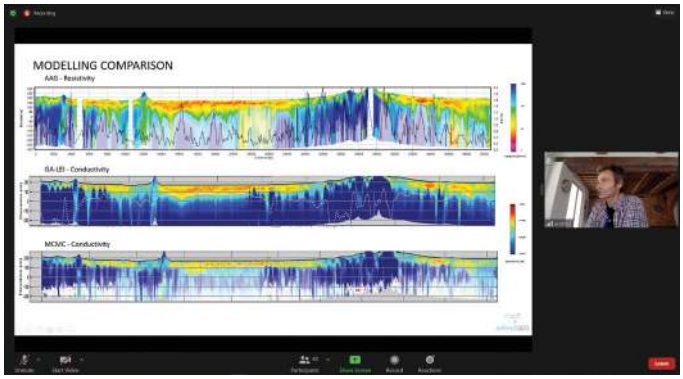
Gianluca Fiandaca (University of Milan): *Induced polarization in airborne EM; friend or foe? The hydrological perspective*



Gianluca not only pulled an all-nighter in a cubicle of the University of Milan, but he also stayed awake and actively involved himself in the discussions. He explored the possibility of extracting hydraulic parameters from the AEM conductivity models. His work follows from some previously successful

examples of deriving hydraulic conductivity from galvanic induced polarization (IP).

Andrea Viezzoli (Aarhus Geophysics): *Dealing with AIP for minerals and groundwater*



Andrea presented a comparison of inversion approaches applied on the Cobar AEM survey acquired in NSW. He showed the effects of what is known as (AIP) airborne induced polarisation by introducing three new variables (Mu, Tau, C) to Ohms laws using the Cole-Cole model and inverting for them. He showed some of the sensitivities around varying the parameters used to model AIP. There was an acknowledgement that more work is needed to investigate the possible sources that create these effects in the data.

Some links to EM modelling resources

These links below are open-source resources with various applications, from educational purposes to production modelling and inversion of extensive regional surveys.

https://simpeg.xyz https://github.com/GeoscienceAustralia/ga-aem

http://www.mtnet.info/EMinars/EMinars.html

https://mare2dem.bitbucket.io

https://petgem.bsc.es/index.html

https://custem.readthedocs.io https://emsig.xyz

https://www.pygimli.org/

https://emsig.xyz/

http://geosci.xyz/

https://sourceforge.net/projects/p223suite/?source = directory

Conclusions

The workshop had a diverse mix of ages, ethnicities, gender and nationality, not to mention time zones!

There was much encouragement for people to contribute to open license, open development and/or open-source code as a way of jointly tackling the complex problem of AEM modelling and inversion.

The need to provide elements and tools for users to make independent assessments on the quality and veracity of products, like maps and sections derived from AEM models used for interpretation and decision-making was identified and that can only happen in a transparent environment with well-informed users.

One of the main conclusions from the day came from the great examples shown. Namely, AEM surveys can serve multiple purposes in diverse scientific and societal applications, ranging from searching for water and exobiology-proxies in the cryosphere to mapping for geology, delineating potential hazards, agricultural engineering, mineral exploration, ecosystem protection, to climate monitoring and infrastructure development. Many different stakeholders can use the same AEM data and interpretive products.

Acknowledgements

We acknowledge the Traditional Owners and First Nations peoples of the lands we flew over to undertake our surveys.

SEE YOU IN *Brisbane*

AEGC 2023

The Australian Exploration Geoscience Conference will be returning to Brisbane Convention and Exhibition Centre.

Date
13 - 18 March 2023

Venue
Brisbane Convention and Exhibition Centre

Co-Chairs
- Megan Nightingale
- Bill Reid

S3, The Precinct 12 Browning Street
West End, QLD 4101, Australia

aegc@arinex.com.au
2023.aegc.com.au

AEGC
Australasian Exploration Geoscience Conference

Canberra observed

David Denham AM
Associate Editor for Government
denham1@iinet.net.au

Australian R & D effort stalls

On 3 September the Australian Bureau of Statistics (ABS) published its latest report on R & D investment in Australia in the financial year 2019-20. Although this increased by $2.5B to $35.6B over the 2017-18 results, the key number, the investment as a percentage of GDP, has remained the same at 1.79 per cent for the last four years (see Figure 1).

Gross Expenditure on R&D (GERD) represents the total expenditure devoted to R&D by the Business, Government, Higher Education and Private non-profit sectors. Table 1 shows the key numbers, provided by the ABS for the last five reports.

Notice that both the Government and the Industry sectors have stagnated. The Higher Education sector has done well, and the effect of COVID and the recent staff losses in that sector are not evident in the numbers.

Investment by the top six sectors over the last seven years is shown in Table 2. The mining investment has the largest change with a decline to almost a third of the value in 2013/14 percent over the period.

The national investment over the last ten years shows two clear trends. A steady increase from 2000 until 2008, and then a steady decline from then until now, when the numbers appear to remain unchanged.

Compared with other OECD countries, our results are not good. For example Japan, Korea, Chinese Taipei, Sweden and the US all invest over 3% of their GDP on R&D, and Israel is top of the list at 4.9%. Australia doesn't even report these statistics annually.

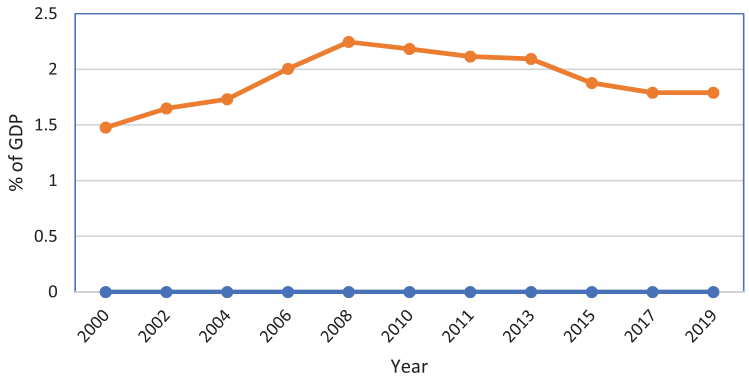


Figure 1. *Changes in levels of investment in R & D as a percentage of GDP in Australia over the last 20 years. Source https://www.abs.gov.au/statistics/industry/technology-and-innovation/research-and-experimental-development-businesses-australia/latest-release.*

Table 1. Gross expenditure on R&D (GERD) in Australia over the last 20 years. The dollars are actual dollars and have not been adjusted for inflation. Source https://www.abs.gov.au/statistics/industry/technology-and-innovation/research-and-experimental-development-businesses-australia/latest-release.

Year	Total $billion	Business	Government	Higher Education	Private non-profit
2011-12	31.70	18.32	3.55	8.89	0.94
2012-13	33.47	18.85	3.75	9.92	0.95
2015-16	31.18	16.66	3.96	9.55	1.01
2017-18	33.06	17.44	3.33	11.23	1.06
2019-20	35.60	18.17	3.38	12.72	1.33

Table 2. Business expenditure on R&D (BERD) in Australia over the last 20 years. The dollars are actual dollars and have not been adjusted for inflation. Source https://www.abs.gov.au/statistics/industry/technology-and-innovation/research-and-experimental-development-businesses-australia/latest-release.

BERD by the top ten industries	2013/14 ($m)	2015/16 ($m)	2017/18 ($m)	2019/20 ($m)
Professional, scientific & technical services	3953	3751	5113	6101
Manufacturing	4844	3908	4599	4763
Financial and insurance	3093	3215	2847	2714
Mining	2830	1876	1,050	890
Wholesale trade	960	877	931	835
Information, media and telecommunications	575	647	610	513

There is some consolation. We are ahead of Canada (1.54%) and New Zealand (1.35%), but as the school reports say: "Could and should do better". We need a focused plan on where to put our R&D dollars and a goal to increase our investment to 3 percent of our GDP.

Mineral exploration powers ahead, petroleum in doldrums

Minerals

Mineral exploration investment continues to rise and a total of $912M was spent in the June Quarter of 2021, according to the ABS recent release of exploration information. As you can see in Figure 2 this is the highest it has been since December 2012.

Gold was the main target, with nearly $430m invested, followed by iron ore with $151M. Unfortunately for the iron ore producers, the price of iron ore has plummeted from $US 220 a tonne in July 2021 to $105 in September – they should be ready for a challenging future.

The search for lithium and other components for batteries is starting to contribute, but it is still small compared to gold and iron ore.

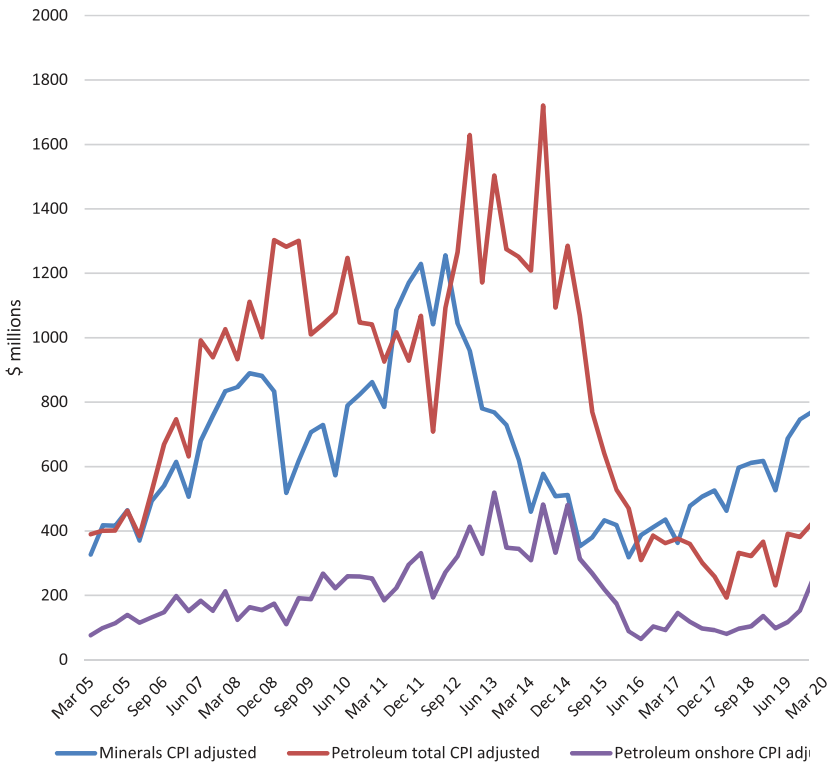


Figure 2. *Quarterly Mineral and petroleum investments 2005-2021, normalised to June 2021 $A. Notice that the onshore and offshore investments for petroleum exploration are now of similar size. Offshore exploration has come close to a halt. Source https://www.abs.gov.au/statistics/industry/mining/mineral-and-petroleum-exploration-australia/latest-release.*

What would we do without COVID-free (so far) WA? A massive $594M was invested there in the June Quarter. Queensland was second with $104M and the other states were "also-rans".

Petroleum

Petroleum exploration is at the lowest levels since 2005. This is not surprising because, although the oil price has slowly climbed back to above $US70/bl there is still the ever more important issue of climate change to consider.

The long-term future of petroleum must have played a part in the merger of Santos ($21B) and Oil Search ($8bn) and an even bigger merger between Woodside and BHP. BHP shareholders will own 48% of Woodside, which has a market capital of $20B and the petroleum part of BHP is valued at $19B. Woodside is now in the world's top ten oil and gas producers and the Santos/Oil Search group will slot into the top twenty.

Meanwhile BHP has bought the Jansen potash mine in Canada for $A8B. According to Mining Technology (https://www.mining-technology.com/projects/jansen-potash/), the Jansen project is an underground potash development project located in east-central Saskatchewan. It will be one of the world's largest potash mines, producing 8 Mt of marketable potash annually when it reaches full capacity.

Development of the mine will be carried out over three phases, at an estimated cost of over $US12B. The mine will operate for an estimated life of more than 50 years. An interesting challenge for a new-look BHP.

Pandemic job losses in Higher Education and their consequences

I have mentioned previously the love/hate relationship between the present government and universities. The Australia Institute has now produced a report (commissioned by the National Tertiary Education Union) analysing in more detail the effects of COVID-19 on our tertiary institutions (Littleton and Stanford, 2021).

The public health measures and the closure of Australia's borders to international students created major financial and operational challenges for Australia's universities. The Commonwealth Government made matters worse by arbitrarily excluding universities from the Job Keeper wage subsidy program (originally budgeted at $130B and meant to support 6 million jobs through the initial lockdowns). Universities were left on their own to deal with collapsing revenues, operational challenges (like online learning), and health restrictions.

This report recommends an additional $3.75B per year (less than 1% of the annual Australian budget) until "normal" teaching can resume. Without this level of support, it is estimated it may not be possible to re-build the world class teaching and research tertiary system that we had before COVID.

The main findings in the report include:

1. So far in 2021, tertiary education lost 40 000 jobs (almost one job in five). Universities suffered more job loss over the last 12 months than any other non-agriculture sector in the economy.
2. Most of those jobs (about 35 000) were lost from public universities. More jobs were lost in TAFEs and other public vocational education institutions.
3. Job losses are getting worse, not better. And they now mostly affect permanent and full-time positions (unlike the initial lockdowns, when casual workers suffered the largest job losses). The pandemic is thus reinforcing the perverse trend of casualisation in universities.
4. Women have experienced disproportionate job cuts – more than their share of total employment (25 000 v 16 000).
5. Reduced staffing and increased casualisation will hurt the quality of education and undermine the ability of Australian universities to support national economic recovery.
6. The Commonwealth Government could prevent these job losses by providing $3.75B in additional funding to universities per year until normal teaching and international education can resume.

Reference

Littleton E. and Stanford J., 2021. An avoidable catastrophe: Pandemic job losses in Higher Education and their consequences, Australia Institute, September 2021.

Education matters

Marina Pervukhina
Associate Editor for Education
Marina.Pervukhina@csiro.au

Education needs to unlock the future

In this issue, we are starting a series of interviews with industry leaders in order to infer what they expect from tertiary education in the field of earth sciences. I am honoured to introduce our first guest Emma Brand, a Renewable Energy Project Leader in Origin and the AEGC President-Elect.

Emma Brand

MP: Emma, can you say a few words about yourself, please?

EB: I'm a seismic geophysicist by background, having worked in the oil and gas sector for almost 20 years. I started out at Origin in the early 2000s and subsequently moved overseas to pursue a Masters in geophysics at Memorial University in St John's, Newfoundland. I then had the amazing opportunity to work for BP in Alaska before returning to Origin in late 2014. So this stint with Origin will be seven years in September, mostly in project management roles, moving from geophysical operations through to managing the entire exploration portfolio for our APLNG joint venture and recently moving into renewable fuels. The other role that I've held over about five years of that time, and that I think is important and relevant to this conversation, is that I chaired both the graduate and summer student steering committees at Origin. That role was looking at ensuring that we got the right talent through the pipeline into Origin, with a real focus on the emerging skill needs for our business but also focusing really strongly on the behaviours of the students - because that's an absolute must. But also taking a really broad diversity lens to those students and thinking about talent differently by identifying, integrating, and retaining fantastic, diverse young talent for the organisation.

MP: It looks like you are absolutely passionate about the young talent. I have chosen the right candidate to talk about future education needs.

EB: Yes, absolutely! So, the question about what gets me out of bed every morning, particularly in my current role - I think there's two aspects to it. One is about the people in the team. The second part is by coaching, unlocking their talents and then working collaboratively in ways that people had never imagined, we can solve the massive problems that are facing the globe, that are facing this generation and will continue to face the next. The energy transition is well underway and we're going to need to do things completely differently to work through it successfully.

There will be jobs and skills, and companies and value chains that we can't even imagine today. These will emerge and our ability to navigate and to position ourselves to step into this opportunity will be critical.

MP: It is a terrific introduction to our conversation today. Maybe you specify a little bit more about your role as a leader of the renewable energy project?

EB: At Origin we've got three projects that we've talked about externally. One of them is an opportunity in Townsville looking at renewable hydrogen to export into Asia. The second opportunity is with renewable ammonia in Bell Bay in Tasmania, and then the third opportunity is looking at developing a domestic market for green gas based in Western Sydney.

I manage a team of seven project managers, project engineers, and project analysts. We're all working on delivering these projects for Origin. I also have a leadership role in the Future Fuels team, which is a really interesting opportunity to bring a new team together, to mobilise behind a really clear vision and our renewable fuels aspirations.

MP: It's very interesting to know what Origin is doing in the field of renewable energy. Does Origin have any project in the CCUS field?

EB: In the Future Fuels Team, I manage the renewable fuels projects, but we also have a Carbon Management arm, who are looking at how to create business opportunities in carbon management. Origin is one of Australia's leading energy companies. The way I think about Origin is that we know about molecules, we know about electrons and we know about data. And so if you think about a Net Zero future - we are going to need to create, move and store molecules, we're going to need to create, move and store electrons and it's all going to be driven by data. There's this incredible synergy across everything that Origin does today that lines up really nicely with how we see the value chain evolving towards a Net Zero future. On the molecules front, we've obviously got subsurface capabilities. We have geologists and geophysicists, we know how to take gas out of the ground, we know how to drill, we know how to undertake seismic surveys. Turning it around, there's some complexity involved in that, but as a core capability Origin is well-positioned.

MP: Very impressive. It looks like being in a commodity business requires such a multidisciplinary team. This brings us closer to the main topic of this interview. What does the industry expect from tertiary education nowadays?

EB: I am so deeply fascinated by that question, and I'm really fascinated about it because all companies should be thinking about their core capabilities versus what can be outsourced, that is, what are the capabilities that we don't need all the time. If I think about geophysics specifically as a core capability, I can see a world where companies like Origin get smaller and smaller in our specialised geophysics or subsurface skill sets, and we look for people that are more multi-skilled across a wide range of disciplines. We want people that have got broad knowledge,

that understand geophysics and geology, know how to interpret, but can also manage projects, have really good communication skills, write business cases, etc.

I can see a trend where we look for people with broad skill sets that can integrate all those things and then deliver outcomes on the basis of that kind of integration.

However, we're never going to get away from the fact that we actually need all the skillsets we've always needed. What I mean, is that we'll still need deep specialists in geophysics and geology, but what I see emerging is a requirement for the layering of multi-skillsets. For instance, we'll need more data scientists and people to work with the data *and* to understand the geoscience to actually know what the data means in order to create insights and do something meaningful with it. I think the question is, what ends up residing in companies like Origin? I think the graduates we recruit will have a broad, multi-layered skill set and then companies will need the ability to contract in the deep specialist skill sets and integrate that as required.

MP: Just for my curiosity… If you do not employ these deep specialists in your company, do you think that the pool of such specialists is going to exist and suffice the industry needs?

EB: That is part of the risk with the outsourcing model, right? This model assumes that specialist skillsets will be on tap, such that there will be a market supply when you need it. And I think that's one of the scary things about what we're seeing with geophysical education in the tertiary sector and the real collapse of that around just a handful of universities. It absolutely concerns me particularly in the context of a Net Zero future where critical minerals are going to be needed to underpin the technology of the future.

MP: Hiring new talent to your company nowadays, what are you doing differently compared to what was done before?

EB: I think two things are different. One, I think there's more structure in the interview process, which is intended to drive out unconscious bias. We create, and look to create, a process that doesn't bias against any kind of a feature of a person, and encourages us to think about talent differently - not to anchor ourselves to what the last person in the role showed up like – to challenge ourselves to think beyond the paradigm that there's only one way to undertake, or perform, or to succeed in that role. And then I think the second thing is, there is an absolute assumption that students are technically competent and that the key differential is our behaviours. Even at that graduate stage, your emotional intelligence - that's effectively what we hire on the basis of.

MP: I just recently started thinking this way. And what does determine the success or the failure of the candidates?

"When you talk about the smooth and efficient transition to clean energy, well, if we don't have today what we're going to need for tomorrow, we're a bit stuffed."

EB: If you get to the interview stage, it is 100% your performance in the interview that will make or break. In that way, all things equal in terms of experience, it can be a bit of a lottery because it kind of depends on how much you might've prepared. You can never be too prepared for an interview!

MP: Coming back to the clean energy transition, should we expect evolution or revolution in tertiary education to ensure a smooth process?

EB: That is what Kate Selway talked about in her recent paper and you in your Education piece in *Preview 210*. When education departments are shut down - that's it. It takes decades to build the competence, the structures, the processes in order to teach a tertiary level skill in a specific discipline. When you talk about the smooth and efficient transition to clean energy, well, if we don't have today what we're going to need for tomorrow, we're a bit stuffed.

I think that's going to be fascinating to see how it plays out in the supply and demand of the brains we need to think through the problems and deliver the work. I believe we'll be talking about human intellect resources and how that may drive our economic growth or cause the economy to shrink. I think it will be really, really interesting and I think in some scientific areas in Australia, we haven't set ourselves up for success in order to capitalize on the potential of our nation to fully participate in the energy transition. Geophysics in particular is one area where I think we will be really sorely lacking.

MP: What role does digitalisation play in the clean energy transition? What kind of education is required to guarantee efficient digitalisation of the sector?

EB: I think digitalisation plays a role in society full stop, let alone in the energy transition. We need people with really good digital skill sets, but the differential for folk will be their ability to ask the right questions of the data, to get insights, and then turn those insights into something tangible. We are currently drowning in information, and what will be fundamental will be our ability to ask the right questions of it, to understand when the data is crap, and to tell what's "fake news". Going back to bias, I think that is an interesting issue for digitalisation, including the way that systems are built by certain people and for certain people. We need to make sure that we really do have a diversity of folk that is involved in this digitisation and in the way that the data are collected, organised, and thought about, such that the outcomes meet all of our needs, not just the needs of the folk that are in there doing that work.

I think everyone will need a really solid education in data science. I do think maths is a key aspect to that. Then it's your ability to parse that information in different ways and get insights and do something with it.

MP: Do you have a special dedicated group of data scientists in Origin or do you bring data scientists into each and every project?

EB: We have a digital team. So there's quite a lot of digitisation all across Origin - we use data in our retail business, giving customers access to their usage data and access to increasingly sophisticated products and services such as demand response and virtual power plants. Then we've got data and insights in generation and how we connected into the national energy market and how we operate our generation assets to be more efficient and safe. Then in our Integrated Gas part

of the business we get information from our well heads, our gathering network, and our gas processing facilities to make great decisions on when and how to operate and maintain our assets.

So we deploy digital capability across the organisation to build applications, to work out how we can get to the root cause and answer questions for us, and put digital solutions in place to help us monitor and understand what's going on in our fields and in our operations.

MP: Do you prefer to have data scientists in this team, people with a double degree or geophysicists and engineers that were trained in data science?

EB: We are super diverse in the folk that we bring into this team. We have mathematicians, data scientists, we have physicists, and engineers - this team in Origin has been led by an environmental scientist. In the digital space, there is such diversity in the way that they bring people in. A lot of what's important, again, is the behaviours that folk bring into that space. It's in the agile process that they use to bring together diverse skillsets, from a variety of disciplines and functions, to solve problems. In a way that is where diversity really comes to life in that business.

MP: The last question is what kind of specialists are required to pursue the Net Zero economy in Australia?

EB: In order to make the Net Zero future happen, we are going to need to pull every lever available to us. It's not just going to be hydrogen and it's not just going to be electrification. We will need to look for every opportunity to get us there. We need to be more efficient with our operations and make sure we don't have fugitive emissions. We'll need engineers, we'll need scientists, we'll need curious folk to go and understand

"I would argue that geoscientists are really well positioned to contribute in this space. Particularly at this moment in time, because we work in uncertainty, we know how to navigate that. We know how to integrate different models and different datasets and create a cohesive story from really sparse data. That's what we do, right? That's a key skill set that will be needed to unlock our future."

if there's a problem in the first place. And we'll need the folk that are operating existing assets to solve problems perhaps in ways that they haven't imagined in the past.

So we have two key areas where we'll need to develop. First is for the removal of CO_2. We will need to develop the engineering techniques to remove CO_2 out of processes and then capture it in some way, transport and store it. It is in that storage space where geoscience knowledge will absolutely be incredibly important. The possible opportunity is enormous for geoscientists.

The second is to reimagine fuel sources to reduce or fully remove their CO_2 footprint. How do we electrify? In that space, you are going to need engineers, you're going to need data scientists, you're going to need to collaborate and do things in completely different ways than you've done in the past. And you'll need geophysicists to find the critical minerals that will underpin the technology that will unlock these renewable fuels.

I would argue that geoscientists are really well-positioned to contribute to this space. Particularly at this moment in time, because we work in uncertainty, we know how to navigate that. We know how to integrate different models and different datasets and create a cohesive story from really sparse data. That's what we do, right? That's a key skillset that we will be needed to unlock our future.

Geophysics education in Australia – AEGC wrap up and updated survey results

Kate Selway
ASEG Education Committee Chair
Education@aseg.org.au

I write this from the Oodnadatta Track in far north South Australia, on a service run for passive seismic instruments that are mapping seismicity and lithospheric structure around north-east SA. It's a great example of geophysics collaboration in Australia, with contributions from ANU, AuScope and the Geological Survey of South Australia. It's also very exciting to see the seismic traces from September's Woods Point earthquake in the records! All the more reason to think about geophysics education and how to ensure we have a new generation of geophysicists coming through to keep building the geophysical picture of our continent.

This month saw the Australian Exploration Geoscience Conference and an excellent keynote address on geophysics education by Richard Lilly, from the University of Adelaide and NEXUS. Richard outlined the challenges to geoscience education not only here in Australia but also globally, with many universities consolidating and cutting degrees like geology and geophysics that are expensive to run and attract only moderate student numbers. He challenged the whole geoscience community to help encourage young people to consider a geoscience degree through visiting schools, being willing to take on work experience students, or even just being enthusiastic about what you love about geophysics when talking to relatives and friends. Richard finished by describing some aspects of the NEXUS program that have proved extremely popular with students and effective at preparing them for industry jobs – a great inspiration that successful education initiatives are possible!

The education keynote session was one of the most highly attended of

the conference and the community's passion for this issue was also reflected in some fantastic ideas that were brought up in the Discussion Forum and Q&A running alongside Richard's talk. Some common themes emerged, including the challenges of enhancing interest in Earth Science at the school level, especially with so few qualified geoscience teachers and a decreasing emphasis on maths, and the challenges of training geophysicists with such a loss of teaching capacity at universities. Perhaps the strongest theme was a strong desire to help. This was expressed over and over again, from individuals and industry, with no shortage of ideas ranging from a geophysicist character in Bluey to competitions to bring high school students to our conferences. These ideas have all been noted! Alongside these offers to help was a request for resources to assist with logistics, content and messaging. Developing such resources is a key priority for the ASEG Education Committee and we are aiming to have resources ready by early in the new school year.

The survey of geophysics teaching in Australian universities, published in the last issue of *Preview*, has also received good attention with hundreds of engagements on both LinkedIn and Twitter from geophysicists in Australia and internationally. The exposure also led to the inclusion of some geophysics teaching that was missed in the initial survey; the updated table is shown here (Table 1), with the inclusion of the University of New England and Federation University and the addition of extra subjects with a geophysics component from Wollongong University and Monash University. Many thanks to everyone who supplied information for this survey. From this now (I hope!) complete base, we plan to repeat this survey annually to enable the community to track changes in geophysics teaching more easily.

Table 1. Geophysics education in Australia – updated table

		Undergraduate			Postgraduate (coursework)		Trends	
State	Institution	Geophysics major (or equivalent)	Number of stand-alone geophysics subjects	Subjects with geophysics components	Named Masters degree	Any postgraduate geophysics teaching	Recent changes (positive/ negative)	Planned changes (positive/ negative)
ACT	*ANU*		5	4				
NSW	*Macquarie*		1	1				
	UNSW		1	3				
	U of Sydney		0	2				
	U of Wollongong		0	3				
	U of New England		1	0				
Qld	*James Cook U.*		0	2				
	QUT		1	1				
	U of Queensland		0	1				
SA	*Flinders*		0	2				
	U of Adelaide		3	2				
Tas	*U of Tasmania*		0	4				
Vic	*Monash*		1	3				
	U of Melbourne		1	0				
	Federation U.		1	1				
WA	*Curtin*		12					
	UWA		0	2				

Environmental geophysics

Mike Hatch
Associate Editor for
Environmental geophysics
michael.hatch@adelaide.edu.au

AEGC 2021 highlights

Welcome readers to this issue's column on geophysics applied to the environment. In this column I will report on some of the interesting talks that I saw at the recent AEGC meeting: held virtually, but based in Brisbane. I have not participated in many virtual conferences so they are somewhat novel for me. Nevertheless, I have to say that I quite enjoyed this, and am pretty sure that the fully-virtual to hybrid conference model is likely to be here to stay.

As predicted in my last column, I quite enjoyed a number of talks. It wasn't a huge programme, which given the circumstances was to be expected. Again though, there was plenty of good content.

On a not-so environmental and a more personal-interest level I quite enjoyed Jamie Speer's presentation on the use of GPR as part of a search for archaeological artefacts/sites on "The Plain of Jars" in Laos. Did you realise that these megalithic "jars" are carved out of solid rock, at quarry sites that are at least 6.5 km from where the jars were finally located (for Site 1 jars), and that the big jars weigh more than 27 tonnes? And that there is something like 90 sites with up to hundreds of jars per site. The current thoughts are that they were carved in the Iron Age (roughly from 1200 BC and 600 BC), but no one knows who the carvers were, or what happened to their civilisation. Unfortunately, Jamie was not able to attend the conference session (work, work, work) but is happy to answer any questions that people have – please contact him on jamie@gbgoz.com.au. Once we can travel overseas I am definitely heading over to Laos to visit some of these sites. Fascinating.

As expected, I enjoyed Gianluca Fiandaca's talk on the use of multiple inversion scales to improve resolution of Cole-Cole parameters in AEM data affected by IP, and not just because I think that there is more IP (and SPM for that matter) in our EM data than is realised/acknowledged and we need ways to handle it. To me it was just as interesting that Gianluca thinks that this will be a good approach in many situations where information "lives" in the data sets at multiple scales and our attempts to make everything resolvable to the same scale may not give us the best results.

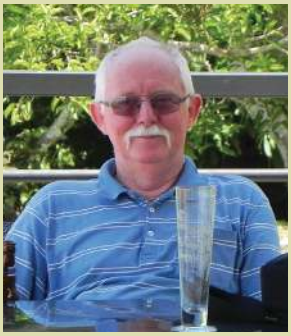
Taylor and his horde of collaborators from the CSIRO presented a comprehensive study of combined AEM and hydrological studies (including both geochemistry and limited groundwater data modelling) at Goulburn Island in the Gulf of Carpentaria, NT. This study determined that there is likely to be enough water in the system, and that recharge is sufficient, to meet the local Aboriginal community's needs, given improved infrastructure, monitoring and water management. Interestingly, like many of us working with data, they feel that there is still not enough data to fully populate a useful three-dimensional numerical groundwater model.

And my congratulations to all of the Best Paper and Poster Award winners, especially Neil Symington and his six co-authors from Geoscience Australia who won the award for the Best paper – Near-surface and groundwater. They presented on the use of probabilistic modelling to help infer groundwater salinity based on inverted AEM and sparse borehole conductivity survey results. Their approach allows the inherent uncertainty in each data set to be used to improve understanding of salinity distribution in the top 10 m of the subsurface. With my limited knowledge of groundwater modelling, it looks to me as if the ability to quantify the salinity distribution, as well as associated uncertainty, would be just the kind of information that groundwater modellers need. Many of us are (still) fixated on the concept of a "single" or "best" solution to the inversions that we use to interpret our data sets. This work makes it clear that we need to think about working in a more probabilistic thought space to ensure that we capture more of the information in our data sets.

And it can't be one of my columns (at least in the last year or two) if it doesn't mention the Loupe EM system. Greg Street (and co-authors, including Andrew Duncan) presented a number of interesting case studies, highlighting the potential of their new portable EM system.

Don't forget that you can go back and watch any of the talks that you missed (or that you missed details on) for at least the next few months. Now that's progress.

Minerals geophysics



Terry Harvey
Associate Editor for
Minerals geophysics
terry.v.harvey@glencore.com.au

By land or air

In mineral exploration, having settled on a particular geophysical method, the choice between using a ground-based or an airborne approach is not necessarily clear cut. The paramount consideration will be the capabilities of the survey technique (resolution, penetration, etc.) to achieve the exploration aims. But there are practicalities such as survey extent, duration, cost, access, ground conditions and system availability that also need to be considered.

A small local survey is clearly a job for ground geophysics; high mobilisation costs and minimum line length and survey size limits will effectively negate airborne options. There may also be issues with resolution. On the other hand, a large sub-regional survey is clearly a job for airborne geophysics; long survey duration and the high cost will effectively negate the ground option. Not unexpectedly, the grey area for choice falls between these two extremes, as the magnetics exploration history of a 3 x 7 km area of interest illustrates.

Pre-existing coverage comprised regional airborne magnetics flown along 200 m spaced lines at a nominal 60 m terrain clearance; however, this was deemed to provide insufficient detail. The total magnetic intensity (TMI) image, windowed for the area of interest, is illustrated in Figure 1a.

A detailed ground magnetics survey was commissioned, with readings taken along 50 m spaced lines at an average station spacing of 1.5 m. By ground survey standards this was quite substantial (380 line km extent, 17 days duration). The survey provided far more detail but results were compromised by effects from widespread surficial maghaemite (see Figure 1b). Extensive re-processing and low-pass filtering were required to deliver a more usable product; detail was definitely superior to that provided by the regional airborne survey (see Figure 1c).

Finally, the area of interest was opportunistically included in an extensive detailed airborne magnetics programme flown over several areas in the general region. Survey parameters for the area of interest comprised 50 m spaced lines flown at 38 m terrain clearance; average station spacing was 3.5 m. By airborne standards this was quite small (490 line km extent, 1 days duration). The survey results provided excellent detail (see Figure 1d).

In hindsight, the detailed airborne survey provided the better product and at a far cheaper cost. However, for this area, the comparison between ground and airborne is skewed by the detrimental effects on the ground survey results of widespread maghaemite, and by the cost and logistic benefits of opportunistically including the airborne survey within a much larger programme. Things are rarely straightforward!

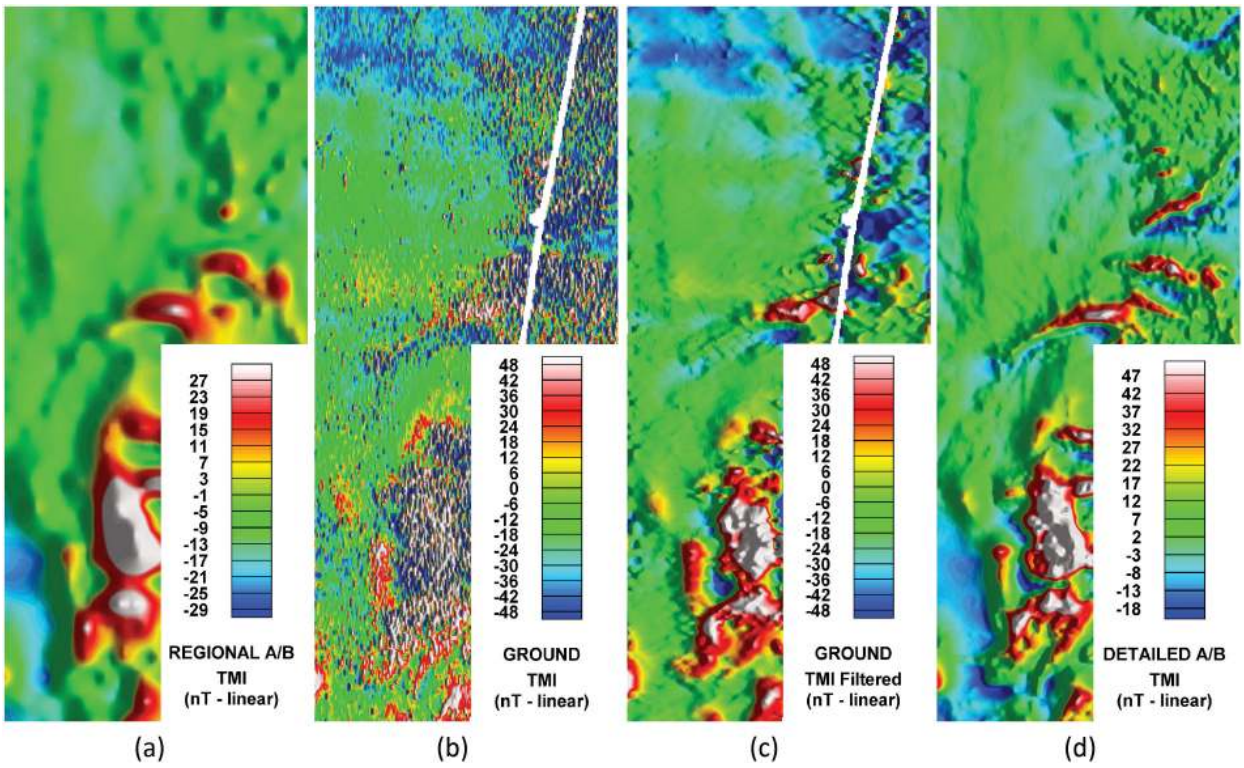


Figure 1. *MI Comparisons left to right: (a) regional airborne, (b) ground, (c) filtered ground, (d) detailed airborne.*

Seismic window

Michael Micenko
Associate Editor for Petroleum
mick@freogeos.com.au

Reflection seismology is 100 years old

The world's first reflection seismic line is shown in Figure 1.

As you can see from the dates, 2021 is the seismic reflection method's 100th birthday, and the *Preview* Editor suggested that I should mark this anniversary in my column. The following is a compilation of information from other articles, not my work because I'm not quite old enough to remember the early years!

The exact date of the birthday is a subject of discussion (see timeline box) but the first seismic section is dated August 9 1921.

The reflection method grew out of the seismic refraction method which was used to map salt domes in Germany by Ludgar Mintrop using a mechanical seismograph he designed in 1914. The reflection method was first conceived by Reginald Fessenden, a Canadian, in 1912, and in 1914 he applied for a patent which was granted in 1917. Unfortunately the war (WWI) intervened and it was not followed up.

Independently, a team in the USA headed by physicist Clarence Karcher conducted experiments that showed the reflection method could be used to map the subsurface geology. It took a while to catch on, and was likened to using a divining rod – actually it was worse than that with one writer saying it was "not even considered on a par with the divining rod for at least that device had a background of tradition."

Things have come a long way since then, and reflection seismology has arguably led to developments in sonar, radar and ultrasound with spin-offs resulting in advances in computer technology and instrumentation.

In Australia, "seismic data is the principal geophysical method used to image the subsurface in both land and marine environments. Geoscience Australia has recognised the importance of the seismic technique since the late 1940s and is a world leader in integrating seismic data with other earth imaging and surface geology datasets to understand mineral and petroleum systems. Geoscience Australia routinely acquires seismic data to gather new pre-competitive data in Australia's unexplored onshore and offshore frontier regions as well as obtaining additional regional seismic datasets in already explored regions of Australia known to have petroleum, geothermal, groundwater or mineral potential" (https://www.ga.gov.au/scientific-topics/disciplines/geophysics/seismic)

The seismic reflection method today can be used to map not only simple structures as in Figure 1, but sand distribution and fault patterns and the type of fluid fill in a reservoir. A good example of this was presented by Satyabrata Mishra at the AEGC virtual meeting in September 2021.

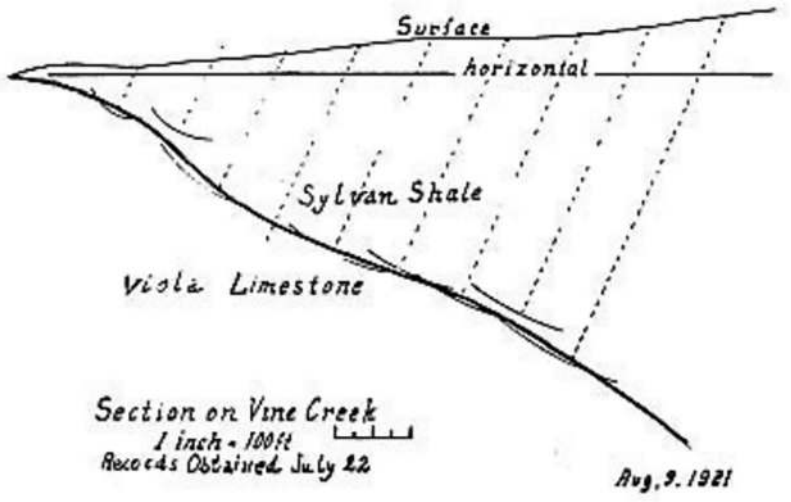


Figure 1. *The world's first reflection seismic line. Vine Creek Oklahoma August 9, 1921.*

SEISMIC REFLECTION DEVELOPMENT TIME LINE
(Modified from agilescientific.com)

April 12 1919
Clarence Karcher recorded the first exploration seismograph record in Washington DC.

1919 -1920
Karcher continued experiments

April 1921
Karcher designed and built apparatus for recording seismic reflections

June 4 1921
Field tests at Belle Isle, Oklahoma City using a dynamite source

June 6 1921 – early July 1921
Profiles recorded with various offsets and spacings

July 14 1921
Tests in Arbuckle Mountains determined seismic velocities

Early August 1921
Group moved to Vines Branch where the first reflection seismograph section was drawn

September 1 1921
Experiments near Ponca City, Oklahoma conducted by Karcher, Haseman and Ryan

September 13 1921 – October 1921
Start of survey for Marland Oil Company. Mixed success

Further reading

100 years of seismic reflection — Agile (agilescientific.com)
Karcher, C., 1932. Determination of subsurface formations. Patent no. 1843725A. Patented 2 Feb 1932.
Mishra, S., Squire, S. and Massey, T., 2021. Application of facies based seismic inversion in developing shallow gas fields in Cooper-Eromanga Basin. AEGC 2021, Brisbane, Australia

Data trends

Tim Keeping
Associate Editor for geophysical data management and analysis
technical-standards@aseg.org.au

A guide to measuring magnetic susceptibility in the field

The quality of petrophysics collected in the field is highly variable and may result in lost opportunities for companies trying to later model and plot their exploration course. In response, ASEG Members Regis Neroni, Mark Duffett and Tim Keeping are producing simple, single sheet (double sided) petrophysical field guides for exploration geologists to download from the ASEG website, print, laminate and hand to a field assistant. Each major category will have its own guide to improve the quality control. These are magnetic susceptibility, specific gravity and conduction.

The guides are not comprehensive nor explanatory, as we would simply be reprinting the device manuals and text books. The simplified guide is intended only as a means of avoiding common errors. We do, however, intend to produce more comprehensive guides with the help of Cameron Adams at the University of Western Australia. These guides will enable on-site exploration geologists to develop a better understanding of the purpose of petrophysical data and how it is likely to be used, as well as assisting them with identifying common pitfalls in data acquisition. The first draft of the magnetic susceptibility field guide is appended below. Please review the guide and email your questions and/or any feedback to technical-standards@aseg.org.au

Australian Society of Exploration Geophysicists

GUIDE TO MEASURING MAGNETIC SUSCEPTIBILITY IN THE FIELD

What are you (mostly) measuring?

– the iron in a rock

Preparing the meter

- read the manual
- set correct drill hole core diameter and units to ***SI***
- Ensure that these settings are recorded together with your data

An ideal sample

- is as wide as the device to maximise rock sample

Taking a measurement

- zero the meter before each measurement (required by GMS-2/RT-1)
- pick up and measure the sample away from metals and other rocks

Avoiding bad measurements

- do not measure in a tray as iron is commonly found in
  - aluminium alloy tray bodies
  - nails and screws in wood trays
  - trestles that trays sit on
- do not wear excessive jewellery
- do not use electronic devices nearby as they create magnetic fields

Recording the exponent number

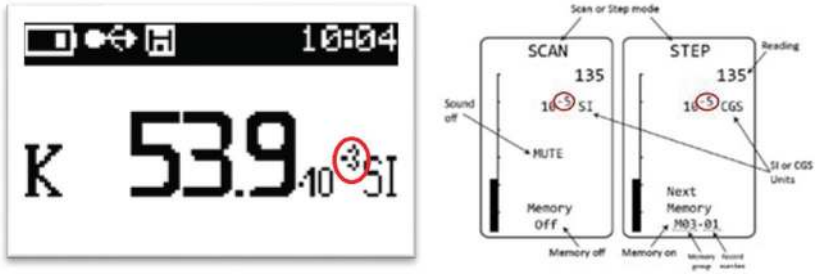


Figure 1. *Picture of KT10 screen, taken from Terraplus KT10 manual (left) and RT-1 screen taken from RT-1 manual (right)*

- it is important to record the exponent number
- this is usually displayed as 10^{-3} or 10^{-5} (see Figure 1)
- the exponent is the -3 or -5
- the exponent converts the measurement to its absolute form
- example: 53.9 x 10^{-3} = 53.9 / 1000 = 0.0539 SI

Exponent tips

- KT series exponent defaults to -3
- GMS-2 and RT-1 default to -5 but high measurements change the exponent so check each time

Recording measurements in a spreadsheet

- a general layout is shown in Figure 2
- *Mag Sus* column uses the formula ***Reading * (10 ^ Exponent)***
- type in K2 = ***I2 * (10 ^ J2)*** and copy down the column

	A	B	C	D	E	F	G	H	I	J	K	L
1	Meter	Serial	Operator	Hole	Core diam	Date	From	To	Reading	Exponent	Mag Sus	Unit
2	KT10 Plus	4567	TK	DDH01	BQ	14/07/2021	10	11	0.03	-3	0.00003	SI
3	KT10 Plus	4567	TK	DDH01	BQ	14/07/2021	11	12	0.53	-3	0.00053	SI
4	KT10 Plus	4567	TK	DDH01	BQ	14/07/2021	12	13	1.23	-3	0.00123	SI

Figure 2. *Example layout of a spreadsheet.*

Check your results are realistic

- graph the Mag Sus column as a line plot (see Figure 3)
- the maximum possible value is 20 and negatives are possible
- Common settings for a readable graph are
  - Y axis has a base 10 logarithmic scale
  - X axis intercepts Y axis at 0.0

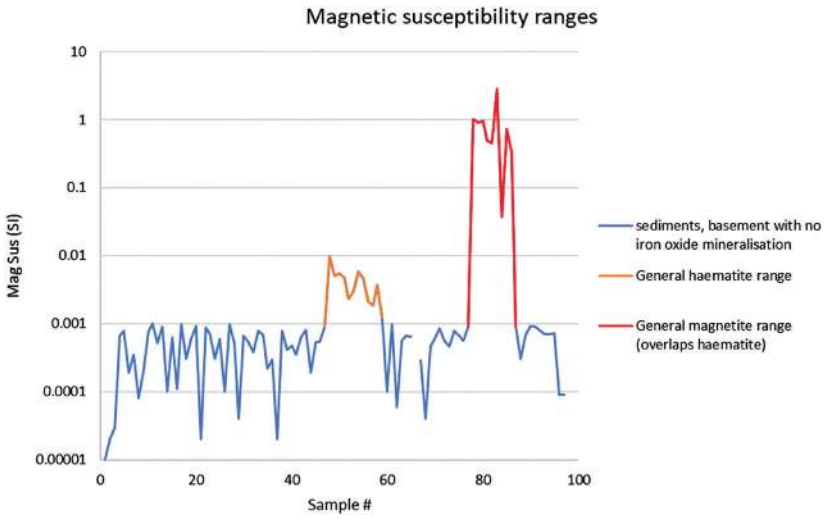


Figure 3. *Example magnetic susceptibility plot*

Webwaves

Ian James
ASEG Webmaster
webmaster@aseg.org.au

Tor and the dark web

The majority of web users interact with the surface web - the networks of webpages that are easily accessible and found by using common internet search engines. These have familiar domains including .com and .com.au.

Extending beyond this is the deep web, which is often confused with the dark web. The deep web contains websites that are not indexed (searched) by internet search engines. This includes websites that are hidden behind security and passwords, such as online banking, and websites behind paywalls such as newspapers and video streaming.

The dark web (or dark net) goes even further - not only are sites are not indexed but they are inaccessible through common browsers. They also contain additional security including encryption and routing between multiple IP addresses. An example of a dark web browser is Tor.

Tor, The onion router (https://www.Torproject.org/). The name is self-descriptive, with a security methodology akin to peeling the layers of an onion. Tor was initially developed by the U.S. Naval Research Lab as a means of creating anonymous, encrypted network connections. Internet connections are anonymised and encrypted using the following workflow (Figure 1).

1. Your Tor client retrieves a list of Tor relay nodes. These are volunteer-run servers that are used for the Onion routing.
2. Your client picks a random path through these relays to the destination. Each connection applies a layer of encryption. Anonymity and encryption are maintained as each relay/layer only knows information about the previous and next node.
3. Should you initiate another connection, a new random path is created.

Navigating the dark web on Tor involves stepping away from the usual domain names and instead moving across to the .onion domain names. This isn't actually a top level domain name, but is an address that is accessible when using the Tor network. These .onion addresses are opaquely named, with 16 (V2) or 56 (V3) character long alpha-numeric strings. It is possible to have partially human readable .onion addresses by brute force generation of random addresses until one is created with the necessary initial string. The CIA site on the dark web is one such address and can be accessed on a Tor browser here: ciadotgov4sjwlzihbbgxnqg3xiyrg7so2r2o3lt5wz5ypk4sxyjstad.onion/

Accessing the dark web is not illegal, and the Tor browser can be used for generic internet browsing. The Tor project receives funding from the U.S. Government in addition to organisations including Google and the University of Cambridge.

While the dark web is associated with illicit purposes, there are legal and legitimate reasons why users may wish to access the dark web. In the case of the link above, users could report security threats to the CIA anonymously. More generally, a privacy focus when browsing should be encouraged. Large quantities of data are routinely collected and this data is exploited for the benefit of the corporations who collect it. We should have the right to browse the internet with privacy.

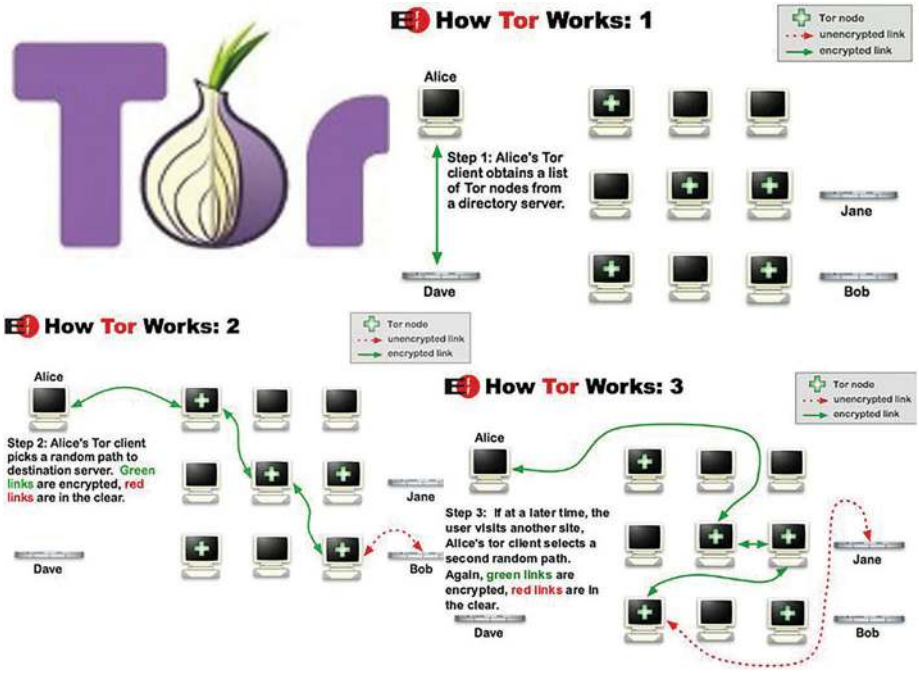


Figure 1. *How Tor works (from https://www.eff.org/)*

Australian Society of Exploration Geophysicists
50th Anniversary Special Publication

MEASURING TERRESTRIAL MAGNETISM

the evolution
of the
AIRBORNE MAGNETOMETER
and
the first anti-submarine and aeromagnetic survey
operations

People, Planes, Places and Events
1100s – 1949

W.D. (Doug) Morrison

This Special Publication is co-sponsored by
Geoscience Australia and ASEG
https://www.aseg.org.au/publications/book-shop

MEASURING TERRESTRIAL MAGNETISM

the evolution of the AIRBORNE MAGNETOMETER and the first anti-submarine and aeromagnetic survey operations – People, Planes, Places and Events 1100s –1949

W. D. (Doug) Morrison

This book, covering a global expanse of more than 800 years, recounts the largely untold story of 'measuring terrestrial magnetism' and of the extraordinary 'people, planes, places and events' that have contributed to the evolution of the magnetometer and the first anti-submarine and aeromagnetic geophysical survey operations. It is a unique journey of science and engineering, of inventions, new methods and instruments – a compelling story of how the measurement of terrestrial magnetism has influenced the history of the world.

This is an operational historical record rather than a history of the theory of terrestrial magnetism. The story begins at the earliest documented geomagnetic discoveries and moves on to observations of magnetic intensity and the first ground magnetic surveys. We see how the instruments used for geomagnetic observations from moving airborne platforms evolved in parallel with the evolution of flight from balloons (from 1784) to airships and eventually aircraft.

In the 1930s and 1940s there were major advances in magnetometry, in USSR, Japan and Germany as well as in USA and UK. In USA and UK these advances were applied in military surveillance systems, including in the detection of submarines. Landmark World War II induction coil and fluxgate instruments – the first of the modern technologies – enabled aeromagnetic acquisition, mapping and direct detections of ore bodies from the air from mid-1944 onwards, foreshadowing today's airborne magnetic surveys. The military developments of magnetometers were taken up, rapidly advanced and applied by the mineral exploration industry to find new economic deposits of magnetic mineral ores. Countries including Australia, Canada and the United States charged their national mining and geological survey departments with investigating and establishing programs of major aerial magnetic surveying and mapping in the search for minerals and energy.

The story explores the inextricable cross-discipline connections of terrestrial magnetism and magnetometers as used for navigation, geodesy, anti-submarine and military purposes, and their role in the geophysical oil and mineral exploration industry. Organisations, people and specific instruments and aircraft are noted, including (at times coincidental) Australian connections.

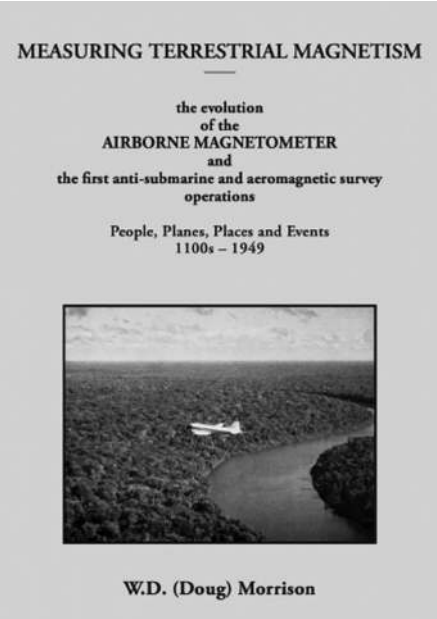
The extraordinary depth and scope of research, over many decades, by the author W.D. (Doug) Morrison, as well as his collection of photos and illustrations, and his astonishing attention to detail, make this book an amazing and immersive historical reading experience and a future primary reference work. Through several decades Doug has developed an extensive 'reference' network of geophysical survey practitioners, and former experts in military, aviation and maritime matters. Through their little-known stories and personal reflections, and his access to personal and official archive material from this network, Doug's narrative brings unique insights into the evolution of the airborne magnetometer. Along that timeline he has produced details that are not available in public historical material.

Measuring Terrestrial Magnetism is a major work of 630 pages, illustrated throughout with 156 plates of figures and photos, and including comprehensive Endnotes, Appendices, References and Index.

ISBN 978-0-6450691-0-5 (paperback)
https://www.aseg.org.au/publications/book-shop

MEASURING TERRESTRIAL MAGNETISM: the evolution of the AIRBORNE MAGNETOMETER and the first anti-submarine and aeromagnetic survey operations. People, Planes, Places and Events 1100s-1949.

W.D. (Doug) Morrison.



Published jointly by the Australian Society of Exploration Geophysicists and Geoscience Australia, 2020.

Paperback AU$70.00 + postage (Australia and International)

ASEG Member's Discount Price AU$45.00 + postage via secure Member login

This book is a *tour de force* of meticulous research combined with detailed documentation of the development of instruments to measure the earth's magnetic field spanning the last millennium. The author has a long career in the practical application of airborne geophysical mapping, together with enthusiasm for geophysical history and the rare research skills and perseverance to pursue primary sources. His astonishing attention to detail, combined with careful analysis of (sometimes) conflicting descriptions of equipment and events, has produced a volume unsurpassed as a history of the practical development of airborne magnetics.

The book is divided into three parts:

Part 1 covers historical magnetic measurements and magnetic surveys up to WWII. Morrison documents the early use of magnetic compasses in mining, measurements of magnetic declination and its importance in navigation, and the growing understanding that certain rock types are strongly magnetic and effect the earth's magnetic field. In 1785, the first "airborne" magnetic measurements were observed in a manned balloon. In the mid-1800s, a number of country-wide ground magnetic surveys were carried out. The method became an accepted tool in exploration and mapping of buried iron ore deposits. During WWI, the first investigations into the practicality of using magnetics for the detection of submerged submarines took place. Magnetic measurements were made in aircraft and airships, including a flight by German Graf Zeppelin in 1930 for solely geological reasons. The saturated core "fluxgate" magnetometer was invented in Germany in 1928, but the development was not published until 1936. Morrison also documents extensive airborne magnetic surveys carried out in the USSR in the late 1930s and during WWII, using induction coil technology, which had relatively low sensitivity, 60-100 nT, but successfully discovered a number of iron ore deposits.

Part 2 tells the story of US and British government efforts to develop magnetometers with the sensitivity and practicality to detect submerged enemy submarines. Hare and Vacquier (Figure 1) submitted a patent application for a new fluxgate magnetometer in 1940, but to have this continuously measure the earth's changing magnetic field whilst mounted in an aircraft (Figure 2) and at any latitude on earth was a problem which occupied the defence establishments in the US and Britain for much of WWII. Compensation for the magnetic effects of the aircraft itself was a major issue. Using source material which was not released until after the war, Morrison carefully documents the equipment advances and test flights to develop a practical MAD (Magnetic Airborne Detection) system and the numerous missions carried out during the second half of the war using progressively upgraded equipment, which ended up being relatively successful. The magnetometers were also installed in blimps, as well as a variety of fixed wing aircraft.

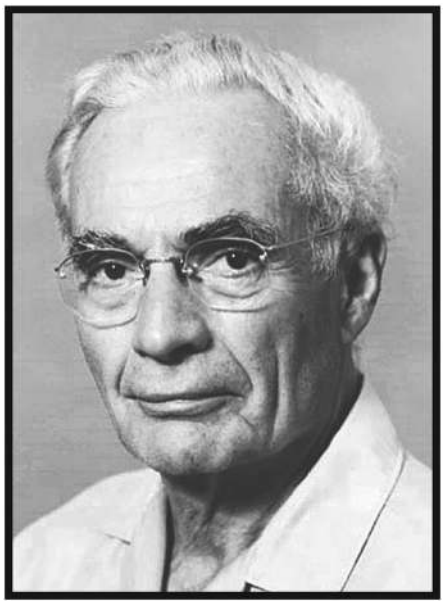


Figure 1 (Figure 39e). *Victor Vacquier at Gulf Research and Development Company invented the airborne fluxgate magnetometer He died in 2009 at the age of 101. Obituary by Shor and Sclater (2010).*

Figure 2 (Figure 48). *The USAAF Sea-Search Attack and Development Unit (SADU) Douglas B-188 Bolo BuNo 07530. One of a series of photographs taken "near British West Indies and Martinique 12 July 1942". These are the earliest identified photographs of an operational aircraft with a magnetometer or MAD mounted in a "stinger". USAF. Public Domain. Various sources including NARA.*

Part 3 (almost half the book) describes the largely post-war development of improved fluxgate magnetometers, paper chart recorders and ancillary equipment for navigation and flight path recovery, to the point where systems were practical for mineral and petroleum exploration. Much of

this work was driven by the USGS, with James Balsley (Figure 3) playing a major role, which recognized the huge potential of aeromagnetics in geological mapping and the direct delineation of ore deposits. The AN/ASQ-3A fluxgate was mounted in a single engine aircraft for test purposes, but quickly moved to a twin-engine aircraft for safety reasons. At the very end of the war, while the magnetometer and other equipment were still highly classified, the USGS under the auspices of the US Navy flew a major survey for petroleum in Alaska. Immediately after the war, Canada, Britain and other countries were eager to acquire the AN/ASQ-3A to commence regional mapping aeromagnetic surveys in their own countries but were held up for several years until the equipment was declassified. Also, Gulf Research was fighting to establish the precedence of its patent application against all others, which caused further delays. Morrison's narrative does an excellent job of documenting these activities from primary sources. By 1948-49 these issues had been largely overcome and the book contains a number of chapters documenting the commencement of large-scale aeromagnetic surveys in Canada and Britain (as well as the continuing surveys by the USGS). Independent of the US technology, Hans Lundberg in 1946 trialled an induction coil magnetometer in a Bell 47 helicopter at Sudbury, Canada. In early 1947, USGS geophysicist James Balsley took part in Operation HIGHJUMP (the US Navy exploration of Antarctica lead by Admiral Byrd) and acquired the first aeromagnetic data in the Southern Hemisphere. The magnetometer was installed in a DC-3. One engine failed during the latter part of the flight and the crew had to ditch all the heavy camera equipment and other supplies… but not the magnetometer! The first Australian surveys were flown in 1949 by Oscar Weiss for The Zinc Corporation, BHP and WMC. The author ends his narrative in 1949, by which time governments and private enterprise had accepted that the technology was mature enough for both detailed and regional surveys. Also, by that time, 14 fixed-wing, high sensitivity aeromagnetic survey aircraft were available for survey flying.

The author is obviously an aircraft historian… in almost every case in the text where geophysical equipment is installed in an aircraft, he meticulously documents the manufacturer, model and serial number, together with the names of the pilot, co-pilot, navigator and instrument operator. Similar details are included for airships, ships and submarines.

Figure 3 (Figure 86b). *James Robinson Balsley of the USGS operating the magnetometer in the US Navy SNB-1 BuNo 51044, 1944-45. US Geological Survey.*

As a measure of Doug Morrison's zealous research for primary sources, the 462 page book includes 100 pages of endnotes and 31 pages of references. There are 156 (unnumbered) pages of photos and maps. In addition to a general index, there are indexes for people, places, aircraft, military squadrons (units), ships and submarines.

Although most significant technological developments in this narrative took place outside Australia, the author (being Australian) has included a number of interesting "snippets" from an Australian perspective. In 1770 Captain Cook observed erratic rock magnetism on Quail Island, Queensland. In 1812 Matthew Flinders determined and wrote procedures for the compensation of Royal Navy ships compasses using iron compensation bars. In 1859 Georg Neumayer observed horizontal magnetic intensity at Ballarat, Victoria, including underground at Black Hill mine. In 1945 Harold Raggatt (Director of the Australian Government Mineral Resources Survey) and his chief geophysicist Jack Rayner visited USA and Canadian geological organisations. They also investigated the potential for a project for magnetic mapping of Australia from the air. I was particularly fascinated by the description of the Arctic voyage of the Graf Zeppelin in 1931, when it was planned to meet up with Australian explorer Sir Hubert Wilkins in his private submarine *Nautilus!* Unfortunately, this fell through because the submarine could not be made ready in time. Who knew Australia had its own Indiana Jones?!

The narrative basically follows historical timeframe, but with some appropriate stepping forwards and backwards to accommodate particular developments or geographic locations. While reading the whole book is obviously advantageous, I believe the more casual reader could select particular chapters of interest to read, without losing too much historical context. In this regard, the author includes a handy eleven page "Selected events in the evolution of the airborne magnetometer" in the appendices.

The book is not a light read… at 462 pages (plus 156 pages of figures) it weighs 1.65 kg (3.64 lbs).

I highly recommend this book to anyone interested in the history of geophysics. In the present day of powerful computers, GPS navigation, sophisticated graphics and instant worldwide cellphone communication, I suggest that it would be a very educational read for younger geophysicists and geologists to be exposed to the early technology development… and better appreciate how good things are now! In my own early career, I still clearly remember struggling with matching negative strip film with positive black and white photo mosaics! In those days, a skilled navigator was vitally important!

Reference

Shor, Elizabeth N. & John G. Sclater (2010) Victor Vacquier (1907–2009). *Eos* 91(30): 264.

Reviewed by
Richard Irvine
Condor Consulting, Inc.
dick@condorconsult.com
September 13, 2021

ASEG 2021 Honours and Awards

ASEG Gold Medal: Malcolm Cattach

The ASEG Gold Medal is awarded from time to time for exceptional and distinguished contributions to the science and practice of geophysics by a Member, resulting in wide recognition within the geoscientific community. The ASEG President announced at the Awards Ceremony held in September in conjunction with the AEGC 2021 that the ASEG Gold Medal has been awarded in 2021 to Dr Malcolm Cattach.

This award specifically recognizes Mal's exceptional contributions to geophysics in Australia and internationally, through his pioneering work spanning 40 years in the development of new and innovative geophysical exploration technologies that have become internationally established.

After graduating with a science degree from University of New England in 1978, Mal worked as a geophysical field hand for two years with Newmont Mining. He returned to UNE in 1981 to complete a Master's preliminary year in the Department of Geophysics. He then enrolled in a Master's study sponsored by Newmont Holdings, analysing the comparison between the performances of commercially available IP receivers. Upon completion of this MSc, Mal had the choice of obtaining employment with Newmont, which had been his original ambition, or join John Stanley at the self-funding Geophysical Research Institute (GRI). John had developed a Cs vapour magnetometer with automatic data positioning and digital recording and pioneered the application of high-definition magnetic mapping to mineral exploration, archaeological mapping and then the detection of UXO. In 1984 the GRI had a contract to develop the TM-3 magnetometer for the Australian Defence Department. Mal chose to support the GRI.

Having gained an appreciation of the benefits of acquiring high-definition magnetic data, and with his Master's experience in electrical methods, Mal proposed the concept of using the fast-sampling Cs magnetometer to simultaneously acquire spatially varying magnetic and time varying electromagnetic responses. Under John's supervision at the GRI, and with funding support from Normandy Poseidon, Mal subsequently undertook a PhD researching all the basic physics underlying the Sub Audio Magnetics (SAM) method by which the four parameters of TMI, TFMMR, TFEM and TFMMIP could theoretically be simultaneously acquired. Within the PhD program, Mal confirmed the simultaneous acquisition of the TMI and TFMMR parameters through practical application with case studies. Mal and John then co-supervised the PhD of David Boggs, who proved that the remaining two parameters could also be simultaneously obtained.

When the GRI transitioned from an Institute to a private Company G-Tek, Mal took on the role of Director of Research and was on the Board. In 2005, after John's retirement, Mal led the regrouping of the former GRI research staff in the formation of Gap Geophysics in Brisbane, and very successfully managed a commercially viable geophysical company providing an invaluable service to the exploration and environmental mapping industries, while continuing to advance an active research and development program. In the 16 years since forming Gap, Mal has been responsible for bringing to maturity all the technologies that in the GRI days were but a dream.

Over the past 40 years, Mal has been a pioneer, often the pioneer, of a sequence of geophysical exploration technologies that have become internationally established as World Leading. In 1984 he introduced microprocessor technology to the newly developed digital Cs magnetometer, facilitating the automatic acquisition of positioned magnetic data that became a precursor to his development of image processing software. This achievement was recognised at the time with the Grahame Sands award of 1988.

His PhD research completed in 1993 produced the Sub Audio Magnetics technology, a task that required both the upgrading of the Cs magnetometer technology, the development of theoretical requirements to enable the separation of the SAM parameters, and case study proof of the combined performance of hardware and software. This work was recognised by a second Grahame Sands award in 1995.

Experience applying SAM using the best available commercial geophysical transmitters enabled Mal to propose a specification for a new, very high-power transmitter to specifically meet SAM requirements. With assistance from a specialist electronic engineer, a range of high-performance transmitters were built. This development earned Mal an unprecedented third Grahame Sands Award in 2012.

A further development of SAM, named SAMSON, enhanced performance in the acquisition of TFEM data. Their paper describing this innovative application of geophysical technology won Mal and his co-authors, the Laric Hawkins Award for best paper at the ASEG Conference in 2007. SAM and SAMSON have now received international acceptance in the geophysical exploration and mapping industries, and are used on all continents. SAM is not just a ground-based technique but has also been successfully applied from a helicopter platform, a development that earned Mal a second Laric Hawkins Award in 2018.

With three Grahame Sands awards for innovation in applied geophysics, two Laric Hawkins awards, and Best Paper awards at ASEG Conferences, Mal has in fact received more ASEG awards for excellence in exploration geophysics than any other awardee in the Society's 50-year history. Mal's contribution to the development of high resolution, and high-definition multi-parameter geophysical mapping was also recognised in Europe as a joint recipient (with John Stanley) of the Comenius University (Bratislava) Medal.

In addition to contributing to many innovative technology developments, Mal has successfully established, managed and operated Brisbane based Gap Geophysics, a commercially viable geophysical contracting and consulting company, providing an invaluable service to the exploration and environmental mapping industries, while continuing to advance an active research and development program.

Mal has also been an active Member and supporter of the ASEG since 1984 and has subsequently participated in almost every ASEG Conference as a trade exhibitor and presenter. Throughout his career, Mal has demonstrated an extraordinary loyalty to the Society and to Australian geoscience by choosing to present and publish his science and technology developments at ASEG conferences and in the ASEG's journal

Exploration Geophysics and in *Preview*. He has also shared his scientific skills as supervisor of post-graduate students and mentor to his staff. He is greatly admired for his achievements by his peers and colleagues.

Malcolm Cattach's scientific and technical inventions and his pioneering contributions to exploration geoscience over four decades, demonstrate his exceptional and distinguished contributions to the science and practice of geophysics, and it is appropriate that the profession now recognises these achievements with the award of the ASEG Gold Medal.

Mal Cattach

Lindsay Ingall Memorial Award: Doug Morrison

The Lindsay Ingall Memorial Award is intended for the promotion of geophysics within the non-geophysical community, including geologists, geochemists, engineers, managers, politicians, the media or the general public. The award honours the memory of an ASEG founder, past President and Honorary Member, the late Lindsay Ingall for his capacity to cross geoscience boundaries, his ability to relate technically and effectively with other professionals, regardless of their own understanding of the principles of geophysics, and for his enduring commitment to assist geoscientists across Australia. It is awarded generally to an individual who has actively promoted geophysics to the wider community.

In 2021, the award is made to Doug Morrison from Sydney. This award recognizes Doug's active promotion of the science, technology, practice and history of geophysics, particularly airborne geophysical surveying, well beyond the bounds of the exploration geophysics and service industries. The award acknowledges his authorship of many non-geophysical science and aviation histories, and in particular the most recent ASEG 50th Anniversary Special Publication.

For more than 50 years, Doug has been well known and highly regarded in those parts of the international aviation industry that have forged the developments in technologies, practices and innovations used in the wide range of aerial surveying and mapping. He is widely acknowledged and respected as an expert in data processing and technical leadership of airborne geophysical surveying and mapping projects around the world. He has managed or contributed to airborne geophysical survey mapping projects in Australia and overseas.

Doug joined Aero Service in 1962 as a 'trainee cartographer and geophysical data compiler' whilst undertaking night studies in land and engineering surveying at Sydney Technical College. Much of Doug's early training, leading to his unique expertise in aerial geophysical mapping, came from his time with the Aero team and had a major influence on Doug's life direction. Through Aero's in-house training setup, he quickly became an expert in precision base mapping, transcribing and processing analogue geophysical data to produce exploration map products that set a world-class standard for that era.

Doug assisted geophysicists on many surveys, including Lindsay Ingall who consulted on some jobs. In 1964 Doug had to make a choice between a six-month contract of the aeromagnetic survey of the Great Barrier Reef, or continuing night college. No one refuses six months paid work on the Great Barrier Reef! He also met his future wife on this survey.

In 1966, at the age of 22, Doug and Brian Lenon arranged with Aero Service to be their sole mapping subcontractors in Australia. After Aero's new parent company, Litton Industries, shut their overseas offices including Sydney at the end of 1966, a group of ex Aero managers formed new groups in competition to Litton. One of these was Geophysical Resources Development Company (GRD) based in Sydney, with Doug retained to manage the data and drafting sections. GRD had five aircraft flying geophysical surveys and over 80 personnel when the mining boom collapsed in 1972, and GRD went into receivership. Californian-based Geometrics formed their own airborne division and took on six ex-GRD Sydney staff including Doug, and two aircraft and crews.

Doug continued with Geometrics until 1980 in various data processing and supervisory roles and later Field Operations Manager. In 1980 Doug resigned from Geometrics and expanded his separate data processing contracting business, Southlands Geophysical Services, carrying out tasks for most airborne contractors in Australia and the Pacific region. In 1994 he joined Geoterrex/DIGHEM as the data production supervisor and quality assurance manager before returning to survey sub-contracting in 1998. In 2006 he was asked to join Fugro Ground Geophysics (later CGG) in Sydney where he remained until his 'retirement' in 2013.

With his deeply embedded background in airborne geophysics, Doug has immersed himself in the history of global exploration and particularly in the detailed history of Australian and international aviation surveying developments, establishing an extensive 'reference' network of aerial survey practitioners and well-known experts in military, aviation and maritime matters. Through their little-known stories and personal reflections, and his international access to personal and official archive material from this network and eminent scientific and history institutions, Doug's most recent book, the ASEG 50th Anniversary Special Publication, has provided the context for specialists and non-specialists to appreciate the evolution of the airborne magnetometer and the early history of geophysical surveying and mapping

In recent years, Doug has written a number of science and aviation histories that have been published in *Historical Records of Australian Science*, the *Transactions of the Royal Society of Victoria* and the *American Aviation Historical Society Journal* and other aviation publications. He has published articles regularly in the ASEG *Preview* magazine covering Australia's early history of geophysical measurement and surveying. His extensive listing of *Preview* articles has captured wider attention in education and community circles, and amongst military, aviation and maritime

survey history enthusiasts. Doug's contributions have added significantly to the international standing and recognition of the ASEG and exploration geophysics.

Doug's new book, the ASEG 50th Anniversary Special Publication "Measuring Terrestrial Magnetism: the evolution of the Airborne Magnetometer and the first anti-submarine & aeromagnetic survey operations, People, Planes, Places & Events 1100s-1949" was released in 2021. The book covers a global expanse of more than 800 years and recounts the largely untold story of 'measuring terrestrial magnetism' and of the extraordinary 'people, planes, places and events' that have contributed to the evolution of the magnetometer and the first anti-submarine and aeromagnetic geophysical survey operations. It is a unique journey of science and engineering, of inventions, new methods and instruments and a compelling story of how the measurement of terrestrial magnetism has influenced the history of the world. The extraordinary depth and scope of research over many decades, as well as his collection of historic geophysical texts and maps, photos and illustrations, and his astonishing attention to detail serve to make this book an amazing and immersive historical reading experience and a future primary reference work.

In 2012, Doug received an ASEG Service Certificate Award for distinguished service by a Member to the ASEG, recognising Doug's service, contributions, loyalty to and promotion of the geophysics profession over 50 years, and to the ASEG over 30 years through his sustained support of NSW Branch activities, his regular contributions to ASEG publications, mentoring junior geophysicists, and promoting the ASEG to young geophysicists in industry.

Doug's many contributions science and practice of geophysics, crowned by his new book, the 50th Anniversary Special Publication of the ASEG, will continue to showcase the ASEG and exploration geophysics to a broad global readership. Because of his consistent long-term promotion of geophysics, particularly airborne geophysical surveying, to the wider community, Doug Morrison is an exemplary recipient of the ASEG's Lindsay Ingall Memorial Award.

Doug Morrison

Grahame Sands Award: Lesley Wyborn

This award is based on an endowment made by Members of the ASEG and the geoscience profession in memory of the late Grahame Sands, who was tragically killed at the prime of his life in an aircraft accident in 1986, whilst developing and testing new equipment for geophysical survey aircraft. Because of Grahame's abilities to turn scientific theory into innovative application, the award is made for innovation in applied geophysics through a significant practical development of benefit to Australian exploration geophysics in the field of instrumentation, data acquisition, interpretation, or theory.

The Grahame Sands Award for 2021 is presented to Dr Lesley Wyborn from Canberra, in recognition of her initiation of the mineral systems framework concept, as well as her long-standing contribution to the F.A.I.R (findable, accessible, interoperable and reusable) data principles as applied to geoscience data. Both of these concepts are pivotal to the current mineral exploration landscape and underpin major Australian initiatives by federal and state governments, AuScope, the National Computational Infrastructure (NCI) and the Australian Research Data Commons, as well as exploration companies. Her recent work in geoscience data standards and F.A.I.R. principles lays the foundation for future machine learning and artificial intelligence approaches to geoscience data. Her work ensures future competitiveness and success of mineral exploration in Australia and paves the way for the prosperity of our nation.

Lesley has had a long and distinguished career as a research geoscientist. After graduating from Sydney University in 1972 with first class honours in geology, Lesley joined the Bureau of Mineral Resources (BMR) in Canberra in 1972, and over the next 42 years, held research scientist, information management scientist, and senior geoscience advisor roles with the BMR and its subsequent incarnations, the Australian Geological Survey Organisation and Geoscience Australia. Lesley took leave from the BMR from 1974-1977 to complete a PhD in geology at the Australian National University (ANU). In 2014, she became an Adjunct Fellow at ANU and is currently Honorary Professor at ANU.

Lesley pioneered the mineral systems framework concept, and revolutionised the approach to mineral exploration. Her 1994 paper, with Chris Heinrich and Lynton Jaques, "Australian Proterozoic Mineral Systems: Essential Ingredients and Mappable Criteria", laid the foundation for a multi-scale, process-based view of determining fluids and "mineral" systems in the Earth's crust. This approach spanned all deposit types and broke the industry away from a 'taxonomy' approach to classifying deposit types, to one that focussed on observing empirical relationships of the distribution of minerals to geological and geophysical features on a district to regional scale.

Lesley was one of the first to put this systems approach into action in a GIS-driven prospectivity analysis, enabling the foundation for subsequent GIS-based concept-driven methods, enabling the conversion of those parameters into mappable criteria that can be computationally modelled as part of regional scale fluid flow analysis to help understand why ore deposits form where they form. Lesley's work transformed the approach to interrogating the mineral exploration search space, and has influenced the way industry approaches prediction and detection of new ore systems.

In more recent times, Lesley's work has gravitated toward enabling geoscientists to better utilise publicly available data at full resolution using high-performance computational facilities. Amongst her recent achievements is her contributions to the development of standards that enable machine readability, thus providing simple machine-to-machine access to open-source geoscience data. With geophysicists collecting data at ever increasing rates and at higher resolutions, the role of data management systems, and adherence to the F.A.I.R. principles of data have become increasingly important. Lesley has been one of the key drivers in Australia of the F.A.I.R. principles, promoting and advocating that all publicly-funded data becomes F.A.I.R. An example of this is her work in facilitating the accessibility to time-series magnetotelluric data that were acquired as part of the national AusLAMP project.

Lesley has made many outstanding contributions to the field of geoscience. She has fought hard to make geophysics a more diverse and inclusive workspace, often encouraging contributions to national and international conference sessions focussed on these matters. She has contributed to AGU, one of the largest international geoscience associations, on matters of diversity and inclusion to help transform workplace culture at scientific institutions.

Lesley has worked hard to ensure Australian perspectives and priorities on diversity, equity and inclusion are considered in international initiatives by consulting broadly in her roles on the AGU Diversity and Inclusion Advisory Committee. She has also represented Australia in a panel to understand international perspectives on inclusive science priorities and opportunities from different regions of the world and discuss local priorities for scientists in their respective countries.

Lesley has been an active participant in ASEG and more recent AEGC conferences, with one or more presentations at these conferences. She has also contributed to the ASEG's *Preview* and *Exploration Geophysics* publications.

Lesley has been recognized by other organizations with several awards for her outstanding career achievements, but it is now prudent that the Australian geophysics community give Lesley the recognition she deserves for her innovative contributions to the science and practice of geophysics with the ASEG Grahame Sands award.

Lesley Wyborn

Early Achievement Award: Stanislav Glubokovskikh

The Early Achievement Award was inaugurated in 2007 to acknowledge significant contributions to the profession at an early stage in a person's career, by way of publications, professional work, or contributions to the ASEG by a Member under 36 years of age. The award includes a $2500 contribution to the recipient in recognition of their achievement.

The Early Achievement Award for 2021 is presented to Dr Stanislav Glubokovskikh, formerly from the WA Branch, for his innovative work in in the field of seismic reservoir characterisation and monitoring, his commitment to the profession, and his extensive publication and presentation record over his short career.

Stanislav, or Stas as he prefers, is currently a career earth scientist at Lawrence Berkeley National Laboratory, Energy Geosciences Division in California, USA. He joined the Berkeley Lab at the end of 2020 to lead the Lab's effort in a multi-year, multi-institutional research programme funded by the U.S. Department of Energy. Prior to that, Stas was a Senior Research Fellow at Curtin University's Western Australian School of Mines: Minerals, Energy and Chemical Engineering. He joined Curtin's geophysics team as a Research Fellow at the beginning of 2015 and was promoted to Senior Research Fellow in 2017. He received a PhD in geophysics in 2012 from, Lomonosov Moscow State University, and Diploma in Geophysics from Dubna University (Russia) in 2008.

Stas is a passionate geoscientist with twelve years' experience of geophysical research and teaching. His research work has involved theoretical and practical aspects of seismic reservoir characterisation, and all aspects of rock physics, seismic inversion, active/passive monitoring and machine learning.

During his six years at Curtin University, Stas co-authored 35 peer-review papers – ten as the lead author and three as the corresponding author - in international journals in geophysics, acoustics and mechanics of materials, and one patent, which has made him an internationally recognised scholar. One thing that differentiates Stas is a rare combination of deep theoretical insight with the expertise in diverse fields of exploration geoscience: seismic and petrophysical data analysis, reservoir simulations and petroleum engineering protocols. He utilises a multi-disciplinary approach to practical exploration geophysics problems, which combines advanced analytical models, computer simulations and statistical analysis of real data. Such an approach allowed Stas to establish accuracy limits of the time-lapse seismic and proposed new approaches to cost-effective reservoir monitoring for CO2 storage, a very topical problem in geophysics.

Stas has also strived to serve his professional community. He has been an active and enthusiastic member of organizing committees at ASEG, EAGE and SEG annual meetings, helping in organising scientific workshops. Whilst at Curtin University, he actively supported the local ASEG WA Branch and encouraged his students to participate in the Honours/Masters projects competition run by the branch. He served on the technical committee for AEGC 2019 in Perth where he was responsible for the seismic reservoir characterisation stream. At the same conference, he co-organised a pre-convention workshop on opportunities and applications for machine learning in exploration geophysics.

He is now a member of the SEG Advanced Modelling group (SEAM), where he is responsible for rock physics modelling related to geological storage of CO_2. He has also served as an Associate

Editor of *Exploration Geophysics*, and *Acta Geophysica,* and in 2019 he became the youngest Associate Editor of *Geophysics*.

Stas is a high achiever for one just at the forefront of his career. He is a role model for younger members of the profession, and a worthy recipient of the Early Achievement Award.

Stas Glubokovskikh

Shanti Rajagopalan Memorial Award: Joel Kumwenda

The Shanti Rajagopalan Memorial Award is presented for the best paper published by a Student Member in *Exploration Geophysics* in the period prior to each national Conference. The award is named in memory of the late Dr Shanti Rajagopalan, who passed away in 2010 at the prime of her career. This award was established in 2013 in honour of Shanti to encourage technical excellence by our Student Members.

Shanti was one of the most respected Members and major contributor to the ASEG. She was a great supporter of her local branch, served as Victorian Branch President, and was actively involved in the organisation of ASEG conferences in Hobart and Melbourne. She was also Editor of *Exploration Geophysics* in 2000 and 2001.

It is most noteworthy in the context of this award that, in 1987, as a student Member, Shanti received the inaugural Laric Hawkins Award for the most innovative use of a geophysical technique from a paper presented at the ASEG Conference. It is therefore very appropriate that an award to encourage technical excellence by our Student Members is named in honour of Shanti.

This year, there were three papers which were in close contention for the award. The Highly Commended runners-up, each receiving a $500 prize, are:

- **Xiuyan Ren** for her paper, co-authored with James Macnae and Lachlan Hennessy "Three conductivity modelling algorithms and three 3D inversions of the Forrestania test site AEM anomaly", published in *Exploration Geophysics*, 2019, **51 (1)**, 14-24
- **Blair McKenzie** for his paper "The magnetic gradient tensor of a triaxial ellipsoid, its derivation and its application to the determination of magnetisation direction". published in *Exploration Geophysics*, 2020, **51 (6)**, 609-641

The winner and recipient of the Shanti Rajagopalan Memorial Award for 2021 and a prize of $1000 is Joel Kumwenda, for his paper co-authored with Mark Lackie entitled "Geophysical interpretation of the geology of the Stanthorpe region using aeromagnetic, gravity and radiometric data" published in *Exploration Geophysics*, 2019, **50 (6)**, 653-666.

Since completing his Master of Geoscience at Macquarie University in 2017, Joel returned to Malawi where he worked briefly with the University of Malawi in 2018, before securing a PhD scholarship with Monash University in 2019. He is currently in his third year of the PhD, but he has been studying remotely since October 2020, as he had to attend to family issues due to the COVID-19 pandemic. He hopes to return to Australia to complete his PhD once international borders are open, and after that he would like to continue working in academia in Malawi.

Joel Kumwenda

ASEG Service Medal: Danny Burns

The ASEG Service Medal is awarded for outstanding and distinguished service to the ASEG over many years. The recipient in 2021 is Danny Burns, in recognition of his outstanding and distinguished service to the ASEG for nearly 40 years. In that time, he has given distinguished service to two State branch committees, three Conference Organizing Committees, and five Federal Executives, in particular in the role of Federal Treasurer from 2016 to 2021.

Danny earned a BSc (Hons) in geophysics from Flinders University in 1983 and has over 35 years oil and gas exploration experience in both technical and leadership roles since graduating. He previously held positions with Delhi Petroleum, Esso Australia, LASMO Oil, Schlumberger and Beach Energy, working and directing projects in Egypt, Tanzania, Romania, Spain, New Zealand and Australia (in the Cooper/Eromanga, Otway, Carnarvon, Galilee, Bonaparte, Browse, Surat and Gippsland Basins). Danny has been involved in multiple oil and gas discoveries, including Sellicks-1, the first oil discovery on Beach's very productive Western Flank in the Cooper/Eromanga Basin and more recently Vali-1, Vintage's first Cooper Basin gas discovery. His recent technical leadership positions include Chief

Geophysicist and International and New Ventures Manager at Beach and Executive-Exploration at Vintage Energy Ltd.

Danny joined the ASEG in 1982 and has been an active and supportive Member and a strong contributor to the leadership of the Society throughout his career. He was an active member of the Queensland and Western Australia branch executives, undertaking President, Secretary and Treasurer roles in these State branches. On his return to South Australia in 1993, he was a member of Conference Organising Committees for the 1995, 2003 and 2009 Adelaide conferences. On these committees, he has chaired the technical programme (1995) and the sponsorship committee (2009) and was a member of the technical programme committee (2003).

In 2015, Danny joined the ASEG's Federal Executive, assuming the role of Treasurer in 2016. Danny's consistent leadership and contribution as the ASEG Treasurer and as one of the ASEG's four Directors was exemplary, bringing the highest level of economic and financial planning, budgeting, and governance oversight of the Society's operations.

In 2018, after a series of Federal Executive changes, Danny took on the role of Publications Chair in addition to Treasurer. He was responsible for the development of the ASEG's major call for tenders and successful selection of a new international publisher for the Society's flagship magazine *Preview* and technical journal *Exploration Geophysics*, as well as for the ASEG's Conference Proceedings and Special Publications.

Danny's diligent modelling of the financial benefits of different publishers, his clear and sound recommendations to the Federal Executive, and his leadership in overseeing the comprehensive development of the legal arrangements and beneficial terms and conditions under new Publishing Agreements, have positioned the ASEG to effectively manage its publications business. Danny co-chaired the 2019 Publications Committee with the ASEG's President, concentrating on achieving the successful transition to the new publishing financial framework.

During this time, he also worked tirelessly on building productive partnerships and shared working arrangements with PESA and AIG and the Conference Organising Committees to deliver successful business and financial outcomes for the AEGC 2018 and AEGC 2019 conferences. The successful partnership arrangements for these conferences have also guided the planning for AEGC 2021.

Over the past five years, Danny's support, guidance and mentoring to new ASEG Directors and Executive members and his proactive and collaborative working style on the Federal Executive and with the ASEG's Secretariat has been outstanding. In stepping down in 2021 from the role of ASEG Treasurer, Danny has put in place rigorous and practical financial management planning and operational processes for the ASEG and guidance documentation to assist incoming ASEG Treasurers.

Danny has been an exemplary role model for embers seeking to augment their careers with voluntary service to their profession. It is most fitting that Danny's substantial and outstanding contributions to the ASEG over almost 40 years are now recognised with the award of the ASEG Service Medal.

Danny Burns

ASEG Service Certificate: Fiona Duncan

An ASEG Service Certificate has been awarded to Fiona Duncan from Brisbane. The award is in recognition of Fiona's distinguished service to the ASEG through her commitment to and active involvement in the Queensland Branch over many years, including eight years as Queensland Branch President.

Following graduation with a BSc (Hons) from Sydney University in 1996, Fiona obtained the role of geophysicist with Velseis Processing in Brisbane. Her interview for this role was conducted during the Sydney ASEG conference in February 1997, and she moved to Brisbane in April to start her geophysical career. With Velseis Processing her role involved processing and interpretation of high-resolution 2D and 3D seismic datasets for the purpose of exploration, mine planning and development.

In 2009 she joined QGC in Brisbane as part of the exploration team and worked as an exploration geophysicist looking for Coal Seam Gas in Queensland. There she worked to define the CSG resource extents through seismic acquisition, seismic interpretation and well planning until 2014. She has spent some time concentrating on raising her young family and has recently re-entered the workforce working casually for Velseis Processing.

Fiona has been an ASEG Member for 22 years. During that time, she has actively participated in Queensland Branch activities. She also contributed as a member of the Conference Organising Committee for the 2001 ASEG Conference in Brisbane, where she assisted in the organisation of the conference social functions.

In 2010 Fiona was elected as Queensland Branch President, and led the branch as President for an outstanding eight years through to 2017. This is the longest serving tenure of any President in Queensland and represents a significant contribution to the Queensland branch and to the ASEG.

During her tenure as President, Fiona worked hard behind the scenes with her branch executive to ensure the Queensland branch remained active and connected. The regular technical meetings were moved to an excellent auditorium at the Castlemaine Brewery in Milton, proving to be a popular move for Members, with many well attended meetings. Fiona also supported regular Quiz nights and other social activities for the Branch membership, providing a great platform and opportunities for ASEG Members to connect.

The ASEG is pleased to recognise Fiona's commitment and distinguished contributions to the ASEG with this award of the ASEG Service Certificate.

Fiona Duncan

Honorary Membership of the ASEG: Gregory Street

Honorary Membership of the ASEG has been awarded in 2021 to Greg Street, in recognition of his significant and distinguished contributions for many years to the geophysics profession, and especially to the ASEG, through his or almost continual involvement in ASEG activities at both State and Federal level since becoming a Member in 1977, and his leadership of Federal Executive Committees, conferences and publications.

Greg has been working with geophysical systems in mining, groundwater and environmental applications for over 40 years. His professional career has spanned corporate, government, contracting and consulting organisations in many diverse roles in Australia and more than 20 countries worldwide.

Greg graduated from University of New England in 1974, with a BSc (Hons) Geology. His professional career commenced in 1975 as an exploration geologist in Victoria. He worked as a field geophysicist for Scintrex in 1976 before heading to the UK to undertake a MSc in Applied Geophysics at the University of London, and a Diploma of Imperial College of Science and Technology. He returned to Australia in 1979 to take on the role of Operations Manager for Scintrex in Sydney, prior to moving to WA where in 1984 he joined the Geological Survey of WA as Project Geophysicist, where he developed an interest in geophysical applications for environmental problems.

In 1991, Greg became Director – Environmental Services for World Geoscience Corporation in Perth. His team at WGC was awarded a two West Australian and one National Landcare Award for their work on dryland salinity. From 2000 to 2015, Greg took on various senior technical, managerial and company director roles including General Manager of Sandfire Resources leading to the discovery of the DeGrussa Deposit. Greg believes it was his voluntary work with ASEG that lead to him being head-hunted for this position.

In 2013, he and Andrew Duncan founded Loupe Geophysics, a WA company which has developed a new EM instrument to map electrical conductivity in the near surface to a depth of around 25 m for use in environment, groundwater, mines, industrial work sites and urban areas with considerable EM interference. In recent years Greg has also been active in promoting geophysics in Myanmar and helped re-establish the undergraduate geophysics course at the University of Yangon with Mike Dentith.

Greg played a significant role in expanding the application of geophysics into the environmental field. From encouraging fellow scientists to pursuing environmental causes, to educating farmers and parliamentary Ministers, Greg's active role in the fight against salinisation and other environmental hazards resulted in numerous public appearances and contributions to all forms of media. Greg teamed with numerous influential geophysicists and environmental scientists to publish many papers on the application of geophysical techniques for environmental applications. Greg also lectured at Curtin University on environmental geophysics from 2002 to 2012.

Greg's contributions to the field of geophysics can be demonstrated by his team receiving an Engineering Excellence award from the Institute of Engineers in 2001 for the study of leakage from irrigation channels using geophysics.

Also in 2001, Greg was awarded the inaugural ASEG Lindsay Ingall Memorial Award for the promotion of geophysics to the wider community. This was in recognition of Greg's outstanding work and considerable efforts to help educate the environmental and farming sectors of our community about how geophysics can be an important aid in groundwater and salinity problems. His work has been recognised widely, with publications and working solutions taking place both in Australia and internationally.

Greg has been an active and supportive Member of the ASEG since 1977. He has been involved on both Branch and Federal Executives in some form of management at the committee member, secretary, or president level for nearly 40 years. Greg was on the Federal Executive 1987-92 and again from 2012-18, Honorary Secretary from 1988-1989, and Federal President twice, from 1989-1990 and 2014-15. He has been an Associate Editor of *Exploration Geophysics* since 2000 to the present and co-edited a special edition on Dryland Salinity.

Greg was also a committee member of the ASEG WA State Branch for two stints, from 1985-1987 and 1992-2004. He was Chairman of the 5th Conference of the ASEG Perth 1987 and sat on the committee of the ASEG Perth Conference in 2007. He also chaired two ASEG specialist conferences on Geophysics for Land Management in Bendigo, Victoria and Katanning, WA. Greg also sat on the committee of the Australian Geoscience Council from 1993-1995.

During his career, Greg has been a mentor to many young professionals, and in particular very supportive of female geoscientists, creating opportunities for women at a time when it was difficult for them to establish a foothold in the profession. He has supported and advised many students from all scientific backgrounds on the application and limitations of different geophysical techniques, including as industry supervisor for a number of PhD students.

To acknowledge these outstanding and distinguished contributions to the profession and the ASEG over many

years, the ASEG has great pleasure in conferring the award of Honorary Membership to Greg Street.

Greg Street

Honorary Membership of the ASEG: Henk van Paridon

The award of Honorary Membership of the ASEG has been conferred in 2021 to Henk van Paridon, in recognition of his passionate and distinguished contributions over 40 years to the profession of geophysics, and in particular to the ASEG through his long-standing support and active involvement with both State and Federal Executives, publications, and conferences.

Henk graduated from University of Adelaide with a BSc and the Queensland University of Technology with a Diploma of Computer Science. Henk's professional work has incorporated the planning and interpretation of land seismic surveys throughout Australia and overseas.

He has worked in many geological environments across the petroleum, coal, and mineral industries, initially as a company geophysicist for Delhi and Crusader, and for more than 20 years as a consultant geophysicist, working for coal, petroleum, geothermal and minerals clients. He has worked on petroleum exploration projects across the Bonaparte, Bowen/Surat, Carnarvon, Cooper/Eromanga, Gippsland, Otway, Petrel and Vulcan basins in Australia, and on overseas projects in USA, Argentina, and New Zealand.

In addition, Henk has planned and interpreted geophysics programs over mineral deposits in Serbia, Northwest Queensland, and Canada. Henk is highly regarded for his expertise in utilising seismic surveys for coal in the Bowen Basin and has worked with both coal and CSG majors.

Henk's involvement with the ASEG goes back to 1981. He was SA Branch treasurer in Adelaide before moving to Brisbane. From 1985, he served continuously on the Queensland Branch committee, including two years as Branch President, up until 1996, when the Federal Executive moved from Melbourne to Brisbane. Henk was the chief instigator and organiser of the new Federal committee, so it was no surprise that he was unanimously elected to take over as ASEG Federal President in 1996.

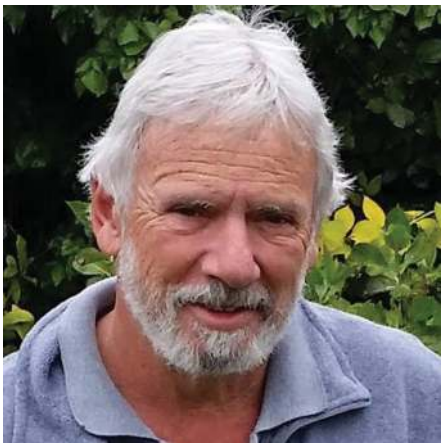
He remained on the Federal Executive until June 1998. He took on the onerous role of Editor of *Preview* from Mike Shalley in mid-1997 and continued in this role until late-1999. Henk has also been very involved in other ASEG activities over the years. In 1992 he was co-chair of the ASEG Gold Coast Conference. He has also served on the Continuing Education Sub-Committee. Henk was awarded an ASEG Service Certificate in 1998 for his distinguished contributions to the ASEG to that time.

In 2010 Henk took up an active role once more as Queensland Branch Treasurer, a position that he held for 10 years. During this time, he was instrumental in keeping the society in Queensland active during difficult times in the industry, and he played a large part in mentoring and handing over the reins to a new generation of geophysicists. He continues to support the local branch, and he is the go-to guru for information on how the committee operates. He has actively encouraged members of his staff to participate on the local committee and contribute to branch activities.

Henk has been mentoring graduates and staff for over 10 years, seeing six early graduates being trained up and introduced to the industry. His passion for geophysics has contributed to the education of hundreds of students through his workshop courses which he has been creating and running since 2010. These have been attended by over 250 students and have included workshops on introductory seismic, projections and datums, SEGY and data loading.

Apart from his long association with the ASEG, Henk has been a Member of AIG, FESQ, PESA, and SEG. He has hosted an annual Trivia night for ASEG/PESA since 2013, bringing both societies closer together. He has presented numerous technical talks at local branch meetings of ASEG, PESA and AIG.

To acknowledge these outstanding contributions to the profession and the ASEG over many years, the ASEG is pleased to confer the award of Honorary Membership to Henk van Paridon.



Henk van Paridon

Special Award to mark the 50th Anniversary of the ASEG

In 2019, then-President Dr Ted Tyne sought to identify an ASEG Member or Members who had contributed above and beyond the level of what would be seen as a significant contribution to ASEG over many years. The aim was to create and confer one or more extra-ordinary awards marking ASEG's 50th anniversary to such Members, recognizing their major commitment to the Society and to the exploration geophysics industry in Australia.

Following a recommendation from the Honours & Awards committee, the Federal Executive approved this special award to two prominent and distinguished Members of the society for

exceptional and highly distinguished contributions by a Member to the ASEG, the profession and the broader community, resulting in wide recognition across the geoscience community.

ASEG 50th Anniversary Special Award: Katherine McKenna

Katherine McKenna from Western Australia receives this special award in recognition of her distinguished contributions to the profession of exploration geophysics and to the ASEG over many years, through modernising and expanding the use of geophysics, and for her hard work for the safety and well-being of geophysicists.

Katherine is nationally and internationally recognised as an expert in mineral exploration, and a leader in Australian and international exploration geophysics. She is a vocal and passionate advocate for the ASEG and has had many behind the scenes roles as well as being ASEG Federal President in 2016-17.

Katherine has had a varied tertiary educational background. She completed a BSc from Macquarie University in geology and geophysics in 1988. She has since completed a Graduate Diploma in Applied Finance from the Security Institute of Australia, a Masters of Business Administration from Curtin University, the Graduate Australian Institute of Company Directors Course and, in 2020, a BA from University of New England in Latin, Ancient Greek and Ancient History.

Katherine has over 30 years of experience in the minerals and energy sector, including more than 15 years in senior management roles. From 1990-2006, working for World Geoscience Corporation, Geoterrex and Fugro, she designed and led geophysical surveys and interpretations of regional and local mine size ground EM, IP, magnetic, gravity, radiometric, downhole EM surveys and airborne EM, magnetic, gravity, radiometric data for Australian and international mineral exploration companies and governments. With the merger and acquisition of five companies she was responsible for the integration of the multidisciplinary departments (aviation, geology, geophysics, software, interpretation, marketing, engineering, R&D, safety and operations). A significant number of international training workshops were led by Katherine upskilling hundreds of scientists in Australia and internationally.

From 2006 to early 2020, Katherine was Managing Director and Chief Geophysicist of GPX Surveys, designing and managing geophysical surveys in Australia, Africa, Canada, Middle East, India, South America and Asia. She managed the development and commercialisation of an airborne electromagnetic system (Xtem) and associated processing and interpretation software, and worked with and led training on geophysics with numerous international government resource ministries on the value of airborne geophysical data as a country's asset in attracting investment. She oversaw the development of a modern management system, by the respective departments that achieved ISO quality and safety standards.

During this time, she identified the need to have safety standards for ground geophysical surveys, bringing together all the contracting companies to form the Ground Geophysical Surveys Safety Association, creating guidelines and standards and taking the association international. She has also been on the executive board of the International Airborne Geophysics Safety Association (IAGSA) for many years, overseeing changes to safety standards, guidelines, and the promotion of safety in airborne geophysical surveys.

Katherine is currently Principal Geophysicist, BHP Mineral Exploration delivering geoscientific advice and services to a major global company.

Katherine has always been driven to create and develop best practices in design, safety, application, modelling and interpretation of geophysics methods. Through her work, she has grown the geophysical exploration industry in Australia and overseas. One of her unique skills is her vast knowledge base and how to utilise geophysical acquisition systems, software, modelling and interpretation to map, identify and model different geological systems. She has been influential through her career in introducing the broader geoscientific community to the application of geophysics.

Katherine embodies the ideal member for a society such as ASEG. Career-long active support and involvement with the society has included roles as Federal President and Vice President, Federal Committee Member and Membership Committee Chairman, and ASEG Conference Committees.

Katherine is an inspirational, result driven, strategic, innovative, and resourceful senior geophysicist, manager and leader with a proven ability to develop, motivate, and work internationally within the exploration geophysics industry.

Katherine's contributions to the Society and the industry have not been formally recognized by the ASEG, and the recommendation to honour her with this special award marking the 50th Anniversary of the Society is a due and fitting recognition of her significant contributions and career achievements over many years.

Katherine McKenna

ASEG 50th Anniversary Special Award: Mark Lackie

Mark Lackie, a long-standing Member of the ASEG, has received this special award for his distinguished contributions, for over 40 years, to the profession of geophysics through teaching,

research and mentoring students, and for the promotion of geophysics to the wider community through ASEG publications, chairing major conferences, and collaborations with other geoscientists. He has been a very active and committed member of the NSW Branch throughout his career and has the record as the longest serving President of the Branch from 2007 to 2020.

Mark graduated with a BSc (Hons) from Melbourne University in 1982, and completed his PhD on palaeomagnetism at Macquarie University in 1989. He worked at the CSIRO until 1994, when he was appointed as lecturer at Macquarie University and continued in that role until the end of 2020. He has now re-located to a quieter lifestyle in regional Victoria.

Mark became a Member of the ASEG in 1981 and has been a consistent supporter and contributor to the ASEG since that time. He was the NSW Branch President for 14 years, and over that time many of his students have remained part of the branch even though they may not work directly in geophysics. He has created an extended geophysics family in Sydney, and over time due to the evolving nature of the group, he has diversified NSW branch meetings to include geoscientific endeavours outside the traditional scope of the ASEG. He has been a primary communicator to the wider ASEG and geosciences community though his regular contributions to *Preview*. One of Mark's greatest legacies is that the current entire committee of the NSW ASEG Branch is comprised of his former students.

Mark was the co-chair of the ASEG's 21st International Conference and Exhibition held in Sydney in 2010, and he also co-chaired the inaugural AEGC, held in Sydney in 2018, In this capacity he played a pivotal role in the first of what has become a successful format, bringing together a diverse array of professionals from all areas of geophysics, geology, geochemistry and remote sensing. Mark helped take us from three separate communities, the ASEG, AIG and PESA into a new era of collaboration between professional geoscientists. Mark has not only been a guiding light for the communication of geophysics to the wider community, but he has also played an important role in getting the wider community communicating with geophysicists.

Mark has especially made, and continues to make, an enormous contribution to the Society and the profession, through his role as Editor in Chief of *Exploration Geophysics* since 2009. In his time overseeing the journal he has enhanced the quality of content and increased its impact factor. He has also played a critical role in transforming the journal, from mainly Australian content, to become a leading international journal in our field. In this sense Mark has both facilitated the transfer of geophysical knowledge to specialists and non-specialists alike, and also enabled promotion of Australian geophysical practice to the wider global community.

Mark has taught of generations of undergraduate and postgraduate geophysicists at Macquarie University, leaving an enduring "Mark" on a large number of young professionals in the Australian geoscience community. Mark has produced excellent quality graduates that have gone on to successful careers. His graduates operate in the environmental sector, mineral exploration, hydrocarbon exploration, government, and academia. Furthermore, by teaching the fundamentals of geophysics to students from other disciplines, Mark has created generations of scientists across many fields who are literate in geophysics.

As a researcher, Mark's primary contribution over the years has been in bringing geophysical techniques to the table to solve geological problems, and in this sense his core research is all about communicating geophysics to the wider earth sciences community. He has also been able to use a wide array of geophysical techniques to provide insights into the deep crustal structure. This has allowed him to interact with a variety of researchers interested in very different outcomes. His collaborations span scales from using gravity and seismic data to map crustal structure, through to detailed petrophysical studies, such as using magnetic anisotropy to map flow directions of ignimbrites and lavas and utilizing palaeomagnetic techniques to constrain plate movements and the timing of intrusive episodes.

Mark's extraordinary contributions to the Society and to education over 40 years have been previously recognized by the ASEG with the award of Honorary Membership in 2016. However, his on-going commitment since then to ASEG publications, conferences and the NSW Branch have represented further outstanding achievements and commitment to the profession and the ASEG.

It is therefore very fitting to honour Mark on the occasion of the 50th Anniversary of the Society with this special award as further recognition of his on-going outstanding achievements and contributions to the ASEG, and to the profession over many years.

Mark Lackie

Richard Lane Scholarship: Zak Weidinger

This new ASEG Scholarship has been established to support geophysics Honours and Masters Students and to commemorate the life and work of ASEG Gold Medal recipient Richard Lane. The scholarship is open to all BSc (Hons) and MSc geophysics students and consists of a grant of $5000 to the best ranked student for the current year. Ranking will be based on a 200 word discussion, overview of geophysics project and on academic transcript. For 2021 we acknowledge and thank Jayson Meyers and Resource Potentials Pty Ltd for the initial donation and concept.

The scholarship will be an annual event and donations to support the continuation of this scholarship are sought from

institutions, companies and individuals. Information on donations via the ASEG Research Foundation can be found at www.aseg.org.au/foundation/donate Please mark donation specifically "Richard Lane Scholarship:"

The winner of the inaugural Richard Lane Scholarship is Zak Weidinger from University of Tasmania School of Natural Sciences, Earth Sciences. Zak is undertaking an Honours degree in geophysics and is to be awarded $5,000. Zak's supervisors are Dr Matthew Cracknell, Dr Clare Miller and Dr Michael Roach.

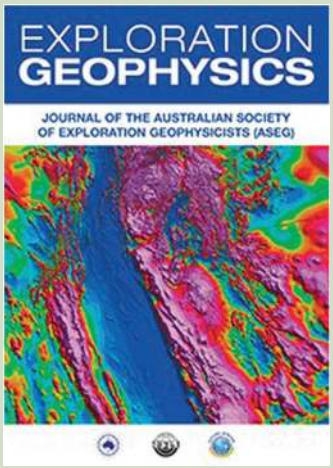
Zak's honours project description**:** In my Honours project I am using time-lapse or four-dimensional geophysics to image and characterise changes in internal flow-paths within an acid producing tailings dump in Royal George, Tasmania in the hope that a remediation solution can be found. The Royal George legacy tin mine closed in 1923 and has been leaching acid and metalliferous drainage, with the notable inclusion of elevated Uranium, since. To characterise the internal flow-paths within the tailings I am using frequency-domain electromagnetics, gamma ray spectrometry, seismic refraction tomography, ground penetrating radar, electrical resistivity imaging and induced polarisation. These methods are accurately repeated to achieve time-lapse models and image change.

Why Zak is studying geophysics (~200 word discussion): I am studying geophysics because I believe it to be an invaluable tool for many different disciplines as well as a fascinating field in its own right. I am passionate about both geophysics and the natural world and see geophysics as a currently underused tool for gaining insight into environmental issues in a non-invasive manner. This is why I chose to use geophysics to investigate AMD leaching for my Honours project.

My path to geophysics began with an interest in geology as a whole and then curiosity surrounding the seemingly magical methods of geophysics. I continue to thoroughly enjoy learning about, and applying my knowledge of, geophysics and I aspire to someday make outstanding contributions to the field of geophysics; much like Richard Lane. Aside from its use for the natural world, I find geophysics to be a diverse and fascinating field in which there is great potential for utility and development. I wish to partake in, and contribute to, this development and push the application of geophysical methods to more diverse fields of study.

Zak Weidinger

Exploration Geophysics Special Issue: Call for papers



We are delighted to announce a special issue of the ASEG's technical journal *Exploration Geophysics,* entitled 'Lithospheric to deposit scale magnetotellurics advancements including AusLAMP in Australia'.

We invite you to submit your expressions of interest to the Special Editors by 31 August, 2021. Accepted expressions of interest will be due for submission to *Exploration Geophysics* by 31 March, 2022.

Scope of issue

Although the magnetotelluric (MT) technique was first used in Australia in the 1960s, it has only been widely adopted by academia, government, and industry over the last two decades, bolstered by the realisation of its important role in mineral and energy exploration undercover.

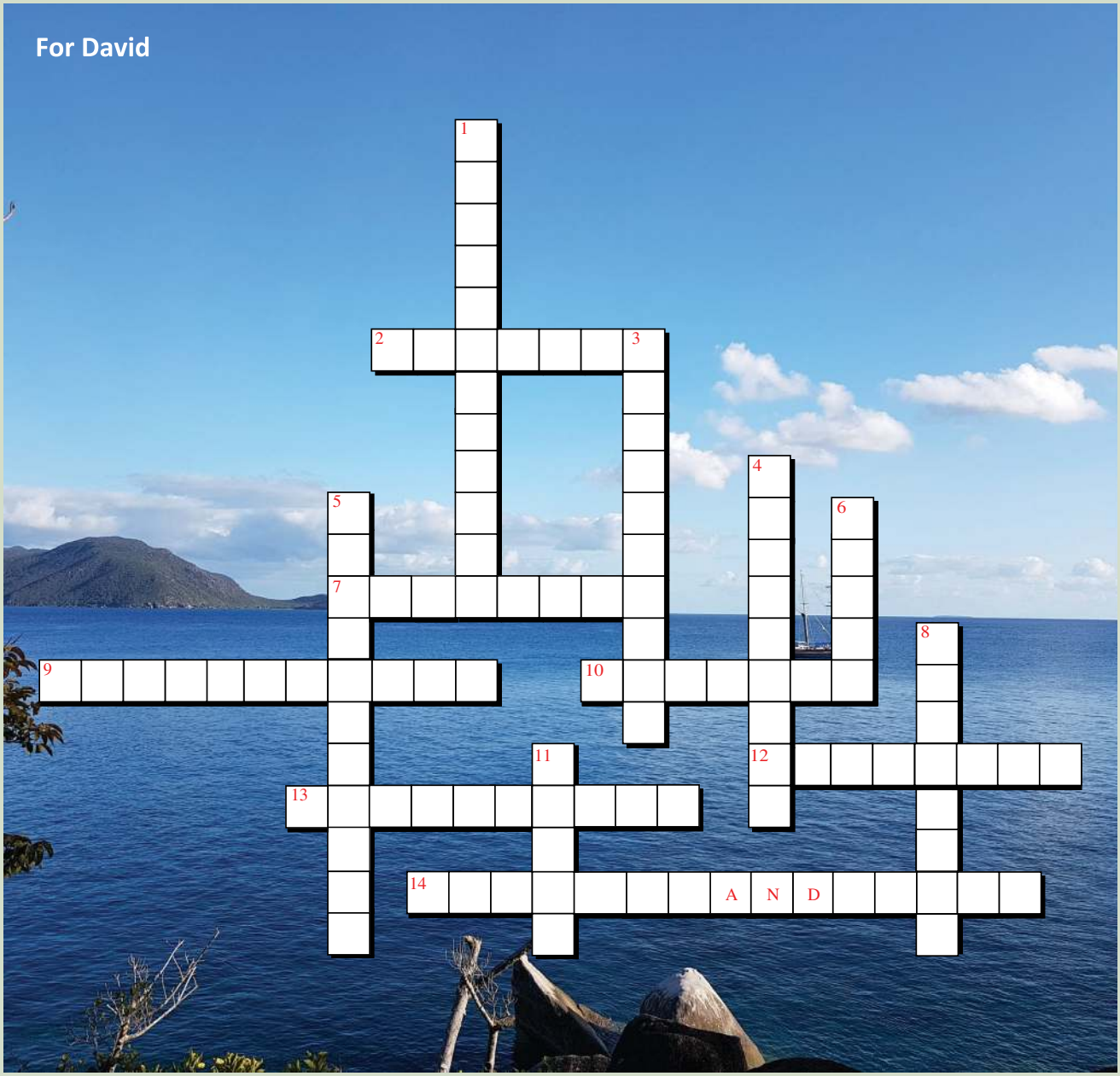
To date, there are many MT surveys and associated innovations across Australia. The national MT programme - Australian Lithospheric Architecture Magnetotelluric Project (AusLAMP), which is half way to covering the continent, has revealed major insights into the tectonic evolution and mineral systems of Australia, and inspired subsequent 'infill-surveys' for further investigations.

This special issue invites papers that focus on MT studies in Australia, including but not limited to applications in resource exploration, modeling/inversion, interpretation, innovations, and representative case studies.

Special editors

Kate Robertson Kate.Robertson2@sa.gov.au
Graham Heinson Graham.Heinson@adelaide.edu.au
Jingming Duan Jingming.Duan@ga.gov.au

Preview crossword #16



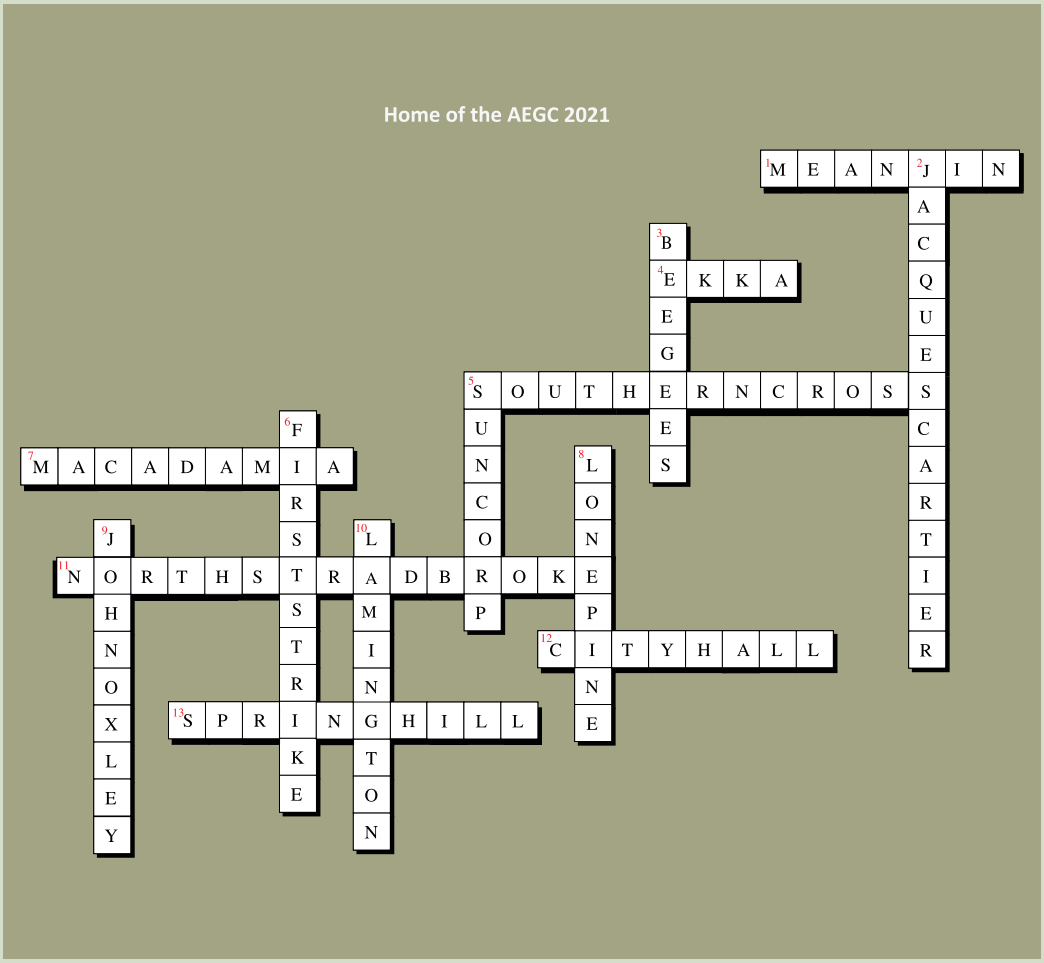
Across	Down
2. Diamonds aren't forever, but this will help you with your next date [7]	**1.** What's the matter? Eternal change for no energy. It's about time [4,8]
7. Age shall not weary these, only injury or disease [8]	**3.** Stronger than steel but it's all a tangled web [6,4]
9. Perpetual clientele, just don't forget to brush your teeth [6,5]	**4.** So far yet so close…for astronauts [5,4]
10. Peachy, not nutty [7]	**5.** It's illogical to be transported to three islands and two lakes simultaneously [6,5]
12. A debut steamboat captain making a trip to the births, deaths and marriages registry [8]	**6.** This Italian goddess will take you for a spin…in the opposite direction [5]
13. Too hot…to even see [5,4]	**8.** The Joker and Queen do not appear in this table [7]
14. Cold at the equator? That's almost close to being nuts! [7 'and' 5]	**11.** I'm no rectangle but I am an official symbol of this country [5]

Play to win!!

Send your answers to *previeweditor@aseg.org.au*. The first correct entry received from an ASEG Member will win two Hoyts E- CINEGIFT passes. The answers will be published in the next edition of *Preview*.

Good luck!

Preview crossword #15 solution



Business directory

Australian Society of Exploration Geophysicists

1970-2020

Join our diverse network of geoscientists from over 40 countries, foster your professional network and receive a wide range of member benefits.

Free access to publications

- Exploration Geophysics - high-quality international technical journal
- Preview Magazine - stay up to date with current trends in exploration geophysics

Professional & Networking Development opportunities

- Reduced registration fee to the Australasian Exploration Geoscience Convention
- Short courses
- Technical Events
- Social Events

Huge range of online content

- Webinars
- Workshops
- Job advertisements

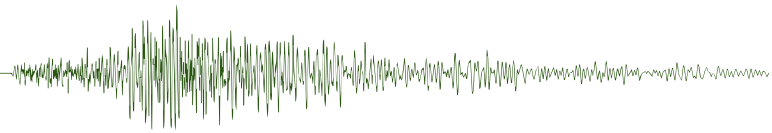
Students

- **Free** membership, support through the ASEG Research Foundation
- Travel scholarships and funding support available

Exclusive member-only discounted wines

Scan to sign up

Visit ASEG.org.au or email secretary@aseg.org.au for more details



AUSTRALIAN SOCIETY OF EXPLORATION GEOPHYSICISTS
A.B.N. 71 000 876 040
PO BOX 576, CROWS NEST NSW 1585 AUSTRALIA
Phone: +61 2 9431 8691) Fax: +61 2 9431 8677
Email: secretary@aseg.org.au Website: www.aseg.org.au

Application for Active & Associate Membership 2021

INSTRUCTIONS FOR APPLICANTS

1. Determine the membership level you wish to apply for, according to the eligibility criteria outlined in Section 2.
2. Fill out the application form. Note that applicants for Active Membership must nominate a proposer and a seconder who are Active Members of ASEG. Student members must include a Supervisors Name and Signature. Under exceptional circumstances the Federal Executive Committee may waive these requirements.
3. Attach the appropriate dues and submit the two pages of your application to the Secretariat at the address shown on the top of this page, retaining a copy of this page for your own records. If payment is to be made by credit card, the application may be sent by fax.

Section 1. Personal Identification

Surname		Date of Birth
Given Names		Mr / Mrs / Miss / Ms / Other
Address		
	State	Post Code
Organisation		
E-mail		
Phone (W)	Phone (H)	Fax
Mobile		

Section 2. Choice of Membership Grade (Tick one)

☐	Active	Please complete all sections
☐	Associate	Please complete all sections
☐	Graduate	Please complete Active or Associate application and also check this box
	Student	Please complete the separate Student Membership Application Form

Active – an applicant must be actively engaged in practising or teaching geophysics or a related scientific field. Conditions for Active Membership include a relevant academic qualification. Any person who does not have such qualifications, but who has been actively engaged in the relevant fields of interest of the Society for at least five years, shall also be eligible for Active Membership upon the discretion of the Federal Executive Committee.

Associate – an applicant must be actively interested in the objectives of the Society. Associate Members are automatically eligible for election to Active Membership after five years as an Associate Member.

Graduate – Active or Associate membership is subsidized by 50% for no more than two years after completion of studies. Members accepting the graduate grant are expected to contribute to society activities and publications with the goals of raising their profile in the society and showing ASEG's support of young professionals.

Student – an applicant must be a full-time graduate or undergraduate student in good standing, registered at a recognised university or institute and working towards a degree in geophysics or a related field. Eligibility for Student Membership shall terminate at the close of the calendar year in which the Student Member ceases their graduate or undergraduate studies. The duration of a Student Membership is limited to five years.

Section 3. Academic and Professional Qualifications

Month/Year (From – To)	Organisation/Institution	Position/Degree (incl. Major)	Professional Record Only: Years of Independent Work

Section 4. Nominators (Must be ACTIVE Members of ASEG)

Nominator	Name	Postal or e-mail address	Phone/Fax
Proposer			
Seconder			

Section 5. Membership of Other Societies

Australian:
- ☐ Aus IMM Grade _____ ☐ AIG Grade _____ ☐ GSA Grade _____ ☐ PESA Grade _____

International:
- ☐ AAPG Grade _____ ☐ EAGE Grade _____ ☐ SEG Grade _____ ☐ SPE Grade _____
- ☐ Others _____

Section 6. ASEG Membership Directory Record

Please complete this section for the ASEG membership database. The same information is included in the ASEG Website (www.aseg.org.au)

Employment area:
- ☐ Industry ☐ Contract/Service Provider ☐ Government ☐ Student
- ☐ Education ☐ Consulting ☐ Other _____

Type of Business:
- ☐ Oil/Gas ☐ Ground Water/Environmental ☐ Coal ☐ Survey/Geotechnical/Engineering
- ☐ Minerals ☐ Petrophysics/Log Analysis ☐ Research/Education ☐ Data Acquisition
- ☐ Solid Earth Geophysics ☐ Archaeology/Marine Salvaging ☐ Computer/Data Processing ☐ Other _____

Section 7. Payment Details (This document will be an Australian Tax Invoice when you have made payment)

MEMBERSHIP GRADES AND RATES

☐ Active/Associate (Australia) - $175.00	☐ Active/Associate 5 Year Membership (Australia) - $874.50
☐ Active/Associate (Group IV Countries) - $159.00	☐ Active/Associate 5 Year Membership (Group IV Countries) - $795.00
☐ Active/Associate (Group III Countries) - $69.00	☐ Active/Associate 5 Year Membership (Group III Countries) - $345.00
☐ Active/Associate (Group I & II Countries) - $13.30	☐ Active/Associate 5 Year Membership (Group I & II Countries) - $66.50
☐ Graduate (Australia) - $69.00	

Section 8. Preview & Exploration Geophysics

The ASEG produces a magazine called Preview and a peer-reviewed journal called Exploration Geophysics. Please read and agree to the following in order to receive ASEG publications:

1) I grant permission for the ASEG to provide my email and postal address to the Taylor & Francis Group so that I can receive copies of the ASEG publications. Taylor & Francis have given an undertaking not to use the member list for any purpose other than advertising and distributing Exploration Geophysics and Preview.

2) I understand and agree that online access to Exploration Geophysics is for my private use and the articles shall not be made available to any other person, either as a loan or by sale, nor shall it be used to substitute for an existing or potential library or other subscription.

3) I understand and agree that Exploration Geophysics articles shall not be networked to any other site, nor posted to a library or public website, nor in any way used to substitute for an existing or potential library or other subscription. 4) I understand and agree that any member who is discovered by the publisher to be in breach of these conditions shall have their subscription access immediately terminated, and the publisher shall have the right to pursue recompense at its discretion from that member.

Yes / No (please circle)

Section 9. Promotional Opportunities

The ASEG provides opportunities for special category listings (eg. Consultants, Contractors) from the ASEG Internet Web Page.

- ☐ I (or my business) am interested in having a link from the ASEG Internet page. Rates will be advised when links are implemented. (Corporate and Corporate Plus Members get a complimentary link.)
- ☐ I (or my business) am interested in advertising in ASEG's publications.

Section 10. Declaration

I, _____ (name), agree for the Australian Society of Exploration Geophysicists to make all necessary enquiries concerning my application and suitability to become a Member. By lodging this Application and upon being accepted in my membership, I agree to be bound by the Constitution of the Australian Society of Exploration Geophysicists, including its ethical and professional standards.

*Signature:*_____ *Date:*_____

AUSTRALIAN SOCIETY OF EXPLORATION GEOPHYSICISTS
A.B.N. 71 000 876 040
PO BOX 576, CROWS NEST NSW 1585 AUSTRALIA
Phone: +61 2 9431 8691) Fax: +61 2 9431 8677
Email: secretary@aseg.org.au Website: www.aseg.org.au

Application for Student Membership 2021

INSTRUCTIONS FOR APPLICANTS

1. Student Membership is available to anyone who is a full-time student in good standing at a recognised university working towards a degree in geophysics or a related field. Eligibility for Student Membership shall terminate at the close of the calendar year in which the Student Member ceases their graduate or undergraduate studies. However, Student Membership must be renewed annually. The duration of a Student Membership is limited to five years.
2. Fill out the application form, ensuring that your supervisor signs Section 2.
3. Submit the two pages of your application to the Secretariat at the address shown on the top of this page, retaining a copy of this page for your own records.

Section 1. Personal Details

Surname Date of Birth

Given Names

Mr / Mrs / Miss / Ms / Other (list)

Address

State Post Code

E-mail

Phone (W) Phone (H) Fax (W)

Mobile

Section 2. Student Declaration

Institution

Department

Major Subject Expected Year for completion of studies

Supervisor/Lecturer Supervisor Signature

Section 3 Membership Grade

(This document will be an Australian Tax Invoice when you have made payment)

MEMBERSHIP GRADES AND RATES

❑ Student (Australia & Group IV Countries)	FREE
❑ Student (Group III Countries)	FREE
❑ Student (Group I & II Countries)	FREE

Section 4 Preview & Exploration Geophysics

The ASEG produces a magazine called Preview and a peer-reviewed journal called Exploration Geophysics. Please read and agree to the following in order to receive ASEG publications:

1) I grant permission for the ASEG to provide my email and postal address to the Taylor & Francis Group so that I can receive copies of the ASEG publications. Taylor & Francis have given an undertaking not to use the member list for any purpose other than advertising and distributing Exploration Geophysics and Preview.

2) I understand and agree that online access to Exploration Geophysics is for my private use and the articles shall not be made available to any other person, either as a loan or by sale, nor shall it be used to substitute for an existing or potential library or other subscription.

3) I understand and agree that Exploration Geophysics articles shall not be networked to any other site, nor posted to a library or public website, nor in any way used to substitute for an existing or potential library or other subscription. 4) I understand and agree that any member who is discovered by the publisher to be in breach of these conditions shall have their subscription access immediately terminated, and the publisher shall have the right to pursue recompense at its discretion from that member.

Yes / No (please circle)

Section 5 Declaration

I, _____ (name), agree for the Australian Society of Exploration Geophysicists to make all necessary enquiries concerning my application and suitability to become a Member. By lodging this Application and upon being accepted in my membership, I agree to be bound by the Constitution of the Australian Society of Exploration Geophysicists, including its ethical and professional standards.

Signature:_____ Date:_____

ASEG CODE OF ETHICS

Clause 4 of the Articles of Association of the ASEG states that "Membership of any class shall be contingent upon conformance with the established principles of professional ethics":

1. A member shall conduct all professional work in a spirit of fidelity towards clients and employees, fairness to employees, colleagues and contractors, and devotion to high ideals of personal integrity and professional responsibility.
2. A member shall treat as confidential all knowledge of the business affairs, geophysical or geological information, or technical processes of employers when their interests require secrecy and not disclose such confidential information without the consent of the client or employer.
3. A member shall inform a client or employer of any business connections, conflicts or interest, or affiliations, which might influence the member's judgement or impair the disinterested quality of the member's services.
4. A member shall accept financial or other compensation for a particular service from one source only, except with the full knowledge and consent of all interested parties.
5. A members shall refrain from associating with, or knowingly allow the use of his/her name, by an enterprise of questionable character.
6. A member shall advertise only in a manner consistent with the dignity of the profession, refrain from using any improper or questionable methods of soliciting professional work, and decline to accept compensation for work secured by such improper or questionable methods.
7. A membership shall refrain from using unfair means to win professional advancement, and avoid injuring unfairly or maliciously, directly or indirectly, another geophysicist's professional reputation, business or chances of employment.
8. A member shall give appropriate credit to any associate, subordinate or other person, who has contributed to work for which the member is responsible or whose work is subject to review.
9. In any public written or verbal comment, a member shall be careful to indicate whether the statements or assertions made therein represent facts, an opinion or a belief. In all such comments a member shall act only with propriety in criticising the ability, opinion or integrity of another geophysicists, person or organisation.
10. A member will endeavour to work continuously towards the improvement of his/her skills in geophysics and related disciplines, and share such knowledge with fellow geophysicists within the limitation of confidentiality.
11. A member will cooperate in building the geophysical profession by the exchange of knowledge, information and experience with fellow geophysicists and with students, and also by contributions to the goals of professional and learned societies, schools of applied science, and the technical press.
12. A member shall be interested in the welfare and safety of the general public, which may be affected by the work for which the member is responsible, or which my result from decisions or recommendations made by the member, and be ready to apply specialist knowledge, skill and training in the public behalf for the use and benefit of mankind.

2021 ASEG WINE OFFER

orders close Thursday 4th of November

The ASEG SA/NT Branch is pleased to be able to present the following wines to ASEG members. These wines were found by the tasting panel to be enjoyable drinking and excellent value. The price of each wine includes GST and bulk delivery to a distribution point in each capital city in early December. Stocks of these wines are limited and orders will be filled on a first-come, first-served basis.

Please note that this is a non-profit activity carried out by the ASEG SA/NT Branch committee only for ASEG members. The prices have been specially negotiated with the wineries and are not available through commercial outlets. Compare prices if you wish but you must not disclose them to commercial outlets.

Pertaringa 2021 Scarecrow Sauvignon Blanc

Each vintage, the Sauvignon Blanc grapes are the first grapes to ripen in the vineyard. The scarecrow is still used as an effective deterrent tot the local grape-loving birds in Adelaide and has also lent its name to this famous Sauvignon Blanc. The nose offers subtle and elegant aromas of passionfruit and snow peas. Combined with a palate that is smooth but lively with delightful tropical fruit flavours, followed by a crisp and refreshing finish. This vintage is perfectly suited to a lazy afternoon in the sun.

ASEG PRICE $145/dozen (RRP $300)

Chain of Ponds NV Chardonnay Pinot Noir

A perfect start to an evening with friends as an aperitif or served with canapés. This sparkling wine is a blend of Chardonnay and Pinot Noir sourced from the cool climate of the Adelaide Hills. Look for green apply, fresh citrus and peach notes from the Chardonnay and strawberry notes from the Pinot Noir couple with subtle freshly baked bread. This sparkling wine made for celebration, to be enjoyed now.

ASEG PRICE $140/dozen (RRP $300)

Stage Door 2018 Full House Cabernet Sauvignon

The 2018 growing season started off well following above average winter rainfall, but it was dry and warm after that. Thankfully, owing to the later veraison in Eden Valley as opposed to the Barossa floor, the hot spell in January and February did not cause any concern to the Avon Brae vineyard and the vines took it all comfortably in their stride. Sourced from 2 single blocks in the Avon Brae vineyard in Eden Valley and a single vineyard in the Barossa Valley. The 2018 Stage Door Wine Company Full House Cabernet Sauvignon is crimson red with spice and vanilla on the nose. A generous palate of black fruits is followed by fine soft tannins. As always, a classy, seamless performer that delivers in spades. This is another fine Eden Valley Cabernet Sauvignon that is ready to drink now or will cellar gracefully in the short term.

ASEG PRICE $160/dozen (RRP $300)

Please order online at www.aseg.org.au and pay by credit card, or fill in the order form below

Name: _____ Phone # _____ Email address: _____

Address: _____ Capital city for collection: _____

I would like to pay by: [ ] Cheque - payable to ASEG SA/NT Wine Offer (enclosed)

Number of orders	Wine	Price	Total
	Pertaringa 2021 Scarecrow Sauvignon Blanc	$145 per dozen	
	Chain of Ponds NV Chardonnay Pinot Noir	$140 per dozen	
	Stage Door Co 2018 Full House Cabernet Sauvignon	$160 per dozen	
		TOTAL	

Order and payment by mail or fax to:

ASEG Wine Offer, c/o. ASEG Secretariat, PO Box 576, Crows Nest, NSW 1585
T: (02) 9431 8622 F: (02) 9431 8677 email: secretary@aseg.org.au

(please follow up any faxes with a phone call to ensure the form has been received)

October	**2021**		
18–21	82nd EAGE Annual Conference & Exhibition https://eage.eventsair.com/eageannual2021/	Amsterdam	Netherlands
18–21	Sapporo, Hokkaido, Japan 14th SEGJ International https://www.segj.org/is/14th/	Sapporo	Japan
25–28	Sixth International Conference on Engineering Geophysics (ICEG) https://seg.org/Events/iceg21	Al Ain	UAE
November	**2021**		
2–5	Summit on Drone Geophysics https://seg.org/Events/Summit-on-Drone-Geophysics-2021		Virtual
9–11	5th Myanmar Oil & Gas Conference https://eage.eventsair.com/fifth-aapg-eage-myanmar-conference/	Yagoon	Myanmar
12	GSWA Open Day http://www.dmp.wa.gov.au/Geological-Survey/GSWA-Open-Day-2021-29468.aspx	Perth	Australia
15–17	Dorothy Hill Symposium https://absoluteevents.eventsair.com/dhweess-2021/	Brisbane	Australia
16–18	SPE/AAPG/SEG Asia Pacific Unconventional Resources Technology Conference https://www.spe.org/events/en/2021/conference/21apur/asia-pacific-unconventional-resources-technology-conference.html		Virtual
23–25	PETEX https://petex.pesgb.org.uk/	London	UK
26	South Australian Exploration and Mining Conference (SAEMC) http://saemc.com.au/	Adelaide	Australia
30–2 Dec	EAGE 4th Asia Pacific meeting on Near Surface Geoscience & Engineering https://eage.eventsair.com/4th-ap-meeting-on-near-surface-geoscience-engineering/	Ho Chi Minh City	Vietnam
December	**2021**		
5–9	23rd World Petroleum Congress https://wpc2020.com/	Houston	Texas
13–17	AGU Fall Meeting	New Orleans	USA
March	**2022**		
7–9	Prospectors and Developers Convention (PDAC) https://www.pdac.ca/convention	Toronto	Canada
10–11	Prospectors and Developers Convention (PDAC) https://www.pdac.ca/convention		
20–23	Geo-Congress 2022 https://www.geocongress.org/	Charlotte	USA
June	**2022**		
5–9	83rd EAGE Annual Conference & Exhibition https://eage.eventsair.com/eageannual2022/	Madrid	Spain
August	**2022**		
15–19	12th International Kimberlite Conference https://12ikc.ca/	Yellowknife	Canada
September	**2022**		
18–22	Near Surface Geoscience Conference & Exhibition 2022	Belgrade	Serbia/Virtual
26–30	Australian and New Zealand Geomorphology Group Conference https://www.anzgg.org/conferences	Alice Springs	Australia
March	**2023**		
13–18	Australasian Exploration Geoscience Conference (AEGC 2023)	Brisbane	Australia

Preview is published for the Australian Society of Exploration Geophysicists. It contains news of advances in geophysical techniques, news and comments on the exploration industry, easy-to-read reviews and case histories, opinions of Members, book reviews, and matters of general interest.

Advertising and editorial content in *Preview* does not necessarily represent the views of the ASEG or publisher unless expressly stated. No responsibility is accepted for the accuracy of any of the opinions or information or claims contained in *Preview* and readers should rely on their own enquiries in making decisions affecting their own interests. Material published in *Preview* becomes the copyright of the ASEG.

Permission to reproduce text, photos and artwork must be obtained from the ASEG through the Editor. We reserve the right to edit all submissions. Reprints will not be provided, but authors can obtain, on request, a digital file of their article.

Single copies of *Preview* can be purchased from the Publisher.

All proposed contributions should be submitted to the Editor by email at previeweditor@aseg.org.au

For style considerations, please refer to the For Authors section of the *Preview* website at: https://www.tandfonline.com/toc/texp20/current

Preview is published bimonthly in February, April, June, August, October and December. The deadline for submission of material to the Editor is usually the second Friday of the month prior to the month of issue. The deadline for the December issue is 12 November 2021.

For the advertising copy deadline please contact the Publisher on advertising@taylorandfrancis.com.au

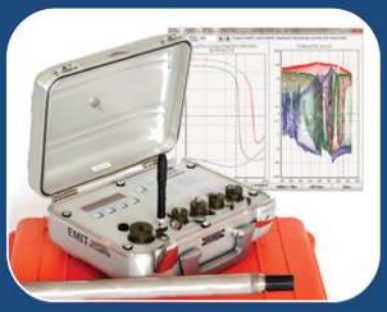
EMIT

www.electromag.com.au

Over
25 YEARS
of helping you
find out

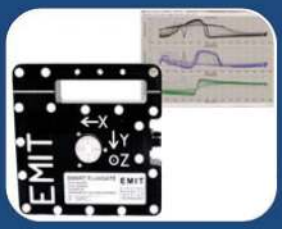
SMARTem24

Rugged and reliable PC-based, 16 channel, 24-bit electrical geophysics receiver system with time-series recording, powerful noise rejection, GPS sync and an optional separate Transmitter Controller. Works seamlessly with a wide range of transmitter systems and most sensors for EM and IP. The SMARTem24 application plots decays, profiles, maps and pseudo-sections providing powerful QC capabilities. Hot-swappable batteries, touch-screen, solid-state HDD and water/dust protection make this an instrument for serious electrical geophysics. Compatible with EMIT's Transmitter Multiplexer and other tools for increasing productivity.



DigiAtlantis

3-component digital borehole fluxgate magnetometer system in a 33mm tool for EM and MMR with simultaneous acquisition of all components, time-series recording and powerful noise rejection. Compatible with a wide range of transmitter systems and EMIT's Transmitter Multiplexer for increasing productivity. Samples the whole waveform providing on and off-time data. Magnetometer DC signals are recorded to give 3-component and total-field geomagnetic data. Orientation data gives hole inclination and azimuth in real-time without additional surveys. Designed to be used with industry-standard winches with 2-core and 4-core cable.

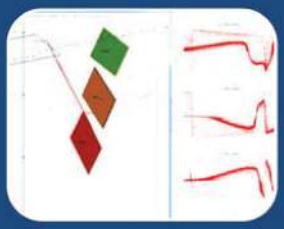


SMART Fluxgate

Rugged, low noise, calibrated, 3-component fluxgate magnetometer with recording of geomagnetic fields, digital tilt measurement and auto-nulling.

SMARTx4

Intelligent and safe 3.6 kW transmitter for EM surveys using standard generators. Clean 40A square wave output, inbuilt GPS sync and current waveform recording.



Maxwell

Industry standard software for QC, processing, display, forward modelling and inversion of airborne, ground and borehole TEM, FEM and MMR data. Training workshops available.

ELECTRO
MAGNETIC
IMAGING
TECHNOLOGY

Advanced electrical geophysics instrumentation, software and support

23 Junction Parade
Midland WA 6056
AUSTRALIA
✆+61 8 9250 8100
info@electromag.com.au