Australian Society of Exploration Geophysicists

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PREVIEW

NEWS AND COMMENTARY

FEATURES

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FRONT COVER

J.P. O'Donnell from GSSA attempting to resuscitate a seismometer. For more information see the report by GSSA on the AusArray SA passive seismic array in this issue.

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Editor's desk

This issue of *Preview* features an article by Don Emerson on the conductivity of chalcocite – a valuable copper sulphide that is particularly deserving of Don's attention!

Also, David Denham (*Canberra observed*) takes a close look at the Federal budget. Marina Pervukhina (*Education matters*) encourages readers to take advantage of online opportunities to educate themselves about the challenges currently facing the energy sector. Mike Hatch (*Environmental geophysics*) shares his picks in the webinar space. Terry Harvey (*Mineral geophysics*) reflects on good surveys that go bad. Mick Micenko (*Seismic window*) gets excited about passive seismic. Tim Keeping (*Data trends*) muses about the impact of artificial intelligence on regression analysis – once so simple and now, well… and Ian James (*Webwaves*) tells us who is watching what on the ASEG YouTube channel!

The Australasian Exploration Geoscience Convention (incorporating the ASEG 28th International Conference and Exhibition) will be held in Brisbane in September this year. The next issue of *Preview* will be the (pre) conference issue. That issue should whet your appetite for the conference if, after the year (2020) that was, your appetite needs any whetting! It will be fantastic to gather, once again, with friends and colleagues. If you are over forty (over thirty in some states and over sixteen in the NT) you should be able to get yourself vaccinated well before the conference – thereby protecting not only yourself but, potentially, the life and livelihoods of colleagues who at this stage don't have the same opportunity to take one for the team. I have "rolled up my arm", completed early bird registration and booked my flights – yes I am keen! A word of warning, however, please do consider booking your accommodation for the conference well ahead of time – Australians are not just holidaying at home but holidaying in Queensland (well who can blame them!) and popular facilities are being booked out early.

See you in Brisbane in September!

Lisa Worrall
Preview Editor
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See in you in Brisbane and yes, Queensland is beautiful one day and perfect the next!

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.*

President's piece

Kate Robertson

Hello Members and readers!

What a busy month (at the time of writing) it has been since I took on the role of President. It's cliché, but I feel so honoured and lucky to be in this role! I have spent the last month gathering ideas, meeting with Members, volunteers and being involved in a number of exciting initiatives - there is a lot to look forward to this year! We have a full schedule of events combining in-person, online or hybrid, with the latter two options providing great opportunities for our international Members. To those reading this who are located outside of Australia, I am hoping that the situation improves soon with vaccine rollouts and wishing you all strength and positivity.

I'm counting down to our 3rd Australasian Exploration Geoscience Convention (incorporating the ASEG 28th International Conference and Exhibition) to be held in Brisbane in September this year. Perhaps we used to take face-to-face conferences for granted, but now it is an opportunity to be seized and savoured. Whilst we are planning a virtual aspect to the AEGC, allowing our international Members and those who are unable to travel due to COVID-19 restrictions, to join in, I highly encourage you to attend in person where possible.

I am looking forward to those moments of eagerly chatting to a colleague or that old friend about the latest light-bulb moment I've experienced while listening to a talk, with a drink in hand over happy hour; for the chance to chat to company representatives about their products and services face-to-face, forming connections; the tired but accomplished feeling as I travel home at the end of the conference, trying to make sense of the scribble of notes I've taken down, followed by the eager return to work with a buzz and enthusiasm, fuelled with new ideas for my work that I only get from being exposed to hundreds of scientists and companies at a conference. I encourage you to register early, to provide assurance to the extremely hard-working conference organising committee led by Eric Battig and Rachel Kieft. Registration fees are refundable in the case of government-imposed travel restrictions, and most flight bookings these days are completely flexible.

We have had a few changes on the Federal Executive. A huge thank you to Danny Burns, who has been an incredible treasurer for the ASEG in the Federal Executive for the last five years, and co-chair of publications. We also bid farewell to Marina Pervukhina who has been a hard-working member of the Federal Executive since 2017, and Millicent Crowe who spent the last year on the Federal Executive doing a great job chairing the Communications Committee. I would like to say a big thank you to David Annetts for his exceptional job as President in a year that can only be described as extraordinary. Thank you for leading the ASEG throughout the COVID-related challenges, and the transition to a very virtual world. And a personal thank you- you have been very responsive, helpful and friendly as I have been learning the ropes. David continues on the Federal Executive in the role of Immediate Past President. Leslie Atkinson's *Executive brief* goes into more detail about the fantastic contributions these Members have made to the ASEG. Joining the Federal Executive this year are President-Elect Emma Brand, and Chair of the Education Committee, Dr Kate Selway, and Chair of the Communications Committee, Mosayeb Khademi Zahedi.

Enjoying the sundowner event at the ASEG-PESA 2015 Conference in Perth. L-R: Stephanie Rees, Fun Meeuws, Kate Robertson, Millicent Crowe and Ian Roach.

I look forward to getting to know a lot of you over the next year, but here's a short introduction. I'm a geophysicist (surprising?) based in Adelaide, at the Geological Survey of South Australia. For my work I use magnetotellurics (MT) to image the deep signatures of mineral systems. I joined the ASEG as I began my PhD in the beginning of 2013. Since then, the ASEG has provided support to me throughout my career as it has developed, from when I first started attending meetings where I was at initially intimidated by the experienced geophysicists surrounding me, but these same Members were actually inclusive and supportive. I have always enjoyed attending our monthly technical meetings, usually at the Coopers Alehouse - for me this is the best way to connect with fellow Members. It's so important we keep these regular ASEG events a safe space for all to attend and, with a recent incident of unprofessional behaviour at an ASEG event, the Federal Executive have taken this opportunity to develop a code of conduct, an initiative led by ASEG President-Elect Emma Brand. This draft code is presented for your review in this issue of *Preview* and your feedback would be very welcome.

I'm sure our Members in Australia are aware of the closures across Australia in geophysics education, a devastating blow to geoscience education and to those in academia who find themselves in the hunt for a new position. In Victoria I am told there is just one unit of geophysics on offer. But it's not all doom and gloom and we plan to collate a list of all the Universities offering geophysics degrees and courses and to place that list on our website to make life easier for potential future geophysicists. Professor Graham Heinson gave an excellent talk at our AGM this year on the past, present and future of geophysics education (available on our YouTube channel youtube.com/asegvideos). Graham highlighted that the path to geophysics may not be as straightforward as it once was (using a map of the London Underground as an analogy for the many pathways into geophysics nowadays!) but the breadth of opportunities for geophysicists in a world that moves toward a low-carbon future is large. As well as the traditional major areas of petroleum and minerals, we are also vital in the discovery of 'green' minerals used for batteries and renewable energy, for carbon sequestration storage, hydrogen, interplanetary exploration, continual discovery of groundwater and much, much more. I look forward to seeing how our field diversifies into the future.

To wrap up my first President's Piece, I would like to take this opportunity to acknowledge everyone who supports our ASEG as we enter its 51st year; of course our Members and Corporate Members, our sponsors, our editors, our technical presenters and of course our volunteers who put countless hours into our Society. I look forward to updating you on our plans for the year in the next issue of *Preview*, and in the meantime don't hesitate to get in touch if you want to chat about anything.

Kate Robertson
ASEG President
president@aseg.org.au

Executive brief

AGM

The Annual General Meeting of the ASEG was held on 6 April 2021. After the success of the first online AGM in 2020, the ASEG FedEx decided, once again, to hold the AGM as an online event. However, moving on from the year that was COVID-disrupted in 2020, this year we were able to add a face-to-face component to the meeting, which was held at Apoteca Bar and Lounge in Adelaide.

Graham Heinson, Professor of Geophysics at The University of Adelaide, gave the talk that he was unable to deliver last year, titled "Training the next Generations of Geophysicists: Challenges and Opportunities". The talk was well received and very informative. The event was well attended with 33 attendees online and 24 attending the face-to-face event.

A number of honoured guests were invited to attend a post AGM dinner including Graham, SA committee members and past ASEG volunteers.

The AGM saw the election of the new ASEG office bearers for 2021. Dr Kate Robertson assumed the position of President for 2021, and Kate has definitely hit the ground running. She has already started to make changes to the Society's constitution to be clearer about the roles and responsibilities of the Directors and committee members on the Board, and is spearheading the introduction of a code of conduct, which will sit alongside our current code of ethics. We definitely look forward to the development of our Society over the next 12 months under the stewardship of Kate.

We wish to extend an enormous thank you to our Immediate Past President, Dr David Annetts. David's tenure as President during the Society's 50th year was highlighted by some special events to celebrate this great milestone, as well as his extensive analysis of membership and webinar attendance, which has helped the Society to provide better experiences for our Members. He also organised the massive job of converting the *Preview* and *Exploration Geophysics* monoliths to PDFs for ease of reading. David will remain on the committee for the next 12 months and will provide a fabulous support to our new President. Thank you again, David.

Emma Brand comes onto the new committee as President-Elect. Emma has already made some massive contributions to the committee and will be a great asset to the Society over the next three years of her tenure. Welcome aboard Emma.

Dr Yvette Poudjom Djomani takes on the role of Federal Treasurer and ASEG Director, Dr Kate Selway comes in as our new Education Committee Chair and Mosayeb Khademi Zahedi as our new Communications Committee Chair. Thank you also to returning members of the Federal Executive: Leslie Atkinson (Secretary), Dr Mark Duffett (Technical Standards Committee Representative), Ian James (Web Committee Chair) and Suzanne Haydon (Membership Committee Chair). Thank you for your efforts over the last 12 months, efforts that have also contributed to the Society's successful year.

David Annetts steps into a caretaker role as Chair of the State Branches Liaison Committee. The position of Chair of the Professional Development Committee Chair has also become vacant. So, if you wish to help out on the committee, you might consider stepping into one of these roles.

With huge thanks and appreciation, we farewell Danny Burns who steps down from the Federal Executive. Danny made an enormous contribution to the ASEG in his six years on the committee as Federal Treasurer. The Society's financial position greatly improved during his time, which will enable us to move ahead strongly.

This year we also saw the resignation of Dr Marina Pervukhina, who steps down as Professional Development Committee Chair after four years in the role. We would like to extend an enormous thank

Members who attended the face-to-face component of the ASEG AGM in Adelaide.

Some of the Members who attended the ASEG AGM online.

you to Marina for her contribution over her years on the committee. Marina has developed a great relationship with our sister organisations to help provide discounted courses for our Members and excellent educational opportunities.

Our last farewell is to Millicent Crowe who oversaw the Communications Committee during 2020 and was very active in our social media. Thank you to Millie for her efforts over the past 12 months, and the committee wishes her the all the best for her studies towards her PhD.

The day after the AGM is usually followed by a strategy day where the Federal Executive, journal editors and representatives from the Secretariat, The Association Specialists (TAS), meet to discuss the short- and long-term issues facing the Society. The 2020 strategy day was cancelled due to COVID-19 restrictions, but the Federal Executive conducted a number of online meetings to discuss the strategic plan for the coming years. A similar format will be followed in 2021.

One objective for the Society over the next 12 months is finalisation of the changes to the Constitution and the adoption of the new code of conduct. A draft copy of this code appears in this issue of *Preview* and will be published on the ASEG website. Members are invited to review and provide feedback on the code prior to its adoption. You will also find a link in the monthly newsletter, so please look out for this and provide any feedback you can.

The Federal Executive would like to thank TAS for organising and facilitating the 2021 AGM online event, and Apoteca Bar and Lounge for providing the venue for the face-to-face event. Finally, a big thank you to Kate Robertson for arranging this venue and hosting both online and in person formats.

Leslie Atkinson
ASEG Secretary
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Welcome to new Members

The ASEG extends a warm welcome to 15 new Members approved by the Federal Executive at its April and May meetings (see Table).

First name	Last name	Organisation	State	Country	Membership type
Akintunde	Akande	China University of Mining and Technology	Osun	China	Student
Mohamed	Alili		Blida	Algeria	Active
Antonio	Castiglia	University of Adelaide	SA	Australia	Student
Sandeep	Chandola	Petronas	Kuala Lumpur	Malaysia	Active
Alex	Farrar	University of Tasmania	TAS	Australia	Student
Oliver	Gate	University of Adelaide	SA	Australia	Student
Farsha Daraei	Ghadikolaei	Australian National University	ACT	Australia	Student
Hajime	Hishida	Waseda University	Ozenji-higashi	Japan	Active
Jerlit	Joseph	Curtin University	WA	Australia	Student
Majid	Karimi		SA	Australia	Associate
Shawn	Letts	Anglo American	British Columbia	Canada	Active
Nicholas	Moran	Queensland University of Technology	QLD	Australia	Student
Yakup	Niyazi	Deakin University	VIC	Australia	Student
Robert	Stewart	University of Houston	Texas	United States	Active
Zak	Weidinge	University of Tasmania	TAS	Australia	Student

Code of ethics and draft code of conduct for review

There are many benefits of being an ASEG Member, and a sense of community and invaluable networking opportunities are amongst these. We pride ourselves on making any ASEG-associated event a safe place for all to attend and, with a report of recent unpleasant behaviour at an ASEG event, the Federal Executive has taken this opportunity to develop a code of conduct. This initiative has been led by ASEG President-Elect Emma Brand. It's important that everyone knows what we deem as acceptable behaviour. Below (and on our website) you will find the draft version of our new code of conduct. There will be a consultation period until the end of August 2021; during this time any comments or suggestions can be made by contacting Emma at President-Elect@aseg.org.au or Kate at President@aseg.org.au During this consultation period, we expect anyone attending an ASEG-associated event or communicating with regards to ASEG-matters to behave in a professional manner in accordance with the draft code.

The ASEG code of ethics – is a set of principles based on the values of the ASEG and requires the Executive and Members to practice their profession according to agreed professional ethical standards.

The ASEG code of conduct – complements the code of ethics and promotes respectful behaviour and general good conduct. It applies to Members and non-members when attending or participating in ASEG-based activities or communicating with regards to ASEG matters, including but not limited to meetings, workshops, conferences, field trips, committee or volunteer work that is conducted either in-person or in a virtual environment.

Code of ethics

No changes are being proposed to our existing code of ethics below, although feedback can be provided.

Section 5.1 of the ASEG Constitution states that "Membership of Society in any class shall be always contingent upon conformance with the Society's Constitution including the By-Laws, Professional Codes of Conduct and Ethics":

> A Member shall conduct all professional work in a spirit of fidelity towards clients and employers, fairness to employees, colleagues and contractors, and devotion to high ideals of personal integrity and professional responsibility.
>
> 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.
>
> A Member shall inform a client or employer of any business connections, conflicts of interest, or affiliations, which might influence the member's judgment or impair the disinterested quality of the Member's services.
>
> 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.
>
> A Member shall refrain from associating with, or knowingly allow the use of the Member's name, by an enterprise of questionable character.
>
> 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.
>
> A Member 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.
>
> 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.
>
> 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 geophysicist, person or organisation.
>
> A Member will endeavour to work continuously towards the improvement of their skills in geophysics and related disciplines, and share such knowledge with fellow geophysicists within the limitation of confidentiality.
>
> 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.
>
> A Member should be interested in the welfare of the public, and be ready to apply specialist knowledge, skill and training for the use and benefit of the public.

Code of conduct

The code of conduct and process for breaches provided below are newly developed and under consultation.

Section 5 of the ASEG Constitution states that "Membership of Society in any class shall be always contingent upon conformance with the Society's Constitution including the By-Laws, Professional Codes of Conduct and Ethics":

> When undertaking ASEG-related activities Members and non-members are expected to respect others, including the community, and protect their health, safety and mental wellbeing.
>
> The ASEG and its Members will promote equality of opportunity, regardless of age, race, nationality, gender, sexuality, religion, disability, ethnicity, marital status, political affiliation, culture or any other attribute.
>
> The ASEG will not tolerate any form of harassment or bullying, which is defined as unreasonable behaviour

directed towards its Members, staff or any other person participating in ASEG-based activity. This includes (but is not limited to): abusive or offensive language or inappropriate comments such as those related to gender, sexual orientation, disability, physical appearance, body size, race, religion or national origin; aggressive and intimidating behaviour; practical jokes or initiation rituals, and unjustified criticism or complaint.

When undertaking ASEG-related activities in the field, ASEG Members are expected to seek permission for access to sites from relevant landowners and / or caretakers, including Traditional Owners where appropriate and / or applicable.

Breaches of the code of conduct

The process with respect to the handling of any reported and alleged breach/s of the code of conduct is as follows:

Establish two independent members of the Federal Executive to undertake the process.

Investigate to obtain sufficient information.

Assess and establish whether a breach of the code of conduct has occurred.

Determine what, if any, disciplinary action(s) will be applied.

All alleged breaches will be investigated, assessed and established by two members of the Federal Executive who are deemed independent from the allegation/s. These members shall also determine and recommend to the Directors what, if any, disciplinary action(s) will be applied. The Directors, managing any potential conflicts of interest appropriately, will then agree on the recommended disciplinary action(s). The process for the handling of any reported and alleged breach/s of the code of conduct will be undertaken according to the following principles:

All steps shall be undertaken to ensure that the Complainant is empowered.

The process shall be undertaken in a private and confidential manner.

The process shall be transparent for both Complainant and Respondent.

The process can be undertaken in either a formal or informal manner. Figure 1 outlines the high-level processes that are followed for either approach.

Reporting process

Persons wishing to report alleged breach/s of the code of conduct should raise this breach with any member of the ASEG Executive, who will engage with one of the Directors to establish two independent members of the Executive to undertake the assessment of the allegation.

The person or persons reporting the alleged breach/s should ensure that they document the alleged breach/s by noting essential factual details such as when and where it occurred, who was involved, if there were any witnesses, and what happened. All reports of alleged breaches of the code of conduct will be dealt with in a private and confidential manner as per obligations under the Privacy Act 1988.

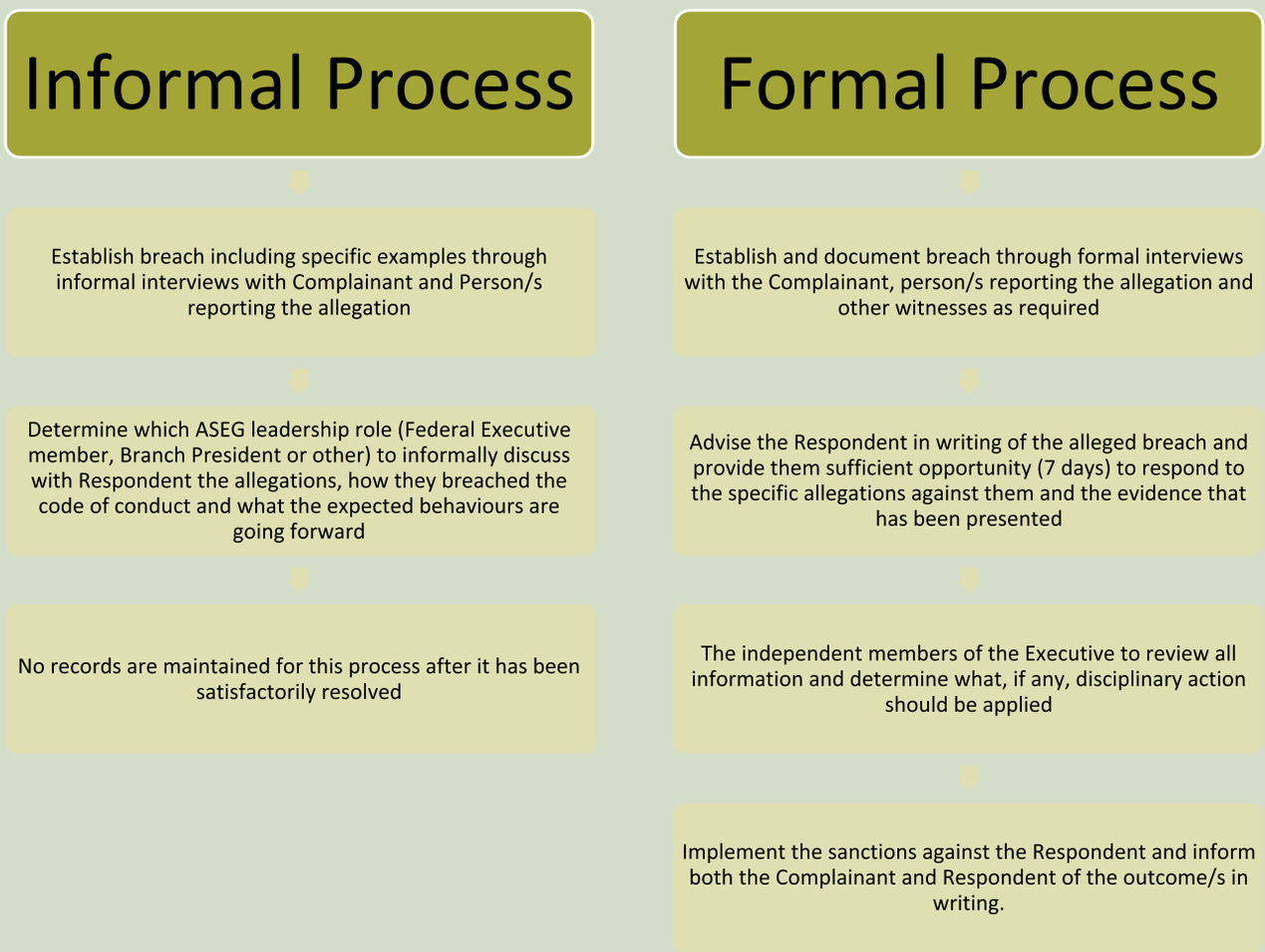

Figure 1: *Informal and formal processes for resolving alleged breaches of the ASEG code of conduct.*

Except where public safety is at risk, a Member's privacy is to be strictly observed, and the matter treated confidentially.

The details of the allegation will be first established by the delegated members of the Federal Executive through an informal interview with the person/s reporting the alleged breach/s and the Complainant (if they are separate people). It should be established what the Complainant's preferred process is, either formal or informal, and this should be taken into consideration by the delegated members of the Federal Executive.

A formal process shall be undertaken based on:

The seriousness of the allegations

Whether the allegations constitute a pattern of behaviour over a period of time.

The preferred process of the Complainant.

Any alleged criminal activity will be reported directly to the Police.

If an informal process is to be followed, it will adhere to the high-level process outlined in Figure 1. The following outlines the detail regarding the formal process.

Investigation process

Once the decision has been made to undertake a formal process, the facts of the allegation will be established through formal interviews with the Complainant, person/s reporting the allegation and other witnesses as required. One of the delegated members of the Federal Executive will be responsible for taking notes during these interviews that will form the basis of the formal notice to the Respondent with respect to the nature of the alleged breach and the elements of the code of conduct that they are alleged to have breached.

Once the nature of the alleged breach has been established, it will be the responsibility of the delegated members of the Federal Executive to notify the Respondent in writing and inform them of:

The nature of the alleged breach.

The elements of the code of conduct that they are alleged to have breached.

The possible sanctions that may apply for breaches of the code of conduct.

The person(s) who will investigate the alleged breach.

The person(s) who will decide whether a breach has occurred.

How the process will be conducted.

The Respondent will then be provided a reasonable time (usually seven working days) to respond to the allegation in writing and have their response considered in the assessment and sanction process.

If at any time the details of the alleged breach/s change, including if additional documents, materials or witness statements are provided to the delegated members of the Federal Executive then this information will be included in the notification to the Respondent, or the notification to the Respondent will be updated.

Assessment process

The details of the allegation will then be assessed by the delegated members of the Federal Executive and it will be established whether the code of conduct has been breached and to what degree of seriousness. The delegated members of the Federal Executive will use all information available.

Sanction process

If it has been established that the code of conduct has been breached, then the Respondent may be subject to imposed sanctions. Sanctions may include, but are not limited to:

A reprimand/warning
Removal from committee positions/ titles (e.g., Fellow, if applicable).

Cancellation of membership for a set period of month(s)/year(s) depending upon the severity of the code of conduct breach - the Respondent may reapply at the end of this sanction period.

Termination of membership and expulsion from the ASEG - with no future prospects for reapplication.

For non-members, banishment from all future ASEG events.

The delegated members of the Federal Executive will recommend to the Directors what, if any, sanction(s) will be applied. The Directors, managing any potential conflicts of interest appropriately, will then agree to the recommended sanctions(s) or amend as per their discretion.

It is noted that the respondent has three opportunities to provide input or comment on the investigation of the allegations against them. They may respond to the:

Specific allegations against them.

Evidence that emerges during the course of the investigation and the delegated members of the Executive's interpretation of that evidence.

Proposed sanctions.

Once an investigation has occurred and the Directors have made a decision as to the actions resulting from the alleged breach, both the Respondent and the Complainant will be notified in writing.

Documentation and privacy

Documentation plays an important part of the process bearing in mind that at all stages, all persons involved in an alleged breach of conduct must have their privacy protected. The Federal Executive committee will formally record the incident to ensure that the responses and outcomes of the investigation are adequately documented for future reference if needed. Access to these documents will be restricted to the Federal Executive committee.

Secure storage of this documentation is important, as it will allow the Federal Executive to review previous records to see whether similar incidents have occurred previously, and to assist local Divisions and branches with identifying continued breaches of the code of conduct.

This document will be updated periodically with improvements and changes to ASEG policies.

ASEG Directors
Emma Brand, Kate Robertson, Leslie Atkinson and Yvette Poudjom Djomani

AEGC Brisbane 2021

Australasian Exploration Geoscience Conference

15-20 September 2021 | Brisbane Convention and Exhibition Centre

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ASEG Young Professionals Network: AEGC 2021 - overview of student and early career events and financial assistance

Student and early career events

The 3rd Australasian Exploration Geoscience Conference (AEGC 2021) will be held in Brisbane from 15-20 September. We are pleased to announce that several student and early career focused events will be held throughout the conference proceedings (Figure 1). These are:

- Informal meet and greet prior to the Welcome Reception.
- Fortescue Metals Group Early Career Network Event.
- High School Geoscience Outreach Day.
- Q&A Industry Panel.
- The GeoPitch – fast-paced 3-minute presentations from students and early career geoscientists!

Thursday 16 September 2021 Informal meet & greet at the BRISBANE Sign – 5.15 pm

The iconic BRISBANE sign will be used as a meeting spot before the AEGC Welcome Reception. All student or early career geoscientists are welcome, whether you are travelling interstate or just from the suburbs, come and meet your peers and find some friendly faces!

Come join us from 5.15 pm, and we will walk over to the Welcome Reception together at 5.45 pm. The sign is located by the river in South Bank outside the Queensland Performing Arts Centre (QPAC).

The Fortescue Metals Group Early Career Geoscientist Networking Evening – 7.30 pm

The Fortescue Metals Group Early Career Geoscientist Networking Evening will officially kick-off the student and early career AEGC programme, providing an opportunity for geoscientists at all career and study levels the chance to network with fellow delegates. The event will be held from 7.30 pm on Thursday 16 September at one of Brisbane's beloved central bars, The Charming Squire. It is conveniently located around the corner from the AEGC venue; the Brisbane Convention and Exhibition Centre. The Fortescue Metals Group Early Career Geoscientist Networking Evening follows the AEGC Welcome Icebreaker.

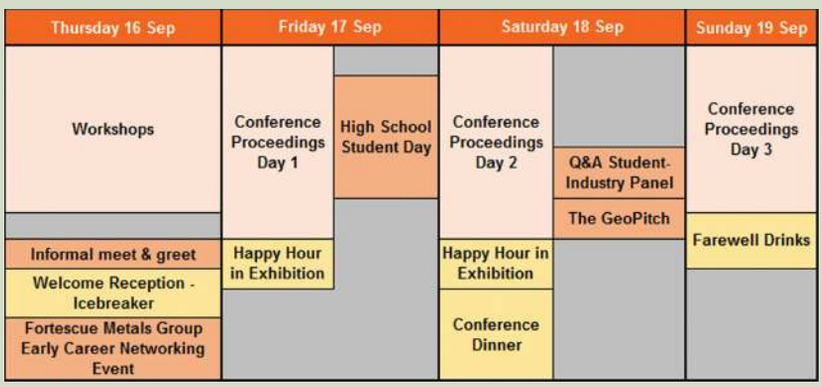

Figure 1. *Schematic overview of AEGC 2021 conference proceedings. Student and early career focused events are highlighted in orange (please note that workshops will also be run on Wednesday 15 and Monday 20 September.*

Meeting point for student or early career geoscientists prior to the AEGC 2021 Welcome Reception.

Undergraduate, early career, and established geoscientists are encouraged to attend the Fortescue Metals Group Early Career Geoscientist Networking Evening, to meet and share experiences, all the while enjoying all-inclusive drinks and a casual meal.

Please note this is a ticketed event. Tickets start from $15 and can be purchased on the AEGC website when registering for the conference (2021.aegc.com.au).

Friday 17 September 2021 High School Geoscience Outreach Day – 9.30 am

The AEGC 2021 has capacity to host up to 100 high school students (preference given to years 10 - 12) for a unique opportunity to experience a day at the AEGC with industry professionals. The High School Geoscience Outreach Day programme is designed to run within school hours and accounts for travel time to and from the venue.

Students will have a guided tour of the exhibition, see the latest in exploration technologies, and have an opportunity to interact with established geoscientists. Scheduled information sessions will cover an introduction to exploration geoscience and provide a variety of career insights (Figure 2). Students will also have an opportunity to have lunch with invited geoscientists.

Saturday 18 September 2021

The AEGC 2021 welcomes undergraduate, honours, masters and PhD students, and early career geoscientists to register their interest to attend the sponsored AEGC 2021 university student and graduate afternoon (Figure 3).

Industry Panel Discussion – 1.40 pm

This interactive Q&A-style panel will consist of a diverse range of geoscientists, allowing students and conference delegates to tackle front-of-mind questions and share experiences. Students are encouraged to attend lunch in the Exhibition Hall, preceding the panel, to explore the latest in exploration technologies and have an opportunity to interact with established geoscientists and

PRELIMINARY HIGH SCHOOL STUDENT DAY SCHEDULE	
0930-0940	Welcome to the AEGC
0940-1020	Opening Session '***The Future of Sustainable Energy and Resources***'
1020-1050	Morning break
1050-1110	Geoscience disciplines forum: What it's like to study Geoscience
1110-1140	Career insights: Life & adventures of geoscientists
1140-1220	Interactive activities / Demonstrations
1220-1300	Lunch (inc. with invited geoscientists)
1300-1330	Closing session
1330-1430	Guided exhibition & technology tour

Figure 2. *Preliminary High School Geoscience Outreach Day programme*

industry. An in-room afternoon tea will follow the panel to foster networking between students and industry, before continuing into an afternoon of student and early career fast-paced presentations: the GeoPitch.

THE GEOPITCH: Fast-paced presentations from university students and early career geoscientists – 3.00 pm

The AEGC 2021 will, for the first time, host an afternoon of fast-paced three-minute presentations, held concurrently to the rest of the conference proceedings. The GeoPitch is open to all students and early career geoscientists to present their research, project work, and new ideas related to earth science. All conference delegates are welcome to attend the event. Several prizes will be up for grabs, with in-room networking drinks following the presentations to foster networking between students, early career professionals, and any conference delegates in attendance. These networking drinks will be held prior to the conference Happy Hour drinks, which will be held in the Exhibition Hall.

The aim of this event is two-fold. It provides a unique industry-level platform, giving students and early career professionals an exciting opportunity to develop their science communication skills, presenting their work to a broad scientific audience. In addition, the GeoPitch gives conference delegates a sneak-peak into the cutting-edge areas of research and work undertaken by our future leaders.

PRELIMINARY UNIVERSITY/EARLY CAREER AFTERNOON SCHEDULE	
1340-1440	Q&A Industry panel
1440-1500	Afternoon tea
1500-1630	The GeoPitch
1630-1730	In-room networking drinks + presentation awards

Figure 3. *Preliminary university student and graduate afternoon programme*

Interested in presenting?

Rapidly and effectively communicate your science to a diverse audience in just three minutes! What big questions are you trying to answer? What was/is your thesis on? Using any cool technology for your research or geoscience work? Have you been on any awesome field trips? Do you have a catalogue of amazing rocks? We want to hear about it.

Each speaker has three minutes and three slides to communicate the core of their research/work in geoscience.

Judging criteria: We want to see passionate talks and cool science!

Applications are open now!! The deadline for submissions is 25 June 2021. Submit your presentation title and a 1-2 sentence description to geopitch.aegc2021@gmail.com.

We look forward to seeing you!

Kat Gioseffi
katgioseffi@gmail.com
AEGC Student and Early Career Committee Chair

Student and Early Career Committee: Kat Gioseffi, Nick Josephs, Genna McDonagh, Margarita Pavlova, Rachel Ciesiolka and Muhammad Atif Iqbal.

With thanks to our student and early career sponsors

Patron sponsor:

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Financial assistance

All of the state presidents have been "encouraged" to promote and award an allocated budget to eligible YPs and students to help attend the AEGC in Brisbane this year. At the time of writing, both QLD and VIC have developed selection criteria and advertised these bursaries locally. Other states are expected to soon follow suit, so please contact your state president for more information.

The QLD branch of ASEG will offer several bursaries to Queensland university students or graduates less than 1 year out of university to attend large ASEG conferences. As Brisbane is hosting the AEGC, the bursaries will be offered first and foremost to regional QLD students this year. If you are or know of an interested party, please contact qldsecretary@aseg.org.au or nick@energeo.com.au.

ASEG Victoria is offering financial support to two (2) lucky candidates up to the value of AU$1000 each towards conference registration fees and either accommodation or travel expenses up to the maximum award amount. Please contact vicpresident@aseg.org.au for more information.

Jarrod Dunne
ASEG Young Professionals Network Federal Chair
ypadmin@aseg.org.au

AEGC 2021 PRESENTS:

THE GEOPITCH

3-minute rapid fire presentations from students and early career geoscientists

APPLICATIONS OPEN NOW!!
Closes Friday 25th June 2021

w: 2021.aegc.com.au
e: geopitch.aegc2021@gmail.com

WHO: Current university students & early career geoscientists (< 5 yrs in industry) attending the AEGC

WHAT: Each speaker has 3 minutes & 3 slides to communicate the core of their research/work in geoscience.

WHERE: Brisbane Convention and Exhibition Centre

WHEN: AEGC held from 15-21 Sep 2021
The GeoPitch held 3 pm Saturday 18th Sep 2021

HOW: Submit your presentation title and a 1-2 sentence description by 25th June 2021, to:
geopitch.aegc2021@gmail.com

WIN: Prizes awarded in Student & Early Career categories

WITH THANKS TO OUR AMAZING STUDENT & EARLY CAREER SPONSORS

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ASEG Research Foundation: Projects sponsored in 2021

The ASEG Research Foundation has sponsored three new projects in 2021 for a total value of $45 450 over the next three years. This brings the total value of sponsorship to $1 495 000 since our inception in 1991. A brief summary of each 2021 project follows.

- University of WA
  Supervisor: Prof M Jessell
  Student: Mahtab Rashidifard,
  Grant: 2 years, PhD
  Title: "Integrated Inversion of Gravity and Reflection Seismic Data with Different Spatial Coverage"
- Monash University,
  Supervisor: Prof P Betts
  Student: Chibuzo Chukwu
  Grant: 3 years, PhD
  Title: "Role of Basement Structures in Controlling Triple Junction Formation and Associated Basins in Southern Australia"
- University of Melbourne
  Supervisor: Dr Graeme Beardsmore
  Student: Youssef Hamad
  Grant: 2 years, Msc
  Title: "Utilisation and comparison of conventional wireline precision temperature sensing, DTS, and aDTS to detect and quantify subsurface geothermal anomalies in the on-shore Gippsland Basin."

The ASEG Research Foundation acknowledges and thanks our donors from the ASEG membership, both individual and corporate. The ASEG as a whole makes a significant donation each year to support the Foundation. For information on donating visit https://www.aseg.org.au/foundation/donate. All donations are tax deductible. Further information on the ASEG Research Foundation can be found at https://www.aseg.org.au/foundation/overview.

Doug Roberts
ASEG Research Foundation
research-foundation@aseg.org.au

ASEG Honours and Awards – Final call for nominations for 2021

Nominations closing 30 July 2021

The ASEG acknowledges the outstanding contributions of its individual Members both to the profession of geophysics and to the ASEG, through the presentation of the Society's Honours and Awards across a range of categories. The next awards are scheduled to be presented in conjunction with AEGC 2021, 15-20 September 2021, Brisbane, Australia.

All ASEG Members as well as State and Federal executives are invited to nominate those they consider deserving of these awards. The available awards are:

ASEG Gold Medal

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

Honorary Membership

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

Grahame Sands Award

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

Lindsay Ingall Memorial Award

For the promotion of geophysics to the wider community.

Early Achievement Award

For significant contributions to the profession by a Member under 36 years of age, by way of publications in *Exploration Geophysics* or similar reputable journals, or by overall contributions to geophysics, ASEG Branch activities, committees, or events.

ASEG Service Awards

For distinguished service by a Member over many years to ASEG branch activities, Federal or State Committees, publications, or conferences or other society activities.

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

Nomination procedure

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

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

Further details of the award categories, lists of previous awardees and citations for recent awards, award criteria, nomination guidelines and nomination forms can be found on the ASEG website at: https://www.aseg.org.au/about-aseg/honours-awards

Further information can be obtained by contacting the Chair of the Honours and Awards Committee. All correspondence and nominations will be treated confidentially.

Nominations including digital copies of all relevant supporting documentation are to be emailed to: awards@aseg.org.au

Nominations close Friday 30 July 2021.

Andrew Mutton
ASEG Honours and Awards Committee Chair
awards@aseg.org.au

ASEG History Committee: Some current activities

The ASEG History Committee is comprised of ASEG Members who have an interest in the history of the Society and its historical activities. The full extent of the activities can be seen from all the separate items on the ASEG History webpage at; https://www.aseg.org.au/history Articles in *Preview* of historical interest are listed at; https://www.aseg.org.au/history/history-articles-preview.

At present Roger Henderson is Chair of the Committee and there are 32 members on the mailing list. Anyone who wishes may join by emailing Roger at; history@aseg.org.au Current activities of the Committee are detailed in regular reports to the mailing list.

A recent project of the Committee was to examine the history of geophysical data processing in Australia. In the period 1965 - 99, the processing capabilities of 34 organisations contributed to a report with ten attachments. A summary of this project is given in *Preview*, 207, 5. The full report is also available by request to; history@aseg.org.au.

Currently the Committee is engaged in two main projects, the first being the recording of the recollections of particular Members by text and interview. The persons involved to date are given on the website at; https://www.aseg.org.au/history-members. This section is continually added to, with Ted Lilley being the latest in Recollections, and Don Emerson is planned to be next. Following Lindsay Thomas as the first interviewee, Phil Harman is to be the next Member to be interviewed.

The last activities report of the History Committee has advice from Bob Smith based on his experience on how best to conduct interviews. The objective of these oral interviews is not only to record both the lives and careers of some of our long standing ASEG Members, but also to record advances in exploration geophysics during their lifetimes.

The other main project of the committee is the compiling of milestones in geophysical methods with particular relevance to Australia (some milestones such as for magnetics and electrical methods are available in the literature but are lacking important Australian dates). In order to spread the load for this undertaking, some individual members have volunteered to 'manage' particular methods.

A list of those methods that are currently active and their managers are:

- Electrical/EM - ASEG version. Contact: Mike Smith
- Ground Magnetics. Contact: John Stanley
- Engineering and Environmental. Contact: Greg Street
- Geophysical Mineral and Petroleum Discoveries. Contact: Bob Smith

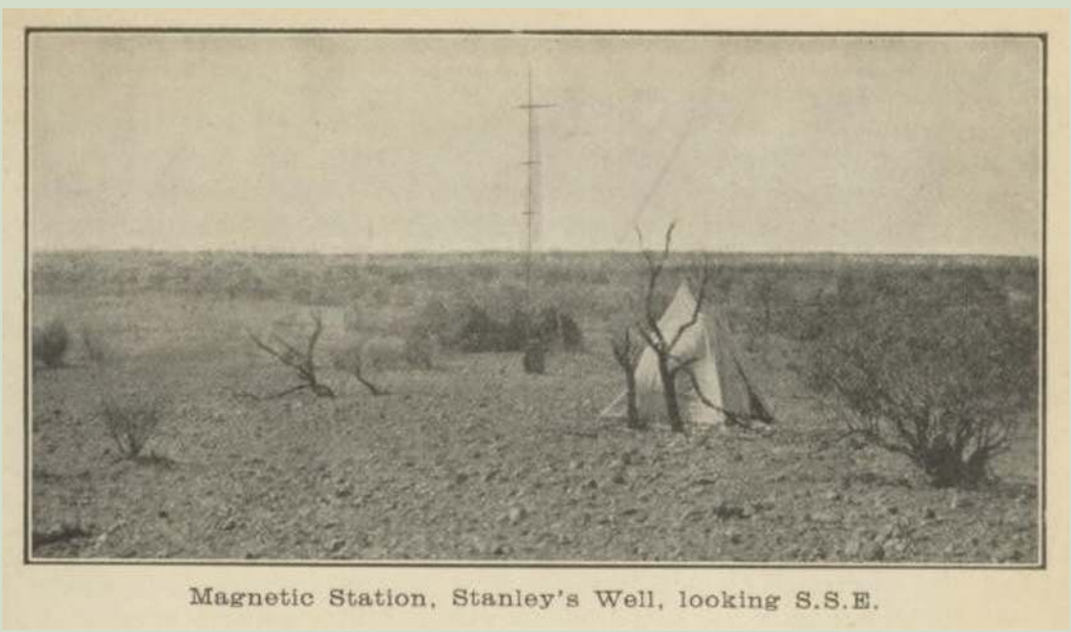
We are hoping Airborne Magnetics will be managed by Doug Morrison who has just written a 465 page book on the subject, soon to be published by the ASEG.

We still need managers for: Seismic Reflection, Seismic Refraction, Gravity and Radioactivity. Anyone wishing to be a manager for any of these methods or who wishes to add milestones should email: history@aseg.org.au.

Already, the Ground Magnetics milestones includes a 21 page document with 19 photos and references from John Stanley. However, as it is mainly about instrumentation, just as with all methods, other milestones still need to be added especially relating to theory, interpretation breakthroughs and special survey techniques. The document reports on the first magnetic measurements by an Australian observer as those of G F Dodwell in the Musgrave Ranges in 1914. The included photo is of one of Dodwell's stations at Stanley's Well, showing his magnetic observation tent and his accompanying wireless aerial for receiving time signals from Adelaide.

The Gravity milestones with relevance to Australia will start with the very first geophysical measurement known to have ever been carried out in Australia. Namely, the measurement of gravity performed by William Dawes in Port Jackson in 1789, immediately after the arrival of the First Fleet.

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



Dodwell's magnetic station at Stanley's Well in 1914. Photo from R Lockhart Jack, 1915.

Geophysics student practicals around Canberra, half a century ago.

Ted Lilley
Honorary Associate Professor
Research School of Earth Sciences
Australian National University, Canberra
Ted.Lilley@anu.edu.au

I arrived in Canberra in November 1968 to take up a research fellowship in the Department of Geophysics and Geochemistry of the Research School of Physical Sciences at the Australian National University (ANU). Such research schools were part of the ANU Institute of Advanced Studies. There was another part of the ANU, the School of General Studies, and in this part existed the Department of Geology, in a Faculty of Science. The School of General Studies had its origin in the Canberra University College, a college of the University of Melbourne, which had been established in 1929 after the seat of federal government moved to Canberra from Melbourne in 1927 (and brought with it Commonwealth public servants studying part-time for University of Melbourne degrees).

The Department of Geology did not have a geophysicist on staff, and a series of guest lectures in geophysics was given by members of the Bureau of Mineral Resources Geology and Geophysics (BMR), and the ANU Department of Geophysics and Geochemistry – which, in 1973, became the Research School of Earth Sciences (RSES).

I was asked to assist with giving classes in geophysics and happily agreed. I found I enjoyed lecturing on topics wider than my research speciality. I continued to contribute over some twenty-five years, last giving classes in 1994. While arrangements varied over this time, I remember the unit as comprising two practical periods (three hours and two hours) and three one hour lectures per week. The unit ran for one semester and was given every year, or sometimes every second year. The first semester was best for practical exercises as, outside, the Canberra autumn is delightful. In contrast the Canberra winter, at the start of the second semester, is less appealing.

Designing classes was an interesting task, in the context of the expertise generously contributed from both the BMR and RSES. With no particular geophysics base in the Department of Geology, setting up practicals from the facilities which Canberra offered was an enjoyable challenge, and my approach was to use the equipment and facilities at hand. As Canberra and its surroundings are well-known to a number of *Preview* readers, details of these geophysical exercises may be of interest. Below I sketch what were for me the high points of several of the practicals; some of them "distinctly Canberra". I hope readers who have done similar things elsewhere will enjoy being reminded of their own experiences.

Foucault pendulum

We made a pendulum (a brass cylinder suspended on piano wire, the material supplied by the RSES Workshop). This pendulum was set up temporarily in the stairwell of the Department of Geology. Once timed for 100 swings, the pendulum and the timer could be left going. Then after say a thousand swings, an exact number of complete swings could be determined from the total elapsed time. An improved estimate of the pendulum period resulted, even though the swings had not been counted individually. Also, over the longer time the pendulum would show the "Foucault characteristic", of a rotation of the pendulum plane demonstrating the rotation of the Earth.

Scrivener Dam profile

The pendulum demonstrated the determination of absolute gravity, and relative gravity was measured with a Worden gravimeter (which had been in the Department of Geophysics and Geochemistry for some years). A memorable use made of this instrument was a traverse across Scrivener Dam, at the western end of Lake Burley Griffin. The purpose was to observe the gravity deficit due to the river valley, and then compare the result with predictions from simple models, calculated in advance on the basis of a topographic map.

We found the traffic across the dam (which also carries a roadway) caused the gravimeter to vibrate. To solve this problem we were greatly helped by the ACT Police. The dam has six buttresses and as our party (walking across the dam) reached each buttress, the police stopped the traffic briefly. We then took our next readings, free of the vibrations caused by cars moving across the dam.

Black Mountain Tower

It was also convenient to take readings at the top of Black Mountain, and at least on one occasion to take the gravimeter up the Black Mountain Tower. The tower swaying in the wind was then a problem (unfortunately no police available to stop that!)

Sledge hammer seismic

Making a seismic source by hitting the ground with a sledgehammer carried the benefit that students were actively involved, instead of merely standing and watching. Capturing the signals thus generated using (industry cast-off) geophones, and displaying them on a portable "cathode ray oscilloscope" (lent by the RSES electronics workshop) brought home the concept that seismology relies on energy transmission. The point was further emphasized when different students, taking turns with the sledgehammer, invariably turned the practical into a "who can get the largest signal" contest.

Using the Megger

The RSES electronics workshop produced a "Megger" earth insulation tester of the time. It was housed in a beautifully-made wooden box, and its voltage source was hand-generated. This instrument worked well measuring earth resistivity when it was connected by cables to four aluminium stakes arranged in a Wenner array, set up on a grassland part of the ANU campus.

The necessary student involvement in winding the handle to drive electric

Student excursion to the Canberra Magnetic Observatory at Kowen Forest, 8 April 1982, hosted by Peter Hopgood (first at right) and Ron Smith (third from the right).

current into the ground, as well as expanding the array as the experiment progressed, was again a distinct benefit in conveying an understanding of how measurements of earth resistivity were made.

Canberra Magnetic Observatory

An excursion to the Canberra Magnetic Observatory, in Kowen Forest near Canberra, worked well as a two hour excursion, thanks to the cooperation and hospitality of observatory staff.

At the time one instrument at the observatory was a proton-precession magnetometer, set up with bias coils, to measure the total magnetic field and also its components as they changed with time. While inspecting the instrument, an instructive exercise for student involvement was to record, as they occurred in real time, the five readings as the magnetometer stepped through its cycle of bias fields. Taking down their own set of readings gave the students a sense of reality not obtained from a set of readings handed out on a printed page. From the set of readings the students could calculate the magnetic field components, thus learning how the bias coils worked.

Mt Stromlo seismic vault and heat-flow hole

An excursion to the ANU seismic vault, driven into the side of a valley near Mt Stromlo, allowed not only an inspection of the classic and massive seismometers installed there, but also the logging for temperature of a hole originally drilled for heat flow studies. The hole had been drilled down through the floor of the vault.

Logging the hole for temperature (using a portable logger, part of the heat-flow equipment held by RSES) showed the local thermal gradient. Also, and rather pleasingly, when logged carefully over its upper several metres the temperature profile showed the signal of the previous season (summer, for an autumn logging) diffusing down in to the ground.

Paleomagnetism of Mt Ainslie

With the invaluable support of the RSES palaeomagnetic group (and in particular of David Edwards) it was possible to spend a three hour practical collecting oriented drill core samples near Canberra, for example on the banks of (igneous) Mt Ainslie. A subsequent two hour practical would then be spent at the ANU palaeomagnetic laboratory, measuring the magnetic properties of the samples. Students could calculate the palaeomagnetic latitude and direction of north, and see that the values they obtained differed from the present day. Having their own core samples brought the message home particularly well.

In retrospect

Looking back I see benefits, given this was a teaching course rather than a professional practice course, in having fundamental principles demonstrated by the simplest of equipment. Even today, I expect there are teaching benefits in using "first principles" basic equipment, albeit in conjunction with items which are latest "state of the art".

Acknowledgements

I first acknowledge the students who took the course. Every lecturer knows how invaluable are the questions asked, and the discussion points which arise. Also I thank the demonstrators, typically research students from RSES, who again would suggest valuable improvements, and without whom the practicals would not have run smoothly. Also, thanks to the experts at the Canberra Magnetic Observatory and the Palaeomagnetic Laboratory, who made our visits so rewarding.

Finally, I thank Roger Henderson for his encouragement to write a memories piece for *Preview*, which has resulted in this item.

ASEG branch news

Tasmania

The Tasmania Branch is pleased to announce the recipients of its 2021 ASEG scholarships, provided to assist ASEG students to attend courses/ conferences. While the applicants are involved in a range of different research projects, from Honours to PhD, they all have a geophysics slant and are ASEG student members. Given the uncertainties around interstate and international travel and the risk averse policies of the University of Tasmania, it is unlikely that any of the students will be able to attend the events mentioned in person. For this reason, it is expected that the grants will be used to cover conference registration for online participation. Please make them feel welcome if you see them (virtually or otherwise) at a conference.

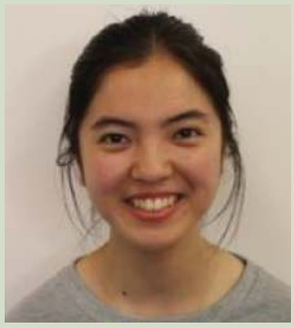
Zak Weidinger: Honours student, thesis title - "Geophysical investigation of groundwater dynamics within a tailings dump at the Royal George legacy mine site, NE Tasmania".

Zak Wiedinger

My Honours project aims to use an array of four-dimensional (time-lapse) near-surface geophysical techniques to image change in the flow of ground water through the tailings dump at Royal George, a legacy tin mine in NE Tasmania. The outcomes of my project will help to understand the role of changes in hydrology on the production of Acid and Metalliferous Drainage (AMD) within the tailings and its subsequent dispersion into the local environment.

Zak intends to use the ASEG grant to attend the AEGC in Brisbane in September this year.

Dina Chu: Honours student, thesis title - "Petrophysics of the Pine Creek mineralisation and stratigraphy".



Dina Chu

My research aims to understand the geophysical response of gold mineralisation within the Pine Creek Orogen through the collection of primary petrophysical data and the integration of this information with pre-existing geological and geochemical datasets. The results from this research will be used generate prospectivity targets throughout the Pine Creek Orogen.

Dina plans to use the ASEG grant to attend the AEGC 2021 conference later this year.

Karla Morales: Masters student, thesis title - "Geological predictors for pre-concentration"

Karla Morales

My Masters project aims to evaluate geological controls such as the role of mineralogy, texture, hardness, magnetic susceptibility, density, etc., on rock breakage and natural fractionation at a range of scales. Multiple mineralisation styles in different rock types are being studied in order to understand the geological features which are related to the propensity of metal to separate into certain size fractions.

Karla plans to use the ASEG grant to attend AEGC 2021 in Brisbane later this year.

Umer Habib: PhD student, thesis title - "Palaeomagnetic analysis of the Palaeozoic of SE Australia".

Umer Habib

My research focuses on the rotation of the tectonic elements within Lachlan Orogen during the middle to late Palaeozoic time using palaeomagnetic techniques. Results from 32 sites in Victoria and New South Wales show the masking of original remanence due to post bending Devonian overprint which is attributed to the fluid expulsion events during the Bindian – Tabberabberan orogenic events.

Umer would like to use the ASEG grant aim to attend AEGC 2021 (Brisbane).

Alex Farrar: PhD student, thesis title – "Spatial and temporal controls on the formation of giant Porphyry Cu Au deposits in the Central Andes".

Alex Farrer

I am marrying lineament analysis of regional gravity, aeromagnetic and seismic hypocentre datasets with structural geology field mapping in the Central Andes, with the aim of investigating how these independent datasets can be integrated to map first-order continental-scale structural architecture. Additionally, I will investigate competing models of geodynamic evolution of the regional stress field since 70 Ma and explore

methods for transferring information in geodynamic models to supervised machine learning methods for predicting giant porphyry mineralisation in the Central Andes.

Alex will use the ASEG grant to attend the Tasmanides conference, in NSW later this year.

Meeting notices, details about venues and relevant contact details can also 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.

Matt Cracknell
tassecretary@aseg.org.au

Warren Grey presenting to the Victoria Branch

Victoria

Well, it's happened. It's finally happened. Surely not? No, I'm not referring to Victoria Branch hosting its first in-person technical meeting night in over 17 months but agonisingly, I can't seem to conjure anything interesting to write about what transpired that evening. For all the satirical witticism and mockery of branch news I find myself scripting for *Preview* every couple of months, I am discovering just how difficult it is to accurately transcribe events of the night of 22 April at The Kelvin Club. Of course, this is not the fault of our guest speaker that evening, nor the topic he chose to communicate – "Three Years in the Marine Seismic Exploration World" – but rather a genuine episode of severe and debilitating writer's "I can't be bothered" block. Sure, I could ceremoniously recount **Warren Gray**'s presentation in a monotonous, repetitive, government-style manual language but where would that leave my legion of adoring fans?

Hahaha…I'm just messing with you. Warren's dazzling presentation gave Members in attendance that night a rare insight into the dynamic world of marine seismic acquisition trends. I shall attempt to summarise his talk through connections with various Beethoven compositions. In 2018, when petroleum companies had much deeper pockets and explorers were enjoying a resurgence in oil prices, activity was bountiful and generous, much like the rapid introduction to *Beethoven's 5th Symphony*. In 2019, acquisitions slowed down somewhat, and techniques varied with the industry seeing an increased demand from traditional 3D seismic to ocean bottom node (OBN) methods – a reflection on companies looking to improve production and recovery rates from existing fields while oil prices regained some lost ground from a mini slump. This was still a prosperous time for major operators, marching along in sync to the highs and lows of *Beethoven's 9th Symphony – Ode to Joy*. The rest as they say, is history - by the time COVID-19 began showing up on every country's doorstep, early 2020 proved to be an incredibly frustrating year for seismic service providers. The dramatic fall in oil prices amplified the dire situation already faced by the oil industry as major seismic service providers went bankrupt, leaving virtually only one or two providers left to fight over what little work was available, much like the sombre mood of *Beethoven's Sonata Opus 27 No.2 1st Movement – Moonlight*. As oil rises back to pre-COVID prices, Warren tells us a number of new unchecked, smaller seismic service providers have appeared. Will they succumb to the ripple effects of COVID-19 like a lamb to the slaughter, or will they prevail? I wonder.

It seems that the Victoria Branch has a revolving door policy regarding the standing term of its committee members. It brings me no joy to announce that **Theo Aravanis**, our incumbent treasurer, will be stepping down from the role. Theo retires by rotation/misconduct/breach of duty/being jaded/coercion (circle one) ☺

I'd like to personally thank Theo for his tireless efforts over the past 18 months in paying my ridiculously exorbitant and very personal bar tabs with branch funds, which I can tell you is an extraordinary feat of superb accounting. **Jarrod Dunne**, a fellow geophysicist, petroleum specialist and President of the ASEG Young Professionals Network ('YPN'), has agreed to step into the treasurer's role effective immediately. Wow, it's just occurred to me we've lost one president, two treasurers and a communications officer – all in the space of 18 months. What is going on here? This committee smacks of bumbling amateurs. I wonder what else can we bungle up while we're all here?

Thong Huynh
vicpresident@aseg.org.au

Western Australia

Greetings once again from Perth and WA. It's still a bit quiet - too quiet… 2021 still is not COVID free, and we've had to postpone several local face-to-face events. But, all good so far. By the time this issue of *Preview* arrives at your door, we should have had some more (very good) webinars in May, along with a Social Bowling Night, also in May. I'm writing this before these events are to go

on, so I'll just say that third or fourth time usually is the charm.

Besides the webinars, we are also planning a Tech night with our brother/sister organisation – the AIG. These nights will be held in June.

In terms of actual completions, our recent home-made survey had a good response back from our WA Members, and we'll be using that feedback as we plan our way forward through another interesting year. I definitely want to thank all of those who did respond. And, from the replies, I've used my Linux box (and srand along with rand) to select the winner of an excellent bottle of red wine. We'll keep winner's identity hidden, of course.

Todd Mojesky
wapresident@aseg.org.au

Australian Capital Territory

From the ACT we can report that it is beginning to look like the dreaded Canberra winter is firmly entrenched!

The public talks by Geoscience Australia (GA), or the Wednesday Seminar Series are now running with a hybrid in-person/online format (https://www.ga.gov.au/news-events/events/public-talks/public-talks-archive). Notable talks in April and May have been by **David Huston** (GA) on "Convergent margin metallogenic cycles: a window to secular changes in Earth's tectonic evolution", **Bradley Moggridge** (University of Canberra) on "Aboriginal People and Groundwater", and an update by **Andrew Heap**, **Kristina Anastasi** and **Karol Czarnota** (GA) on "Second phase of the Exploring for the Future Program (EFTF, 2020-2024)".

In other more geophysical news, an AEM extension survey for the Great Artesian Basin has been commissioned by the groundwater group within GA, and will be flown in May 2021. It will be followed in the coming months by a Surface Magnetic Resonance (SMR) survey to map shallow subsurface water content. Also, throughout April and May, thirty-two Magnetotelluric (MT) sites as part of the AusLAMP program will be occupied in a rolling fashion by GA in Queensland. These MT sites fill a data gap in south-western Queensland, next to the Northern Territory border. The data will bring additional regional insight to the Barkly-Isa-Georgetown EFTF project area, while also contributing to the national AusLAMP survey.

On May 12 GA staff highlighted the importance of the International Women in Mathematics Day, commemorating the life and work of Fields Medallist and mathematician Maryam Mirzakhani, in concert with ongoing discussions on making the work culture in the field of earth science more inclusive.

Finally, we are very pleased to announce that **Michelle Henderson** will be talking to the ACT Branch on 8 June. As a professional coach across government and scientific agencies, she will be addressing some of the problems we face in dealing with the cyclical and unstable nature of the resources industry, and how it impacts staffing and enthusiasm, and where the solutions and opportunities lie. Details to be released shortly.

Anandaroop Ray
actpresident@aseg.org.au

New South Wales

ASEG NSW has been able to enjoy regular monthly meetings so far, a far cry from the mayhem that was happening a year ago, fingers crossed this trend will continue!

In March, **Dr Peter Gunn** (Bohuon Resources Pty Ltd) presented a talk entitled "An explanation for the distribution of Broken Hill style mineralision invoking dense rift-related igneous intrusions". This talk was not only well-received by the geophysicists but also, the wider geoscience community in NSW. Peter's work showed that the major gravity anomalies at Broken Hill are cause by deep seated mafic intrusions sit in the core of an ancient rift, whereas the mineralisation was controlled by marginal normal faults. Peter presented supporting evidence from modern basins and mineral systems gathered during his decades of work around the globe, e.g., the Egyptian Qattara Depression and the Libyan Plateau. With the knowledge that major gravity anomalies could be used as guides for future deposits, where will the next Broken Hill type deposit be found?

Dr Bhavik Harish Lodhia (UNSW) presented at our April meeting, "Shallow mantle convection beneath West Africa and source to sink at continental margins: A novel approach to reservoir prediction in offshore deep-water settings". Bhavik offered a crucial link between onshore denudation and offshore sedimentation to predict future reservoirs. This was achieved through modelling of sedimentary flux measurements, analysis of regional subsidence patterns, tomographic modelling and isostatic calculations in the Mauritanian Basin. The presentation was enjoyed by all and followed by much discussion.

An invitation to attend NSW Branch meetings is extended to interstate and international visitors who happen to be in town at the 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.

Peter Gunn (centre) happy to be receiving his bottle of red as thanks from the NSW Secretary (left – Steph Kovach) President (right – Jim Austin).

Smiles from Bhavik (left) and Jim (right) after a very interesting April presentation.

Stephanie Kovach
nswsecretary@aseg.org.au

Queensland

On April 9, 20 students from UQ and QUT were bussed, courtesy of the ASEG Queensland Branch, to Velseis Seismic. The students were introduced to some basics of seismic geophysics, shown a Univibe in action and got to try and place some nodes. A full report on the day can be found in *Education matters* in this issue of *Preview*. The students were buzzing afterwards, and no doubt will be more engaged in geophysics further into their careers. The Queensland Branch would like to thank Velseis for putting on a great day and experience for our students.

On April 27, the Queensland Branch held our AGM. **Ron Palmer** stepped down as President after three years of service. **James Alderman** was voted in as the new QLD ASEG President and on behalf of the whole Queensland Branch James thanked Ron for his service. Other committee members are **Nick Josephs** as Secretary and **Roger Cant** as Treasurer. **Tim Dean** was also welcomed onto the committee. Following the AGM, **Peter Fullagar**, from Fullagar Geophysics, gave a talk titled "Beyond plates – fast TEM inversion using conductive ellipsoids". His talk went into depth on how "ovoid" type massive sulphides could be more accurately modelled using triaxial ellipsoids, rather than the usual flat plate models. This talk covered the forward modelled response of ellipsoids and we hope to welcome Peter back later in the year for Part 2, talking about inversion.

Irwan Djamaludin will give a talk in June on Glenhaven 3D Seismic Survey for CCS. This is the geophysics part of a twin talk given to PESA on 18 February, by **Darren Greer** of CTSCo carbon capture and storage project in the Surat Basin.

Moving forward we're looking into the ability to stream and record our technical talks for the benefit of QLD and other ASEG Members outside of the Brisbane area.

The QLD Branch are offering student and recent graduate bursaries to Queensland Members. Universities have been contacted and if anyone would like to apply please email qldsecretary@aseg.org.au

Nick Josephs
qldsecretary@aseg.org.au

South Australia & Northern Territory

On Tuesday April 13 the SA/NT Branch hosted a lunch time technical presentation at the Hotel Richmond by **Anandaroop Ray** from Geoscience Australia. Anand presented on a new probabilistic method he's been researching for recursively inverting for regularisation, with some good examples of statistical inference, AEM and CSEM inversions using his algorithm. We forayed into our first hybrid event, with virtual attendees also getting involved in the discussion at the end. You can find this talk on the ASEG YouTube channel (Youtube.com/ASEGVideos).

On April 28 we co-hosted a joint event with PESA, SPE and YPP (Young Petroleum Professionals), the Fall Fling, at the Havelock Hotel. A spin-off from our previous Spring Flings, these fantastic networking events are becoming a staple on our events calendar. A perfect evening and the promise of valuable face-to-face interactions brought out over 60 attendees.

Next on our calendar we have an ASEG-sponsored Adelaide University Geological Society (AUGS) student event at the Belgium Beer Café - we will update you on how this event went in the next issue of *Preview*.

Our Branch Committee is always looking for volunteers. If you would like to join, please email our Branch President Ben Kay (sa-ntpresident@aseg.org.au).

We couldn't host these fantastic events without the valued support of our sponsors. 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**.

Kate Robertson
ASEG SA/NT Branch Committee Member on behalf of
Ben Kay
sa-ntpresident@aseg.org.au

Attendees enjoying the evening at the Fall Fling event.

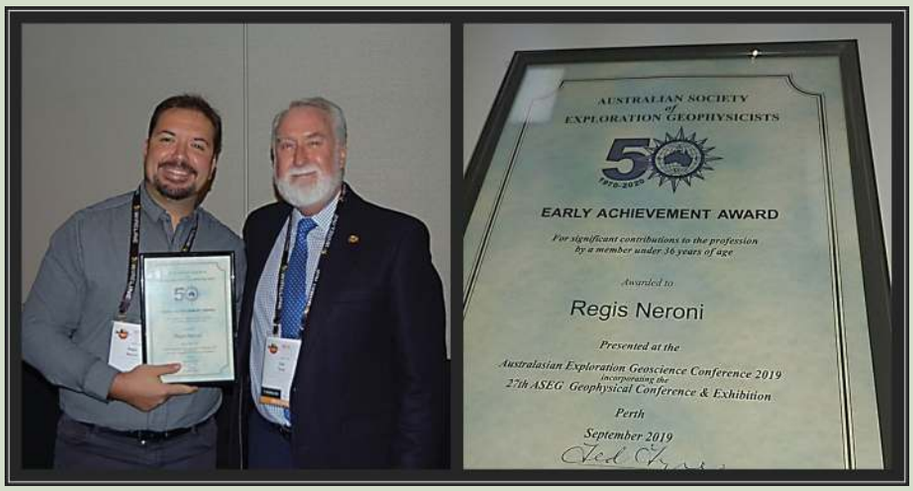
ASEG national calendar

Date	Branch	Event	Presenter	Time	Venue
ASEG Branch face-to-face meetings have resumed in all states. Many 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 information about upcoming webinars and other on-line events					
08 Jun	ACT	Tech talk	Michelle Henderson	1600	https://us02web.zoom.us/webinar/register/WN_yNHpLyXNTOOXe5Qx4FsGSA
16 Jun	NSW	Tech night	TBA	17:30	Club York, York Street, Sydney
Jun	QLD	Tech night	Irwan Djamaludin	17:30	XXXX Brewery, Cnr Black &, Paten St, Milton
21 Jul	NSW	Annual dinner	TBA	18:00	https://us02web.zoom.us/webinar/register/WN_yNHpLyXNTOOXe5Qx4FsGSA
10–11 Aug	National	DISC	Dave Monk	10:00	https://seg.org/shop/products/detail/287093232

Invitation for expressions of interest to receive a travel grant to attend AEGC 2021, Brisbane, Australia.

Available to geoscience students or early career professionals

The ASEG Early Achievement Award, which acknowledges significant contributions to the profession at an early stage in a person's career, was presented in Perth at the AEGC 2019 to Regis Neroni from the WA branch, for his outstanding contributions to the ASEG through conference and branch related activities, and through mentoring, community engagement and development and application of new technology within his professional career.



The Award included a $2 000 contribution to the recipient in recognition of their achievement. Regis indicated that he wished to donate these funds toward a travel grant to assist a geoscience student or early career professional to attend the next AEGC conference, being held in Brisbane from 15-20 September 2021. The one-off cash grant is primarily designed to cover travel, accommodation and workshop costs incurred by the recipient. The ASEG will also provide assistance by covering the recipient's registration fee to attend the conference.

Regis and the ASEG are now seeking expressions of interest from Australian-based geoscience students or early career professionals to be the recipient of this grant and experience the unique professional development and networking opportunities.

Any young professional or geoscience student who is keen to attend the conference and wishes to seek such financial support is invited to directly contact Regis (rneroni@fmgl.com.au) to submit an expression of interest. ASEG membership is not a pre-requisite but would be considered an advantage.

Expressions of interest must be received before Wednesday 14 July 2021.

The AGC launches the National Geotourism Strategy

The Australian Geoscience Council (AGC) is Australia's peak council of geoscientific societies, including the ASEG. The AGC President, Professor David Cohen, recently announced that the Council has embarked on implementing a National Geotourism Strategy that is designed to support the orderly development of major geotourism projects and activities in line with overseas trends and domestic regional development imperatives. The AGC sees the articulation of a National Geotourism Strategy with a staged and incremental approach as being essential to ultimately gaining government endorsement at all levels.

Tourism industry development benefits can be significantly enhanced through the holistic approach of geotourism, a pursuit that enhances the value of traditionally structured, nature-based tourism by generating new product development (i.e., including geology, landscape, flora and fauna, as well as cultural heritage attributes, both Aboriginal and post European settlement, including mining).

The development of a National Ecotourism Strategy in 1994 and subsequent state/territory-based initiatives is considered as a particularly useful precedent and guide. It is significant that the development of geotourism in Australia lags many countries' approach, notwithstanding the fact Australia has already taken the initiative in several areas in development of the concepts underpinning geotourism, through the identification and development of several significant georegions and establishment of an array of geotrails.

The pursuit of geotourism offers the potential for new industries and employment opportunities through the development of major projects within Australia. Also, very significantly from a strategic perspective, the AGC recognises that the development of geotourism may be one of the best ways to communicate the value of geoscience to the broader Australian community. The AGC considers that this improved profile for geoscience is likely to have a positive impact in other areas of strategic importance, most notably the need for continuing tertiary enrolments in geoscience that is required to meet Australia's needs for highly qualified geoscience graduates and researchers into the future. It is recognised that this objective can be achieved if the National Geotourism Strategy is structured to deliver and interpret for the traveller or visitor, quality natural heritage content, highlighting geology and landscape.

The National Geotourism Strategy embraces seven strategic goals:

1. To develop new digital technologies to deliver and interpret for the traveller or visitor quality natural and cultural heritage content, highlighting particularly geology and landscapes. Working Group Chair: Mark Williams, E: mark.williams@utas.edu.au

The Granites, Murchison georegion, Western Australia. Photo: Jarrad Seng

Conjoint Associate Professor Ron Boyd from the University of Newcastle at the launch of the Port Macquarie Coastal geotrail in May 2018, New South Wales. Photo: Ivan Sajko, Port News.

2. To define an approval pathway for major geotourism projects. Working Group Chair and Strategy Coordinator: Angus M Robinson, T: 0418 488 340, E: angus@leisuresolutions.com.au
3. To establish a framework for creating high quality, sustainable geotrails. Working Group Chair: David Robson, E: robodavidf@gmail.com
4. To establish a national framework for geoheritage listings suitable for geotourism. Working Group Chair: Jason Bradbury, E: Jason.Bradbury@dpipwe.tas.gov.au
5. To develop geotourism in regional mining communities with potential geoheritage and cultural heritage sites. Working Group Chair: Dr Melinda McHenry, E: melinda.mchenry@utas.edu.au Developing mechanisms for collaboration with providers of other cultural elements and landscapes inclusive of mining and resource industry heritage (e.g. mining companies, geological and mining museums, historical and professional societies and geological surveys) has also been identified as an opportunity to further the socio-economic benefits of geotourism. The AGC has consulted widely to determine how best the development of geotourism throughout Australia can enhance the scope of regional development of mining areas during past and current mining activities, and after mine closure. To participate in the work of implementing this goal, members of the Geoscience Society are invited to contact the Working Party Chair, or the Chairs of any of the other working groups should an interest area be identified.
6. To strengthen Australia's international geoscience standing through geotourism excellence. Working Group Chair, Dr Bill Shaw, E: pastpresident@agc.org.au
7. To develop and enhance the geoscience interpretation and communication skills of everyone actively involved in the presentation of geosites, enabling the provision of accurate and thematic information in an accessible manner. Working Group Chair: Simone Meakin, E: simone.meakin@planning.nsw.gov.au

Geotourism is booming internationally, and it is important that iconic Australian geotourism destinations and products, particularly in regional and outback regions, can be transformed to meet both the needs of domestic and global travellers seeking superior travel experiences.

David Robson
ASEG Representative
National Geotourism Strategy
Australian Geoscience Council
robodavidf@gmail.com

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/

Geoscience Australia: News

The end of the financial year brings no rest for the wicked (geophysicist) and Geoscience Australia is acquiring and processing data on a number of national fronts. With our key collaborative State agency partners of Western Australia, South Australia, Northern Territory, Queensland, New South Wales, Victoria and Tasmania, the national pre-competitive datasets continue to grow in resolution and coverage (Figure 1 and tables in the following section). Through front-end tools like the new Geophysical Acquisition and Data Delivery System tool (GADDS - https://portal.ga.gov.au/persona/gadds) and other 2 - 3D data portals (see https://portal.ga.gov.au/), access and 'integratability' have never been easier. Some select updates follow.

Exploring for the Future - East Resources Corridor AEM survey

A new regional AEM survey commenced in April straddling the borders of South Australia, Queensland, New South Wales and Victoria (Figure 2). Under the banner of the Federal Government's Exploring for the Future Programme (https://www.ga.gov.au/eftf), the 32 000 line km survey will expand continental regional airborne EM coverage across a 500 km-wide belt of terrain for district-scale base-metal, energy and groundwater investigations. At current acquisition rates, the survey should be completed by mid-year, with the results (including Geoscience Australia inversion routines) released in the third quarter of 2021. Data integration and interpretation will follow into 2022; all adding to the long-term goal of national AEM coverage (Figure 3).

Development of the Jin Jin Airborne EM calibration range

The Jin Jin AEM calibration range is located approximately 70 km from the small township of Gingin, Western, Australia (Figure 4). The town has had an increasing focus on science with the establishment of the Australian International Gravitational Observatory and Gravity Discovery Centre, and now the Jin Jin AEM calibration range. The calibration range is located where Geoscience Australia, Geological Survey of Western Australia, CSIRO

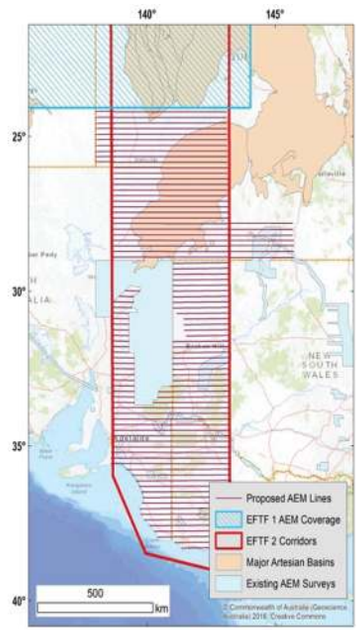


Figure 2. *Proposed regional AEM survey across the East Resources Corridor, Exploring for the Future Programme. At 20 km line spacing, the 32 000 line km survey will take 3 months to complete. As of May, the survey was at 50% complete. Note that the proposed survey gap in South Australia has already been covered with AEM as part of the regional Frome survey (data available from Geoscience Australia). Line plans are schematic only and do not reflect the final flight path map.*

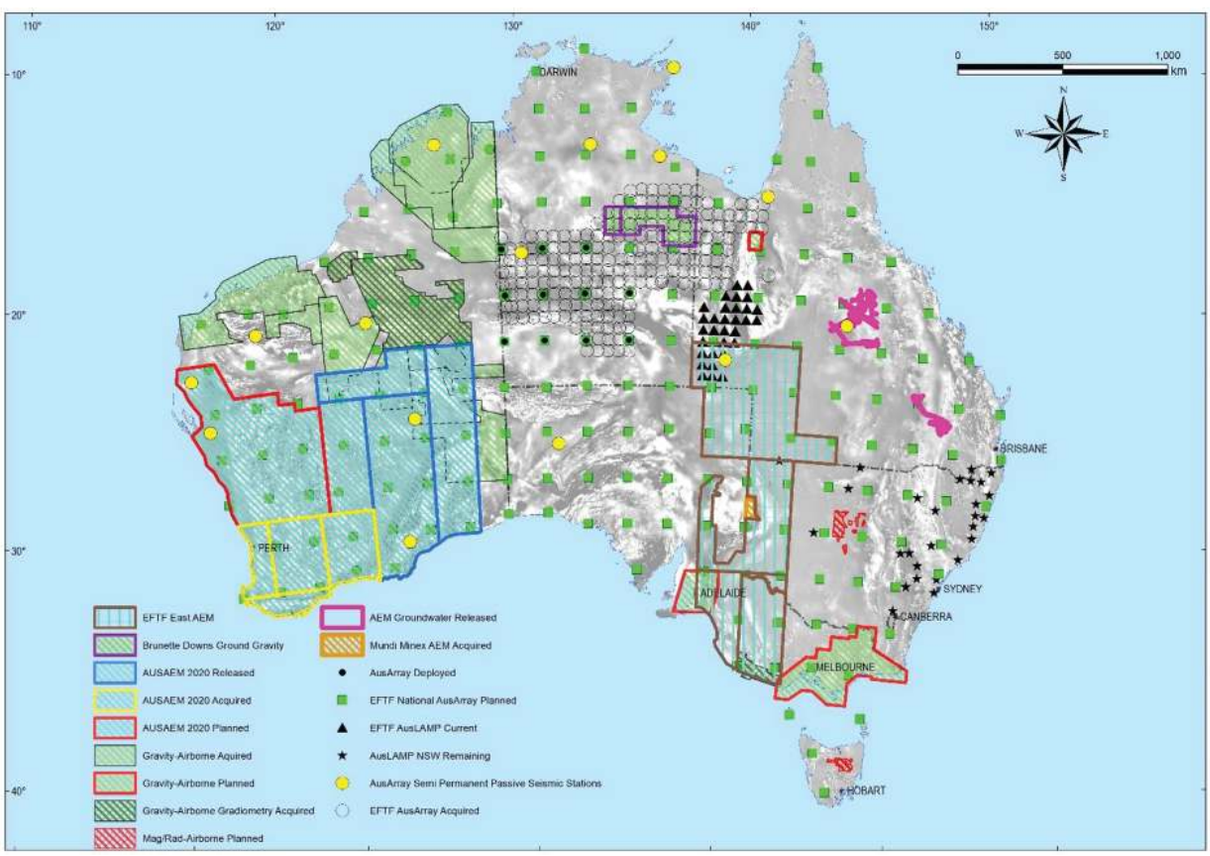


Figure 1. *2019-21 geophysical surveys – in progress, planned or still for release by Geoscience Australia in collaboration with State and Territory agencies.*

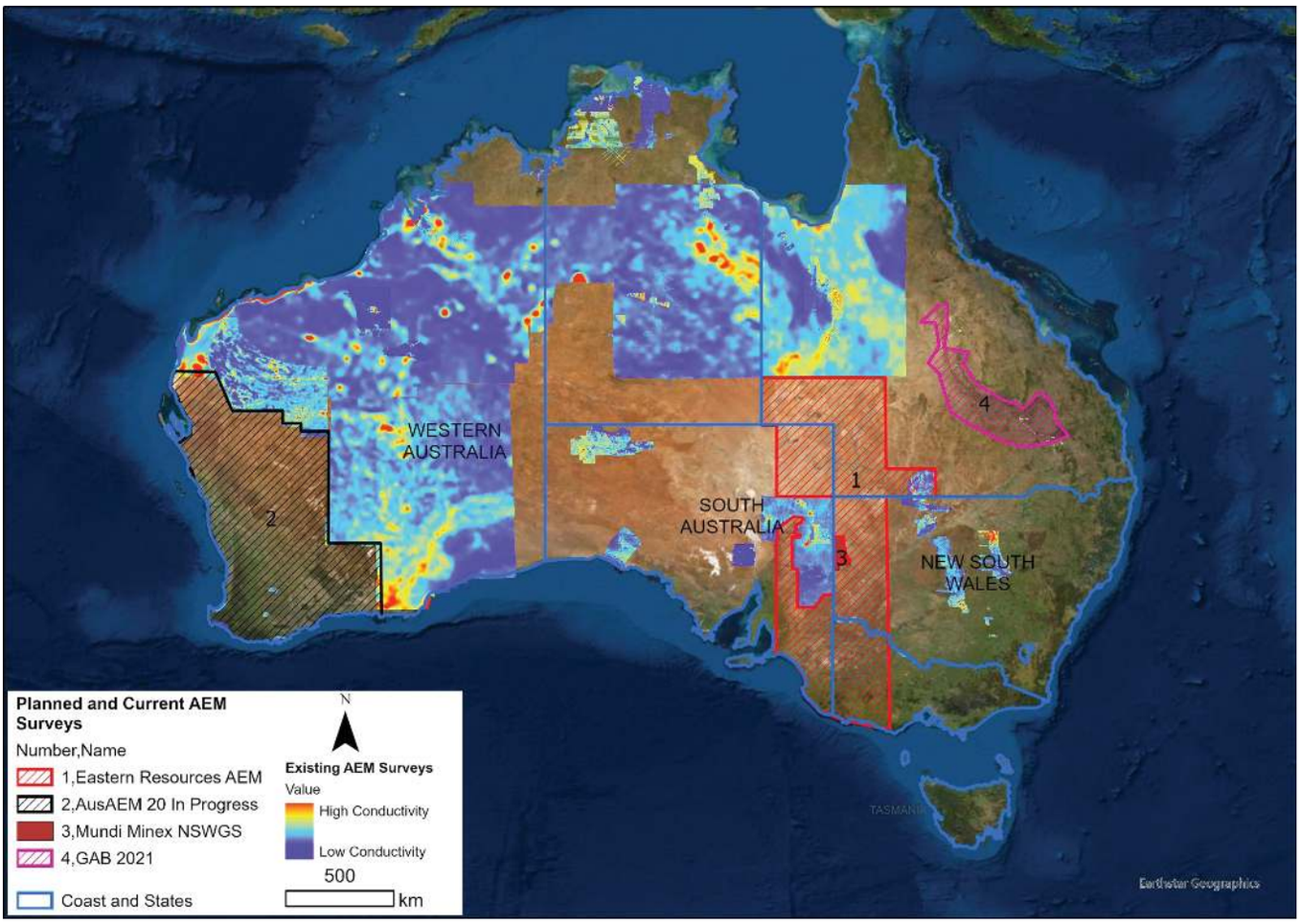


Figure 3. *Existing and planned Geoscience Australia and State Geological AEM surveys across Australia, May 2021. Surveys in progress and or recently completed shown against 100 m AEM depth slice for completed coverage. New surveys referenced include the East Resources Corridor (1), AusAEM20 (2), Mundi AEM survey (3) and the Great Artesian Basin survey programme (4).*

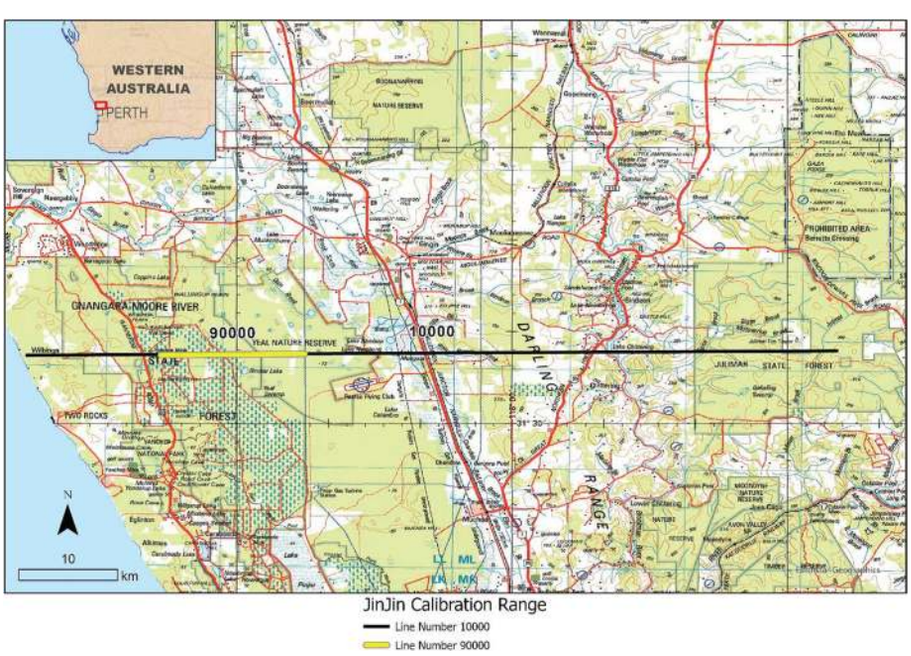


Figure 4. *The Jin Jin EM calibration range, Western Australia. Located 70 km to the north of Perth, the proposed calibration range consists of two lines: line 90000 (12.5 km long) and line 10000 (70 km long) that cover a broad range of host, cover, geology and salinity conditions. A procedure is currently being written to cover flying pattern and tolerances required. Note that a section of line falls under restricted air-space (western portion) and extends across to a new area of significant exploration interest (Julimar).*

and other government agencies have significant geological and conductivity information from previous studies, including downhole conductivity logs, previously flown AEM lines and ground EM stations.

Over the next two years, GA and CSIRO will work on further testing of various EM systems to establish the range as the definitive base-line for resolution, depth-of-investigation and system modification checks. In collaboration with some of the region's stakeholders, including the RAAF, Traditional Owners, Mining Companies and local community, it is *hoped* that both ground and airborne access can be better structured and facilitated.

Victoria and South Australia airborne gravimetry survey

Geoscience Australia, in collaboration with Geological Survey of Victoria, Surveyor-General Victoria, and the South

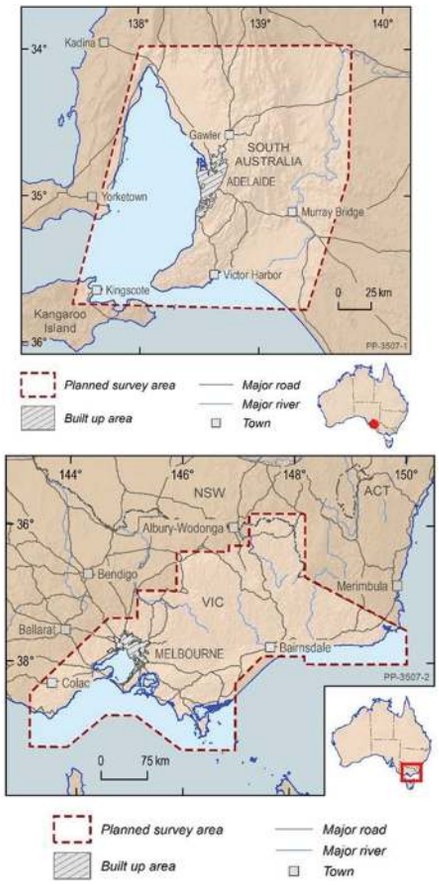


Figure 5. *Airborne gravity survey extents extent over South Australia (top) and Victoria (bottom).*

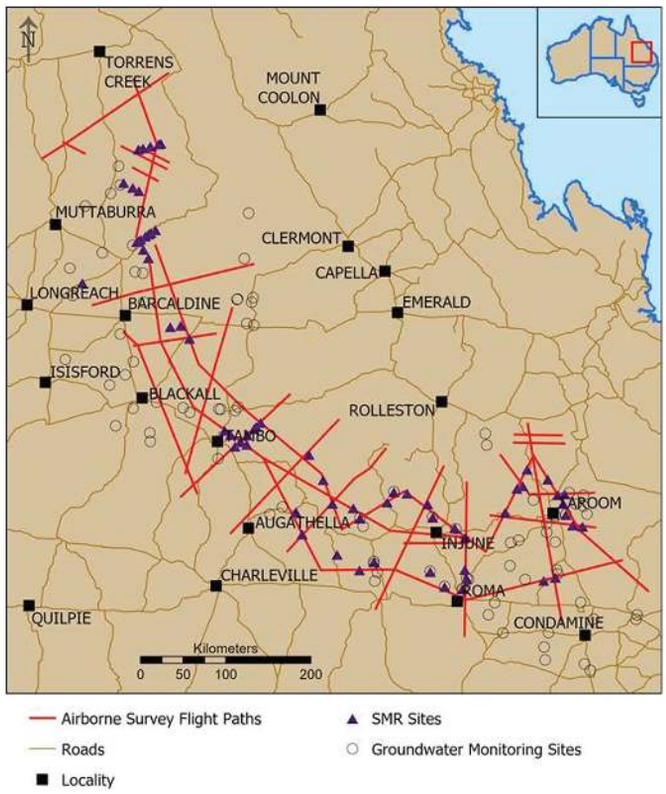


Figure 6. *Great Artesian Basin Airborne EM survey programme, May 2021. As part of the data inversion and ground calibration process, airborne survey data will be tied to both surface magnetic resonance soundings (SMR) and the regional borehole network.*

Australian Department for Infrastructure and Transport, are conducting airborne gravity surveys across Victoria and South Australia throughout 2021 and into 2022. The surveys will cover nearly 150 000 square kilometres, including the Victorian coast from Cape Otway to Cape Howe, metropolitan Melbourne and the Australian Alps, and the Greater Adelaide region (Figures 5a and b).

The airborne gravity surveys will provide consistent and evenly distributed gravity measurements across diverse land types including urban and rural areas, mountainous and coastal terrain and parks/reserves where existing data are unevenly scattered. Flight lines will be spaced every 500 m over the Eastern Victoria Highlands, 1 km over Greater Melbourne and 5 km over Greater Adelaide. The data will be used to improve the accuracy of the National geoid model (Australian Gravimetric Quasigeoid – AGQG2017) from 5-8 cm down to 2-3 cm, and to support better geological modelling across targeted areas.

Great Artesian Basin AEM survey programme

The Great Artesian Basin (GAB) Groundwater Project is acquiring approximately 4300 line kilometres of airborne electromagnetic (AEM) data in the eastern Eromanga and northern Surat basin areas in Queensland during May. The AEM survey is designed to provide information on along-strike and down-dip geometry of the geological units (aquifers and aquitards) that characterise the groundwater recharge beds of the eastern GAB, including any evidence for structural, stratigraphic and/or lithologic variation that may impact recharge and groundwater flow. In the northern part of the study area, the survey has been designed to tie in with a previous AEM survey. Ground-based surface magnetic resonance soundings (MRS) at approximately 60 sites will provide water level, water content and porosity data in the upper 100 m to support interpretation of the AEM. Groundwater sampling from a subset of the regional monitoring bore network will provide hydro-geochemical data to help characterise the aquifer systems. The results of these surveys will facilitate revision of the regional groundwater conceptual model and assist in developing an updated water balance for the GAB (Figure 6)

Mike Barlow
Geoscience Australia
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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 on 17 May 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)	Jun 2021
Cobar	GSNSW	GA	GPX	Jun 2021	58 000	200 m	11 600	Jul 2021	TBA	See Figure 1 in previous section (GA News)	TBA

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	TBA	~ Jul 2021	TBA	1–2 km	7000	TBA	TBA	TBA	
Melbourne, Eastern Victoria, South Australia	AusScope GSV DEL WP	GA	Sander Geophysics	Jul 2021	137 000	1–5 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 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 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 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 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 2021
SE Lachlan	GSNSW/ GSV	GA	Atlas Geophysics	May 2019	303.5 km with 762 stations	3 regional traverses	Traverses	Jun 2019	Jul 2019	See Figure 1 in previous section (GA News)	Set for incorporation into National database by 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
East Resources Corridor	GA	GA	CGG	Apr 2021	32 000	20 km	640 000	Jun 2021	TBA	See Figure 1 in previous section	TBA
Mundi	GSNSW	GA	NRG	Mar 2021	1900	2.5	~ 5000	Apr 2021	May 2021	See Figure 1 in previous section (GA News)	Jun 2021
Surat-Galilee Basins QLD	GA	GA	SkyTEM Australia	2 Jul 2017	4627	Variable	57 366	23 Jul 2017	Nov 2017	188: Jun 2017 p. 21	TBA
AusAEM20	GSWA	GA	CGG & SkyTEM	Aug 2020	62 000	20 km	1 240 000	Dec 21	TBA	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 16 stations deployed in 2021	50 km	Long period MT	The survey covers areas of NT and Qld. Data to be released early 2021. Acquisition of 32 new sites in SW Qld underway.
AusLAMP NSW	GSNSW/ GA	NSW	AusLAMP NSW	~300 stations deployed 2016-21	50 km	Long period MT	Covering the state of NSW. Acquisition ongoing. Phase 1 data release: http://pid.geoscience.gov.au/dataset/ga/132148.
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.
AusLAMP TAS	GA	TAS	King Island MT	4 stations completed	<20 km	Long period MT	Covering King Island. Acquisition completed.
Cloncurry	GSQ/GA	QLD	Cloncurry Extension	500 stations have been acquired	2 km	AMT and BBMT	Data acquisition complete.
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 CO2 emissions. The additional seismic data obtained will provide greater certainty in the future drilling exploration programme. The acquisition due to start at the end of the May 2021.

(*Continued*)

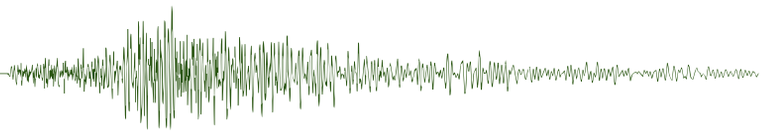

Table 5. Seismic reflection surveys (*Continued*)

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	Geoscience Australia commissioned reprocessing of selected legacy 2D seismic data in the Officer Basin, SA, as part of the Exploring for the Future (EFTF) programme. The objective of the seismic reprocessing is to produce a modern industry standard 2D land seismic reflection dataset. The data will be available as pre-competitive information to assist industry to better target areas likely to contain the next major oil, gas and mineral deposits. GA contracted Velseis to reprocess the dataset. Reprocessing of these data started in April 2021with the aim of completion by Jul 2021.
Officer Basin	GA	SA	L137 Officer Basin	550	40 m	240 m	20 sec	2D deep crustal seismic explosive reflection seismic	Geoscience Australia commissioned reprocessing of 2D legacy deep crustal seismic data in the Officer Basin, SA, as part of the Exploring for the Future (EFTF) programme. The objective of the seismic reprocessing is to produce a modern industry standard 2D land seismic reflection dataset. The data will be available as pre-competitive information to assist industry to better target areas likely to contain the next major oil, gas and mineral deposits. GA contracted Velseis to reprocess the dataset. Reprocessing of these data started in April 2021with the aim of completion by Jun-Jul 2021.
Pedirka Basin	GA	SA	Shallow legacy data	~2000	Varies	Varies	3-6 sec	2D shallow legacy data, explosive, vibroseis	Geoscience Australia commissioned reprocessing of selected legacy 2D seismic data in the Pedirka Basin, SA, as part of the Exploring for the Future (EFTF) programme. The objective of the seismic reprocessing is to produce a modern industry standard 2D land seismic reflection dataset. The data will be available as pre-competitive information to assist industry to better target areas likely to contain the next major oil, gas and mineral deposits. GA contracted Geofizika to reprocess this dataset. Reprocessing of these data started in May 2021 with the aim of completion by Sep 2021
Eastern Goldfields	GSWA	WA	L132 1991 Eastern Goldfields Seismic	260	40 m	160 m	20 s	2D deep crustal seismic explosive reflection seismic	GSWA and GA have been working with Velseis to reprocess legacy explosive data acquired by the BMR G&G in 1991. This project is now complete. It is expected that the data will be released in Jun 2021.

(*Continued*)

Table 5. Seismic reflection surveys (*Continued*)

Location	Client	State	Survey name	Line km	Geophone interval	VP/SP interval	Record length	Technique	Comments
East Kimberley	GA	WA/NT	Bonaparte Basin	619	Variable	Variable	Variable	2D reflection land seismic	GA commissioned reprocessing of selected legacy 2D seismic data in the East Kimberley, onshore Bonaparte Basin as part of the Exploring for the Future (EFTF) programme. Reprocessing of these data occurred between September 2017 and May 2018. Reprocessed seismic data are available via eCat http://pid.geoscience.gov.au/dataset/ga/135578

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
Northern Australia	GA	Qld/NT	AusArray	About 135 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 is expected by the end 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
Northern 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" www.iris.edu

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Geological Survey of South Australia: The AusArray SA passive seismic array and new MT data

AusArray SA passive seismic array

Over the course of 17 days in April 2021, a team from the GSSA carried out the first service run of the AusArray SA broadband passive seismic array (Figures 1 and 2). The 38-station array was deployed across the eastern-central Gawler Craton in October 2020 to record seismic data for an 18 month period. In conjunction with partners at ANU (led by Dr Caroline Eakin), the composite AusArray SA and Lake Eyre Basin arrays will shed light on the 3D seismic structure of the eastern Gawler Craton and its margins. Data from the permanent stations of the Australian National Seismic Network and Australian Seismometers in Schools programme, and from preceding temporary arrays, will also be leveraged (Figure 1).

A range of passive seismic modelling techniques will be applied to map the 3D-structure of the eastern Gawler Craton from the upper crust to the lithosphere-asthenosphere boundary (e.g., body and surface wave tomography, variably using teleseismic earthquakes, local earthquakes and the ambient noise field for illumination; receiver functions; noise autocorrelation; shear wave splitting; Love-to-Rayleigh scattering; seismicity mapping). Furthermore, the contrasting sensitivities of seismic and magnetotelluric data to factors including temperature, composition, fluids and melt will facilitate a more robust identification of primary indicators of mineral prospectivity such as metasomatism and fluid pathways.

Here we present snapshots of AusArray SA seismograms associated with (i) a large teleseismic earthquake that occurred in the Kermadec Trench in March 2021 (Figure 3), (ii) a smaller, local earthquake which occurred near Marree in April 2021 (Figure 4), and (iii) a sonic boom generated by a spacecraft above South Australia (Figure 5)!

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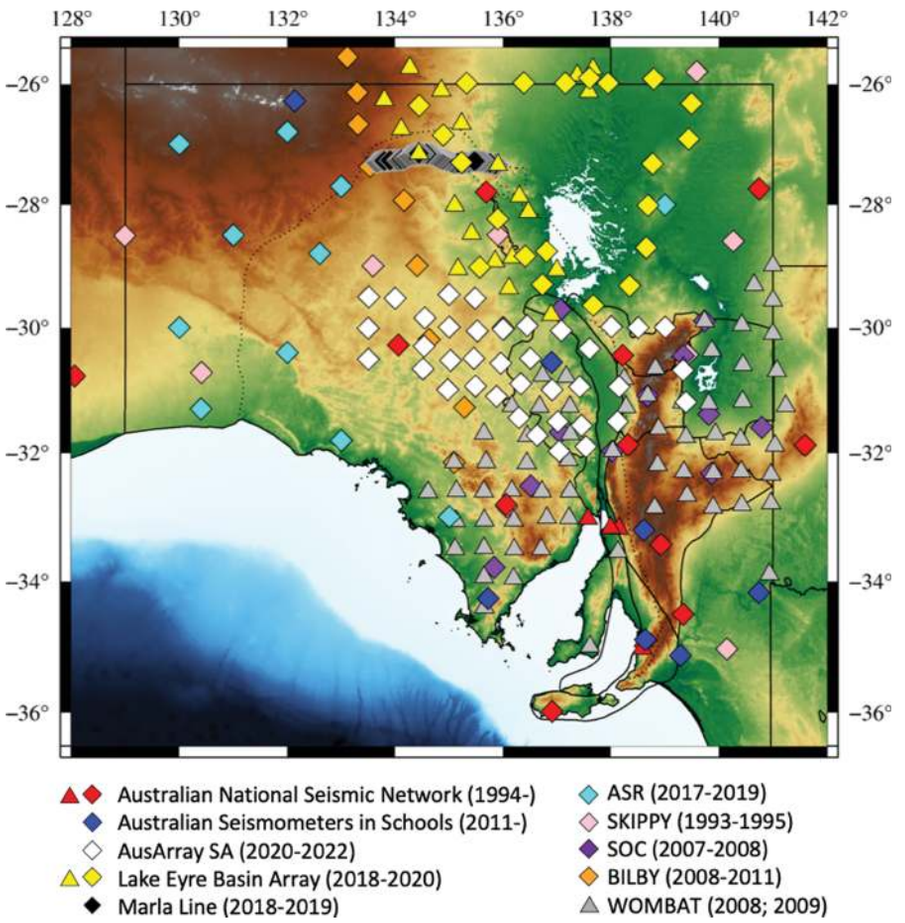

Figure 1. *Passive seismic arrays in South Australia, past and present.*

Figure 2. *AusArray SA service run, Commonwealth Hill, April 2021.*

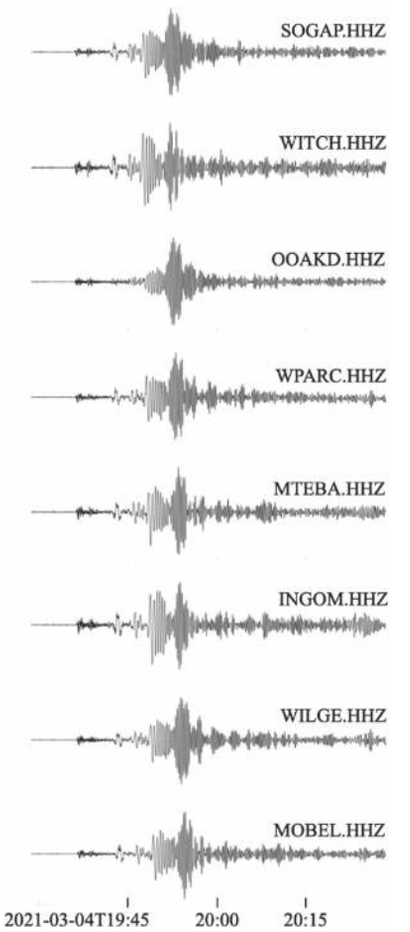

Figure 3. *A selection of vertical-component AusArray SA seismograms capturing body- and surface-waves arriving in South Australia from the magnitude 8.1 earthquake which occurred near the Kermadec Islands in March 2021. Such seismograms encode a huge amount of structural information about the Earth, from the crust to the core.*

New MT data

New magnetotelluric (MT) data are available on SARIG (map.sarig.sa.gov.au) for the 63 stations of the Central Delamerian Broadband MT survey (see December 2020 GSSA Preview update for details on this survey). To view these data on SARIG and to download, click on 'All map layers.' In the search box type 'MT' and scroll down to select 'Electrical Survey (Magnetotellurics (MT)).' Click the 'Identify' tool in the 'Actions' toolbar, then click on one of the Central Delamerian MT Broadband sites (shown within the black rectangle on the SARIG screengrab below). Information about this dataset along with a link to download the data will be shown. This work has been accepted for an oral presentation at the AEGC in Brisbane in September 2021, we look forward to sharing the latest results then, or see the Department for Energy and Mining

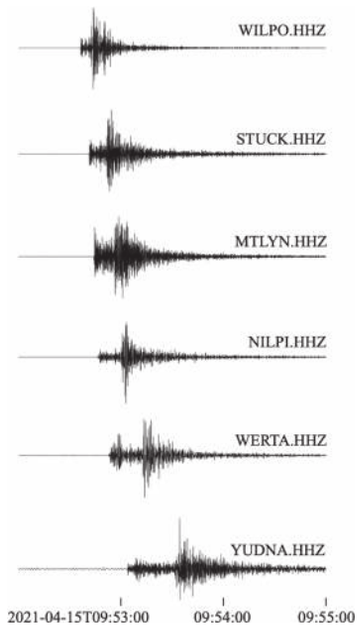

Figure 4. *A selection of vertical-component AusArray SA seismograms capturing a magnitude 3.2 earthquake which occurred approximately 35 km southwest of Marree in South Australia in April 2021. The AusArray SA array will significantly enhance local seismicity and fault mapping capability.*

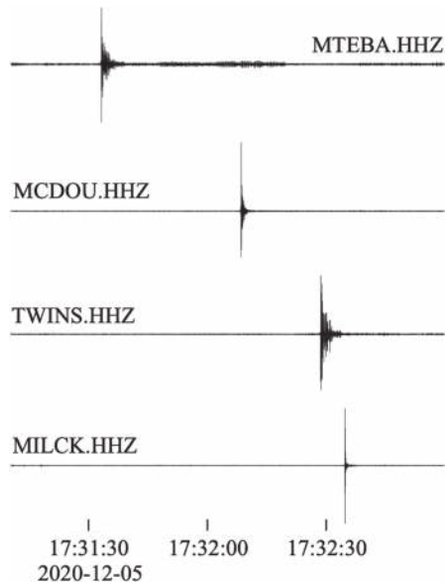

Figure 5. *Several AusArray SA seismograms captured the sonic boom generated by the Hayabusa-2 capsule re-entry into Earth's atmosphere above South Australia in December 2020. The capsule contained the first sub-surface samples from an asteroid, and its landing at Woomera concluded a six-year journey of more than 5 billion kilometres.*

Youtube channel (https://www.youtube.com/energyandminingSA) for some preliminary results.

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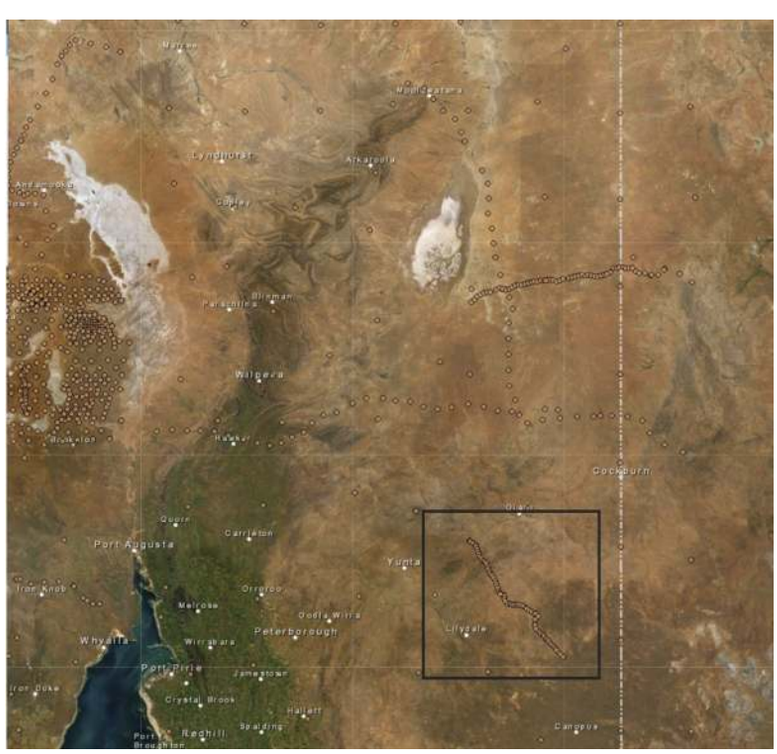

Figure 1. *Screengrab of SARIG, with an overlay of a black rectangle highlighting the location of the Central Delamerian Broadband MT survey (MT stations shown as small brown circles).*

Mineral Resources Tasmania: Regional airborne geophysical survey completed

The magnetic and radiometric survey on behalf of Mineral Resources Tasmania in collaboration with Geoscience Australia (GA), has now concluded. The contractors demobilised on 2 April, with data processing and QA/QC to be finished soon.

With extra funding made available by GA as part of the Federal Government's Exploring for the Future programme, the survey was extended significantly beyond the boundaries previously published in *Preview*. The aim of Exploring for the Future is to drive investment in the resources and agricultural sectors by providing industry and land and water managers with pre-competitive data about potential mineral, energy and groundwater resources.

As shown in the figure, the swath of new high quality data (200 m spaced E-W flight lines, 80 m terrain clearance) extends over half way across the island, from the upper Forth River to the east coast. In addition to traversing many of Tasmania's most significant geological units and structures, including potential sub-surface extensions of the Mt Read Volcanics, the survey bridges a long-standing gap in the State's geophysical coverage between the main body of data in the north and west and the 1999 southern Midlands survey.

Derived grids as well as processed line data will be made available from both GA and MRT portals as soon as possible after final product receipt from the contractors and final QC by GA. Radiometric data will be provided in equivalent ground concentration terms, enabled by system calibration via GA spectrometer ground measurements, as described in the previous edition of *Preview*.

It is anticipated that magnetic and radiometric coverage will be further expanded in the near future, as the new projects announced by the Federal Government in March 2021 as part of its $125M expansion of the Exploring for the Future programme are rolled out.

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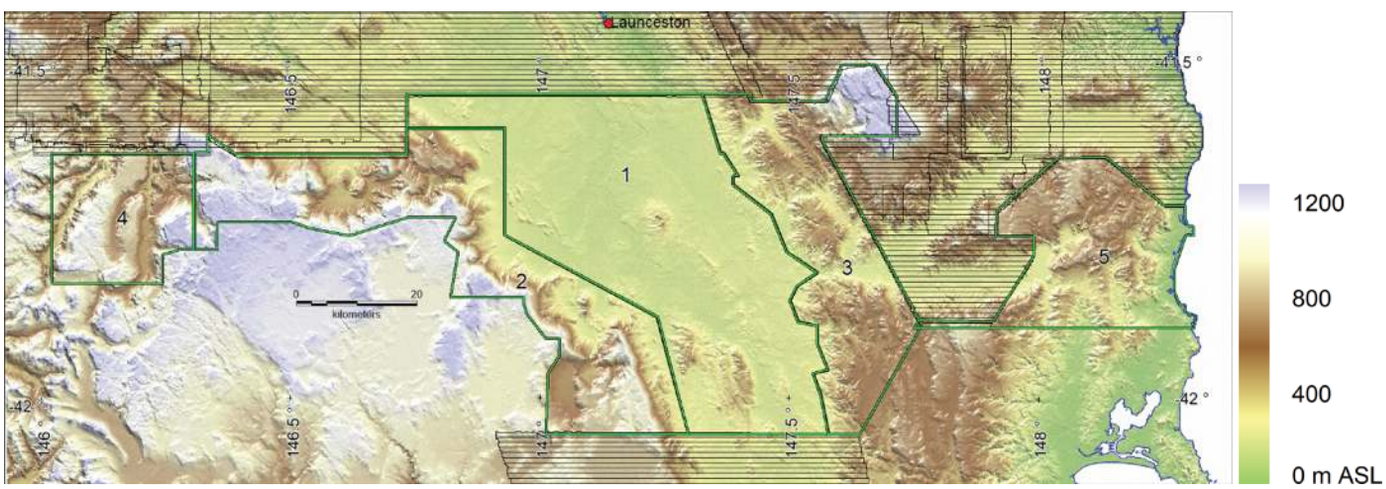

Figure 1. *Location of survey blocks (green outline) flown February-April 2021. Blocks 1-3 were acquired as originally planned by MRT, with the extension to blocks 4 and 5 enabled by provision of an extra $250 000 by Geoscience Australia. Block 1 was flown with a fixed-wing aircraft, and the remainder by helicopter. Horizontal black lines indicate previous similar surveys constituting the existing coverage.*

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Canberra observed

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Budget 2021-22 – built for an early election

$3.4 billion for women's issues

It could also be called Brittany's Budget, as a response to Brittany Higgins' courage to expose undesirable behaviour in Parliament House. For the first time there is a Women's Budget Statement. This statement deals with "The COVID-19 pandemic's impact on women; Women's safety; Women's economic security; Women's health and wellbeing; and a strong economy is vital for women's interests."

The words in the statement are well crafted: "Respect, dignity, choice, equality of opportunity and justice are fundamental to the safety, economic security and status of women in Australia."

It does not say much for Australian values and behaviours that it was deemed necessary to make this statement, but the government had no choice as they were terrified of losing too many votes from women.

The "$3.4 billion investment will be used to promote these values so that women, right across the country, can be safe from violence, economically secure, realise their potential and enjoy good health." We will have to wait until after the election to see if the investment was worth it.

Winners in the resource sector

Fossil fuels, particularly gas

More than $1.8 billion has been allocated in the 2021-22 Budget for the energy sector, including $58.6M for the gas sector; but the largest component is for emissions reduction, with more than $1.2B allocated to this segment. It includes:

$639M for low emissions international technology partnerships and initiatives by co-funding research and demonstration projects in our Indo-Pacific region.

- $276M to develop four more clean hydrogen export hubs (for a total of five), increasing the commitment to building a hydrogen industry to more than $850M.
- $264M to support the development of carbon capture technologies and hubs, building on the $50 million provided in the 2020-21 Budget
- $60M to support a National Soil Carbon Innovation Challenge and trial new agricultural feed technologies that reduce emissions from livestock.
- $280M to reduce energy consumption and emissions while improving productivity and international competitiveness

The Beetaloo development in the Northern Territory is the government's first pick for its energy-led recovery. It has offered $50M for companies who want to drill in the NT, where Santos and Origin Energy are trying to prove a shale gas resource to be extracted by fracking. In January this year, a total of $217M was earmarked for the road upgrade in the region.

The big questions are can Carbon Capture and Storage technologies be made to work (they have not been successful at the Gorgon Field)? Will hydrogen be produced from renewable sources rather than fossil fuels? Can the gas from Beetaloo Field be produced economically, without degrading the environment?

Geoscience Australia

Geoscience Australia will get $40.2M from the Australian Government's $1.2B Digital Economy Strategy for the development of a Digital Atlas of Australia. Funding for the national UNCOVER programme will continue.

Some of the losers

The universities

For some reason, the Coalition government does not like universities and their suffering under COVID has continued into the 21/22 Budget. In 2020, 17 300 jobs and $1.8B were lost at Australian universities according to Catriona Jackson the CEO of Universities Australia. She said universities' operating revenue fell 4.9% in 2020 against 2019 figures, and the sector is estimated to lose a further 5.5%, or $2B, in 2021.

Universities did not qualify for Job Keeper support and the $1B grant last year was a one off for research, focused mainly on projects cooperating with industry.

Somehow or other the government does not appear to care that the skills needed for the future jobs, and the research that underpins these skills, are going to be generated from our universities and that universities are central to national recovery.

Continuing border closures mean universities face the reality of fewer returning students in 2021, and reduced numbers in 2022. They would love to have the students back and the borders open again.

The Government must have the view that tertiary education and research is not of interest to the average voter, to behave like it has.

The environment

There is no government encouragement to use electric vehicles or generate renewable energy. The Australian Conservation Foundation estimates that only 0.8% of the budget is spent on the environment.

Without a healthy and sustainable environment all else fails. People are becoming more aware of this situation, so it is not clear why the government does not recognise this.

The final report from the review of the Environment Protection Biodiversity and Conservation (EPBC) Act carried out by Graeme Samuel, found that our environment is suffering from two decades of failure by governments to improve protection systems meant to ensure the survival of the country's unique wildlife. The message could not have been clearer.

Samuel recommended:

- Strong, outcome focussed national environmental standards to guide decision making.

Table 1. Funding in AUD$M provided by the Federal Government via Appropriation Bill No 1 for scientific agencies

	2018/19	2019/20	2020/21	2021/2022
ANSTO	214	235	279	277
ARC	797	820	835	844
BOM	270	273	309	356
Antarctic Management	119	149	217	224
Geoscience Australia	189	197	176	265
CSIRO	834	839	961	946
NHMRC	970	902	911	921
ABS	344	395	426	590
DSTG*	435	420	?	?

**Defence Science Technology Group*

- Independent oversight by an Environment Assurance Commissioner and audit by an Office of Compliance and Enforcement to build confidence that the Act and the national environmental standards are working and
- A mandated, rigorous compliance and enforcement regime to ensure compliance and enforcement of environmental approval conditions.

There is no money in the budget to establish an Environment Assurance Commissioner or for audits by an Office of Compliance and Enforcement. It is almost as if the government has been hypnotised by dreams of new technologies serving as a Cargo Cult to solve global warming, land degradation and loss of biodiversity, even when the basic physics of greenhouse gases has been known for over a hundred years.

The Integrity Commission

The government clearly does not want anything to do with establishing an Integrity Commission. In December 2018, the Attorney-General outlined a 14-page plan for what the government called a Commonwealth Integrity Commission. He sent that plan out for public consultation and received over 3000 critical submissions. So, nothing happened.

Then the Senate passed the National Integrity Commission Bill 2018 (No 2). When this bill was referred to the House of Representatives the government would not allow time for debate. The matter has been buried again. And the 2021 Budget indicates the Commission will have zero staff until after the election.

Funding for the agencies

Table 1 shows the funding provided for scientific agencies by the Government via Appropriation Bill No 1 for four financial years from 2018 - 22. This Bill usually represents annual operating expenditure. The forward estimates have not been included because they are Pie in the Sky. The funds contributed from cost recovery have also been omitted. The ABS funding is perturbed by the funds required for each census.

Notice that DSTG allocation is now embedded somewhere else in the Defence budget, for security reasons. The funding for the National Health and Medical Research Council, easily eclipses the whole of the ARC and is closing in on the funding received by CSIRO.

The table shows that apart from Geoscience Australia, which had a large increase in funding, most agencies were able to just maintain their funding, though, from the information provided in the budget papers, it is not easy to make sure the numbers are comparable year by year.

Staffing numbers

One of the interesting data sets in the budget papers is the average staffing levels of agencies in the Australian Government sector over a 15 year period. Figure 1 shows the average staffing levels in the Australian Government Sector, excluding the military and reserves. In the same period, the population of Australia rose more than 25% from 20.4 million to 25.8 million. It would be interesting to obtain numbers of contractors working for the government, during the same period. Notice the impact of COVID-19 on the data.

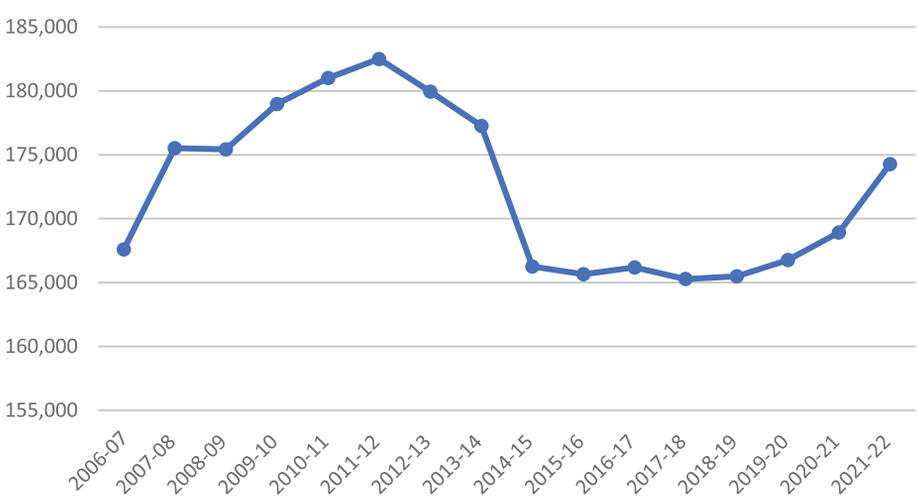

Figure 1. *Staffing levels in the Australian Government. Figure 1 shows the average staffing levels in the Australian Government sector, excluding the military and reserves.*

Education matters

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Education about environmentally friendly energy options

It seems that energy is never far from the news, and at the time of writing two stories were competing for attention. The first of these (Australian Broadcasting Commission, 2021) concerns a Federal Government decision to support a new gas-fired power station in Kurri Kurri in NSW. At AUD$600M, this is a significant investment. The second of the two major energy-related stories concerns the release of the International Energy Agency's (IEA) "Net Zero by 2050" report. (International Energy Agency, 2021). A headline finding of this report was that if global CO_2 emissions are to be reduced to zero by 2050, consistent with efforts to limit the long-term increase in average global temperatures to 1.5 °C, then the energy industry would need to move towards renewable sources. *Prima facie*, these two stories would seem to be at odds, because the requirement for net-zero emissions means a reduction in the use of fossil fuels to around 20% of their current levels. How then to reconcile the rhetoric as scientific problems rapidly expand into economic and social domains?

One route to such reconciliation is through education. Harvard University's edX course "Energy within environmental constraints" (https://bit.ly/3u5gDwp), one of a number of online education options introduced in *Preview* **210**, may provide motivated readers with the background with which to ask the right questions and, in so doing, properly consider the consequences of different choices. The following is a very high level review of this excellent USA-centric course.

As a precursor, I invite the reader to consider the following three questions:

(1) By how many times does the anthropogenic carbon flux exceed the sum of all the analogous natural processes?
(a) 10 times (b) 100 times (c) 1000 times

(2) Which of the following is closest to the half-life of CO_2 in the troposphere?
(a) 1 year (b) 100 years (c) 1000 years

(3) What fraction of land (as a percentage of the total surface of the Earth) would be required to run a future energy system using biofuels technology only?
(a) 5% (b) 20% (c) 50%

The overarching goal of the course is to audit energy resources available at the current technological stage. The list of the energy alternatives contains fossil energy, renewable energy (hydro, wind, biomass, and solar photovoltaic), and alternative sources of energy. The appraisal criteria include the price of the energy produced using this alternative, and associated environmental impacts, and the land footprint. Figure 1 compares the power potential of different low-carbon options for electricity production under various land-use constraints.

As energy is a commodity business and energy inputs to developed economies are at least 5%, it is useful to consider the flow of energy throughout the economy starting from primary energy sources to the consumption by industries and end-users. For the USA, this flow is very complex. First addressed by Bridges (1973), the energy flow across the USA in 2018 has been visualised in Figure 2. The main purpose of Figure 2 is to illustrate the complexity rather than detailed analysis, and for motivated readers, an interactive version of Figure 2 (https://bit.ly/3hHLoow) may be more instructive.

Each of the energy markets identified in Figure 2 are discussed along with the associated difference in prices for both fossil energy and renewables. Such economics terms such as levelised cost, the cost of use of a single alternative throughout a powerplant lifespan, and cost of mitigation, the cost associated with the choice of cleaner energy source, are discussed in detail.

Air pollution, climate change and land footprint are the main environmental impacts of energy production. Air pollutants emitted from industrial activities such as lead, nitrogen oxides, sulphur dioxide, carbon monoxide, ozone, and particulate matter cause various severe impacts on human health. The course explains how (USA) governmental regulations have helped to reduce the amount of these harmful pollutants in the atmosphere over the last few decades.

The course contrasts the successful story of pollutants reduction locally (in the USA and some other countries) with the

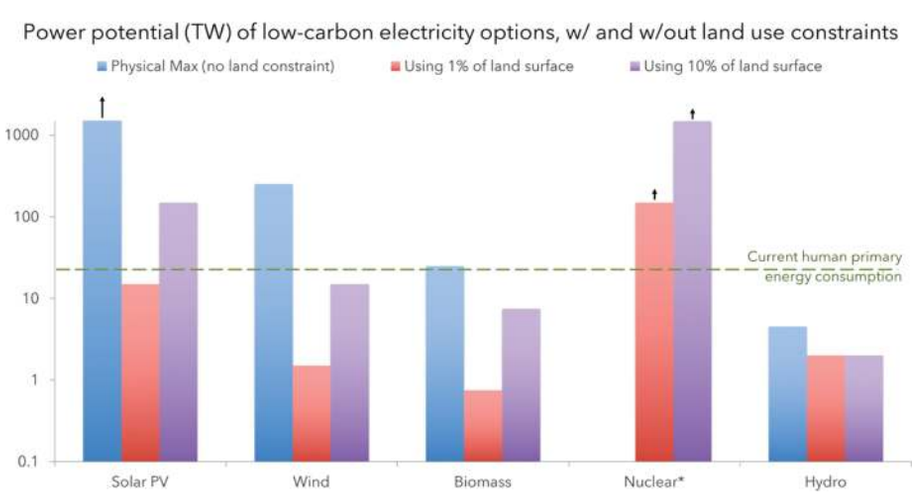

Figure 1. *Comparison of power potential for different low-carbon electricity production options. Source: HarvardX course "Energy within environmental constraints" (https://bit.ly/3u5gDwp)*

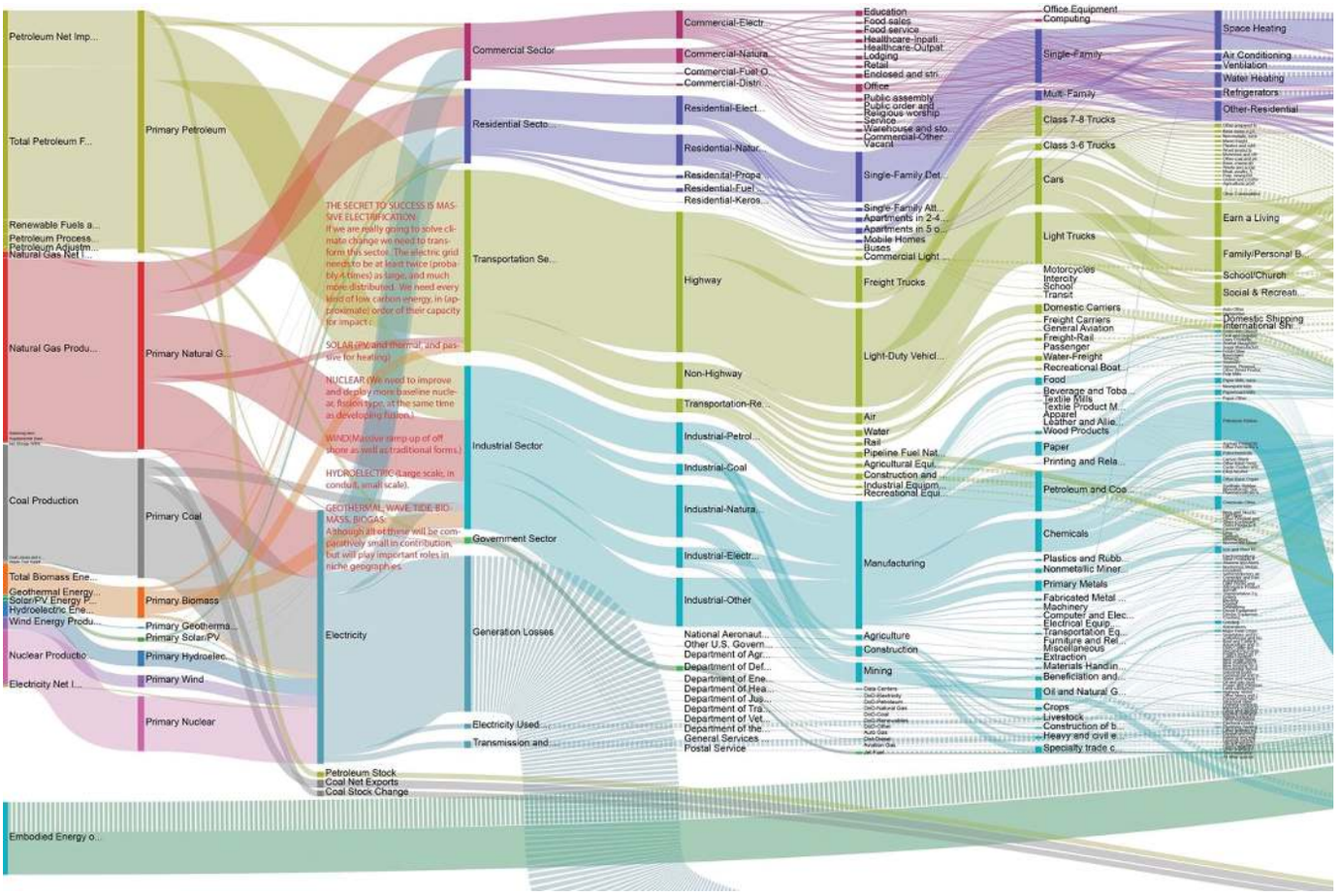

Figure 2. *Energy flow across the USA economy in 2018. An interactive version (https://bit.ly/3hHLoow) may be more instructive. Source: Otherlab, 2018.*

global problem of climate change caused by an accumulation of CO_2 and other greenhouse gases in the atmosphere. Nowadays, humans emit 100 times more carbon dioxide than the analogous natural processes altogether. Part of this CO_2 will stay in the atmosphere for thousands of years. Global efforts are necessary to change the trends.

Generation and production of energy need land. Power density, the rate at which energy is extracted per unit of land, is used for the evaluation of land footprints of energy technologies. Twenty percent of the entire surface of the Earth would be required to run a future energy system using exclusively biofuels technology. This is more than is currently used for cropland.

Fortunately, solar power density is an order of magnitude higher than biofuels, and only two percent of the Earth's surface suffices. This makes solar the most promising alternative among all contemporary renewable energy technologies.

Typically, when we talk about solar energy, we usually refer to solar photovoltaics and the solar panels many readers have installed. However, there are other forms of solar power systems, such as concentrating power, large industrial systems that concentrate the sun to high intensity, or solar power for hot water heating or other solar heating systems. While the latter can be rather considered as a part of smart building systems, the former has true potential but it is still at the development stage.

The main issue with solar power is that it is intermittent. Can we make use of intermittent renewables and still enjoy a reliable electric power supply? The answer is yes, and one option is the use of natural gas to provide peak power. The advantage of natural gas is that it is cheap, dispatchable, and, if it is only used to provide peak power, the total carbon emissions to the atmosphere is much less than those coming now from electricity systems dominated by coal. The course offers an electricity system planning and dispatch calculator, which allows calculating electricity cost and carbon emissions associated with different scenarios to meet electric power demand using gas, coal, solar, and battery.

What I liked about this detail-rich course is that it addresses both how to reduce environmental impacts, and how to make the energy systems more reliable and democratic. Equipped with the knowledge provided in the course, readers can make informed decisions both working on governmental regulations and developing environmentally friendly and affordable future energy systems.

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Queensland University industry student field trip

This year Velseis Pty Ltd hosted Queensland students from UQ and QUT for a tour of their facilities and to give the students industry exposure to geophysics. Organised and run by Nick Josephs and Ron Palmer from the local ASEG branch, the student numbers were great – the trip was attended by no less than 20 students, mainly from geoscience but also engineering and environmental-science backgrounds. The students were happy and keen to take half a day off from their holidays to learn more about our industry.

On April 9 the chartered bus picked up the students and drove to Velseis at Sumner Park. After a brief introduction by Steve Hearn, Shaun Strong and Nick Josephs, everyone moved to the induction presentation room. First the group were asked to fill out COVID and safety forms - further preparation for industry! They were then given a thorough overview of seismic geophysics by Troy Peters. Students certainly perked up once Troy showed how synthetic seismograms allowed well ties with geophysical logs to map horizons across the survey.

Students discovering the world of inductions.

Students were then split into two groups. Dale Harpley and Ron guided one group and Shaun and Nick guided the other. The first station was a look at the three types of Vibe trucks Velseis use, demonstrated by Simon McMonagle. Students were introduced to the nimble Envirovibes, the Univibes and the big 80 000 lb peak-force Renegades. Shaun explained that each vibe worked best

The field group pose in front of a Renegade Vibe. Left to right: Ron Palmer, Adam Marinas, Chris McMahon, Emma Sands, Riaan Armes-venter, Chris Powell (front), Sally Nielson, Nick Parr (front), Yasmine Campbell, Ryan Bartlet, Jordie Karolak (front), Hector Hilberto, Thomas Scott, Sophie Osborne, Sarah Purdom, Anthony Caracella (front), Nick Josephs, Cameron Duchatel (front), Jessica Thornton, Shayla Yavari, Dale Harpley, Angus Hammond, Shaun Strong.

for a different environment: for shallow coal surveys, oil and gas exploration and deeper imaging of the crust. The students were curious about where in the world vibes had "shot" seismic. Simon pointed out that these particular vibes had worked in Australasia, Middle-East, North America and Africa. The students were keen to see the Univibs perform a few sweeps.

We had a look at the different types of cabled receivers, and students were given the task of laying out and placing some geophones into the ground, with most admitting being a Juggy would be tough. The second station was a tour of the nodal Dogbox with John McMonagle. There were a few pertinent questions on scripting, which was encouraging to see, and the logistical challenge of a 3D survey with 20 000 nodes with a rolling patch was dawning on the students. Dale then showed us the nodal units and the students passed them around. We went to see an array of them set out and then it was time for lunch.

After pizza and drinks, Steve Hearn gave some closing thoughts, encouraging interested students to take advantage of companies who are keen to support industry-based projects. A happy snap was taken for *Preview* and the students got on the bus abuzz with conversation about future options and careers.

This type of industry-driven activity will be of increasing importance in Queensland. Following a recent school merger at UQ, geoscience education has experienced a major adjustment, including the discontinuation of the longstanding and respected exploration geophysics program. This puts the onus on industry to engage and encourage quantitatively-inclined students to experience geophysics via other mechanisms. There is potential for postgrad projects to be taken by geoscience students at UQ and QUT, but there will be increased need for industry backing and mentoring. Networking will be essential in linking up like-minded individuals to create good outcomes. We cannot afford to let eager, bright-minded individuals slip through the growing cracks.

This has been the sixth trip organised by the local branch and after this year's success, more will be organised. A big thank you to Steve, Shaun, Troy, Dale and the rest of the Velseis staff for hosting the students. Thanks to Ron Palmer, Candice Bell and Hector Hilberto for giving up their time to make this a great trip. Thanks to Henk van Paridon for allowing me to take time off. Without industry support for events like these we will not expose future leaders to our sector and both the resources industry and geophysics will miss out. Please look out for these students in the coming years; they are the eager ones.

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Results of the 2021 Frank Arnott – Next Generation Explorers Award

Innovation, excellence and collaboration was on display this past March during the inaugural event of the Frank Arnott - Next Generation Explorers Award (NGEA™), an international competition challenging university geoscience students to transform data sets into their interpretation of subsurface geology and mineralisation targets.

Frank Arnott (1951-2009), an exceptional exploration industry leader, in whose honour the Frank Arnott - Next Generation Explorers Award (NGEA™) was created.

Over a year in the making and despite the difficulties of the global pandemic, 19 teams consisting of over 100 students from Australia, Brazil, Canada, Colombia, France, Germany, Indonesia, Peru, Switzerland, the UK and the USA entered the 2021 NGEA Challenge. An international panel of independent judges from industry and academia reviewed the submissions, and in December 2020 selected six finalist teams to present at the Prospectors and Developers Association of Canada (PDAC) 2021 convention.

The six finalists included the CSM Exploration Initiative from the Camborne School of Mines, Platypus Xplorer from UniLaSalle, Team Emerald from the Industrial University of Santander, Team UWA from the University of Western Australia, the Pinhão Anomaly from the Federal University of Paraná, and the Inca Team from the National University of San Marcos.

As the convention was being held online due to COVID-19, finalists prepared for the virtual format by condensing their presentation to seven minutes while still sufficiently explaining their model and filming it ahead of time in cooperation with the PDAC and its virtual platform provider. In addition, finalists were given the opportunity to sit down with the judges for a virtual interview where they discussed other aspects of their submission and their experience.

Wanting to ensure as many students as possible could attend the convention and watch the presentations, the NGEA™ provided all members of the finalist teams, as well as the other 13 contending teams, with a complimentary All-Access Pass to the convention.

This all came to a head when in March hundreds of attendees viewed the finalist presentations, interviews and live awards of the inaugural NGEA™. Taking place over two days, the finalists waited in anticipation to hear the results as along with the winning title up for grabs were cash prizes of C$5k for first-place, C$3k for second and C$2k for third.

It was a nail-biting finish, but the judges returned with their decision and the first-place winner was the Inca team!

Inca worked on the Yukon Plateau (Canada) dataset and featured students from the Universidad Nacional Mayor de San Marcos in Peru, the University of Tasmania in Australia and Brigham Young University in the USA.

"Our team found the NGEA to be an amazing and realistic exploration experience as we were able to work with a complete geo-database and a multidisciplinary team with different levels of expertise and backgrounds," said Sylvie Littledale, Inca Team. "This allowed us to generate viable and robust exploration targets that considered ESG (environmental, social, governance) factors while striving for scientific excellence for the next discovery on the Yukon Plateau."

"Taking part in this competition during the Covid-19 pandemic, despite its challenges, allowed us to work closely

The winning Inca team.

as a team with members in multiple countries," said Victor Torres Pacheco, Inca Team. "The NGEA also gave us the opportunity to build connections with others based on collaboration and foster friendships which we will always have going forward."

Team UWA from the University of Western Australia placed second and the CSM Exploration Initiative from the Camborne School of Mines, University of Exeter came third.

"Competing in the NGEA was remarkable, illuminating and it advanced my exploration skills," said Sharlotte Mkhonto, CSM Exploration Initiative. "My team contained people from geology, geophysics, geochemistry and environmental geology; working with a very diverse group of people has amassed me not only with collaborative skills but has also improved my teamwork skills."

The video presentations of the six finalists can now be viewed on the '2021 Challenge' tab of our website: www.frankarnottaward.com.

Since March, all 19 of the contending and finalist teams were given the opportunity to meet with several of our industry sponsors to discuss their presentations and career opportunities. The support of our industry partners and sponsors was integral to the success of the challenge and we would like to thank each and every one of them for their contribution.

First and foremost, this includes NGEA™ gold sponsors, Rio Tinto and BHP, both of which have joined for multi-year commitments. It also includes silver sponsors Barrick Gold, DMEC, Lundin Mining and the Geological Survey of Canada, as well as bronze sponsor Newmont, host sponsor PDAC, media sponsor the Society of Economic Geologists and contributing sponsor Seequent.

We would also like to thank the following organisations for providing the data students used to submit entries this year: Geological Survey of Canada, Geological Survey of South Australia, Saskatchewan Geological Survey, Ugandan Directorate of Geological Survey and Mines, Geoscience BC, and the Government of New South Wales.

2022 NGEA Challenge

With the inaugural challenge now over, the NGEA™ has opened up registration for the 2022 award! Students currently enrolled in either an undergraduate earth science degree or post-graduate research (masters or PhD) are encouraged to register their team at www.frankarnottaward.com.

This year's challenge features new datasets from Ireland and Queensland, and a grand

Team UWA

CSM Exploration Initiative

prize of C$5k for the team with the highest judges' score. Three new prize categories of C$3k each have also been created: 1) Innovation, 2) Data integration and 3) Impact & Exploration Significance.

Teams are encouraged to be multi-disciplinary and include members from other fields of study (i.e., engineers, data scientists, economists, social scientists, etc.), and it's important to note each team must meet a minimum of two aspects of "Team Diversity" for entry into the NGEA™ (discipline/specialisation, gender, nationality, culture, etc.). The deadline to enter a submission is October 31, 2021, with the finalist awards and presentations occurring at the PDAC 2022 convention.

As the NGEA™ is an international competition, the challenge is open to exploring opportunities to host future renditions of the event in other locations to help encourage more universities to participate.

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Acknowledgments

With teams, coordinators, judges, volunteers and sponsors operating in various languages and different time zones, the 2021 NGEA™ truly was an extraordinary exercise of building bridges and creating community within the mining and exploration industry. The NGEA™ Executive and Organising committees are grateful for the support we received from everyone involved, including our panel of judges consisting of Dave Andrews from gold sponsor Rio Tinto, Mary Doherty from the Colorado School of Mines, Eun-Jung Holden from the University of Western Australia, John Miller from gold sponsor BHP, Sally Pehrsson from the Geological Survey of Canada and Donna Kirkwood, independent advisor

and former Chief Scientist at Natural Resources Canada.

On a personal note, we would like to also acknowledge Peter Spora, who was also one of this year's judges. Prior to sadly passing away last December, Peter made a personal financial contribution to the award. The success of the NGEA™ was built on the strong foundation laid by the previous Frank Arnott Award (FAA) 2017 in which Australian universities figured prominently in the student category with the top prize going to Adelaide and the third to Macquarie.

The FAA and NGEA™ were founded in honour of Frank Arnott (1951-2009), an exceptional exploration industry leader who three decades ago, championed innovative techniques and the integration multidisciplinary data which still underpin exploration campaigns worldwide.

If you would like to get involved in the NGEA™ as a mentor, sponsor or participants, please visit www.frankarnottaward.com, follow us on social media or email nextgenerationexplorersaward@gmail.com.

Environmental geophysics

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Webinars worth watching

Welcome readers to this issue's column on geophysics applied to the environment. In this month's column I am reporting on a fascinating webinar that I saw recently. This webinar was run by the EEGS (the US-based Environmental and Engineering Geophysical Society) as part of their Talking About Geophysics series (TAG: https://www.eegs.org/tag-webinars). This is an approximately monthly series of webinars scheduled through to at least July of this year (I am sure that it will go past this date and it looks as if they are looking for new contributors - in case anyone is interested in presenting).

The webinar I watched featured three speakers talking about their work on cutting-edge aspects of near-surface geophysics. All three covered subjects within our science that I may have heard of, but have certainly not seen applied (or even contemplated applying). I am pretty sure that this webinar will eventually be available as a webcast, but so far there has been no sign of it on the EEGS website.

Leon du Plessis, an independent consulting engineer, until recently working for Freeport McMoRan, with an abiding interest in using muons as an imaging tool, gave a talk titled "Subsurface density mapping using muon technology". He spoke about the use of extra-terrestrially sourced muons to create tomographically-derived images of density contrast based on the passage of muons through the earth in the vicinity of the detectors.

Muon particles originate from the interactions of cosmic rays with the atoms of the upper atmosphere; they are partially absorbed as they pass through the atmosphere, and then the rocks, etc. of the near- surface; absorption increases with water content and rock density (and in the case of the pyramids less absorbed by the air in hidden voids). Most of us would have heard about an early success of the technique when muons were used to find at least one hidden room inside the Great Pyramid of Giza (Morishima *et al.*, 2017 – an absolutely fascinating article in its own right).

Leon mostly concentrated on the potential of the technique for mapping density distributions in and under tailings dams and other mining infrastructure in order to locate potentially lethal voids that would be prone to collapse at some time in the future. Much of the innovation in this space is in the development of "mobile" sensors that can be used to collect this type of data (still relatively slowly) along, for example, a horizontal borehole.

Isobel Barton, a geometallurgist from the University of Arizona, spoke about the use of drone-based hyperspectral imaging in the mine environment to assist with the determination of ore grade, as well as the identification of potential mining issues (impurity distribution, etc.), all in something approaching real-time. Her biggest issues involved the size of her data sets (potentially collected on a nearly daily basis), the difficulty in processing these huge data sets and then integrating and presenting the results in the mine context so that the images are useful to the mine engineers. Her talk was titled "Mineral mapping using drone-based hyperspectral imaging".

Trenton Franz, a researcher working in the hydro-geophysics space at the University of Nebraska, is combining some interesting technologies to (nearly practically) measure soil moisture distribution over farms – his examples were taken from work he and his group did over land irrigated by some of the huge irrigation pivots in the vast farmlands of Nebraska. His talk was titled "Opportunities and challenges towards integration of hydro-geophysical sensors in agriculture". As with the talk on muon-based techniques, much of the innovation on which Trenton reported relates to the use of cosmically-sourced particles that end up as fast-neutrons at the end of cosmic ray cascades, many of which interact with the soil. Much of the following, overly-simplified description of the technique is based on a publication put out by the International Atomic Energy Agency (https://www.iaea.org/publications/11097/cosmic-ray-neutron-sensing-use-calibration-and-validation-for-soil-moisture-estimation). Another interesting paper on the subject is Stevanato *et al.* (2019).

Fast-neutrons are scattered in the top metre or two of the soil, with most of the energy lost when the fast-neutron encounters water. The relative concentration of heavy to light neutrons at the instrument is measured, and this ratio used to estimate soil moisture over areas up to several hundred hectares (these fast-neutrons cover some distance). In his talk he reported on combining this type of data with more traditional towed-DualEM conductivity data to characterise soil moisture in areas that were pivot-irrigated to allow farmers to use their limited water supplies more efficiently.

Overall, I found that these three talks were well worth watching. I am hoping to see this webinar come out soon as a podcast – and will keep you posted.

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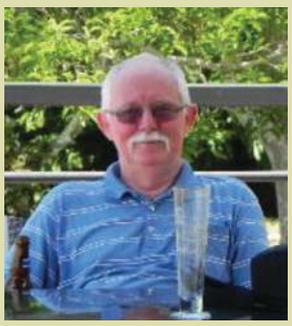
Minerals geophysics



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When good surveys go bad

Geophysical surveys do not always go to plan. Sometimes the technique is found to be inappropriate or the equipment inadequate, sometimes it's the environment that causes unforeseen problems, and sometimes it's the conduct of the survey itself. Timely recognition of such problems can save wasted effort and expenditure, but it's not always that simple. Modification of survey parameters and practices can often be done on the fly, but with a firm commitment to survey, and work already underway, there may be an understandable reluctance to abandon the survey altogether. Some of these considerations and their impacts can best be illustrated by an example.

Our particular "Survey from Hell" was a rolling dipole-dipole array induced polarisation (IP) -resistivity survey planned for a rugged jungle-covered area off-shore from Australia. Some short lines of IP-resistivity had been completed in the area twenty years previously and appeared to work; more recently, extensive IP-resistivity had been successfully surveyed elsewhere in the region. Tenders were called and the work awarded to a geophysical contractor who'd worked well for us in the region several years previously. We were confident that the IP-resistivity survey was both feasible in this difficult terrain and appropriate to the exploration target sought, and that we'd engaged the right contractor with the right equipment for the work. We decided that a geophysicist on site would not be necessary; getting personnel to site was difficult, the contractor was very experienced and data quality could be monitored remotely. Logistics were an important consideration and timing was critical: we needed to clear lines prior to survey commencement, transport the geophysical equipment and crew to the remote site, then complete the survey prior to the onset of the rainy season; returning next year was not an option.

There were problems from the start. Line clearing was delayed when the available labour were re-prioritised to other work - not everyone shares your view on the role of geophysics – and mobilisation to site of the geophysical crew and equipment was pushed back. A miscommunication between the contractor's supervisor, who couldn't be on site because of an injury, and the crew leader resulted in the use of an incorrect dipole size for the first line, which then had to be re-surveyed.

With the survey finally underway, results began to flow in. However, all was not well. Negative receiver voltages for some dipoles indicated problems with the bundled cables. Where a negative voltage dipole was juxtaposed to a dipole with a higher than expected voltage, it was probable that just two wires were interchanged and data could be reprocessed accordingly. Where multiple misconnections were present, recovery of usable data was effectively impossible. There were errors in next-day overlap repeat readings as well. At our request, all bundled cable segments and take-outs were checked, and several found to be incorrectly wired were discarded. Not the best of starts!

There were problems with the IP decay curves too. Many were 'noisy', there were lots of negative (reversed) decay curves, and some otherwise normal IP decays showed 'overshoot' where a positive curve would decay past zero to negative values and reversed decay curves would decay past zero to positive values. In short they were a mess! We doubled the transmitter dipole size to increase signal strength, modified survey procedures to ensure that maximum possible currents were being used, and asked the crew to dig larger deeper holes for the receiver electrodes and pre-water them to improve stability.

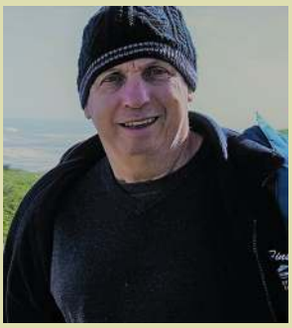
The survey continued with some improvements to data quality, but problems persisted. Faulty line segments were re-surveyed, generating many repeat readings. However, some of these repeat readings differed markedly from values that we'd earlier thought to be OK. Were positional mismatches in areas of sharp resistivity gradients a problem? The terrain was locally very steep with highly resistive silica caps on some of the hilltops. The rainy season had started (it began early that year) and we wondered whether moisture in connectors was a cause of some of our problems. We instigated procedures to minimise water ingress and pushed on.

Although it took twice as long as expected, we did complete the survey. Very late in the programme we found out that, unbeknown to us, the contractor was using stainless steel plates rather than the porous pots used in previous surveys as receiver electrodes (don't assume – always check!). We theorised that interactions between the plates and the humus layers may have generated localised voltage differences which compromised many of the IP decay curves, but it was too late to run checks.

Why did we persist for so long? There was always the thought that the problems could and would be solved. Some never were. So much effort had been invested in getting the survey underway that abandonment did not seem a viable option, and time constraints meant that we could not come back the next year. Having a supervisor or geophysicist on site would have been preferable, but it just wasn't possible. Much of the resistivity data and some of the IP data appeared usable, although our confidence had been shaken by the poor repeatability in some areas. And we did have a possible explanation for the weird IP decay curves. In the end we made do with what we had, but it was not a happy experience.

So, when you're next stewing over yet another weather-related stand-by day, take some comfort in the fact that things could be a lot worse.

Seismic window



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Passive seismic

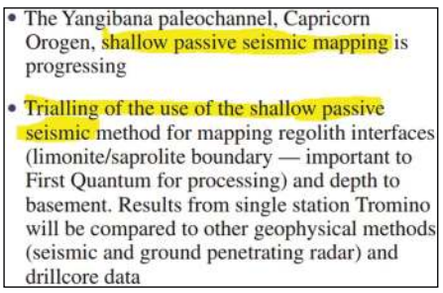
I was chatting at a networking lunch recently, and the discussion turned to passive seismic, or more specifically, using passive seismic to distinguish hydrocarbons from water in a subsurface reservoir. Passive seismic records data from naturally occurring seismic events rather than from a controlled source. The method is commonly used to monitor micro-seismic events, to map fracture lengths following hydraulic stimulation, or to record tele-seismic arrivals to map crustal structure, but using passive seismic to differentiate fluid fill was new. Or so I thought. But, after some follow up, I found it had been used in Eastern Europe for at least 10 years and possibly for over forty years. Closer to home, several surveys have been carried out in recent years by The Geological Survey of Western Australia to map the thickness of sedimentary overburden (Figure 1). The passive method is cheap, environmentally friendly and can detect hydrocarbons directly - just what we need in this day and age.

A paper by Irinyakov, Mikhailov and Khabibulin (2008) describes the successful use of low energy passive seismic to prospect for hydrocarbons in complicated geological conditions. They recorded naturally occurring seismic activity using high sensitivity, broad band seismometers to obtain measurements of spectral properties at several points across an oil discovery, which they then calibrated to well control. They found a low frequency anomaly at 3Hz was present at points above the hydrocarbon, and an impressive correlation between their "DHI value" and nett pay thickness. Sounds like the bees knees – what could possibly go wrong? Well here's a list of some of the problems:

- The presence of artificial sources such as traffic, production wells or pipelines can affect the data quality
- Amplitude of the measured signal depends on the time of day possibly because of gravity induced forces like tides
- The spectrogram is non-stationary in time or space

Just one of these problems has the potential to derail the method, and all three together appears to be insurmountable, but I'm assured the method works if the proper processing is applied.

This is all interesting but I had to ask about the source. What is the cause of the apparently never ending and ubiquitous supply of low energy seismic events? It appears the Russians had a theory where they considered the earth was not made of simple solid layers but rather a system of separate bodies under different stress conditions, some of which are close to a state of instability. In this state even a weak effect could trigger a change in the properties and energy state of the system. As a result of this instability real rocks constantly emit micro-seisms caused by temporary changes in stress resulting from geodynamic and geochemical processes. A bit waffly but essentially differential movement of grains in the upper mantle creates a continuous source of micro-seismic events that can be recorded at the earth's surface, and information about the fine structure of the earth can be extracted despite it being low frequency data (0-10Hz).



- The Yangibana paleochannel, Capricorn Orogen, shallow passive seismic mapping is progressing
- Trialling of the use of the shallow passive seismic method for mapping regolith interfaces (limonite/saprolite boundary — important to First Quantum for processing) and depth to basement. Results from single station Tromino will be compared to other geophysical methods (seismic and ground penetrating radar) and drillcore data

Figure 1. *Extract from page 23 of the Geological Survey of Western Australia Annual Review 2018 - 19. Passive seismic has been used in WA to aid mineral exploration for some time.*

As I understand it, the passive seismic method involves using a 3 component seismometer to continuously record what most of us call seismic noise. This noise, generated in the ever moving mantle by grain to grain interactions, is modified as it passes through the overlying rocks before being recorded at the surface. If there is no change in the overlying strata the seismic signal does not change but if there is even a subtle change the signal is altered. The recorded data is analysed and processed to obtain a frequency spectrum that is compared to a model and neighbouring events and an interpretation of the cause of any differences is made.

This innovative technique is still experimental but I believe a pilot project may be kicked off in Australia later this year.

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Data trends

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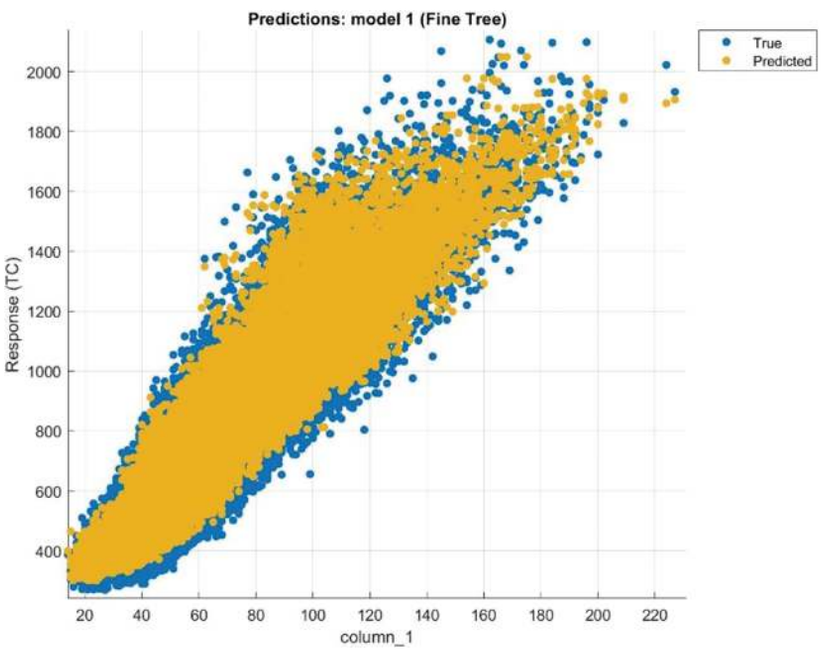

Figure 1. *True vs predicted graph after running Matlab™ Regression Learner module with the Fine Tree option.*

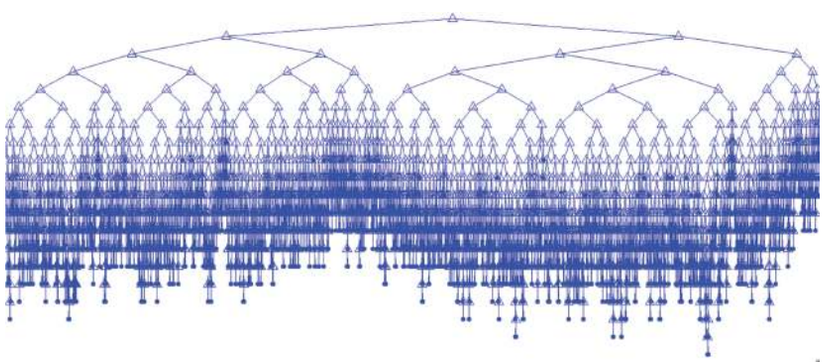

Figure 2. *Decision tree for three variables produced by Matlab™ Regression Learner module. This is what you might get instead of equation coefficients in the future.*

Regression, easy to do but difficult to interpret

It used to be a relatively simple request. Gary wants to investigate linear regression for radiometric data to try out Brian Minty's method for identifying naturally occurring high gamma emitting rocks from other sources. A simple linear regression model based on three variables each with 161 000 data points will provide a reasonable prediction model that when subtracted from Total Count (hopefully) leaves the unexplained anomalies. Similar to removing the "regional" in magnetics.

There are plenty of options at hand such as R, Excel's long time add-in Analysis Toolpak™ and many languages have inbuilt functions. Every option gave roughly the same coefficients below to make graphs similar to Figure 1.

$6.24K + 7.36U + 7.38Th = TC$

However, this was a chance to explore machine learning because machine learning is designed to solve this kind of problem. Out of 12 general options I followed the default choice of *Trees* and tried both *Coarse* and *Fine Trees*. Instead of the simple equation that impresses pundits on a conference poster I received a trained model data object larger than my input data.

The trained model data object contains a trained regression model (Figure 2) and the original data to help calculate predictions on new data. The regression model itself is a binary tree similar to the b-tree search algorithm we learnt from Dr Dobbs Journal in C programming. A giant "if" statement that adjusts itself (balances) so searches start in the middle of the tree for the fastest average search time each run.

Machine learning calls them decision trees and nodes are determined by bunching data into clusters by closeness of proximity resulting in the 41 961 decision nodes that dictate which cluster future data will assigned to. It sounds more thorough than a general three coefficient equation, and it may well be, but according to my O'Reilly's *Hands-on machine learning* (Géron, 2019), by letting machines build the decisions, we give up the ability to pinpoint why a decision was made and adding more variables creates more, not less, ambiguity. *Coarse trees* produced 6353 decision nodes and *Fine Trees* 41 961.

Gary gets three coefficients he can use but a model he cannot. How do I exchange machine learning models? How can I explain my thinking when I did not think it? Will training models be the required "full waveform" for any data set touched by AI in the future? For now we will discuss whether to stick with easily reproducible equations or the not so exchangeable or reproducible road of machine learning.

Reference

Géron, A., 2019. *Hands-on machine learning with Scikit-Learn, Keras and TensorFlow: concepts, tools, and techniques to build intelligent systems* (2nd ed). O'Reilly.

Webwaves

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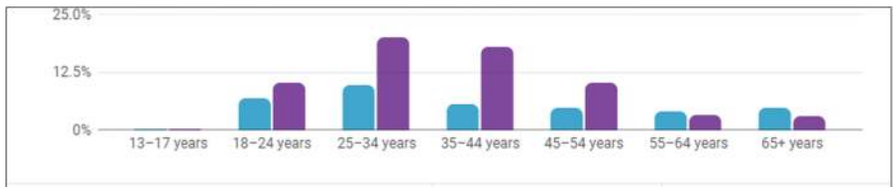
Review of the ASEG YouTube channel.

In 2020, with in-person technical talks cancelled, the ASEG moved to streaming technical talks using Zoom. Additionally, where the presenter consented, recordings were posted on the ASEG YouTube channel (https://www.youtube.com/c/ASEGVideos). During this time 37 videos have been made freely available for the wider community to watch, a rate of close to one upload every ten days.

The growth of the channel has been encouraging, with 229 subscribers in the past year, and 944.8 hours of content watched across 12 500 views (average view duration of 4:32). Moreover, the ASEG channel has created 373 500 impressions (number of times our video thumbnails have been shown to YouTube users), with a click through rate of 1.1%. This resulted in 4200 views with an average view duration of 5:32. Of these impressions, 82.1% of views came from YouTube recommending our content to users.

YouTube produces generalised statistics based on their knowledge of viewers' age and gender. For the ASEG channel, women are more likely to watch the content for longer. This is particularly apparent with the older cohorts >55, where we have a greater watch time from women than men. Overall, the YouTube channel shows marginally more gender equality than the ASEG website, with females contributing 35.6% (by watch time). Encouragingly, the channel also appeals to the younger generations, with considerable viewership in the 18-24 cohort.



Viewer age	Views		Watch time (hours)	
	Female	Male	Female	Male
Total	**24.7%**	**75.3%**	**35.6%**	**64.4%**
13–17 years	0.4%	0.7%	0%	0%
18–24 years	4.8%	18.9%	6.9%	10.2%
25–34 years	7.2%	28.8%	9.6%	20.1%
35–44 years	6.8%	15.6%	5.6%	17.8%
45–54 years	2.8%	6.4%	4.7%	10.3%
55–64 years	1.8%	3.0%	3.9%	3.2%
65+ years	0.9%	1.9%	4.9%	2.9%

Figure 1. *ASEG YouTube viewers by age and gender.*

Viewer location returns some interesting results by absolute viewer numbers. India is top with 1586 views, with an average view duration of only 44 seconds, which is very short. When sorted based on watch time - a more representative metric - Australia has the most hours, followed by the USA, UK, India and Canada.

Geography	Watch time (hours)	
Total	**944.8**	
Australia	128.5	13.6%
United States	125.4	13.3%
United Kingdom	37.7	4.0%
India	19.5	2.1%
Canada	19.0	2.0%

Figure 2. *ASEG YouTube viewers by location and watch time.*

Top ASEG videos in the past year.

A look at the ASEG videos on YouTube highlights the breadth of content that has been presented in the past year, with a spread between academia, industry and covering a wide range of geophysical topics. Below is some information on our most popular three videos.

3rd Place
Title: "End-to-end seismic inversion of geostatistically complex reservoir facies models with deep convolutional neural networks"
Presenter: Anshuman Pradhan, Stanford University
Link: https://youtu.be/ewcWgi-bXnU
Views: 642
Comments: Anshuman's talk still receives daily views 275 days after first being published. It is most likely to be viewed from people on LinkedIn, highlighting the value in social media advertising content. Over three quarters of views are from various LinkedIn sources.

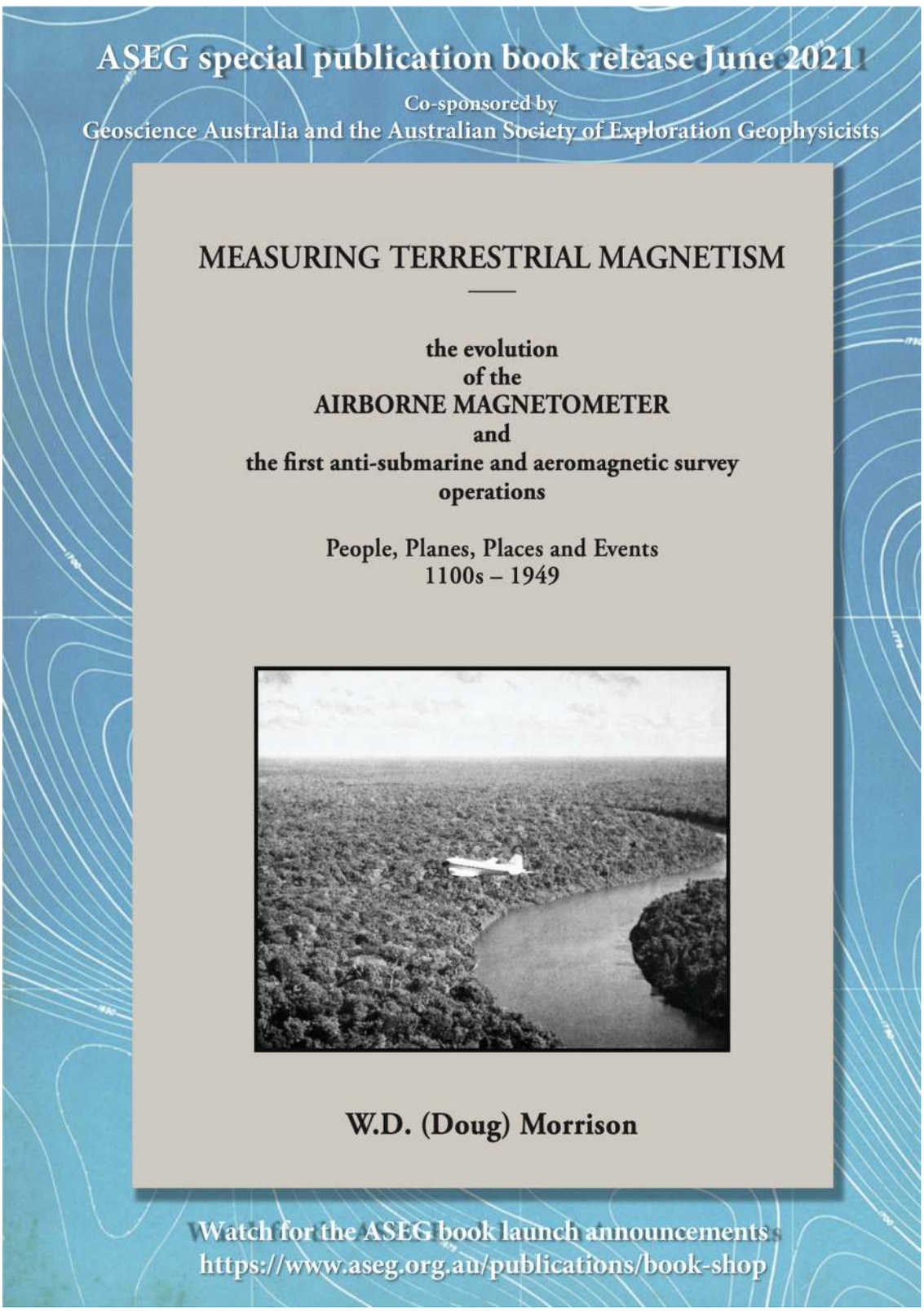
2nd Place
Title: "The application of 2.5D AEM inversion to resource exploration with reference to open file survey examples from NSW, QLD and WA"
Presenter: Rob Paterson
Link: https://youtu.be/UbHXv4Xm-k0
Views: 880
Comments: Rob's presentation is our most viewed non-seismic talk and it is great to see an AEM inversion talk so well received. The largest source of views for this video are from YouTube recommendations to users.

1st Place
Title: "Pre-stack Depth Imaging: Challenges in exploration-scale volcanic geobody model-building in the Potiguar Basin, Brazil"
Presenter: Rich Bartlett
Link: https://youtu.be/hJh3OzHbHRc

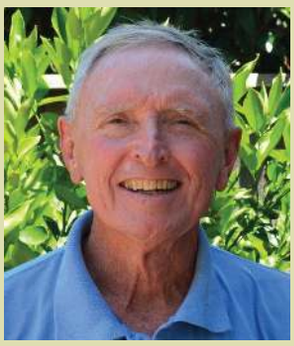
Views: 2631
Comments: Our most viewed upload to date. A large portion of the views come from YouTube suggested videos, with Google search also contributing viewership. Rich's video has been viewed most by users in the US, UK, Germany, Canada and France, with Australians only watching 36 times (which doesn't include those who listened live).

The success of the ASEG YouTube channel has been fantastic in the past year. With the resumption of in-person technical nights in Australia we have continued to hold hybrid events that have a streamed component. This will allow us to continue to upload videos to the YouTube channel and promote the science of geophysics, and specifically exploration geophysics, throughout Australia and the world.

We are always looking for additional speakers at technical nights, so please contact us at secretary@aseg.org.au if you are interested in presenting.



The conductivity of chalcocite, the richest copper sulphide



Don Emerson
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Figure 1. *Chalcocite crystals exhibiting platy habit and metallic lustre (lateral dimensions ~30 mm) from (left) Mammoth Mine northwest Queensland and (right) Cornwall, England. Chalcocite crystals or crystal aggregates can display a bluish tarnish (left) and striations (right). Good crystals are not common, and collectors pay high prices (hundreds to thousands of dollars) for nice specimens. Most chalcocite, however, occurs as unattractive duller, dark, fine grained granular aggregates, or as porphyry style disseminations. Source: Chalcocite / Rob Lavinsky, iRocks.com – CC-BY-SA-3.0*

Introduction

Exploration for copper has long been a focus for humankind. Developments in modern technologies have generated even more demand for this most useful metal. The cuprous sulphide, chalcocite (Cu_2S) with a 79.8% Cu content is the richest and most valuable sulphide of copper (compare chalcopyrite, $CuFeS_2$, 34.5% Cu), but its conductivity has been little investigated. This article aims to contribute to the limited database with some inductive electromagnetic (EM) measurements.

Chalcocite can occur as a primary crystalline sulphide e.g., in the hydrothermal veins of granite in Cornwall, but most of it forms as fine-grained dark blankets under the water table in the supergene enrichment zone above primary chalcopyrite ore, in metasediments. This zone of enrichment is fed by copper sulphate solutions descending through the weathered zones.

The old CSA Mine, Cobar NSW, had a nine metre supergene zone. The Mt Isa Inlier, northwest Queensland, hosts several deposits of supergene chalcocite. Much chalcocite occurs as disseminations in low grade porphyry coppers. Further information on occurrences, genesis, and mines in Australia and overseas can be found in Blanchard (1968), Lindgren (1933), Read (1970), Richardson and Moy (1998), Jones (2016, 2018), and will not be repeated here. An instructive summary of chalcocite and its structure may be found at https://www.mindat.org/min-962.html. Figure 1 shows two examples of collector grade chalcocite.

Ore genesis

Consider a primary chalcopyrite body, usually associated with pyrite, which undergoes weathering and develops an enrichment cap. In the weathered zone, oxidation generates iron sulphate (which, when hydrated, is green vitriol) and very mobile copper sulphate. The copper sulphate descends in solution to interact with chalcopyrite and pyrite, possible reactions are:

$$CuFeS_2 + CuSO_4 = 2CuS + FeSO_4 \qquad \text{(covellite + vitriol)}$$

then

$$5CuS + 3CuSO_4 + 4H_2O = 4Cu_2S + 4H_2SO_4 \qquad \text{(chalcocite + acid)}$$

and

$$5FeS_2 + 14CuSO_4 + 12H_2O = 7Cu_2S + 5FeSO_4 + 12H_2SO_4$$

Thus, a very desirable secondary ore of copper is produced in secondary, messy, acidic reactions resulting in a highly altered, porous environment. The chalcocite, Cu_2S, is dark, sometimes sooty, soft (Moh's hardness ≤ 3), imperfectly sectile, dense (5.5 – 5.6 g/cc, t/m^3). It is a p-type semiconductor (Shuey, 1975), crystallising in the monoclinic system, but readily pseudomorphs e.g. after pyrite. Usually, it is found as tabular crystals, mainly fine to very fine grained; rarely coarse.

Measurements

Mass property (Emerson, 1990) and EM conductivity (Yang and Emerson, 1997) measurements were carried out at mesoscale on 21 samples from the USA, D R Congo, and Australia. The samples, categorised in Groups I to VII, ranged from high conductivity, collector grade, crystal aggregates through fine grained massive ores varying in chalcocite, chalcopyrite, pyrite and graphite content, to a low conductivity carbonaceous siltstone host rock containing minor amounts of chalcocite and pyrite. Samples were examined under the microscope to estimate mineralogy. In Table 1, for Groups I to V, the samples have been listed in decreasing order of chalcocite content, so for Group V #11 has the most chalcocite and #14 has the least. Group VI is dominantly pyritic with only minor chalcocite, some of these samples show signs of decomposition and disaggregation. The various mineral assemblages were galvanically micro-probed to investigate, qualitatively, relative conductivities. This established that conductivity diminished in the order: graphite – chalcopyrite – chalcocite – pyrite. The samples and results are given in Table 1 along with relevant information and measurement techniques discussed in other previous articles (e.g. *Preview* **203**, 52-64, on pyrite).

Results

The results given in Table 1 are plotted against density in Figure 2. A feature of the results is the extraordinary values

Table 1. Mass property measurements on chalcocite samples.

	Category	No.	Plot Symbol		EM Cond. S/m	DBD (dry)	WBD <-- densities, g/cc --> (sat.)	GDA (grain)		P_A porosity %
	medium grain size (mm) crystalline									
I	high grade Cu	1	▲	massive	1831	5.15	5.22	5.56	(fract.)	7.4
	high grade Cu	2	▲	massive	1285	4.98	4.99	5.04		1.2
II	high grade Cu	3	●	massive	1100	4.99	5.00	5.04		1.0
	med. grade Cu	4	●	vein	191	3.57	3.58	3.61		1.1
	low grade Cu	5	●	stringer	3	2.71	2.72	2.75		1.3
	micro to very finely crystalline (µm) massive									
III	cc > cpy > gr	6	■		4330	3.68	3.97	5.20		29.2
		7	■		2660	3.91	4.15	5.09		23.1
		8	■		2010	4.40	4.53	5.02		12.3
IV	cc > py > gr	9	●		806	3.69	3.93	4.92		25.0
	(sooty)	10	●		188	2.14	2.61	4.02		46.8
V	cc > py	11			420	3.89	4.11	5.00		22.1
		12	×		129	3.91	4.02	4.38		10.8
		13	×		34	2.41	2.81	4.02		40.1
		14	×		19	2.96	3.18	3.79		21.9
VI	py >> cc	15			25	3.40	3.65	4.53		24.9
		16			18	3.83	3.95	4.36		12.1
		17	◆		14	4.17	4.23	4.44		6.0
		18	◆		6	3.76	3.95	4.65		19.1
		19	◆		5	3.97	4.11	4.63		14.3
		20	◆		4	3.25	3.53	4.54		28.5
VII	host carbon. siltstone + minor py	21			< 1	2.28	2.40	2.60		12.5
	reference values from literature				cond s/m			assumed density		
	(Harvey, 1928)	H1	○		12500	galvanic microarray measurement		5.65		n/a
		H2	○		20000			5.65		
	(Telkes, 1950)	T1	○		370	galvanic measurement		5.65		n/a
		T2	○		1667			5.65		
	comparison cond. values from some massive deposits (in author's experience)									
	graphite	gr	□		10000			2.2		
	chalcopyrite	cpy	□		5000			4.2		
	pyrrhotite	po	□		100000			4.6		
	pyrite	py	□		200			5.0		

Notes

1. Densities: DBD dry bulk density (105°C dried), WBD fresh water saturated (vacuum technique), P_A apparent (water accessible) porosity, GDA apparent composite grain density of minerals in sample (porosity removed), RTP measurements (22°C). [GDA = DBD/(1-P_A)]
2. Magnetic Susceptibility: not cited because all quite low (< 10 x 10^{-5} cgs)
3. EM conductivity: measured on wetted samples; for techniques see previous *Preview* articles (e.g. Pyrite, *Preview* **203** Dec 2019 p61, 62 Table 3 Fig 10). Values rounded.
4. Reference values: from Harvey and Telkes who measured galvanic resistivities on presumably single crystals; the resistivities have been inverted to conductivities in the Table; the density ascribed to their materials has been assumed to be about 5.65 g/cc the midpoint of the range of densities, 5.5 - 5.8 g/cc, reported for chalcocite
5. Mineralogy: cc - chalcocite (Cu_2S), cpy - chalcopyrite ($CuFeS_2$), py - pyrite (FeS_2), graphite (C); chalcocite (cc) has 79.8% Cu content making the most valuable copper sulphide ore; in the listed category cc content increases from #2 to #1, #5 to #3, #8 to #6, #10 to #9, and #14 to #11.
6. Samples #1, 2 are from the Flambeau Mine, Wisconsin, USA where cc occurs in quartz sericie schists; #3-5 are from the Katanga Copper Belt, DR Congo, where cc is hosted by carbonate-veined felsic sediments, #6-21 are from the Mount Isa Inlier in NW Queensland where cc is associated with carbonaceous pyritic siltstones. All samples are from Proterozoic metasedimentary sequences
7. Harvey's samples from Harvard Uni. mineragraphy collection; Telkes' T1 Sonora Mexio, T2 Butte Montana (presumably these were all single crystal measurements)

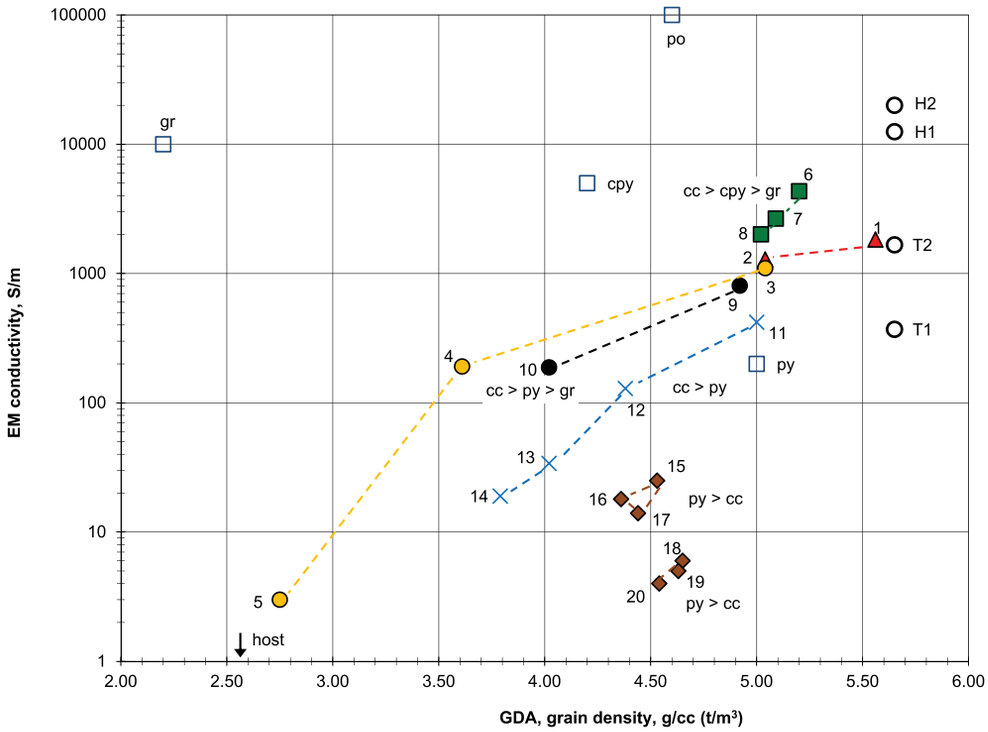

Figure 2. *A cross plot of EM conductivity against inferred solid grain density (porosity removed). For each of categories I to V (#1 – 14), chalcocite content increases from left to right as density increases. Category VII a host siltstone, with minor pyrite and graphite, plots below 1 S/m. In categories I to V conductivity increases with density, and more or less trends to a value of ~1800 S/m at nominal density 5.65 g/cc for chalcocite, near Telkes' T2. For the fine grained dark massive chalcocite, chalcopyrite is seen to boost conductivity as does graphite (IV), but pyrite diminishes conductivity (V). Heavily pyritic samples VI (#15 – 20) have low conductivity. By way of comparison, typical values (encountered by the writer) for massive graphite (Sydney Basin cindered coal), chalcopyrite ores (Cobar NSW), pyrrhotite nickel ores (Kambalda WA), and pyrite (various; see Emerson, 2019) are shown. This limited evidence seems to suggest that chalcocite in massive aggregates is a fairly good connector / threader conductor intermediate between chalcopyrite and pyrite.*

for porosity (up to 47%) recorded for the fine grained massive granular samples #6 – 21 embracing categories II to VII. This is consistent with the mode of genesis. The porosity for #1 (7%) is due to fracturing and intergranular voids. The chief interest in this work is how well the solid materials conduct and, especially, how good a conductor is chalcocite. To this end, conductivity was plotted against inferred solid grain density (porosity removed). Conductivity plotted against porosity, or wet, or dry density was not particularly informative. Although, clearly, porosity development cannot help conductivity it seems that, except for the pyritic dominant Group VI and the host VII, the solid framework of the mineral assemblage is well networked by the conducting elements i.e., sulphides of copper, and graphite. The results here are for mineral aggregates i.e., ores, not single crystals. However, single (presumed) crystal data from the sparse literature are included for reference: Harvey's (1928), measured by galvanic microprobe arrays (fractions of mm Wenner electrode spacings); and Telkes' (1950), by a technique that is not clear in her paper. Also included in Figure 2, for comparison, are typical values, encountered by the writer, for deposits of commonly encountered sulphides (pyrite, chalcopyrite, pyrrhotite) and graphite.

Discussion

In Figure 2, generally, conductivity increases to moderate levels as density increases to chalcocite's nominal value of 5.65 g/cc. This trend in conductivity at lower densities is not due to chalcocite alone as there are contributions from chalcopyrite and minor graphite (Group III) graphite and pyrite (Group IV), pyrite (Group V). Also, metasedimentary host rock content diminishes as sulphide content increases. Chalcopyrite and graphite appear to boost fine grained, massive chalcocite ore conductivity, pyrite seems to lower it. This is a plausible result given the conductivity and nature of both graphite and chalcopyrite: very good conductors with a threading / connecting habit; compared to pyrite which, in aggregate, is often a moderate, not very well-connected conductor (Emerson, 2019). Samples #3 – 5 in Group II diminish in conductivity as density decreases owing to increasing amounts of metasedimentary host rock. The pyrites in Group VI are poor conductors. They are altered, most of them are disaggregating ("sugar" pyrite), and chalcocite content is low.

A pure chalcocite aggregate (#1, Group I) has a conductivity similar to Telkes' T2 i.e. ~1800 S/m. To which samples #3 – 5, 9 – 14 trend as density increases. This value of 1800 S/m appears to be indicative, but by no means definitive, of very high copper grade chalcocite ore. Until further data becomes available it seems reasonable to regard chalcocite as a good conductor, probably with good connectivity (noted by Shuey, 1975), ranking below chalcopyrite and above pyrite in conductivity.

Concluding remarks

Chalcocite manifests a good, but not excellent, mesoscale conductivity at least for the samples in this limited test. More needs to be done not only on chalcocite, but on the chalcocite family, which includes the little studied, copper deficient variants: digenite Cu_9S_5 (78.1% Cu), djurleite $Cu_{31}S_{16}$ (79.4% Cu),

and perhaps anilite Cu_7S_4 (77.6% Cu). Digenite may have a conductivity two orders of magnitude greater than chalcocite, and djurleite one order of magnitude greater (Shuey, 1975). These two minerals dominate the economic mineralogy of the Esperanza copper deposit in the Mt Isa Inlier (Richardson and Moy, 1998). Chalcocite is black cuprous sulphide, a closely associated mineral is the indigo-blue cupric sulphide, CuS, covellite (66.4% Cu), which acts as a p-type metal with a conductivity exceeding 1 000 000 S/m. Covellite usually does not occur in abundance, but as inclusions in, or coatings on, other copper sulphides. It does not match its associated sulphides in copper content, but it surely could affect their electrical properties. Although known to occur sometimes as primary sulphides, e.g., in hydrothermal veins, all these minerals are mainly encountered in the supergene zone and, to better to target an important metal resource, they warrant further petrophysical studies. Any such investigations should be tied tightly to chemistry and mineralogy, as work carried out on synthetic copper sulphides (e.g. Okamoto and Kawai, 1973) has shown that conductivity is highly sensitive to variations in stoichiometry.

Acknowledgements

Thanks are due to David and Lainie Kalnins for suggestions, and for the preparation of the manuscript and figures.

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Don Emerson is a geophysical consultant specialising in the physics of minerals and rocks, he also has an interest in ancient and medieval geoscience.

Preview crossword #14

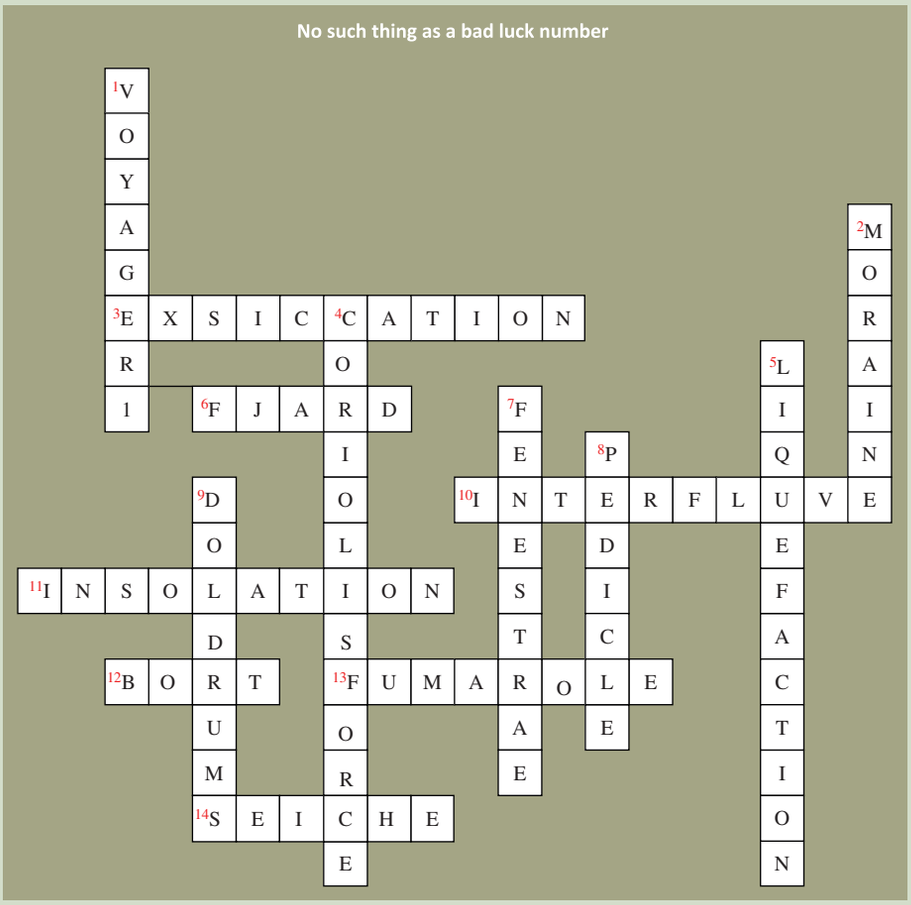
Across	Down
3. German physicist whose ground-breaking study of the effect of radiation on a blackbody substance helped revolutionised modern quantum theory.	**1.** The word 'dollar' derived it origins from the silver coins minted from the silver mines in (11).
4. The town at the centre of a nuclear disaster, resulting from a flawed reactor design that was operated with inadequately trained personnel.	**2.** The nickname of the strange shiny black material that appeared where silver veins ended in the silver mines in (11), earning it the nickname 'bad luck rock'.
9. The SI unit of radioactivity, named after the French physicist who first discovered its existence.	**5.** A type of uranium concentrate powder obtained from leach solutions.
10. The world's single largest deposit of uranium resource.	**6.** Viennese physicist who made the startling discovery that would revolutionise nuclear physics – nuclear fission – and lead to the development of the atomic bomb.
12. Name of the atomic bomb dropped on the Japanese city of Hiroshima.	**7.** Code name of the secret military project for the first detonation of a nuclear device.
13. The only known location in the world where self-sustaining nuclear fission reactions are thought to have taken place approximately 1.7 billion years ago.	**8.** The element discovered by Marie Curie after successfully isolating radioactive 'salts' from the shiny black minerals dumped as tailings from the silver mines in (11).
14. The German chemist who discovered uranium from the piles of 'useless' shiny black material thrown away from the silver mines in the Czech Republic (11).	**11.** Town where uranium was first 'found' in silver mines in what is now part of the Czech Republic.

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 – which can be used after cinemas re-open. The answers will be published in the next edition of *Preview.*

Good luck!

Preview crossword #13 solution



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Scan to sign up

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.

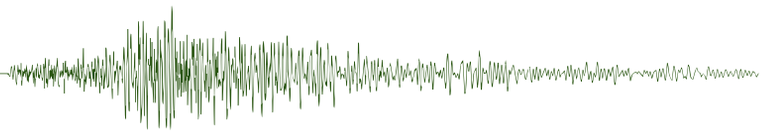
Student – an applicant must be a full-time graduate or undergraduate student in good standing, registered at a recognised university or institute and working towards a degree in geophysics or a related field. Eligibility for Student Membership shall terminate at the close of the calendar year in which 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

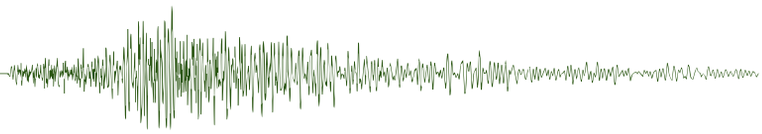
The ASEG produces a magazine called Preview and a peer-reviewed journal called Exploration Geophysics. Please read and agree to the following in order to receive ASEG publications:

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.

June	**2021**		
14–17	82nd EAGE Annual Conference and Exhibition https://eage.eventsair.com/eageannual2021/	Amsterdam	The Netherlands
July	**2021**		
26–28	Unconventional Resources Technology Conference (URTeC) https://urtec.org/2021	Houston	USA
27	Latin Geophysics Explore 2021 https://chilexploregroup.cl/en/latin-geophysics-explore-2021-en/		Virtual
August	**2021**		
3–5	Machine Learning: The artificially intelligent Earth exploration	Kuala Lumpur	Malaysia
16–21	36th International Geological Congress https://www.36igc.org/	Delhi	India
23–27	Advanced Earth Observation Forum 2020 https://earthobsforum.org/	Brisbane	Australia
September	**2021**		
8–10	Mines and Wines 2021 Discoveries in the Tasmanides https://minesandwines.com.au/	Orange	Australia
15–20	Australasian Exploration Geoscience Conference (AEGC 2021) 2021.aegc.com.au	Brisbane	Australia
26–1 Oct	SEG International Exhibition and 91st Annual Meeting https://seg.org/AM	Denver	USA
October	**2021**		
10–14	11th Balkan Geophysical Congress https://appliedgeophysics.ro/events/bgs2021/	Bucharest	Romania
13–14	Geophysics in Geothermal Energy – Today And Tomorrow https://seg.org/Events/Geophysics-in-Geothermal-Energy-Today-and-Tomorrow	Jakarta	Indonesia
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**		
9–11	5th Myanmar Oil & Gas Conference https://eage.eventsair.com/fifth-aapg-eage-myanmar-conference/	Yagoon	Myanmar
15–17	Dorothy Hill Symposium https://absoluteevents.eventsair.com/dhweess-2021/	Brisbane	Australia
23–25	PETEX https://petex.pesgb.org.uk/	London	UK
30	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**		
13–17	AGU Fall Meeting	New Orleans	USA
March	**2022**		
20–23	Geo-Congress 2022 https://www.geocongress.org/	Charlotte	USA
August	**2022**		
15–19	12th International Kimberlite Conference https://12ikc.ca/	Yellowknife	Canada
September	**2022**		
26–30	Australian and New Zealand Geomorphology Group Conference https://www.anzgg.org/conferences	Alice Springs	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.

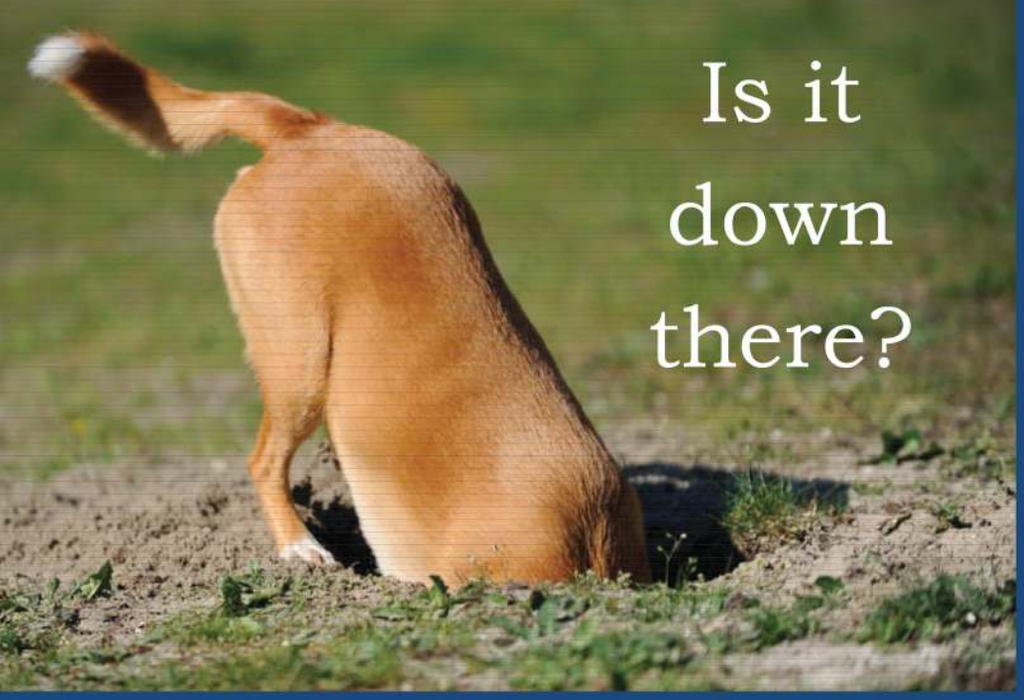
Single copies of *Preview* can be purchased from the Publisher.

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 August issue is 9 July 2021.

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



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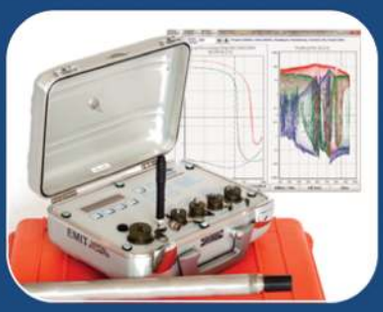

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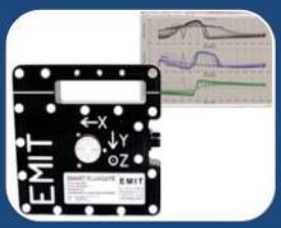
3-component digital borehole fluxgate magnetometer system in a 33mm tool for EM and MMR with simultaneous acquisition of all components, time-series recording and powerful noise rejection. Compatible with a wide range of transmitter systems and EMIT's Transmitter Multiplexer for increasing productivity. 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.



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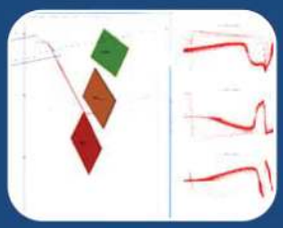

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