



PREVIEW



NEWS AND COMMENTARY

Fraser Institute rates GSSA #1
for databases

Elinor Alexander on being
an employer of choice

Flat spots aren't flat

ASEG website redesign and photo
competition

FEATURES

A Sliding Doors moment



*Integrated Seismic
Technologies*



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ADVERTISERS INDEX

AEM 2023	1
Bartington.....	20
Groundwater imaging.....	23
CoRMaGeo	37
Tensor Research.....	37
EMIT.....	BC

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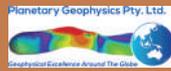
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FRONT COVER



High school students classifying resources during the AEGC 2023 High School Student programme. See *ASEG Young Professionals Network: Volunteering at AEGC 2023* in this issue for more information.

Preview is freely available online at <https://www.tandfonline.com/toc/txp20/current>
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CONTENTS

Editor's desk		2
Letter to the Editor		2
ASEG news		
President's piece		3
Executive brief		4
New Members		4
Committees	Research Foundation:	Grants in 2023
	Honours and Awards:	Call for nominations for 2024
	YPN:	Volunteering at AEGC 2023
	Technical Standards:	Meeting summary
		8
Branch news		9
ASEG national calendar		13
News		
Conferences and events: AEM 2023: Update		14
Geophysics in the Surveys GA:	Australian Fundamental Gravity Network refurbishment.	15
	Cobar-Yathong region airborne electromagnetic survey (AEM) and airborne magnetic and radiometric (AMR) survey	15
	Update on progress of all geophysical surveys	17
GSSA:	Fraser Institute rates GSSA #1 for databases	20
GSWA:	Western Officer and Perth Basins SEEBASE reports	21
Commentary		
Canberra observed	Budget 2023-24 good for science <i>and</i> delivers a surplus	22
	What's happening with CCS	23
	Oz Minerals is no more	23
Education matters	Putting effort into being an employer of choice	24
Environmental geophysics	Weird and wonderful	27
Seismic window	Flat spots aren't flat	28
Webwaves	ASEG website redesign and photo competition	30
Feature		
A Sliding Doors moment		32
Crossword		
Business directory		37
International calendar of events		44

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AEM2023

REGISTRATIONS NOW OPEN

8th International Airborne Electromagnetics Workshop

4 -7 September 2023
Fitzroy Island, QLD, Australia

The 8th International Workshop on Airborne Electromagnetics will be held at Fitzroy Island, Queensland Australia, in person between the 4th and 8th September 2023. Fitzroy Island is an unspoilt tropical paradise of rainforest and beaches within the calm sheltered waters of the Great Barrier Reef. The island is a National Park, with walking trails, tropical plants and animals, and abundant marine life.

The Workshop will encompass advances in airborne electromagnetic systems, modelling and interpretation. Case studies covering geotechnical, mining, energy, groundwater and environmental applications will be presented. The event will be a platform to contribute, discuss and learn about airborne electromagnetics and provide a forum for in-depth conversations on the subject area with colleagues from Australia and worldwide.

A four-day program will feature speakers from academia, government and industry, with keynotes delivered by leading experts in their respective streams.

TO REGISTER NOW
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INFORMATION
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Australian Society of
Exploration Geophysicists



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Editor's desk

This issue of *Preview* features an article by Des FitzGerald (and we must thank Terry Harvey for being the midwife for this piece) that really got my brain fizzing. Firstly, I found myself asking whether older scientific literature is being neglected, and secondly, I got to contemplating how processing strategies, and the outcomes of those processing strategies, become entrenched in scientific practice.

Much to my astonishment, there is an entire branch of scientific endeavour devoted to the ins and outs of scientific communication, and numerous papers have been published on the statistical analysis of citation, readership and publication. Needless to say, these papers appear to be somewhat contradictory in terms of whether the availability of digital libraries and the convenience of online searches has led to readers being biased towards material that was published in the digital era. An era that, roughly speaking, began in the late 20th century and accelerated with the introduction of Digital Object Identifiers (DOIs) in the year 2000. It is reasonable to suppose, however, that humans are inclined to take the path of least resistance when it comes to foraging through scientific literature. That being the case, the article by Des FitzGerald is a timely reminder that there is "gold in them there hills".

However, Des is also making the point that geophysicists may have been railroaded into particular analytical

pathways because of the barriers posed to analysis by complex and time-consuming calculations. The dramatic changes in the speed and processing ability of computers in the 21st century means that many of those barriers have been removed, and it may be time to revisit the basics in terms of how we analyse many data types. The payoff could be considerable, providing we can overcome the inertia associated with entrenchment of certain processing strategies in commonly available software. And why stop at geophysical software, we can think about processing strategies in AI in much the same way – looking at you ChatGPT!

I really would recommend that you read what Des has to say.

In other news and commentary, in this issue of *Preview* David Denham (*Canberra observed*) reports on the Federal Budget for 2023-24. Marina Pervukhina (*Education matters*) interviews Elinor Alexander, who is the Director of the Geoscience and Exploration team in the Department for Energy and Mining, South Australia. Marina particularly asks Elinor about the effort her Department is putting into becoming an employer of choice. Mike Hatch (*Environmental geophysics*) also has a brain that is fizzing, as he explores surprising applications of Global Navigation Satellite System instruments. Mick Micenko (*Seismic window*) considers flat spots that aren't flat, and

Ian James (*Webwaves*) brings us up to speed with the re-design of the ASEG website and invites us to participate in the ASEG's third photo competition.

The next issue of *Preview* will bring you a taste of the AEM 2023 workshop on Fitzroy Island. We will be publishing the programme and short abstracts so that those of you who aren't lucky enough to attend in person won't be entirely missing out!

Lisa Worrall
Preview Editor
previeweditor@aseg.org.au



The Editor on Fitzroy Island – preparing to welcome participants in the AEM 2023 workshop, which is being held on the Island in September 2023.

Letter to the Editor

Dear Lisa

I generally look forward to the commentary of the *Canberra Observed* column for its analysis of national exploration statistics and coverage of matters relating to federally funded geoscientific research and education. Which only made the sharp detour into denunciation of Australian military and

geopolitical strategy ("AUKUS nuclear-powered submarine pathway a risky strategy", *Preview* 223) that much more surprising and disappointing.

I am with considerable difficulty refraining from taking issue with almost every line of this piece, only because I believe this is not an appropriate forum for it. No doubt there is a place for

debating talking points of the Chinese Communist Party ("Taiwan is essentially an internal China issue" among the more egregious), but I don't think that place is the pages of *Preview*.

Respectfully yours

Mark Duffett
markduffett@gmail.com

Letter to the Editor

Dear Lisa

Mark Duffett's letter raises some issues relating to what we publish in *Preview*. I would like to clarify the situation.

The words in my *Canberra Observed* column are mine, and do not represent the views of the ASEG.

Regards

David Denham
denham1@inet.net.au



President's piece



Eric Battig

I begin this *President's Piece* by taking a moment to acknowledge the tremendous effort of all our volunteers. Simply put, the ASEG could not function without their passion and incredible hard work. They dedicate significant personal time to the ASEG, across all facets of the organisation. Much of this work happens behind the scenes, and I am excited to announce that we will soon be releasing our 2022 Volunteer Almanac. The Almanac lists over 180 of our amazing volunteer members, and we welcome with open arms our newest volunteers to the Standing and State Branch Committees. It's especially pleasing to see recently vacant positions once again filled, namely our International Committee Chair (Randall Taylor), Education Chair (Michelle Thomas) and Vice-President (Ian James). So, thank you to all our volunteers, and remember there is always room for more, so please reach out to me, or your local branch committee, if you would like to help.

In the last issue of *Preview*, I hinted at some of the headwinds facing our Society, and on the sidelines of this year's AEGC in Brisbane your new Federal Executive met for our annual Strategy Day. Throughout the day the team reflected on how the ASEG is positioned with respect to the Society's four key focus areas:

1. The Next 50: Creating a sustainable model for the ASEG to support another 50 years
2. Who We Are: Understanding and communicating the identity of the ASEG

3. Member Value: Creating, articulating, and delivering exceptional member value and satisfaction
4. Volunteer Focus: Improving the volunteer experience

These focus areas provide a framework for establishing a set of high-impact outcomes to help set the ASEG up for a bright future:

1. Growing geophysical capabilities in Australia
2. Revitalising publications with a focus on relevance to members
3. Increasing branch impact and improving content accessibility
4. Creating content to better articulate volunteer expectations and onboarding

The stark decline in specialised geophysical education at Australian universities will challenge the sustainability of the ASEG, and over the next twelve months we will be exploring and hopefully adopting ways in which we can respond. We will be focused on mentoring and training, and increasing the reach of geophysics into primary and secondary education (e.g. leveraging the spotlight on our very own Superstars of STEM). Acknowledging that a lot of good work is already in progress across other geoscientific societies, we will collaborate through the AGC on the promotion of geophysical education and professional development.

Leading directly on from this it was recognised, once again, that our international members (incidentally our second largest branch) need more support. With Randall stepping into the role of International Committee Chair these members will have direct representation on the FedEx, and we can expect to see the ASEG increase its international profile, which brings with it more opportunities for our members to engage and share their knowledge. Throughout this year we will also be initiating a review and renewal process for all our sister organisation MOUs.

During the day's discussions, it became obvious that to deliver value for our members we are going to need to focus on the current and future state of our

publications. Elevating the quality, over quantity, of ASEG publications was unanimously recognised as a critical task for the ASEG. This year we will review the commercial contracts for *Exploration Geophysics* and *Preview*, looking at how we manage extended abstracts from joint conferences and exploring emerging digital publication models. I am pleased to say that the Publications Committee have already begun work on this critical initiative, and we are well placed to see material progress over the course of the year.

Our state branches continue to be our frontline, and our face into the geophysical and broader public community. We agreed we need to do what we can to improve the impact of the branches in the capital cities but also, importantly, in our regions. We will continue to deliver substantial online content and we are exploring ways in which we can bring ASEG events to regional centres and/or capital cities that are not traditionally hosts to larger conferences. We thank those members that have provided feedback through the recent online survey but as always, please reach out directly if you have any ideas or comments. Our state branch presidents have also begun attending our monthly FedEx meetings, further encouraging collaboration and knowledge exchange across the Society. We are also continuing to make important progress on the new website, which will be launched later this year. This will significantly improve content accessibility and member engagement and will transform our online presence.

Finishing off where I started, I am very excited by what the ASEG will achieve over the next twelve months with the help of our amazing volunteers and supporters, and I look forward to updating you through this forum, or when I next see you at an online or in-person event.

As always, please reach out with any thoughts, comments or feedback.

Eric Battig
ASEG President
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Executive brief

The Federal Executive of the ASEG (FedEx) is the governing body of the ASEG. It meets once a month, via teleconference, to see to the administration of the Society. This brief reports on the meetings held in April and May. We hope you find these short updates valuable. If there is more you would like to read about on a regular basis please contact Asmita on fedsec@aseg.org.au.

The new FedEx members had their first meeting on 19 April 2023 and their second on 18 May 2023. There was some discussion about how we can improve volunteer experience and we decided to create an onboarding package for volunteers. FedEx also endorsed the ASEG Research Foundation proposals regarding 2023 grant applications. General updates on finance, membership, events and communications are as follow.

Finances

The financial report presented in the April meeting covered the reporting as of 31 March 2023. The March 2023 operating income was \$38 584, which mainly included membership fees that totalled \$4390 and shared Royalties of \$34 017 from Taylor and Francis. The March 2023 operating expenses were \$42

284, these included the TAS Management fee, ASEG branch awards, the EG Editor payment and social functions. YTD profit for the society is \$77 950.

Membership

As of 12 May 2023, the ASEG has 781 Members. We welcomed nine new Members in April and May. In the last few years the ASEG membership trend has not been our friend. Since 2018 ASEG membership has been trending in a negative direction with a year-on-year decrease. Thanks to all our renewed Members, Corporate Members, and local sponsors of our local branches for their continued support in 2023. Membership renewal is open now and if you haven't renewed your membership yet, I would urge you to do so. Each Member is an asset to our Society.

Events

All upcoming events are listed in *Preview*, the newsletter and on the ASEG website. There are also events happening in state branches so keep an eye on notifications via email. ASEG events are good platforms for networking, presenting technical work and learning from each other. I would like to encourage everyone to actively participate. There are also some excellent

webinars coming up, and links to the past webinars are available in the ASEG website on our YouTube channel <https://www.youtube.com/@ASEGVideos/videos>.

Communications

There are many avenues to stay connected with ASEG including *Preview* magazine, our fantastic website and our wonderful newsletter. You can also follow us on social media; search for Australian Society of Exploration Geophysics. We are on LinkedIn, Twitter and Facebook and we can see an increased page views on all three platforms. We have new working committees and volunteers starting in 2023. A brief introductory video of FedEx directors and Committee Chairs (with scope for other committee members to follow later) are on the way, as part of ASEG's internal and external communications strategy. The ASEG photo competition is open now. Also, remember early and midcareer Members can join the ASEG Young Professional Network <https://www.aseg.org.au/about-aseg/aseg-young-professionals>. Please stay tuned for these updates and videos from ASEG communication channels.

Asmita Mahanta
ASEG Secretary
fedsec@aseg.org.au

Welcome to new Members

The ASEG extends a warm welcome to nine new Members approved by the Federal Executive at its April and May 2023 meetings (see table).

First name	Last name	Organisation	State	Country	Membership type
Donna	Cathro	Geoscience Australia	ACT	Australia	Active
Tjaart	de Wit	Colorado School of Mines and Institute of Mine Seismology	Tas	Australia	Student
Uwe	Kirscher	Curtin University	WA	Australia	Active
Lahra	Lanigan	Santos		Australia	Associate
Andrew	Lockwood	Dante Geoscientific	WA	Australia	Active
Gemma	Mitjanas	University of Queensland	Qld	Australia	Active
Michael	O'Connell		On	Canada	Active
Britney	Russell	University of Adelaide	SA	Australia	Student
Nihal	Yavuz	Teck Resources	BC	Canada	Active



ASEG Research Foundation: Grants made in 2023

The ASEG Research Foundation makes an annual call for grant applications for projects in geophysics at Australian institutions closing in late February each year. For the details on this process see the Foundation's pages at <https://www.aseg.org.au/foundation/overview>.

In 2023 we received four applications for four students (one BSc (Hons) and three PhDs). These were reviewed by the appropriate subcommittees, and all were adjudged worthy of support. Basic details of the four successful grants are shown in Table 1. The total commitment for these projects is \$59 950 over three years. The Foundation acknowledges a donation of \$45 000 from the FedEx of the ASEG that allowed the support of these projects. The remaining funds come from Member and corporate donations to the Foundation that

Table 1. Successful grant applications in 2023

Institution	Supervisor	Student	Degree	Years	Topic
University of WA	Prof Mike Dentith	Abhijit Kurup	BSc (Hons)	1	Understanding magnetic responses in the high-grade gneiss terrains in the Yilgarn Craton, Western Australia
University of WA	Prof Mike Dentith	Alireza Almasi	PhD	3	Understanding basin-hosted mineral systems using geophysical datasets: The importance of evaporites and salt tectonics
Monash University	Prof Peter Betts	Alanis Olesch-Byrne	PhD	2	Investigating the link between mineralised shear zones and subsurface granites for rare earth element exploration in Australia: A geophysical study of the Mary Kathleen Syncline
University of Adelaide	Prof Simon Holford	Iain Campbell	PhD	3	Geophysical-geomechanical constraints on the operating limits for basin-scale CO ₂ storage

are gratefully acknowledged. For information about making donations please 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 Secretary
research-foundation@aseg.org.au

ASEG Honours and Awards: Call for nominations for 2024

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 the next conference in 2024. We had outstanding feedback and praise for the 2023 awardees and encourage you to nominate people in your field that also deserve this recognition.

The Honours and Awards Committee does not submit nominations, we rely on you, all ASEG Members including State and Federal executives, to nominate people you 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, 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).

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

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 emailing the Chair of the Honours and Awards Committee at awards@aseg.org.au.

Nominations including digital copies of all relevant supporting documentation are to be emailed to: awards@aseg.org.au. All correspondence and nominations will be treated confidentially. Nominations will close mid-2024, more details to follow.

Marina Costelloe
ASEG Honours and Awards Committee Chair
awards@aseg.org.au

ASEG Young Professionals Network: Volunteering at AEGC 2023

As Jarrod pointed out in the last issue of *Preview*, the sun has gone down and the dust has settled on AEGC 2023. For those on the Early Careers and Student Committee (EC&S), it was a success, but still had its highs and lows.

I want to thank those who spent countless hours organising and making AEGC 2023 the success it was. There were some exhausted, there were some sullen, but mostly there were relieved looks on the Conference Organisation Committee's faces at the sundowner drinks, a testament to the effort put in by all. It was good to be a part of it.

The AEGC Early Careers and Student Committee comprised of Kat Gioseffi (GSA, PESA), Rachel Ciesiolka (PESA/AIG), Genna McDonagh (AIG), Mike Kowalczyk and Nick Josephs (ASEG, PESA). This Committee, which was formed in 2020 for the AEGC 2021 virtual conference, certainly captured the range of geo-societies involved. Learnings from the 2021 conference were that a successful GeoPitch could be run (20ish presenters) and that networking over Zoom worked well enough. So, the committee all thought, "Why not do it again?".

The first few meetings involved brainstorming and it set the scene for an ambitious programme. The day before the conference was the initial meet and greet, providing the chance for those who hadn't been to a conference before to identify some friendly faces. On the eve of the first day of the conference the sold-out FMG networking night was held. With plenty of food and drink, industry conference-goers were able to mingle and answer questions from those about to come into the industry. The 'Guess the rock' competition was a challenging one, with none of the secretly submitted answers getting it right. Eventually Dominic Brown from GSQ yelled out "stibnite" and took home the rare rock.

On the Thursday, the six hour long High-School Student programme was attended by ~50 students from across Brisbane and was packed full of activities. The Committee organised various stations including: Geochem molecular model building, Interpreting the deep seismic GA section, Water quality mapping, and Resource contouring from boreholes. The day was MC'd by an Australian of the Year-Local Hero winner

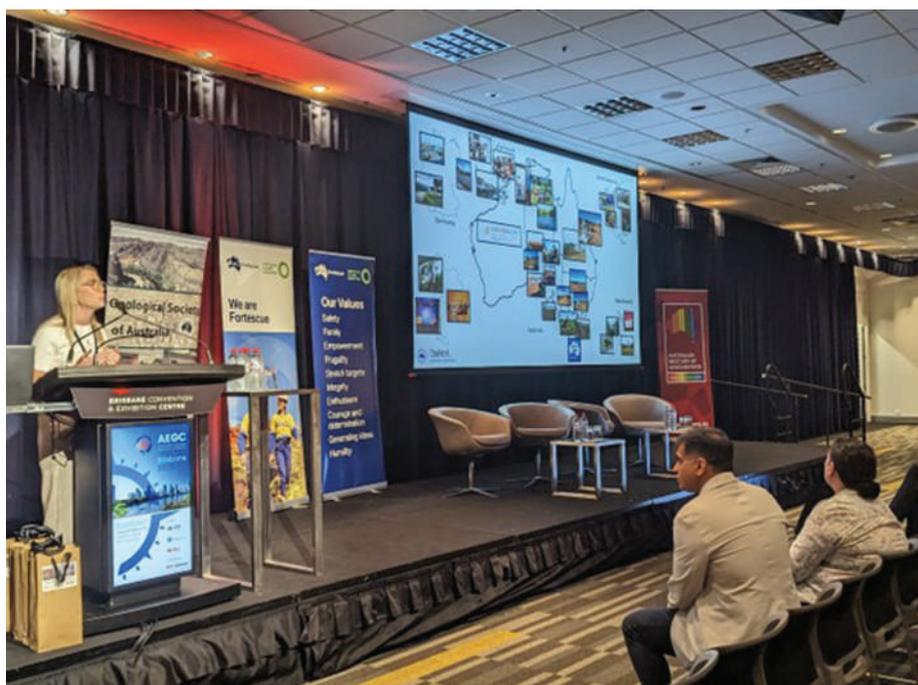


Suzy Urbaniak asking the high school students to classify their resources during the AEGC 2023 High-School Student programme.

and STEM educator, Suzy Urbaniak. Suzy flew from WA and her colourful hair and 'Get-them-to-figure-it-out-for-themselves' and 'Don't help the kids Nick' attitude was really engaging. Suzy started by giving the students a pop-quiz about what resources are used in day-to-

day life and where to mine/extract them. This got the students thinking and once they warmed up, they hit the stations.

The geophysics station required the students to put pen to paper and interpret structures and horizons and to



Dr Kate Brand in the Industry Q&A panel session showing a national view, through images, of where geoscience can take you.



Ao Chang at the GeoPitch explaining her PhD work on a geostatistical approach to Full Waveform Inversion.

position some drill hole locations to test some made up resource targets on GA seismic line 17GA-SN5. The high school students had no seismic experience, no geophysics experience, and some had no geoscience knowledge at all, yet in 15 mins they had created a variety

of interpretations. They did a very impressive job, the brightest picking out that 'this group of wiggles looked like that group of wiggles', and the best asking 'why'? Following the station activities and a Suzy-led 'what did you learn?' debrief, the students were let



Young Professionals networking during the Brisbane Brews event.

loose in the Exhibition Hall to engage with the booths, which morphed into a 'grab as much merch you could carry' event.

The Committee's next organised day commenced with an Industry Q&A panel session designed to facilitate the engagement of Young Professionals or Early Career attendees with some of the most interesting and successful people in geoscience: former ASEG President and general 'the sky is not the limit' go-getter, Kate Brand, the esteemed new CEO of the AIG, Jaime Livesly, and globe-trotting SEG Member, Jan Franke. The turnout was low, but this allowed for a much more open and free-flowing Q&A. The mic was run to nearly every single member of the audience, and the event touched on some pretty personal topics like gender in the workplace, work-life-family balance and even team leadership tips. One early career/PhD candidate said it was her favourite part of the conference, which certainly made the panel worthwhile.

That afternoon came the GeoPitch, attracting ten very keen and impressive undergraduate and early career presenters who gave a strict three-minute geoscience summary of a topic they were interested in. They were so impressive that the judges, including me, had a difficult job picking a winner. It turns out at least one GeoPitcher has already had job opportunities stem from their presentation.

Finally, a Brisbane Brews event on the last afternoon was well warranted, allowing for the exchange of contact details, congratulations and farewells to new connections made during the conference. This was one of the most well attended YPN events at the conference, and was put together by the new ASEG President Elect Janelle Simpson. From the loads of meetings, the emails and phone calls hunting for rocks, to the horrendously butchered pronunciation of panellists names, and meeting one student whose merch grabbing skills surpassed my own, all the work our EC&S Committee poured into these events did, in hindsight, pay off!

Nick Josephs
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ASEG Technical Standards Committee: Meeting summary

ASEG Technical Standards Committee held an online meeting a month after the AEGC 2023. Thirteen members participated. Apologies to those unable to attend due to other commitments, and who missed the opportunity to make a contribution on their topics of interest. The meeting minutes have been distributed and only the topics which elicited discussion or are considered timely are summarised here.

Magnetic gradiometry

The conversation has quickly shifted from *if* to *when*, as the GSNSW has already taken the lead by commissioning magnetic gradiometry surveys for their projects. The technique was also included in Geoscience Australia's new guide to airborne surveying standards. <https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/147457>

While we have been pushing this technique for producing superior grids, the NSW members of the Committee explained that there is another benefit in that surveyors can fly above 50 m, which is safer, whilst retaining data fidelity. It is important to understand, however, that in *lieu* of gradients, contractors may not fly tie lines, and that there are IP issues over the gridding technique. So, it is recommended clients seek grids made using suitable software that accounts for these issues.

Radar, elevation and ellipsoids

Three topics that reduce to one. Laser altimeter surveys are increasingly

common but they are not a staple and questions remain about discriminating ground from vegetation when surveys can change height abruptly by 50 m.

A push for better DEM models generated by LiDAR began with airborne gravity users but appears to be catching on. LiDAR data is being lodged with state surveys by industry, and various government initiatives have covered 70% of Tasmania with 1 m resolution.

All this led to a discussion of preferred gravity height datums. Ellipsoidal heights from GPS require no transformation and therefore there are fewer errors, but most products are AHD. DEM models provide back calculation, but can you trust a value? Kim Frankcombe demonstrated some geoid transformation confusion where ellipsoidal gravity heights differ by 15 m to their surrounds. Consequently, it was agreed that the measured GPS ellipsoidal heights should be included in metadata along with details of the geoid model used to derive the geoid height.

Airborne gravity

Geoscience Australia is currently running surveys to improve geoid definition with whoever wins the tender. Hopefully the various airborne gravity platforms can be brought together to find a common data set.

Drones

The state of drone magnetic surveys, usually using 1000 Hz magnetometers, is still considered substandard to airborne

with problems such as the inability to cleanly merge surveys only one day apart over the same area. Consultants also have trouble converting data into an acceptable format. It is hoped that companies continue to work on ironing out the problems and look to Geoscience Australia's published airborne survey standards as a general guide

To promote improvements the Committee will petition the Federal Executive to join the SEG's Near-Surface Geophysics Inter-Society Committee, which authors the UAV Guidelines for drone geophysics <https://www.guidelinesfordronegeophysics.com/>

File and data naming conventions

Finally, we compared GA's new guide to airborne surveying standards and the SEG's guide "An introduction to Total Magnetic Field Magnetic Nomenclature" for tackling standard names for data collected and grid products. Most surveyors have experience with GA and generally follow the naming conventions recommended by that organisation. Both are good references for column names and GDF2/database aliases. The Committee will formally respond to the SEG authors with thanks and express the ASEG's agreement on most points.

Thank you for your interest. If you have any comments, please email the Committee at technical-standards@aseg.org.au.

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

The ASEG in social media

social

sow+shl

[adjective]

Relating to society or its organisation.

[noun]

Social media sites, applications, or accounts.

"Follow all our socials for the latest updates!"








ASEG branch news

Queensland

Following a hiatus to allow the haze of perhaps one too many 'networking'

events at the AEGC to clear, the latest event in Queensland was the 2023 AGM on 27 April. Hosted within the luxurious confines of the Stock Exchange Hotel

in central Brisbane, a raucous crowd was on hand to witness the latest ASEG regime change. After a robust exchange of ideas and a compelling leadership debate, **Nick Josephs** elbowed his challengers aside and assumed the mantle of Branch President. His first abuse of power was to anoint his successor as Secretary (**Tim Dean**), with **Roger Cant** keeping the financial path smooth as Treasurer. Following the coup formalities, the rowdy crowd settled down to a compelling presentation of his geophysical career by **Denis Sweeney**, hard to imagine that it would be possible to fit more into 46 years (including his brief career as an (alleged) master criminal).

Upcoming events in the Sunshine State include a presentation by **Randall Taylor** on "Exploration in Timor Leste" on 20 July. As always, we strongly encourage Brisbane-based members to get along to events, especially those who have an interesting presentation they would like to share (the audience are always gentle and the beers are always cold!).

Tim Dean
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Outgoing Queensland President James Alderman transfers the microphone of power to incoming President Nick Josephs in exchange for a bottle of wine.

South Australia and Northern Territory

Following on from the highly successful 2023 AEGC in Brisbane, the SA-NT Branch hosted **Nick Jarvis-Bardy** from Orica: Digital Solutions on April 12. Nick gave a highly educational talk entitled "Using NMR to characterize aquifer properties in *in-situ* mining: An Australia uranium case study".

On May 24 we hosted SEG Honorary lecturer **Professor Roman Pevzner** for an interesting lunch time lecture entitled "Surface and borehole seismic monitoring of CO₂ geological storage".

The committee has been busy getting this organised for this year's Melbourne Cup Event, the 2023 Wine offer, and the next technical talk to be presented by **Dr Mike Hatch** entitled "Application of shallow electromagnetics surveys (Loupe EM) to support management of environmental water to floodplains on the River Murray in SA". Keep your eyes peeled for further information.



Denis Sweeney summarising his varied career in geophysics at the April meeting of the Queensland ASEG Branch.

And lastly, we couldn't host any of our fantastic events without the valued support of our sponsors. The SA-NT Branch is currently sponsored by **Beach Energy, Borehole Wireline, Oz Minerals, Vintage Energy, Minotaur Exploration, the Department for Energy and Mining, Zonge, Santos and Heathgate.**

Paul Soeffky
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Tasmania

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

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Victoria

I am relishing my Sundays of late. The cooler weather hasn't curbed my enthusiasm for outdoor activities, nor has it dampened my outlook for the anticipated frenzied work week ahead. Rain or shine, hail or snow, I am revelling in the delights Sundays have to offer. As the saying goes, "Sunday Funday", and that's my favourite motto of late. It is exactly what the 1980s pop band, The Bangles, endorsed in their mega-hit song Manic Monday – "I wish it was Sunday, cause that's my funday." Of course, the flip side to enjoying the weekend too much, on this particular weekend, was forgetting to write this Victoria Branch contribution for *Preview* and submitting it on time to our Editor. Dang!

On this extraordinarily lazy Sunday night, I had just generously heaped my third glass of red wine after watching my beloved footy team win its round match. There's no denying it, I was uber loafing. What on Earth should I write about for this *Preview* edition? I was staring at a blank screen that was staring right back at me, or so I thought it was (excessive drinking makes you question your sanity). I must have stared at the computer screen for a good 60 seconds before having a light-bulb moment – I should let ChatGPT write this contribution on my behalf. For those of you living under a rock the

past few months, which is nothing to be proud of, by the way, ChatGPT (**Chat Generative Pre-Trained Transformer**) is this crazy new artificial intelligence chatbot developed by OpenAI that uses natural language processing to create humanlike conversational dialogue. I sh** you not. Here's what I asked it to perform – "Write the *Preview* contribution article for the Victoria Branch of the Australian Society of Exploration Geophysics." The following was its response:

Certainly! The Australian Society of Exploration Geophysicists' Victoria Branch has been making waves recently with their latest news. As a community of geophysicists, this group is dedicated to promoting the exploration and development of natural resources within Australia. One of their recent events was a seminar on the use of geophysics in mineral exploration. This seminar brought together experts from the field to discuss the latest advances and techniques in geophysical exploration, with a focus on how these can be applied to mineral exploration in Victoria.

Another exciting development from the Victorian Branch is their partnership with local universities and research institutions. Through this collaboration, they are able to provide opportunities for students and young professionals to learn from experienced geophysicists and gain valuable hands-on experience in

the field. Additionally, the ASEG Victoria Branch is committed to promoting diversity and inclusion within the geophysics community. They do this through initiatives such as scholarships for underrepresented groups and outreach programmes to encourage young people from diverse backgrounds to consider a career in geophysics.

Overall, the Australian Society of Exploration Geophysicists' Victoria Branch is a vibrant and active community dedicated to advancing the field of geophysics in Australia. With their commitment to innovation, education, and diversity, they are sure to make a positive contribution.

Now, I don't know about you, but the above answer made me look very, very respectable as Branch President. It all sounds very plausible, but it isn't entirely correct. Of course, the language is excessively verbose, which is not my style 😊. I started playing around with my questions, tweaking my input phrase, even making inappropriate requests. Interesting how it responded to somewhat harmful instructions, which I won't reproduce here (you'll just have to download the code yourself!). ChatGPT is astoundingly powerful, and scary. It can write your essays or social media posts, give you quick answers to anything you might want to know more on, write code, craft resumes and cover letters,



Rob Hewson presenting to the Victoria ASEG Branch.

ASEG news

translate content, improve grammar... hell, even give you culinary ideas and make restaurant suggestions.

Not surprisingly, ChatGPT has been collecting my data. Eeeek! Every conversation I've had so far, regardless of how uncomfortable, personal or stupid they may be, has made the model slightly more aware and smarter. I am worried it has been manipulating the information I've been sharing with it. This is quite sinister. The more I interact with it, the more sophisticated it becomes in crafting the illusion of accuracy. I am wholly addicted to it now.

In actual Branch news, members greeted Dr **Rob Hewson** to The Kelvin Club on 9 May where he presented "Current and future trends in spectral and remote sensing geology". Rob introduced members to some of the latest hyperspectral satellite VNIR-SWIR sensors available to explorers that are providing a wealth of new global surface mineral related imagery. He provided several examples for geological applications with data from Aster (NASA/METI), WorldView-3 (Maxar), Sentinel-2 (ESA) and PRISMA (ESA) over the Jervois Cu-Pb-Zn-Ag polymetallic deposit in the Northern Territory and the Haib copper porphyry prospects in Namibia as a means for routine geological mapping. The imagery can potentially discriminate changes in the physical properties of soils, regolith and outcropping basement rocks where they relate to the distribution of minerals and variations in mineral chemistry at the surface.

The Victoria Branch is expecting a flurry of social and technical events over the next few wintery months. Make sure you subscribe to the ASEG's various social media outlets for up-to-date information. Now, if you don't mind me, I'm going to pick a fight with ChatGPT by trying to convince it that Klingons and Vulcans are two silicon-based lifeforms that never would have evolved the way they did in the Star Trek Universe had Captain James Cook not observed the transit of Venus from Tahiti in 1769 😊

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Western Australia

The ASEG WA Branch hosted a technical talk on April 27 as part of its

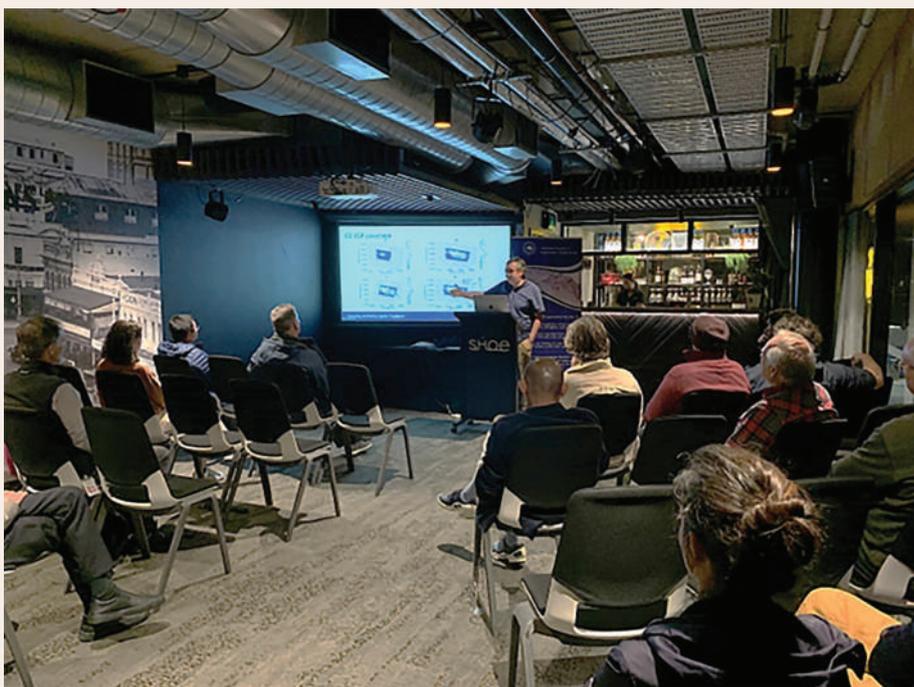
monthly technical talk series. The talk, entitled "Surface and borehole seismic monitoring of CO₂ geological storage", was presented by Professor **Roman Pevzner**. Professor Pevzner joined Curtin University (Perth, Western Australia) in 2008 as an Associate Professor in exploration geophysics, progressing to Professor in 2018. Previously, from 2002–08 he was head of the software development department at DECO Geophysical Service Company. Simultaneously he conducted research and taught in the Geological Faculty of Lomonosov Moscow State University, Seismometry and Geo-acoustics Department. Roman Pevzner received his PhD in geophysics (2004), Master of Science in geophysics (2001), and Bachelor of Science in geology (1999) from Lomonosov Moscow State University.

In his talk, Professor Pevzner presented geological carbon capture and storage (CCS) or sequestration as a critical component of CO₂ emission reduction, which aims to alleviate global climate change. Geological carbon storage requires a subsurface monitoring programme to address two main goals: surveillance at the reservoir level to verify compliance of the growing CO₂ plume with the original plan, and early detection of adverse effects - such as leakage of the injected fluid from the containment

zone or significant induced seismicity associated with the injection.

Seismic methods play an important role in achieving both goals. Changes in CO₂ saturation in the pore space inside the storage reservoir or in the overburden result in changes of elastic properties detectable through changes in seismic reflectivity or travel times. Induced seismicity generates a direct signal usually associated with the propagation of the pressure front.

The range of seismic methods that can be deployed includes surface and borehole active time-lapse seismic surveys with re-deployable or permanently mounted source and receiver arrays, and passive monitoring, e.g., using any wave field components originating from seismic sources beyond our control. Many CO₂ geosequestration sites are located near large sources of CO₂ emission, such as populated areas with existing infrastructure. As such, the monitoring strategy must accommodate sharing the land (or ocean) with other users and have a minimal environmental impact. Furthermore, geosequestration is a form of waste disposal that must be cost-efficient. All these factors make CCS a leader in innovation, being an early adopter of such disruptive technologies as distributed fibre optic sensing and permanent reservoir monitoring. Small-scale demonstration



Professor Roman Pevzner addressing ASEG WA Branch members at the technical night.

projects focusing on the testing and development of CCS technologies play a critical role in this innovation.

This talk was based on Australian CCS projects, such as the CO2CRC Otway Project and CSIRO In-situ Lab Project, which showcase the evolution of the seismic monitoring technology from conventional land 4D seismic to continuous or on-demand monitoring using permanent downhole and near-surface geophone and distributed acoustic sensing (DAS) arrays. Professor Pevzner discussed how monitoring objectives can be achieved using various acquisition geometries, including land 4D, 4D vertical seismic profiling (VSP), and offset VSP, all of which can be implemented using conventional and permanently mounted seismic sources. He also covered in his talk the automation of data acquisition and analysis and passive data analysis.



The ASEG WA Branch recently took part in the [Perth Careers Expo 2023](#). The careers event is one of a kind in WA, bringing together all the local, and several interstate, universities. Additionally, a huge range of vocational and professional training organisations, industry associations and employers were represented. The event was held over four days between May 18-21. ASEG members volunteered their time to help staff a booth packed with brochures, photos, rock samples and various geophysical instruments, all of which aimed to promote careers in geophysics to high school and tertiary students and parents.

On the Young Professionals front, ASEG WA have launched the 2023 Joint Industry Mentoring Programme, which is a collaboration between nine professional associations: Energy Club of WA (ECWA), Australian Society of Exploration Geophysicists (ASEG), Petroleum Exploration Society of Australia (PESA), Society of Petroleum Engineers (SPE), Engineers Australia (EA), Society for Underwater Technology (SUT), Subsea Energy Australia (SEA), Professional Petroleum Data Management Association (PPDM) and WiSE. This exclusive programme is free

for ASEG Members and is designed to provide students and early career geoscientists with the opportunity to develop a relationship with an experienced industry professional and to enhance professional development and provide support. The duration of the programme is six months (May – October).



Emad Hemyari
WA Branch Communications Officer
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Australian Capital Territory

On April 19 the ACT Branch hosted a talk by **Leslie Wyborn** titled “Using 2030 computational techniques to unleash the untapped potential of existing geophysical datasets in mineral exploration: Opportunities and challenges”. Leslie discussed the ways that we can prepare our increasingly large geophysical datasets for the next generation of technologies and computational infrastructures by 2030. She also discussed how many organisations like AusScope, Australian Research Data Commons (ARDC), and Australia’s Terrestrial Ecosystem Research Network (TERN) are working towards these goals. The talk raised a number of questions and discussion is ongoing.

After Leslie’s talk, the ACT Branch held its 2023 AGM. Thank you to the outgoing committee and congratulations to the new committee. It’s good to see a balance between experienced people and new blood on the new committee. After the AGM about a dozen people had a delicious dinner at the nearby Rubicon Restaurant.

In the last week of May **Sebastian Wong** gave a very interesting talk entitled “Continental-scale multilayered chronostratigraphic interpretation of

airborne electromagnetics”. We have also invited a number of other talks that will be given in coming months.

I would like to acknowledge **Phillip Wynne** for his presidential work over the past year and thank **Mike Barlow** for staying on as Secretary. I greatly appreciate their help with my first attempt at the ACT Branch news.

And, don’t forget the about Geoscience Australia’s Wednesday seminars (<https://www.ga.gov.au/news-events/events/public-talks>). These seminars are a good source of geoscientific information that includes the use of geophysics.

Wenping Jiang
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New South Wales

In April, **Jaime Andres Alvarado Montes**, a PhD Candidate from Macquarie University, presented a talk entitled “Unveiling New Horizons of the Cosmos with the James Webb Space Telescope.”

As a technologically sophisticated (and costly) instrument, the James Webb Space Telescope (JWST) is revolutionizing our understanding of the cosmos. Jamie delved into the ground-breaking discoveries and advancements made possible by the JWST. Positioned at the second Lagrange point, the JWST operates in the earth’s shadow and employs a solar shield to block out heat from the sun, earth, and moon. This unique advantage keeps the telescope at extremely low temperatures, allowing it to observe in the infrared range with unparalleled precision.

Jaime explained how JWST’s cutting-edge instruments and thermally stable position provide unprecedented access to the most distant reaches of the universe. This access facilitates our understanding of the universe’s origins, ancient galaxy formation and evolution, properties of extrasolar planets, and the development of our own solar system and life as we know it. During the talk, Jaime also discussed JWST’s intricate journey to orbit and highlighted some of its most significant discoveries to date, showcasing the telescope’s remarkable impact on the field of astronomy.

An invitation to attend NSW Branch meetings is extended to all interstate



and international visitors who happen to be in town at the time. Meetings are generally held on the third Wednesday of each month from 17:30 at Club York. News, meeting notices, addresses and relevant contact details can be found at the NSW Branch website.

Harikrishnan Nalinakumar
 nswsecretary@aseg.org.au

Jamie discussing the different components associated with the James Webb Space Telescope.

ASEG national calendar

Date	Branch	Event	Presenter	Time	Venue
ASEG Branches hold face-to face meetings and webinars. Registration for webinars 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/2ZNglaz). Please monitor the Events page on the ASEG website for the latest information about events.					
25 May	SA-NT	Fall Fling		1700	Havelock Hotel, 162 Hutt Street, Adelaide
25 May	Qld	ASEG-PESA Trivia night	Henk van Paridon	1700	Stock Exchange Hotel, 131 Edward Street, Brisbane City
1 Jun	WA	Tech night	Michelle Thomas	1730	The Shoe Bar and Café 376-420 Wellington St., Perth
15 Jun	SA-NT	Tech talk	Mike Hatch	1730	Thomas Cooper Room, Coopers Alehouse, Adelaide
22 Jun	WA	Tech night Title:	Brian Evans	1730	The Shoe Bar and Café 376-420 Wellington St., Perth
19 Jul	NSW	Technical meeting	TBA	1730	Club York, York St., Sydney
20 July	Qld	Tech talk	Randall Taylor	TBA	TBA

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



AEM 2023: Update

On behalf of the AEM 2023 Organising Committee I invite you to become part of the **8th International Airborne Electromagnetics Workshop**. The event will be held between Sunday the 3rd and Thursday the 7th of September 2023, at the Fitzroy Island Resort in tropical north Queensland, Australia. The conference is hosted by the Australian Society of Exploration Geophysics (ASEG) and CSIRO.

It's getting close to the event, and we've had over 60 abstract submissions from ten countries. The subjects vary

from acquisition, system development and improvements, semi-airborne systems, case studies for groundwater, volcanology and minerals applications, open-source data and software and AI to name just a few. It's great to see work from such widely varying perspectives being shared at this workshop, which is part of a series held only every five years.

Our invited speakers will also be covering a variety of topics, with authors including Andrew Green, Magdel Combrinck, Lindsey Heagy,

Katherine McKenna, Bradley Moggridge, Andi Pfaffhyber and Bernhard Siemon. Our confirmed sponsors include Xcallibur Multiphysics, Skytem, Geoscience Australia and NRG. For those considering sponsorship, there are still plenty of opportunities.

We are taking over the whole resort to host AEM 2023 and anticipate a relaxing and intimate occasion to update yourself with all things AEM. To reiterate information available on the webpage (www.aem2023.org.au) the conference kicks off at sunset on Sunday the 3rd September, with the technical programme starting early in the morning on Monday the 4th September. It's a four-day workshop but, to provide participants with an opportunity to experience the unique setting of Fitzroy Island, we have a half day of leisure activities planned for Wednesday morning. We recommend people stay on after the full day session on Thursday, and depart on Friday morning.

Whilst in north Queensland it would be a shame to miss the variety of tourist attractions on offer, and we suggest that delegates plan to prolong their visit. I recently took a boat trip to the outer reef and I can personally recommend a day on a pontoon with the opportunity to snorkel, scuba dive, or simply ride in a glass bottom boat as a way of exploring the marine life of the Great Barrier Reef. There are also plenty of onshore activities ranging from visiting the Daintree rainforest, to visiting a local crocodile farm. Go to <https://www.tropicalnorthqueensland.org.au/> to see what other attractions may be of interest to you.

Andrew Fitzpatrick
Chair Organising Committee
AEM 2023
Andrew.Fitzpatrick@igo.com.au



My daughter snorkeling with a Blue Wrasse on the outer reef – an opportunity not to be missed.

AEM2023

REGISTRATIONS NOW OPEN

8th International Airborne
Electromagnetics Workshop

4 - 7 September 2023
Fitzroy Island, QLD, Australia

Contact: aemconference@theassociationsspecialists.com.au








Geoscience Australia: News

Recent highlights of Geoscience Australia’s geophysical projects, as conducted under the Australian Government’s Exploration for the Future initiative, and in collaboration with our State and Territory survey partners, are summarised below. Details of all current and recently completed projects and survey locations can be found in [Figure 1](#) and the tables that follow this section.

Australian Fundamental Gravity Network refurbishment.

Geoscience Australia (GA) is responsible for the maintenance of the Australian Fundamental Gravity Network, which underpins the Australian National Gravity Database and provides the datum for gravity surveys carried

out throughout Australia. As part of ongoing maintenance to the Australian Fundamental Gravity Network, staff from GA and the Geological Survey of Queensland (GSQ) are currently undertaking a field trip to locations in northern Queensland to remediate and create AFGN benchmarks by re-establishing destroyed benchmarks and establishing new AFGN benchmarks as required, plus checking the conditions of other benchmarks ([Figure 2](#)). This work is a collaborative effort between GA and GSQ. Field work will be completed by the end of May 2023.

For further information on the AFGN, please contact Phillip Wynne, Geophysicist - Geophysical Acquisition and Processing, at Phillip.Wynne@ga.gov.au

Cobar-Yathong region airborne electromagnetic survey (AEM) and airborne magnetic and radiometric (AMR) survey

Geoscience Australia, in collaboration with the New South Wales (NSW) Government’s Geological Survey of NSW, have been undertaking an airborne AEM survey over the Yathong region of NSW ([Figure 3](#)). Acquisition is now 100% complete, with approximately 2700 km of data acquired over the area. The Cobar-Yathong region airborne magnetic and radiometric (AMR) survey is expected to commence acquisition in the third week of May. Acquisition will be along east–west lines spaced 200 m apart and north–south lines spaced 2 km apart. The objective of this survey is to

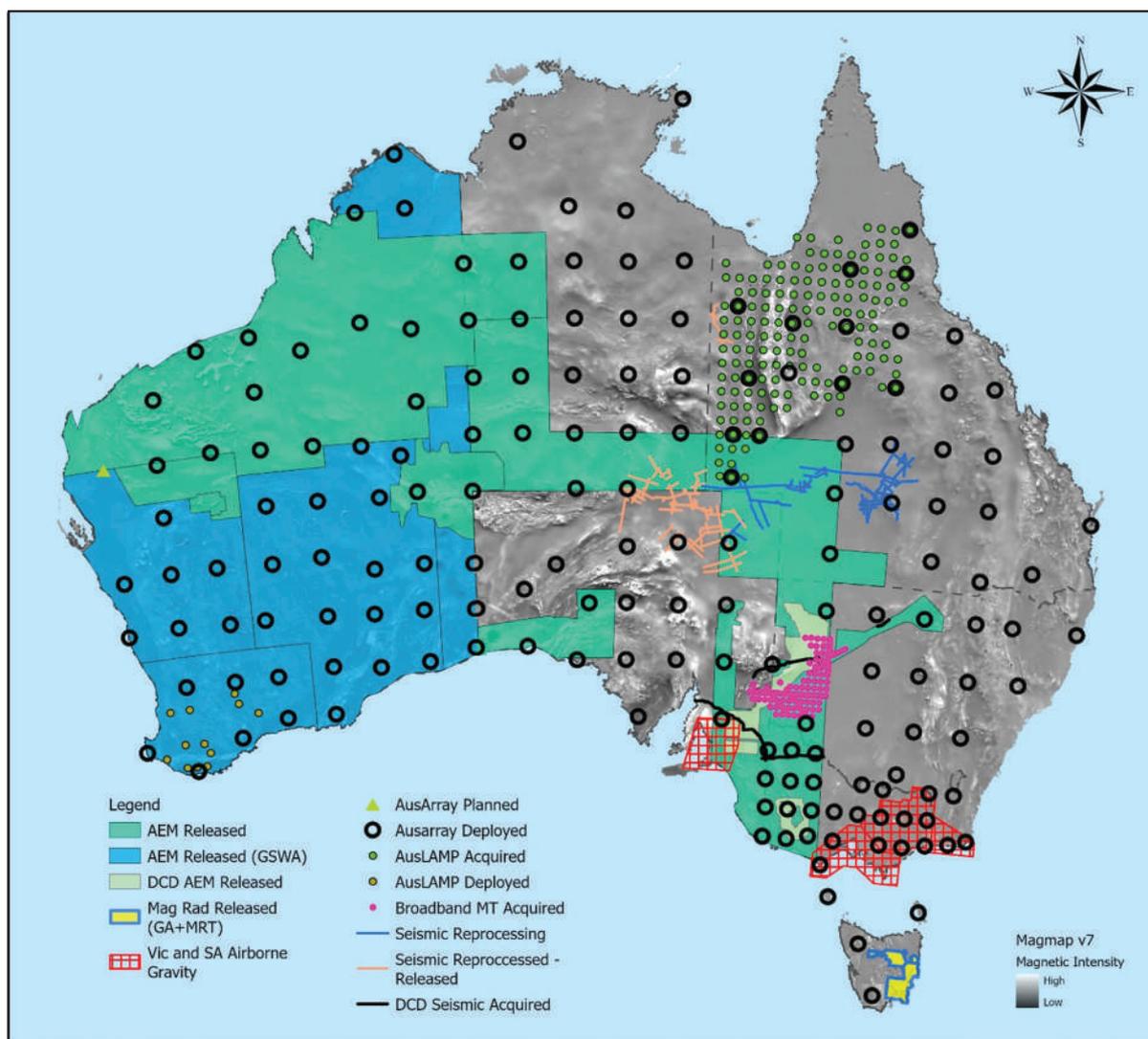


Figure 1. 2021-2023 geophysical surveys – in progress, released or for release by Geoscience Australia as part of Exploring for the Future (EFTF) and in collaboration with State and Territory agencies. Projects that are partially or wholly funded by state government agencies are identified by the bracketed contributors. Background image of national magnetics compilation (first vertical derivative of the reduced to pole magnetics), Geoscience Australia, 2019 (see <http://pid.geoscience.gov.au/dataset/ga/144725>).

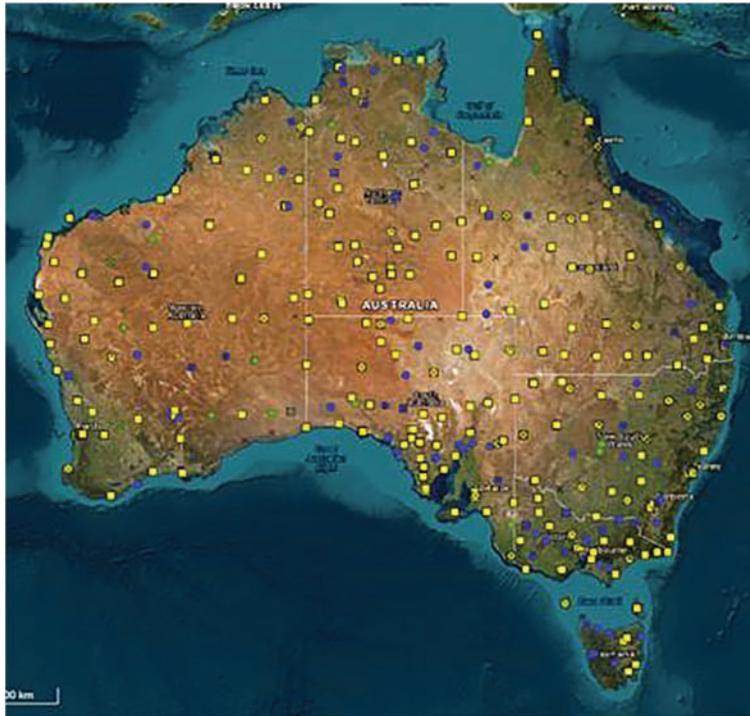


Figure 2. The Australian Fundamental Gravity Network, showing current status of instruments: blue and green circles, good; yellow squares, unknown; black cross, destroyed.

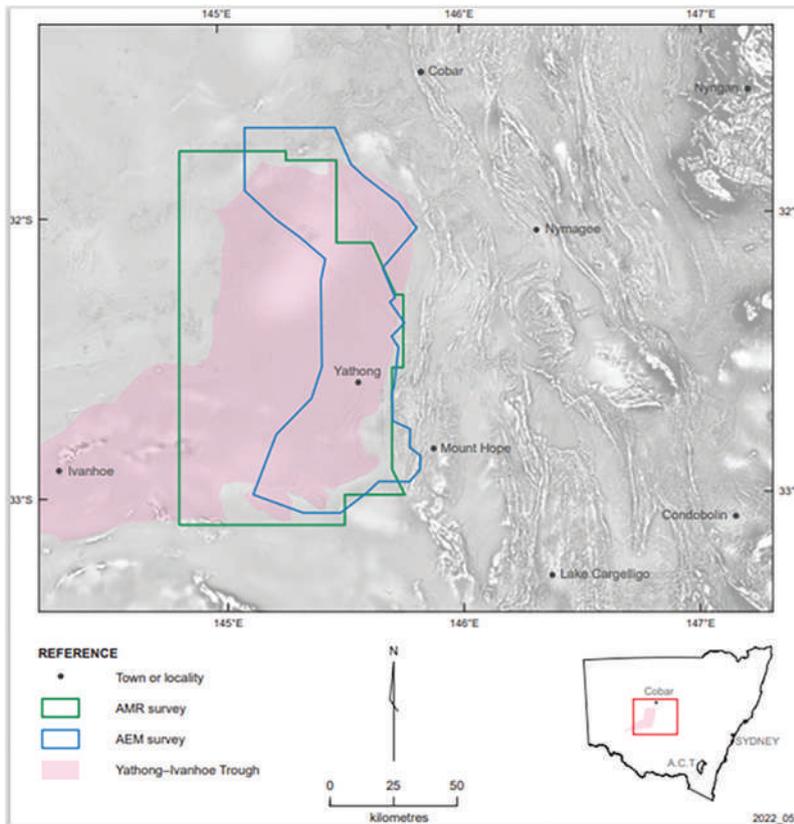


Figure 3. Location of the Cobar-Yathong region AEM and AMR surveys.

acquire data to expand knowledge of the geology and potential deep groundwater resources in the area.

For further information on these surveys, please contact Astrid Carlton, Senior

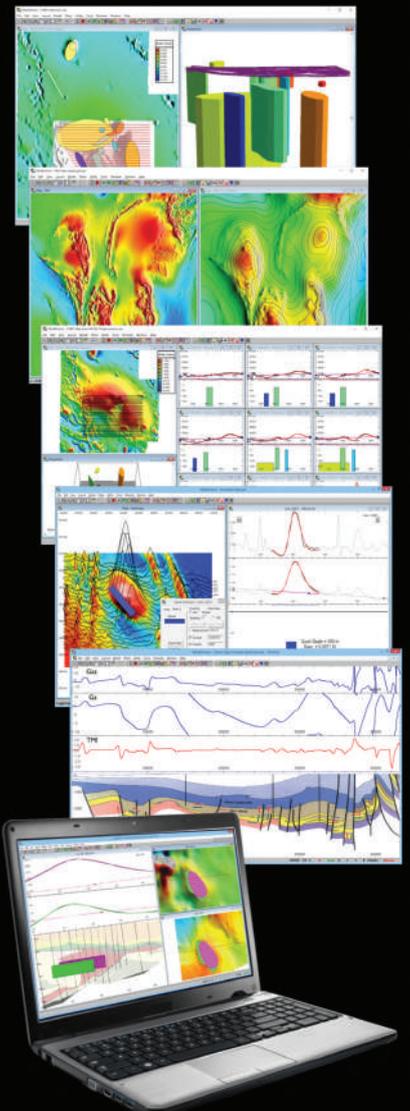
Geophysicist - Geological Survey of NSW, at astrid.carlton@regional.nsw.gov.au

Donna Cathro
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News

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 30 May 2023)

The survey details are provided for information only, and on the understanding that the Australian Government is not providing advice. Further information about these surveys is available from Adam Bailey Adam.Bailey@ga.gov.au (02) 6249 5813 or Donna Cathro Donna.Cathro@ga.gov.au (02) 6249 9298 at Geoscience Australia.

Table 1. Airborne magnetic and radiometric surveys

Survey name	Client	Project management	Contractor	Start flying	Line km	Line spacing Terrain clearance Line direction	Area (km ²)	End flying	Final data to GA	Locality diagram (Preview)	GADDS release
Eastern Tasmania	MRT	GA	MAGSPEC	Mar 2022	57 000	200 m	11 600	Jun 2022	Sep 2022	See Figure 1 in previous section (GA news)	Dec 2022 - http://pid.geoscience.gov.au/dataset/ga/147455

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 (km ²)	End survey	Final data to GA	Locality diagram (Preview)	GADDS release
Canobie	GSQ	GA	Xcalibur Multiphysics	Nov 2021	~5000	1–2 km	5300	Dec 2021	Mar 2022	See Figure 1 in previous section (GA news)	Released by GSQ and GA, Apr 2022 https://dx.doi.org/10.26186/146760
Brunette Downs Ground Gravity	NTGS	GA	Atlas Geophysics	Oct 2021	~ 12 000	2 x 2 km grid	55 000	Apr 2022	May 2022	See Figure 1 in previous section (GA news)	Released by NTGS and GA in Jun 2022 https://dx.doi.org/10.26186/146941
Melbourne, Eastern Victoria, South Australia	AusScope GSV DEL WP	GA	Sander Geophysics	TBA	137 000	0.5–5 km	146 000	Expected Jun 2023	~ Oct 2023	See Figure 1 in previous section (GA news)	Late 2023
Kidson Sub-basin	GSWA	GA	Xcalibur Multiphysics	14 Jul 2017	72 933	2500 m	155 000	3 May 2018	15 Oct 2018	See Figure 1 in previous section (GA news)	Dec 2022 http://pid.geoscience.gov.au/dataset/ga/147481
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	Oct 2022 https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/147066
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	Oct 2022 https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/147066
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	Oct 2022 https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/147066
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)	Nov 2022 https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/147265
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 the national database in 2022

TBA, to be advised

Table 3. Airborne electromagnetic surveys

Survey name	Client	Project management	Contractor	Start flying	Line km	Spacing AGL Dir	Area (km ²)	End flying	Final data to GA	Locality diagram (Preview)	GADDS release
Western Resources Corridor	GA/GSWA	GA	Xcalibur Multiphysics	May 2022	~ 38 000	20 km	760 000	Oct 2022	Dec 2022	See Figure 1 in previous section (GA news)	Mar 2023 https://dx.doi.org/10.26186/147688
Musgraves	GA	GA	Xcalibur Multiphysics	Jun 2022	~ 22 000	1 – 5 km	~ 100 000	Aug 2022	Dec 2022	See Figure 1 in previous section (GA news)	Mar 2023 https://dx.doi.org/10.26186/147688
Upper Darling River	GA	GA	SkyTEM	Mar 2022	25 000	.25 – 5 km	14 509 line km	Jun 2022	Oct 2022	See Figure 1 in previous section (GA news)	Oct 2022 http://pid.geoscience.gov.au/dataset/ga/147267
Darling-Curnamona-Delamerian	GA	GA	SkyTEM	Jun 2022	14 500	1 – 10 km	25 000 line km	Oct 2022	Dec 2022	See Figure 1 in previous section (GA news)	Feb 2023 https://dx.doi.org/10.26186/147585
Eastern Resources Corridor	GA	GA	Xcalibur Multiphysics	Apr 2021	32 000	20 km	640 000	Jul 2021	Oct 2021	See Figure 1 in previous section (GA news)	Oct 2021 http://pid.geoscience.gov.au/dataset/ga/145744
AusAEM20	GSWA	GA	Xcalibur & SkyTEM	Aug 2020	62 000	20 km	1 240 000	Nov 2021	Dec 2021		Released Mar 2022 - http://pid.geoscience.gov.au/dataset/ga/146345

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/WA	Exploring for the Future – AusLAMP	483 stations deployed 2016-22	50 km	Long period MT	The survey covers areas of NT, Qld and WA. Data acquired 2016-19 and related model released 2020. Data package: http://pid.geoscience.gov.au/dataset/ga/134997 Model: http://pid.geoscience.gov.au/dataset/ga/145233 News article: http://www.ga.gov.au/news-events/news/latest-news/exploring-for-the-future-takes-a-deeper-look-at-northern-australia Data acquired 2020-22 and related model will be released mid-2023.
AusLAMP NSW	GSNSW/GA	NSW	AusLAMP NSW	~300 stations deployed 2016-21	50 km	Long period MT	Covering the state of NSW. Acquisition is essentially complete with fewer than 10 sites remaining to be acquired or reacquired. Phase 1 data release: http://pid.geoscience.gov.au/dataset/ga/132148 .
Curnamona Province-Delamerian Orogen	GA/GSNSW/GSSA/University of Adelaide	NSW/SA	Exploring for the Future - Curnamona Cube Extension	~100 stations deployed 2023	25-12.5 km	Audio and broadband MT	This survey will extend the University of Adelaide-AuScope Curnamona Cube MT survey from the Curnamona Province into the Delamerian Orogen. Data will be released mid-2023.

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
Darling – Curnamona – Delamerian deep crustal reflection survey	GA	SA, NSW, VIC	Darling – Curnamona – Delamerian deep crustal reflection survey	~1275	10	10/40	20	2D Deep Crustal/ high resolution vibroseis seismic survey.	This survey will create an image of important crustal boundaries including the structure of the Delamerian margin, which runs through NSW, SA and Vic, separating older rocks of the Gawler Craton and Curnamona Province from younger rocks of the Lachlan Fold Belt (Tasmanides). Acquisition commenced in Jun 2022 and concluded in Aug. Raw data for this survey are available on request from clientservices@ga.gov.au Quote eCat# 147423. Data are currently being processed.

(Continued)



News

Table 5. Seismic reflection surveys (Continued)

Location	Client	State	Survey name	Line km	Geophone interval	VP/SP interval	Record length	Technique	Comments
Central Australian basins	GA	Qld/SA	Shallow legacy data	~1257	Varies	Varies	3-20 sec	2D shallow & deep legacy data, explosive, vibroseis	GA commissioned reprocessing of selected legacy 2D seismic data in Qld and SA, as part of Exploring for the Future, Australia's Future Energy Resources Project. The objective is to produce a modern industry standard 2D land seismic reflection dataset to assist in imaging the subsurface. Reprocessing of these data is underway.
Adavale Basin	GA	Qld	Deep and shallow legacy data		Varies	Varies	3-20 sec	2D shallow & deep legacy data, explosive, vibroseis	GA commissioned reprocessing of selected legacy 2D seismic data in the Adavale Basin, Queensland Australia, Data driven Discoveries Initiative. The objective is to produce a modern industry standard 2D land seismic reflection dataset to assist in imaging the subsurface. Reprocessing of the legacy data is complete and the data package will be released in the second half of 2023.

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. Deployment of this national array commenced with an initial 11 seismic stations deployed in the NT in 2021. Deployments in SA and NSW commenced in Apr 2022 and will progress through other states during 2022.
Northern Australia	GA	Qld/NT	AusArray	About 265 broad-band seismic stations	50 km	Broad-band 1-2 years observations	The survey covers the area between Tanami, Tennant Creek, Uluru and the WA border. The first public data release of the transportable array was in 2020. See: http://www.ga.gov.au/efft/minerals/nawa/ausarray Various applications of AusArray data are described in the following Exploring for the Future extended abstracts: <ul style="list-style-type: none"> • AusArray overview: http://pid.geoscience.gov.au/dataset/ga/135284 • Body wave tomography: http://pid.geoscience.gov.au/dataset/ga/134501 • Ambient noise tomography (including an updated, higher resolution model for the Tennant Creek to Mount Isa region): http://pid.geoscience.gov.au/dataset/ga/135130 • Northern Australia Moho: http://pid.geoscience.gov.au/dataset/ga/135179
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
AusARRAY Victoria Collaborative	Project	GA/GSV	Victoria	AusArray – Victoria	~ 20 temporary seismic stations	~100 km	Broad-band ~12-18 months of observations Data acquired from the movable array sites will add to the scientific understanding of the Earth's lithosphere on the national and regional scale. Phase 1 of the deployment (~100 km) was undertaken in Mar 2023.

Table 7. Survey technical requirements

Survey type	Author	Contributors	GA Release
Magnetics, radiometrics and horizontal magnetic gradiometry	James Goodwin	Brian Minty, Ross Brodie, Mark Baigent, Yvette PoudjomDjomani, Matt Hutchens with acknowledgements to Peter Milligan, Laz Katona and Mike Barlow	Mar 2023 http://pid.geoscience.gov.au/dataset/ga/147457
Airborne Gravity and Gradiometry	Negin Moghaddam and Mark Dransfield	Jack McCubbine and Mike Barlow	Mid 2023

Geological Survey of South Australia: Fraser Institute rates GSSA #1 for databases

The Fraser Institute Annual Survey results were released in early May, and South Australia is shining bright! Approximately 1966 exploration, development and other mining-related companies around the world were surveyed in the last five months of 2022, and represent reported exploration spending of US\$1.90 billion in 2022. Amongst other high rankings, SA was ranked number one in the world for "Geological Databases".

The Geological Survey of South Australia (GSSA) manages numerous databases housing a variety of geoscientific information. The GSSA also manages SARIG (the South Australian Resources Information Gateway), an online portal allowing public access to many of those databases.

From a geophysical perspective, one of our most important databases is an Oracle database named SA Geodata. SA Geodata is comprised of numerous modules including a Gravity Module and an Electrical Technique Module. The Gravity Module allows us to

upload gravity observations, along with positional data, and calculates the Bouguer Anomaly for spherical cap and slab models of the Earth, as well as the Free Air Anomaly. There are homes for all survey metadata within the module, and we've flagged individual points that are not suitable for inclusion in state grid products. SARIG auto-harvests gravity information, but some manual work is still required behind-the-scenes to ensure all the spatial layers are updated and re-uploaded.

The Electrical Techniques Module houses Magnetotelluric (MT) metadata and .edi files. Due to their large size, raw MT field observations are not housed on SA Geodata. The induction arrows and phase tensor ellipses that are visible on SARIG are automatically calculated from the .edi files on SA Geodata.

Airborne geophysics, including magnetics, radiometrics, EM, DTM, and gravity are not stored on SA Geodata. We still use an in-house database to track these surveys and all the metadata, but

when interacting with SARIG a user is looking at prepared packages that are not automatically generated. In general, the geophysical survey layers on SARIG need to be generated manually and are run through a test environment before moving to production. For these airborne surveys, SARIG also includes a time slice option, allowing a user to view surveys in the state over 5-year time periods.

Finally, state-wide geophysical imagery aren't part of a database as such, but moving forward it is likely that we'll implement something to keep track of the various products in a robust manner.

For assistance accessing any of these geophysical data packages, please [contact dem.customerservices@sa.gov.au](mailto:dem.customerservices@sa.gov.au)

Ngaityalya
(Kurna, thank you)

Philip Heath
Geological Survey of South Australia
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Geological Survey of Western Australia: Western Officer and Perth Basins SEEBASE reports

In 2005, Frogtech Geoscience completed the Structurally Enhanced View of Economic BASEment (OZ SEEBASE) project, which resulted in a continental-scale depth-to-basement grid highlighting the Phanerozoic basins across Australia. With the acquisition, since then, of many new potential field, seismic and well datasets, as well as more recent Geological Survey of Western Australia (GSWA) seismic interpretation, GSWA contracted Geognostics Australia Pty Ltd to revise the SEEBASE model of the western Officer Basin (within the State jurisdiction) and the Perth Basin, which also includes offshore areas in Commonwealth Waters.

The two SEEBASE projects have markedly increased the resolution of the depth-to-basement model compared to the 2005 version, and have improved identification of major structures, basement faults, crustal architecture and basement composition (Figures 1 and 2). These new products were funded by the State Government's Exploration Incentive Scheme (EIS) and form a valuable pre-competitive dataset for both the minerals and energy industries.

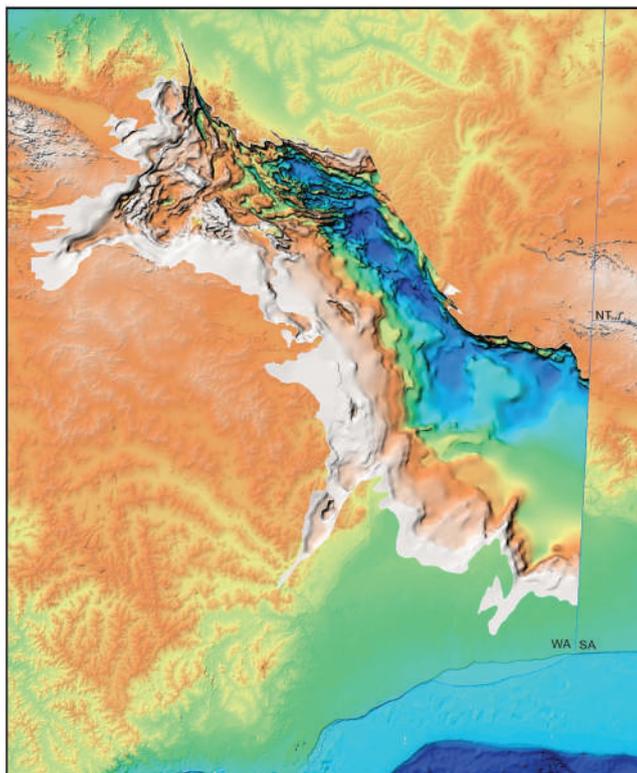


Figure 1. Depth-to-basement map of 2022 SEEBASE project of the western Officer Basin, superimposed on the digital elevation model.

How to access the reports

Report 235 western Officer Basin SEEBASE structural study and GIS, and Report 236 Perth Basin SEEBASE structural study and GIS are available on the Department of Mines, Industry Regulation and Safety eBookshop <<https://www.dmp.wa.gov.au/ebookshop>>. The digital layers and ArcMap projects are available as USB packages and can be ordered from the same location. Digital layers include the various interpreted basement-related layers and processed and filtered magnetic and gravity datasets. The interpreted basement layers can also be viewed in the Energy Systems Atlas, an online interactive map viewer available via [Western Australian Petroleum and geothermal Information Management System \(WAPIMS\)](https://www.wa.gov.au/government/energy-systems-atlas) at <<https://wapims.dmp.wa.gov.au/wapims>>.

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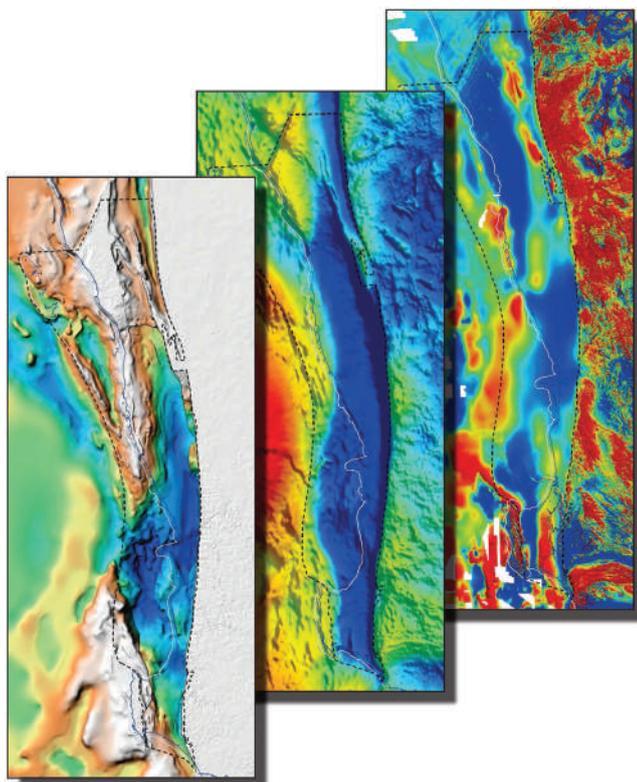


Figure 2. The depth-to-basement, Bouguer gravity anomaly and reduced-to-pole magnetic images from the 2022 Perth Basin SEEBASE project (left to right).

Canberra observed



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Budget 2023-24 good for science and delivers a surplus

What's good now

Treasurer, Jim Chalmers, delivered a good budget for science and technology as well as a small surplus of \$4.2 billion. However, unless the Stage 3 tax cuts are re-considered, and additional revenue generated, the budget will be in deficit for the foreseeable future.

Let's have look at some of the good stuff for science (from the [Science & Technology Australia](#) website).

- \$392 million for the Industry Growth programme over four years (then \$65 million a year ongoing) including funding for Industry Growth Centres.
- \$101 million to grow critical technologies such as quantum and AI.
- \$60 million over four years for Questacon to enable building and technology upgrades and fund its national touring and schools outreach programmes.
- \$9 million to secure funding over the next four years for the Prime Minister's Prizes for Science, Science Meets Parliament and the Prime Minister's National Science & Technology Council.
- \$50 million for the National Measurement Institute to upgrade facilities and create new measurement tools for an array of new frontier technologies.
- Undisclosed funding for ANSTO to upgrade Australia's nuclear medicine facilities.

- \$163 million over four years (doubling operational funding and ongoing funding thereafter) to the Australian Institute of Marine Science.
- \$2 billion for a Hydrogen Headstart programme to accelerate the development of hydrogen clean energy technologies.
- \$1.3 billion for a Powering the Regions programme for emissions reduction and clean energy development.
- Establishment of the National Reconstruction Fund Corporation with ongoing funding of \$64 million a year.
- 4000 new university places for students studying degrees to advance Australia's nuclear-powered submarine capabilities under AUKUS.

Details of how the main scientific agencies fared are shown in [Table 1](#). This was compiled from Budget paper No 4, an easy-to-use document listing the funding for all the agencies funded by the Australian Government. The table shows how they fared. The numbers speak for themselves but notice that CSIRO now has an allocation of \$1 billion and ANSTO has a 37 percent increase in its annual allocation.

Future challenges

The main challenge for the future is to raise enough money to pay for increased defence and health spending and reduce the inequality throughout our society.

Various commentators are urging the government to consider:

- Stage 3 tax cuts, which apply to high income earners, worth \$254 billion over ten years and start on 1 July 2024
- Fossil fuel subsidies, with the fuel tax credit increasing to \$9.4 billion in 2023-24
- The Resource Rent Tax; at present the tobacco excise (\$13.4 billion), visa application fees (\$3.3 billion) and the beer excise (\$2.8 billion) will raise more revenue than the PRRT (\$2.7 billion) in 2023-24
- Defence spending, which is already (\$70.9 billion/year) or about 3 percent of GDP.
- JobSeeker, when a \$3 a day increase is well short of the \$25 a day needed to lift those on Jobseeker out of poverty.
- Migration targets, to stabilise the population. The housing crisis is very dependent on population. Neither the Greens, the ALP nor the Coalition have tackled this issue.

Table 1. Funding for Australian Government agencies 2018/19 – 2023/24

Agency	Government appropriation in \$m and average staff numbers, where available in brackets*					
	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24
AIMS	47	44	45	46 253	63 (300)	100 (272)
ANSTO	214 (1275)	235 (1356)	220	280 (1333)	233 (1364)	319 (1421)
ARC	793 (133)	818 (136)	833	804 (127)	867 (140)	935 (140)
Bureau of Meteorology	296	315	294	358 (1599P)	408 (1627)	443 (1754)
Antarctic Division	188 (384)	185 (392)	225	270	270	269
Geoscience Australia	238	232	226	265 (592)	340 (603)	329 (627)
CSIRO	834	839	834	949 (5001)	991 (5449)	1009 (5764)
NHMRC	946	926	943	927 (183)	939 (195)	971 (195)
ABS	401	413	187	592 (3364)	362 (2865)	425 (2843)
Renewable Energy Agency					313 (2)	319 (2)

*AIMS (Australian Institute of Marine Science), ANSTO (Australian Nuclear Science and Technology Organisation), ARC (Australian Research Council), NHMRC (National Health and Medical Research Council), ABS (Australian Bureau of Statistics).



What's happening with CCS

In the October 2022 Budget, the government stripped \$250 million from the Carbon Capture and Storage programme. The reason was that more than \$3.5 billion of public money had been spent on CCS over the last fifteen years, but there is little to show for it. For CCS to work there needs to be good examples to show that the technology works, and that the business case is robust and worthwhile.

Questions still remain over Chevron's Gorgon CCS plant on Barrow Island, where it is still operating at just one third capacity after six years. Santos is developing a site at

the Moomba anticline in South Australia, where the geological structure appears favourable for CCS operation. It has also done a deal to bury CO₂ under the Timor Sea at the Bayu-Undan Gas Field. This is situated 500 km offshore from Darwin and 250 km south of East Timor.

APPEA and Santos are currently lobbying the Government for a long-term strategy and are using the US arrangements as an example. Companies there can claim a tax deduction of US\$85 for every tonne of CO₂ properly buried. I expect that the Government will wait until the Moomba project is completed before taking any action.

Oz Minerals is no more

BHP took over Oz Minerals on 18 April 2023. Oz Minerals had a market capital of \$9.45 million and BHP had a market cap of \$605.6 million on that day.

You might have thought that the purchase would have raised the market capital of BHP, because it has acquired an asset worth nearly \$10 million. This did not happen, and BHP's value declined from \$605.6 million to 579.8 million as a result. I wonder if the purchase was worth it.

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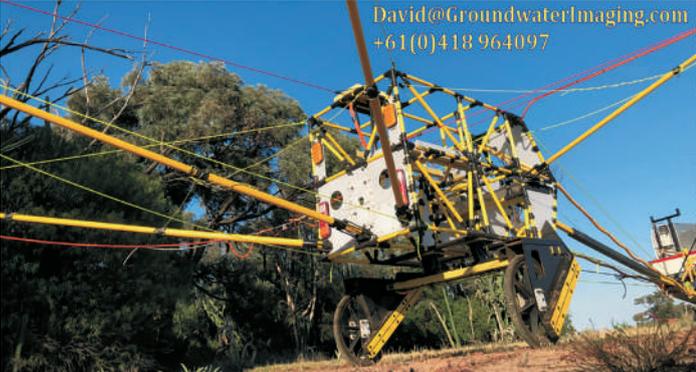


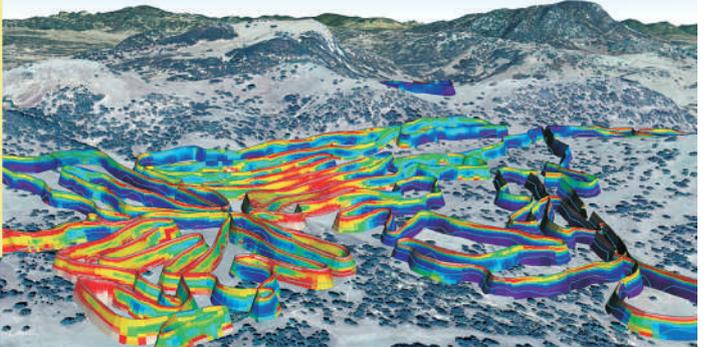


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Education matters



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Putting a lot of effort into being an employer of choice

In this issue of *Preview* we continue a series of interviews on educational needs in the field of earth science. I am pleased to introduce our special guest today: Elinor Alexander, the Director of the Geoscience and Exploration team in the Department for Energy and Mining, South Australia.



Elinor Alexander

MP: Elinor, thank you so much for being here for this interview. Before we start, please tell me a little about your background and journey to your high-level leadership position at South Australian Department for Energy and Mining (SA DEM).

EA: I graduated as a sedimentologist with an Honours degree from the University of Adelaide in 1985 and joined the South Australian Department of Mines and Energy, Oil, Gas and Coal Division. I've been working on basin analysis, sedimentology, petroleum systems and reservoir petrophysics for many years. Then, as my career progressed, I was able to take on some leadership responsibilities, and now I've ended up as the Director of the Geoscience and Exploration team in SA DEM.

SA DEM's focus has evolved and broadened particularly over the last five years and to quote SA DEM's vision – we are “leading the global transformation economy, overseeing the responsible mining and production of the minerals, metals and fuels of the future, to safely and sustainably generate the energy and low carbon products of the future” so, it's not just petroleum now – like many other organisations and companies around the world SA DEM is working on the energy transition. Apart from oil and very importantly natural gas - a key pathway to net zero - our role includes geothermal energy, we're looking at natural hydrogen, hydrogen storage, and carbon capture and storage. I have colleagues in the Geological Survey working on critical minerals and copper, the Growth and Low Carbon team are involved in renewable energy - batteries, solar and wind, colleagues are developing legislation for Hydrogen and Renewable Energy and the new SA Office for Hydrogen Power is progressing green hydrogen. We're all working to achieve the Government's Net Zero target.

I think oil and gas companies and their highly skilled staff are pivotal in achieving net zero

MP: And in this currently rapidly changing world, what does the Department expect from tertiary education? How do you see your “fresh blood”?

The Department has had a long and productive relationship with the university sector and leadership has always recognised the role the Department can play. The Department funds the State Chair of Petroleum Geoscience, currently held by Prof Simon Holford, at the University of Adelaide. The Department was instrumental in establishing the NCPGG in the mid-1980s, has supported the Australian School for Petroleum and Energy Resources (ASPER), and is now working with the University's GeoEnergy resource engineers and geoscientists on multidisciplinary CCS and hydrogen storage research. Some of the support is about our research needs, but some of it's also about getting graduates with the right skills to be employed in the Department, industry, or interstate and Federal government departments, and perhaps some even going on to other universities to continue research. We've had very close

links with the University of Adelaide for many years, reflecting its strong reputation for geoscience education and research. As the Department has evolved, so we've seen the University evolve in this changing energy landscape that we are all in now. We've been able to have input through representation on University Advisory Boards along with industry and other academics towards how the courses are structured. So, it's something very close to us.

One of the fundamental issues is getting school students interested in STEM so they want to go to university and study science, technology and engineering courses - subjects that are fundamental to our country. I think many of us have heard anecdotal evidence of students being concerned about oil and gas or minerals, whether it's because they are worried about the stability of a career in these sectors, the future, or environmental perceptions. However, it's not all bad news - emerging fields like space and defence in SA are starting to attract students into STEM and it's great to see Adelaide University offering a space geology course, as well as a new GeoEnergy course focused on the various different components relevant to meeting societal needs and Net Zero targets.

Another issue my university contacts tell me is that a lot of students don't want to get specialised too quickly because they are focussed on employment outcomes. They are going into more general science, geoscience and engineering courses, for example the traditional civil, chemical or mechanical engineering courses, rather than specialising in petroleum geoscience or subsurface engineering. This also applies to more niche engineering courses like mining, environmental or water engineering - it's not just about petroleum or mining. So future graduate employees are likely to need bridging courses and add-on training when they start work. If they leave university with less specialist subsurface training, employers like the Department and companies may need to consider getting their graduate employees back to university for top up courses – for example seismic interpretation and geophysics, reservoir and subsurface engineering, reservoir petrophysics, seals, carbon capture storage, petroleum systems etc. There's an emerging need to have that top-up available for graduate employees.



How do you get the best talent, train it and retain it? If they have a broader Bachelor's degree focus, what's available to top up their knowledge and skills for the job? We know we're going to need gas for decades for an orderly and equitable energy transition, and I think there's a perception out there that it's all old, yesterday's industry, it's a dinosaur so forget it. However, industry demographics mean that a lot of us will be retiring in the next five to ten years (the 'great crew change') and there's less and less young engineers, geologists and geophysicists to replace us – so it could be there will actually be lots of jobs for decades to come! In addition, the petroleum industry has essential knowledge and experience for carbon capture and storage, hydrogen generation and storage for the energy transition. So, there are plenty of opportunities still to come, and it's important to make sure that students are aware of that.

MP: Thank you for sharing your vision, and it is great to know that there are plenty of opportunities for young specialists in Adelaide. It is also very exciting to hear that Adelaide University is offering a space geology course. The next question is, what has changed in the recruitment process in the last couple of decades?

EA: For a government agency, recruitment processes are pretty set, but recruitment targets have changed since I was employed with a more general Honours degree in 1985. I needed to get up the learning curve on oil and gas exploration and petrophysics and did a lot of reading and went to Core Lab and Schlumberger courses, the NCPGG wasn't established then. The NCPGG, ASP and ASPER have been providing employers with work-ready petroleum geoscience and engineering students since the late 1980s, many of whom have industry placements. As I discussed previously, that's changing so the situation may end up similar to my recruitment in 1985 – new more generalist graduate employees may need training in specialised exploration, mining and petroleum skills.

Graduates from courses that offer guided learning, working on real-world data and case studies, with internships an exposure to industry certainly have an advantage. Whereas back in my day you could graduate with a degree in geology but you may not have picked up much knowledge about working in industry. Joining an organisation with experienced geos around you to learn

from was great, but I also had to get busy reading and picking up the knowledge needed to do the job.

Carbon capture and storage is one of the stepping stones into the energy transition

Another part of recruitment is being an employer of choice – while government doesn't pay as well as industry, it offers flexible work conditions and a broader scope of work. You're not necessarily going to work on one gas field or mine – you may need to look at the geology of Australia or South Australia for a basin analysis or regional project. Of course COVID-19 has changed work, and companies are a lot more flexible. So being an employer of choice becomes important. Does the organisation have the culture and values a graduate aspires to? Will my work make a positive difference for South Australians? Does the organisation offer continuous learning, development and training, flexible work? What about working from home – it can actually be a better environment than an open plan office for geos and engineers that are trying to write reports or thinking deeply on concepts and models. What about employee wellbeing, equity and diversity? They'll all part of the mix that any organisation can offer.

The flip side is seeing people leaving petroleum geoscience to apply their transferable skills in mining, renewable energy, data analytics and, in South Australia, the space industry. These sectors are now competing for oil patch talent. However, I think oil and gas companies and their highly skilled staff are pivotal in achieving net zero. I think it's worth reminding students that the 'old-fashioned' oil patch has the skills, the technologies and the highly educated staff to conceptualise and deliver net zero programmes like carbon capture and storage, blue hydrogen, green hydrogen, and natural hydrogen exploration. The petroleum sector has the hard-earned knowledge to drive an orderly, fair and equitable energy transition.

MP: Should we expect evolution or revolution in tertiary education to ensure a smooth and efficient transition to clean energy?

EA: There could be a bit of both evolution and revolution, but, talking to my university colleagues and friends, they're saying it's more likely to be an

evolution because of the risks involved in a revolution – universities need to have confidence in student uptake before launching a completely new degree programme. What I see, and again I'm sorry, it's a very University of Adelaide-centric perspective, is that they are incrementally adding new subjects and courses with options to study carbon capture and storage and hydrogen storage, so interested students can build on the basics. I think carbon capture and storage is one of the stepping stones into the energy transition.

The Department has provided seed funding for the University of Adelaide's successful and significant ARC grant applications for carbon capture and storage and hydrogen storage research and research infrastructure. So there's now a pathway into energy transition research but it's not a radical shift, it's an evolution utilising the basics of petroleum geoscience and engineering. I think the universities that are building this incrementally are probably going to be quite successful in attracting students and sustaining them through post-grad student projects and into employment as well.

We are passionate about data. It sounds very nerdy, but a lot of us in the Department are data wonks. We just love data.

You can't beat the basics, thinking about the courses that we did – structural geology, basin analysis, petroleum plays, reservoirs, sandstone, sedimentology, fluid flow, and reservoir engineering – we did them with a view to getting oil and gas out of the ground. But you apply them to sequestering CO₂ and maybe one day storing hydrogen. What's happening now, to put it extremely simply, is becoming about putting gases in the ground rather than taking them out.

MP: I am delighted to know that it will not be a revolution. From your point of view, what role does digitalisation play in the clean energy transition? What kind of education is required to guarantee efficient digitalisation of the energy sector?

EA: One of the critical roles of the Department, since it was formed, was to collect and archive data generated by explorers, universities and our own geoscientists. And back in the early days, that data was long seipia seismic sections, paper well completion reports, paper seismic survey reports, paper and seipia well logs. We put a lot of effort into



getting all that paper converted into digital formats back in the 1990s under the State's ground-breaking exploration initiatives. Now companies have to submit data in digital format. So we have massive amounts of digital data. We are passionate about data. It sounds very nerdish, but a lot of us in the Department are data wonks. We just love data. We are making sure we get it from companies, it's verified and archived until it's released to open file for our customers and stakeholders to access. I've always taken the view that the key to discovering the next Olympic Dam or Cooper Basin could be sitting in a database, or it could be sitting at the core library waiting to be found.

The next Olympic Dam or Cooper Basin could be sitting in a database

What's exciting now is that all of this lovely digital data needs to be made more accessible and available for people to apply AI – what sort of expertise and effort does that take? What could you get out of SA DEM's mineral and petroleum databases by applying some of the new AI systems, ChatGPT and whatever the analytical tools will be in future? What on earth could you unleash with that? How do we make it easy for people to mine our data and then play with it? So that's a big push for the Department, and universities are responding with new courses like applied data analytics for engineers and geoscientists. So that's opening up a whole new field of specialisation for students that could apply to the energy resource and minerals sectors.. or medicine... agriculture... defence... space. Professor Graham Heinson, who *Preview* readers will be familiar with for his work on magnetotelluric surveys, is one of the leading academics who is launching programmes on data analytics at the University of Adelaide.

Perhaps we'll see a bright graduate in data analytics who doesn't know what a seismic line was, but can apply AI to look at it afresh - so let them loose on the data and see what happens. Or you have a geophysicist or a geologist coming at it from the traditional earth science side. You're going to need a bit of both. Not being an expert in AI, I do think it will need expert steering by geoscientists rather than data scientists. There are massive opportunities to develop new skills, but we still need people with our earth science background interpreting data.

MP: Many exciting developments related to hydrogen are taking place in South Australia today. So what kind of specialists are required to pursue the hydrogen economy in Australia?

EA: From a government agency point of view, to get to a hydrogen economy - this could include gold, blue and green hydrogen – starting at the beginning for all of the colours of the hydrogen rainbow - we're going to need to provide an effective regulatory regime, easy access to data and a secure tenement regime for explorers or project proponents. Companies will need engagement experts to help get land owners, traditional owners and communities on board with land access and environmental experts to manage impacts. Then we get to STEM skills again! If it's exploration for gold hydrogen it needs geoscientists, if it's constructing a hydrogen plant, pipeline and export facilities it needs engineers, chemists, technologists, designers, safety experts, civil and chemical engineers and specialised builders. If green or blue hydrogen is to be stored underground that needs geoscientists and petroleum engineers.

In terms of gold or natural hydrogen in South Australia, we had a legislative or regulatory tweak that occurred in February 2021. It enabled hydrogen to become a regulated substance which meant that explorers could apply for Petroleum Exploration Licences to explore for natural hydrogen, store hydrogen and transmit it via pipelines. There's a whole lot of data and reports about hydrogen occurrences in the Department's archive, some of which go back to 1915, 1921, and 1931. Viacheslav Zgonnik's 2019 global review of natural hydrogen occurrences included these South Australian occurrences. Professor Isabelle Moretti analysed imagery of Australian salt lakes that could be possible natural hydrogen seeps and published another piece of evidence in 2021.

A company called Gold Hydrogen was smart enough to put this all together and was the first mover in mid-2021 to apply for Petroleum Exploration Licences to explore specifically for natural hydrogen in SA. All of these things came together to trigger a massive rush by explorers over the last 18 months to apply for licences to explore for natural hydrogen – there's now over 40 applications from seven companies who've all got their own exploration models and ideas. It's great to see a diversity of exploration

models and thought in this space. SA has attracted all the interest so far because we were the first state where exploration for natural hydrogen and transmission in pipelines can occur. Other jurisdictions are working to enable this now.

All of these things came together to trigger a massive rush by explorers over the last 18 months to apply for licences to explore for natural hydrogen.

Gold Hydrogen has announced that they will be undertaking a roadside soil gas survey and acquiring an airborne geophysical survey over the Yorke Peninsula in Q1/2 2023 following their community engagement programme. H2EX will commence soil sampling over the Eyre Peninsula soon. Dr Ema Frery of CSIRO in Perth is a leading Australian researcher in the field detection of natural hydrogen and is involved. Gold Hydrogen are planning to drill an exploration well and have been working with Schlumberger on specialised safety, logging, and drilling equipment for the rig.

However, as exciting as this all is, it is early days with natural hydrogen with only one producing field in Mali in West Africa. Many will be watching Australian company Hyterra's current testing of a natural hydrogen well in the USA. I can't wait to see how things progress in SA in what will be a critical year for this potential new energy resource.

MP: It's all fascinating. Do you think we have enough specialists of the right kind to progress with the hydrogen economy in Australia?

EA: I think in some fields we're doing fine but no doubt the hydrogen economy will require new specialised skill sets too. Putting aside STEM issues, Australia has world-leading experienced geoscientists in the fields of mineral exploration and petroleum exploration who have the skills and expertise for natural hydrogen exploration. Australian innovators and inventors, universities and the CSIRO have the expertise needed to develop new exploration technologies and methodologies. However, with the 'great crew change' underway in the petroleum and mineral sectors, we need a stream of enthusiastic STEM graduates who see a career ahead of them in these exciting new opportunities - whether it's green, gold or blue hydrogen, carbon capture and storage or discovering natural gas for the nation's energy transition.



Environmental geophysics



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Weird and wonderful

Welcome readers to this issue's column on geophysics applied to the environment. For this issue, my intention was to write about an interesting intellectual 😊 experience that occurred recently, and that is related to environmental geophysics at most only tangentially. Unfortunately (interestingly?) I fell down a few rabbit holes along the way, two of which I will report on here as well.

So, my original "theme" for this article was going to be how interesting it is when an instrument that is designed for one specific task is used for something unrelated and possibly never envisioned when the instrument/setup was planned. I am specifically referring to the array of Global Navigation Satellite System (GNSS) instruments that measure Australia's relatively rapid travel to the north. Recently I attended the weekly group meeting of atmospheric physicists at the University of Adelaide (I am part of the group as I have some "expertise" in measuring greenhouse gases using things like eddy covariance towers – it's true, some of us just like to measure things) and they started discussing a paper that one of the participants had read that perked my interest (Lin *et al.*, 2022) and some of which I understood. Apparently, there is a large network of GNSS receivers located all around Australia and New Zealand (~600), Japan (~1300) and Taiwan (~140), with quite a few scattered on ocean islands in between, especially to the north of Australia. The Australian network is administered by Geoscience Australia, and is used at least partially to measure the relative tectonic-plate motion in this particularly active part of the world. I'm

sure that most of you know that Australia is moving generally northeast at a rate of about 7 cm per year. See, for example, *The Conversation* from February 6, 2017 (<https://theconversation.com/australia-on-the-move-how-gps-keeps-up-with-a-continent-in-constant-motion-71883>). I hadn't really thought about it, but when you are moving north at that rate, those of us who need to consistently return to exactly the same location on continental Australia need that kind of correction.

Interestingly, parts of the atmospheric physics community use the raw data available from the GNSS satellites and receivers to estimate total electron density/count (TEC) in the ionosphere along the path of the GNSS signal. These densities change dramatically as a transient ionospheric disturbance (TID) passes through the atmosphere (specifically the ionosphere). One of the mechanisms that cause TIDs are interactions between neutral particles in the atmosphere with plasma in the ionosphere – these interactions may ultimately be "pushed" by large explosive forces in the lower atmosphere. These explosive forces include events like rocket launches, and importantly, volcanic eruptions. As reported in Lin *et al.* (2022), the 15 January 2022 series of eruption of the Hunga-Tonga Volcano in the remote South Pacific Ocean east of Fiji (near Tonga) was one of these sorts of events. These TIDs travel very quickly through the atmosphere, on the order of 360 to 390 m/s (*i.e.* at approximately the same velocity as the lower-atmospheric Lamb atmospheric pressure wave directly associated with the eruption), although there are other similar events listed in the Lin paper with much higher velocities. Ultimately (besides scientific curiosity), the goal is to see if GNSS receivers recording TIDs are able to provide early warning information about remote volcanic eruptions, and possible associated tsunamis... There is much more to this story than I report here and there are also a number of articles on the subject that can be found by searching the web for terms like "TID GNSS", and looking through some of the references in the Lin *et al.* (2022) paper. I found the whole subject quite interesting and certainly a good example of scientists getting information from unexpected sources. Since I wrote this piece the ABC has reported on an article in the journal *Space Weather* that discusses the impact of the Tongan eruption on

GNSS/GPS positions <https://www.abc.net.au/news/science/2023-05-25/tonga-volcano-eruption-super-plasma-bubble-gps-atmosphere/102377782>

Following are two of the (related) rabbit holes that I fell into along the way. I am going to work my way through them over the next few weeks/months (my success with both so far is not great) but am sure that others in the ASEG community have experience with these, and I would not mind being enlightened as to their usefulness.

Rabbit hole #1: The first is a Geoscience Australia (GA) open-sourced code called GINAN, that you can run to improve the positional accuracy from a GPS/GNSS device to (possibly) better than a decimeter (at no cost) (<https://www.ga.gov.au/scientific-topics/positioning-navigation/positioning-australia/about-the-program/analysis-centre-software>). I downloaded it, but still (at the time of writing) need to test the program. For the real-time corrections, it requires (at the minimum) that you be able to output raw GNSS data to a laptop and that you have an internet connection. Sounds "simple" but it feels as if the learning curve might be steep and require more time than I have at the moment. Also, I am somewhat expecting to find that it needs a geodetic quality GNSS receiver but I am not sure about that.

Rabbit hole #2: I also found an online service on the GA website (AUSPOS) that applies corrections to Rinex files, output from geodetic quality, dual-frequency geodetic quality GNSS receivers collected in static mode (<https://www.ga.gov.au/scientific-topics/positioning-navigation/geodesy/auspos>). Unfortunately, it won't correct the Rinex output from my handheld GPS (among other things I don't receive both frequencies). Too bad – wouldn't it be great to get <1 decimeter quality positional information from a handheld GPS?

Reference

Lin, J.-T., Rajesh, P. K., Lin, C. C. H., Chou, M.-Y., Liu J.-Y., Yue, J., Hsiao, T.-Y., Tsai, H.-F., Chao, H.-M., Kung, M.-M., 2022. Rapid conjugate appearance of the giant ionospheric lamb wave signatures in the Northern Hemisphere after Hunga-Tonga Volcano eruptions, *Geophysical Research Letters*, **49**, e2022GL098222. <https://doi.org/10.1029/2022GL098222>



Seismic window



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Flat spots aren't flat¹

Seismic flat spots are flat reflections on a seismic section and are potential indicators of hydrocarbons (Figure 1). They are usually flat because they are reflections from a fluid interface (such as gas over oil, oil or gas over water) within a petroleum reservoir (Figure 2). I have written about flat spots in previous issues of *Preview*, however my focus on those occasions was on how to highlight and recognise flat seismic reflectors. But what if the reflector is not flat? An interesting presentation by Jarrod Dunne at the AEGC earlier this year explored the world of non-flat flat spots, with examples from a variety of settings and locations – shallow gas hazards in Sakhalin, oil fields in Brazil and gas-oil contacts in the Browse Basin of Australia. As it happens, non-flat flat spots are common enough for Jarrod to propose a more representative nomenclature for this type of direct hydrocarbon indicator (DHI). He would like us to stop calling them flat spots and to use the term “contact indicator”.

There are several reasons a contact indicator does not appear to be flat, including hydrodynamic effects (Figure 3), aquifer depletion prior to the seismic acquisition, semi-permeable barriers (Figure 4), and reservoir heterogeneity, but possibly the most common is variation in the seismic velocity of the overburden and the limitations in resolving the velocity. These limitations lead to explorers either misinterpreting flat events as hydrocarbon contacts, or passing over a prospect by failing to recognise a rugose

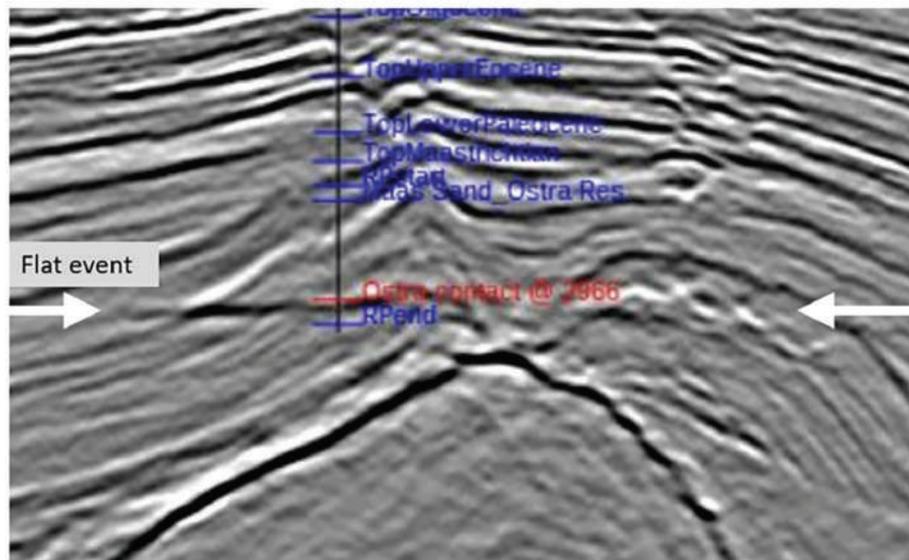


Figure 1. Screen grab of an example flat spot (indicated with white arrows) from Brazil. The top of the hydrocarbon reservoir (white) and the base of the hydrocarbon column (black) are opposite polarity. Image provided by Jarrod Dunne and James Parsons.

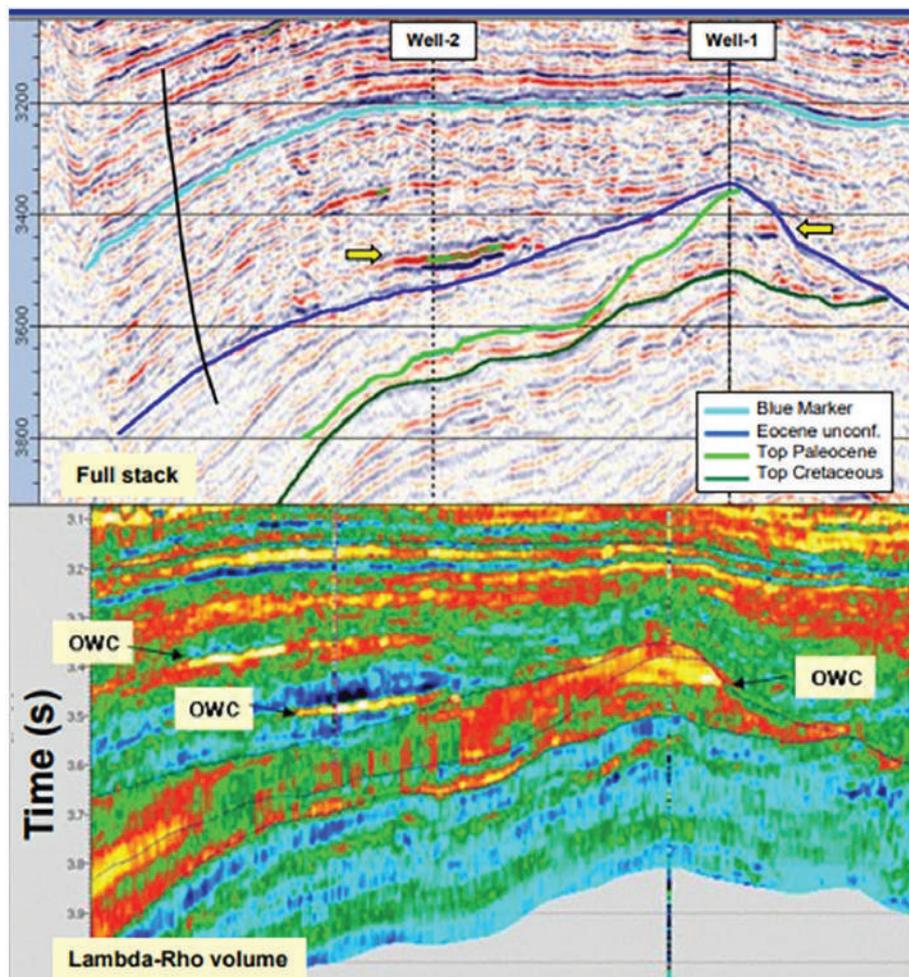


Figure 2. Another example of a contact indicator. Image provided by Jarrod Dunne and James Parsons.

¹ This article is based on a paper by Jarrod Dunne and James Parsons presented at the AEGC 2023

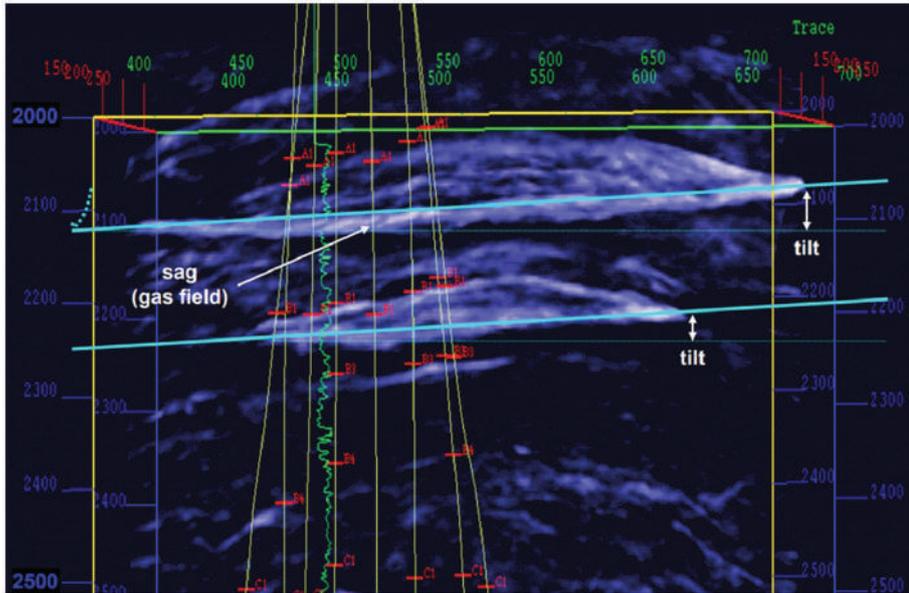


Figure 3. Example of a tilted flat spot, most likely caused by overburden velocity variations and also push-down beneath a gas accumulation caused by the slower velocities in the gas saturated reservoir. Image provided by Jarrod Dunne and James Parsons.

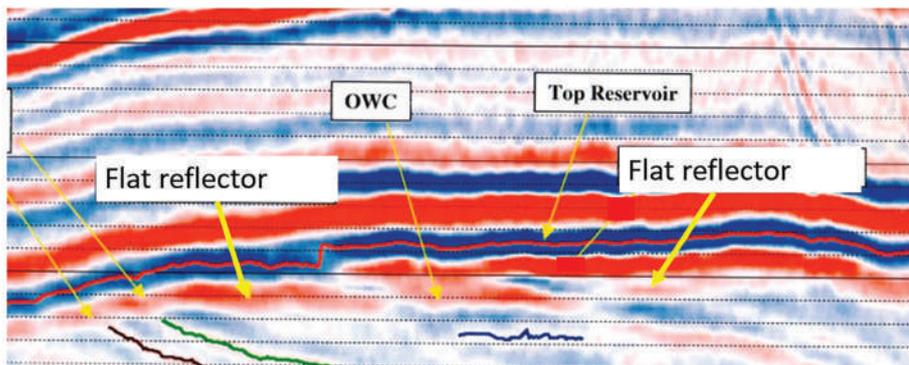


Figure 4. Flat reflectors indicating an oil-water contact becoming shallower from left to right. The difference in depth is real. There is a permit boundary about halfway across this structure and the rival permit holders held many meetings to determine what was happening and resolve estimated reserves on either side of the boundary.

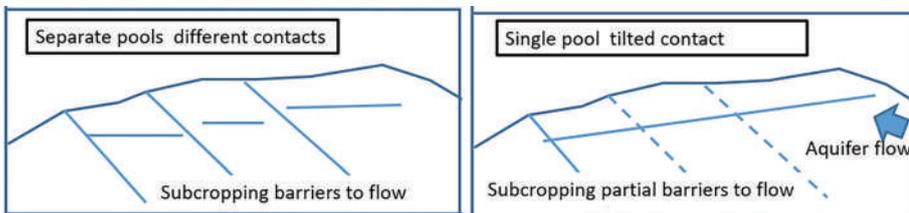


Figure 5. Two possible models for the geology. There could be separate pools separated by subcropping shales or a single contact that is being distorted by aquifer flow.

contact indicator as a DHI. Of course a flat spot may be caused by something other than changes in fluid such as diagenetic effects, residual multiples (they are always hanging about), igneous intrusives and unconformities.

Dunne and Parsons suggest that modelling is helpful, but not just any modelling. They propose holistic AVO modelling where the depth structure and amplitude response are modelled simultaneously since both properties rely on the same P wave velocity. The result is a better understanding of a prospect and hopefully fewer dry holes.

Flat spots are commonly not flat so we should stop calling them flat spots.

Figure 4 is an example from the NW Shelf of Western Australia. There are some obvious cross cutting reflectors that are not quite flat that become shallower from left to right. Shortly after this oil field was discovered, there were discussions about whether the oil-water contact was at a constant depth or was tilted, or even if there were separate pools with different contacts in each (Figure 5). To complicate matters there was a permit boundary halfway across the field with different companies in each permit. This led to talks about unitisation. Obviously the companies either side of the boundary had an interpretation of the contact indicator that was most advantageous for their company.

The unitisation talks broke down.

Perhaps some modelling would have helped.

Reference

Dunne, J. and J. Parsons, 2023. Direct hydrocarbon indications from fluid contacts – stop calling them flat spots! AEGC 2023 Extended Abstracts

I would like to thank APPEA for recognising my media credentials and offering me a place at the 2023 APPEA conference in Adelaide. Media delegates are sponsored by Santos.

Webwaves



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Website redesign and photo competition

This year, ASEG commenced a website redesign to replace the current website, which has been live since 2016. A committee, comprising Ian James and Gokul Venu Sreebindu (Web), Mikayla

Sambrooks (Communications), Suzanne Haydon (Membership), Janelle Simpson (Branch) and Emma Brand (Past-President), is currently working through the process with external developers. The new website aims to simplify and streamline user and volunteer website interaction, and is coupled with a change of the membership database from Currinda to a new platform, Membes. The Membes database will fully integrate with the website, solving common pain points around login and membership renewal.

As part of the 2023 redesign, ASEG are holding our third photo competition (previous competitions were held in 2016 and 2018). The entries will feature prominently on the ASEG website and social media channels. Users will note the ASEG YouTube channel banner comes from Jeremy Lee's equal 3rd place entry to the 2016 competition "Heavily deformed graphite schists from the Aileu Formation in Timor-

Leste" (<https://www.youtube.com/ASEGvideos>). The current ASEG website homepage displays Richard Barnwell and Clinton Avenell's 1st place entry to the 2018 competition "Watching the milky way rise as the sun sets just off the Barkly Highway. Roadside seismic camp, NT"

Full results of previous photo competitions can be found at the following links:

2016: <https://www.aseg.org.au/about-aseg/aseg-photo-competition>

2018: <https://www.aseg.org.au/about-aseg/2018-photo-competition>

For the 2023 competition, alongside photography, we are also encouraging entrants to submit AI/computer generated imagery based on geophysics related inputs. One example of a tool to generate such imagery is Stable Diffusion (<https://stablediffusionweb.com/>). From the website, "Stable Diffusion is a latent text-to-image diffusion model capable of generating photo-realistic images given any text input, cultivates autonomous freedom to produce incredible imagery, empowers billions of people to create stunning art within seconds". Users can enter text-based prompts to have images generated. From a test of the software, the potential is somewhat limited for niche topics but can produce amusing results. When prompted with a good descriptive phrase, results are better. When prompted with the title from the winning entry in 2018 (Figure 1), results are quite impressive (although with some details askew).

2023 ASEG photo and artwork competition

Submission deadline: 30 June 2023

Accepted forms of entry:

- High resolution (minimum 300 DPI) digital photographs or images that are geophysics related (including but not limited to geophysical field operations, geophysics data or a model generated from geophysics data).
- Artificial intelligence/computer generated image or artwork that is a result of geophysics related input reference material.
- Digitally created image or artwork that is geophysics related.

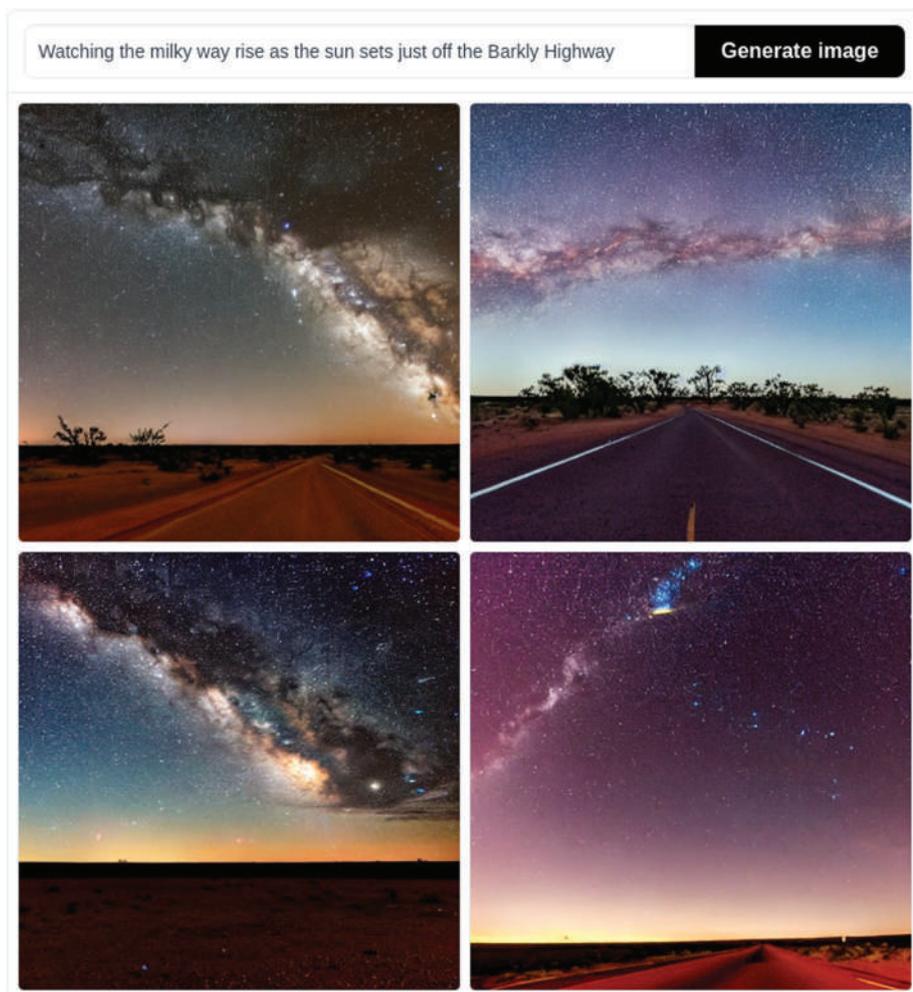


Figure 1. Stable Diffusion imagery generated using the title of the 2018 photo competition winner as a prompt.



- Entries should be accompanied by a short description or title that is suitable for publishing online. ASEG may edit the length of the description or title to suit the publication media

Prizes:

- 1st: \$100 gift card
- 2nd: \$50 gift card
- 3rd: \$50 gift card

You must be an ASEG Member to submit.

Please email entries to webmaster@aseg.org.au.

Entries are governed by the ASEG Competition Policy found at <https://www.aseg.org.au/competitions-policy>

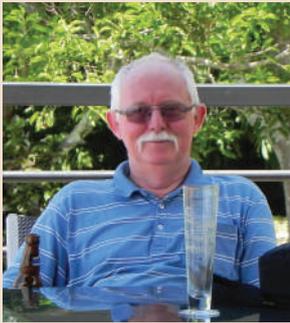


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Aspects of innovation: A Sliding Doors moment



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Was it just me, or was there widespread pleasure among participants at the recent Australian Exploration Geoscience

Conference (AEGC) in Brisbane at being able, once more, to interact socially and professionally with one's peers in a conference setting? I certainly took every opportunity to resume face-to-face conversations with fellow explorationists and service providers.

Someone I always take the opportunity to catch up with at our conferences is Des Fitzgerald; we share both hopes and concerns for the future of exploration geophysics. This time Des had a great story to tell about recent innovations in potential field processing realised by revisiting aspects from 200 years of mathematical theory. This work really does epitomise innovation through reassessment of previous efforts.

I invite you to read Des' article "A Sliding Doors moment". It makes quite a read. I also talked to other geophysical contractors and consultants who are innovators in their field, and I'll bring their stories to future issues of *Preview*. And, if you or your organisation have a story of innovation in geophysics you'd like to tell, please get in touch. We'd love to hear it.

A Sliding Doors moment

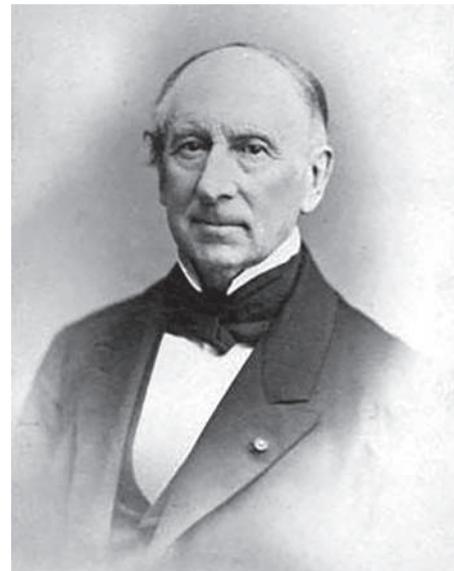


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Cauchy's integral theory

200 years ago in Paris, during the enlightenment period, the Sun King had been overthrown, Napoleon had transformed the European world, and a new king was on the throne.

The *L'École Royale Polytechnique*, having passed back under the patronage of the king, encouraged the elite to create theoretical and practical ideas. Mathematical notation was also evolving at this time. Augustin-Louis Cauchy fought for recognition for some of his ground-breaking insights, and published his book "First Part, *Analyse Algèbre*" in 1821.



Augustin-Louis Cauchy

Cauchy is most famous for his single-handed development of complex function theory. The first pivotal theorem proved by Cauchy, now known as Cauchy's integral theorem, was the following:

$$\oint_C f(z) dz = 0,$$

where $f(z)$ is a complex-valued holomorphic function on and within the non-self-intersecting closed curve C (contour) lying in the complex plane. The contour integral is taken along contour C .

The rudiments of this theorem can already be found in a paper that the 24-year-old Cauchy presented to the *Académie des Sciences*

A Sliding Doors moment

Feature

(then still called “First Class of the Institute”) on August 11, 1814. In full form the theorem was given in 1825. The 1825 paper is seen by many as Cauchy’s most important contribution to mathematics.

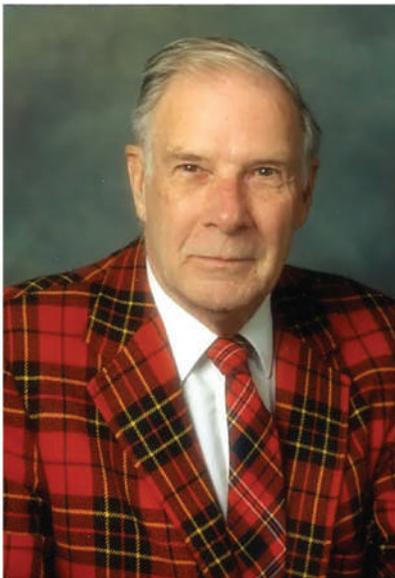
However, Cauchy was also the first to prove Taylor’s theorem rigorously, establishing his well-known form of the remainder. He also gave us the current form and notation for tensors.

Hamming’s finite impact response filter

Until now, this story has had little relevance to members of the ASEG!

The history of modern airborne geophysics in Australia started during World War II, with survey instruments developed for submarine detection. Analog charts were used to plot the readings along lines, and then there was a search for anomaly “blips.”

The Manhattan project’s chief mathematician, Richard Wesley Hamming, also worked on signal processing algorithms during World War II. After the war he joined Claude E. Shannon at Bell Laboratories, where in the 1950s and 1960s he invented Hamming codes that were used in telecommunications but have subsequently found general use.



Richard Hamming

Richard Hamming was at Bell Laboratories, about the same time as modern computer languages and operating systems were being imagined.

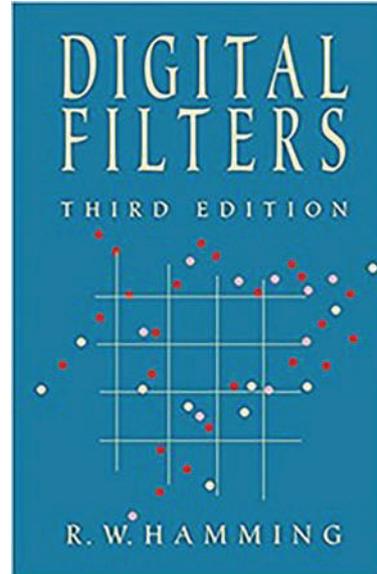


The distinctive logo of Bell Laboratories

Exploration geophysics, as we understand it, arguably emerged only after World War II. Geophysicists started by using very basic physics, and higher mathematics was mostly ignored. In terms of early-stage signal processing Hamming’s codes and direct descendants were copied and adopted. Hamming concentrated on the problem of helping remove the “crackle” from audio signals in telephony. This was also the transition time from using analog hardware filters, which used resistors and capacitors, to modern



digital filters. The Fast Fourier Transform (FFT) and the “spectral” method for signal processing and analysis also came out of this period. Hamming wrote an excellent book on digital filtering that summarises the applications and theory involved, with strengths and weaknesses identified. It includes a chapter on differentiation, and the Finite Impact Response filter (FIR) and its application.

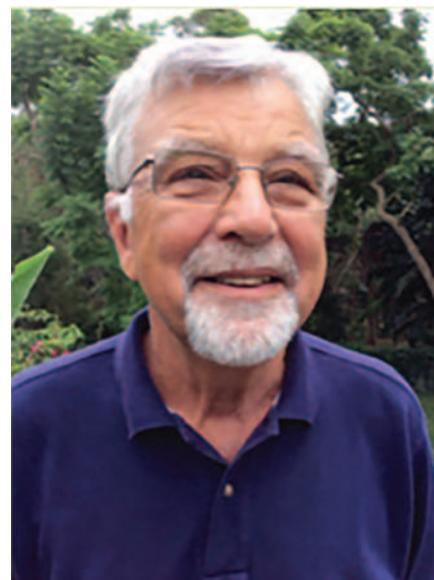


The front cover of Hamming’s book on digital filtering.

The computer languages Algol, Cobol, and Fortran dominated the scene, and vendors such as ICL, IBM, and CDC were dominant.

Gunn and the MAGMAGE Project

Despite this timeline, exploration geophysics only came to this FFT work in 1965, when Bhattacharyya first published. This was followed by Peter Gunn in mid-1976, when he published his seminal paper on linear transforms of gravity and magnetic field in *Geophysical Prospecting*.



Peter Gunn

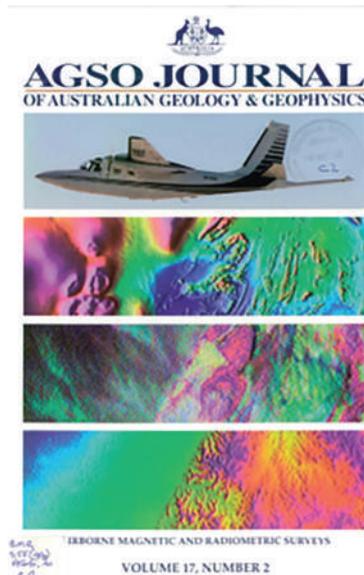
In discussions I have had with Peter, he tells how hard it was to take Bhattacharyya’s work and apply it to real survey data.

Gunn's 1976 paper is widely acknowledged as a breakthrough in exploration geophysics (personal communication Alan Reid), as Peter sorted out the notation and the application of the convolution theorem to all potential field signals. This importantly included the vertical derivative.

When Peter Gunn joined AGSO (now Geoscience Australia) around 1993, he immediately set about the process of creating a practice manual for airborne magnetic and radiometric surveying. This effort resulted in publication of the now famous *AGSO Journal of Australian Geology & Geophysics*, **11** (2). This journal has been a best seller for many years. The purpose of the publication was to present the methodologies and ideas of various specialists who were active in the disciplines that contributed to the acquisition, processing, presentation, and evaluation of airborne magnetic and radiometric data.

The joint paper "Enhancement and Presentation of Airborne geophysical data", written by Peter Milligan and Peter Gunn in this volume, is a good summary of this pivotal moment. It lays out the derivative methods that became dominant.

At this same time, Peter Gunn approached me to champion the MAGMAGE project. He was concerned that innovative thinking would stagnate once the "flat earth" version of practice was sorted. This is the classic trap of engineering science. The first approximation that seems to keep folks happy is what is settled upon, and an entrenched set of followers develops. The 15 MAGMAGE projects mentioned in the proposal led to many innovations, but not all were finished or followed up in time.



The front cover of the *AGSO Journal of Australian Geology & Geophysics*, **11** (2).

Looking again, from the perspective of 2023, at least one or two projects did not go anywhere, but still deserve a run. Project 1, "Instantaneous plot of anomaly maxima and minima" developed into a project where the complex trace analysis methods from seismic were looked at for magnetics (Figure 1).

The magnetic trace from airborne magnetic surveys was treated as the real part of a complex magnetic trace and the imaginary part is minus the Hilbert transform (quadrature) of the real part. It is this project that floundered without the help of Cauchy. If only that sliding door had opened in 1995.

Even into the 1990s, practical applications of digital filters were hampered by lack of CPU power, restricted CORE memories, disc space (a 5-megabyte disc was considered the ultimate), etc.

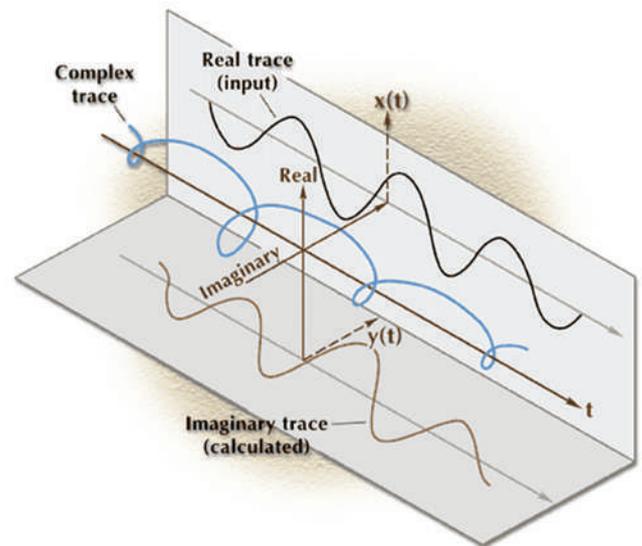


Figure 1. Explanatory figure from the MAGMAGE project where the complex trace analysis methods from seismic were looked at for magnetics.

Instead of using the more proper Fast Fourier Transform, for many years a Hartley Transform was used in many codes to save memory. With the benefit of what we now know, this was also less stable than the FFT methods.

Differentiation by integration

Now we jump to 2021 and a phone call from Richard Smith, Geophysics Professor at Laurentian University, Sudbury. He started by saying he could not find any interested commercial partners in Canada, and would I have a look at the whole subject of differentiation? Jeff Thurston, who had worked with Richard in the Fugro R&D team in Ottawa during late 1990s, had returned to looking at the fundamentals. The practical technique comes from a 1981 paper authored by Bengt Fornberg titled "Numerical Differentiation of Analytic Functions" and is based on Cauchy's Integral Formula.

While more involved than Hamming's FIR methods, this approach, using complex numbers, is inherently more stable and avoids the horrible band-pass side-effects of FIR filters. Turns out Hamming himself had recognised this problem in his textbook but did not take it further or suggest any alternatives.

Now for the tie back to the complex trace analysis, where the TMI and its Hilbert transform is used to calculate well-conditioned, high-order derivatives of gravity and magnetic data. Jeff left Fugro in late 2000 and subsequently became part of the R&D team at Intrepid, which started an investigation and series of experiments and case studies.

The importance of differentiation

Why is differentiation so important in exploration geophysics?

Basically, all interpretation methods for edge detection, depth determination, inversion and source body property estimation depend upon the quality of the estimated gradients. It would seem even magnetic compensation algorithms look to be caught up in all this required revision. The limitations of existing popular tools that use FIR methods has led to a recognition that only limited gradient products can be produced. It has also forced more efforts in our industry to measure gradients during acquisition to avoid using poor estimates from digital differentiation.

A Sliding Doors moment

Feature

We all know that FIR calculated gradients are not capable of estimating past a first derivative without noise starting to swamp the coherent signal.

In contrast to this current situation, Cauchy methods completely re-write the rule book (Figure 2).

Downwards continuation

One immediate consequence of this development has proven to be direct prediction of the potential field below the ground surface. Derivatives that remain coherent to above order 10 are fed into a Padé series expansion.

Flat-land thinking can be relegated to the trashcan because 3D representations of the measured magnetic and gravity field, extending hundreds of metres below and above the ground surface, are now routinely possible to estimate. 3D processing and visualisation for all potential field survey datasets can be made available to the interpreting geologist. This is not an inversion but a simple continuation, made possible by the Cauchy-stabilised high-order derivatives; there is no modelling and no artificial means to alleviate the ambiguity in the algorithm (Figure 3).

The black shale Coocerina Formation wraps the Knapdale Quartzite. This syncline has two most distinctive magnetic dipole responses (as seen in Figure 3, middle to right) just

below the surface, associated with the black shales. In the version shown in the top image the predicted magnetic field is not clipped by topography, allowing the full expression of north/south poles to show. The folded quartzite formation has no magnetic response - as expected. As there can be Cu in the mafic porphyry, with a magnetic response, some of the indicated sub-vertical veins deserve another look.

Continuing work has shown that several of exploration geophysics' standard methodologies need to be reconsidered and re-imagined. Astoundingly, gravity practice may well end up being the biggest beneficiary and subject to more change, as the notion of terrain correction may become a thing of the past. The magnetic field also perfectly reflects any remanence in the rocks.

For me personally, this story is reminiscent of Moses going to the top of Mt Sinai to see the promised land, without having the time left in his life to watch the full implications being realised. I thank all my colleagues who have contributed their time and passion to this on-going journey on the road less travelled.

So back to the title:

Let's shut the Hamming door and step through the Cauchy door and, in the words of W.S. Gilbert, let's "polish up the handle of the big brass door".

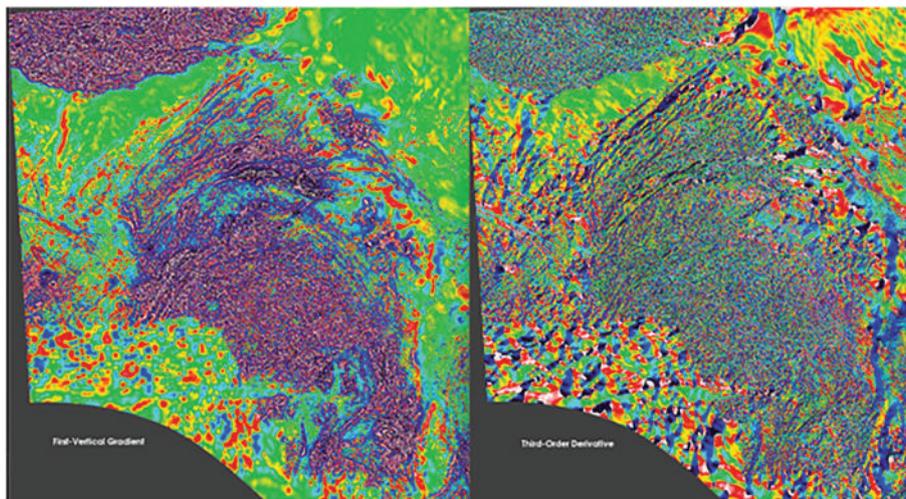


Figure 2. GSSA Gawler Craton Regional Mapping, Total Magnetic Intensity, Variable Reduced to Pole. The image on the left-hand side is first vertical derivative. The image on the right-hand side is third vertical derivative, using Cauchy. These images are downloadable from the SARIG website.

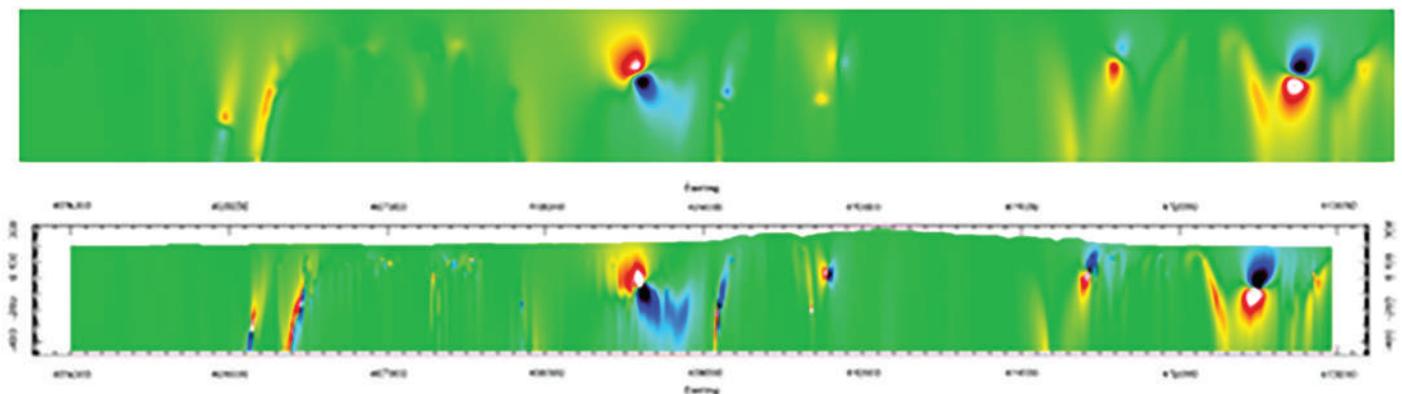
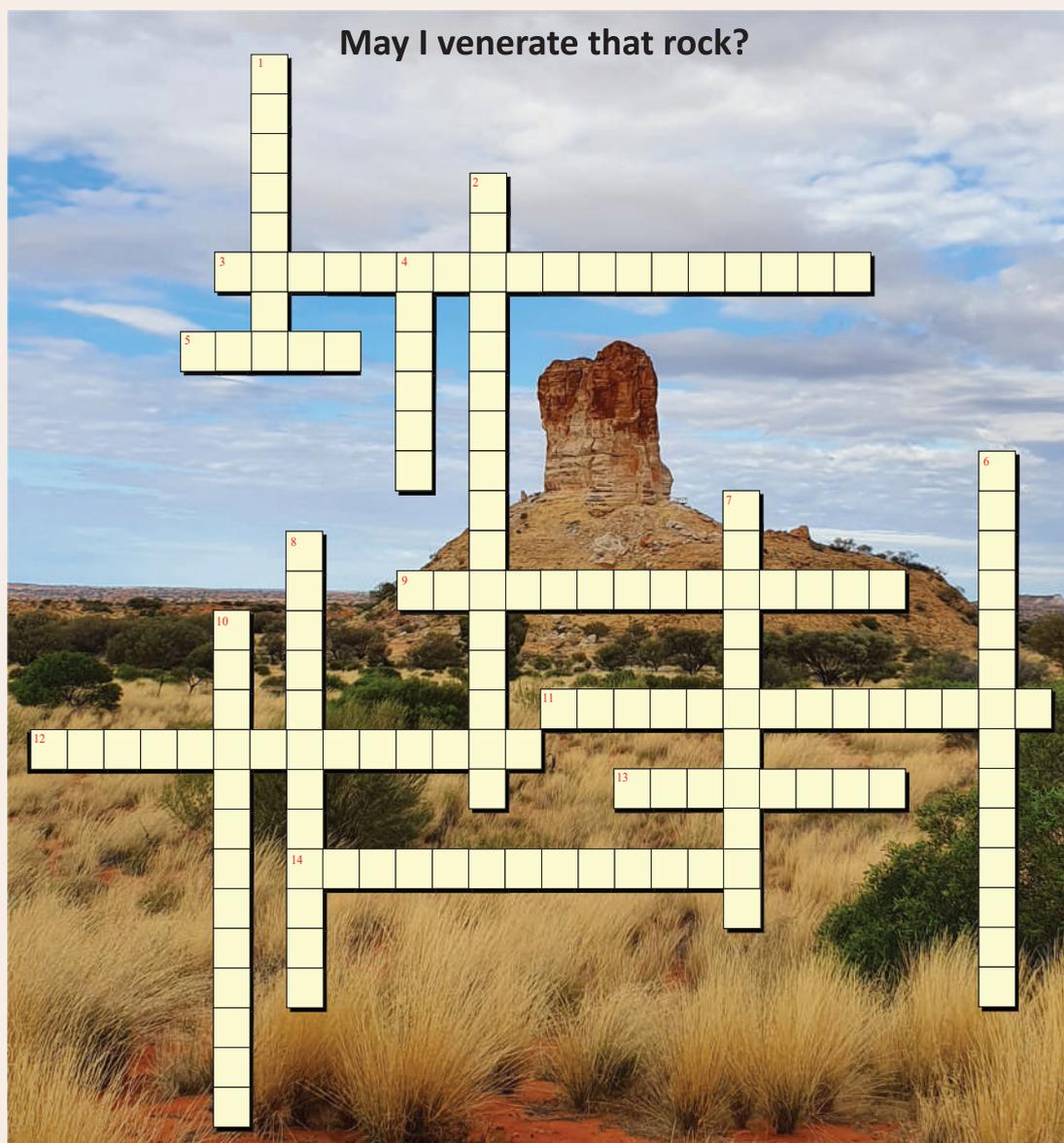


Figure 3. Two versions of a depth section of TMI data, continued from survey line 16101, Dugald River VTEM survey, showing a range of in-section dipoles, with a variety of polarities, using uncompensated TMI data. The version shown in the top image is smoother, and not clipped to topography. The version shown in the bottom image is at sampling resolution, is clipped to topography, shows the depth scale to 500 m, and better indicates the recent near surface cover depths.

Preview crossword #26



Across

- 3.** Mushroom rock, maybe a goblet, a leafy stem, a wonky heart or a lopsided whale tale bursting through the surrounding stones [12,6]
5. Massive sandstone monolith in the heart of the Northern Territory's arid "Red Centre"
9. Not quite the disciples of Jesus, only eight are left standing [6,8]
11. Legendary footsteps of giants [6,8]
12. Toko Ngawha, unusual granite formation in Tasman Bay [5,5,4]
13. Big swell rises from vast outback plains, captivates surfers worldwide, no ocean in sight [4,4]
14. Stone tree of Bolivia [5,2,6]

Down

- 1.** Large limestone column protruding from the sea, resembles a large nail hence its name in Thai [4,4]
2. Rock wedged between two mountain sides, overhanging the majestic Lysefjorden [12,4]
4. Stone forest of Yunnan Province
6. A beautiful and remarkable formation in Tai Shan [8, 6]
7. Hoodoos of the Badlands [2,3,3,3]
8. Erosional remnant of a shield volcano, tallest volcanic stack in the world [5,7]
10. Narrow vertical column of basalt overlooking St. Mary's Bay [9,4]

Play to win!!

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

Good luck!



Preview crossword #25 solution

Here today, gone tomorrow

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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 2023

INSTRUCTIONS FOR APPLICANTS

- Determine the membership level you wish to apply for, according to the eligibility criteria outlined in Section 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. Under exceptional circumstances the Federal Executive Committee may waive these requirements.
- Submit the two pages of your application to the Secretariat at the address shown on the top of this page, retaining a copy for your own records. The Secretariat will generate an invoice for payment that includes payment instructions. The invoice will be sent electronically so please check your email inbox and spam folders.

Section 1. Personal Identification

Surname		Date of Birth	
Given Names		Title	
Address			
Country	State	Post Code	
Organisation			
E-mail			
E-mail (alternate)			
Mobile	Phone (W)	Phone (H)	

Section 2. Choice of Membership Grade (Active or Associate)

- Active Please complete all sections
- Associate Please complete all sections apart from Section 4 (Nominators)
- 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 of Active Membership applicants must be ACTIVE Members of ASEG

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

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 Member Record**

Include me in the ASEG Member Search on the Secure Member Area of ASEG's Website (search is only available to current ASEG members who opt-in)

 Yes No*Please complete this section for the ASEG membership database.***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. Membership Grades and Rates** Active/Associate (Australia) - \$193.00 (incl GST) Active/Associate 5 Year Membership (Australia) - \$965.00 (incl GST)
 Active/Associate (Group IV Countries) - \$175.50 Active/Associate 5 Year Membership (Group IV Countries) - \$877.50
 Active/Associate (Group III Countries) - \$52.70 Active/Associate 5 Year Membership (Group III Countries) - \$263.50
 Active/Associate (Group I & II Countries) - \$19.30 Active/Associate 5 Year Membership (Group I & II Countries) - \$96.50
 Associate-Graduate (Australia) - \$97.00 (incl GST)**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:

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 Yes NoPreview is published bi-monthly and is available for open-access at www.aseg.org.au/publications/PVCurrent.

ASEG members can elect to have hardcopy Preview delivered to their nominated address (offer does not apply to Student members).

I would like to receive hardcopy Preview as part of my ASEG membership.

 Yes No**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: _____



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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.



AUSTRALIAN SOCIETY OF EXPLORATION GEOPHYSICISTS

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INSTRUCTIONS FOR APPLICANTS

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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 you provide contact details for your supervisor or coordinator
3. Submit your application to the Secretariat at the address shown on the top of this page, retaining a copy for your own records.

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Surname		Date of Birth
Given Names		Mr / Mrs / Miss / Ms / Other (list)
Address		
Country	State	Post Code
E-mail		
E-mail (non-University alternative)		
Mobile	Phone (W)	Phone (H)

Section 2. Student Declaration

Institution	
Department	
Major Subject	Expected Year for completion of studies
Supervisor/Lecturer	Supervisor Email

Section 3 Membership Grades and Rates

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

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- 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

Section 5 Declaration

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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 2023			
5–8	84th EAGE Annual Conference & Exhibition https://eageannual.org/	Vienna	Austria
26–29	26th World Mining Congress https://wmc2023.org/	Brisbane	Australia
July 2023			
9–14	Goldschmidt 2023 https://conf.goldschmidt.info/goldschmidt/2023/meetingapp.cgi	Lyon	France
August 2023			
27 Aug–02 Sep	International Meeting for Applied Geoscience & Energy (IMAGE) https://www.imageevent.org/	Houston	USA
September 2023			
3–7	Near Surface Geoscience Conference & Exhibition 2023 https://eagensg.org/	Edinburgh	UK
4–8	8th International Airborne Electromagnetics Workshop (AEM 2023) aemconference@theassociationspecialists.com.au	Fitzroy Island	Australia
12–13	EAGE Conference on the Future of Energy - Role of Geoscience in the Energy Transition https://eage.eventsair.com/eage-conference-on-the-future-of-energy---role-of-geoscience-in-the-energy-transition	Kuala Lumpur	Malaysia
October 2023			
17–20	Seventh International Conference on Engineering Geophysics (ICEG)	Abu Dhabi	UAE
25–27	Offshore Technology Conference (OTC) https://otcbrasil.org/	Rio de Janeiro	Brazil
November 2023			
7–8	EAGE/Aqua Foundation Second Indian Near Surface Geophysics Conference & Exhibition https://www.nearsurfacegeophysics.in/	New Delhi	India
December 2023			
5–7	Latin America URTeC https://urtec.org/latinamerica/2023/	Buenos Aires	Argentina
February 2024			
28 Feb–02 Mar	Offshore Technology Conference Asia (OTC Asia) https://2024.otcasia.org/	Kuala Lumpur	Malaysia
May 2024			
13–15	6th Asia Pacific Meeting on Near Surface Geoscience and Engineering https://eage.eventsair.com/6th-asia-pacific-meeting-on-near-surface-geoscience-and-engineering/	Tsukuba	Japan
June 2024			
10–14	85 th EAGE Annual Conference & Exhibition	Oslo	Norway
August 2024			
25–31	International Meeting for Applied Geoscience & Energy (IMAGE) https://www.imageevent.org/	Houston	USA

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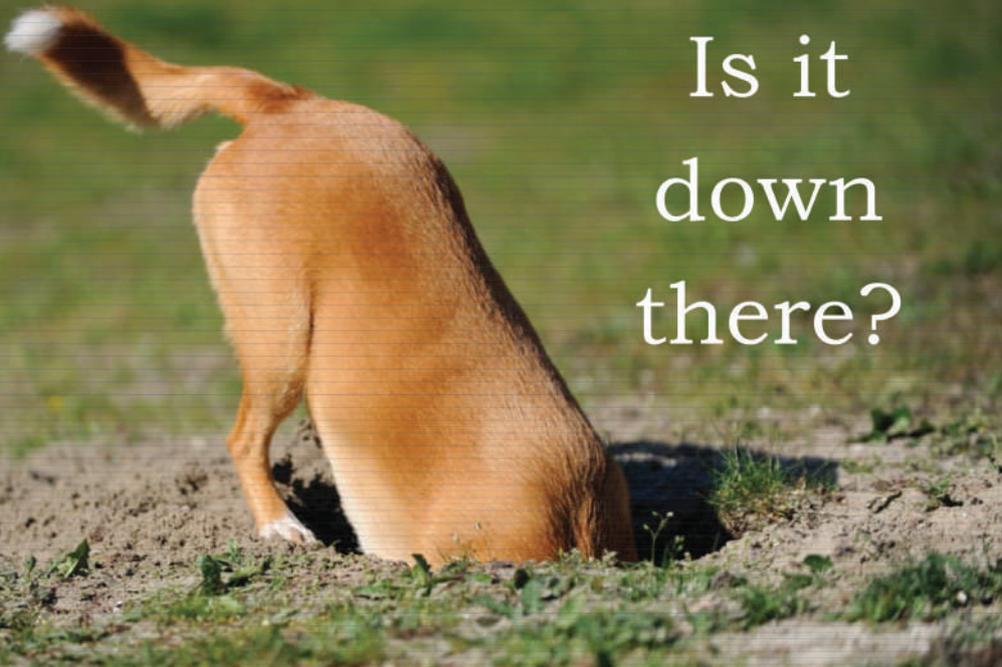
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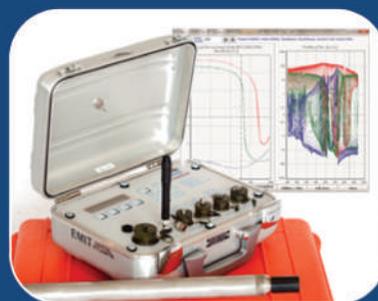
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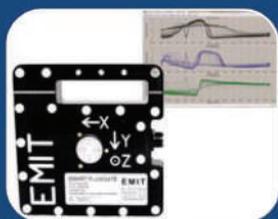
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Rugged and reliable PC-based, 16 channel, 24-bit electrical geophysics receiver system with time-series recording, powerful noise rejection, GPS sync and an optional separate Transmitter Controller. Works seamlessly with a wide range of transmitter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



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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.



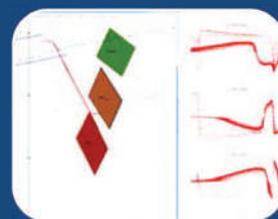
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