Australian Society of Exploration Geophysicists

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PREVIEW

NEWS AND COMMENTARY

FEATURES

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FRONT COVER

AusLAMP equipment being recovered from a site west of Winton, Queensland. Photo taken by J Pheeney, Geoscience Australia. See Geophysics in the Surveys for more information.

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

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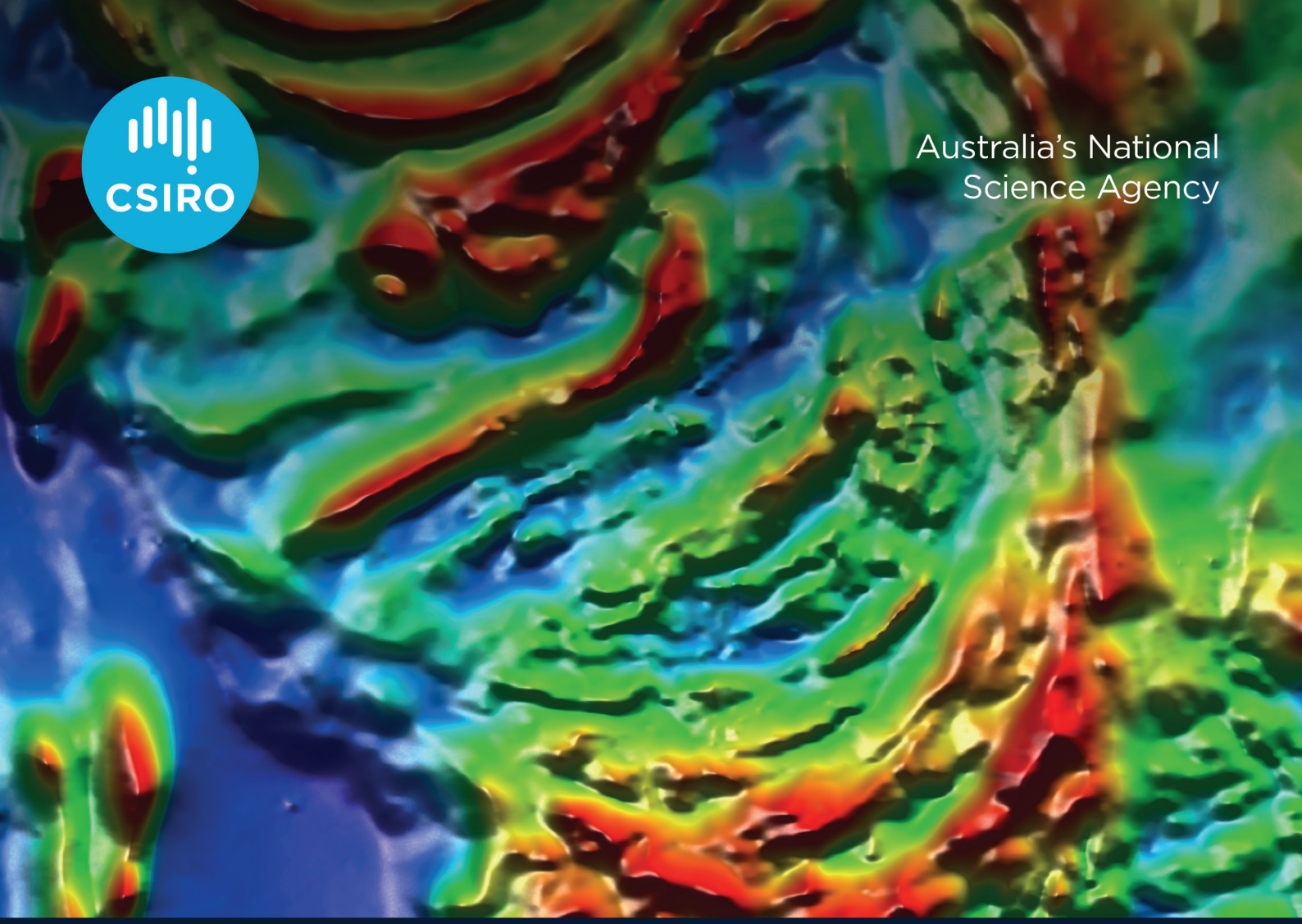

CSIRO

Australia's National Science Agency

Sub 22

From imaging structures to predicting processes

Our Deep Earth Imaging Future Science Platform presents Sub 22, an interdisciplinary subsurface conference.

The event will provide the geoscience community with:

- A platform to contribute, discuss and learn about the interdependence between the science pillars imaging, conceptualisation and prediction for the exploration, characterisation and management of energy, mineral and water resources.
- A forum for in-depth conversations about the transition from imaging structures to predicting processes and their outcomes, underway in the geosciences.

28–30 November 2022

The National Wine Centre of Australia, Adelaide

research.csiro.au/dei/sub22

B&M | 22-00094

Editor's desk

On July 12 the American Geophysical Union (AGU) announced that it would transition its journal *Geophysical Research Letters* to fully open access in January 2023 (https://fromtheprow.agu.org/agu-acceleration-to-open-access-with-geophysical-research-letters-transition/). Nine of AGU's 23 journals are already open access, and the Union has announced its intention of transitioning at least one journal to fully open access per year over the next five years. Without doubt, the trend to open access by the world's best known scientific journals is accelerating.

Initially it could be argued that the move was driven by funding agencies demanding that, as the public was largely funding the research that was being published in scientific journals, the public should be able to access the results freely. There was also a general disquiet about the large profits being made by publishing houses on the back of publicly funded research and the efforts of mostly voluntary editorial teams and scientific reviewers.

However, once the movement to open access got going it became apparent that, on average, open access articles were downloaded more than three times as often as subscription articles. Open access articles were also cited 50% more frequently compared to subscription articles, and open access articles received nearly three times as much alternative metrics attention as subscription articles (https://authorservices.wiley.com/author-resources/Journal-Authors/open-access/the-open-access-advantage.html).

Preview is open access, and it could be argued that a large part of *Preview*'s success in terms attracting global readership is because it is freely available online.

The downside of open access can be the Article Publication Charge (APC). The most expensive journal in Wiley's list of 1400 journals with APC charges is $US 6100. The APC for *Geophysical Research Letters* is $US 2700. The APC for *Geophysical prospecting* is $US 3650, and the APC for the *Journal of Geophysical Research* is $US 3600. Our own *Exploration Geophysics* is not open access, but authors can choose to make their article freely available via "Open Select". The APC for articles published in *Exploration Geophysics* via Open Select is $US 2850 or $AU 4130.

Preview authors can rest easy in that the ASEG does not charge an APC for articles published in *Preview*. The cost of publication is covered by advertising and, in the case of any shortfall, by ASEG Members. Please do consider advertising in *Preview* (email me at previeweditor@aseg.org.au if you are interested) – for obvious reasons we treasure your contribution!

In parallel with a move to open access, many journals have signed up to the FAIR (Findable, Accessible, Interoperable, Reusable) guiding principles for research data management. Contributing authors are asked to lodge the data (raw and processed) that forms the basis of their article, together with copies of code used to process and/or model the data, in a community accepted, trusted repository. Many such repositories exist see for example https://data.agu.org/resources/useful-domain-repositories. This move is designed partly to ensure scientific integrity (the data can be checked and analysis repeated etc.) but will also help to address the problem of the preservation of, and access to, historical data and code. However, the practice may not suit those who are working under a confidentiality agreement, or those that feel that there is more in their data that they would like to explore without the feeling that some eager beaver might breathing down their neck. We live in interesting times!

This issue of *Preview* features a gem of an article on the discovery of the Havieron Gold-Copper deposit in WA by Jim Hanneson and Callum Baxter. The deposit was discovered under 420 m of post-mineralisation cover because of some clever geophysical modelling. All hail Jim and Callum!

We also have a mini-feature by Bhavik Harish Lodhia on the stability of CO_2, a topic that should be of great interest to those of you getting into the CO_2 geo-sequestration game.

In news and commentary, David Denham (*Canberra observed*) takes a look at key players in the new Federal Government from the geoscientist's perspective. He also takes a look at the latest data on the health of the mining industry. Marina Pervukhina (*Education matters*) urges readers to unleash their creativity by exploring online offerings in the "soft" sciences. Mike Hatch (*Environmental geophysics*) delivers the fourth episode of Niels Christensen's adventures in which Niels describes his first meeting with local hero Jim Macnae!

Terry Harvey (*Mineral geophysics*) muses about the advantages and disadvantages of remote management of mineral exploration projects in Australia and Mick Micenko (*Seismic window*) re-visits the glory days of Australian oil and gas exploration. Tim Keeping (*Data trends*) invites readers to consider contributing to a new ASEG library of historical data file formats, and Ian James (*Webwaves*) asks "have you been Pwned"?

Enjoy!

Lisa Worrall
Preview Editor
previeweditor@aseg.org.au

The Editor in the Herberton Tinfields – Vulcan Mine at Irvinebank to be precise!

President's piece

Emma Brand

Members and readers

I hope that you've found enough layers to stay warm throughout the coldest start to winter for the last several decades. In Brisbane throughout July an unusually cold wet haze set in, plunging the sunshine state and its residents into permanent Ugg boot wear. And in my new home of Auckland, I've been learning not to worry too much about what the forecast says, and embrace the almost certain downpour, wind and sun that emerge at least once a day, in varying amounts!

Now that I've got on two layers of merino, in this issue of *Preview* I wanted to highlight what we're doing to improve the volunteer experience. I've always known that the ASEG has an incredibly dedicated band of volunteers that keep the organisation moving forward, from the FEDEX to the state branch leadership. However, this was brought home even more powerfully with the publication of last year's Volunteer Almanac. This awesome publication lists all the dedicated volunteers across our organisation, and the statistics are clear, almost 20% of our Members give back through volunteer roles. What this tells me is that we don't just exist because of membership renewals and conference income, but that the *time* our Members dedicate to the ASEG is a form of revenue in and of itself. With this insight in hand, a key priority this year is to ensure that we remove process duplications and streamline our systems so that volunteers are spending their time on high value activities.

We have numerous initiatives this year to improve the volunteer experience. These include:

1. Volunteer recognition and training, which includes the annual publication of the Volunteer Almanac;
2. Leveraging the monthly meeting of branch representatives to share learnings across the states;
3. Reviewing all our processes to identify wasted effort and redesign our workflows to be more efficient.

In addition to the above initiatives, I also want to use this *Piece* to highlight the upgrade of our website. This initiative, in and of itself, might not ordinarily be associated with a better volunteer experience, but in this case it is. This is because we're not simply upgrading the website, we're moving to an integrated association membership system. This means that all the activities we currently undertake separately, such the website, event management, marketing and communications, membership management and online membership payments, can now occur in a single environment. This will create better visibility for all Members on events across the country, as well as integrate your membership data with these activities. This will simplify the processes for state branch volunteers, for the Communications Committee and the Publications Committee amongst others.

The business case for the website upgrade was presented and endorsed by the FEDEX at the July meeting. We're focussed on delivering this upgrade in time for the AGM in April next year. This timeline will ensure that any issues with the database changeover will be resolved before the 2024 membership renewal drive, which is another area that we hope that both Members and volunteers will have a streamlined and simplified experience.

In other news, the deadline for short abstract submissions for AEGC 2023 closed in August and I'm delighted to report that we received some fantastic submissions for next year's conference in Brisbane. The conference is an excellent forum, not only to get exposed to world class science, but in a world of entrenched working from home, to connect with your peers face to face. I'm therefore especially excited about the role the AEGC will play in facilitating peer to peer engagement between geoscientists across the Australasian region for 2023. If you're keen to know more about the conference, then head to the website or contact our ASEG co-chair Megan Nightingale, who will be able to assist with any of your enquiries.

Finally, I want to give a massive shout out to Immediate Past President, Kate Brand, and the work she and the team have been doing to establish CAGE, a one-week Camp for Applied Geophysics Excellence, in South Australia in September. The camp is a collaboration between the ASEG and AuScope and will provide seven days of real-world application of major geophysical techniques to students and young professionals. Over 70 applications were received for 20-25 free placements that are sponsored by ASEG, NExUS and AuScope. This is truly an amazing opportunity to enable participants to learn how to process geophysical data, complete practical sessions on basic data importation and reduction, filtering, modelling, inversion, data display and importantly, interpretation. In addition, participants will learn how to integrate diverse geophysical datasets in order to map/image the sub-surface in the vicinity of a copper deposit environment in South Australia. I'm so pleased that the ASEG can take a leading role in delivering opportunities like this to students and young professionals, closing a gap that has been created with the shrinking of geophysical education across universities in Australia.

As I close, keep warm out there, and if there are any processes or pain points that create barriers to you volunteering your time with the ASEG, please reach out. As always, I am open to your thoughts, feedback and suggestions, so please don't hesitate to connect.

Emma Brand
ASEG President
president@aseg.org.au

Executive brief

The Federal Executive of the ASEG is the governing body of the ASEG. It meets once a month via teleconference, to deal with the administration of the Society. This brief reports on the monthly meetings that were held in June and July 2022. If there is anything you wish to know more about, please contact Leslie at fedsec@aseg.org.au

Finances

The Society's financial position at the end of June 2022 was:

Year to date income: $194 260

Year to date expenditure: $193 603

Net assets: $1 026 789

Membership

As of 14 July 2022, the Society had 767 financial Members, compared to 799 at this time in 2021. The ASEG currently has eight Corporate Members, including two Corporate Plus Members. A huge thanks to all our Corporate Members; **Velseis, Total Seismic, Santos, Southern Geoscience, Transparent Earth Geophysics, DUG Technology, Instrumentation GDD,** and **HiSeis,** for your continued support into 2022. Don't forget to have a look for our Corporate Members on the contents page of *Preview* and to support them as much as you can. Our state branches have additional local sponsors. These sponsors are acknowledged at all branch meetings and at the beginning of all webinars.

If you have not yet renewed your membership for 2022, please consider renewing your membership now. Five-year membership options are available to Active/Associate and Retired members. Early and mid-career Members are also encouraged to join the ASEG Young Professionals Network at www.aseg.or.au/about-aseg/aseg-youngprofessionals.

Positions vacant

We still have vacancies for the position of Chair of our International Affairs and Education Committees. Our other standing committee chairs would also welcome any support that you can offer. If you would like to contribute to your Society, please consider volunteering for a position on one of these standing committees. You can contact Leslie at fedsec@aseg.org.au if you have any queries.

Social media

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

Online events

It's great to see the state branches are increasing their face-to-face events. Keep a look out for notifications from your state branches to see what is coming, and get out there and reconnect with your colleagues. The ASEG will also continue with the webinar series with some interesting talks in the pipeline. The webinars are coordinated and run at both state and federal level. Sessions are all recorded and available for viewing at the ASEG website or on our YouTube Channel.

Leslie Atkinson
ASEG Secretary
fedsec@aseg.org.au

Welcome to new Members

The ASEG extends a warm welcome to 11 new Members approved by the Federal Executive at its June and July meetings (see table).

First name	Last name	Organisation	State	Country	Membership type
Ademolawa (John)	Afelumo	Monash University	Vic	Australia	Student
Sarah	Alkemade	Monash University	Vic	Australia	Student
Mohammed	Alsaleh	Monash University	Vic	Australia	Student
Mackenzie	Baker	UNSW	NSW	Australia	Student
Dina	Chu		WA	Australia	Associate
Thyagarajulu	Gollapalli	Monash University	Vic	Australia	Student
Juan	Graciosa	Monash University	Vic	Australia	Student
Gokul Venu	Sreebindu	Monash University	Vic	Australia	Student
Angus	Rogers	Monash University	Vic	Australia	Student
Eric	Wang	University of Sydney	NSW	Australia	Student
Naima	Yilo	Southampton University	WA	Australia	Student

ASEG Research Foundation: Winner of the second Richard Lane Scholarship

Tom McNamara

The winner of the second annual Richard Lane Scholarship is Tom McNamara from University of Melbourne – School of Geography, Earth and Atmospheric Sciences. Tom is undertaking a Masters degree in geophysics and is to be awarded $5000. Tom's supervisor is Dr Mark McLean.

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

The scholarship is awarded annually and donations to support the scholarship's continuation are sought from institutions, companies and individuals. Information on donations via the ASEG Research Foundation can be found at www.aseg.org.au/foundation/donate Please mark donation specifically "Richard Lane Scholarship:"

Why Tom is studying geophysics (200-word discussion)

I have a deep personal interest in how the world works on a mechanical level. Initially as I was studying, I explored this through physical sciences and thought I might pursue theoretical physics. Instead, I've found fulfilment in pursuing those questions through geology and the long histories of the Earth. It was by coincidence that I came back to physics later in my degree, and its applications in exploration.

The central principle of exploration geophysics – that we can image and understand sequences buried in the crust without ever needing to see them – reminds me constantly of the strangeness and complexity of the natural world, and the depth of knowledge that is still buried.

It was important to me when designing my Masters' project that it could have applications that would be useful beyond obtaining the degree. When I've finished my Masters, I plan to spend time in industry and learn as much as I can about a breadth of resource industries at each level. My long-term goal is to work on constructive applications for geophysics in environmental remediation. I also have an interest in modelling tools and intend to spend time developing more comprehensive multi-discipline modelling and integration methods.

Tom's Masters project

Characterisation of metavolcanic megaclast structures within the Moyston Fault hangingwall mélange (Moornambool Metamorphic Complex), western Victoria: Insights from potential field modelling and machine learning.

Victoria's goldfields are highly prospective, and are the target for ongoing large-scale exploration and mining operations. With advances in undercover exploration driven by geophysical imaging and recently acquired high-resolution geophysical surveys over major gold prospects, Victorian gold exploration is seeing renewed activity. The Stawell Corridor is a highly prospective goldfield with multiple large-scale mining operations currently active. One of these operations is Stawell Gold Mine, the second largest hard rock gold mine in Victoria. The mine has produced 62 tonnes of gold since 2016, and the goldfield has produced a historical total of 170 tonnes. Undiscovered gold resources in the region are estimated to be up to 900 tonnes.

The Stawell Corridor is bounded by the north-northwest trending Moyston Fault and Congee Fault, and extends approximately 250 km. Along the corridor, a suite of kilometre-scale metavolcanics lies beneath the Murray Basin sedimentary top cover. These metavolcanics are referred to by the local miners as dome structures, and are known to be high potential gold targets. Stawell Gold Mine is hosted in the Magdala Dome, where mineralisation occurs along a sheared contact between the dome metabasalt and the sedimentary country rock. The currently accepted model for mineralisation is that the competence contrast between the lithotypes caused major deformation in the sediments and provided a vector for fluid flow along the dome body. This style of ore deposit is termed "Magdala-style mineralisation". Miners are actively exploring the other domes along the corridor to determine potential for other Magdala-style domes. However, the top cover becomes thicker as the corridor progresses north, and geometries of the dome structures become more difficult to identify and constrain.

The project aims to characterise the gravity and magnetic responses of a few targeted dome structures along the Stawell Corridor, and subsequently develop a method for applying machine learning algorithms to the exploration of undercover "Magdala-style" volcanic domes. We have partnered with the operator of Stawell Gold Mine, North Stawell Minerals (NSM) for the project. NSM have recently acquired a high quality aerial gravity gradiometry survey over their tenement in the corridor, which includes the high-potential Wildwood and Lubeck domes. We will collect high resolution ground gravity data across the Magdala, Wildwood and Lubeck domes to help constrain their geometry, then with the data provided by NSM, train a machine learning algorithm on real and synthetic gravity responses to identify potential undercover domes at various depths out of regional datasets.

Beyond the scope of this project, an algorithm like this could be scaled and applied to other datasets and deposit styles, to recognise potential targets for undercover deposits that have not yet been identified or explored.

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

ASEG Young Professionals Network: News

An ASEG Young Professionals networking event, held jointly with Petroleum Exploration Society of Australia (PESA), Society of Petroleum Engineers (SPE) and Australian Institute of Geoscientists (AIG), was held on Friday 24 June in the Shoe Bar in Perth. The event featured Allison Selman (Atteris), Andrew Lockwood (Woodside) and Lewis Mounsher (Woodside).

The event was a success and the speakers were well received, with approximately 30 young professionals from earth science and engineering backgrounds taking the opportunity to get to know their peers in the industry. We are hoping to host another event sometime in November this year.

Also, a reminder to Young Professionals keen to network in other states, there is an ASEG budget to support your initiatives. All you have to do is organise a local YP networking event. Please get in touch for more information (*ypadmin@aseg.org.au*).

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

Allison Selman, Andrew Lockwood and Lewis Mounsher holding the floor at the Perth multi-society Young Professional's networking event.

ASEG Honours and Awards: Calling for nominations for 2023

A reminder to all ASEG Members that nominations are open for the next round of ASEG Honours and Awards, which are scheduled to be presented in conjunction with AEGC 2023 to be held in Brisbane between the 13th and 18th of March 2023. All ASEG Members as well as State and Federal executives are invited to nominate those they consider deserving of these awards. The available awards are:

ASEG Gold Medal - for exceptional and highly significant distinguished contributions to the science and practice of geophysics, resulting in wide recognition within the geoscientific community.

Honorary Membership - for distinguished contributions by a Member to the profession of exploration geophysics and to the ASEG over many years.

Grahame Sands Award - for innovation in applied geophysics through a significant practical development of benefit to Australian exploration geophysics in the field of instrumentation, data acquisition, interpretation or theory. The nominee does not need to be a Member of the ASEG.

Lindsay Ingall Memorial Award - for the promotion of geophysics to the wider community, including geologists, geochemists, engineers, managers, politicians, the media or the general public. The nominee does not need to be a geophysicist nor a Member of the ASEG.

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. The nominee must be a Member of the ASEG and have graduated for at least three years.

ASEG Service Awards - for distinguished service by a Member to the ASEG, through involvement in and contribution to State Branch committees, Federal Committees, Publications, or Conferences over many years. Where the nomination details outstanding contributions to the shaping and the sustaining of the Society and the conduct of its affairs over many years, consideration will be given to the award of the ASEG Service Medal to the nominee.

Nomination Procedure

Any Member of the Society may submit nominations for candidates meeting the criteria for the above awards. Details of all award criteria and nomination guidelines can be found on the ASEG website at https://www.aseg.org.au/about-aseg/honours-awards.

Proforma nomination forms are also available by contacting the Committee Chair. Nominations including digital copies of all relevant supporting documentation are to be sent electronically to the Chair ASEG Honours and Awards Committee via email awards@aseg.org.au.

ASEG Technical Standards Committee: Update on JORC advice

A sub-committee has been formed to discuss how the ASEG can best advise those using geophysical data and information in public reports. The owners of JORC (AIG, AusIMM, MCA and the ASX) are pushing towards recognising competent teams that cover a number of specialities, rather than having a single person sign off on ASX releases, particularly releases relating to resource estimates. While exploration reporting is seen as less specific, most ASX resources related releases are exploration reports and anything designed to fix problems at the mining end of reporting will filter down in some way to exploration. "Best practice in reporting geophysical information to stock exchanges" (working title) will act as a guide both to geologists incorporating geophysical data and information and to geophysicists co-signing ASX releases.

Whilst the sub-committee is relatively small in order to stay workable for now, the group welcomes any advice or questions. We can be contacted via technical-standards@aseg.org.au.

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

Breaking news: SensOre acquires Intrepid Geophysics.

On the 5th of July 2022 SensOre Ltd (ASX: S3N) informed the Australian Stock Exchange that it had reached an agreement to acquire Intrepid Geophysics, a leading provider of geophysics software and services headquartered in Melbourne, Australia, with distributors and resellers globally.

The deal valued Intrepid Geophysics at $5 million. SensOre will pay $1 million cash, and issue stock worth $3 million to Intrepid's vendors, equivalent to 6.2% of the company based on 70c per share, plus a deferred cash payment of $1 million that will become due after one year but is contingent on several performance milestones including key personnel retention. The deal will be primarily funded through the issue of new fully paid ordinary SensOre shares.

SensOre was formed in 2018 and has offices in Melbourne and Perth. The company aims to become the top performing global minerals targeting company in the world, optimising discovery and enhancing exploration performance through deployment of big data, AI / machine learning technologies and geoscience expertise. Ex-BHP staff Tom Whiting and Nic Limb were involved the company's formation. Nic Limb is currently a Non-executive director. Other members of staff that will be well known to *Preview* readers are Alf Eggo, the Chief technology officer, and Thong Huynh, the Principal geophysicist.

SensOre Chief Executive Officer, Richard Taylor, said: "Acquiring Intrepid Geophysics is a major opportunity for us. Intrepid Geophysics' deep geoscience and machine learning expertise in geophysics complements SensOre's geochemistry and economic geology focus for targeting in mineral exploration. Demand for advanced geophysics software is strong and deployable globally. Intrepid Geophysics' years of product leadership, data collation and collaboration with government geological surveys will benefit SensOre's data platform development and client service offerings. We are looking forward to integrating Intrepid Geophysics' exceptional talent with our team of innovators."

Intrepid Geophysics Managing Director, Dr Desmond FitzGerald, said: "The combination of SensOre and Intrepid Geophysics will unlock growth opportunities in a strong market for high level exploration targeting. We look forward to being part of a growing and exciting geoscience group."

Intrepid Geophysics (formerly Desmond FitzGerald & Associates Pty Ltd) was founded in 1978 by Des FitzGerald as an independent consultancy specialising in the use of computer methods for mining and geophysics. In the 1990s Des led the development of the Intrepid Geophysical Processing System, which began with an amalgamation of the successful BHP Pitts and BMR ARGUS geophysical processing systems, but under Des' leadership was developed into a world-class, flexible, adaptable system to allow both GUI-based interactive and batch processing of potential field and radiometric data.

As well as the Intrepid data processing system, Des was instrumental in the development of the Jetstream data management and delivery system that is at the core of the GADDS data delivery system used to deliver geophysical data collected by Geoscience Australia and state and territory surveys to the exploration industry.

Intrepid Geophysics has distributors active in Australia and Namibia, and resellers active in India, China, UK, Europe, southeast Asia and the Americas. The company and its distributors employ more than fifteen geophysicists, software developers and a range of professional support staff. The company's products have found a home in a range of sectors and industries including government, academia, minerals exploration, petroleum (oil and gas), hydrogeology, geothermal energy and geotechnical engineering. Intrepid Geophysics has long-term contractual agreements with over 20 geological surveys and a number of mining and oil and gas companies.

The software for which Intrepid Geophysics is renowned includes: Intrepid 3D, Moskha EM, Argus, JetStream II and Sea g Marine Gravity.

Des Fitzgerald is a legend in exploration geophysics and has won numerous awards including the ASEG's Graeme Sands Award in 2016. The *Preview* editorial team is hoping that the acquisition of Intrepid Geophysics by SensOre will mean that Des might have some time to share highlights of his career with *Preview* readers. Niels Christensen is showing him the way!

ASEG branch news

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.

Gerrit Olivier
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Victoria

Benjamin Franklin once said that "if you want something done, ask a busy person." I can definitively, with 110% confidence, attest to the veracity of this sentiment. It's currently mid-year school holidays and I am nursing two sick and very needy children at home. At the same time, I am juggling the demands of work while working from home and tending to every whim of my contagious children. Then there's running the household. The cooking, the cleaning, the washing, the entertaining. Couple this with the lack of sufficient rest I am not receiving at night (sick children don't sleep so soundly) and you have the perfect recipe to transform oneself into a *bona fide* zombie. Interrupted sleep affects concentration and awareness (excessive alcohol consumption also does this). In what was my first day/night free from responsibility in almost ten Earth revolutions, I get a reminder that the Victorian Branch's contribution to *Preview* was due… yesterday…sigh ☹

As I reach across the coffee table to top up my whisky tumbler, I muse over our recent branch events and wonder if my fragmentary recollection will do our guest presenters any justice with my current state of unwillingness and spiritless mindset on this cold wintry evening in early July. I suddenly feel as though I am the protagonist in Edgar Allan Poe's utter masterpiece, The Raven…as I slowly descend into madness during my confrontation with a talking bird ☺

On the night of 17 May, members welcomed Monash University post-graduate students **Mohammed Alsaleh** and **Chibuzo Chukwu** to The Kelvin Club where they presented their ASEG prize-winning talks from this year's Victorian Universities Earth and Environmental Sciences Conference (VUEESC). The title of Mohammed's study, "Estimation of sand dunes properties using time-depth seismic data from the Empty Quarter Desert of south-eastern Saudi Arabia", was a thorough examination of the different mathematical models used to approximate seismic travel times as a function of the volume fraction of clay against measurements from wells drilled

Mohammed Alsaleh presenting to the Victorian Branch at the Kelvin Club.

Chibuzo Chukwu presenting to the Victorian Branch at the Kelvin Club.

The audience at the Kelvin Club for Pete Betts presentation.

through sand dunes. Admittedly, I had never seen so many third-order calculus equations in a presentation before. Well done, Mohammed.

Our second presenter that night was Chibuzo whose thesis, "A new approach to imaging deep crustal structures across passive continental margins: revisiting the crustal architecture of southeast Australia's passive margin" (why are these academic paper titles so long?), revealed an interesting approach to imaging crustal scale features. He applied Euler deconvolution on global EMAG data then analysed those results via an unsupervised clustering analysis (a machine learning method) before validating against forward gravity models constrained by seismic data to predict the likely extension of mapped faults. Great to see the use of alternative global-scale geophysical data where higher resolution data does not exist. A neat effort, Chibuzo.

Pete Betts presenting to the Victorian Branch at the Kelvin Club.

To close off the first half of 2022, on 15 June members were treated to a special technical meeting night with honoured guest presenter, **Dr Pete Betts**, also at The Kelvin Club. Pete is a Professor in Structural Geophysics at the School of Earth, Atmosphere, and Environment at Monash University where he is also the Associate Dean of Graduate Research. In his spare time, he holds the office of President of the Geological Society of Australia. Pete delivered an invaluable message that night when he presented a talk entitled "Is it time to rethink the Geoscience narrative to save our discipline - what can you do as an individual?", shocking the record audience in attendance.

The decades-long, slow decline of geosciences as a study discipline happens to be a global phenomenon. Fallout from the impact of COVID appears to have accelerated the geosciences' academic demise. We live in a world where fossils fuels are no longer viewed as a necessary evil. Younger generations are hell bent on punishing generations past for consigning them to a world without a clear future, a world facing the sustained effects of climate change. No matter how our industry tries to rationalise exploration and mining, we inadvertently shoot ourselves in the foot. Take for example, large mining companies that typically promote their businesses by showing images of vast land that has been razed and replaced by heavy mining equipment or workers wearing high-vis gear and PPE covered in red dust standing next to an excavator or a large truck loader before highlighting the volume of treasured ore that has been displaced from the Earth. This creates a hugely negative impression of the mining and extractive industries as one of devastation and destruction of the Earth, and further clouds the fundamental reason why we choose to study our planet. We are clearly not doing ourselves any favours with the unfortunate ways we propagandise the geosciences. As geoscience individuals, we are facing a growing hostile dislike from most groups – indigenous and farming communities (think Juukan Gorge), environmental and social groups, climate action groups, geopolitical groups…the list goes on. What we need

to do, as Pete suggested in his talk, is to start changing the geoscience narrative and better communicate what we do and why we love the geosciences. Sure, job creation and contributions to the local and regional economies is great, but that can no longer be a key motivation for our industry. Ultimately, we mine materials that are needed to create the next generation of technological innovations that will provide the many goods and services that consumers currently enjoy. How we convey that message is absolutely important. We are in the greatest battle of good versus evil and for a long time coming, we are officially not on the "good" side.

Thong Huynh
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***Editor's note**: Thong tested positive to COVID the day that he submitted the Victorian Branch news. I am sure you will all join me in wishing him (and his children) all the best for a speedy recovery!*

Alex Costall, Brad Cox and Grant Couston at the WA Branch June social night.

Revellers at the WA Branch June social night.

Western Australia

It has been a busy few months for the WA committee. We have kicked off our Young Professionals programme with a joint networking event, organised by our state YP coordinator **JJ Leong**, in conjunction with SPE, AIG and PESA. The WA mentoring programme gets underway in July, with industry volunteer mentors being matched with student and early-career geoscientists.

The June social night was a success, despite the arrival of stormy weather on the night of the event (something we are not used to dealing with in Perth!). It was a casual catch up at one of the city's newest brewpubs, perfect for a relaxed beverage and a great chance to meet people from different parts of the geophysical spectrum. Kudos to **Jarrad Trunfull**, our social coordinator for organising the event for us.

For the June Tech Night we returned to the theme of machine learning, this time applied to the topic of seismic processing. **Amarjeet Kumar**, Senior Research Geophysicist at DUG Technology presented an excellent talk entitled "Machine learning solutions to seismic processing challenges". Operations such as deghosting, multiple attenuation and swell noise rejection have been dramatically improved by employing deep learning methods, often with reductions in processing time! Amarjeet also insisted that use of machine learning must go hand-in-hand with an understanding of the underlying physics. A comforting message for geophysicists still trying to wrap their heads around these new techniques! This is an exciting and rapidly developing aspect of seismic processing, also very pertinent for other areas of geophysical data analysis.

We are also in planning for a big event later in the year. Last year's inaugural MAG21 symposium was a mineral case studies event which was enjoyed by WA geoscientists who were kept home by our our state's hard border policies. This year we hope that MAG22 can be bigger and better and that we are able

Amarjeet Kumar presenting to the WA Branch.

to welcome interstate and international visitors as well.

Darren Hunt
wapresident@aseg.org.au

Australian Capital Territory

It has been a quiet month for the ACT Branch, but hopefully leading into an interesting July and August. We are seeking greater ties with the Geological Society of Australia (GSA) as a means of cross promoting both organisations and highlighting the work that both societies undertake. By the time this issue of *Preview* has been published we aim to have attended a social gathering with both societies. In the coming year we aim to provide interesting talks that highlight what geophysics can contribute to geoscience.

In sad news, **Ted Lilley**, who many people in ASEG will know, passed away on July 4. Ted was a long-time friend to many. He worked in Geoscience Australia's predecessor organisations and with the aeromagnetic team in the 1960s, taught at the ANU over many years, and was a longstanding member of the ASEG community. He will be sorely missed.

Phillip Wynne
actpresident@aseg.org.au

New South Wales

Following a quiet May, we returned to our usual monthly technical seminars in June. **Giovanni Spampinato** from CSIRO Mineral Resources presented a talk entitled "3D geological modelling: a multi-source heterogeneous data integration tool to advance the knowledge of geological regions, mineral systems and groundwater resources. An example from NSW".

Giovanni took us through building three-dimensional geological models using a variety of different datasets, including surface geological maps, geological cross-sections, well data, digital elevation models, seismic, gravity and magnetic data and 2D forward models. Giovanni's work included creating a three-dimensional geological model of NSW, which was used to establish a state-wide framework that will provide context for future 3D models and geological surveys. Giovanni also took us a through a case study of a recent project at Western Sydney Airport, where 3D geological modelling was applied to interpret the depth to bedrock. This information was crucial for engineers designing the airport.

An invitation to attend NSW Branch meetings is extended to interstate and international visitors who happen to be in town at the time. Most talks are livestreamed on zoom and uploaded to ASEG's YouTube page later, so you also have the option to join us online. Meetings are generally held on the third Wednesday of each month from 17:30 at Club York. News, meetings notices, addresses and relevant contact details can be found at the NSW Branch website. All are welcome.

Bhavik Harish Lodhia
nswsecretary@aseg.org.au

Bob Musgrave *(right) introducing Giovanni Spampinato to the NSW Branch.*

Queensland

The Queensland Branch AGM was held on Wednesday 25 May. We had a great turnout and the 2021 committee was re-elected for another year, with **James Alderman** as President, **Nick Josephs** as Secretary, **Roger Cant** as Treasurer and **Tim Dean** as Communications Representative. It's an exciting time for geophysics and geophysicists in Queensland, with the majority of contractors and consultants I talk to busy with surveys looking to add to the state's mineral and energy discoveries. It is also great to see QUT advertising this week for an Associate Professor in Geophysics and Remote Sensing. With our search space for new deposits getting deeper and accessing land becoming more challenging, geophysics will only continue to play an even larger part in our mission for discovery.

After the AGM we welcomed **Adrian McCallum**, geophysicist and glaciologist at the University of the Sunshine Coast, to talk about his work in polar and mountainous regions all around the world. It was great to hear about applications of geophysics such as ice thickness and ice movement mapping and Adrian's passion for his subject was truly infectious. For anyone that missed it, Adrian's talk is available for viewing on the ASEG YouTube channel.

The next event for the Queensland Branch was our Zoeppritz social night on 22 July, held this year in conjunction with AIG, and continuing the Brisbane Brews nights, on this occasion at Valley Hops Brewing in Fortitude Valley. The Queensland committee enjoyed catching up with members over a beer or few.

Later in the year we have several talks lined up, including **Dan Eremenco** from GAP Geophysics and **Ken Witherly** from Condor Consulting; more details and other speakers will follow.

James Alderman
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South Australia and Northern Territory

After a busy start to the year with a quick succession of events, the SA/NT Branch has had a small reprieve over the last two months. Rest assured though, the committee is busy planning several events. Of course, the annual ASEG wine tasting event will be on the calendar again this year. You'll hear more about these events by email as we finalise details (so check that your contact details are up-to-date).

On Friday 19 August at 17:15 PESA, SPE, GSA and ASEG will be co-hosting a talk by Professor **Juergen Schieber**, Indiana University, "With one arm tied behind our back – doing geology by proxy in a faraway place (Mars)". This event is sure to be fascinating and a great networking opportunity so please join us at the Mawson Lecture Theatre at the University of Adelaide.

The SA/NT Branch AGM held on Wednesday 25 May marked the end of Branch President **Ben Kay**'s leadership. We thank him for his generous commitment and contributions to the role over the last two years. We look forward to Ben continuing to volunteer in the Branch Treasurer role, replacing **Sam Jennings** who has stepped down. We also welcome incoming Branch President **Paul Soeffky**.

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 **SA Department for Energy and Mining**, **Zonge**, **Santos** and **Heathgate**.

Kate Brand
ASEG SA/NT Branch Committee Member
past-president@aseg.org.au

ASEG national calendar

Date	Branch	Event	Presenter	Time	Venue
ASEG Branch face-to-face meetings have been disrupted in many states due to COVID outbreaks. Some branches are hosting webinars. Registration is open to Members and non-members alike, and corporate partners and sponsors of state branches are acknowledged before each session. Recorded webinars are uploaded to the ASEG's website (https://www.aseg.org.au/aseg-videos), as well as to the ASEG's YouTube channel (https://bit.ly/2ZNglaZ). Please monitor the Events page on the ASEG website for the latest information about upcoming webinars and other on-line events.					
1-2 Aug	National	NExUS workshop	David Isles and Leigh Rankin	TBA	Virtual
17 Aug	NSW	Tech night	TBA	1730	Club York, York St, Sydney
19 Aug	SA/NT	Tech talk	Juergen Schieber	1715	Mawson Lecture Theatre, University of Adelaide, Adelaide
21 Sep	NSW	TBA		1730	Club York, York St, Sydney
27 Sep	ACT	Tech talk	Constanza Manasser	1600	Virtual

#17SAGA2022

South African Geophysical Association's 17th Biennial Conference & Exhibition

The Conference's Organising Committee invites the ASEG to the 17th Biennial SAGA Conference & Exhibition to be held within Sun City from the 28th of November to the 1st of December 2022. With the world recovering from the Covid-19 health and economic crisis, "RECONNECT. REIMAGINE" has been chosen as the event's theme. Not only did pandemic-related lock downs disrupt most global economies, they also accelerated deep change in supply chains to key global sectors such as mineral exploration, mining, energy, environment, and technology. Whilst hybrid events have become more common, in-person collaboration, whilst observing sensible safety measures, remains the preferred medium.

The theme of "reconnect. reimagine geophysical collaboration for growth" broadly aims to promote new thinking, innovation and expansion to collaborate more closely with other disciplines. Authors will challenge conventional solutions and showcase cutting-edge methods and applications which can bring about effective solutions for the future. After a long hiatus between meetings, we encourage exciting projects submissions that will inspire new synergies and unlock sustainable solutions for future generations.

SAGA 2022 presents a unique opportunity to reconnect across the industry to discover as well as share emerging technologies and research discoveries with one of the world's leading assemblies of geoscientists, young professionals, decision makers, and technical experts.

Our venue, Sun City, is located along the border of the Pilanesberg National Park, in the North West Province of South Africa – a premier conference venue with all that Africa has to offer. Conveniently situated just 2 ½ hours' drive from Johannesburg's OR Tambo International Airport, it provides a serene atmosphere and contemporary style to the 17th Conference & Exhibition.

Here's what delegates have to say, "…I have attended a great number of conferences over the last few years …SAGA always rates on top with its organisation, technical content and social aspects. Well done.", and "…the SAGA format is such that there are lots of opportunities to actually sit down and talk with people".

The technical sessions span all aspects of exploration, mining and engineering geophysics and are an ideal platform to engage directly with colleagues, clients and industry experts to develop thinking, share knowledge and showcase one's brand.

reconnect . reimagine

geophysical collaboration for growth

With more than just a technical conferencing programme, additional options for continuous professional development in the form of CPD workshops and both technical and recreational field trips are available. Realise value in sharing knowledge with the global community, secure your workshop opportunities at #17SAGA2022, space is limited for 28 November so book your place now. Keep a look out for workshop registration options on the event website.

An integral component of the event is the exhibition & trade show which has steadily grown at each event – this year's venue provides world class facilities allowing both exhibitors and delegates to interact in style. Hosted on the doorstep of the largest mineralised and mined province in the world, the show provides a one stop shop for all the best geophysical products and professional services drawn from across the globe – exploration and mining, geology and engineering professionals cannot afford to miss out.

One needs no further incentive to participate, however once again SAGA is honoured and grateful to First Quantum Minerals Ltd for their continued sponsorship of our Conference awards. For the fourth conference running, FQML sponsor four 1/10th ounce Krugerrands for the best paper & poster in both professional as well as student categories.

Themes and topics include, but are not limited to, the following:

ENERGY:

- Hydrocarbon exploration
- Geothermal exploration
- Coal exploration
- Renewable energy, helium & hydrogen gas exploration

MINERAL EXPLORATION & MINING:

- Mineral exploration & mining
- Rock physics & physical properties
- Geotechnical assessment

ENGINEERING & ENVIRONMENTAL GEOPHYSICS:

- Near-surface geophysics
- Environmental, anthropogenic, seismic & geohazard
- Engineering, infrastructure planning & monitoring
- Groundwater exploration & management
- Geophysical studies for CO_2 & waste storage

GEOLOGY:

- Depositional systems
- Plate tectonics & structural geology
- Mineral systems
- Petroleum systems
- Petrophysics

GENERAL:

- Data science, data integration, machine learning & AI
- Earthquake & mine seismology
- Forensic geophysics / geosciences
- Archaeo-geophysics
- New developments & approaches in geophysics
- Palaeomagnetism
- Geomechanics & pore pressure
- 3D modelling & visualization
- Safety & standards

AEGC 2023

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

Date
13 - 18 March 2023

Venue
Brisbane Convention and Exhibition Centre

Co-Chairs

- Megan Nightingale
- Bill Reid

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

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2023.aegc.com.au

AEGC
Australasian Exploration Geoscience Conference

Geoscience Australia: News

With our key collaborative State Agency partners in Western Australia, South Australia, Northern Territory, Queensland, New South Wales, Victoria and Tasmania, GA continues to acquire, process, interpret and deliver high quality pre-competitive geophysical products to support Australia's future. Along with some Exploring for the Future highlights below, a summary of programmes and survey locations can be found in Figure 1 and the following tables.

Exploring for the Future programme: Magnetotelluric activities

About 90 AusLAMP long-period magnetotelluric (MT) sites were acquired during 2021 and 2022 in northern and western Queensland under the Exploring for the Future Barkly-Isa-Georgetown project (Figures 1 and 2). This part of Queensland hosts one of Australia's major electrical conductivity anomalies – the Carpentaria Conductivity Anomaly – that runs from the Gulf down through the rich North West Queensland mineral province. Working with the Geological Survey of Queensland, this new MT data will help define this enigmatic anomaly and better understand its mineral potential. The photo shows the equipment being picked up from a site west of Winton, Queensland. AusLAMP data acquisition is expected to shift into Western Australia from late 2022, initially in the southwest of the state under the Exploring for the Future Australia's Resources Framework project.

Broadband MT data acquisition at around 100 sites as an extension to the University of Adelaide-AuScope Curnamona Cube project is scheduled for acquisition in September or October 2022 (pending finalisation of land access permissions and cultural heritage clearances). This work is part of the Exploring for the Future Darling–Curnamona–Delamerian project.

Exploring for the Future programme: New airborne gravity proposal

A new proposal is well underway to acquire airborne gravity across eastern South Australia and portions of western

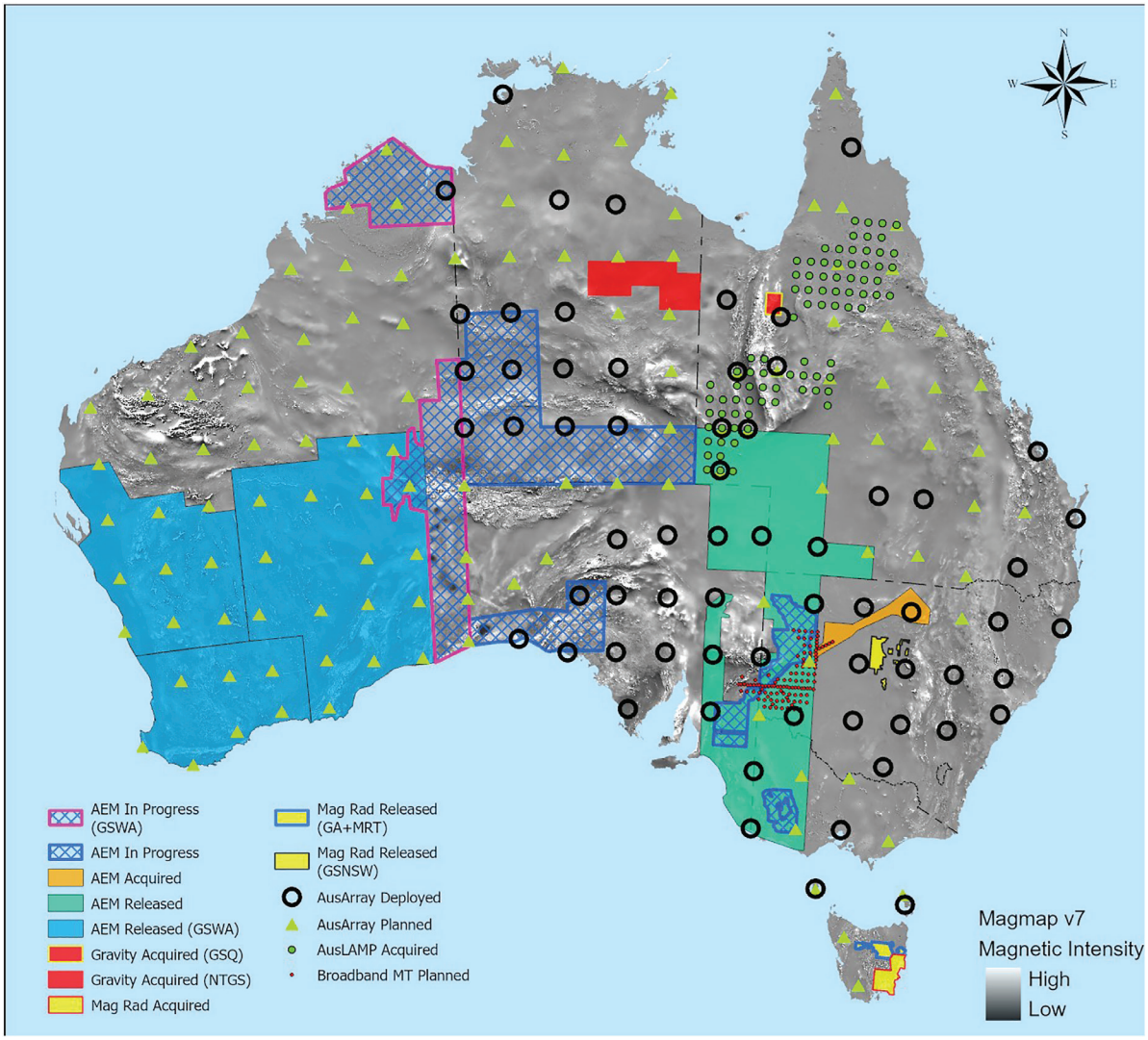

Figure 1. *2021 -2022 geophysical surveys – in progress, planned or for release by Geoscience Australia as part of the Exploring for the Future (EFTF) programme and in collaboration with State and Territory agencies. Projects that are substantially or wholly funded by state government agencies are identified by the bracketed contributors. Background image of national TMI compilation, Geoscience Australia, 2019 (see http://pid.geoscience.gov.au/dataset/ga/144725).*

Figure 2. *AusLAMP equipment being recovered from a site west of Winton, Queensland. (Photo credit: J. Pheeney, Geoscience Australia, 2022)*

Victoria (see Figure 3). The survey will complement current programmes across Adelaide and southeastern Victoria.

As a collaborative programme with our state partners, the Geological Survey of South Australia and the Geological Survey of Victoria, the survey will serve two purposes:

1. Generate a high quality height reference surface (quasi-geoid model) to support 1-3 cm accurate vertical positioning via Global Navigation Satellite System (GNSS) [#]. This will benefit both industry and government agencies for advanced (often autonomous) operations, along with more general benefits in terms of remote positioning.
2. Improve equivalent ground gravity coverage over areas that still have portions with the old Bureau of Mineral Resources 10 mile grid. This will cover highly prospective terrain over parts of the Gawler Craton and Olary/ Curnamona blocks.

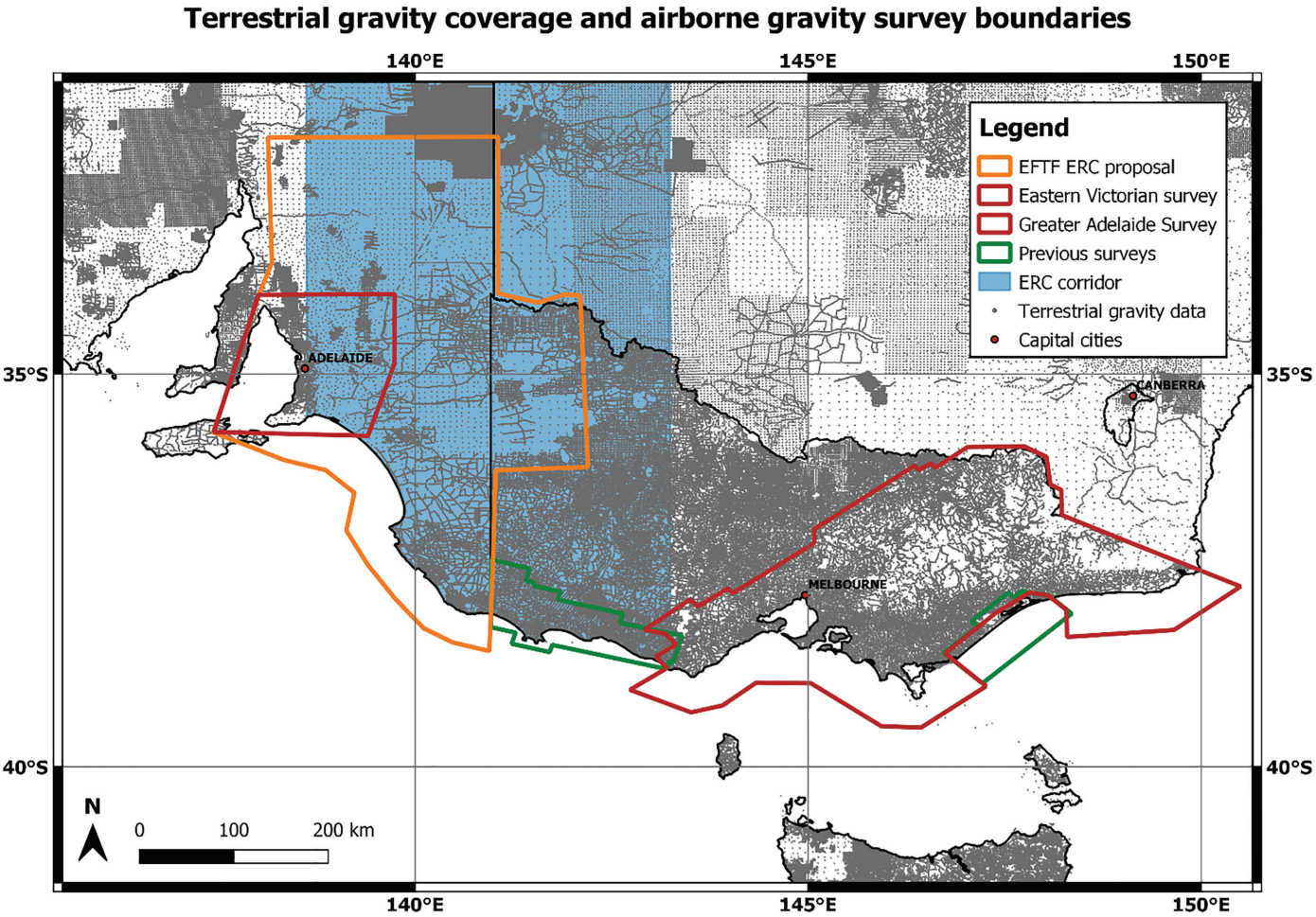

Figure 3. *The proposed survey area in the Eastern Resources Corridor (ORANGE), current AuScope and Victorian Government funded surveys over South Australia and Victoria (RED), existing 2018/19 Gippsland and Otway surveys (GREEN), and terrestrial gravity data coverage as black dots.*

Table 1. Statistics for requests through the GADDS API for the period 1 July 2021- 30 June 2022.

Summary	National aggregates	GA surveys	TAS surveys	WA surveys	SA surveys	NSW surveys	VIC surveys	QLD surveys	NT surveys	Total	% aggregates	% surveys	
# requests										**3621**			
# unique users										**864**			
# downloads	7231	1612	137	1222	376	513	336	925	301	**12653**	57.1%	42.9%	
# files	101	580	61	499	192	219	146	287	193	**2278**	4.4%	95.6%	
Files by theme										**Total files**	**% theme**	**Total requests**	**% theme**
gravity	39	124	18	107	46	34	35	70	22	495	22.3%	3398	27.2%
radiometrics	13	205	18	163	71	48	47	85	78	728	32.7%	3214	25.7%
magnetics	43	191	18	99	65	82	60	81	83	722	32.5%	4552	36.4%
elevation	6	60	7	103	9	39	4	40	10	278	12.5%	1331	10.7%
Files by format										**Total files**	**% format**	**Total requests**	**% format**
grid	59	242	32	325	100	134	45	200	96	1233	54.2%	8632	68.2%
line/pt	0	338	29	174	85	85	97	87	97	992	43.6%	2200	17.4%
image	42	0	0	0	7	0	0	0	0	49	2.2%	1817	14.4%

Acquisition is expected to commence in September and run through to June of next year. It will involve airborne gravity surveying to deliver spatial resolution of 5 km or shorter. The survey will cover a total area of approximately 192 000 km^2. Details of data releases will be provided in due course.

#. "The expansion in application and reliance on Global Navigation Satellite System technology has increased the need to support accurate and reliable determination of real-world heights (such as Australian Height Datum) from GNSS positioning. This is achieved through application of a geoid model (such as AUSGeoid2020), which is essential for the observation of real-world heights from GNSS positioning.

The geoid model is derived from a national database of gravity data. There are regions in eastern South Australia and western Victoria where the gravity data is low in quality and distribution. This degrades the accuracy of the geoid model in these regions and thus the ability to derive accurate heights from GNSS observations. Hence, the initial need for airborne gravity survey data to be collected over targeted regions of interest is to enhance the geoid model and thereby optimise height determination from GNSS positioning". (Dr Anna Riddell, Director, Geodesy, National Geodesy Section, Geoscience Australia, 2022)

GADDS statistics

And finally, with the end of Financial Year behind us, I just wanted to share some Geophysical Archive and Data Delivery (GADDS) statistics with you (Table 1). If you ever doubted the value of this great GA system (and particularly the new one), we can confirm that we have delivered over 12 000 files of geophysical data to 864 users since 1 July, 2021.

Additionally:

- There was close to a 60-40 split between National aggregate and survey downloads.
- Magnetics and radiometrics are the most popular themes. This is markedly different from the previous year when gravity and radiometrics were the most popular themes.
- Close to 20% of the requests are for survey line and point data; most of the requests involve grids and images.

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

Update on geophysical survey progress from Geoscience Australia and the Geological Surveys of Western Australia, South Australia, Northern Territory, Queensland, New South Wales, Victoria and Tasmania (information current 12 July 2022)

Further information about these surveys is available from Mike Barlow Mike.Barlow@ga.gov.au (02) 6249 9275 or Adrian Hitchman Adrian.Hitchman@ga.gov.au (02) 6249 9800.

Table 1. Airborne magnetic and radiometric surveys

Survey name	Client	Project management	Contractor	Start flying	Line km	Line spacing Terrain clearance Line direction	Area (km²)	End flying	Final data to GA	Locality diagram (*Preview*)	GADDS release
Eastern Tasmania	MRT	GA	MAGSPEC	Mar 2022	57 000	200 m	11 600	Jun 2022	Jul 2022	See Figure 1 in previous section (GA News)	TBA

TBA, to be advised.

Table 2. Ground and airborne gravity surveys

Survey name	Client	Project management	Contractor	Start survey	Line km/ no. of stations	Line spacing/ station spacing	Area (km²)	End survey	Final data to GA	Locality diagram (*Preview*)	GADDS release
Canobie	GSQ	GA	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
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
Melbourne, Eastern Victoria, South Australia	AusScope GSV DEL WP	GA	Sander Geophysics	TBA	137 000	0.5–5 km	146 000	TBA	TBA	See Figure 1 in previous section (GA news)	TBA
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)	Set for release 2022
Little Sandy Desert W and E Blocks	GSWA	GA	Sander Geophysics	W Block: 27 Apr 2018 E Block: 18 Jul 2018	52 090	2500 m	129 400	W Block: 3 Jun 2018 E Block: 2 Sep 2018	Received by Jul 2019	195: Aug 2018 p. 17	Set for release 2022
Kimberley Basin	GSWA	GA	Sander Geophysics	4 Jun 2018	61 960	2500 m	153 400	15 Jul 2018	Received by Jul 2019	195: Aug 2018 p. 17	Set for release 2022
Warburton-Great Victoria Desert	GSWA	GA	Sander Geophysics	Warb: 14 Jul 2018 GVD: 22 Jul 2018	62 500	2500 m	153 300	Warb: 31 Jul 2018 GVD: 3 Oct 2018	Received by Jul 2019	195: Aug 2018 p. 17	Set for release 2022
Pilbara	GSWA	GA	Sander Geophysics	23 Apr 2019	69 019	2500 m	170 041	18 Jun 2019	Final data received Aug 2019	See Figure 1 in previous section (GA News)	Set for release 2022
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 (km²)	End flying	Final data to GA	Locality diagram (*Preview*)	GADDS release
Western Resources Corridor	GA/ GSWA	GA	Xcalibur Multiphysics	Mar 2022	~ 38 000	20 km	760 000	TBA	TBA	See Figure 1 in previous section (GA News)	TBA
Musgraves	GA	GA	Xcalibur Multiphysics	Jun 2022	~ 22 000	1 – 5 km	~ 100 000	TBA	TBA	See Figure 1 in previous section (GA News)	TBA
Upper Darling River	GA	GA	SkyTEM	Mar 2022	25 000	.25 – 5 km		Jun 2022	TBA	See Figure 1 in previous section (GA News)	TBA
Darling-Curnamona-Delamerian	GA	GA	SkyTEM	Jun 2022	14 500	1 – 10 km		Oct 2022	TBA	See Figure 1 in previous section (GA News)	TBA
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	Oct 2021 http://pid.geoscience.gov.au/dataset/ga/145744
Mundi	GSNSW	GA	NRG	Mar 2021	1900	2.5	~ 5000	Apr 2021	Dec 2021	See Figure 1 in previous section (GA News)	Oct 2021 https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/145897 or https://www.regional.nsw.gov.au/meg/geoscience/minexcrc/mundi
AusAEM20	GSWA	GA	Xcalibur Multiphysics & SkyTEM	Aug 2020	62 000	20 km	1 240 000	Nov 21	Dec 2021	See Figure 1 in previous section (GA News)	Mar 2022 see 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	Exploring for the Future – AusLAMP	366 stations deployed in 2016–19 32 stations deployed in 2021	50 km	Long period MT	The survey covers areas of NT and Qld. Data package: http://pid.geoscience.gov.au/dataset/ga/134997 Model: http://pid.geoscience.gov.au/dataset/ga/145233 News article: http://www.ga.gov.au/news-events/news/latest-news/exploring-for-the-future-takes-a-deeper-look-at-northern-australia Acquisition of 32 new sites in SW Qld completed mid-2021, data to be released late 2022 together with additional data planned to be acquired under Exploring for the Future during 2022.
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 planned 2022	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.

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
Perdirka Basin Phase 2	GA	SA/ NT	Shallow legacy data	~1800	Varies	Varies	3-6 sec	2D shallow legacy data, explosive, vibroseis	GA commissioned reprocessing of selected legacy 2D seismic data in the Pedirka Basin, South Australia, as part of the Exploring for the Future programme. The objective is to produce a modern industry standard 2D land seismic reflection dataset to assist industry to better target areas likely to contain the next major oil, gas and mineral deposits. Reprocessing of these data by Geofizika started in Dec 2021 and is planned to be complete by the end of Jun 2022. Reprocessing and checking of the processed package is complete. The data package is due to be released in Jul-Aug 2022.
Central Darling Basin	Coal Innovation NSW (CINSW)	NSW	Central Darling seismic survey	~208	10 m	10 m	6-16 sec	2D high resolution and deep crustal seismic	GA and CINSW signed an MoU to acquire and process 2D high resolution and deep crustal seismic data in the Central Darling Basin. New seismic data will be acquired, processed and interpreted to assist in proving up a geological resource in NSW for the safe and permanent storage of CO_2. The new seismic data obtained will provide greater certainty in planning for future drilling. Data acquisition was completed in May 2021. CINSW contracted Velseis to process the data and the GA seismic team is QCing the processing of this dataset. Processing of these data is complete and a data package will be released in mid-2022.
2019 Camooweal 2D Seismic Survey Archiving Project	GSQ	Qld	Camooweal seismic survey	~300	30 m	10 m	20 s	2D deep crustal seismic	Under a MOU with GSQ, GA is preparing a Data Processing Package for the 300 line km 2019 Camooweal 2D Seismic Survey. This data package will support an interpretation project being undertaken by GSQ to produce new precompetitive geoscience information to assist industry in better targeting areas likely to contain significant gas and sedimentary-hosted mineral deposits. The data package is available from http://pid.geoscience.gov.au/dataset/ga/146301 (GA) or https://geoscience.data.qld.gov.au/seismic/ss095590 (GSQ)

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 mid-2022.
Northern Australia	GA	Qld/NT	AusArray	About 265 broad-band seismic stations	50 km	Broad-band 1 year observations	The survey covers the area between Tanami, Tennant Creek, Uluru and the Western Australia border. The first public data release of the transportable array was in 2020, with further data and model releases expected by Dec 2022. See: http://www.ga.gov.au/eftf/minerals/nawa/ausarray Various applications of AusArray data are described in the following Exploring for the Future extended abstracts: · 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

Mineral Resources Tasmania: Acquisition of new data complete

Following over three months of field operations, acquisition of airborne magnetic and radiometric data in South East Tasmania (Figure 1) concluded on 23 June. Approximately 57 200 line km have been flown, predominantly on east-west lines at 200 m spacing and a nominal ground clearance of 80 m. The nature of the terrain in the survey region (Figure 1) dictated that a helicopter be employed as the platform for the entirety of the survey.

Together with last year's Tiers survey, the new data have increased Tasmania's radiometric and high resolution magnetic coverage by nearly a third. Processing including correction for 3D terrain effects on the radiometric signal (Minty and Brodie 2016) and preparation of final data for public release should be approaching completion around the time this issue of *Preview* hits the streets. It will be available for download through the websites of Mineral Resources Tasmania and Geoscience Australia.

The 2022 South East Tasmania magnetic and radiometric survey was supported mainly by Geoscience Australia's Exploring for the Future programme, with a contribution from Mineral Resources Tasmania.

Reference

Minty, B. and Brodie, R., 2016. The 3D inversion of airborne gamma-ray spectrometric data. *Exploration Geophysics* **47**(2): 150-157.

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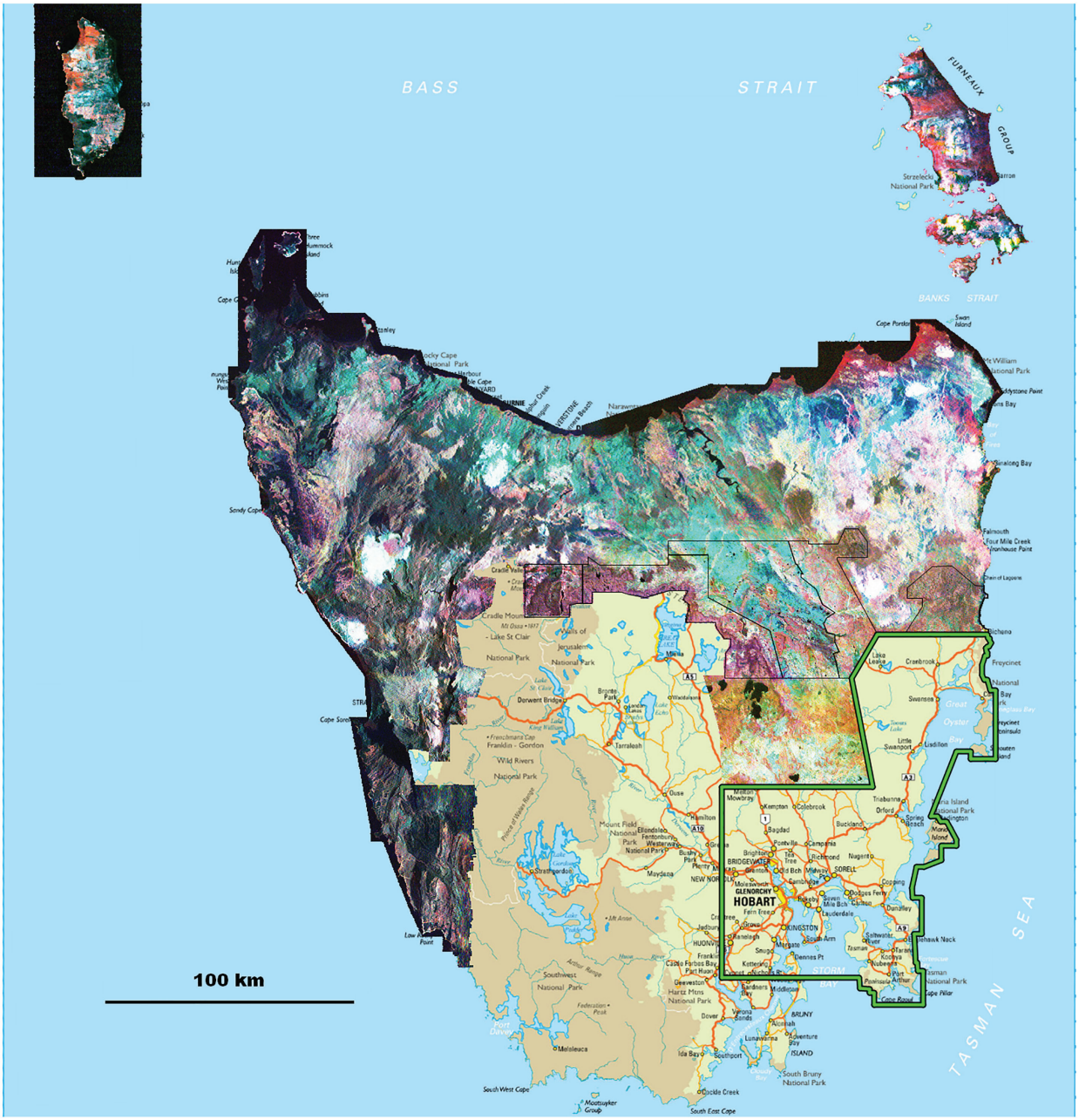

Figure 1. *Existing Tasmanian radiometric coverage, with the area of the 2022 SE Tasmania magnetic and radiometric survey outlined in green.*

Geological Survey of New South Wales: NSW's largest geophysical data acquisition campaign

The Geological Survey of New South Wales (GSNSW) is preparing for its largest geophysical data acquisition campaign – ever! In 2022 through to 2023 eight geophysical surveys, at a total cost of $4.4 million, will be carried out covering over a sixth of the state, and new geophysical data will be generated (Figure 1). The data acquired will support numerous projects, such as:

- Our ongoing mission to provide precompetitive geophysical data to encourage exploration. You can access all our open-file geophysical data through MinView, this link has all the geophysical data layers pre-loaded.
- NSW's Critical Minerals Strategy, unveiled last year by NSW Deputy Premier and Minister responsible for resources Paul Toole. GSNSW will acquire geophysical data around Cobar, Forbes to Dubbo and in the New England Orogen, as these areas are highly prospective for critical minerals and require improved geophysics to aid mineral discoveries.
- The NSW Government's Future Ready Regions strategy. The GSNSW will be looking for deep groundwater and rocks in which to store water during times of surplus. GSNSW is focusing on Devonian sandstones in the Bancannia and Yathong troughs and small Devonian basins in the greater Dubbo to Forbes region. And,
- The MinEx Collaborative Research Centre (CRC), which is working to improve exploration in mineralised terrain under cover. GSNSW will acquire geophysical data over the greater Forbes to Dubbo region to support mapping and drilling as part of MinEx CRC.

GSNSW will collaborate with Geoscience Australia to acquire many of the planned surveys. Airborne electromagnetic (AEM) data will be acquired at 2.5 km line spacing. Airborne magnetic and radiometric (AMR) data will be acquired at 200 m line spacing with a flight height of 60 m. New gravity data will improve existing coverage to 1 - 2 km spacing, and deep crustal reflection seismic data will be acquired over approximately 350 km of roads and tracks.

All data will be made publicly available through MinView throughout 2022 and 2023.

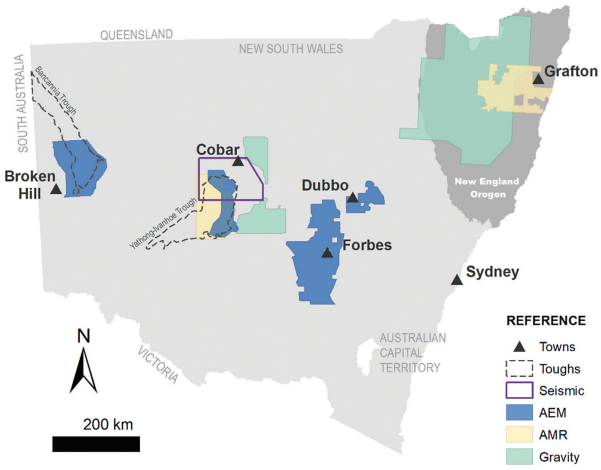

Figure 1. *Map of proposed geophysical surveys. Please use the QR code to request a download that contains a shapefile of the proposed survey boundaries:*

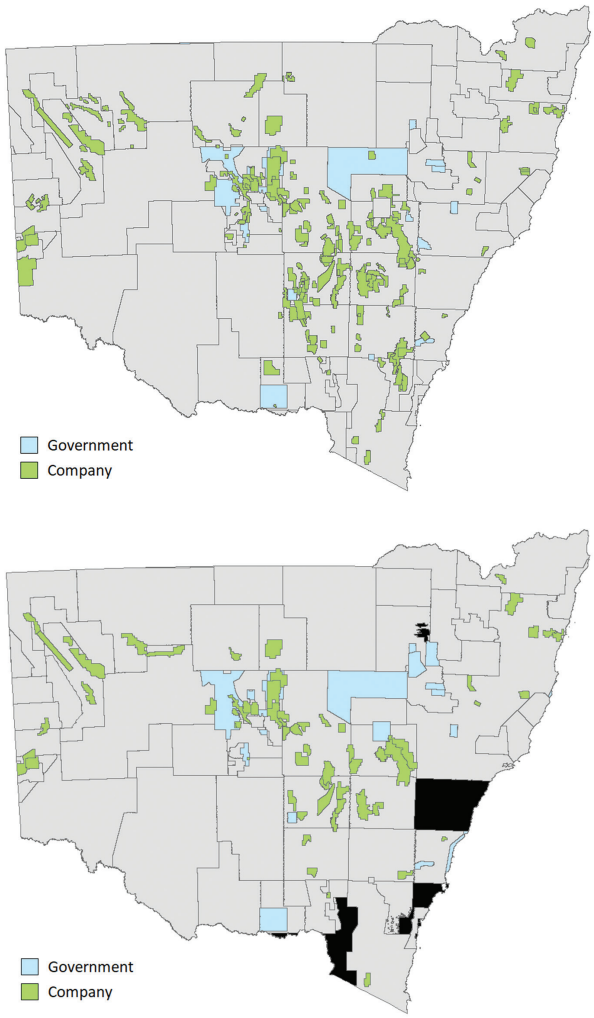

Figure 2. *Maps showing boundaries of magnetic (top) and radiometric (bottom) surveys used in the State-wide merges. Grey surveys were used in the pre-2020 State-wide merge. The coloured surveys (blue and green) are surveys that have been incorporated into the new 2022 merges.*

Updated State-wide magnetic and radiometric merges

GSNSW released updated versions of their State-wide magnetic and radiometric merges in June 2022. State-wide geophysical merges are typically created and maintained using regional government-funded surveys. As a result, the products use a grid cell size of 40 - 50 m. This is because the line-spacing of most regional surveys is 200 - 250 m. On a State-wide scale, these products provide excellent imagery of regional geological features, however any geophysical survey flown at less than 200 m line-spacing has finer details aliased out.

In the latest update the magnetic grid has a cell size of 25 m and the radiometric 50 m, which represents a large improvement on resolution, containing four times the data density (Figures 2 and 3). The cell size has been reduced to accommodate a large suite of high-resolution company surveys flown at 100 m or closer line-spacing. The inclusion of this data has added an estimated $11 million worth of value to the final products.

Geophysical merging is a complicated process that benefits from following a series of best practices in the preparatory stages. GSNSW have fully documented the procedure, allowing for seamless iteration upon existing products with newly acquired data. Full details of the merge procedure can be found in the ASEG webinar by Sam Matthews in October 2021.

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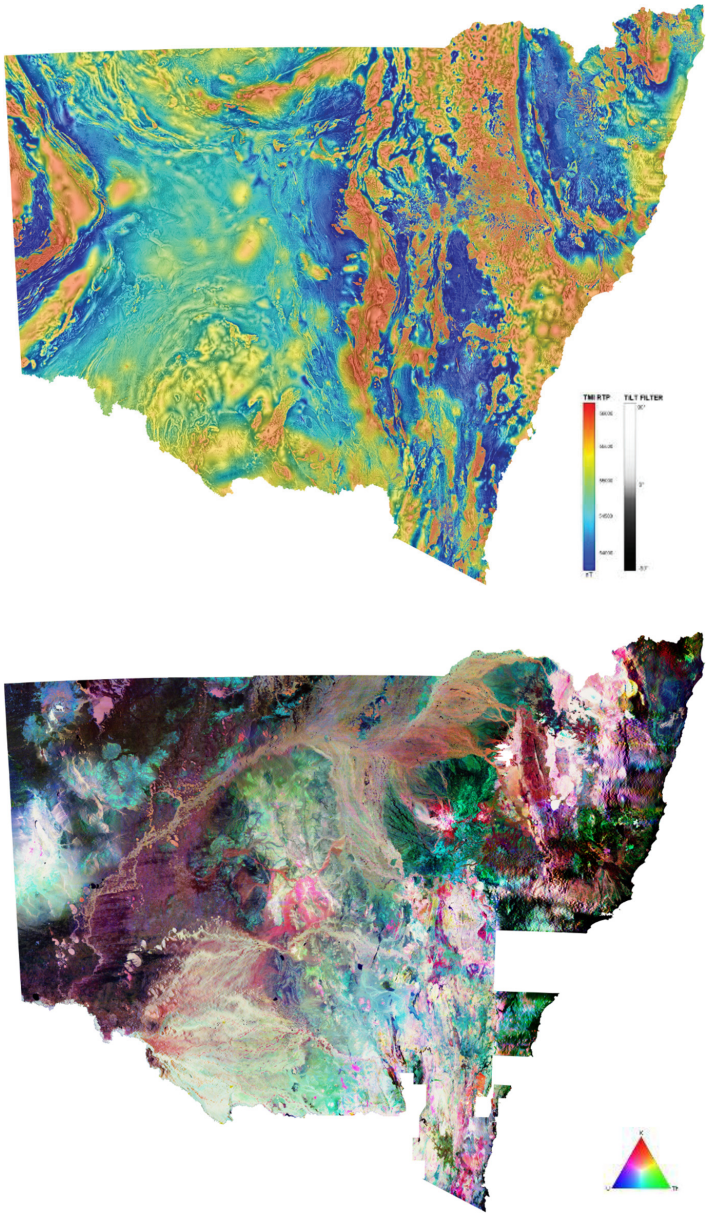

Figure 3. *Pseudocolour total magnetic intensity (TMI) reduced to the pole (RTP) overlain on greyscale TMI RTP tilt-angle filter (top). Potassium – Thorium – Uranium (KThU) radiometric ternary image (bottom).*

The ASEG in social media

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

Geological Survey of South Australia: Update

The geophysicists at the Geological Survey of South Australia (GSSA) would love to write a feature article on one of our major projects, but the reality is that we don't have a new and shiny product to show off right at this moment. So instead, here is a quick run-down of our various projects.

The Gawler Phase 2 geophysical acquisition is underway, with Zonge Engineering commencing magnetotelluric acquisition in the central Gawler Craton in South Australia. MT stations are spaced at approximately 12.5 km intervals in a regular grid pattern, with closer spacing along two detailed traverses. These traverses cross the Challenger Gold mine and Tarcoola areas. We anticipate gravity acquisition - to be undertaken by Daishsat Geodetic Surveyors - will commence in August. Gravity stations will be acquired on a regular 2 x 2 km grid, with a detailed 1 x 1 km grid over the Challenger mine.

Acquisition is continuing for the collaborative GSSA-Geological Survey of Victoria magnetotelluric survey along a 750 km long profile to augment Geoscience Australia's EFTF 2 project following the DCD2 Geoscience Australia seismic reflection line. Two-thirds of the MT stations have been acquired in Victoria and eastern SA with the remaining data to be acquired in September. Nominal site spacing is 3-4 km and will highlight the crustal and upper mantle structure associated with the Delamerian and Lachlan Orogens. It further constrains the geological framework for the recently completed GSSA's southern MinexCRC drilling campaign.

The AusArray SA survey has now been demobilised after recording ambient noise and teleseismic events over the last 18 months across 35 stations spaced approximately 50 km apart. Over the coming months, the data will be analysed to produce seismic velocity models of the crust and mantle across the central-eastern Gawler Craton and greatly constrain local seismicity for the region.

Additionally, the GSSA has installed the majority of sites of Geoscience Australia's AusArray 2 x 2 degree grid across South Australia. The array will be part of the national EFTF seismic array to create a backbone seismic velocity model of the Australian lithosphere.

The GSSA is creating a new suite of State-wide geophysical imagery, focusing on gravity and radiometrics. Following the methods described in Katona (2017), we are creating a Spherical Cap Bouguer Gravity State-wide image. This follows on from our gravity module update where we have flagged stations that do not contribute to the overall state image. These stations are generally either duplicate readings in the database - with changes in number precision that result in gridding artefacts - or surveys where elevation data are not suitable to calculate the Bouguer Anomaly. The creation of the State-wide image is an iterative GIS and gridding process, and we anticipate this product to be available in a few months.

A new suite of State-wide radiometric images are also in the works, incorporating recently acquired GCAS (Gawler Craton Airborne Survey) data, as well as the full catalogue of South Australian airborne radiometric data. As in previous State-wide radiometric images, these will be created using Intrepid Gridmerge software. We anticipate the suite of grids will be ready late in 2022.

One of our most frequent data requests is for detailed processing information regarding the state grids. We are currently compiling a report book detailing the processes that went into the most recent state magnetic image, and anticipate a similar body of work for the new radiometric grids. We are exploring ways to automate the creation of the report book given the large amount of near-repeated information that needs consideration. We anticipate the release of these report books later in 2022.

The task of processing geophysical survey data from exploration companies exploring in South Australia remains an ongoing job for GSSA geophysicists. Since the previous data release we have lined up over 30 airborne surveys acquired between 1961 and 2011. These will be made available online via SARIG. We are currently updating the software in the backend of SARIG that allows the surveys to be cookie-cut to a user's area of interest. Once the update is complete these surveys will be available for public consumption.

Finally, the GSSA welcomed three Year 10 work experience students for a three-day stint with the GSSA. It was an opportunity to introduce them to everything geoscientific in SA. The geophysics team introduced the students to the basics of gravity acquisition, taking them on a gravity calibration run to the Burnside Rugby Club and Norton Summit Hotel in Adelaide's suburbs. The students were grateful for the opportunity to explore a branch of science that they were not aware even existed.

Reference

Katona, L., 2017. Gridding of South Australian Ground Gravity Data, using the Supervised Variable Density Method. 10.13140/RG.2.2.17491.37923

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CSIRO: Mapping 3-component magnetic field data alongside core segments

CSIRO Mineral Resources, in conjunction with the MINEX CRC, are investigating how best to recover information from petrophysical measurements for integration with magnetic field studies and application to mineral exploration. Our first study area is the Cobar Region, where mineralisation is associated with large volumes of pyrrhotite, which is anomalously conductive and chargeable and has substantial remanent magnetisation (in the monoclinic form).

A major challenge in applying petrophysical data to magnetic field studies arises from the scale differences between the volumes sampled in petrophysical measurements, and the volumes responsible for the measured geophysical field expressions. We are trying the bridge that gap with high volume petrophysical measurements made with a newly developed mobile petrophysics laboratory. However, for remanent magnetisation studies upscaling using conventional measurements is difficult, time consuming and expensive. A possible solution being developed and tested by CSIRO is a methodology using a 3-component magnetometer run in a fibreglass track of square section alongside oriented segments of core to map its magnetic field (Figure 1). Repeat measurements following rotations of the core allow separation of induced magnetisation, which changes only slightly with the rotations from remanent magnetisation, which changes substantially with the rotations.

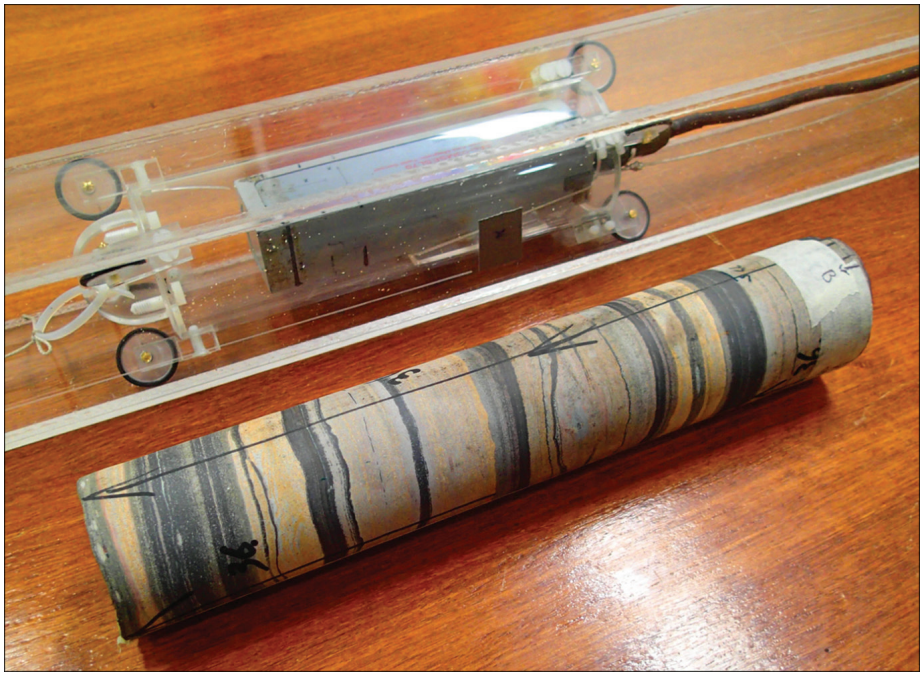

Figure 1. *An early feasibility test of mapping 3-component magnetic field data alongside core.*

We expect these results to provide a more representative estimate of the total core magnetisation, and will compare results with conventional remanent magnetisation measurements. Extraction of some samples for conventional measurement is still required to provide demagnetisation analysis of the stability and genesis of the magnetisation, but we hope that the reduced sampling for this will be guided from the mapping of magnetisation along the core. We also hope to gain new insights into the structural controls on ore formation in the Cobar region from magnetic fabric studies on the pyrrhotite using anisotropy of magnetic susceptibility (AMS) measurements.

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Canberra observed

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A new parliament and a new government

The 47th Parliament of Australia opened on 26 July 2022, with a new government led by Anthony Albanese, the 31st Prime Minister of Australia. There was a smooth transfer from the last Coalition government with very few changes in administrative responsibilities. Let's have a look at the Ministers who will be important for the ASEG.

Madeline King, Minister for Resources and Minister for Northern Australia

Madeline King was elected to the House of Representatives for Brand, WA, in 2016, and re-elected in 2019 and 2022. This is her first Ministry. She was born in March, 1973, in Kwinana, WA, and completed a Bachelor of Laws degree at UWA.

King worked as a commercial lawyer in private practice from 1997 to 2005 and, from 2005-2008, in UWA's legal department as a research contracts lawyer and as chief of staff to the Vice-Chancellor (2008–2011). Her focus on politics started in 2011 when she became a ministerial adviser to federal Labor MP Gary Gray, and eventually was pre-selected for Brand in 2016.

Chris Bowen, Minister for Climate Change and Energy

One of the most experienced ministers in the Albanese Cabinet, Bowen served on the Fairfield City Council from 1995 to 2004, including a term as Mayor. He was elected to the House of Representatives for Prospect, NSW in 2004, re-elected in 2007, elected to the House of Representatives for McMahon, NSW in 2010, following an electoral redistribution, and has been re-elected for that seat in every election since then. He served as Cabinet Minister for a number of portfolios in the Rudd-Gillard years from 2007-2013.

Bowen was born in January 1973, obtained a Bachelor of Economics in 1994 from the University of Sydney, and he also has an MA in International Relations and a Diploma in Modern Languages (Bahasa Indonesia).

Tanya Plibersek, Minister for the Environment and Water

Tanya Plibersek is another very experienced minister. Elected to the House of Representatives for Sydney, NSW, in 1998, and re-elected for this seat at all subsequent elections. She was Deputy Leader of the Labor Party and a cabinet minister in the Rudd-Gillard years from 2007-2013 and Deputy Leader of the Opposition from 2013-2019.

Plibersek was born in Sydney in December 1969, obtained a BA (Comms) (Hons) from UTS and a Master's degree in Public Policy and Politics from Macquarie University.

Jason Clare, Minister for Education

Jason Clare was elected to the House of Representatives for Blaxland, NSW, in 2007 and has been re-elected for that seat ever since. He had Ministerial appointments during the Rudd-Gillard period from 2010-2013 and was a member of the Shadow Cabinet from 2013-2022.

Clare was born in the Western Suburbs of Sydney in March 1972. He obtained a BA in Arts with Hons and a Batchelor of Law from the University of New South Wales. He was a senior adviser to former NSW Premier Bob Carr, and manager of corporate relations at Transurban from 2003 to 2007.

What are the government's plans for universities?

One of Minister Clare's first tasks will be to re-build the universities.

The higher education sector had a fraught relationship with the former government, which declined to include universities in the JobKeeper scheme during the COVID pandemic, tried to turn the Australian Research Council into a research institution that serves the private sector, and was not helpful with granting visas for overseas students.

At his speech to the Universities Australia (UA) annual meeting in Canberra, Clare pledged to: "Reset, Rebuild and Reform our universities". He has committed to a "reset" of relations between government and universities,

and promised more effort to boost the proportion of students from disadvantaged backgrounds. He also wants to speed up visa processing to help rebuild Australia's education export industry, and wants Labor's September jobs summit to discuss how to retain foreign students after they complete their degrees, in order to enlarge Australia's skilled workforce.

Clare also announced an independent inquiry into the role and function of the Australian Research Council, which administers the national research grants programme. There has been a recent history of delays in awarding the grants and political interference. He wants these trends to end.

Clare also said he would appoint a group of eminent Australians to lead Labor's planned "Australian Universities Accord". This accord would draw on university staff, unions, businesses, students, parents and all political parties, and look at "everything from funding and access to affordability, transparency, regulation, and employment conditions".

What would Universities Australia like from the government?

On the same day that Minister Clare was speaking to the universities, Professor John Dewar, the Chair of Universities Australia (UA), was speaking at the National Press Club. He argued that universities make essential contributions throughout Australia, and we should ensure they are healthy and effective: "The fact is, the importance of universities is going to continue to increase. Especially their economic importance."

In their submission to the Productivity Commission's inquiry earlier this year, UA demonstrated that:

"For every dollar we invest in university teaching, we get three dollars back and for every dollar we invest in university research, we get five dollars back."

Furthermore, if we could lift our investment in higher education research and development by just one per cent, we could lift productivity and increase the size of Australia's economy by 28 billion dollars over ten years.

Universities support more than 250 000 jobs every year. Before the COVID pandemic international education generated $40 billion per year in export income. Now due to the downturn it is $22 billion, but international education remains our largest services export industry and our fifth-largest export industry overall.

Employers depend heavily on universities, not just to provide graduates with job-ready skills, but for their broad conceptual skills as well. Whether their new employees have studied engineering, science, the law, or the liberal arts, employers value their capacity to think broadly and creatively, "And they tell us this all the time."

To get a good job these days in the major areas of jobs growth you will need a university or vocational qualification. Consequently, more people are graduating with a bachelor's degree or above than ever before, particularly women: "We need to ensure that supply of university places keeps up. We can't let these young people down and rob them of their aspirations."

Last year, a significant milestone was reached. 50.3% of all young women aged 25 to 34 now hold a bachelor's degree or higher. That's up from just 26% in 2001- almost a doubling in just 20 years.

Another crucial priority for our country is producing the ideas and the products of the future from our research programme. On the world stage, Australia is lagging and dropping further behind. Leading innovation nations now invest significant proportions of their Gross Domestic Product (GDP) in R&D. For example, Israel 5.1%, South Korea 4.6%, and the USA 3.2%. Across the OECD that figure is going up. But in Australia, it's going down. Overall R&D investment, as a proportion of GDP, declined from 2.5% in 2008-09 to 1.8% when the last figures were collected in 2020.

At present, Australia spends $35.9 billion on all types of research, but only $2.83 billion on basic research. Without basic research, we would reduce the supply of new ideas to translate into new products, applications and services. This makes us dependent on others to supply those ideas. That's not a place where Australia should be.

The arguments have been made, we need to invest in universities, and we need to do it now!

Mining industry powers ahead

The latest information on the annual estimates of key economic and financial performance of industries in Australia, released by the Australian Bureau of Statistics, in May 2022 for the year 2020-2021 (https://www.abs.gov.au/statistics/industry/industry-overview/australian-industry/2020-21) showed how the mining sector is powering ahead as the largest and most effective of all Australian industries analysed. Table1 shows the results obtained by the ABS for 2019-2021.

The value of the mining industry has more than doubled over the last four years and the number of employees has only increased by about 11%. We really should cherish the wealth this industry provides the nation.

You must read the ABS release to obtain information on how the "value" was calculated.

Table 2 shows the results for 2017- 2019. Earlier results can be obtained from the ABS website.

Table 1. Employment numbers and value of Australian industries 2017-2019.The employment numbers are estimates for 30 June for each financial year.

ANZSIC division	Employment		Value	
	2017-18	2018-19	2017-18	2018-19
	'000	'000	$m	$m
Agriculture	459	451	20 578	19 580
Mining	169	179	104 879	138 625
Manufacturing	840	854	36 951	40 297

Table 2. Employment numbers and value of Australian industries 2019-2021. The employment numbers are estimates for 30 June for each financial year. Source: Australian Bureau of Statistics, Australian Industry 2020-21 financial year.

Australian industry employment and IVA data and movements, 2019-20 to 2020-21				
ANZSIC division	Employment		Industry value	
	2020	2021	2019-20	2020-21
	'000	'000	$m	$m
Agriculture, forestry and fishing	443	439	26,725	31,446
Mining	187	189	208,231	216,116
Manufacturing	830	839	106,995	107,381
Electricity, gas, water and waste services	118	123	49,724	49,142
Construction	1,104	1,196	127,518	130,795
Wholesale trade	547	569	72,447	71,731
Retail trade	1,337	1,388	82,916	89,856
Accommodation and food services	957	1,055	39,396	40,287
Transport, postal and warehousing	634	639	74,998	71,682
Information media and telecommunications	159	167	37,716	36,948
Rental, hiring and real estate services	402	413	85,121	86,491
Professional, scientific and technical services	1,130	1,200	136,843	145,108
Administrative and support services	885	930	69,482	67,139
Public administration and safety (private)	87	90	6,615	6,906
Education and training (private)	422	451	32,053	33,096
Health care and social assistance (private)	1,370	1,446	102,419	110,201
Arts and recreation services	200	217	12,834	11,958
Other services	492	534	32,227	32,555

Geoscience Australia headquarters sells for $370 million

In the April 2022 issue of *Preview* we noted that the Geoscience Australia headquarters was up for sale, for the third time, and it was expected to sell for $360 million or more.

Well, it was bought by property investment group Charter Hall for $370 million.

Built in 1997, the property features more than 32 000 m^2 of net lettable area and underwent a significant refurbishment in 2019. The asset is fully leased to Geoscience Australia until 2032, and has an annual net income of $26.8 million.

Before the financial year was out, Charter Hall also acquired 24 Wormald Street in Symonston Canberra for $36 million. This is currently leased to the Attorney-General's Department. They also acquired the ActewAGL building in the City centre for $76 million.

I am still at a loss as to why the Australian Government wanted to sell its properties in the first place. Selling valuable assets does not make any sense.

Energy transition webinars: Call for contributors

Are you working in the 'Energy Transition' space? Are you active in geothermal, mining for critical metals and minerals, geotechnical preparations for wind and solar farms, CCS/CCUS, or any other related discipline?.

We are soliciting contributing speakers and subject matter experts who can provide webinars to ASEG Members and affiliates on the many elements of this "Energy Transition" revolution. In the manner of previous ASEG webinars, content will be archived for public access and should be non-commercial.

The world around us is changing at a remarkable speed, so the more we can do to educate and inform both stakeholders and ourselves about the shift to a "New Energy" economy, then better.

If you can offer some content or suggest someone who can, please contact Andrew at Andrew.Long@pgs.com

Education matters

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Unleash your creativity and improve your soft skills

Numerous online platforms offer many different types of courses. I wrote about Coursera and edX in the February 2021 issue of *Preview* (*PV* 210), and have been exploring other opportunities since then. I recently enrolled in a course via the CreativeLive platform, and I would like to share my experience.

"Anyone who keeps learning stays young" – Henry Ford.

"Once you stop learning you start dying" - Albert Einstein.

Research shows that the classics are right - there is a link between education and longevity, and that one year of formal education adds six months to your lifespan. But, even if we forget about the formal education and the boring lifespan statistics, have you ever noticed that going for a dancing class or diving course or language lessons somehow changes the flow of time? Slows it down and stretches the days or weeks of studying? You remember this time as if it lasted for months or years. And no one can forget the years spent at school or university, not ever!

This column is not about university degrees or even professional development in geophysics related disciplines. It is about hobbies and creative habits. However, it will also help soft skills development: time management, communication skills, public speaking, project management, and negotiation. It is inspired by the "Creative Calling" book by Chase Jarvis, an American photographer and entrepreneur, co-founder, and CEO of CreativeLive.

According to Wikipedia, CreativeLive is "an online education platform that offers free online courses in a variety of fields." However, when I googled CreativeLive, I ended up on a page with a Subscribe button and found that to access 2000+ "free" courses, one must pay $149 billed annually or $39 billed monthly. If you are like me, such a subscription does not sound free, and I started poking around in search of bits and pieces accessible in a lost-credit-card scenario.

There are five main categories of courses offered: Photo & Video, Money & Life, Art & Design, Craft & Maker, and Music & Audio. If you click on one of these categories you will see the most in-demand courses and a complete list of them divided into subcategories. Every course offers a complimentary introduction class, and sometimes an accessible class in the middle of the course. That is awesome as you can evaluate instructors and understand whether their words resonate with you and whether there is a synergy that will help you to learn and enjoy their courses.

However, what if you want to listen to the whole course for free? In this case, you are limited to the Free and Upcoming courses that you can find at the bottom of the page. You can watch the On-Air classes straight away. With these classes, you do not have much control. For instance, you cannot jump from one lecture to another or accelerate it. But neither do we have such power with real-life face-to-face classes, have we? If the lecturer is boring or unfriendly, we cannot immediately play them at a higher speed, or switch to another lecture. So I stopped complaining about the absence of control of the online classes and listened to what they had to say at the pace, and in the order, they wanted to say it. Most online lecturers are great. If they were not, we could leave online lectures immediately and with minimum discomfort, couldn't we?

The upcoming courses are different. You have to RSVP, and you are enrolled. Great, isn't it? However, if you live in Australia, your class will be scheduled at a weird time in the middle of the night as the classes are planned for USA mornings - streaming at 9 AM PDT. No worries about that - you can access your class 24 hours after it starts steaming. So, I believe the platform asks you to RSVP to get you more committed to attending.

The CreativeLife platform has several changing daily On-Air courses in all five categories - you have lots of options to choose from. And if you really want a particular course, you can buy it. I planned to get a monthly subscription to write this piece and to share my experience with the readers. However, I had enough material and excitement playing with free options on the platform. I enrolled for free and listened to a "Write Copy that Compels and Sells" short course by Melissa Cassera, which I enjoyed. I might return later and subscribe for a course or a month/year as I had a positive experience.

Of course, CreativeLive is only one of many education platforms offering online courses. Google promptly advised me that people who looked for CreativeLive also looked for many other platforms (see Figure 1). I may explore others in the upcoming issues. However, please, do not wait and use these opportunities to learn today. Scientists believe that by studying, we build new neural networks in our brains. At the end of the day, guaranteed extra years of life is a reasonable incentive to pick up a course or two and stretch up your comfort zone.

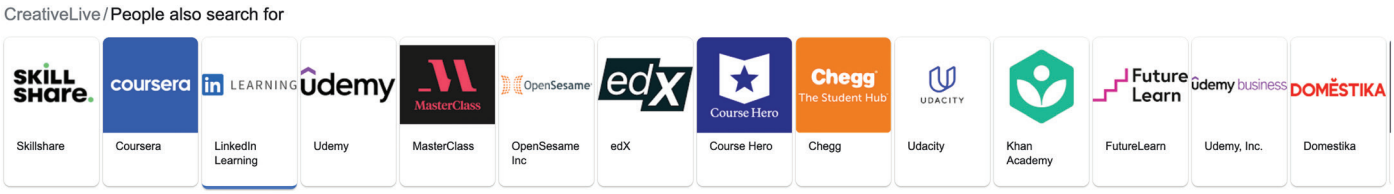

Figure 1. *A snapshot of Google suggestions for online learning.*

Environmental geophysics

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Welcome readers to this issue's column on geophysics applied to the environment. We are now on Scene 4 of the reminiscences by Niels Christensen on his career at Aarhus University and that group's progress into and through electrical geophysics starting in the 1970s through to the 1990s and beyond. There are no "geophysical war stories" in this one, just an interesting recounting of the challenges of the times. Over to Niels…

Pivotal moments: Seven scenes from a geophysics adventure

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Scene 4

… in which our protagonist has unusual luck, goes to Australia, and finally succeeds in finding the key to fast approximate computing.

EAGE conference, Paris 1992

I'm on the roof of the conference centre where the EAGE conference is held in Paris in 1992, enjoying a beautiful sunset over the roofs of Paris with a glass of cool white wine in my hand. Life could certainly be worse. Besides making a presentation, I have another reason for attending. I'm searching for a person who might, or might not, be here.

By 1992 we had gathered a lot of experience with the TEM method, both in terms of field work, data inversion and geological/hydrogeological interpretation of the results. Even though the Selma inversion program that Bo Holm Jacobsen and I had put together was more than an order of magnitude faster than other programs that we had access to, an inversion with a 1D 3- or 4-layer model took 45 minutes. Field data were coming in a steady stream every day, and the computation time was getting intolerably slow.

At the time I knew that certain options existed in terms of approximate inversion of TEM soundings data, and I had collected a few open source programs that existed at the time. However, I did not find them to be particularly good. My intention was to use the results of an approximate inversion as the initial model for the usual inversion to speed up convergence. I knew that Jim Macnae from Australia had worked with fast approximate inversion, and I had read some of his papers on the subject which as far as I could see were some of the best on the subject, so wanted to have a talk with him.

These thoughts went through my mind that evening on the roof, and I wondered if Jim Macnae would actually be at the conference. I just had to keep a lookout over the next days among the ~4000 conference participants. I turned towards the person standing to the right of me on the rooftop who also had a glass of white wine in his hand - you just had to start somewhere – and read his badge. It read: Jim Macnae. Sometimes they just get it spot on, those guardian spirits.

We talked several times at the conference, and Jim directed my attention to a thesis by Benjamin Polzer, which I requested to be sent to me when I was back in Aarhus. That was a truly original piece of research, and I did my best to program up the approximate inversion that was laid out in the thesis, but I could not make it work and I had to put it aside, very frustrated that I could not find the error.

Frustration often spurs you to think for yourself, and I started to have some clues about constructing approximate inversions. However, it was not easy for me to find the time, as an associate professor with teaching obligations and many students to supervise, to concentrate on the task, so it was not until 1995 that I got some time to dig into it. I had asked Jim if I could come visit, and I spent two months at Macquarie University, just north of Sydney, and that's where it all came together. I can still remember the moment when I knew that I had nailed it! The fruit of years of work! When I finally relaxed, I looked at the code that I had written to implement Polzer's approach, and … there was the error! I corrected my program based on Polzer's work. And then came the next Eureka moment: The codes suggested by Polzer produced exactly the same results as my new code even though the concepts behind them were quite different! When

I found out why that was, I learned something very fundamental about the scaling properties of EM phenomena in general and about those of the TEM method in particular (more on that below).

During my last days in Australia, I frantically wrote a draft for a paper on my approximate inversion procedure - I knew I would not have the time to write when I came back home - and that proved to be a very wise decision.

The breakthrough in Australia became an event that in many ways decided my future research directions. I have given quite a bit of attention to approximate methods for modelling and inversion of TEM and other geophysical data with 1D and 2D models. Approximate methods have an important role to play and I also found them deeply fascinating.

When I began the development of approximate methods, the necessity arose from the computational cost of inverting a single sounding. You would think that as computer speeds increased, approximate methods would become less important, but that turned out to be wrong. At the same rate that computers got faster, geophysical instruments got computerised and thereby more efficient due to much improved electronic components and their integration with computing power. This opened up possibilities of new data acquisition methods such as continuous methods where data were measured from a moving platform, either on or above the ground. In 1999, I was invited to be a keynote speaker at the EAGE conference in Amsterdam with a presentation on the future of EM methods, and in one of my slides, I demonstrated that Moore's Law was also valid for the amount of data that can be collected in one day, meaning that approximate methods were still relevant.

My fascination with approximate methods lies in the fact that a successful approximate method must meet certain requirements. First of all, evidently, it must work, meaning that it must be sufficiently faster than traditional approaches while still being sufficiently accurate in some context. In principle, it is completely irrelevant what makes it work, as long as it actually does! It's a sort of street fight with all of its dirty tricks in comparison to established and regulated traditional martial arts. The other aspect that I found deeply fascinating is that to actually work and be sufficiently fast, it must be in accordance with the fundamental characteristics that govern the physical phenomena associated with the method. So, the development of a good approximate method requires a deep understanding of the fundamental physical processes, as well as skills in improvising and simplification. Figure 1 might give the reader some insight into how I at least start to think about approximate methods.

Figure 1. *A row of approximate human beings in a rice paddy in Japan. They fulfil all of the criteria for an appropriate approximation: They are cheaper than the accurate human equivalent in terms of construction and running cost; they actually do the work of keeping the birds away; and they have the basic physical properties of humans: a torso, two arms and two legs, and a head (Public domain: https://commons.wikimedia.org/w/index.php?curid = 140870en:Image:Kakashi2.jpg*

Through continuous development efforts I have succeeded in finding approximate methods for TEM data on two levels: One that is ~50 times faster than traditional methods and one that is ~10 times faster, the latter so accurate that model sections done with the good approximate inversion and traditional accurate inversion are identical except for small details. Both approximate methods are based on an approximate forward mapping and an inverse formulation identical to the one used with accurate responses, and they have both been used extensively in large airborne TEM surveys. These days I use the approximate methods in a hybrid setup, where approximate and traditional methods are used in a bootstrap strategy to obtain the best from both worlds: speed and accuracy.

To be continued…

Minerals geophysics

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Remote control

On several occasions I've had cause to ponder the relative merits of local versus remote management of mineral exploration projects in Australia. That is, running the exploration programme from a local on-site base versus running exploration from headquarters located, say, in an Australian capital city, or even overseas. Compared with the past, improved modern communications have dramatically narrowed the difference between the two alternatives; in many ways the "remote" of old is now nowhere near as remote, and headquarters need no longer be so detached from the actual exploration. But there do remain differences.

An exploration programme can be considered to comprise a series of stages; for example: design, implementation, and evaluation. Local versus remote management may impact each stage differently. Here I am going to focus particularly on geophysical aspects of mineral exploration programmes. And, perhaps showing a personal bias, I am applying the terms "local" and "remote" with reference to management's location with respect to the scene of the action itself.

Design

An exploration programme is typically designed to find a particular style of mineralisation within the geological environment considered most prospective for this target style. Selection of the geological environment, particularly in a mature exploration area, may require an innovative approach. Perhaps a remote management team, unburdened by past experiences and more exposed to new and different ideas, could be the more innovative? Having selected the area, the ability of a particular geophysical technique (or techniques) to detect and discriminate the targeted mineralisation within the environment being explored is paramount. Both local and remote management would be capable of deciding which technique to use and how best to apply it, but local knowledge and experience would surely be vital to the potential success of any programme.

A case in point is the influx of overseas oil companies into mineral exploration in Australia in the 1970s and 1980s, and their initial broad-brush application of North American style geophysical methods (most notably airborne electromagnetics) to typically Australian deeply weathered, surficially electrically conductive environments. While such programmes did provide systematic data sets, the potential for success of such techniques was severely compromised by the unfavourable geo-electrical environment. On the positive side, the typically negative experiences from such an approach did hasten the development of more appropriate lower frequency / longer time delay electromagnetic techniques for use in Australian conditions.

Implementation

Having decided on the type and style of geophysical methods, it is then necessary to select the appropriately qualified geophysical contractors. The history of operations of the contractor and crews in the local environment would arguably be the best indicator here, and this knowledge could be available through prior experience to either local or remote management teams.

However, once the surveys are underway, local supervision will be the more hands-on. On-site interaction between client and geophysical crews will result in a shorter response time to address survey access difficulties, instrument problems, and other events at the time that they are encountered, thus increasing the efficiency and effectiveness of survey conduct and procedures. Clearly, there are benefits from on-site, face-to-face communication, particularly for the more unusual situations. There is less chance of confusion about what is happening, and of miscommunication about what actions should be taken.

Remote crew supervision is necessarily less immediate, particularly if there is a significant time zone difference between the crews and the supervisors. Survey results are more likely to be reviewed over-night as far as the crew are concerned, and there can be resulting delays in responses. The end result may be the same as for on-site interaction, but the time factor can be quite different. However, head office typically does have better access to a larger data-base and to a greater breadth of technical knowledge.

Evaluation

Stages of geophysical evaluation could comprise processing, presentation, and interpretation of the survey results. Data processing is typically carried out by experienced personnel more usually employed by the geophysical contractor. Data presentation may be undertaken by either the geophysical contractor or the client, or often a mix of the two, with the client fine-tuning the survey results in the light of local knowledge. Interpretation, where other knowledge is incorporated into the mix, is more likely the domain of the client.

Again, there is a mix of potential advantages and disadvantages with respect to local versus remote management. Local team members may have more intimate knowledge of the conduct of the survey and the effects on its results, whereas remote management may have access to a more sophisticated data processing capability. However, we shouldn't discount the value of a project champion, particularly where persistence is required. This, in my experience, is more likely to come from someone within the team on-site, rather than someone in a remote management team. There are instances (not always well documented!) where the perseverance and actions of someone on site, sometimes contrary to remote management's instructions, have resulted in exploration success.

The wrap-up

What would be the ideal exploration programme management arrangement? Probably having the entire management team on-site, thus getting the best of both worlds, but in most cases this isn't feasible. Realistically, then, a combination of both on-site and remote approaches would be the way to go, supported by the best possible inter-communications between the on-site and remote elements. And a mutual appreciation of each team's strengths, limitations and knowledge bases.

Seismic window

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Australia's early oil discoveries

The Kingfish story in the last issue of *Preview* prompted me to look into other discoveries that led to commercial developments and the spawning of a successful Australian oil industry. I intend to give a brief description of these discoveries, one in each state except NSW over the next few issues. I will start with the Moonie oil field in Queensland because the discovery of this field had such an impact it was taught in Primary school back in the 1960s. Primary school was different back then - we used ink and pens to write with, young children were let loose with an axe to chop firewood for the classroom stove and everyone was given a free bottle of milk every day. Primary school was often the last formal schooling for some people so at the end of Grade 7 we received a graduation certificate.

Moonie is located 262 m above sea level in the Surat Basin, 280 km west of Brisbane. The Moonie discovery well was drilled in 1961 by a Union Oil led joint venture and was the first commercial oil field in Australia. The discovery well flowed oil at 1765 barrel per day and the field peaked at a rate of ~9000 barrels per day shortly after it began production in 1964 (Figure 1). Cumulative production from the subcropping Evergreen Formation and Precipice Sandstone (Figure 2) is over 24 million barrels.

Figure 1. *Detail on monument in Brisbane commemorating the construction of the Moonie Brisbane pipeline.*

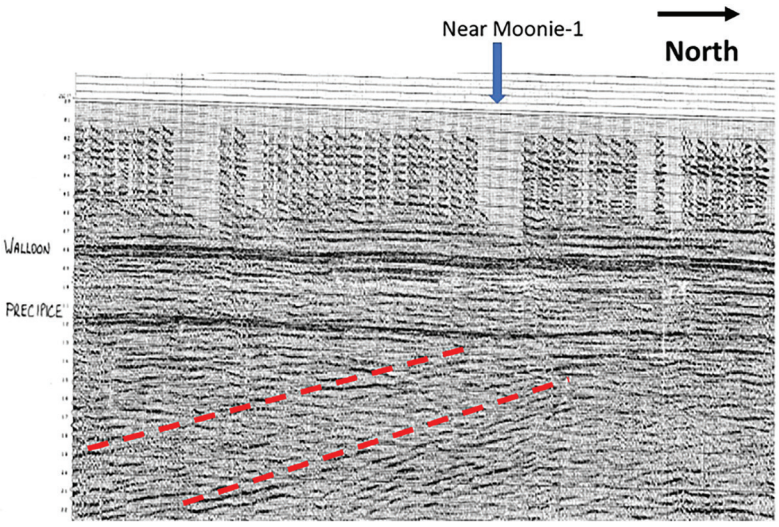

Figure 2. *Seismic line M-2 recorded in 1979 near Moonie-1. The line is 6 fold and unmigrated making it difficult to pick the subcropping geology below the Precipice reflection at 1.1 seconds.*

Ten years earlier, on the other side of the country, Rough Range – 1 was drilled by WAPET in 1953 and intersected an 8.6m oil column (Figures 3 and 4) in the Birdrong Sandstone. This well produced at 550 barrels per day when completed in 1955, and caused unprecedented

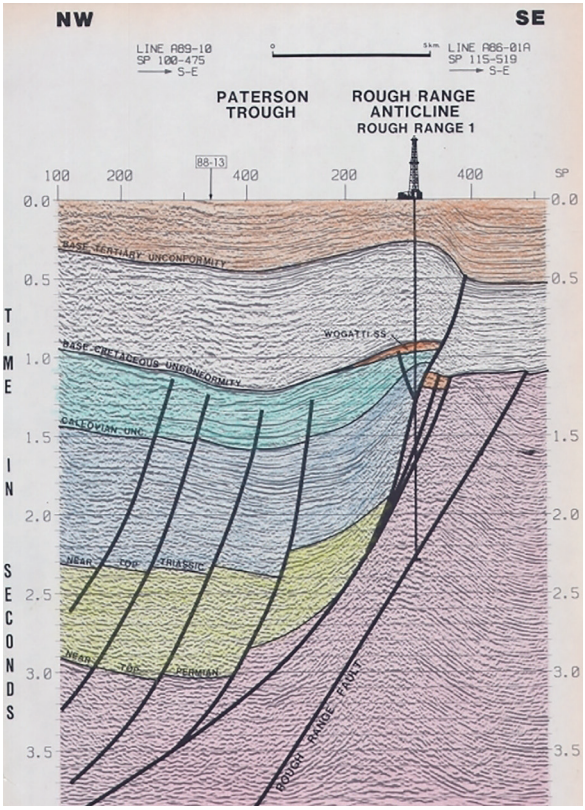

Figure 3. *Seismic section across Rough Range illustrating the complex structure and limited oil column (from Rough Range -1 well completion report).*

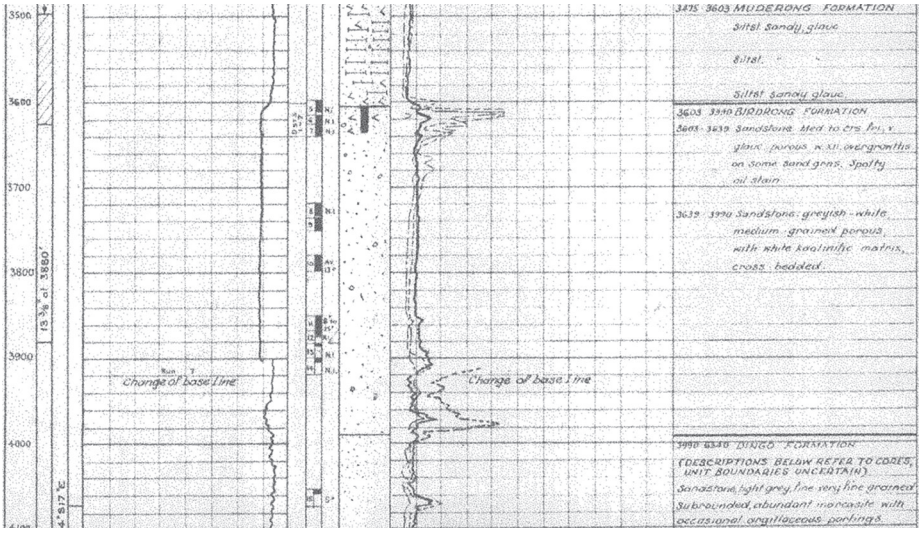

Figure 4. *Resistivity (right track) and SP log (left track) across the Rough Range oil column.*

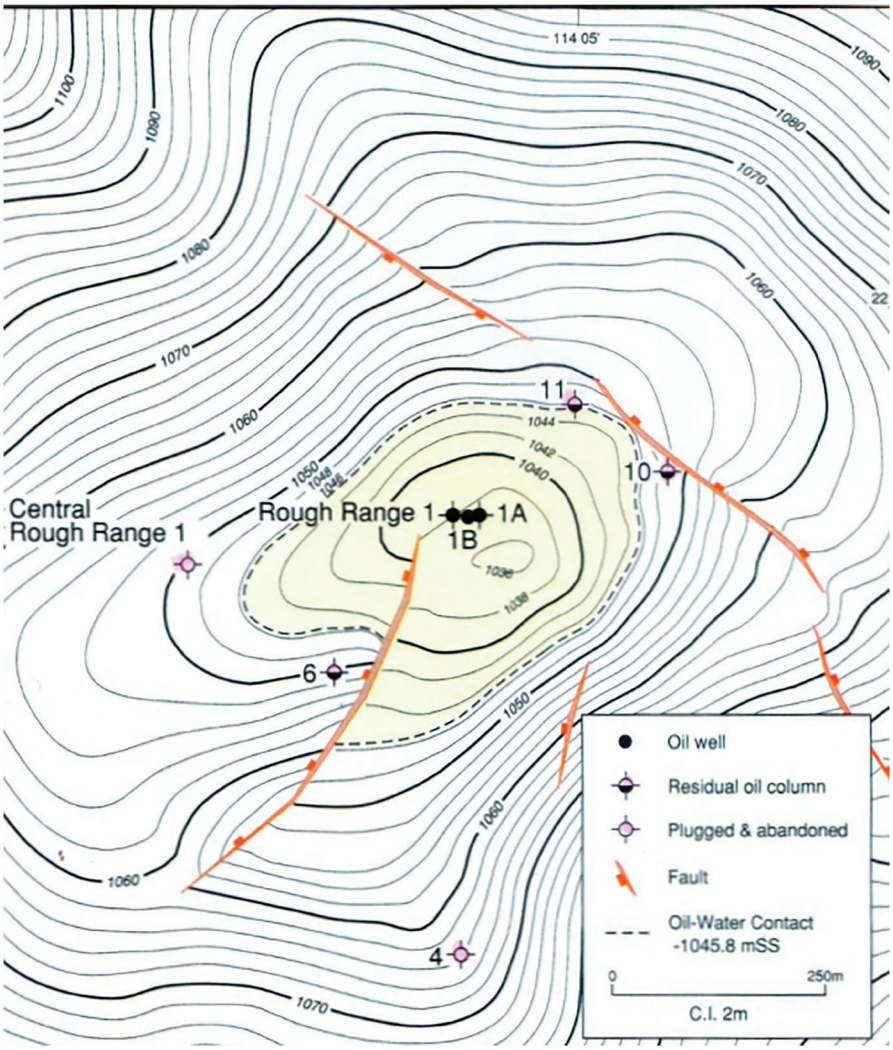

Figure 5. *Rough Range depth map near top reservoir. Closure is less than 300 m across (map from Sedimentary Basins of WA - WABS2002).*

activity on the Australian stock market. Follow up wells on the structure failed to find producible oil. During the 20 months it took to complete Rough Range-1, 1A, 1B seven surrounding wells were drilled and all were dry. Rough Range-9 was also dry and Rough Range-10, drilled only 200 m from the discovery well, only intersected a disappointingly thin oil column.

An extended production test of the discovery well produced 16900 barrels of oil which has been estimated to be 20% of the field recoverable resource.

The colour of hydrogen

Hydrogen is going to save the world. When combusted it produces nothing but water. However it has to be the right kind of hydrogen. It is common to assign a descriptive colour to hydrogen to indicate its origin. While it is not universal, Table 1 is a handy reference to distinguish between the many colours of hydrogen. If it's not green, it's not green.

Table 1. The colour of hydrogen.

Colour	Description
Green	Electrolysis using electricity from renewable resources
Turquoise	Thermal splitting of methane (no CO_2 produced just solid carbon)
Yellow	Electrolysis using grid electricity
White	Naturally occurring or a by-product of an industrial process
Pink	Electrolysis using nuclear power
Purple	Electrolysis using nuclear power
Red	Catalytic splitting using nuclear power
Black	Gasification/reforming of black coal
Grey	Steam reforming of natural gas
Brown	Gasification/reforming of brown coal
Blue	Grey or brown hydrogen with CO_2 sequestered or reused

Data trends

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Proposed ASEG library of file types, documentation and programs

Geophysics has generated an enormous number of files produced by an enormous number of devices and consultants over the years, many of which we have endeavoured to preserve. However, as device manufacturers and software companies disappear, or people retire, so can file access. The Technical Standards Committee would like to find a way to document and archive data file types, programming code and programs, just as we do instruction manuals.

We will begin with a list of devices or programs, the data file types that they generate, and how those data files can be opened. Raw device files are common in older open-file company data, so this covers geophysics files ranging from raw data up to processed data, grids and 3D models.

Locating open or donated programs and source code for generating the various files out there is the next objective. Commercial software offers read/write APIs, but at the whim of a license change.

UBC GIF provides free utilities to prepare and view inversions, but they are not re-distributable and depend on one internet page never changing at a university. Source code is rarely provided.

A minor example of abandonment concerns the ER Mapper file reference web page, which has disappeared from the internet after a decade of corporate takeovers. As a consequence, the ASEG's adopted archival grid format appears no longer to have an official help file enabling others to write ERS functions. Such information is vital to preserve.

The value of archived files from forgotten instruments will only grow as land access decreases, so remembering how they were used is as important as being able to read the data generated. It is yet to be determined whether the information might be stored on Github or the ASEG website, but the repository must be easy to access and use.

Are Members interested in contributing to such a library? Example input could be old gravity, mag, EM or IP meter output files with instructions or code to correctly read them. Similarly input could be files generated by passive seismic geophones, MT sensors and EDI. Different programming languages are likely to be involved, but code written in any language would be useful. Binaries of your own programs would be appreciated, and the source code a godsend.

Unless this is your software, however, we enter the grey world of abandonware - distributing programs no longer sold or supported, perhaps with distant, disinterested ownership. We have seen programs moved around owners unchanged for years until operating system changes demanded an update. Others fell off the radar. Hopefully those companies can be persuaded to contribute.

If interested please email technical-standards@aseg.org.au.

Webwaves

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Have I been Pwned?

Password security was the focus of several *Webwaves* columns by David Annetts, the previous webmaster, and it seems timely to revisit the topic.

In *Webwaves Preview* issue 195 (Annetts, 2018), password hygiene was reviewed, with a number of recommendations put forward that can be implemented by readers to improve their security. The security.org "how secure is my password" tool is mentioned (https://www.security.org/how-secure-is-my-password/). This tool will estimate how long it will take to crack a given password. Readers are encouraged to try variations such as webmaster, Webmaster and Webmaster00 to see the impact of adding characters to a password and changing the case of some of those characters (see also Figure 1).

Meanwhile, *Preview* issue 191 (Annetts, 2017) covered data breaches and some of the EU's GDPR requirements around protecting user data and informing individuals of data breaches within 72 hours.

This led to *Preview* issue 199 (Annetts, 2019). Here readers were made aware of the "have I been pwned" website and the ability to check if your details and credentials have been compromised. In this column we are going to elaborate on this and other tools that are available to highlight compromised accounts and refresh readers on recommendations for password security.

Pwned

Pwned pronounced 'poned', comes from leetspeak (https://leetspeak-converter.com/) and is a deliberate misspelling of "owned". Pwn has been an official Scrabble word since 2015, Pwn: To own, defeat, dominate.

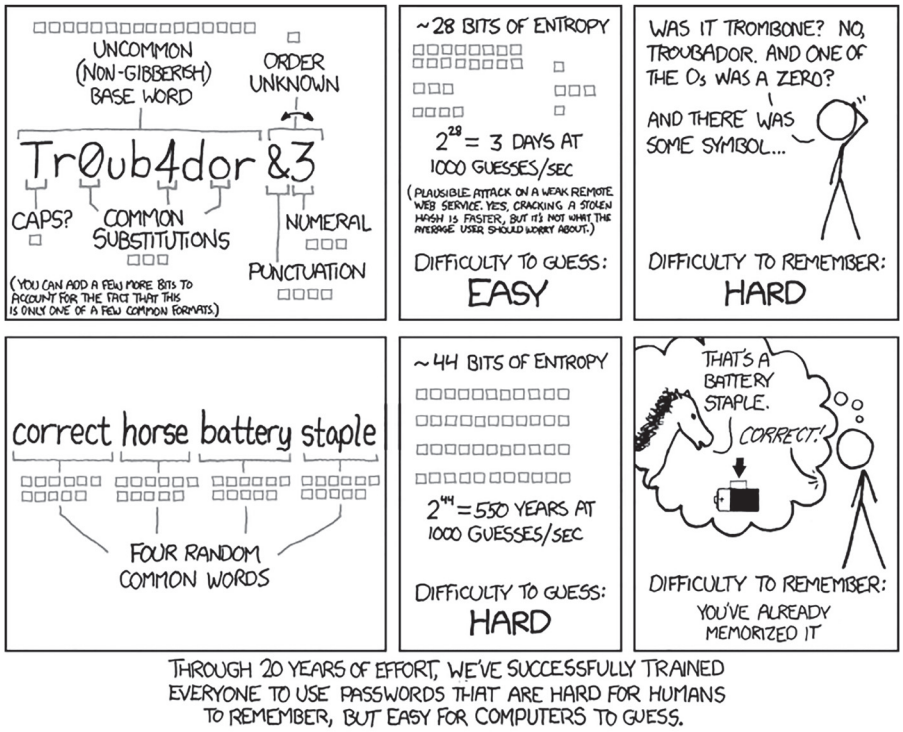

Figure 1. *Password Strength (from https://xkcd.com/936/)*

Have I Been Pwned (https://haveibeenpwned.com/) is a data breach search website created (and subsequently maintained) in 2103 by security consultant Troy Hunt. The website allows users to enter their details and search the billions of leaked accounts across hundreds of data breaches. Some of the features include:

- Email or phone number search. Enter your email or phone number to see if your details have been compromised. For any data breach, details of the information available and a backstory of the breach are provided.
- Notify me. Enter your email address and receive notifications of any future data breaches implicating that email address.
- Domain search. The ability to search for data breaches featuring any email account on a domain. This is particularly useful for IT departments to check all email accounts in an organisation.
- Pwned passwords. Enter a password to anonymously check if it has featured in a data breach. Details of how privacy is protected when searching passwords is provided. This is a very useful way to alert people to the risk of password reuse.

Other tools

An API exists for "Have I Been Pwned" (https://haveibeenpwned.com/API/v3) ensuring that Hunt's extensive database can be freely accessed. Various browsers, password managers and tools now use the data to check users accounts, or have created their own implementation of the site. These include Firefox Monitor in the Firefox web browser, Google's Password Checkup and Apple's Password Security Recommendations.

Recommendations

To build on some of the recommendations in Annetts (2018), it is strongly recommended that:

- Unique passwords are used for each account. The use of a Password manager (eg. LastPass, Bitwarden, https://xkcd.pw/), with a unique password generated for each account using a built in generator.
- Strong passwords are used. Users can use https://www.security.org/how-secure-is-my-password/ to see how secure various passwords are.
- Multifactor authentication is used where possible.

- The use of features such as Apple's 'Hide My Email'.
- Checking account details on Have I Been Pwned, signing up to get notifications of future breaches and immediately changing any credentials that have been compromised.

Ultimately, common password strength indicators including those recommended in this article are nothing more than simple calculators. They know nothing of human behaviour and human behaviour is a critical element of how passwords are created, managed, compromised and exploited.

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Australian Society of Exploration Geophysicists
50th Anniversary Special Publication

MEASURING TERRESTRIAL MAGNETISM

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

People, Planes, Places and Events
1100s – 1949

W.D. (Doug) Morrison

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Does surface temperature and climate change affect CO_2 stability?

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CO_2 storage is an important factor in the drive towards decarbonisation and the energy transition. It is a well-established field, and there have been many advancements in the last two decades on the geological storage of CO_2. This is dependent on the existence of conditions required to keep CO_2 stable on human timescales and prevent leakage that will undoubtedly cause environmental problems. These conditions include existence and effectiveness of geological seals to prevent leakage and absence of features, e.g., faults, which may act as conduits for CO_2. However, given the fundamental chemistry of CO_2 and the fact that the triple point is at conditions encountered at shallow depths (P_c = 7.38 MPa, T_c = 30.98°C), there is an obvious question: do variations in surface temperature affect the condition of CO_2 in the subsurface? If so, can surface or near-surface temperature variations caused by climate change or urbanisation affect the depths for which CO_2 will remain stable for storage in rocks?

As we know, it can get very hot in Australia and in many places around the world. Low-frequency temperature signals (e.g., decadal climate change) may be retained at depth (> 100 m) while high-frequency temperature signals (e.g. monthly) are generally retained at shallow depths of < 10 m (Lesperance *et al.*, 2010). Recent research indicates that fluids migrating along fracture networks through rock volumes may be significant propagators of heat, and the combined effects of urbanisation and global warming may reach more than 100 m below the surface (Kurylyk and MacQuarrie, 2014; Taniguchi *et al.*, 2007; Westaway and Younger, 2016). Under normal geological conditions (Pressure-Temperature gradient of 0.5 MPa/K), an increase in temperature of 20°C corresponds to change in the phase boundary between CO_2 gas to liquid/supercritical fluid of 0.4 km to 0.6 km, respectively (Figure 1).

Application of basic chemical equations of state and determination of rock properties with depth for sandstones and carbonates indicates that at these depths, vertical CO_2 velocities may increase by over an order of magnitude, due to the significant step in buoyancy when CO_2 changes from liquid or supercritical fluid to gas (Figure 2, Lodhia and Clark 2022). This raises the prospect of increased surface or near-surface temperatures and the subsequent transportation of heat through shallow conduits (e.g., faults) influencing the depth of CO_2 gas-fluid phase transitions on human timescales. This is intriguing as most experiments and test wells for CO_2 injection are typically drilled at depths of less than 1 km. Increased subsurface temperatures due to long-term climate change and urbanisation may mean that CO_2 must be injected deeper

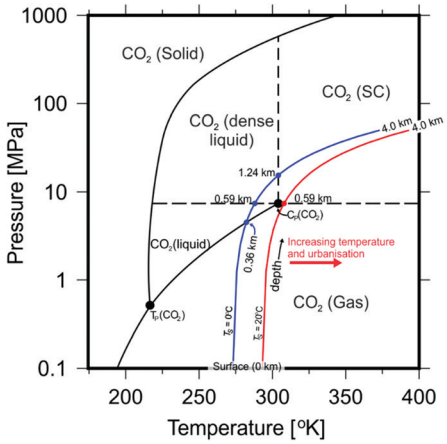

Figure 1. *Phase diagram for CO_2, methane calculated at normal geological conditions and geothermal gradient = 25 °C /km. Blue and red lines represent PT paths calculated at Ts = 0 °C and 20 °C, respectively. Black lines and points represent phase diagram for CO_2. Tp = triple point, Cp = critical point. Modified from Lodhia and Clark, 2022.*

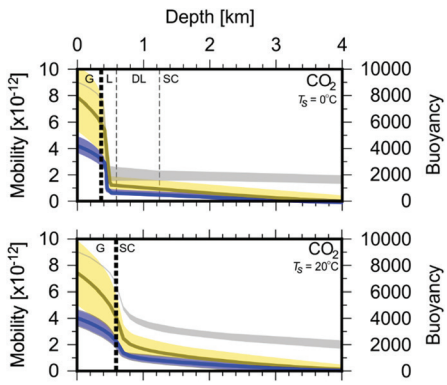

Figure 2. *Fluid mobility for CO_2 and methane calculated according to Eq. (1). Fluid mobilities are calculated at Ts = 0 °C (top) and Ts = 20 °C (bottom), respectively. Units for fluid mobility are $m^2\ Pa^{-1}\ S^{-1}$ and buoyancy are $kg\ m^{-2}\ S^{-2}$. Yellow and blue lines represent fluid mobility in sandstone and carbonate, respectively. Grey lines represent buoyancy and shaded regions represent range of values calculated using different Equations of State and lithological parameters. Dashed lines represent phase transitions: G gas, L liquid, DL dense liquid and SC super-critical. Gas-fluid phase transitions are shown in bold. Vertical fluid velocity may be calculated by multiplying mobility and buoyancy. Modified from Lodhia and Clark, 2022.*

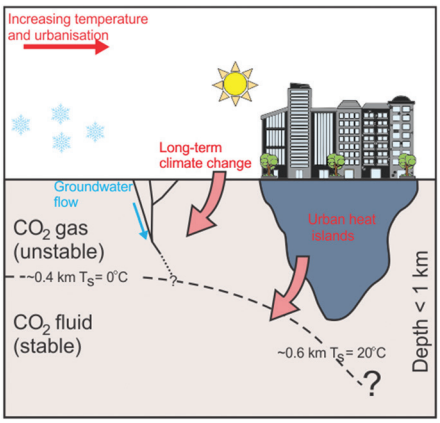

Figure 3. *Schematic diagram of the potential effects of surface or near-surface temperature variations on CO_2 stability.*

than previously thought to remain in the stable non-gas phase (Figure 3, Lodhia & Clark 2022).

Determining fluid velocities in rocks on human timescales remains a key challenge for accurate modelling of CO_2 migration and storage. This is area that has surprisingly little literature, which I for one would be keen to see more development. It will also be interesting to see whether recent CO_2 injection experiments record the jumps in velocity expected from its fundamental chemical properties and how these vary with surface temperatures around the world.

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Discovery of the Havieron Gold-Copper deposit, WA

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Summary

The high-grade Au-Cu Havieron deposit exhibits near coincident ovoid magnetic and gravity anomalies and was discovered in 2018, under 420 m of post-mineralisation cover, through geophysical modelling and drilling.

At Havieron, the aeromagnetic image defines a 100 nT near-circular magnetic anomaly having a half-width of 800 m within generally bland magnetic terrain. Gravity data define an irregular gradient with values decreasing to the north east. Three large WNW trending sand dunes disrupt the Bouguer gravity image due to over-correction using the standard density of 2.67 gm/cc, but the disruption is reduced using a density of 1.50 gm/cc consistent with the notion that the dunes consist of loose dry sand. The revised gravity image shows an obvious bulge in the contours of the gravity gradient which appears as a weak (0.5 mGal) irregular gravity ovoid in a residual gravity image. The peak of this ovoid is at least 200 m to the south of the magnetic peak. Including a remanent magnetic vector in the magnetic model simplified the model body and shifted it southward to a position coincident with the residual gravity anomaly. The discovery hole was designed to intersect this coincident source of the magnetic and gravity anomalies.

Introduction

The Havieron gold-copper deposit is located 45 km east of the large Telfer gold-copper mine in the Paterson Region of northern Western Australia (Figure 1). The deposit is hosted in Neoproterozoic age Lamil Group metasediments which consist of variably altered sandstones, siltstones and calc-silicates. High grade gold and copper mineralisation was discovered at Havieron under more than 400 m of Phanerozoic age post-mineralisation cover via drill testing of a coincident 100 nT magnetic and 0.5 mGal residual gravity anomaly. Current exploration drilling continues to expand the limits of mineralisation which has now been intersected over more than 1000 m of vertical extent. Havieron is an intrusion- related system with gold and copper mineralisation hosted in breccia, vein and massive sulphide replacement styles.

The Havieron target was first recognised and drilled by Newcrest Exploration between 1991 and 2003 with most holes displaying alteration and low grade anomalous gold and copper mineralisation. Following re-evaluation of geophysical datasets Greatland's first hole in 2018, HAD001, intersected 121 m @ 2.9g/t gold and 0.23% copper from 497 m down hole. Other follow-up holes in 2018 were also supportive including HAD005 with two zones of mineralisation; upper of 103 m at 3.5g/t gold and 0.93% copper from 459 m, and a lower zone of 128 m at 7.4g/t gold and 0.54% copper from 680 m.

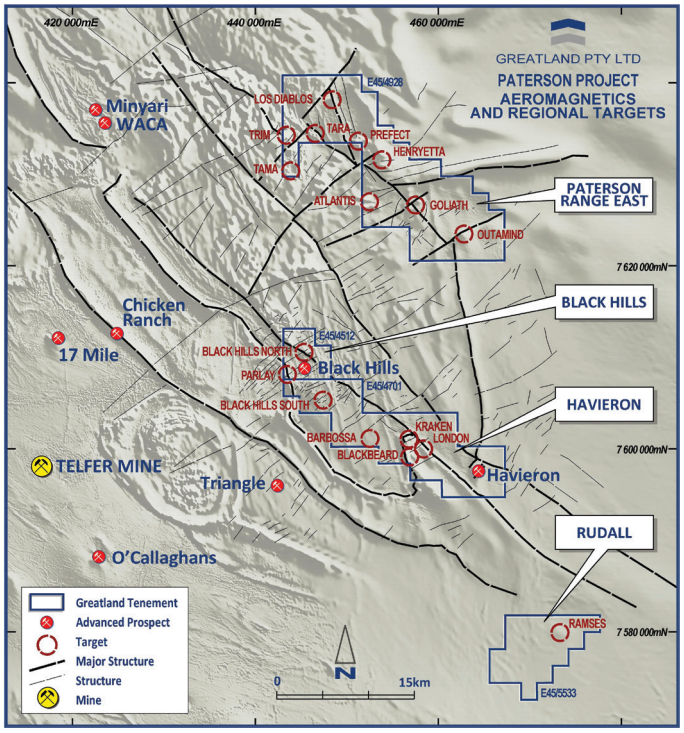

Figure 1. *Havieron location map with regional aeromagnetics.*

Data

Detailed aeromagnetic data, collected along 50 m spaced NNE flight lines at 40 m altitude and shown in Figure 2, define a circular magnetic anomaly of about 100 nT with a half width of 800 m within generally bland magnetic terrain. Images that follow also show collar locations for six of Newcrest's historical "HAC" holes with surface traces if non-vertical.

Figure 3 shows the topography which is a subset of the digital elevation model created from the airborne data streams, indicating flat terrain interrupted by a number of WNW sand dunes. Coordinates are MGA Zone 51.

The gravity data is a compilation of two surveys, yielding mostly 100 x 100 m and 100 x 200 m spacings (shown as small "x" symbols in Figure 4) that define an irregular gradient with values decreasing to the north east. Three large WNW trending

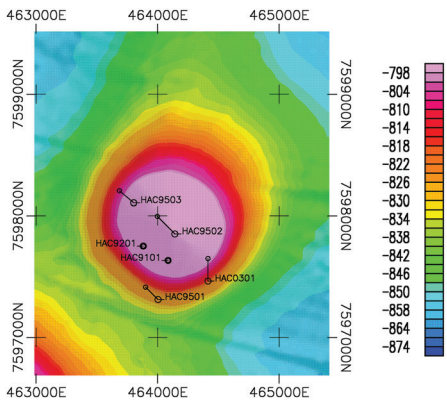

Figure 2. *Aeromagnetic data; sensor height 40 m.*

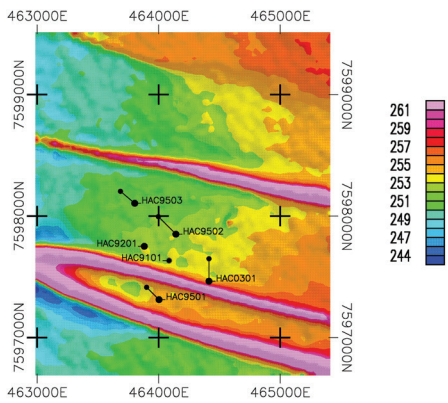

Figure 3. *Digital terrain model.*

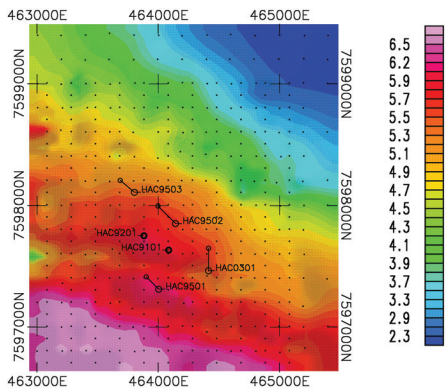

Figure 4. *Bouguer gravity image created using the industry standard correction density of 2.67 gm/cc.*

sand dunes disrupt the Bouguer gravity image when over-corrected using the standard density of 2.67 gm/cc, but the disruption is minimised using a density of 1.50 gm/cc which is consistent the notion that the dunes consist of loose dry sand (Telford, *et al.*, p25). Terrain corrections, using an algorithm based on the method of Hammer (1939), were applied but only three points in the far south west yielded corrections greater than normal measurement noise (0.02 mGal). The effect of the sand dunes is not apparent in the revised gravity image (Figure 5.1) which shows a clear bulge in the contours of the gravity gradient. After removing the regional trend, a residual gravity image exhibits a weak irregular ovoid (Figure 5.2), the approximate centre of which is located slightly more than 200 m south of the magnetic peak.

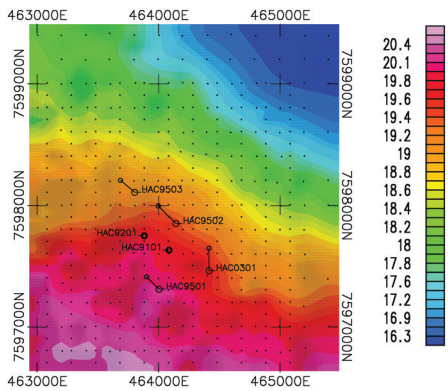

Figure 5.1. *Terrain corrected gravity; density 1.50 gm/cc.*

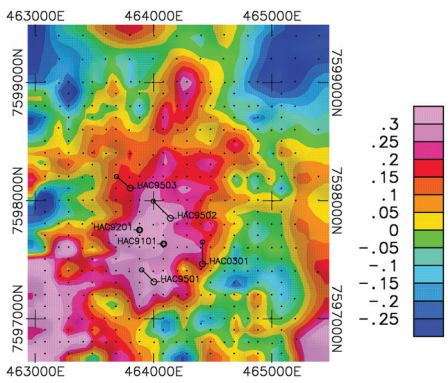

Figure 5.2. *Residual of the terrain corrected gravity.*

Even with the density-optimised terrain-corrections, the gravity image is disappointing. Many short wavelength highs and lows of up to half a milligal, in some cases single point readings, disrupt a simple ovoid that might be expected from the magnetic image. We believe these variations to be caused by topographic undulations at the base of the unconsolidated cover. The model discussed below simulates most of these variations using irregularly shaped polygons a few metres to several tens of metres thick and having density contrasts of around 1 gm/cc (to simulate a bedrock ridge) or -1 gm/cc (to simulate a trough). These high frequency variations are almost an order of magnitude stronger than what might be expected of measurement noise in what are judged to have been well executed surveys.

Model and method

In an era when geophysical interpretation is dominated by inversion algorithms, we maintain that value can still be gained from the "old fashioned" method of forward modelling used here. The importance for a geophysical model to have geological credibility cannot be overstated, and, unlike most inversion codes, forward modelling leaves the user in control of the direction a model takes through the many iterations that are invariably needed. Furthermore, forward modelling helps to develop a keen understanding of just how ambiguous potential field data is, and it provokes critical thought throughout the arduous process required to arrive at some final model that is offered as an interpretation of the data. The writers do not recommend against the use of inversion algorithms when the user feels they add value to a project; however, we prefer forward modelling because of the control maintained on the final form of the model and because of the ease with which numerical experiments can be performed to test the significance of key model bodies, as well as alternate models. In addition, forward modelling is easily linked to the phase/scatter diagram method (Hanneson, 2003), also called the *MagGravJ* method, which provides a quantitative link between the physical properties of the model bodies and geological aspects of the rocks that the bodies represent.

The geophysical data was simulated using a forward modelling algorithm based on the theory of Talwani (1960, 1961). The tops and bottoms of model bodies are horizontal, and the bodies and have polygonal outlines with sides that are defined by vertical lines through the vertices which can be altered collectively (to simulate a plunging body with the same shape) or individually (to simulate a body shape that changes with depth).

Rather than creating separate models for the magnetic and gravity data, however, a *joint interpretation* of the two data sets was made possible through recognition that magnetite, the main and often sole contributor to the local magnetic response, is dense (5 gm/cc), and, in sufficient concentrations, can contribute to the local gravity field. For example, *MagGravJ* makes it possible to calculate the gravity response of a magnetic phase like magnetite or pyrrhotite separately from the gravity response of dense non-magnetic material like hematite and/or sulphides. Furthermore, *MagGravJ* uses the physical properties of model bodies to estimate percentages of a dense non-magnetic mineral category like a hematite-sulphide mixture (because they have similar properties) and dense magnetic minerals like magnetite or pyrrhotite (subject to assumptions about the lithology). Terms like "App%hts" and "App%mag" are used to report these estimates and are more meaningful to geologists than density and susceptibility, once they become familiar.

These are important considerations in the search for iron-oxide-copper-gold [IOCG] deposits which, in early days, was invoked as a potential deposit model for the Havieron anomaly. Known IOCGs tend to occur under significant cover, and can exhibit ovoid magnetic and gravity anomalies that appear coincident in plan but normally derive from shallower, dense, non-magnetic, oxidised rocks, that transition to more reduced magnetic rocks at greater depth.

Modelling results

To apply the method, the magnetic model response is calculated at all points where there is magnetic data, and likewise for the gravity. Changes for subsequent iterations are influenced by plan views of the point-by-point differences and by discrepancies in profiles in numerous cross-sections. The model can be displayed by selecting the horizontal depth slices and vertical cross-sections that best illustrate the model.

While the shallow bodies, discussed above, that simulate the supposed cover variations are not shown in plan, depth slices at the unconformity depth of 420 m (known from the historic drilling) and at 1320 m are presented in Figures 6.1 and 6.2, respectively. The dark green Body 3 was deemed to be the main drill target; it is 420 m deep, has a depth extent of 900 m, and, upon applying the *MagGravJ* method, has the density expected for felsic rock averaging a percent magnetite and 3.7 percent of a dense non-magnetic component like a hematite + sulphide mixture. In addition, Body 3 has a shallow, south-directed remanence vector with a Koenigsberger ratio of 2.2. Some large regional bodies extend outside the study area and have been clipped for the presentation.

The 1320 m deep yellow-green Body 1 seen in Figure 6.2 has the same magnetic properties as Body 3. It was introduced to simulate a northward bulge in the low amplitude contours of the anomaly and is interpreted to represent deep rocks similar to those represented by Body 3; however, it was not assigned the dense non-magnetic component since its depth makes the gravity data too insensitive to require it.

Figures 6.1 and 6.2 show straight lines annotated P1 to P4 that indicate the locations of model cross-sections shown in Figures 7.1 to 7.4 which were designed for proximity to the historic drill holes and show drill collars and down hole points that are within 50 m of the section. A modest amount of magnetic susceptibility readings were available for holes HAC9101 and HAC0301; values ranged from 0 to 83 but the unitary system

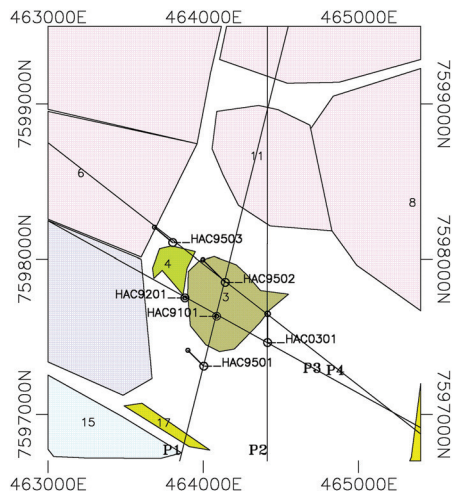

Figure 6.1. *Model depth slice; d = 420 m with drill collars and surface trace for non-vertical holes.*

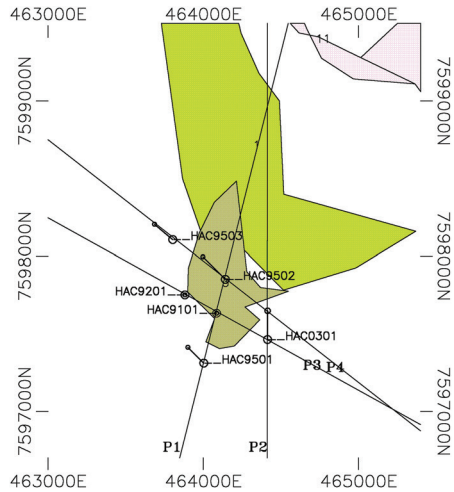

Figure 6.2. *Model depth slice; d = 1320 m.*

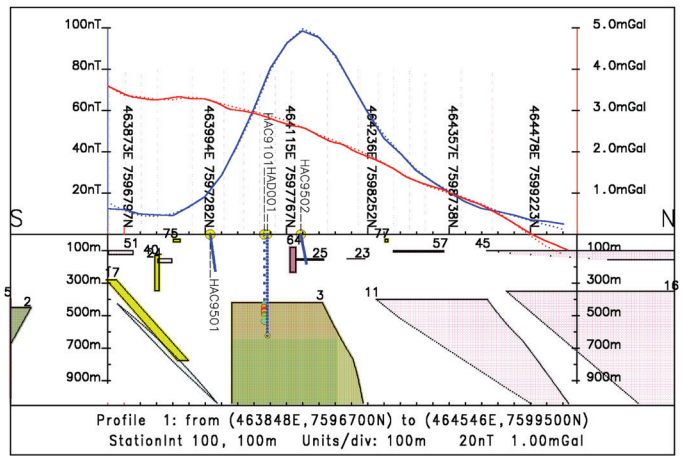

Figure 7.1. *Model cross-section and profiles along line P1.*

was not recorded in the archive. Consequently, coloured circles indicate relative values of down-hole susceptibilities in logarithmic intervals from blue (low) to red (high).

In model displays, the bodies are given colours that are consistent with the background colour at their plot points on

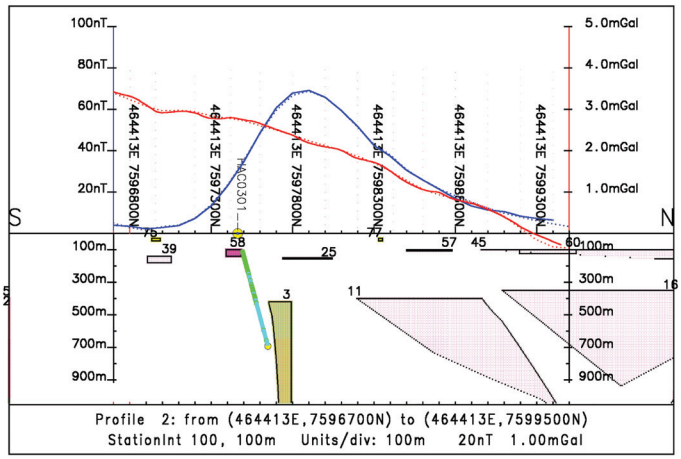

Figure 7.2. *Model cross-section and profiles along line P2.*

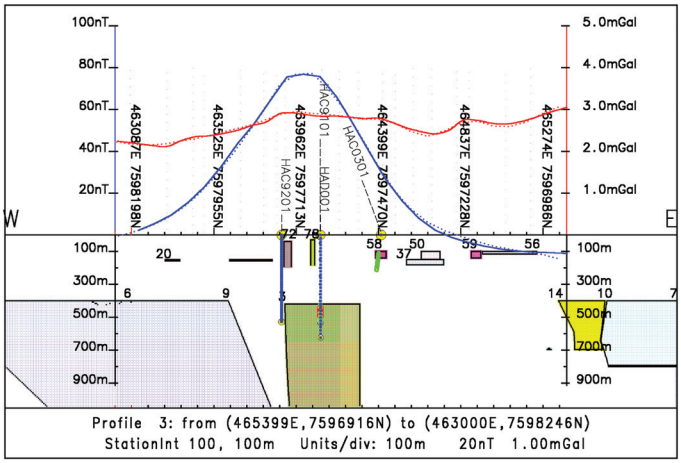

Figure 7.3. *Model cross-section and profiles along line P3.*

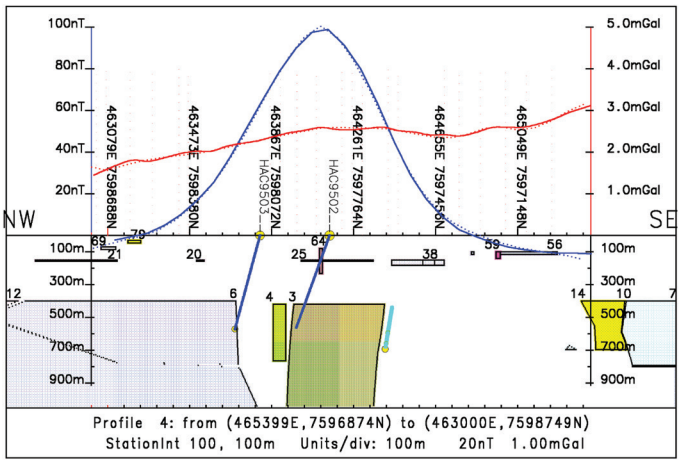

Figure 7.4. *Model cross-section and profiles along line P4.*

the phase/scatter diagram (Figure 8), making the model more readable. For example, yellow-green Body 4 in Figure 6.1 plots on the Magnetite Line (the left-hand limit of the coloured area of the phase/scatter diagram shown in Figure 8), suggesting that for the rocks it represents the elevated density is due only to the inferred magnetite and not to any hematite + sulphide component.

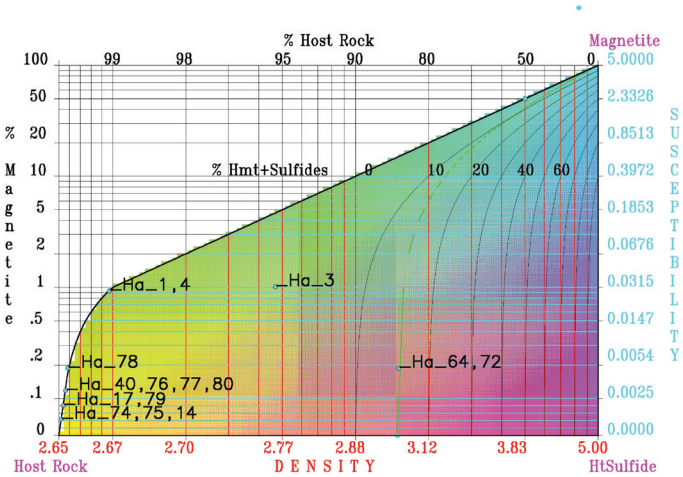

Figure 8. *Combined phase and scatter diagram.*

Green Body 3 plots on the 1 percent apparent magnetite contour and between the zero and 10 percent hematite + sulphide contours. Body 72 in Figure 7.3 and Body 64 in Figure 7.1 depict shallow mafic dykes with 0.2 percent magnetite that plot at the intersection of the dashed green Gabbro Line and the 0.2 percent (horizontal) magnetite contour.

Numerical experiments

As stated, numerical experiments on a given model are easily performed, and, illustrating other possibilities can sometimes lead to improved confidence in a model and even ameliorate the perceived element of risk.

Remanence

An early version of the model was nearing completion when the notion of geological credibility provoked a rethink of the results that were emerging. Figure 9.1 shows the early model with body 3 having a clear southward dip. The magnetic model response (dotted blue) is an accurate simulation of the data (solid blue) indicating that the model is *permitted* by the magnetic data. However, careful attention to the shape of the modelled gravity response for the short wavelength peaks and troughs using small shallow bodies seemed to suggest that the overall gravity

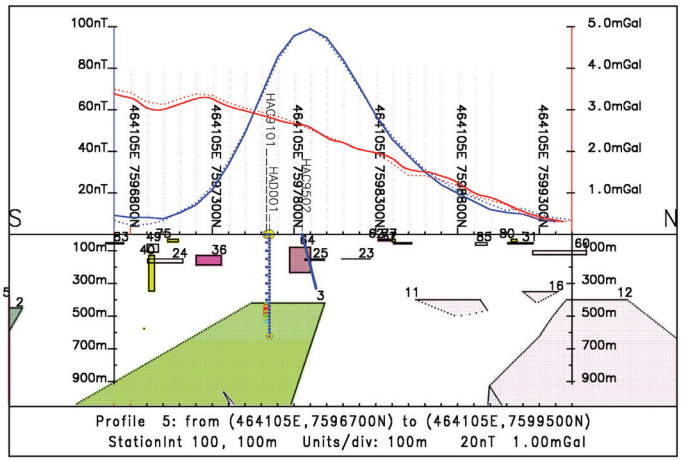

Figure 9.1. *Without magnetic remanence, the source of the magnetic anomaly requires a shallow southward dip and yields a very slight systematic discrepancy in the gravity response.*

model response (dotted red) was systematically too strong to the south and too weak to the north of Body 3 by about 0.1 to 0.2 milligals.

The south side of the magnetic anomaly has a steeper gradient than the north side but the anomaly does not exhibit a low to the south as expected for induced polarization in the southern magnetic hemisphere. The lower geological credibility of the dipping model (and to a lesser extent the gravity discrepancy which could have easily been resolved using a very deep body that altered the gravity gradient) led to the inclusion of a remanent vector (Inc = -7.0, Dec = 180 and Q = 2.2). Further adjustments led to the accurate simulation of the entire magnetic anomaly using a simpler, more believable model in the nature of a vertical cylinder, and for which there was no systematic discrepancy in the gravity. The changes led to the model presented above (Figure 6.1 through Figure 7.4) which was offered as an interpretation of the data.

Introducing the remanent vector required shifting the magnetic body southward some 200 m so that the same body, when given a density contrast of 0.11 gm/cc, also simulates the gravity data. The discovery hole was designed to intersect rocks represented by the now coincident source of the magnetic and gravity anomalies.

As part of the post-discovery analysis, 25 remanence measurements from three early HAD holes became available. Table 1 is a statistical summary of the results. The medians of the measurements are consistent with the remanence vector used in the model.

Density effect, Depth extent, Effect of remanence

Figure 9.2 shows results from three numerical experiments. In the first, the density and susceptibility contrasts of Body 3 were set to zero to yield a model response (red dotted and lowermost blue dotted profiles) showing that this body contributes 90 nT to the magnetic anomaly and less than half a milligal to the local gravity anomaly.

In the second experiment the 900 m depth extent of Body 3 was alternately increased by 200 m and decreased by 200 m, to yield the two (dotted blue) magnetic model responses closest to the magnetic data profile (solid blue). One response is too sharp, the other is too broad. The differences are minor but systematic, and are sufficient to suggest a confidence interval for the depth extent parameter; however, because the bottoms of the model bodies are flat, unlike what is expected geologically, the conclusion would refer to the overall form of the deposit itself.

In the third experiment in this group the remanence vector was removed and the magnetic susceptibility was revised upwards from 0.01 to 0.031 SI notionally to reassign for induction, magnetite otherwise bound up in remanence. The calculated induced anomaly is the dotted blue response with the 200 m northward shift relative to the data peak. Without

Table 1. Statistical summary of remanence data

Parameter	Min	Max	Mean	StdDev	Median
Inclination	-83.	73.	-9.44	48.8	-7.0
Declination	77.	349.	202.	71.3	182.
K-Ratio (Q)	0.30	11.6	3.31	3.1	1.9

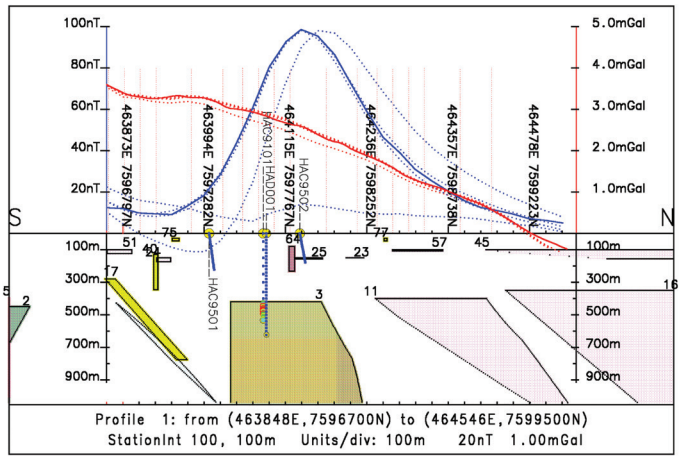

Figure 9.2. *Three numerical experiments illuminate the effects of density, depth extent and remanence.*

remanence, the apparent location of the source would be too far south (and would exhibit a low to the south that would need to be simulated in some way other than the vertical cylinder).

IOCG and gabbro potential

After some initial testing, Body 3, with its inferred 1.0 percent magnetite and 3.7 percent hematite + sulphides, was revised as a dense, non-magnetic, 40 m thick layer with an intrinsic density contrast of 0.7 gm/cc (app%ht + s = 25) resting on a deeper 900 m thick magnetic unit having a density contrast of 0.024 gm/cc (as expected for felsic rock with 1 percent magnetite within non-magnetic felsic country rock). This comprises the IOCG scenario and its response (not shown) simulates, and is therefore permitted by, the data. However, the inferred hematite + sulphide component is an order of magnitude less than what occurs with known IOCG deposits, and with no justification for interpreting prodigious amounts of iron, this mineralisation type was removed from the prognosis.

In a similar experiment, when the volume of Body 3 was assigned a density contrast of 0.37 gm/cc, which is the value expected for mafic rock with one percent magnetite, the magnetic data was simulated as before but the gravity response was too strong by about 0.7 mGal (not shown). Gabbro, even though minor mafic units occur locally, was deemed improbable as a source for the anomaly.

Magnetite vs pyrrhotite

In the original description of the phase/scatter diagram method (Hanneson, 2003), the question of pyrrhotite rather than magnetite as the dominant mineral in the magnetic category was raised, and, an easy but unsatisfactory suggestion was to lump it in with the magnetite and merely tolerate any inaccuracy for want of an alternate solution.

On learning from post-discovery drilling that pyrrhotite is the dominant magnetic mineral, we reset the initial phase/scatter diagram parameters for the magnetic component to 1.25 SI and 4.65 gm/cc suggested for pyrrhotite by Telford *et al.* (1980, p121, 28). The physical properties of Body 3 were not altered, and so the responses still simulated the data; however, the component percentages were translated differently by the *MagGravJ*

algorithm to yield app%mag = 3.56 and app%ht + s = 0.53, to use the same nomenclature, or more correctly now that the magnetic mineral component is known to be pyrrhotite, app%pyrr = 3.56 and app%ht + s = 0.53, where the "s" now refers to non-magnetic sulphides. Visual inspection of pyrrhotite in drill core is broadly consistent with this estimate.

Conclusion

We have sought to tell the Havieron story from first-hand experience – up to the 2018 discovery hole (HAD001). Some post-discovery information is provided where it shows, for example, that the assumed remanence was confirmed and because it supports the methodology that was applied.

The first of the historic holes HAC9101, which seems to have been directed into the magnetic peak, had the potential to make the discovery had it been drilled deeper. A similar comment may also pertain to the second hole, HAC9201, but how these holes were designed is unknown to the writers. The remaining four historic holes seem to have been designed based on a different philosophy, or perhaps a different modelling algorithm, but they were ineffective- missing what the present model deems to be the primary target.

Remanence required shifting the magnetic source and provided a more concise model body, so that by adding mass, the same body could also be used to simulate the source of both the magnetic and gravity anomalies.

We believe HAD001 succeeded where HAC9101 failed because of improved geophysical analysis and geological determination.

Acknowledgements

We thank Newcrest Mining personnel, who first recognised the potential of the area, for permission to publish. Thanks also to Greatland for permission to publish. We also thank Bernie Stockill of Daishsat Surveys Ltd. for putting the authors in contact and Ken Cross for suggesting several improvements to the manuscript.

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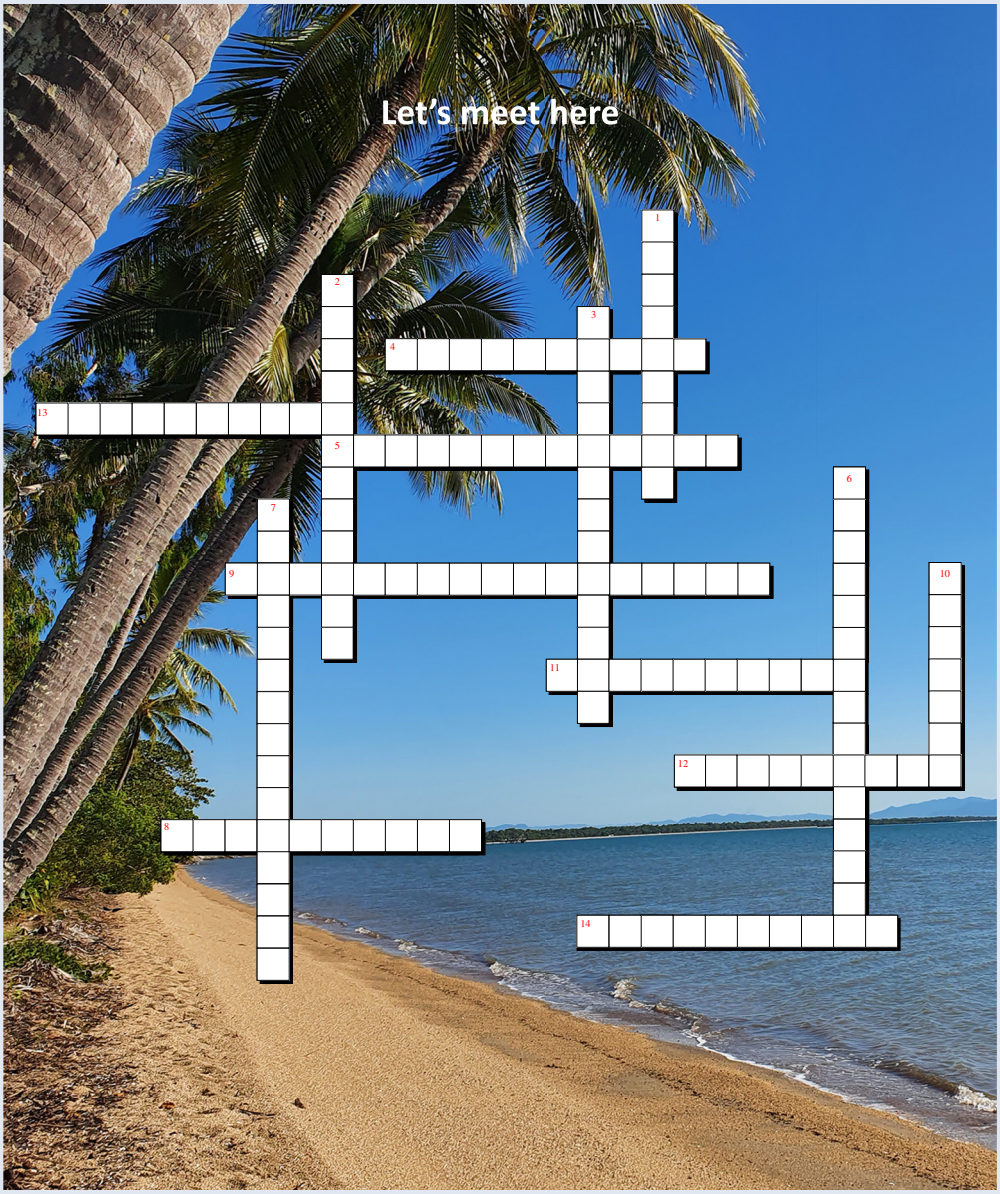
Preview crossword #21



Across	Down
4 Divergent tectonic boundary between the North American and Eurasian plates (6, 4)	**1** A series of underground cascading waterfalls (4, 5)
5 The river of five colours (4, 9)	**2** Sailing stones (3, 4, 5)
9 Geological depression that has resulted from the divergence of three tectonic plates in the Horn of Africa. Nice acid pools (7, 10)	**3** Giant marine sinkhole off the coast of Belize (5, 4, 4)
8 The seven giants	**6** The eye of Africa (6, 9)
11 Iron oxide-tainted plume of saltwater flowing from the tongue of Taylor Glacier (5, 5)	**7** Terraces in Pamukkale (10, 5)
12 Rainbow Mountain	**10** Aside from some microorganisms and algae, this saltwater lake is completely devoid of life (4, 3)
13 Spooky, haunted suicide forest	
14 Large geoglyphs etched into the Earth's surface in Peru (5, 5)	

Play to win!!

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

Good luck!

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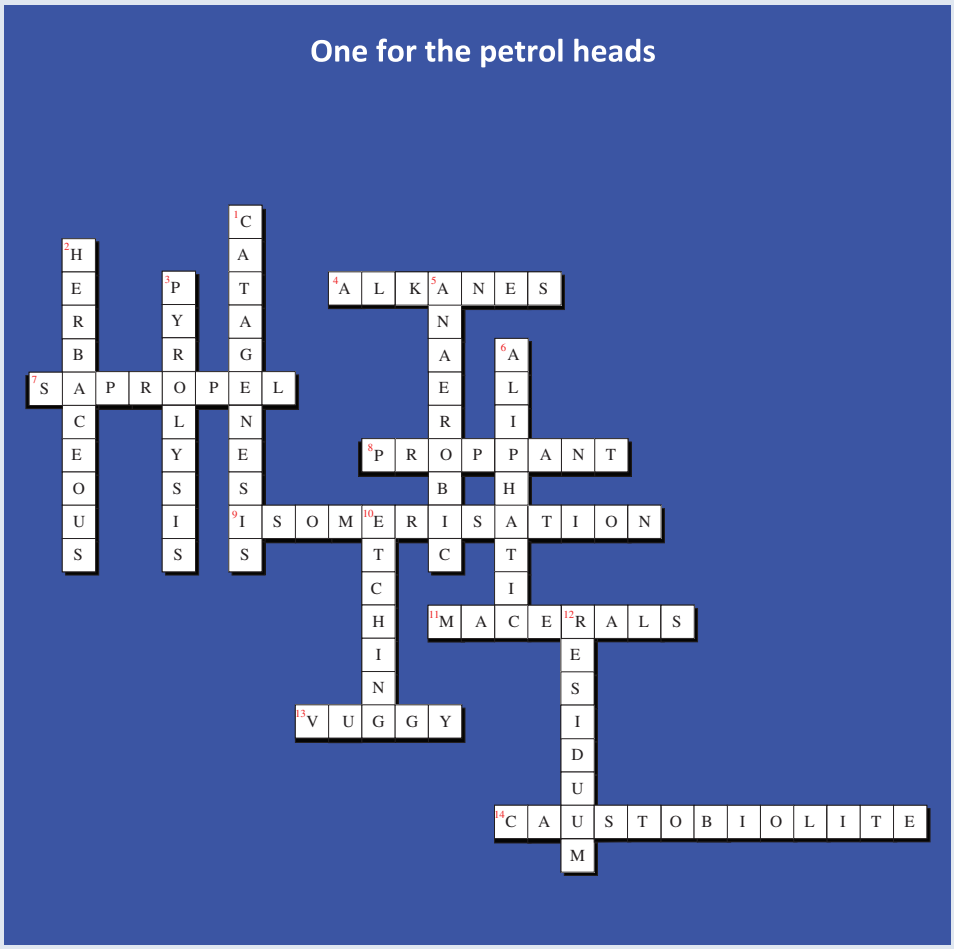

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Application for Active & Associate Membership 2022

INSTRUCTIONS FOR APPLICANTS

1. Determine the membership level you wish to apply for, according to the eligibility criteria outlined in Section 2.
2. Fill out the application form. Note that applicants for Active Membership must nominate a proposer and a seconder who are Active Members of ASEG. Under exceptional circumstances the Federal Executive Committee may waive these requirements.
3. 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.

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Surname | Date of Birth
Given Names | Mr / Mrs / Miss / Ms / Other (list)
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
- ❑ 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.

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

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

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

Section 5. Membership of other societies

Australian:
❑ Aus IMM Grade _____ ❑ AIG Grade _____ ❑ GSA Grade _____ ❑ PESA Grade _____
International:
❑ AAPG Grade _____ ❑ EAGE Grade _____ ❑ SEG Grade _____ ❑ SPE Grade _____
❑ Others _____

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Please complete this section for the ASEG Membership database.

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Type of Business:
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❑ Solid Earth Geophysics ❑ Archaeology/ Marine Salvaging ❑ Computer/ Data Processing ❑ Other_____

Section 7. Membership grades and rates

❑ Active/Associate (Australia) - $182.00	❑ Active/Associate 5 Year Membership (Australia) - $910.00
❑ Active/Associate (Group IV Countries) - $165.50	❑ Active/Associate 5 Year Membership (Group IV Countries) - $827.50
❑ Active/Associate (Group III Countries) - $49.70	❑ Active/Associate 5 Year Membership (Group III Countries) - $248.50
❑ Active/Associate (Group I & II Countries) - $18.20	❑ Active/Associate 5 Year Membership (Group I & II Countries) - $91.00
❑ Associate-Graduate (Australia) - $91.00	

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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** ❑ **No**

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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.

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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.
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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.

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   Eligibility for Student Membership shall terminate at the close of the calendar year in which the Student Member ceases their graduate or undergraduate studies.

   Student Membership must be renewed annually.

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2. Fill out the application form, ensuring that your supervisor signs Section 2.

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 Signature

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❑ **Yes** ❑ **No**

Section 5 Declaration

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

Signature: _____ Date: _____

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5. A Member 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 Member shall refrain from using unfair means to win professional advancement, and avoid injuring unfairly or maliciously, directly or indirectly, another geophysicist's professional reputation, business or chances of employment.
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1–3	Diggers and Dealers https://www.diggersndealers.com.au/	Kalgoorlie	Australia
15–19	12th International Kimberlite Conference https://12ikc.ca/	Yellowknife	Canada
28 Aug–02 Sept	International Meeting for Applied Geoscience & Energy (SEG | AAPG IMAGE 2022) https://imageevent.org/2022/Save-the-Date	Houston	USA
September	**2022**		
18–22	Near Surface Geoscience Conference & Exhibition 2022 https://eage.eventsair.com/nsg2022	Belgrade	Serbia/Virtual
21–23	The 46th IPA Convention and Exhibition https://convex.ipa.or.id/	Jakarta	Indonesia
27–29	AIG Symposium: Structural Geology and Resources 2022 https://www.aig.org.au/events/aig-symposium-structural-geology-and-resources-2022/	Kalgoorlie	Australia
26–30	Australian and New Zealand Geomorphology Group Conference https://www.anzgg.org/conferences	Alice Springs	Australia
October	**2022**		
24	Asia Pacific Meeting on Near Surface Geoscience & Engineering https://eage.eventsair.com/5th-asia-pacific-meeting-on-near-surface-geoscience-engineering/abstract-submission	Taipei	Taiwan
26–29	Summit on drone geophysics 2022 https://seg.org/Events/Summit-on-Drone-Geophysics-2022		Virtual
November	**2022**		
28	SAGA 2022 https://m.facebook.com/events/sun-city-conference-centre/saga-2022-17th-biennial-conference-exhibition/1846354198894057/	Sun City	South Africa
28–29	Asia Petroleum Geoscience Conference and Exhibition (APGCE) https://icep.com.my/apgce	Kuala Lumpur	Malaysia
28–30	Sub 22 https://research.csiro.au/dei/sub22/	Adelaide	Australia
February	**2023**		
21–23	2nd AAPG/EAGE Papua New Guinea Petroleum Conference & Exhibition https://www.aapg.org/global/asiapacific/events/workshop/articleid/51699/1st-aapg-eage-png-petroleum-geoscience-conference-exhibition	Port Moresby	Papua New Guinea
March	**2023**		
1–3	The International Petroleum Technology Conference (IPTC) https://2023.iptcnet.org/	Bangkok	Thailand
13–18	Australasian Exploration Geoscience Conference (AEGC 2023) https://2023.aegc.com.au/	Brisbane	Australia
June	**2023**		
5–8	84th EAGE Annual Conference & Exhibition https://eageannual.org/	Vienna	Austria
September	**2023**		
4–8	8th International Airborne Electromagnetics Workshop (AEM 2023) aemconference@theassociationspecialists.com.au	Fitzroy Island	Australia

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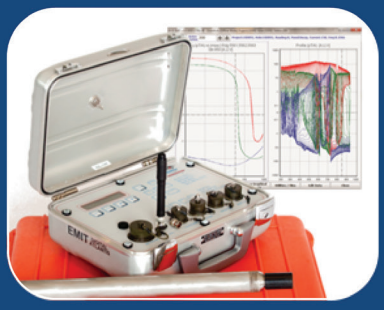

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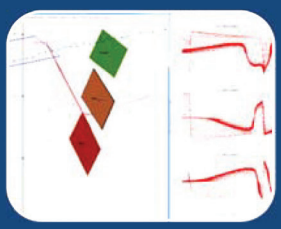

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