Geotourism in the West
A Trail Through Geology and Flowering Native Plants

Inside this AIG News...

From Your President • Institute News • Membership Updates • Registered Professional Geoscientists Applications • Climate Change: Natural cycles and Unnatural Forcing • Geoscientist Employment Recovery Stalled • A Mob of Geologists and Friends on a Geotrail in the West • Long-term Forecast of Australia’s Mineral Production and Revenue - The Outlook for Gold: 2017-2057 • Good Vibrations for Passive Seismic • A Short Report on the NExUS Reunion Workshop • Smart Use of Smart Technology and Data • South Australia Exploration & Mining Conference 2017 • International Mining Geology Conference • H₂O Insight a Critical Resource • 2017 Tenth International Mining Geology Conference • New Rock for the National Rock Garden • AIG Council & AIG News • Events Calendar • And much more...
On behalf of the Conference Organising Committee, we would like to invite you to attend the First Australasian Exploration Geoscience Conference in Sydney, to be held from February 18-21 2018. The event will be jointly hosted by ASEG, PESA and AIG. The theme of the meeting is Exploration, Innovation and Integration.

The Conference will also incorporate the Eastern Australia Basins Symposium normally managed by PESA and the rolling 18 months Conference of ASEG and will be home to the highest quality technical program and Exhibition that members will have grown accustomed to from our three organisations.

Discover Sydney, Australia’s famous harbour city and capital of New South Wales. Plan your Sydney visit with beautiful sundrenched beaches and much more.

See you in Sydney in 2018!

Max Williamson and Mark Lackie (Co-Chairs)
Inside this AIG news...

AIG News Issue 130 · December 2017

4 From Your President

6 Institute News

Snippets
Membership Updates
Registered Professional Geoscientists Applications
Education News
NSW Branch Report

20 Climate Change: Natural Cycles and Unnatural Forcing

28 Geoscientist Employment Recovery Stalled

30 A Mob of Geologists and Friends on a Geotrail in the West

33 Long-term Forecast of Australia’s Mineral Production and Revenue

The Outlook for Gold: 2017-2057

37 Good Vibrations for Passive Seismic

42 A Short Report on the NExUS Reunion Workshop

46 Smart Use of Smart Technology and Data

49 South Australia Exploration & Mining Conference 2017

50 International Mining Geology Conference

51 H₂O Insight a Critical Resource

53 2017 Tenth International Mining Geology Conference

54 New Rock for the National Rock Garden

55 Events Calendar

56 AIG Council & AIG News

AIG Secretariat
Contact: Doug Wiles
Ph: (02) 9431 8662
Fax: (02) 9431 8677
Email: aig@aig.org.au

The Association Specialists (TAS)
PO Box 576
Crows Nest NSW 1585
Australia
The end of another year is looming. Geoscience unemployment during 2017 as measured by AIG’s quarterly surveys has shown a steady improvement since June 2016, although the rate at the end of September this year was unchanged from the March quarter. There is hope in latest Mineral Exploration data from the Australian Bureau of Statistics which revealed that exploration expenditure increased by 6.6% to $428.5 million in the June quarter. Copper was the biggest improver of the commodities being explored for in Australia, with a 73% increase or $39.7M (Australian Mining September 5, 2017). There is also positive news from the finance sector predicting the industry will start the 2018 in a climate of emerging buoyant market conditions for resource equities.

Two major events are on the radar in 2018; AEGC2018 in February and AGCC in October. AIG is proud to be joining the Australian Society of Exploration Geophysicists (ASEG) and the Petroleum Exploration Society of Australia (PESA) to present the first Australasian Exploration Geoscience Conference (AEGC2018) to be held from the 18th to 21st February 2018 at the International Conference Centre in Darling Harbour, Sydney. I must congratulate the joint chairs Max Williamson and Mark Lackie and their committee for their efforts in organising what will be Australia’s premier event showcasing exploration geoscience.

Work on the technical program is advanced and will allow for the normal plenary and five
concurrent sessions. Now it is up to you as members of AIG to support the conference. There are some excellent workshops attached to the conference. AEGC have all the conference, venue and registration information on their website at www.aegc2018.com.au.

If you are familiar with the extraordinary amount of work involved in organising such an event then you won’t be surprised that a call has gone out to AIG members interested in joining the conference organising committee for the 2019 AEGC. The second AEGC is going to be held in Perth so any Perth residents keen to assist contact the AIG WA Branch.

The inaugural Australian Geoscience Council Convention (AGCC2018) is being held 14th to 18th October at the Adelaide Convention Centre in South Australia. The convention will focus on the Asia Pacific region and is supported by all eight Member Organisations of the Australian Geoscience Council. The theme is “Big Issues and Ideas in Geoscience”. Early bird registration is open. Visit the AGCC website at www.agcc.org.au for further information.

The AIG has received the first in a series of reports on the long-term forecast of Australia’s mineral production and revenue – “The Outlook for Gold: 2017-2057” by Richard Schodde. The report is available for download on the AIG website. The study forecasts the likely number of mines, production, revenues and employment out to 2057 for this vital sector of Australia’s economy.

The study concludes that in the medium to longer term, most production will come from new discoveries. In 15 years’ time (i.e. by 2032) over half of Australia’s gold production will come from mines that are yet to be discovered. Of concern is the fact that the weighted average delay between discovery and development is 13 years. Consequently, government and industry need to support exploration today otherwise we run a real risk of a significant supply disruption in the medium term.

When the three components (existing mines, new projects and exploration success) are added together the overall result is that Australia’s gold production is forecast to fall by half over the next forty years – from 9.7 Moz pa in 2017 to 4.7 Moz pa by 2057. Over the same time, revenues are expected to fall from $15 billion to $7.3 billion pa. The number of active mines will decline from 71 to 47, and the number of workers directly employed will drop from 28,000 to 7,300. Sobering figures! Richard Schodde is scheduled to complete forecasting of the remaining seven commodities using the methodologies for gold shortly.

On behalf of the Federal Council I would like to wish everyone a pleasant Christmas break, thoughts go out to those rostered on over the Christmas period, and a prosperous New Year.

Mike Erceg
President

---

**ROCK-EX Enterprises Pty Ltd**

ACN 010 515 652

**Survey Controlled Geological Mapping Course – The Anaconda Mapping Technique**

Twin Hills Project, Texas South Queensland, early February 2018

Rock-Ex Enterprises PL announces that a course using the “Anaconda Mapping Method” will be held in February 2018 at Twin Hills, Texas, South Queensland. This course will be conducted with the assistance the project owner MRV Metals Ltd, subsidiary of Moreton Resources Ltd. Graham Rolfe BSc MSc FAIG RPGeo was immersed in the “Anaconda Mapping Technique” at Carr Fork, Utah and Los Pelambres, Chile while employed by Anaconda in Australia in the 70-80’s. Graham has taught this technique in on the job mentoring in PNG & Queensland and formal courses at operating mines in Northern Territory & Western Australia.

The mapping technique involves the direct measurement of the geological features in the field together with direct plotting of the data to scale. The procedures are an adaption of the method originally developed by Reno Sales at Butte, Montana in the formative stages of the Anaconda Copper Company. Until the 1980’s, Butte came to be known as one of the best postgraduate “schools” in the United States. The techniques have been refined and developed to suite the needs of modern geological mapping. To quote McKinstry from the section on “Geological Mapping” in his book “Mining Geology”, “A map is a record of geological fact in their correct space relations – facts be it noted not theory. There must always be sharp distinction between observation and inference.”

For facts read recorded observations, which have to be plotted accurately not sketched to develop a 3 dimensional model.

For details contact Graham Rolfe at Phone: +61 418874881 Email: rockexenterprises@gmail.com Web: www.aredcedar.com
OPTIRO Professional Development Courses:
Using real-life data-sets

The Optiro courses give you the knowledge, skills and tools to confidently and efficiently work on your own.

We believe that the best way for you to learn, is to take you step-by-step through the processes - using real-life data sets - to ensure you gain the practical experience you need to immediately put what you have learned into practice when back at work.

---

**Essential Excel Skills for Geologists**

key tips, tricks, tools and templates to save you time and effort – and make your work look great!

**Sampling Theory and Best Practice**

understanding the key issues - how to optimise the frequency, size and the nature of the sample, and quantifying the errors associated with the sample. Practice of how the sample is taken, delimited, reduced, transported and prepared; and the theory of how to measure the errors associated with our sampling protocols, and to optimise those protocols.

**Getting The Most Out of QAQC Data**

covers the QAQC life cycle: planning types and frequencies of QAQC data to be collected; mechanics of collecting, transporting and submitting samples; analyses for systematic and trending errors; what is and what isn’t a failure; making changes in the resource database.

**Reconciliation - getting it right the first time**

all aspects of reconciliation process, including key data to be collected, importance of unbiased measurement of volumes, tonnages and grades (among other metrics). How to map out the production data flow and discuss the important measures of performance – using real-life data.

**Resource Estimation and Evaluation**

uses a real-life data set to cover the entire resource estimation and evaluation cycle and its requirements - from data collection and quality assurance through to classification. The 5th day of the course consolidates all that you have learned by taking you step-by-step through a check-list of the resource estimation and evaluation processes, and gives you the opportunity to bring your own data along to discuss and get advice on.

**Recoverable Resources: getting to the High Grade**

demystifies and solves one of the great paradoxes of project evaluation – how to do more with less information. How to assess the recoverable resources for project valuation when the relative drill spacing does not provide sufficient coverage for the direct estimation into small blocks or selective mining units (SMU) required at the production stage.

**Report Writing for Geologists and Engineers**

plan your document; write summaries and conclusions; the essential grammar rules; styles and formatting; key features and time-saving tips in Word; review your document and review others’ documents; write the references, abbreviations, acronyms, glossaries and the appendices; write an accurate report that grabs your readers’ attention!

**Mining & Geology Fundamentals for Non-Miners**

courses has been designed for non-miners working, investing, financing or associated with the mining industry – non-miners working, investing, financing or associated with the mining industry – who need to understand the key fundamentals about the mine cycle, from exploration through to mine closure.

**Understanding Mineral Processing – metallurgy fundamentals for non-metallurgists**

courses has been designed for engineers, geologists, mineralogists, environmental scientists, plant operators, marketers, financial advisors and anyone who either deals with mineral processing or needs a better understanding of the principles of extractive metallurgy. It gives an overview of mineral processing – from how metal is geologically detected, extracted from rocks and minerals to the final metal product.

**Surpac Geology Fundamentals**

courses use a real-life data-set to cover the basics of using Surpac as a geologist. You learn about the fundamental concepts of Surpac’s interface, graphics environment, geology database, string files, DTM surfaces, solids modelling (wireframing), block modelling and macros.

**Resource Estimation and Evaluation with Surpac**

courses use a real-life data-set to cover the resource estimation and evaluation cycle and its requirements - from data collection and quality assurance through to classification, using Surpac. All attendees receive a free copy of Optiro’s OREpack Declus Optimiser, and FREE 30 day trial of one of these OREpack modules: Kriging Neighbourhood Analysis; Localised Uniform Conditioning; Drillhole Spacing Optimiser; or Estimation Manager. Bring your data and Rowdy will set it up to ensure you’re able to use the modules by the end of the course.

**Corporate Compliance in Resource and Reserve Reporting**

courses have been designed for successful and compliant reporting for the Australian Market. Guidelines and standards for ASX-listed companies wishing to report Exploration Results, Mineral Resources and Ore Reserves to the public. Summarises key issues for reporting (2012 JORC Code, ASX Listing Rules) and presents the formula for achieving maximum impact in market reporting while meeting changing compliance benchmarks.

---

You can register online at:

www.optiro.com/services/training/
New Zealand geology book launched (and its free!)

FREE E-BOOK LAUNCHED: NEW ZEALAND GEOLOGY - AN ILLUSTRATED GUIDE

By the late Peter Ballance, 397 pages. This was his 10 year retirement project. The book provides a magnificently illustrated guide for the layperson and student and is published and sponsored by the Geoscience Society of NZ.

It has been illustrated with colour maps and diagrams by Geoclubber Louise Cotterall and readied for e-publication by Geoclubbers Jill Kenny and Bruce Hayward. Download it for a great holiday read and use the various regional chapters as you travel around the country.

Download at...


INTRAW Video now available

The video "INTRAW – Discover The Project" is now available. The AIG is a third party partner for this EU-funded Horizon 2020 project, and the video will explain the purpose and significance of the project.

https://tinyurl.com/aignews130-intrawvideo or find out more at http://www.intraw.eu

SMEDG has been a part of the Mineral Exploration industry in NSW since October 1972. Set up as a group of enthusiastic geoscientists to discuss techniques and concepts of mineral exploration on an informal basis.

Everyone is most welcome, especially students starting their careers and other professionals seeking to learn and update their skills and networks.

Presenter Awards at the recent Mines & Wines DISCOVERIES in the TASMANIDES at Orange

Stay in-touch at www.smedg.org.au for up-coming events
AEGC 2018 keynote speakers announced

HALLBERG 1:25,000 GEOLOGICAL MAPPING GIS DATASETS

Compilation of Hallberg mapping as seamless GIS datasets is in progress, allowing the mapping to be viewed in its overall context and integrated with other datasets (geophysical, geochemical etc). The database is unique, incorporating extensive petrographic and geochemical support and offering consistent mapping carried out by one person.

For more information or to register visit http://aegc2018.com.au/
Institute News

You are invited to submit an abstract for AGCC 2018. The submission form is now open and will be available until the cut-off date of 16 June 2018 on the convention’s official website.

Please note that individuals will only be permitted to deliver one oral presentation (unless they are a plenary or invited keynote speaker), but they may co-author multiple oral presentations and may give multiple poster presentations. Full details on abstract submission requirements and terms available on the website noted below.

AGCC 2018 is supported by all eight Member Organisations of the Australian Geoscience Council, and is proudly sponsored by Geoscience Australia.

AGCC2018 abstract submission now open!

You are invited to submit an abstract for AGCC 2018. The submission form is now open and will be available until the cut-off date of 16 June 2018 on the convention’s official website.

Please note that individuals will only be permitted to deliver one oral presentation (unless they are a plenary or invited keynote speaker), but they may co-author multiple oral presentations and may give multiple poster presentations. Full details on abstract submission requirements and terms available on the website noted below.

AGCC 2018 is supported by all eight Member Organisations of the Australian Geoscience Council, and is proudly sponsored by Geoscience Australia.

Professional Issues Subcommittee Survey of Members

We need your input.

The Professional Issues Subcommittee was formed by Council with a mandate to create a "Road Map" to improve competency and increase professionalism (and the community perception of professionalism) of geoscientists.

We are asking you to complete this short on-line survey. Your answers and comments will help the Subcommittee finalise its recommendations for the Roadmap*.

Sincerely,
Wayne Spilsbury - Chair, Professional Issues Subcommittee
Australian Institute of Geoscientists

This survey is open to AIG members only till 15th January 2018. An email with instructions to the survey has been sent to your email directly.
AIG Mentoring Program
An initiative of the National Graduate Group for BSc/MSc/PhD students and Early career geoscientists (<5 years experience)

Our 2018 program is planned to start early in 2018 but you can express your interest now!

AIG Mentoring Program

Our program connects undergraduate students, honours, MSc and PhD candidates, and early career geoscientists (0-5yrs) with experienced industry professionals. The aim is to build our community by providing emerging geoscientists with connections, knowledge and experiences from knowledgeable professionals who are looking to give back. Our professionals provide practical advice and guidance on a number of areas of interest in regards to beginning and maintaining a healthy career within geoscience.

Program details
• The program is free for both mentees and mentors!
• During the program mentees and mentors meet regularly to discuss and work on their mentoring program objectives.
• In addition to mentor-mentee meetings, the program includes three formal events:
  - Kick-Off Event – May/June
  - Mid-term Social Event
  - Final Event/Program finish - Oct
• Programs are currently running in WA, VIC and QLD urban centres.
• For people located outside urban areas or in a state without an active program, the Distance Program is for you. This program uses online technology to facilitate mentoring, regardless of location.

Join us!

Fill out and submit an expression of interest form for the program you’d like to join via www.aig.org.au/mentoring-program/. Note the deadline for submissions is 1 April 2018.

Participants will be notified of their acceptance into the program in May 2018.

AIG membership is a prerequisite to participate in the mentoring program as a mentor or as a mentee. If you are not already an AIG member then this is a great reason to join up – sign up for membership online at www.aig.org.au/membership/.

Call for state champions

If you are passionate about giving back and want to make an impact in your community, we are seeking mentoring program state champions who have >15-20 yr practical industry experience to lead dynamic mentoring committees in NSW/ACT, SA/NT and TAS. You will help connect our program across the nation by joining our network of established programs in WA, VIC and QLD.

Any questions? For more details about the AIG Mentoring Program please contact us at aimentoringprogram-nationalchair@aig.org.au.

Whether you are a mentee or mentor – Express interest now!
Junior Minerals Exploration Incentive

The legislation introducing the new Junior Minerals Exploration Incentive (JMEI) has been introduced into Federal Parliament this week – Treasury Laws Amendment (Junior Minerals Exploration Incentive) Bill 2017.

The Bill amends the tax law to replace the former Exploration Development Incentive (EDI) with the JMEI. Like the EDI, the JMEI provides a tax incentive to invest in small minerals exploration companies undertaking greenfields minerals exploration in Australia. Australian resident investors of these companies receive a tax incentive where the companies choose to give up a portion of their tax losses relating to their exploration expenditure in an income year.

Unlike the EDI, under the JMEI:

• eligibility for the incentive is limited to investors that purchase newly issued shares; and
• the incentive is allocated between eligible exploration companies on a first come, first served process (subject to integrity requirements) until the annual cap has been reached.

The scheme applies from 1 July 2017 until 30 June 2021, with total credits limited to $100 million. There is a cap on the amount of credits that may be allocated to an entity of five per cent of the total amount available for each year.

For full details on the new JMEI, see the Explanatory Notes on the Bill. It is expected that this will be passed before the end of the year.

AIG hand lenses are available to members through the Institute’s publications on-line shop. The hand lenses provide approximately 10x magnification across a wide, 25mm field of view and feature a bright, white LED light powered by an internal, replaceable battery which helps to provide a great view of samples. The hand lenses also have a lanyard attachment and come in a storage box with a battery removal tool.

National Graduate Group Update 2017

2017 has been a busy year for the AIG National Graduate Group. We have had active mentoring programs across three states QLD, WA and VIC. As well as the introduction of the Distance Program. We have built up AIG NGC representation across most states in Australia. NGG has been represented at major conferences throughout the year ASEG-PESA-AIG Conference, AusIMM 10th International Mining Conference and also been involved with the National Exploration Undercover School.

The National Graduate Group (NGG) is an initiative by the Australian Institute of Geoscientists (AIG) to better communicate with its graduate and student members. Graduate members of the AIG were nominated by each state, who now sit on the National Graduate Committee (NGC) and are responsible for generating and implementing NGG initiatives to improve communication and engagement by:

- Increasing student and graduate membership and assist in the transition to professional membership;
- Promoting interaction between all members;
- Providing progressive communication to student and graduate members; and
- Encouraging continued education and training

2018 is shaping up to be another fantastic year with events organised across the country and mentoring program to be kicked off in another couple more states plus the distance program. If you would like to get involved for 2018 please get in contact with Genna on gennamcdonagh@gmail.com or follow us on Facebook AIG National Graduate Group.

Joshua Trestrail, Genna McDonagh, Josh Leigh, Ivana Gear.

The Call for #RFG2018 Abstracts is officially open!

Resources for Future Generations 2018 (RFG2018) will showcase advances in earth science, societal and technical innovation, and education that can change the course of history.

Docked in six themes — Energy, Minerals, Water, the Earth, Education & Knowledge, Communities & Resources — RFG2018 will showcase advances in earth sciences, education, and innovation that can change the course of history.

Present your work to an international cohort of scientists, policy-makers, innovators, educators, industry leaders, and visionaries who are committed to creating a sustainable future.

Be part of the sustainable future. Submit an abstract at https://goo.gl/8ygFDi Abstracts will be accepted until January 15, 2018. AIG is a partner organization for this conference.
Membership Update
A warm welcome to AIG’s new members

NEW/UPGRADES SEPTEMBER 2017

STUDENTS  BENSEMANN, Renee  •  JONES, Emily-Rose  •  MITCHELL, Jordan  •  MURUGES, Shastri
•  PARK, Maxine  •  ROSS, Zachary  •  SARIMAN, Tamara  •  SCULETT-TEAN, Grace  •  SMYTHE, Jason  •  TEH,
Matthew Shuan-Zi  •  THOMAS, Darren  •  WELSH, Owen  •  WISE, Lucas  •

GRADUATE  BEVERIDGE, Tegan  •  BLUNDELL, Casey  •  CALEO, Thomas  •  CASINADER, Eloise  •  CLARK, Brianna
•  ECKERT, Nicholas  •  EDDY, David  •  FYFFE, Matthew  •  HOLT, Peter  •  KAHN, Elliot  •  LOGAN, Mark  •  SYMONS,
Damon  •  WALSH, Jessica  •  WOLFRAM, Lauren  •

MEMBER  BLYTHMAN, Robert  •  BUER, Adrian  •  CLEETON, Anthony  •  COOK, Christopher  •  CORTES
MANZO, Omar  •  DINES, Alison  •  DUERDEN, Peter  •  EENSAAR, Tonis  •  FARRELL, Rhianna  •  FERREIRA,
Marlon  •  GAUGHAN, Maree  •  GAWLINSKI, Stefan  •  GIANNFRIDDO, Charles  •  HORNABROOK, Angus  •  JAMES,
Adam  •  LEONARD, William  •  LYNCH-SLAUNTON, Mark  •  MAYCOCK, Shayne  •  MCINTYRE, Christine  •  MCKAY,
David  •  MOROZOV, Alexandr  •  MURPHY, Dominic  •  MUZYKA, Ivan  •  NGANTS, Paul  •  NICHOLLS, Hamish
•  RAO, Asha  •  RIDGWAY, David  •  ROCCA, Frank  •  THOMPSON, Alan  •  TOLLAND, Gayle  •  WARRINNER,
Stephen  •  WINTERBOTHAM, David

FELLOW  BAILEY, Andrew  •  DE LA MARE, Graham  •  LOVE, Michael  •  TRIPP, Gerard

NEW/UPGRADES NOVEMBER 2017

STUDENTS  BILLINGS, Phillip Mark  •  BROWN, Terrence Robert  •  CARMONA, Dina  •  CARY, Francesca  •  DALAL, Pariki  •  FONG, Andrew Andrew Lee  •  GATT, Elysa
•  GRIGSON, John Luis  •  IRADUKUNDA, Tony  •  JAMES, Darcy  •  LIEPA, Elizabeth Austra Gaminele  •  MORRISON,
Jessica Louise  •  ROY, Sheeren  •  RUDUVO, Loveness Rumbidzai  •  SPENCE, Joshua Stanley  •  SUGALAN, Arigene
•  SYLVESTER, Ethan  •  VULETA, Sophie

GRADUATE  CULVERWELL, Shane  •  EVANS, David Peter  •  FLETCHER, Patrick Thomas  •  GEAR, Ivana
GUERINI, Rick Silva  •  HODGSON, Samantha Buay  •  HORRADO, Christian Leo  •  LUTTER, Timothy John  •  STREATER, Patrick Joseph  •  SWANN, Lauren Paige  •  WALLACE, Madeline  •  WAWRYK, Michael  •  WILDING, Bradley James

MEMBER  ARMIT, Robin John  •  BARBIER, Vincent Louise Michel  •  BEAL, Vrnickas  •  BEST, Fiona  •  BRAUD, Xavier Jacques Emmanuel  •  BRIDGES, Jed Leon  •  BURKE, Sean  •  CAMPBELL, Jamie  •  DEAN, Rodney Arthur  •  DIALLO, Badara Aliou  •  FELL, Paul Alfred  •  FORGETTE, Michelle Marie  •  GAMBLE, Steven Allen  •  GREGORY, Russell Kim  •  GRIESSMANN, Martin  •  GUYER, Lara End
HESFORD, Christopher  •  HOBBS, Jacqueline Marie  •  HUGH, Melinda Joy  •  H WITH, Peter Henry  •  JEMMETT-
PAGE, Alekhi  •  KE, Sean Xusheng  •  KHAN, Mohammed Akram Ullah  •  KOEGELENBERG, Petrus Johannes  •  KUHN,
Stephen  •  LANG, Brandon  •  LANGLANDS, Ian Stuart  •  LLAGAS, Mark Lester Flores  •  MARSH, Jonathan William
•  MCGILL, Allan  •  MCINTYRE, Daniel  •  MILNER, Ross Mark  •  NASH, Richard Michael Lewis  •  O’MALLEY, Thomas James  •  OUEDRAOGO, Didier Soutongnoma  •  ROBINSON, Simon  •  ROLFE, Matthew James  •  STEWART, Alistair John  •  TRANTER, Alana Catherine  •  TURNBULL, Dean George  •  TURNER, Emma Louise  •  VAN KAL, Shaun Michael
•  WILLIAMS, Jamie Matthew  •  WILLIAMS, Karen Marie

Fellow  KIRWIN, Douglas John

RPGeo Applications

CANDIDATES APPROVED BY AIG COUNCIL IN NOVEMBER, 2017

MR RENE STERK of Dunedin, New Zealand, in the fields of Mineral Exploration and Mining.

CANDIDATES APPROVED BY AIG COUNCIL IN SEPTEMBER, 2017

MR RHYS DAVIES of Camp Mountain, Queensland, in the field of Mineral Exploration.

DR TARIQ RAHMAN of Carseldine, Queensland, in the fields of Geophysics and Geotechnical & Engineering.

NEW CANDIDATES PUBLISHED FOR PEER REVIEW BY THE MEMBERS OF THE AIG

MR PETER DUERDEN of Orange, New South Wales, is seeking registration in the field of Mineral Exploration.

Optiro

Specialist resources advisory and consulting services group

Our expertise and fresh thinking ensures strong sustainable relationships with our clients

TALK WITH CONFIDENCE TO OPTIRO TODAY
WE LOOK FORWARD TO TALKING WITH YOU

Ian Glacken – Director of Geology
BSc (Hons), MSc (Min. Geol), MSc (Geostatistics), FAusIMM(CP), CEng, FAIG
iglacken@optiro.com
Level 1, 16 Ord St, West Perth 6005
T: +61 8 9215 0000
www.optiro.com

iglacken@optiro.com
Education Report

Kaylene Camuti
Chair, AIG Education Committee

AIG Bursary Awards

This year’s AIG Bursary Program received 36 applications from geoscience students enrolled at 14 Australian universities. As in previous years, the Education Committee had the privilege of reviewing applications from students with a wide range of geoscience interests and research topics. The AIG awarded 10 bursaries this year and we congratulate the following students on their awards.

- **Sarah Arnoldi**, from Curtin University, who was awarded an AIG-Honours Bursary. Sarah’s honours project was on the Spatial and temporal relationships in rocks of the Leeuwin Complex, and their setting within the Pinjarra Orogen of Western Australia.

- **Joel Burkin**, from UWA, who was awarded an AIG-Honours Bursary. Joel’s honours project was titled: Objectively defining confidence in the mineral systems approach to prospectivity analysis: a nickel sulphide case study from the King Leopold Orogen.

- **Ross Chandler**, from James Cook University. Ross was awarded a Davis-AIG Honours Bursary to assist with field expenses for his project: The magmatic evolution and rare metal potential of the Peak Range Volcanics, central Queensland.

- **Martin Nguyen**, from Monash University, who was awarded a SMEDG-AIG Honours Bursary. Martin’s honours project was titled: The application of lithogeochemistry and structural mapping to assessing prospectivity in the Zuleika-Kunanalling Corridor, Eastern Yilgarn.

- **Lena O’Toole**, from Sydney University, who was awarded an AIG Honours Bursary. Lena’s honours project was titled: Newly discovered volcanic centres of Northern Zealandia: part of an intraplate volcanism pulse?

AIG Third Year Bursaries were awarded to:

- **Dillon Brown**
  Adelaide University

- **Owen Hackenburg**
  University of Queensland

- **Jack McInerney**
  Federation University

- **Thomas Stevenson-Vissers**
  Federation University

- **Owen Welsh**
  University of Queensland

The AIG Education Committee thanks all bursary applicants for their contribution to the Bursary Program. Thank you, also, to our bursary sponsors whose support ensures the continuation of the Bursary Program and through the Program and the efforts of AIG state branches, fosters interaction between students and professional geologists.

I would also like to thank the members of the AIG Education Committee and acknowledge their continuing commitment to the Bursary Program, and the time and effort they give to reviewing the bursary applications:

- **Martin Robinson** (AIG, Vic)
- **Graham Teale** (AIG, SA)
- **Anne Tomlinson** (AIG, WA)
- **Chris Torrey** (AIG, NSW)
- **Doug Young** (AIG, Qld)

The AIG would also like to acknowledge and thank all the AIG members who have donated to the AIG Education Foundation when renewing their membership. Your support and generosity are important to the continuing education activities of the AIG.

If you would like to learn more about sponsoring the Bursary Program, or about donating to the AIG tax deductible Education Foundation, please contact anyone in the Education Committee. We’d be very happy to hear from you. You can contact the committee via the AIG secretariat or send an email to education@aig.org.au.
AIG Bursary Sponsors – December 2017

The AIG wishes to than the following individuals and organisations for their support of the Geoscience Student Bursary Program.

Geoscience Student Bursary Program

DIAMOND
- **CHRIS BONWICK**
  Sponsoring the Bonwick – AIG Geoscience Student Bursaries
- **GEOFF DAVIS**
  Sponsoring the Davis – AIG Geoscience Student Bursaries.
- **MACQUARIE ARC CONFERENCE - GSNSW**
  Sponsoring the Macquarie Arc Conference – AIG Geoscience Student Bursaries
- **SYDNEY MINERAL EXPLORATION DISCUSSION GROUP (SMEDG)**
  Sponsoring the SMEDG – AIG Geoscience Student Bursaries

PLATINUM
- **AIG STATE BRANCHES**
  Sponsoring AIG Geoscience Student Bursaries
- **JONATHAN BELL**
  Sponsoring the Jonathan Bell-AIG Geoscience Student Bursary

GOLD
- **GNOMIC EXPLORATION SERVICES PTY LTD**

BRONZE
- **DOUG YOUNG**
- **EXPLORGEEO**

MRGraphics, a team that **KNOWS** Geology, Exploration & Mining.
We specialise in...

- Annual reports
- Powerpoint presentations
- Business material design
  (business cards, letterheads, etc.)
- Print design & broking
- Website design & development
- Hosting & Domain registration
- Content & Document management systems

Email fiona@mrgraphics.com.au
or call Fiona or Wency on (03) 5422 3337

For more information on the Student Bursary Programme visit www.aig.org.au/education-training/student-bursary-programme
Institute News

NSW Branch Report

Verity Borthwick
NSW Committee member

The NSW Branch of the AIG is active in organising events during the year. These include workshops, student information nights and the bi-annual Mines and Wines Conference, as well as joint events with other societies.

NSW AIG provides funding support for young and for unemployed geoscientists. Plenty of funding is available to provide NSW-based AIG members with opportunities to participate in professionally organised geological field trips, conferences and courses (see the AIG web site under the Education tab, NSW AIG Support Fund).

The NSW branch also has a number of workshops in the pipeline, including career support for geoscientists, a valuation seminar, JORC update seminar, geological mapping and field skills workshop, as well as another core logging workshop, this time to be extended to 3 days after the success of the first.

We take a leading role in organising the Mines and Wines Conference every two years. This year’s conference was held from the 6 - 8th September, 2017, in Orange, and drew a crowd of 210 attendees. The technical program was excellent, with presentations on exploration in the Tasmanides including the following sessions; “The Big Picture” of the mineralisation of the Tasmanides, “Arc Mineral Systems”, “Orogenic Deposits”, “Basins and More” and “Granites and More”. This is the first time that the conference extended abstracts have been presented in digital form. To access a paper visit the following link: www.minesandwines.com.au/papers-2017.php. A full day field trip on the 6th showcased the latest developments in geological understanding of CMOC’s Northparkes Cu-Au Porphyry Mine and Alkane’s Tomingley orogenic Au mine.
The AIG is also involved in organising the 26th AEGC (Australasian Exploration Geoscience Conference). The conference is a joint effort between the AIG, ASEG and PESA and will be held from the 18 – 21st February 2018. The technical program is based around three overarching themes: Energy, Mineral Geoscience and Near Surface and Groundwater and many technical and practical workshops are being run before and after the conference. Financing for students to attend the conference is available, and it is a great opportunity for networking and attending some informative presentations, so get in contact to make an application. Registration is open online at the following website http://www.aegc2018.com.au/ if you are interested in attending the conference.

The AIG recently assisted with funding the latest Cartoscope Geotourist maps of NSW, a great resource for anyone interested in learning more about Geology while travelling the state.

Support was also provided for the GSA Earth Sciences Student Symposium on the 10th November and a number of student career nights took place at UNSW and Macquarie University.

AIG NSW has a close association with SMEDG (Sydney Mineral Exploration Discussion Group). SMEDG meetings are held on the last Thursday of the month.
The monthly meetings are held at Club99 on York Street in the city. Gatherings are very informal with a free bar at the beginning, an interesting speaker and often dinner afterwards. For more details go to the SMEDG web site www.smedg.org.au and scroll down to “Join the SMEDG mailing list” to register for your free membership. You will then receive an email once a month reminding you of the meeting and the topic. If you’re interested in giving a talk about mineral exploration please get in touch with the committee members (you can find their details on the SMEDG website).

SMEDG will hold their David Timm’s Christmas Cruise of the Sydney Harbour on Friday the 15th of December, so register on the website above to catch up with your old mates and make some new ones.

For those living and working in the Central West of NSW, CWEDG (Central West Exploration Discussion Group) has restarted regular informal meetings, with speakers from a variety of companies who operate within the Central West. If anyone is interested in helping organise these catch ups, please contact the NSW AIG.

The branch committee continues to assist in the assessment of applicants from NSW, seeking Registered Professional Geoscientist status with the AIG.

The NSW branch committee meets every two months in Sydney – visitors, guests, members and potential committee members are always welcome. If anyone is interested in joining the committee, or helping in any capacity they should contact any NSW branch committee member or email nsw@aig.org.au. In particular we are looking for young professionals and graduates who might be interested.

2018 promises to be a good year, and we are looking for any suggestions of ways we can assist NSW AIG members, particular young geologists in their endeavours.
Small ship adventures to
ANTARCTICA

Only 54 Guests · Expert Guides · Daily Shore Landings

ANTARCTICA & SOUTH GEORGIA
Retrace Shackleton’s epic voyage and explore the Antarctic coastline before discovering the wildlife-packed beaches of South Georgia.
18 DAYS from US$14,300pp
27 Nov 2017 • 27 Dec 2017 • 7 Mar 2018

ANTARCTIC EXPLORER
Deep within the Weddell Sea, fossil-rich islands dot the landscape and vast ice shelves calve tabular icebergs of unfathomable size.
11 DAYS from US$9,500pp
17 Feb 2018 • 25 Feb 2018

SPIRIT OF ANTARCTICA
Enjoy Antarctica at its liveliest and most pristine. We pack in continental landings, visit historic sites and revel in the near-midnight sun.
12 DAYS from US$8,900pp
16 Dec 2017

Contact Aurora Expeditions for more information or to order a FREE Antarctica Brochure.
Call us on 1800 637 688, email info@auroraexpeditions.com.au or visit auroraexpeditions.com.au

antarctica | south georgia | greenland | spitsbergen | scotland | kimberley coast | ecuador & galápagos | patagonia

*AIG Members will save 10% on selected departures across Aurora Expeditions 2017-18 Antarctic expeditions including ASG70, EAP30, ASG71, ANP120, ASG73 and FLK05. Please quote AIG on booking along with proof of membership. Bookings must be made before 30 September 2017. Discount is not combinable with any other offer. Discount is valid on new bookings only, subject to availability and may change at any time. Other terms and conditions may apply; contact Aurora Expeditions for full details.
Climate Change: Natural Cycles and Unnatural Forcing

Dave Shatwell
FAIG, Former Editor AIG News

Throughout March 2017 (an El Niño year), there were devastating floods and mudslides, locally known as huaycos, in Peru, when heavy rain in the Andes washed houses, bridges, cars, animals and people into coastal rivers. 242,433 houses and 549 bridges were damaged, and over a million people were affected, including 114 who lost their lives (www.infobae.com). Crops were destroyed and Lima’s water supply collapsed, unable to deal with the debris and silt entering the filtration system as the Rimac River burst its banks. Communication was disrupted as bridges and roads were swept away.
The floods weren’t confined to Peru. In early April, a mudslide killed 254 people in Mocoa, Colombia, and the Category 4 cyclone Debbie brought flooding to Queensland and New Zealand. In July, floods and typhoons killed 612 people, damaged 1.27 million houses and caused damage worth $35 billion in China.

Are the recent floods part of a trend, or are they isolated events related to normal climatic cycles? The National Climate Assessment summarises trends in once-in-five-year rainfall events in the US since the start of the 20th century, in a graph reproduced as Figure 1 (www.nca2104.globalchange.gov/highlights/report-findings/extreme-weather). The graph shows a decrease until the 1930s, fluctuation in the 1940s and 1950s, and an increase each decade thereafter.

Warmer air can contain more moisture than cooler air, and when the climate warms for whatever reason, more water evaporates from the oceans and falls as rain. In areas of low rainfall, increased evaporation with warmer temperatures tends to dry the soil even further, and may increase desertification. More CO₂ in the air warms the land and the oceans. Warmer oceans can contain less CO₂ so it evaporates back into the atmosphere. Cause feeds back into effect, and there are no simple answers. More and more people are affected as changing demographics and changing climate combine in a deadly mix.

**Figure 1.** Trends in heavy rainfall events in the US from the 1900s to the 2000s. (www.nca2014.gov)
Natural cycles and ice cores

The Antarctic ice cap is fossilized snow, which was originally distilled from the sea by solar radiation. The lighter isotopes of oxygen and hydrogen in water ($^{16}$O and $^{1}$H respectively) evaporate more readily, and precipitate more slowly, than the heavier ones ($^{18}$O and $^{2}$H, or deuterium), so rain and water vapor in the atmosphere are isotopically lighter than seawater. The degree of fractionation is inversely proportional to the temperature, so during warmer periods, the $d^{18}$O and $dD$ of water vapor are higher than during warmer intervals. Some of the moisture drops out as rain, restoring the isotopic balance to the ocean; however, some also falls on land. During cool periods at high latitudes, or on mountain peaks, precipitation falls as snow and is preserved as ice sheets, ice caps and glaciers which carry an isotopic record of the temperature where the evaporation occurred — higher $d^{18}$O and $dD$ correlate to higher temperatures in a relationship that is close to linear.

The Pleistocene-Holocene ice cores from Antarctica provide a record of past temperature and the partial pressure of carbon dioxide in the atmosphere ($pCO_2$) for the last 800,000 years at Dome C, 400,000 years at the Vostok Dome (Masson-Delmotte et al, 2006), and for shorter periods in other locations. The ice cores record CO$_2$ directly from air trapped in bubbles in the ice, and $dD$ records past temperature.

There have been eight glacial and interglacial peaks and corresponding cycles of pCO$_2$ in the last 800,000 years. Temperature maxima correspond closely to pCO$_2$ peaks, and, less exactly, to the ~100,000 year Milankovitch orbital cycles in the eccentricity of the Earth’s rotation around the Sun. It has been suggested that the Milankovitch cycles are the trigger for global warming; CO$_2$ solubility decreases in the warmer oceans, so it is out-gassed into the atmosphere, intensifying the warming cycle in a positive feedback loop (www.svs.gsfc.nasa.gov). Figure 3, from the Vostok ice cores (www.climatedata.info), shows the 100,000 year Milankovitch cyclic pattern, and that pCO$_2$ increases with temperature but lags during cooling phases, underscoring that the temperature-CO$_2$ connection works both ways. Shakun et al., (2012) have explored this relationship in more detail.

Figure 2. Temperature and pCO$_2$ over the last 400,000 years, from Vostok ice cores. Brown curve is ppm CO$_2$, red curve shows temperature change in degrees C. (www.climatedata.info). Year 0 on the graph is 2007; CO$_2$ has now reached 400 ppm.

Figure 3. Holocene $d^{18}$O trend from Huascarán ice cores, Perú. Redrawn from www.climatedata.info, original source is Thompson (2000)
The last 20,000 years
As well as polar ice caps, tropical mountain glaciers also provide ice-core data, and Peru’s highest peak, Huascarán, has provided ice samples which go back almost 20,000 years (Thompson, 2000). The Huascarán δ18O data, as a proxy for temperature, (Figure 3) clearly show the last glacial stage 17,000 years ago, and the rise in temperature, estimated at 8-9°C, to a maximum 11,000-9000 years ago. The warming trend was punctuated 12,800-11,500 years ago by an extremely rapid episode of global cooling, the Younger Dryas, whose cause is still debated. After peaking ~10,000 years ago, the temperature dropped steadily towards the next glacial period until the current warming trend of the last 200 years.

The last 1000 years
The Law Dome in Antarctica is an area of high snow-fall and so provides good detailed ice-core data over the more recent past. The curve in Figure 4 is plotted from the year-by-year CO2 data reported by the Carbon Dioxide Information Analysis Center (www.cdiac.ornl.gov) between AD 1000 and AD 2004. There is little change until about 1750, and atmospheric pCO2 was below 290 ppm until 1882. CO2 reached 300 ppm in 1913, and has continued to rise at an accelerating rate, reaching 350 ppm in 1990 and 375 ppm in 2004, the last year of the Law Dome data.
Climate Change

CO₂ levels in the atmosphere have been made at the Mauna Loa laboratory in Hawaii since 1959. Data from the NOAA Earth System Research Laboratory www.esrl.noaa.gov/gmd/ccgg/trends show that average annual atmospheric pCO₂ increased by 28%, from 316 ppm in 1959 to 404 ppm in 2016, (and reached 406 ppm in February 2017), an average annual increase of 1.5 ppm.

The measurements of CO₂ in ice cores at Law Dome overlap with the atmospheric data from Mauna Loa for the years 1959 to 2004. The correlation between both data sets is reasonably good: the Mauna Loa data show about 2 ppm higher pCO₂ content than the ice cores, and the overall trend is the same. The right-hand curve on Figure 5 shows the combined data, increasing by almost 40% from 290 ppm in 1880 to 400 ppm in 2015.

Systematic temperature measurements on land have been made since about 1880, and the data are available from NASA and NOAA web pages. According to Bennett (2014), the degree of uncertainty is about 0.1°C before 1900, improving to 0.03°C for post-1980 data. The left-hand graph on Figure 5 shows surface air temperature variation since 1880 (composited to five-year running mean values), compared to the average temperature for 1951-1980. The graph shows that temperatures were below that average up to about 1940, and consistently higher on a steeper trend from 1970. 2016 was the warmest year on record, 1 degree Celsius above the mid-twentieth century mean.

Modern CO₂ emissions from fossil fuels

In 1992, 197 countries, including all UN and EU member states, signed the United Nations Framework Convention on Climate Change (UNFCCC), which provides for unified reporting and QA/QC of greenhouse gas emission data. The Carbon Dioxide Information Analysis Center (www.cdiac.ornl.gov), a branch of the US Department of Energy, publishes estimated global carbon emissions since AD 1751 under headings which equate to liquid petroleum, natural gas, coal, cement manufacture (from limestone), and gas flaring. (The carbon totals can be converted to CO₂ by multiplying them by 3.67).
How accurate (and reliable) are the estimates of greenhouse gas emissions? In 2014, the much-maligned IPCC estimated that the uncertainty of CO₂ emissions from fossil fuels was about 8%. One has to assume that pre-UNFCCC estimates have greater uncertainty, balanced by the lower absolute values and diminishing relevance to the current situation. Figure 6 shows the carbon emission trend between 1751 and 2014. Total carbon emissions to 2014 are 402 gigatonnes (Gt), of which 47% comes from coal, 49% from petroleum and natural gas, and about 4% from other sources. Appreciable amounts of carbon started to be produced around 1850, which is generally regarded as the start of the industrial revolution. The curve rises to about 1950, then follows a steeper trend (with a hiccup at the oil price hike of the 1970s) until the present day. To put this into perspective, 1.31 Gt of carbon (0.3% of the total) were emitted between 1751 and 1850, 61 Gt (15%) between 1851 and 1950, and 339.74 Gt (85%) between 1951 and 2014. Thirty percent of all carbon from these sources was produced between 2000 and 2014.

Not all of this carbon ends up directly in the atmosphere. The NASA website (www.earthobservatory.com) estimates that land plants absorb about 25% and another 30% is taken up by the oceans, leaving 45% to directly enter the atmosphere. Plants and oceans will eventually absorb the carbon, over a time span measured in thousands of years.
Emissions from volcanoes

Ancient volcanoes from large igneous provinces have been linked to past climate change and mass extinctions (e.g. Bond and Wignall, 2014), but cannot account for the rise in atmospheric pCO$_2$ today. Gerlach (2011) estimated that terrestrial and submarine emissions were between 0.13 and 0.44 Gt of CO$_2$ per year, and cited other sources from 1991 to 1998 which gave similar numbers. Gerlach discusses what it would take for volcanic CO$_2$ emissions to account for the 135 Gt of CO$_2$ which was added to the atmosphere in 2011. It would require the currently-estimated level of global magmatic output (about 81 Gt a year) to contain 30% CO$_2$ compared to average levels of about 1.5%. Or for magma with normal CO$_2$ content, it would take about 9500 present day ‘normal’ volcanoes (or 700 Pinatubos, or 3500 Mount St Helens). It would require 135 mid-ocean ridge systems, if they are considered to be the source.

In another review, Hards (2005) cites data indicating that annual global CO$_2$ emissions from volcanic activity are about 0.1 Gt from each of mid-ocean ridges, subduction-related terrestrial volcanoes, and hot-spot terrestrial volcanism, giving a total of 0.3 Gt per year from all sources. She notes that most or all of the CO$_2$ from mid-ocean ridges is probably consumed by hydrothermal alteration of the lava.

Some critics suggest that not all ‘volcanic’ CO$_2$ is emitted during eruptions, and that the amount of CO$_2$ that diffuses through faults etc on the flanks of volcanoes might be much larger than previously thought. This seems to be a legitimate concern, and Hards (2005) admits that flank degassing has only been studied in a few volcanoes, but may contribute around 0.05 Gt/yr to the total estimate of 0.3 Gt/yr of CO$_2$.

What about fluxes of non-volcanic mantle- or crustally-derived CO$_2$ emissions? Mörner and Etiope (2002) provide an inventory of such sources, including metamorphic decarbonation, leakage from hydrocarbon reservoirs, escape from the upper mantle, and near-surface processes. They provisionally estimate 0.01 to 0.1 Gt/yr of CO$_2$ from these sources, while emphasizing the insufficiency of the data.

Volcanoes also discharge SO$_2$ which forms aerosols and has a short-lived cooling effect. In a study of the 1991 Mount Pinatubo eruption in the Philippines, claimed to be the second largest eruption in the 20th century, Self et al., (1999) concluded that the eruption had caused global cooling of about 0.4°C in 1992-93, but had little or no effect in later years.

Isotopic signature of fossil fuel carbon

During photosynthesis, plants prefer the lighter carbon isotope $^{12}$C to the heavier one $^{13}$C, whereas volcanoes show no such preference. Coal is the biggest single contributor to global emissions since the start of the industrial era (47%, compared to 35% for liquid petroleum and 14% for natural gas). Since coal is decayed plant matter, it might be assumed that burning of coal would cause a shift in the d$^{13}$C of atmospheric CO$_2$.

One way of measuring such a trend is from the isotopic composition of carbon in the skeletons of long-lived marine organisms such as sponges. Like other marine animals, sponges precipitate aragonite from carbon dissolved in seawater, whose isotopic signature closely reflects that of the atmosphere at the time.

In 1993 and 1996, four German scientists analysed the d$^{13}$C of the skeletons of four living sponge specimens from shallow water in the Caribbean (Bohm et al., 2002). Sponges show annual growth layers a bit like the growth rings of trees, so the isotopic history of the aragonite skeleton can be determined by detailed sampling, in this case using a fine dental drill. Bohm et al. carried out $^{14}$C and U/Th age determinations on a number of layers, extrapolated the age of all layers assuming a steady growth rate, and analysed the d$^{13}$C of each layer. Figure 7 shows the change in d$^{13}$C between the years 1421 and 1994 for one of their specimens. The graph shows a slight increase between 1550 and 1700, corresponding to the Little Ice Age, then a downward trend starting about 1800 and steepening in the second half of the 20th century, consistent with the CO$_2$ emission trend shown in Figure 6.
Can climate change be halted?

The Earth has been in an ice age for the last 2.6 million years, but has cycled between colder (glacial) and warmer (interglacial) periods for at least the last 800,000 years, probably in response to a feedback between Milankovitch cycles and atmospheric pCO2. Ice cores show that over the last 800,000 years, there have been eight glacial/interglacial cycles, each lasting about 100,000 years. However, there were perturbations like the Younger Dryas which the Milankovitch cycles can’t explain. Atmospheric pCO2 ranged between 200 and 300 ppm, but never reached the present level of 400 ppm since reliable estimates from ice cores have been made. The last interglacial peaked about 10,000 years ago, melting the northern hemisphere glaciers and causing a rise in sea level of 120-130m. The climate has started its slide into colder (glacial) and warmer (interglacial) conditions and decreased demand for heating oil.

Perhaps there is a silver lining. A report by the United States Environmental Protection Agency (EPA), (www.epa.gov/climatechange) showed that US greenhouse gas emissions in 2015 were 11.5% below the level in 2005 – ironically, due in part to warmer winter conditions and decreased demand for heating oil.

REFERENCES

Bennet, J., 2014, A global warming primer: Answering your questions about the science, the consequences and the solutions. Big Kid Science, Boulder CO.


Marcott, S.A., Shakun, J.D., Clark, P.U., and Mix, A.C., 2013, A reconstruction of regional and global temperature for the last 11,300 years. Science, v. 339, issue 6124, p. 1198-1201.


Shakun, J.D., Clark, P.U., Feng He, Marcott, S.A., Mix, A.C., Zhengyu Liu, Otto-Bliesner, B., Schmittner, A., and Bard, E., 2012, Global warming preceded by increasing carbon dioxide concentrations during the last global warming. Nature, v. 484, p. 49-54.


Richard Carver Consulting Geochemist

32 Years In Exploration Geochemistry
- Extensive International Experience
- Australia - China - Africa
- Project Management
- Survey design & implementation
- Laboratory Audits
- QA/QC & Data due diligence
- Data & Database Compilation
- Arcview/MapInfo GIS

richard.carver@gcxplor.com

AIG NEWS Issue 130 - December 2017 27
The latest quarterly survey of Australian geoscientist employment, covering the third quarter of 2017, shows that employment prospects for geoscientists have remained unchanged since March 2017, despite anecdotal evidence pointing to an upturn in mining and exploration industry activity. The survey was conducted during October 2017 by the Australian Institute of Geoscientists (AIG).

The national unemployment rate at 30 September 2017 amongst Australia’s professional geoscientists was 12.2%, up slightly from the 30 June figure of 11.3%. Underemployment amongst self-employed geoscientists for the same period, however, fell to 18.0% from 19.0%.

The combined figures point to no improvement in employment prospects for the geoscience professions as a whole since March 2017.

AIG spokesperson Andrew Waltho expressed surprise at the flat result in the latest survey. “Australian geoscientists were looking forward to an improvement in the employment situation in the September survey due to what appeared to be improved sentiment amongst professional geoscientists”. “The survey results, however, don’t contain any good news”. “Unemployment in the mineral exploration sector continues to sit at around 12%”. “The surprise in this survey’s results was that unemployment in metalliferous mining geology increased from 5.2% in June to 11.0% at the end of September”.

The survey results point to:

- An ongoing lack of exploration investment in activities that deliver discoveries: mapping, sampling, geophysical surveys and drilling.
- A decline in orebody knowledge generation – an essential element in optimising the value of known orebodies and generating brownfield discoveries that help to extend the life of mines and provide a basis for mine expansions. Expansions are, by far, the lowest cost means of adding to our metal and mineral production base.

![Geoscientist Employment](Figure 1. Geoscientist unemployment and under-employment in Australia June 2009 – September 2017)
"We need to remember too that for every job lost in exploration and mining in Australia, three to four other jobs are lost in the broader community" Mr Waltho said. "Initiatives announced recently by both federal and state governments to promote investment and sponsor drilling of advanced exploration projects don’t appear to be having an impact across the exploration and mining sector".

“This could be due to none of the initiatives announced tackling the thorny question of access to land and perceptions of growing sovereign risk in Australia”. “Both of these have a negative impact on investment” Mr Waltho said. “Recent talk of royalty and tax increases in Western Australia appear to have had an immediate impact on industry sentiment which has already had a negative impact on geoscientist employment” Mr Waltho said.

State unemployment rates were relatively uniform, between 11.0% in New South Wales to 12.3% in Western Australia (Figure 2). Underemployment results amongst self-employed geoscientists were more broadly spread, ranging from 14.7% in Western Australia to almost 28% in South Australia. Employment conditions improved in Queensland, and unemployment also fell in both Victoria and South Australia. In all other states, however, unemployment and underemployment rates were static or increased (Figure 3).

Some 492 responses were received to the survey.
A Mob of Geologists and Friends on a Geotrail in the West

1895 came and a narrow-gauge railway line was built up the valley of Jane Brook to climb onto the Darling Range. That line was the mainline railway from Perth eastwards to the Wheatbelt and Goldfields. Three years later land either side of the line was proclaimed Greenmount National park that, in 1947, was renamed John Forrest National Park on the centenary of the birth of Lord John Forrest. Forrest had been a renowned explorer of WA, its first Premier, later a member of the Commonwealth of Australia’s first Cabinet and was acting Prime Minister.

The railway was decommissioned in 1971, when the standard gauge line was built several kilometres to the north, and the formation became a lonely, little-used track for several years. It has now become popular as a weekend-walking and bike-riding route for tens of thousands of people each year. We are now referring to the trail from the western edge located on the Darling Scarp to the national park headquarters as the John Forrest Geotrail.

The cuttings along the western kilometre are excellent exposures of the Darling Range.
Batholith with the many Boyagin Dolerite Dykes cutting through it. An excellent guide to the first part has been written by John Bunting and teacher’s lesson guides released by Earth Science Western Australia (ESWA) for that section. That was the focus of the first 2017 AIG geological walk in April. On a glorious, spring, Sunday morning we held the second walk along the eastern part of the geotrail.

So, at 10AM on Sunday 8th October, 2017, 28 intrepid geologists and their friends and relatives collected for the two kilometre walk to the National Park Waterfall, led by Mike Freeman. Although the geology is not so apparent along this part of the route, contrasted with the western end, there are a number of interesting aspects particularly with the relationship of humans and developments to the geology during the construction of the railway. And another contrast along the geotrail is that it was built for 1890s steam technology but now the walk is over opposite level of technology as a major optic-fibre cable is now under the former railway line and carries much of Perth’s electronic signals to the rest of the World – underfoot along the walk!

This part of Jane Brook is a gentle-flowing stream with deep soil and dense forest vegetation in a shallow, old valley. Arriving at the National Park Falls, Jane Brook’s character changes enormously, falling 20 metres at a nick-point into a valley that is deep, narrow, bouldery and with sparse tree-growth in a youthful form possibly reflecting the change of the valley character following Cenozoic uplift along the Darling Fault.

Back along the northern bank of Jane Brook showed a marvellous diversity of flowering native plants. Beauty to the beholders.

"The cuttings along the western kilometre are excellent exposures of the Darling Range Batholith with the many Boyagin Dolerite Dykes cutting through it."

On the former railway.

Lemon-scented Darwinia – named after Erasmus Darwin, the grandfather of Charles Darwin.
Hi Mike,

Thank you for the AIG Geological Walk at John Forrest National Park last Sunday. It was very informative and most enjoyable. The overall format for the morning worked well. The general approach of presenting the information in layman’s terms, yet providing detailed background information where requested, was quite appropriate given the diversity of ages, interests and experiences within the group.

In my opinion these walks bridge a gap. The geo walks offer people an opportunity to gain “hands on” experience that is generally not available outside of formal studies. Most of the currently available courses are designed either for Year 12 students, or for university students wishing to pursue a career in earth sciences. However, many people have completed Year 12 and pursued other careers while still maintaining an active interest in geology.

As an active member of the WA Lapidary and Rock Hunting Club I can see the benefits of geotourism. Our club members travel widely to view geological formations, attend exhibitions, and liaise with similar organisations in other States. At club level, “rock hunts” are extremely popular and regularly support the tourist industry throughout WA. Many of our members are retirees with the knowledge, time and resources to travel in pursuit of that “hidden gem”. The club also fields enquiries from locals and interstate visitors about where to fossick in WA and what services and attractions are available.

Please let me know if we can assist in any way with the development of the geology walks. The club has a broad range of skills and experiences available owing to the breadth of its membership. I’ve circulated a copy of the “draft” notes to one or two of our members for review, and will follow up in due course.

Feel free to add my email address (above) and the club’s email address: enquiries@walapidaryclub.org.au to your mailing list. This will allow us to notify our members of upcoming events.

Once again, thank you for organising the John Forrest National Park Geological Walk.

Regards,

Steve Moller

For people interested in looking at the map available from the GSWA website, you are referred to: http://www.dmp.wa.gov.au/Eastern-railway-walk-1657.aspx

A Paleozoic perspective of Western Australia

by

Arthur J Mory

To order your copy:
email <bookshop@dmp.wa.gov.au>
or call +61 8 9222 3459

* Purchase five or more copies for $22 per book

And Tom Lanene helpfully was able to describe many of the plants and flowers to the walkers – thanks Tom.

Mike had an ulterior motive of organising and leading the two AIG walks. A geotrail guide is planned for the four-kilometre route and draft copies were handed out with Mike hoping to get some free editing and critique of the concepts and ideas presented! Mike is the AIG’s nominate link to the Standing Committee on Geotourism of the Geological Society of Australia and would be keen to hear of any ideas AIG members have in regards to geotourism to pass on. The GSWA already has a geotrail map available on its website.
Under the combined support and sponsorship of six government agencies (both State and Federal), three research organisations and three industry groups, a landmark report has been published by MinEx Consulting looking at the forty-year outlook for the Australian gold industry. It forecasts the likely number of mines, production, revenues and employment out to 2057 for this vital sector of Australia’s economy.

In the past, most industry studies rarely look beyond ten years. The report’s author, Richard Schoodde, says that “there are two good reasons for this: Firstly; the future is highly uncertain – and any single-line forecast is almost certain to be wrong. Secondly; most of these studies only looked at existing mines and possible new projects. This is fine for short- to medium-term forecasts but it ignores the important contribution of new discoveries for mine production in the longer-term.”

It goes without saying that every mine has a finite life (and will eventually close down); it also equally true that all mines were once a gleam in the eye of a geologist (i.e. it took someone to find them). Leaving out the discovery story results in an incomplete view on the long-term future of the mining industry.

As discussed below, nurturing exploration success is critical for ensuring the long-term sustainability of the mining industry.

MinEx Consulting’s approach to the task was via the following eight-step process:

1. Embracing uncertainty and using a Monte Carlo approach to assess 1000 different possible scenarios of the future. This included generating a series of commodity price cycles that reflect what the industry has experienced in the past.

2. Estimating future production from existing mines, adjusted for changes in the gold price, variability in operating performance and possible mine-life extensions.

3. Assessing whether the future gold price scenario is sufficiently high enough to trigger the development of new mines on known projects.

4. Using the price scenarios to predict likely future exploration expenditures. And from this,

5. Estimating the likely number, size and quality of discoveries made over time.

6. Determining the likelihood that a given discovery will be developed and, if so, incorporating a time delay between discovery and development.

7. Developing a model to estimate the likely production rate and mine life for these discoveries. From this, estimating their likely timing and contribution to future revenues and employment.

8. Integrating together the results for existing mines, new projects and exploration success.

### TABLE 1: LIST OF SPONSORS FOR THE STUDY

The 12 sponsors of the study are:

- Association of Mining and Exploration Companies (AMEC)
- Australian Institute of Geoscientists (AIG)
- Centre for Exploration Targeting (CET)
- Chamber of Minerals and Energy of Western Australia
- CSIRO
- Deep Exploration Technologies Cooperative Research Centre (DET CRC)
- Department of Industry, Innovation and Science
- Geoscience Australia
- Geological Survey of Western Australia Geoscience Australia (GSWA)
- Northern Territory Geological Survey (NTGS)
- NSW Department of Trade & Investment, and the
- South Australian Geological Survey
The study assumes that there is a 90% chance that over the next forty years the gold price will lie between $793 and $2258 per ounce, with an average price of $1524 (in constant 2017 A$). Today’s price is ~A$1650/oz.

The key results are summarised in two sets of charts.

- Figure 1 shows the “mean” (or average) forecast gold production over the next forty years for Australia, broken down by source (from existing mines, known new projects and exploration success).
- Figure 2 shows the trend (and degree of uncertainty) in the overall forecast number of mines, gold production, employment and revenues for the industry under different possible scenarios. Although there is a wide range of outcomes, the overall trends are clear.
Figure 1 shows that over the short-term (i.e. the next 5 years) production is dominated by existing mines. Output from these mines will remain steady for the next two years (with 9.7 Moz produced in 2017) then quickly decline thereafter. In forty years-time only four of the current 71 mines will still be operating – with most closing down over the next two decades. This includes iconic mines like the Kalgoorlie Super Pit and Telfer. MinEx forecasts that, by 2057, the remaining mines will produce less than 0.4 Moz pa of gold.

In the medium term (i.e. 5-10 years out) an increasing amount of production will be supplied from new mines based on known deposits. However, it won’t be enough to offset the decline from existing mines. By 2057, output from new projects will only total 0.3 Moz pa.

Many of these new projects are only economic under high gold price scenarios.

In the long term (i.e. 10-40 years out) exploration success will play a major role in overcoming much of the looming shortfall in gold production. The model forecasts that, over the longer term around $677 million pa will be spent on gold exploration in Australia (slightly up on current levels), resulting in 266 new gold deposits being found over the next forty years. Half of these will be developed, and will contribute 4.06 Moz pa of gold in 2057. This is equal to 87% of the combined total production of 4.69 Moz pa in that year. Consequently, in forty years-time almost all of Australia’s future gold production will come from exploration successes.

It is significant to note that the model predicts that in 15 years-time (i.e. by 2032) half of Australia’s gold production will come from mines that are yet to be discovered.

However, of serious concern is the fact that the weighted average delay between discovery and development for a new discovery is 13 years. There are also indications that it is getting harder and slower to convert a discovery into a mine.
Consequently, government and industry need to support exploration today. We only have the next couple of years to properly identify and address ways to improve our exploration performance - otherwise Australia runs the real risk of a significant supply disruption in the medium-term.

Figure 2 shows that over the next forty years, gold production and revenues are set to drop by half – to 4.69 Moz and A$7.3 billion respectively. The number of operating mines is set to fall by a third (from 71 to 47) and total employment by 70% (from 27,980 to 8,300 workers). Half of the fall in employment is associated with productivity gains associated with automation.

Sensitivity studies indicate that each additional dollar spent on exploration generates an extra $11.40 in revenue.

MinEx estimates that for the Australian gold industry to maintain production at current levels in the longer term, it will either need to double the amount spent on exploration or double its discovery performance (i.e. reduce unit discovery costs from $70/oz to $35/oz). The incremental benefits of reaching this target will be an extra 4.05 Moz of annual production, an extra $6.23 billion in revenues and additional 7160 jobs.

The above-mentioned outlook is premised on "business-as-usual". The opportunity exists for industry and government to take the initiative to invent its own future. In addition to developing policies that encourage/stimulate exploration, the opportunity also exists to be more efficient and effective at making discoveries. The challenge is that many of these initiatives require effort (and money) and will take several years to bear fruit.

Given the long lead times involved (both for R&D, discovery and mine development) there is an urgent need to start the process now.

The above report on the forty-year production outlook for Australia’s gold industry is part of a larger study assessing the long-term outlook for Australia’s minerals industry. This includes iron ore, coal, base metals and uranium. These reports will be progressively released over the next few months. View the study report https://tinyurl.com/aignews130-outlookforgold.
A one day AIG workshop was organised by Jayson Meyers and Chris Wijns, and was attended by about 60 geoscientists, with participants and presenters from the minerals and geotechnical industries, academia and government. The motivation for this workshop was the growing number of geophysicists and geologists who are starting to use near surface passive seismic surveying for regolith and sedimentary cover mapping as a stand-alone survey method, or in conjunction with other classical geophysical surveys methods, such as gravity, magnetics, EM, resistivity, GPR, seismic reflection/refraction, etc. While the passive seismic survey method has been around for a long time, it has mainly been carried out by specialist researchers to prove up the technology, and has only been utilised for production surveys by seismologists for earthquake hazard area mapping. Shallow passive seismic is now starting to gain traction as a practical geophysical exploration survey tool, since it can be done quickly using a single seismometer instrument, or small array of seismometers, without the need for an active seismic source. Depth calibration can be carried out by taking readings at drillholes which intersect the fresh/hard bedrock acoustic basement, the data are simple to process, or modelled or inverted where there are no drillholes, and results can be quite robust. Yet there is still a lot of uncertainty and scepticism amongst geoscientists concerning the reliability of various passive seismic methods and their results, and these issues were raised and discussed during the workshop.
Passive Seismic Surveying

The workshop consisted of 7 presentations, and started off with a review on the Spectral Analysis of Surface Waves (SPAC) method, which compares vibration data between seismometers in an array, and the Horizontal to Vertical Spectral Ratio (HVSR) method, which requires only a single 3 component seismometer for rapid surveying. The HVSR method was the primary focus of the workshop, where quite a few examples of different surveys were presented, including background on HVSR theory, acquisition, processing and depth conversion methods, including modelling and inversion, especially a rapid trans-dimensional inversion method being developed by GA. The strengths and weakness of the passive seismic method were also highlighted, and it was made clear up front that passive seismic is not a ‘silver bullet’ technology for mineral exploration, but it can provide another layer of useful subsurface information for reducing drilling risk and...
different types of geological, regolith and mineral deposit settings, where passive seismic results were also compared to drilling data and results from other geophysical survey methods. The HVSR method was clearly shown to be a valuable mapping tool for detecting thickness of sedimentary cover deposits and regolith, and for mapping some layering within the regolith, where deposit layers provide a sufficient acoustic impedance contrast. Passive seismic survey results were shown for layer thickness and velocity mapping in the following geological settings: Kalahari deposits in Southern Africa, loess thickness in northern China, laterite and saprolite in Australia, paleochannels in Australia for sulphate of potash brines (Figs. 3 and 4), alluvial gold, calcrete uranium and channel iron deposits, heavy mineral sand deposits in New Zealand, Chile and

tying geological information from in-between drillholes. Its simplicity, small instrument size and low cost also make it very effective for low budget surveying and practical for remote areas. Several industry presenters, including two presenters from the GSWA, one from GA and one from Curtin Uni, showed case histories of predominantly HVSR survey results from...
South Australia, tundra and glacial deposits in Canada, mining waste dump and tailings dam embankments in Australia, shallow intra-cratonic basin mapping in Australia and Nevada, and some geotechnical and groundwater applications. Other applications were also shown for: cementation zones and unconformities, as well as using cover mapping results to remove the regolith anomaly response from gravity data.

A newly discovered and relatively young (Neogene to Quaternary?) meteorite crater, located in the centre of the Coolgardie Goldfield of WA, was also revealed for the first time, where passive seismic and other geophysical survey methods were instrumental in the identification of the circular crater and a low density mass caused a breccia zone in the Archaean bedrock below the crater fill.

A microphone was circulating during the workshop to field questions and stimulate discussions, and the workshop finished off with a group discussion, where speakers addressed questions and comments posed attendees; and fortunately this followed by drinks.

Figure 4. Passive seismic HVSR and gravity profile across a newly discovered meteorite crater in Coolgardie, WA, which has a diameter of 800 m, crater depth of 150 m filled with Cainozoic (Neogene to Quaternary?) peat and clay deposits, sitting above Archaean greenstone bedrock, and a 'fang' shaped zone of gravity modelled low density which corresponds to brecciated greenstone bedrock units in drilling (from Meyers, Resource Potentials).

The fee for the workshop was kept as low as possible and drinks were provided at the end, thanks to sponsorship from the following eight organisations:

![Sponsor Logos]
Resource Potentials are geophysical consultants specialising in a range of geophysical methods, survey design, budgeting, acquisition and QAQC, data processing, modelling and inversion, data integration and interpretation of geophysical results.

Sales, rentals, surveying and data processing for equipment developed by MoHo s.r.l (Italy)

Please contact Resource Potentials for further information.

TROMINO®
- Passive and active seismometer
- Self-contained with in-built A-D, data recorder and memory, GPS, radio trigger or synchronisation, powered by in-built rechargeable batteries via USB to power plug adapter or PC
- Small and light, high precision triaxial velocimeters (0.1Hz - 2kHz range) and accelerometers
- Passive seismic (stratigraphy and depth to fresh rock soundings), seismic amplification analysis and MASW for site characterisation
- Vibration monitoring and model analysis of structures
- USB download or interface for continuous monitoring or linked arrays
- Comes with Grilla processing and modelling software

SOILSPY®
- Self-contained digital multi-channel seismic for 1D/2D passive seismic and all conventional active and passive seismic (MASW, REMI, refraction, reflection)
- Lightweight, A-D conversion at geophone take-outs
- USB direct connection and power with PC only
- Comes with Grilla and acquisition and data processing software

ELECTRA
- Self-contained networked multi-channel resistivity surveying and ERT
- Lightweight A-D conversion at cable
- USB direct connection to PC, comes with acquisition software

For instrument sales, Tromino® trade-ins, rentals, data processing and surveying enquiries, please call + 61 8 9289 9100 or email info@respot.com.au

www.respot.com.au
In July 2017, seven months after the inaugural Minerals Council of Australia funded National Exploration Undercover School, participants reconvened in Adelaide to compare and reflect on the impact the program has had on their careers and professional development pathways, and how their careers have progressed.

A one-day workshop was organised by NExUS coordinators Graham Heinson, Richard Lilly and Anna Petts and was hosted at the Science Exchange in Adelaide’s CBD.

To kick off the workshop, Joe Milton from Science Communication presented on topics related to the importance of scientific writing and how to communicate with the audience without relying on overly technical terms and vocabulary. Although geologists don’t often directly release information to the media, it is important that we are aware of these skills to apply them through documents such as project development reports.
These transferable communications skills are also vital in the economic geology industry to assist with effective communication between, for example, different technical specialist groups and management.

As exploration geologists, we are often among the first to initiate discussions for matters relating to cultural heritage and to organise meetings with local stakeholders. Therefore, it was fantastic having Glenn Wingfield representing the Kokatha people and Andrew Wingfield (HSE superintendent, Oz Minerals) both attend to provide their perspectives. We learnt that open and transparent communication between all stakeholders are fundamental during the early stages of any exploration program.

During the afternoon, Tim Craske (Thinker Cafe) presented a range of thinking theories, perspectives on mentoring and how to make decisive decisions in career pathways.

Richard Lilly also gave an insight into S-IMEW (Student-Industry Minerals Exploration Workshop), a similar program to NExUS that has been successfully run in Canada by the Prospectors and Developers Association of Canada (PDAC) for the last 11 years.

To round off the day participants had time to reflect on what were the most beneficial aspects from NExUS which helped to launch themselves in the industry. During this discussion some common themes popped up:

- The benefits of effective networking.
- Building personal confidence in different aspects of technical geology.
- Awareness of and implementation of new and emerging technologies.
- A holistic approach in exploration looking at all data sources.
The NExUS cohort of 2016 is a group of geologists who have cemented a strong network across Australia which effectively spans the distances between them. Participants have passed on opportunities across the group and actively used not only their immediate connections but have continued to grow each other’s networks.

“As exploration geologists, we are often among the first to initiate discussions for matters relating to cultural heritage and to organise meetings with local stakeholders.”

LinkedIn: linkedin.com/company/alexander-research-pty-ltd
Twitter: AlexanderValue
Email: info@alexanderresearch.com.au
It is a testament to the high calibre of participants who are constantly looking at ways to improve and develop the current resources industry within Australia.

"Through building my networking and communication skills it has helped me gain work and has allowed me to be more confident when talking to people across multiple work situations, for example landholders, laboratories and during conferences." Charlotte Barry, NExUS 2016

It is fantastic to see almost all of the thirty participants (who were not completing their Honours or Masters degrees) had secured themselves a role within the resources industry (see below). Some of the major hiring companies from the NExUS cohort include: Fortescue Metals Group, Rio Tinto, KCMG, and BHP. It is exciting to see that the participants are transferring the skills learnt during NExUS to directly contribute to discovering and developing Australia’s next tier one deposits.

NExUS 2017 will take place between 26th November and 16th December and is set to build on last year’s success. A new cohort of 33 exceptional and eager geoscientists have accepted their places on the 2017 program, which is shaping up to be just as fantastic as the inaugural year.

For further information please email nexus@nexus.org.au.
Smart Use of Smart Technology and Data

Steven Williamson
Victoria Branch Chairman

On a very pleasant Spring day in the lee of Mt Macedon some 80 delegates gathered for the Annual AIG Victorian Conference. The theme for the day was Smart Use of Smart Technology and Data. A broad topic but underlying the theme is the existential question, what is the future for geoscience and geoscientists.

What skills will we need as Geoscientists to interpret the data presented to us? How will we add value to understanding the data?

We assembled 12 speakers from academia and industry to share their thoughts, research and experience on various aspect of the topic. Our first keynote speaker, Professor Peter Betts from Monash University talked about how new data and smart technology tools such as geophysical inversion, 3D modelling, reconstruction, image processing and geodynamic modelling have made a world of difference to Geoscience in terms of mapping the surface and understanding the interior. He noted that from a geophysics perspective Australia is relatively data-rich (spatially) but
we seem hell bent on collecting more and more. We are happy collecting and processing data but less comfortable interpreting it due to a lack on investment in training people to interpret the data.

He observed that becoming reliant on the new “SMARTER” technology could lead geologists to switch off their brains or reduce their thinking time. The challenge he suggested is to use the SMART technology to assist the Geoscientist to achieve more – not make them redundant.

For our second Keynote we were treated to a tag team from UWA, Bruce Hobbs and Alison Ord, who challenged our powers of comprehension with talks on “Hydrothermal mineral systems as nonlinear dynamical systems” and “Data driven geological models: how to comprehend big data”. It left us a little dizzy as we tried to absorb concepts such as The Attractor – the complete range of states that the system occupies, The Embedding Dimension - the multidimensional space in which the attractor lives, Recurrence Plots and Non-parametric Non-linear Prediction.

The take home message was that hydrothermal systems can be analysed using the same techniques that have been developed for analysing climate systems. These include techniques for measuring the multifractal nature of the system, nonlinear correlations, recurrence plots and quantitative measures that can be derived from such techniques including predictability and determinism. All of these techniques are based on the PROCESSES that operated in the system. They are data driven with no model assumed.
Other speakers included Professor Steven Micklethwaite from Monash University talking on Photogrammetry and Neural Networks, Bert De Waele of SRK Consulting on Paperless Mapping and Cameron Cairns from the GSV on the 3D Explicit modelling they have undertaken on the Stavely Arc.

The full list of speakers is on the AIG website and PDFs of most presentations will be posted shortly.

The GSV was the Gold Sponsor for the event and we would like to thank them along with our other sponsors for their contribution to the success of the event.

One lucky attendee Andrew Wilson took home an Amethyst Geode Slice generously donated by Crystal World, and Mike Love was the recipient of a GoPro donated by East West Drilling and Mining Supplies.

ALS Minerals and On Site Laboratories kindly sponsored our lunch and post conference drinks. We would also like to mention Fiona, Wency and Peta from MRGraphics, our Silver Sponsor and IT provider, who greatly assisted with the staging of the event and arrangements for the day.

Lastly special mention goes to Rod Boucher, Peter Caristo and Ben Jupp, our Conference Sub-Committee for their work in planning the event and putting together an impressive list of speakers.

Season’s Greetings
from the AIG

Wishing everyone a joyous holiday season and prosperous 2018!
With over 500 delegates in attendance, this year’s South Australian Exploration and Mining Conference was a huge success. The conference has been held annually near the end of each year since 2004 and grows from strength to strength.

The conference is designed to provide an opportunity for active mineral explorers and miners to present succinct technical updates to their peers of activities on their flagship mines and exploration projects. Participants gain a comprehensive appreciation of the diverse activities in South Australia and gain ideas from each other which collectively improve our chances of mineral discovery and improved mining developments.

The conference is organised by a voluntary committee representing five local branches of professional associations:
- Australian Institute of Geoscientists (AIG)
- Australian Society of Exploration Geophysicists (ASEG)
- Australasian Institute of Mining and Metallurgy (AusIMM)
- Geological Society of Australia (GSA)
- South Australian Chamber of Mines and Energy (SACOME)

This year’s program covered themes including:
- Early stage exploration projects
- Mature exploration projects and feasibility studies
- Feasibility studies and mines
- Mines

This was a great conference to attend from a technical perspective, and was also a terrific networking opportunity to catch up with so many of our peers just prior to Christmas. The before and after conference workshops were well attended and I’d recommend you mark the first Friday of December next year in your calendar to attend this event in 2018.
 Hobart put on glorious weather for the Tenth International Mining Geology Conference in September, jointly hosted by the AIG and AusIMM.

Topics covered across the three days included:

- Advances in grade control and reconciliation
- Case studies in brownfields exploration
- Case studies in resource modelling
- Case studies in grade control and reconciliation
- Mining geology and geotechnical and mining engineering
- Case studies and advances in sampling practice
- Advances and case studies in geometallurgy and geoenvironment
- The future of mining geology
- Organisational, social, economic and political environment
- Advances in grade control and resource modelling

Bob Findlay, federal AIG councillor, presented on Professionalism in the industry - if you’ve not completed our survey on this topic, please do so prior to the 15th January 2018 when the survey closes (see page 9).

Ashleigh Smyth attended representing the AIG National Graduate Group (NGG) and spoke to a full room of upcoming students on the benefits of a group like the NGG and tips regarding transitioning from university to industry and how to land that job. For the full report from Ashleigh and Lance Glasser, please see page 53.

Well done to all involved in the organising committee! 🎉
Groundwater is a critical ingredient in production at most mines in Australia. So, Brian Luinstra finds it astounding that many mine operators still see demonstrating the viability of a water source as a “regulatory tick box” rather than a critical factor in the feasibility of their projects.

At least one-quarter of mining projects in Australia encounter some type of groundwater challenge. Luinstra, SRK Australia’s Perth-based principal consultant (hydrogeology), says it is therefore practical to include a hydrogeological assessment as early as possible in the exploration phase. Ideally, prior to the scoping study, he says.

“As a mining hydrogeologist, I’ve seen projects go under as a result of having too much or too little water, or water which is contaminated,” he says. “In my experience, water often doesn’t seem to be front of mind in the early stages of Australian mining projects.”

Luinstra says it is common to wait until the bankable phase of the project to investigate the project’s water supply. But that is too late. “When millions of dollars are on the line, complacency about groundwater can put the profitability of the entire project at risk. Too often, the task begins well into the mining project development cycle and valuable groundwater data that could easily be collected during exploration is overlooked,” Luinstra says.

While the early understanding of groundwater needs and issues can help save costs in the long-term, it can also provide valuable guidance for future work. The information gathered, properly interpreted by a professional, can also be invaluable for assessing risks and acquiring the level of detail of the required groundwater investigations for project development.

“Understanding the groundwater system is essential to the success of any mining project. Dewatering is often required for open-cut and underground operations, and groundwater is a critical water supply source for processing operations. Managing the impacts of seepage from waste rock landforms and tailing facilities on aquifers is often a critical component of environmental assessment to meet mining regulations.

“The impacts of failing to adequately understand the groundwater system can result in reduced mill throughputs, increasing drilling and blasting costs and regulatory issues related to water disposal from excess dewatering,” Luinstra says.

“All these factors can have profound impacts on project economics and in rare cases, the profitability of the entire project.”
cases have resulted in some operations becoming perilously close to failure."

Traditionally, mine operators have viewed dewatering, sourcing sustainable water supplies and ensuring minimal environment impacts on nearby water sources from run-off as manageable risks. However, these risks have been heightened with increased production rates and the push to mine deeper and farther below the water table.

These factors have increased the groundwater-related risk profile, says Luinstra. "Even though the risk profile has been elevated, the work required to address these risks is not always completed until far too late – and in some cases not all – in the project development cycle," he says.

In his 20 years working in hydrogeology field, Luinstra has seen first-hand many projects fail, or nearly fail, due to unexpected water supply complications. These could have been overcome and planned for if early investigations had been implemented in the project planning cycle, he believes.

"One project that I have been involved in was at an advanced stage before the operators realised they needed to build a 10km pipeline to tap the nearest water source," Luinstra says. "Very few companies accurately estimate their water costs before the development phase."

Mining operators need to understand that water complications, and a lack of understanding of quality and quantity, as well as water costs and consumption, can have significant economic impacts on a project. "Ultimately, the cost of acquiring this information later in the project will be much higher and cost valuable time, so it pays to start early," he says.

For more information contact Brian Luinstra, Principal Consultant at SRK Consulting, Australia. Brian provides technical direction and review on hydrogeological projects.

THE COMPLETE SOLUTION ➔ QUALITY DATA, DELIVERED EFFICIENTLY

Data Compilation and Management (historical and current data)
Desktop Assessment Reports
Competent Person Reports
Compilation of Code Compliant Mineral Resource Reports (eg. JORC, NI 43-101)

LIKE SOME MORE INFO!

Map to Mine

Contact Dee or Michael for a helpful friendly chat (07) 4724 1199 www.maptomine.com.au
The 2017 Tenth International Mining Geology Conference, held in Hobart during September this year, hosted a variety of Australian and international mine geologists. The conference provided the perfect stepping stone to enhance AIG National Graduate Group (NGG) presence in the mining community as well as raise awareness among new professionals who attended the conference.

AIG NGG representative Ashleigh Smyth (St Barbara Ltd), joined AusIMM New Professional Network Member Simon Travers (Rio Tinto) and Elliot Khan (BHP) in presenting to approximately 40 UTAS geology and environmental students. The new professionals spoke about their personal transition from university into the industry, tips to land ‘that job’ and the importance of being a part of professional bodies (such as AIG & AusIMM). It was a great opportunity to highlight the benefits the AIG National Graduate Group offers, including:

- Mentoring Program
- Soft Skill Workshops
- Networking opportunities across Australia

Another initiative during the conference was the Early Career Quick Fire Presentations which encouraged early career professionals to present on a technical discussion in a less than 2 minutes. This involved the skill of professional speaking and conveying critical ideas in the current industry environment. A major theme from the conference highlighting the important of the fundamentals of geology in a progressive environment of new technology and innovation.

It was a positive to see a strong presence of companies at the conference. NGG is looking forward to providing more opportunities for the next generation of geoscientists in 2018. If you would like to get involved please contact the Genna McDonagh NGG Chair via email nationalgraduatecommittee@gmail.com.

Lance Glasser & Ashleigh Smyth

CSA Global Mining Industry Consultants

For expertise and services from project generation through to mine production, CSA Global cover all stages of the exploration and mining cycle.

Our broad experience and integrated approach result in high quality solutions for our clients in areas such as:

- EXPLORATION
- RESOURCES
- MINING
- TECHNOLOGY
- CORPORATE

www.csaglobal.com

Head Office
Level 2, 3 Ord Street, West Perth
Western Australia 6005

T +61 8 9355 1677
E csaaus@csaglobal.com
New Rock for the National Rock Garden

Ken McQueen
AIG Representative, National Rock Garden Steering Committee

On the 1st November a large block of Mount Gibraltar Microsyenite was added to the growing collection of iconic rocks at the Australian National Rock Garden. The Mount Gibraltar Microsyenite is a small alkaline intrusive body emplaced into Triassic Hawkesbury Sandstone at around 178 Ma BP. It is now exposed as an imposing mountain 863 m high, near Bowral in the Southern Highlands of New South Wales. The rock is a dark pinkish grey colour and prized by stone masons for its qualities of dense strength and durability. It provides a rare example of a feldspar-rich, magmatic rock that contains siderite (FeCO₃).

Known commercially as the Bowral Trachyte, the Mount Gibraltar Microsyenite has been quarried and used extensively as a decorative building stone in Sydney and the Southern Highlands. In Sydney it features in the Queen Victoria Building in George St, Challis House in Martin Place, the ANZAC Memorial in Hyde Park and the 1901 Commonwealth Stone in Centennial Park. It was used for the Canberra foundation stone, for many war memorials and in Australia House in London. It was also quarried for ballast in construction of the Great Southern Railway line from Mittagong to Goulburn. The Mt Gibraltar quarries were an important aspect of Bowral’s industrial history. The quarries closed in 1986 and are now part of a heritage reserve and popular tourist attraction.

This important rock was donated by Wingecarribee Shire Council. The $3000 cost of transportation and preparation of a plaque and polished surface was covered by a generous donation of $2000 from the Mount Gibraltar Landcare & Bushcare Volunteers and a $1000 grant from the Veolia Mulwaree Trust.
Events calendar 2018

Keep up to date with upcoming AIG and Geological events at www.aig.org.au/events

- EGRU PD Training - Integrated Spatial Analysis and Remote Sensing of Exploration Targets
  January 8-17, 2018
  James Cook University, Townsville QLD

- EGRU PD Training - Ore Textures and Breccias: Recognition Techniques
  January 23-25, 2018
  James Cook University, Townsville QLD

- EGRU PD Training - Core Logging Techniques
  January 29-30, 2018
  James Cook University, Townsville QLD

- EGRU PD Training - Business and Financial Management for the Minerals Exploration Industry
  February 5-16, 2018
  James Cook University, Townsville QLD

- AEGC 2018: First Australian Exploration Geoscience Conference
  February 18-21, 2018
  Sydney International Convention Centre, Sydney NSW

- AEGC2018 conference presentation skills workshop - Find your Voice - Present with Confidence
  February 18, 2018
  TBA, Sydney NSW

- AIG SA: Metamorphism of Massive Base Metal Sulphide Deposits
  April 5-6, 2018
  Regal Park Motor Inn, North Adelaide SA

- AIG SA: Broken Hill Field Workshop
  April 9-13, 2018
  TBA, Broken Hill NSW

- Resources for Future Generations: RFG 2018
  June 16-21, 2018
  Vancouver Convention Centre, Vancouver, British Columbia, CANADA

- Gold2018@Perth
  August 2-3, 2018
  Perth WA

- AGCC 2018
  October 14-18, 2018
  Adelaide Convention Centre, Adelaide SA

---

PETROLOGICAL (CONSULTING) SERVICES
Roger G Taylor (PhD, DIC, MAIG)
Descriptive and overview interpretation of:-
  • Ore Textures
  • Breccias
  • Alteration
  • Paragenetic sequencing
  • Gossans-leached outcrops/supergene enrichment
Porphyry copper, IOCG, Skarn, Carbonate replacement, Tin-Tungsten
Epithermal and Granite related gold systems
roger-taylor@bigpond.com
Mobile 0417621273 Phone 0363265562

---

Mineral Resources Bulletin 25
GEMSTONES OF WESTERN AUSTRALIA
SECOND EDITION
by J Michael Fetherston, Susan M Stocklmayer, and Vernon C Stocklmayer

To order your copy:
email <bookshop@dmp.wa.gov.au>
or call +61 8 9222 3459

* Purchase five or more copies for $40 per book
AIG NEWS

AIG News is published quarterly as per the following table.
Avoid disappointment by contacting the Editor at least several days beforehand to advise submission of items for the newsletter.

<table>
<thead>
<tr>
<th>Issue Date</th>
<th>Contribution deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>January 31st</td>
</tr>
<tr>
<td>June</td>
<td>April 30th</td>
</tr>
<tr>
<td>September</td>
<td>July 31st</td>
</tr>
<tr>
<td>December</td>
<td>October 31st</td>
</tr>
</tbody>
</table>

AIG News is published by the Australian Institute of Geoscientists to provide information for its members and a forum for the expression of their professional interests and opinions. Observations, interpretations and opinions published in AIG News are the responsibility of the contributors and are not necessarily supported by the Australian Institute of Geoscientists or the Editor of AIG News.
While the Editor and the Australian Institute of Geoscientists have taken all reasonable precautions and made all reasonable effort to ensure the accuracy of material contained in this newsletter, they make no warranties, express or implied, with respect to any of the material published in AIG News.

The business address of AIG News is:
PO Box 576, Crows Nest NSW 1585
Tel: (02) 9431 8662  Fax: (02) 9431 8677
Email: aig@aig.org.au  Web: www.aig.org.au
Please use these contacts for all matters relating to changes of address or membership.

The editorial address is:
Editor: Fiona Makin
Email: editor@aig.org.au
Tel: (03) 5422 3337
Please submit all articles, letters and advertisements to the above email address.

SUBMISSION FORMATS
Text: Word Files (Please DO NOT EMBED pictures in Word, supply as separate files.) Pictures, Logos, Maps, Diagrams: Resolution 300dpi. Photoshop EPS, Tiff, Jpeg or press-optimized PDF files. Please provide images of all pictures separate to text. Please EMBED ALL FONTS in EPS and PDF files.

ADVERTISEMENTS
AIG News provides an ideal opportunity to advertise your company and services to the AIG membership throughout Australia (and some overseas). There are over 2,800 members who receive the newsletter four times per year. Please contact the Editor for further details or to book advertising.
Note: All advertisements; no bleed or trim marks.. Prices are inclusive of GST Per Issue.

| Full page | 264 mm (h) x 188 mm (w) $545 |
| Three quarter page | 200 mm (h) x 188 mm (w) $458 |
| Half page | 130 mm (h) x 188 mm (w) or 264 mm (h) x 90 mm (w) $372 |
| Third page | 90 mm (h) x 188 mm (w) $273 |
| Quarter page | 75 mm (h) x 188 mm (w) or 130 mm (h) x 90 mm (w) $198 |
| Business card | Members 90 mm (h) x 55 mm (w) $25  Non Members 90 mm (h) x 55 mm (w) $125 |