



THE SCHOOL OF MINES. BALLAARAT.

School of Science, Engineering and Information Technology
Geoscience and Mining Group

2018

ANNUAL REPORT

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Front cover image: Courtesy of Federation University Historical Collection.

Introduction

Federation University Australia has a strong history with Geology, Metallurgy and Engineering as the founding disciplines when it was established in 1870 as the School of Mines and Industries Ballarat (SMB). In the early history, the international fame of SMB's education in mining brought distinguished visitors from across the globe, such as the Chinese Imperial Commissioner, Hwang How Cheng, at the behest of the Chinese Emperor. In December 2018 the teaching of geology from the earliest days of the institution was recognized by a visit from the great and great-great-grandsons of SMB's first lecturer in geology, Prof. Ferdinand Moritz Krause.

Recent program reviews commended Federation University Australia for the strong and positive reputation that staff and graduates hold with industry. The review also acknowledged that Federation University is the only Victorian university that offers a 3-year pathway to geoscience/geometallurgy careers, with high employment rates post-graduation.

The following report has been prepared by Federation University staff in mining engineering, geology and metallurgy. This is the first Annual Report for the group and presents some of the staff and student achievements/activities for the calendar year 2018. Highlights of the year include a staff member receiving a prestigious medal, organizing the AusIMM Central Victoria Regional Symposium, and the award of several grants. A group of undergraduate students was invited by Rio Tinto to examine mining in the Pilbara, while another benefited from New Colombo Plan awards from the Australian government to visit Timor-Leste to study its geology.

We hope you enjoy this insight into the work by mining-related disciplines at Federation University Australia.

Annual Goals

- Maintain existing and build new networks within industry.
- Provide students with industry connections and quality educational experiences.
- Conduct research with industry and geology/metallurgy/mining engineering disciplines.
- Increase program marketing and promotion both inside and outside of the University.

Contributing Staff

Dr. Stephen Carey	Geologist	- <i>Sedimentology, Stratigraphy, Regolith and Palaeontology</i>
Nicole Cox	Geologist	- <i>Structural Geology, Tectonics, and Geomorphology</i>
Dr. Ander Guinea	Geologist	- <i>Applied Geophysics, and Hydrology</i>
Dr. Manoj Khandelwal	Mining Engineer	- <i>Rock Fragmentation, Surface Mining Operations, and Slope Stability</i>
Larissa Koroznikova	Metallurgist	- <i>Inorganic Chemistry, Mineral Processing, and Metallurgy</i>
Stafford McKnight	Geologist	- <i>Mineralogy, Petrology, Structural Geology, and Analytical Techniques</i>
Haydn Swan	Geologist	- <i>Economic Geology, Exploration Geochemistry, GIS, and Environmental Contamination</i>
Associate Professor Michael Tuck	Mining Engineer	- <i>Mine Planning, Subsurface Mining Operations and Conditions, including Ventilation</i>
Dr. Greg You	Mining Engineer	- <i>Rock Mechanics, Mine Power and Services, and Surface Mining Operations</i>

FedUni academic awarded prestigious Selwyn Medal

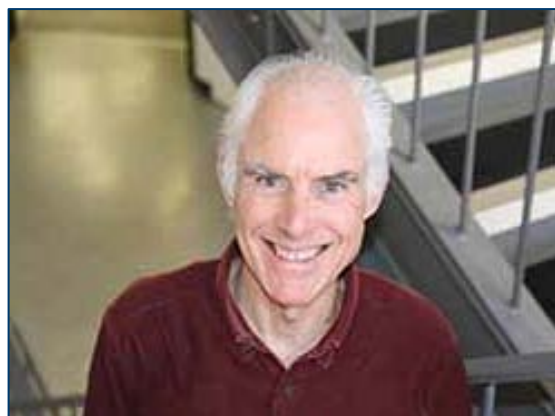


Federation University Australia academic **Dr. Stephen Carey** has been announced as the recipient of the 2018 Selwyn Medal, the premier geology award in Victoria. The award recognises “significant ongoing, or former, contributions of high calibre to any field of Victorian geology”. Steve, Lecturer in Geology, teaches palaeontology, sedimentology, stratigraphy, regolith science and fieldwork.

“I am delighted and honoured to be presented with this prestigious award,” Steve said. “I have been involved in geology for all my academic life. To be acknowledged with the Selwyn Medal is very much a career highlight for me. My thanks go to the Geological Society of Australia’s Victorian Division and my industry colleagues for the award of this Medal.”

Professor Leigh Sullivan, Deputy Vice-Chancellor (Research and Innovation), said the award of the Medal to Dr Carey was recognition of the significance of Steve’s contributions to Victorian Geology. “On behalf of the University, I congratulate Dr Carey for his achievements in geology,” Professor Sullivan said. “He also has been a wise mentor for many of our students over the years.”

Steve’s research is mainly concerned with the Australian trace fossil record of Pleistocene vertebrates, the development of silcrete in humid regions, and the stratigraphic context of a possible early human site at Moyjil, Victoria.



Dr. Stephen Carey. On the right, Dr. Carey and students are pictured near a megafuana fossil trackway site along the edge of a lake on the Western District plains (source: Courier, 2009).

Achievements and Appointments with Professional Organizations

AusIMM's 125 Faces

For more than a century, the Australasian Institute of Mining and Metallurgy (AusIMM) has been a cornerstone for the resources sector, providing consistent support and advocacy for professionals. Throughout its history, AusIMM members have made significant contributions to the resources sector.

Larissa Koroznikova has been selected as one of 125 faces in the Australian Industry of Mining and the AusIMM's 125th Anniversary. The campaign showcases a range of hardworking, talented, and inspiring people from the Institute and industry reflecting the diversity of experience, age, gender and background of industry professionals. The 125 faces citation for Larissa is as follows:

"...Larissa is a major contributor to the AusIMM Central Victoria Branch Committee, where she has contributed to the organisation of numerous technical seminars and student presentations. She is also a major proponent of the resources sector to the wider community, profiling the industry through arts, articles, the media and practical workshops in schools."

AusIMM 20-years Membership

Assoc Prof. Michael Tuck was awarded a certificate recognising twenty continuous years of membership with the Australasian Institute of Mining and Metallurgy (AusIMM) at the recent president's dinner held in Ballarat.

GSA 40-years Membership

Stafford McKnight received a forty-year membership recognition from Australia's premier geoscience society, the Geological Society of Australia (GSA). McKnight has also been accepted as a full-member of the Australian X-ray Analytical Association (AXAA).

Society, Conference and Symposium Appointments

Dr. Manoj Khandelwal has been elected as a Professional Member of the Society for Mining, Metallurgy and Exploration (SME).

Dr. Khandelwal was appointed as a Scientific Committee Member for SME's 2nd International conference on Energy & Power, held in December in Sydney. He was also appointed as an Organizing Committee Member for the 3rd International Conference on Geo-Mechanics, Geo-Energy and Geo-Resources (IC3G) held in September in China, as well as the 3rd International Conference on Civil Engineering, which took place in December in China.

Dr. Khandelwal was part of the International Technical Committee for the 2nd World Symposium on Civil, Environment and Building Engineering held in August in Bali and the 3rd International Symposium on Civil and Environmental Engineering; Computing, Modelling and Simulation, which was held in Hong Kong in December.

Assoc. Prof. Michael Tuck has been appointed to the organising committee for the 12th International Mine Ventilation Conference (IMVC), Sydney 2022. Selecting Australia to host the next prestigious international Mine Ventilation Conference is a strong endorsement of the Australian mine ventilation engineering community, including mine ventilation engineering professionals, academics, researchers, equipment suppliers and regulatory bodies.

Assoc. Prof. Michael Tuck was also appointed as a Member and Technical Stream Co-Chair to the Automation in Mining Engineering – IEEE Conference, which will take place in February 2019 in Melbourne. The IEEE International Conference on Industrial Technology is one of the flagship conferences of the IEEE Industrial Electronics Society. This prestigious event is held every year in a different part of the world. The main theme of the conference is Advanced Technology in Service of Resources Industry. In addition, there will also be a special stream on Automation in Mining Engineering.

Prof. Tuck has been appointed a Member of the organising committee for the Australian Mine Ventilation Conference 2019 in Perth. This is the fifth time this highly successful conference has run and is the first time it has been held in Western Australia.



An Editor-in-Chief and Editorial Board Member

Dr. Manoj Khandelwal was appointed as an Editor-in-Chief for the International Journal of Mining Science, ARC Journals, Journal of Mining Engineering and Safety Technology, Clausius Scientific Press Inc. and International Journal of Geological Resources and Geological Engineering, Clausius Scientific Press Inc.

Dr. Khandelwal has also been appointed as an editorial board member for the International Journal of Mining Engineering and Technology (Unique Pub International), Journal of Geotechnical Engineering (STM Journals), SCIREA Journal of Mine Engineering (Science Research Association) and SCIREA Journal of Safety Science and Technology (Science Research Association).

Peer Review Award

Dr. Manoj Khandelwal has been awarded a Publons Peer Review Award 2018 for placing in the top 1% of reviewers in both Engineering and Geosciences. The top 1% of reviewers in each field are those who performed the most verified pre-publication peer reviews on Publons for 2018.

Monetary Awards and Support

Dr. Stephen Carey and **Nicole Cox** were successful applicants for the Australian Government 2018 New Colombo Plan Mobility Program. The grant provided \$30,000 AUD in scholarships to support ten Geoscience students in a study course to Timor-Leste, which took place 19 September to 5 October, 2018.

Assoc. Prof. Michael Tuck received a \$ 10,000 AUD research contract with Anglo American Metallurgical Coal to investigate the effectiveness of Effective Temperature as a heat stress index. This study will review the applicability of the Effective Temperature heat stress index for application in underground coal mining in Queensland. The study will focus on the basic Effective Temperature index, given the requirement for miners to be fully clothed underground.

Research funded by the School of Science, Engineering and Information Technology (SEIT)

Dr. Greg You has initiated a pedagogical project called “Mine Tunnelling Virtual Education”. The school has strongly supported this initiative with the establishment of a new laboratory known as the Emerging Technologies Laboratory. Dean, Professor Syed Islam, has taken leadership and prepared an Australian Research Council Linkage Infrastructure, Equipment and Facilities (LIEF) grant application entitled “Virtual and Augmented Reality Simulation Laboratory for Next Generation Mining and Relevant Research”.

Geoscience and Mining program researchers as well as Higher Degree by Research (HDR) students have been successful in securing funding through SEIT to support research across the school in 2018. One such opportunity was the Research Support/Training Programs.

Larissa Koroznikova, **Stafford McKnight** and Associate Professor Jason Giri successfully obtained funding for research into the effects of mechano-chemical treatment on recovery of gold from refractory ores.

Dr. Greg You received support to investigate (1) interfacial shear strain propagation of high strength rock bolt using embedded Fibre Bragg Grating (FBG) sensors and (2) the effect of shape on crack development of model pillars of different cross-sections using FBG sensors.

Dr. Ander Guinea received support to investigate the boundaries and ground properties of decommissioned landfill sites using geophysical resistivity methods.

Haydn Swan and Assoc. Prof. Kim Dowling have likewise received support to investigate mercury contamination in decommissioned landfills.



Dr. Guinea and Haydn Swan running resistivity surveys and testing for mercury contamination at the Chisolm Reserve, Ballarat.

AusIMM Central Victoria Regional Symposium

The Central Victoria Regional Symposium hosted by AusIMM and the School of Science, Engineering and Information Technology was held on 14th September. The gathering was attended by more than 75 delegates from industry, professional bodies and FedUni. Feedback received from the delegates was outstanding. This was the fifth such event held in the past five years, which has seen close to a total 400 delegates converge upon Mt Helen.

The AusIMM, Australia's primary body representing professionals in the minerals industry, is celebrating its 125th anniversary this year. Federation University Australia and the AusIMM share a common history in many ways. The former commenced with the School of Mines and Industries Ballarat in 1870, whilst the latter was established in Adelaide in 1893 but had its first meeting to discuss its establishment at the George Hotel in Ballarat in 1892. Both organisations can claim their alumni and members have contributed much to Australasia's economic growth and social wellbeing. Federation University Australia has supported the Central Victoria branch of the AusIMM over many years.

The symposium was an opportunity for the Institute's Victorian members to become acquainted and share information, experiences and opportunities regarding the latest happenings within the minerals industry. Students and young career enthusiasts also had opportunities to engagement with AusIMM members.

Prof. Islam Syed, Dean of SEIT, welcomed delegates and facilitated the Symposium. Presenters include Prof. Keir Reeves (Federation University), Sandy Gray (Gekko), Peter McCarthy (AMC), Serena Ioannucci (The Sovereign Hill Museums Association), David McInnes (Search Exploration), Lauren Swann (Kirkland Lake Gold), Bill Reid (Castlemaine Goldfields), Paul Quigley (Catalyst), Danny Kentwell (SRK), Aaron Reed (Rio Tinto and recent graduate of Federation University Australia) and consultant, Dennis Arne, who is a former lecturer at Federation University.

Topics covered during the morning session were:	Topics covered during the afternoon session were:
• Mining History Respective	• Geological Tourism
• Innovations at Gekko Systems	• The Next Chapter in the Long Story of Mining at Ballarat
• History of Sovereign Hill Ballarat	• Exploring for Bendigo-Style Mineralisation Under Cover
• History of Women in the Victorian Goldfields	• Destroying the Distinction Between Implicit and Explicit Modelling
• How to Find an Orebody with EM.	• Reflections of a Recent Graduate.

At the closing of the event, Angela Lorrigan and Stafford McKnight thanked:

- The University for providing the venue and sponsoring the event
- On Site Laboratory Services, Kirkland Lake Gold, SWICK, GBM Gold Ltd., ChemiPlas, Catalyst Metals Ltd., HMP Drilling Services, Mining Plus and Pybar Mining Services for their valuable contributions
- All presenters for their contributions
- AusIMM for promoting the event
- All delegates and supporting industries for their attendance.

The Central Victoria branch also thanked others who helped to make this event a great success. It was achieved through outstanding teamwork including Federation University, professional bodies, industry and the wider community.

Rex Berthelsen, past president of AusIMM.



Delegates from leading industries, professional bodies and University in the morning session.

Ballarat Technical Talk by Stafford McKnight, Central Victorian Goldfield Indicators

The AusIMM Central Victoria branch and Ballarat Geology hosted a technical presentation by guest speaker **Stafford McKnight** on Central Victorian Goldfield Indicators on 18th October.

Stafford is a long-time lecturer in mineralogy, petrology and structural geology at Federation University. His main interests are in the application of x-ray diffraction and transmission electron microscopy techniques to mineralogy. His current research projects include lithium-tantalum-niobium (LCT) pegmatites of eastern Victoria and the Indicators of the central Victorian goldfields. Stafford is an active consultant to the Australian mineral and ceramic industries.

Stafford presented a summary of the historical records of Indicators together with analyses of about twenty samples from Ballarat and other goldfields.

In the 1870's, Ballarat hard-rock miners discovered that certain persistent "favourable beds" with distinctive features, if followed were likely to lead to appreciably higher gold occurrences when intersected by or associated with quartz-reef systems. These favourable beds or structures are the Indicators. Some were correlated for some distance across the Ballarat goldfields and were given descriptive names, e.g. the Pencil Mark, the Double Indicator, the Black Seam and the Red Steak. Most Indicators are thin (1-20mm), generally bedding-parallel, carbon and/or sulphide-rich laminae hosted in or part of the general slate sequences. Indicators were subsequently also recognised at other central Victorian goldfields.

Considerable differences in the interpretation of these structures exist in the historical records and also in more recent accounts. Stafford explained that the Indicators share some significant common characteristics and some differences in mineralogy and other characteristics, as described in historical records. These structures are somewhat enigmatic, and research into their significance is ongoing.



(above) Audience paying close attention to the presentation on Central Victorian Goldfield Indicators by Stafford McKnight.



The audience packed the top floor of the Mallow Hotel, Ballarat.

Government funded Timor-Leste Study Tour and Ongoing Relations

Advanced Fieldwork Course to Timor-Leste



Consistent with the saying that 'the best geologist is the one who has seen the most rocks', the advanced fieldwork excursion to Timor-Leste in Sept-Oct provided FedUni geoscience students with the opportunity to examine a geological setting that contrasts strongly with that of modern Australia. The island of Timor is situated at the northern edge of the Australian plate in a very active tectonic environment. It features a young uplifted landscape due to a tectonic collision between the Australian continental shelf and the Banda Volcanic Arc, which initiated approximately 8 million years ago.

Over 16 days, **Nicole Cox**, Prof. Ron A. Harris (Brigham Young University), and **Dr. Stephen Carey** took participants to a variety of localities (including Dili, Same, Viqueque, Baucau, Com and Los Palos) selected to provide insight into the geologic complexity that is Timor-Leste. Several topics were addressed, such as identifying and measuring structures of various scales (temporal and spatial), describing lithostratigraphy but also understanding the importance of biostratigraphy, assessing geologic hazards, and the role of orogens with natural resources. Assessed components of the course included pre-trip presentations, a geologic map compiled in the field, measured and correlated stratigraphic columns, quality of field notes and overall professional conduct. An important part of the excursion was the involvement of Timorese geologists from the Instituto do Petróleo e Geologia (IPG) and students from the Universidade Nacional Timor Lorosa'e (UNTL) who provided a local perspective to both the geology and unique culture.

The course was primarily funded by the New Colombo Plan Scholarship Program, which provides opportunities for Australian undergraduate students to undertake semester-based study in one of 40 participating Indo-Pacific locations. The New Colombo Plan was established by the Minister for Foreign Affairs, the Hon Julie Bishop MP in 2014. The New Colombo Plan is a partnership between government, universities and the private-sector to provide a new generation of Australians with direct experience of living, studying and undertaking work placements in the Indo-Pacific.



(above left) Excursion participants discuss the duplexed Maubisse Formation with the crinoid-rich Maubisse limestone cliffs in the background and a traditional hut near the cliff base.



(above right) Nicole Cox (FedUni), Isaias Barros (IPG), Ron A Harris (BYU), and Paulo Carvalho (IPG) on top of Mount Fleicha while exploring the excursion destinations.

Alfredo Pires Scholarship

FedUni is offering an HDR scholarship, the Alfredo Pires Scholarship, to an eligible Timorese student to study a geological project. Alfredo Pires, a graduate of FedUni's geology program, was named FedUni's inaugural International Alumnus of the Year in 2014 because of his distinguished service as the long-time Minister for Petroleum and Natural Resources in Timor-Leste.

The first scholarship recipient, Mr Valente Ferreira, will commence his PhD candidature in March, 2019, to investigate a hydrogeological problem in Timor-Leste. His supervisory panel will include Peter Dahlhaus (principal) and **Dr. Stephen Carey** (associate), as well as a co-supervisor from RMIT University. Mr Ferreira had the opportunity to join the latter half of the Advance Fieldwork course mentioned on page 12.

4th International Geoscience Conference on Timor-Leste Resources

Nicole Cox was in Dili, Timor-Leste, in November as one of seven invited keynote speakers for the 4th International Geoscience Conference on Timor-Leste Geological Resources Data and Information for Economic Diversification and Development. The conference was attended by more than 300 participants from industry, universities, government institutes, and political figures and representatives. Political figures included the current President of Timor-Leste, Francisco Guterres, and former first President, Xanana Gusmão.

Nicole's talk was titled "*Quaternary uplift and deformation as recorded by the Timor-Leste north coast Baucau Limestone*". The presentation addressed studies of uplift rates along the north coast of the country and its implications for natural hazard assessment and development.



IPG upper management, keynote speakers (Nicole Cox centre back row) and other distinguished guests at the 4th International Geoscience Conference on Timor-Leste Resources with the President of Timor-Leste, Francisco Guterres (centre-right front row).



From left to right – Jorge Martins, vice-president of IPG; Nicole Cox, FedUni Geology Lecturer; Jose Soares, IPG director of Management Administration; Elias Cabral, IPG director of Geological Investigation; and Dr. Brendan Duffy, University of Melbourne Geoscience Lecturer.

Instituto do Petróleo e Geologia (IPG) visits FedUni

Nicole Cox, along with Dr. Ron Harris (Brigham Young University) and Brendan Duffy (University of Melbourne), has submitted a paper proposing a research program entitled “A New Geologic Map of Timor-Leste: Assessing Natural Resources and Hazards in Timor-Leste Through Professional Geological Mapping by Timor-Leste Geoscientists”. The intent of the program is to build geological capacity in Timor-Leste, which is seeing expansion in the mineral exploration sector, but is also highly exposed to pronounced geological hazards. In particular, the aim would be to develop geological expertise in the Instituto do Petróleo e Geologia (IPG) by enrolling institute geologists in HDR programs at the participating universities.

The importance IPG attaches to this goal is underscored by the visit of three officials from the institute to FedUni in December, 2018, to discuss the prospective relationship between IPG and FedUni. A special recognition and thanks goes to **Dr. Stephen Carey** for his efforts with organizing meetings and logistics for their visit.

Seminars

Howden Australia Introduction to Mine Ventilation Seminar, March/April 2018 (four days). **Assoc. Prof. Michael Tuck** delivered a workshop to Howden clients at the Pybar Mining Offices in Sydney, NSW. The course included ventilation fundamentals and ventilation system design using VentSim.

Worksafe Victoria Introduction to Mining Seminar, October 2018 (three days). **Assoc. Prof. Michael Tuck** delivered an “Introduction to Mining” course to 15 staff members from WorkSafe Victoria at the Mount Helen FedUni campus. The course included two days of classroom-based activities and a site visit on the final day to the Ballarat East mine of Castlemaine Goldfields. Mick express his thanks to the staff at the Ballarat East mine for providing a site visit at short notice.

AusIMM EEF Scholarship

Cody Holman (3rd year Mining Engineering student) has been awarded the AusIMM EEF scholarship. The core theme of the EEF program is to identify future industry leaders among the AusIMM's student members and ensure they are offered meaningful opportunities to develop professionally over the course of their scholarship.



"..Receiving this scholarship will enable me to fulfil a career in the mining industry and opens many different avenues to explore. I am excited for what lies ahead and I am looking forward to having a mentor to guide and encourage me..." *Cody Holman*

Frank Canavan Award

Jose Fernandez (3rd year Geoscience student) is the recipient of the Frank Canavan award for 2018. This award recognizes the best second-year geoscience student in the state of Victoria for 2017. Jose won the award from a field that included nominees from Monash University and the University of Melbourne.

National Australian Mining Games AusIMM

The Camborne School of Mines (CSM) hosted the 40th International Mining Games at the King Edward Mine, Camborne, Cornwall. With seven gruelling events in all, it was a marvellous opportunity to witness traditional mining skills first-hand.

The International Mining Games involved 40 teams from mining schools across the world (including USA, Brazil, UK, Australia and Europe). The teams competed in seven events involving the use of traditional mining methods to commemorate those who have lost their lives in industry and to preserve those traditional methods for many years to come. Hosting in Camborne is where many of the modern hard-rock techniques originated, and holding the games there, surrounded by the proud local community, was a great way to honour mining's heritage.

Two students from Federation University Australia were part of the Victorian team.

The event was run over one week, with the first two days devoted to the "New Leaders" conference, as well as several networking events. The second half of the week involved the competition events, with student teams battling it out to determine a winner in every event, as well as the overall champion.

Events included swede saw, hand-steel, rock ID, blast face design, mucking, gold panning, and airleg. Each game was chosen for its key role in the mining industry. The final event of the week was a Grand Ball, held to celebrate the games, and reward competitors for their efforts during the games.



Participants, including Fed Uni's Cody Holman, competing in events at the 40th International Mining Games at the King Edward Mine, Camborne, Cornwall.



Student Presentations and Attendance

GB O'Malley Presentation Evening

The Central Victoria Branch has a proud history of supporting the Student Chapter of the Australian Institute of Mining and Metallurgy (AusIMM) at Federation University. The University AusIMM Student Chapter was formed in the mid-1990's and provides a direct link between the University, its students and the mining industry.

The Chapter also provides the students with personal and professional development opportunities. An important one is the GB O'Malley Medal award in which students compete in presenting their third-year and Honours projects to mining professionals.

This year's Central Victoria Branch competition was held in Ballarat in November and three papers were presented. The jury of professionals selected Aden Cross for the first prize, Daniel Matthews second and Brendon Carlisle third. Congratulations to all who presented and we wish Aden good luck in the next phase of the competition.

"The University has a long record of teaching and mentoring highly successful geology, metallurgy and mining students," Keith Whitehouse (Director Australian Exploration Field Services Pty Ltd, AEFS) said. "We are pleased to congratulate the FedUni graduates who have been honoured by the recent GB O'Malley student selection event awards...They are outstanding students and we know they will succeed extremely well in their chosen careers."



A few participants and visitors of the GB O'Malley Presentation evening.

From left to right, Keith Whitehouse (member of AusIMM Central Victoria branch committee), Aden Cross (Honours, metallurgy), Brendon Carlisle (Honours, mining engineering) and Daniel Matthews (Honours, mining engineering).



Technical Talk by Tom Stevenson-Visser and Jack McInerney, *Geology of Timor Leste*

As mentioned in previous sections, students and staff from FedUni's Geoscience program undertook a field excursion to Timor-Leste to observe the geology and learn something of the local culture with the help of the New Colombo Plan award scheme.

FedUni Geoscience graduates of 2017, Tom Stevenson-Visser and Jack McInerney, are currently completing their respective Honours projects at Fed Uni as well as working part-time within the mineral industry.

Tom and Jack presented to The AusIMM Central Victorian Branch and Ballarat Geology group on the Geology of Timor-Leste in November. Highlights of their presentation include the following points:

- The geology of Timor-Leste, while complex, is very well exposed. Aside from the island of Taiwan, Timor-Leste is the only place in world where an active island arc-continent collision zone and its associated features can be observed in such extraordinary detail and beauty.
- The geology and landscapes of the island are highly structurally controlled with large-scale features such as thrust faulting and duplexing on display, along with a host of rock types including low-grade metamorphics, passive-margin sequences, wide spread melange and uplifted limestone reefs.

Timor-Leste boasts some of the most beautiful untouched landscapes in the world, ranging from crystal clear waters and vibrant coral reef systems to sheer mountains and gorges, as well as a vibrant culture.

Austmine held a presentation in August, 2018, to launch the women in STEM Mets career pathways scholarships/internships. As well as speakers from AustMine, FedUni graduate Eliza Molloy provided a synopsis of her mining career. In addition, Phoebe Chamberlain described her internship with Caterpillar from the 2017 program. Following the launch Zoljargal Munkhbat has accepted the offer of three-month internship under the 2018 scheme with AMC in Melbourne.

Zoljargal Munkhbat attended an Austmine smart mining networking event in Melbourne in February, 2018. The speaker was Chris Cawood, CIO, OceanaGold.

A student attended the inaugural **Mine Ventilation Society of Australia seminar** in Perth in July, 2018. This was the first seminar to be hosted by the MVSA and included presentations by regulators, practitioners and academics.

Workshops

Vulcan Training

Maptek provided two three-day training sessions in Vulcan on campus at Mount Helen for Mining students (April and June). The course introduced students to the software and then addressed more advanced aspects of the software.

The courses were funded by a successful bid in 2017 for AusIMM EEF funding.

Interview, cover letter and resume workshops

Job applications are crucial in the selection process of all organisations. They are also commonly the first point of contact between a graduate and a potential employer. So it is essential our graduates be competent at preparation applications and use them as a strategic marketing tool. A high standard job application will maximise the chance of being selected for an interview.

This was the fifth year that Larissa Koroznikova ran a workshop series on resume and cover letter writing and interview skills for mineral processing, geology and mining engineering students.

Students worked on constructing professional resumes and cover letters to use in their job applications. Many students were successful in obtaining interviews in industry after polishing their resumes and cover letters in the workshops.

The workshops have helped students gain vacation jobs and graduate employment in the minerals industry across the Australia. In the last three years our graduates have succeeded in winning graduate positions with mining companies such as Rio Tinto, Glencore and BHP.



Participants of interview, over letter and resume workshops.

Mine Visits and Other Excursions

Students visit Rio Tinto Iron ore mine

For 145 years, Rio Tinto has been pioneering the production of materials essential to human progress and which are fundamental to modern society.

Rio Tinto creates and nurtures partnerships with universities by providing vocation work for students and employing graduates. This year Federation University students from Ballarat were invited by Rio Tinto to visit their Nammuldi iron-ore mine in the Pilbara region of Western Australia. Rio Tinto operates a world-class iron-ore business, supplying the global seaborne iron ore trade. Iron ore is the key ingredient in the production of steel, and is an essential and durable product for modern living, with uses from railways to refrigerators, and pipes.

The eleven students from Federation University are enrolled in geology, metallurgy and mining engineering. On arrival the students were exposed to Rio Tinto's values of safe operation, teamwork, integrity and excellence. These values were reinforced throughout the two-day visit, as everyone on site helped make the students feel safe, welcomed and comfortable.

The student visitors were impressed by Rio Tinto employees' evident pride in such examples of the company's high-performance culture as the safe performance of driverless trucks during loading, transporting, unloading and returning to loading point.

Safety is the number one priority, and students were introduced to the company approach to safety at the mine through exercises with experienced operation staff.



Federation University students returned to Ballarat excited and enthusiastic about possible careers in the dynamic mineral industry. They also experienced the nature of fly in/fly out work and excellent living conditions at the operation.

Federation University is delighted to support its students in gaining such valuable experience to assist them in building their future careers.

Federation University students visiting Rio Tinto Iron ore mine.

Fosterville Gold Mine Open Day

Fosterville Gold Mine, located 20 km from Bendigo, held an open day on Saturday 24th of March. The event provided an opportunity for the public, students and industry professionals to become familiar with the mine, processing plant and new technologies.

Gold mining has been a part of Bendigo's history since the first alluvial gold was found in a creek by Mrs Kennedy and Mrs Farrell in 1851. Today Fosterville is a 300,000-ounce per year operation.

Twenty Federation University students participated in the Open Day.

All visitors on the day both enjoyed and learned a great deal from the Fosterville staff. Bus tours of the site were a marvellous way to show those unfamiliar with the mining industry the extent and sophistication of such operations. The display of mining equipment was impressive and the chance for anyone interested to climb aboard added excitement to the experience.

A good overview of the activities as well as a more detailed understanding of key parts of the operation for those having an interest in a particular area.

The gold panning activity kept many children occupied, whilst the opportunity to be photographed with a gold ingot will remind many of us about this wonderful experience.



FedUni students on site at Fosterville Gold Mine.

Central Deborah Gold Mine site visit

Second-year Geoscience students travelled to Bendigo as part of their program to visit the Central Deborah tourist mine. Students were given a tour of the historic mine by FedUni graduate, Billy Allen, who is now the Mine Geologist at Central Deborah. Students examined mineralisation styles and evidence for structural control of the deposit. They were challenged to visualise the deposit in three dimensions, and saw the conditions faced by early miners.

Annual Fieldwork Course in Outback South Australia

Second- and third-year geoscience students travelled to Weekeroo in eastern South Australia for a combined field camp over the July lecture break. Students were accommodated in shearers quarters for much of the ten-day camp after an introduction to the geology of Broken Hill during the first three days where they stayed in the historic township of Silverton. Students and staff were impressed with the extraordinary geology of the Adelaidean and Olary complex on display in the mapping areas. The successful conduct of the camp again reinforced the importance of field experience for Geoscience students.



Third-year FedUni Geoscience students Mikayla Ward, Alisha Van Es, and Jose Fernandez mapping 1.6 billion year-old metamorphic rocks of the Olary Block.



Dr. Stephen Carey assists Second-year student Krystal Baron with mapping the Adelaidean rocks on the Weekeroo Station, SA.

Employment Opportunities and Figures

Federation University Australia graduates have been rated the best in Australia for employability, technical and adaptive skills (Employer Satisfaction Survey 2017, January 2018). FedUni has also been ranked number one in Victoria for overall employment, median starting salary, student support and teaching scale (QILT, 2018). The students studying and graduating from the Geoscience, Metallurgy, and Mining Engineering programs in 2017 and 2018 are excellent examples of this.

2018 Graduates

100% of the undergraduate students who graduated from geology, mineral processing and mining engineering disciplines in 2018 are currently employed.

- 75% are working in the mineral industry
- 6% are working in another field related to their discipline of study
- 19% are working in a field unrelated to their discipline of study

Of the mineral industry employment, 33% represents vacation work for the summer 2018/2019 and 67% is considered on-going. The mineral industry companies that have employed our 2018 graduates (see list below) were primarily based in either Victoria or New South Wales, with one graduate winning a position in Western Australia.

List of Companies who Employed FedUni 2018 Graduates

Ballarat East Mine, Castlemaine Goldfields, Ballarat, VIC

Rerilya Limited, Broken Hill, NSW

Catalyst Metals, Bendigo, VIC

AGR Geoscience, Ballarat, VIC

CBH Resources Ltd, Broken Hill, NSW

Evolution Mining, Cowal, NSW

Ramelius Resources, Mt Magnet gold mine, WA

Downer Mining visited the Mount Helen Campus in August to discuss graduate and vacation work positions with mining engineering students. Downer has contractors located at a number of Australian mine sites. A presentation outlining the company, its projects and employment opportunities was provided by FedUni graduate, Scott Indian.

Undergraduates with Vacation Work

Several students who have not yet graduated were able to obtain vacation employment in the minerals industry for summer 2018/2019.

Examples of Current Undergraduates with Vacation Work and place of Employment	
4 th -year Mining Engineer	Kirkland Lake Gold, Fosterville, VIC
3 rd -year Mining Engineer	Kirkland Lake Gold Operation, Darwin, NT
3 rd -year Mining Engineer	Kirkland Lake Gold Operation, Darwin, NT
3 rd -year Geologist	Rio Tinto, Perth, WA
2 st -year Geologist	Kirkland Lake Gold, Fosterville, VIC

2017 Graduates

Many of the 2017 FedUni graduates were successful in obtaining on-going employment in the mineral industry during 2018.

Examples of 2017 Graduates who Gained On-going Employment in 2018	
Mining Engineer	Graduate Mining Engineer, Fosterville Gold Mine, Kirkland Lake Gold
Mining Engineer	Graduate Mining Engineer, Marandoo Technical Services, Rio Tinto
Mining Engineer	Graduate Mining Engineer, Anglo American
Metallurgist	Plant Operator, Fosterville Gold Mine, Kirkland Lake Gold
Metallurgist	Graduate Metallurgist, Stawell Gold Mines Pty Ltd, Stawell
Metallurgist	Process Technician, CBH Resources Ltd
Metallurgist	Graduate Metallurgist, Nyrstar, Port Pirie
Geologist	Graduate Geologist, Perilya Limited, Broken Hill
Geologist	Geological Field Assistant, Ballarat East Mine, Castlemaine Goldfields
Geologist	Geological Field Assistant, Ballarat East Mine, Castlemaine Goldfields
Geologist	Graduate Geologist, Westgold Ltd Meekatharra Mine

HDR News

Robert Holmes (School of Science, Engineering and Information Technology) received notification that he has met the requirements for award of his PhD in December, 2018. Robert's thesis title is "*Reducing Climate Change Related Fugitive Greenhouse Gas Emissions from Operational Longwall Coal Mines*". Principal supervisor Mick Tuck, associate supervisor Greg You.

Abstract

This work investigates how to significantly reduce fugitive greenhouse gas emissions from operating underground coal mines in Australia, in a safe and cost-effective way. Coal seam gas is largely removed prior to mining by gas drainage, however, some residual gas still remains in the seam. The target here is the residual coal seam gas methane, which escapes into the atmosphere during the mining process, through the mine fans. Some of that methane could be prevented from escaping into the atmosphere, by the use of a non-gas drainage method. The method used involved six measures and was trialled at a Hunter Valley coal mine. A total reduction in fugitive greenhouse gas emissions of 95,398 tonnes CO₂ equivalent below that projected over the subsequent year was achieved, at a cost of A\$1-08 per tonne. Three-year projections indicate that over 250,000 tonnes CO₂ equivalent of fugitive emissions were prevented at this mine without further expenditure, so reducing the overall mitigation cost to 40c per tonne. Greater levels of emissions cuts would be possible, albeit at a higher cost per tonne. The two most successful of the six measures were sealing up unused roadways and pressure balancing mined-out longwall panels. To investigate the transferability of this method to other underground Australian coal mines, gas concentration and other data was collected from two large Queensland coal mines and modelled. The results show that the measures would produce a very similar level of mitigation at these other two mines, although at a slightly higher cost. If this validation of the method holds more widely, and these mitigation methods were applied across all Australian underground coal mines, a reduction in emissions of at least several million tonnes CO₂ equivalent per year should be possible.

Publications

Book:

Pillay, M. & Tuck, M., eds., 2018. Occupational Health and Safety: A multi-regional perspective. *InTech Open, London*

Book Chapters:

Al Mandalawi, M., You, G., Dahlhaus, P., Dowling, K., and Sabry, M., 2018. Modelling and analyses of rock bridge fracture and step-path failure in open pit mine rock slope, In: Hoyos and McCartney (editors), *Novel Issues on Unsaturated Soil Mechanics and Rock Engineering, Proceedings of the 2nd GeoMEast International Congress and Exhibition on Sustainable Civil Infrastructures*, Egypt, pp198-226.

Al Mandalawi, M., You, G., Dahlhaus, P., Dowling, K., and Sabry, M., 2018. Analysis of a combined circular-toppling slope failure in an open-pit, In: Wasowski and Dijkstra (editors), *Recent Research on Engineering Geology and Geological Engineering, Proceedings of the 2nd GeoMEast International Congress and Exhibition on Sustainable Civil Infrastructures*, Egypt, pp10-30.

Papers:

Bowler, J.M., Price, D.M., Sherwood, J.E., & Carey, S.P., 2018. The Moyjil Site, South West Victoria, Australia: Fire and environment. *Proceedings of the Royal Society of Victoria* (in press).

CAMENS, A.B., CAREY, S.P. & ARNOLD L.J., 2018. Vertebrate trace fossils from the Late Pleistocene of Kangaroo Island, South Australia. *Ichnos* 25, 232-251, doi 10.1080/10420940.2017.1337633.

Carey, S.P., Sherwood, J.E., Kay, M., McNiven, I.J. & Bowler, J.M., 2018. The Moviiil Site, South West Victoria, Australia: Stratigraphic and geomorphological context. *Proceedings of the Royal Society of Victoria* (in press).

Guinea, A., Hollins, S., Meredith, K., Hankin, S., Cendon, D.I. (2018): Characterization of the subsurface architecture and identification of potential groundwater paths in a clay-rich floodplain using multi-electrode resistivity imaging. *Hydrological Sciences Journal* 63, 909-925.

Khandelwal, M., 2018, Prediction of Index Properties of Different Rocks Using Non-Destructive Testing, *52nd US Rock Mechanics/Geomechanics Symposium, 17-20 June, Seattle, Washington*.

Khandelwal, M., A. Marto, S.A. Fatemi, M. Ghoroghi, D.J. Armaghani, T.N. Singh & O. Tabrizi, 2018, Implementing an ANN model optimized by genetic algorithm for estimating cohesion of limestone samples, *Engineering With Computers, Springer Publications*, 34 (2), 307-317.

Li, H.C., Liu, D.S., Zhao, L., and You, G., 2018. Sensitivity analysis, determination and optimization of granite RHT parameters, *Journal of Beijing Institute of Technology* (English version, in press).

Martin, R., Dowling, K., Nankervis, S., Pearce, D., Florentine, S. & McKnight, S., 2018. In vitro assessment of arsenic mobility in historical mine waste dust using simulated lung fluid. *Environmental Geochemistry and Health* 40, 1037–1049.

Sherwood, J.E., Bowler, J.M., Carey, S.P., Hellstrom, J., McNiven, I.J., Murray-Wallace, C.V., Prescott, J.R., Questiaux, D.G., Spooner, N.A., Williams, F.M. & Woodhead, J.D., 2018. The Moyjil Site, South West Victoria, Australia: Chronology. *Proceedings of the Royal Society of Victoria* (in press).

Wen, Y.M., Wang*, C., Zhao, L., You, G., Zeng, X.Y., Yang, Z., Sun, W., Cheng, Y., Lin, Y., 2018. Reliability analysis of shear strength parameters of rock mass derived from Hoek-Brown criterion, *Journal of Mines, Metals & Fuels*, 66(8), 438-443.

W.G.P. Kumari, D.M. Beaumont, P.G. Ranjith, M.S.A. Perera, B. L. Avanthi Isaka & Khandelwal, M., 2018, An experimental study on tensile characteristics of granite rocks exposed to different high temperature treatments, *Geomechanics and Geophysics for Geo-Energy and Geo-Resources*, (in press).

Zhao, L., You*, G., 2018. Stability study on the northern batter of MBC Open Pit using Plaxis 3D, *Arabian Journal of Geosciences*, doi.org/10.1007/s12517-018-3454-1.

Zhang, J.J., Cliff, D., Xu*, K.L., You, G., 2018. Focusing on the patterns and characteristics of extraordinarily severe gas explosion accidents in Chinese coal mines, *Journal of Process safety and Environmental Protection*, 117:390-398, doi.org/10.1016/j.

Tuck, M., Submitted three papers to Narrow Vein Mining Conference, conference postponed until 2020.

Tuck, M., Submitted two papers for SME annual meeting, 2019.

Poster:

Eagle, R., McKnight, S., Dowling, K., 2018. Lithium mineralogy and petrogenetic differentiation of granitic pegmatites of the Dorchap Dyke Swarm, NE Victoria, Australia. XXII International Mineralogical Association Convention, August 2018, Melbourne.

Other

Technical Review Board Mick Tuck was appointed to the Technical Review Board by the Minister for Resources, Victorian Government at the end of 2017 for a three-year term commencing in 2018. The TRB provides advice to the Minister relating to mining projects and activities within Victoria. The TRB has met three times in 2018 to date.

Active Research Projects

Dr. Ander Guinea	Closed landfills, in collaboration with RMIT and EPA Victoria.
Assoc, Prof. Michael Tuck	Supervision of PhD research VAM mitigation Mine Planning Cable elevator Thermal properties of conveyed ore Mine automation Research contract Anglo American Metallurgical Coal, investigation of the effectiveness of Effective Temperature as a heat stress index
Stafford McKnight	Lithium and rare element mineralisation in eastern Victoria – Masters project Effect of mechano-chemical treatment on leaching of gold from a refractory ore - PhD project Central Victorian Goldfields Indicators, with CGT and Museum Victoria
Dr. Greg You	Supervision of five PhD projects and ten Master's projects.
Haydn Swan	PhD research into legacy mercury contamination in the central Victorian goldfields Mercury contamination associated with closed landfill sites
Nicole Cox	Coastal change monitoring and risk assessment of various locations on the Bellarine Peninsula Geologic Mapping and Hazard assessments of Timor-Leste
Dr. Stephen Carey	Moyjil, a possible early human site, south-western Victoria: geological context Silcrete development in south-eastern Australia Fossil vertebrate trackways in coastal aeolianites, southern Australia
Larissa Koroznikova	PhD research into mechano-chemical treatment of ores, mineral concentrates and mining tailings

Consulting

Stafford McKnight	Local industry or enterprise:
	Selkirk Brick
	Gekko Systems
	Calix Ltd
	FMP Group (Aust)
	Rheem Australia Pty Ltd
	Allied Mills
	Ferro Corporation (Aust)
	Mining company or related industry:
	CBH Resources – Rasp Mine Operation, Broken Hill
	Sanfire Resources NL
	Core Resources
	AMML Pty Ltd
	Bluestone Tin JV
	Dart Mining
	Mandalay Resources
	Pacifico Mining Ltd
	Environmental Consultants:
	Earth System Technologies
	Levay & Co. Environmental Services
	Peter Bellairs Consulting Pty Ltd
