

# ORE SOLUTIONS

NEWSLETTER OF CODES CENTRE FOR ORE DEPOSIT AND EARTH SCIENCES

> Summer 2019 No.35

## 30 YEARS OF HUGE ACHIEVEMENTS

**As we near the end of 2019, CODES Director Professor David Cooke looks back on what has been another solid and busy year for the Centre, and reflects on its 30 years at the forefront of ore deposit research.**

CODES is currently celebrating 30 years of operation and I am sure our founding director, Emeritus Professor Ross Large, is as delighted as I am that the Centre continues to maintain its hard-earned status as a global leader in ore deposit research and training. CODES began operations in 1989 when Ross and his team won an Australian Research Council Key Centre grant, providing the foundation for the establishment of our flagship Master of Economic Geology degree. Since its inception, the Masters program has been based on intensive two-week short courses that are offered over a two-year cycle. Our students currently have the option of completing the Masters entirely by coursework (eight short courses) or completing a minor research thesis (six short courses plus a thesis). Under the excellent stewardship of Masters coordinators Bruce Gemmell, Andrew



**The three trainers:** the 30th anniversary of the CODES Masters program was celebrated in mid-November. Here Masters coordinator Dr Rob Scott, CODES founder Emeritus Professor Ross Large and former Masters coordinator Dr Tony Webster synchronise the cutting of three cakes to mark the occasion. Around 60 people including Masters students and CODES staff, students and invited guests attended.

Tunks, Tony Webster and most recently Rob Scott, the Masters program has now completed three decades of training and upskilling of industry geoscientists. Indeed, due to growing demand, this year for the first time CODES ran four Masters short courses instead of our usual three – with ‘Ores in Magmatic Arcs’ offered in Indonesia (March) and South America (October). The final Masters course for the year (Geometallurgy) wrapped up in November with a celebration of 30 years of the Masters program. Looking forward, we are intending to add more Masters short courses to the program in 2020 and 2021 due to increased student demand.

During 2019 we initiated a major new project to investigate the 4D

architecture of the Cowal district in NSW with support from Evolution Mining; this project is being led by postdoctoral research fellow Francisco Testa and involves several graduate students. Shaun Barker and David Selley have been successful in securing funding for a new AMIRA pilot study in association with Murray Hitzman (iCrag) and Scott Halley (Mineral Mapping) – this project, which focuses on resistate minerals in sediment-hosted mineral systems, will have its start-up meeting in December. Our Lachlan Orogen project, led by Sebastien Meffre, had a successful sponsors’ meeting in September and will conclude early in the new year, and has been successful in achieving its aims with tie-in follow-up projects in the pipeline.

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**Oh, what a feeling!**: participants in the 'Ores in Magmatic Arcs – South America' Masters short course pictured in the Domeyko Cordillera of northern Chile, home to the giant Eocene-Oligocene porphyry copper deposits, and with the principal volcanic arc that forms the border of Chile and Bolivia in the background, jump for joy towards the end of an action-packed and highly successful two weeks in Peru and Chile.

The Australian Research Council Industrial Transformation Research Hub (TMVC) has been extended from its original completion date of mid-2020 to mid-2021 due to the funding extension provided by AMIRA project P1202, which is approaching the half-way mark of its three-year program.

In mid-November, the Australian Research Council announced funding success for our ARC Linkage project entitled 'Exploration targeting from next-generation volcanic facies reconstruction'. This project will run from 2020–2022 and will involve postdoctoral research fellow Martin Jutzeler and several graduate students. The grant application was supported by Evolution Mining, the Geological Survey of NSW, Department of State Growth Tasmania and OceanaGold, and involves collaborations with the University of Auckland and the University of Strasbourg. A very big thank-you to Martin Jutzeler, and the project's Chief Investigators and Partner Investigators: Rebecca Carey, Ray Cas, David Cooke, Sebastien Meffre, Shaun Barker, Kate Bull, Julie Rowland and Michael Heap for all of their hard work in putting the successful ARC bid together.

The University of Tasmania recently appointed two new profile staff members in CODES and Earth Sciences: Dr Angela Escolme (currently a postdoctoral research fellow here in the TMVC Research Hub) has been

appointed as a lecturer in geology and geometallurgy. Clare Miller from Queens University, Ontario, will be joining us as a geoenvironmental lecturer at the start of 2020. We welcome both Angela and Clare to the profile staff, and look forward to their contributions to our research and teaching programs for years to come.

Our PhD program continues to attract high-calibre geoscientists who play an integral part in our industry-partnered research projects by helping to drive innovation in research. So far this year eight students have submitted their PhD theses: Adam Abersteiner, Ayesha Ahmed, David Douth, Matt Ferguson, Jodi Fox, Shawn Hood, Brian McNulty and Naomi Potter. These students are all looking forward to graduating soon. By the end of the year five new PhD students will have joined our PhD program – Xin Ni Seow, Alex Farrar, Max Hohl, Hannah Moore and Takeshy Coaquira, along with two MSc students: Nathaly Guerrero and Zeb Zivkovic.

Around this time each year, our main cohort of Honours students submit their theses. The Honours program remains an essential stepping-stone for our graduates who are seeking to pursue a career in industry; this newsletter celebrates the contributions of the 2019 cohort of CODES and Earth Sciences Honours students through a series of student profiles that highlight their inventive research contributions.

# HONOURS CLASS OF 2019 SHINES

This year's Honours cohort project areas have covered a broad and fascinating range of topics. Again, there was a spread of research – across economic geology, geology of Tasmania, environmental geochemistry and volcanology. Most students found Honours hard work but definitely worth it: many of those who are on the cusp of graduating have found work they know will follow through on their research interests.



**Left: Future promise:** Johanna van Balen takes a break from collecting core samples at Copper Mines of Tasmania's Princess Creek Tailings Storage Facility as part of her Honours research into the mineralogy and geochemical properties of tailings. **Right: Digging deep:** Rob James' Honours project has involved detailed characterisation of the textures, sequence and trace element composition of sulfides in the various ore types at the Lantern Gold Deposit, Northern Territory.

Through our Honours program in Earth Sciences at the University of Tasmania (UTAS), we aim to provide the best strategies to prepare our students for careers in industry or academia. The Honours degree in Earth Sciences consists of thesis-based research balanced with a literature review and four weeks of short units that take place in Tasmania or at universities in Victoria. The Honours program has two intakes a year (February and July) and consists of around 38 weeks of study, with graduations in December and August. Our Honours program allows full- or part-time enrolment. The program has been coordinated by Dr Martin Jutzeler for the past three years, and this role will be passed on to Dr Angela Escolme in early 2020.

The 2019 academic year has again been excellent for our Honours program, with 13 students enrolled, which represent a large proportion of students completing an Earth Sciences

major in the Bachelor of Science. Two students graduated in August this year, eight will graduate in December, and we have three mid-year starters who will graduate in August 2020. The student numbers for 2020 look very good as well, demonstrating continued interest from our graduate students in obtaining additional qualifications before joining the workforce.

## RESEARCH TOPICS

Of the eight students who started Honours in February four carried out projects related to economic geology (including one in geophysics), two in environmental geochemistry on mine tailings, and two in subaerial and submarine volcanology. All eight students have recently submitted their theses and will graduate this December. The three mid-year starters all chose research projects in economic geology on the mainland; these will be completed by May 2020, with

their graduation planned for August 2020. Our research projects are spread around Australia and overseas, with two projects in Tasmania, seven on the mainland (in five different states!) and two in New Zealand. Details of these eleven projects are covered here.

## SPONSORS

Many of the student projects were sponsored by industry and academia. We are most grateful to sponsoring companies and organisations, which included the TMVC Research Hub, Mineral Resources Tasmania, the CockerTwo Scholarship through the UTAS Foundation, the Australian Research Council, AusIMM, BHP, Copper Mines of Tasmania, Dacian Gold, Environment Institute of Australia and New Zealand, Evolution Mining, Kirkland Lake Gold, MMG, Signature Gold and Vedanta. In addition, a proportion of the project work was supported by internal, university-based funding.



## 1 JOSEPH BEHAN

Current student, completing end 2019

**Supervisor:** Michael Roach

**Project title:** Characterisation of the geophysical signature of the Fosterville Gold Deposit: Implications for exploration at Fosterville Gold Mine, Victoria

Joseph Behan's Honours project involves a geophysical assessment of gold mineralisation at the Fosterville mine in Victoria. His project is supported by Kirkland Lake Gold Pty Ltd.

Mineralisation at Fosterville is broadly considered as orogenic or turbidite-hosted but two distinct styles of mineralisation are apparent, refractory gold associated with structures that host disseminated sulfides, and bonanza-grade free gold within quartz-carbonate lodes.

Joseph's study has involved collection of two new datasets. Petrophysical data have been acquired from the quartz-carbonate Swan orebody and its surrounding rock units to characterise the likely geophysical response of this important new ore system.

*'In 2019 with my supervisor Michael Roach, my Honours topic has now evolved into an ear-splitting passion for mineral exploration geophysics – I am thoroughly looking forward to a future career in this field. This was accomplished thanks to my two 'homes away from home': the AusIMM, and the Riawunna Centre. Importantly, I thoroughly enjoyed my time here in Earth Sciences and owe much of this passion and drive to the experienced lecturers that I was exposed to. At this stage, I am heading to Perth to start summer contract work in geophysics followed by a two-year graduate program to hopefully develop a framework to build a career on.'*



## 2 JUSTIN BURNS-NICHOLS

Current student, completing mid-2020

**Supervisors:** Martin Jutzeler, Rebecca Carey, Ray Cas

**Project title:** Volcanic architecture east of E41E, Cowal gold mine, NSW

Justin Burns-Nichols started his Honours degree in July 2019. His project aims to identify new volcanic stratigraphy to the southeast of the gold-mineralised Lake Cowal Volcanic Complex (NSW). This research is sponsored by Evolution Mining, and utilises new cores that were drilled east of E41.

The project targets four small holes that have been drilled from the now-dried up Lake Cowal, revealing a new stratigraphy to the southeast of the gold corridor. Justin's cores are quite varied, with some cores being mostly composed of tens of intrusions, whereas other cores are chiefly volcanoclastic. The volcanic textures are beautifully preserved, and allow in-depth characterisation of the volcanic host. Justin spent three weeks logging volcanic and sub-volcanic textures at the core shed at Cowal in September. He will conduct volcanic facies analysis through macroscopic and microscopic studies to identify emplacement, eruption and transport processes, allowing him to stratigraphically correlate the cores on the basis of textural and geochemical data.

*'So far in my Honours course I've gained many new skills, both geological and otherwise, as well as been lucky enough to see and study an area completely new to me. I look forward to gaining new skills and knowledge as I continue my research into the diverse geology of my study area.'*



**Top: On track:** Acacia Clark (left) and Imbi Simpson pictured on Mount Ngauruhoe in New Zealand while attending a volcanology course as part of their Honours research into New Zealand's subaerial and submarine volcanology. **Second from top: Out of the depths:** A bathymetry map of Havre volcano, off the northern coast of New Zealand, produced as part of Acacia Clark's Honours project. **Third from top: At the rockface:** Cameron Foster's Honours project has attempted to unravel the gold mineralisation history at the Archean Mount Morgans gold deposit in Western Australia, operated by Dacian Gold. **Bottom: Career move:** Joseph Behan onsite during fieldwork; he is happy that his Honours research has led to further work in the minerals industry.



### 3 ACACIA CLARK

Current student, completing end 2019

**Supervisors:** Rebecca Carey, Martin Jutzeler

**Project title:** Transitions of eruptive style for deep submarine silicic eruptions: The example of the 2012 eruption of Havre volcano, New Zealand

Transitions from high magma explosive discharge to more passive effusion of lava are very commonly observed during subaerial volcanic eruptions. However, transitions of eruptive style in a submarine eruption have never been recorded and thus their dynamics are unknown.

Acacia's project is focused on the transition from high mass discharge disruption of magma to effusive volcanism at the end of the 2012 deep submarine eruption of Havre volcano, Kermadec Arc, New Zealand. In 2015, a team of researchers used underwater robotic vehicles to understand the stratigraphic framework and architecture of the 2012 eruption. For the first time on the seafloor, eruption rates and the products related to the transition were studied and sampled. Acacia studied the abundance and size of vesicles in the erupted products of the late-stage effusive dome in order to compare these data with those from different stages of the eruption. This study will shed light on the transitions in eruptive style that occurred during this eruption, and help in understanding what eruption dynamics are at play for deep-water volcanism in general.

*'The Honours year has been unlike any study I have done before. Working on a research project of my own has been immensely enjoyable but also challenging. It has involved some huge learning curves but from these I have gained a much better understanding of the research that volcanology entails and the insights it provides. The staff and students have been wonderful to work alongside and it has been a privilege to see the exciting work undertaken by Earth Sciences here at UTAS.'*



### 4 CAMERON FOSTER

Current student, completing end 2019

**Supervisors:** Rob Scott, Shaun Barker

**Project title:** Hydrothermal alteration and gold distribution in BIF-hosted gold deposits of the Westralia Mine area (Mount Morgans), WA

Cameron Foster's Honours project is an investigation of the alteration and mineralisation history at the Archean Mount Morgans gold deposit, WA. The project is sponsored by the mine operators, Dacian Gold. At Mount Morgans, gold is primarily hosted by a series of banded iron formations (BIF) separated by volcanoclastic deposits and later porphyry intrusives. The mineralised sequence is itself hosted within a much thicker package of mafic and ultramafic rocks. Gold is spatially and genetically related to iron sulfides (pyrite and pyrrhotite), which replace magnetite in the BIF horizons. However, gold grades of the pyrite-/pyrrhotite-bearing BIFs are highly variable, suggesting sulfidation of the BIF was not always accompanied by gold mineralisation.

Cameron's project has attempted to unravel the gold mineralisation history at Mount Morgans by characterising the textures, sequence and trace element compositions pyrite and pyrrhotite formed in the various BIF units. Cameron also investigated the role of primary textural/compositional variations in the BIF (e.g. oxide, carbonate, and silica facies) in localising mineralised structures and the distribution of gold at the deposit.

*'Honours has been a great opportunity to combine different aspects of geology into one project. It has been a challenging but rewarding year. I am exceptionally grateful to Dacian Gold for providing me with the opportunity to work on their deposit. After honours I am moving to Western Australia to pursue my career in the industry.'*



### 5 ROBERT JAMES

Current student, completing end 2019

**Supervisors:** Rob Scott, Mike Baker

**Project title:** Characterisation of gold mineralisation styles and vein types in the Lantern Gold Deposit, Northern Territory

Rob is investigating hydrothermal alteration and controls on high-grade gold mineralisation at the recently discovered Lantern deposit in the Pine Creek Inlier, NT. The project is sponsored by Kirkland Lake Gold Pty Ltd (KLG). The Lantern deposit is situated in the footwall of the previously mined, ~1 Moz Cosmo-Howley gold deposit.

Previous work on Cosmo-Howley related mineralisation to emplacement of the underlying Palaeoproterozoic I-type Cullen Batholith with gold being deposited in chemically and/or structurally favourable trap sites. The distribution and mineralogical associations of gold at the newly discovered Lantern deposit exhibit some differences to those at Cosmo-Howley. Rob's project has involved detailed characterisation of the textures, sequence and trace element composition of sulfides in the various ore types using optical microscopy, SEM and LA-ICP-MS. In addition, KLG provided comprehensive whole rock geochemical data for sections of the drill holes logged and sampled by Rob for this study. This data has been used to better understand the composition of the host rocks and nature of wall rock alteration associated with gold mineralisation.

*'I have really enjoyed the challenges associated with Honours and the opportunity to utilise the analytical facilities here at CODES and at the CSL. I have broadened my geological knowledge and diversified my geological skills greatly. I am grateful to Kirkland Lake Gold Ltd for providing me with this opportunity.'*



## 6 CLAUDIA JENKINS

Current student, completing mid-2020

**Supervisors:** Martin Jutzeler, Rebecca Carey, Ray Cas

**Project title:** Volcanic architecture east of GRE46, Cowal gold mine, NSW

Claudia Jenkins started her Honours degree in July 2019. Her project aims to identify new volcanic stratigraphy to the northeast of the gold-mineralised Lake Cowal Volcanic Complex (NSW). This research is sponsored by Evolution Mining, and utilises new cores that were drilled east of GRE46. This project is very exciting, as it targets the first two holes to be drilled from the now-dried up Lake Cowal, revealing an entirely new stratigraphy to the northeast of the gold corridor.

The cores Claudia is studying chiefly comprise volcanoclastic units that are intruded by small dykes and are stratigraphically below the classic succession of the Lake Cowal Volcanic Complex. The volcanic textures are beautifully preserved, and allow in-depth characterisation of the volcanic host. Claudia spent three weeks logging volcanic textures at the core shed at Cowal in September. Claudia will conduct volcanic facies analysis through macroscopic and microscopic studies to identify eruption and transport processes, allowing her to stratigraphically correlate the cores on the basis of textural and geochemical data.

*'I have gained a better understanding of the direction I would like to see my career go in. Undertaking the fieldwork in September was a fantastic experience as it was my first time working at a mine site and I thoroughly enjoyed it. I'm really looking forward to the next few months of bringing together all the data that was collected.'*



## 7 VERITY KAMENIAR-SANDERY

Current student, completing mid-2020

**Supervisors:** Rob Scott, Martin Jutzeler

**Project title:** Investigation into high  $\delta^{34}\text{S}$  anomaly in wall rock pyrite from Costerfield Mining District CD001 drill core

Verity is investigating the morphology, trace element content and sulfur isotopic composition of diagenetic pyrite in the Early Silurian Costerfield Siltstone, which hosts the epigenetic (Devonian) Costerfield Sb-Au deposit in central Victoria. The Costerfield Siltstone is a poorly dated, >1000 m thick, relatively monotonous sequence of moderately to intensely bioturbated siltstone and fine-grained sandstone. The sulfur isotopic composition of marine pyrite has varied continuously over Earth history in response to changes in sulfur budget and fractionation processes. Over the last 500 m.y., marine pyrite has mostly varied between  $\delta^{34}\text{S}$  values of -20 and +20 ‰, however, short-lived excursions to much heavier values (i.e.  $\delta^{34}\text{S}$  >30 ‰) are also known, including one in the Early Silurian. The origins and extent (e.g. global versus local cause) of these abrupt S-isotopic excursions are still controversial, but proposed trigger

mechanisms include the catastrophic release of evaporative brines (including sedex deposit formation), global increases in glaciation, as well as local controls such as diagenetic pyrite growth being becoming increasingly coupled to the anaerobic oxidation of methane. Verity's study, with in-kind support from Costerfield Mine operators, Mandalay Resources, has so far involved logging and sampling of core from the deepest hole yet drilled into the Costerfield Siltstone. Samples containing diagenetic pyrite were collected at semi-regular intervals down hole, and these will be analysed to test for systematic stratigraphic variations in  $\delta^{34}\text{S}$  and/or trace element compositions of the pyrite. If variations in S-isotopic composition are present, the patterns may help refine the age of the Costerfield Siltstone, and provide a novel basis for improved stratigraphic correlation at the Costerfield deposit.

*'I'm enjoying the freedom of managing my own time during the course as well as finding the project I'm working on very interesting...this course will help me learn how to work in the workplace as well as teach me techniques and skills I may need in the future.'*



**Knowing the drill:** Honours students Claudia Jenkins (front) and Justin Burns-Nichols examining drill core from the now-dried up Lake Cowal at the Evolution Mining core yard, Cowal, New South Wales, during September 2019.



### 8 LEXI K'NG

Current student, completing end 2019

**Supervisors:** Sebastien Meffre, Anita Parbhakar-Fox (external advisor)

**Project title:** Geochemical and mineralogical characterisation of tailings: Evaluating the potential for reprocessing the Bobadil Tailings, Rosebery

Lexi is a current environmental geology Honours student who is studying the tailings of the Bobadil Tailings Storage Facility (TSF) at Rosebery, western Tasmania. She is the recipient of the Governor's Environment Scholarship and the AusIMM, BHP and EIANZ Environment and Community award.

Western Tasmania has a fantastic geology which hosts world-class base metal deposits. Rosebery Mine is a polymetallic mine that has operated for more than 100 years. This mine has two tailings dams which are the Bobadil and 2/5 tailings TSF. Sulfidic tailings have high potential to produce acid mine drainage (AMD) which is harmful to the surrounding environment. Lexi's work is focused on characterising the mineralogy and geoenvironmental behaviours of tailings to evaluate the potential for reprocessing the Bobadil tailings, and the AMD potential as a feasibility study for site remediation. After completing a sampling campaign, Lexi used a variety of analytical tools on her samples. For example, reflected light microscopy, XRD, FE-SEM, pXRF, whole rock geochemical analysis, elemental analysis, LA-ICP-MS and static leach test work (paste pH, NAG pH, solution ICP-MS).

*'I enjoy doing this project because my work can assist MMG Rosebery in considering the future remediation options for Bobadil TSF and the closure planning for the operation. Moreover, I have learnt a variety of techniques which will come in handy in the future.'*



### 9 HUGH RIVETT

Current student, completing end 2019

**Supervisors:** Lejun Zhang, Mike Baker

**Project title:** Geochemical footprint and paragenesis of the Specimen Hill Au prospect, central New England Orogen, Queensland

Hugh's project, sponsored by Signature Gold, is an investigation of the Specimen Hill–Mount Rainbow gold prospects within the northern New England Orogen, southeast Queensland. The Specimen Hill prospect covers an overall area of 3 km<sup>2</sup> and comprises four interrelated zones of porphyry-epithermal-style gold–copper mineralisation. The four zones of mineralisation are all related to the same intrusive complex, the 'Andrews Gully Intrusive Complex' (AGIC).

Previous studies have identified five distinct alteration zones around Specimen Hill, including the Mount Rainbow deposits, that comprise advanced argillic alteration zones associated with adjacent phyllic and propylitic alteration. Two other

alteration zones discovered during fieldwork contain surface expressions of mineralised low-sulfidation epithermal and a less mineralised garnet skarn zones. Hugh has employed ICP-MS mineral chemistry analysis of silicate (epidote, garnet and chlorite) and sulfide (pyrite) phases along with zircon U-Pb geochronology in order to constrain the age and alteration chemistry of the prospect and aid Signature Gold in targeting their next stage of exploration drilling.

The results of Hugh's project study, coupled with newly applied exploration techniques, may help form the basis for advanced exploration targeting of similar epithermal-style deposits throughout the New England Orogen.

*'I have learnt a lot about the analytical techniques and methods involved in exploration. I have also gained a greater understanding of requirements and standards expected within the exploration industry. All of this I will take with me into furthering my career as a geologist.'*



**Searching for gold:** Hugh Rivett examining outcrop as part of his Honours project looking at the geochemical footprint and paragenesis of the Specimen Hill Au prospect, Queensland. His research was sponsored by Signature Gold.



### 10 IMBI SIMPSON

Current student, completing end 2019

**Supervisor:** Rebecca Carey

**Project title:** Transition in eruption dynamics between two major phases of the 1.8 ka eruption of Taupo Volcano, New Zealand

Large-scale silicic volcanic eruptions typically are comprised of multiple phases of contrasting intensity and style. One of the largest super-eruptions in recent history was the Taupo eruption at Taupo caldera volcano ~1800 years ago. Taupo caldera is located in the middle of the North Island of New Zealand. The Taupo eruption included at least seven different eruptive phases that produced pyroclastic fall and flow deposits over a period of months. The different styles of eruption for the phases have been accounted for by changing vent location and magma decompression rates. Imbi's research focuses on a particular transition in the Taupo eruption, the transition from a wet large-scale eruptive phase to a dry and more powerful phase. By using samples collected in the field, determining their components and analysing grain size, the exact role of water and the external vent environment can be determined, thus giving clues on the drivers of eruption dynamics.

*'Throughout the Honours course I have gained a deeper understanding of the data, work and effort it takes to produce a scientific body of work. By taking part in a voyage aboard the RV Investigator and the CAPSTAN program, I have realised the importance of working in unison with other disciplines and the duty we have as scientists to connect and enlighten the general public. Most importantly, this year has taught me a greater sense of resilience, and the ability to face challenges as they come.'*



### 11 JOHANNA VAN BALEN

Current student, completing end 2019

**Supervisors:** Sebastien Meffre, Anita Parbhakar-Fox (external advisor)

**Project title:** Determining the mineralogical and geochemical properties of tailings at Copper Mines of Tasmania: Opportunities for metal recovery

Johanna's project involved research in the fields of geochemistry and geoenvironmental studies. Her project is sponsored by Copper Mines of Tasmania and focuses on the mineralogy and geochemical properties of tailings within the company's Princess Creek Tailings Storage Facility (PCTSF). Johanna spent five days using a weight-driven corer (UWITEC) to manually collect 21 core samples from the 2.10 ha storage facility. Core samples were collected with PVC piping from the side of a small dingy. All core was cut and logged by Johanna. Following

this, a variety of analysis techniques were used, including static testing, laser ablation-ICPMS, elemental analysis (carbon-sulfur), whole rock geochemistry, pXRF, XRD, MLA, FE-SEM and reflected light microscopy. The major focus of Johanna's project is to understand if there is economic value in recovering metals, such as cobalt, contained within the sulfidic waste (if so, what is it contained in, can it be extracted from the waste?) and to determine the feasibility of various rehabilitation options.

*'I most enjoyed bringing the elements of chemistry and geology together with some environmental aspects. This project showed promising results, which was exciting to work on, and also showed promise for development. After I graduate, I will be relocating to Perth where I have accepted an exciting geologist role with Gold Fields at one of their newly commenced sites.'*



**In the field:** Imbi Simpson pictured on White Island, New Zealand, where she was taking part in a volcanology course to further her Honours research interests.

## 2019 Honours students and their projects



- |    |                         |                              |
|----|-------------------------|------------------------------|
| 1  | JOSEPH BEHAN            | FOSTERVILLE GOLD MINE, VIC   |
| 2  | JUSTIN BURNS-NICHOLS    | COWAL GOLD MINE, NSW         |
| 3  | ACACIA CLARK            | HAVRE VOLCANO, NZ            |
| 4  | CAMERON FOSTER          | MOUNT MORGANS, WA            |
| 5  | ROBERT JAMES            | PINE CREEK INLIER, NT        |
| 6  | CLAUDIA JENKINS         | COWAL GOLD MINE, NSW         |
| 7  | VERITY KAMENIAR-SANDERY | COSTERFIELD, CENTRAL VIC     |
| 8  | LEXI K'NG               | ROSEBERY, WESTERN TAS        |
| 9  | HUGH RIVETT             | SPECIMEN HILL, SOUTHEAST QLD |
| 10 | IMBI SIMPSON            | TAUPO VOLCANO, NZ            |
| 11 | JOHANNA VAN BALEN       | PRINCESS CREEK, WESTERN TAS  |

**Remediation potential:** Honours student Lexi K'ng pictured during her fieldwork at the Bobadil Tailings Storage Facility, part of the Rosebery Mine complex, in western Tasmania.

## NATIONAL RECOGNITION FOR AN OUTSTANDING RESEARCHER

**Earth Sciences/CODES Senior Lecturer Dr Rebecca Carey has won the 2019 Tasmanian Young Tall Poppy Scientist of the Year Award for her research on volcanology in modern and ancient terrains and her outstanding ongoing efforts to communicate her science to the wider community. She was presented with the award in a ceremony at the Sandy Bay campus on 15 October in which Dr Amelie Meyer from IMAS also received an award to recognise her research into the Southern Ocean.**

These prestigious awards, which are run by the Australian Institute of Policy and Science (AIPS), recognise outstanding early-career researchers' efforts within their chosen field, with particular emphasis on the work they have undertaken to spread the word about the importance of their science to the broader community. Awards are made across each state and territory.

Dr Carey said of the accolade: 'The award makes me reflect on the support of my family and close friends who have



**Proud moment:** Dr Rebecca Carey receiving the 2019 Tasmanian Young Tall Poppy Scientist of the Year Award from UTAS Deputy VC (Research) Professor Anthony Koutoulis on 15 October. The Tall Poppy Campaign is run by the independent Australian Institute of Policy and Science, with awards presented in each state and territory.

enabled my research career and, further, all of the really amazing mentors, colleagues and students I have worked with during the past decade that have enabled me to grow as a scientist and have fun at the same time. It also comes with the responsibility to communicate and promote science across the state, which I am really embracing.'

During the coming year Dr Carey will be engaged by the Tall Poppy Campaign to take part in activities

to promote an interest in science among school students and teachers, as well as an understanding and appreciation of science in the broader community. She said that during the coming year she 'would like to focus on science communication in regional Tasmania wherever possible'.

Dr Carey is leader of CODES' *Program 4: Magmatic and volcanic processes*, and heads a team of dedicated geoscientists conducting fundamental research into magma genesis and eruptions in both subaerial and submarine environments. The team has an international profile in this area, and collaborates widely with researchers from many institutions across the globe.

From everyone at Earth Sciences/CODES: Well done, Bec!

*The Tall Poppy Campaign was created in 1998 by the Australian Institute of Policy and Science (AIPS) to recognise and celebrate Australian intellectual and scientific excellence and to encourage younger Australians to follow in the footsteps of our outstanding achievers. It has made significant achievements towards building a more publicly engaged scientific leadership in Australia.*



**Feeling the heat:** Dr Rebecca Carey leads a group of students on a visit to White Island, off the coast of New Zealand's North Island in March 2019.

# UNLOCKING THE INNER GEOMETALLURGIST

Dr Angela Escolme reports on the recent successful Master of Economic Geology short course in Geometallurgy.



**Record numbers:** Master of Economic Geology Geometallurgy short course 2019 participants at Horseshoe Falls, Queenstown, en route back to CODES from their West Coast mineral processing excursion. Course leaders were Angela Escolme and Julie Hunt (third and fourth from left).

During the first two weeks of November, the Master of Economic Geology short course in Geometallurgy was held for the fifth time here at CODES, and was led this year by Dr Julie Hunt and Dr Angela Escolme. The course was attended by a record number of 26 students and industry participants from across Australia and the world, with attendees travelling from as far afield as the USA and the Philippines.

The course took participants on a geometallurgical journey beginning with characterisation tools and techniques that involved presentations and demos from a number of the CODES staff. Students toured the CODES facilities and also had the opportunity for hands-on experience with a variety of tools at the Mineral Resources Tasmania core library. The course included an impressive line-up of invited experts to get everyone up to speed on mineral processing, including Toni Kojovic (SimSAGE), Teresa McGrath (Curtin University), Joe Pease (Mineralis), Clint Bowker (Bureau Veritas) and Luke Keeney (CRC ORE). New to the 2019 course, Sefton Darby (KPMG) spoke on social licence, and industry case studies were presented by Kathy Ehrig (BHP), Karyn Gardner (Newcrest Mining Ltd) and Steinar Ellefmo (NTNU).

With a newfound appreciation for mineral processing, the group also made an excursion to the ALS Metallurgy Lab, Burnie, and processing plants on Tasmania's West Coast at Hellyer (Hellyer Gold Mines Pty Ltd) and Renison Bell (Bluestone Resources) where they were treated to extensive tours by the company representatives.

The course closed with each participant giving a summary of a potential metallurgical issue at a site

of their choice and how they might de-risk it through a geometallurgy program based on what they had learnt. Feedback from attendees has been very positive. Dr Escolme commented: 'It's really nice to see how empowering it is for geologists to gain an insight into mineral processing; this course enables them to unlock their inner geometallurgist and have impact back onsite'. The course is scheduled to run again in late 2021.



Dr Julie Hunt (right), one of the course leaders, showing participants in the MRT core library how to use rock characterisation tools suitable for drill core.

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## WHERE ARE THEY NOW?

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In our continuing series of short interviews with past CODES alumni, Kim Denwer gets straight to the point about his hands-on geology role with MMG and his passion for running ultramarathons.

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## 'GEOLOGY ISN'T JUST A CAREER...IT'S WHO YOU ARE'

### What is your current job and your work responsibilities?

I work for MMG as the Group Manager of Geoscience; I have worked for MMG for the past seven years in many different geology roles.

In my current role I oversee mine geology and brownfields exploration for MMG at all mine sites. So, that's Las Bambas in South America, Rosebery in Tasmania, Dugald River in Far North Queensland, and Kinsevere in Congo. So, lots of travel... My responsibilities are to ensure geoscience excellence and we do this by employing geologists called 'orebody knowledge geologists'. Their primary role is geoscience and understanding and increasing the geological knowledge; if we don't know the geology, we cannot mine the orebody properly. Every week is different – one day I may be ensuring that the drill sampling is being done correctly, another day I may be in the pit mapping with the mine geologists, or I may be checking that the 3D model for the orebody is correct.

### What are the things you most enjoy about your role?

I enjoy the travel, I love seeing lots of different rocks and I enjoy mentoring geologists and discussing geology. I especially enjoy working in new countries and learning new cultures and at least attempting new languages. But I really struggle with French in Congo! I am a geology advocate... I've worked as a geologist for 32 years...and I could count on my hands the number of bad days I've had in my whole career...I enjoy every day. I really enjoy it.

### How did you get to where you are, and how has your role changed?

I graduated in 1986, a long time ago. I have worked in both mines and exploration. I started with an Australian company called RGC for 10 years and worked at Mt Lyell in Tasmania, and



**KIM DENWER**

**Group Manager of Geoscience, MMG**

**Master of Economic Geology completed in 1994**

then in exploration in the Northern Territory, Queensland and Papua New Guinea. I then worked as a contractor and was employed a lot on the west coast of Tasmania, Papua New Guinea and for four years in Thailand. In 2007, just before the GFC, I started a role as Exploration Manager for Bass Metals looking for base metal ore and mining the Fossey deposit near Hellyer. This was an exciting mine; Bass Metals had found the Fossey deposit just 100 metres from Hellyer. In 2012 I left to join MMG as Principal Geologist managing the exploration on the west coast of Tasmania based at Rosebery. Since then I have worked

in eight different roles for MMG, all of which have been around mining and brownfield exploration. I worked for most of my early career in exploration only and in the past decade I have become more involved in mines and brownfield exploration.

### What is your career highpoint, your greatest achievement?

Mmmm...it's all been fun. I think there have been half a dozen people in my career who I've really helped and they've gone places. That's the highlight of my career – to actually recognise strengths in people and empower them to go and achieve.

I have also been involved with some discoveries – this is a great time.

**When you were here, what did you specialise in?**

I did a geology/chemistry double major – I really enjoyed chemistry, and I believe that all geologists should do chemistry as well. But I love working outside, so it was always going to be geology. I did my Honours on oil shales as a joint CSIRO–UTAS project. I did the Master of Economic Geology degree in the 1990s. This is a great degree. I was in one of the very early intakes when CODES started the course. In the early 2000s I did three-quarters of a PhD on the Mt Lyell deposit that I never finished as life got in the way, but I did publish a paper on it recently. I've always maintained a contact with the University.

**How do you see the way the industry has changed over your career?**

Computers, computers and computers. When I graduated everything was done on paper and now most geologists spend much of their time staring at computer screens. Don't get me wrong, computing has allowed us to visualise better in 3D, estimate better resources etc. but not enough geologists actually look at the rocks.

**So do you think that's going to impact the industry negatively if it keeps going that way?**

Absolutely...it's why we're not finding new orebodies. There's too much reliance on technology. You don't find ore bodies with IQ you find them with HQ.



**Teamwork:** Kim Denwer pictured here with other geologists working in the Lubumbashi area in the Democratic Republic of Congo. They are (L–R): Corey Jago, Mike Sloan, Kim Denwer, Claudio Coimbra, Levi Wani and Chance Byamungu.

**Words of wisdom for up-and-coming geologists?**

If you really want to succeed at geology you need to always be inquisitive; geology isn't just a career...it's who you are. Working overseas is so exciting – I have seen a lot of the world as part of my job. There are two distinct streams in economic geology – mine and exploration.

Mine geology focuses on the small scale and allows a reasonably stable home life. Exploration, on the other hand, focuses on the large scale and is typically a much less stable home life as one is away all the time.

**And any little-known facts about yourself?**

I run ultramarathons, both single-day and multi-day events. I have done several 100-km one-day events including one in the Blue Mountains. I did a 250-km six-day event in the Simpson Desert in 2015; I ran from Mt Cook to the coast in NZ in 2018 (330 km in seven days); and I have just signed up for a 270-km event starting at the Grand Canyon. I am a bit fat! It really confirms my life motto: 'Say you can, say you can't. Either way you're right'.

I spend most of my free time in Hobart and Tasmania. I have five children and six grandchildren so I love spending time with this lot.



**Long haul:** Kim Denwer enjoys taking on the challenge of ultramarathons when he is not on-site at an MMG mine. Here he slogs it out during 2016 Tarawera Ultramarathon in New Zealand in which he ran 87 km.

## CODES STANDS TALL AT THE SGA IN GLASGOW

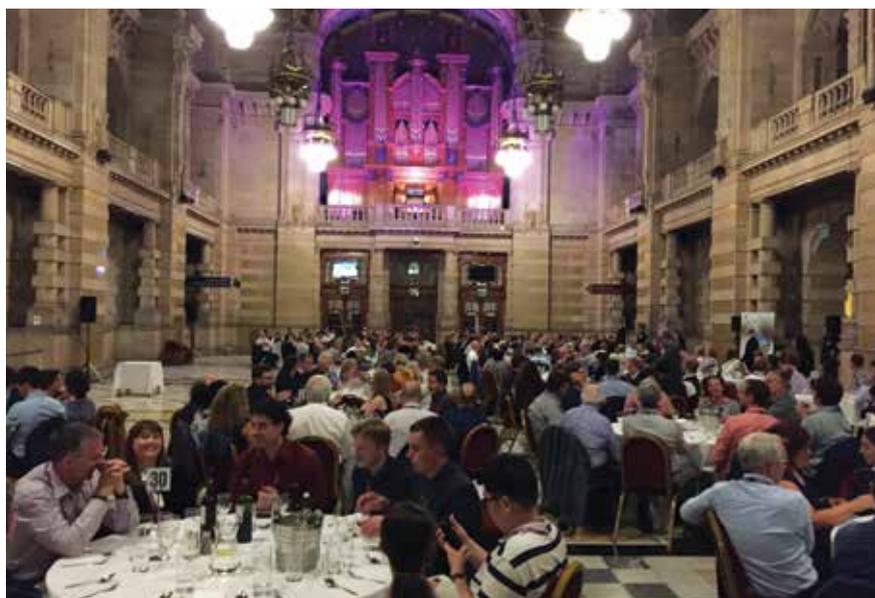
**CODES had a strong presence at the SGA conference held in Glasgow between 27 and 30 August. Staff from CODES took prominent roles in two short courses, led the 'New Techniques for Ore Discovery' session and ran a booth to promote the Centre.**

Professor David Cooke was part of the team that delivered the 'Fertility to Vectors: Porphyry Exploration' short course which provided an overview of developments in petrological and geochemical methods applicable to the understanding of, and exploration for, porphyry-style deposits at the regional and camp scale. Dr Jonathan Cloutier organised and was part of the team who delivered the 'Mineralising Processes in Basins' short course that focused on basin architectures, structural evolution of basins, sequence stratigraphy, diagenesis, fluid flow, ore deposition and exploration strategies using geochemical and hyperspectral data. Both short courses were well attended with 30 and 22 participants respectively, and received positive feedback.

The 'New Techniques for Ore Discovery' session was led by Dr Jonathan Cloutier and aimed to discuss how new techniques can be integrated into more effective mineral exploration in deep, remote and covered environments. The keynotes for the session were James Cleverley from Imdex Limited who discussed 'How will technology facilitate agile discovery?' and Tim Ireland (a CODES alumnus) from First Quantum Minerals who presented 'To make better exploration tools, we first need to better understand ore deposits'. The session included 21 presentations and 12 posters that ranged from more classic geochemical and geophysical techniques to hyperspectral reflectance in exploration to random forest classification of pyrite using machine learning.



**Double shift:** ARC TMVC Research Hub Research Fellow Dr Angela Escolme (left) and TMVC Hub Manager Helen Scott make sure everything is shipshape at the CODES booth in the Hunter Hall of Glasgow University in which the exhibitors were housed at the SGA conference in Glasgow.



**Posh nosh:** the SGA conference gala dinner was held in the spectacular Kelvingrove Art Gallery and Museum and several CODES people attended. Dr Jonathan Cloutier can be seen at table 30 (wearing maroon shirt). This photo was taken by Dr Peter McGoldrick who gave an invited keynote talk at the conference.

Finally, Sibeles Nascimento, a TMVC PhD student under the supervision of Anita Parbhakar-Fox (external advisor), Matthew Cracknell and David Cooke won a student prize for her presentation entitled 'Geo-environmental characterisation of the King River Delta: A combined geophysical, geochemical and mineralogical approach' (see separate item on page 20).



**Setting the scene:** Dr Jonathan Cloutier's title slide from his pre-conference workshop at the SGA on 'Mineralising Processes in Sedimentary Basins'.

## Northern highlights

Dr Julie Hunt, who was a keynote speaker at the SGA conference in Glasgow, attended the post-conference fieldtrip to the Skelleftea district in northern Sweden. This included visits to the Kristineberg and Bjorkdal mines plus examination of drill core from the Boliden and Kankberg deposits and visits to local outcrops. The course was led by Tobias Bauer, Nils Jansson and Mac Fjellerad Persson, and there were 13 participants.



**Above:** An example of massive sulfide mineralisation, Maurliden, visited on Day 3 of the post-SGA conference fieldtrip to the Skelleftea district in northern Sweden.



**Right:** Entrance to Boliden's Kristineberg zinc-copper-lead mine site, northern Sweden, visited on Day 4.

## IT TAKES 62 TO TANG<sup>3</sup>O



**There was a big turnout of 62 participants for the TANG<sup>3</sup>O meeting, which ran from 6–7 November here at CODES/TMVC, and was preceded by a short course on the topic of laser ablation, as Dr Margaret Hawke reports.**

CODES/TMVC were very pleased this year to host the annual ThermoChronology and Noble Gas Geochronology and Geochemistry Organisation (TANG<sup>3</sup>O) meeting on November 6 and 7. TANG<sup>3</sup>O is a voluntary association of researchers in the fields of thermochemistry, noble gas geochemistry and geochronology, and its purpose is to optimise access to facilities and results, enhancing technical developments and technique implementation, and creating a forum for dissemination of technical advances and research results relevant to the Australian geochronological, geochemical and geological communities. Each year TANG<sup>3</sup>O researchers meet in a different location in Australia to collaborate, present their most recent work and discuss the



**Well-attended:** Participants in the 2019 TANG<sup>3</sup>O meeting held at CODES/TMVC in early November pictured on the steps of the Earth Sciences Building at UTAS.

challenges that they face in their field of expertise. Many people travelled from interstate as well as overseas to participate in the meeting.

This year's meeting provided a chance to showcase the current capabilities of CODES/Earth Sciences and their facilities. A short course on the Laser Ablation Data Reduction (LADR) software, recently developed by Professor Leonid Danyushevsky (CODES) and Dr Ashley Norris (Norris Scientific), was held on the preceding Tuesday afternoon and was well-attended. It covered the capabilities and workflow in LADR for processing U-Pb LA-ICP-MS analyses, including

loading data, setting up quantification protocols and options, common Pb correction on calibration reference materials, error propagation and data export.

The meeting was a great success, and would not have been possible without the generous assistance of a number of sponsors: AuScope, Cameca, Ametek, Applied Spectra, Isotopx, Rio Tinto, Agilent, Teledyne Cetac Technologies, ThermoFisher Scientific, CODES and TMVC.

Learn more about TANG<sup>3</sup>O at: <https://tang3o.org/>

## HARD WORK BUT WORTH IT: THE SEG 2019 CONFERENCE



The SEG 2019 Industry Outlook Dinner was held at Restaurante Vista Santiago, Cerro San Cristobal, and afforded spectacular views of Santiago and the Cordillera (photo by Dr Angela Escolme).

**Around 900 attendees gathered in Santiago, Chile, in early October to take part in the SEG 2019 conference, which was themed 'South American Metallogeny: Sierra to Craton'. Among them was a large contingent of CODES staff and research students who took part in a busy schedule presenting papers and posters, running workshops, learning, networking and staffing the highly popular CODES conference booth.**



Dr Angela Escolme presenting at the SEG conference about her work on the Chilean Productora Cu-Au-Mo deposit.

The conference ran from 7–10 October and encompassed a wide range of studies on copper, gold and polymetallic deposits, complemented by sessions on new discoveries and geomettallurgy. All CODES staff and PhD/Masters students who attended either gave talks or presented posters.

The proceedings in Santiago kicked off with a series of pre-conference workshops and field trips, among them a talk by Dr Pete Hollings, who presented on the geodynamic controls on porphyry mineralisation that he is working on as part of our TMVC AMIRA P1202 porphyry copper – gold project. Although he had a very busy schedule, Professor David Cooke stepped in at short notice following a cancellation to present a pre-conference workshop: 'Porphyry deposits – characteristics, origins and exploration strategies'. TMVC Postdoctoral Research Fellow Angela Escolme also participated in an Early Career session as a mentor in inclusivity and diversity.

Dr Angela Escolme gave two talks once the conference proper got underway. These were timed to take place pretty much concurrently, which meant that she was literally kept on her toes as she had to run between rooms. These

talks focused on the geometallurgy and geology outcomes from her PhD on the Chilean Productora Cu-Au-Mo deposit, and covered predictive models of mineralogy from whole-rock assay data, and an overview of the camp scale paragenesis.

CODES/TMVC PhD student Javier Merrill also presented on his PhD project in the Geometallurgy session. His talk ('Quantitative textural assessment for sample selection guided by drill core hyperspectral imagery') was very well received and stimulated significant discussion.

Professor David Cooke gave a presentation entitled 'Geodynamic setting and origins of giant porphyry Cu-Au deposits in the East Sunda Arc, Indonesia' in the Gold II session. Despite being the final presentation of the conference, the talk drew a large audience.

Among the conference highlights was the 'Core Shack', a new addition to the SEG conference displaying drill core from a variety of deposits, including particularly spectacular core from Regulus Resources' AntaKori deposit and Chakana Copper's Soledad project (both in Peru). The conference also included a series of speed talks for the first time; these gave chosen poster presenters a five-minute slot to summarise their work. Among these was a speed talk by Angela Rodrigues (a Monash PhD student who is part of the AMIRA P1202 research team).



CODES staff gathered at the CODES exhibition booth: (L-R): Karen Huizing, Dr Michael Roach, Associate Professor Shaun Barker, PhD student Christopher Leslie and TMVC Research Fellow Dr Matthew Cracknell.

CODES staff also played an active role in the less formal side of the conference during the SEG Dinner and Awards Ceremony at the Sheraton Santiago Hotel. Associate Professor Shaun Barker gave the citation for Stuart Simmons for the SEG Marsden Award, which recognises service to the Society of Economic Geologists. And Professor Cooke gave the citation for Yongjun Lu, who was presented with the Waldemar Lindgren Award. During the evening former CODES PhD student and now Head of Discovery Strategy at Anglo American, Dr David Braxton, received the Brian J. Skinner Award for the most outstanding paper published in *Economic Geology* during 2018.

The CODES exhibition booth was a hive of activity throughout the conference and was capably run by Karen Huizing from the CODES administration team who dealt with enquiries from students, industry and researchers all wanting our publications, giveaways (especially the rock sweets) and information about study and collaboration.

Dr Michael Roach's interactive display of the AusGeol Virtual Library of Australia's Geology at the booth was the focus of much interest from both students and industry representatives.

## A FELLOWSHIP FOR KHIN ZAW

CODES Honorary Professor of Economic Geology Khin Zaw has been awarded an Honorary Fellowship to the Geological Society of London (GSL). Honorary Fellows are recognised for their achievements and potential, not only in science but as ambassadors for geological science and its promotion to the wider public.

Professor Khin Zaw commented: 'I feel overwhelmed by this international recognition as it comes out of nowhere. I was informed of the nomination by GSL External Relations that Council had recommended me...recently they informed me that I was a recipient of the fellowship. I am really proud of this as an Australian citizen with an ethnic Myanmar background. Not only is the GSL the oldest geological society in the world, it recognises my more than 40 years of contribution to geoscience and I join a list of other pre-eminent scientists.'

'My academic career has not been straightforward. I studied geology at the University of Rangoon graduating in 1968. After obtaining an MSc in 1976 from Queen's University in Canada, I was appointed to a lectureship at the University of Yangon. However, I incurred the displeasure of the then Military Government and was dismissed from my post. Eventually, I was allowed to leave Myanmar with my family in 1986 to study for a PhD at the University of Tasmania. After obtaining my PhD, I joined CODES in 1990. I am highly indebted to former directors and the current director of CODES, Professor David Cooke, for allowing me the opportunity and giving me the professional environment to pursue my research in ore fluids and genesis of ore deposits across the globe.'





Looking up towards the imposing Fiero Thrust in the Rio Maipo valley, photographed during the AMIRA P1202 field trip.

## PERFECTLY TIMED: AMIRA MEETING IN CHILE

**Dr Mike Baker reports on the AMIRA P1202 Sponsors Review Meeting 3, which took place in Santiago, Chile, on 3–5 October.**

The AMIRA P1202 project, *Far-field and near-mine footprints – finding and defining the next generation of Tier 1 ore deposits*, held its third Sponsors Review Meeting (SRM) at the Hotel Plaza el Bosque in Santiago, Chile, on 3–4 October 2019 with the third day of the meeting devoted to a field trip. The timing and location of the SRM took advantage of the timing of the Society of Economic Geologists' (SEG) annual conference, which was also held in Santiago in early October.

The SRM was well attended by both industry and researchers, with 15 representatives from sponsor companies, seven CODES/TMVC staff and students led by Professor David Cooke, and five AMIRA P1202 collaborators, including staff and students from Lakehead University, Monash University and Universidad Austral de Chile present.

Over the first two days of the review meeting, the AMIRA P1202 research team provided updates on the progress of their research activities across several study sites, with a particular focus on the project's research activities in South America. On the third day of the SRM Professor Cooke and former CODES PhD graduate – and now Universidad Austral



Dr José Piquer from the Universidad Austral de Chile (wearing blue hat) gives an introduction to participants on the AMIRA P1202 field trip to the Rio Maipo valley southeast of Santiago, which took place following the AMIRA meeting. Professor David Cooke (wearing white hat) is helping to hold the map.

de Chile lecturer – Dr José Piquer led participants on a field trip along the Rio Maipo valley southeast of Santiago to view several notable geological features of the central Chilean Andes. These included exposed volcanic sequences

of the Cenozoic Abanico basin and the spectacular Fiero Thrust.

The third AMIRA P1202 SRM will be repeated in Hobart on 27–28 November, to coincide with the CODES Annual Review meeting.

# THE ITALIAN JOB



Professor Leonid Danyushevsky (at front wearing dark glasses) with fellow 'Fluids in the Earth' presenters Professors Maria Luce Frezzotti and Robert Bodnar, and course participants in Milan.

Professor Leonid Danyushevsky was invited to participate in the delivery of a short course entitled 'Fluids in the Earth' at the University of Milano-Bicocca, Italy, which took place on 9–13 September. The course was presented

in conjunction with Professor Maria Luce Frezzotti and Professor Robert Bodnar. This five-day course covered theoretical and practical aspects of the application of fluid and melt inclusions to solving geological questions. It is

aimed at PhD and Masters students, and this year was attended by 25 students from many European countries, China and India. Leonid has been participating in the delivery of this course since 2009.

## Industry partnerships available in 2020

**As flagged in our last newsletter CODES has new opportunities for Tasmanian resources companies to support our work from 2020 onwards.**

CODES has a variety of entry options that cater for the research and training needs of all levels of mining operations – from small to medium enterprises (SMEs) through to the major multi-nationals.

For more details on our Industry Partnership Program, please visit our website.

### 2019 Industry Partners

#### GOLD



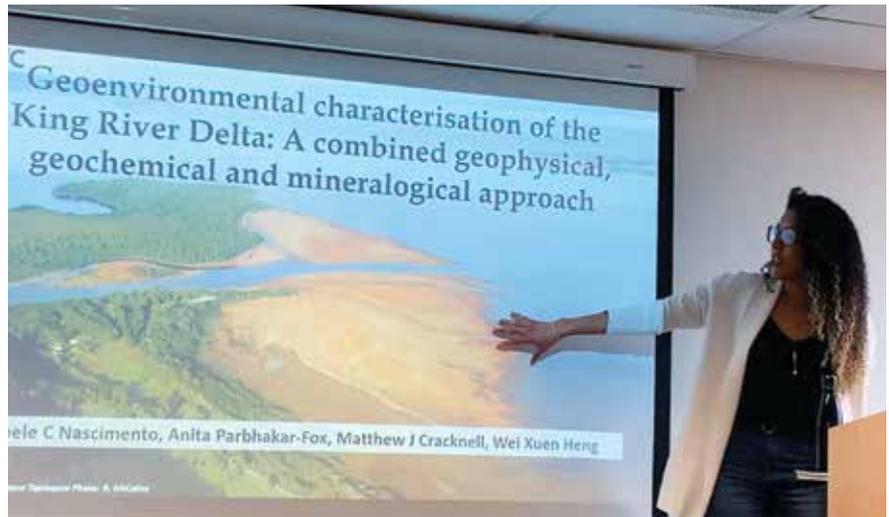
#### SILVER



## EYES ON THE PRIZE

**CODES/TMVC PhD student Sibele Nascimento came away with one of three prizes for the Best Student Oral Presentation at the recent SGA conference held in Glasgow. Her talk was entitled 'Geoenvironmental characterisation of the King River Delta: A combined geophysical, geochemical and mineralogical approach'. Her PhD examines and evaluates opportunities for the reprocessing of mine waste. Here she reflects on her time in Glasgow.**

*'Taking part in the SGA conference was an enormous pleasure for me. First, because I was able to attend amazing talks about economic geology, mineral resources, industrial minerals and environmental geology. It was interesting to see what researchers, professionals and students have been doing in other parts of the world, and at the same time see that, somehow, we are all connected by focusing on mining development and by being more engaged in doing it in a more sustainable way. And second, I was also pleased to see long-term friends and former professors who have helped me in my academic growth.'*



**Talking point:** CODES/TMVC PhD student Sibele Nascimento at the SGA conference held in Glasgow during September pictured presenting her talk about her research into evaluating the possibilities for mine waste reprocessing for which she won one of three prizes for the 'Best Student Oral Presentation'. She received a certificate and a handy 250 EUR.

*'I had the opportunity to give a talk about the work I've been doing at UTAS as a PhD student. I received positive feedback from the audience and was able to discuss with other researchers and professionals several different aspects of my project. At the end of the conference I was awarded – from a range of so many great talks by other students – a 'Best Student Oral*

*Presentation' prize, which absolutely surprised me. It made me feel confident about the work I've been doing as a PhD student, motivated me even more to keep working hard, and especially made me want to pursue my career in the environmental/sustainable aspects of the mining industry.*

*'Overall, it was an experience that I will always remember.'*

## VIRTUAL TEACHING RESOURCES GRANT SUCCESS

**Senior Lecturer in the Discipline of Earth Sciences Dr Michael Roach has been successful in securing a \$40,000 grant to develop virtual teaching resources for a diverse range of disciplines within the College of Sciences and Engineering (CoSE) at UTAS.**

The project will use and build on existing Earth Sciences hardware, software and expertise originally developed principally by Dr Roach and used in the AusGeol Virtual Library of Australia's Geology ([www.ausgeol.org](http://www.ausgeol.org)). He will also coordinate this new project, which aims to provide the following resources:

- virtual tours of significant geological outcrop in SE Tasmania
- virtual tours of Tasmanian forest ecosystems
- virtual tour of the University Farm, Cambridge

- virtual tour of the Mt Pleasant Astronomy Facility
- virtual resources for Hobart human geography, physical geography and geoheritage assessment.

Dr Roach will work with academics from the Discipline of Biological Sciences, the Discipline of Geography and Spatial Sciences, the Discipline of Physics, and the Tasmanian Institute of Agriculture to develop the virtual resources. The project will address UTAS Priority Areas by, among other things, supporting the use of innovative practices and optimising the student learning experience. And it will address the place-based principles outlined in the UTAS Strategic Direction document (November 2018) by creating educational resources to highlight Tasmania's outstanding natural and cultural environment.

Recent advances in imaging hardware and software can now facilitate the rapid and inexpensive generation of photorealistic virtual objects and tours that can be used to enrich (but not replace) conventional laboratory and field education programs.

This internal grant has been given by the College of Sciences and Engineering and will be used to purchase camera equipment, software and to finance research assistants to work on data acquisition and processing.

Dr Roach says that this grant will facilitate development of educational resources for our undergraduate Earth sciences teaching program and will also demonstrate the potential of these new virtual education methods in other field-based disciplines.

# CHANGING FACES

New faces continue to come and go at CODES; we welcome two more PhD students who have commenced their research in the latter part of 2019, and we have a new member of our Analytical Laboratories team.

PHD STUDENT	START DATE	PROGRAM	PROJECT TOPIC
 <b>Hannah Moore</b>	1 October 2019	Program 4, working with Rebecca Carey and Martin Jutzeler	The 1886 basaltic Plinian eruption of Tarawera volcano, New Zealand
 <b>Takeshy Coaquira</b>	Mid-November	TMVC, AMIRA P1202 project working with David Cooke, Angela Escolme and Lejun Zhang	Resolving multiple generations of phyllic and advanced argillic alteration at the Resolution Cu-Mo porphyry, Arizona

## Arrivals



**Terrie Sawyer** has re-joined the team at CODES Analytical Laboratories. Terrie's main responsibilities will involve

operation of the clean room, sample preparation and solution ICPMS analysis. Terrie will also participate in the R&D program of the Laboratories by developing new methods for bulk analysis of challenging matrices, which are required for development of quantitative LA-ICP-MS analytical methods for in-situ trace element analysis of minerals.



**Dr Margaret Hawke**, a CODES PhD graduate, started a six-month part-time new project at the

start of September working with Professor Ross Large on 'Pyrite vectors for the Cobar Basin'. She is funded by an Innovation Connection Grant with Peel Mining, and her work aims to define any possible vectors to VHMS deposits in the Cobar Basin using trace element geochemistry.

## Departures



**Dr Wei Hong** left his role as a postdoctoral researcher at CODES in October and took up a position as a

postdoctoral research fellow at the University of Adelaide. He is employed within the MinEx CRC, the world's largest mineral exploration collaboration, working with the Geological Survey of South Australia and the mining industry on the mineral systems and mineralisation potential of the Delamarian Orogen, southeastern SA.

## NEW ROLES



**Dr Angela Escolme** will be moving from her role as a Research Fellow in Geometallurgy, ARC TMVC Research Hub, to a new role as a Lecturer in Geology and Geometallurgy and will be taking up this post in early January 2020. In her new role she will divide her time between teaching and research.



**Dr Indrani Mukherjee** moved to a new role as a Postdoctoral Research Fellow in Geochemistry in late September supported by an Ian Potter Foundation grant and various industry partners, and is working on 'Characterising pyrite chemistry of black shales hosting stratiform Zn-Pb-Ag and application to mineral exploration'.

## JUST ADD WATER

**Hobart-based hydrogeologist Cynthia Palfreyman explains what those three extra letters in her job title mean, and the importance of understanding them – especially for young geology students looking to map out a career.**

In September I was honoured to speak at the Loftus Hills Memorial Lecture, which is held prior to the annual UTAS Geology Society dinner each year. Dr Michael Roach was one of my Honours supervisors and we have kept in touch over the years. Michael invited me to speak to describe an alternative geology career to that of economic geology, as well as how I have managed the work/life balance with a family while working in my chosen career. I have worked as a hydrogeologist since leaving UTAS in 2002, and am now a mother of two children working part-time as a hydrogeologist at engineering/environment consultant company GHD in Hobart.

### **What does a hydrogeologist do?**

A hydrogeologist studies groundwater while a hydrologist studies surface water. There are many different aspects to the work of a hydrogeologist: you might be dewatering mine sites, looking for water supply for towns or agriculture, remediating contaminated sites, or investigating surface water-groundwater relationships to protect a wetland.

### **Are hydrogeologists more important now because of global warming?**

Yes, especially in areas where climate change is having an effect on water supply. People look to groundwater to augment or become their main water supply. There is some interesting work in aquifer storage recovery projects and using treated wastewater to inject into aquifers to replenish depleted groundwater supplies.

Some of my first work was in Victoria with groundwater supply work due to drought conditions at the time. If you work in the groundwater resources



Here Cynthia is hand-augering soil sample sites on the east coast of Tasmania; the photo was taken while she was working full-time before she had her children.

sector you will be highly sought after in certain areas of mainland Australia. This work is easily transferrable to mine site dewatering work as well.

### **What inspires you the most about your work?**

I love working outdoors and on projects which have a lasting environmental benefit. I am inspired by the people I work with and in particular I enjoy educating people on how to undertake their work whilst protecting the environment.

### **Your greatest work-related achievement?**

That's a tough question. Probably some of the earlier work I've done:

in particular in the Philippines we educated the local people and groundwater managers about how to protect their groundwater drinking supply. We worked hard under trying conditions and I believe the work has had a lasting impact. To be honest, overall I'm proud of the great working relationships I've built over the years across the country and in the Philippines.

### **Do you have any practical tips for young geologists trying to get into your field?**

The best way to get into hydrogeology is to get into hydrogeology! Look for and apply for hydrogeology jobs, research the jobs and the companies

you want to work for, and then actively contact the people at those companies, and not just the HR personnel... contact the other hydrogeologists there. You may not start out in the exact job you want but get your foot in the door and prove yourself!

If you are still at uni and picking subjects, geochemistry and GIS skills are great complementary skills in the hydrogeology field. You need to be a whiz on Excel as well!

**What does GHD do? It is perhaps not that well-known as a company here in Hobart.**

GHD is an international consulting company (it is not the other GHD – the hair straightener.....!). They have offices in Australia, America, Canada, South East Asia, South America, Europe, basically most places. GHD offers services in engineering, architecture, energy and resources,

environmental (botany, zoology, etc), geosciences, transport, water, waste management and project management to name a few.

GHD has an office in Salamanca here in Hobart, as well as offices in Burnie and Launceston. In Hobart, I work with five other hydrogeologists as well as a team of environmental scientists across a wide range of projects.

**Anything else we should know?**

I love rock climbing – but that's not unusual for a geologist is it?!

And I love hydrogeology and where my geology degree has taken me. I have loved meeting the likeminded people I have worked with over my career and the travelling to amazing places. You will never be bored as a geologist! You won't regret a geology degree; it is applicable to so many careers and will take you to wherever you want to go in this world!



Hydrogeologist Cynthia Palfreyman delivers her Loftus Hills Memorial Lecture at CODES during September.

## AN ACCOLADE FOR ADAM!

**CODES PhD student Adam Abersteiner, who is studying under the supervision of Professor Vadim (Dima) Kamenetsky, was recently awarded the Peter W. Smith CSL Postgraduate Award by UTAS.**

This award is presented for producing the most outstanding peer-reviewed publication in the past 12 months by a University of Tasmania postgraduate student that makes extensive use of Central Science Laboratory (CSL) facilities and expertise. The article by Adam that clinched the prize was entitled 'Djerfisherite in kimberlites and their xenoliths: implications for kimberlite melt evolution', and was published in the journal *Contributions to Mineralogy and Petrology*.

This is a prestigious award that has been running since 2014 and is not only a great accomplishment for Adam but also for CODES and the Discipline of Earth Sciences.

**Congratulations from all at CODES!**



Deputy Director of the CSL Dr Thomas Rodemann holds a display board naming recipients of the Peter W. Smith CSL Postgraduate Award, while PhD student and award winner Adam Abersteiner holds his award certificate and Professor Dima Kamenetsky looks on.

## SOUTH AMERICA MASTERS SHORT COURSE: PLANNED TO PERFECTION



Some of the 2019 'Ores in Magmatic Arcs – South America' Masters short course participants pictured near the Soledad tourmaline breccia-hosted Cu deposit, central Peru. The impressive Cordillera Blanca mountain range is in the background.

**This year's Masters short course to South America was another big success in terms of the geological and mine sites visited, as Dr Mike Baker reports. Civil unrest in two of the three countries visited – which began shortly before and during the course – was a challenge that was overcome by some adept planning input by the course leaders, South American course participants and a CODES administrative officer.**

The Master of Economic Geology 'Ores in Magmatic Arcs – South America' short course (KEA707) was run from 12–25 October with 22 participants. Originally scheduled to visit sites in Ecuador and Chile, the first week

of the course was changed from Ecuador to Peru due to civil unrest in Ecuador that arose in the days before the course was scheduled to begin. This last-minute change to the program was well received by all, as the deposits visited in Peru provided a greater and more varied array of mineralisation and deposit styles than was originally planned for the Ecuadorian leg of the trip.

The course was led by Professor David Cooke (Director of CODES) and Dr Mike Baker (CODES/TMVC Research Fellow), with significant logistical and translation support provided by CODES Masters students Victor Torres Pacheco and Carlos Diaz Castro. The first week of the course saw the

participants visit several deposits in Peru, including the Soledad Cu-Au-Ag tourmaline breccia-hosted prospect near Huaraz and associated core facility in Lima (Chakana Copper), the Pasco Complex magmatic-hydrothermal district, which contains skarns and carbonate replacement deposits, intermediate sulfidation Ag-Pb-Zn veins and porphyry Cu-Mo mineralisation at the Atacocha and El Porvenir mines and surrounds (Nexa Resources), and the Ayawilca Zn-Ag carbonate replacement deposit core facility in Huánuco (Tinka Resources).

The second week of the course saw the focus first shift to northern Chile, with brief excursions to San Pedro de Atacama, Valle de la Luna and a transect along the Domeyko Fault zone

north of Calama, along with a visit to the El Abra porphyry Cu-Mo deposit north of Calama (Freeport McMoRan). Unfortunately, due to civil unrest that began in Chile in late October, additional visits to CODELCO and Anglo American sites in northern and central Chile were last-minute cancellations, so the course ended with two days of lectures on porphyry deposits in Santiago.

Special thanks to David Kelley and Doug Kirwin (Chakana Copper), Mervin Tapia (Exploration Manager, Nexa Resources), Alvaro Fernandez-Baca (VP Exploration, Tinka Resources) and Wolfram Schuh and Marcelo Astengo Montenegro (El Abra) for facilitating our visits to the various deposits and core facilities in both Peru and Chile. We also thank CODELCO and Anglo American for all of their work in terms of coordinating our planned site visits to several of their deposits in Chile. We would also like to give huge thanks to CODES Administration Officer Karen Huizing for her tremendous support in organising logistics for the fieldtrip, including the numerous last-minute changes that were necessary to shift the first week from Ecuador to Peru, Victor Torres Pacheco for helping to pull together site visits and transport in Peru at such short notice, and Carlos Diaz Castro for helping to organise transport and site visits in Ecuador prior to the civil unrest in that country.



South America Masters short course students examining rock piles at El Abra porphyry Cu-Mo deposit open pit, northern Chile (Freeport McMoRan), prior to the civil unrest that curtailed further mine visits in that country.



CODES Masters student Victor Torres (left) explaining the geology of the Cordillera Negra in central Peru, while CODES Masters student Carlos Diaz holds the whiteboard.

## CODES CONNECT

CODES and Earth Sciences have many ways of keeping in touch with our researchers, staff, students, graduates, stakeholders, the mining and minerals research community, and industry bodies.

The CODES website (<https://www.utas.edu.au/codes>) is constantly being updated. UTAS is gradually upgrading its webpages and a new-look CODES website will be available soon.

The Discipline of Earth Sciences webpage ([https://www.utas.edu.au/natural-sciences/earth-](https://www.utas.edu.au/natural-sciences/earth-sciences)

[sciences](#)) has been updated and now has a link to the Earth Sciences Facebook page as well as short profiles with videos about some of our student researchers.

You can follow one of our Facebook pages:

**f CODES:** <https://www.facebook.com/CODES.UTAS/>

**f Earth Sciences:** <https://www.facebook.com/EarthSciUTAS/>

**f TMVC:** <https://www.facebook.com/tmvc.utas/>

You can also follow one of our LinkedIn pages:

**in CODES:** [linkedin.com/company/codes-utas](https://www.linkedin.com/company/codes-utas)

**in TMVC:** [linkedin.com/company/tmvc\\_utas](https://www.linkedin.com/company/tmvc_utas)

### BECOME A SUBSCRIBER

If you want to join one of our mailing lists to receive regular updates (newsletters/annual reports/short course information/PhD opportunities or job vacancies) please email us at: [CODES.info@utas.edu.au](mailto:CODES.info@utas.edu.au)

# THE VISITORS' BOOK

**CODES has welcomed several visitors and speakers in the past few weeks as well as four Chinese visiting academics and students.**



PhD student **Mathilde Henri** from the Institut de Physique du Globe de Paris visited CODES/Earth Sciences for six weeks from the start of October. She worked with Dr Rebecca Carey and Dr Martin Jutzeler on a submarine volcanic succession from the Lesser Antilles Arc.

**Professor Bruce Houghton** from the University of Hawaii visited CODES/Earth Sciences and gave a very well received public lecture on the 2018 volcanic crisis in Hawaii on 9 October. He described the physical events and the social impacts of this unusual eruption. As the Hawaii State Volcanologist Bruce worked on the frontline response team from the Hawaii Volcano Observatory taking numerous videos of the fissure eruption. In 2017 he was awarded volcanology's highest honour: the Thorarinsson Medal, which is awarded once every four years.

Professor Houghton was also a Visiting Scholar to Earth Sciences/CODES and worked with Dr Rebecca Carey.

In mid-October **Anton Rada**, the Chief Geophysicist at Unmanned Aerial Magnetics, gave a presentation about his work, which is at the forefront of the development and implementation of drones for geophysical surveys.

In early November **Emeritus Professor Ray Cas** gave a talk about the geological and volcanological reconstruction of the Yilgarn craton at a regional scale.

In mid-November **Karyn Gardner**, Principal Geologist, Ore Deposit Knowledge at Newcrest Mining, gave a GSA talk entitled 'Ore deposit knowledge – the value of continuous improvement, Lihir Gold Deposit'.

## CHINESE VISITORS



**Dr Hongying Qu** from the Institute of Mineral Resources at the Chinese Academy of Geological Sciences was invited to CODES by Professor David Cooke as a Visiting Research Fellow for the last three months of the year. Her research focuses mainly on magmatism and mineralisation of typical deposits in East Kunlun, northwest China.



Visiting PhD student **Tao Zhang** is from the School of Earth Sciences and Resources, China University of Geosciences (Beijing), where he is majoring in geochemistry. Tao was invited to CODES by Professor Leonid Danyushevsky for the period October 2019–January 2020. His research will mainly focus on high heat production (HHP) granite and its implications for gold mineralisation, trying to clarify the relationships between HHP granites and gold deposits in the north of North China Craton (NCC).



**Dr Cui Minli** arrived in early November and will be at CODES until the end of April 2020 working on collaborative research with Dr Lejun Zhang. Dr Minli is a senior geologist who works in the Development and Research Center, China Geological Survey. His research fields are related to mineralogy, petrology and ore deposits, and he has carried out investigation into deposits in many countries including Laos, Mongolia, Indonesia, Namibia and Argentina.



Professor Bruce Houghton, who came to UTAS as a Visiting Scholar during 2019 to work with Dr Rebecca Carey on a paper about recent volcanism in New Zealand, is pictured here at the Taupo volcano while he was running a University of Hawaii graduate course in volcanology. Dr Carey took several students from UTAS over to New Zealand to attend this course in March this year.



Visiting PhD student **Shaorui Zhao** from the School of Earth Resources, China University of Geosciences at Wuhan, arrived to study at CODES in mid-November. Shaorui was invited to CODES by Professor Ross Large, and will be working with him for a year on two papers: 'Gold sources for the late Mesozoic gold mineralisation in the North China Craton' and 'The first Paleoproterozoic gold deposit in the North China Craton'.

## RELAX...IT'S THE GEO DINNER...

Once again fun and frivolity were the order of the evening at the annual UTAS Geology Society dinner held at the Royal Yacht Club of Tasmania in Sandy Bay during October and organised by the Earth Sciences students. This year's photographer was Wei Xuen Heng. While around 50 attendees tucked into a hearty meal, the traditions of the quirky awards presentations and the staff v. students song competition continued to provide much mirth.



**A good time had by all:** CODES and Earth Sciences staff and PhD students enjoy the nosh; they were (L-R): Dr Paul Olin, Dr Rebecca Carey, Dr Evan Orován, Helen Cooke, Professor David Cooke, Dr Michael Roach, PhD student Tobias Staal, Dr Matthew Cracknell and Laura Cuff.



**Left: In full swing:** the PhD student team song – *Frothy Friday on my Mind* (an adaptation of The Easybeats' hit *Friday on my Mind*) – won the singing competition, which is a historic first as the PhDs have never won it before. It helped that all PhD singers were musicians in their spare time! They were (L-R): Javier Merrill (guitar), Tristan Wells (bass), Thomas Schaap (sax) and Tobias Staal (lots of instruments but mainly piano). **Right: The award for what?:** PhD student Tristan Wells holds his award certificate presented at the dinner for the person 'Least likely to wear shoes', which he took in good heart. Third-year Earth Sciences students Olivia Wilson, Lachlan Dick and Fergus Giec-Yorston enjoyed the task of presentation.



**Making merry:** more CODES and Earth Sciences staff and friends, (L-R): Associate Professor Sebastien Meffre, Lecturer Martin Jutzeler, Research Fellow Dr James Tolley, Chris Large, Research Fellow Dr Indrani Mukherjee, Researcher Dr Margy Hawke, Andrea Conachev, and TMVC PhD student Javier Merrill.

UPCOMING MASTER OF ECONOMIC GEOLOGY SHORT COURSES

## VOLCANOLOGY AND MINERALISATION IN VOLCANIC TERRAINS

7-24 MARCH 2020

**COURSE LEADERS:** MARTIN JUTZELER, DAVID COOKE, SHAUN BARKER,  
ANDREW McNEILL AND ROBERT SCOTT

In this highly practical, field-based short course, participants gain first-hand experience in the recognition, classification and interpretation of modern and ancient volcanic rocks. The short course begins with participants studying well-preserved modern and recent volcanic landforms, volcanic deposits and associated hydrothermal systems on the North Island of New Zealand. By visiting a range of spectacular field locations, participants gain insights into the processes and products of different eruption styles, contrasts in scale and structure of volcanoes, and the identification, description, logging and interpretation of key volcanic facies associations. Armed with an understanding of volcanic products and processes based on the inspection of New Zealand examples, where primary textural and compositional features are well-preserved, participants travel to western Tasmania to inspect deformed and altered ancient (~500 m.y. old) volcanic successions of the Mount Read Volcanics and associated mineral deposits.

A flyer with further information about the itinerary, costs and payment options is available on the CODES website: [www.utas.edu.au/codes](http://www.utas.edu.au/codes)



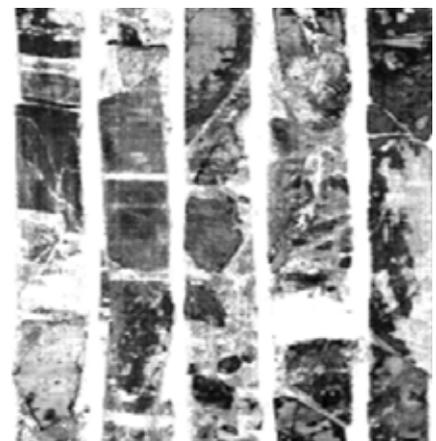
## EXPLORATION IN BROWNFIELD TERRAINS

1-12 JUNE 2020

**COURSE LEADERS:** JONATHAN CLOUTIER, ROBERT SCOTT

The compilation and analysis of large datasets that are common in areas of significant previous exploration can present a challenge for any geologist. This lab-based short course looks at exploration strategies in areas close to existing mine sites, where abundant, but commonly under-utilised, data is typically available. The short course gives participants first-hand experience in the use of cutting-edge technologies in geochemistry, hyperspectral mineral analysis and 3D visualisation for mineral exploration in data-rich environments. The short course is presented by expert teaching staff from CODES and leading minerals industry professionals using real data from world-class mineralised districts.

A more detailed program with information about presenters, costs and payment options will be available soon from the CODES website: [www.utas.edu.au/codes](http://www.utas.edu.au/codes)



For further information about either short course please email:

[CODES.Info@utas.edu.au](mailto:CODES.Info@utas.edu.au)

OR

Master of Economic Geology Program Co-ordinator, Dr Robert Scott:

[Robert.Scott@utas.edu.au](mailto:Robert.Scott@utas.edu.au)