# ORE SOLUTIONS

NEWSLETTER OF **CODES** CENTRE FOR ORE DEPOSIT AND EARTH SCIENCES

> Summer 2020 **No.38**


## INSPIRED: CODES' NEW ENVIRONMENTAL GEOLOGY LECTURER

**Dr Clare Miller joined CODES earlier this year from Canada, where she carried out research in the remote Northwest Territories. Her Canadian research experience, along with her love of outdoor pursuits, motivates her to carry out her research into sustainable resource development and the protection of Tasmania's rugged wilderness while inspiring her students to do the same.**

Dr Clare Miller, CODES' new Lecturer in Geoenvironment and Geometallurgy (right), and her Honours students, Olivia Wilson (centre) and Eliza Fisher (left), monitoring water quality parameters and collecting samples from a stream at the legacy Endurance mine site, northeastern Tasmania. These samples were collected as part of a collaborative and multidisciplinary project between CODES-TMVC and MRT to investigate the source and transport of acid and metalliferous drainage and inform remediation activities at the site.

Environmental geology is a multidisciplinary field of Earth sciences focussed on establishing a holistic understanding of the dynamics of environmental systems. Integrating knowledge and techniques from chemistry, physics, limnology, hydrology, metallurgy, mineralogy (just to name a few), this field aims to better understand the complex relationships between human activities and natural systems. Through a truly collaborative approach, environmental geology provides a unique opportunity to lessen our impact on the natural environment, leading to a more sustainable future.

As a global leader in ore deposit research, the impacts of resource

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**FROM THE DIRECTOR**

**Professor David Cooke thanks staff and students at CODES for the huge efforts they have put in during the COVID-19 pandemic, and looks forward to a gradual return to 'service as normal' in 2021.**

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development on our environment are central to CODES' research and teaching. For over 20 years, researchers and students at CODES have contributed substantially to the development of improved mine waste characterisation and sustainable resource development, in Tasmania and globally. As an early career researcher and the new Lecturer in Geoenvironment and Geometallurgy here at UTAS, I hope to build on the strong foundations of the Environmental Geology program and contribute to the growing knowledge and mitigation of mining impacts on environmental systems.

As an environmental geochemist, my research focuses on the mineralogical controls on the mobility of metal(loid)s in mine waste and environmental systems (i.e., lakes, wetlands, soils). Through field-based sampling, laboratory experiments and microanalytical laboratory techniques, the primary aims of my research include: informing remediation activities at legacy mines sites; developing innovative strategies to mitigate the impacts of mining on environmental and community health; and understanding the impacts of climate change on mining activities, metal(loid) mobility, and baseline geochemical conditions. Through this research I hope to contribute to the reputation of CODES as a global leader in sustainable resource development and environmental protection.

## TASMANIA: THE PERFECT "LAB"

As an explorer, hiker, paddler and mountain biker, protecting these pristine environments for future generations inspires my work. My graduate research focussed on understanding the effects of climate change on geochemical baselines and the long-term fate of legacy mining contaminants in sub-Arctic lakes of the Northwest Territories, Canada. The opportunity to study the lakes of northern Canada and work on-the-land with northern communities had a profound influence on me; I was inspired not only by the vastness of Canada's north, but more particularly by its peoples and cultures. Building on the lessons learned from research in northern Canada, I hope to inspire the next generation of geoscientists to re-think our approach to mineral resource extraction, community engagement, and protection of the pristine wilderness and environmental ecosystems here in Tasmania. The remote wilderness, coupled with a legacy of historical mining, makes Tasmania the perfect "laboratory" to learn from the past and to develop innovative methods for remediating degraded environments and preventing future impacts to our lakes, soils, forests and waterways and their immense biodiversity.

The first year has been an exciting and busy one for the new Environmental Geology research group here at CODES. We have been fortunate to complete five environmental field trips: four Honours studies, and one week-long field trip for the third-year Environmental Geology course. These trips featured the collection of a wide range of environmental and mine waste samples in both eastern and western Tasmania. I have had the opportunity to work closely with Dr Matthew Cracknell (TMVC-CODES) on a project combining geophysics, geochemistry and hydrogeology to inform remediation activities at a legacy tin mine in northeastern Tasmania (see the Honours feature on page 4). We have also developed interdisciplinary collaborations with Geography on a project with Dr Vishnu Prahalad, where we are examining the effectiveness of native Tasmanian wetland species to improve water quality at legacy mine sites (also see Honours feature page 4). There are a number of exciting projects on the horizon for the Environmental Geology research group at active and legacy mine sites across Tasmania, with many opportunities for continued collaboration within CODES and at UTAS.

As I begin exploring the research possibilities here in Tasmania, I continue to work in collaboration with my Canadian colleagues. Currently, I am working with Natural Resources Canada and Environment and Climate Change Canada on a project titled "Tracking water quality in a changing climate". In maintaining international connections, we can foster productive international research collaborations to advance the aims of Environmental Geology.

# TENACITY IN THE FACE OF ADVERSITY: HONOURS COHORT OF 2020 SHINES

**Dr Angela Escolme took over as Honours Coordinator for the Earth Sciences/CODES students just before the COVID-19 pandemic began. She has huge admiration for the way this year's cohort of Honours students have got on with the job despite some very difficult circumstances. Read about their varied projects, their hopes for the future and how they coped along the way….**

Honours student Wei Xuen Heng conducts a seismic survey in June 2020 to understand the internal structure of mine waste piles at the legacy Endurance mine site in northeast Tasmania.

Earth Science students continue to hone their crafts through our Honours program here at the University of Tasmania where we aim to prepare 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 Angela Escolme since early 2020 – what a year to take the baton!

The 2020 academic year has again been excellent for our Honours program, with 14 students enrolled, which represents a large proportion of students completing an Earth Sciences major in the Bachelor of Science. Three students graduated in August this year (Justin Burns-Nichols, Claudia Jenkins and Verity Kameniar-Sandery) and six students will submit in December. We also have five mid-year starters, four of whom will graduate in April 2021. The student numbers for 2021 look very strong, demonstrating continued interest from graduate students in obtaining additional qualifications before joining the workforce.

## RESEARCH TOPICS

Tasmania is well represented in our 2020 initiated research projects, with seven projects based on Tasmanian sites, three on samples from interstate or overseas, and one method development project. Details of these eleven projects are covered in the following pages. Of the six students who started Honours in February, four carried out projects related to environmental geochemistry (including one in geophysics), and two on economic geology projects. Despite experiencing a range of challenges this year stemming from the global pandemic, including delayed or cancelled fieldwork and the isolation of working from home, all these students will submit theses before Christmas and most will graduate in December. This is a real testament to both the tenacity of the students to achieve their goals in the face of adversity and the support of supervisors and staff – a huge "well done" to all involved! The five mid-year starters are also working across a range of geology, geochemistry and economic geology topics with projects designed to be feasible under the current circumstances for completion in April 2021.

## SPONSORS

Many of the student projects commencing in 2020 were sponsored by industry and academia. We are most grateful to sponsoring companies and organisations, which included the ARC TMVC Research Hub, the CockerTwo Scholarship through the UTAS Foundation, Mineral Resources Tasmania, the AMIRA P1202 sponsor group, and CODES Analytical Laboratories. In addition, a proportion of the project work was supported by internal, university-based funding.

## LACHLAN DICK

Current student, completing end 2020

**Supervisors**: Evan Orovan, Mike Baker

**Project title**: Granites and greisen of the Anchor Mine, Tasmania

This project seeks to describe and investigate the occurrence of hydrothermal alteration, mineralisation, and quartz-bearing magmatic-hydrothermal transition textures in a Sn-bearing, greisenised Late Devonian granite in the Blue Tier Batholith, eastern Tasmania. Mineralisation occurs as disseminations of Sn- and Cu-bearing minerals (with minor Pb and Zn) in the greisenised apex of the Lottah S-type biotite alkali-feldspar granite, which is capped by a conspicuous unidirectional solidification texture (UST) at the contact with the Poimena I-type biotite monzogranite.

In the lab at UTAS: Honours student Erik Fabreschi undertaking sulfide mineral identification and analysis of HCl etched pyrite using reflected light microscopy in November 2020.

This study will investigate in detail the relationships between I- and S-type granites of the Blue Tier Batholith, as well as their relationship with magmatic-hydrothermal textures and potential for Sn mineralisation. This has involved digitising and interrogating historic data and drill core logs stored at MRT and re-logging of available drill core from the Anchor Mine. Laboratory-based studies have included LA-ICP-MS analysis of white micas and U-Pb age determinations of zircon, monazite and cassiterite from the intrusions. It is hoped that the outcomes of this study will help expand our knowledge of the melt-fluid interface in relation to Sn-bearing granite systems of Tasmania.

*"The Honours year has been unlike any study I have undertaken before. COVID-19 threatened to derail my project but I am very proud of how I overcame hurdles and adapted along the way. I have gained many skills and learnt a huge amount during my Honours year. After Honours I am moving to Western Australia to pursue my career and enhance my knowledge".*

## ERIK FABRESCHI

Current student, completing mid-2021

**Supervisors:** Angela Escolme, Mike Baker

**Project title:** Pyrite trace element geochemistry at the Spence Cu Mo porphyry deposit, Chile

This project will investigate the geochemistry of pyrite from the deeply eroded and moderately overprinted Spence Cu-Mo porphyry deposit, Chile. Erik is working with the AMIRA International Project P1202 Module 4 research team to improve our understanding of the transition zone in porphyry systems (i.e., the region between deep and early potassic alteration and later shallow epithermal environments). He is working with drill core samples collected by researchers in 2019 and will be specifically investigating variations in pyrite trace element geochemistry in time and space at the deposit. A number of studies exist in the literature where early-stage pyrites are compared to late epithermal pyrite, but data for transitional/phyllic stage pyrites are scarce. The Spence deposit provides an excellent opportunity to document phyllic stage pyrite geochemistry and make comparisons to the deposit's early-stage high-temperature pyrite. Erik's research program will begin with a focus on developing a detailed paragenetic framework, with particular attention on pyrite, before embarking on an analytical program. The project will involve petrographic studies, pyrite etching, SEM-based analyses, LA-ICP-MS spot and map analyses and multivariate analysis of geochemical data. This work will enable deportment of potential credit or deleterious trace elements to be resolved, as well as review potential exploration vectors.

*"Undertaking Honours has been a very rewarding experience. I have enjoyed managing my own time and partaking in research that has real-life applications. The whole process has been challenging, stimulating and gratifying. I have thoroughly enjoyed participating in the courses held at UTAS as well as listening to seasoned veterans share their wisdom."*

## ELIZA FISHER

Current student, completing end 2020

**Supervisors:** Clare Miller, Matthew Cracknell, David Cooke

**Project title:** Geochemical analysis of mine waste and pit lakes at Endurance mine, NE Tasmania

Honours student Eliza Fisher taking deep water samples and parameters (pH, electrical conductivity, dissolved oxygen) from a boat on Blue Lake. She said: "We had to really pick our days with the wind and rain, so it was great to get a blue sky in this picture! The pit-lake has formed in the legacy Endurance Mine workings. The purpose is to study the water chemistry and sediment geochemistry of the lake."

Eliza's project was part of a collaborative, multidisciplinary approach to mine waste characterisation and rehabilitation at the legacy Endurance mine in northeastern Tasmania. Her project was funded by Mineral Resources Tasmania (MRT) under the Tasmanian Government's Mining Sector Innovation Initiative Program (MSIIP), which supports new and continued mining activities within the state.

Alluvial tin mining at Endurance occurred intermittently from 1922 until the 1980s. The shallow, cassiterite-bearing, deposits were mined leaving three open pits and the uneconomic wastes of sluicing activities exposed at surface. Almost four decades after mine closure acid mine drainage continues to be generated from the legacy wastes, negatively impacting the local environment. The legacy mine waste piles and lakes formed in the former open pits are also used by locals for recreational activities such as four-wheel-driving, boating and waterskiing. The elevated acidity and trace metal concentrations in the lakes make this site a priority for rehabilitation efforts. Through field-based sampling (water samples, sediment cores samples) and lab testing (shaker flask tests, µXRF, XRD, SEM, AMEX), Eliza's Honours project aims to determine the source and fate of acid and metals of concern (Al, Fe, Pb, Zn) at the former mine site. By determining the geochemical and mineralogical controls on trace element mobility, the findings of Eliza's project will help to guide remediation efforts at the site. Eliza, Wei Xuen Heng and Olivia Wilson presented the findings of their collaborative research at the online GSA Earth Science Student Symposium in October.

*"I appreciated a project that allowed me to do fieldwork and then analyse the data collected. I've gained so many new skills, from field sampling methods to a range of analytic techniques. An Honours year lifts the veil on some of the hands-on aspects of scientific technique and independent research. Gaining experience collaborating with our Environmental Geology research group has also been a unique and positive experience. I feel like I'm now prepared for both practical work and further research."*

## TILL GALLAGHER

Current part-time student, completing mid-2022

**Supervisors:** Karin Orth, Rebecca Carey, Grace Cumming (MRT), Ralph Bottrill (MRT)

**Project title:** Nature, structure and origin of the St Marys Porphyrite, northeastern Tasmania

Till Gallagher commenced his Honours degree in July 2020. His project aims to re-appraise the volcanic architecture of the St Marys Porphyrite in eastern Tasmania. This research is supported by Mineral Resources Tasmania and Dr Anthony Brown.

The project targets one drillhole and brilliant coastal outcrops between Falmouth and Four Mile Creek and other outcrops between Falmouth and St Marys to the west. Till's core includes the underlying Mathinna Supergroup, the basal contact breccia and basal portion of the St Marys Porphyrite that appears to be welded ignimbrite and grades up into enigmatic granodiorite-like porphyry. He will target the variety of lithic fragments and try to assess their distribution and abundance across the area. The new work on the distribution of the lithic clasts along with macroscopic and microscopic studies will allow Till to identify emplacement and post-emplacement processes related to formation of the St Marys Porphyrite. Some zircon dating work on the St Marys Porphyrite, underlying the Mathinna Supergroup and proposed feeder dyke will help to unravel some of the connections of the St Marys Porphyrite with the crustal architecture and development of northeast Tasmania, and compare with similar units in Victoria.

*"I have enjoyed the process of developing my research question and realising how the research direction evolves with more knowledge. My fieldwork is especially compelling to me; my field area is located in a particularly beautiful part of Tasmania and it feels like a privilege to work there."*

Grace Cumming and Ralph Bottrill from Mineral Resources Tasmania pictured in 2020 with Honours student Till Gallagher (right) at Hughes Point in northeastern Tasmania. Till was carrying out reconnaissance fieldwork on the St Marys Porphyrite.

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## WEI XUEN HENG

Current student, completing end 2020

**Supervisors:** Matthew Cracknell, Clare Miller

**Project title:** Geophysical investigation of the legacy Endurance mine site, northeast Tasmania

The legacy Endurance mine site is an abandoned alluvial tin mine in northeast Tasmania. Between 1872 and 1985, mine waste was discharged into the Ringarooma River and on site. The lack of soil profile and presence of acidic waters have led to the failure of rehabilitation programs. This study used several geophysical methods to define and characterise the thickness and internal structure of abandoned mine waste at the legacy Endurance mine site.

Direct-current resistivity was successful in delineating dry and saturated mine waste, within 5–10 m of the surface and weathered and fresh granite to depths of ~20–30 m. Ground Penetrating Radar was used as a quick and reliable method to detect the boundary between the quartz-rich mine waste and kaolinitic clay layers. Refraction seismic analysis indicates the presence of weathered granite overlying a granitic basement and was useful for inferring basement depth.

By integrated interpretation of the geophysical data and models produced in this study, a three-dimensional model of depth to the base of mine waste, the water table and granitic basement was created and used to estimate the mass of mine waste at ~4 Mt. This model also provides constraints for concurrent hydrogeological and sediment geochemistry Honours projects. Collectively, the results of these projects will inform rehabilitation strategies at the legacy Endurance mine site.

*"It's been a challenging year with self-isolation, travel restrictions and the global pandemic. Honours year has been great with getting into the field for fresh air and data! I enjoyed the Honours year and I have learnt a range of skills and techniques that will be of practical use in the future. I am very grateful to Mineral Resources Tasmania for providing me with this opportunity, and to my supervisors for bringing three projects together."*

## KATE JENKINS

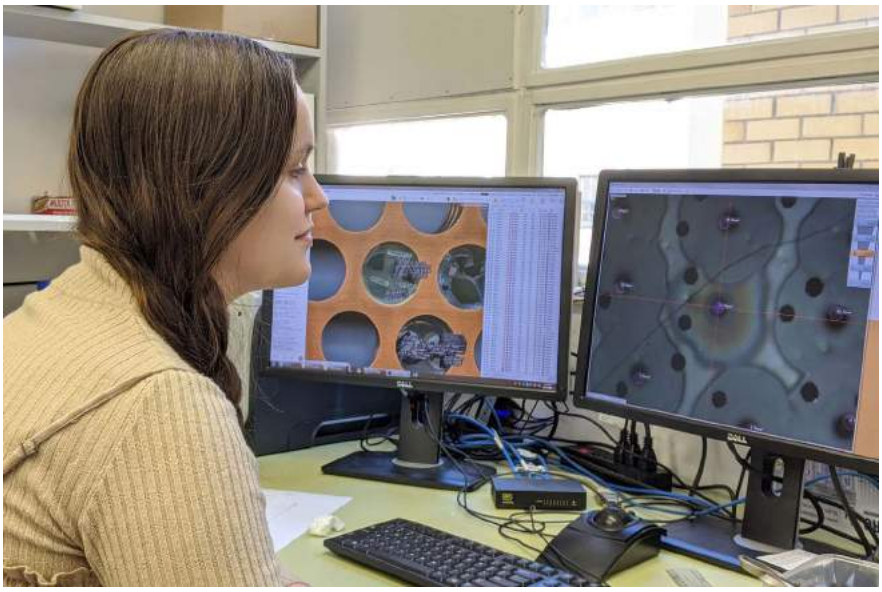
Current student, completing mid-2021

**Supervisor:** Leonid Danyushevsky

**Project title:** Characterisation of element fractionation in U-Pb dating by LA-ICP-MS of rutile and garnet

Kate's Honours project is aimed at developing methods for U-Pb dating of garnet and rutile using LA-ICP-MS to extend the range of minerals that can be reliably dated by this technique. The project involves detailed characterisation of ablation characteristics and the extent of elemental fractionation during LA-ICP-MS analysis of rutile and garnet, including the extent of the influence of variations in the garnet major element composition on these processes. During the project, the ablation rates of both minerals will be characterised using an optical interferometer to link the extent of elemental fractionation to the rate of ablation. EPMA and SEM techniques will be used to assess the extent of melting during ablation, the shapes and dimensions of ablation craters, the composition of mineral phases formed during ablation, and to determine the major elements compositions of garnets. Based on this information, the best analytical conditions and quantification strategies will be developed, including the choice of reference materials to be used for calibration. The work will focus on three garnet and four rutile samples with known ages.

*"I have thoroughly enjoyed being able to use the analytical techniques and instruments I have learnt about in lectures during my bachelor's degree. Finally being able to put them into practise has solidified my passion for geochemistry and research. I look forward to applying my new skills to future projects."*



Kate Jenkins pictured selecting spots on her garnet samples and reference standards to ablate using LA-ICP-MS for her Honours research.

Fun in the mud: Honours student Fu Rong Mah collecting sediment cores at the legacy Balfour mine site in Balfour, northwest Tasmania, in September 2020.

## FU RONG MAH

Current student, completing mid-2021

**Supervisors:** Clare Miller, Sebastien Meffre, Vishnu Prahalad (Geography)

**Project title:** Investigating passive remediation of copper and acid mine drainage using local native plant species, Western Tasmania

Fu is a current Environmental Geology Honours student; her project is funded by Mineral Resources Tasmania (MRT) under the Tasmanian Government's Mining Sector Innovation Initiative Program (MSIIP). Through her project, Fu had the opportunity to conduct fieldwork with the rehabilitation team at MRT and research scientists at the Environment Protection Authority (EPA).

The environmental, social and economic issues associated with abandoned mine sites are a concern in Tasmania. Across Tasmania, 215 out of the 681 historic metal mines have the potential to generate acid and metalliferous drainage (AMD). As many mine sites are located in remote locations, methods of remediation that require minimal monitoring and upkeep are attractive waste management options. Wetlands provide a passive treatment option as they act as a natural filter to improve water quality by removing particulate matter and sequestering contaminants from surface water.

Fu's project aims to examine the biological, geochemical and climate conditions controlling the effectiveness of wetland species (*Restio*) as passive remediation tools in mining-impacted regions of western Tasmania. Her project is focussed on three impacted sites: Mt Lyell, Bank D along the King River, and the legacy Balfour mine site. She also sampled plants, sediments and waters at unimpacted locations to establish baseline concentrations. Fu's project will help to establish 'guidelines' for engineering wetlands to treat AMD using Tasmania's unique flora and geology.

*"My Honours course has enabled me to work on a unique cross-disciplinary project that ties both my plant science and geology background together, with a multifaceted approach in aqueous, plant and geochemistry. I have learnt to think on my feet and experiment with different approaches throughout the course of my project."*

## HUGH SAYERS

Current student, completing end 2020

**Supervisor:** Sebastien Meffre

**Project title:** Understanding framboidal pyrite formation mechanisms and their potential environmental implications

Hugh's Honours project examined small (<30 micron) rounded pyrite formed by sulfate-reducing bacteria in oxygen-poor sedimentary environments. These crystals have been shown to be important for both understanding past ocean chemistry but also for environmental remediation. Although these crystals have been studied extensively, much uncertainty remains with how the crystals absorb trace elements from their environment. Hugh's project not only studied the framboidal pyrite from natural sediments in Tasmania but also grew sulfides in controlled chemical conditions in the laboratory.

The project aims were to

- determine factors for trace element enrichment in framboidal pyrite;
- design and implement an experiment to grow framboidal pyrite; and
- understand trace element pyrite uptake in experimental pyrite.

Hugh's results showed that distinct differences could be observed in the trace element composition of pyrite growing in open ocean, coastal, estuarine and mine-impacted sediments. He also successfully grew sulfides in bottles using natural waters containing sulfate-reducing bacteria. The bacteria started to reduce sulfates after a few days, changing the oxidation-reduction potential of the waters. He also showed that the sulfides absorbed metals, in particular copper, from the water.

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*"It has been a tough and challenging year. I have enjoyed designing and bringing to life a study that is new and exciting. It has been a fantastic opportunity to use the analytical facilities on offer at CODES and the CSL. It has been a pleasure to work alongside the staff and students at CODES and a delight to see the interesting research taking place in Earth Sciences."*

Honours student Hugh Sayers in the lab at CODES preparing to gas sulfide experiments with nitrogen. His research aims to understand framboidal pyrite formation mechanisms and their potential environmental implications.

## BEN SPEAKMAN

Current student, completing end 2020

**Supervisors:** Shaun Barker, Mike Baker

**Project title:** The fertility indicator potential of titanite and apatite from the Yerington District, Nevada

This project forms part of the AMIRA International Project P1202 Module 3 on magmatic mineral chemistry and is using samples collected by former CODES-TMVC PhD student Ayesha Ahmed in 2016 from the Yerington district of Nevada, USA, as part of the AMIRA P1153 project. It is examining the potential use of titanite and apatite as indicator minerals for the prospectivity of intermediate composition intrusions related to porphyry Cu-(Au-Mo) mineralisation. Over the past decade several studies have looked at the influence of titanite on the rare earth element (REE) signatures of other accessory minerals, particularly zircon, and how their presence may influence the use of zircon mineral chemistry data for examining the prospectivity of intrusions related to porphyry mineralisation.

Analytical work on this project has involved the use of SEM-AMICS and XMOD imaging for the identification of titanite and apatite in sample heavy mineral separates, cathodoluminescence (CL) and backscattered electron (BSE) imaging of apatite and titanite, respectively, to identify growth zoning within individual crystals, electron microprobe (EPMA) analysis of titanite and apatite for quantitative major and halogen element chemistry, and LA-ICP-MS analysis of titanite and apatite for trace element and REE chemistry.

Ben Speakman said he "spent a lot of time on the microscope looking at titanite and apatite occurrences from the Yerington district, Nevada" in 2020 while doing his Honours.

*"I got a lot out of this year in terms of time management and organisation skills. It was the largest project I've ever worked on and it pushed me all year to stay focussed and plan ahead which was a skill I was lacking coming into the year. I also learnt some new lab techniques and enjoyed using some of the more advanced machines at UTAS."*

## OLIVIA WILSON

Current student, completing end 2020

**Supervisors:** Clare Miller, Matthew Cracknell, David Cooke, Michael Roach

**Project title:** Hydrogeological studies of acid mine drainage at the legacy Endurance mine site, northeast Tasmania

Using a multidisciplinary approach combining geochemistry, hydrogeology and geophysics,

Olivia's Honours project aims to characterise subsurface contamination flow and transport of acid mine drainage through the waste rock piles at the former Endurance mine site, Tasmania. Olivia's project was part of a multidisciplinary approach to mine waste characterisation, in collaboration with Wei Xuen Heng and Eliza Fisher. Her project was funded by Mineral Resources Tasmania (MRT) under the Tasmanian Government's Mining Sector Innovation Initiative Program (MSIIP), which supports new and continued mining activities within the state. From the planning stages of her project to final computational modelling of field data, Olivia worked closely with the professional hydrogeologists at GHD Ltd to guide her analysis and interpretations. Through the installation, sampling and field-based testing of nine groundwater monitoring wells, ranging in depth from 2 to 18 m, Olivia's project aimed to create a hydrological flow model of groundwater through the legacy mine wastes. Integration of geophysical and geochemical data to Olivia's model allowed her to fill knowledge gaps and create a high-resolution model of the site using industry software (GMS and MODFLOW).

Fieldwork in September 2020: Honours student Olivia Wilson examines mine wastes brought up by the drill rig during the installation of groundwater wells at Endurance, northeast Tasmania.

Olivia was the recipient of the GSA Endowment Fund and was invited to present the findings of her research at the Strahan Geoscience Forum in December 2020.

*"Undertaking Honours and self-directed learning has been a highly challenging but fulfilling experience. I have had the opportunity to learn a wide range of skills, ranging from specific hydrogeological and hydrogeochemical techniques, through to organising and conducting fieldwork. With all the challenges this year has thrown up, I would like to sincerely thank everyone who has provided guidance along the way, in particular my supervisors Clare Miller and Matt Cracknell for their support. I will fondly look back on my time with Earth Sciences at UTAS!"*

## RILEY WINTER

Current student, completing mid-2021

**Supervisors:** Lejun Zhang, Mike Baker, Noel White

**Project title:** Geology, geochemistry, and genesis of advanced argillic alteration at Currowong Hills, Wirrinya District, NSW, Australia

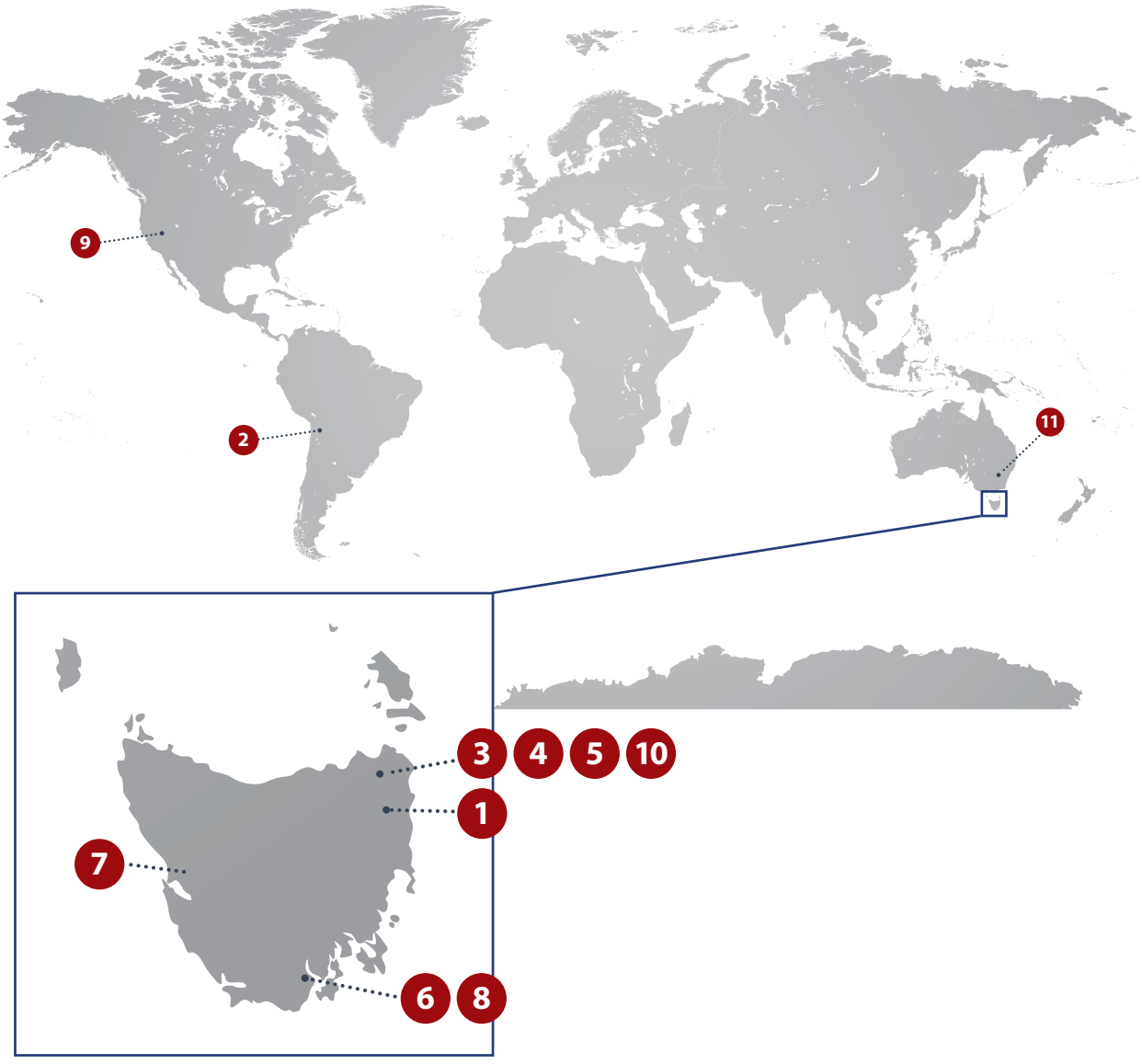
Extensive advanced argillic (AA) alteration that is characterised by the presence of quartz, alunite, dickite and kaolinite has been recognised in Currowong Hills, Wirrinya district, NSW, Australia. In the same belt, several large- to giant-scale porphyry and epithermal deposits have been discovered. However, no detailed studies on the AA alteration (or potential lithocaps) have been reported.

Riley Winter will mainly focus on the Currowong Hills area to investigate the geology, hydrothermal alteration, and mineral textures and chemistry of key alteration minerals, with the aim of advancing our understanding of the genesis of AA alteration in the district, and to contribute to future exploration in the Macquarie Arc. Riley will investigate the presence of AA alteration and constrain the genesis and evaluate the prospectivity using age dating, detailed mapping, historical drill core logging (aided by TerraSpec and HyLogger), and mineral chemistry of key alteration minerals (alunite, APS mineral, quartz etc.). The outcomes of the study will advance our understanding of the characteristics and genesis of ancient AA alteration at Wirrinya district, as well as contribute to the overall understanding of the metallogeny of the Macquarie Arc to assist with district exploration targeting.

Riley Winter panning for minerals in the Weld River in northeast Tasmania; Riley's Honours thesis is looking at the geology, geochemistry and genesis of advanced argillic alteration at Currowong Hills, Wirrinya District, NSW.

*"My Honours experience has vastly built upon my confidence in understanding geological systems. The Honours coursework component has given me the confidence that I can be a competent geologist, and the regular coordination with my supervisors has been both extremely interesting and fulfilling."*

# 2020 HONOURS STUDENTS AND THEIR PROJECTS




**1 LACHLAN DICK**
EASTERN TASMANIA

**2 ERIK FABRESCHI**
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**3 ELIZA FISHER**
NORTHEASTERN TASMANIA

**4 TILL GALLAGHER**
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**6 KATE JENKINS**
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**7 FU RONG MAH**
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**8 HUGH SAYERS**
LAB-BASED PROJECT

**9 BEN SPEAKMAN**
YERINGTON, NEVADA, USA

**10 OLIVIA WILSON**
NORTHEASTERN TASMANIA

**11 RILEY WINTER**
CURROWONG HILLS,
WIRRINYA DISTRICT, NSW

# NEW BOOK THROWS LIGHT ON PAST MINERAL DISCOVERIES

***Australian Mineral Discoverers* is a new collection of short biographies in which 65 exploration geologists reveal the blood, sweat and metaphorical tears behind the discovery of many of the world's most productive mines. Former CODES director Emeritus Professor Ross Large is one of the driving forces behind the book, which is now available to purchase through CODES.**

**How and when did the idea for the book first evolve?**

The book was instigated by geologist John Hill who had the idea several years ago that, although there were published case studies about ore deposit geology and discovery, there was nothing written about the geoscientists who made these discoveries. This was particularly true for the period 1950–2000 when many major ore deposits were discovered in Australia by the application of determination and good scientific investigation. John asked me to help with the project, and we also approached David Royle and Tony Hope, who had many contacts in the exploration industry.

**How long has it taken to get the project off the ground?**

That was an initial problem as John had approached AusIMM and I talked with AIG to get behind the project and provide financial support; however, they already had book projects on the go and declined assistance. Eventually the Royal Society of Tasmania agreed to back the project and act as publisher, for which we were very grateful. The RST have previously published some very beautiful and successful books so it was great to have them onboard.

**How supportive have the mining companies been?**

A number of companies including BHP, Rio Tinto, Newcrest and Newmont have been incredibly supportive by providing pre-publication orders for several hundred copies of the book. They see the book as a valuable education opportunity for their geoscientists, as it describes the life, successes and failures of 65 exploration geologists many of whom were highly successful in the field of ore discovery.


Professor Ross Large was a driving force behind the publication of *Australian Mineral Discoverers*, which contains biographies of 65 geologists and is now available through the CODES website.

**Was it easy to get other geologists to contribute?**

In most cases the people we approached were very keen to contribute their stories. A few declined and many more worthy candidates could not be contacted. We are sorry if some feel they were not invited, but we hope they will contribute to a second edition. The idea is that this is a living book that will continue the stories of each generation of geoscientists and ore finders.

**Have you enjoyed working on it?**

Yes, it has been a pleasure to work with John, David and Tony on this project, and learn about the incredible lives of many of our colleagues. As Professor Geoffrey Blainey, writes in the foreword for the book: "Outstanding geoscientists resemble a first-class poet, painter, architect, mechanical inventor, medical scientist; all have creative minds and all are explorers".

## THE PERFECT CHRISTMAS PRESENT FOR A GEOLOGIST!

In the words of fellow editor John Hill: "The book … includes the discovery of 150 mineral deposits, from the very largest (Olympic Dam of over 6 billion tonnes of copper, gold and uranium ore) to the smallest (the gold-rich Juno deposit in Tennant Creek). Collectively these mineral discoveries amount to many hundreds of billions of in-ground value that have supported many mines, towns and communities in outback Australia for 50 years and beyond."

*Australian Mineral Discoverers* is available from the CODES website (https://www.utas.edu.au/codes/publications/publications-for-sale) at $60 plus P&P.

**In this issue we talk to Dr Heidi Pass, who graduated from CODES in 2010, and who has just ventured out on her own as a consultant geochemist-geologist. Heidi has had a number of geochemistry roles in the mining industry and is also passionate about inclusion and diversity, particularly for women, within the industry.**

# GOOD COMMUNICATION IS KEY

## DR HEIDI PASS

**Consulting geochemist-geologist & STEM advocate**

PhD completed at CODES in 2010 entitled 'Breccia-hosted chemical and mineralogical zonation patterns of the Northeast Zone, Mt. Polley Cu-Ag-Au alkalic porphyry deposit, British Columbia, Canada'.

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

As of October this year, I've started my own business as a consulting geochemist-geologist, offering both applied geochemistry skills and advice to the mining and exploration industry, as well as STEM advocacy and public speaking. My technical geochemical services are similar to those in my most recent role as Chief Geochemist of Gold Fields Australia, only now I can work with a variety of companies across a range of commodities.

As Chief Geochemist of Gold Fields Australia, I was responsible for leading the collection and interpretation of multi-element geochemical data across multiple Archean shear-hosted gold tenements. I provided in-house technical expertise as part of the Exploration Specialist Group and built lithogeochemical and alteration models for the mines, prospects and mineralised areas. A big part of my role included collaborating with site-based teams and group principal generative geologists as well as mentoring geologists in the collection and interpretation of geochemical data through training programs and in-house workshops. I learned a lot by collaborating with industry-leading practitioners to deliver new technologies and leading practices to the company. I enjoyed spending roughly a quarter of my time on-site and having the opportunity to see the geology and geochemistry of a handful of world-class mines up close!

**What are the things you enjoy most about this role?**

I've been hooked on understanding the processes and rocks that shape our Earth at the micro- and macro-scales since taking Earth Science 101. I like combining my knowledge of the periodic table with my knowledge of rocks, minerals and ore deposits to turn multi-element data back into rocks and minerals to solve specific exploration, mining and geometallurgy questions. At times it seems a bit like magic; using geochemistry to reveal rock and mineral characteristics that aren't always visible to the eye alone. Getting out bush and seeing beautiful landscapes and remarkable rocks with fun people is pretty good, too!

In addition to being a keen Earth scientist, I am also a passionate champion for STEM and Gender Intelligence, that is creating inclusive cultures where everyone's differences are not only valued but leveraged for success. Currently, I enjoy leading the Diversity and Inclusion Subcommittee for Women in Technology WA (WiTWA) and being a mentor with Women in Mining WA (WIMWA). By sharing my experiences as an Earth scientist and volunteering, I hope to contribute to the sustainability of our industry.

**How did you get there and how have past roles shaped your path?**

The majority of my career decisions have involved three considerations:

1. Does it involve what I like doing (i.e., asking questions, analysing, problem-solving, adventure, travel, being outdoors)?
2. Does the opportunity provide growth or play to my strengths?
3. What are the costs and benefits of making a particular decision? This could be financial, time, opportunity, network or something else.

I recall the conversation that set me on a course for the next 20 years and which I am still on today. One of my Honours supervisors, Steve Cook (then a geochemist with the British Columbia Geological Survey), and I were driving back to Vancouver. We'd spent two months working and camping out bush in the Yukon conducting greenfields exploration for VHMS deposits. Steve asked me, "So what was I thinking of doing after I graduated?". A reasonable question, but I wasn't sure. Steve casually said there weren't many geochemists in industry and even fewer with a degree in chemistry plus Earth and Ocean Science like me. He thought becoming a geochemist would be a good choice, as I'd be able to add value to a company whether the industry was booming or busting. Then and there I decided to start my career as a geochemist.

After graduating from UVIC in 2000, the industry was in a downturn. Like

Dr Heidi Pass pictured in a Zodiac during a cruise of Cierva Cove (on the west coast of the Antarctic Peninsula near the Argentinean base "Primavera") during the fourth Homeward Bound Program.

several geologists then, I became an Environmental Geoscientist, conducting contaminated site assessments and remediation in remote areas of western and northern Canada. While I loved the fieldwork, over four years it became clear I was at the wrong end of the exploration-mining-remediation chain. My thoughts returned to undertaking a postgraduate degree. I wanted a greater understanding of the fantastic rocks I was seeing. Following a stint as a contract mapping geologist and another as part of a geochemical field crew conducting diamond exploration, I moved to Australia to undertake my PhD at CODES in 2005.

It wasn't until I started working as a Senior Geochemist with ioGlobal Consulting (subsequently REFLEX Geochemistry) in 2010 that I started to hone my skills as an applied geochemist in the style of work I do now. I am fortunate to have worked with such talented people over those six-plus years. We were "the world's largest" group of applied geochemical consultants (I think there were at a maximum 10 of us!). We worked on data from deposits and prospects around the world, and it opened my eyes to the world of exploratory data analysis, some of which we would now call machine learning. The solid relationships I built as a consultant led me to apply for the role of Chief Geochemist at Gold Fields Australia in 2016.

**Your career highpoint/greatest achievement to date/source of greatest satisfaction as a geologist?**

In 1996, after a year of correspondence and networking, I became the first Canadian undergraduate to sail with the Ocean Drilling Program on the JOIDES *Resolution*. During Leg 169 – Sediment Ridges 2, the modern formation of VHMS deposits was investigated by deep ocean drilling. As a volunteer temporary marine lab technician, I worked alongside an incredible group of international scientists during 12-hr night shifts for 60 days straight at sea. I loved every minute of it!

Volunteering for the Australian Institute of Geoscientists (AIG), I led the creation of the AIG WA mentoring program for students and early career professionals. It was well-received in its first year, and I was asked to roll out the program across Australia as its National Chair. The program is still running and has grown to hundreds of active participants across four states plus a distance mentoring program.

I'm proud of the four years I spent as the Chief Geochemist of a major gold mining company, particularly as a woman in STEM. The opportunity to lead technical interpretations and applications that influenced geological understanding towards discovery was exciting.

In 2018, I was one of 100 women in STEM selected globally to participate in the fourth cohort of Homeward Bound. Homeward Bound is a leadership initiative aiming to heighten the influence and impact women have in decisions shaping our communities, industries and planet. After 11 months of training in collaborative and inclusive leadership styles, the twelfth month took place on a ship in Antarctica! Without intending to, we set the world record for the largest all-women expedition to Antarctica – it was the experience of a lifetime!

**What did you specialise in at CODES and how did CODES help you to get where you are?**

My PhD formed part of a global CODES–MDRU collaborative project investigating the formation of alkalic porphyry and epithermal Cu-Au deposits. My research determined the sources and character of the fluids responsible for the magmatic-hydrothermal breccia-hosted Mt. Polley Cu-Au deposit. A new genetic model

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for Mt. Polley and implications for silica-undersaturated porphyry deposits elsewhere was proposed by examining the geology, establishing the paragenesis and conducting isotope and mineral chemistry studies.

It was a steep learning curve at the start as my undergraduate degree focussed on a holistic Earth system science education (i.e., geology, oceans and atmosphere). I'd only taken one course on economic geology when I started, but I loved the deep dive into ore deposits and unravelling some of the Earth's secrets in how these are created.

I made lifelong friends at CODES, and I enjoyed the incredible number and variety of opportunities available to me there. It was also the pinnacle of my sporting career to play for Tasmania in three national Ultimate Frisbee competitions!

**How has the industry changed since you were at CODES? And how do you see it developing in the future?**

From a geochemical technology point of view, a growing number of downhole core scanners are on the market, providing continuous elemental, hyperspectral and other data. Development of "container-sized" tools is a logical progression from small, handheld instruments for analyses outside of the laboratory that were a focus during my PhD. These "container-sized" instruments, while still portable, can be more powerful than handheld instruments, delivering reliable results with improved detection limits and granularity, plus the bonus of sample prep limited to clean and dry core in the core-box.

It is an exciting time to be in geochemistry. Scanning instruments are changing the way we look at deposits and prospects, revealing new and useful information. Continuous and consistent data provide the opportunity to objectively model entire mine sites in 3D for interpretations such as lithogeochemistry, alteration and other variables impacting the entire exploration-mine planning-geometallurgy value chain. Shifting a science of observation to include more objective data is well-matched with the growth in machine learning and artificial intelligence applications.

From another point of view, industry continues to face slow progress in building a diverse and inclusive sector. We have seen improvements in recent years; however, key demographics remain underrepresented and underutilised. In 2019, the Australian Academy of Science reported STEM skills are the foundation on which the Australian workforce, industries and the economy thrive. Yet, demand for these skills cannot be met unless we work together to maximise the attraction, retention and progression of women and men in STEM. PWC Australia showed by shifting only 1% of Australia's workforce into STEM jobs, $57.4 billion would be added to Australia's GDP over 20 years, further strengthening Australia's business, scientific and research capability. Yet, we need to remember, diversity alone does not work. Without inclusive work cultures, the most innovative policies and initiatives designed to advance equity and improve organisations will not deliver the change we need. To create inclusive cultures, it is a personal choice for each and every one of us. Like the safety culture we live in today, I want to see our industry become a leader in enabling everyone to bring their whole self to work, having both fulfilling work and family lives. There is extraordinary power in our collective voice and actions to create the change needed.

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

I collect seashells and sand (aka mini rocks) as a hobby! My home has many glass jars of various shapes filled with sand of different colours and shells from my travels around the world. A portion of my collection I obtained from trips while at CODES – good memories!

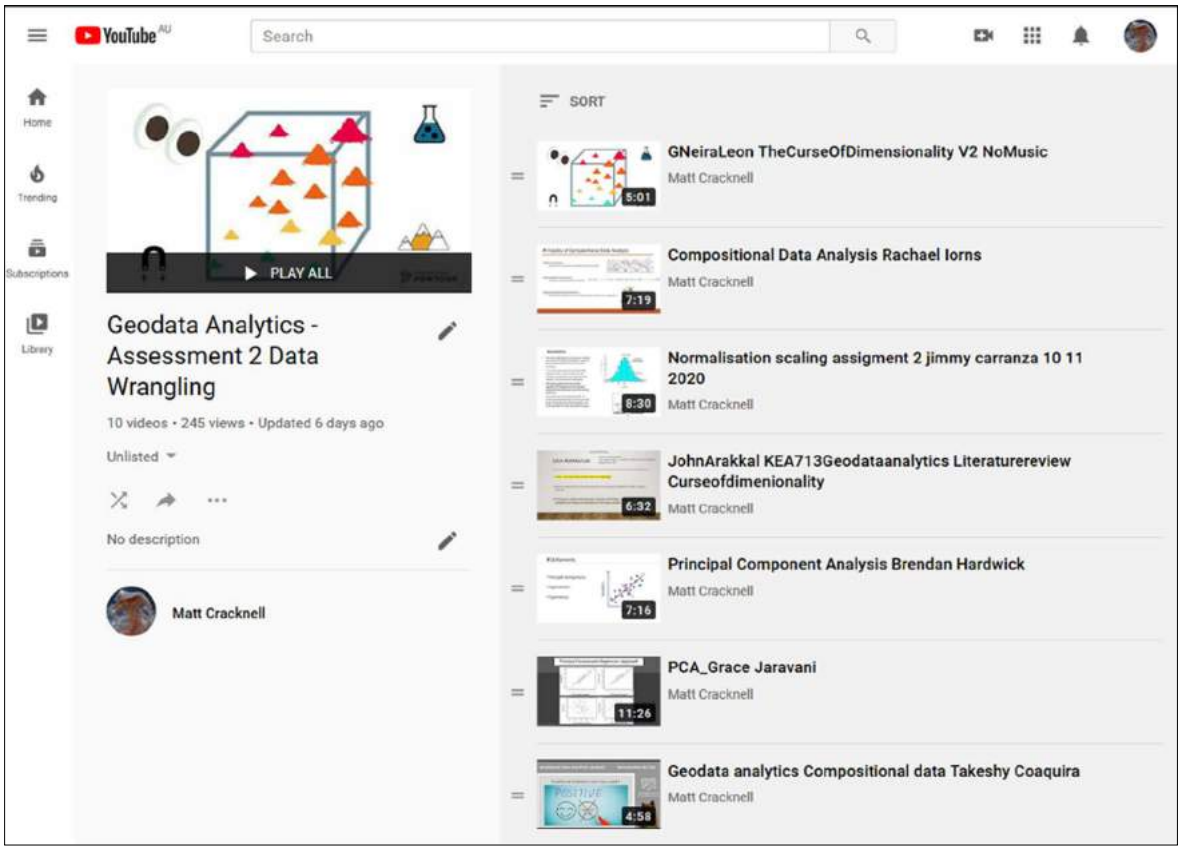
## Words of wisdom for up-and-coming geologists graduating from CODES?

- Doing good technical work is only half the job. Being a skilled communicator, particularly a skilled science communicator, is essential. Unable to share your ideas and results clearly, people won't understand them, and your work will have less impact.
- Learn how to have difficult ("crucial") conversations. You can take this skill anywhere, and it will allow you to build bridges out of most adversity life throws at you.
- Relationships and networks are indispensable – you can start building these today. When you need a relationship, it's too late to start building it.
- Harnessing the positive aspects of the digital world while recognising the full impact technology can have on our mental, physical and social health is essential to our digital wellbeing (especially our children's).
- Life is a team sport – choose your teammates wisely.
- A top tip from the incredible pioneer, Dame Stephanie Shirley – choose your life partner wisely. It has a significant impact, particularly for women.

Dr Heidi Pass and her "penguin fieldie" in the Granny Smith Mine's Exploration Core Shed. This mine is located in the Laverton Greenstone Belt of the Yilgarn Craton, in Western Australia's goldfields.

# GEODATA ANALYTICS: STUDENT ENGAGEMENT EXCEEDS EXPECTATIONS

**Dr Matthew Cracknell reports on another highly successful Master of Economic Geology short course – Geodata Analytics – and says that those who weren't able to take part in this online course in 2020 will have another chance in early 2021.**




Master of Economic Geology Geodata Analytics short course leader Dr Matthew Cracknell said that the literature review videos produced by students during the course exceeded expectations.

Over the past month or so, the Geodata Analytics short course, which is a new offering in the Master of Economic Geology, has been running online.

The first part of the course ran for six weeks and was completed by 40 or so students. Participants were provided with online learning materials covering a diverse range of fundamental data analytics topics, including data wrangling, machine learning and image processing. An effort was made to emphasise the application of data analytics to geological problems.

A highlight of this part of the course was the literature review videos students produced. Students were required to make a short video of between 5 and 8 minutes in length that summarised one of 20 literature review topics. These videos were uploaded to YouTube and students were asked to give constructive feedback and discuss content. The quality of videos and level of student engagement for this assessment task has exceeded expectations.

The second part of the course, structured around a week of online lectures and practicals, wrapped up in mid-November. About 30 students were exposed to a range of guest presenters, from all corners of the globe, who focussed on their expert topic, such as geochemical exploratory data analysis (EDA), hyperspectral image classification, and big picture views of what the future of geodata analytics might look like.

The last part of the Geodata Analytics course sees students split into teams to tackle a geodata analytics problem. This will culminate in a series of group presentations that will summarise their approach and outcomes.

In this brave new world of online learning, teachers are being forced to reassess how to engage students, in what may otherwise be an isolating experience. Based on student feedback, adjustments to improve the Geodata Analytics course content and delivery modes will be carried out in the coming months, just in time to run it again in March 2021. Hope to see you in Zoomland!

To view some of the student YouTube video summaries of literature reviews, go to: https://www.youtube.com/playlist?list=PL7CqCzQkBQIHK5_dnragi0qdNBI4d27Po

# ONLINE COLLABORATION A WINNER FOR AMIRA RESEARCH

**Senior Research Fellow in the TMVC Research Hub Dr Mike Baker reports on how CODES-TMVC has adapted to online industry meetings during this year of COVID-19, and concludes that the outcomes have been very positive, particularly for the AMIRA P1202 project: Far-field and near-mine footprints: Finding and defining the next generation of Tier 1 ore deposits.**



Screenshots taken from one of the recent AMIRA P1202 online meetings with industry participants. The new way of working engendered by COVID-19 during 2020 has had many benefits.

The COVID-19 pandemic has brought its fair share of challenges to most facets of work within CODES in 2020. For the AMIRA P1202 footprints project, one of the major challenges faced by the research team has been in continuing our strong level of engagement and communication with our industry sponsor group. In a typical year, this involves six-monthly sponsors' review meetings and workshops at CODES or at sponsor company sites. In 2020 these meetings, like most others, have gone online.

The AMIRA P1202 research team has adapted to this change by running a series of online workshops for sponsor companies in August and September, in addition to the regular review meetings. A total of seven online AMIRA P1202 workshops were held, including two that were abridged re-runs of earlier workshops. The workshop topics included deep-dives into projects within the Green and White Rock Environment (P1202 Module 1), the Lithocap Environment (P1202 Module 2), Magmatic Mineral Chemistry (P1202 Module 3), Sweep by sweep analysis of LA-ICP-MS data, and Geochemical Data Mining and Machine Learning. Significantly, the move to an online meeting format has led to fantastic levels of attendance by sponsor company representatives, with some workshops entertaining up to 100 industry participants from around the world, including locations in North and South America, Europe, Asia and Australia.

**"…the move to an online meeting format has led to fantastic levels of attendance by sponsor company representatives…"**

The feedback received from sponsor representatives on the timing, content and level of detail in the P1202 workshops has been overwhelmingly positive, and all the researchers involved should feel a strong sense of achievement about the professional way in which all the meetings were conducted. For the project sponsors, the move to online workshops has carried the added benefit of producing video recordings for all workshop presentations, so the usual travel, time zone or monetary issues that previously prohibited meeting attendance are no longer an issue! Although the online meetings and workshops were well received by the project's sponsor group, there was an acknowledgement that a return to the 'traditional' face-to-face meetings should happen when conditions permit, as they have been a catalyst for significant progress and engagement within the AMIRA footprints projects over the past fifteen years.

**The AMIRA P1202 project** is directed by Professor David Cooke and is located in the ARC Transforming the Mining Value Chain (TMVC) Research Hub at CODES, University of Tasmania; research collaborators include Lakehead University, Mineral Mapping, Monash University and Universidad Austral de Chile.

This global collaborative project is sponsored by Anglo American, BHP, Boliden, Codelco, Fortescue Metals Group, Freeport-McMoRan, Mt Isa Mines – A Glencore company, Merdeka Copper Gold, Newcrest Mining, Newmont, Northparkes – CMOC Mining Services, Rio Tinto, Teck Resources and Vale.

**Amira Global Project P1249 – Exploring, characterising, and optimising complex orebodies**

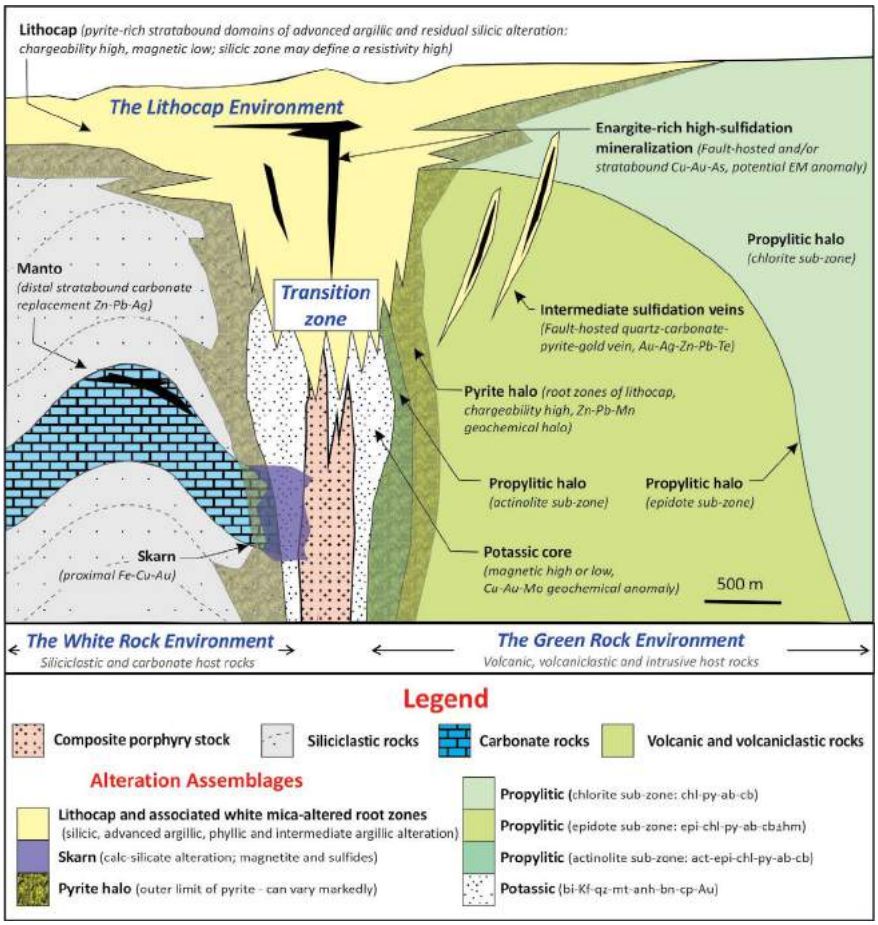
# NEW PHASE OF AMIRA FOOTPRINTS RESEARCH PROGRAM SEEKS SPONSORS

As explorers search for large, high-grade resources at greater depths, and mining operations are required to manage mineralogically and texturally complex orebodies, it is more critical than ever to develop effective exploration and characterisation tools that can be applied at the earliest stages of exploration and resource definition to reduce cost and risk.

Amira Global's P1249 research project will embrace the challenges and realise the opportunities provided by complex orebodies of copper, gold and critical metals by developing new tools, methodologies and workflows for early mineralogical characterisation of complex orebodies and their alteration halos that can be upscaled to facilitate exploration for and domaining of complex orebodies. P1249 will provide new geochemical and geological exploration tools to aid exploration for and characterisation of porphyry, epithermal, skarn, carbonate-replacement, and other types of hydrothermal ore deposits. Research will focus on transitions zones – the upper and outer parts of orebodies and the barren alteration halos that surround them. Technology transfer will be at the forefront of the project, with the new tools, methods and workflows developed through P1249 to be transferred to project sponsors at regular intervals throughout the course of the project. The P1249 tools, workflows and methodologies will be designed to aid characterisation of, and opportunity recognition for, discovery of high-grade, large resources from their fringing alteration domains.

AMIRA Global is currently seeking sponsors for P1249, with a scheduled commencement date of early 2022. The project will build on the success of five previous Amira projects that have provided tools, guides and workflows for the diverse environments associated with porphyry copper systems and for other environments that can provide challenges to exploration. These projects compose the Amira Footprints research program, and include P765 (2004–2006), P765A (2008–2010), P1060 (2011 –2014), P1153 (2015–2018), and P1202 (2018–2021). The project will be led by CODES, with research collaborators at MDRU, Monash University, Lakehead University and Universidad Austral de Chile.

*For more information regarding sponsorship of P1249, please contact David Cooke (d.cooke@utas.edu.au) or Adele Seymon, Program Director – Future Resources, AMIRA Global (adele.seymon@amira.global).*




The nitty-gritty: Schematic illustration of relationships between porphyry and epithermal mineralisation styles. The "green rock environment" comprises three propylitic alteration sub-facies (actinolite, epidote and chlorite zones) that occur around the porphyry system and peripheral to epithermal veins. The white rock environment encompasses highly reactive carbonate rocks, which suppress geochemical dispersion, and unreactive siliciclastic rocks, which can facilitate widespread dispersion of pathfinder elements. In this schematic model, both the green rock and white rock environments have been partially overprinted by a lithocap and related epithermal mineralisation styles, and the roots of the lithocap produce a pyrite halo to the porphyry system. This complex area of alteration overprinting is referred to here as the "transition zone" and can contain a complex array of overprinting alteration assemblages including phyllic, intermediate argillic and advanced argillic overprinting early potassic and propylitic alteration. The degree of superposition of the lithocap into the porphyry system and its contribution to the complexity of the transition zone is contingent on uplift and erosion rates at the time of mineralisation. The outer extent of the pyrite halo occurs in the propylitic zone, and merges with the lithocap at shallow elevations. The extent of the pyrite halo is schematic – it remains poorly defined in many systems.

# EXPLORATION IN BROWNFIELD TERRAINS SHORT COURSE: A VIRTUAL SUCCESS!

**This year Exploration in Brownfield Terrains was significantly redesigned to allow for online delivery for the first time, as Dr Jonathan Cloutier and Dr Rob Scott explain.**

The Master of Economic Geology short course Exploration in Brownfield Terrains (KEA710) was delivered online 19–30 October. Attendees included 20 Masters students, 15 other CODES and external students and nine industry participants attending all or part of the short course. The short course was led by CODES staff Dr Jonathan Cloutier, Dr Robert Scott, Dr Michael Roach and Associate Professor Shaun Barker, and delivered virtually via the Zoom platform. It was originally scheduled for face-to-face delivery in June but, as the year progressed, it became apparent that, due to COVID-19, travel would not resume, so the decision was made to redesign the unit for online delivery.

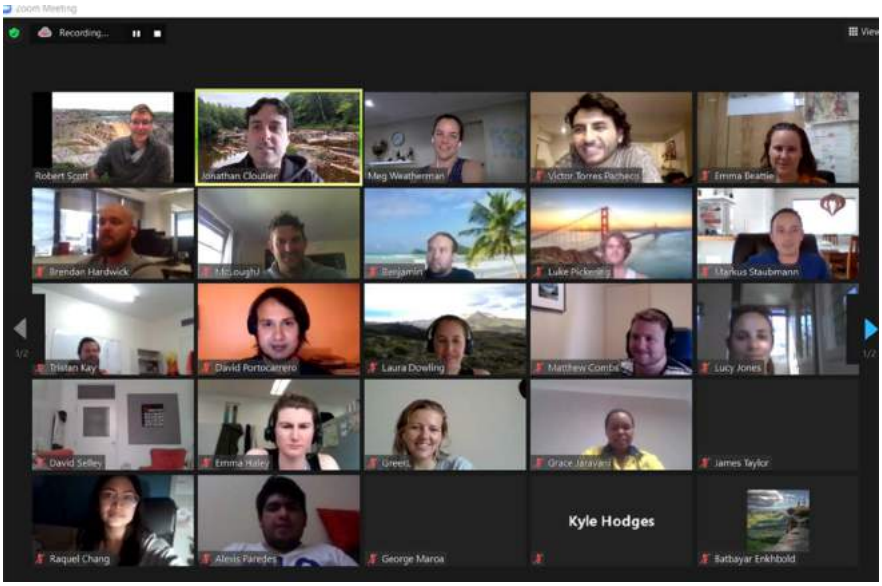
The redesigned course was built around three case studies supplemented by presentations and panel discussions from industry and academic experts situated all around the globe. This year, a total of 33 presenters contributed to the course delivery, a new record for Brownfields.

The first case study was the Zn-Pb-Cu Lemarchant volcanic massive sulfide (VMS) deposit in Canada. For this, short course participants were introduced to 3D geological modelling using Leapfrog Geo software and the EDGE module for resource estimation, as well as the use of hyperspectral reflectance data to help define exploration targets. Scott Halley from Mineral Mapping delivered a half-day workshop on the interpretation of lithogeochemical data in VMS districts and how to constrain mineralogy from whole rock assay.

The second case study was on the Au-Ag Waihi low sulfidation epithermal deposit in New Zealand. This included an introduction to geophysical exploration methods by Terry Hoschke, with a particular focus on epithermal deposits. The Waihi practical exercise involved the integration of multiple datasets (geology, geochemistry, structure, geophysics, hyperspectral reflectance) to aid in the definition of exploration targets.

During the second week, attention turned to the final case study, examining controls on gold mineralisation in the southern part of the Pine Creek Orogen, Northern Territory. Kirkland Lake Gold (special thanks to Meg Ellis and Wess Edgar) generously provided an extensive compilation of proprietary mine and mineral exploration data, augmented by publicly available geological and geophysical information, for an area centred on the Burnside Granite and including the Cosmo-Lantern gold deposit. The case study was split into two parts; the first involved a district-scale, GIS-based aeromagnetic interpretation and prospectivity analysis using QGIS, and the second required participants to build a 3D geological model of the Cosmo-Lantern gold deposit, and to use this to identify potential targets for future near-mine/in mine exploration.

Two weeks after the intensive delivery period for the short course, the enrolled Masters students reconvened (again via Zoom) to present short talks on their analysis of various aspects of the Pine Creek Orogen and Cosmo-Lantern case study.




Participants pictured during a Zoom session on the last day of the Exploration in Brownfield Terrains Masters short course, which was held in late October.

The short course organisers would like to extend their gratitude to Mike Vande Gutche (Constantine Resources; formally at NorZinc), Shannon Richards (Oceanagold) and Wess Edgar and Meg Ellis (Kirkland Lake Gold) for providing the datasets used for the case studies and for their participation in the short course. We also greatly thank everyone who delivered lectures and participated in the discussion panels; namely, John Ashton (consultant to Boliden Tara Mines), Nick Cook (Mawson Resources), Kevin Creel (Barrick), Kim Denwer (MMG), Bruce Gemmell (CODES, Gemmell Geoscience), Scott Hall (Laneway Resources), Scott Halley (Mineral Mapping), Jeff Hedenquist (consultant),

Kate Hine (Mitre Geophysics), Terry Hoschke (consultant geophysicist), Ned Howard (Evolution Mining), David Isles (Southern Geoscience), David Kelley (Chakana Copper), Ross Large (CODES), Andrew McNeill (Mineral Resources Tasmania), Gustav Nortje (Newmont), Dave Rhys (Panterra Geoservices), Shaun Schmeider (Newmont), Ian Scrimgeour (Northern Territory Geological Survey), David Selley (Base Instinct Consulting, CODES), Tony Webster (GeoDiscovery Group), Andy Wurst (Barrick) and Lesley Wyborn (ANU). The various lectures and panel discussions were all excellent and provided invaluable insights into the philosophies and methodologies underpinning successful brownfield exploration programs. The teaching staff would also like to extend a huge thanks to CODES administration officer Helen Scott for all of her work in the background organising the Zoom sessions and ensuring that everything ran as smoothly as possible.

# CODES SPEAKERS FACE-TO-FACE AT LAST

**Two CODES staff members gave talks during August and October for the Tasmanian branch of the GSA in Hobart, and both took place with real people in the room. GSA Tasmania Division Chair Dr Karin Orth gives an overview of the proceedings**

*6 August, talk by Dr Peter McGoldrick: Tasmania's oldest fossil* Horodyskia williamsi*: animal, mineral or vegetable? OR What do a palaeontologist from New Jersey, a nineteenth-century Irish rebel, some of the bloodiest battles of the American Civil War, and 1.4 billion-year-old fossils from the Tarkine have in common?*

How wonderful to get together face-to-face and have a meeting. In his talk **Dr Peter McGoldrick** took the audience through the discovery and controversies on the *Horodyskia williamsi*. We did not get a detailed analysis of the phylogeny of *Horodyskia*. Instead, Peter used this fossil to give an overview of the very concepts and timing of the origins of complex life forms. He also interwove into his talk the story of Irishman Thomas Francis Meagher, who was an Irish nationalist involved in an 1848 uprising and transported to Van Diemen's Land. He escaped to the United States. During the American Civil War Meagher formed an Irish Brigade who fought for the Union. Later he was appointed the governor of Montana where the original *Horodyskia* were discovered.

Peter has been to both the sites in northeast Tasmania and the location of the *Horodyskia* in the mountains of Montana. He described how the work of CODES PhD graduates Dr Jacqui Halpin and Dr Jack Mulder have confirmed the proximity of these two areas during the later Proterozoic.

*15 October, talk by Dr Clare Miller: Impact of climate warming on the speciation and long-term stability of arsenic in sub-Arctic lakes: Implications for environmental monitoring of mining impacted sites*

**Dr Clare Miller**, an environmental geochemist who arrived at CODES this year from Canada, talked about her graduate research in northern Canada. Climate change is influencing the biogeochemical dynamics of lake systems. These changes may affect the loading and cycling of naturally occurring metal(loid)s and the long-term stability of mining-derived contaminants, particularly in Arctic and sub-Arctic lakes. Arsenic (As) concentrations of lakes in the Courageous Lake Greenstone Belt (CLGB), Northwest Territories, Canada, are elevated from the weathering of mineralised bedrock and/or the operation of historical gold mines. In this region, the cumulative effects of resource extraction and modern climate warming make it difficult to discern between anthropogenic impacts and baseline geochemistry. The findings of this study demonstrate baseline As concentrations in lake sediments and provide evidence that weathering of mineralised bedrock and terrigenous material provides an ongoing source of naturally derived As to some lakes of the CLGB. Building on the knowledge generated from this study, we can begin to examine how climate-related processes may influence the loading and mobility of metals in Tasmanian lakes. This presentation explored how these learnings can contribute to understanding the impacts of Tasmania's future climate on regions central to the natural values and biodiversity of the island.

Dr Clare Miller, who gave a recent GSA talk in Hobart, is pictured collecting a sediment gravity core from a lake within the Courageous Lake Greenstone Belt, Northwest Territories, Canada.

# TIMELY PUBLICATION OF CODES' RESEARCH

A Special Issue of *Economic Geology* devoted to green rock alteration around porphyry deposits was published in June this year. It was edited by Dr Evan Orovan (TMVC Research Fellow in Ore Deposit Footprints at CODES) and Professor Pete Hollings (Lakehead University). The issue focussed on advances in mineral chemistry research and its application to help predict the distance and direction to mineralised centres, fertility and prospectivity studies, fingerprinting, and determining the source of fluids responsible for green rock alteration.

This Special Issue showcased the outcomes of many years of research performed at CODES on green rock minerals, and highlighted the importance and efficacy of using mineral chemistry to aid in exploration activities. The publication of these results and techniques are timely, as exploration has become increasingly expensive and new discoveries are occurring at considerable depths or obscured through extensive post-mineralisation cover. These new tools, refinement of known tools, and application of technological advancements are important for continued success given the complexity faced in modern exploration. One of the strengths of the Special Issue is that it provided examples from five countries (Canada, the USA, Chile, Australia and the Philippines), three geologic eras (Cenozoic, Mesozoic and Paleozoic), and both continental and island arcs, demonstrating the diverse potential of these developed techniques across a wide range of terrains and adding confidence to explorers around the globe.


Researchers from CODES contributed to a Special Issue of *Economic Geology* published in June this year.

# CODES MASTER OF ECONOMIC GEOLOGY SHORT COURSES 2021

**Advanced Field Skills in Economic Geology** **NEW** 7–20 February (see page 28)

**Geodata Analytics** (see page 28)

**Ore Deposit Geochemistry, Hydrology and Geochronology**

**Geometallurgy**

# CODES INDUSTRY PARTNERS 2020

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# AESC GOES ONLINE FOR 2021 – AND EXTENDS ITS REACH!

**CODES and Earth Sciences staff and students are the chief organisers of the Australian Earth Sciences Convention 2021, the principal biennial gathering of the Geological Society of Australia, which is open to all Earth sciences professionals.**

The 2021 convention, themed 'Core to Cosmos', which was due to take place in Hobart, will be held entirely online between 9–12 February although participants will have access to all presentations from 27 January so they can familiarise themselves with the topics. In fact, they are encouraged to watch them beforehand so they're better prepared for the online live Q&A sessions and discussion forums.

Joint technical program director for the convention, Dr Karin Orth, said that in the months leading up to the AESC COVID-19 was the 'elephant in the room: we couldn't move forward until we had decided what to do. We would have had to move it to the following year if we didn't go virtual'.

'But PhDs and young scientists need venues and avenues for their science…and this would end up being just another cancelled conference. For me, it was about providing a venue to get science out when most other organisations have cancelled. Eventually we got the backing to take the risk. And we are really pleased that the Earth sciences community has embraced the idea. We have around 400 abstracts so far… and we're trying to make it as dynamic as we can…. weaving networking into the event and creating platforms for communication.'

There will be a strong economic flavour to the 2021 AESC with input from several leaders in the field. Theme 1 'Energy and Resources' is devoted to industry in exploration, mining and extraction. The other five themes offer the newest information and research across a range of topics, including new insights into geological regions such as the Tasmanides (Theme 2) as well as innovations in remote sensing and digital data (Theme 6). Exciting virtual field trips, using Dr Michael Roach's world-leading virtual geology visualisations, are also planned as are online workshops.

All four plenary speakers are Australian-based: Dr Orth says this was decided early on because of the restrictions placed on international travel but, she said, it has turned into a 'great way to showcase high-profile Australian scientists and industry leaders in a worldwide space'.

- Professor Martin Van Kranendonk (Director of the Australian Centre for Astrobiology and the Big Questions Institute at UNSW) is presenting on 'Searching for life on Mars in our own backyard: the quest for a second genesis'.
- Paul Agnew (Chief Geologist at Rio Tinto) will talk about 'The future of exploration geoscience'.
- Dr Jess Melbourne-Thomas (CSIRO Oceans & Atmosphere, and 2020 Tasmanian Australian of the Year) will talk on 'Engagement, diversity and interdisiplinarity to tackle future challenges'.
- Dr Megan Clark (Head of the Australian Space Agency) will also be speaking (topic TBC).

AESC diversity coordinator Dr Indrani Mukherjee said that the committee had tried very hard to promote diversity and inclusiveness 'in an unconventional manner'. She said: 'We are asking our plenary speakers to talk about their role models, and asking PhD and Honours students to share their experiences. And every conference presenter has the option to share a slide with an opinion, statistics or other information about diversity at the conclusion of their presentation'.

The Tasmanian Division of the GSA is sponsoring 20 free places for students who apply to participate in the Rapid Fire 3-minute presentations; registration costs have been kept to a minimum for all other participants. CODES-TMVC is also a sponsor of the AESC.

*To register for the convention, go to the AESC 2021 website at: https://www.aesconvention.com.au/*

A report on the Australian Earth Sciences Convention 2021 will be published in our next issue.

# RECOGNITION FOR CODES FROM UTAS

Members of the CODES Analytical Laboratories team, which received a CoSE Commendation for Service Excellence in Response to COVID-19, pictured here in the CODES Rock Garden (L–R): Maxwell Morissette, Terrie Sawyer, Paul Olin (Deputy Leader), Michelle Makoundi, Leonid Danyushevsky (Leader), Al Cuison, Michele Chapple-Smith (front), Claire Rutherford (back), Elena Lounejeva and Ivan Belousov. Troy Finearty was unable to be present.

In late November the College of Sciences and Engineering (CoSE) at UTAS held an online commendation ceremony to recognise several groups and individuals who have made outstanding contributions to the College during 2020.

Among those recognised were the **CODES Analytical Laboratories** (CAL) team, which received a Commendation for Service Excellence in Response to COVID-19 as the labs were able to continue functioning throughout the worst of the COVID-19 restrictions.

Dr Indrani Mukherjee received a Commendation for Service Excellence to CoSE in the Early Career Researcher category; she is pictured here in her office at CODES.

Director of CODES Professor David Cooke said of the team: "Their efforts have drawn praise from our industry partners globally, as most university labs shut down during that period. They have helped our research staff and students to maintain research excellence and momentum throughout the year." Leader of the CAL team Professor Leonid Danyushevsky echoed these sentiments: "We were very excited to see the staff of the Laboratories acknowledged in this way in recognition of their efforts throughout the lockdown to keep our analytical research continuing as normal and ensuring successful operation of all our research projects throughout the year. Their efforts have also been appreciated by our industry partners."

CODES Postdoctoral Research Fellow in Geochemistry **Dr Indrani Mukherjee** received an individual commendation in the category of Early Career Researcher for Service Excellence to CoSE. Professor David Cooke said this was "a well-deserved recognition of research excellence from a brilliant, creative and hard-working young scientist". She received her award in recognition of her research towards CoSE strategic goals. Currently Indrani is researching elemental and isotope geochemistry of marine black shales in the McArthur Basin to infer deep time evolution of early life and mineralisation potential.

CODES PhD student **Tristan Wells** was part of the 2020 Young Tassie Scientists' team that received a Commendation for Service Excellence in Response to COVID-19. And Earth Sciences Senior Administration Officer **Trish McKay** was part of the Diploma of Sustainable Living team, which was also recognised for its response to COVID-19.

## A QUARTER OF A CENTURY OF SERVICE

In addition, two CODES staff members received acknowledgement for 25 years of service to UTAS: **Professor Vadim (Dima) Kamenetsky** and **Dr Karin Orth**.

Professor Cooke also recognised Professor Kamenetsky's service, "during which he has made many exceptional and truly original research contributions, which are the foundation of his long-standing global recognition as an outstanding research scientist".

"Dr Karin Orth was also recognised for 25 years of service to the university – as we all know, Karin has been an absolute stalwart of our teaching and research over the years, and is well-loved by our undergraduates for her great efforts in the teaching program", said Professor Cooke.

# FAREWELL TO TWO QUIET ACHIEVERS

**Two CODES staff are leaving us and will be sorely missed. Dr Karin Orth has decided to retire after 25 years of service at UTAS, and Elena Lounejeva has moved to Mineral Resources Tasmania.**

**Dr Karin Orth** has spent more than a quarter of a century studying at and working for Earth Sciences/CODES, carrying out a range of part-time and full-time roles including as a demonstrator, lecturer and research assistant.

After doing a degree in geology at Monash University and nine years working at the Geological Survey of Victoria, Karin arrived at UTAS in 1992 to do a PhD with Jocelyn McPhie on the volcaniclastic units of the Koongie Park Formation and the Koongie Park basemetal deposits in the Kimberley of Western Australia. During the early 2000s, after achieving her degree (and two children), she consulted to industry and government while still working as a casual lecturer, demonstrator and research assistant at Earth Sciences/CODES. Between 2009 and 2017 she worked on research projects in the Northern Territory, South Australia and Western Australia.

For the past five years (overlapping with her fieldwork research) she has taught first-, second- and third-year geology units and has built a strong reputation as a practical and thorough Earth Sciences teacher and mentor. She was also instrumental in creating a new geology unit with colleagues from across UTAS called Humans: Earth Shapers. Karin has good sea legs too, and says that the highlights of her career have included two RV I*nvestigator* voyages: in 2018 she mapped and sampled the Bellany Seamount Chain in the Tasman Sea. And the following year she went on to do the same in the Coral Sea.

In October, Karin gave the Loftus Hills Memorial Lecture in which she outlined her 'shiny career' and showed off a great range of slides from past years, demonstrating her capacity for enjoyment while doing geology! In fact, the last two bullet points in a list of tips from her lecture were:

- Look at as many rocks as you can
- Don't forget to have fun!

**Elena Lounejeva** joined CODES Analytical Laboratories in January 2012 as a geochemist and brought with her versatile analytical skills. Since that time, she has contributed to AMIRA projects P1060, P1153 and P1202 focussing on geochemical vectoring for mineral exploration, by using her experience in LA-ICP-MS. She has given much professional support to the research project "Trace Elements in Oceans" run by Professor Ross Large. And Elena has participated in methods developments led by Professor Leonid Danyushevsky and has assisted with mineral separation and cathodoluminiscence imaging of zircons and apatites for geochronological studies.

During the past few years, Elena has focussed on whole rock analysis techniques, such as Solution ICPMS, XRF and XRD, and has prepared an introductory course about X-ray diffraction technique for postgraduate students.

Elena's role as a Senior Laboratory Technician at Mineral Resources Tasmania will see her continue to collaborate with some of the CODES staff. We hope to see Elena back with us bringing innovative ideas to developing CODES-TMVC-MRT collaborative projects.

Elena Lounejeva is leaving the CODES Analytical Laboratories to work at Mineral Resources Tasmania after eight years with us.

Dr Karin Orth checking samples on board the RV *Investigator*; her research voyages on board this ship have been a highlight of her 25-year career at Earth Sciences/CODES.

# WITCHFUL THINKING AT THE SEG HALLOWEEN DRINKS

**On 30 October the CODES SEG Student Chapter organised a socially distanced event to mark Halloween, and all were encouraged to dress up in appropriately spooky gear. This was the first time CODES/Earth Sciences students and staff had gathered socially for some months and UTAS COVID-19 protocols were strictly adhered to.**

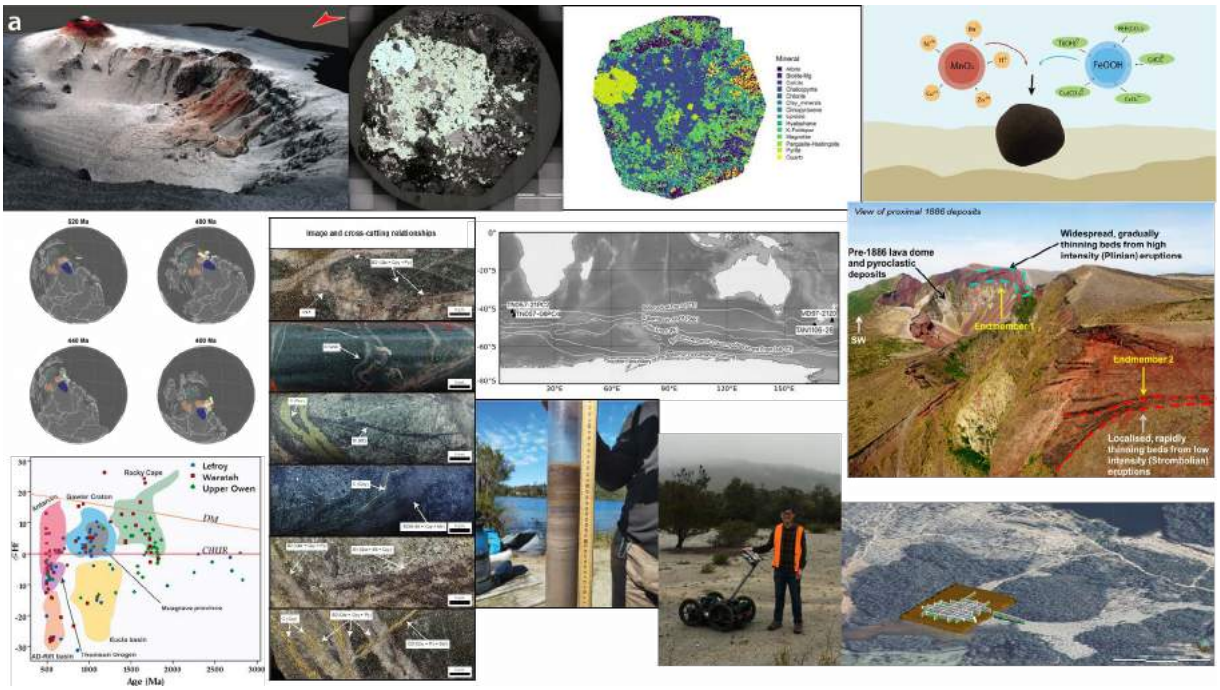
ABOVE LEFT: The CODES Rock Garden was the setting for socially distanced Halloween celebrations. L–R: TMVC PhD student Nanda Mrabawani; CODES PhD student Peter Berger; TMVC PhD student Rhiannon Jones; CODES Analytical Laboratories Deputy Leader Dr Paul Olin; Honours student Kate Jenkins; CODES Master of Science student Karla Morales and TMVC PhD student Javier Merrill.

ABOVE RIGHT: TMVC PhD student Emily Smyk was the main organiser of the SEG Halloween event; here she is cutting one of the delicious pumpkin pies she had baked for the occasion, and which went down a treat with everyone.

LEFT: CODES Administrative Assistants Caroline Mordaunt (left) and Karen Huizing enter into the spirit of the occasion.

# NO GUESSWORK WITH GESSS 2020

**GESSS 2020 was another online success for the CODES postgrad students involved and ran from 12–17 October with participation from students across Australia, as CODES PhD student Hannah Moore reports.**




All bases covered: a compilation of figures drawn from each GESSS-TAS presentation.

The Geological Society of Australia's Earth Sciences Student Symposium (GESSS) went virtual this year in response to the COVID pandemic. GESSS is the flagship event for the GSA during Earth Science Week. Virtual GESSS was a week of afternoon/evening sessions which comprised of approximately two hours of student and recent graduate presentations followed by a 20–30-minute networking session titled INTRA GSA.

Each state participating in Virtual GESSS formed a committee of students to plan, curate and host that state's Virtual GESSS session. The GESSS-TAS (Tasmania) session took place on Tuesday 13 October and was hosted by committee members Olivia Wilson, Rhiannon Jones and Hannah Moore (all CODES postgraduate students). In this session we had 10 students (from Honours to PhD level, and from CODES and IMAS) presenting, with an impressive range of Earth science subjects including ancient tectonics, marine geology, ore deposits, volcanology, environmental geology and geophysics.

The best presentation from each session won free registration to the Australian Earth Science Convention 2021 (AESC) and a rock/mineral customised to each state (crocoite for Tasmania). The award for the best GESSS-TAS presentation went to Hannah Moore, who presented findings from her PhD research project titled 'The shallow conduit and vent processes involved in the 1886 basaltic Plinian eruption of Tarawera, New Zealand'.

The Professional Development session was held on Thursday 15 October. This was an important aspect of the symposium. The GESSS-TAS committee would like to make a special mention of Tom Schaap (CODES PhD student), who presented a highly informative talk within this session titled 'Gold at the end of the rainbow: How your choice of colour can impact data interpretation'.

GESSS-TAS would like to thank the National Working Group: Sue Fletcher, Verity Normington, Tim Holland and the GESSS-TAS judges, Dr Peter McGoldrick and Associate Professor Sebastien Meffre. All GESSS committees would like to thank CSIRO for sponsoring this event.

*To download a copy of the GESSS 2020 program, which contains details of all the presentations, go to: file:///Users/cmm2/Downloads/Program_compressed%20pics%20-%20FINAL-3%20(1).pdf*

2020 Committee members for GESSS-TAS (L–R): Olivia Wilson, TMVC-CODES Honours student; Rhiannon Jones, TMVC-CODES PhD student; and Hannah Moore, CODES PhD student.

# CHANGING FACES

**The ongoing situation with COVID-19 has continued to make life difficult for our new PhD students. However, one new student has been able to start his research here at CODES and two more have been able to start their research remotely, and are working from Africa and mainland Australia respectively. In addition, two members of CODES staff are leaving us and others have had changes to their roles.**

| PHD STUDENT | | START DATE | PROGRAM | PROJECT TOPIC |
|---|---|---|---|---|
|  | **Gilles Ngoran** | 1 October (working remotely from Cameroon) | Program 4, supervised by Rebecca Carey and Martin Jutzeler | Submarine volcanic architecture at IODP Site U1437 |
|  | **Peerapong Sritangsirikul** | 20 October | Program 3, supervised by Sebastien Meffre and Khin Zaw | Tectonic evolution and related mineral deposits of mainland SE Asia: Insights from geochemistry and geochronology of zircons |
|  | **Malai Ila'ava** | 1 December (working remotely from QLD/NSW) | Program 4, supervised by Rebecca Carey and Martin Jutzeler | Volcanic architecture reconstruction at Cowal District, NSW |

## Departures

**Elena Lounejeva** left her role as a Laboratory Analyst in the CODES Analytical Laboratories at the end of November, a position she has held for eight years. She has taken up a role as a Senior Laboratory Technician at Mineral Resources Tasmania, and will continue to work on her PhD here at CODES (see page 23).

**Dr Karin Orth** has decided to retire and will leave her role as Lecturer and Research Fellow in the Discipline of Earth Sciences at the end of the year. Karin has been with Earth Sciences and CODES for 25 years, and is much admired for her teaching achievements by students and staff alike (see page 23).

## Promotions and new roles

**Dr Rob Scott**, Senior Lecturer and Masters Program Co-ordinator, has had his role converted to a continuing position.

**Dr Matthew Cracknell**, Research Fellow in Earth Informatics, ARC TMVC Research Hub, has been appointed as a fixed-term lecturer for two years.

# BLAST FROM THE PAST

Here's the CODES sedimentology brains trust – former CODES postdoc Stuart Bull, together with former sedimentology lecturer Peter Haines (at the time working for the Northern Territory Geological Survey) trying to get moving on the legendary 12-day 'Gulf Classic' field excursion to northwest Queensland and the Northern Territory in 1993. CODES' budget was apparently a lot tighter back in the day…

This photo was taken at the Lawn Hill Mineral Field in northwest Queensland near the Century zinc deposit.

If you have photos from CODES' past you are willing to share please email us (CODES.Info@utas.edu.au)

# 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-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:

- **CODES:** **https://www.facebook.com/CODES.UTAS/**
- **Earth Sciences:** **https://www.facebook.com/EarthSciUTAS/**
- **TMVC:** **https://www.facebook.com/tmvc.utas/**

You can also follow one of our LinkedIn pages:

- **CODES:** linkedin.com/company/codes-utas
- **TMVC:** 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**

CODES UNIVERSITY of TASMANIA

## A MESSAGE FROM THE CODES DIRECTOR, PROFESSOR DAVID COOKE

As we come to the end of this year of unprecedented challenges, it is timely to reflect on the stellar efforts of our staff and students, and how they adapted to the unique circumstances of 2020. Although we have all keenly felt the impact of restrictions on travel and fieldwork, our team have risen to the occasion by adapting to the change in circumstances, adapting to working from home for much of the year, and to teaching and delivering research presentations effectively online. The Masters program has thrived in the online environment, with our most recent course offerings (Brownfields Exploration – October; Geodata Analytics – November) fully subscribed and well-received by the course participants. We have been somewhat fortunate in that most of our major research projects were in a phase of major data acquisition in 2020 prior to the arrival of the pandemic, but nonetheless we would not have been able to continue to deliver our research outcomes without the amazing efforts of the staff of CODES Analytical Laboratories in 2020, who worked tirelessly throughout lockdown thanks to swift implementation of strict and appropriate work practices to ensure staff safety.

It has been a somewhat melancholy year, with the departure of several key staff, including Karin Orth, Evan Orovan, Elena Lounejeva, Troy Finearty, Deborah Macklin and James Tolley, and I thank them all for their contributions – they will be sadly missed. I'd particularly like to thank Shaun Barker, who recently left us to take up the Directorship of MDRU. Although Shaun was only at CODES for a relatively short time, he made some profound changes, driving the expansion of the Masters program, and impacting significantly on several of our major research projects. I wish Shaun every success at MDRU and hope that his appointment will lead to a new era of collaboration between our research groups.

Looking forward to 2021, we have the completion of several major research projects scheduled for mid-year, an exciting new portfolio of collaborative research projects currently seeking sponsorship or in development, and an expanded program of Masters short courses to deliver. We anticipate a gradual return to normal field-based research later in 2021, with a transition to blended online and face-to-face meetings and short course presentations.

I wish you all the very best for the festive season.

Dave

## UPCOMING MASTER OF ECONOMIC GEOLOGY SHORT COURSES

### ADVANCED FIELD SKILLS IN ECONOMIC GEOLOGY

**7–20 FEBRUARY 2021 (IN TASMANIA)**

UNIT COORDINATOR: ROBERT SCOTT

CODES is pleased to announce the inaugural running of a new field-based Master of Economic Geology short course: Advanced Field Skills in Economic Geology, to be held in Tasmania over two weeks in February 2021. The mapping area for the first week is ~15 km south, along strike from the world-class Rosebery Zn-Cu-Pb-Au-Ag volcanic-hosted massive sulfide deposit in the Cambrian Mount Read Volcanic belt, western Tasmania. Techniques covered include graphic and structural core logging, volcanic facies mapping and interpretation and structural mapping and analysis of simply deformed regions. The second week of the short course involves visits to sites on the east and northeast coast of Tasmania. Topics covered include the Anaconda mapping technique, magmatic–hydrothermal transition features in granites, mapping and interpretation of fault and vein systems and structural mapping techniques for multiply deformed regions.

### GEODATA ANALYTICS

**EARLY 2021 (ONLINE)**

COURSE LEADER: MATTHEW CRACKNELL

The Geodata Analytics course provides industry-based geoscientists with an understanding of the fundamental concepts of data analytics, data wrangling, supervised and unsupervised learning and image processing. Learning materials cover in detail geological databases, statistical analyses, pattern recognition and machine learning for the processing, analysis and modelling of large volumes of multivariate geoscience data. Students will gain skills in rigorous and repeatable methods for extracting and visualising meaningful information from geochemical, geophysical and geological information. Case study examples of applications to mineral exploration will be explored. The communication of resultant models to aid interpretation and facilitate decision making, to both geoscientists and non-geoscientists, is an important aspect of computer-assisted analysis of data and will be covered using a range of delivery modes.

For further information about short courses, please email: **CODES.Info@utas.edu.au** OR Master of Economic Geology Program Co-ordinator, Dr Robert Scott: **Robert.Scott@utas.edu.au**
**For all other CODES contacts, see page 2.**