

# ORE SOLUTIONS

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

> Autumn 2020 **No.36**



## WORLD CLASS: THE LABS AT CODES

**CODES Analytical Laboratories have established a global reputation for cutting-edge analytical work on mineral micro-analysis focussing on applications relevant to the mining industry – from exploration to metallurgy. They provide analytical services to external users that are not available from commercial analytical laboratories. Leader of the Laboratories Professor Leonid Danyushevsky here outlines their scope and importance.**

CODES Analytical Laboratories were established within the ARC Centre of Excellence in Ore Deposits, which operated at the University of Tasmania between 2005 and 2013, and have continued to operate and expand since then. Our vision is:

- To be at the forefront of analytical developments in the field of in-situ micro-analysis and bulk sample

analysis of geological and other relevant materials.

- To ensure that research programs within CODES are underpinned by state-of-the-art analytical capabilities thus enabling CODES to remain a research provider of choice for the minerals industry.

Our vision is supported by UTAS and CODES through the provision

of laboratory spaces, infrastructure and funding for some of our equipment and refurbishment of the Laboratories. In addition, the continued success of our Laboratories operations would not be possible without support from the Earth Sciences/CODES Maintenance, Field Equipment and Safety Officer Troy Finearty, who is always willing to assist us.

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## SERVICE AND RESEARCH: THE DUAL ROLE

The Laboratories play a dual role, being simultaneously a research unit undertaking R&D projects within CODES Program 5 (Analytical Research) and a service unit that allows CODES staff and students, our academic and Industry Partners and collaborators to perform geochemical analyses using the methods we develop through our R&D program.

As a service unit, the Laboratories operate on cost recovery, generating analytical data on a fee-for-service basis for UTAS staff and students, and for external partners and collaborators. By providing access for CODES Industry Partners to the analytical methods developed within CODES, the Laboratories ensure the continuing industry support of CODES, and thus play a vital role in securing a successful future for CODES.

As a research unit, the Laboratories are the foundation of CODES Program 5 (Analytical Research). We participate in a range of R&D projects aimed at developing analytical methods and instrumentation which underpin research activities within CODES and form the basis of many research projects funded by the ARC programs (such as Industrial Transformation Research Hubs, Discovery, Linkage and LIEF) and industry (through AMIRA projects and one-on-one projects with leading mining companies such as BHP, Rio Tinto and Newcrest Mining).

## RESEARCH AND DEVELOPMENT

Our current R&D projects include the development of:

- a fundamental understanding of laser ablation and ICP-MS as drivers for new applications in the field of mineral analysis;
- advancing precision and accuracy of mineral analysis through the means of simultaneous detection of elements provided by the time-of-flight ICP-MS;
- data reduction software in collaboration with Norris Software;
- a mineral-specific method for accurate quantitative analyses of major and trace elements by LA-ICP-MS;

- reference materials to enable improved precision and accuracy of our applications for quantitative analysis and geochronology;
- algorithms for data processing of images of elemental distribution within minerals; and
- new approaches to bulk-rock analysis using solution ICP-MS, XRF and LA-ICP-MS.

## INSTRUMENTATION AND FACILITIES

Our current instrumentation and facilities include four laser-ablation inductively-coupled plasma mass spectrometry (LA-ICP-MS) instruments for in-situ mineral analysis including a recently acquired time-of-flight mass spectrometer which is used in our R&D; a solution inductively-coupled plasma mass spectrometry instrument for bulk rock analysis; X-ray fluorescence spectrometry and X-ray diffraction spectrometry instruments for bulk rock analysis; elemental analyser for bulk rock analysis of sulfur and carbon; optical interferometer for precise surface topography measurements; clean room laboratory for acid digestion of rock samples; rock crushing and milling facilities for sample preparation for bulk rock analysis and heavy mineral separation; and a lapidary laboratory for rock cutting, mineral separation, thin section preparation, grain mounting and polishing.

## CODES LABS INTO THE FUTURE

Going forward we plan on expanding the range of applications on the time-of-flight ICP-MS and experimenting with a triple-quad instrument which can allow us to develop specialised applications for analysis of challenging metals at low concentrations which suffer from interferences when using conventional ICP-MS.

We regularly publish the outcomes of the R&D program in the international peer-reviewed literature and present at high-profile international conferences. Since 2009 we have published four papers on fundamental aspects of LA-ICP-MS technique; two papers on the development of reference materials for LA-ICP-MS; and seven papers on specific applications of the technique. Additionally, we regularly participate

in publications which involve the application of our methods to geological problems.

Research projects supported by the Laboratories have won prestigious national and international awards,

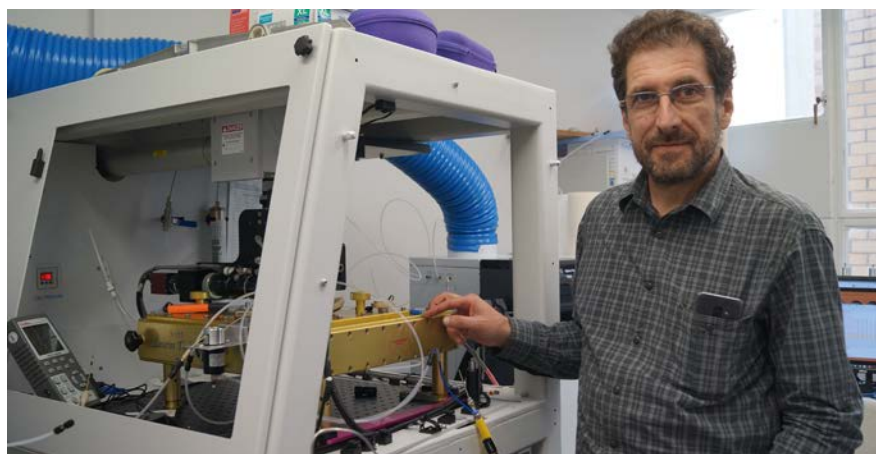
such as a Eureka Prize in 2016 and an Innovation Award from the UK Institution of Engineering and Technology in 2014.

We aim at commercialising suitable outcomes of the R&D program.

Currently this involves data-reduction software for LA-ICP-MS and calibration reference material for analysis of sulfide minerals by LA-ICP-MS.

## MEET THE TEAM

**CODES Analytical Laboratories have a dedicated staff of professional and highly qualified technicians and geologists who carry out the busy schedule of sample analysis.**



### PROFESSOR LEONID DANYUSHEVSKY LEADER

I moved to Hobart in 1991 after completing a PhD in Geology in Russia at the Vernadsky Institute. Throughout the 1990s I was funded by the ARC through several Fellowships and Discovery grants to work on petrology and geochemistry of subduction-related lavas in the southwest Pacific arcs using melt inclusions in minerals as the main tool. This required close familiarity with various micro-analytical techniques, and in 2001 I took over running the LA-ICP-MS instrument CODES had at that time, after Dr Marc Norman moved to the ANU in Canberra. Our LA-ICP-MS laboratories saw significant expansion between 2002 and 2010, and I led the developments within the ARC Centre of Excellence in Ore Deposits, which eventually led to the creation of CODES Analytical Laboratories.

As the Leader of the Laboratories I am responsible for their overall management, direction and budget, ensuring that the external income is maintained at sufficient levels; negotiations with external clients, understanding their needs

and matching the capability of the Laboratories to those needs; expanding the number and scope of collaborative projects with researchers from other institutions and industry; suggesting the best practices for the users; determining the costs and turn-around times; overseeing our analytical work and preparation of reports. As an academic staff member of UTAS I contribute to teaching undergraduate and Honours courses, supervising PhD students and conducting original research in the fields of analytical geochemistry, igneous geochemistry and economic geology.

### DR PAUL OLIN DEPUTY LEADER

As Deputy Leader of CODES Analytical Laboratories, I have been a part of the team for more than seven years, arriving in February 2013. I have a PhD in Geology from Washington State University, USA, built upon research in igneous petrology, geochemistry and volcanology, and I have now accumulated nearly 20 years of geochemical laboratory experience. As Deputy Leader, I assist Professor Leonid Danyushevsky oversee and manage the Laboratories, from geologic samples coming in to high-quality geochemical data going out to researchers and industry partners. I am directly responsible for our sulfide minerals laser ablation ICP-MS laboratory and XRF facilities, while also contributing to all LA-ICP-MS analytical specialties of the Laboratories.

In order to keep it all running, I also manage our infrastructure and instrumentation, dealing with problems from routine maintenance of instruments to unexpected breakdowns of equipment. This is a rather tall order,

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**Top Left** Leader of the CODES Analytical Laboratories **Professor Leonid Danyushevsky** next to a RESolutions laser ablation microprobe in Lab A which is used for research and development.

**Below Right** Deputy leader of the CODES Analytical Laboratories **Dr Paul Olin** beside the PanAnalytical Axios X-ray fluorescence spectrometer (XRF) in the CODES X-ray Lab. This instrument is used for whole rock chemical analysis. It can analyse rock powders for major, minor and trace elements.



given the amount of equipment we have in the Laboratories, and the high demand we put on our instruments to accomplish the heavy workloads due to the high volume of samples and analyses we deal with on any given day, week or year.

You can find me working on analytical projects in one or more of our laboratories, writing reports for our industry partners, conducting safety inductions into our laboratories, fixing equipment with tools in my hands, or assisting staff, students and researchers with their analytical needs and questions.

#### DR JAMES TOLLEY

RESEARCH FELLOW IN LA-ICP-MS

I joined CODES Analytical Laboratories after completing my PhD in Geology at the Australian National University in Canberra. My main responsibilities involve managing and running our LA-ICP-MS laboratory which is primarily focused on geochronology applications using U-Pb systems in zircon and other minerals. The results are used to determine the ages of rocks and help constrain the timing of processes that form them. The laboratory I run is also used for analysis of low-level trace elements in silicate minerals. I process the data and report the results back to industry and internal/external academic collaborators. In my research, I investigate the fundamentals of LA-ICP-MS and its application to analysing geological materials. My other duties within the Laboratories include overseeing the preparation of submitted rock samples for geochronology.

#### TERRIE SAWYER

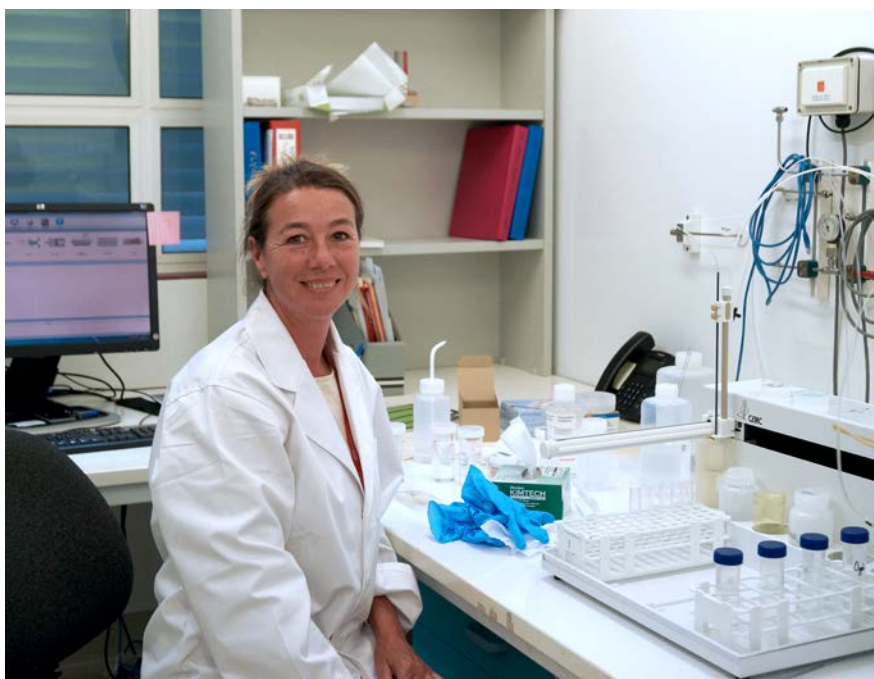
LABORATORY ANALYST

Originating from the UK, I recently re-joined the team at CODES Analytical Laboratories at the end of 2019, having worked here during 2008–09. I have worked as a marine geochemical analyst at the Scottish Association for Marine Science analysing trace elements by Inductively Coupled Plasma Mass Spectrometry (ICP-MS and LA-ICP-MS) and as a researcher within the Camborne School of Mines (University of Exeter). Here at CODES I will be supporting the team by focussing on the bulk sample chemical



**Left** Research Fellow in LA-ICP-MS **Dr James Tolley** assisting a user during an analytical session in Lab C which is used for U-Pb dating of minerals and low-level analysis of silicate minerals.

**Below** Laboratory Analyst **Terrie Sawyer** in Lab B where the class 100 clean laboratory and solution ICP MS is located. The ICP MS (Agilent 7700 and Cetac 520 autosampler) is being prepared to optimise its performance before running dissolved rock samples for multi-elemental analysis, including rare earths.



compositions using solution ICP-MS analysis which involves the dissolution of whole rock samples using the class 100 clean room laboratories. For this I will be primarily using a high-pressure digestion system (PicoTrace) which can achieve full dissolution of whole rocks with resistant phases. In the future I would like to get more involved in the XRF analysis of bulk samples aiming at carrying out comprehensive trace and major element analyses for CODES staff, academic and industry partners, as well as external users and collaborators.

#### DR IVAN BELOUSOV

TMVC RESEARCH ASSOCIATE

I joined CODES Analytical Laboratories in 2013 with a PhD in Geology from Moscow's Vernadsky Institute. My PhD

research was focussed on petrology, geochemistry and mineralogy of the mantle sections of ophiolites. My current role within the Laboratories involves management of one of our LA-ICP-MS labs, which is used for both silicate and sulfide analyses; data reduction and interpretation of the results of all our zircon U-Pb dating projects; interpreting chlorite and epidote trace element compositions for our Industry Partners exploring for porphyry Cu deposits, to obtain vectoring and fertility information; and writing reports for our industry partners. Last year I produced over 100 reports for industry. I am also involved in the ARC TMVC Research Hub projects: I help the AMIRA P1202 project team with analyses, data reduction and interpretation, and



techniques of sample preparation, data collection, data processing and presentation of results. Currently, I run our X-ray diffraction instrument performing quantitative mineralogical analysis of rocks and soils for a wide range of minerals. I also prepare samples (fuse disks and make pressed pellets) for whole rock analysis by X-ray fluorescence, process LA-ICP-MS data and make images of individual mineral grains using cathodoluminescence and other methods of scanning electron microscopy. I also oversee the safe workflow and operation of our crushing and milling facilities and transfer data from individual analytical instruments into our database.

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**Left** TMVC Research Associate **Dr Ivan Belousov** inspecting the condition of a sampling cone in the Agilent 7900 ICPMS instrument, which forms part of the LA-ICP-MS system in Lab E.

**Below** Laboratory Analyst **Elena Lounejeva** carrying out a sample exchange on the X-ray diffractometer (XRD) in the CODES X-ray Lab. This model of benchtop XRD system (D2 Phaser, Bruker) is designed for the speedy collection of high-quality diffractometric data. The data collected can be further analysed using several types of software for the identification of different crystalline substances, and their grade of crystallinity, as well as for performing quantitative phase analysis.

am participating in the development and testing of a fast washout ablation cell design which will be used with our ICP-TOF-MS instrument. Over the last several years I have led the development of our new calibration reference material for sulfide analysis by LA-ICP-MS. The new reference material called STDGL3 has now been supplied to over 15 laboratories all over the world.

**ELENA LOUNEJEVA,**  
LABORATORY ANALYST

I joined CODES Analytical Laboratories eight years ago, moving to Hobart from the National Autonomous University of Mexico where I ran a solution ICP-MS laboratory. Working at the CODES Laboratories, I have become familiar with the various methods and techniques we use, and as a Laboratory Analyst, I have mastered different







## AL CUISON

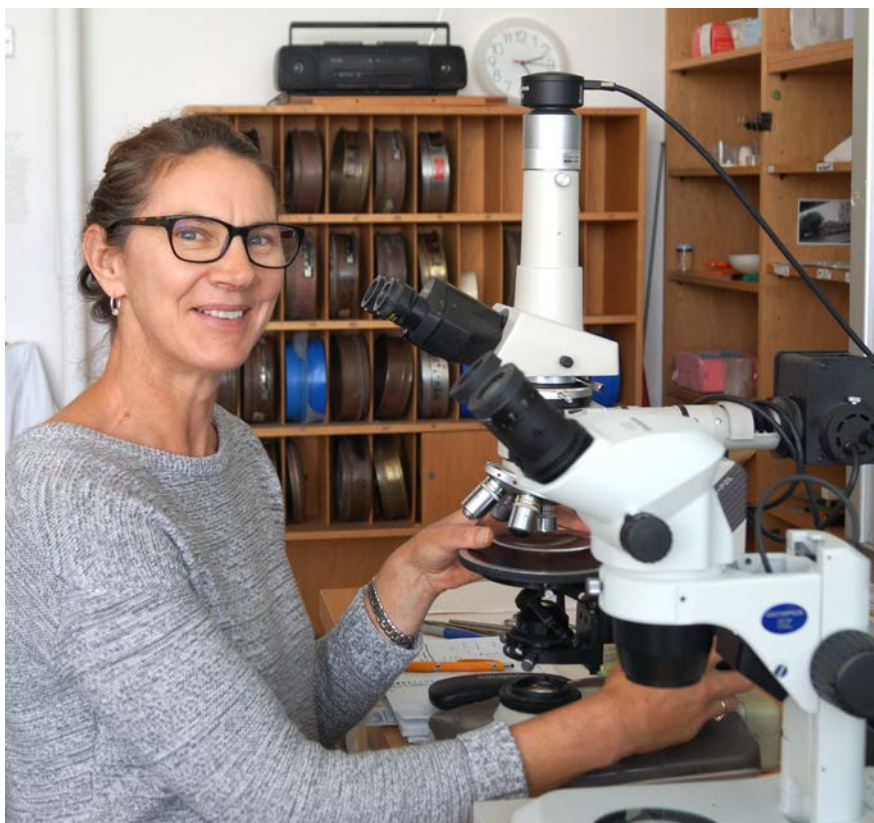
### LAPIDARY MANAGER

I manage the Lapidary Laboratory at CODES. With more than ten years' experience working in the laboratory, I specialise in preparing and producing high-quality thin and thick sections, polished sections, laser mounts of rock specimens for microscopy and in-situ chemical analyses. Over the years, I have effectively managed the workflows for all activities in the Lapidary Lab, including maintenance and upgrades of our state-of-the-art lapidary tools and equipment, overseeing budgets, cost recovery and ensuring that sample throughput at all stages of the lapidary process leads to rapid turnarounds. I have built and managed effective relationships with students, researchers and external users of the Lapidary Lab so as to understand and consistently meet their requirements by developing new, and improving existing, sample preparation techniques, thus providing high-quality outputs. Last year the scope of our activities expanded to include heavy mineral separation and mounting of separated minerals for geochemical analysis.

## MICHELE CHAPPLE-SMITH

### LAPIDARY TECHNICIAN

My role within the CODES Analytical Laboratories team is sample preparation within our Lapidary Laboratory. Here my primary tasks are thin section preparation and laser mount production for both internal and external projects. More recently I have diversified my skills to include heavy mineral separation. During this process heavy minerals such as zircon, apatite and other datable minerals are isolated, and these are used for geochronology or other types of analysis. These samples are carefully prepared to avoid cross-contamination. My role is vital to the Analytical Laboratories, as a high standard of sample preparation forms the basis of quality analytical data research outputs.



**Top** Lapidary Manager **Al Cuison** using the rock saw in the Lapidary Lab to cut rocks in preparation for making polished thin/thick sections, laser mounts, ground and polished slabs, which will then be examined by CODES staff.

**Below** Lapidary Technician **Michele Chapple-Smith** examines a heavy mineral separate using a Nikon optical microscope. She will then take images of the separate using a camera attached to the microscope and record them to produce a database of samples.



**Left** Technical Officer **Michelle Makoundi** with the new hydraulic crushing machine used for crushing rock samples with minimal cross-contamination. The crushed samples are then milled to the required particle size using a range of mills, depending on the type of rocks.

**Top Right** Administrative Support Officer **Claire Rutherford** is responsible for all accounting and administrative functions within the CODES Analytical Laboratories.

**Bottom Right** Maintenance, Field Equipment and Safety Officer **Troy Finearty** plays a vital role in ensuring that all the highly specialised equipment in the CODES Analytical Laboratories meets compliance and safety standards.

#### **MICHELLE MAKOUNDI** TECHNICAL OFFICER

I am originally from the Republic of the Congo (also known as Congo-Brazzaville). I came to Tasmania ten years ago and started working in the CODES Analytical Laboratories soon after I arrived. My main responsibilities involve sample preparation for X-ray fluorescence, X-ray diffraction and solution ICP-MS analyses. I do sample crushing using either a jaw crusher or a hydraulic press and milling of samples using a variety of ring mills. The choice of ring mill to use depends on the type of samples and the purpose of the analyses. My other responsibilities involve assisting the team by organising our workflow and ensuring that each project is completed on time. I receive new samples when they arrive and ensure that we have received all information required to start working on the samples. I enter the samples in our tracking spreadsheet, prepare logbook templates for the mineral separation laboratory, enter project milestones into the tracking system and remind our team of the deadlines.

#### **CLAIRE RUTHERFORD** ADMINISTRATIVE SUPPORT OFFICER

I formally joined CODES Analytical Laboratories six years ago, although I used to help out on a casual basis before then. Essentially, my primary job is to keep track of the financial costs associated with our projects, ensuring that projects are charged for all services used and delivered, and that our clients are invoiced accordingly. I also keep track of our internal projects, ensuring that all services provided by the Laboratories are on-charged as a cost recovery. I am also the liaison link between the Laboratories and the University Finance section, and I order all consumable supplies for the Laboratories and also for staff and students using our facilities, as well as anything else that we need to keep the Laboratories going and the instruments in order.

#### **TROY FINEARTY** MAINTENANCE, FIELD EQUIPMENT AND SAFETY OFFICER

I play a key role in ensuring the labs run smoothly and efficiently on a daily basis, and have a close working relationship with the laboratory managers. My role primarily focuses on:

- developing safe working practices and risk assessments
- developing and implementing induction processes and training when new equipment arrives
- coordinating and establishing maintenance and replacement plans for equipment
- coordinating the purchasing, delivery, labelling, storage, tracking and disposal of hazardous substances.

The types of jobs I do are many and varied, and range from replacing a jaw crusher in the crushing and milling room (requiring a car engine hoist and resulting in the old machine being relocated to the UTAS Inveresk campus as a museum piece) to investigating equipment failures such as air leaks, and the replacement of safety limit switches.



# THE 2020 MASTERS CLASS

**Change is in the air for the Master of Economic Geology program, as Masters Program Co-ordinator Dr Robert Scott explains. And the COVID-19 crisis will necessitate some changes to our 2020 delivery of short courses.**

After celebrating its 30th birthday in 2019, the Master of Economic Geology program has big plans in place for 2020 and beyond.

To address the reduction in the number of cross-institutional course work units available, due to the departure of James Cook University from the national Minerals Geoscience Masters (MGM) program in early 2018, CODES plans to increase its coursework unit offering from the current six units to 12 units by 2022. We are currently in the process of seeking UTAS approval for our plans. The proposed new units include: Geodata Analytics; Social, Environmental and Economic Responsibility in the Minerals Industry; Advanced Field Skills; Economic Geology Fundamentals; Geophysics for Geologists; and Special Topics in Economic Geology. If all goes to plan, the first of these units, Geodata Analytics will be delivered in November this year. The new units are designed to address current and future needs of the minerals industry, and the proposed expansion comes at a time of record student numbers in the MEconGeol program.

In fact, change appears to be something of a recurring theme in the MEconGeol program of late, with our two most recent field-based units, Ores in Magmatic Arcs – South America (delivered in October 2019) and Volcanology and Mineralisation in Volcanic Terrains (March 2020), both being disrupted by circumstances beyond our control. Civil unrest in Ecuador in October 2019, forced the cancellation of plans to spend the first week of the short course in that country visiting several significant mineral deposits including the recently discovered, world-class Cascabel Porphyry Cu-Au deposit. Remarkably, given less than a week's notice, trip leaders Professor David Cooke and Dr Michael Baker (with invaluable assistance from South American MEconGeol students Victor Torres Pacheco and Carlos Diaz Castro) successfully relocated week one of the short course to neighbouring Peru, where participants were wowed by incredible geology, spectacular scenery, and visits to many significant porphyry, skarn and epithermal deposits. The second week of the short course, delivered in Chile as originally planned, was also a great success.

If we thought our bad luck with delivering field-based short courses was behind us, we were wrong. Three days before the start of the Volcanology short course, travel bans put in place as part of UTAS's response to the COVID-19 outbreak, forced cancellation of the planned ten-day visit to the Taupo Volcanic Zone on the North Island of New Zealand. However, again undaunted, trip leaders Martin Jutzeler and David Cooke revised the field program and the short course commenced on time but in a different location. During the first week participants examined landforms and products associated with some of the youngest volcanoes in Australia in the 4.5 Ma – 5000-year-old Newer Volcanics (basaltic) Province of SW Victoria. While in Victoria, the group also examined relatively undeformed, unaltered Devonian felsic volcanic rocks exposed to the



Dr Martin Jutzeler leading the Master of Economic Geology field excursion to the Airey's Inlet Volcanic Complex in southwestern Victoria, where the eruptive products of an Oligocene Surtseyen-style basaltic volcanic eruption are exposed on the foreshore.

north of Melbourne, and part of the Older Volcanics province exposed on the Victorian coastline. A key objective of this first part of the short course is to introduce participants to volcanic processes, products and nomenclature at outcrops where primary features are well-preserved, before heading to Tasmania to examine their altered and deformed equivalents, where textural interpretation is much more challenging. The Tasmanian component of the short course included a day of lectures and practical exercises at CODES, a day at MRT logging drill cores from the Mount Read Volcanic belt, and a three-day field trip to Cape Grim to examine well-exposed products of Tertiary basaltic volcanism. Unfortunately, the planned four-day field trip to the Mount Read Volcanic belt was cancelled as policies to slow the spread of COVID-19 resulted in the loss of access to key field sites.

Despite the current uncertainty surrounding the impacts of COVID-19 on tertiary education delivery, CODES plans to deliver our remaining 2020 short courses – Exploration in Brownfields Terrains (KEA710) and Ore Deposit Models and Exploration Strategies (KEA712) – this year. However, at least the June short course will most likely need to be delivered fully online. As the KEA712 content is more easily adapted for online delivery, we are swapping the order of these units, bringing KEA712 forward to the first two weeks in June, and delaying KEA710 until the last two weeks of October.

Currently around 25% of MEconGeol students complete a two-unit research thesis as part of their degree. On the following pages you can read about the exciting research projects that some of the current crop of MEconGeol students are undertaking.





### 1 ASHLEIGH BALL

Current student,  
Master of Economic Geology

**Supervisor:** David Cooke

**Project title:** Geology, structural control and exploration implications for Au mineralized Fenix gold project, Maricunga Belt, Chile

Ashleigh Ball's research project will characterise the geology, structural control and mineralisation of Rio<sup>2</sup> Ltd's Fenix gold project, located in the Maricunga Belt of Chile. Fenix is hosted within the Miocene Ojo de Maricunga volcano, within an andesite dome that is crosscut by several phases of dacite and a polyphase breccia that hosts the bulk of the mineralisation. A breccia complex hosts the mineralised zone, which has dimensions of >2500 m by 300–600 m, with mineralisation open at depths of 350 m in the central zone.

Ash's research aims to determine the nature and composition of the mineralised black banded veins at Fenix using an array of petrographic and analytical techniques. She will constrain the ages of volcanism and brecciation using U-Pb zircon dating that will in turn constrain the age of mineralisation. Ash will define the spatial distribution of the black banded veins and the structural and rheological control on their emplacement and orientations in order to develop a geological, structural and exploration model for mineralisation at the Fenix gold project.

*"Deciding to commence a Masters in Economic Geology with CODES has been one of the best career decisions I have made. The expertise offered from the lecturers and PhD students as well as fellow students is exceptional. I've had exposure to numerous ore deposit styles, have had the opportunity to visit world-class deposits on amazing field trips in Australia, Indonesia and South America and have had a lot of fun along the way! I am excited to commence the Fenix Masters project to see yet another new deposit style and to further extend my skills in economic and structural geology."*



### 2 MERTKAN BOZOGLU

Current student,  
Master of Economic Geology

**Supervisors:** Evan Orovan,  
David Cooke

**Project title:** Geology and genesis of the E20 porphyry prospect, Northparkes district, NSW, Australia

With the full support of the Turkish government, Mertkan Bozoglu is conducting detailed studies of pyrite textures and compositions and white mica chemistry from the E20 Cu-Au porphyry prospect, NSW, Australia, for his Master of Economic Geology thesis. The Northparkes district contains several Cu-Au porphyry deposits and prospects, with combined resources of 602.7 Mt @ 0.56% Cu and 0.19 g/t Au, including the large, high-grade E26 and E48 deposits. Mertkan's study involves drill core logging and sampling, optical microscope and automated scanning electron microscope analysis, and laser ablation mass spectrometer analysis to document the pyrite and white mica textures and chemistry composition variations in a phyllic overprint on the small E20 prospect, for the purposes of comparison with the larger, high-grade systems at E26 and E48.

This study will advance our understanding of the ore-forming processes at Northparkes. He also aims to apply and develop exploration tools for aiding porphyry exploration.

*"I wanted to study my Masters at CODES because it is one of the best centres in the world to study porphyry-type mineralisation. I am looking forward to working with CODES' expert team."*



### 3 BATBAYAR (BAGGY) ENKHBOLD

Current student,  
Master of Economic Geology

**Supervisors:** Shaun Barker, Mike Baker

**Project title:** Alteration and paragenesis of the Eastern Creek Volcanics below the Mount Isa Copper Deposits, NW Queensland

Batbayar Enkhbold commenced his Masters research thesis study of the Eastern Creek Volcanics below the Mount Isa copper deposit in late 2019. His study will form part of the AMIRA P1202 Module 1, where he will focus on documenting the various hydrothermal alteration styles present in the Eastern Creek Volcanics, including magnetite-calcite, chlorite-quartz-carbonate veins, potassium feldspar and albite alteration. He will then use this knowledge to construct a paragenetic history for the observed alteration assemblages, linking them to periods of mineralisation within the Mount Isa deposit where possible.

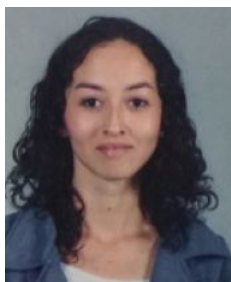
It is hoped that Batbayar's work will help focus Mount Isa Mines' understanding of the genesis of the Mount Isa copper deposits.

*"It is very exciting and a great experience to study under the supervision of well-known researchers and a skilled team. Also, I am glad to have a unique opportunity to meet with international students and develop my professional networking."*



Master of Economic Geology student Batbayar (Baggy) Enkhbold from Mongolia logging drill core at the Oyut-Ulaan Cu-Au porphyry project in Southern Mongolia during 2013 where he was working as the project geologist for Xanadu Mines.

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#### 4 NATHALY GUERRERO

Current student,  
Master of Science

**Supervisors:** Julie Hunt, Matt Cracknell, Angela Escolme

**Project title:** Geometallurgical controls on grade by size department of gold ores

Nathaly commenced her Masters research thesis study in mid-2019 as part of a CODES–CRC ORE (Cooperative Research Centre for Optimising Resource Extraction) collaborative project focussed on grade by size fractionation. This is a form of natural department whereby economic phases partition into specific size fractions during early comminution stages. This tendency represents the underlying driver for CRC ORE's Grade Engineering® approach – in some cases most of the metal can be contained in < 50% of the mass of the material being tested (www.crcore.org). Utilisation of natural department on a mine scale has the potential to improve mill feed grades through rejection of uneconomic coarse size fractions early in the comminution circuit and/or to upgrade very low-grade ore or mineralised waste.

Nathaly's project will examine grade by size fractionation for gold ores using samples from the Gramalote (Colombia) and Telfer (Australia) deposits as examples. The project aims to evaluate the roles of paragenesis, mineralogy and texture in influencing natural fractionation and to provide predictors that can indicate a tendency for natural fractionation of valuable elements and minerals.

*"It is amazing to be part of this project; it is a new area of study for me and I am really excited for all the knowledge that I can gather. Also, working with people with huge experience is wonderful."*



#### 5 GREER LANE

Current student,  
Master of Economic Geology

**Supervisors:** Mike Baker, Lejun Zhang, Evan Orovan

**Project title:** Genesis of the Four Mile Diamictite and implications for uranium mineralisation, South Australia

Greer Lane commenced her Masters research thesis in March 2020 at CODES. Her industry sponsor is Heathgate Resources, which owns and operates the Beverley and Beverley North uranium mines and holds tenement over the nearby Four Mile uranium deposit within the Frome Basin in northeast South Australia. Her project will seek to characterise the geology, provenance, and uranium depositional process affecting the Four Mile Diamictite. It will aim to constrain the provenance and ages of igneous clasts that comprise the diamictite using radiometric dating and will characterise the paragenetic evolution of uranium deposition and radiation damage to quartz gangue minerals within the diamictite using an array of petrographic and analytical techniques. The potential to use zircon mineral chemistry and whole rock geochemistry as tools for fertility assessments of other intrusive complexes in the district will also be assessed. A genetic and exploration model for uranium mineralisation in diamictite of this type will also be proposed as part of her project.

Greer is currently employed as a geologist by Heathgate Resources and will continue working for them while completing her Masters. As part of her research and analytical activities, Greer will undertake fieldwork at the Four Mile deposit in early April and will make several visits to CODES over the course of the year to complete her analytical work program.



#### 6 KARLA MORALES

Current student,  
Master of Science

**Supervisors:** Julie Hunt, Michael Roach, Matt Cracknell, David Cooke

**Project title:** Geological predictors for pre-concentration

Karla commenced her Masters research thesis study in January 2020 and is also part of the CODES–CRC ORE collaborative project focussed on grade by size fractionation – see *description of this project under MSc student Nathaly Guerrero*.

Karla's project will examine geological controls on grade by size fractionation for multiple mineralisation styles and commodities using samples from the CODES archives and CRC ORE projects. This is a first step in establishing a library of mineralisation styles that show a tendency for pre-concentration in early comminution stages. The ultimate aim is early prediction of pre-concentration amenability from intact drill core.

*"It's such a great opportunity to be part of this research and have the chance to interact directly with experts in different branches of geology who can guide me to develop the project. I am very excited about all the experience, knowledge and friends that I will acquire during these two years."*



Karla Morales, who is studying for a Master of Science degree at CODES, is seen here checking drill core at the rig site of the Cascabel Project at Imbabura, Ecuador, while working for SolGold shortly before joining CODES to study.





## 7 ZEBEDEE (ZEB) ZIVKOVIC

Current student,  
Master of Science

**Supervisors:** Shaun Barker, Sebastien Meffre, Scott Halley (Mineral Mapping)

**Project title:** Lithogeochemical and mineral analysis of the Mt Read Volcanics, Western Tasmania: Implications on mineralisation and exploration

Zeb commenced his Masters thesis study at CODES in June 2019. His thesis focusses on the lithogeochemical signatures of intrusive and volcanic rocks associated with VHMS deposits hosted in the Mount Read Volcanics, Tasmania, and his project is being supported by Mineral Resources Tasmania and CODES, in collaboration with ALS Minerals.

Zeb is seeking to identify unique lithogeochemical signatures of volcanic units associated with the formation of VHMS deposits. He hopes this will develop into a new set of exploration tools that can be used to explore for VHMS deposits in the Mount Read Volcanics, and potentially all over the world. To date, Zeb has sampled historic rock chips and drill holes from the

Mount Read Volcanics, which have been analysed by ALS Minerals using the latest 4-acid, ultratrace geochemical methods. Zeb has identified a set of geochemical signatures that are interpreted to reflect extreme fractionation of magmas. These signatures are then recorded by the volcanic rocks which are coincident in space and time with known VHMS deposits.

Zeb was a graduate geologist with BHP in 2011 and became a senior geologist in 2016 where he was running greenfields exploration for iron ore, before then working as a senior geologist for Arrow Minerals, working on greenfields exploration for gold, nickel and lithium.

*"I've really enjoyed my time at CODES over the past six months. I've found the work and the environment to be very stimulating and feel very lucky to have access to the many people at CODES with such a wealth of knowledge and experience. I'm really getting into my project and am excited about the exploration application of the project and hope to refine this over the next 12 months".*



CODES Master of Science student Zeb Zivkovic drilling in the NE Pilbara Archean granite-greenstone terrane while working for BHP.

## 8 CHLOE CAVILL

Current student,  
Master of Economic Geology

**Supervisors:** Garry Davidson, Robert Scott (from 2017)

**Project title:** Geochemical classification of ore fluids, Costerfield Sb-Au deposit, Victoria

Chloe Cavill has just completed her MEconGeol research thesis on ore paragenesis and the source of sulfur for the Costerfield antimony – gold deposit near Heathcote, Central Victoria. Her research has been supported by Mandalay Resources. Chloe analysed samples collected from each of the three main antimony lodes at the Augusta Mine, as well as from a late-stage fault that offsets the stibnite lodes, and the surrounding wall rocks (Early Silurian Costerfield Siltstone) at distances up to 100 m from the lodes.

Chloe resolved six main stages of sulfide  $\pm$  gold deposition at the deposit. The earliest sulfides, present only in the wall rocks, are interpreted to be diagenetic in origin. The remaining stages relate to either formation (Stages 2–5), or local remobilisation (Stage 6), of the Sb–Au ores. Chloe found that the sulfur isotopic compositions of stibnite and ore-related pyrite all fall in a relatively narrow range ( $\delta^{34}\text{S}$ : 0–6 ‰); similar to S-isotopic values reported for other Central Victorian gold and antimony deposits. However, the big surprise was the S-isotopic composition of the Stage 1 pyrite in the distal wall rocks. All the distal Stage 1 pyrite analysed had remarkably heavy sulfur, with  $\delta^{34}\text{S}$  values as high as +50 ‰. Values this high have not previously been reported from the wall rocks at any of the Victorian gold deposits. Indeed, if this pyrite is diagenetic, as Chloe's work suggests, it is the most  $^{34}\text{S}$ -enriched diagenetic pyrite yet reported for Phanerozoic marine sedimentary rocks, and ranks amongst the isotopically heaviest marine diagenetic pyrite ever found on Earth!

The stark contrast in S-isotopic composition of the pre-existing wall rock pyrite and the ore-stage stibnite and pyrite at Costerfield indicates a local (wall rock) source for sulfur in the ores is untenable. Instead, Chloe interpreted the source of sulfur in the Costerfield ores to be either magmatic or derived from older sedimentary rocks at depth.

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## LOCATION OF CURRENT AND RECENTLY COMPLETED CODES MASTERS PROJECTS



### ACTIVE STUDENT RESEARCH PROJECTS

- |                                    |   |
|------------------------------------|---|
| <b>1</b> ASHLEIGH BALL             | CENTRAL CHILE, SOUTH AMERICA                      |
| <b>2</b> MERTKAN BOZOGLU           | CENTRAL NEW SOUTH WALES                           |
| <b>#</b> CARLOS DIAZ               | NORTHERN ECUADOR, SOUTH AMERICA                   |
| <b>3</b> BATBAYAR (BAGGY) ENKHBOLD | NORTHWEST QUEENSLAND                              |
| <b>4</b> NATHALY GUERRERO          | COLOMBIA, SOUTH AMERICA, AND NORTHWEST QUEENSLAND |
| <b>5</b> GREER LANE                | NORTHEAST SOUTH AUSTRALIA                         |
| <b>#</b> GEORGE MAROA              | WESTERN KENYA, AFRICA                             |
| <b>6</b> KARLA MORALES             | LAB-BASED PROJECT                                 |
| <b>#</b> VICTOR TORRES             | CENTRAL PERU, SOUTH AMERICA                       |
| <b>7</b> ZEB ZIVKOVIC              | WESTERN TASMANIA                                  |

### COMPLETING STUDENTS

- |                       |                  |
|-----------------------|------------------|
| <b>8</b> CHLOE CAVILL | CENTRAL VICTORIA |
| <b>#</b> COREY JAGO   | NEW SOUTH WALES  |

# These students were previously profiled in issue No.33 of *Ore Solutions*

**The Master of Economic Geology degree at CODES is approved for government student income support. For more, go to:**  
<https://postgradaustralia.com.au/institutions/university-of-tasmania/courses/master-of-economic-geology>

**Top Right** Ashleigh Ball, who has recently started a Master of Economic Geology degree, is pictured in the Cordillera Negra (Black Mountains) east of Huaraz, Peru, during the 'Ores in Magmatic Arcs – South America' short course run by CODES in October 2019.

**Bottom Right** Master of Science student Nathaly Guerrero in a CODES microscope lab describing mineralogy around some lines of laser ablation made on a drill core slab as part of research into geometallurgical controls on grade by size department of gold ores.





# ACADEMY AWARD FOR BEC

**Senior Lecturer in Earth Sciences Dr Rebecca Carey has been awarded the prestigious 2020 Dorothy Hill Medal by the Australian Academy of Science, and will be presented with her medal at a ceremony in Canberra during May.**

She received the award for her internationally recognised research into volcanology, and is one of only 18 of Australia's top scientists to receive an honorific award in 2020 from the Academy. The Dorothy Hill Medal supports research in the Earth sciences by women researchers up to ten years post their PhD.

The Academy summarises Dr Carey's research as follows:

*She has contributed significantly to the understanding of eruption and hydrothermal processes on land and on the seafloor. Her achievements in the field of submarine silicic volcanism include demonstration of the influence of confining pressure provided by overlying ocean in modifying the style of volcanic eruption on the seafloor, and pioneering quantification of volatile fluxes through the magma into the surrounding seafloor. Parallel work on basaltic volcanism has identified a previously unrecognised mechanism for explosive basaltic eruptions involving volatile supersaturation, bubble nucleation and explosive fragmentation, triggered by a compression-decompression wave within a shallow magma conduit, and the first quantification of the duration of magma convection using the microtextures of erupted clasts.*

Rebecca said of the award: 'I am honoured to be awarded the Dorothy Hill Medal. Marine science of whatever flavour is always a group effort, so sincere thanks to all of my colleagues, students, mentors, ship technicians and facilitators who make transformational science happen!'

Earth Sciences/CODES Professor David Green, a Fellow of the Academy, nominated her for the award. The definition of Earth sciences under the Dorothy Hill Medal is very broad and includes oceanography, hard/soft rock geology and marine geology.

Watch a short Academy of Science video about Rebecca's work here: <https://youtu.be/zNJ2NTzVK08>



**Outstanding contribution to science** Dr Rebecca Carey next to the Autonomous Underwater Vehicle (AUV) Sentry operated by Woods Hole Oceanographic Institution while on a research voyage in 2015. Rebecca and her team (which included Professor Jocelyn McPhie, Dr Martin Jutzeler and PhD student Fumihiko Ikegami, all from CODES) used the AUV to collect high (1m) spatial resolution data of the seafloor of Havre volcano, Kermadec Arc, New Zealand, after the 2012 eruption. Rebecca was awarded the Dorothy Hill Medal partly based on the transformative outcomes about submarine eruption dynamics derived from this voyage.

## OUT OF AFRICA: NEW AMIRA RESEARCH PROJECT FOR CODES

CODES/TMVC has recently initiated a new AMIRA research project led by Associate Professor Shaun Barker in collaboration with Professor Murray Hitzman and Dr Sean Johnson (iCRAG), Dr David Selley (Base Instinct Consulting and CODES) and Dr Scott Halley (Mineral Mapping). AMIRA International's P1206 project 'Identifying unique Resistate Indicator Mineral (RIM) chemistry as a guide to aquifer fertility and vectoring for sediment-hosted copper mineralisation', which is focussed on deposits found in the Central African Copper Belt, aims to provide a rapid assessment of how resistate indicator minerals (RIMs) can be used to aid exploration for sediment-hosted copper deposits.

RIMs are now widely used to evaluate fertility and to vector towards diamond and porphyry copper deposits. This one-year project aims to determine if RIMs can

be used similarly in sedimentary rock-hosted copper systems. The project will focus on units which served or could have served as aquifers for hydrothermal fluids to determine if RIMs were altered to a degree that will allow prediction of fertility. The project will also examine whether deposit-centred alteration affected RIMs to the degree that this could be used to vector towards mineralised zones. The project will largely utilise existing samples from the world-class Central African Copper Belt (CACB) collected as part of AMIRA projects P544 and P872 which were led by CODES. This project takes advantage of previous research activity and significant in-house CODES expertise to allow this research program to be completed in one year. It is anticipated that the approach and results generated will be applicable to other basins globally; our intent is to develop a future project to test this in other regions.

# GIRLS LOVE LEARNING ABOUT ROCKS!

Earth Sciences Lecturer Dr Karin Orth led the first ever all-women field trip to the East Coast during February.



Excursions are a major part of learning in the Discipline of Earth Sciences. In February, before the start of Semester 1, second-year students commencing KEA208 Earth's Materials and Interior hit a milestone not achieved before in Earth Sciences at the University of Tasmania: all the participants were female. This is a far cry from the 1960s and 1970s when there may have only been one woman student in the whole of the class in any year. The students were led by

Dr Karin Orth and visited some iconic geology sites on the East Coast, including Piccaninny Point and Coles Bay. Earth Sciences is enrolling more women than ever before and equipping them to see their world differently and enter the many careers on offer in this area of STEM.

Standing on a sizeable slab of Coles Bay granite at Coles Bay itself are (left to right): Dr Karin Orth, Remie Bampton, Talitha Nelson, Emma MacDonald, Jessica Malisauskas, Ari Gilham and Bridget de Lange.

## ECONOMIC GEOLOGY SCRIBES NEEDED

Adjunct Professor and former CODES Director J. Bruce Gemmell has been appointed as the technical editor for the Society of Economic Geologists (SEG) newsletter (renamed *SEG Discovery*, starting in 2020). *SEG Discovery* is a quarterly publication that features a peer-reviewed article of topical interest to the economic geology community. Later this year, *SEG Discovery* will be hosted electronically on GeoScienceWorld (GSW). It will also continue to publish in the traditional print format.

Bruce will be soliciting articles from both industry and academia. Articles should be no more than 5,000 words, including references, and should be submitted typed, double-spaced, in 12-point font. If you have an article that you think would be appropriate for *SEG Discovery*, contact Bruce at: [bruce.gemmell@utas.edu.au](mailto:bruce.gemmell@utas.edu.au) or [gemmell.geoscience@inet.net.au](mailto:gemmell.geoscience@inet.net.au).



Bruce (here sporting his SEG cap) is on the lookout for technical articles for the revamped SEG newsletter, *SEG Discovery*.



## WHERE ARE THEY NOW?

In our continuing series of short interviews with past alumni, Tracey Kerr talks about her career highlights and explains that she could not have achieved her leading role with Anglo American without her Master of Economic Geology degree from CODES.

## MAKING A DIFFERENCE TO THE LIVES OF OTHERS IS KEY

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

My current role is Group Head of Safety and Sustainable Development with Anglo American. I am responsible for Safety, Operational Risk Management, Health, Environment, Permitting and Mine Closure. I am currently focussed on the following key programs:

- Elimination of Fatalities – delivering a step change in safety performance to sustainably achieve zero fatalities.
- Climate Change and Carbon Neutrality – developing a detailed, technically sound pathway to carbon neutrality for Anglo American.
- The Living Mine and Future of Work – rethinking the value proposition of mining companies to society.
- Circular Economy – understanding the opportunities and challenges the circular economy presents for Anglo American.

I am also an independent non-executive director on the board of the FTSE 100-listed gold and precious metal mining company Polymetal International Plc, where I chair the Sustainability Committee and serve on the Remuneration Committee.

### What do you enjoy most about this role?

My current role with Anglo American is an opportunity to really make a difference to people's lives – employees, their families, and members of the communities and societies in which we operate. At Polymetal I enjoy the opportunity to participate in the full spectrum of the business of a mining company.

### How did you get there?

I graduated from the University of Sydney in 1987 with a first-class BSc Honours degree in geophysics. I had worked as a vacation student with BHP's mineral exploration group, and I started work with them upon graduation. Vacation

experience was a great way for me to be sure I really wanted a career in mineral exploration, and for BHP to get to know me and be sure I was right for them.

From here I went on to grow my career, initially as a technical specialist in geophysics, while completing my Masters in Economic Geology at CODES in 1995. I moved on to progressively broader and more senior exploration management roles with different companies in different countries. Ultimately, I made the switch to a completely new area for me: Safety & Sustainable Development (S&SD). I also gained qualifications with the Institute of Directors and took on a role as an independent non-executive director of a London listed mining company.

### What is your career highpoint/greatest achievement to date?

Many exploration people would list their key achievements as involvement in successful exploration discoveries that went on to become mines. As we all know, the days of the lone discoverer are largely gone and nowadays these successes are the result of team efforts. I am proud to have contributed to a number of these throughout my career with BHP, Vale and Anglo American.

If I think about highlights from another point of view, I think the opportunity to work in many different countries with people of different backgrounds and cultures has been a real personal highlight. At last count I have worked in more than 30 countries, and learnt at various times to speak French, Spanish, Russian and Portuguese.

I am also proud to have had a successful exploration and mining career as a woman. I have been included in the Top 100 Women in Mining for the past three years. I have never experienced any difficulties and in fact have experienced great support from colleagues and managers. However, I was often the first woman in different situations and I am happy that today younger women can see people like me and know they can



**TRACEY KERR**

**Group Head of Safety and Sustainable Development, Anglo American**

achieve a successful career and balance their personal life as well.

From a professional point of view highlights particularly include:

Principal Geophysicist for BHP in Russia in the late 1990s – this was soon after glasnost and a real political, cultural and social learning experience for me, as well as quite the adventure working on remote projects from the Kola Peninsula to Kamchatka.

BHP's Chief Geophysicist in 1999 – from a professional exploration geophysicist's perspective, the Chief Geophysicist role is the ultimate technical point to reach, and especially at quite a young age. One of the key projects I was involved in was the successful transition of BHP's falcon gravity gradiometer system from a research project to an operational exploration geophysical system.

Director of Exploration for the Americas with Vale – I was accountable for Vale exploration activities in the Americas, including Brazil. I was responsible for projects in eight countries across a wide range of commodities including Cu, Ni, bauxite, iron ore, coal, potash, phosphate. During this time, we concluded pre-feasibility studies and

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Tracey Kerr (centre) in the field on a reconnaissance greenfield exploration field program with junior company, Millrock Resources, in Alaska during 2011.

delivered five projects to the mining business units (copper, iron ore, thermal coal, potash, bauxite). Most of all though I am proud of having been appointed one of the first foreign directors of Vale. This to me was a sign that I had successfully made the transition to operate successfully within a very different corporate culture.

Group Head of Exploration for Anglo American – In this role I had the opportunity to lead Anglo American's global exploration team. For any mineral exploration professional, the opportunity to lead a global exploration team is a career highlight. Key results included transformation to a multi-commodity exploration group with a balance of brownfields and greenfields programs in mature, merging and frontier terranes, with an increased focus on S&SD, project generation and commercial/economic evaluation.

Group Head of Safety & Sustainability for Anglo American. Many exploration people go on to have second careers in this area. If I think about why, it is because part of the reason we originally became explorers is that we are passionate about the natural environment. In exploration we are often the first people to enter an area, and we see the impacts, both positive and negative, that a project can have on the community and environment. In this role I have the chance to really shape that impact. A very significant achievement for Anglo American was that in 2019, for the very

first time, we did not lose any of our employees in South Africa to HIV-related illnesses. As recently as 2016, 65 of our employees lost their lives. We hear a lot about serious safety accidents in the mining industry and we are very focussed on eliminating this, but I was shocked when I started this role to learn that preventative illnesses like HIV and TB kill far more of our work colleagues.

Independent Non-Executive Director of Polymetal – In 2018 I was appointed an independent non-executive director of Polymetal International Plc, a FTSE 100 listed company in the UK. I have been fortunate to attain my first board role with such a successful and principled company. As a non-executive director you have a particular technical background or set of skills you are bringing to the board (in my case S&SD) but you have a role to play in all aspects of the board's responsibilities.

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

At CODES I completed the Master of Economic Geology part-time, whilst continuing to work for BHP. I was part of the second cohort. This degree gave me a much broader background in exploration strategy and management which provided an important platform to be a better exploration geophysicist (I became Chief Geophysicist for BHP Minerals), then to move onto increasingly broader roles in exploration

management (Director of Exploration for the Americas for Vale, and Group Head of Exploration for Anglo American) and ultimately to move outside my area of specialist technical expertise to become Group Head of Safety & Sustainable Development. Without my Masters I would not be where I am today.

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

The industry has changed, but not as dramatically as you might expect. Exploration teams have become smaller and more focussed, and there is less expenditure on greenfields exploration globally. When I graduated BHP had more than 20 geophysicists in their Australian exploration team alone. Today exploration teams in major companies are smaller, and more work is performed by specialist contractors. However, we are still using largely the same techniques – geologists still go mapping and sampling in the field and log drill core; geophysical techniques are still largely the same.

I do see that it will change dramatically in the future. We have hints of this future. They are not mainstream yet but will become so. A lot more data collection will become automated or remotely sensed – logging of drill core using hyperspectral sensors and optical scanners will become mainstream. We will still have geologists and geophysicists but they will be working in a world of data analytics and their role will be much more focussed on analysis and interpretation, integration of multidisciplinary information and decision making.

Mining itself will change dramatically – today we are still fundamentally mining in the same way we have for a 100 years, just with bigger trucks moving more waste and extracting progressively lower grade ores. In the near future we will see fully automated mines, operated from remote control rooms. The industry will be much safer because we will remove people from exposure to risk. Climate change is an imperative for all of us – mines of the future will be energy efficient, carbon neutral and self-sufficient in terms of water use. The physical footprint of mines will change – we will see new selective ways of extracting minerals from rock through technologies such as novel leaching.

CONTINUED ON P.19.



## TECHNOLOGY TRANSFER

# LEADING THE FIELD WITH NEW TECHNOLOGIES

Senior Lecturer in Earth Sciences at CODES Dr Michael Roach led the first ever field-based meeting of the Australasian Universities Geoscience Educators Network (AUGEN) and here reports on a successful and productive few days in Tasmania's northeast.

**'Field Geology in the 21st Century', AUGEN 2020, NE Tasmania Field Meeting, 29–31 January**



**Above** Dr Michael Roach (CODES) demonstrating and discussing the applications of drones for small-scale mapping at Bellingham.

**Top Right** Dr Luke Nothdurft (QUT), a participant in the AUGEN field trip, measuring bedding at Bellingham using an iPad.

**Bottom Right** AUGEN participants compare their 'student' maps to detailed drone imagery at Piccaninny Point.

*All photos courtesy of Will Stearman and Luke Nothdurft, Queensland University of Technology.*

In late January Earth Sciences/CODES hosted a meeting of the Australasian Universities Geoscience Educators Network (AUGEN). AUGEN is a loose network of educators that coordinates conferences and workshops that provide a forum for promotion of excellence in tertiary Earth science education. For the first time, the 2020 AUGEN conference was held as a field-based meeting that specifically explored the changing nature of field geology. Tertiary education programs must develop basic student skills such as mineral and rock identification, structural measurements and mapping but in addition to these fundamentals educators need to also expose students to the potential of a range of new, rapidly-evolving, technologies. This was the focus of the AUGEN field meeting.

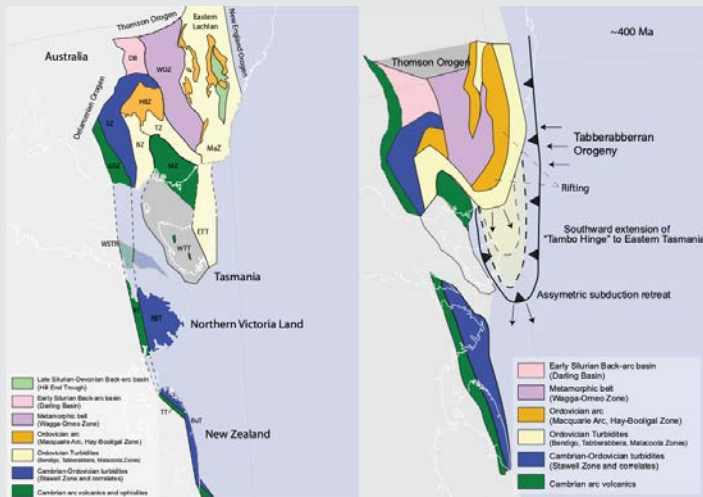
The three-day field trip to northeast Tasmania was attended by 26 educators from Australian and New Zealand universities. The geological theme was 'Palaeozoic Sedimentation, Deformation and Magmatism'. The world-class geological sites visited were used as a stage for exploring best-practice methods for modern field-based education. The field trip, evening talks, discussions and workshops provided a relaxed forum for exchange of ideas about improving the student field experience. A key element of the field trip was the active involvement of the participants who were often asked to undertake typical student activities and to then evaluate the effectiveness of each exercise. Some sites were used to explore the applications of new and emerging technologies such

as portable field data recording, the use of digital devices for structural mapping and the applications of drone-based models and imagery.

Participants enjoyed great weather on the field trip and explored fantastic outcrops including folded Silurian turbiditic metasediments at Bellingham, the contact aureole at Piccaninny Point and magmatic-hydrothermal features at Bluestone Bay. The only minor issue was a temporary road closure due to a bushfire en-route to the accommodation on the second night that necessitated a couple of tough hours sitting on a fairway at St Marys Golf Club having beers, wine and cheese.

# LACHLAN OROGEN: MAJOR HIGHLIGHTS

Associate Professor Sebastien Meffre provides a summary of the final meeting of the Australian Research Council Linkage project: Ore deposits and tectonic evolution of the Lachlan Orogen, southeast Australia



CODES PhD student Thomas Schaap's reconstruction showing oroclinal folding of the Lachlan Orogen as a model to explain the distribution of Palaeozoic geological structure in southeast Australia.

This project began in December 2017 aiming to develop predictive and explanatory models to help mineral exploration in southeast Australia, as well as to provide deeper knowledge of the geology and tectonic evolution of the Lachlan Orogen. Mineral chemistry, geochronology and isotopic data were collected both at the ore deposit-scale and the regional-scale to investigate ore deposit footprints and regional tectonics.

Some highlights of the project include:

- collection of >10,000 pyrite epidote and chlorite analyses providing information on fertility for porphyry and volcanic-hosted massive sulfide deposits throughout southeast Australia
- the discovery of new Cambrian island arc rocks beneath the Ordovician rocks of the Macquarie Arc
- the creation of new fertility maps for porphyry deposits in New South Wales
- the creation of a tectonic model in the G-Plates software allowing reconstruction of ore deposit fertility maps data back in time to their configuration 445 million years ago.

The project's final meeting was held in Hobart on 11–12 March. The first day took the format of a workshop where industry and government representatives were shown how to manipulate and query the project data. On the second day the latest findings were presented.

Four CODES PhD students are continuing with thesis research using project data (Chris Leslie, Tristan Wells, Thomas Schaap and Umer Habib). The results from this work will be published in the scientific literature and the project data will be made publicly available through the NSW and Victorian geological surveys and Mineral Resources Tasmania.

## BECOME A CODES INDUSTRY PARTNER FOR 2020

We value highly the support of our Industry Partners, who make a significant contribution in many ways to the work we do, and entry to the program is still ongoing for 2020. CODES has a variety of Industry Partner entry options that cater for the research and training needs of all levels of mining operations – from small to medium enterprises (SMEs) through to the major multi-nationals. For more details, please see our website: <https://www.utas.edu.au/codes/about-us/industry-partnership-program>

### OUR CONFIRMED 2020 INDUSTRY PARTNERS SO FAR:

#### PLATINUM



#### GOLD



RioTinto

Teck

#### SILVER



BARRICK





# THE VISITORS' BOOK

Early 2020 has been a busy time for visiting academics and speakers at CODES (some of whom have also had to navigate the coronavirus quarantine regulations). The following people have arrived to study or work here, or have presented talks to the CODES community.

## VISITING ACADEMICS AND STUDENTS



Visiting PhD student **Ms Fengqin Ran** arrived in early January and is from the School of Earth Sciences, Chengdu University of Technology, China. Fengqin has been invited to carry out research at CODES by Dr Lejun Zhang until the end of the year. Her research will mainly focus on 'Geochronology, geochemistry and exploration implications of garnet at Jiama skarn-porphyry deposit, Tibet, China'.



**Dr Xuejing Gong** arrived in mid-January and is an assistant professor at the Chinese Academy of Geological Sciences (CAGS). She specialises

in economic geology, in particular magmatic controls on porphyry-related lead-zinc deposits.

During her three-month stay at UTAS, Xuejing plans to investigate melt inclusions using in-situ analysis techniques (i.e. LA-ICP-MS, EMPA) at CODES based on detailed microthermometry to: (1) clarify the composition of the melt inclusions, especially the contents of Pb and Zn; (2) evaluate the contribution of porphyry magma to the formation of the deposit; and (3) determine the genetic relationship between granite porphyries and the Pb-Zn mineralisation.

**Dr Jing Chen**, who recently completed her PhD at CODES, visited CODES for a month in January-February in order to complete lab work.



**Dr Alkiviadis Kontonikas-Charos (Alkis)** is visiting CODES from the University of Adelaide and is here for three months (February to April) working with Professor Dima Kamenetsky, Dr Maya Kamenetsky and Dr Kathy Ehrig. He completed his PhD on alkali alteration and REE remobilisation in Fe-oxide Cu-Au deposits of South Australia. His current research focusses on fluid/melt inclusions in quartz, fluorite and carbonates from granite surrounding and hosting the Olympic Dam Cu-U-Au-Ag deposit. Dr Ehrig, who has an honorary position at CODES, is his primary supervisor in this research.



**Dr Anton Kuttyrev** from the Institute of Volcanology and Seismology in Kamchatka, Russia, arrived in early March for a month to work with Professor Dima Kamenetsky on platinum, and osmium and iridium in Tasmania. It is planned that he will work as a postdoc on a project involving platinum if funding is forthcoming.



**Ivan Chayka** from Novosibirsk in Russia also arrived in early March to work with Professor Dima Kamenetsky on comparisons between Tasmanian and Russian nickel deposits. He is a prospective PhD student and will be working on Professor Kamenetsky's new ARC Discovery project, which has recently received funding.

## SPEAKERS



**Alex Farrar**, a CODES PhD student and FQM geologist based in Santiago, Chile, visited for a week during January and gave a presentation entitled 'Interpretation and validation of translithospheric structures in northern Chile'.

**Professor Sandy Cruden** gave a talk entitled 'Emplacement of Jurassic dolerite sills in Tasmania: Implications for Australia-Antarctica connections and Gondwana breakup' on 30 January in the GSA series of presentations.

**Dr Gerrit Olivier**, Head of Applied Geophysics at the Institute of Mine Seismology, spoke at the GSA meeting in February on the topic of 'Insights into the 2018 eruption of Kilauea Volcano from ambient seismic noise and the application of seismic noise for imaging and monitoring in mines'.

**Dr Chun Kit Lai**, a former CODES PhD graduate, gave a talk in mid-March entitled 'The Kalimantan Gold Belt: An Overview' as part of the GSA series of presentations.

## CONTINUED FROM P.16.

### Words of wisdom for up and coming geologists?

Firstly, I would say follow your passion. My career was not particularly planned. I followed interests and opportunities, but if I look back, I see that each step along the way was essential in where I am today. What I did do was to always focus on doing my current role very well. If you have a reputation for performing

at a high level and being a team player who helps others to succeed, people will want to have you in their team and opportunities will come your way. And then be open minded when unexpected opportunities happen.

Recognise that your interests will evolve as you go through your career and move with these changes – continue to study and be curious. I would not have


predicted when I was a student at CODES that I would live in Brazil and work for a Brazilian mining company or ultimately work in safety and sustainability.

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

I am married (to an exploration geologist) and have two children aged 21 and 17. I enjoy travelling, fly fishing and reading.

# CHANGING FACES

As the new year gets underway, we welcome new faces at CODES including one PhD student and also farewell two colleagues. Some PhD students have been caught up in the coronavirus restrictions and will be joining us later in the year.

PHD STUDENT	START DATE	PROGRAM	PROJECT TOPIC
 <b>Bridie Le'Gallais</b>	December 2019	Program 4, working with Leonid Danyushevsky and Paul Olin in collaboration with MRT	The Tectonic significance of mafic/ultramafic igneous rocks in Western Tasmania

## ARRIVALS



**Dr Clare Miller** joined the CODES and TMVC team in mid-February after completing her

PhD in Environmental Geochemistry at Queen's University in Ontario, Canada. As a Lecturer in Geoenvironment and Geometallurgy, and a researcher, she will be teaching and supervising students in addition to leading the growth and development of the Environmental Geochemistry laboratory here at CODES.



**Sophie Davidson** joined the Discipline of Earth Sciences in early

March as an Administration Officer based in the Earth Sciences reception. She is replacing Deborah Macklin for a year while Deborah is on secondment to the School of Technology, Environments and Design. Sophie has previously worked in administration in Finance-Shared Services and the Discipline of Biological Sciences at UTAS.



**Asher Riaz**, who hails from Pakistan, has recently joined the PY005 project PY005:

'Characterizing pyrite chemistry of black shales hosting stratiform Zn-Pb-Ag and stratiform Cu deposits: Application to mineral exploration' as a Database Officer. He will be working with the pyrite group for the next six months. Asher recently submitted his PhD with IMAS.

## DEPARTURES



**Dr James Tolley** resigned from his position as a Research Fellow in LA-ICP-MS in early March and will take a break

in New Zealand before moving to another role in Australia or the UK. James has worked in the CODES Analytical Laboratories for almost two years.



**Deborah Macklin** moved from her role as Administrative Assistant in the Discipline

of Earth Sciences to take up a year's secondment position as Executive Assistant to the Head of School, School of Technology, Environments and Design, in early March.

## KEEP IN TOUCH

### BECOME A SUBSCRIBER

If you want to join one of our mailing lists to receive regular updates (newsletters/annual reports/short course information/PhD opportunities or job vacancies) please email us at:

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



# FLYING HIGH (AND IN FORMATION)

Another crop of CODES and Earth Sciences students graduated in December; pictured below is what can rightly be described as a 'formation of geologists'. Or a 'conglomeration of geologists'...yes, there are actually two official collective nouns for geologists. We wish them all the best in their upcoming brilliant careers!



December 2019 graduates and their supervisors pictured above are (L–R): Back row: Johanna van Balen (Honours), Josh Phillips (PhD), Robert James (Honours), Imbi Simpson (Honours), Sam Holt (PhD), Dr Rebecca Carey (supervisor), Professor David Cooke (supervisor), Callum Cooper (BSc), Cameron Foster (Honours). Front row: Yun Fann Toh (BSc), Wei Xuen Heng (BSc), Professor Jocelyn McPhie (supervisor), Bonnie Ferguson (BSc), Dr Martin Jutzeler (supervisor), Libas Ulaiwi (Masters).

Jing Chen and Naomi Potter both graduated with a PhD on the same occasion but didn't attend the graduation ceremony.



**Left** Jodi Fox also graduated with a PhD in December and is pictured here flanked by her supervisors Professor Jocelyn McPhie and Dr Rebecca Carey.



**Centre** Josh Phillips after receiving his PhD pictured with one of his supervisors, CODES Director Professor David Cooke.



**Right** Honours graduates Acacia Clark, Imbi Simpson and Lexi K'ng with supervisors Dr Rebecca Carey and Dr Martin Jutzeler.

# UNDER THE GUM TREES....

The 2019 Christmas drinks for CODES and Earth Sciences staff were held in late December in the leafy CODES Rock Garden under the much-needed shade of gum trees and gazebos on a very warm day. A large turnout of staff and students gathered in the early afternoon to spend a convivial couple of hours chatting to colleagues, enjoying a drink or two, and relaxing after a year's hard yakka.

Voting for the annual CODES Christmas photo competition took place prior to the drinks; this year the ten categories for entries comprised the six CODES research programs plus training, industry, outreach and social. A great range of excellent entries was received, so many thanks are in order to all those who entered.

CODES Director Professor David Cooke presented the sought-after bottles of Tasmanian wine as photo competition prizes, and substantial eats, organised by CODES Administrative Officer Karen Huizing, were enjoyed by all.

There is space here for only one of the winning entries; to view all the winners, please go to:  
<http://www.utas.edu.au/codes/codes-annual-photo-comp/photo-comp-2019>

*Thanks to Helen Scott for all photographs taken on the day.*



**Dave plays Santa:** a general view of the photo competition prize-giving in which ten bottles of Tasmanian wine featured prominently.



**Toy story:** CODES PhD student Chris Leslie with his children Mac and Emmy – and a bouncy friend – under the gum trees at the Christmas drinks held in December.



**Double take:** Masters student Nathaly Guerrero receiving her prize from Dave Cooke for her Program 2 winning photo (which was fittingly a photo of Dave himself!).





**Beers in hand:** PhD students (L–R) Thomas Schaap, Thomas Ostensen and Tristan Wells relax in the shade and contemplate their summer break.



**Christmas the Australian way:** enjoying the thoroughly Australian gathering were some of our Chinese visitors and students: L–R: Dr Cui Minli (visiting geoscientist), Xianzheng Guo (PhD student), Tao Zhang (PhD student), Shaorui Zhao (PhD student).



**Program 4 winning photo:** ‘Beautiful stop for lunch looking out towards Volcan San Pedro, northern Chile’, taken by CODES PhD student Chris Leslie while on the ‘Ores in Magmatic Arcs – South America’ short course in October.



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

As the newsletter goes to press, we are currently in a fluid and continually evolving situation regarding the COVID-19 crisis. The University of Tasmania has instructed research staff and students to work from home and for our undergraduate teaching to move online.

CODES Analytical Laboratories currently remain fully operational and we have established protocols for our staff and students to continue to generate their data, in order to minimise disruptions to our laboratory-based research activities.

With regards to the Master of Economic Geology program, we successfully completed teaching of the volcanology short course in mid-March after having to relocate the New Zealand leg to Western Victoria at short notice. For our next short course, we are undertaking contingency planning for online delivery. To facilitate this, the 'Ore Deposit Models and Exploration Strategies' short course is being rescheduled to take place in June as the unit most amenable to online delivery. The 'Exploration in Brownfields Terrains' short course will now be offered in October. We will provide more details to our Masters students in the next few weeks as the situation continues to develop and ask that you reach out directly to us if you have any issues or concerns (see contact details at the foot of this page).

To conclude, I wish all of you – our staff, students, stakeholders and friends – the best of health and thank you for your ongoing support in this time of crisis. Please keep connected and reach out to us if you need help.

Kind regards  
Dave

For further information about short courses, please email: [CODES.Info@utas.edu.au](mailto:CODES.Info@utas.edu.au)

OR

Master of Economic Geology Program Co-ordinator,  
Dr Robert Scott: [Robert.Scott@utas.edu.au](mailto:Robert.Scott@utas.edu.au)

For all other CODES contacts, see page 2.



## UPCOMING MASTER OF ECONOMIC GEOLOGY SHORT COURSES

### ORE DEPOSIT MODELS AND EXPLORATION STRATEGIES

**1-12 JUNE 2020**

Presented by a mix of CODES staff and invited experts, for the first time, it is likely that this short course will be delivered entirely online. It provides an up-to-date synopsis of key ore deposit types including porphyry, skarn and epithermal, volcanic-hosted massive sulfide and sea-floor hydrothermal, sediment-hosted U, Cu and Pb-Zn, IOCG, and orogenic and Carlin-type gold deposits. In most cases, each deposit type receives a full day of lectures, tutorials and practical exercises, addressing location, characteristics, genesis and exploration strategies. As usual, participants will have the opportunity to examine and work with samples and data sets from many world-class deposits and mining districts. However, in keeping with the planned online delivery of this unit, this year participants will work with high-resolution photographs and 3D imagery of samples, rather than handling the rocks themselves. The unit will also include a breccia workshop presented by David Cooke, Nick Oliver, Shaun Barker and Robert Scott. This workshop will provide a comprehensive overview of breccia formation in a range of hydrothermal and ore-forming environments.

### EXPLORATION IN BROWNFIELDS TERRAINS

**19-30 OCTOBER 2020**

Exploration in data-rich environments, close to existing mines, has become a preferred method of increasing company resources in recent years. With this exploration philosophy in mind, CODES is proud to present a Masters-level short course designed to bring participants up to date with the latest exploration techniques. The Exploration in Brownfields Terrains short course covers a range of cutting-edge technologies in geophysics, geochemistry, hyperspectral reflectance and 3D visualisation, using real data from world-class mineralised districts. The short course is presented by expert teaching staff from CODES and leading minerals industry professionals.