

ORE SOLUTIONS

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

> Autumn 2019 **No.33**

EVERYTHING IN ORDER FOR ROSS!

Emeritus Professor Ross Large, former director and founder of CODES, was awarded the Officer of the Order of Australia (AO) in the Australia Day Honours list in January. This is the second highest honour given by the Council for the Order of Australia, and was awarded for “distinguished service to education, and to scientific research, in the field of economic geology, and to professional societies”.

Ross says he is honoured to have received the award: “I think I can say that the recognition is for my work in economic geology in establishing CODES as a highly successful international research centre that is now being emulated in various places around the world, such as Canada, the USA and Ireland.

“I am very proud of the recognition given to me by the Council, and it’s particularly pleasing because it is also honouring my wife and family for the strong support they have given me throughout my career. It is satisfying to get the recognition not only as a research geoscientist but also as an educator of many young geologists.”



Medal winner: Ross Large in his office at CODES with Rosie the dinosaur, who is presenting him with a facsimile of the Officer of the Order of Australia (AO) – thanks to the wonders of Photoshop. The actual medal will be presented to Ross in May.

Asked about the importance of his research, Ross says that it is “in linking the research capacity we have here at CODES in our geoscientists with industry geoscientists to produce breakthroughs in mineral exploration”. He adds that there are so many examples, particularly in the areas of volcanic-hosted massive sulfide deposits, sediment-hosted lead-zinc deposits and sedimentary black shale gold deposits.

“This is now being followed on by the brilliant research by David Cooke and his team in porphyry-copper deposits,” he adds.

He acknowledges that the AO was awarded in part for his work with various learned societies, such as the

Society of Economic Geologists, the Australian Academy of Technology, Science and Engineering (Tasmanian Division), and the Royal Society of Tasmania. Ross is currently President of the Royal Society, and wanted to return to the role at a time when the Society is celebrating its 175th anniversary.

“I think when I took over the Royal Society it was at a point where it needed to raise its profile – and it was in great shape to do so. My job was to start some new initiatives.” The current dinosaur exhibition at the Tasmanian Museum and Art Gallery, which has been organised jointly by the Royal Society has been one of Ross’s key achievements. “The

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Good times: L-R: Professor Vadim Kamenetsky, Emeritus Professor David Green, Emeritus Professor Ross Large and Ross's son Chris enjoying a drink during a celebratory event held at CODES on 30 January 2019 to mark Ross's AO award.

whole idea is that there have been some exciting discoveries related to dinosaurs in the past 15 years. The exhibition and the symposium [which took place earlier in March] are designed to excite and educate young and aspiring scientists." The exhibition has been highly successful, particularly for families. UTAS provided funds to purchase two dinosaur "suits", which star in the exhibition and which earlier this year were the main attractions at a dinosaur picnic held in the Royal Tasmanian Botanical Gardens. "The kids love them – we had 6,000 people turn up to the picnic", he enthuses.

As to future research, Ross says that he has changed direction over the past seven years to focus on pyrite geochemistry using "our world-class laser ICP-MS laboratories; this has taken me into studying fundamental questions about the chemistry of past oceans and the evolution of the atmosphere, and how they relate to the cycles of ore deposits". He continues that work at CODES in an honorary capacity.

Ross will receive his AO medal at an inauguration ceremony at Government House in Hobart during May.

BIG TURNOUT FOR THE PUB

On 7 February CODES/TMVC Postdoctoral Research Fellow in Geometallurgy Dr Angela Escolme (pictured) joined Dr Mark Duffett, Geophysicist at Mineral Resources Tasmania, and Dr Lawrence Meinert, Center for Space Resources, Colorado School of Mines, USA, for a regular Science in the Pub session on the topic of 'From Tasmania to Space: Rocks and future mineral resources'. The event was attended by over 80 members of the public with standing room only. Angela was the first speaker and discussed the importance of copper as a future resource, particularly in the



green energy sector. Mark highlighted Tasmania's potential to continue to supply mineral resources and Larry provided insights into the future of mining in space – which is not as far away as you might think! The short talks were well received and stimulated a wide range of discussion.

GEOLOGY MASTERS CLASS

Masters Program Co-ordinator Dr Robert Scott provides some background to the CODES Master of Economic Geology (MEconGeol) course – which celebrates 30 years in 2019 – and explains its renewed success. And we meet the current (and one recently completed) Masters students who have chosen the research option of the degree and are carrying out fieldwork across the world.

The largely coursework-based MEconGeol degree program commenced in 1989, in CODES' first year of operation. It was initially designed for industry and government geoscientists with two to 15 years' experience, who could complete the degree part-time, while working full-time. This was achieved by compressing the teaching into a series of intensive, two-week short courses that aimed to provide students with state-of-the-art education and training in the areas of mineral deposit genesis, mineral exploration, and mining and management in the minerals industry. These areas of focus, and the manner of unit delivery, continue to the present day.

The number and diversity of units available increased significantly in 2001, when the MEconGeol was incorporated into the national Mineral Geoscience Masters (MGM) program. The MGM began as a collaboration between the federal Department of Education, Training and Youth Affairs (DETYA), the Minerals Council of Australia (MCA), CODES at UTAS, the Centre for Global Metallogeny (now Exploration Targeting) at UWA, and the Economic Geology Research Unit at JCU. The national program enabled economic geology Masters students from UTAS, UWA and JCU to take units for credit towards their degree from any of the other universities, as well as a selection of minerals finance-focused units from the Curtin School of Business. The national program continues as a collaboration between CODES, CET and the Curtin School of Business, but JCU withdrew from the MGM in early 2017.



Flying high: Corey Jago (nearest camera) takes a helicopter ride to White Island with (L-R) Tom Ralston, Richard Spilsbury and Martin Jutzeler during the Master of Economic Geology Volcanology short course held in March 2018.

The MEconGeol program at UTAS now boasts 120 graduates, with an average of seven new graduates per year over the past five years (up from an average of three per year over the previous 23 years of the program). Award of the MEconGeol degree requires the successful completion of eight units over two years, if completing the degree full-time, or 3–5 years if, as is the case for most of the students, the degree is completed part-time. The degree can be done by coursework only, or by completing six units of coursework and a two-unit research thesis. These days most students choose the coursework only option. However, some students still opt to include a research thesis, and descriptions of some of the research projects being undertaken by our current students are contained on the following pages.

Last year was one of the most successful years ever for the MEconGeol program. We had the largest ever intake of new (19) and returned (3) students in a single year, and the number of students in the program also reached an all-time high (57). A total unit enrolment of 69 across the three short courses offered in 2018 was also the equal second highest enrolment for a calendar year, and just two short of the all-time record enrolment in 2013. With ten new applications to join the Masters program already in 2019, these positive trends look set to continue. Another pleasing recent sign has been an increase in the number of students who are financially supported, or partly supported, by their employers to complete the degree. This vote of confidence is a sure sign that a sense of optimism is returning to the minerals industry, and with it, an increasing demand for highly-trained geoscientists.



Eyes on the prize: David Cooke, Angela Escolme and Masters student Libas Ulaiwi examining core in the core shed at the Batu Hijau mine, Sumbawa, Indonesia, during the Ores in Magmatic Arcs – Indonesia short course, March 2019. (Photo courtesy of PT Amman Mineral.)



1 PEERAPONG SRITANGSIRIKUL

Current student, Master of Science (Earth Sciences)

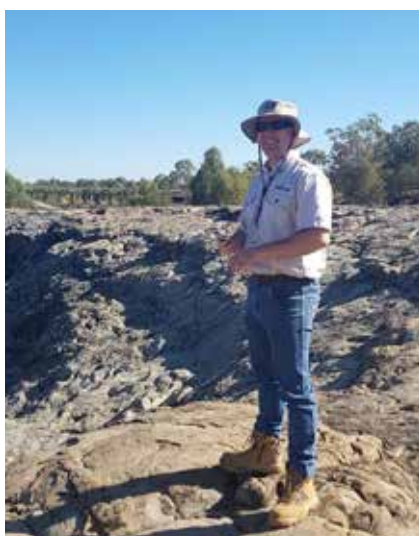
Supervisor: Sebastien Meffre

Project title: Tectonic evolution and ore deposit prospectivity of the Rockley Volcanics, NSW, Australia

The aim of Peerapong's Masters research project is to provide an integrated knowledge of the geology, geochemistry and geochronology of the Oberon district in New South Wales (300 km east of Sydney). Peerapong has finished his research and is in the final stages of writing up with submission due in the next few weeks.

His project has mapped and sampled the Ordovician and Silurian rocks around Oberon and strengthened the geological correlation with mineralised rocks from NSW using a combination of basic geological mapping, petrography, whole rock geochemistry and U-Pb geochronology. He has looked at both the intrusive rocks and the extrusive rocks focusing not only on the volcanic units but also on quartz-rich sedimentary units. The results of his work have important implications for porphyry copper exploration in the area and for unravelling the complex geological history of the rocks.

"The MSc (Earth Sciences) is a course very similar and close to a PhD because there is only your research that you have to focus on. It's very hard and challenging to me for a person who wants to be a good PhD candidate and also a future researcher. This course is a great one to prepare myself for that."



Top: Peerapong Sritangsirikul (Master of Science (Earth Sciences)) takes a break from fieldwork in the Rockley Volcanics, New South Wales. **Middle left:** Carlos Diaz carrying out Anaconda mapping at Alpala creek in the Cascabel Cu-Au porphyry cluster in northern Ecuador during December 2018. **Middle right:** Brendan Hardwick examines Proterozoic rocks of the Georgetown province near Einsleigh in northeast Queensland. **Bottom:** Arga Firmansyah pictured at Beskauga, Pavlodar Region, Kazakhstan, where he was drilling porphyry targets in late 2017 for Resource Development.



2 CARLOS DIAZ

Current student,
Master of Economic Geology

Supervisor: David Cooke

Project title: The Cascabel Cu-Au porphyry cluster in northern Ecuador

Carlos Diaz commenced his Masters research thesis study of the Cascabel porphyry deposit cluster in Ecuador in late 2018. His industry sponsor is SolGold, and their discovery of the Alpala Cu-Au porphyry deposit in the Cascabel district, with a maiden mineral resource estimate of 2.95 Bt @ 0.52% CuEq, in an under-explored northern section of the Ecuadorian Andean Cordillera, has rejuvenated copper exploration in Ecuador. The discovery of Alpala highlighted the need to better understand the geological controls of porphyry emplacement and development in the region, so as to improve the effectiveness of regional exploration. With excellent logistical and financial support from SolGold, Carlos has spent the first two months of 2019 conducting field mapping, drill core logging and sampling that have been focused on the Alpala, Tandayama and Aguinaga prospects.

Carlos moved to CODES in late February 2019 to commence his analytical work program. Through the application of an appropriate array of geological, geochronological and geochemical analytical techniques, Carlos will build new models for the magmatic and metallogenic evolution of the Cascabel district that will help to guide ongoing exploration in the district and broader region.

"It's a great experience to be part of an incredible project like Cascabel in Ecuador. For my career it is wonderful to be part of this amazing discovery and the possibility of doing research related to this project will give me new and great experiences. I'm really excited about the new knowledge and experiences that I will have during the next two years of my research."



3 ARGA FIRMANSYAH

Current student,
Master of Economic Geology

Supervisor: David Cooke

Project title: Geology and mineralisation of the Trenggalek district, East Java, Indonesia

The Trenggalek district in Java, Indonesia, is part of the Miocene-age eastern Sunda-Banda arc. This region is highly prospective for porphyry-style mineralisation, because giant porphyry copper-gold deposits have been discovered at Tujuh Bukit (Java), and Batu Hijau and Elang (Sumbawa), defining Indonesia's major porphyry metallogenic belt. With the support of PT. Pamapersada Nusantara, Arga Firmansyah is conducting a prospectivity analysis of the porphyry potential of the southern Trenggalek district for his Master of Economic Geology thesis. His study involves an appraisal of all available district-scale geological, geochemical and geophysical datasets to identify areas of potential exploration interest, allowing for the development of preliminary prospectivity ranking criteria. Phase two of the research will involve ground-checking of areas highlighted by the preliminary rankings, allowing refinement of the ranking criteria, and ultimately helping to focus exploration activities in the Trenggalek district and in other areas of interest along the Sunda-Banda arc.

"What I enjoy most from doing a Masters at CODES is that I can learn directly from the people who wrote books that I read during my bachelor's degree...it makes it a lot clearer than ever before."



4 BRENDAN HARDWICK

Current student,
Master of Economic Geology

Supervisors: Sebastien Meffre, Mark Doyle (AngloGold Ashanti)

Project title: Ore mineral textures and their implication for gold genesis and deportment at the Tropicana Gold Mine, Western Australia

Brendan Hardwick has examined various ores from the Tropicana Deposit in Western Australia to understand where the gold is within those samples and how the gold relates to the various events that have affected this deposit.

Brendan is using the conventional optical microscope, the automated scanning electron microscope and the laser ablation mass spectrometer to find the gold and document how it relates to other minerals within ore samples. Brendan has finished much of his analytical work and is currently writing up the results.

"I enjoy the variety of challenging classes and opportunity to meet new people with a wide range of backgrounds in the industry."



5 COREY JAGO

Current student,
Master of Economic Geology

Supervisors: Sebastien Meffre,
David Cooke

Project title: Spectral characterisation
of the E26 and E48 porphyry Cu-Au
deposits, Northparkes, New South Wales

Corey Jago's project involves the validation of hyperspectral mineral zonation work at the E26 and E48 deposits in the Macquarie Arc, NSW. This work builds on a collaboration between Northparkes Mines and the Geological Survey of NSW to characterise and document alteration mineral zonation at two of the Northparkes deposits. Over 5,000 m of core across eight diamond drill holes from the two deposits was analysed using the HyLogger-3 system at the Geological Survey of New South Wales, Londonderry. An initial study of E48D134 by Quigley et al. 2017 shows strong spectral zonation in alteration mineralogy of the Goonumbla Volcanics around the E48 deposit. Corey's research continues from this work to build a 3D representation of the alteration systems of the two porphyry deposits from all eight drill holes. Additional aims include comparison and validation using other mineral identification techniques.

"Undertaking the Master of Economic Geology degree has been challenging but rewarding. I started with the goal of learning the latest thinking in economic geology and brushing up on old skills, which has surpassed my expectations. Since beginning the course in 2016 I have measured various structural features in the Yilgarn, toured the active processing plants throughout western Tasmania, completed Ron Berry's geometalurgy party games, and walked around the active crater of White Island. However, the most enjoyable part has been meeting all the incredible people along this journey and the memories that have been made. If you are considering whether to begin the degree, stop thinking and enrol now!"



6 SITTHINON (GUN) KULTAKSAYOS

Current student,
Master of Economic Geology

Supervisor: Sebastien Meffre

Project title: Provenance and
mineralisation in latest Cambrian
to Silurian sedimentary rocks in
western Tasmania

The main aim of Sitthinnon Kultaksayos' research is to study the provenance, geochronology and tectonic implication of the latest Cambrian to Silurian sedimentary rocks in western Tasmania as well as examine a small deposit hosted within the basal unconformity of this sequence.

Sitthinnon's work has shown that there are some major changes in provenance recorded in the rocks with the Late Cambrian Owen group mainly recording derivation from Mesoproterozoic quartzite switching to a more distal Gondwana provenance in the Pioneer Sandstone and the Eldon Group. He has also shown that the small deposits in the base of the Owen Group are related to hydrothermal activity associated with the Devonian granites.



7 GEORGE MAROA

Current student,
Master of Economic Geology

Supervisor: Robert Scott

Project title: Geology, mineralisation
and genesis of the Bumbo polymetallic
sulphide deposit, Busia-Kakamega
Greenstone Belt, Western Kenya

George Maroa is undertaking the Master of Economic Geology with the financial support of an Australian Awards Scholarship, awarded by DFAT. Additional financial support for his research project is provided by Acacia Exploration Kenya Ltd.

George's research will thoroughly examine geological relationships at the Bumbo polymetallic deposit in western Kenya. The Bumbo Zn-Cu (Ag-Au) deposit is hosted in the Busia-Kakamega Greenstone Belt, the northernmost greenstone belt of the Lake Victoria Goldfields and the Archaean Tanzania Craton. It was discovered and mined for gold on a small scale during the colonial period. More recently, limited drilling between 1997 and 2012 (55 drill holes) has delineated two stratiform lenses of massive- to semi-massive sulfide in a volcano-sedimentary sequence in the metamorphic aureole of a granite. The most recent resource estimate (inferred + indicated) for the Bumbo deposit is 1.58 Moz at 4.5% Zn, 2.08% Cu, 33.8 ppm Ag and 0.56 ppm Au. George's study will involve documenting the nature and structural history of mineralised rocks and the host volcano-sedimentary sequence using outcrop and diamond core, building a 3D geological model of the deposit and assessing the further exploration potential of the area.

"Being my first year here at CODES, I look forward to getting the most exciting and practical training from my Masters course. The fieldwork component in most of the units will enable me to build more confidence and expand my skills and approach to mineral exploration. This is because, apart from looking at the rocks, I will get to meet industry experts who review various exploration methods and challenges."



8 JUAN DIEGO ROJAS LOPEZ

Completed studies end 2018,
Master of Economic Geology

Supervisor: Angela Escolme

Project title: Origin, characteristics and age of mineralisation of the Ollachea orogenic gold deposit, Region Puno, southeastern Peru: Implications for exploration

Juan Diego came to CODES to complete the Master of Economic Geology program, including thesis submission, from Peru where he had previously worked as an exploration geologist on the Ollachea deposit.

The Ollachea deposit, situated in north Region Puno, southeastern Peru, contains >2.4 Moz Au with an average grade of 3.5 g/t Au. Mineralisation is hosted within slates belonging to the Silurian-Devonian Ananea Formation, and locally within metamorphosed igneous dykes and sills.

Juan's studies were funded by a PRONABEC Scholarship. The aims of his project were to document the characteristics of the Ollachea deposit, constrain the age of mineralisation and develop a new genetic model. Juan's meticulous observations, data collection and review indicate that three main paragenetic stages of gold-bearing veins and breccias occur at Ollachea, and gold is predominantly associated with the first stage, with evidence for local remobilisation. Juan submitted his thesis in December 2018; it was described by Rob Scott as "a beautiful example of exactly how to organise and present geological data in a thesis".

"During my studies ... I most enjoyed both the lectures imparted by knowledgeable and passionate professors, and the field trips where ... I had the opportunity to visit numerous world-class ore deposits and a variety of geologic terrains. The lectures and field trips enhanced my knowledge of various mineral deposits and strengthened my skills as an exploration geologist."



9 VICTOR TORRES

Current student,
Master of Economic Geology

Supervisor: David Cooke

Project title: Geology, genesis and exploration implications of Cu-Au mineralised tourmaline breccias pipes at Soledad, central Peru

The Soledad tourmaline breccia complex in the Cordillera Negra of central Peru is the focus of Victor Torres' Masters research thesis. A combination of field mapping, drill core logging, whole rock geochemistry and geochronology will be used to resolve the genesis and exploration implications of the cluster of Cu-Au mineralised tourmaline breccia pipes at Soledad. The project is part of the Aija-Ticapampa Mining District in the Cordillera Negra, a region with a long history of exploration and mining. The district is located 35 km south of the Pierina high sulfidation epithermal gold deposit.

Previous exploration in the Soledad area identified numerous high-grade quartz-tourmaline-sulfide breccia pipes that crop out at surface. The breccia pipes are principally hosted in the thick Calipuy group volcanic rocks, consisting of andesite flows, tuff and dacites. Despite the mineralised breccia pipes being impressive in

terms of grade and vertical extent, previous explorers were focused on a blind mineralised porphyry target inferred to be the source of the breccia mineralisation. The property is now being explored by Chakana Copper Corp, who are testing the economic potential of the breccia pipes. A 25,200-m drill program was initiated in September 2017 to determine the geometry of several previously drilled pipes, determine the true grade profile by drilling across the pipes and define an initial inferred resource on three of the pipes. In June 2019 they are planning to start the second stage of drilling in 10 breccias out of 18 identified so far. Exploration is ongoing and Victor is integrating data from the surface and drilling exploration activities to evaluate the origins and exploration potential of the district.

"I joined this program late last year because of the expertise CODES has in economic geology... the classes, support and feedback we get are exceptional, not only from the teachers, but also from the students participating in the course. Furthermore, I am doing a research thesis on 'Soledad tourmaline breccia' located in Peru and the personal support and facilities for doing this are outstanding. I am really happy to be part of this group of economic geologists!"



Victor Torres pictured in mid-December 2018 examining a mineralised Cu-Au-Ag tourmaline breccia pipe called Bx3 West, one of the 18 identified breccias at the Soledad project, central Peru, which will be drilled in the next program in June 2019.

Location of current and recently completed CODES Masters projects



- | | | |
|---|--------------------------|---|
| 1 | PEERAPONG SRITANGSIRIKUL | ROCKLEY VOLCANICS, NEW SOUTH WALES |
| 2 | CARLOS DIAZ | NORTHERN ECUADOR, SOUTH AMERICA |
| 3 | ARGA FIRMANSYAH | EAST JAVA, INDONESIA |
| 4 | BRENDAN HARDWICK | WESTERN AUSTRALIA |
| 5 | COREY JAGO | NEW SOUTH WALES |
| 6 | SITTHINON KULTAKSAYOS | WESTERN TASMANIA |
| 7 | GEORGE MAROA | WESTERN KENYA, AFRICA |
| 8 | JUAN DIEGO ROJAS LOPEZ | REGION PUNO, SOUTHEASTERN PERU, SOUTH AMERICA |
| 9 | VICTOR TORRES | CENTRAL PERU, SOUTH AMERICA |



Left: Juan Diego Rojas Lopez ready to take a sample of a mafic dyke for zircon U-Pb geochronology at the Ollachea deposit, Peru, January 2018.
Right: George Maroa pictured in 2017 observing a clear andesite-granite contact in Kerebe Prospect located within the Lake-Zone Camp of the West Kenya Project owned by Acacia Exploration.

UPCOMING MASTER OF ECONOMIC GEOLOGY COURSES FOR YOUR DIARY

Once again CODES is running a full complement of short courses in 2019 for Master of Economic Geology students and interested industry participants. The Ores in Magmatic Arcs course – Indonesia short course has just taken place (see report on page 23). But there are several important courses that are still open for applicants. They are:

ORE DEPOSIT GEOCHEMISTRY, HYDROLOGY AND GEOCHRONOLOGY.

This two-week short course (3–14 June) will be based in Hobart and led by CODES Director David Cooke and CODES Associate Professor of Economic Geology Shaun Barker.

FURTHER DETAILS OF HOW TO REGISTER ARE ON THE BACK PAGE OF THIS NEWSLETTER.

ORES IN MAGMATIC ARCS – SOUTH AMERICA.

This two-week course is back by popular demand and will run 11–26 October in Ecuador and Chile. It will be led by CODES Director David Cooke.

GEOMETALLURGY.

This two-week intensive short course will take place 4–15 November based in Hobart and will be led by CODES Postdoctoral Research Fellow Angela Escolme.

For further information about all CODES short courses contact: Robert.Scott@utas.edu.au (Ph: +613 6226 2786).

HONOURS FOR HONOURS

Three Honours students who have just started their courses this year at CODES have been successful in gaining awards to help them with their research and studies. Congratulations to all three!

Johanna van Balen

Honours project: 'Determining the geometallurgical properties of mine tailings at Copper Mines Tasmania: Opportunities for metal recovery'

Johanna was awarded:

- A Governor's Environment Scholarship valued at \$7,500 (awarded by UTAS for students commencing an honours or masters research project in any area with demonstrated relevance to a Tasmanian environmental topic).
- An AusIMM Education Endowment Fund Premium Scholarship valued at \$11,000.

Le Xi K ng

Honours project: 'Geochemical and mineralogical characterisation of tailings: Evaluating the potential for reprocessing the Bobadil Tailings, Rosebery'



Left: Award winners: Honours students Le Xi K ng (Lexi) and Johanna van Balen pictured in the field near Henty Gold Mine at the start of the Honours Exploration Field Skills mapping camp which was held recently. **Right: Absolute gold:** Cameron Foster is looking forward to his Honours year at CODES.



Lexi was awarded:

- A Governor's Environment Scholarship valued at \$7,500 (as above).
- An AusIMM, BHP and EIANZ Environment and Community Award valued at \$3,000 (This award provides financial support to students interested in pursuing a career in the environment and/or community disciplines within the minerals industry.)

Cameron Foster

Honours project: 'Hydrothermal alteration and gold distribution in BIF-hosted gold deposits of the Westralia Mine area (Mount Morgans), W.A.', which is sponsored by Dacian Gold

Cameron was awarded:

- An AusIMM Education Endowment Fund Scholarship valued at \$11,000 and includes access to a mentoring program with an industry professional, substantial recognition and career building opportunities and a one-week intensive field trip to Mt Isa in early July (awarded to a student who displays a passion for the resources sector, strong leadership qualities and a proactive approach to personal and professional development).

SEG CODES Student Chapter hosts Larry Meinert in spades!



Detailed explanation: Students on the SEG Student Chapter's skarn short course gather around Larry Meinert while he explains skarn paragenesis at Trial Harbour on Tasmania's west coast.

The Society of Economic Geologists Student Chapter at CODES hosted a skarn short course led by Dr Larry Meinert (Research Affiliate at Carnegie Institute, Colorado School of Mines and Editor of *Economic Geology*) in early February 2019.

The course was well-attended (by around 25 participants) and very well-received by Honours and postgraduate students, postdoctoral researchers and visiting industry participants. Larry covered the fundamentals of the formation of skarns, associated mineralisation and exploration strategies.

Larry also participated in two field trips to the west and east coasts of Tasmania. The field trips introduced new postgraduate students, researchers and visiting international students to the diverse Tasmanian geology and its mineral deposits. The trip to the west coast was a success, navigating forest fires, road closures and intermittent bad weather, to visit and examine the tourmaline orbicules in the Trial Harbour granites, the Renison tin deposit and the historic Mount Bischoff tin mine and workings.

The east coast trip focused on world-class magmatic-hydrothermal textures in the Devonian granites.

And Dr Larry Meinert, Dr Angela Escolme (CODES-TMVC) and Dr Mark Duffet (Mineral Resources Tasmania) formed a discussion panel at the

monthly Science in the Pub gathering on 7 February. The panel spoke on issues surrounding 'From science to space: Rocks and future mineral resources'. The venue was packed, the discussion well-received and the gathering well-attended by geologists and science enthusiasts alike.



A job well done: L-R: PhD students Tom Schaap, Tristan Wells and Emily Smyk with Larry Meinert, at the post-skarn short course drinks, at which Larry was presented with a bottle of vino to thank him for his sterling efforts.

WHERE ARE THEY NOW?

In the second of our series of regular interviews with former CODES postgraduates, Ned Howard outlines some detailed guidelines for up and coming geologists, and marvels at just how much he really enjoys his work as a geologist.

EARLY FIELDWORK PAYS DIVIDENDS

What is your current job and your work responsibilities?

Principal Technical Geologist within the Discovery Group at Evolution Mining, an Australian mid-tier gold mining company. My role is to provide technical assistance to our exploration teams and lead geoscience initiatives within the Discovery Group.

What are the things you enjoy most about this role?

Thinking and talking about rocks! I really enjoy the creative and problem-solving aspects of mineral geoscience, integrating different types of data, processes and scales.



Top: Colleagues and guides with Ned during fieldwork in southern Sumatra, way back in 2005. **Bottom:** Ned takes a breather during fieldwork in northwestern Ontario, Canada, in 2010.

How did you get there?

After finishing my Honours degree at CODES in 2004, I spent five years with a fantastic group of geologists in Barrick's regional exploration team working around Australia, Indonesia and Papua New Guinea. I then spent a couple of years with technically-focused junior companies in Canada and Australia before joining Evolution Mining six years ago. With Evolution I've mainly been in technical and project generation roles. It's been a fantastic experience getting exposure and having input into the understanding of our deposits and realising new opportunities.

What has been your career highpoint/greatest achievement to date?

What I'm doing now! Getting the opportunity to find new exploration projects for Evolution and now drive our geoscience initiatives across the Discovery Group.

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

I specialised in ore deposits and ore deposit geochemistry at CODES, undertaking my Honours research project looking at short-wave infrared (SWIR) spectral and geochemical zonation at the Henty Gold Mine, Western Tasmania. As soon as I entered the minerals industry, I realised how much of an advantage going through CODES had been to my skills and ability as an economic geologist. It provided an excellent background from which to build on through my career. The skills I gained during my Honours project doing SWIR spectral work have been a real door-opener for the technical roles I've had.



WORDS OF WISDOM FOR UP AND COMING GEOLOGISTS GRADUATING FROM CODES?

- Build your basic geological skills, learn your minerals, understand geological processes (not tick-lists) and how to integrate across datasets and scales.
- Technologies, 3D software and machine learning are tools, not magic. If you don't understand rocks and geological processes, all you will create are pretty fictions that will end up destroying value.
- Don't be too ambitious to rise through the ranks quickly – early on seek to get exposure to different geology, geological roles and ways of doing things.
- Take opportunities to get in the field, work rosters and travel early – it will only get harder as your life progresses and it will pay dividends down the track.
- Question, seek evidence and don't believe what someone says just because of their reputation.

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

The growth of the use of new technologies, 3D visualisation software and the growing recognition of the value of geometallurgy (i.e. the mineral make-up) of ore bodies are all things that are having an increasing impact on the industry. I'm concerned that the level of fundamental geological understanding and time spent in the field seems to be dropping across the industry and the impact this will have as ore deposits get harder to find.

VOYAGE INTO THE DEEP UNCOVERS IMPORTANT FINDS

Just two days after Christmas, on 27 December 2018, a group of intrepid scientists from across the country, led by University of Tasmania's Dr Jo Whittaker (IMAS) and Dr Rebecca Carey (CODES), climbed aboard the *RV Investigator* for a two-week voyage designed to unravel the complex tectonic history of the Tasman Sea.

Other CODES researchers onboard included Dr Karin Orth, Dr Martin Jutzeler, and PhD student Tom Schaap, along with undergraduate Earth Science students Fionnuala Campbell, Stephanie Morrish, Zali Potts and Yun Fann Toh.

The voyage spanned research in the CODES Program 4 areas of Submarine and subaerial volcanism, Sedimentary volcanology, and Magma genesis.

The scientists hope that the detailed dating of rocks collected from the various seamount chains in the Tasman Sea during this voyage will help improve their understanding of the timing of the ocean basin opening between Tasmania and Antarctica, which may have allowed the Antarctic Circumpolar Current to initiate. Such an event would have globally significant geological and climatological consequences.

Setting off from Hobart, the *RV Investigator* steamed into the Tasman Sea with the aim of mapping and sampling the seamounts which litter the ocean floor. Each seamount was mapped in detail by swath bathymetry, and this information



Manganese crusted volcanic conglomerate from the Zeehan Seamount, Tasman Sea, hauled from the ocean onto the *RV Investigator* during the January 2019 research voyage.



CODES researchers aboard the *RV Investigator*: (L–R) Dr Rebecca Carey, Dr Karin Orth and Dr Martin Jutzeler – obviously enjoying their work!

was used to assess the logistics and scientific value of the sampling. With the ideal location and plan of attack settled on, a dredge was lowered from the trawl deck to the ocean floor, thousands of metres below. Up to several hours of nail-biting tension passed with each trawl, as the ship's crew carefully navigated the dredge in an attempt to collect rocks without getting the rig snagged on the sea floor. Once the dredge was recovered, the science team then assessed the haul, decided which samples should be sawn into pieces, described and characterised the samples, and finally bagged them up for later assessment on dry land – all in a carefully constructed workflow which operated

like clockwork. Sixteen sites were dredged, recovering approximately two tonnes of rock, and many more seamounts were mapped and named.

The voyage was greatly enjoyed by all. New Year's Day was brought in with a "rock star" themed dress-up party, while down-time was enjoyed through movies, science presentations and spectacular ocean sunsets.

The *Investigator* returned to Hobart on 10 January 2019, and research is ongoing to discover what secrets the samples collected will reveal.

See page 22 for an update on funding received by Rebecca and Martin for two further research voyages.

RESEARCH FUNDING BOOST FOR JAVIER!

CODES/TMVC PhD student Javier Merrill from Chile has been awarded \$20,000 in research funding by the Minerals Council of Australia (MCA), and will use the money to further his study of geometallurgy in the TMVC's AMIRA P1202 project ('Far field and near-mine footprints – find the next generation of Tier 1 ore deposits').

"Working in a transdisciplinary and applied field such as geometallurgy requires very close collaboration with industry partners and technology providers, to achieve a deep understanding of the problems and challenges that they are facing in the rock processing stages associated with rock characteristics. But at the same time understanding and assessing the opportunities within the current mining workflows for incorporating novel solutions to those challenges", says Javier.



In the money: CODES/TMVC PhD student Javier Merrill receives his \$20,000 Minerals Council of Australia award from the MCA Chairman Vanessa Guthrie. The presentation took place in mid-February during 'Minerals Week', in Canberra.

The MCA award will contribute to conference expenses to help Javier remain at the leading edge of rock characterisation techniques, and it

will allow him a more active role in fieldwork campaigns, thus enhancing collaboration and communication with industry partners.

DIGGING THE DIRT FOR AMD TREATMENT IN TASMANIA

Annah Moyo joined CODES in late 2018 and is working with David Cooke in Theme 3 of the TMVC Hub; she originally started her research with Anita Parbhakar-Fox, who has recently moved to the W.H. Bryan Mining & Geology Research Centre at the University of Queensland.

Annah hails from the University of Cape Town where she obtained her Masters in chemical engineering looking at the geoenvironmental properties of coal waste. Annah's PhD research is supported by Mineral Resources Tasmania, and will focus on the remediation of legacy mine sites in Tasmania. Specifically, Annah will be investigating at laboratory scale the applicability of industrial waste as a remedy for acid mine drainage (AMD) treatment; she has already sourced a diverse range of mine waste (from sites including Balfour, Zeehan and Endurance) and industrial waste materials (including red muds, green liquor dregs and a range of shells) from across the state.

Annah will be conducting static and kinetic test work on these materials and will determine opportunities for repurposing waste with an opportunity to set up a field trial depending on the results.



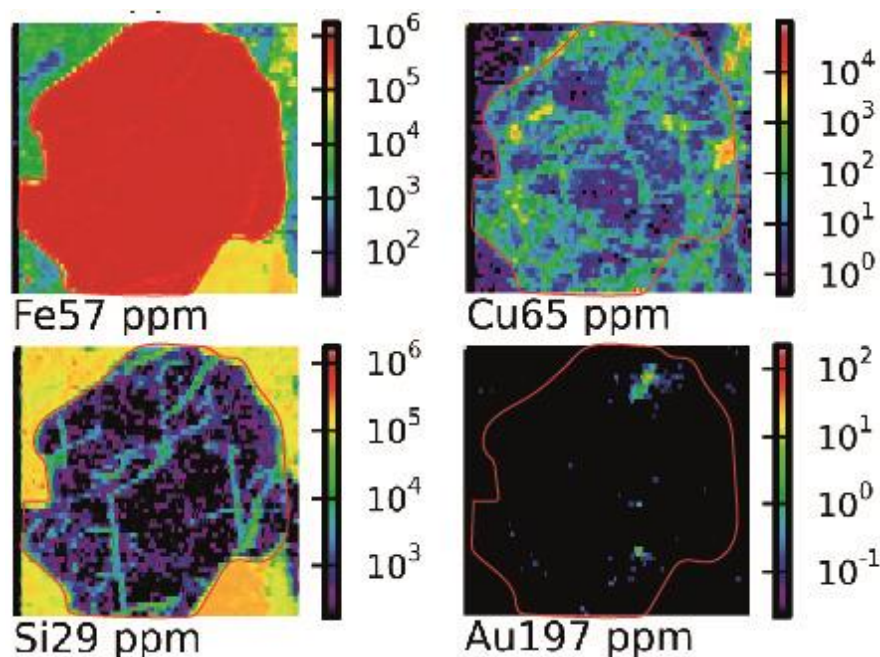
Annah Moyo hard at work in January 2019 at the Zeehan smelter site gathering samples of waste for her PhD, which will examine the remediation of legacy mine sites in Tasmania.

FIRST RESULTS ARE IN AS THE NORTHWEST QUEENSLAND JOINT PROJECT RAMPS UP

Associate Professor Shaun Barker reveals what the Northwest Queensland project has discovered so far, and what's planned next.

The new research project 'Mineral geochemistry vectoring: Uncovering Northwest Queensland's hidden potential', part of the Strategic Resources Exploration Program funded through the Geological Survey of Queensland, has recently ramped up with the arrival of postdoctoral research fellow, Jonathan Cloutier, who will be working on this project alongside Jeff Steadman, Shaun Barker, David Cooke, Peter McGoldrick and Rob Scott. The project aims to expand the 'footprint' of precious and base metal ore deposits in Northwest Queensland to aid exploration efforts, through the application of mineral chemistry. In particular, the project aims to characterise the signature and extent of the hydrothermal alteration halo which surrounds deposits through mineral chemistry to aid exploration efforts.

The first results from this project have recently been delivered; these focus on the trace element chemistry of pyrite in the Lady Loretta Zn-Pb-Ag deposit, and the chemistry of magnetite and pyrite in samples from within and above the SWAN IOCG deposit (work which is being carried out in collaboration with the University of Queensland and CSIRO). We have recently begun collecting mineral chemistry data on magnetite and pyrite from the Starra,



SWAN IOCG analysis: Laser ablation maps of magnetite from sample SWN037C, showing isotopes of iron, silicon, copper and gold. The red outline on the Si29, Cu65 and Au197 maps shows the approximate extent of magnetite (defined by the ^{57}Fe isotope) on each map. Note that elevated Cu and Au are present within the fractured areas defined by elevated Si, indicating that Cu and Au were introduced after magnetite formed.

Osborne and Merlin deposits, with the aim of comparing the mineral chemistry characteristics of different IOCG deposits in Northwest Queensland. Collectively, this project will deliver the first systematic assessment of the alteration mineral chemistry 'fingerprints' from a series of IOCG and sediment-hosted ore deposits, and will test how mineral chemistry can best be used to assist mineral exploration in the Mount Isa district.

A workshop is being held by the Geological Survey of Queensland in Mount Isa in late March, and the CODES research team will present mineral chemistry results, while researchers from CSIRO, James Cook University and the University of Queensland will be presenting research findings from the broader Strategic Resources Exploration Program to the mineral exploration community.

Order your CODES work shirts here



The CODES SEG Student Chapter is now taking orders for the CODES

hi-vis work shirts, which were previously highly popular with students and staff alike.

Examples of the shirts can be found on the following links; they will be embroidered with your name and the CODES logo:

- ZW720 (women's rugged cooling taped hi-vis spliced shirt) <https://www.syzmik.com/au/products/zw720>
- ZW129 (men's rugged cooling taped hi-vis spliced shirt) <https://www.syzmik.com/au/products/zw129>

Cost per shirt is \$70 which is slightly cheaper than cost. If you would like a shirt, please email your details (first name, surname, size, number required, email address) to: segutaschapter@gmail.com

JONATHAN CLOUTIER WILL ENHANCE CODES RESEARCH IN NORTHWEST QUEENSLAND

Dr Jonathan Cloutier joined CODES at the beginning of February in his new role as a Postdoctoral Research Fellow – Geochemical halos to Proterozoic sediment-hosted ore deposits. He is working in Program 3 with Shaun Barker and Jeff Steadman on the 'Mineral geochemistry vectoring: Uncovering Northwest Queensland's hidden potential' project. Here he outlines his interest in precious metals, and what he's looking forward to in his new role.

I obtained a PhD in economic geology from Queen's University, Canada, in 2009. My PhD research project focused on determining the critical differences between unconformity-related uranium mineralised and barren alteration systems of the Athabasca Basin, Canada. After completing my PhD, I worked for CanAlaska Uranium Ltd, a junior exploration company in Saskatchewan, Canada, until I joined CSIRO in November 2010 to work as an embedded researcher at the Gold Fields St Ives gold mines in Western Australia. My research there focused on orogenic gold deposits using a multiscale approach.

In 2013, I moved back to Canada where I undertook postdoctoral research at the Memorial University of Newfoundland, focusing on the lithological, structural, chemical and hyperspectral reconstruction of VMS deposits. I moved to the University of St Andrews in Scotland in August 2015 as a Teaching and Research Fellow and was promoted to Lecturer in December 2016 with the aim of creating a new taught Masters program in mineral resources. The program started in September 2017 and is still running today.

During my time at St Andrews, I taught several courses, such as magmatic-related ore deposits, hydrothermal

ore deposits, mineral exploration and 3D geological modelling. I also led several field trips focused on field mapping, mineral exploration and acid mine drainage (Rio Tinto) in Scotland and Spain. Having moved to CODES in February to start a new research position on sedimentary-hosted and IOCG deposits, I am excited to join a team with such a reputation and look forward to getting to know everyone.

My main research interests are in the areas of geochemistry, isotope geochemistry, economic geology, petrology, mineralogy and hyperspectral geology. In particular, my research aims to increase our understanding of the genesis and geodynamic setting of ore deposits using a multidisciplinary and multi-scale approach, supported by fieldwork and various high-precision analytical techniques. In addition to the immediate ore deposit environment, my research also focuses on weakly mineralised and barren alteration areas, as understanding these systems is key to understanding the processes leading to ore deposition, but also why some areas are not endowed with mineralisation. I am currently undertaking research on sedimentary-hosted stratiform Cu, VMS, orogenic gold, and Cu-Mo porphyry deposits.



Jonathan Cloutier, who joined CODES in February, pictured at the Rio Tinto VMS deposit in Spain, taken during his time at the University of St Andrews.

JONATHAN ATTENDS AUSTRALIA–FRANCE TALKS

Jonathan Cloutier attended the workshop on Materials-Energy-Mining at the 2019 Australia–France Joint Science and Innovation Meeting in Canberra on 27 February. The main objectives of the workshop were to discuss high-level priorities that could benefit Australia and France and foster academic and industrial collaborations.

Five broad themes were discussed:

- 1 Materials for energy generation;
- 2 Novel methods for synthetic fuels;
- 3 Materials for energy storage;
- 4 System integration standards; and
- 5 Mining.

From the mining theme, the discussion focused on increasing the sustainability of mining by reducing its environmental impact and the role of data analytics in exploration and the mines of the future (Mining 4.0).

THE VISITORS' BOOK

An important aspect of CODES' ability to stay at 'the top of the tree' is ensuring that researchers from other institutions who are at the cutting edge of their fields visit the department and exchange ideas and collaborative plans. Staff and students alike at CODES gain immensely from these visits, and visitors too take away new learnings. Here Professor Leonid Danyushevsky gives a run-down of recent key visits.

A delegation from the National Research Center for Geoanalysis, Chinese Academy of Geological Sciences, Beijing, (**Professor Yabin Qi, Professor Wenjun Qu, Dr Keyan Tan and Dr Limin Zhou**) visited CODES and the CODES Analytical Laboratories on 21 November 2018, to discuss possible collaboration in the field of micro-analysis of geological materials.

During the visit, Leonid Danyushevsky made a presentation describing current research projects within CODES and the analytical capabilities within CODES Analytical Laboratories. Dr Limin Zhou presented on the recent developments in Re/Os isotopic analysis at NRCGA-CAGS.

PhD student Rocky Barker from the University of Waikato in New Zealand visited CODES on 3 December 2018 and presented a seminar on his research project 'Hyperspectral Mineral Characterization From μ -XRF and Machine Learning: Applications to Carlin-Type Gold Deposits', in which Rocky is integrating different analytical technologies to provide enhanced interpretation of infrared spectral data from fine-grained sedimentary rocks. Rocky is co-supervised by CODES staff member Dr Shaun Barker.

Dr David Clases, Postdoctoral Fellow within the Elemental Bio-Imaging Facility in the School of Mathematical and Physical Sciences, University of Technology Sydney, visited CODES Analytical Laboratories on 4–8 December 2018 to perform



Exchange of ideas: Dr Limin Zhou from the National Research Center for Geoanalysis at the Chinese Academy of Geological Sciences in Beijing, gave a presentation to CODES staff and students in late November last year along with our own Professor Leonid Danyushevsky.

imaging of trace elements in biological tissues using LA-ICP-TOF-MS. This is part of a collaboration between CODES Analytical Laboratories and the UTS Bio-Imaging Facility aimed at developing imaging applications using TOF-MS.

Dr Steve Barnes, Science Leader at CSIRO Mineral Resources in Perth, visited CODES on 5 December 2018. Steve presented a seminar on komatiites of the east Yilgarn Large Igneous Province and met CODES researchers and students.

Sefton Darby, Associate Director in KPMG Banarra, visited CODES on 12 December 2018 and presented a seminar entitled 'How not to lose friends and alienate people – the challenge of (re) building social licence in the mining sector'. Sefton Darby looked at the challenges around declining social licence, and identified the kinds of individual, company and industry-wide changes that need to happen in order to start rebuilding trust.



Associate Professor Nathan Daczko spoke at CODES on 31 January; his talk was entitled 'The recognition of melt

pathways in the crust: A view from the base of a magmatic arc'. He discussed the different modes of melt transfer recognised in the lower crustal sections of the well-exposed Mesozoic magmatic arc of Fiordland, New Zealand.

In early February **Dr Larry Meinert** visited CODES and presented a skarn short course, and participated in two field trips within Tasmania – *see full report on page 10*.




Catherine Reynolds, project geologist from Anglo American, visited CODES Analytical Laboratories during February to participate in LA-ICP-MS, EPMA and SEM analyses of zircon and apatite minerals to determine their trace element concentrations and age.

Richard Chopping from the Geological Survey of Western Australia was a guest speaker at the ASEG/GSA/AIG Joint Technical Meeting on 28 February. Richard presented a talk highlighting a new book he co-authored with Brian Kennett and Richard Blewitt: *The Australian Continent: A Geophysical Synthesis*. A digital version of the book is available as a free download from ANU press.



CHANGING FACES

Three more PhDs join the ranks of CODES

PHD STUDENT	START DATE	PROGRAM	PROJECT TOPIC
 Annah Moyo	December 2018	TVMC, Theme 3, working with David Cooke	Controlling acid and metalliferous drainage at legacy sites in Tasmania using industrial waste materials
 Stewart Jackson	December 2018	Program 6, working with Mike Roach and Gerrit Olivier (Institute of Mine Seismology)	Integrating passive and active methods of seismic imaging for structural stability of tailings dams
 Xin Ni Seow	March 2019	Program 1, working with Lejun Zhang, in TMVC, Theme 1	Geochemistry, mechanism of formation and mineral exploration implications of alunite supergroup minerals

New staff member for CODES

Dr Jonathan Cloutier, who hails from Canada, started in his new position at the beginning of February as a Postdoctoral Research Fellow working on geochemical halos to Proterozoic sediment-hosted ore deposits. He will be working in Program 3 on the 'Mineral geochemistry vectoring: Uncovering Northwest Queensland's hidden potential' project.



NEW SEG COMMITTEE SETTLES IN

Elections took place in December for the Society of Economic Geologists CODES Student Chapter office bearers, and the following PhD students were voted into office:

President:	Tristan Wells
Vice President:	Emily Smyk
Treasurer:	Tom Schaap
Secretary:	Kyle Eastman
General Committee members:	Adam Abersteiner and Matt Ferguson

To contact the CODES SEG Student Chapter you can use:

✉ Email: segutaschapter@gmail.com

🐦 Twitter: @segscodes

📘 Facebook: <https://www.facebook.com/segscodes/>



FOUR CODES RESEARCHERS LEAVE THIS ISLAND HOME

The early months of 2019 have seen the departure of four key CODES staff who have gone on to further their careers in pastures new both here and overseas...here they give a summary of their time at CODES and where they are headed. We thank these two impressive husband-and-wife teams for their hard work, dedication and for the valuable contribution they have made to CODES.

ANITA PARBHAKAR-FOX

I arrived at CODES in 2006 to start work as a research assistant in the AMIRA P843 GeM (2006–2007) project where I was given the unique opportunity to compile a literature review on environmental waste management practices in the mining industry and from this, select an area in which to pursue my PhD research. I chose to research acid and metalliferous drainage (AMD) prediction methods and proposed ways in which mineralogical tools and textural assessments could be effectively used to enhance predictions therefore reducing long-term environmental risks.

This research continued into my first postdoc with CRC ORE (2012–2015) but during my second contract with the ARC TMVC Hub (2015–2019) I also started working at the opposite end of the mining value chain dealing with mine closure and rehabilitation, with a

strong focus on the geometallurgical characterisation of mine waste to determine remining potential.

I have been fortunate to work with many different stakeholders: industry, local government, even MONA! But the real joy I had was working with a range of students. Seeing them share in my passion for wanting to improve the management of mine waste gives real hope that the future of mining will have stronger green credentials. It has been a great place to start my career and I will continue with CODES in an adjunct role, in which I will be able to establish collaborations between the two institutions.

I am looking forward to my new role as senior research fellow in geometallurgy/environmental geochemistry at the W.H. Bryan Mining & Geology Research Centre at the University of Queensland.

NATHAN FOX

I joined CODES in October 2006 to carry out my PhD research under the supervision of Anthony Harris and Dave Cooke. My PhD project evaluated the controls on mineralisation and alteration at the Cadia East porphyry copper gold system, in New South Wales and offered an ideal combination of site-based fieldwork and laboratory analysis.

After completing my PhD thesis, I worked as a postdoctoral research fellow on a range of projects at CODES including the AMIRA P1060 enhanced geochemical targeting in magmatic-hydrothermal systems (2011–2014), CRC ORE Environmental Indicators (2015–2016) and most recently the CRC ORE geometallurgical controls on grade by size fractionation (2017–2019) project.

During my time at CODES I had the opportunity to expand my research interests from fundamental ore deposit



Anita Parbhakar-Fox: The challenge remains to improve water quality in Queenstown, western Tasmania; Anita hopes to continue working on this problem in collaboration with UTAS.



Nathan Fox steps out in Sweden while visiting the Laver deposit at Boliden in early 2017; the visit was part of a project looking into waste rock domaining at the Laver deposit.

geology and exploration geology into applied mineralogy and geometallurgy. I greatly enjoyed co-supervising postgraduate and Honours students at CODES who have worked in the fields of magmatic-hydrothermal systems, geoenvironmental mineralogy and geometallurgy. In February 2019 I moved on to the W.H. Bryan Mining and Geology Research Centre, part of the Sustainable Minerals Institute at the University of Queensland, where I will continue research in the fields of ore deposit geology and geometallurgy.

IRINA ZHUKOVA

On 1 February 2019 it was exactly five years since I joined the CODES team. I came to CODES after completion of my PhD in experimental petrology at the Research School of Earth Sciences, ANU. During my years at CODES I have worked on several ARC- and industry-funded projects. Hundreds of analyses of pyrite and data reduction for the ARC 'Trace elements in past oceans' project, project management and data coordination as well as mineral chemistry and isotopic analyses for the ARC Linkage 'Ore deposits and tectonics of the Lachlan Orogen' project and thousands of zircons for commercial



Irina Zhukova hard at work in the lab; she has carried out thousands of analyses during her time at CODES.

U/Pb geochronology have all given me valuable experience in analytical chemistry and data processing.

I was extremely lucky not only to work alongside outstanding researchers at CODES but also to find lifetime friends here whose impact on my life cannot

be overestimated. In March I took up an appointment at the China University of Geosciences at Wuhan, as an Associate Professor. As much as I am excited to move to the next level of my career, I am also sad to leave this magnificent island and especially its wonderful people. All will always remain in my heart.



Sasha Stepanov in one of the CODES laboratories carrying out a sample exchange for LA-ICP-MS.

SASHA STEPANOV

I have worked at UTAS since November 2012, and am moving to a research position at the China University of Geosciences (CUG) at Wuhan in China. I completed my PhD project at the ANU on the geochemistry of trace elements in metamorphic rocks, and came to CODES full of ideas on the role of minor minerals on the fractionation of elements. I managed to develop a new theory of the formation of deposits of the strategic rare metal Ta (tantalum). Meanwhile, working in the ICP-MS lab I have reduced a lot of data and gained priceless experience in many types of analytical work. It is this combination of skills and experience that gave me the opportunity to win a position as a Professor at CUG, and to continue the development of my career. I am looking forward to starting a new chapter of my life. However, the amazing island of Tasmania will always remain in my memory.

CODES Christmas frivolity in the frame



Voters' choice: Jodi Fox's winning photograph in the 'Fieldwork' category of the inaugural CODES Christmas photo competition: 'Commitment to accessing outcrop – Professor Kano leads the way'. She took this picture at Shimane, Japan, in August 2018 while attending the IAVCEI Commission on Submarine Volcanism Field Workshop.



PhD student Tristan Wells receives his prize for the best photo in the the 'Outreach' category.

It seems like a long while ago now...but the inaugural CODES Christmas photo competition, which was run to coincide with the CODES Christmas drinks on 20 December last year, garnered a respectable number of entries, many of which will be considered for inclusion in the 2018 CODES annual report.

There was a buzz in the room as the winners in the eight categories were announced, and many people resolved to enter an image or two next time around after having seen the long row of Tasmanian wines on offer as prizes – and the kudos extended to the winners. There were a few teething problems with the judging arrangements, which we will iron out for next time. We look forward to receiving more great entries from you all at Christmas this year!

Thank you to everyone who entered.

To view all the winning photos, go to:
<http://www.utas.edu.au/codes/photo-comp>

After what seemed like a bevy of beverage-fests at the end of 2018, the CODES Christmas drinks rounded them all off. Children were happy with the magician, adults enjoyed the drinks, eats and company, and prize winners in the photo competition savoured their Tasmanian wine.



Lejun Zhang was very pleased with that bottle of Josef Chromy – for best photo in the 'Industry participants' category.

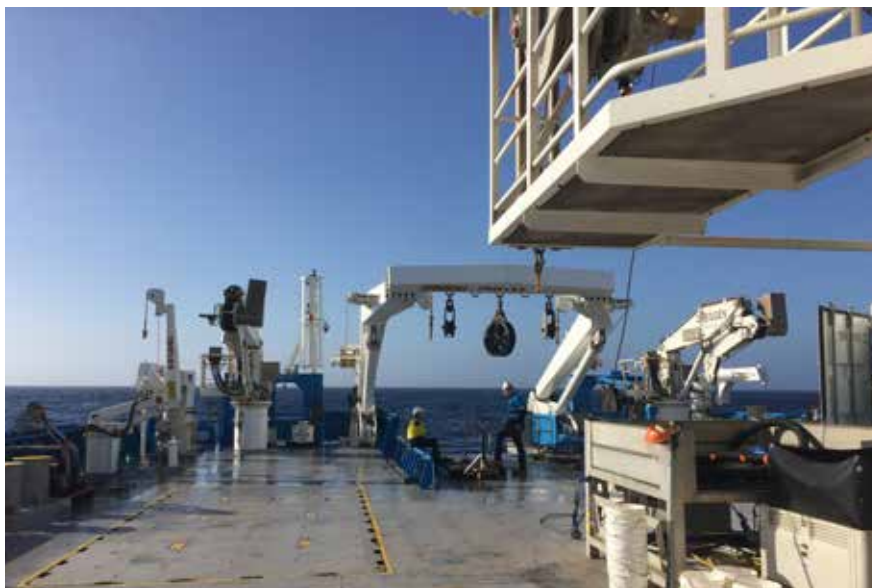
Top: Fashions on the field: L-R Angela Escolme, Josh Phillips, Shawn Hood and Ayesha Ahmed. Obviously, they get the prize for dressing up, so it was a pity we didn't actually have one. **Middle:** A huge number of pizzas and sundry Christmas comestibles were consumed during the proceedings...thanks to Jane Higgins for organising the eats. **Bottom:** CODES offspring (and some parents) were enthralled by Melinda the balloon lady!

SUCCESSFUL SHIP-TIME PROPOSALS DEMONSTRATE CODES' STANDING IN THE WORLD OF VOLCANOLOGY

The CSIRO's Marine National Facility has recently announced successful proposals for ship-time on Australia's scientific research vessel – the *RV Investigator*. Dr Rebecca Carey and Dr Martin Jutzeler were both successful in gaining ship-time for 2020, demonstrating CODES' significant research profile in the field of volcanology.

Rebecca's proposal is focused on the recovery of biological communities and the hydrothermal systems of Havre volcano, Kermadec Arc – the site of a large magnitude submarine caldera eruption in 2012. This project is highly multidisciplinary and includes an internationally renowned group of scientists from New Zealand, Japan, Australia and the USA, and the use of a robotic vehicle. Rebecca will be the Chief Scientist, and will spend 30 days at sea in September–October 2020, which represents a \$3 million in-kind contribution to research conducted at CODES and other institutions. The voyage also represents an opportunity for UTAS undergraduates to come to sea and learn about the interrelationships between volcanoes and the biosphere.

Martin's proposal is focused on three large silicic caldera volcanoes also in the Kermadec Arc (Havre, Macauley, Healy), and will use the new



Huge catch: CODES' researchers are looking forward to more ship-time on the *RV Investigator*.

multichannel seismic reflection and sediment coring equipment on board the *RV Investigator*. This project is focused on elucidating the architecture of volcanoes on the modern seafloor; in particular it is focused on the dynamics and footprint of large-volume and potentially caldera-forming events from these volcanoes. This research includes high-profile international partners from the USA, New Zealand and Germany. Martin and Rebecca are the Chief and Deputy

Chief Scientists respectively on this three-week voyage, which will take place between October and November 2020. The investment by the CSIRO is ~\$3 million in this research. UTAS students will also have the opportunity to be involved in this voyage, and to learn about the integration of geophysical and geological data to address fundamental questions about modern and ancient volcanic architectures, the style of submarine explosive eruptions, and their tsunamigenic potential.

CODES stands tall at premier world mining convention in Canada

The PDAC 2019 convention was held in Toronto, Canada, from March 2–6. CODES was represented heavily by current and former staff members, as well as current and former graduate students who have gone on to have successful careers around the world in the mineral exploration and mining industry – the CODES alumni are truly remarkable and reflect the enormous contribution that CODES has made to research and training in the mineral resources sector over the past 30 years.

Associate Professor Shaun Barker attended PDAC in his role as the Society of Economic Geology Publications Board chair, as well as CODES faculty member. A number of meetings were held with representatives of the mining industry from Australia and around the world, on topics including current and future research projects, new and emerging analytical technologies, geoscience education and training, and public outreach.

More broadly, Tasmania was ably represented by Mineral Resources Tasmania, with the Australian Minerals exhibit receiving many visitors over the four days of the exhibition. Over 25,000 people were expected to attend PDAC overall from the mineral resources sector.



Popular: The Australian Minerals exhibit at the Prospectors & Developers Association of Canada (PDAC) 2019 convention; Shaun Barker attended as a CODES faculty member and chair of the SEG Publications Board.

ON THE GROUND IN INDONESIA

CODES/TMVC Research Fellow Lejun Zhang reports from Lombok, where he is co-leading a Masters short course...



In ore: Participants in the *Ores in Magmatic Arcs – Indonesia* Masters short course pictured in the open pit of the Batu Hijau porphyry deposit, Sumbawa, Indonesia, where they were undertaking Anaconda open pit mapping.

In early March, the highly popular two-week *Ores in Magmatic Arcs – Indonesia* short course for our Master of Economic Geology students and other interested industry participants and academics commenced on Lombok island in Indonesia. Sixteen Masters students and 13 other participants are attending the course, led by CODES staff Lejun Zhang, David Cooke, Noel White and invited presenters Adi Maryono, Iryanto Rompo and Rachel Harrison.

This course has a strong focus on field observations and hands-on practical skills, supported by an understanding of theoretical aspects. The full spectrum of deposits in magmatic arc settings is being covered, including giant porphyry Cu-Au deposits (Batu Hijau, Elang, Tumpangpitu), modern hydrothermal systems on an active volcano (Mt Ijen), and several lithocap, diatreme breccia, high sulfidation-porphyry projects on Lombok. In addition to site visits, participants also have the opportunity to spend

half a day learning and applying the Anaconda open pit mapping method inside the Batu Hijau open pit.

During the trip, Masters students are presenting a series of talks they had prepared on their literature review topics and are working in groups of four doing a deposit evaluation exercise. There is great enthusiasm amongst the participants for learning about the amazing ore deposits of the Sunda-Banda arc, and also for enjoying the wonderful hospitality and culture of Indonesia.

More CODES students are crowned!



In December last year three more CODES students received their research higher degrees. Subira Sharma (left), with CODES Director Professor David Cooke, received her PhD following her research into the Cloncurry fold belt in Queensland.



Indrani Mukherjee and Eyob Andemeskel are pictured together with their supervisors. Indrani's PhD project was 'Pyrite trace element chemistry of black shales of the "boring billion" period'. And Eyob Andemeskel graduated with a Master of Science after researching the Rosebery Group on Tasmania's west coast. Indrani and Eyob are flanked here by their supervisors. L-R: Dr David Selley, Indrani Mukherjee, Eyob Andemeskel, Dr Rebecca Carey, Professor David Cooke and (at front) Emeritus Professor Ross Large.

MASTER OF ECONOMIC GEOLOGY SHORT COURSE ORE DEPOSIT GEOCHEMISTRY, HYDROLOGY AND GEOCHRONOLOGY

3–14 JUNE 2019

In June, as part of the Master of Economic Geology program, CODES is pleased to again be offering the two-week intensive short course Ore Deposit Geochemistry, Hydrology and Geochronology. One-off industry participants and other students are also invited to attend.

The short course provides an up-to-date review of the theory and practice of geochemistry, hydrology and geochronology as applied in mineral exploration and studies of ore deposit genesis. The first week begins with two days on the basic principles of ore fluid chemistry, metal transport and deposition, hydrology and fluid-rock interaction, lithogeochemistry and geochemical mass-balance. This is followed by two days on granite geochemistry and the controls on magma composition and metallogeny, and a full-day workshop on the use of exploration geochemical data for mapping and interpreting ore-related hydrothermal systems. The first week concludes with a full day on the theory and application of geochronology in studies of ore deposit genesis.

The second week covers advanced geochemical exploration techniques, including stable isotope geochemistry, the application of pyrite trace element composition to mineral exploration (using samples provided by short course participants), assessment of magma fertility in magmatic arcs, and mineral chemistry vectoring in porphyry and epithermal environments. Guest presenter, Dr Poul Emsbo from the USGS will also present some of his exciting recent work on the fluid and metal budgets of sedimentary-exhalative ore systems and their apparent impact on ocean chemistry.

COURSE PRESENTERS

Invited Speakers

Phil Blevin is the Leader of Mineral Systems at the Geological Survey of NSW. He has extensive expertise in the relationships between igneous geochemistry and metallogenesis in eastern Australia.

Poul Emsbo is a Research Geologist at the USGS Geology, Geophysics, and Geochemistry Science Center in Denver, Colorado. His research expertise includes the genesis and geochemical and isotopic signatures of a range of sediment-hosted and sedimentary exhalative ore deposits, and metal transport in brines and hydrocarbons.

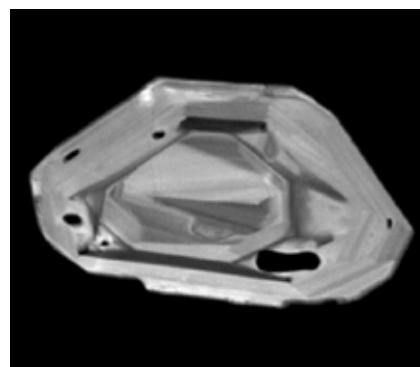
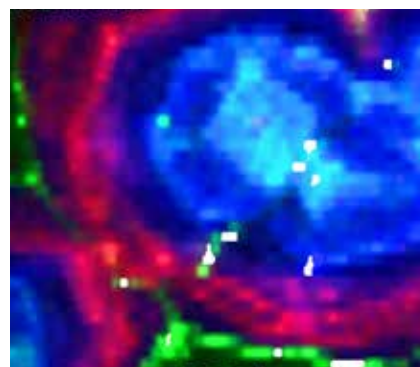
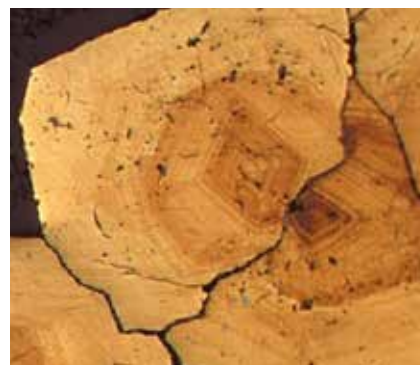
Scott Halley is a minerals industry consultant specialising in exploration geochemistry, and in particular, the use of multi-element ICP geochemistry and SWIR analysis to map far-field expressions and alteration mineral zonation patterns around hydrothermal systems.

Nick Oliver is Principal and Consultant at HCOV Global. He specialises in combining structural and geochemical approaches to understanding ore deposits and their associated hydrothermal systems.

Lesley Wyborn is an Adjunct Fellow at the National Computational Infrastructure Facility and Research School of Earth Sciences, ANU. She is a specialist in Proterozoic granite geochemistry and metallogeny, and information systems.

CODES Presenters

Mike Baker, Shaun Barker, Ron Berry, David Cooke, Leonid Danyushevsky, Sebastien Meffre, Paul Olin, Robert Scott, Jeff Steadman, Lejun Zhang



A detailed flyer covering the program, costs and payment options will be available very soon on the CODES website: www.utas.edu.au/codes

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