New porphyry project expands the toolbox

A new project has been launched that builds on AMIRA P765A, often referred to as the explorer’s toolbox for porphyry and epithermal districts, while branching out into essential new areas of study.

AMIRA P1060, Enhanced Geochemical Targeting in Magmatic-Hydrothermal Systems, builds on the P765A research by augmenting this toolbox through a variety of enhancements and new developments. The overall aim is the recognition, definition and discrimination of ore bodies using mineral-specific pathfinder elements. This encompasses a focus on exploration in lithocaps, including methods that target high grade ore zones, determine the level of erosion and likely degree of telescoping, and discriminate barren or weakly mineralised areas. The team will also further develop...

Project leaders Dave Cooke (left) and Bruce Gemmell (right) with team member Huayong Chen at the Cerro Casale porphyry Au-Cu deposit, which is likely to be a key case study site in the new project.

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CRC bid provides opportunities for SMEs

CODES is looking to expand its engagement with small to medium enterprises (SMEs), including junior producers and explorers, as part of its bid to become a Co-operative Research Centre (CRC).

CODES became an Australian Research Council (ARC) Centre of Excellence (CoE) in 2005, and later it successfully applied for an extension of this funding model. This took its tenure as a CoE to eight years, which is the maximum period allowed under ARC rules. The natural progression beyond that point is to become a CRC, which facilitates commercialisation of research outcomes and encourages a higher level of involvement with SMEs.

Planning for the CRC commenced in May 2010 and the application was submitted on the 1st of July this year. So far, CODES has signed collaborative agreements with 11 major mining companies, 7 SMEs* and 3 State Geological Surveys. The main external research institute involved in the bid is the highly regarded Sustainable Minerals Institute at the University of Queensland. Together with CODES/UTAS, they are known as an Essential Partner.

“CODES has evolved significantly, and as part of that process our collaborations with mining companies have increased substantially. We have successfully built a team of truly world-class researchers with a wealth of knowledge and experience, and a number of organisations have benefited over the years by being able to tap into this resource, while being able to tailor research projects to meet their individual requirements. The CRC model will enable us to expand our collaborators to a wider group of research institutions and companies, including a broader range of junior explorers and producers who will be able to leverage off our resources in an extremely cost effective manner,” says Director, Professor Ross Large.

The range of collaborative research initiatives proposed for the CRC will enable mining companies to benefit from improved geochemical and geophysical detection techniques that focus on gathering key information early, so that deposits are discovered quicker and at less cost – ideally by reducing the amount of drilling required. It also helps them to characterise ore bodies at an early stage, allowing them to establish what problems may lie ahead, and whether the deposit is worth mining. These outputs are particularly relevant to junior exploration companies that may not have the resources or expertise to conduct major characterisation studies. These are just examples of the many benefits miners can receive from a range of projects that cover a wide spectrum of the geosciences from genesis, detection and early characterisation, through to processing and post-mine environmental remediation. These are underpinned by a comprehensive suite of technology-based micro-analysis and software initiatives that form an integral part of all the programs. Also inherent to all the programs is the Centre’s renowned education activities, which benefit mining companies in a variety of ways including specially tailored short courses, workshops, on-site training programs, postgraduate project work, and having first call on a steady stream of the world’s finest geoscience graduates.

“With our increasing focus on end-user driven outcomes, applying to become a CRC is seen as a natural step in our evolution, and we are excited by the opportunities that lie ahead,” says Large. CODES’ application was one of 26 submitted on 1 July, with those successful in progressing to the interview stage expected to be announced by the end of August.

For more information on collaboration opportunities, for companies large and small, you can contact Ross Large on +61 3 6226 2472 or ross.large@utas.edu.au

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* Note: In terms of the CRC, an SME is classed as a company with less than 200 employees and a market capitalisation of less than $500 million.
Respected environmental geochemist, Bernd Lottermoser, has joined the School of Earth Sciences under the UTAS New Stars Program. Bernd’s initial work with CODES is on the GeM III project, where he will play a key role in developing Theme 1 – predictive environmental indices, and linking its activities with the other themes within the project.

A research team has been built around Bernd within this theme, which aims to develop more cost-efficient small-scale testing and modelling to provide predictive indices for environmental attributes, mainly in the area of propensity for dust generation and splosion; characterisation of texture-related acid base reactions; and provision of new and more effective micro-analytical technologies to map deposition of deleterious and harmful trace elements, with an emphasis on secondary mobility and bioavailability.

The team will also build on its early success at gold mines in Queensland, where they are continuing to focus on combining mineralogical and textural data with geochemical assays to establish more realistic characterisation of rocks in regard to acid generation. By combining element and mineral mapping results, they believe they will be able to predict the release of deleterious elements based on the solubility of the host minerals.

Bernd comes with an impressive CV that spans a career encompassing work in the mining industry, teaching at prestigious universities in Germany, the UK and Australia. His exceptional research record has been recognised by the awarding of a Humboldt Research Fellowship in Germany, a European Union Erasmus Mundus Fellowship, and the Australian Government’s Endeavour Executive Award and Michael Daly Award for Excellence in Science Communication. He has also authored and co-authored over 150 publications in various areas of the earth sciences, with a particular focus on the environmental geochemistry of mine sites. His seminal textbook entitled Mine Water: – Characterisation, Treatment, and Environmental Impacts is used widely around the world, and has even been used in legal cases presented in the Supreme Court of the United States. This acclaimed publication is now in its third edition, with plans for it to be translated into other languages.

His international reputation has led to invitations to be a member of various international scientific bodies, including the committee for the forthcoming International Conference on Uranium Mining and Hydrogeology in Germany. In addition, he is on the editorial boards of a number highly rated journals, including Geochemistry: Exploration, Environment, Analysis, Environmental Earth Sciences; and the Australian Journal of Earth Sciences.

Signature publication launched

There is a new addition to CODES’ popular range of geological publications. Geophysical signatures of copper-gold porphyry and epithermal gold deposits, and implications for exploration, written by experienced geophysicist Terence (Terry) Hoschke, outlines and discusses the geophysical data from a number of porphyry and epithermal deposits from the Pacific Rim, including Bataclan, Elang, Grabberg, Alumina, Martabe, Yanacocha, Pairings and Waihi.

The publication is considered essential reading for anyone involved in porphyry or epithermal exploration or seeking a comprehensive update on the current state of knowledge in this field. For details on the full range of CODES publications, please visit our website at: www.codes.utas.edu.au

Research broadens in SE Asia

A new extension project is set to commence in Southeast Asia that builds on previous work in the region, while expanding the research in terms of its geographical footprint and geological scope.

GIS studies of the region were conducted from 1992 to 1999, which led to an ARC Linkage Project that was completed in 2007. The Loi Le Project was superseded in 2008 by the original Ore Deposits of Southeast Asia Project, funded by CODES and industry sponsors, broadening the research to include the Triung Son Fold Belt, in Vietnam and Laos, related to the formation of the Paleo-Tethys Ocean realms. However, this extension to that latter project widens the scope of the research even further to encompass the tectonic and metamorphic frameworks of a much larger part of the Southeast Asian region and, in addition to the Paleo-Tethys, will include the Meso-Tethys and Cenozoic realms.

“Rifting of coastal fragments from Gondwana, and the formation and closure of both the Meso-Tethys and Cenozoic realms, are particularly important factors in the metallogeny of Pb-Zn, porphyry Cu-Au, and related epithermal and sediment-hosted Au deposits in the region. We will be focusing on these aspects, while extending the methods and techniques developed in the previous projects to cover the remaining parts of Southeast Asia, such as the Sibumasu terrain, the Kalei-Dala and Kawlin-Wunthu-Martabe fold belts, and the Bentong-Raub and Song Ma (Khalasun) ‘suture zones’, says project leader, Assoc. Prof. Khin Zaw.

The following deposits have been provisionally selected for detailed studies, but Khin Zaw says that other deposits can still be added to the list to suit the requirements of existing and prospective industry partners:

- Sediment-hosted Au (Selinung, Tesang, Penjomb and Lubuk Mandii) in Malaysia.
- Intrusive related gold (IRG), sediment-hosted Cu-Mo-Au, and Pb-Zn-Ag deposits in the Kutai-Dala Fold Belt in Camboodia, Vietnam and Laos.
- Alkaline epithermal Au system at Lamari, central Thailand.
- Polymetallic Au-Pb-Zn system in the Bau Mining District, East Malaysia.
- High-sulphur Cu-Au systems (Wattabi, Monyusa, Miyah) in Sumatra and Myanmar.
- Stratatbound Pb-Zn-Ag deposits in Sinibusu and the south China Terrane.
- Luang Namtha porphyry Cu-Mo-Ag deposits in northern Laos.
- Pb-Zn-Ag deposits in Thailand and Malaysia.

One of the principle aims of the project is to provide sponsors operating in Southeast Asia with an increased understanding of the formation and evolution of the ore deposits in the area and, most importantly, where they are located. This will result in an improved geological and geochronological framework that will greatly assist the companies with area selection and exploration targeting.

By building on micro-analytical, geochemical, isotopic and geochronological techniques developed in the earlier research, the team will be able to deliver a number of important outcomes, which include:

- Region-specific exploration models for the main ore deposit types.
- Geochemical, geochronological and isotopic criteria to distinguish favourable volcanic/magmatic belts and specific ore target types.

By building on micro-analytical, geochemical, isotopic and geochronological techniques developed in the earlier research, the team will be able to deliver a number of important outcomes, which include:

- Region-specific exploration models for the main ore deposit types.
- Geochemical, geochronological and isotopic criteria to distinguish favourable volcanic/magmatic belts and specific ore target types.
The deposit lies within the 125 square kilometre Oued Amizour tenement, which contains a number of lead-zinc prospects. The overall project is being undertaken by Terramin Australia via Algerian company WMZ, of which Terramin has 65% shareholding. Although the 68 million tonne Tala Hamza deposit is the most significant ore body in the tenement, Brendan plans to expand his research to look for similar mineralisation styles within the broader lease area. “It is a very exciting project because so little is known about the deposit. While it is widely understood that it contains an unusual style of volcanic-hosted mineralisation, its genetic origin is poorly understood. The research to date has been sparse, and very little is known about the nature of the source, the character of the mineralising fluids and their mode of transport, or the manner of deposition of the minerals,” says Brendan. He plans to remedy this lack of knowledge by developing a genetic model for the deposit. This will greatly help to resolve the uncertainties surrounding the nature and timing of the alteration and mineralisation relative to deposition of the host rocks.

Field work was undertaken last year, and consisted mainly of the logging and sampling of diamond drill core from both within the deposit and regional exploration holes. Samples are already back at CODES and have undergone short wavelength infrared (SWIR) analyses to determine the alteration mineralogy, dating of the host, altered and mineralised rocks; and whole-rock geochemistry. Terramin has completed its feasibility study for mining at Tala Hamza, and this is currently under review. If the proposal is successful, the operation has the potential to be one of the top ten zinc mines in the world, based on annual production. Let’s hope that this high value increases even further as Brendan helps to reveal its secrets.

The first course, held over two days in May, was led by Dr Dave Lawie from ioGlobal, who demonstrated his company’s latest version of its iGAS geochronological and data analysis software. Attendees saw how this innovative package can aid their research through a suite of interactive tools designed to optimise workflows, maximise the value gained from data, and deliver a range of high quality interpretive outputs.

The second course was presented by Dr Jun Cowan from Prestologics, who demonstrated the updated version of the versatile Leapfrog 3D modelling software. This novel software rapidly generates intricate 3D models from maps and drill hole information which enable users to utilise significantly more of their geological data. Attendees learned how even the most complex geologies can be understood, as Jun demonstrated how the software is capable of building interlocking geological models incorporating a variety of folds and faults. The first day and a half of the three-day course was devoted to learning the theoretical side of the software, with the remaining time spent applying the software in a practical sense by using it to build a model of the geology of the Helvetian VHMS deposit.

“It is important to ensure that our students and researchers are educated in the very latest technological developments, and we have access to the best available tools to aid our research. Courses by such highly regarded experts as Dr Lawie and Cowan are a key part of achieving these aims. A total of 35 people attended the courses, and I believe we all found them to be extremely beneficial. I was particularly impressed with how both packages enable the maximum value to be gained from accumulated data,” says Andrew McNeil, who organised the courses.

Both software packages are being used in CODES’ education programs, including the McGeoGeo Brownfields Course, plus a number of its research projects around the world. For example, Drs Helen Thomas and Sebastien Meffre are using iGAS to help efficiently analyse quantified LA-ICP-MS mapping data as part of the Application of New Technologies to Gold Deposits project (AWRA P1041). Use of iGAS in this context enables fast and effective classification of laser data, which allows value-added results to be provided to sponsor companies.

**Algerian first**

A lead-zinc project has commenced in Algeria, which marks the first time that CODES has been involved in research in this major North African country. Brendan McGee’s PhD project aims to develop ore deposit vectors for resource expansion at the Tala Hamza deposit, adjacent to the country’s Mediterranean coast.

**Students meet industry**

Students at various academic levels took the opportunity to meet with key people from CODES’ industry sponsors at a networking event held at the UTAS Uni Club in April. Each of the sponsor companies involved made good use of their allocated time slot at the podium to give a brief synopsis of their company and talk about potential employment opportunities. Industry participants included Anglo American, AngloGold Ashanti, Barrick, BHP Billiton, Newcrest, Newmont and Rio Tinto. On behalf of the budding geologists, Jeff Steadman gave an overview of SEG Student Chapter activities, with similar talks by WM Hagel and Eddie Morris for the student members of the Geological Society, and Meg Ellis on behalf of the AusIMM Student Chapter. With the short speeches over, the group were free to mingle, socialise and talk about opportunities of mutual benefit. Everyone agreed that the event was a great success and one that should appear at regular intervals on the calendar. The forum was organised in conjunction with the SEG Students Chapter, to coincide with the day of CODES’ Science Planning Panel meeting.
A program of Discovery for Andrew

Andrew McNeill has been appointed as leader of the Discovery Program, taking over from Jeff Foster who now leads the Recovery Program – as reported in the last issue of Ore Solutions. There was strong competition for this senior position, but Andrew’s blend of academic and industry experience, coupled with his excellent track record as a long-standing member of the Discovery team, were key factors in the appointment.

He takes over the reins of the program at an interesting time. AMIRA project P1065A, Geochemical and Geological Halos in Green Rocks and Lithocap, has just come to an end, and a new project building on this research is beginning to gain momentum (see article on P1060 on the front cover). There are also interesting developments in a number of geophysical research initiatives, including a project that investigates the application of near-mine ambient seismic methods to brownfields mineral exploration, and in-mine seismic rock mass characterisation. Another new project (AMIRA P1011) is researching the location and formation of copper, uranium and precious metals in oxidising sedimentary basins. And the existing project researching the structure and formation of Grange Resources’ Savage River magnetite deposit is being expanded to include a geological interpretation of the Centre Pit and South Pit deposits.

“There is a lot planned for the coming months. I am looking forward to the challenges that lie ahead, both in the projects where I am directly involved and the ones in which I play more of a supervisory role. It is certainly a time of transition for the program, with some of the key projects coming to an end, and other projects just beginning, or being substantially expanded.

“My main objective is to build on the extensive wealth of knowledge gained by the previous research, while ensuring that we continue to branch out into new and challenging areas...”

One of Andrew’s greatest legacies is the profound influence he had on his students. His lively and insightful lectures were known for bringing subjects alive and inspiring young, aspirant geologists to strive for greater heights in their chosen career paths. He also played a vital mentoring role to many of those students as they followed their vocation. Therefore, what better way to pay tribute to Mike than through a lecture delivered by one his former students who has gone on to become a leader in their chosen field? There were many potential candidates for that role, but the person given the honour of delivering the first lecture was Dr Paul Kitto, who studied under Mike as an undergraduate. Paul is now the MD and CEO of Ampella Mining, and he gave a fascinating talk on his company’s highly successful exploration activities at various projects in Burkina Faso, West Africa, and how they are approaching the transition to becoming a significant gold producer in the next few years. His talk highlighted the tremendous potential for discovery in this mineral-rich area of the continent, which is one of the few areas in the world that has shown significant potential in new gold resources in recent years.

The Mike Solomon Honorary Lecture was delivered by Andrew McNeill, one of Mike Solomon’s former students, in honour of Mike Solomon during April. When Mike Solomon sadly passed away in 2009, CODES’ management got together with the SEG Student Chapter to discuss the best way to pay tribute to someone who had played such a pivotal role within the Centre and in the development of Economic Geology, both in Australia and internationally.

It was decided that rather than have a plaque that gathers dust on a wall, a more fitting tribute would be an ongoing lecture that would keep Mike’s memory alive in a way that would best reflect his approach to the sciences – via a dynamic forum that would further the understanding of geology and encourage lively debate on cutting-edge issues.

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Part of the tour included an overview of the Vedanta group of companies. Tasmania, which is part of the fast growing is currently owned by Copper Mines of Australia. The mine opened in 1893 and was producing without a break for over one hundred years until it closed for just twelve days. It was the longest continuously operating mine in the world. The CODeS SeG Student Chapter has completed an informative, four-day field excursion to western Tasmania that included visits to five mining operations.

Also included in the packed itinerary was a stop at the world-famous Beaconsfield Mine in the north of the state, which was squeezed into a hectic final day. The first four mines visited fell within the Cambrian Mt Read Volcanics, which are well known to many geologists as being an arcuate belt of acid to intermediate volcanics occupying the eastern margin of the Dundas Trough. The volcanic belt is bounded to the east by Precambrian volcano-sedimentary rocks of the Dundas Group and to the west by a belt of acid to intermediate volcanics occupying the eastern margin of the Dundas Trough. The volcanic belt is bounded to the east by Precambrian volcano-sedimentary rocks of the Dundas Group and to the west by a belt of acid to intermediate volcanics occupying the eastern margin of the Dundas Trough.

The excursion started with a tour of the Queenstown-based Mt Lyell copper mine, which holds the record for being the longest continually operating mine within a single headframe. The old headframe is located on the eastern side of the mine. Once at the surface, perhaps just slightly relieved and metasomatic reactions that occur on the grain boundaries in mantle and crustal rocks. A greater knowledge of the processes that occur at mineral boundaries is essential for building accurate models of fluid percolation through rocks at different pressures and temperatures which, in turn, are required for constraining models of deep-earth resources.

Vadim Kamenetsky was part of a team of five UTAS Chief Investigators that has successfully secured a $240,000 ARC Linkage Grant to purchase a laser Raman system for the university’s Central Science Laboratory. While the instrument will be available for use by a number of areas within UTAS, it is an important addition to the suite of the art equipment available at CODeS’ UTAS Hub. This new generation instrument provides numerous benefits including fast imaging capabilities that enable researchers to analyse materials rapidly, in a non-destructive manner, with minimal sample preparation.

The instrument will be advantageous across the range of CODeS’ programs. For example, it will play an important role in gold mineralogy, and the relationship between gold and organic matter, which is a topic of major interest to the sediment-hosted gold team. It will also be critical in gaining a better understanding of the partial melting and metasomatic reactions that occur on the grain boundaries in mantle and crustal rocks. A greater knowledge of the processes that occur at mineral boundaries is essential for building accurate models of fluid percolation through rocks at different pressures and temperatures which, in turn, are required for constraining models of deep-earth resources.

Vadim (Dima) Kamenetsky (right) and Thomas Rodemann, Deputy Director of the UTAS Central Science Laboratory, test drive the new laser Raman system.

Laser Raman system adds to capability

The penultimate day started with a trip to Basset Metal’s Hellyer mine, where they examined drill core from the newly developed Fossey deposit and high grade samples from the Hellyer and Que River deposits. This was the last of the tour, and the group examined drill core from the newly developed Fossey deposit and high grade samples from the Hellyer and Que River deposits. This was the last of the tour, and there was no doubt that the group was fascinated by the alteration associated with the mineralisation, but it was the visible gold in the core that really captured its imagination. The group visited the world-class VHMS deposit at Rosebery. This mine comprises three principal open pits — North, Central and South — that average 100-150m in depth, covering a 4km strike length and separated by unmined zones of thin or low grade material. The Central Pit is separated from the North Pit by the Savage River, which runs through a narrow area left to retain the river channel. This was the first time that many of the group had visited an iron ore mine and the scale of the operation left a lasting mark. After the tour of the site, the remainder of the day was spent collecting magnetite and goethite coated specular hematite specimens, followed by a late night drive to the north ready for the final leg of the excursion.

The group had an early start on the final day to go underground at the Beaconsfield Mine along with the first morning shift. Everyone enjoyed a highly informative stay underground where they examined the mineralised reef at three different levels. On the eastern side of the mine. Once at the surface, perhaps just slightly relieved knowing the well-publicised events of 2006, the group examined drill core from the western (higher grade) side of the mine. All that was left was the drive back to Hobart after a very full and rewarding few days.
Yangtze trip for students

There is no doubt that the 12-day field excursion in May to China’s Middle and Lower Yangtze Mineral Belt was the main event on this year’s SEG Student Chapter events calendar.

The trip commenced with an activity-packed two days at Hefei University of Technology in Anhui Province, where Dave Cooke, Zhaochun Huang, and Huayong Pan delivered a porphyry, epithermal, skarn and IOCG workshop. This also included an overview of the geological background of the Middle and Lower Yangtze Mineral Belt, presented by Hefei University’s Taofa Zhou, plus presentations and lively discussions on all the students’ research papers.

The field activities got off to a fascinating start with a visit to the developing Fushan National Geopark. Undergraduate students from Hefei University joined the group and walked through successions of volcaniclastic breccias and erosional caves that were covered with ancient Chinese scripts carved into the walls.

The group then ventured west to Jinzhai to visit the Shapinggou Mo deposit, where stockwork mineralisation is hosted in a granodiorite porphyry, displaying text book examples of unidirectional solidification textures (USTs) coated with molybdenite. Next stops on the busy itinerary were the Nihe deposit and Longqiao Fe skarn mine in the Luzong Volcanic Basin. Skarn mine in the Luzong Volcanic Basin. Nickeliferous hydrothermal breccia hosted by a succession of bedded sandstone and Upper Carboniferous siltstone. A Cretaceous syenite intruded the sedimentary package and closely predates the large molybdenite plates that are associated with mineralisation.

Later on, the group visited the Dafanshan mine, where molybdenite has been mined intermittently since the Tang Dynasty (~700AD). This was followed by an interesting stop at the Makou iron workings.

On the penultimate day, the group studied drill core from the Yaojialing Cu-Au-Pb-Zn deposit, where Permian limestone contacts are associated with mineralisation. Most of the next day was spent at the Xinqiao Cu-Au-Pb-Zn mine. This deposit occurs on the northern limb of a regional antcline where the Upper Devonian sandstone and Upper Carboniferous dolomite decoupled during folding. Mineralisation is characterised by massive pyrite and lesser chalcopyrite, with local Pb-Zn lenses up to 10 metres thick.

After spending some time in the famous Confucius Temple. As the great philosopher once said: “I hear and I forget. I see and I remember. I do and I understand.”

While some students may argue that they won’t forget what they heard, none would disagree that they will always remember what they saw – and it has certainly improved what they understand.

The trip was organised by the SEG Student Chapter Committee who would like to thank David Cooke, Huayong Pan, and Zhaochun Huang from CODES for leading the excursion, plus Taofa Zhou, Lejun Zhang and Fan Yu from Hefei University for their considerable help along the way. They also thank the industry-based geologists from AngloGold Ashanti, Gold Fields, Rio Tinto, and OZ Minerals for their participation, plus AngloGold Ashanti, CODES, and Data Metalligenica for their additional financial support.
Ross Large receives Distinguished Alumni Award

CODES’ Director, Ross Large, has received a Distinguished Alumni Award at the UTAS Foundation Awards Dinner held at Wrest Point. Over 500 guests attended the gala event, which recognised alumni that have gone on to achieve exceptional success in their chosen fields since graduating from the university.

Excellence rewarded

Research Fellow, Dr. Jacqui Halpin, has received a UTAS Award for Research Excellence. The award is just reward for the significant contribution she has made to CODES’ research activities in recent years. Jacqui joined the Centre in 2007, after completing a PhD on Antarctic geochronology and metamorphic petrology. Her early work at CODES focused on the nature and age of the basement rocks of the Naturaliste Plateau offshore south-western Australia, which was followed by major contributions to the Congolese-Zambian Copper Belt and Ore Deposits of Southeast Asia projects, particularly in the field of geochronology. Jacqui has also built an excellent publication record in high-ranking journals over this period and fostered productive collaborations with a number of national and international researchers. Jacqui was the only person at her research level to be selected for the award, which celebrates excellence in research and teaching across the breadth of UTAS.

Graduates find serendipity in Mongolia

What are the chances that three people, from different locations, will meet up in a remote corner of the world and discover that they all graduated from CODES?

We will come to the odds of that occurring in a moment, but that is exactly what happened to Luisa D’Andrea, Graham Cook and Roger Norris on a recent trip to Ulan Bator. Each had been sent to Mongolia’s capital by their respective employers within the Rio Tinto group to attend a workshop on drilling safety. One evening, after a long day of workshops, the delegates got chatting over dinner and were surprised to find their common link went well beyond working for the same company. What are the odds of that happening? Actually, they are probably not as long as you would expect; bearing in mind CODES’ ever-growing international family of geologists and the far-flung places that they find themselves in - but it is a tale worth telling, nonetheless.

Where are you now?

The story of Luisa, Graham and Roger meeting up in Mongolia prompted us to think that it would be good to have a regular article featuring people that have spent time at CODES at some point in their lives – graduates, researchers, staff, collaborators etc. Therefore, we welcome anyone that falls into that category to send us a suitable photo, plus a few details on where they are now, and any other significant milestones since leaving the Centre. Anecdotes like the Mongolia incident are welcome, but are not essential. Send to steve.calladine@utas.edu.au

Dr Janina Micko, from Canada, has joined the Formation Program working on the Exploring the Porphyry Environment project with Dave Cooke.

Deborah Macklin has been appointed as PA to the Director, Ross Large.

PHD student Daniele Redi is working with Leonid Danyushevsky on the characterisation of volcanic products.

Andy Wakefield has been appointed as Geophysics Technician.

PHD student Evan Orovan, from Canada, is working on the Exploring the Porphyry Environment project with Dave Cooke.

XRF analyser a handy tool

The small, lightweight handheld analyser is perfectly suited for use at mine sites and in the field.

PHD student Evan Orovan, from Canada, is working on the Exploring the Porphyry Environment project with Dave Cooke.

The small, lightweight handheld analyser is perfectly suited for use at mine sites and in the field.

A group, including a number of industry visitors, at a demonstration of the new Delta portable handheld XRF analyser, which has been acquired by CODES. The analyser enables initial qualitative geochemical screening of rock samples, semi-quantitative spot analyses, and quick, inexpensive quantitative analyses of a wide range of major and trace elements. It is ideal for initial geochemical evaluation of sample suites, and qualitative analysis of small-scale geological features, relationships and associations.
Geophysicists maximise opportunity

A team led by Anya Reading has proposed alternate strategies for analysing data that will result in a significant increase in the amount of useful geological information available from a variety of geophysical research techniques.

The approaches, which have been published in a feature article in the April 2011 issue of the CSIRO’s Preview journal, could have far-reaching effects across the field of geophysics through the next decade. The other team members are Jeff Foster and PhD candidate Matt Cracknell from the CODES Hub, plus Malcolm Sambridge, via an important collaboration with the ANU Node.

Currently, most geophysical techniques enable inferences to be made from airborne, ground-based or borehole data through a deterministic process whereby a single model answer is generated. Well-founded algorithms include uncertainty estimates for different parameters in the model and/or some form of model validation. Whereas, utilising a broader range of mathematically-based methods will provide a much richer understanding of the model and, most importantly, likely are deposit drill targets are not overlooked, says Reading.

The goal of exploration geophysics is to infer the nature of buried structure and, in particular, generate drill targets that lead to a mineral deposit discovery or reserve delineation. Some of the alternate methods being proposed to increase the probability of achieving this goal are multiple model ensembles, machine learning and model parameter sampling.

MULTIPLE MODEL ENSEMBLES

One of the techniques used in the multiple model ensembles approach searches the range of parameters more widely, producing an ensemble of reasonably well fitting models, rather than focusing on just one best-fit model. This style of inversion has become known as the ‘Monte Carlo’ approach because it works primarily on the principle that if you calculate enough models you will eventually find a ‘winner.’ That description can be misleading because it implies a scattering approach, while in reality it is opening up the research to a much wider range of potential findings, as opposed to the deterministic method, which focuses narrowly on a direct linear relationship. Therefore, Monte Carlo is particularly suited to inverse problems where deterministic methods can sometimes provide skewed results. In the past, this alternative method was computationally very expensive. However, it has now become viable due to refinements to the method and advances in computer processing and data storage capabilities.

MACHINE LEARNING

Machine learning takes an empirical approach. Its algorithms use sets of related observations that do not necessarily have an obvious physical relationship between each other. They may be described as ‘disparate’ datsets, related only in that they are observed at the same point on the surface of the Earth. Predictive relationships are then extracted by means of the patterns occurring between the disparate observables. Although these methods are commonly used within the IT community, they are seldom used in geophysics and the team believe that there is a lot of scope to expand their use in this area.

MODEL PARAMETER SAMPLING

This approach provides a solution that consists of a probability distribution for each of the model parameters, rather than just for a single model. The result is a full set of probabilistic information, which is then used to construct the best-fit model. The distributions are found by sampling the multi-dimensional posterior model space, taking into account the probability of the occurrence and value of each parameter. Model parameter sampling falls under the category of Bayesian techniques, which have met with failure in the past when applied to exploration applications. However, the team believes that the subsequent criticism of this technique is unfounded and, with improved understanding of the underlying fundamentals and insightful use, it facilitates extremely well-founded, high opportunity algorithms that are suitable for use in a desk-top environment.

The team’s vision for exploration is to provide a suite of tools that will enable geophysicists to use their data to infer geological information more effectively, thereby providing results with a combination of geological assurance and enhanced target generation opportunity. In addition to the paper in Preview, results from this project have been presented at the 2010 ASEG International Geophysical Conference and at the 2011 International Union of Geodesy and Geophysics Conference. For further information, contact Dr Anya Reading on +61 3 6226 2477 or email anya.reading@utas.edu.au.

Inversion Strategy | Constrained | Unconstrained
--- | --- | ---
Deterministic | Widely used | Less used
| High assurance | Lower assurance | Increased opportunity
Multiple model ensembles | Less used (computation) | Less used (computation)
| Managed assurance | Managed assurance
| Increased opportunity | Maximum opportunity
Machine learning | Now tractable | Now tractable
| Managed assurance | Managed assurance
| Increased opportunity | Maximum opportunity
Model parameter sampling | Now tractable | Now tractable
| Managed assurance | Managed assurance
| Increased opportunity | Maximum opportunity

Diagram top: illustrates that while deterministic strategies provide high assurance results, they only provide a single answer. Whereas, alternate strategies increase opportunity by suggesting a number of models that are appropriate to the data.

Diagram left: provides a summary of selected data inference strategies as applied to geological modelling and inversion. Strategies are grouped according to inference style. Current usage patterns and assurance/ opportunity characteristics are noted.

HIFFING THE SPOT

– a question of balancing assurance and opportunity

Mineral deposit target generation is the primary goal of geophysical modelling and inversion. Assurance and opportunity are two important concepts that play a key role in achieving this goal and delivering successful outcomes for mining companies.

• Assurance – In simple terms, this covers the extent to which a model is likely to lead to the discovery of an economically viable ore body. High assurance corresponds to low risk. However, confining drilling to high assurance targets can result in viable targets being overlooked. We also have to consider that there may be no high assurance targets.

• Opportunity is the concept that targets are generated with sufficient open criteria that few targets are overlooked. It ensures that not only the best opportunities are investigated, but also all other potential areas of viable mineralisation. This unconstrained approach is of particular benefit in new exploration areas, where the natural variability of the mineral systems might result in a target still being prospective even if one indicator parameter changes.

The team proposes that opportunity can be maximised by adopting a broader range of mathematical approaches, while assurance can be managed very effectively.
Hands-on in the Andes

Two years flashed by in the blink of an eye and it was time for another group of Masters students to head off to the Andes for the Ore Deposits of South America Short Course.

This biennial course is one of the most popular on the Master of Economic Geology program because of the highly practical nature of its content, the range of deposit styles covered, and the exciting locations in the itinerary. The course takes places in the southern part of the Andes in Peru and Chile and incorporates the major ore deposit styles of the continent, including porphyry Cu-Mo, high sulphidation epithermal Au, and iron-oxide Cu-Au.

Highlights of this year’s packed travel program included climbing the peaks of the world famous Toromocho porphyry Cu-Mo and skarn deposit in Peru, and stops at El Teniente - the world’s largest underground copper mine, and Chuquicamata - the world’s largest open pit copper operation.

During their two weeks in South America, the students participated in studies of the regional and local geology, with detailed evaluations of the ore deposit characteristics, mineralisation styles and genetic models. Exploration techniques for porphyry and epithermal deposits were also discussed first-hand in the field.

Success for former student

Ampella Mining, headed by former CODES’ PhD student and Research Fellow Paul Kitto, was recently named Gold Explorer of the Year by Gold Mining Journal.

“It is an honour to receive such an award that has been judged by our peers in the industry. Our exploration success is due to a dedicated and hardworking team of employees who are continuing to work towards upgrading our current resource and targeting new prospects at Bate West,” said Dr Kitto.

Bate West in Burkina Faso was one of the main projects that he covered during his address at the Mike Solomon lecture in April (see article on page 8). The nine Bate West tenements cover an area of 1,800 square kilometres and occupy a 110 kilometre long gold-bearing shear zone that occurs along the south-west margin of the Boromo Greenstone Belt in southern Burkina Faso, adjacent to the country boundaries of Côte d’Ivoire and Ghana.

The French exploited this region in the 1940s, but no modern exploration has been undertaken since. However, Paul realised the potential in the area after noticing that the prospective lithologies in Burkina Faso are the same as in Ghana (part of the Proterozoic Birrimian Greenstone Belt), which have produced a world-class gold resource in the Ashanti deposit, among others. Furthermore, about 70% of the total surface exposure of these rocks is in Burkina Faso, yet no major gold discoveries have been made in this country to date.

Since taking the helm at Ampella in June 2008, Paul has undertaken a thorough review of the company’s current exploration programs and consequently made strategic recommendations to take the company forward. In addition to his current position as MD and CEO of Ampella, he has had a highly successful international career in exploration, including positions with Gold Fields, Renison, and Aurion Gold.

More recently, he was Exploration Director for Sun Mining, which has operations in Russia and other former Soviet Union countries. He says that he received the news of the explorer of the Year award while standing in a core shed in Burkina Faso, logging in 45°C heat. That’s a long way from the bitter cold of Russia. It is also a long way from his days experiencing the chilly Tasman winters at Renison Bell – but then Paul Kitto has indeed come a long way since those days.

PhD graduations

A selection of PhD graduates and supervisors* taken at the last graduation ceremony. From left: Ana Liza Cuison, David Cooke*, Jaclyn McPhee*, Heidi Pass, Jacqueline Blackwell, Susan Reford, Adam Bath, Canny Davidson*. A total of seven PhD students graduated on the day. Graduates not in the photo are Paul Cromie and Ralf Schaa.

A further six students were due to graduate at the August graduation ceremony, which was just too late for this issue of Ore Solutions.
OUR INVOLVEMENT IN THE COMMUNITY

OUTREACH

Schools visit CODES

Left: Pupils from Mount Stuart Primary School learn about seismology from Mike Roach.
Bottom left: Mike Roach explains the science behind the Ring of Fire to students from Claremont Primary.
Below: Research Fellow, Helen Thomas (far right), guides students from Fahan School for girls through an interactive educational exercise that utilises a variety of rock samples from around the world.

Workshop for Year-11 students

The Centre continued its ongoing participation in the Science Experience initiative by hosting a workshop for Year-11 students. The program’s objective is to inspire students to continue their science studies.

CODES visits schools

Anya Reading tells Year 6 girls at Mount Carmel College what it is like to work as a geophysicist. The girls had lots of questions for Anya about her career and recent seismic events around the world.

Seniors schooled in geology

Andrew McNeill addresses a meeting of the School for Seniors at the Rosny LINC facility on Hobart’s eastern shore. The group meets regularly to hear guest speakers talk on a wide range of subjects, with the aim of broadening their horizons in a relaxed, sociable setting. Andrew fitted the bill perfectly, delivering a presentation that covered an insight into the world of geology, interspersed with amusing anecdotes from his much-travelled career.

TESEP continues

CODES continued its support for the Teacher Earth Science Education Program (TESEP), which is primarily a series of professional development workshops aimed at upper primary / lower secondary school teachers.

Left: Simon Stephens takes the teachers on a tour of the lapidary facility.
Below: The teachers perform a range of practical experiments and exercises during one of the workshops.

ORE SOLUTIONS

SPRING 2011 / NO. 28
Breathtaking honour for Garry

Congratulations to Garry Davidson, who was selected to represent Tasmania at the recent National Underwater Hockey Championships in Canberra. Garry has represented the state at either Men’s or Masters levels an exhausting 14 times over the years, gaining two national Men’s titles and five Masters titles in the process. He is also a regular player for local team ‘The Berserkers’.

Guests get a taste of Portugal

Guests sample the range of fine cheese and wines on offer at the latest social event organised by the CODES SIG. The wine and cheese tasting evening was held on July 26th and included an array of fine produce from Tasmania, mainland Australia, and much further afield. Particularly popular was the selection of cheeses from Portugal.

Good sports

PhD student, Pedro Fonseca, stretches to make a shot during one of the regular badminton sessions held at the UTAS Unigym. The sessions are organised by PhD students Lindsey Clark and Mathieu Agenceau and are open to everyone at CODES.

The yin and yang of Yangtze

The serious, geological part of the Yangtze trip is covered in the centre spread. Here is a small selection of photos from the social side of the trip.

Right: Rocky mountain high. The group celebrates reaching the top of Bright Summit Peak during a trip to the Huangshan Geopark.

Middle right: He ain’t heavy… Chris Large (left) and Dan Gregory give Jeff Stedman a lift on a traditional Chinese sedan chair in Huangshan Geopark.

Below: Roisin Kyne looks in need of a lift.

Bottom: A relaxing dinner in Hefei.

Cryptic conundrum

It is found in gold, but never in copper.

It is integral to mining, yet it is never seen in any part of mines.

It is also an important part of geology, but is never included in earth sciences.

What is it?

You don’t necessarily have to be a geologist to work out this issue’s puzzle. In fact, it might help if you are not. Email entries to steve.calladine@utas.edu.au by Friday, 28 October, 2011. The winner will have the choice of receiving either one of CODES’ publications or a selection of corporate gifts to the value of approximately $50. The competition is open to readers in Australia and overseas.

SOLUTION TO PREVIOUS PUZZLE:
The five elements that make up chocolate were carbon, holmium, cobalt, lanthanum, tellurium (C Ho Co La Te).

AND THE WINNER IS...
The first name out of the hat was PhD student Selina Wu who chose one of CODES’ publications.
Mastering Economic Geology
...AND YOUR FUTURE

Would you like to broaden your knowledge of mineral deposit geology while adding the world’s most comprehensive postgraduate mineral exploration and mining geology degree to your CV? If so, then the Master of Economic Geology (M EconGeol) program at the University of Tasmania could be just what you are looking for.

The M EconGeol is designed for working geoscientists and provides a thorough update on the latest developments in economic geology and mineral exploration, delivered by a team of highly qualified national and international presenters from both industry and academia. Through a series of manageable short courses, the program emphasises practical content, including research opportunities, and field excursions to diverse locations — from the arid plateau of the Atacama Desert in Chile, to Amazon rainforest, the snow-capped heights of the Andes and the spectacular active volcanic formations of New Zealand.

FLEXIBLE COMPLETION OPTIONS
-- ideal for industry participants

The program is offered jointly between the University of Tasmania (CODES), the University of Western Australia (CET), James Cook University (EGRU) and Curtin University (WASM). Each of the participating universities offers up to five, two-week courses in rotation over a two-year period. There are two options for completing the degree:

• Option 1 – complete six units of coursework and a minor research thesis. Four of the units must be completed at CODES, and the remainder at other participating universities. Duration: Up to 30 months part-time (but this is flexible).

• Option 2 – complete eight units of coursework, at least four of which must be undertaken at CODES. Duration: Up to 30 months part-time (but this is flexible).

We realise that as a working geoscientist you are busy, so we endeavour to have all of the assessment tasks completed immediately before or during short courses (while you are on campus or on the field trips). For some short courses there may be some pre-course work, usually in the form of pre-course reading, or a short assignment (such as preparing a PowerPoint presentation).

There is no obligation to enrol. If you want to see what the courses are like before committing to a return to part-time study, then you can participate as an industry geoscientist. All our courses are open to not-for-degree participants and count as continuing professional development. You can just attend for particular modules that might interest you, or you can attend for the whole short course. If you attend as a not-for-degree participant but complete all the assessment tasks, we will keep your final results on file and if you decide to take on the Masters at a future date, we will credit that unit to your degree. It is a way of trying before you buy.

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