ore solutions

Newsletter of the Centre for Ore Deposit Research, an ARC Special Research Centre at the University of Tasmania

Master of Economic Geology Research Leads to Exploration Success

Follow-up drilling to research by Newcrest exploration geologist and CODES student, Dan Olberg, has led to an exciting new epithermal discovery in Indonesia. Dan completed his Master of Economic Geology thesis entitled 'Ore shoot targeting in the Gosowong Vein Zone, Halmahera, Indonesia' in late 2001.

Dan Olberg examining outcrop in the Gosowong district.

Gosowong is located in the Maluku province of eastern Indonesia, on the north arm of the island of Halmahera. It is a classic example of a volcanic-hosted, low-sulfidation, epithermal quartz vein deposit. Gold mineralisation at Gosowong was discovered by Newcrest Mining Limited geologists in May of 1994 as a result of a ground reconnaissance program in northern Halmahera, targeting porphyry style gold-copper mineralisation. The mineralised structure is known as the Gosowong Vein Zone (GVZ) and has been traced along strike for 2 km, though the Gosowong deposit encompasses only a 400 m section of the total strike length. Economic mineralisation is predominantly hosted in two gently south-plunging ore shoots along an east-dipping normal fault that contain quartz–adularia–electrum and quartz–chlorite–electrum styles of epithermal mineralisation.

Newcrest geologist at the Kencana discovery hole monument.

The Gosowong resource at the commencement of mining in 1999 was estimated at 0.99 Mt at 27 g/t Au and 38 g/t Ag for a total of 870 000 ounces Au, using a cut-off grade of 2 g/t Au. Mining of the Gosowong deposit finished in early 2002, however milling of both high-grade and low-grade stockpiles continued into 2003.

Dan worked as a senior exploration geologist at Gosowong during the course of his Master of Economic Geology studies. The primary aim of Dan's study was to identify additional high-grade ore-shoots along the GVZ. A multi-faceted approach was implemented incorporating structure, stratigraphy, vein textures, alteration zoning, fluid inclusions, and metal zoning, with the ultimate aim being to construct a model for predictive targeting of high-grade ore-shoots along the GVZ.

Dan created a Gosowong specific 'prospectivity matrix' based on the sum total of the relative prospectivities of each of the components analysed in his study. This matrix indicated that the most prospective area of the GVZ was deep and to the south of the deposit.

In May Newcrest Mining Limited announced (Market Release 23/05/03) that drilling has resulted in the discovery of a significant zone of mineralisation at the Kencana prospect, on a separate structure to the GVZ, south of the original Gosowong

CODES SRC
University of Tasmania
Private Box 79
Hobart Tasmania Australia 7001
Tel: 03 6226 2472
Fax: 03 6226 7662
www.codes.utas.edu.au

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P544 Zambia final meeting: (L to R) Back row - Peter Pelly, Murray Hitzman, Cam Allen. Middle row - Peter McGoldrick, Nick Franey, Alan Stephens, Rob Scott, Alan Goode, Hugh Carruthers, Ross Large, Stuart Bull, Wellington Mukumba, Giddy Mwali, Mike Buxton, Ross McGowan, John Woodhead, Dave Armstrong, James McMaster, John Barr, Mawson Croaker, David Broughton, Jelena Puzic. Front - David Selley. Photographed in Mindola open cut.

P544 Hobart final meeting: (L to R) Nick Hayward, Ross Large, Galvin Dawson, Peter McGoldrick, Dave Andrews, Paul Heithersay, Murray Hitzman, Alan Goode, Mawson Croaker, Darren Griggs, Stuart Bull,Wallace McKay, Rob Scott, David Broughton and David Selley.

EXPLORATION SUCCESS from page 1

mine. This newly discovered mineralisation lies 1 km south of the original Gosowong mine and in an envelope approximately 250 m long, 100 m down-dip with a thickness ranging from 3 to 20 m. It remains open along strike and at depth. Some of the drilling intersections reported include: 10.55 m @ 20 g/t Au, 23.45 m @ 110 g/t Au, 13.5 m @ 29 g/t Au, 3.5 m @ 105 g/t Au, 10.4 m @ 34 g/t Au, and 10.4 m @ 130 g/t Au.

The discovery hole at Kencana was targeted on the southern zone on the Gosowong structure which Dan identified as highly prospective. Dan reports that "the Gosowong vein structure was intercepted as planned, but another high-grade epithermal vein was intersected in the hangingwall". The Kencana vein strikes NW and is located adjacent to the intersection between the Gosowong structure and the NW Kencana structure and does not crop out at surface. The Kencana vein has the same characteristics as Gosowong deposit, with both quartz-adularia style and quartz-chlorite styles of veining.

Understandably, Dan says "I'm ecstatic that my thesis actually turned out to be useful in discovering an ore deposit, which was really my whole objective in writing it". Newcrest Mining Limited reports that drilling is continuing on this new discovery. Dan was supervised by Associate Professor Bruce Gemmell.

PROJECT STATISTICS

Title

Proterozoic sediment-hosted Cu deposits: a comparison of Zambian and Australian environments.
CODES Project 4.6, AMIRA Project P544.

Staff

D Selley, P McGoldrick, S Bull, R Scott, D Cooke, R Large and M Hitzmann (CSM)

PhD Students

M Croaker, W Mackay, N Pollington and D Broughton (CSM)

Funding

AMIRA/ARC Linkage 2000-20003 ARC $393,000, AMIRA Sponsors $1,092,000

Industry sponsors

Anglo American, AngloVall Minerals, BHPBiliton, PIRSA, First Quantum-Mopani, Inco Exploration, Mount Isa Mines Exploration, Outokumpu, Phelps Dodge Exploration, Rio Tinto, Straits Resources, TeckCominco, Western Mining Corporation.

Work accomplished

- 165 person weeks in the field
- 55,000 m of core logged
- >1000 thin sections examined
- 1000 geochemical analyses
- 150 sulfur isotope analyses
- 500 C and O isotope analyses
- 45 new dates from Zambia, 65 from South Australia

The Zambian Copperbelt: clues for Australian deposits?

Neoproterozoic sedimentary sequences of Zambia and the Democratic Republic of Congo are hugely endowed with copper and cobalt. By comparison similar age sequences in South Australia are not known to contain large amounts of these metals.

Since mid-2000, CODES staff and post-graduate students, in collaboration with researchers from the Colorado School of Mines, have been using modern basin analysis and geochemical techniques to better understand why the Zambian sequences contain so much copper, and to use this knowledge to predict whether the Australian basins may yet be hiding much larger copper deposits.

The project is funded by through AMIRA and by an ARC-Linkage grant to Peter McGoldrick and Stuart Bull from CODES, and Murray Hitzman from CSM.

Three years of the AMIRA work culminated with meetings in Hobart and Kitwe (Zambia) in July this year. The meetings ran for two days in each instance, and were attended by over 25 sponsor representatives.

The project's original approach was to compare and contrast the Katangan sequences in Zambia with the Adelaidean of South Australia. This was later extended to include a review of copper deposits in the Paterson Province in Western Australia. Broadly, the work was aimed at improving our understanding of the geological processes that produce economic concentrations of copper in sedimentary basins.

Project leader Peter McGoldrick explains the state of play when the project began. "For the Zambian deposits, very little new work had been carried out over the previous 20 years, and much of the earlier published work emphasised a syngenetic model for the copper ores originally championed by Garlick in the 1950s and 1960s."

"For South Australia, we had an excellent framework of good information from previous mapping efforts of the Geological Survey of South Australia, and investigations of individual small copper deposits published in the 1980s. The Adelaide Fold belt has copper showings and prospects through much of its stratigraphy, and small, but historically important, stratiform copper deposits at two stratigraphic levels that have been compared to Zambian Copperbelt."

"Western Australia, however, had the poorly exposed Yeneena basin with significant sediment-hosted copper mineralisation. Previous detailed work had been restricted to several PhD studies of mineral deposits and GSWA mapping."

Overall, he says the project's main premise has been to synthesise these existing geological and geophysical data to improve our understanding of basin development, timing and controls on development of stratabound copper deposits, to allow comparisons with Zambian Copperbelt.

Zambian focus

Work in the project has identified the structures that controlled sedimentation during deposition of the Lower Roan, and how some of these structures played a role in localising individual orebodies. Careful re-logging of numerous regional drill holes, mainly by David Broughton, has allowed the development of a more robust stratigraphy and solved some long-standing correlation problems for the Roan, Mwashia and lower Kundelungu sequences.

A better picture of the broad-scale basin architecture for the Zambian Copperbelt has emerged and an appreciation of the importance of (former) evaporates.

"We can now see how important different types of breccias are in the Upper Roan and their probable relationship to evaporates," Peter explains.

"We also have a better understanding of the timing and distribution of potassic and sodic alteration in the Roan rocks, how this alteration relates to copper mineralisation, and how these processes are manifested in whole-rock geochemical and stable-isotope signatures."

Australian focus

"Our work in South Australia has refined the understanding of basin evolution and mineralising processes at two important stratigraphic levels. Wallace Mackay's PhD studies have focused on the sedimentology, structure and mineralisation of part of the Callana Group in the Willouran Ranges. At a higher level in the stratigraphy we have concentrated on copper in the Tapley Hill Formation and associated units, both in the Adelaide Fold Belt and on the Stuart Shelf."

In Western Australia, Peter says the work synthesised recent PhD studies of the Nifty and Maroochydore deposits, with regional mapping by the Geological Survey of Western Australia leading to a better understanding of the important similarities and differences between stratabound copper mineralisation in the Paterson Orogen compared to the Zambian Copperbelt.

Next on the agenda

Of the future, Peter says we now have a fundamentally better understanding of the basin evolution controls and geochemical/alteration aspects of the Zambian Copperbelt mineralising processes and are in a position to make more astute comparisons with Proterozoic sedimentary basins elsewhere in the world.

But, problems remain.

"The source and genesis of cobalt, the sulfur isotopic story, the source of reductants, salt tectonics (including breccia genesis) and the difference between Zambian and Congo deposits are problems we now need to solve," he says.

While ongoing work by PhD students will be completed in the next year, Peter says that CODES is proposing a follow-on project to address these and other issues.

RESEARCH PROFILE

New breakthroughs expected in mineralogical, geochemical and isotopic studies of the Mount Lyell alteration system

How did the giant Mount Lyell copper–gold orebody form?

That question has exercised some of the sharpest geological intellects in Tasmania and the experts continue to argue a diversity of opinions. For more than 100 years the Mount Lyell field has produced numerous papers and theses, over 100 million tonnes of ore from over 20 separate deposits, and geological disputes un-numbered. Still, its origin/s and age remain subterranean and mysterious. Our new PhD researcher, Kim Denwer, is set to reveal these dark secrets.

Kim is a Tasmanian with a solid career in mineral exploration in Australia and Papua New Guinea, which commenced a couple of decades ago at Mount Lyell. Now he's come the full circle and taken a two-handed grasp of the Lyell genetic controversy in the first system-wide investigation aimed at delineating the altered facies, distribution of sulfide assemblages and stable isotopic variations. His research will provide insight into the composition/s of the mineralising fluid/s for the entire Mount Lyell field and the processes of mineralisation.

The various Cu–Au deposits are enclosed in a large (6 km x 1 km x +1 km deep) alteration zone, which has not previously been studied in systematic detail. Sericite + chlorite generally dominate the deeper parts of the system with chalcopyrite as the main copper phase. Some shallower parts of the system contain pyrophyllite (indicative of acid hydrothermal fluids) and common bornite (indicative of oxidising conditions). Do these differences represent the evolution of a single mineralising event from early and deeper level neutral reduced fluids, to later and shallower acidic oxidised fluids, or were there two separate mineralising events?

Kim Denwar

The system has some similarities with:

- the footwall stringer zones of VHMS deposits,
- porphyry Cu-Au deposits and
- acid sulfate/high sulfidation epithermal deposits.

Are the deposits one or more of the above types, or are they hybrid deposits?

These are muddy hydrothermal waters but we know Kim will enjoy the swim. His research will certainly enhance understanding of Mount Lyell ore genesis. It's also likely to turn up some new exploration targets that could lead to discovery of additional ore at Lyell and set it up for a second century of production.

Outstanding achievement for joint Freiberg-CODES PhD student

In June, Thomas Monecke defended his PhD thesis entitled 'Geology, host rock succession, and hydrothermal alteration of the Waterloo volcanic-hosted massive sulfide deposit, nothern Queensland, Australia' at the Technische Universitat Bergakademie Freiberg in Germany.

The Waterloo project was part of the CODES/AMIRA P439 project 'Studies of VHMS-related alteration: development of geochemical and mineralogical vectors to mineralisation'. Thomas came to Australia in December 1996 to begin his fieldwork at the RGC core yard in Charters Towers. After a stint of national service in Germany, Thomas came back to Australia in January 1999 for a second field season and several months of mineral and whole-rock analytical work at CODES. The rest of his analytical research and writing of the thesis was completed at Freiberg.

Thomas' research is an excellent contribution to the understanding of the Waterloo deposit, and will be of significant interest to academics and industry geologists alike who investigate or explore for VHMS deposits. Thomas was supervised by Associate Professor Bruce Gemmell (CODES) and Professor Peter Herzig (Freiberg).

During his time as a PhD student Thomas published three refereed papers in international journals and four abstracts on his Waterloo research. In addition Thomas undertook another project on the distribution of footwall stringer veins at the Hellyer VHMS deposit in Tasmania. This research led to the publication of one refereed paper in an international journal and two abstracts.

Peter Herzig, Thomas Monecke and Bruce Gemmell at Thomas' PhD thesis defence.

For his PhD research Thomas was awarded the highest honour in the German academic system "magna cum laude". Congratulations Thomas on a job well done!!

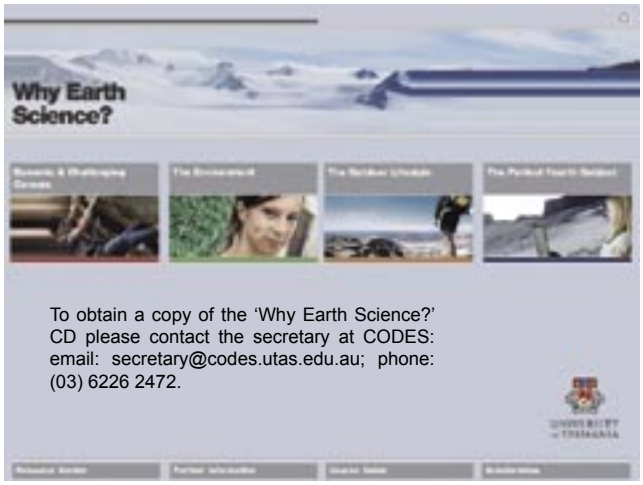
New CD boosts first-year enrolments in Earth Sciences

First-year enrolments in Earth Sciences at the University of Tasmania have increased significantly since the release of an exciting new marketing tool – a CD titled 'Why Earth Science?' CODES and the School of Earth Sciences, with funding from the Minerals Council of Australia, assistance from the University of Tasmania Marketing Department and significant staff involvement, developed the CD and released it in December 2002. As a result, student enrolments increased by almost 50% in 2003, compared with 2002.

Market research on the subject preferences of first-year University students revealed that they were motivated by four major factors: the pursuit of a challenging career; an outdoor lifestyle; environmental interests; and sometimes, their requirement for a 'filler' subject to complete their first-year subject load. Armed with this information, Crank Media were contracted to create a CD, combining interviews with first-year students and working professionals, and a large amount of content provided by CODES staff. The result is an edgy, modern product with immediate appeal for technology-savvy, prospective first-year students. The users can navigate around the CD to select the areas of interest to them, drilling down to target information as specific as unit descriptions, or scanning around general interest pages such as the 'Ore bodies around the world' which provides case studies of areas of geological interest.

The CDs were mailed in December 2002 to all students who had applied for admission to the Bachelor of Science degree, and to selected prospective students who had applied for admission to Arts, Commerce or Computing degrees. Copies were also sent to the Heads of Science and career advisors at all Tasmanian colleges. The increase in student enrolments in 2003 revealed the effectiveness of this targeted approach. Follow-up questionnaires revealed that many students' 2003 enrolment choices were influenced by the information they received through the 'Why Earth Science?' CD.

Future projects which will flow on from the success of 'Why Earth Science?' include the modification of the CD for use as an ongoing yearly campaign, the creation of a slightly different version to target prospective undergraduate students across Australia, and, possibly, the creation of a similar product to market post-graduate courses in Australia and overseas.



Research Excellence

Professor Jim Reid (Dean of Science, Engineering & Technology) with Associate Professor Bruce Gemmell and Professor Ross Large, representing the Ores in Volcanic Arcs Research Group, and University of Tasmania Vice-Chancellor, Professor Daryl Le Grew.

Bruce Gemmell, as leader of CODES Program 3 'Ores in Volcanic Arcs', was recently presented with a University of Tasmania Research Excellence Grant. The purpose of the Grant scheme is to recognise and reward research programs which reflect the Faculty of Science, Engineering & Technology's research strengths and areas of research excellence.

Over 100 research and teaching staff from the Faculty attended the presentation during which Vice-Chancellor of the University of Tasmania, Professor Daryl Le Grew, praised the Faculty's excellence in research and teaching at a time of increased competition for funding and critical peer review. He also mentioned the significance of CODES three-year funding extension and CODES role in furthering the University's national and international profile.

'Ores in Volcanic Arcs' is one of the five research programs in CODES. The research focus is on the relationships between magmatism, volcanism and ore formation in volcanic arc settings, with particular emphasis on the nature, diversity and genesis of volcanic-hosted massive sulfide Cu–Pb–Zn deposits and epithermal Au–Ag deposits throughout Australia and the Pacific Rim.

The research team is led by Bruce Gemmell and comprises five senior researchers (Bruce Gemmell, Ross Large, Mike Solomon, Jocelyn McPhie, David Cooke), eight Research Fellows (Robina Sharpe, Rob Scott, Garry Davidson, Cathryn Gifkins, Wally Herrmann, Dima Kamenetsky, Khin Zaw, Cari Deyell), a Research Assistant (Mike Blake), and 12 PhD students (Michael Agnew, Andrew Davies, Russell Fulton, Sarah Jones, Neil Martin, Thomas Monecke, Karin Orth, Andrew Rae, Robina Sharpe, Briony Sinclair, Andrew Wurst, Bill Wyman).

The 'Ores in Volcanic Arcs' program consists of 14 major research projects. These are multidisciplinary projects that use a combination of personnel with specific research strengths.

The major achievements of the team over the last five years have been:

- Publication of 43 referred papers, 1 book, 69 conference abstracts, and 89 industry reports.
- Obtained $3,063,375 in external funding — $1,570,975 (51%) from ARC and $1,492,400 (49%) from industry.
- Edited and published a special issue of *Economic Geology* in 2001, containing 14 papers based on industry collaborative research.
- Organised and convened an international conference, 'Volcanic Environments and Massive Sulfide Deposits' and associated field trips in 2000.
- Accepted 17 invitations to deliver keynote papers at international conferences, 13 invitations to convene or chair sessions at international conferences and 14 invitations to teach shorts courses.
- Graduated 15 Honours, 10 Masters and 5 PhD students in the 'Ores in Volcanic Arcs' program.
- Collaborated with 20 minerals companies in research on how to improve mineral exploration success rates.
- Adoption by mining companies of our exploration models and methodologies in their exploration, in particular the geological and geochemical vectors developed for both VHMS and epithermal deposits.

In complimenting the Program 3 team on the award, CODES Director Ross Large said, "Bruce and his team are very deserving of this award, having achieved a high international profile over the past five years for their work on ore deposits in volcanic environments."

Kate Bull amongst the steaming craters of Mt Usu, on the island of Hokkaido, Japan.

SEG Grant

In May of 2003 the Society of Economic Geologists (SEG) awarded a Hugh E McKinstry Grant, worth $US1500, to Kate Bull.

Thee grants are awarded to students whose projects involve studies of mines or ore districts, topical studies toward improved understanding of ore genesis, and experimental research with field applications.

This year there were 31 recipients. The SEG Foundation "reviewed [Kate's] project proposal and determined it to be of the quality and type that Dr McKinstry encouraged during his tenure as professor of mining and economic geology at Harvard University."

The principal aim of her project is to map and describe in detail the character and setting of Early Devonian submarine intrabasinal volcanic successions and associated mineralisation in the Lachlan Fold Belt of New South Wales, Australia. The focus will be on the Ural Volcanics, Lake Cargelligo, in comparison with equivalent successions, such as the mineralised Mount Hope Volcanics and the Cobar mineral region volcanics.

Kate scorias double success

AGU Grant

In 2003, the National Science Foundation in the USA provided funds to the American Geophysical Union to award to American students as travel grants to attend the 2003 General Assembly of the International Union of Geodesy and Geophysics (IUGG) held in June in Sapporo, Japan.

Kate Bull was a recipient of one of these grants, worth $US1500. The grant allowed Kate to not only attend the meeting and present her research in an IAVCEI forum, but also to take advantage of the opportunity to go on field trips to active and ancient volcanoes on island of Hokkaido, which, she reports "…brought us to the craters and deposits of Komagatake, Usu, Toya, Shikotsu, Tarumai and Eniwa volcanoes. Foggy, rainy weather prevented good views of several of the craters and surrounds, but we were able to access the usually restricted 1977 Usu crater, where fumaroles and vent-proximal deposits are exposed. The grey skies, the volumes of billowing steam and the patches of sulfur and other colorful surficial deposits allowed for some fantastic photo opportunities."

"We also went up to the Usu 2000 cryptodome and crater area tourist site. The walk up and over the dome brought us past crumpled, deformed road pavement, a smashed kindergarten with a block still embedded in the outer wall, squashed buildings, steaming phreatic craters and a lake formed by the river that is now blocked by the dome."

"In addition to fantastic volcanic outcrop visits, we were treated to Japanese-style hotels with hot baths and delectible food. The field trip was an invaluable learning experince both geologically and culturally."

Staff News

Jocelyn McPhie

At this year's IUGG meeting in Sapporo, Japan, CODES Volcanology Program Leader, **Jocelyn McPhie**, was appointed Vice-President of IAVCEI for the next four years. She has been a member of the Executive Committee of IAVCEI since 1999.

IAVCEI (International Association for Volcanology and Chenistry of the Earth's Interior) is the major international association for volcanologists and responsible for promoting research in volcanology, supporting professional activities aimed at mitigating volcanic hazards, and publishing the premier volcanological journal, *Bulletin of Volcanology.*

CODES Senior Research Fellow, **Khin Zaw**, has been invited to join the editorial board of the *Ore Geology Reviews* which is the official journal of the International Association on the Genesis of Ore Deposits (IAGOD).

Kylie Kapeller, has been appointed Personal Assistant to the Director of CODES. Kylie comes to CODES from the University of Tasmania Research Office via the Faculty of Arts, so is no stranger to university administration.

Kylie Kapeller

PhD Roundup

Drs Robin Cantrill (on left, School of Earth Sciences, palaeontology) and Karin Orth (CODES) ably supported by (l to r) Catherine Reid, Andrew Rae and Cathryn Gifkins at the August 2003 University of Tasmania graduation ceremony.

Since December 2002, seven PhD candidates in CODES have submitted their PhD theses and three others have graduated. This is a credit to the students and their supervisors. David Cooke, in particular, deserves particular credit, being the principal supervisor of five of these students – life and work will hopefully ease up somewhat for Dave for the remainder of 2003. The students are:

- Mike Agnew (Thesis title: 'Volcanic setting, lithogeochemistry and genesis of the Lewis Ponds massive sulfide deposits, New South Wales') – currently on a three-month writing-up scholarship in CODES.
- Steve Bodon – ('The geodynamic evolution and genesis of the Cannington Broken Hill type Ag-Zn-Pb deposit, Mt Isa Inlier (Australia)') – currently contracting in southern Africa. Graduated December 2002.
- Andrew Davies ('Geology and genesis of the Kelian Au deposit, east Kalimantan, Indonesia') – currently with AngloGold in Peru. Completed and will graduate December 2003.
- Peter Frikken ('Breccia-hosted Cu-Mo mineralisaton at Rio Blanco, Chile') – currently with CODELCO in Chile.
- Owen Hatton ('Basin configuration, sedimentology and volcanology of the Toole Creek Volcanics, Mt Isa Inlier (northwest Queensland)') – currently with LionOre in WA.
- Vanessa Lickfold ('The intrusive history and volatile evolution of the Endeavour porphyry Cu-Au deposits, Goonumbla district, New South Wales') – currently with Kumba Resources, South Africa. Graduated December 2002.
- Glen Masterman ('Genetic relationships between the Rosario porphyry Cu-Mo deposits and the high-sulfidation Cu-Au veins, Collahuasi district, Chile') – currently with PlacerDome.
- Karin Orth ('Setting of the Palaeoproterozoic Koongie Park Formation and carbonate-associated base metal mineralisation at Koongie Park, northwestern Australia') – currently on three-month CODES writing-up scholarship. Graduated August 2003.
- Andrew Stewart ('Facies architecture of a mineralised arc volcanic island, Milos, Greece') – currently with Ivanhoe Resources in Mongolia.
- Alan Wilson ('The genesis and exploration context of porphyry Cu-Au deposits in the Cadia district, NSW') – currently with Newcrest in Western Australia.

Colourful characters, Mike Roach and Garry Davidson, amongst the cabbage plants on Macquarie Island.

These students reflect the diversity of backgrounds that characterises CODES PhD students, with seven Australians and three international students (Andrew Davies from Canada, Vanessa Lickfold from South Africa and Alan Wilson from Scotland).

During 2003 CODES has welcomed the following new PhD students:

- Sophia Tetroeva (from Vernadsky Institute, Russia) – Petrogenesis of adakitic lavas in modern SW Pacific settings, particularly in Fiji.
- David Braxton (University of Utah, USA, 5 years industry experience in Peru and Utah) – Origin of the Boyongang porphyry Cu-Au system, Philippines.
- Paul Cromie (University of Tasmania, 5 years industry) – The Seppon Cu-Au deposit, Laos.
- Rod Maier (University of Newcastle) – Northern Australia basins stratabound mineralisation.
- Mike Baker (University of Sydney) – Geochemistry of the mafic rocks in the Precambrian Georgetown Block, North Queensland.
- Ruth Shepherd (University of Tasmania, 4 years industry) – Structure and geochemistry of gold mineralisation, Abosso, Ghana.
- Blackwell Singoyi (MExpGeosci, University of Tasmania, 7 years with Caledonia Mining in Zambia) – Hydrothermal magnetite textures and trace element chemistry.
- Kim Denwer – (University of Tasmania, 8 years industry experience in Australia and Papua New Guinea) – Genesis of the Mount Lyell deposits, Tasmania.

RESEARCH PROFILE

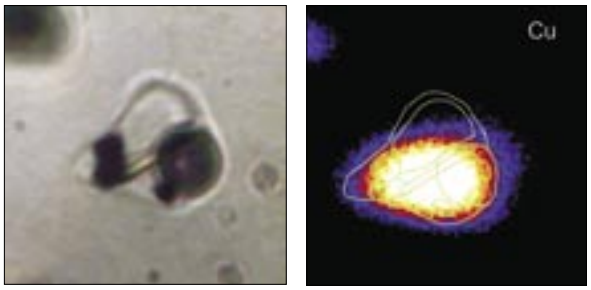
Melt, bubbles and porphyry ore deposits: Unravelling the magmatic–hydrothermal transition

Anthony Harris

Since starting at CODES SRC in October 2002, Anthony Harris has been involved in studies that aim to bridge the gap between porphyry ore deposits and their magmas, i.e., the so-called magmatic-hydrothermal transition. Porphyry ore deposits largely form from magmatic fluids exsolved from crystallising, upper crustal silicic magmas. Despite this process being well constrained by numerical models, the direct evidence for the physical separation has been limited. New interpretations of primary igneous textures, combined with microanalysis of melt and fluid inclusions, are completing the continuum of petrological features that preserve evidence of volatile exsolution and link magmatic and hydrothermal systems.

The focus of this study is Bajo de la Alumbrera in NW Argentina. With its near-perfect concentric zonal arrangement of hydrothermal alteration, Alumbrera is a textbook example of a Cu–Au porphyry ore deposit, where potassic alteration assemblages overprint several dacite intrusions. While several previous studies have documented the evolution of the huge magmatic-hydrothermal system responsible for Cu and Au mineralisation at Bajo de la Alumbrera, this research has recognised previously overlooked primary igneous textures (such as interconnected miarolitic cavities and comb-quartz layered textures) that preserve evidence for the exsolution of large volumes of magmatic aqueous fluids from the magma. Combined with aqueous fluid phase equilibria from inclusion microthermometry and microanalysis (including laser ablation ICPMS at CODES), this research is providing important constraints for the magmatic-hydrothermal transition.

One of the more surprising results to date lies in the microanalysis of brine- and vapour-rich fluid inclusions trapped in some of the earliest veins (with temperatures over 800°C) at Bajo de la Alumbrera. Typically, inclusions in the Cu-bearing potassic alteration assemblages at Bajo de la Alumbrera have Cu concentrations of less than one percent. Microanalysis (via CSIRO-GEMOC nuclear microprobe) has identified inclusions with over several weight percent Cu – these represent one of the most primitive magmatic fluids (i.e., prior to ore deposition) introduced to the deposit. Such preservation affords a unique opportunity to study the magmatic fluids responsible for mineralisation at the very point of their separation from the magma, and to determine their characteristics by measurement rather than by inference or extrapolation. Drs David Cooke and Vadim Kamenetsky, with Professor Tony Crawford, instigated this project, and it represents a collaborative effort that blurs the division between what is truly magmatic versus hydrothermal. The research is an extension of the results of Anthony's PhD study at the University of Queensland.



Optical image and PIXE Cu map of a polyphase hypersaline brine inclusion in early quartz vein from Bajo de la Alumbrera.

Masters Roundup

There has been considerable movement in the Masters of Economic Geology enrolments in 2003. Some old faithfuls have finally completed and several new faces have arrived keen to get started. Amongst those to recently submit their theses were Allan Kneeshaw, Phill Tornatora, Michael Buchanan and Ian Laurent, all of whom completed some excellent work.

Phill is now working for Anglogold in Mali West Africa, Allan also works for Anglogold based in Western Australia. Michael Buchanan has moved on to the giant Collahuasi porphyry Cu deposit in northern Chile, and when last heard from Ian Laurent is working in Mexico but based out of Paris, poor bloke!

Andrew Dacey and Simon Henderson, both from New Zealand, have also completed, but rather than do a thesis they have transferred to the National Masters program and completed coursework units outside CODES to satisfy the degree requirements.

In what is fast becoming the norm, five of the six new students to have enrolled in the Masters program are internationals. Kamonporn Krumkhin (better know as Yee) hails from Thailand and is working in collaboration with Khin Kaw on several gold deposits. Allan Ignacio works for Anglo American in the Philippines and will be undertaking a thesis on the Boyangang porphyry system with Dave Cooke.

Mannie Mehu is from Papua New Guinea and is studying prospects around the Lihir gold mine. Steve Lewis is from Malawi via London and is completing some work with Wally Herrmann and Ross Large on Broken Hill. Len Kolf is a Dutchman studying the giant Seemandoo iron deposit in Guinea West Africa, and finally, Peter Pring is an Aussie boy working at Scuddles and Gossan Hill.

We now have a very diverse troupe with a vast range of backgrounds and experience, which should bode well for some lively discussions over a beer or two on our next Masters short course, which will be run in Chile and Peru in November 2003.

17th Australian Geological Convention

8-13 February 2004
Wrest Point Convention Centre
Hobart, Tasmania

The 17th Australian Geological Convention is to be held in Hobart Tasmania at Wrest Point Convention Centre located 5 minutes from the city on the beautiful shores of the Derwent River. The program will encompass scientific presentations across the full breadth of Geology and will be complemented with a broad range of pre, post and mid conference excursions.

For registration and program details please visit the website where regular updates will be posted ***www.17thagc.gsa.org.au***

Convention Themes include:

THEME 1: Geology, environment and impact on the community
THEME 2: Geology and resources
THEME 3: Tectonic processes and reconstructions
THEME 4: GEOCAM: Geology of Earth's oceans and continental Australian margins
THEME 5: Sedimentary processes and products
THEME 6: Magmas and volatiles

Convention Workshops:

1. The Future of Antarctic Geoscience Research
2. Melt Inclusions
3. LAVA: Understanding Volcanic Successions that Host Ore
4. SGGMP: Magmatic Sulfide Deposits: Ni & PGE

Invited Speakers for the Conference include:

Ed Eshuys, Dr Kathleen Grey, Professor Alex Sobolev, Professor Millard F. Coffin, Dr James White & Dr Shane Cronin, Dr Terry Planck, Dr Ken Lawrie, Professor Wolfgang Maier, Dr Peter Roy and Professor Tim Lyons.

Convention Registration Fees: *(includes GST)*

	before 26/9/03	after 26/9/03
Full – Member*	$575	$660
Full – Non-Member	$720	$820
Full – Retired Member	$250	$265
Full – Student	$250	$265
Day – Member	$180	
Day – Non-Member	$200	
Day – Student	$60	
Conference Dinner	$65.00 per person	

Important Dates:

26/9/03	• Deadline for receipt of abstracts for all presentations
	• Last day for early bird registration
28/11/03	• Notification of acceptance of papers
4/2/04 – 8/2/04	• Pre-Convention field trips
9/2/04 – 13/2/04	• Convention – scientific program
14/2/04 – 18/2/04	• Post-Convention field trips

www.17thagc.gsa.org.au

17AGC
DYNAMIC EARTH:
Past, present and future
2004

Pre-Conference Excursions

Northeastern Tasmania: gold & granites
NW Tasmania: Neoproterozoic sedimentary rocks and their deformation features
Mount Read Volcanics
Maydena-Gordon Road
Cenozoic Basalts (Icing on the Cake)
Maria Island
Footsteps of Darwin (Bellerive & Lauderdale)
Huon Valley/Forster Prospect

Post Conference Excursions

Western Tasmanian mines
Tasmania Basin stratigraphy & fossils; Mt Nassau
King Island
With Charles Darwin to Mt Wellington
West Coast mineralogy
Tasman Peninsula

Mid Conference Excursions

Cruising through History – geological, colonial and later
Coal River Valley – Vineyard tour
Cygnet alkaline complex
Huon Valley/Tahune AirWalk
Shag Bay-Oyster Cove: Aboriginal sites
Proctors Rd/Fossil Cove

If you have any queries in the meantime, please contact the Conference Secretariat:

Andrea Goodwin
Conference Design Pty Ltd
PO Box 342 SANDY BAY
TAS 7006
Phone: 03 6224 3773
Fax: 03 6224 3774
Email: andrea@cdesign.com.au

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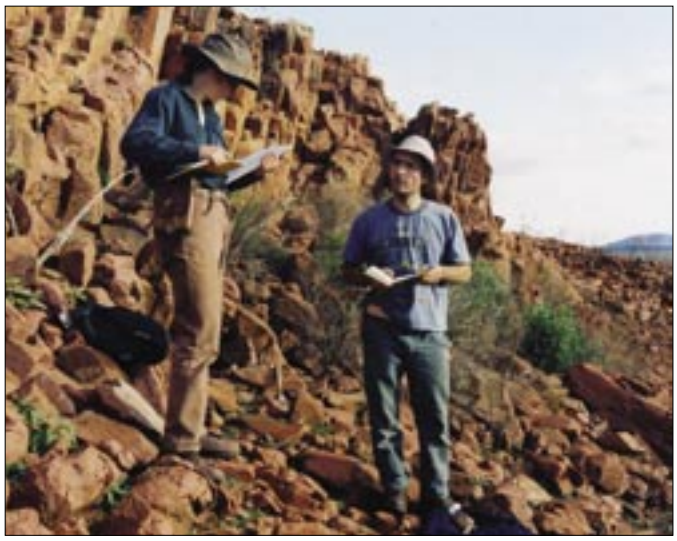
A.C.N. 050 462 507

New volcanology project to find the sources of extensive felsic lavas in the Gawler Range Volcanics

A new research project has commenced on the Mesoproterozoic Gawler Range Volcanics in South Australia. The new project is funded by an ARC Discovery Grant awarded to Jocelyn McPhie and aims to track the outflow paths of very extensive felsic lavas. These lavas cover thousands of square kilometres and are up to a few hundred metres thick. They represent substantial melting events in the Earth's crust but their sources have not been recognised.



Sharon Allen and Fernando della Pasqua collecting data on flow directions in the Gawler Ranges, South Australia

The new project will employ two techniques to detect flow directions. One technique involves careful measurement of the orientations of elongate crystals and has been used successfully elsewhere on a variety of volcanic facies types. The other technique is geophysical and requires measurement of the anistropy of magnetic susceptibility (AMS) of oriented samples. Volcanic rocks may have their flow direction locked in by alignment of fine magnetic minerals. This technique has been used only rarely in Australia but more widely and successfully overseas.

Fernando Dellapasqua will work on the project, and brings to it considerable experience in the use of petrographic techniques to detect palaeoflow directions. Fernando completed fieldwork for the project in June, carefully sampling a series of sections through the best known of the felsic lavas. The AMS analyses will be performed at Macquarie University in collaboration with Dr Mark Lackie, an expert in the application of the technique to volcanic rocks.

NEWS FROM THE CODES SEG STUDENT CHAPTER

The CODES SEG Student Chapter was established several years ago to provide all geology students at the University of Tasmania with the opportunity to enhance their knowledge of economic geology and promote interaction with the wider geological community. This year the committee has endeavoured to continue the excellent work of previous incumbents by organising another overseas field excursion and undertaking a range of fund-raising activities.

The main fieldtrip this year was a week-long excursion to the historic Kupferscheifer deposits in Poland. This trip, which took place in mid-August during the height of the blazing European summer, was a joint initiative of the SEG Student Chapters from CODES and the Colorado School of Mines. It evolved during last year's Charters Towers–Mount Isa trip when visiting Polish academic Professor Zbigniew Sawlowicz (Head of Geological Sciences at the Jagiellonian University in Krakow) extended an invitation to visit his 'neck of the woods'. Students and academics from Poland also participated on the trip which visited several important mines including the MVT style deposit at Pomorzany and the medieval salt mines at Wieliczka. Many lasting friendships were made along the way and the event was truly an eye-opener for the CODES participants. The success of this trip hinged on the fantastic support and assistance offered by Professor Sawlowicz and his faculty. CODES PhD student Wallace Mackay is thanked for his tireless effort in organising many logistic details. The generous sponsorship provided by the SEG and CODES is sincerely appreciated.

University of Tasmania Student Chapter

Fund-raising activities are an important aspect of generating support to underwrite student participation in fieldtrips and excursions. Following on from the outstanding success of the 2002 GODS conference wine sales the Student Chapter will again be releasing a limited-edition range of fine, geologically-inspired wines to coincide with the up-coming 17AGC in February 2004. A pre-release wine-tasting evening is planned for later in the year, when the 2004 SEG Student Calender will also be unveiled. Another fund-raising success was the launch of the stylish and colourful range of stubby holders.

Never willing to rest on their laurels, the committee has also been planning the next major Student Chapter fieldtrip. With Hobart playing host to the 17th Australian Geological Convention in 2004, a student-oriented field trip is being planned. This trip aims to involve visiting mainland Australia and international students and give them the opportunity to experience Tasmania's geological highlights. Hopes are high for several mine site tours on the west coast and visits to Maria Island, Mount Wellington and Lake St Clair.

The CODES Student Chapter is also convening a 17AGC symposium session under the theme of 'Geology and Resources'. The committee is hoping to receive a range of high-quality abstracts to ensure the success of the session and to allow students from Australian and international universities to showcase their research.

The SEG Student Chapter is also an active participant on the CODES social scene. 'Friday arvo' beers and the weekly run-around on the oval (touch football) are just a few of the social activities supported by the SEG students. With the coming of the warmer months other social outings such as the infamous staff–student cricket match and end-of-year BBQ are also eagerly anticipated.

The 2003 committee comprises: Steven Lewis (President), Andrew Stacey (Vice-President); Kate Bull (Secretary), and Russell Fulton (Treasurer), with Alan Chester, Mawson Croaker and Wallace Mackay as able committee members. For further information please contact Steven Lewis on (03) 6226 2423 or e-mail: lewissj@utas.edu.au

Bessell award for Dima

Dima Kamenetsky reveals the mysteries of komatiites and shoshonites.

In recognition of 'accomplishments in research and teaching' the Alexander von Humboldt Foundation (Germany) elected CODES Research Fellow Dima Kamenetsky to receive a highly prestigious Friedrich Wilhelm Bessel Research Award in 2003. Dima was nominated by Prof Albrecht W. Hofmann, the Director of the Max Planck Institute für Chemie in Mainz, Germany. These research awards (approximately 10 annually during the period 2001–2003) are awarded to 'top-flight, foreign scientists and scholars who are already recognized as outstanding researchers in their fields' (ww.avh.de/en/programme/preise/bessel.htm). Dima worked in Germany from April to August, 2003, on the petrology and geochemistry of komatiites (Gorgona Island, Finland), shoshonites (Kamchatka, Solomon Islands) and ocean island (Mauritius) and mid-ocean ridge basalts (Macquarie Island, central Atlantic). His results on the magmatic-hydrothermal transition were presented to seminars at research institutions in Heidelberg, Münster, Hannover and Potsdam.

AMIRA Project P765: Transitions and zoning in porphyry–epithermal districts

AMIRA project P765 commenced in June 2003. It aims to improve exploration success in porphyry-epithermal mineral districts by investigating the links and pathways between the diverse deposit styles that occur within these districts. P765 will evaluate relationships between individual deposits within these districts, in order to improve understanding of the processes of magmatic-hydrothermal ore formation. This knowledge is being used to develop predictors that can help to identify the likely locations of high grade copper and gold accumulations. Potential discriminators between productive and non-productive districts are being examined by thorough study of well-mineralised systems and comparison with sub-economic and barren control sites.

The project is being led by David Cooke and Bruce Gemmell (CODES). Research team members include Cari Deyell, Noel White and James Reid (CODES) and Jeff Hedenquist (Colorado School of Mines). Alan Goode is the AMIRA coordinator.

P765 is currently being sponsored by Anglo Gold, Anglo American, Newcrest, Newmont, Placer Dome, TeckCominco and Gold Fields. Additional sponsors are welcome to join the project. Please contact David Cooke (d.cooke@utas.edu.au) or Bruce Gemmell (Bruce.Gemmell@utas.edu.au) for more details.

Lepanto, Philippines

Porphyry copper-gold-molybdenum deposits (PCDs) are the world's major source of copper and molybdenum, and are an important source of gold. They form within and around porphyritic igneous intrusions at depths of one to five kilometres below the Earth's surface. The magmatic-hydrothermal systems associated with and emanating from the porphyritic intrusions can extend far beyond the confines of the porphyry copper orebody itself. Consequently, porphyry-related mineral districts host many major ore deposits of diverse styles and metal associations. The largest metal accumulations (Cu-Mo-Au) occur in the PCDs themselves, but various styles of high grade epithermal Au-Ag deposits, skarn Cu-Au deposits, carbonate replacement Zn-Pb-Ag, and sediment-hosted Au can be found peripheral to the porphyry centre. Because of their potential to yield major discoveries, these districts continue to be the focus of intense exploration activity.

The broad association between the diverse deposit styles within the porphyry environment has been long recognised, and genetic links with magmatic activity have been inferred for many of the deposit types. We know that some of the minor (and major) mineral occurrences in these districts are produced by prolonged magmatic-hydrothermal activity. This is true for many skarn and high-sulfidation epithermal deposits, although genetic relationships between low-sulfidation deposits and magmatic systems are more obscure.

The discrete mineralised zones (within a porphyry-epithermal district) are typically separated by gaps of barren veins and/or background hydrothermal alteration assemblages. We do not see continuity between the various deposit styles, nor seamless transitions from one style to another, and hybrid mineralisation styles are rare. This indicates that, if indeed the deposits are produced from an evolving magmatic-hydrothermal system, then there are only discrete points along that evolutionary path where ore formation can occur.

Rosario, Chile

Because we lack a comprehensive understanding of the links between different deposit styles, or of the critical features that characterise different productive stages in the evolution of magmatic-hydrothermal systems, exploration in these settings can be ad hoc. Seldom can minor mineralisation or background alteration be used to locate big deposits. Companies currently need to fully explore each occurrence to determine whether it meets economic criteria. Exploration is often complicated by shallow-level alteration systems, structural complexities and differences in erosional levels and host rocks. Exploration within lithocaps can be particularly challenging, due to their diversity of possible origins (hypogene, steam-heated, supergene, or combinations thereof), and the difficulties associated with assessing the depth to potentially mineralised zones. However, the rewards can be plentiful, with some of the world's major PCDs (e.g., Far Southeast, Philippines; Rosario, Chile) and HS gold deposits (e.g., Yanacocha, Peru; Pueblo Viejo, Dominican Republic; Lepanto, Philippines) associated with lithocaps. We aim to help explorers systematically evaluate whether a large, high-level alteration system is mineralised or barren, by evaluating whether it is possible to systematically track alteration and metals in lithocaps as a pathfinder to ore.

GOLD DEPOSIT WORKSHOP
14–16 June 2004
CODES, Hobart, Australia

A three-day workshop on gold deposits, comprising six half-day sessions on specific deposit types

LODE GOLD
PORPHYRY COPPER - GOLD
LOW SULFIDATION EPITHERMAL GOLD
VHMS GOLD
HIGH SULFIDATION EPITHERMAL GOLD
CARBONATE REPLACEMENT GOLD

each addressing ore deposit characteristics and the anatomy of a giant ore deposit discovery.

Confirmed speakers: Francois Robert (Barrick Corp.), Mark Hannington (Geological Survey of Canada), Doug Kirwin (Ivanoe Mining), Jeff Hedenquist (Colorado School of Mines), Larry Meinert (Washington State University, Jean Cline (University of Nevada at Las Vegas), Noel White, Bruce Gemmell, David Cooke (CODES).

Earth Science Week
12–18 October 2003

Earth Science Week is an international event, and its aim is to help people develop an understanding of the importance, and impacts, of earth science to every day life, as well as encouraging a sense of responsibility for the use and protection of our natural resources and the environment. Its objectives are to:

- To give students new opportunities to discover the Earth sciences.
- To highlight the contributions that the Earth sciences make to society.
- To publicise the message that Earth science is all around us.
- To encourage stewardship of the Earth through an understanding of Earth processes.
- To develop a mechanism for geoscientists to share their knowledge and enthusiasm about the Earth and how it works.
- To have fun!

Earth Science Week is an opportunity for all those involved in earth sciences around the world to present the results of their activities, highlighting the importance of their work to the community. This special week gives geoscientists, teachers and parents special opportunities to help students explore and discover connections between their lives and the Earth.

Contact Jeanette Holland, Communications Unit, Geoscience Australia on (02) 6249 9731.

Modern rivals of Congolese geology, Drs Henri Kampunzu, Sharad Master, Jacques Cailteux and Merak Wendorff, agree for the first time: yes, the Fungurume ore body (background) is pretty impressive!

With the help of personal trainers and encouragement from the local constabulary, delegates conquer the Kundelungu Plateau. Mawson Croaker, from CODES, seated right.

At 373m, the Koloba Falls are the tallest in Africa.

A Congolese Sojourn

by David Selley

There were elements of chaos as we boarded the craft. Excess baggage, being crammed into hopelessly undersized overheard compartments, excess passengers perched precariously on boxes and crates along the aisle. Only the steward affected an air of serenity as he stood leaning against the wall of the cock-pit – a position which he maintained throughout takeoff and landing. He made rare inflight visits to the back of the plane, where he scavenged Gitanes from gasping passengers – smoking was not just permitted, it was positively encouraged. Yes we were to develop a fondness for the 'Sandman' over the coming three weeks: a throbbing cavern of failing rivets and floor-to-ceiling deep-pile crushed grey velvet, that was lacking only in a water bed and heart-shaped bubble windows.

As we were making a rather unconvincing attempt to take off, I looked at the engines and leant over to Sharad Master, "those things wouldn't have the torque to pull your trousers down". He looked at me quizzically and I regretted the words as soon as they had passed my lips. "It's fine", he said, pointing out the Rolls Royce insignia on the engine cowling. And so it was – flying out on the 'Best of British' from the stodgy world of egg and chips of Zambia, to the rich creamy sauces, croissants and prospect of chilled Campari of the Congo.

Once landed in Lubumbashi (the bustling political and economic capital of the Katanga province), we were swept through immigration and quarantine with an ease that would make an Australian customs official shudder: our first signs of the remarkable efforts of the conference organising committee. The UNESCO-sponsored IGCP 450 project brings together active explorers and researchers from southern and central Africa, western Brazil and Antarctica. Its aim is to compare stratigraphy, tectonic history and sediment-hosted base metal deposits from Western Gondwana. Now in its third year, previous field-based meetings have been held in Bambui and Vazante Group regions of Brazil and the Otavi Mountain Land of northern Namibia. This, the third conference and field meeting, was surely one of the most eagerly anticipated events on the geological calendar – quite literally, a 'once in a life time opportunity' for many to visit the greatest sediment-hosted Cu–Co system in the world. The Congolese deposits have achieved almost mythical status, in part due to their impressive size and grade, but also due to their remote and exotic locations.

An initial two-day conference held in at the University of Lubumbashi saw presentations on Neoproterozoic geology and sediment-hosted copper mineralisation from around the globe. In addition to works from heavy-weights such as University of Witswatersrand, Musee Royal de L'Afrique Cenrale (Brussels), BRGM, Colorado School of Mines, CODES and Rod Kirkam, the forum provided great exposure for central African research units including universities of Lubumbashi, Zambia, Namibia and Botswana. Industry was also well represented, with delegates from BHP-Billiton, Anglo America, Anglovaal, First Quantum as well as significant contribution from local miners Gécamines, Australian-based operator in DRC, Anvil, and Groupe Georges Forrest International. Providing a link with Tasmania was the inclusion of Doug Jack, a 'larger-than-life' industry geologist now exploring successfully in southern Congo, and discoverer of the Hellyer massive sulfide deposit.

It was time to hit the road. Seven days of bone-jarring joy as our convoy of 4WDs took on the best that Congo road and works could come up with. Strangely, it was those with local experience who came a cropper, with cartonable offences being perpetrated by Anglovaal geologists in particular, including collapsing one vehicle through a bridge and another running the gauntlet across a row of tyre spikes. The locals seemed to view all this with amusement – but, everywhere we went, we were welcomed with smiles and good wishes from all.

Led by a team of local exploration and academic geologists, we were given a fantastic overview of the Neoproterozoic geology from the basal Roches Argilo-Talqueuse and culminating in a 600 m near-vertical scramble to the uppermost Plateaux Subgroup. I doubt that there was any delegate who did not, by the end of the trip, find the two globally deposited Neoproterozoic glacial units (Grand & Petit Conglomérat) strangely alluring. Even the least economically-minded of us could not help but be awed by the visit to the massive Tenke-Fungurume deposit, an effectively unmolested and largely outcropping leviathan: 46 x 10^6 tonnes of contained Cu. On standing upon the Cu-strained hills above the village of Fungurume, James MacDonald of BHP-Billiton declared that his 'virginity tax', a US$10 fine for entering the country for the first time, was repaid a thousand-fold by the experience.

If being exposed to such fantastic geology was not enough, our social schedule was also pretty hectic: gala celebration of Bastille Day, marvellous reception from the Belgian Consulate-General and his wife and two audiences with the Governor of Katanga. More than 60 delegates are greatly indebted to conference organiser Dr Jacques Cailteux's phenomenal efforts. His ability to gain conference sponsorship from locally brewer, Brasseries SIMBA, was simply pioneering, and has set a standard for all future gatherings of geological minds.

CODES SHORT COURSE PROGRAM

Ore Deposits of South America

1–14 November 2003

An exciting field-based course in the Andes covering the major ore deposit styles of South America — deposit types include porphyry Cu-Mo, high sulfidation epithermal Au and iron-oxide Cu-Au. Mines visited include El Teniente (the world's largest underground mine) and Chuquicamata (the world's largest open pit). A series of presentations by researchers and exploration geologists working in South America will address the geology, tectonic setting and important exploration criteria for each deposit style. Course leaders: David Cooke and AndrewTunks

Volcanology and Mineralisation in Volcanic Terrains

14–28 March 2004

A two-part short course on volcanology and mineralisation in volcanic terrains for geologists interested in a review of current approaches to mapping, facies analysis and mineralsation in ancient and modern volcanic successions. The course is field-based on North Island of New Zealand and in western Tasmania. Course leaders: Jocelyn McPhie and Bruce Gemmell.

These courses form part of the National Geoscience Teaching Network, supported by the Minerals Council of Australia and DETYA. The course is offered jointly between CODES, the University of Western Australia, James Cook University, Monash University (VIEPS) and CRC LEME (University of Canberra).

Units offered by University of Western Australia:
Ore deposit models
Computer applied exploration techniques
Management for exploration and mining
Applied structural geology and field mapping
Ore deposit field trip to South Africa

Units offered by James Cook University (EGRU):
Advances in ore genisis
Resource definition: Theory and practice
Business and financial management
Advanced field training
Exploration techniques in ore search

Ore Solutions banner: Sulfides in tremolite+chlorite+calcite gangue representing metamorphosed chlorite+carbonate altered rhyolite;WestThalanga, north Queensland.

What the best-(hair)-dressed geologist wears! Robina Sharpe, between engagements with CODES, in discussion with geologists Peter Adjaye, Aziz Thompson and Sylvester Obyeng at Damang mine in Ghana.

CONTACTS

Director
Ross Large
Tel: (03) 6226 2819
Ross.Large@utas.edu.au
Deputy Director
Leader, Program 1
Education & PhD Coordinator
Tony Crawford
Tel: (03) 6226 2490
Tony.Crawford@utas.edu.au
Leader, Program 2
Jocelyn McPhie
Tel: (03) 6226 2892
J.McPhie@utas.edu.au
Leader, Program 3
Bruce Gemmell
Tel: (03) 6226 2893
Bruce.Gemmell@utas.edu.au
Leader, Program 4
Peter McGoldrick
Tel: (03) 6226 7209
P.McGoldrick@utas.edu.au
Leader, Program 5
David Cooke
Tel: (03) 6226 7605
D.Cooke@utas.edu.au
Short Courses & Masters Coordinator
Andrew Tunks
Tel: (03) 6226 2374
Andrew.Tunks@utas.edu.au
PA to the Director
Kylie Kapeller
Tel: (03) 6226 2472
secretary@codes.utas.edu.au
Book Sales
Nilar Hlaing
Tel: (03) 6226 2472
publications@codes.utas.edu.au
Publications and Media Resource Centre
June Pongratz
Tel: (03) 6226 2479
june.pongratz@utas.edu.au
Public Relations
SciBiz Media Group
Tel: (03) 6211 2335
jtyler@tassie.net.au