

ore solutions

Newsletter of CODES, an ARC Centre of Excellence in Ore Deposits at the University of Tasmania



New Centre of Excellence for UTAS

The Minister for Education Brendan Nelson recently announced that the Federal Government will fund a Centre of Excellence in Ore Deposits at the University of Tasmania. Eleven new Centres of Excellence have been funded by the Australian Research Council in this latest round of grants.

The Centre of Excellence will build on the outstanding reputation of the current Centre for Ore Deposit Research (CODES) and the School of Earth Sciences at UTAS.

UTAS will be the lead institution, linking with other internationally recognised research groups — including Colorado School of Mines, Johns Hopkins University, University of British Columbia, Julius Kruttschnitt Mineral Research Centre at University of Queensland, ANU, University of Melbourne and CSIRO.

\$15 million will be provided by the Australian Research Council over five years, matched by a further \$15 million coming from the Australian minerals industry, participating Universities and the Tasmanian government. The industry contribution includes over \$4 million from AMIRA International.

Professor Daryl Le Grew, Vice Chancellor at UTAS said, “This is a major coup for UTAS. It recognises that we have one of the top geology schools in Australia and one of the best in the world. With Centre of Excellence status, and all that it



Minister for Education Brendan Nelson (left), Ross Large and UTAS Vice-Chancellor Daryl Le Grew after the announcement of CODES' success in the latest round of ARC Centres of Excellence grants.

brings, Tasmania will become the global leader in mineral exploration research and technology.” This will be of major benefit to the Australian minerals industry.

Professor Ross Large, Director of the new Centre, said that the chief reasons for the success in gaining the Centre funding were the world-class research team at CODES, and very strong support from UTAS and the Australian and international minerals industry for CODES research. The minerals industry has guaranteed \$1.8 million a year towards the Centre's research programs. The main contributing companies are BHP Billiton, Newcrest, Anglo American, Zinifex, Newmont, Barrick, Teck Cominco, AngloGold Ashanti and RioTinto.

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CODES
Centre of Excellence in Ore Deposits
University of Tasmania
Private Box 79
Hobart Tasmania Australia 7001
Tel: 03 6226 2472
Fax: 03 6226 7662
www.codes.utas.edu.au

Haddon King Medal

The Australian Academy of Science awarded its Haddon King Medal for contributions to mineral discovery in Australia, to Professor Ross Large at a special ceremony in Melbourne recently.

The award recognises the contributions of the late Haddon Forrester King to the application of the geological and related sciences to the search for mineral deposits in Australia and elsewhere. Haddon King joined Zinc Corporation as its Chief Geologist in 1946, became Director of Exploration for the merged Conzinc Rio Tinto of Australia (CRA) in 1962 and continued in this capacity until his retirement in 1970. He was a consultant at CRA until 1986. The award is made to a scientist for original and sustained contributions to Earth and related sciences of particular relevance to the discovery, evaluation and exploitation of useful mineral deposits, including the hydrocarbons.

The citation accompanying the medal reads: "Ross Large is a Professor of Geology and the Director of the ARC Centre for Ore Deposit Research (CODES) at the University of Tasmania. Over the past 30 years he has made a major contribution to economic geology and has transformed CODES into the premier ore deposit research centre in Australia and into one of the top centres in the world. CODES has, very recently, been established as the ARC Centre of Excellence in Ore Deposits, with substantial new funding from the Commonwealth government and industry. Ross is recognised internationally for his research on the genesis of volcanic-hosted massive sulphide

deposits of Cu-Zn-Pb and stratiform sediment-hosted Zn-Pb-Ag deposits. His research has involved close collaboration with the mining industry to determine the geological and geochemical factors that control the genesis of, and exploration for, mineral deposits. His awards include the 1983 Society of Economic Geologists' Lindgren Award for research excellence and the 1989 Australasian Institute of Mining and Metallurgy President's Award. He was the Society of Economic Geologists Distinguished Lecturer for 1998 and President of the Society of Economic Geologists in 2004. He was elected to the Academy of Technological Sciences and Engineering in 1999."



Professor Richard Stanton (left) presented the Haddon King Medal to Ross Large on behalf of the President of the Australian Academy of

MOVING ON ...

Cathryn Gifkins, senior author of CODES publication *Altered Volcanic Rocks*, has departed these shores to join fiance Mike Buchanan (UTAS Master of Economic Geology 2002) in Vancouver, Canada.



MCA Lecturer **Andrew Tunks** has resigned from CODES, effective mid-September, to take up a position with Gallery Gold in Botswana. Asked how he would like this item to read, he said "Something that paints my going as a great loss to CODES and me as an all round good bloke who will be sorely missed, would be ideal." Says it all!



CODES Research Fellow, **Andrew Rae**, is leaving CODES to undertake geothermal research with the Institute of Geological and Nuclear Sciences in Taupo, New Zealand. Since finishing his PhD studies at UTAS, Andrew has worked on sulfide trace-element geochemistry related to gold and base-metal ore deposits.



CODES erstwhile computer support person, **Alistair Chilcott**, has moved on to the Menzies Research Institute (population health studies) in Hobart after four years with CODES.

Dean's Award for Research Excellence won by CODES Volcanology Group

One of the ways that the Dean of Science, Engineering and Technology, Professor Jim Reid, rewards the efforts of research groups in the faculty is through an annual award for research excellence. The award for 2005 went to the Volcanology Group, led by Professor Jocelyn McPhie.

The main players in the Volcanology Group are Sharon Allen (ARC Research Fellow) and CODES Research Fellows, Cathryn Gifkins, Wally Herrmann and Stuart Bull. PhD students in the Volcanology Program have also made a substantial contribution, being collectively very productive in converting their theses into papers in international journals.

Research performed by the Volcanology Group has led to major insights in three main areas:

- Advances in understanding the character and eruptive behaviour of submarine volcanoes; there are few research groups worldwide with expertise in this area, even though submarine volcanic rocks are the most common kind preserved on the continents and they dominate all the ocean basins
- Recognition that some volcanic units are far larger than anything produced in an historic eruption; we have identified lavas with dimensions far in excess of any produced by an active volcano and have greatly extended our concepts of the impact and magnitude of volcanic eruptions beyond that evident in the historic record
- Identification of the links between volcanic processes and the



The Dean of the Faculty of Science, Education & Technology Professor Jim Reid, Kate Bull (CODES PhD student), Sharon Allen (ARC Research Fellow at CODES), Jocelyn McPhie, David Bartlett MHA, and UTAS Vice-Chancellor Daryl Le Grew at the SET research awards evening, held at Parliament House, Hobart.

character, location and composition of hydrothermal systems that produce ore deposits; no longer are host rocks considered merely inert “containers” for hydrothermal systems; economic geologists now recognise that the volcanic “containers” participate in and strongly influence the series of steps that lead to ore deposition in and around volcanoes.

The Dean's Award for Research Excellence was presented to the Volcanology Group by the Vice-Chancellor, Professor Daryl Le Grew, at a celebration of the faculty's research achievements, held at State Parliament House in April. The award comes with cash grant (\$7500) and an engraved wooden plaque.

MOVING IN ...

Since our last newsletter was produced, CODES has welcomed the following new PhD and Honours students.

Susan Belford is studying the Jaguar VHMS deposit in the Eastern Goldfields of the Yilgarn Craton.

Reia Chmielowski is from Anchorage in Alaska, and has a BSc from Southern Oregon University, USA. She has come to CODES to work on the metamorphic history of Tasmania.

Teera Kamvong's PhD study is on the characteristics of intrusive-related porphyry-skarn Cu-Au deposits in the Loei Fold Belt, NE Thailand and Laos.

Joe Moyer is working on a reconstruction of the original architecture of the Ridgeway gold deposit and its lithotectonic environment in the late Proterozoic Carolina Terrane of South Carolina, USA. Joe has a BSc and MSc from North Carolina State University.

Ralf Schaa has an MSc in geophysics from Cologne University, Germany. His PhD project is on rapid approximation algorithms of TEM data.

Wojciech Zukowski comes to CODES from the Jagiellonian University (Geochemistry and Mineralogy Institute) in Krakow, Poland, after completing an MSc on the biomineralogy of apatites.

Weerapan Srirachan (aka Bee) is from Chiang Mai University in Thailand. At CODES, his PhD program involves the petrology, geochemistry and tectonic significance of late Palaeozoic and

Mesozoic mainly volcanic and volcanoclastic rocks in the Chiang Rai-Lampang belt in northern Thailand.

Quang Sang Dinh - Sang is a lecturer in igneous petrology at the Vietnam National University (Ho Chi Minh City) who has come to CODES to do a PhD on the tectonic evolution of the northern margin of the Khontum massif in central western Vietnam.

Honours students

Joel Kitto: Lithostratigraphy, alteration and mineralisation of the Cadia East porphyry Au-Cu Deposit, NSW.

John De Little: Aspects of the hydrothermal geology of the Loei Au deposit, Thailand

Adam King: Characterisation of heavy metal contamination in the subsurface of the Zinifex smelter, Hobart

Kim Hurd: Characteristics of the Jubilee Cosmos gossan and discrimination of Ni sulfide gossans from false gossans in the Norseman-Wiluna Belt, Yilgarn, Craton, WA

Melanie Sutterby: The structural history and alteration of Songyang gold deposit, EGP (NW Belt, WA)

Brendan McGee: The genesis of the Weldborough sapphires, NE Tasmania

Corey Jago: Tracking the Rosebery Host: Along-strike variation of units at the top of the CVC south of Rosebery Zn-Pb VHMS mine

Sam Ekins: Stratigraphy of the Sepon Lane Xane Cu Au deposit, Sepon, Laos PDR

Kathryn Harris: Characterisation and causes of dryland salinity in the Hamilton district, Tasmania



AMIRA P843 GeM^{III} Up and Running

CODES is pleased to announce that the AMIRA P843 GeM^{III} research project – Geometallurgical Mapping and Mine Modelling —has received major industry support and sponsorship and formally commenced on 1 January 2005 for a period of 4.5 years. The project marks a significant new research direction for CODES involving collaboration with the Julius Kruttschnitt Mineral Research Centre (JKMRC) at the University of Queensland, widely regarded as a world leader in mining and mineral processing. This is the first time that CODES and JKMRC have entered into a formal collaboration and the GeM^{III} project is a centrepiece for the new Recovery program in the Centre of Excellence.

The AMIRA P843 GeM^{III} project aims to develop new fundamental approaches to the quantification and integration of geological characterisation with mineral processing performance and mine optimisation. This represents the largest and most ambitious AMIRA project that CODES has been involved with and has received outstanding support from industry sponsors. The project was developed in direct response to industry needs with the research designed to support the major initiatives currently underway within many companies to develop geometallurgical integration.

The current sponsor list includes Newmont, Rio Tinto, BHP Billiton, Inco, Newcrest, Teck Cominco, Barrick, CVRD, WMC, Xstrata and Zinifex with additional sponsors currently under negotiation. A feature of the project will be site-based research carried out at six world-class mining operations provided by sponsors. According to Dr Alan Goode from AMIRA International the extent and rapid time frame of this industry support are unprecedented for major AMIRA projects and reflect the extremely positive reception of the project concept by companies around the world during its development. The level of industry sponsorship is expected to exceed \$1 million per annum of direct funding in the short-term. Following the success of the ARC Centre of Excellence submission the project will also receive around \$0.5 million per annum of direct funding from the new Centre.

Associate Professor Steve Walters is leading the project and reports that the first six months involved a phased ramp-up supported by industry in anticipation of the successful ARC funding outcome. This has now moved into full start-up from 1 July with a major sponsors meeting recently held in Brisbane to endorse the detailed research plan. In addition to the obvious

technical challenges there are a range of cross-discipline and cultural hurdles that need to be addressed by the research groups in order to avoid the 'silo' effect common on many operational sites. To assist with this process, the project manager will become a joint appointment between UTAS and UQ, spending equal time at both institutions.

The GeM^{III} project is based on a modular structure involving:

Module 1. A more effective approach to on-site core and chip logging based on automated multi-sensor logging instruments with routine software-based interpretation of data to define domains either through direct correlation with small-scale testing or use of indirect proxies for both mining (geotechnical) and processing attributes.

Module 2. An integrated micro-analytical 'mineral mapping' approach to quantified ore characterisation that will expand current SEM-based techniques (e.g. MLA and QemSCAN). This will involve integration with other analytical platforms including optical microscopy, IR microscopy, electron microprobe and the laser ablation microprobe. The aim is to provide cost-effective methods that allow more extensive use of automated mineral mapping at an early stage of ore characterisation.

Module 3. Application of new techniques for 2D/3D textural classification relevant to mineral processing based on statistical simulation of quantified data derived from Modules 1 and 2.

Module 4. Development of a methodology to correlate mineralogical and textural simulation with the results of empirical small-scale geotechnical and mineral processing testing, leading to a fundamental modelling approach that creates new mining and processing attributes.

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AMIRA P843 GeM Project team members at a workshop held at JKMRC, May 2005.

HAVING A BLAST

Kirstie Simpson graduated from UTAS in 2001. Her PhD involved study of the volcanic facies architecture of the Mount Windsor Volcanics in Queensland, under the supervision of Jocelyn McPhie and Ron Berry. After working at a geophysical observatory in Jamaica for a year, she returned to Vancouver to work for the Geological Survey of Canada. She has worked closely with many US Geological Survey scientists over the years and when Mount St Helens erupted in October 2004, was invited to help them in their response efforts at the Cascade Volcano Observatory.

Over three weeks, her field duties included assisting in the installation of a time-lapse camera on the crater rim, maintaining the GPS stations located on the volcanoes flanks, and observing and reporting any obvious changes in the growing lava dome. Office activities included participation in daily science meetings, providing information for media, building equipment and cables for instruments to be deployed on the volcano, taking shifts in the operations room (to monitor changes in the character, magnitude and number of seismic events) and leading an eruption chronology project (which involved compilation of all data, observations and representative photographs from the ongoing eruption).



Looking through a thermal imaging camera with Mount St Helens reflected in the lens.



Mount St Helens after a snowfall. View looking to the SE from Johnston Ridge Observatory.

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Module 5. Provision of methods to spatially model the distribution of new ore processing attributes into orebody models and integrate this modelling to mine planning optimisation and ore valuation.

Module 6. Delivery of formalised geometallurgical awareness, education and training that will help break down existing divides and promote the next generation of more multi-skilled mining professionals.

Although presented as discrete modules, a key aspect of the *GeM^{III}* project is integration of outcomes. The emphasis will be on research that can potentially generate new methodologies, tools and protocols that can be embedded in existing software-based interpretation, visualisation and mine planning packages wherever possible.

In addition to providing the main research impetus for the new Recovery program within the Centre of Excellence, the project will also facilitate a range of new hardware and expertise

that will support applications in other CODES programs. This includes the SEM-based MLA facility commissioned in the Central Science Laboratory during July, and the forthcoming acquisition of a GEOTEK automated core logger that will be equipped with a range of petrophysical and mineralogical sensors.

The MLA provides major new capabilities for automated mineralogical and textural mapping and analysis that are becoming standard techniques for mineral processing, and CODES will also be developing a range of more fundamental geological applications. Automated core logging has the potential to significantly increase the reliability and sophistication of current visual logging in relationship to processing attributes. The emphasis on petrophysical sensors will also provide an opportunity to generate much more extensive and systematic rock property data of direct relevance to improved geophysical exploration models.

For more details contact: Associate Professor Steve Walters <steve.walters@utas.edu.au>, phone +61 (0)412 31 233

New Automated SEM-Based Mineral Mapping Facility

The University of Tasmania was successful in late 2004 with an ARC Linkage grant application for a new SEM facility with automated mineral mapping capabilities. This has replaced the ageing SEM instrument in the Central Science Laboratory and provides state of the art facilities for Life and Earth Science applications. An important aspect for CODES will be provision of support for the AMIRA P843 *GeM^{III}* project in the area of automated mineral mapping and ore characterisation (see article in this edition of *Ore Solutions*).

Automated SEM-based mineral mapping (ASeMM) techniques have become widely used by resource companies for quantitative analysis of mineralogy and texture. The technique is based on a software-driven approach to the collection, processing and classification of point-based energy dispersive X-ray spectra typically using polished blocks or thin sections. Spectra are collected on a variable grid spacing that can range from tens of microns to less than one micron. Many thousands of spectra are collected to build up spatial resolution of mineralogy and texture. Mineral identification is on the basis of reference spectra that are a function of major element chemistry (generally >1%). The system is highly automated and capable of running with minimal supervision for long periods of time.

The automated and digital nature of the output allows a high-level of additional off-line data processing and analysis. This can include quantification of attributes such as grain size, texture and grain intergrowths or degree of liberation in the case of comminuted products. Compared to optical microscopy the technique is automated, is not operator-dependant and can resolve attributes that are not amenable to optical methods (e.g. Fe or Mn content of sphalerite).

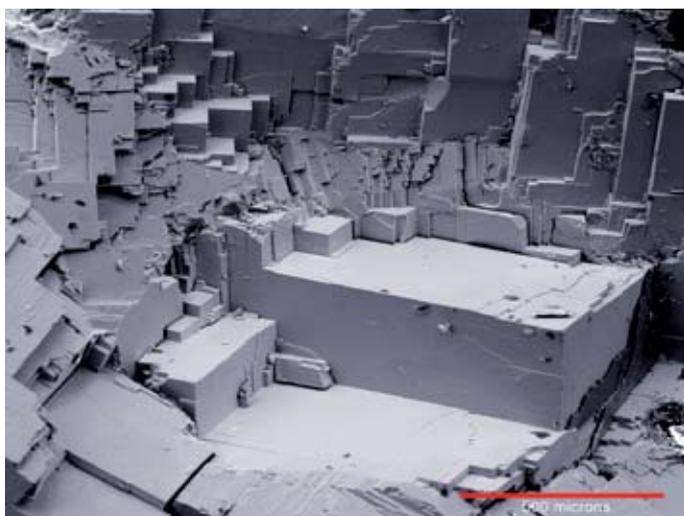
There are two current commercially available ASeMM instruments – QemSCAN (developed by CSIRO and now marketed by Intellection), and the MLA (developed and marketed by JKTech). Australia is a world-leader in the technology with in-house instruments now operated by the majority of the major global resource companies. These are largely used for routine process mineralogy applications including characterisation and auditing of comminuted feed or concentrates. Until recently the technology has not been widely appreciated or embraced by university-based research groups. This is about to change with at least four ASeMM facilities being established at universities in the UK, Canada and Australia during 2005.

The new University of Tasmania facility is based on an FEI Quanta 600 SEM with dual EDAX X-ray detectors equipped with MLA software. The system is capable of both ASeMM and high quality SEM, BSE and CL imaging for Earth and Life Science applications. Commissioning was completed in July 2005 and the facility is now fully operational. In addition to supporting the P843 *GeM^{III}* project a range of other geological applications will be investigated ranging from automated petrology to alteration studies and environmental remediation related to mining.

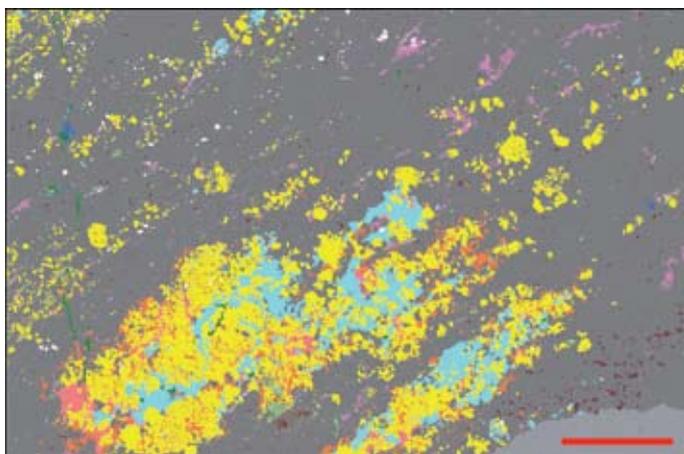
For more details contact: Associate Professor Steve Walters (CODES) <steve.walters@utas.edu.au>, phone +61 (0)412 319233.



Steve Walters at the new UTas MLA facility – FEI Quanta SEM with dual EDAX detectors.



Detailed view of cleavage planes in galena using the SEM in imaging mode.



MLA digital mineral map of a thin section of Rosebery ore showing mineralogy and texture identified using EDS X-ray mapping.

Submarine pumice: how, what and where

Pumice is a significant component of ancient marine volcanic successions, however the eruption of hot, vesicular pumice in several hundred metres of water has never been observed, confronting volcanologists with numerous outstanding problems regarding the processes involved. For example, how does vesiculation occur with increasing water depth? What are the effects on explosive eruptions of increasing water depth? What mechanisms are involved in dispersal and deposition of hot pumice? Finding the answers to such questions is a major part of Sharon Allen's research, funded by an ARC Discovery Grant.

The focus on pumice in CODES volcanological research arises because it is an important component of the submarine volcanic successions that host base- and precious metal ore deposits in eastern Australia. Collaborations between UTAS, the Japanese Marine Science and Technology Centre (JAMSTEC) and the Smithsonian Institution are allowing direct observation and sampling of pumice on the modern sea floor around submarine volcanoes along the Izu-Bonin Arc. At least one of these submarine volcanoes (Myojin Knoll) has also generated a substantial massive sulfide deposit.

Two recent JAMSTEC cruises (Kaiyo 2003, Natsushima 2004) have explored submarine volcanoes that produced coarse (up to 10 m) pumice clasts in the Sumisu area of the Izu-Bonin Arc. The volcanoes are well constrained by Sea-BEAM mapping, deep-tow camera and Remotely Operated Vehicle dives, and dredging. These rhyolitic volcanoes vary in eruption size (magma volumes 1-15 km³), eruption depth (1100 m to 120 m bsl) and morphology (single or nested dome complexes) and provide an opportunity to compare vesiculation and the formation of pumices at different water depths. Preliminary results suggest that, regardless of water depth, all volcanoes produced highly vesicular pumice (~70-80 vol% vesicles),



Piece of pumice with a quenched margin sampled by the Natsushima ROV. Sample size 25 cm across.



The RV Natsushima. View of the rear deck showing the Remotely Operated Vehicle used to map and sample pumice on the sea floor.

however, the volume of pumice produced significantly decreased with water depth. In addition, vesicle size and clast shape vary with water depth.

Sharon Allen

SEG Foundation Grants

Four CODES PhD students have won 2005 SEG Foundation grants for their research projects:

David Braxton, \$5000

Constraining the timing and tectonic environment of hypogene mineralisation and supergene oxidation at the Boyongan and Bayugo porphyry Cu-Au deposits, Mindanao, Philippines

Tim Ireland, \$5400

Structural and metallogenic evolution of the Collahuasi porphyry-epithermal district, northern Chile

Bryan Bowden, \$1800

Age and genesis of alteration and iron oxide Cu-Au mineralisation at Prominent Hill, South Australia

Teera Kamvong, \$3000

Geologic, mineralogic, paragenetic, isotopic and fluid geochemical characteristics of intrusive-related porphyry-skarn Cu-Au deposits: a case study at the Loei Fold Belt

The grants are in US\$ which makes them even better.

The SEG awarded 67 grants to students from 38 different universities in 15 countries: United States - 21; Canada - 17; Australia - 10; United Kingdom - 5; Bulgaria - 2; Germany - 2; New Zealand - 2; and one each from Argentina, Chile, Greece, Hong Kong, Nigeria, Russia, South Africa and Switzerland.

CODES success of four of the ten grants for Australia is excellent. Congratulations David, Tim, Bryan and Teera for a great effort.

Brownfields Exploration

CODES latest Masters course — Brownfields Exploration — has been developed to cover a wide range of topics and exploration strategies designed to facilitate exploration in the data-rich environments close to mining operations. Thirteen Masters students and two visitors from Anglo American's operations in India attended the inaugural course.

Simon Gatehouse presented on new geochemical techniques and making the most of historical data. Vic Wall, from Taylor Wall and Associates, presented an excellent and inspiring half day on the winning submission to the US\$100,000 GoldCorp Challenge, and the geology of the Red Lake Dome district. Ian Tedder, from Newcrest, documented the discovery history of the Cadia Ridgeway system.

Of course, the guest presenters were ably complemented by in-house staff including Steve Walters, Michael Roach, James Reid, Ross Large, Peter McGoldrick, Bruce Gemmill, Kim Denwer and Andrew Tunks.

The culmination of the course came during the "West Coast Challenge", which is a two-day data compilation and targeting exercise based on 3D integration of open-file data from 50 years of exploration in the Mount Read Volcanic Belt

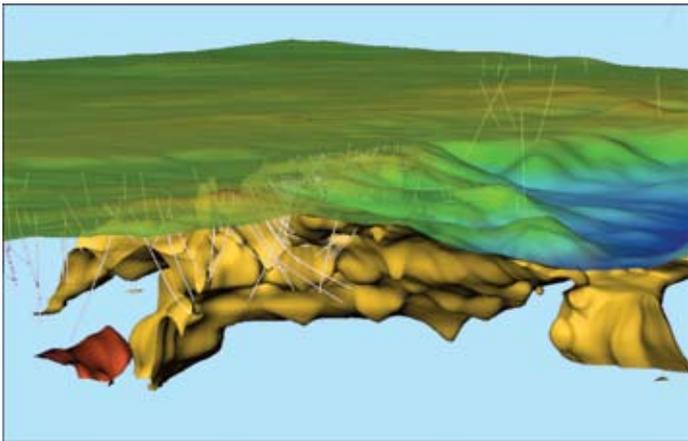
of western Tasmania. Students selected which datasets they felt most relevant and planned a limited drilling program to test for VHMS-style mineralisation in the Que River–Hellyer area. The large amount of available historical data, use of geophysical inversion models for detailed magnetics and gravity, and ability to visualise and integrate the data in 3D using FracSIS software, presented a genuine challenge. Students were then required to prepare a Powerpoint® presentation and present their exploration programs to a panel of judges.

The inaugural winner was Steven Groves from Newmont, closely followed by Steve Brown. The cup was presented by Steve Walters — which tells you that too many Steves were involved!

CODES acknowledges Intec for permission to use data from Hellyer, software support provided by Fractal Technologies and Leapfrog, and use of data compilations from the Tasmanian 3D Geological Model produced by Mineral Resources Tasmania.

Many thanks to GoldCorp for making the entire mine and exploration database of the Red Lake Mine available for the students to use in exercises.

The Brownfields Exploration course will be run again in 2006.



Example of 3D data integration used in West Coast Challenge. Orange and red are magnetic susceptibility isosurface volumes, drill traces in white, topography colour coded for relief. Hellyer-Que River region



Steve Walters presenting the "West Coast Challenge" trophy to Steve Groves.



Participants in the Brownfields Exploration short course.

Dima Kamenetsky



CODES post-doc Dima Kamenetsky (pictured) has been awarded a prestigious five-year Australian Research Council Professorial Fellowship (APF) to continue his research on the exsolution of fluids from magmas, and their potential role in forming ore deposits, based on the melt inclusion methodology. Only one or two APFs are awarded annually in the earth sciences,

and this award is a great credit to Dima, an endorsement of the value of his ground-breaking research, and a just recognition of his outstanding publication record.

Dima completed a PhD at the Vernadsky Institute of Geochemistry in Moscow in 1991 with Prof. Alex Sobolev. Soon after, Dima was awarded a two-year post-doctoral fellowship at UTAS to work on melt inclusions as an aid to elucidating conditions of generation and crystallisation of mafic magmas. Following this, Dima moved to Paris for a one-year post-doc with Prof. Robert Clocchiatti in 1993–94, before returning to Hobart and winning an Australian Research Council (ARC) post-doctoral fellowship (1995–98). This was followed by another ARC post-doctoral fellowship (1999–2003), during which Dima became an Australian citizen and shifted his focus to melt inclusions in felsic magmatic systems, research carried on into 2004 and funded by CODES.

Dima's major research interests and publications fall within three overlapping themes: (1) petrology and geochemistry of mantle-derived mafic and ultramafic magmas in diverse

tectonic settings, including island arcs, ocean floor basalts, flood basalts, and intra-plate basalts. (2) the application of melt inclusion studies to altered rocks in ophiolites and ancient volcanic belts, and (3) the evolution of volatiles and metals during crystallisation of both mafic, and felsic magmas. The latter research, in particular, has led to some ground-breaking developments in our understanding of the way that fluids are exsolved from felsic magmas, and how they change physically and chemically with decreasing temperature. This work has important implications for the formation of porphyry Cu-Au and VHMS deposits, and it is notable that some of Dima's more recent papers are in *Economic Geology* (as well as the more fundamental journals such as *Earth and Planetary Science Letters* and *Journal of Petrology*).

Dima has averaged 7–8 papers per year in leading journals over the last three or four years, an outstanding effort, and one that reflects his astonishing (even alarming!) commitment to his research. He has collaborated widely at both the international and national level, and perhaps more than any other person at CODES, he has sought to 'cross-pollinate' ideas and research directions across CODES five research programs. Strongly supported by his wife Maya, herself a graduate petrologist from the University of Moscow and now a CODES PhD student, Dima lives and breathes his work. In every sense, and as justifiably recognised by his continuing support from the Australian Research Council and CODES, he epitomises the 'perfect post-doc' in being energetic, capable, entrepreneurial, reliable, highly productive and friendly on all fronts. Despite Dima having had several recent job offers from abroad, we are privileged that he has chosen to stay on at CODES, now as one of Australia's leading hard rock geologists.

Tony Crawford



Altered Volcanic Rocks

A guide to description and interpretation

Cathryn Gifkins, Walter Herrmann and Ross Large

A follow-up to the highly successful "Volcanic Textures"

Altered volcanic rocks is designed to be a practical guide for systematically describing and interpreting altered volcanic rocks, and determining their significance in terms of mineral deposit prospectivity. It discusses the processes and products of the common alteration styles in submarine volcanic settings, including diagenetic alteration, burial metamorphism, hydrothermal alteration and mineralisation, and intrusion-related alteration. It takes a multi-disciplinary approach combining alteration mineralogy, textures and intensity with litho-geochemistry to constrain the characteristics of different alteration styles. To emphasize the ore deposit context, the book includes a major chapter that uses innovative illustrated data sheets to describe the main alteration facies or zones associated with a variety of volcanic-hosted massive sulfide (VHMS) deposits. The final chapter describes and presents examples of how altered rocks and their characteristics may be applied to exploration for volcanic-hosted deposits.

The book contains 275 pages: 127 figures and 66 full-page alteration data sheets, which include 274 colour photographs that illustrate the textural and mineralogical characteristics of different alteration intensities, facies and styles.

\$AUD135.00
(plus postage and packing)

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SEG Top End Geo-Explorer Tour

From 11–22 July 2005, six members of the University of Tasmania Student Chapter of the Society of Economic Geologists undertook a major event — the “Top End Geo-Explorer Tour” — in the Northern Territory, Australia.

Our first day was an easy drive south from Darwin to Batchelor and the Browns polymetallic deposit. The Browns deposit is near the former Rum Jungle uranium deposit, and we were given a very enthusiastic and comprehensive tour of the regional and local geology by site manager John Earthrowel and then spent the afternoon looking at some drill cores and spectacular samples. Late in the afternoon, we made a quick dash for the Litchfield National Park and a cooling dip at Florence Falls.

Our second day was another easy drive east to the Toms Gully gold deposit and then Jabiru. Toms Gully is a medium sized gold deposit and is about to commence underground mining from its exhausted open pit. In the morning, Scott Hall, mine geologist, showed us around the open pit, the processing plant and gold room. After lunch, he showed us some typical sections of drill core. Late in the afternoon, the bus departed for Jabiru and a welcome swim in the caravan park pool.

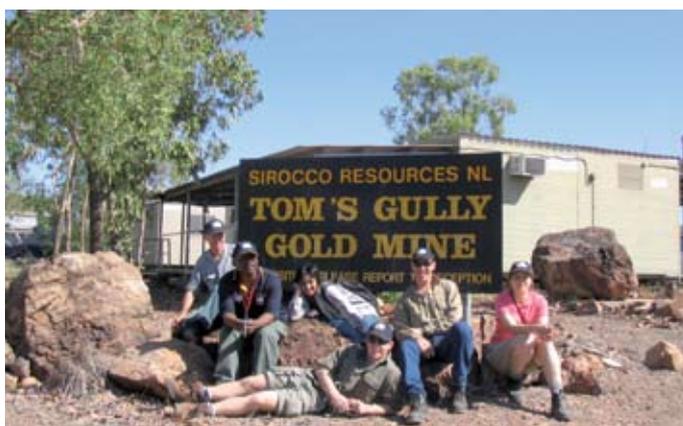
Day 3 was spent in the world heritage Kakadu National Park. In the morning, we drove to Ubirr – renowned as one of the best Aboriginal art sites in Australia. A short walk nearby provided some spectacular scenery of the sandstone ranges to the west, and swamps/floodplains to the east. In the afternoon, we visited Nourlangie Rock, another famous site for Aboriginal rock paintings, and again, spectacular scenery. Back to Jabiru for yet another swim, a pleasant winter's day at just 34°C!

Day 4 – Ranger Uranium mine visit. During the day Peter, Chris and Emily from the geological office explained some of the geological and geotechnical challenges of the deposit. After a tour of the #3 open pit, we viewed some recently drilled core from the ongoing exploration activities.

Day 5 was a driving day from Jabiru to Katherine via Pine Creek. The NT is the place for unusual sights —roughly half-way to Pine Creek, we passed a guy on roller-blades with his friend in support on a bike! Pine Creek was only another ~150 km ahead!

On Day 6, the team went for a quick trip to Edith Falls, just north from Katherine. In the afternoon, the highlight was a canoe paddle through the Nitmiluk Gorge National Park (Katherine Gorge). The gorge has numerous sections, each with a small series of “rapids” between which need to be negotiated with the canoes. Aside from the stunning scenery and cool water, paddling canoes was a first for both Yee and Singoyi.

Day 7 was a designated travel day – from Mataranka to Cape Crawford via Daly Waters. Far from being a long day watching the scenery change outside, we unwittingly tagged along with the Coffin Cheaters motorcycle gang on their annual trip. Speeding along at 130 km/hr most left us in their dust. The bikies travel in style and leave nothing to chance, even having their own support B-Double semi trailer and a catering van! Just as impressive as the sight of ~100 Harley Davidson bikes was the NT police and SWAT team entourage: one police officer/Coffin Cheater! By the end of the night at Cape Crawford, we had almost secured a few PhD recruits.



NT adventurers (L to R) Alan Chester, Singoyi Blackwell, Kromkhun Kamonporn (Yee), Bryan Bowden, Rod Maier and Sofia Tetroeva.

On Day 8, we drove from Cape Crawford to the Merlin diamond deposit for a tour. During the day, exploration manager Tom Reddicliffe gave us a comprehensive and enthusiastic tour. Tom and Striker Resources kindly allowed us to stay at the Merlin camp for the night.

On Day 9, up early, we drove back to the main road and headed north to the McArthur River Zn-Pb mine for the day. Mine geologist Nick Spanswick showed us a typical drill core intersection and the results of rapid core oxidation in the tropics. We then headed underground for a look at the orebody up close. After lunch, we collected a few specimens of hemimorphite from the oxidised discovery outcrop, and viewed some spectacular stromatolite boulders and outcropping orebody in the dry McArthur River bed.

Day 10 was a designated driving day as we headed from Cape Crawford to Tennant Creek.

On Day 11, we visited Giants Reef Mining and their Chariot/Malbec gold mines. The morning was spent at the office with Exploration Manager Brad Parker who gave us a presentation on the company's operations, its exploration strategies and the regional geology. In the afternoon, mine geologist Ian Blutcher showed us around the Malbec and Chariot open pits followed by a viewing of some representative drill cores.

Day 12 was the final day of the trip. After packing the mini bus for the last time, we headed ~400 km to Alice Springs. Along the way, we stopped at the Devils Marbles and the not-so scenic towns of Elliot, Ti-Tree and Barrow Creek.

The tour had been a great success, thoroughly enjoyed by all the participants. In addition to the past and present members of the UTAS SEG Student Chapter, we would like to acknowledge assistance and support from Phil Ferenczi and Ian Scrimgeour from the Northern Territory Geological Survey.

A trip such as this requires a substantial amount of funding. During the past two years, a number of fundraising events have been held by the UTAS SEG Student Chapter. In addition, the trip would not have been possible without the direct financial sponsorship from CODES, the Society of Economic Geologists and the following organisations: the Northern Territory Minerals Council (Inc); Anglo American Exploration, Australia; Copper Co.; TasGold Ltd; Oxiana Ltd; Newcrest Mining Ltd; Gravity Diamonds Ltd; and Boyer Exploration & Resource Management Pty Ltd. We thank you all sincerely.

Bryan Bowden

Fieldtrip to Lena Gold Fields, Siberia



A general view of the Sukhoi Log hill that contains the deposit, looking south. The open pit of the Zapadnoe deposit is in the middle distance at the right-hand side of the photo.

In July this year, Ross Large and Leonid Danyushevsky visited Sukhoi Log, one of the world largest sediment-hosted gold deposits. This trip is a part of CODES research project “Sediment-hosted gold deposits”, led by Rob Scott, which is aimed at understanding the source(s) of gold in this type of ore deposit. The trip was organised by Prof. Valery Maslennikov from the Institute of Mineralogy of the Siberian Branch of Russian Academy of Science (SB RAN), who obtained permission to visit the deposit from the Lena Gold Mining Company (LGMC).

The first stop of the trip was Irkutsk, a large Siberian city near Lake Baikal, the largest fresh-water reservoir on the Earth. The deepest parts of Lake Baikal are >2 km. The Baikal Rift was formed during the Tertiary and is ~11 km deep. The bottom 8.5 km of the rift is filled with sediments. In Irkutsk we were joined by Prof. Maslennikov, Dr Andrian Sintsov from the Institute of Earth’s Crust SO RAN in Irkutsk, Prof. Vladimir Simonov from the Institute of Geology and Geophysics SO RAN in Novosibirsk and Dr Oktyabrin Sadyrov, Vice-President of the Kara-Balta Analytical Laboratory in Bishkek, Kyrgyz Republic.

From Irkutsk we flew ~1000 km north to Bodaibo, the central town of the Lena Goldfields. In Bodaibo we visited the headquarters of the LGMC where we were given maps with drillhole locations within the Sukhoi Log and several cross-sections of the deposit. The deposit is located near Kropotkino, ~100 km northwest of Bodaibo. In Kropotkino we stayed at the Vernensky Mill owned by the LGMC.

Sukhoi Log was discovered in the 1960s and extensively explored in the 1970s. The main type of gold mineralisation is in the form of disseminated pyrite within a monotonous Proterozoic sequence of thin-bedded black shale and siltstone. The deposit has no surface outcrop and is located at depths of 40–400 m. Total reserves of the deposit are estimated at 50 Moz of Au. Several smaller deposits have also been discovered in the area, one of which, Zapadnoe (~ 2.4 Moz), is at the western termination of Sukhoi Log and is currently being mined from an open pit by the LGMC.

During the fieldtrip, ~240 samples were collected (mainly core from drillholes within and around the Sukhoi Log deposit, and also from the pit of the Zapadnoe deposit). We plan to study the trace-element geochemistry of the sulfide mineralisation by laser-ablation ICPMS at CODES.

Leonid Danyushevsky



Vernensky Mill near Kropotkino.



Ross Large (left) and Valery Maslennikov in the open pit of the Zapadnoe deposit.

Leaders

Drs David Cooke and Peter McGoldrick

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Contact

For more information on ORE DEPOSITS OF SOUTH AMERICA contact Peter McGoldrick.
P.McGoldrick@utas.edu.au
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CONTACTS

Director

Ross Large
Tel: (03) 6226 2819
Ross.Large@utas.edu.au

Deputy Director

Bruce Gemmell
Tel: (03) 6226 2893
Bruce.Gemmell@utas.edu.au

Leader, Program 1, Location

Tony Crawford
Tel: (03) 6226 2490

Tony.Crawford@utas.edu.au

Leader, Program 2, Formation

David Cooke
Tel: (03) 6226 7605

D.Cooke@utas.edu.au

Leader, Program 3, Discovery

to be appointed

Leader, Program 4, Recovery

Steven Walters
Tel: (03) 6226 2804

Steve.Walters@utas.edu.au

Leader, Program 5, Technology

Leonid Danyushevsky
Tel: (03) 6226 2469

L.Dan@utas.edu.au

Education Program

Jocelyn McPhie
Tel: (03) 6226 2892

J.McPhie@utas.edu.au

PA to the Director

Katrina Keep
Tel: (03) 6226 2472
secretary@codes.utas.edu.au

Book Sales

Katrina Keep
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



Anthony Harris training for the Tour de France. This photograph was taken (in the early hours of the morning) during Anthony's visit to the Advanced Photon Source, Argonne National Laboratory, Chicago, in December last year.

Ore Solutions banner: Polished core slab from Mount Isa showing dolomitic siltstone and shale beds (dark) interbedded with crinkly laminated fine grained pyrite and coarser, sphalerite-rich, base metal sulfides (brown). Height of photo is 35 mm.



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