ore solutions

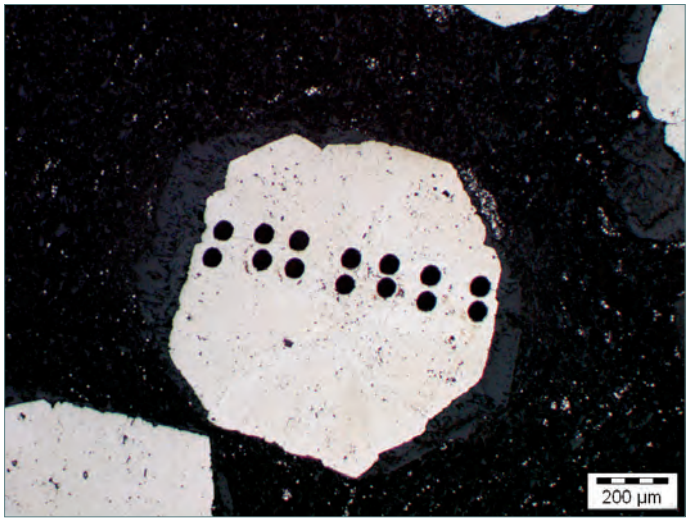
Newsletter of CODES, the ARC Centre of Excellence in Ore Deposits at the University of Tasmania

The latest in laser technology at CODES

Laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS) is rapidly becoming the analytical technique of choice for a range of geological materials. High spatial resolution quantitative analysis of ore sample trace elements can characterise the compositions of different growth zones within minerals and of different mineral generations, providing new insights into ore-forming processes. The compositions of different generations of fluid inclusions within ore samples can also provide information on the evolution of the fluid component of the ore-forming system. Add to this the ability to derive the precise age of a geological event with U-Pb dating of zircons and monazites and you have a powerful research tool.

CODES LA-ICPMS analytical facility has recently installed a new mass spectrometer and laser microprobe. The mass spectrometer, an Agilent 7500cs quadrupole, is designed for analysis of almost the entire periodic table of chemical elements. It can analyse concentrations from trace elements (tens of ppb) to major elements, but will mainly be used for trace elements. The instrument analyses elements consecutively in order of their atomic mass, and is characterised by a very fast switching time between the elements (2–3 ms) and a very short measuring time for each element (about 20 ms). Thus, a set of 40 element concentrations can be measured in a sweep lasting less than half a second. To perform a quantitative analysis, 100 to 200 sweeps are required resulting in a total analysis time between 1 and 2 minutes. Traditionally, bulk samples of rocks are first digested in a mixture of acid and then their compositions are analysed by percolating the resultant solution into the mass spectrometer. However, the sweep rate of the quadrupole mass spectrometer allows analyses in situ, with continuous laser ablation of the material of interest. This new laser technology has significantly improved the rate of analysis of elements of interest to ore deposit researchers.

The newly purchased laser probe, the first of its kind in Australia, uses an ultraviolet Nd-YAG solid-state laser with the final wavelength of 193 nanometres. The ablation rate of this laser is about 1 micrometre per second and the diameter of the beam can vary from 8 to 100 micrometres, providing a very high spatial resolution. This laser probe allows for analysis of a wide range of minerals and their various inclusions, again significantly improving the rate of analysis of elements.



Ablation holes in pyrite from Que River shale, near Hellyer VHMS deposit, western Tasmania

Currently, CODES performs quantitative analyses of sulphide, silicate and oxide minerals, metals, fluid and solid inclusions in minerals, natural and experimental glasses, and fish otoliths. With a team of 30 researchers and five technical staff, CODES has an analytical solution for a variety of difficult mineral questions. For more information on our analytical services contact Leonid Danyushevsky (email: l.dan@utas.edu.au).

IN THIS ISSUE

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MOVING IN …

Jaqueline (Jacqui) Halpin has just completed her PhD with Prof. Geoff Clarke and Dr Nathan Daczko at the University of Sydney, working on metamorphic petrology and geochronology of Precambrian rocks in Antarctica. She will be working this year with Tony Crawford on documenting the age, P–T conditions of formation, and tectonic significance of metamorphic rocks dredged last year from the Naturaliste Plateau off WA, and from the adjacent on-land Pinjarra Orogen.

Christopher Hollitt has Honours degrees from the University of Adelaide in electronic engineering and in physics. He has recently submitted a PhD thesis on the design and construction of a laser-based instrument to measure minute vibrations in sapphire and other optical media. His interests are in precision metrology, mathematical modelling and electronic and optical design. He will be looking after the lasers and helping with the running and development of the ICPMS systems.

Caroline Mordaunt joined CODES as a part-time administrative assistant at the beginning of February and assists June Pongratz in the Media Resource Centre. Since graduating in English from King's College, London, she has worked in the publishing industry (magazines, books, journals). She is also a freelance editor and proofreader.

Anya Reading received a PhD from the University of Leeds, UK, for research on subduction zone structure in New Zealand. Following five years in marine and land-based geophysics with the British Antarctic Survey, she joined the University of Edinburgh as a Lecturer in 1998. In 2000, she moved to Australia, taking up a Research Fellowship at ANU. Anya now holds a joint appointment as Senior Lecturer in Geophysics within the School of Earth Sciences and CODES. Anya specialises in finding the structure of the crust and uppermost mantle, by geophysical means, in remote and challenging environments, and brings to CODES her experience in a wide range of earth science applications to the development of field and computational techniques in applied and environmental geophysics. An avid West Coast Eagles fan, we won't hold that against her.

Donna Roberts comes to CODES from the UTAS Antarctic CRC where she received a PhD in Antarctic microbiology, undertook two post-docs in Antarctic palaeoclimate and a year as Communications Manager. Last year Donna tasted life with the State Government, developing the Department of Economic Development's Tasmanian Biotechnology Industry Strategy. A recovering academic, Donna takes on the role of Communications and Technology Transfer Manager for CODES and is responsible for public relations, reporting requirements, research contracts, IP and commercialisation. Go the Dons!

Mengist Teklay is an igneous petrologist–geochemist from Eritrea. He recently completed post-doctoral work at the Max Planck Institute and the University of Munster in Germany on the geochemistry of 30 Ma flood basalts in the Ethiopia-Eritrea-Yemen region. He will be working this year with Leonid Danyushevsky, Andrew McNeill and Tony Crawford applying melt inclusion and PGE studies to elucidating links between flood basalt compositions and their potential to form PGE- and NiCu-deposits.

Olga Vasyukova, awarded a CODES PhD scholarship to work with Dima Kamenetsky and Leonid Danyushevsky, will research economic mineralisation in porphyry systems (e.g. Cu-Mo-Au), aimed at establishing the role of silica gel in the formation of porphyry ore deposits.

CODES population explosion continues — Cathryn Gifkins (PhD 2001 and Graduate Research Fellow) and Michael Buchanan (M.Econ.Geol.2002) are the proud parents of Heath Robert, born on ANZAC Day in Vancouver, Canada. Our best wishes go to the new family.

Australian Journal of Earth Sciences: Thematic Issue on the Ordovician Macquarie Arc, NSW

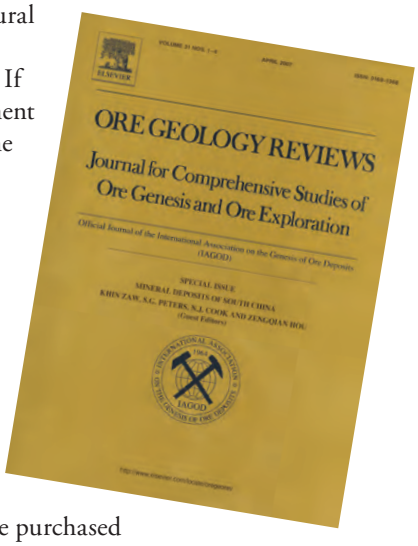
Co-editors Tony Crawford and Dave Cooke are proud to announce the arrival of their *Australian Journal of Earth Sciences* Thematic Issue on the 'Geological evolution and metallogenesis of the Ordovician Macquarie Arc, Lachlan Orogen, NSW'. Published by the Geological Society of Australia, the March/April 2007 edition (Volume 54) contains 14 papers of which 13 are authored by CODES researchers. It covers Ordovician to earliest Silurian history and development of the Macquarie Arc through to Middle and Late Ordovician magmatic evolution, components and structure, and more! Congratulations to all involved.

Ore Geology Reviews: Special Issue on mineral deposits of South China

Khin Zaw and fellow guest editors Stephen Peters, Nigel Cook and Zengqian Hou are pleased to announce the publication of their *Ore Geology Reviews* Special Issue on 'Mineral Deposits of South China' (Volume 31).

Ore Geology Reviews, the Journal for Comprehensive Studies of Ore Genesis and Ore Exploration, aims to familiarise all earth scientists with recent advances in a number of interconnected disciplines related to the study of, and search for, ore deposits. This special issue focuses on the variety of mineral resources in the South China region located north of Myanmar, Lao PDR, and Vietnam, and includes Yunnan, Sichuan, Guizhou, Hunan, Guangdong, Jiangxi, Hubei, Fujian, Anhui, Zhejiang, Jiangsu, Tibet, part of Shandong Province, and the Guangxi District.

China is the driving force and powerhouse of a currently booming global metals industry and now attracts more foreign direct investment than any other country. China has undergone rapid economic growth for the past 15 years and this growth has spread to other countries in Asia, such as India and SE Asia. Development in China has been influenced primarily by infrastructure projects and this has resulted in significant demand for mineral resources. The emergence of China, and India, is producing a structural rather than cyclical shift in the global minerals market. If China's economic development matches South Korea's in the next 25 years, the demand for copper in China could outstrip current world production



This Special Issue, a timely publication, is recommended to geo-scientists with an interest in the future of ore genesis and exploration in South China.

This Special Issue can be purchased online from the CODES bookstore for $77 plus postage. <www.codes.utas.edu.au>

2007 Ore Deposits of South America Short Course

David Cooke and Bruce Gemmell recently led a CODES-Minerals Council of Australia (MCA), National Masters Program short course through some of the best-known ore deposits of South America. CODES students and staff, together with industry representatives from Australasia and the Americas, were treated to an exhilarating geologic exposé of contrasting worlds across the Andes — visiting the extreme Atacama Desert in Chile followed by the Peruvian rainforest.

The 15-day course visited a wide range of deposit types, highlighted by excursions to the world's largest open pit and underground porphyry copper mines, including Chuquicamata, Rio Blanco and El Teniente. The CODES-MCA group was shown open pit and drillcore from several large-scale and well known iron-oxide copper-gold deposits (Candelaria, Manto Verde) and epithermal gold deposits (El Penon, Colquijirca and Cerro de Pasco). The enormity of these Chilean mining operations was contrasted with the small family-owned zinc-lead operation exploiting the San Vincente MVT deposit visited deep in the Peruvian rainforest. The group was also fortunate to visit an advanced exploration camp at Sierra Gorda, Chile.

Comprehensive presentations by enthusiastic mine and exploration geologists, combined with research highlights from David Cooke and Bruce Gemmell, ensured that the CODES-MCA study group gained new insights into these world-class systems and the exploration strategies used in their discovery.

An exciting and educational time was had by all. One exhilarated student is quoted as saying, "this trip was the best thing of my geologic career".

The CODES-MCA Ore Deposits of South America short course is run biannually, and is recommended for both students and industry participants seeking training in ore deposit geology. It is made possible with the logistical support of mine staff and industry interpreters. Please contact David Cooke or Tony Webster for information regarding future South American short courses.

Underground at El Teniente, Chile.

David Cooke lecturing in the core shed at Sierra Gorda, Chile.

Congratulations Tony!

One of CODES own, Tony Crawford, received the Royal Society of Tasmania's Clive Lord Memorial Medal at a special presentation at the Society's rooms at the Tasmanian Museum and Art Gallery on 1 May 2007. The Royal Society Chair, Professor John Hunn, presented the medal to Tony for his contribution to understanding the geological evolution of Tasmania. Tony joins several well-known researchers on the Clive Lord recipient list including Phillip Law (leader of the Australian National Antarctic Research Expeditions 1949–66 and founder of Mawson, Davis and Casey bases in Antarctica) and Winifred Curtis (champion of Tasmanian plants and author of the multi-volume *Flora of Tasmania*). Tony presented his Clive Lord Memorial Lecture to a capacity crowd and all had a most enjoyable evening.

Tony Crawford (CODES) receiving the Clive Lord Memorial Medal from the Royal Society of Tasmania Chair, Professor John Hunn.

RoundUp 2007

A delegation of CODES staff and students attended RoundUp 2007 in Vancouver from 29 January–1 February. Mineral Exploration Roundup, the world's largest technical mineral exploration conference organised by the Association for Mineral Exploration British Columbia, attracts geoscientists, technicians and exhibitors from around the world and largely focuses on ore exploration. RoundUp 2007 attracted a record attendance with more than 6000 participants from 30 countries.

CODES showcased its research expertise in ore deposit location, formation, discovery, recovery and technology, its publications, including the newest release, 'The Geology of the Broken Hill Pb-Zn-Ag Deposit', and attracted interest in research higher degree courses.

In addition to exhibiting at RoundUp 2007, Ross Large presented a short course entitled 'View from the fringe: Far-field alteration around ore deposits'. The two-day course, aimed at mineral exploration, government, academic and student geologists provided an opportunity to meet and exchange data and views with leading researchers in the field. The course examined the fringes of ore deposits in a range of environments, including sedimentary rock hosted (SEDEX, sedimentary copper, Carlin gold), volcanic rock hosted (VMS) and intrusion hosted and centred (porphyry, skarn and cordilleran base metal). As hydrothermal systems are much larger in aerial extent than any concentration of metals, being able to identify the scale of the systems and recognising where an altered outcrop or drill holes sit within a palaeohydrothermal system can provide important vectors towards undiscovered resources.

For the second year in a row, David Cooke, Jocelyn McPhie and Bruce Gemmell, together with Andrew Davies (CODES PhD 2003; Teckcominco) and Kirstie Simpson (CODES PhD 2001; Geological Survey of Canada) taught a short course entitled 'Volcanology and breccias for the explorationist: From description to interpretation'. The three-day course consisted of lectures on physical volcanology and breccia formation and classification. These were combined with hands-on practical exercises consisting of hand-sample observation and interpretation and an introduction to graphic core logging principles. Fifty participants from the exploration and mining industry, government geological surveys, academia and PhD and Masters students attended.

Jacqui Blackwell, Sarah Gordee, Bruce Gemmell and Ross Large at CODES RoundUp 2007 booth.

Jocelyn McPhie revealing the secrets of graphic core logging.

A quinella for UTAS earth sciences graduates!

Emeritus Professor David Groves, a UTAS graduate, received the Australian Academy of Sciences 2007 Haddon Forrester King Medal for original and sustained contributions to earth and related sciences at an award ceremony in Perth (WA) on 16 May 2007. The Haddon Forrester King Medal, sponsored by Rio Tinto, recognises the contributions of the late Haddon King to the application of the geological sciences to the search for Australia's mineral deposits. The award is for work of particular relevance to the discovery, evaluation and exploitation of mineral deposits, including the hydrocarbons. Ross Large, himself a UTAS graduate and Haddon Forrester King Medal recipient (2005) attended the ceremony on behalf of CODES.

Michael Skirka
1 April 1969–8 April 2007

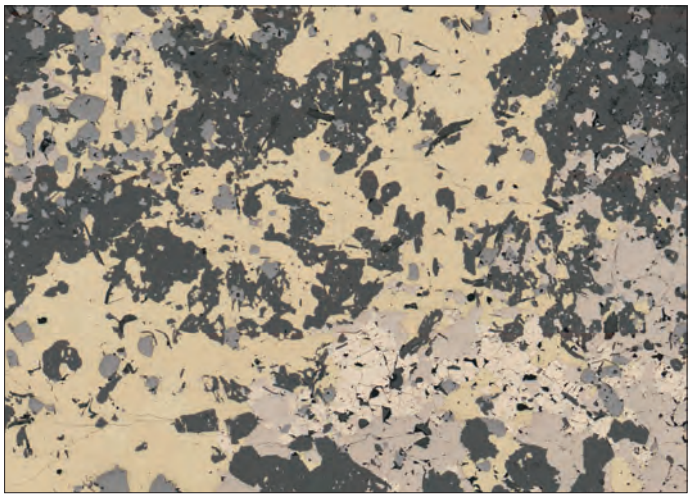
The Tasmanian geological community was saddened last Easter to hear of the death of Michael (Mick) Skirka as a result of an fall while climbing on Federation Peak in Tasmania's southwest. Mick was one of the most outstanding students to pass through CODES in the last decade. He had a genuine curiosity about about how the Earth worked and an insightful mind. He was a mature-age student who found his vocation a little later than most and graduated with First Class Honours in 1998. His Honours research, supported by Zinifex (then Pasminco), was on the Duddar zinc deposit in Pakistan. Although, a long time since he did his Honours work, Mick was excited to have the opportunity to present his Duddar story at CODES 'Ores in Sediments' meeting last November. A paper he prepared on Duddar will appear in the forthcoming conference volume. At the time of his death Mick was employed by Zinifex, exploring for base metals in the Mount Read Volcanics near Rosebery. Colleagues and friends at CODES and SES extend their sympathy to his partner Louise and young sons Hamish and Angus.

Polarising views at CODES

CODES with the support of Anglo Platinum, has recently installed a fully automated Leica DM6000 polarising microscope. This system can generate mosaic images up to 4 cm^2 with a resolution of 2 microns. The high precision stage allows for close registration of transmitted and reflected light images so they can be combined in multispectral image processing systems for accurate automated mineral mapping. This system is particularly advantageous for the study of ore deposits where the abundance and distribution of gangue minerals influences the mineral processing behaviour.

Ron Berry demonstrated the new microscope at CODES after the AMIRA P843 GeM^{III} sponsors meeting in Hobart last February. GeM^{III} is developing protocols for using optical microscope images to produce automated mineral maps suitable for application to geometallurgy.

Ron Berry (on right) demonstrating the new polarising microscope to (left to right) John Hammond (Newmont), Robert Schoustra (Anglo Platinum) and Roger Leighton (Anglo Platinum).



Sample of Sudbury ore. Chalcopyrite (yellow), pendlandite (white), pyrrhotite (mauve/tan) and magnetite (grey) in a hornblende gangue (dark grey). Field of view 5 mm wide by 4 mm high. Reflected polarised light.

CODES and Thailand collaboration via Endeavour Australia Cheung Kong Award

Somboon Khositanont from Chiang Mai University and the Department of Mineral Resources (DMR) in Bangkok has recently received a 2007 Endeavour Australia Cheung Kong Award. Somboon was granted the award (A$25,000) to work with Khin Zaw from CODES on the metallogenic relations and exploration significance of base- and precious-metal deposits in Thailand.

This highly prestigious award is part of the Australian Government's Endeavour Program, which was established in 2003 to support high-achieving individuals from around the world to undertake international study, research or professional development.

The Minister for Education, Science and Training, the Hon. Julie Bishop MP, wrote to Somboon to congratulate him on receiving the award and she explained that the Endeavour Program enables collaboration in the areas of shared interest between the people of Australia and people from other countries. The program aims to foster enduring linkages between institutions and individuals. This award recognises ongoing work between CODES and institutions in Thailand.

CODES, Chiang Mai University and the DMR have a proud history of collaboration dating back more than 25 years. We look forward to developing these relationships into the future

Somboon Khositanont (left) and Khin Zaw at Phu Lon skarn Cu-Au deposit in Loei area, northern Thailand.

University of Nevada, Reno, SEG Student Chapter visit

It is the responsibility of the CODES SEG Student Chapter to host several geology-themed talks, symposiums and workshops throughout the academic year. Thus, a visit to CODES from the University of Nevada, Reno, SEG Student Chapter (as part of their tour of Australian active mines and mineral deposits) was the perfect catalyst to host the first symposium.

On 19 March, a party of eight students led by Professor Tommy Thompson attended a mini-symposium on Tasmanian geology. Many CODES postgraduate students also attended. Ross Large gave a detailed overview of CODES, followed by an hour-long talk on 'world class ore deposits of Western Tasmania'. This was followed by a talk on 'exploration for Cambrian VHMS deposits in Western Tasmania' presented by Andrew McNeill. Both talks provided an excellent introduction to the ore deposits of Western Tasmania, exploring not only the varying styles of mineralisation and their controls, but also the geophysical techniques employed in Tasmanian mineral exploration. The students were then invited to attend the CODES Earth Science Forum Monday seminar, given by Visiting Professor Alexey Ariskin on 'using COMAGMAT Model in igneous petrology: genetic reconstructions for mafic magmas' which gave an insight into research undertaken at CODES. A typical Australian BBQ was held at lunchtime, which was made all the more enjoyable by large amounts of Tasmanian sunshine.

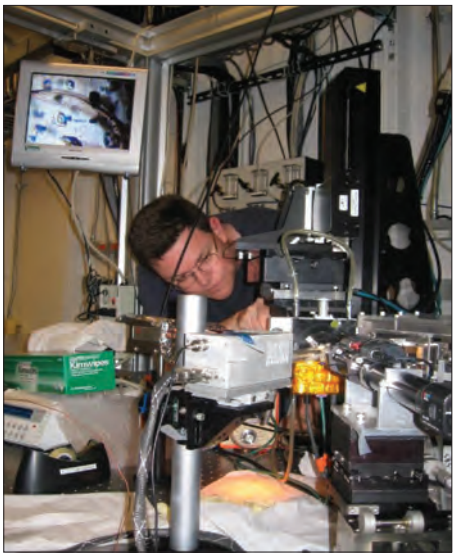
The CODES Student Chapter is currently organising several more workshop. The next will be held in June 2007 and will be given by the SEG Thayer Lindsley Visiting Lecturer Dr Jamie Wilkinson (Imperial College, University of London). Other workshops throughout the year will be given by Associate Professor Dave Craw (University of Otago), concentrating on orogenic gold formation and deposition and the environmental impacts of mining activity; Dr. Phil Bland (Imperial College, University of London) giving talks on developments in planetary geology; and Bill Pennell (Rio Tinto) who will be hosting a series of workshops on the challenges of practical exploration geology, as well as offering advice on career development as a geologist.

CODES and University of Nevada, Reno, SEG Student Chapter group.

ADVANCING ORE SOLUTIONS AT THE APS

Advanced microanalysis is providing a new knowledge of aqueous metal complexes in hydrothermal fluids. CODES, together with research scientists at Imperial College (University of London), is conducting in-situ non-destructive spectroscopy experiments of natural metal-rich fluid inclusions at the Advanced Photon Source (APS), Chicago. Using high-energy synchrotron radiation, our research team is recording metal X-ray absorption features for single fluid inclusions at magmatic conditions. Initial work has focused on Cu, seeking to characterise oxidation state and coordination environment of pristine ore-solutions trapped in primary igneous minerals. Future studies will investigate other important elements, including Fe, Zn and Mn. This research is revolutionising our understanding of high-temperature solution chemistry and has important implications for interpreting ore-forming processes in major hydrothermal systems such as porphyry Cu deposits.

CODES Project F5.3 (Metal speciation at magmatic-hydrothermal conditions: in-situ fluid inclusion spectroscopy using synchrotron radiation) is an on-going collaborative effort between Anthony Harris, Andrew Berry (Imperial College), Dima Kamenetsky, David Cooke and APS GSE-CARS beam-line scientists Matthew Newville and Steve Sutton. Our research is made possible with the financial and logistical support from the US Department of Energy Argonne National Laboratories (University of Chicago), the Australian Synchrotron Research Program (ANSTO) and CODES.



Anthony Harris loading a sample into the inverted heating stage at beamline 13.

MASTER OF ECONOMIC GEOLOGY

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This coursework Masters program is for geoscientists who want to gain a thorough up-date on advances across the spectrum of economic geology applied to mineral exploration. It is part of the Minerals Council of Australia national masters program which is offered jointly between CODES, the University of Western Australia, James Cook University, Monash University (VIEPS) and CRC LEME.

Course structure: The Masters course can be completed in either of two ways:
Option 1 requires the completion of six units of coursework and a minor research thesis. Four of the units must be completed at CODES, the remainder are completed at other participating universities. Duration 18–24 months full time; up to 30 months part time.
Option 2 requires the completion of eight units of coursework, at least four of which must be undertaken at CODES. Duration 12–18 months full time; up to 30 months part time.

Course content: Each of the participating universities will offer up to five courses in rotation over a two-year period. Each course is of two weeks' duration.

Courses offered by CODES are:
- Volcanology and Mineralisation in Volcanic Terrains (NZ/Tasmania)
- Ore Deposit Models and Exploration Strategies
- Ore Deposit Geochemistry, Hydrology and Geochronology
- Ore Deposits of South America (Chile/Peru)
- Target Generation for Brownfields Exploration

Fees: The course fees are $2000 per unit, and for international students $AUD 16,000 pa. There are some additional costs associated with field-based courses. Entry qualifications: BSc (Hons) or BSc with at least two years' industry experience.

For further information contact
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Putting their best feet forward …

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Australian Government
Australian Research Council

Ore Solutions banner: 'Zebra' ore, banded sphalerite-calcite with clots of galena, San Vinciente MVT deposit, Peru. Width of view = 12 cm.

another Pongratz Production 2007