



New facets for GeM^{III}



Over its initial four-year lifespan, the GeM^{III} project became the fastest growing and largest foundation project in AMIRA's 50-year history ...

Industry support for geometallurgy and satisfaction with the outcomes of the P843 GeM^{III} (geometallurgical mapping and mine modelling) initiative have resulted in a four-year extension project (P843A). In total, 13 sponsors have already signed up for P843A and 10 case study sites have been nominated – providing continuity for the project and a seamless transition into new areas of research, such as predictive hydrometallurgy, blasting and environmental geometallurgical attributes.

"The indications are very promising that the project will continue to grow, which will be reflected by a further increase in sponsors. This will help us achieve the GeM^{III} vision to collaboratively develop

a new cross-discipline research platform that provides predictive inputs into mine planning, economic optimisation and sustainability. Many companies have already embraced this discipline and are seeing the benefits. This project not only supports this trend, but also accelerates the significant changes in culture and technology required to successfully establish industry best practice via new tools and methodologies," says P843 project leader Professor Walters.

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The mill at OZ Minerals' Prominent Hill mine, with grinding media in the foreground. This location was nominated as a P843A case study site.



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Geometallurgy is becoming increasingly recognised as a high-value activity that delivers significant economic benefits. These are achieved mainly through enhanced mine planning that creates more effective and sustainable mine site operations. It involves a quantitative and comprehensive approach to ore characterization in terms of critical processing attributes, including blasting, crushing, grinding, liberation, recovery, product quality and environmental effects.

New collaborations

The collaboration between CODES and JKMRC is vital to GeM^{III} and is a cornerstone of the P843A extension project. Significant collaborations have also been established with:

- The Parker Centre CRC – a recognised world leader in applied hydrometallurgy.
- The WH Bryan Mining and Geology Research Centre (BRC) at the University of Queensland – a leader in the areas of mass mining, geotechnical engineering, optimisation in mine design and planning.
- The Centre for Mined Land Rehabilitation (CMLR) at the University of Queensland – a leader in environmental aspects of mining.

The benefits

Detailed geometallurgical models that reflect inherent geological variability reduce the technical risk associated with the design and operation of mines. This approach is particularly important in feasibility studies as a precursor to design, when knowledge of the ore body is limited because of restricted access. Key benefits include:

- Improved forecasting.
- Reduced technical risk.
- Enhanced economic optimization of mineral production.
- More efficient use of the resource.

Final project meeting for P843

The initial AMIRA P843 GeM^{III} project was completed in June and was marked by a final sponsors' meeting in Brisbane, attended by over 70 people. Over its initial four-year lifespan, the project became the fastest growing and biggest foundation project in AMIRA's 50-year history, with life of project funding of over \$8 million. It is the largest industry-supported research collaboration ever undertaken at CODES.

In appreciation of Steve Walters' leadership of P843, his team presented him with an antique microscope at the final project meeting. Work is now underway to automate this fine example of 19th century engineering excellence.

Above: Steve Walters receives an antique microscope in recognition of his project management skills.

Top left: Attendees at the final P843 sponsors' meeting in Brisbane.

Bottom left: The poster presentation was a popular feature at final sponsors' meeting.

Below: Close-up view of the antique microscope.



For further details on the project and sponsor opportunities:

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Trip to the Troung Son Fold Belt



Left: Khin Zaw (left) with PanAust Senior Geologist, Anousone Sisayphone at the Plain of Jars.

Below: Honours student, Mark Hotson, views weapon casings being put to pragmatic use by the locals.

A research group comprising of Associate Professor Khin Zaw, Research Assistant Grace Cumming, Postgraduate student Takayuki Manaka, and Honours student Mark Hotson has successfully commenced a program of deposit-scale characterization and regional sampling in Laos; specifically in the provinces of Xieng Khouang, Khammuan, Bolikhamsai and Savannakhet. The initiative, which forms part of the Ore Deposits of East Asia project, is expected to significantly extend the geological knowledge of the major metallogenic and tectonic elements of the Troung Son Fold Belt.

The first part of their journey involved extensive field work and sampling at the skarn Cu-Au and epithermal Au deposits in Xieng Khouang Province, which was made possible through the support of PanAust Limited – a leading copper-gold producer in the region. The area is famous for its fascinating Plain of Jars, which is an area containing over 400 historical sites that

house thousands of stone jars dating to a period between 500 BC and 800 AD. The origins and purpose of the jars remain one of the world's most intriguing mysteries. Theories range from their use as funeral urns or food storage containers, through to receptacles for the brewing of rice wine by a race of giants that once inhabited the area – according to local legend.

After successfully negotiating a number of bureaucratic hurdles to acquire permits to conduct regional sampling, the team continued its journey by skirting past the Jurassic-Mezozoic Khorat red bed sequences along the Mekong River. They then headed east into areas that included deeply incised Late Palaeozoic to Early Mesozoic limestone, terrestrial sandstone sequences, large domains of granodiorite, granite and diorite. Excellent samples were taken from good creek exposures and road cuttings during this phase of the trip.

In Khammuan Province, the crater-filled road through lush, green jungle suddenly opened up to a relatively smooth, gravel semi-highway through unmapped river valleys. After fording a number of swirling rivers in their trusty 4WD, the team entered the small township of Sen Phan in an area notorious for the high number of unexploded weapons from the Vietnam



War – making it one of the most dangerous geological sites on the planet.

As the team entered the township, they were made acutely aware of past and present dangers as they viewed large craters in roadside fields, and smiled in admiration at the handiwork of the inventive and resilient locals who had fashioned bomb casings into plant pots, and even turned aircraft fuel tanks into makeshift canoes. Despite the danger, the team continued their sampling work – just to prove that there is nothing that can keep a geologist from their rocks. Nevertheless, the risks were certainly rewarded because the team is confident that the samples and data collected from the trip will make a significant contribution to the understanding of the geology of the region.

Clues to continental collision found in Vietnam



Left: Taka Manaka and Khin Zaw (partly obscured) ford a creek at the Pac Lang Au deposit, north-eastern Vietnam.

Below: (from left) Jacqui Halpin and Khin Zaw, CODES, with Hai Thanh Tran, Hanoi University, at the Sin Quyen IOCG deposit, north-western Vietnam.

A team from CODES has completed a highly fruitful field trip to northern Vietnam, where they collected a great variety of rock samples from the Proterozoic right through to the Tertiary periods – including samples that could lead to solving a long-running debate regarding the timing of a continental collision along the Song Ma suture zone. As an illustration of the remarkable array of rocks in this geologically-rich region, samples collected include world-class ore, high grade metamorphic rocks, ophiolites, sediments, intrusions and volcanics.

“The visit to the deposit was a very special event, as we were the first foreign geologists ever to be granted permission to view the site ...” Khin Zaw.

The team was led by Associate Professor Khin Zaw and included Research Fellow Dr Jacqui Halpin and postgrad student Taka Manaka. Joining them on the trip was Dr Hai Thanh Tran from Hanoi University of Mining and Geology.

“Dr Tran’s local knowledge proved invaluable for guiding the team through the difficult and geologically complex terrains and for gaining access to areas that are normally off-limits to visiting geologists,” says Khin Zaw.

The fault zone of Sin Quyen

The team started their trip in the remote mountainous areas along the border between Vietnam and China, which include the renowned Sin Quyen and Lung Po IOCG deposits.

At Sin Quyen, they examined an unusual example of the Fe oxide-Cu-Au-REE group of deposits, where magnetite-orthite (REE allanite)-chalcopyrite-gold mineralisation occurs in a fault zone and is hosted by extremely altered amphibolite and biotite-gneiss lenses within the highly deformed and metamorphosed sedimentary sequence of the Proterozoic Sin Quyen Formation. Samples were collected of



the metasedimentary and orthogneissic host rocks, as well as chalcopyrite- and pyrrhotite-rich ore.

Sin Quyen has a turbulent history and this rare visit by geologists to the area was only made possible through Dr Tran, who obtained special permission from the government of Vietnam.

The Lung Po deposit

Next on the itinerary was the Lung Po IOCG deposit, situated to the north-west of Sin Quyen on the border with China.

“The visit to the deposit was a very special event, as we were the first foreign geologists ever to be granted permission to view the site. Once again, access would not have been possible without the efforts and contact network of Dr Tran,” says Khin Zaw.

Very little information is available on the Lung Po Cu-Au deposit; therefore, this was naturally an eagerly anticipated part

of the trip. The group viewed the edge of the Vietnamese riverside outcrop and were shown the Chinese workings across stream. They viewed host rocks that were highly deformed felsic gneisses, schists, amphibolites and calc-silicates, plus chalcopyrite- and chalcocite-rich ore that is disseminated and associated with quartz veining. Pyrite and galena-bearing ore were also observed.

Packing for Pac Lang

The group then moved on to the Pac Lang orogenic Au deposit in the north-east – a mineralised system comprised of a group of Au-bearing quartz veins, initially exploited by the French early in the 20th century. The



Left: Taka Manaka takes a break at the Vietnam–China border near Lung Po. The hills in the background are part of the Yunnan province of China.

Below: Panoramic view of Sin Quyen.



narrow (typically < 2 m) mineralised quartz veins have a combined inferred strike length of 3.3 km; preliminary sampling (1999) reportedly assayed between 0.4 and 49 g/t Au. At least three generations of veins have been interpreted from structural analysis and are considered to have formed along fault splays generated and controlled by a multi-activated regional fault system. A Triassic sedimentary package hosts the vein system; volumetrically minor dolerite intrusions also occur. Scheelite-bearing veins are also common in the region, and the relationship/timing of Au and W mineralisation is not yet well understood.

Clues to big collision at Song Ma

At this point the group disbanded and Dr Halpin and Dr Tran continued on the final leg of the trip, which was to the Song Ma suture zone. This is an area where Dr Tran has been working for many years and, once again, his local knowledge proved priceless.

“Vietnam is composed of two major continental blocks: South China and Indochina. At some point in the past, a collision occurred along the Song Ma suture zone, which has resulted in it being complexly deformed and dismembered. However, geologists have long disagreed

about whether this occurred during the Permian-Triassic period or earlier. In an exciting development, Dr Tran was able to guide us to some beautifully preserved pillow basalts, which we hope to date and subsequently establish the first robust estimates of the timing of suturing via the age of the former oceanic crust,” says Dr Halpin.

Regional sampling was mostly undertaken during this second part of the field trip, with priority given to igneous and volcanic suites for targeted geochronological and geochemical analysis. In particular, the geologists hope to be able to constrain the age of ophiolitic material, which outcrops as fault-bounded slivers between the Indochina and South China blocks. New pillow basalt locations were observed and, along with flysch-type sediments and chert packages, much evidence was found for a complexly deformed suture zone. At present, mafic and ultramafic suites are being prepared for in situ zircon analysis; small zircons (if present) will be targeted using a new method developed at CODES that incorporates the use of in situ imaging and U-Pb analysis.

Another priority was to sample metamorphic rocks (many considered to be Precambrian) in order to constrain

the P-T-t history of core complexes within the region. Metamorphic rocks also host the Sin Quyen and Lung Po IOCG Cu-Au deposits. The team

intends to use both zircon and monazite to unravel the age of the protoliths and major metamorphic events. Metamorphic mineral assemblages will allow investigation of the P-T history of these events. Sedimentary rocks were also collected across the region in order to confirm the age of these strata via zircon geochronology.

Over the two parts of the trip, the team travelled in excess of 3000 kilometres, visited sites that have never been viewed by foreign geologists, and collected enough high quality samples to keep them busy for a very long time – and included in those samples could be the key to settling a long-running dispute about the date of a great continental collision. Jacqui describes the trip as “amazing and highly successful” – who could disagree?

“In an exciting development, Dr Tran was able to guide us to some beautifully preserved pillow basalts, which we hope to date and subsequently establish the first robust estimates of the timing of suturing ...” Jacqui Halpin.

High profile at Asian conferences

CODES had a high profile presence at the GEOSEA Regional Congress on Geology, Mineral and Energy Resources of South-east Asia, held recently in Kuala Lumpur. GEOSEA is a premier triennial conference covering a broad cross-section of geoscience disciplines, including fundamental geology, tectonics, geophysics, geochemistry, mineral exploration and ore deposits.

Attended by geoscientists from Asia and around the world, the event provided the ideal platform to showcase the latest developments in CODES' Ore Deposits of South-east Asia project. Project leader, Dr Khin Zaw, presented a keynote address



CODES researchers with fellow delegates at GEOSEA 2009: (from left) U Nyunt Htay (Myanmar), Somboon Khositantont (Thailand), Khin Zaw (CODES), Teh Guan Hoe (University of Malaya), Zaw Naing Oo (Myanmar), Grace Cumming (CODES), Takayuki Manaka (CODES) and Charles Makoundi (University of Malaya).

entitled *Metallogeny of Mainland South-east Asia*, worked with Prof Teh Guan Hoe from the University of Malaya to organise a section entitled *Resource Issues Towards Sustainable Use*, and presented a short course/workshop on *Ore Deposit Models in South-east Asia*. The workshop was held at the nearby Mineral and Geoscience Department of Malaysia (MGDM), which was made possible through the help and support of its Director General, Yunus Abdul Razak. In addition to the keynote address,

Khin Zaw presented a further five joint papers at the conference.

Not long after GEOSEA, Khin Zaw attended the Asia-Oceania Geosciences Society (AOGS) Conference in Singapore, where he was convenor of the section entitled *Geological Terranes and Metallogenesis in Asia*. In total, he presented seven CODES group papers. As an active member of AOGS, Khin Zaw has been a regular contributor at this annual conference.

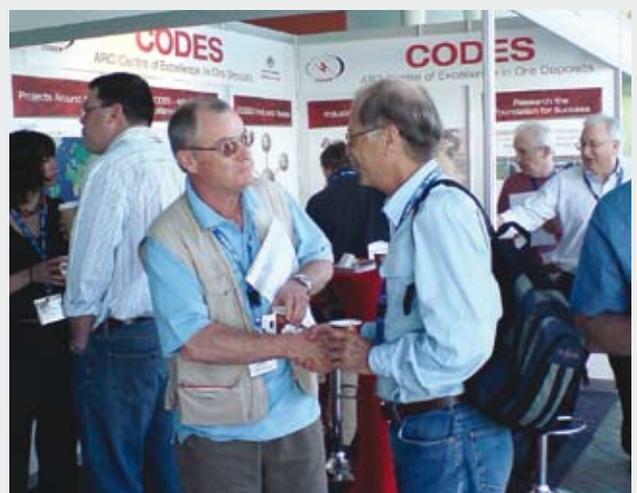
Extensive participation in SGA 2009

CODES researchers played a major role in SGA 2009, held in Townsville from 17 - 20 August. Participation included an exhibition booth, three keynote speakers, two convenors, one plenary speaker, 27 oral presentations, and six poster presentations. This represented the top contribution by any organisation at the event and raised the Centre's profile to a large, influential international audience of nearly 500 delegates.

It was the first time in 20 years that this important biennial event had been held in Australia, and the task was completed with aplomb by the Society for Geology Applied

to Mineral Deposits (SGA), the Society of Economic Geologists (SEG), and the Economic Geology Research Unit (EGRU) at James Cook University – the hosts of conference.

As usual, the CODES booth was a focal point for networking and catching up with old friends.



Course has worldwide appeal



The recent two-week Master of Economic Geology short course on Ore Deposit Geochemistry, Hydrology and Geochronology attracted participants from as far afield as the USA, China, Mongolia, Indonesia, Philippines, Laos, Canada, and South Korea. In total, there were 17 Masters students, plus four industry participants and one PhD student. There was also a mix of top national and international speakers, including former CODES Research Fellow Peter Hollings, who is now at Lakehead University in Canada.

The course covered a range of geochemical and geochronological techniques used to interpret environments of ore formation and the processes of ore genesis. Topics included Ar-Ar, U-Pb and Re-Os geochronology, whole rock and trace element chemistry of igneous rocks, sulfide trace element chemistry, stable and radiogenic isotopes, fluid inclusions and hydrothermal geochemistry.

The course started with a focus on basic theoretical principles, with a series of practical case studies being introduced during the second week. CODES short courses are known for providing a good level of practical content and the students took full advantage of the opportunity to debate real-life situations with an impressive line-up of 16 experts. Discussions ensued on the application of various geochemical,

Former CODES Research Fellow, Dr Peter Hollings, was one of the international speakers. On a note of interest, the striking photo used on CODES 2008 Annual Report was taken by Dr Hollings.

isotopic and dating techniques in relation to the genesis and exploration of three important styles of ore deposit.

The course was led by Professor Dave Cooke and forms part of the CODES segment of the Master of Economic Geology program, which is managed by Dr Tony Webster and run in conjunction with the University of Western Australia, James Cook University and Curtin University.

The next CODES short course is Volcanology and Mineralisation in Volcanic Terranes, which will be held in March 2010.

ARD work helps the environment

Research by PhD candidate Anita Parbhakar-Fox has been used by the Queensland Department of Mines and Energy to help develop a new management strategy for acid rock drainage (ARD), a process that presents significant environmental challenges in Australia and around the world. ARD occurs when rock surfaces are exposed to air and rain, which can cause drainage water to become more acidic and leach out environmentally harmful elements. Although ARD can occur through a natural oxidisation process in sulphide-bearing rocks, mining activities can trigger this phenomenon by exposing large surface areas of rock to water and oxygen. It can also occur through newly exposed, fragmented rocks in mine waste. In Australia alone, 1750 Mt of mine waste is produced annually, with the associated costs of managing this waste amounting to approximately \$50 million.



Anita Parbhakar-Fox presents at ICARD in Sweden.

Anita presented her findings at the International Conference on Acid Rock Drainage (ICARD) at Skelleftea, Sweden. Her paper consisted of a summary of salient points from the first part of her PhD thesis, which focuses on predictive modelling of acid rock drainage based on an innovative ARD mineralogical index, using waste-rock samples from an abandoned Proterozoic-Au mining operation. The adoption of this mineralogically driven approach followed an extensive laboratory evaluation of the current wet chemical ARD tests, which found that many of the routine 'static' tests were inadequate and inconclusive; particularly if test results were to be used for

the life cycle of a mine – in a block model, for example.

"I believe that adopting a predictive, rather than a reactive approach to ARD mitigation is the key to its successful management. And shortcomings associated with geochemical tests are often discussed in scientific literature; therefore, a new mineralogical and textural approach to predicting acid generation was the logical direction for the research to follow," says Anita.

The research is part of the AMIRA P843A (GeM¹¹¹) extension project and is co-supervised by Steve Walters and Dee Bradshaw (JKMRC).

Kimberlite volcanoes in the spotlight

Fifty-five eager geologists filled the Earth Sciences First-year Lecture Theatre on 11 August to see Professor Ray Cas, Head of the School of Geosciences at Monash University, deliver a fascinating talk entitled *The Holy Grail in Kimberlite Volcanology: Understanding the Nature of Kimberlite Volcanoes and their Eruption Styles from their Vent Fill Deposits*.

The visit was organised by the SEG Student Chapter and the CODES Volcanology Group and included a lively discussion session later in the day.



Seeing double top Swiss geoscientist delivers two presentations



Dr Robert Moritz, from the University Of Geneva, presented two talks at CODES during August entitled:

- Carboniferous Shear Zone-hosted Gold Vein Deposits of the Eastern Peruvian Andes: Orogenic or Intrusion-related Deposits?
- Cretaceous-Tertiary Tethyan Geodynamics and Metallogeny of the Balkans and the Caucasus.

Dr Moritz is a lecturer at the Department of Mineralogy within the university's Faculty of Science, and was the main supervisor for our Research Fellow, Dr Isabelle Chambefort, during the completion of her PhD.

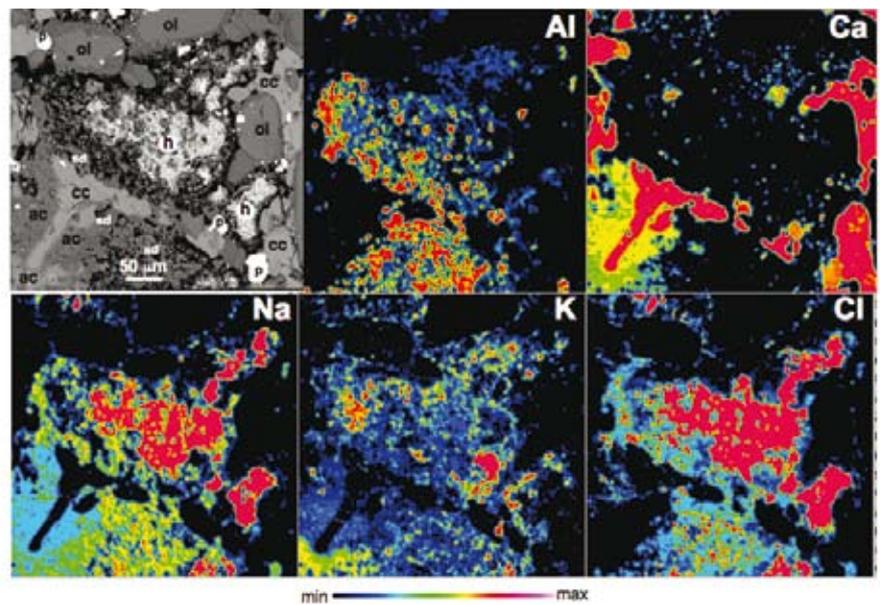
It is interesting to note that the University of Geneva celebrated its 450th anniversary this year. However, even at that ripe old age, it is not Switzerland's oldest university. That accolade goes to the University of Basel, which was opened in 1460.

Researchers reveal a salty rise for kimberlite

Groundbreaking research by a team of CODES researchers has featured in the September issue of the highly regarded *Nature Geoscience* publication.

The article focused on research on the Udachnaya-East kimberlite pipe in Siberia. The pipe contains unusually high levels of sodium and chlorine, and there has been debate for some time whether these elements are present at the mantle source or integrated via sediments as it reaches the surface.

Isotopic data produced by the CODES researchers shows that perovskite crystals are intermingled with the salt in the Udachnaya-East pipe. Because the perovskite is formed from the parent magma, if the magma had been exposed to salt-rich sediments near the surface then the isotopic composition of the perovskite would have changed. However, the team's work shows that the strontium



Backscattered electron image and X-ray element maps showing intimate association of perovskite (p) with Na–K chlorides (h), alkali carbonates (ac), calcite (cc), sodalite (sd) and olivine (ol) in the groundmass of Udachnaya-East kimberlite.

isotopic composition of the mineral is in line with what would be expected from uncontaminated primary magmas. These results support the team's earlier findings, and provide conclusive proof that the salt was present at the mantle's source.

In an interesting development, this particular magma is shown to be low in water content. As water has long been thought to be the main driver for kimberlite magma's explosive rise to the surface, the team now believes that the reason could

be found in the salt content, which would provide the fluidity and propulsion required for kimberlite emplacement.

The CODES team is comprised of Professor Vadim Kamenetsky and Dr Maya Kamenetsky from the CODES Hub, plus Dr Roland Maas, Dr Chad Paton, and Associate Professor David Phillips from the University of Melbourne Node. The team also collaborated with earth scientists from Siberia.

Voyage to unlock the secrets of Hunter Ridge

A team of seven CODES researchers led by Professor Leonid Danyushevsky and Dr Trevor Falloon has completed a detailed mapping and sampling survey of the Hunter Ridge in the south-west Pacific. It is anticipated that the voyage will enhance the understanding of the tectonic history of the ridge and the geological processes that occurred during its evolution. There is still relatively little known about this predominantly submarine volcanic structure, which joins Fiji with the southern end of the Vanuatu island chain and provides a geological boundary between the North and South Fiji Back-arc Basins.



Top right: Julie Hunt describing rocks in the ship's lab.

Above: The RV Southern Surveyor birthed in Lautoka, Fiji.

Right: Trevor Falloon cutting rocks with a rock saw.



Above: Expedition leader, Leonid Danyushevsky, with Matthew Island Volcano in the background. Matthew Island is located at the south-eastern tip of the Quaternary volcanic chain of the New Hebrides island arc.

Above left: Repairs to the dredge on the aft deck between dredging stations.

Left: Trevor Falloon recovers glass samples from the wax corer head.

Below: Researchers in the operations room monitor the ship's movement during seafloor mapping.



The team was eager to gather as much information as possible during the 25-day expedition, but particularly evidence that supports or disproves a theory of an active, north-facing subduction zone at ~3–7 Ma. Samples of volcanic rocks were collected from the older, volcanically inactive central and north-eastern parts of the ridge, plus its volcanically active south-western sector.

In total, 53 successful dredges and 30 wax core stations were performed.

The voyage, entitled SS03/2009, was undertaken on the RV *Southern Surveyor*, which is owned and managed by the CSIRO as part of its Marine National Facility. The vessel is in high demand by Australia's scientific community for oceanographic, geoscience, fisheries and ecosystem research.

CODES CAMIRO collaboration



Collaborator, Daniel Layton-Mathews, using CODES LA ICPMS facility to analyse pyrite.

CODES is participating in a three-year project to investigate the 'geochemistry of shales/exhalites in vectoring to ore deposits'. The project is being conducted in collaboration with the Canadian Mining Industry Research Organization (CAMIRO) – a not-for-profit organization run by the Canadian mining industry to manage collaborative mining research. Professor Bruce Gemmill is leading the CODES team, supported by Professor Ross Large and Dr Andrew McNeill.

Objectives

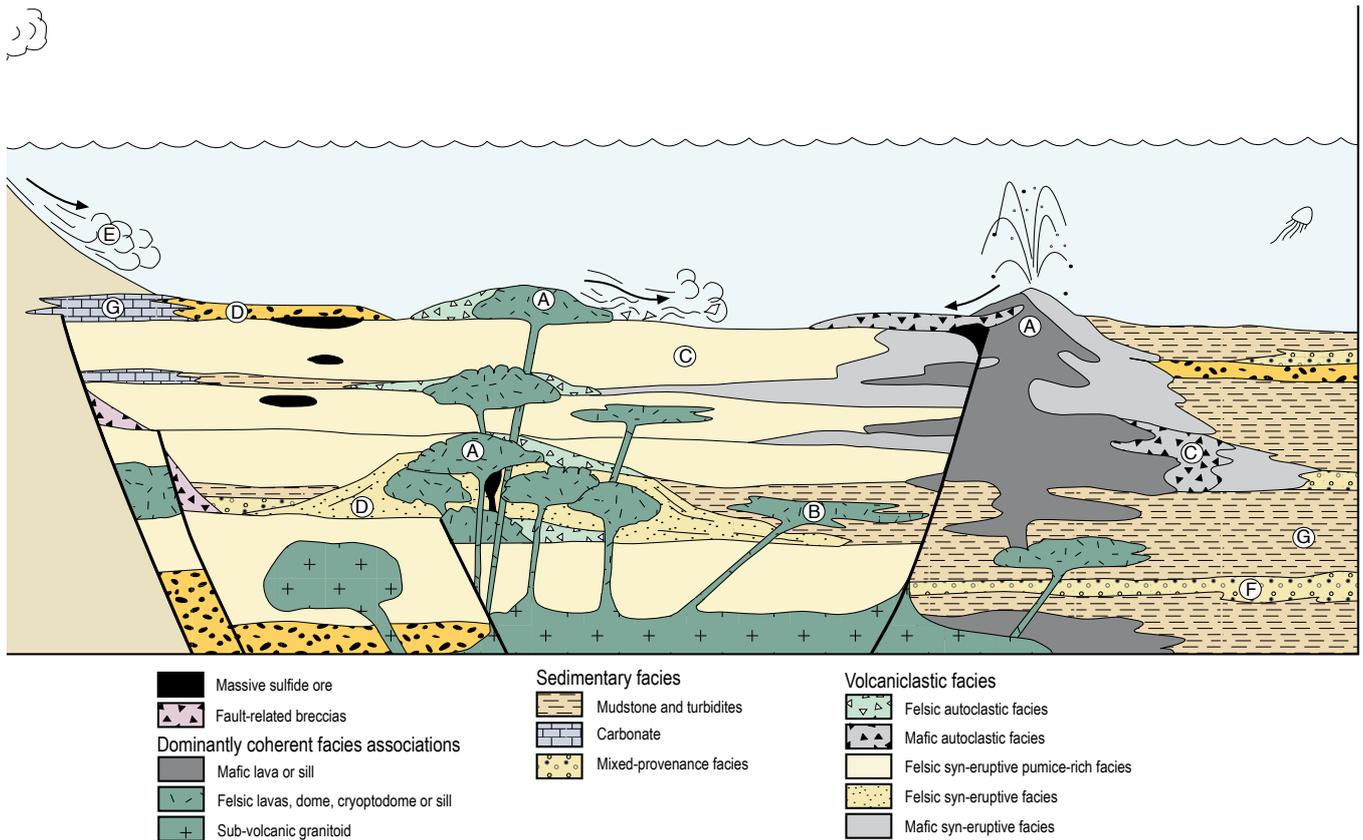
The initiative aims to improve the understanding of the behaviour and concentration mechanisms of trace metals associated with hydrothermal processes, both in marine sedimentary and volcano-sedimentary successions as metal traps in post-burial metallogenesis. It also develops new mineralogical, geochemical and isotopic tools to discriminate between mineralized and unmineralized horizons in many mineralized districts. Major goals are the recognition of hydrothermal activity within a basin, and the development of vectoring methodologies for exploration.

Study areas

Data will be compiled from numerous mineral districts of varying age and location, which will be chosen on the basis of sound geochronological and geological evidence linking mineralization to the enclosing stratigraphic successions. Study areas include the Abitibi greenstone belt in Quebec and Ontario, the Central Volcanic Belt in Newfoundland, the Bathurst District and New Brunswick, the Selwyn Basin and Finlayson Lake District in Yukon Territory, several SEDEX-mineralized basins in British Columbia and Alaska, Eskay Creek and Myra Falls in British Columbia, and the Mount Read Volcanics in Tasmania. Examples of unconformity uranium, orogenic gold and sediment-hosted copper will be added to the project according to sponsor requirements.

Methodology

New field and laboratory criteria are being developed for the classification and recognition of productive versus non-productive sedimentary horizons in ancient greenstone belts and marine sedimentary basins. This will be achieved using mineralogy and mineral chemistry, trace element geochemistry and traditional stable isotopes (carbon and sulphur). Methods include conventional laboratory-based bulk geochemical analysis and x-ray diffraction, plus lesser-used field instruments, such as short-wavelength infrared spectrometry, portable x-ray fluorescence (XRF) spectrometry, and portable x-ray diffraction. Mineralogical and sub-centimetre bulk compositional variations will be evaluated in hand samples, and multi-collector-ICPMS is being used to evaluate small-scale compositional variations, plus conventional and non-conventional stable and radiogenic isotope variations (e.g. along strike isotopic variations in Nd-Sm, Fe, Cu, Zn, Mo, Re-Os). Pyrite is being analysed using laser-ICPMS. All data will be incorporated into 2D and 3D geographical information for interpretation and presentation.



Facies model of a submarine basin in which a variety of coherent and clastic volcanic facies are intercalated with sedimentary facies.

Key questions

The collective analysis of datasets (from property, ore deposits, through to basin-scale) addresses several key questions:

1. Can deposit-forming hydrothermal events be identified at the basin-scale?
2. Can one vector toward mineralized hydrothermal centres within a given basin?
3. What is the importance of basal redox conditions (reducing to oxidizing) in relation to the siting and targeting of exploration targets?
4. Is shale geochemistry a sensitive indicator of hydrothermal events, compared to other rock units? At what distance can mineralized centres be recognised?
5. How well can field geochemical tools be used to recognise distant mineralization? Where is laboratory geochemistry required?

Deliverables

The major deliverables will be to:

- Assist exploration companies to focus their activities in areas of maximum prospectivity.
- Develop new field and laboratory criteria for the classification and recognition of productive versus non-productive sedimentary horizons in ancient greenstone belts and sedimentary basins.
- Identify chemical and isotopic variability of large-scale hydrothermal systems recorded in the sediments.
- Emphasize regional-scale signatures that extend well beyond known deposits.
- Significantly increase the target size of mineralized areas by isolating chemical and isotopic signatures carried into the overlying water column at the time of ore formation – and recorded in contemporaneous sediments.

Collaborators, industry partners and funding

To date, Barrick, HudBay Minerals, Newmont,

Teck and Ur-Energy have come on board as industry partners, with a subsequent funding commitment of C\$12K per annum. Ongoing research is funded by the Targeted Geoscience Initiative III Program of the Geological Survey of Canada and the National Science and Engineering Research Council of Canada (NSERC) under collaborative research agreements with Canadian mining companies. These funds will support research students, field sampling at Canadian and international sites, associated travel, collaboration, and analytical costs. CODES is contributing equivalent funds from the Formation Program, and an NSERC grant proposal for matching funds was submitted in October.

The collaborators on the project are Steve Piercey (Piercey Consulting / Memorial University of Newfoundland and Labrador), Jan Peter, Wayne Goodfellow, John Chapman and Simon Jackson (Geological Survey of Canada), Mark Hannington (University of Ottawa), Daniel Layton-Mathews (Queen's University), Thomas Monecke (Colorado School of Mines) and Fernando Tornos (Instituto Geologico y Minero de Espana).

Top rankings for citations

Professors Vadim Kamenetsky and Leonid Danyushevsky have been ranked in Essential Science Indicators (ESI), a highly respected and exclusive citation ranking list confined to scientists in the top 1% by citations in a given field.

ESI is compiled by Thomson Reuters, one of the world's leading providers of business information. To determine the rankings, it analyses citation data from the previous 10 years, combined with figures from a number of successive two-month periods from the current year. Over the combined periods, they record over nine million articles, notes and reviews, published in approximately 9000 indexed, quality journals. The number of citations it gathers from these sources is around 53 million. From all this data, it produces lists of the very best performers (top 1%) in terms of citations in a variety of scientific fields.

Congratulations to both our professors – to be named in such a prestigious list is an outstanding accomplishment, achieved through a great deal of hard work.



The high ranking professors - Leonid Danyushevsky and Vadim Kamenetsky.

Honorary doctorate for Ross Large

Professor Ross Large has been awarded an honorary doctorate from Luleå University of Technology, Sweden. The doctorate was awarded in recognition of his outstanding contribution to the earth sciences. Professor Large travelled to Sweden to receive his honorary doctorate at a prestigious dinner and awards ceremony, held on 7 November.



Professor Large (centre, in red and white gown) at the ceremony in Sweden.

Modern concepts in volcanology workshop



Left: Attendees of the volcanology workshop.

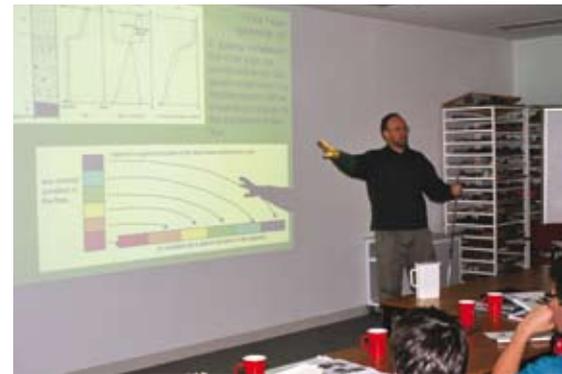
Below: Renowned volcanologist, Colin Wilson, was one of the speakers at the workshop.

A successful five-day workshop, entitled Modern Concepts in Volcanology, was held at CODES during the last week of October. The programme comprised talks spanning several topics, including the products of explosive and effusive volcanism, the Taupo Volcanic Zone (New Zealand), pyroclastic density currents, subaqueous volcanism, and alteration facies in volcanic rocks. Speakers included Professor Colin Wilson (Victoria University, NZ), Dr Darren Gravley (University of Canterbury, NZ), plus a number of CODES team members. More than 35 participants attended the workshop, including students from universities in Australia, New Zealand and Canada.

A highlight from the week was a talk by the main speaker, Colin Wilson, on the relationship between regional tectonism, caldera formation and super-eruptions – similar to what is found in the Taupo Volcanic Zone. Professor Wilson re-assessed his model of fluidization for the deposition from highly turbulent pyroclastic density currents, and compared it to other available models of deposition. In total, the professor delivered no less than 10 presentations during the week, which must go down as some kind of record for an invited speaker.

Sharon Allen presented the model of Neptunian eruption, which describes a gas-driven, pumice-forming, explosive subaqueous eruption, to which numerous depositional facies worldwide can be linked. In addition, a group from CODES presented on the many ways volcanic deposits are altered, and the tools that can be used to reconstruct their original textures. The workshop finished with a practical session focussed on subaerial and subaqueous volcanic textures, presented by Jocelyn McPhie.

There is no doubt that the students benefited greatly from the large range of expertise of the speakers, both during the presentations and the informal sessions that



were held to discuss participants' research projects. Furthermore, these discussions continued during the various social events organised during the week, which also helped to foster ties between the various university groups

The workshop was organised by the CODES volcanology Group, and supported by CODES, the SEG Student Chapter and the LAVA Association – a specialist group in volcanology under the auspices of the Geological Society of Australia.



SEG Student Chapter Field Excursion 2010

Geology & Ore Deposits of Thailand & Laos



A 10-day Field Excursion To Thailand & Laos is being organised by the CODES Student Chapter of the Society of Economic Geologists

Highlights:

- Visit to several major ore deposits in the region
- Visit to a high-grade metamorphic complex in northern Thailand, representing a Mesozoic tectonic boundary of microcontinent
- Visits to well-preserved Palaeozoic to Cenozoic volcanic sites

The field excursion will run for about 10 days from mid to late February 2010. The Chapter would like to invite members of industry to participate in this opportunity to see some unique ore deposits in the region.

For further details see the CODES-SEG website: www.geol.utas.edu.au/studentchapter

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Moving in



Victoria Braniff
 PhD student, from the UK, will be working on the Savage River deposit, supervised by Tony Webster and Ron Berry.



Dr Marcel Guillong
 Has been appointed as a Lab Analyst working on the LA ICPMS.



Karen Mollross
 Karen has joined the finance team as an Administrative Assistant.



Gisela Cobenas
 PhD student, from Peru, will be supervised by Leonid Danyushevsky for work on melt inclusions in volcanic rocks from the south-west Pacific.



Roisin Kyne
 PhD student, from Canada, working on structural controls on mineralization at the CSA Mine, Cobar, NSW, and supervised by Ron Berry.



Jeff Steadman
 PhD student, from the USA, working on BIF-hosted gold, supervised by Ross Large.



Pedro Fonseca
 PhD student, from Portugal, will be supervised by Jocelyn McPhie and Andrew McNeill for work on the Mount Read Volcanics.



Alexey Lygin
 PhD student, from Russia, will be working on the Avebury deposit, supervised by Jeff Foster.



Dr Zhiming Yang
 Visiting scholar from the Institute of Geology, Chinese Academy of Geological Sciences. Dr Yang is visiting CODES for five months and will be working mainly with Zhaoshan Chang on a porphyry Au deposit and unidirectional solidification textures (UST's) in China.

Science Planning Meeting

The proceedings at this year's Science Planning Meeting followed a slightly different format, which included giving the stage to the postgraduate students to allow them to talk about their project work. There was also a venue change, with the event moving to the Wrest Point complex, after outgrowing the CODES Conference Room and the Geology Lecture Theatre in the two previous years.

Above right: Postgraduate student, Andrea Agangi, delivers his presentation.

Right: Increased attendance resulted in a move to Wrest Point.



Golden prize for Steve

Research Fellow, Dr Steve Micklethwaite, has won the \$25,000 first prize in the 2009 UTAS Business Competition. He won the prize for a proposal to commercialise a concept that reduces risk in minerals exploration.

The competition was open to all staff and students at UTAS and involved a rigorous evaluation process, including four intensive training workshops on the art of taking a concept to market.

His award-winning concept uses earthquake and tectonic fault movement data to aid the discovery of gold deposits, which has significant cost benefits for mining companies. During the research and development stage, the technique was

successfully used to locate good gold grades at the Mt Pleasant goldfield in Western Australia. A number of other mining companies have shown a keen interest in using the technique in their exploration, including the Barrick Gold Corporation.

Dr Micklethwaite plans to use his prize money to develop the concept further, including using the technique to find other resources such as copper, lead and zinc.



The winner takes it all – Steve Micklethwaite with his 'winner's cheque'.

Hard Rock Café

The lighter side of CODES



Research Fellow, Emily Johnson, married Reed Burgette in Teton, Idaho (USA) in July.



Gee-gee ologist, Jeff Foster, on the road to 'discovery' in China.



Above: The 'choir of hard rocks' at the annual Geology Dinner.

Left: Research Fellow, Isabelle Chambefort, married Jamil Scarberry in Swansea, Tasmania, in August.

Geomentallurgy ITWC - in tune with Christmas

Solution to previous puzzle: The three letters required were B G H. The first name out of the hat was one of our Honours students, Mark Hotson, who received the \$50 prize.

Below are eight clues, each of which relates to a different Christmas carol or song. The clues represent the first letters of each of the words in the tune's opening line.

1. CROAOF
2. IDOAWC
3. RTRNRHAVSN
4. IHABCWY
5. ISMKSC
6. DTTSIAOHOS
7. FTSWAJHS
8. JBJBJBR

Can you figure out all eight tunes? Please note that we are looking for the official names of the songs or carols. However, in the spirit of Christmas we will show some leeway if you do not have the exact titles.

Email entries to: steve.calladine@utas.edu.au by Friday, 12 February. Winner will receive the choice of either any one of CODES publications, or a selection of corporate gifts to the value of approximately \$50.

Outreach

Our involvement in the community



Visits aplenty

It has been a busy time for visits from schools and colleges over the past few months. Here are a few photos from some of these visits.

Left: Good vibrations – students from East Derwent Primary School feel the Earth move during a seismic demonstration.

Below left: Students from Devonport High School spellbound by Mike Roach.

Below centre: Inquisitive students from Herdsmans Cove Primary School.

Below right: Pupils from Dunalley Primary School – a range of age groups were covered by the various visits.



East Timor's Consul-general discusses geology

Associate Professor Ron Berry (left) and Professor Bruce Gemmill (right) with East Timor's Consul-general, Abel Guterres, during a visit to UTAS in September. Part of the Consul-general's itinerary included a stopover at CODES and the School of Earth Sciences, where he was keen to discuss issues related to the geology of East Timor, in particular the geology of the seabed for a proposed offshore pipeline. The Consul-general had certainly come to the right place for information, especially as Ron Berry completed his PhD on the geology of East Timor at the University of Adelaide.



Developing links with India

Professor Mihir Deb and PhD research scholar, Ms Swati Deol, from the Department of Geology at the University of Delhi, were very welcome recent visitors to CODES.

During their visit, the pair worked mainly in the LA-ICPMS laboratory analysing trace elements of gold-bearing sulphides from the Bhukia-Jagpura prospect in south

Rajasthan, India. The results from the analyses provided significant inputs relating to the timing and genesis of gold in the prospect, as well as presenting new insights into gold exploration at the site.

"It was a pleasure to visit CODES. It is a special centre that provides the perfect amalgamation of the best minds from industry and academia," says Ms Deol.

Although it was a hectic schedule,

Prof. Deb managed to squeeze in a trip to Tasmania's west coast, where one of the highlights was a visit to the Minmetals Rosebery mine. Prof. Deb has developed a strong association with CODES over the past 10 years, and Ms Deol was introduced to Professors Ross Large and Tony Crawford during their trip to India in 2008, where they attended an international workshop on the metallogeny of gold.



Above: Swati Deol hard at work during her recent visit

Left: Ms Swati Deol and Mihir Deb

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