

ore solutions



UNIVERSITY OF TASMANIA

**Newsletter of the Centre for Ore Deposit Research
at the University of Tasmania**

This Issue:

August 1998

Hydrothermal Research

issn 1440-4109

Hydrothermal Alteration Research Breakthrough

In May this year CODES researchers completed a three-year AMIRA/ARC collaborative project on alteration halos associated with volcanic-hosted massive sulfide (VHMS) deposits. According to Director Ross Large, the results will have significant implications for the exploration industry.

“The thrust of the project has been to quantify the complex halos of alteration which typically surround VHMS deposits, so that companies have strategies to widen their exploration targets” he says.

“The critical aspect of the project was its multidisciplinary nature – combining research on volcanic facies, alteration mineralogy, alteration geochemistry, chemostratigraphy, volatile elements and isotopes – to constrain the features of hydrothermal alteration related to major ore deposits.”

Most of the research has been conducted in the Mt Read Volcanics (Tasmania) with other field work in the Mt Windsor Volcanics (Queensland) and the Murchison Province (Western Australia) in a range of deposit studies.

Outcomes of the project include: seven deposit-specific alteration halo models; a compilation of alteration data sheets which relate texture, mineralogy, geochemistry and facies; a database of 1739 new whole-rock and 1020 mineral microprobe analyses; the application of PIMA and FTIR to VHMS alteration and a new alteration box plot relating alteration facies to ore deposit types.

A future objective is to produce a book on alteration mineralogy, geochemistry and textures in volcanics related to VHMS deposits, following in the footsteps of the very successful *Volcanic Textures* by Jocelyn McPhie.

The project has been a significant industry-university collaborative venture supported by AMIRA and the ARC plus Rio Tinto, Pasminco, Aberfoyle, RGC, Pancontinental, Denehurst, Normandy, CMT and Queensland Metals with support from AGSO and Mineral Resources Tasmania.

Research Team

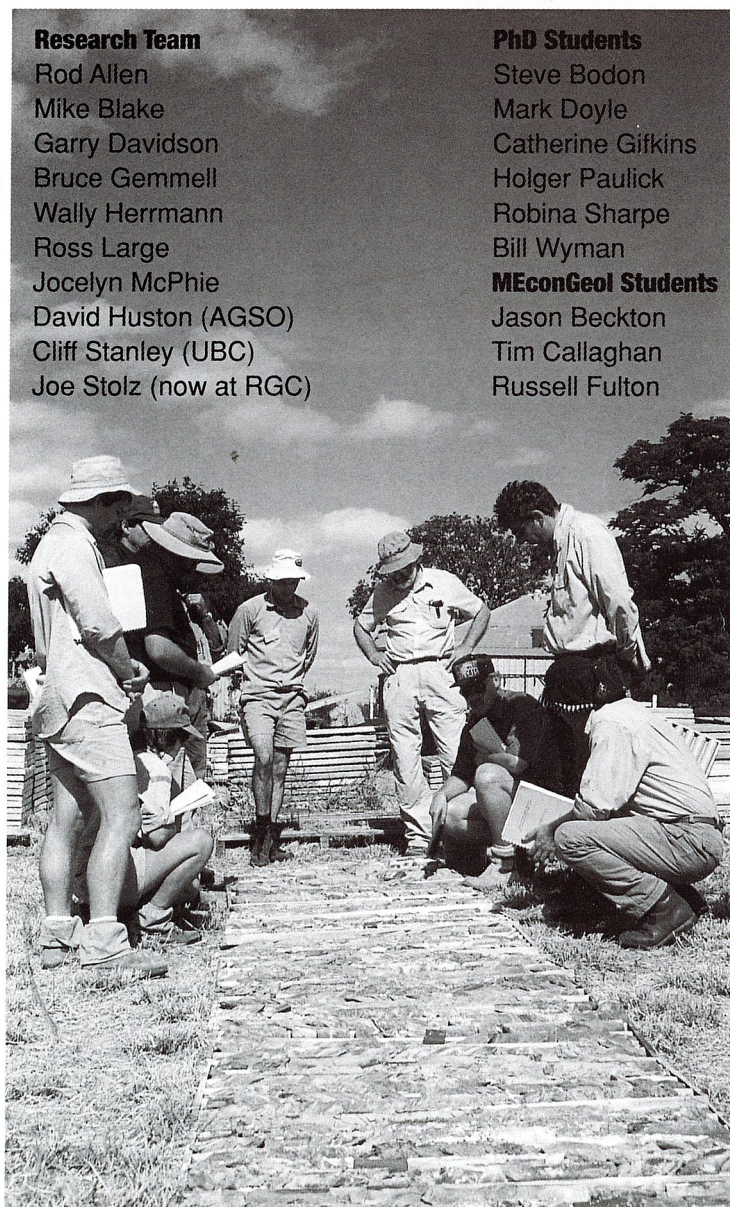
Rod Allen
Mike Blake
Garry Davidson
Bruce Gemmell
Wally Herrmann
Ross Large
Jocelyn McPhie
David Huston (AGSO)
Cliff Stanley (UBC)
Joe Stolz (now at RGC)

PhD Students

Steve Bodon
Mark Doyle
Catherine Gifkins
Holger Paulick
Robina Sharpe
Bill Wyman

MEconGeol Students

Jason Beckton
Tim Callaghan
Russell Fulton



Industry and CODES researchers at RGC's Charters Towers core yard, viewing core from the Waterloo deposit. Deposit case studies included Hellyer, Rosebery, Henty, Western Tharsis, Thalanga, Highway-Reward & Gossan Hill.

From the Editor

Our new publications released earlier this year – the 1997 Annual Report and the 1997/98 Research Compendium – have been popular, both reports providing a comprehensive overview of our research program and results in the past year.

Continuing our dialogue with industry and the geoscience community, recent times have been busy for CODES students and staff, who have participated in two major conferences in the last three months (see pages 4 and 5). Our new commercial display booth at the 14th AGC was a popular venue for discussions and showed the value of displaying material about our research at conferences.

On the homefront, the CODES symposium in June 'Basins, Fluids & Ores' co-convened by the SEG University of Tasmania Student Chapter, proved to be a great success (see pages 6 and 7). International and local presenters gave a series of talks and discussion sessions generated plenty of ideas for future research and new collaborations.

In this edition we present the flyer for an upcoming AGSO workshop on geochemical modelling which will be delivered in November. The research behind the workshop – an important part of our technology transfer to industry – is detailed in the Research Profile on pages 4 and 5.

This edition also contains a registration flyer for the CODES 'Tectonics, Structure & Ore Deposits' short course in November. On the back page are short course dates for 1999 and registration flyers for next year's courses will be distributed with **oresolutions** as usual three months or so prior to each course.

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Sponsor joins AMIRA project

Billiton has joined our Sediment Hosted Base Metal Deposits AMIRA project (P384A) which featured in the last edition of **oresolutions** (Number 2, pages 4-5). A three-day seminar and field trip to Tasmania and northeast Queensland has been organised for September to introduce Billiton.

Antarctic research

Research Fellows Dima Kamenetsky and Garry Davidson recently received a grant from the Australian Antarctic Division for work on Macquarie Island – the only emergent part of the Macquarie Ridge and one of the few localities in the world where the crust of a major ocean basin is exposed.

The project is titled 'Primary sulfur abundances and the oxidation state of sulfur in the Macquarie Island glasses and melt inclusions: implications for the sulfur budget during seafloor alteration'.

It aims to relate petrological and geochemical characteristics of ocean floor magmatism using a detailed study of the Macquarie Island volcanic glasses and melt inclusions. Also, the project will use sulfur abundances and specification data to determine the sulfur composition of the Island's rocks prior to their alteration. The effects of mantle melting, shallow-level crystallisation, degassing and sulfide immiscibility on sulfur distribution will also be examined.

The project complements Garry's ARC Large Grant with Rick Varne (University of Tasmania), Tony

Brown (Mineral Resources Tasmania) and Jeff Alt (University of Michigan) titled 'Sulfur geochemistry of hydrothermally altered oceanic crust- a view from Macquarie Island' (1998-2000).

New PNG mineralisation discovery

Between July 20 and August 2, CODES program leader Bruce Gemmell was part of a German-Canadian oceanographic cruise (SO-133) of *R/V Sonne* into the active tectonic zone south of Lihir Island, Papua New Guinea. Indications of epithermal-style vein mineralisation at the summit of one volcano (conical seamount) were confirmed, and a major new deposit of polymetallic epithermal-style vein mineralisation and its associated pyritic stockwork were mapped.

The discovery represents a new type of seafloor mineralisation and has important implications for understanding the metallogenic history of the Lihir area.

The cruise was led by Professor Peter Herzig and Dr Mark Hannington, to map and sample as well as to establish the extent of seafloor volcanism and hydrothermal activity associated with active extension of the old forearc crust of New Ireland.

The main focus of the work was on several young volcanic cones discovered during an earlier cruise and nearby fault zones associated with the uplift of the Lihir pedestal.

The cruise was funded by the German Ministry of Education, Science, Research & Technology

News

From the Director

through a grant to Freiberg University of Mining and Technology.

Distinguished SEG award

Ross Large has been selected by the Society of Economic Geologists as the **SEG Distinguished Lecturer** for 1998. The award is selected on the basis of 'pre-eminence in economic geology, either in some phase or phases of scientific research or in the application of the science to minerals exploration or development'.

Ross was selected for his widely recognised expertise in mineral exploration technology, ore deposit models and hydrothermal geochemistry as well as for his significant contributions to the understanding of volcanic-hosted massive sulfide deposits.

He will deliver his lecture at the joint SEG-GSA meeting in Toronto, Canada in October 1998.

Community education roundup

Minerals Week 1998

Mining & Minerals Week (May 1998) with the theme 'Clever Industry' was a great opportunity to explore links between education and industry, and we received wide coverage in the statewide media for the School of Earth Sciences, CODES and the Australian Student Mineral Venture.

Science Week 1998

We participated in Science Week (May 1998) activities co-ordinated

through the University's Faculty of Science & Engineering. We helped out with the western Tasmania component of a travelling roadshow around the state.

Back from the Brink

Back from the Brink is an important document for CODES and the School of Earth Sciences and earlier this year Ross Large attended a combined meeting of the Australian Vice Chancellors Committee and the Minerals Council of Australia (MCA). This combined committee was set up to discuss the role of Universities in educating tertiary students with the aim of advancing minerals industry education in Australia to a position of world leadership. The meeting formed three new discussion groups: funding and overview; undergraduate courses; graduate and postgraduate issues. CODES Director Ross Large is a member of the third group.

More recently, Dick Carter, President of the AusIMM and Chair of the MCA's Education Taskforce, accepted our invitation to visit the School of Earth Sciences and CODES to discuss our research and teaching programs.

Refurbishments

The School of Earth Sciences and CODES have just finished a major refurbishment of the geography/geology/CODES/Physcis building. Developments include new offices, a complete revamp of lecture theatres with top a/v equipment, a high-level clean laboratory and upgraded teaching laboratories.

The refurbishments were a high priority of the Faculty of Science & Engineering in supporting CODES.

Mining history in Tasmania has turned a corner with the recent takeover of Aberfoyle Resources by Western Metals.

Aberfoyle had its origins in Tasmania mining tin and tungsten at the Story's Creek Mines in the Rossarden district in the northeast of the state. The company grew by successful exploration strategies which lead to discoveries and substantial mines at Cleveland (1965), Que River (1974) and Hellyer (1983). Further exploration success led to increased reserves following acquisition of the Gunpowder deposit in Queensland.

There has been a close association between CODES and Aberfoyle over the last fifteen years and many of us feel that we have been part of this very successful exploration and mining team. In particular, the research collaboration at Que River, Hellyer and more recently Gunpowder developed between Aberfoyle and CODES has been of considerable benefit to both partners. Aberfoyle's membership of our Advisory Board, their contribution to our teaching program in mine geology and their employment of many of our graduates over the years has strengthened the association.

While Tasmania may be losing a mining and exploration icon with the departure of Aberfoyle, we will however be gaining a new company in Western Metals, which has rapidly developed a growing reputation for successful lead-zinc-silver exploration and mining on the Lennard Shelf (Western Australia). We wish Western Metals every success as a new player in Tasmania's mining industry.

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International Volcanological Congress

11-16 July 1998

Cape Town, South Africa

Presenters

Cathryn Gifkins: Ancient examples of pumiceous peperite and hyaloclastite.

Jocelyn McPhie: Pumiceous sills, peperite and vesicular sediment at Mount Chalmers, Qld.

Rick Varne (School of Earth Sciences): Tasmanian/Ferrar magmatism: possible product of mantle-lower crustal melt interaction during aborted rifting.

Posters

Sharon Allen: Mixing of ignimbrite and unconsolidated mud during emplacement of the Kos Plateau tuff.

Also: Eruption of the rhyolitic Kos Plateau tuff.

David Rawlings: Extensive basalt sheets with marginal peperite, Australia: shallow tubular sill analogy of tube-fed lava?

Also: Emplacement structures associated with the Jimbu granite, McArthur Basin, NT: analogy with experimental models.

Holger Paulick: Volcanic facies interpretation in a hydrothermally altered felsic succession hosting base metal mineralisation.



View of the Etendenka flood basalt and quartz laterite in the Namibian Desert, southern Africa.

ResearchProfile

Fluid Flow Modelling from David Cooke Program Leader

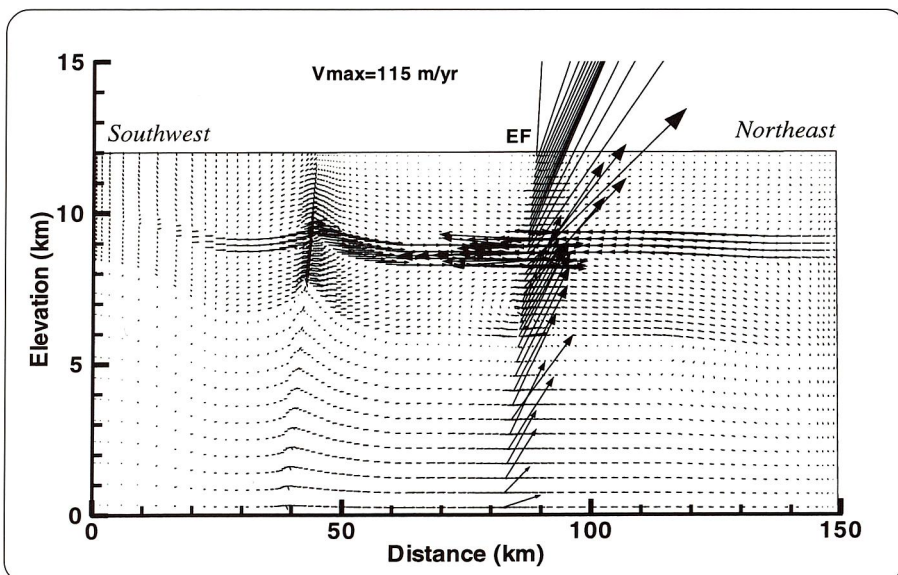
The nature of fluid flow and the chemical evolution of hydrothermal fluids should be an integral component of any genetic model for hydrothermal ore deposits. Often overlooked, these two aspects are fundamental to the formation of base and precious metal mineralisation and related hydrothermal alteration assemblages. CODES is developing a research program to investigate the hydrological and chemical evolution of hydrothermal solutions, with an emphasis on SEDEX, VHMS, porphyry and epithermal environments. Our ultimate aim is to integrate chemical and hydrogeological models for ore formation in selected environments, leading to a better understanding of ore genesis.

To assist this aim, Professor Grant Garven from the Department of Earth and Planetary Sciences, Johns Hopkins University

(Maryland) joined CODES in January as an SRC Visiting Fellow and Senior Fulbright Scholar. Grant is spending his sabbatical at CODES applying computer-based fluid flow models to the problem of Pb-Zn ore genesis in the McArthur Basin. He brings numerical software for modelling hydrothermal flow systems in sedimentary basins, including software for modelling reactive flow fields that can be used to evaluate geochemical processes such as diagenesis and ore-forming processes (see figure below).

In related research, MSc student Christian Schardt (Germany) is modelling the Hellyer massive sulfide deposit in western Tasmania using CHILLER to evaluate the likely chemical processes responsible for the alteration zonation and paragenesis. Previous research by Bruce Gemmell and Ross Large into the genesis of the Hellyer VHMS deposit has shown that fluid/rock interaction in the vent zone has produced a zoned alteration pipe with enveloping

Hydrodynamic cross section for McArthur Basin showing flow rates after release of overpressures by opening of Emu Fault.



shells of silica, chlorite, carbonate and sericite mineralogy. Christian's work so far has shown that it is possible to reproduce the zoned alteration system via water/rock interaction between the host sequence and a high-temperature vent fluid. It has also highlighted temperature controls on alteration assemblages. His work has important implications for determining criteria to distinguish ore-related alteration zones from apparently 'barren' alteration systems in submarine volcanic environments.

Reaction path modelling software, such as CHILLER and SOLVEQ, that is useful in this type of research is unfortunately not user-friendly, so are rarely used by economic and exploration geologists. CODES is developing a more user-friendly IO interface for both packages so that this variety of thermodynamic modelling software is available to more ore deposit and industry geologists. The new application (CHILL+) will also contain a sub-program that will generate activity diagrams based on the input fluid compositions, and this will allow further testing of genetic models.

Darren Turner (computer programmer) is finalising the interface work and is developing systems to provide simple graphical representations of output from reaction path modelling with CHILLER. He has also simplified the data processing routine for easier analysis and presentation of results, and has simplified the process of modifying critical fluid compositions in SOLVEQ. A software demonstration will be given at an AGSO workshop in late November 1998 (see flyer). 

14th Australian Geological Convention

6-10 July 1998

Townsville, Australia

Presenters

Tony Crawford: Melt Inclusions: a new tool for monitoring volatiles and chalcophile metals in evolving magma suites. Petrogenesis and geodynamic significance of the basement complex ophiolite, Pentecost Island, Vanuatu Island Arc, southwest Pacific.

Bruce Gemmell: Actively forming high sulfidation lateration on the seafloor, Desmond Caldera, eastern Manus Basin, Papua New Guinea.

David Cooke: Oxidised (sulfate-bearing) brines: their importance for the formation of Australian Proterozoic Pb-Zn (SEDEX) deposits.

Garry Davidson: Repeated feldspar alteration events during the consolidation history of the McArthur Group, Northern Territory, Australia.

Trevor Falloon: Mantle melting at 1 and 1.5 GPa and the petrogenesis of MORB: implications for determining the compositions of high-pressure mantle melts using diamond aggregates and natural mineral mixes.

Leonid Danyushevsky: H₂O geochemistry in depleted- to moderately-enriched mid-ocean ridge magmas.

Fernando Della-Pasqua: Composition of primary melt and fluid inclusions in olivine phenocrysts from Lombok, Indonesia: implications for magma genesis and metal enrichment.

Nick Direen: Gnalta Group, far western New South Wales: a late Cambrian tectonic melange?

Mark Doyle: The sub-seafloor replacement origin of the Highway-Reward deposit.

Dima Kamenetsky: Unusual mineral and melt inclusion compositions in basalts from 43°N, mid-Atlantic Ridge: evidence for melt-peridotite interaction.

Alison Raos: A geochemical adventure on Efate Island, Vanuatu Arc, southwest Pacific.

Briony Sinclair: The Gap: an unusual bornite-rich VHMS ore body, Myra Falls District, British Columbia, Canada.

Rohan Wolfe: Dinkidi: an alkaline Au porphyry deposit from North Luzon, Philippines.

Posters

Andrew Tunks & David Cooke: Structural and geochemical controls on gold deposition at the Tanami Gold Mine, Northern Territory, Australia.

Grant Garven: The hydrodynamics and geochemistry of MVT ore genesis in southeast Missouri: numerical simulations of fluid flow and metal transport in the fractured Irish Zn-Pb-Ba ore district.

Bruce Anderson: Lead isotope evolution on mineralisation in the Proterozoic Throssell Group, Western Australia.

Kirstie Simpson: Characteristics of subaqueous basaltic andesite fire fountain deposits: an example from the Mt Windsor Volcanics, Queensland, Australia.

Carsten Münker: The Cambrian evolution of the Lachlan Fold Belt: new stratigraphical, geochemical and isotopic constraints from New Zealand.

In Circulation

New PhD student

Sarah Jones: Geology and geochemistry of the cap rocks associated with the Myra Falls VHMS deposit, Canada: implications for ore genesis and exploration.

Graduations May 98

Mark Doyle (PhD): A Cambro-Ordovician submarine volcanic succession hosting massive sulfide mineralisation, Mt Windsor subprovince, Queensland, Australia.

Michael Roache (PhD): Timing and mineralisation and the nature of the mineralising fluids at the Menninnie Dam Pb-Zn-Ag deposit, South Australia.

Will Godsall (Master of Economic Geology): Cu-Au mineralisation and alteration, Royal Tharsis deposit, Mt Lyell, Tasmania.

Januz Ryba Graduate Diploma of Economic Geology.

Visitors

Robin Morritt from Pacific Nevada visited in July and gave a presentation titled 'Pacific Nevada and its exploration effort in Tasmania'.

Dr Bruce Christenson from the Institute of Geothermal and Nuclear Sciences (New Zealand) visited in June and gave a presentation titled 'Kawerau hydrothermal system: evolutionary processes in a TVZ ore-forming system'.

Dr Mike Worthing from the University of Oman visited during August and gave a presentation titled 'Petrology and tectonic setting of potassic igneous rocks from eastern Oman and their relationship to the petroleum potential of the area'.

Matt Rowland from the Department of Geology at Imperial College (England) visited in July with a presentation

titled 'A fundamental role for mafic-melt derived volatiles in porphyry-copper mineralisation'.

Associate Professor Mark Person, University of Minnesota (USA) will visit in September. Mark is a distinguished researcher on the role of fluids in rift environments and basin-scale hydrogeologic modelling.

Dr Stuart Simmons from the Goethermal Institute, University of Auckland (New Zealand) visited during July to discuss collaborative research.

Mayuko Tada from the Japan Society for the Promotion of Science visited as part of a national tour to gain an understanding of Australian science with a view to enhancing Australian-Japanese collaboration.

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The symposium ran over four days with 14 presenters and 46 participants. Invited presenters at the CODES Symposium 'Basins, Fluids & Ores' (left to right) Peter Muhling, BHP Minerals; Jeff Hanor, Louisiana State University; Wayne Goodfellow, Geological Survey of Canada; Murray Hitzman, Colorado School of Mines; Grant Garven, Johns Hopkins University. Not pictured: Malcolm Wallace, University of Melbourne.



Society of Economic Geologists
University of Tasmania
Student Chapter
sponsored by CODES SRC

Symposium report

During mid June, the Student Chapter co-convened a symposium on Basins, fluids and ores with the Centre for Ore Deposit Research. The short course concentrated on the various types of sediment-hosted Zn-Pb deposits, their tectono-sedimentary setting and the geochemical processes in operation during fluid evolution and migration.

One of the main aims of the symposium was to provide a forum for informed debate and discussion at the end of each session. To that end, a number of students participated in the symposium and recorded all questions and discussion. Ultimately, these discussions will be included in a CODES Special Publication, which will contain material presented at the symposium. This publication will be on sale and a proportion of the profits will go toward supporting future SEG Student Chapter events. The Executive Committee would like to thank Bruce Anderson, Mark Duffett, Owen Hatton, Daryl Clark, Steve Hunns, and Holger Paulick for their efforts in recording and transcribing various sessions. Special mention should also be made of the contributions of David Rawlings, who organised the taping of each session, and Oliver Holm, who has managed to pull together all these contributions into a coherent form.

SEG student grants

PhD students Andrew Davies and Kirstie Simpson have both received a Hugh McKinstry Grant. The grants are provided by the Hugh McKinstry Grants Committee and the SEG Foundation Student Research Grants Committee for the kind of study that Professor McKinstry encouraged during his lifetime.

Andrew's project is 'The geological setting, geochemistry and genesis of carbonate base metal enriched, epithermal Au mineralisation, Kelian Gold Mine, East Kalimantan, Indonesia'.

Kirstie's project is 'Volcanic facies architecture of the Mt Windsor Volcanics, Queensland, Australia'.

Fundraising activities

One of the Student Chapter aims is to raise the profile of the Earth Sciences through activities such as field trips and seminars. To help subsidise these events for students, the Executive has arranged a number of fundraising activities including a raffle and the sale of shirts embroidered with the SEG and CODES logos. The shirts are made by Canterbury Australia and are midnight blue. They range in size from S through to XL and are \$42. If you are interested in supporting the Student Chapter, please contact either:

Peter Winefield
p.winefield@utas.edu.au
or David Rawlings
d.rawlings@utas.edu.au

Donation of economic geology journals

The Student Chapter is delighted to have received 45 boxes of the journal *Economic Geology*, generously donated by the Society of Economic Geologists. The journals comprise a set which dates back to 1930 and will take pride of place in a new reading room in the department to be developed in conjunction with the School of Earth Sciences and CODES. The collection will include other material that has been donated over the years and will be open to all staff, students and visitors in the very near future.

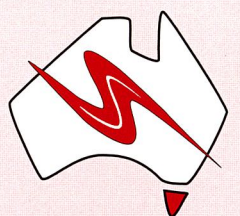
Farewell

The Executive Committee would like to take this opportunity to farewell two of the stalwarts of the Student Chapter. Mark Duffett and Steve Hunns have been an integral part of the formation and running of the SEG Student Chapter through their help, advice and participation in various events. Both are coming toward the end of their PhDs and moving on to new things. Mark is moving to Darwin to take up a position with the Northern Territory University, while Steve is moving on to new challenges in Germany. We wish them all the best in their respective futures and offer them our thanks for their help and friendship over the last few years.

Peter Winefield
President
SEG

University of Tasmania
Student Chapter

◀ continued on page 6

**CODES SRC**

Centre for Ore Deposit Research

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All material may be reproduced with due acknowledgment to CODES.

Design:

Clemenger

Typesetting:

Jessica Tyler

Prepress:

Photolith

Printing:

Printing Authority of Tasmania

WebSite

www.geol.utas.edu.au/codes

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UNIVERSITY OF TASMANIA

Short course dates for 1999

exploration geochemistry and hydrothermal geochemistry

8 – 19 March 1999. Leader: Bruce Gemmell

Covers recent developments in exploration geochemistry, with particular emphasis on the importance of the regolith and landscape evolution, as well as an introduction to the chemistry of hydrothermal systems. Includes a review of the importance of metal solubilities and ore fluid chemistry in controlling types and locations of ore deposits.

exploration geophysics, remote sensing and image processing

28 June – 9 July 1999. Leader: Mike Roach

Focuses on the theory and application of potential field and electrical geophysical techniques in exploration geology. The uses, problems and pitfalls of each method will be covered. Both prospect evaluation and regional geophysical studies will be discussed, as well as structural interpretation of airborne geophysical data, remote sensing, data integration and the application of GIS systems to exploration geology.

economic, management and environmental aspects of exploration and mining

1 – 12 November 1999. Leaders: Bruce Gemmell and Ross Large

Includes a one-day session on economic modelling at the feasibility stage, and a session on financing and floating companies. Exploration philosophy, exploration management styles and the factors contributing to exploration success will be debated with a panel of exploration managers. Geological and hydrologic aspects of acid mine drainage will also be considered in a three-day session including a field trip to western Tasmania.

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