

# ANNUAL REVIEW 2013

Centre for **EXPLORATION  
TARGETING**

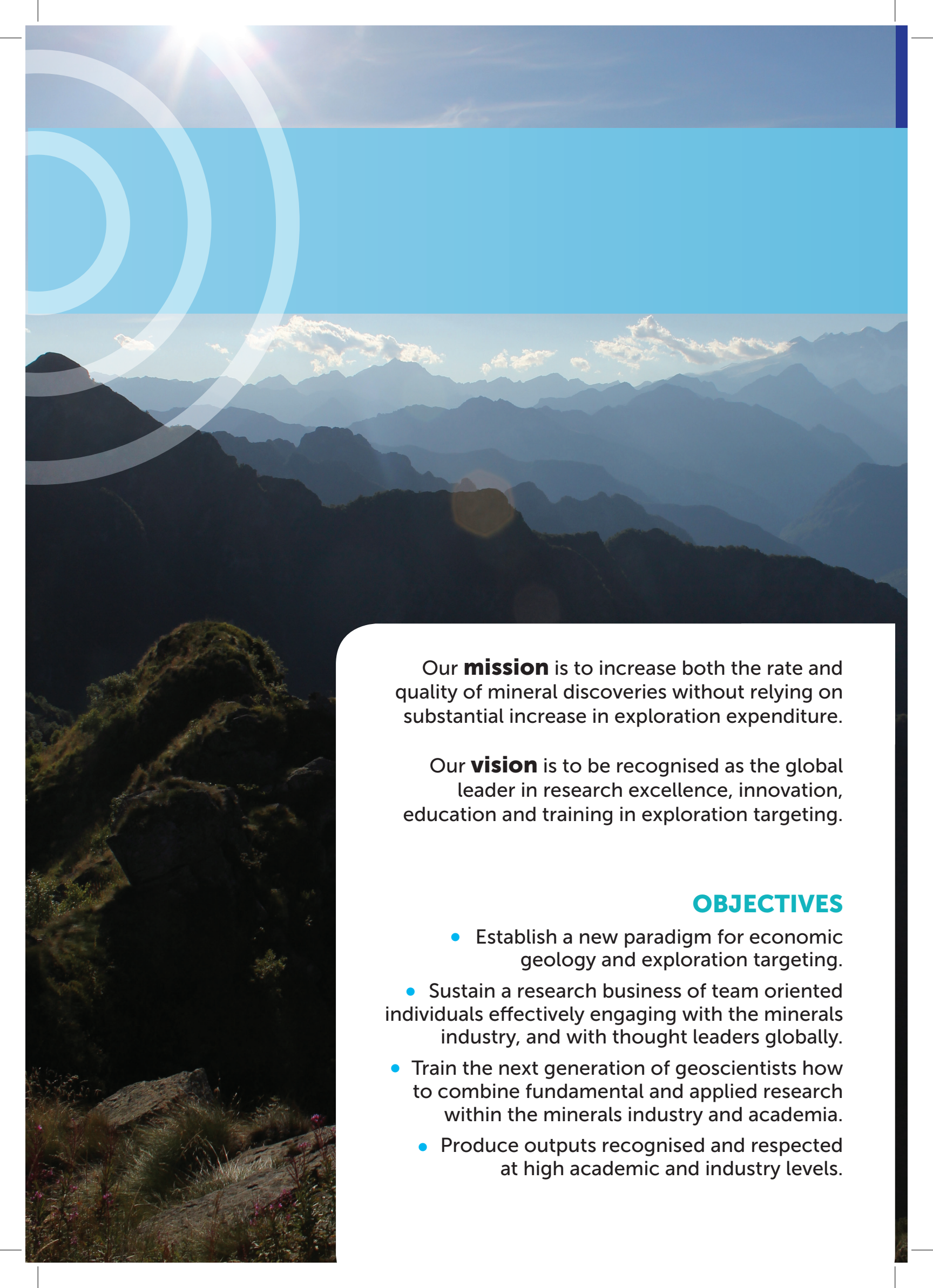


Curtin University



THE UNIVERSITY OF  
WESTERN AUSTRALIA  
*Achieve International Excellence*





Our **mission** is to increase both the rate and quality of mineral discoveries without relying on substantial increase in exploration expenditure.

Our **vision** is to be recognised as the global leader in research excellence, innovation, education and training in exploration targeting.

## OBJECTIVES

- Establish a new paradigm for economic geology and exploration targeting.
- Sustain a research business of team oriented individuals effectively engaging with the minerals industry, and with thought leaders globally.
- Train the next generation of geoscientists how to combine fundamental and applied research within the minerals industry and academia.
- Produce outputs recognised and respected at high academic and industry levels.

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## CHAIRMAN'S REPORT

Despite an ongoing downturn in our key customer base, the mineral exploration industry, the CET has continued to perform strongly in 2013. Research revenues have been maintained at levels comparable to previous years and we continue to undertake high impact science.

Importantly, the CET has worked hard to position itself strongly with respect to the ongoing national drive to address the major challenges of the Australian resources-related research sector. This strategic alignment has been achieved through collaborative engagement bridging academia, industry and government agencies (in our case, most notably CSIRO and the geological surveys). Specific examples of this emerging "macro-trend" include the Australian Academy of Sciences UNCOVER initiative, which is now gaining widespread traction throughout our community, the SIEF Distal Footprints project which is perhaps the largest single geoscience research project ever funded in this nation, and the National Resources Science Precinct. The CET has a significant role in all of the above.

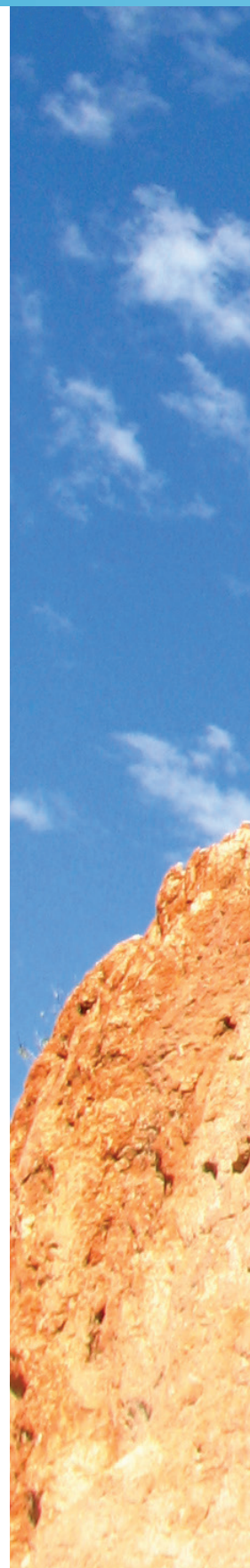
The CET is very comfortable with collaboration because it is in our DNA. Although largely based at UWA, the CET was founded as a collaborative venture that also included Curtin University, the government of Western Australia and the mineral exploration industry. Our continuing commitment to this collaborative vision is demonstrated by the opening of a CET node at CSIRO's ARRC building in Kensington and the deepening of our links with Curtin University in 2013. I would like to also acknowledge the very strong relationship that has been established in recent years between staff at the CET and at the Geological Survey of Western Australia to deliver key scientific outcomes in the very important Exploration Incentive Scheme. I anticipate that collaborative ventures are only going to become more important to the CET as we move into the future.

A great strength of the CET has always been its responsiveness to the demands of the industry. The key to this has been the very active engagement of a board that comprises a number of mineral exploration industry leaders. We are also fortunate to be supported by a very committed group of leading industry scientists who provide critical technical advice via our External Advisory Group. In addition, the industry members of our Finance, Risk and Commercialisation sub-committee play a critical role in guiding the management of the CET. These important contributions by industry leaders are all made on a pro-bono basis and I would like to say here to all those involved that your work on the CET's behalf is gratefully appreciated and your advice is taken very seriously.

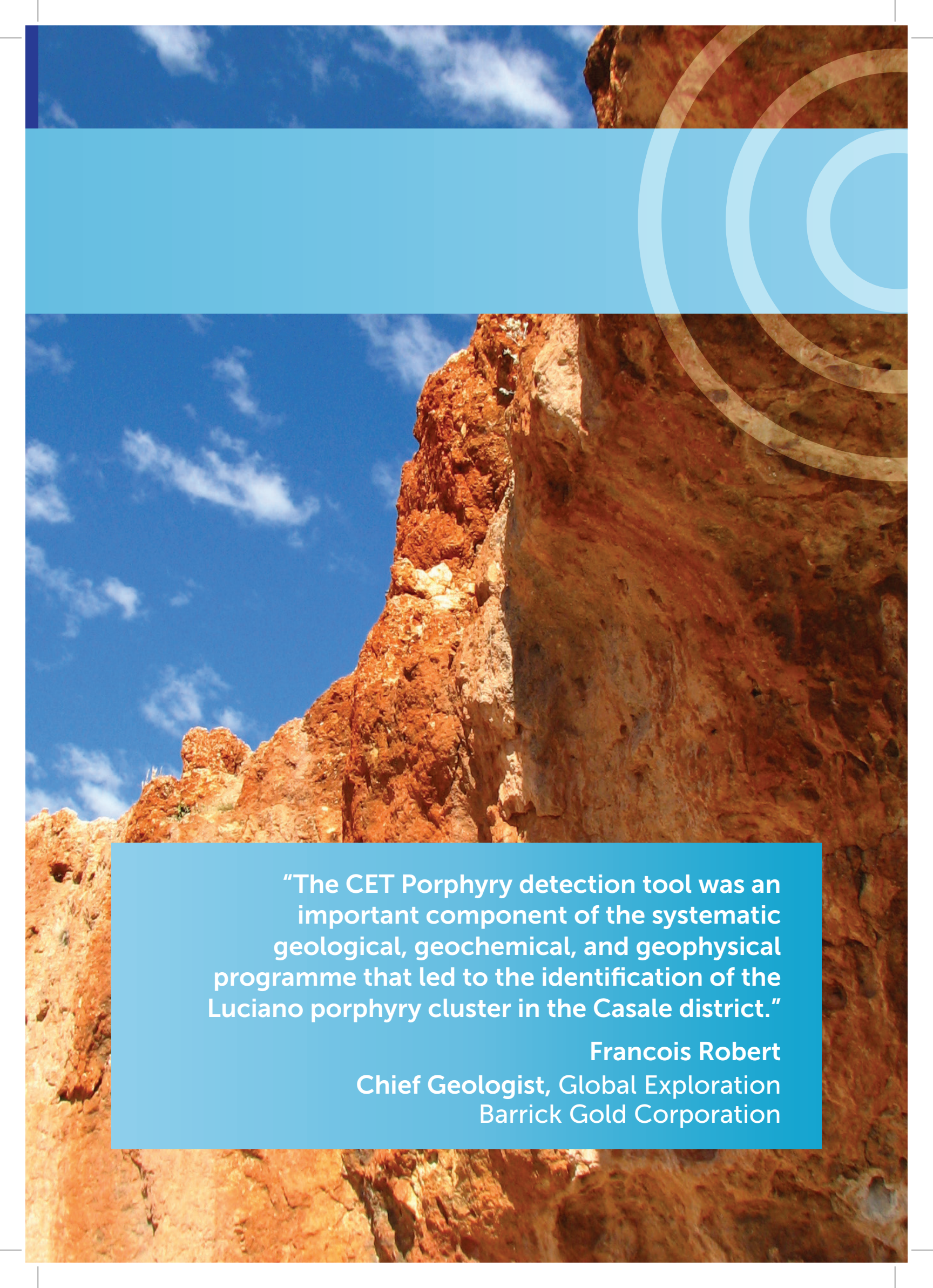
As Chairman of the CET board during a period of significant strategic development, I am very pleased that we have the benefit of high-level input from senior representatives of our two host institutions, UWA and Curtin University. As a large research business that is continuing to grow, it is essential that the development of the CET is guided by and supports the strategic goals of its host institutions.

Finally, I would like to thank the talented staff of the CET, ably led by Professor McCuaig for another year of hard work, dedication, and delivery of high-quality outcomes for the mineral exploration industry.

**Dr Jon Hronsky**  
**CHAIRMAN OF THE BOARD**







**"The CET Porphyry detection tool was an important component of the systematic geological, geochemical, and geophysical programme that led to the identification of the Luciano porphyry cluster in the Casale district."**

**Francois Robert**  
Chief Geologist, Global Exploration  
Barrick Gold Corporation





## DIRECTOR'S REPORT

After 3 straight years of unprecedented growth at close to 30% per annum, 2013 was a year of consolidation for the CET. Staff numbers have now stabilised at more than 50, alongside close to 30 PhD's, making the CET one of the largest geoscience research groups globally focused on mineral exploration. In a year that has witnessed a continuation of market aversion to the mining sector, I have been pleased to see that we maintain a strong and stable Corporate Membership base, and that over 40% of this membership is from the junior sector of the mineral exploration industry. We see this as an indication that industry perceives tangible value in engagement with our Centre, and are delighted in this vote of confidence. Revenues for the year were maintained at the same level as 2012 at approximately \$AUD8M, with over 50% of this revenue coming from external stakeholders.


The CET continues to have a strong research presence on every continent, and in fact has gone interplanetary with a project funded by the European Space Agency looking at the potential for mineral systems on Mars! The major change in our project portfolio over the past 12 months has been further growth in the average size of project, continuing a trend seen throughout the 8 years of Centre operation. Our strategic focus has been on the generation of a number of giant multidisciplinary collaborative initiatives, as it is through such programmes that the greatest potential for transformational breakthroughs in large scale understanding of mineral systems relevant to exploration targeting emerges.

Examples of successful initiatives include: the Distal Footprints project over the Capricorn Orogen in Western Australia – one of the largest single geoscience projects ever funded in Australia; the West African Exploration Initiative (WAXI) funded through AMIRA, which is lauded internationally as a model for precompetitive geoscience research in developing nations; the Exploration Incentive Scheme with GSWA generating 4D geology-geophysics interpretations and targeting products over greenfields terranes; and the ARC Centre of Excellence in Core to Crust Fluid Systems (CCFS), currently the largest fundamental geoscience research initiative in Australia, which is focused on understanding the underlying processes of mass, energy and metal transfer critical to the development of mineral systems.



(Right) Professor Cam McCuaig delivering an invited address during AMEC 2013.





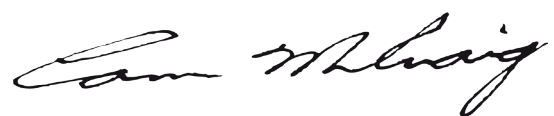
With more than 90 publications in refereed international journals and books during 2013, scientific outputs from the CET are at unprecedented levels, with citation levels and external recognition demonstrating continued high impact on the research community. Multiple invitations to deliver research papers and keynote presentations at international meetings, and the number of prestigious awards conferred on CET staff and students all speak to the high profile of the Centre on a world stage.

Successful commercialisation of CET software for the mineral exploration industry also continues, with our new televiewer image interpretation tool currently undergoing commercial development with a leading software provider in downhole imaging for the resource industry. In applied results too, the CET's previously released porphyry detection software tool, developed in collaboration with Barrick Gold, has been credited with contributing to the discovery of the Luciano porphyry cluster in the Casale district, Chile.

The CET has an exciting future. The next two years will see a reorganisation of our research structure to be more closely geared to the needs of the mineral exploration industry, as detailed in this annual report. Further growth of the Curtin Geoscience node and the CET node at the Australian Resources Research Centre through collaborations with CSIRO

is planned. The CET also continues to be a major driver in the UNCOVER initiative, helping to shape the vision for mineral exploration geoscience on a national level.

The success of the CET is due to the integrated work of an incredible team. This includes the contributions of our highly skilled and enthusiastic staff and students; our industry dominated Board and External Advisory and Finance, Risk and Commercialisation committees; the strongly supportive organisations hosting the CET at the University of Western Australia and Curtin University, the army of highly engaged adjunct researchers working in industry, national and international collaborators; and our Corporate Membership base. This membership in particular is critical to our success, continually engaging with the Centre in the identification of key challenges and the pursuit of fundamental science to improve mineral exploration outcomes. To all of these stakeholders, I offer my sincere thanks for your contribution to another very successful year for the CET.



Professor T. Campbell McCuaig  
**CET DIRECTOR**



# RESEARCH OUTPUT, QUALITY & IMPACT

## GRADUATING STUDENTS

The CET continues its strong tradition of attracting and training top quality students, welcoming the following PhD candidates during 2013: Maria Linda Iaccheri, Katarina Bjorkman, Franco Pacheco Ortiz, Juliana Pertille De Silva, Raphael Baumgartner and Manas Kumar Singha.

The following students graduated during 2013, and are congratulated on their achievements:

### Graduating PhD Students

| Student         | Topic   |
|-----------------|---|
| Jane Collins    | The structural evolution and mineralisation history of the Flying Fox komatiite-hosted Ni-Cu-PGE sulfide deposit, Forrestania Greenstone Belt, Western Australia. |
| Zoja Vukmanovic | Microstructural characterisation of sulphide and oxide minerals in magmatic sulphide ores.  |

Table 1.

### Graduating Masters Students

| Student              | Topic                                     |
|----------------------|---|
| Alyssa Barron        | Master of Science - Thesis and Coursework |
| Christopher Bishop   | Master of Science - Thesis and Coursework |
| Ristch Camille       | Master of Geoscience - Coursework         |
| Michael Carroll      | Master of Science - Thesis and Coursework |
| Rebecca Gallagher    | Master of Science (Ore Deposit Geology)   |
| Kewame Gwandu        | Master of Ore Deposit Geology             |
| Dusk Mains           | Master of Science - Thesis and Coursework |
| Sidy Morin           | Master of Science (Ore Deposit Geology)   |
| Franco Pacheco Ortiz | Master of Ore Deposit Geology             |

Table 2.

### Total Students 2013

|                        | 2013 |
|------------------------|------|
| PhD students enrolled  | 30   |
| PhD students completed | 2    |
| MSc students enrolled  | 40   |
| MSc students completed | 9    |

Table 3.

(Top Left) Professor Cam McCuaig presenting at the Mineral Geoscience Honours Sundowner 2013.

(Top Right) Training and Knowledge Theme Leader Dr Steven Micklethwaite presents PhD student Aileen Roberts with the CET Award for Best Student Poster at the 2013 Corporate Members Day.



## RESEARCH HIGHLIGHTS

The CET achieved record research publication output this year, with 83 papers in refereed international journals, 4 major books, a further 9 substantive book chapters, and numerous refereed abstracts presented at national and international conferences.

CET research activity is divided into five streams that reflect its core strengths (Figure 1). These work streams are brought together in a number of multidisciplinary flagship projects operated collaboratively with world-class researchers from other institutions to address key research questions. Detailed information on each of these research themes and projects can be obtained from our website ([www.cet.edu.au](http://www.cet.edu.au)). Among the Centre's most important outputs, as always, are our high quality postgraduate students. In 2013 the CET had 30 affiliated Ph.D. students and 40 M.Sc. students enrolled (Table 3). During the course of the year, 2 Ph.D. and 9 M.Sc. students successfully completed their studies and graduated (Tables 1 and 2).

The CET has also maintained its tremendous success in winning competitive grants, a major independent measure of research design quality. In 2013, the Centre was awarded \$5.2 million in competitive funding. This headline figure included \$1.2 million to the CET (from a larger \$4 million grant shared with collaborating organisations) awarded by the Science and Industry Endowment Fund (SIEF) and \$2.9 million from the Western Australian Exploration Incentive Scheme (EIS), along with substantial support from the Western Australian Fellowship Program and the International Mining for Development Centre (IM4DC). The SIEF and EIS funding, together with major additional support received in 2014 from the Minerals Research Institute of Western Australia (MRIWA) is driving the 'Distal Footprint' project, a multi-institutional collaboration between UWA, Curtin University, GSWA and CSIRO, badged under the new National Resources Research Precinct. The major focus area of this work is the under-explored Capricorn in Western Australia.

The CET's activities continue to be global in extent, with projects spanning every continent (Distribution of Active Research pg. 14). Nonetheless, we maintain a strong focus on research within Australia, and particularly within Western Australia.

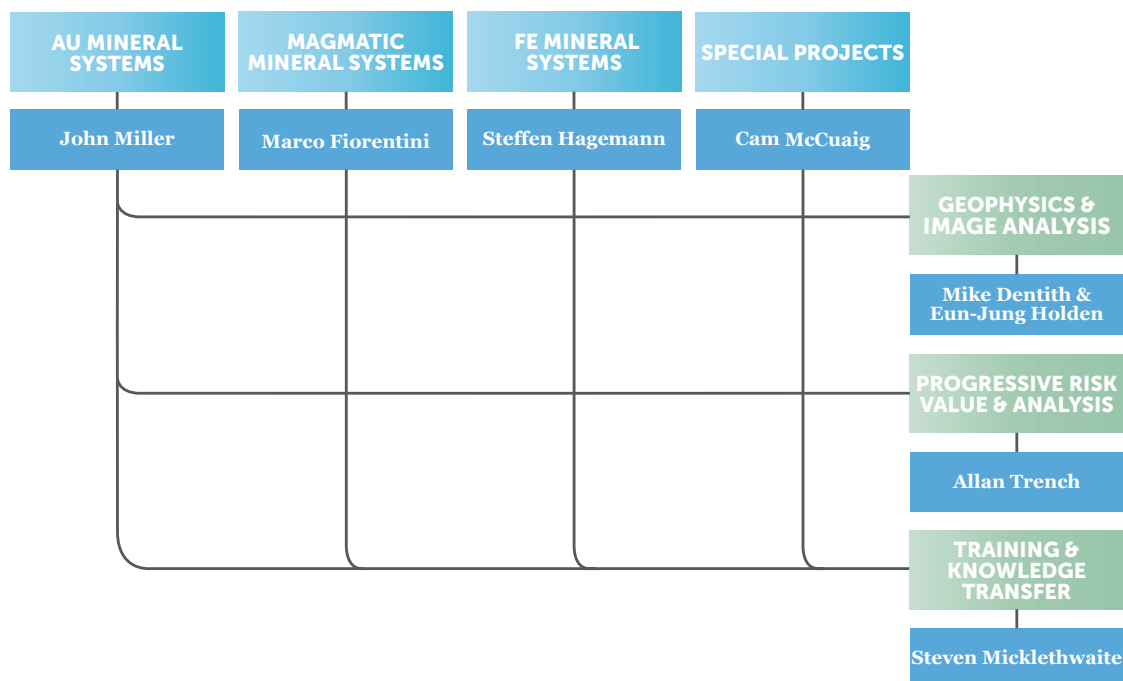


Figure 1. CET Research Theme Structure and respective Theme Leaders.

The significant outputs from these projects are too numerous to detail in this report, and readers are referred to the CET website ([www.cet.edu.au](http://www.cet.edu.au)) for more detail. However, selected highlights are summarised below:

- Our Director, Professor T. Campbell McCuaig, was awarded the Geological Society of Australia's Gibb-Maitland Medal for substantial contributions to geoscience in Western Australia – particularly those relating to the occurrence or discovery of mineral resources. This medal is the highest award granted by the Geological Society of Australia's Western Australian branch.
- Professor Mark Jessell was awarded a prestigious Western Australian Fellowship to undertake research into next generation 3D inversion and geology-geophysics integrated modelling. Professor Jessell's arrival cements the CET as one of the leading research groups globally in integrated geology-geophysics interpretation applied to mineral exploration.
- Professors Peter Kovesi, Eun-Jung Holden and Assistant Professor Jason Wong (Geophysics and Image Analysis) won the Laric Hawkins Memorial Innovation Award for the most innovative use of a geophysical technique, for their paper on interactive multi-image blending for data visualisation and interpretation.
- Through our Risk and Value stream, the CET continues to influence government policy towards the minerals industry. The latest substantive impact in this area has been the completion of a source book for the World Bank on 'How to Improve Mining Tax Administration and Collection Frameworks', focusing on the African nations of Burkina Faso, Ghana, and Mali. Further work in this space is continuing with the World Bank and the International Mining for Development Centre (IM4DC).
- Commercialisation of software tools for industry has become an annual event for the CET, and 2013 was no exception, with commercial release of a new potential field data enhancement tool – Dynamic Range Compression – in the upgraded CET Grid Analysis Extension for Geosoft Oasis Montaj.
- 2013 also witnessed the successful completion of a 3 year industry-sponsored project "Development of Software for the Geotechnical Interpretation of Televiewer Imagery", with the resultant algorithms currently undergoing commercialisation with a major international software provider.





- The second phase of the AMIRA P934a West African Exploration Initiative (WAXI2) was successfully completed, with outstanding reviews of the programme's success provided by sponsors. This project, a collaboration between 18 industry sponsors, 9 government agencies in West Africa, AusAID, the Australian Research Council and research institutions in France, Ireland, West Africa, South Africa, the Czech Republic and Australia, has revolutionised understanding of mineral systems and their relationship to the tectonic architecture of West Africa. A third phase, WAXI3 - intended to run for a further 4 years, is scheduled to commence in 2014. Three special issues of international journals have been arranged to publish the exciting outcomes of this programme.
- Among the outputs of this programme, CET researchers achieved major progress in defining the mineral system architecture and evolution of the richly endowed Ashanti belt of Ghana; Siguri basin of Guinea; and the Sadiola and Yanfilola belts of Mali, West Africa.
- The CET successfully completed a 3-year collaboration with the Geological Survey of Western Australia (GSWA) to develop integrated 3D geology-geophysics models and targeting products over greenfields terranes as part of the GSWA's Exploration Incentive Scheme (EIS). A series of outputs from this project are in the process of being released to industry through the GSWA, detailing geology-geophysics interpretation and targeting insights for the Arunta Orogen, Musgrave Orogen, and Southern Yilgarn. Continued development of the products of this successful research programme has been approved under the EIS2 scheme for another 4 years.
- Years of effort by the CET Iron Systems research group documenting and characterising Archean iron-oxide deposits in Australia and around the world culminated in 2013 with the publication of a codified Fe Mineral systems approach to deposit analysis and exploration targeting.
- Centre research has demonstrated a previously unrecognised link between late granitic magmatism and Au mineralisation across both the Southern Cross and Agnew Goldfields within the Yilgarn Terrane.
- Long-lived structural controls on mineralisation identified in CET studies of the world class Telfer Au-Cu system have provided new targeting concepts for the Paterson Orogen in Western Australia's under-explored north.



*(Left) CET Professor Marco Fiorentini and Dr Nicolas Thebaud with industry participants on a fieldtrip into the Iurea Zone, Italian Alps.*

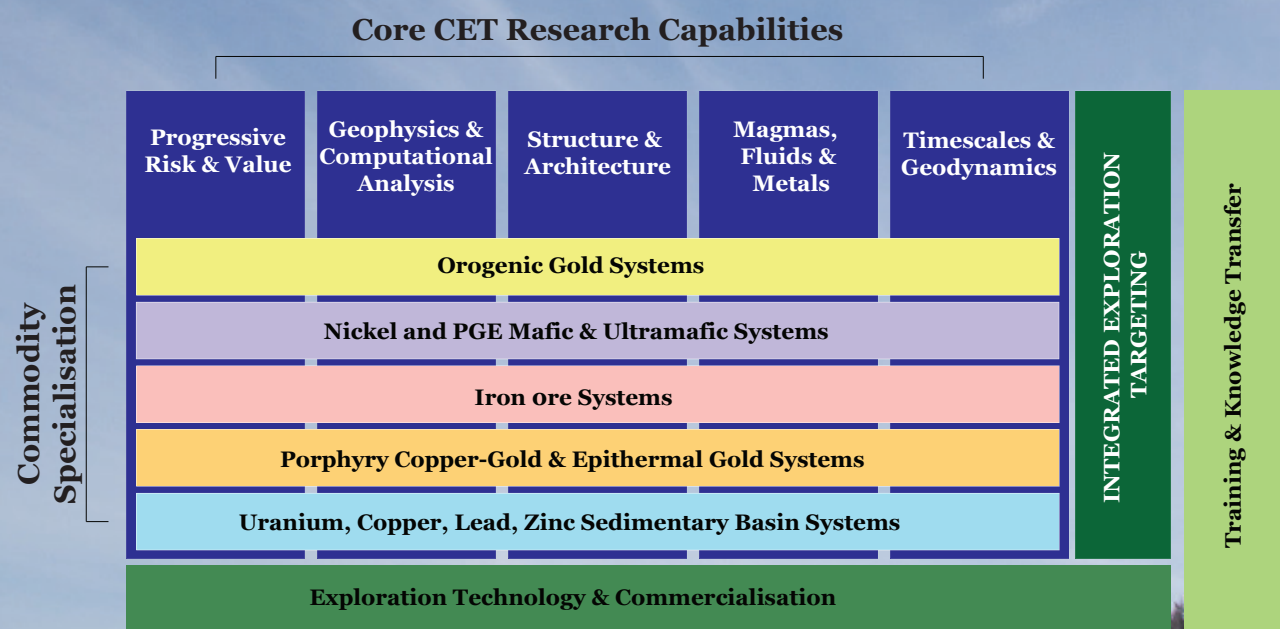
*(Right) PhD Student Katarina Bjorkman explains her research to Industry participants at the 2013 Lithospheric Dynamics Workshop*



(Far Left) Professor Marco Fiorentini hosting another successful Greenland Day in association with the Greenland Ministry of Minerals and Resources.

(Far Right) Image Analysis researcher Dr Jason Wong demonstrates his prototype exSim research at the 2013 CET Corporate Members Day.

(Below) Figure 2. Future CET Theme Organisational Structure.





## FUTURE DIRECTIONS

Analysis of global markets shows us that world metal demand is increasing – and seems set to continue to do so, despite international financial volatility. This increased demand can ultimately only be met by increased supply, which in turn can only be achieved through innovative discovery of new high quality mineral districts, and not by the development of increasingly marginal resources and brownfields exploration alone – a model which has arguably resulted in much value destruction through the past decade.

The CET is positioning itself to help transform industry exploration success rates, proactively reorganising its research effort and generating a series of large collaborative initiatives that will deliver the transformative insights required for the mineral exploration industry to meet these future resource challenges.

The first major change for the CET towards this future vision is the redesign of its research structure (Figure 2). This reorganisation will emphasize core strengths, aligning the Centre's key themes with a mineral systems framework directed towards integrated exploration targeting. Important CET work bridging both research capabilities and strengths in individual commodity areas will also be recognised through formal identification of "Training and Knowledge Transfer", "Exploration Technology and Commercialisation" and "Integrated Exploration Targeting" as key streams of Centre activity.

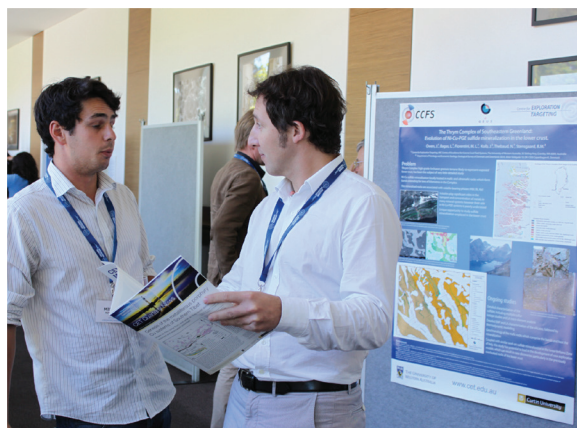
An aspect of particular note within this reorganisation is the creation of a new research theme in the Geodynamics and Timescales of mineral systems. This theme will focus on dating the mineralisation and modification of ore systems in order to identify, understand and spatially map the transient geodynamic events responsible.

The theme leader position for this new research stream will be hosted at Curtin University, and will link strongly with the technical expertise and facilities of the John de Laeter Centre for Mass Spectrometry, the minerals industry, and the brains trust available through the ARC Centre of Excellence in Core to Crust Fluid Systems.

This revised Centre structure will be translated through to a comprehensively redesigned and more user-friendly version of the CET website, to be launched in mid-2014. Built around an architecture designed to better support and engage with our Corporate Members, this website renewal will include enhanced content, multimedia hosting, and communication tools to allow the rapid dispersal of significant research outcomes and news from the Centre.

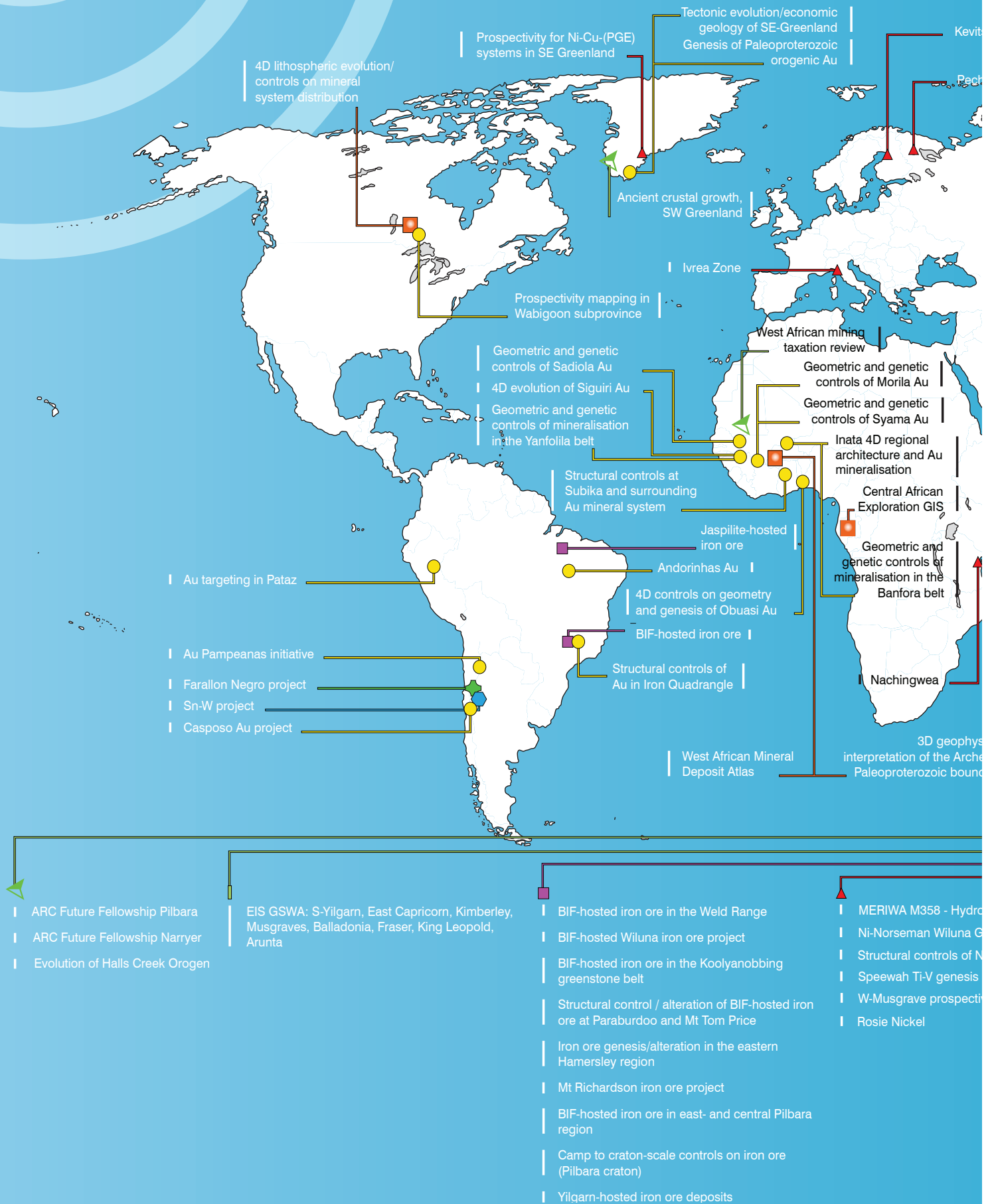
Much of the CET's research efforts in the coming year will be focused on delivering and expanding the scientific activity and outputs associated with three major industry-collaborative projects: the Capricorn Distal Footprints and EIS2 initiatives in Western Australia, and the WAXI3 project in West Africa.

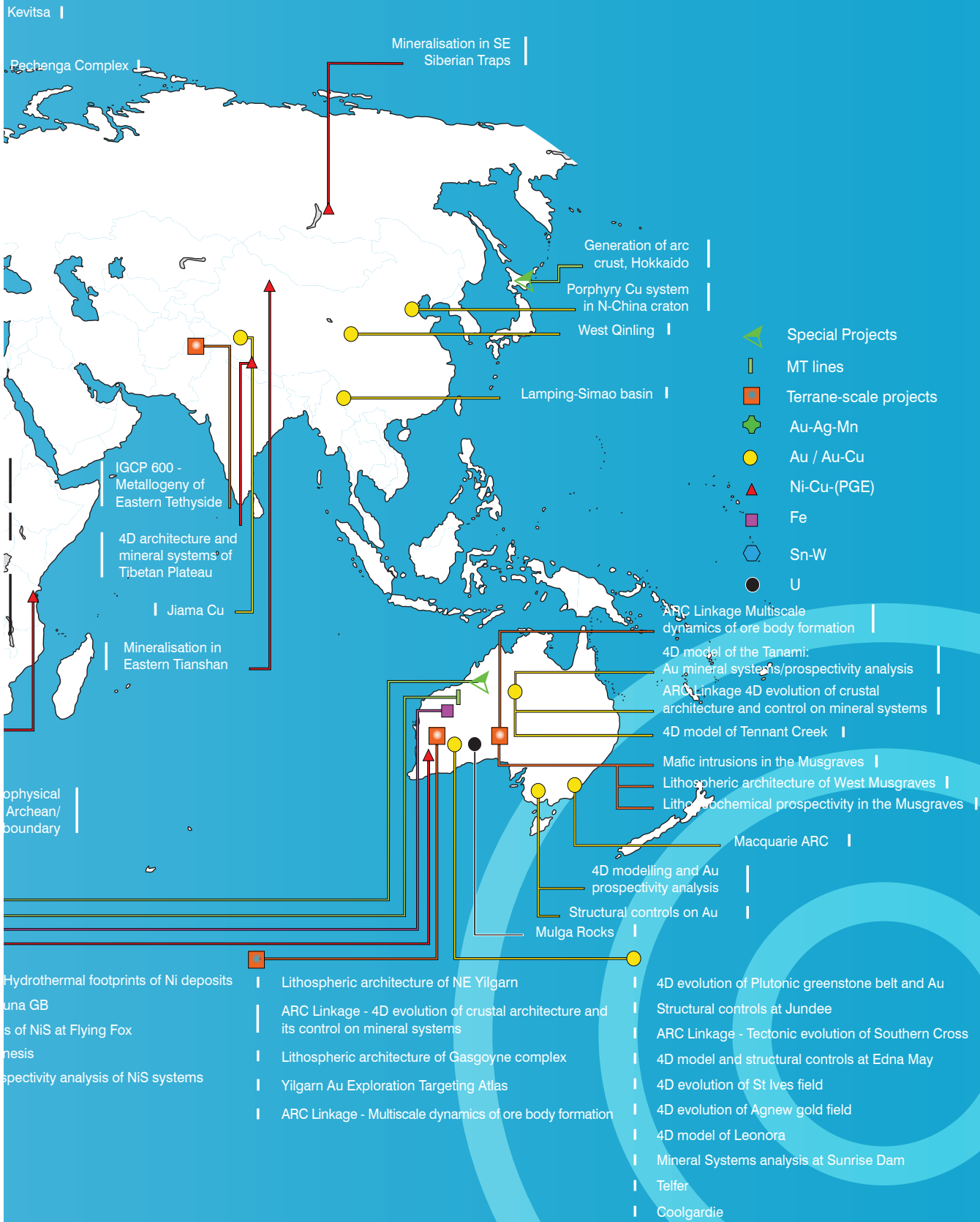
At a more strategic level, all of the above activities are consciously aligned with the mission of UNCOVER ([www.science.org.au/publications/searching-deep-earth-vision-exploration-geoscience-australia](http://www.science.org.au/publications/searching-deep-earth-vision-exploration-geoscience-australia)), a federally-endorsed vision for the future of mineral exploration geoscience in Australia. The CET has played a major role in shaping this programme through our position as a thought leader and innovation in these fields. Our continued ambition is to remain a driver of this and other initiatives shaping the future of the mineral resources industry on both the Australian and international stages.





# DISTRIBUTION OF ACTIVE RESEARCH





- Special Projects
- MT lines
- Terrane-scale projects
- Au-Ag-Mn
- Au / Au-Cu
- Ni-Cu-(PGE)
- Fe
- Sn-W
- U

## CET GOVERNANCE AND MANAGEMENT

Central to the success of the CET is the engagement of the CET Board and its committees: Finance, Risk and Commercialisation (FRC), External Advisory Group (EAG) and Executive. These groups collectively ensure proper governance of the CET and provide guidance on the scientific strategy and business directions of the Centre to ensure they are of maximum benefit to the entire range of stakeholders. Members of these committees are nominated from industry and other collaborative partners.

### Board

The Board provides an invaluable high-level external perspective to guide the operations of the CET. The majority of the members are independent of the CET and hail from a range of industry and academic partners.

### Finance, Risk and Commercialisation Committee

The Board's financial monitoring responsibilities are addressed through the Finance, Risk and Commercialisation Committee. This committee considers, and recommends to the Board for approval, the annual budget and monitors the CET's risk management practices, staffing strategy, and opportunities and strategies for commercialisation of the Centre's research outputs.

### Executive Committee

The Executive Committee was newly formed in 2013, with a stated role of developing and reviewing the major strategic business, tactical, and staffing requirements of the CET, as well as monitoring the needs of the CET's internal stakeholders.

## FINANCIAL PERFORMANCE AND SUSTAINABILITY

The CET recorded revenues of \$7.9 million in 2013, a level unchanged from 2012. Of this revenue, 62% was derived from industry sources or competitive government bids.

Expenditures were \$7.8 million resulting in a slight surplus of \$109,000 for 2013.

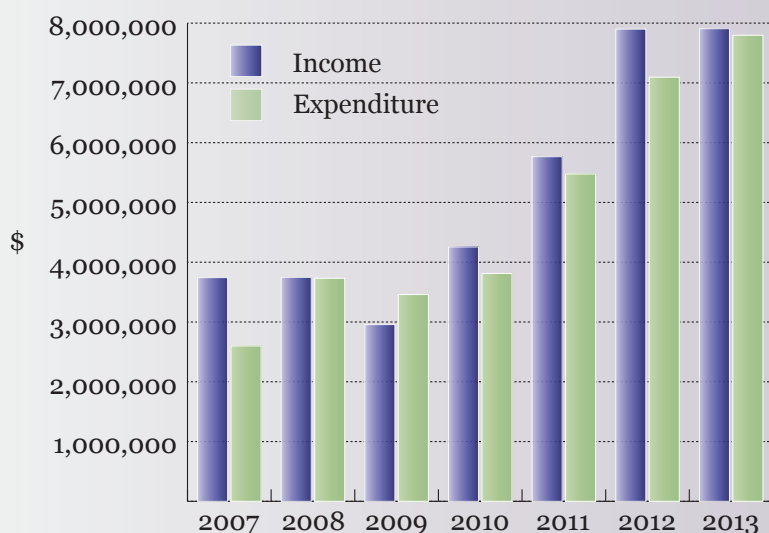


Figure 3. CET Income and Expenditure showing financial performance over time.

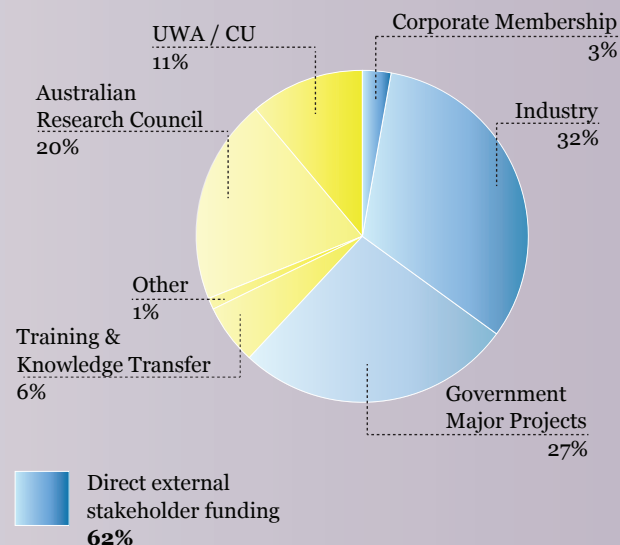


Figure 4. Revenue Sources segmented to highlight Industry participation.



## Board

**Jon Hronsky (Chair)**  
Western Mining Services

**Cam McCuaig**  
CET

**Ed Baltis**  
Gold Fields Australia Pty Ltd

**Peter Buck**  
Independent Company Director

**Lynda Daley**  
Independent Consultant

**Estelle Dawes**  
CET

**Mike Doepel**  
Sipa Resources International NL

**Kevin Hart**  
Endeavour Corporate

**Allan Kneeshaw**  
AngloGold Ashanti Australia Ltd

**John Miller**  
CET

**Tony O'Donnell**  
University of Western Australia

**Steve Reddy**  
Curtin University

**Ian Sandl**  
Teck Resources Ltd

**Donna Sewell**  
AngloGold Ashanti Australia Ltd

**Tim Shanahan**  
University of Western Australia

**Matthew Tonts**  
University of Western Australia

**Tim Walton**  
Curtin University

## Executive Members (all CET)

**Estelle Dawes**

**Mike Dentith**

**Cam McCuaig**

**John Miller**

**Allan Trench**

## Finance, Risk & Commercialisation Committee

**Peter Buck (Chair)**  
Independent Company Director

**Estelle Dawes**  
CET

**Kevin Hart**  
Endeavour Corporate

**Jon Hronsky**  
Western Mining Services

**Cam McCuaig**  
CET

## External Advisory Group

**Ed Baltis (Chair)**  
Gold Fields Australia Pty Ltd

**Mark Armstrong**  
Teck Resources Ltd

**Steve Beresford**  
First Quantum

**Rob Bills**  
Emmerson Resources Ltd

**Barry Bourne**  
Terra Resources

**Graeme Broadbent**  
Rio Tinto

**Mark Doyle**  
AngloGold Ashanti Ltd

**Steve Garwin**  
Independent Consultant

**Howard Golden**  
Rio Tinto

**Jon Hronsky**  
Western Mining Services

**Joe Knight**  
BHP Billiton Ltd (Iron Ore)

**Dave Lawie**  
IMDEX

**Paul Polito**  
Anglo American Exploration

**Ian Tyler**  
GSWA

**John Vann**  
Anglo American Exploration

**Lisa Vella**  
Southern Geoscience Consultants

**Chris Yeats**  
CSIRO



CET would like to thank its Corporate Members for their ongoing support in 2013

## MAJOR PRODUCERS



## EMERGING PRODUCERS



## MINERAL FINANCE



## JUNIOR EXPLORERS



## IN-KIND





## CORPORATE MEMBERSHIP

Strong engagement with the minerals industry is critical to the CET's sustainability. Most importantly, the Centre maintains a strong and deliberate engagement with the entire range of industry participants, from major producers through to junior explorers and the mineral finance sector.

Commencing in 2014, an Individual Membership category will be added to offer a means of engagement to explorationists and senior industry professionals who are not affiliated with a corporate member.

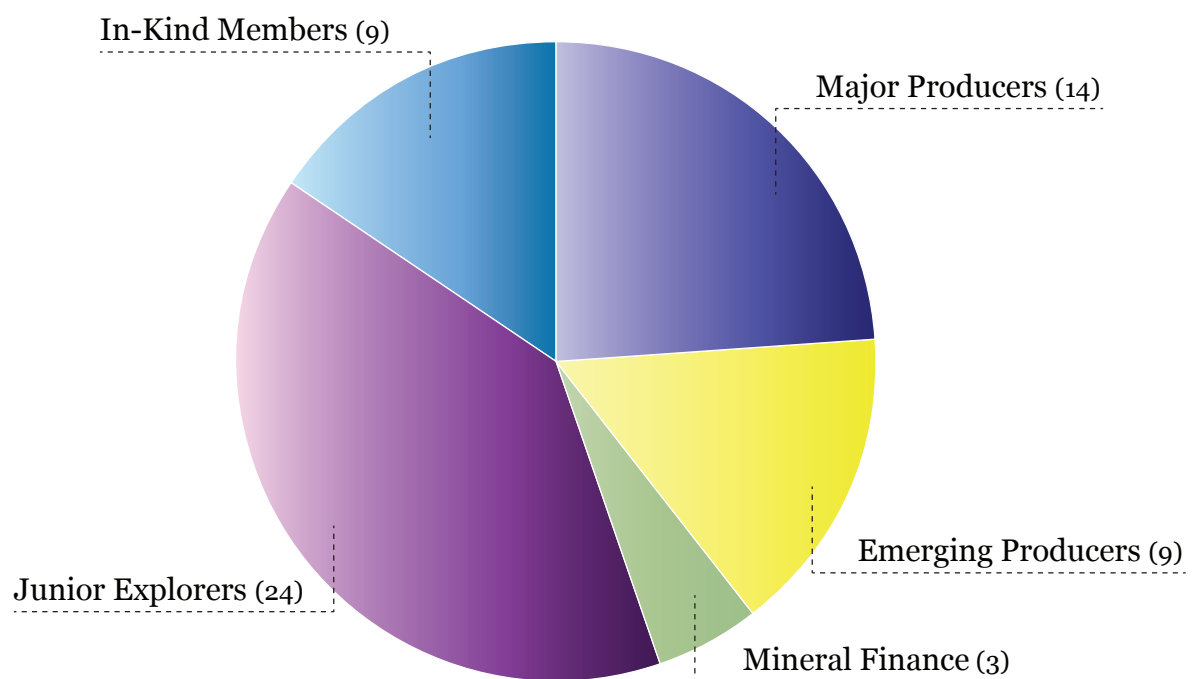


Figure 5. Number of CET Corporate Members in 2013 per membership tier.



(Left) Professor Cam McCuaig and Dr Steven Micklethwaite host industry at the CET booth, PDAC 2013.

(Right) CET Researchers with international friends at SGA 2013, Uppsala, Sweden.



## STAFF

### Professors

T. Campbell McCuaig (Director)

John Miller (Deputy Director)

Adrian Baddeley • Mark Barley

Mike Dentith • Marco Fiorentini  
(ARC Future Fellow)

Pietro Guj • Steffen Hagemann

Mark Jessell • Peter Kovesi

Bryan Maybee • Alison Ord

Allan Trench

### Associate Professors

Leon Bagas • Geoff Batt

Paul Duuring • Paul Greenwood

Eun-Jung Holden • Anthony Kemp  
(ARC Future Fellow)

Yongjun Lu • Vaclav Metelka

Steven Micklethwaite • Mark Munro

Sandra Occhipinti • Nicolas Thebaud

### Assistant Professors

Alan Aitken • Thomas Angerer

James Davis • Steve Denyszyn

Arianne Ford • Weronika Gorczyk

Tom Horrocks • Mark Lindsay

Marek Locmelis • Vanessa Markwitz

David Mole • Nuru Said

Jose Saavedra-Rosas • Yoram Teitler

Huaiyu Yuan • David Wacey

Daniel Wedge • Jason Wong

### Business Support

Wendy Carter • Susie Cass

Estelle Dawes • Cindi Dunjey

Hayley Newberry • Kristy Scahill

Jan Wilkinson

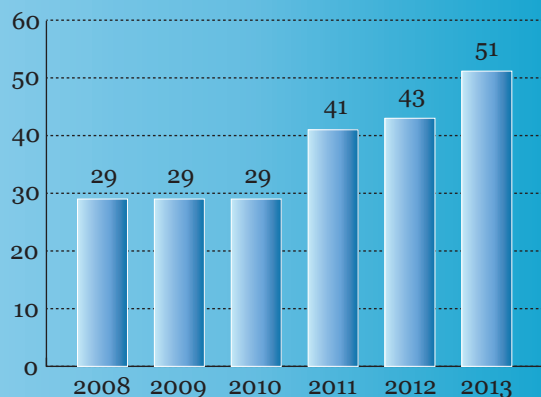
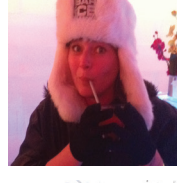
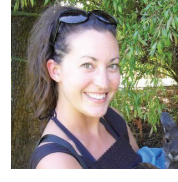
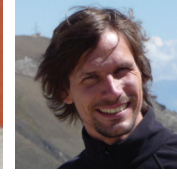
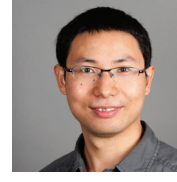
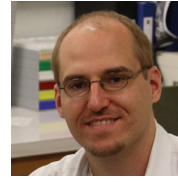


Table 4. CET Staff Member numbers.



## NEW RESEARCH STAFF

**Mark Jessell** Internationally acclaimed geologist Professor Mark Jessell joined the Centre for Exploration Targeting as one of three prestigious Western Australia Research Fellows appointed in the state. Formerly based at the Institut de Recherche pour le Développement in France, Professor Jessell joined the University of Western Australia to establish WA as the internationally recognized research leader in advanced regional-scale 3D modelling.

**Adrian Baddeley** has joined CET for 3 years as a Professorial Research Fellow. As one of Australia's top statisticians, and a Fellow of the Australian Academy of Science, he works mainly in the field of spatial statistics. Adrian was Professor of Statistics at UWA for 16 years, and has recently been working for CSIRO.

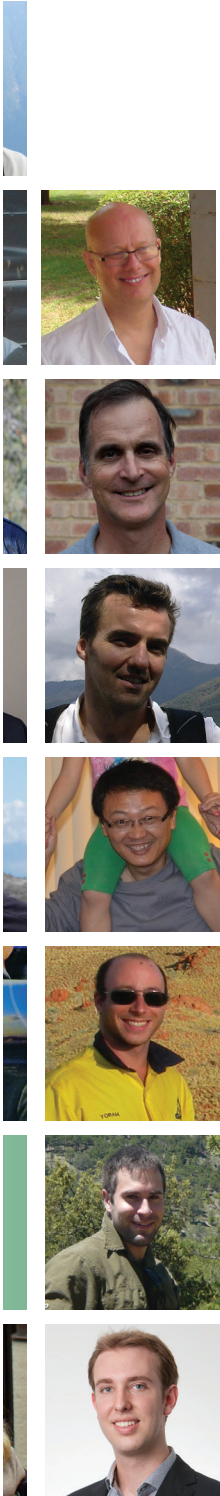
**Mark Lindsay** Assistant Professor Mark Lindsay joined the Geophysics team to work on the Exploration Incentive Scheme project with the GSWA. He will be using a combination of structural geology, geophysical interpretation and 3D modelling to gain a better understanding of the tectonic evolution and mineral systems in the West Kimberley, Northern Australia. He completed his PhD (cotutelle) at Monash University and Université Paul Sabatier (Toulouse III) where he developed techniques to determine uncertainty contained within 3D models, and to characterise their geological parameters.

**Huaiyu Yuan** joined the CET as a new CCFS Associate Professor from Macquarie University. Huaiyu's research focuses on craton evolution using conventional earthquake seismology imaging techniques, including body wave tomography, receiver functions, and shear wave splitting. During his PhD at the University of Wyoming, USA, Huaiyu constructed crustal and upper mantle seismic images of the Wyoming craton, and inferred information regarding the formation of the craton and its interaction with subsequent tectonic episodes of rifting, subduction, and most recently the Yellowstone hotspot system.

**Yoram Teitler** joined the CET Iron Systems Theme as an Assistant Professor. Over the next two years he will be working on a project focused on BIF-hosted iron ore in Archean greenstone belts of the North Pilbara Craton, Western Australia. This project aims to identify practical vectors for industry exploration using a combination of structural geology, geochemical data and geophysical interpretation.

**Mark Munro** joined CET as an Assistant Professor undertaking a MRIWA-funded research programme investigating multi-scale dynamics of hydrothermal mineral systems. The overall project is working to establish criteria that promote the development of large economically viable hydrothermal Cu-Au systems – with the ultimate applied aim of producing practical vectors to mineralisation for drill-core and field-based exploration. This work will involve an integration of many research methodologies, including lithospheric-scale numerical modelling, wavelet analysis of hyperspectral drill core data, and multi-scale structural analysis.

**Tom Horrocks** joined the CET as a part-time Research Assistant, having recently graduated from UWA with Bachelor's degrees in Science (Physics and Applied Mathematics) and Engineering (Software). He completed his engineering honours dissertation on lithology classification and well log correlation, under the supervision of the CET's Eun-Jung Holden and Daniel Wedge.



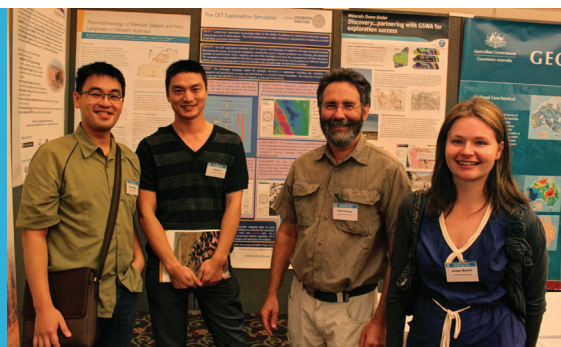


# PUBLICATION HIGHLIGHTS & GLOSSARY

Selected from a total of over 90 publications in refereed forums. A full list of CET publications for 2013 can be found on our web site at [www.cet.edu.au](http://www.cet.edu.au).

1. Aitken, A. R. A., Raimondo, T., and Capitanio, F.A., 2013. The intraplate character of supercontinent tectonics. *Gondwana Research*, v. 24: 807-814.
2. Aitken, A. R. A., Smithies, R. H., Dentith, M. C., Joly, A., Evans, S., and Howard, H. M., 2013. Magmatism-dominated intracontinental rifting in the Mesoproterozoic: The Ngaanyatjarra Rift, central Australia. *Gondwana Research*, v. 24: 886-901.
3. Bagas, L., Boucher, R., Li, B., Miller, J., Hill, P., Depauw, G., Pascoe, J., and Eggers, B., 2013. Paleoproterozoic stratigraphy and gold mineralisation in the Granites-Tanami Orogen, North Australian Craton. *Australian Journal of Earth Sciences*, v. 61: 89-111.
4. Barnes, S. J., Heggie, G. J., and Fiorentini, M. L., 2013. Spatial variation in platinum group element concentrations in ore-bearing komatiite at the Long-Victor deposit, Kambalda Dome, Western Australia: enlarging the footprint of nickel sulfide orebodies. *Economic Geology*, v. 108: 913-933.
5. Duuring, P., and Hagemann, S., 2013. Genesis of superimposed hypogene and supergene Fe orebodies in BIF at the Madoonga deposit, Yilgarn Craton, Western Australia. *Mineralium Deposita*, v. 48: 371-395.
6. Evans, K. A., McCuaig, T. C., Leach, D., Angerer, T., and Hagemann, S. G., 2013. Banded iron formation to iron ore: A record of the evolution of Earth environments? *Geology*, v. 41, 99-102.
7. Ford, A., and Hart, C. J. R., 2013. Mineral potential mapping in frontier regions: A Mongolian Case Study. *Ore Geology Reviews*, v. 51: 15-26.
8. Giuliani, A., Phillips, D., Fiorentini, M. L., Maas, R., Kendrick, M. A., Wing, B., Woodhead, J. D., Bui, T. H., and Kamenetsky, V. S., 2013. Mantle oddities: An alkali-sulphate melt in the lithospheric mantle sampled by the Bultfontein kimberlite (Kimberley, South Africa). *Earth and Planetary Sciences Letters*, v. 376: 74-86.
9. Gorczyk, W., and Vogt, K., 2013. Tectonics and melting in intra-continental settings. *Gondwana Research*, <http://dx.doi.org/10.1016/j.gr.2013.09.021>
10. Guj, P., Bocoum, B., Limerick, J., Meaton, M. and Maybee, B., 2013. How to Improve Mining Tax Administration and Collection Frameworks: A Sourcebook. The World Bank, Washington, D.C.
11. Kemp, A. I. S., and Hawkesworth, C. J., 2013. Growth and differentiation of the continental crust from isotope studies of accessory minerals. In 'Treatise On Geochemistry (2nd edition), Volume 12 - The Crust', Rudnick, R. (editor), Elsevier Science, Oxford.
12. Loemelis, M., Fiorentini, M. L., Barnes, S. J., and Pearson, N., 2013. Ruthenium variation in komatiitic chromites – a potential mineralogical indicator for nickel-sulfide mineralization. *Economic Geology*, v. 108: 355-364.
13. Lu, Y. J., Kerrich, R., Kemp, A. I. S., McCuaig, T. C., Hou, Z. Q., Hart, C., Li, Z. Z., Cawood, P. A., Bagas, L., Yang, Z. M., Cliff, J., Belousova, E., Jordan, F., and Evans, N. J., 2013. Intracontinental porphyry Cu mineral systems of Yunnan, western Yangtze Craton. *Economic Geology*, v. 108: 1541-1576.
14. Mole, D. R., Fiorentini, M. L., Cassidy, K. F., Kirkland, C. L., Thebaud, N., McCuaig, T. C., Doublier, M. P., Duuring, P., Romano, S. S., and Maas, R., 2013. Crustal evolution, intra-cratonic architecture and the metallogeny of an Archaean craton. Geological Society, London, Special Publications, v. 393: 393-398.
15. Guj, P., and Trench, A., 2013. An Introduction to Mineral Finance. In 'Australian Mineral Economics', Maxwell, P., and Guj, P. (editors), AusIMM Monograph 29, second edition. Chapter 8.
16. Romano, S., Thebaud, N., Mole, D., Wingate, M., Kirkland, C., and Doublier, M., 2013. Geochronological constraints on nickel metallogeny in the Lake Johnston belt, Southern Cross Domain. *Australian Journal of Earth Sciences*, v. 61: 143-157.

(Right) CET delegates Dr Jason Wong, Ben Li, Dr Peter Kovesi and Jelena Markov at the 2013 GSWA Open Day.



17. Stevenson, D. B., Bagas, L., Aitken, A. R. A., and McCuaig, T. C., 2013. A geophysically constrained multi-scale litho-structural analysis of the Trans-Tanami Fault, Granites-Tanami Orogen, Western Australia. *Australian Journal of Earth Sciences*, v. 60: 745-768.
18. Wacey, D., McLoughlin, N., Kilburn, M. R., Saunders, M., Cliff, J. B., Kong, C., Barley, M. E., and Brasier, M. D., 2013. Nanoscale analysis of pyritized microfossils reveals differential heterotrophic consumption in the ~1.9-Ga Gunflint chert. *Proceedings of the National Academy of Sciences of the United States of America*, v. 110: 8020-8024.
19. Wong J. C., Holden, E. J., Kovesi, P., McCuaig T. C., and Hronsky, J., 2013. CET exSim: mineral exploration experience via simulation. *Exploration Geophysics*, v. 44: 272-281.
20. Zi, J. W., Cawood, P. A., Fan, W-M., Tohver, E., Wang, Y-J., McCuaig, T. C., and Peng, T. P., 2013. Late Permian-Triassic Magmatic Evolution in the Jinshajiang orogenic belt, SW China and implications for orogenic processes following closure of the Paleo-Tethys. *American Journal of Science*, v. 313: 81-112.

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| AMEC  | Association of Mineral Exploration Companies                 |
| AMIRA | Australian Mineral Industry Research Association             |
| ARC   | Australian Research Council                                  |
| ARRC  | Australian Resources Research Centre                         |
| ASEG  | Australian Society of Exploration Geophysicists              |
| BIF   | Banded iron formation  |
| BMP   | Bureau of Minerals and Petroleum                             |
| CCFS  | Core to Crust Fluid Systems                                  |
| CET   | Centre for Exploration Targeting                             |
| CoE   | Centre of Excellence   |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| CU    | Curtin University  |
| EAG   | External Advisory Group                                      |
| EIS   | Exploration Incentive Scheme                                 |

|       |  |
|-------|--|
| ExSim | Exploration Simulator                            |
| FRC   | Finance, Risk and Commercialisation Committee    |
| GA    | Geoscience Australia                             |
| GFC   | Global Financial Crisis                          |
| GSWA  | Geological Survey Western Australia              |
| IM4DC | International Mining for Development Centre      |
| MRIWA | Minerals Research Institute of Western Australia |
| MSc   | Master of Science                                |
| OGMS  | Organic Geochemistry of Mineral Systems          |
| PhD   | Doctor of Philosophy                             |
| SIEF  | Science and Industry Endowment Fund              |
| TAKT  | Training and Knowledge Transfer                  |
| UWA   | The University of Western Australia              |
| WAXI  | West African Exploration Initiative              |



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Cover Photo: An exploration drilling rig on Lake Lefroy, south of Kambalda.  
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# ANNUAL REVIEW 2013

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