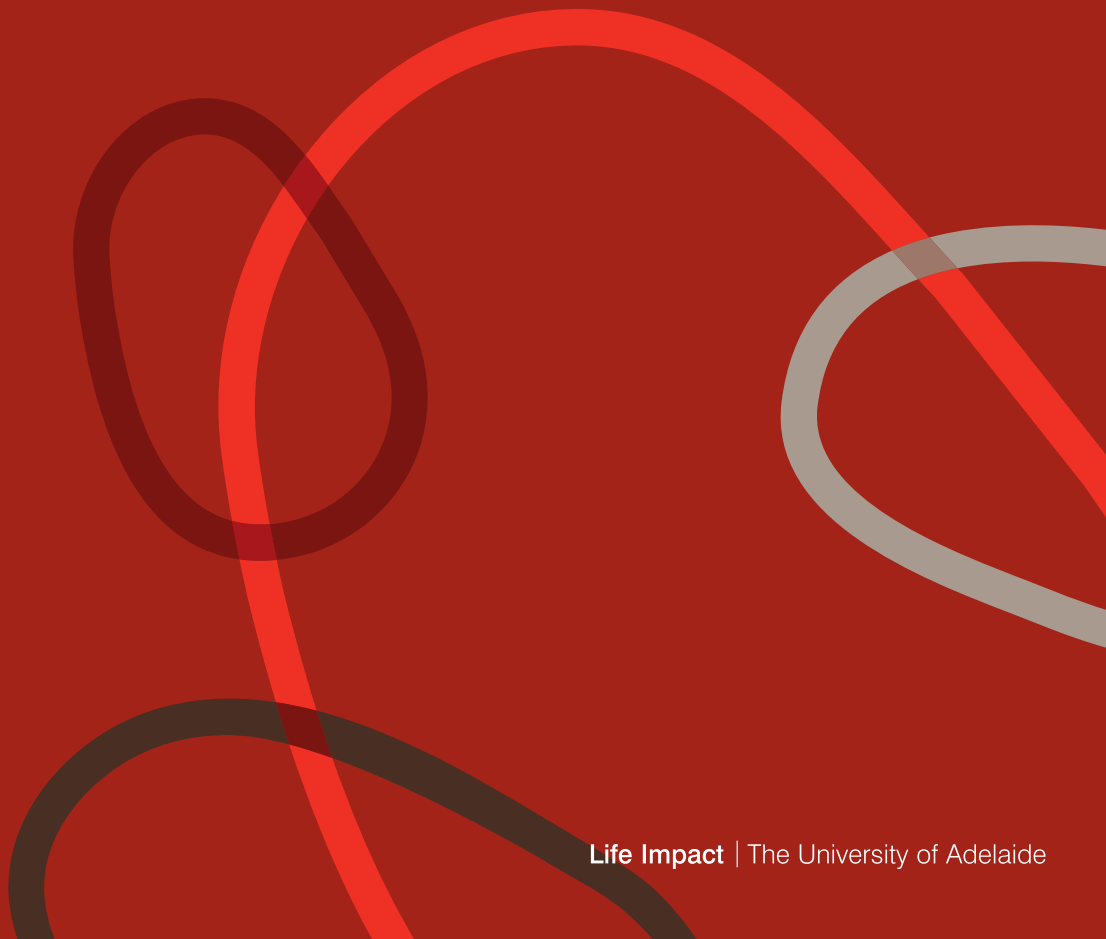
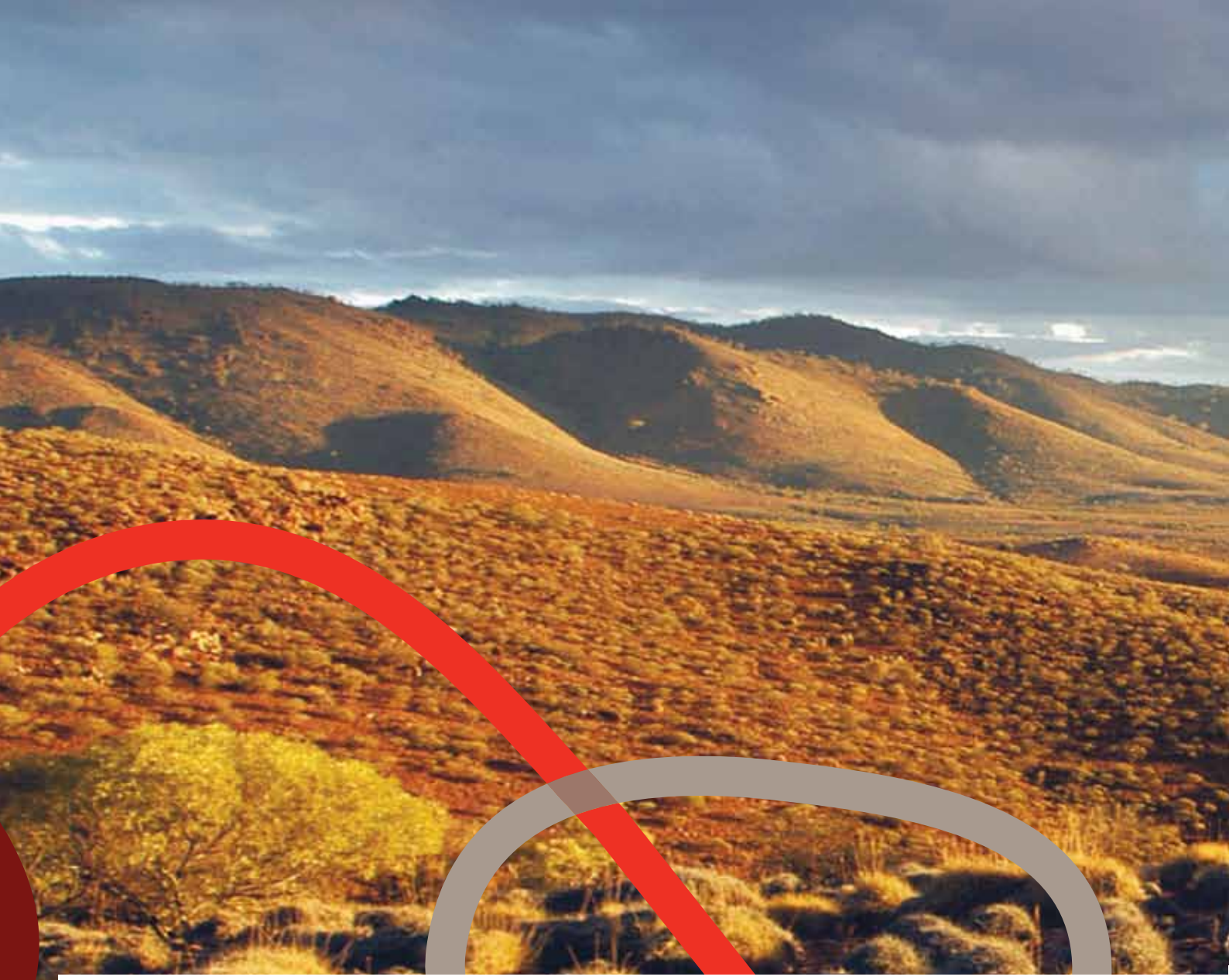
Institute for Mineral and Energy Resources

THE UNIVERSITY of ADELAIDE

Inaugural Report 2009-10



GROUP OF EIGHT MEMBER



The Institute for Mineral and Energy Resources is part of the University of Adelaide, Australia. This leading university, situated in Adelaide, South Australia, is committed to producing graduates and researchers recognised worldwide for their creativity, knowledge and skills. The University of Adelaide makes an impact on the world. Life Impact.

Vision

The vision of the Institute for Mineral and Energy Resources (IMER) is to enable the efficient and sustainable use and development of the world's mineral and energy resources for the benefit of society, industry and the environment.

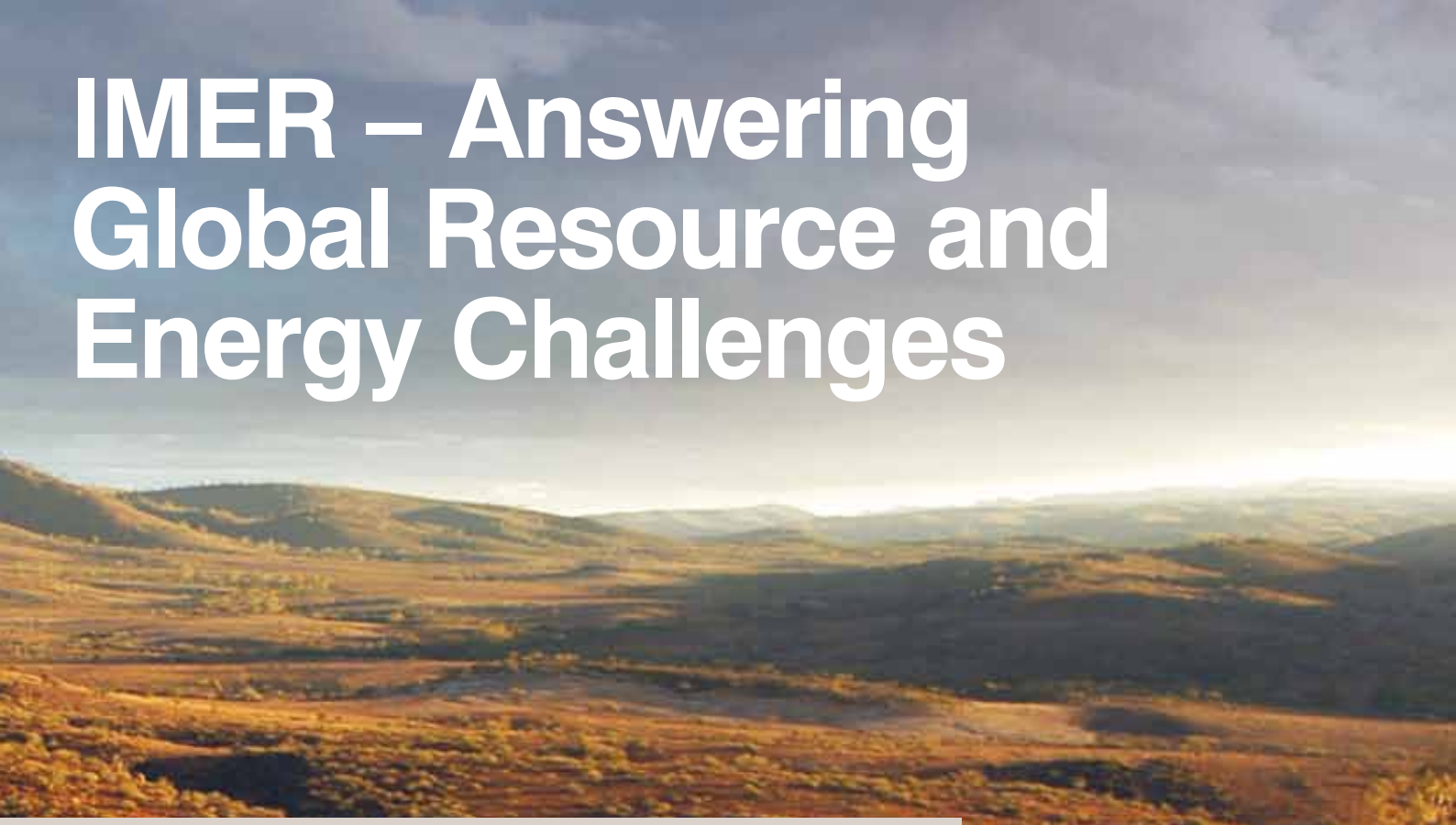
Mission

IMER's mission is to be globally recognised as a centre of excellence for fundamental and applied research, innovation and technology transfer in mineral and energy resources.

Objectives

- Advance the science and technology needed to enhance the prospectivity, discovery and extraction of mineral and energy resources, including petroleum and geothermal resources;
- Advance the science and technology needed to lower the cost and enhance cleaner energy generation, storage, transmission and utilisation of energy;
- Increase the energy efficiency and reduce the impact of industrial processes, especially those related to mining and mineral processing;
- Maximise the social and economic benefits of mineral and energy resource developments across regions, states, national and international communities;
- Advance the prevention, assessment and remediation of environmental impacts of mineral and energy resource developments.

IMER – Answering Global Resource and Energy Challenges



Who We Are

The Institute for Mineral and Energy Resources (IMER) is an interdisciplinary research institute of the University of Adelaide which addresses scientific, technological, environmental and social challenges in the provision of mineral and energy commodities globally.

Established in December 2008, IMER aims to become a leading research and educational facility for the mining and energy sectors in the Asia-Pacific region.

The University of Adelaide is unique within Australia for its strong research and teaching groups in geology and geophysics, petroleum engineering, mining engineering and energy technology. These groups form the Institute's core.

Key IMER fields of research are:

Earth Sciences – geology; geochemistry; geo-sequestration; geophysics; and physical geography.

Energy Technology – combustion and fuels; renewable power and energy systems; bioenergy generation, conversion and storage; control of sound and vibration; physical chemistry aspects of energy storage and transformation.

Resource Engineering – petroleum and mining engineering.

Additionally, cross-disciplinary research is conducted in geothermal energy, decision analysis, industry and labour economic studies and environmental impacts specifically related to energy and mineral resource developments.

World-leading research is conducted across numerous University of Adelaide schools and faculties encompassing the Australian Institute for Social Research and Centre for Labour Research; the Australian School of Petroleum; the Business School; School of Chemical Engineering; School of Chemistry and Physics; School of Civil, Environmental and Mining Engineering; School of Earth and Environmental Sciences; School of Economics; School of Electrical and Electronic Engineering; School of Mathematical Sciences and School of Mechanical Engineering.

The Institute is the principal point of contact for the strategic interests of the University of Adelaide in mineral and energy resources research, both internally to the University of Adelaide and with its industry and government partners. A major global advantage of IMER is the capacity to cross link diverse disciplines to research solutions for global resource and energy challenges.

Highlights

$A18.5
Million in Research Funding

The University of Adelaide attracted more than $A18.5 million in funding for mineral and energy resources related research projects and infrastructure over 2009 and 2010.

1
Institute Launch

The Minister for Mineral Resources Development in the South Australian Government, Hon Paul Holloway, launched IMER on October 5, 2010 at the National Wine Centre, Adelaide.

2
Centres Launched

The Centre for Energy Technology (CET) and the Centre for Tectonics, Resources and Exploration (TRaX) were launched in 2009.

3 Cooperative Research Centres

Deep Exploration Technologies Cooperative Research Centre (DET CRC) and Energy Pipelines Cooperative Research Centre (EPCRC) were established in 2010, while the Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC) was extended.

2010
New Executive Director Appointed

Professor Stephen Grano was appointed IMER Executive Director in March 2010.

3
New funding for these ongoing chairs

Bruce Ainsworth
Petroleum Geology

Ian Plimer
Professor of Mining Geology

Barry Brook
The Sir Hubert Wilkins Chair of Climate Change.

L to R

Dr Jordan Parham (IMER Manager, University of Adelaide);

Hon Paul Holloway (Minister for Mineral Resources Development) MLC;

Professor Stephen Grano (Executive Director IMER, University of Adelaide);

Mr Bob Kennedy (Chairman, Beach Energy Limited);

Mr Reg Nelson (Managing Director, Beach Energy Limited);

Professor James McWha (Vice Chancellor and President, University of Adelaide);

Professor Mike Brooks (Deputy Vice Chancellor, Research, University of Adelaide)

$A1.6
Million for Geothermal Energy Research

The single-largest funding commitment by the South Australian Government's Renewable Energy Fund was awarded to establish the South Australian Centre for Geothermal Energy Research.

550
Refereed Publications

IMER researchers' work was published in more than 550 refereed books, book chapters, journals and conference article papers over 2009 and 2010.

57
PhD Students Supervised by IMER Members completed their degrees

Over 2009 and 2010, plus 16 Masters by Research, in areas relevant to IMER's focus.

60+ Major Projects

A significant number of active or ongoing projects were underway across IMER in 2010.

10 Sponsors

Ten key industry sponsors supported Phase I of Professor Bruce Ainsworth's *WAVE* Consortium project on 'Reservoir Architecture and Heterogeneity in Marginal Marine Systems' - BAPETCO, BHP Billiton, Chevron, ConocoPhillips, Nexen, OMV, Shell, Statoil Hydro, Todd Energy and Woodside.

121 Staff

More than 100 staff across three faculties and eight schools, with 51 members at Associate Professor level and above researching issues related to mineral and energy resources.

55 m/s Wind Speed

Maximum wind speed in the aerodynamic section of the University of Adelaide's new wind tunnel - the only industrial-scale wind tunnel in South Australia and the second largest wind tunnel in Australia.

65 nA
Maximum Probe Current

The FEI Helios Nanolab 600 is a flagship instrument operated by Adelaide Microscopy. The probe current, combined with the lowest voltage (500V) for excellent sample preparation quality, characterises material and mineral samples in morphology, chemistry or crystalline structure.

Contents

01. Chairman's Report

Mr Robert Kennedy

As the first chair of the IMER Advisory Board, I am delighted to present this inaugural report of the Institute for Mineral and Energy Resources (IMER).

In late 2008, the Institute was created to consolidate and further grow the University of Adelaide's existing mineral and energy resources expertise. By building state, national and international collaborations, the long-term strategy aims to ensure the University of Adelaide is recognised as a centre of excellence in the integrated provision of research, education and consulting services for the mineral and energy resources industries in the Asia-Pacific.

Significant progress has been made in two short years. This report demonstrates conclusively the University's huge strength in mineral and energy resources research, recognised by industry and government partners and our research collaborators. IMER consolidates this expertise under one banner.

Despite the challenges of the Global Financial Crisis, outstanding research and innovation outcomes have been achieved.

Teaching to the best can make great researchers - and great researchers make innovation happen.

The University of Adelaide has attracted over $A18.5 million in funding over 2009 and 2010 for mineral and energy resources related research. A key area has been increasing competitiveness success in winning industry grants.

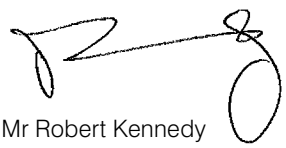
More than 150 staff and postgraduate students have contributed to research in mineral and energy resources across the fields of Earth Sciences, Energy Technology, Resource Engineering and other related fields.

A key role of IMER is to showcase the success of these many researchers.

In addition, more than 550 refereed books, book chapters, journal, and conference articles were published over 2009 and 2010 in mineral and energy resources. This meets a key outcome in confirming the Institute as a place renowned for excellence in research.

Earth Sciences attracted an ARC Excellence in Research for Australia (ERA) rating of 5, the maximum possible score, as well as 5 in the discipline area of Geology. This independent assessment demonstrates the research as being well above world standard in these key fields. This is an outstanding result for IMER's Centre for Tectonics, Resources and Exploration, which incorporates significant geology expertise.

The Institute has a sound plan for growth based around its research priority areas. Attention will turn increasingly towards establishing partnerships with industry; developing strong international collaborative links in its priority research areas; developing approaches for technology transfer to industry; and the sustained and fulfilling growth in the research careers of its staff and postgraduate cohort.



Mr Robert Kennedy
25 August 2011

02. Executive Director's Report

Professor Stephen Grano

The need for establishing the Institute for Mineral and Energy Resources is pressing and globally significant.

Energy demand is set to rise, while real energy costs will increase markedly as the world competes for energy. Water constraints and associated cost rises will impact the community while carbon constraints will be implemented in the future.

These global challenges present opportunities for research and require innovative solutions.

Industry will need well-trained, multi-skilled and problem-solving research leaders to tackle the significant technical and social challenges of the future.

IMER was established on December 19, 2008, being one of five research institutes at the University of Adelaide.

IMER is the principal point of contact for the strategic research interests of the University of Adelaide in mineral and energy resources. The Institute was founded to maximise the core strengths of existing University Centres across geology and geophysics, petroleum engineering and mining engineering, as well as renewable energy and energy efficiency research.

These Centres are: the Centre for Mineral Exploration Under Cover (CMXUC) established mid-2005; the Centre for Energy Technology (CET) and the Centre for Tectonics, Resources and Exploration (TRaX), both established mid-2009; and the South Australian Centre for Geothermal Energy Research (SACGER) established in 2010.

The University also houses three Cooperative Research Centres (CRCs) relevant to IMER: the CRC for Greenhouse Gas Technologies; Deep Exploration Technologies CRC; and the Energy Pipelines CRC.

Relevant Research Programs included under the auspice of IMER are: Resource Engineering; Socio-Economic Impact of Mineral and Energy Resource Development and Environmental Impact of Mineral and Energy Resource Developments.

IMER seeks to add value to existing Centres and Programs by developing research areas which are new to the University of Adelaide through a range of linked approaches. IMER aims to build strong research collaborations and make significant, measurable advances in both fundamental and applied research.

These linked approaches extend to the development of new research projects within Centres and Programs aligned to the strategic direction of the Institute, new inter-disciplinary research between Centres and Institutes across the University of Adelaide and developing new capability and relationships through strategic investments.

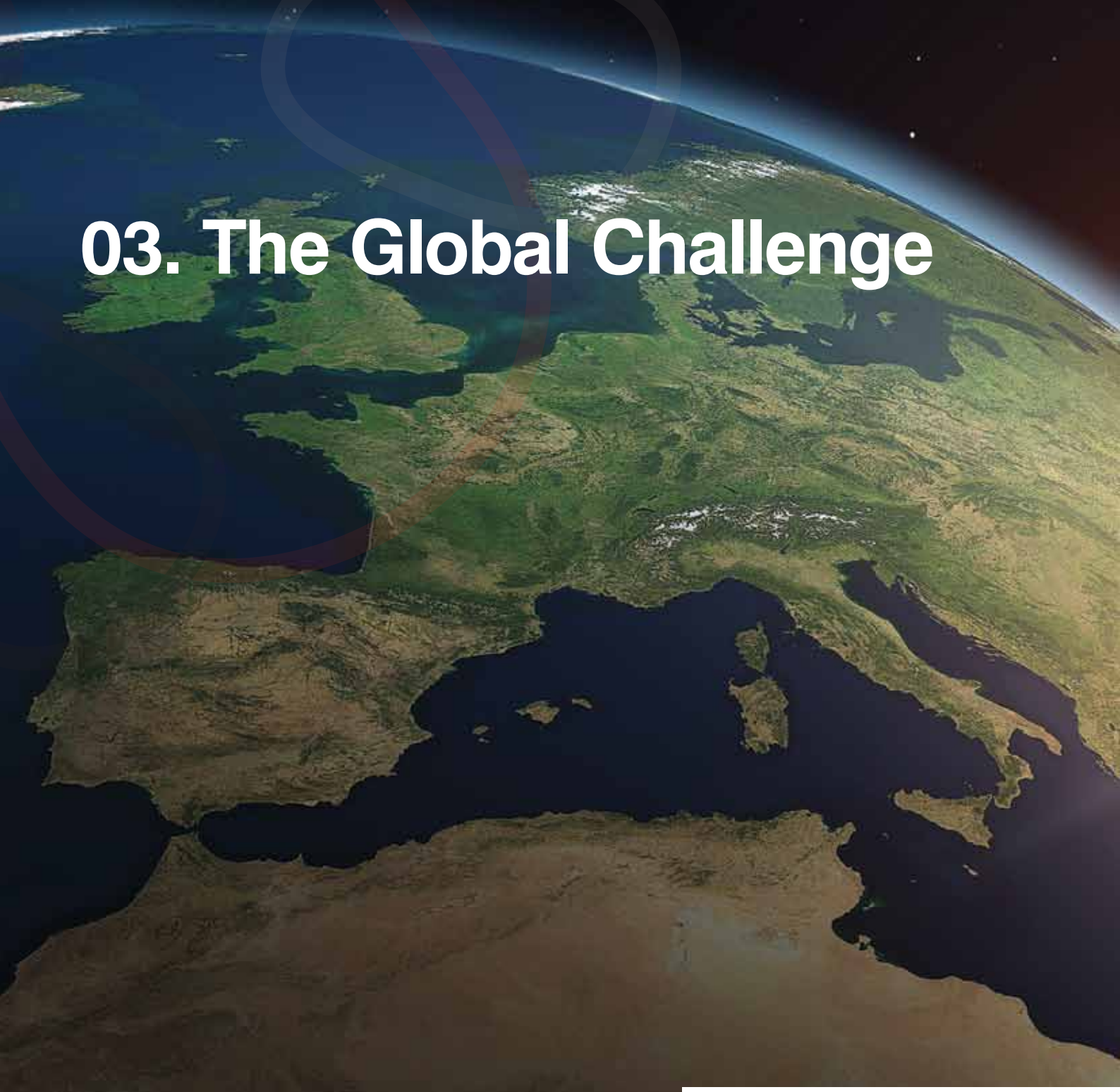
This inaugural report covers the calendar years 2009 and 2010. Future reporting will be on an annual basis.

Professor Peter Dowd, Executive Dean of the Faculty of Engineering, Computer and Mathematical Sciences, was the founding Director of IMER. Professor Richard Hillis, formerly Head of the Australian School of Petroleum, became the interim Director of IMER in December 2008. I was appointed as Executive Director in March 2010.

I have worked closely with the members of the Advisory Board and I thank all the members for their feedback and discussions on all aspects of the Institute.

As the IMER Executive Director, I look forward to answering the global challenges ahead with a dedicated team of world-class researchers, Centre and Program leaders.

Professor Stephen Grano
25 August 2011



03. The Global Challenge

IMER is well placed to address future resource and energy demands.

The resources expansion in South Australia, and across Australia, is anticipated to be the single most significant driver of economic development in this State for at least the next two generations.

The latest information on this development from the Department of Primary Industries and Resources SA (PIRSA), Government of South Australia, is both illuminating and challenging. In South Australia, the number of major operating mines is

currently 13, an increase from five in 2004, and 11 in 2009. However, there are a further 31 projects currently under evaluation and approximately 80 prospects.

These developments are driven in large part by the expanding consumption of resources by Australia's trading partners, notably China and India. It is well established that the consumption of commodities such as aluminium, copper and iron ore are strong functions of Gross Domestic Product (GDP) per capita.

With the GDP per capita set to increase globally, consumption of copper and iron ore, for example, is expected to increase by about 5–10% per annum.

Energy demand is also set to increase. The International Energy Agency predicts that, on current policies, world energy needs and CO_2 emissions will be 60% higher in 2030 than they were in 2004.

The implications of these commodity scenarios are a marked increase in real energy costs as the world competes for energy.

There will be increased water constraints and associated cost rises which will impact the community plus carbon constraints and associated costs are scheduled for implementation.

It is anticipated there will be tighter regulation of the environment and an increased emphasis on sustainability which will affect mining and downstream processing.

There will be a greater demand by local and international communities to benefit from resource developments while the scale and complexity of mineral and energy resource developments will increase. This will heighten risk and scale of capital cost overruns.

These global scenarios will require quality research and innovation and have been specifically addressed in IMER's strategies and priorities, outlined within this report.

With very large projects such as Santos's $A16b Gladstone LNG project, Shell's $A12b Prelude floating LNG project, Chevron's $A20b Wheatstone project, and BHP Billiton's $A20b Olympic Dam expansion project on the horizon, the supply of highly-skilled people and innovation are high on the list of industry needs.

IMER seeks to achieve excellent quality research performance by establishing and developing long-term partnerships with its key stakeholders in industry and government, underpinning their research needs particularly in these vital, globally-significant challenges.

04. Strategies and Priorities

IMER's mission is to be globally recognised as a centre of excellence for fundamental and applied research, innovation, and technology transfer in mineral and energy resources.

IMER's mission emphasises four key concepts:

- **Global recognition** reflects the strategic intent of the University of Adelaide to be considered a great research University by world standards, and necessarily places global benchmarks on the performance of IMER;
- The need to focus on both **fundamental and applied research** recognises the critical importance of fundamental research to enhance understanding, underpinning applied research. Applied research provides a focus for targeting research at problems of global significance;
- **Innovation** recognises the key importance of step-change research and the break-throughs required to make a deep and lasting impact on industry and societal problems globally;
- **Technology transfer** in all its forms, such as commercialisation and the transfer of information and know-how, is a key aspect of the University of Adelaide's interaction with industry and society.

Moving from its 2008 formation, IMER aims to develop national and international leadership in specific research priority areas and to increase the number and portion of articles in highly-ranked journals.

By further increasing the success rate, number and scale of national competitive grants or funding, IMER intends to build research capability in the minerals and resources sector.

IMER plans to foster productive relationships with industry, government and public organisations which may offer avenues for commercialising research outcomes.

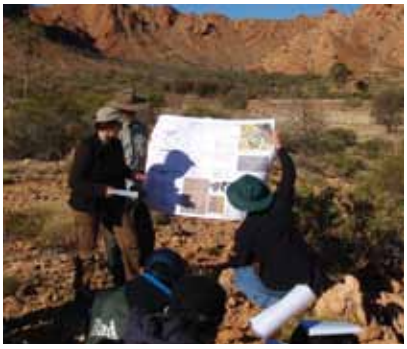
IMER aims to increase the number of postgraduate completions and ensure adequate support for early career researchers. Opportunities will be communicated to researchers to assist them to develop successful proposals.

New strategic partnerships will be forged including international engagements, joint ventures and partnerships, which may also bring together multi-disciplinary teams from across the University of Adelaide to address our research priority areas.

IMER uses four key performance indicators to monitor success.

These are:

- To **advance and accelerate** high-quality research performance in mineral and energy resources, targeting inter-disciplinary research challenges of global significance;



- To **foster state, national and international collaborations** and partnerships with the aim of making the University of Adelaide the recognised Asia-Pacific centre of excellence in the integrated provision of research, education and consulting services for the mineral and energy resources industries;
- To **attract, retain and develop** excellent research staff and students;
- And to **promote and support** pathways to commercialisation of applied research expertise.

These high-level performance indicators are directly aligned with the mandatory outcomes required by the University of Adelaide.

Answering Global Resource and Energy Challenges

IMER's research priorities have been developed after a thorough marketplace analysis.

A team of independent sector industry and government stakeholders provided input into a study to ensure IMER's strategy reflected important international and national industry, government and research concerns. The 2010 study found these significant global trends:

1 Natural gas from unconventional sources, and in particular shale gas, will expand markedly as a cleaner burning, transitional fuel for the 21st century; the production of gas (as LNG) from coal and (oil) shale reserves will increase in importance;

2 Real energy prices will increase through both global competition and the introduction of a carbon tax or similar; a key factor will be marked increases in the cost of transportable fossil fuels such as LPG and diesel, for which Australia is a nett importer at present; opportunities to convert coal to liquid fuels will increase in importance;

3 The need to reduce greenhouse gas emissions from existing industries that drive Australia's mineral exports will increase markedly with the introduction of a carbon tax, which will at this stage commence in Australia, July 2012. This will be followed by an emissions trading scheme and carbon cap with significant increases in the price of energy;

4 Advances in technologies to explore to greater depths and under cover will be required; also new techniques and approaches to explore for ore bodies at shallower depths for which the signature at the surface is obscured or requires new approaches for discovery will be required;

5 Continuing emphasis on low-energy and low-impact exploration, mining and extraction methods. This will be particularly critical to operations which are not connected to the electrical grid and are dependent on imported LPG or diesel for electrical energy production for use in the operation and local community;

6 Nuclear energy will feature prominently into the future as a legitimate response to the need to both reduce greenhouse gas emissions and secure energy supplies by some countries;

7 Underpinning all these developments, the need to grow technology and market place strategies to allow the introduction of alternative, low greenhouse gas emission energy technologies will be needed;

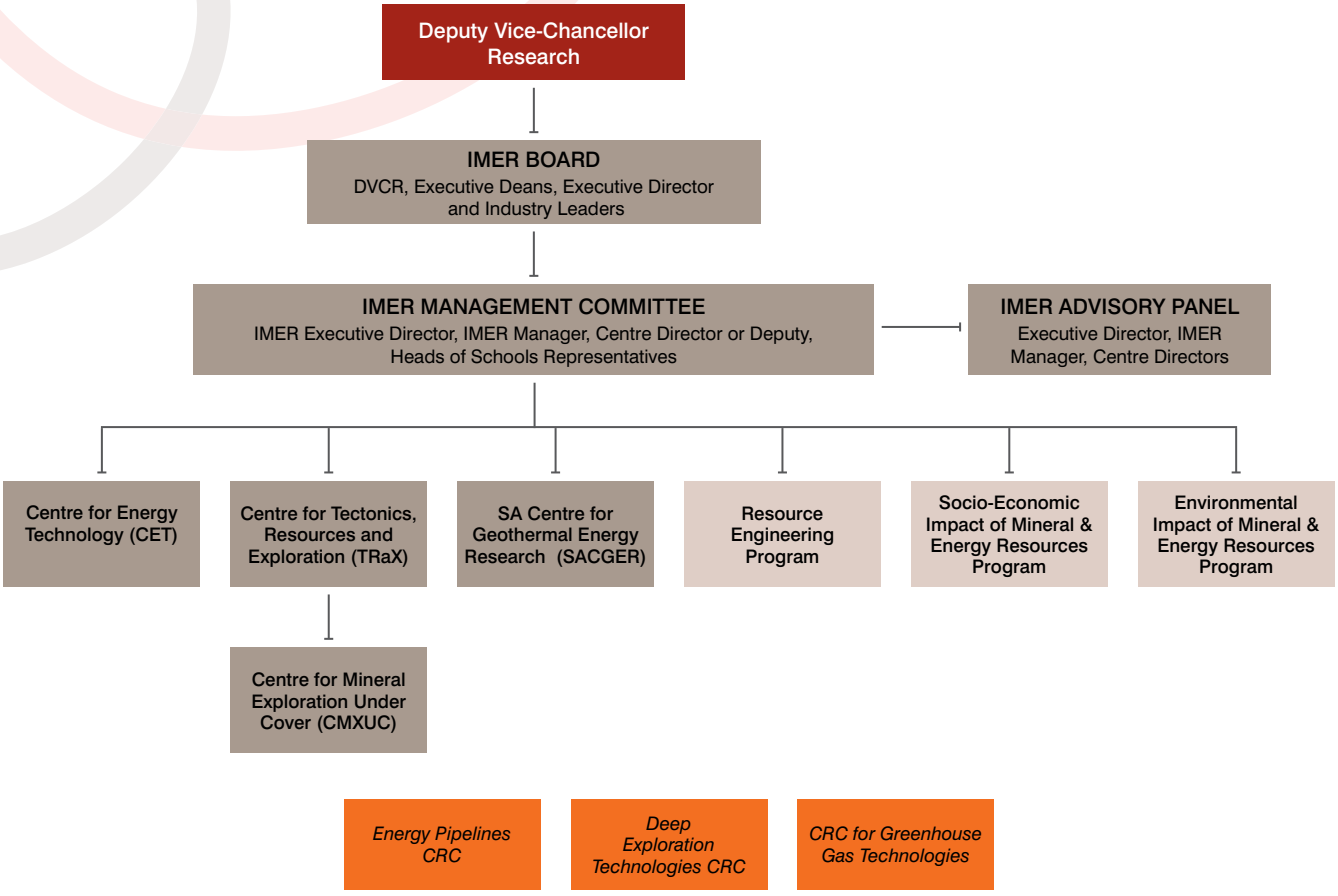
8 Local, regional, state and national communities will need to benefit from the resources expansion while environmental harm has to be minimised;

9 The scale and complexity of mineral and energy resource developments will increase markedly, increasing the risk and scale of capital cost overruns and potential environmental damage, as well as the need for highly skilled people.

Based on the review process, IMER's research priority areas for support are:

- Non-conventional natural gas extraction and utilisation;
- Understanding, discovering, and exploiting iron, copper and gold deposits;
- Uranium and rare earth elements, exploration and extraction;
- Low energy and low impact exploration, mining, extraction and value adding to resources;
- Pathways to cost effectively reduce greenhouse gas emissions in energy transformation;
- Geothermal energy;
- Step change reduction in energy consumption in mineral recovery;
- Sustainable communities and life after mining.

05. Organisational Structure



Institute Team

Executive Director
Professor Stephen Grano

Professor Stephen Grano is an internationally recognised metallurgical engineer with nearly 30 years of research experience. He was appointed Executive Director of IMER in March 2010. Professor Grano brings a tremendous depth of knowledge and experience to the role. He worked in industry as a metallurgist and for the Ian Wark Research Institute at the University of South Australia from 1987. Professor Grano also previously led the AMIRA P260 Project, the largest flotation project in the world, which provided a total demonstrated value to industry of $A436m from delivered and expected gains.

In 2009 Professor Grano won the Science Excellence Award for Excellence in Research Commercialisation and was recognised for forging a range of industry partnerships at national and international levels, as well as for the potential of his research to make a major contribution to reducing energy consumption and improving productivity in mineral processing operations.

Manager
Dr Jordan Parham

Dr Jordan Parham combines extensive experience in both research and industrial environments. Dr Parham was appointed IMER Manager, from a previous role as Research and Development Manager of the Centre for Energy Technology at the University of Adelaide.

Dr Parham previously worked for Adelaide company, FCT, as a senior project manager and combustion engineer. In this role he contributed to the development of a wide range of technologies and their implementation throughout the world with wide experience in the minerals process sector. Dr Parham oversaw the supply of industrial burner systems internationally, and worked on high profile flame projects including Olympic torches and cauldrons. He also managed FCT's research and development programs.

Dr Parham holds a PhD from the University of Adelaide in the control and optimisation of mixing and combustion from precessing jet burners for mineral processing applications. He undertook post-doctoral research at the University of Edinburgh, Scotland, related to coal-fired power stations.

06. Board and Committees

Advisory Board

The 10-member Board brings industry and government leaders with a comprehensive knowledge and experience of the mineral and energy resources sector together with internal university representatives.

Meeting at least quarterly, the Board offers an external perspective on the Institute's activities plus valuable insights from members of global business entities. IMER is established in accordance with the University of Adelaide's Research Centres and Research Institutes framework.

Chair
Mr Robert Kennedy
Chairman, Beach Energy Limited

Professor Mike Brooks
Deputy Vice-Chancellor (Research) and Vice-President
The University of Adelaide

Professor Peter Dowd
Executive Dean, Faculty of Engineering, Computer and Mathematical Sciences
The University of Adelaide

John England
Vice President Technology, Uranium Customer Sector Group, BHP Billiton

Dr Stephen Forbes
Director, Adelaide Botanic Gardens

Professor Stephen Grano
Executive Director, IMER
The University of Adelaide

Dr Paul Heithersay
Executive Director, Minerals and Energy Resources, Department of Primary Industries and Resources SA, Government of South Australia

Professor Robert Hill
Executive Dean, Faculty of Sciences
The University of Adelaide

Ms Susan Jeanes
Chief Executive Officer, Australian Geothermal Energy Association Inc.

Dr Kevin Wills
Managing Director, Flinders Mines Ltd

** Mr Dean Dalla Valle, Chief Operating Officer, Uranium Customer Sector Group, BHP Billiton, was a member of the IMER Advisory Board from August 2009 until August 2010.*

Advisory Panel

The IMER Advisory Panel meets as required and provides direction on project development and management priorities to the IMER Manager and evaluates funding applications to IMER.

The Advisory Panel is comprised of the IMER Director, IMER Manager, and IMER's affiliate Centre Directors and one independent member of the Management Committee.

Management Committee

IMER's Management Committee comprises relevant University of Adelaide Centre, Program and School research leaders. This Committee generates research ideas, reviews funding and engagement opportunities, discusses project management issues and oversees IMER's strategies.

The group is important for developing IMER's research capability to address issues relevant to the global mineral, energy and resource sectors. The Management Committee meets monthly, identifying research questions which are aligned with members' expertise to answer the challenges facing society in the 21st century and beyond.

Management Committee Members

Professor Stephen Grano
Executive Director, IMER

Professor Bruce Ainsworth
Deputy Head of School, Australian School of Petroleum

Associate Professor Peter Ashman
Deputy Head of School, School of Chemical Engineering

Associate Professor Barry Burgan
Head of School, Business School

Associate Professor Sue Carthew
Head of School, School of Earth and Environmental Sciences

Associate Professor Emmanuel Chanda
Associate Professor, School of Civil, Environmental and Mining Engineering

Associate Professor Nigel Cook
Director, Centre for Tectonics, Resources and Exploration

Professor Christopher Findlay
Head of School, School of Economics

Mr Simon Firth
Commercial Development Manager, Adelaide Research and Innovation Pty Ltd

Professor Martin Hand
Director, South Australian Centre for Geothermal Energy Research

Professor Graham (Gus) Nathan
Director, Centre for Energy Technology

Dr Jordan Parham
Manager, IMER

Associate Professor John Spoehr
Executive Director, Australian Institute for Social Research and Centre for Labour Research

Management Committee Alternates

Professor Steve Begg
Head of School, Australian School of Petroleum

Associate Professor Bassam Dally
Deputy Director, Centre for Energy Technology

Associate Professor Jose Facelli
Associate Professor, School of Earth and Environmental Science

Dr Simon Holford
Deputy Director, Centre for Tectonics, Resources and Exploration

Dr David Lewis
Senior Lecturer, School of Chemical Engineering

Dr Chris Medlin
Senior Lecturer, Business School

Mr Simon Molloy
Team Member, Australian Institute for Social Research

Dr Yung Ngothai
Deputy Director, South Australian Centre for Geothermal Energy Research

Dr Ernesto Valenzuela
Executive Director, Centre for International Economic Studies

Dr Chaoshui Xu
Senior Lecturer, School of Civil, Environmental and Mining Engineering

07. Research Funding

Funding which can be attributed to IMER members has been calculated from the total funding obtained by IMER member researchers for projects and research infrastructure grants that are relevant to IMER.

As IMER is highly cross-disciplinary and encompasses a very diverse cross-section of research fields, only projects and infrastructure that relate to core IMER research areas of expertise and priorities have been included in this financial data.

Research funding is shown according the Australian Higher Education Research Data Collection categories:

Category 1
Nationally competitive research grants

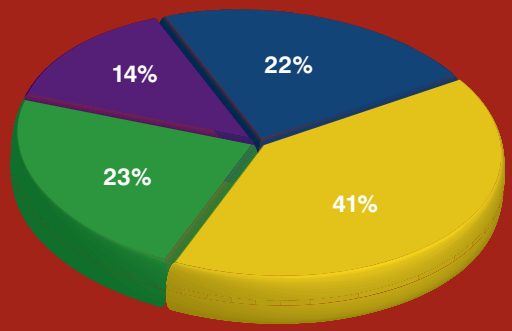
Category 2
Other public sector funding

Category 3
Australian industry, donations and international grants

Category 4
Cooperative Research Centres

2009 Research Income

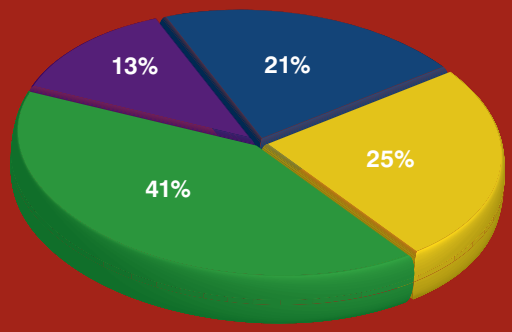
Total Income 2009 | $A9,338,000



Category 1 | $A2,023,000
Category 2 | $A3,868,000
Category 3 | $A2,107,000
Category 4 | $A1,340,000

2010 Research Income

Total Income 2010 | $A9,458,000



Category 1 | $1,991,000
Category 2 | $2,372,000
Category 3 | $3,875,000
Category 4 | $1,220,000

08. Major Research Sponsors

Over 2009 and 2010, IMER member researchers attracted sponsorship funding from leading international companies, state and Australian government departments and successfully won highly-prestigious international research grants.

CRC for Greenhouse Gas Technologies

Core Industry and Government Sponsors:

- Anglo American
- Australian National Low Emissions Coal Research and Development
- BG Group
- BHP Billiton
- BP Australia
- Brown Coal Innovation Australia
- Chevron Australia
- Department of Primary Industries and Resources SA, Government of South Australia
- Inpex Corporation
- Korea Institute of Geosciences and Mineral Resources, Korea
- Ministry of Science and Innovation, New Zealand
- New South Wales Government, Industry and Investment
- QER Pty Ltd
- Queensland Government
- Rio Tinto Limited
- SASOL

Deep Exploration Technologies CRC

Core Industry and Government Sponsors:

- Barrick Australia Pacific Ltd
- BHP Billiton Olympic Dam Corporation Pty Ltd
- Boart Longyear Company
- Department of Primary Industries and Resources SA, Government of South Australia
- Gold Fields Australia Pty Ltd
- Newcrest Technology Pty Limited
- Vale Exploration Pty Ltd

Energy Pipelines CRC

Core Industry Sponsor:

- Australian Pipeline Industry Association

Lake Eyre Basin Analogues Research Group

Core Industry Sponsors:

- Anadarko Petroleum Corporation
- BP Australia
- BG Group
- BHP Billiton
- Chevron Australia
- ExxonMobil
- Shell
- Woodside Energy Ltd

Reservoir Architecture and Heterogeneity in Marginal Marine Systems – *WAVE* Consortium

Core Industry Sponsors:

- BADR Petroleum Co.
- BHP Billiton
- Chevron Australia
- ConocoPhillips
- Nexen
- OMV Group
- Shell
- Statoil
- Todd Energy
- Woodside Energy Ltd

Major Sponsors

Adelaide Airport Limited

Adelaide Hills Council

Adelaide Mount Lofty Natural Resource Management Board

Adelaide Resources

Anadarko Petroleum Corporation

Anglo American

Agri Energy Ltd

Arid Lands Natural Resources Management Board

Asia Pacific Partnership on Clean Development and Climate

Australian Agency for International Development

Australian Coal Association Research Program

Australian Nuclear Science and Technology Organisation

Australian Research Council

Australian Society for Exploration Geophysicists

Australian Water Quality Centre

Barrick Gold of Australia Ltd

BHP Billiton

BP Australia

BP Exploration (Caspian Sea) Limited

Biomatters Ltd, NZ

Boart Longyear Company

Bureau of Meteorology Research Centre

Chevron Energy Technology

City of Norwood, Payneham and St Peters

City of Onkaparinga

City of Tea Tree Gully

ConocoPhillips Company

Defence Science and Technology Organisation, Australian Federal Government

Department for Environment and Heritage, Australian Federal Government

Department for Families and Communities, Government of South Australia

Department for Transport, Energy and Infrastructure, Government of South Australia

Department of Education, Employment and Workplace Relations, Australian Federal Government

Department of Environment and Natural Resources, Government of South Australia

Department of Further Education, Employment, Science and Technology, Government of South Australia

Department of Innovation, Industry, Science and Research, Australian Federal Government

Department of Mines and Petroleum, Government of Western Australia

Department of Premier and Cabinet, Government of South Australia

Department of Primary Industries and Resources SA, Government of South Australia

Department of Primary Industries, Government of Victoria

Department of Water Land and Biodiversity Conservation, Government of South Australia

ESSO Australia Pty Ltd

ESSA Exploration Inc

ExxonMobil

Foundation for Research, Science and Technology (NZ)

FCT Ltd (Fuel and Combustion Technology)

GreenRock Energy

Goldfields Australia

Geological Survey of Western Australia

Geoscience Australia

Geothermal Electrolysis in SA

Glassy Metal Technologies

Heathgate Resources

HF Radar Study

Hillgrove Resources

Hot Dry Rocks

Hybrid Energy Australia Pty Ltd

Iluka Resources

Kingsgate

Maximus Resources

Melbourne Water Corporation

Microsoft Research

Minotaur Resources

Mitsui & Co. (Australia) Ltd

Newcrest Mining Limited

Newmont Australia

Nexen Inc.

Northrop Grumman Space Technology

New South Wales Department of Primary Industries

NZ Resource Consortium

OMV Exploration and Production GmbH

OneSteel

Origin Energy

Oz Minerals

Pacific Marine Batteries

Perilya

Premier's Science and Research Fund, Government of South Australia

Queensland Department of Mines and Energy

Rex Minerals

Ricoh Australia

Rio Tinto Limited

SA Water

Santos Ltd

Santos (Sampang) Pty Ltd

Schlumberger Limited

Schlumberger Oilfield Australia Pty Ltd

Shell (Petroleum Mining) Company Limited

Shell International Exploration and Production

Sir Ross and Sir Keith Smith Fund

Solid Energy New Zealand Ltd

South Australian Arid Lands Natural Resources Management Board

South Australian Forestry Corporation

South Australian Government, Strategic Initiative Fund

South Australian Grain Industry Trust Fund

South Australian Murray Darling Basin Natural Resources Management Board

South Australian Water Partnership

SQC Pty Ltd

Stanwell Corporation Ltd

Statoil

Teck Cominco Australia Pty

Terramin

Todd Taranaki Limited

Torrens Energy

United Water International Pty Ltd

Water Corporation of Western Australia

Water Quality Research Australia

Whistler Research

Woodside Energy Ltd

Xstrata Coal

Z Filter Pty Ltd

09. Key Collaborations

The global challenges facing humanity in the 21st century involve complex and seemingly intractable problems.

By bringing together diverse sets of skills and capabilities, collaborative approaches allow holistic perspectives of these complex challenges.

Research collaborations at both national and international levels are a critical part of the research life at the University of Adelaide. The synergies identified and created from collaboration can be harnessed to create innovative research outcomes.

Australia

Australian Museum
Australian National University
AuScope
Charles Darwin University
Commonwealth Scientific and Industrial Research Organisation
Curtin University Australia
Flinders University of South Australia
Geoscience Australia
Geotrack International
ioGlobal
James Cook University
La Trobe University
Macquarie University
Monash University
Murdoch University
Olympus Innov-X
South Australian Museum
South Australian Research and Development Institute
Southern Cross University
University of Canberra
University of Melbourne
University of New South Wales
University of Queensland
University of South Australia
University of Sydney
University of Tasmania
University of Western Australia
University of Wollongong

International

Åbo Akademi University
Advanced Photon Source
AG-Research
Alberta Research Council of Canada
BG Group
British Geological Survey
Bruker Scientific
Brunei Shell Petroleum Company Sendirian Berhad
Natural History Museum London
Canadian Museum of Nature
Catholic University of the North
Centre for Chronological Research Nagoya University
Chinese University of Petroleum, Beijing
Delft University of Technology
Durham University
East China University of Science and Technology
Eidgenössische Technische Hochschule Zürich
European Synchrotron Radiation Facility
Federal University of Minas Gerais
FEI Ltd Pty
Geological Survey of Canada
GeoPressure Technology
GFZ Potsdam

Ho Chi Minh City University of Technology
Indian Institute of Technology
Indian Statistical Institute
Istanbul University
The Joint BioEnergy Institute
Kochi University
Lawrence Berkeley National Laboratory
Los Alamos National Laboratory
Lund University
Luleå University of Technology
Massey University
McGill University
Murphy Sabah Oil Co. Ltd
Nagoya Department of Earth and Planetary Sciences, Nagoya University
National Geophysical Research Institute (CSIR)
Natural History Museum of LA County
Natural History Museum Vienna
Parry Nutraceuticals Ltd
Peking University
Pennsylvania State University
Peshawar University
Petroleum Geo-Services
Petroliam Nasional Berhad
PTT Exploration & Production PCL
Purdue University
Queen's University
Royal Holloway, University of London
RWTH Aachen University
Saudi Geological Survey
Simon Fraser University
South China University of Technology
Stanford University
Tanzanian Geological Survey
Tarbiat Moallem University
Tokyo Institute of Technology
Toliara University
Tsinghua University
Universidade de Sao Paulo
Universidade Federal de Minas Gerias
Universidade Federal de Rio de Janeiro
Universidade Federal do Para
University of Aberdeen
University of Auckland
University of Balochistan
University of Bern
University of Birmingham
University of Bristol
University of British Columbia
University of California
University of Cambridge
University of Chile
University of Colorado at Boulder
University of Edinburgh
University of Freiberg
University of Halle-Wittenberg
University of Iowa
University of Lausanne
University of Kansas
University of Karlsruhe
University of Liverpool
University of Manchester
University of Munster
University of Nebraska-Lincoln
University of Notre Dame, South Bend
University of Nottingham
University of Oklahoma
University of Otago
University of Oxford
University of Stavanger
University of Salzburg
University of Utah
University of Western Ontario
Wadia Institute of Himalayan Geology
Western Geco

10. Key Awards

Chairs

New funding was awarded for four chairs in recognition of the calibre of these established IMER researchers.

Professor Bruce Ainsworth
South Australian State Government Chair of Petroleum Geology

Sponsor: Primary Industries and Resources SA, Government of South Australia

Dr Corey Bradshaw
MISA Senior Scientist - Ecosystems modelling position

Sponsor: South Australian Research and Development Institute (in association with the Environment Institute)

Professor Barry Brook
The Sir Hubert Wilkins Chair of Climate Change

Sponsor: State Government of South Australia (in association with the Environment Institute)

Professor Ian Plimer
Professor of Mining Geology

Sponsor: Primary Industries and Resources SA, Government of South Australia

Professor Bruce Ainsworth
South Australian Government State Chair of Petroleum Geology

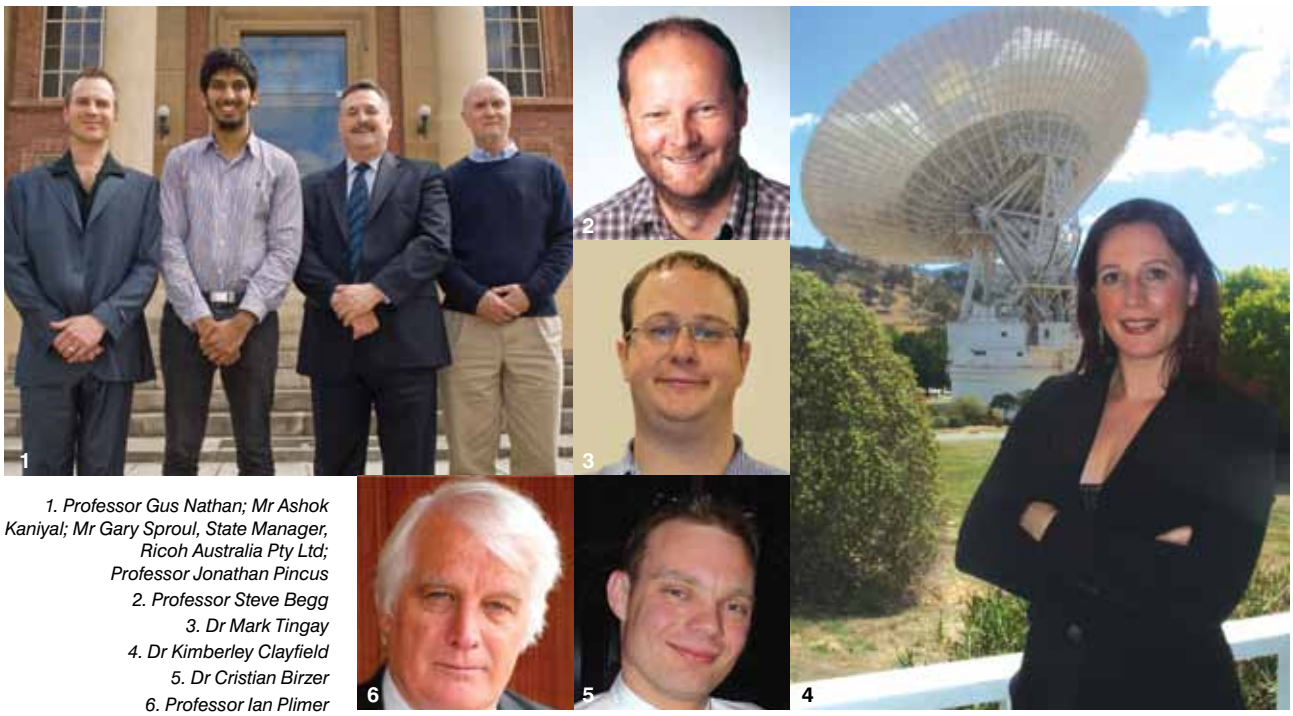
Sponsor: Primary Industries & Resources SA (PIRSA), Government of South Australia.

The University of Adelaide's Professor Bruce Ainsworth was named South Australian State Government Chair of Petroleum Geology in January, 2010.

The Deputy Head of the Australian School of Petroleum (ASP) has extensive industry experience with Shell International Exploration and Production Company and two years as a Statoil and BP-funded researcher at the University of Liverpool in the United Kingdom. Professor Ainsworth joined the ASP in 2007.

With teaching interests in 3D Reservoir Modelling, Sedimentology, Sequence Stratigraphy and Seismic Stratigraphy, Professor Ainsworth is currently the leader of the ASP Reservoir Analogues Research Group and the *WAVE* Consortium.

The *WAVE* Consortium is a company and industry sponsored consortium with a Phase 1 (April 2008 to September 2010) research budget of around $A1.1 million. Consortium sponsors are located globally – in Australia, Austria, Canada, Egypt, New Zealand, Norway and the United States of America. The aim of the group is to better characterise mixed-influence (wave, tidal and fluvial processes) coastal depositional environments and to analyse the potential impact of shales and cemented zones (heterogeneities) on reservoir connectivity and compartmentalisation. It looks at how these can best be predicted and mitigated in the sub surface. Predictive aspects of the *WAVE* knowledgebase can be used in exploration, development and production settings. Phase II of the project runs from April 2011 through to March 2014 with a total value of funding of $A1.42 million. *WAVE* Consortium sponsors include BADR Petroleum Company, BHP Billiton, Chevron, Conoco Phillips, Nexen, OMV, Shell, Statoil, Todd Energy and Woodside.



1. Professor Gus Nathan; Mr Ashok Kaniyal; Mr Gary Sproul, State Manager, Ricoh Australia Pty Ltd; Professor Jonathan Pincus
2. Professor Steve Begg
3. Dr Mark Tingay
4. Dr Kimberley Clayfield
5. Dr Cristian Birzer
6. Professor Ian Plimer

Awards

Society of Petroleum Engineers' Distinguished Lecturer
Awarded to Professor Steve Begg

The University of Adelaide's Australian School of Petroleum (ASP) Professor and Head of School Steve Begg was selected as a Distinguished Lecturer by the Society of Petroleum Engineers for a 2010 and 2011 tour. Each year the Society selects a group of around 30 individuals who are experts in their field and capable speakers to share their expertise with members. Individuals are nominated by their peers and selected by the Distinguished Lecturer Committee. Steve's topic of 'Reliability of Expert Judgements and Uncertainty Assessments' is founded upon results obtained through research with Dr Matthew Welsh in the Centre for Improved Business Performance, part of ASP. This Centre researches decision-making under uncertainty, in particular, the human input element. Professor Begg had 19 years' experience in the oil and gas industry before his academic career. The 2010 tour encompassed Norway, Denmark, Romania, England and Spain. In 2011, the tour continues to Azerbaijan, Japan, Singapore and China.

2009 Australian Society of Exploration Geophysicists Early Achievement Award
Awarded to Dr Mark Tingay

Dr Mark Tingay, Senior Lecturer in the Australian School of Petroleum and member of the Centre for Tectonics, Resources and Exploration (TRaX) was awarded the 2009 Australian Society of Exploration Geophysicists Early Achievement Award. Mark is the inaugural recipient for his "significant contributions to geophysics by a scientist under the age of 36".

Australia's Most Inspiring Young Engineers Award 2010
Awarded to Dr Kimberley Clayfield

Dr Kimberley Clayfield was named "Australia's Most Inspiring Young Engineer for 2010" by Engineers Australia. Dr Clayfield graduated with B.Eng. (Mech) in 1999 and a PhD in 2005 under the supervision of Associate Professor Richard Kelso and Dr Gerald Schneider in the area of aerodynamics.

2010 Young Mechanical Engineer of the Year Award
Awarded to Dr Cristian Birzer

Dr Cristian Birzer, a University of Adelaide graduate and School of Mechanical Engineering research fellow, won the 2010 Young Mechanical Engineer of the Year Award. Dr Birzer is working on exciting research which looks at the dynamics of small fibrous particles and their interaction under different fluid dynamic conditions. The Award recognises the achievement and contribution of a young mechanical engineer, technologist or associate to the profession of Mechanical Engineering.

RICOH Clean Energy Scholarship
Awarded to Ashok Kaniyal

The Ricoh Clean Energy Postgraduate Scholarship was awarded to Ashok Kaniyal in 2010. It was initiated by Ricoh Australia to support research by a postgraduate PhD student at the Centre for Energy Technology, the University of Adelaide. The aim is to attract the best students to undertake research into clean energy, consistent with Ricoh's mission to be a corporate leader in sustainability. Mr Kaniyal's thesis will address investment strategies in renewable energy infrastructure. In particular, it will address barriers to the utilisation of renewable resources such as remote locations far from the electricity grid. It will consider pathways for investment in these remote and geographically disparate renewable energy resources in a socially optimal manner by evaluating the broader societal benefits and associated costs.

11. Centre for Energy Technology

Vision

The vision of the Centre for Energy Technology (CET) is to deliver innovative technologies for a clean energy future through strategic partnerships.

Mission

The mission of CET is to accelerate the national and international transition from a high to low CO_2 emission society through world-leading research and development activities in partnership with leading industry, government agencies and other research organisations, resulting in cost-effective clean energy technologies, notably in the:

- Sustainable utilisation of fossil and alternative fuels;
- Utilisation of alternative energy sources including solar, biomass, wind, wave and geothermal (in collaboration with the South Australian Centre for Geothermal Energy Research);
- Novel integration of technologies and practices to increase their efficiency; and
- Novel energy transport and storage systems.

Objectives

CET's vision and mission will be achieved by working towards the following objectives:

- To increase the output of high quality research in energy technology at the University of Adelaide;
- To accelerate the development and deployment of clean energy technology; and
- To provide increased support for CET researchers in line with its objectives.

Director's Report

Professor Gus Nathan

The mission of the Centre for Energy Technology (CET) is to deliver innovative technologies for a clean energy future. With the support of the Centre's Advisory Board, ably led by Hon John Olsen, AO, the Centre has identified its research priorities as solar-combustion hybrids, wind energy and alternative fuels. These areas are well aligned with CET's research capability and with national priorities and the group has developed plans to advance research and technology in each of these areas.

CET has invested considerably in developing a number of novel concepts for the direct integration of concentrated solar radiation into hybrid energy systems and in establishing partnerships and submitting funding applications to take these ideas further. The first to come to fruition is the recent award of an Australian Research Council Linkage grant in partnership with Heliotherm. CET has established a new wind tunnel to assist research in wind turbines with the support of the State Government of South Australia and the Sir Ross & Sir Keith Smith Trust. The bio-fuels team has established a pilot scale facility to grow micro-algae in Karratha in partnership with SQC Pty Ltd and Murdoch University.

The Centre's efforts to build new industry partnerships culminated with the signing of a Platinum Partnership program with Adelaide Airport. This partnership supports research directed to programs aligned with both organisations' strategic priorities, split equally between projects targeted to directly reduce greenhouse emissions at the airport and projects supporting the development of technologies with substantial potential to deliver long-term CO_2 mitigation.

Since CET's launch in May 2009, the Centre has broadened its membership from within the University so that it now incorporates researchers from the School of Chemical Engineering, the School of Chemistry and Physics, the School of Electrical and Electronic Engineering, the School of Mathematical Science and the School of Mechanical Engineering. Our members continue to publish extensively, with a high number of papers in leading international journals that demonstrate the depth of fundamental capability backing our technology development programs.

Advisory Board

Chairman
Hon John Olsen, AO
Former Premier of South Australia

Associate Professor Peter Ashman
Deputy Head of School of Chemical Engineering

Mr Mark Bonnar
Investment Manager, Cleantech Ventures

Mr Mike Congreve
Manager Alternative Energy Projects, Santos

Associate Professor Bassam Dally
Head of School, School of Mechanical Engineering

Mr Stephen de Belle
Managing Director, Granite Power

Ms Ros de Garis
Group Sustainability Manager, Adelaide Brighton Ltd

Professor Stephen Grano
Executive Director, Institute for Mineral and Energy Resources

Mr Ross Haywood
Practice Director, Hatch Global

Mr David Holland
Director, Right Angle Business Services

Mr Terry Kallis
Managing Director, Petratherm Ltd

Professor Gus Nathan
Director, Centre for Energy Technology

Mr Craig Oakeshott
Senior Manager Strategy and Economics, Australian Energy Market Operator

Dr Jordan Parham
Manager, Institute for Mineral and Energy Resources

Mr Andrew Stock
Executive General Manager – Major Development Projects, Origin Energy

Hon Trish White
Executive Strategic Adviser, Worley Parsons

Mr Mark Young
Chief Financial Officer, Adelaide Airport Limited

Professor Mike Young
Executive Director, Environment Institute

Formerly on Board:

Mr Ian Chessel
Chief Scientist, Department of Further Education, Employment, Science and Technology, Government of South Australia

CET Research Areas

- **Combustion and fluid mechanics;** innovative burner technologies, turbulent flows, two-phase flows, heat transfer, clean coal technologies.
- **Renewable energy integration;** solar-combustion hybrids for solar fuels, minerals processing or electricity generation; techno-economic assessments of energy systems, and markets.
- **Energy efficiency;** novel power cycles, aerodynamic optimisation, air-conditioning systems, electrical power quality, conditioning; low-cost converter systems.
- **Alternative fuels;** the production and utilisation of alternative fuels from biomass and micro-algae.
- **Wind energy;** micro wind turbines, aero-acoustics, novel generators, wind farm optimisation.
- **Physical chemistry;** new photovoltaic materials, nanocatalysis, gas-storage and separation, nanostructured materials for energy conversion and storage.

Home Schools

School of Chemical Engineering

School of Chemistry and Physics

School of Electrical and Electronic Engineering

School of Mathematical Sciences

School of Mechanical Engineering

Highlights

Centre Launched

The Centre for Energy Technology (CET) was officially launched on May 7, 2009 at the University of Adelaide with around 100 representatives from government, industry and the University. Guest speakers included the Department of Premier and Cabinet Deputy Chief Executive of Sustainability and Workforce Management, Mr Tim O'Loughlin; Acting Vice-Chancellor, Mr Paul Duldig; Deputy Vice-Chancellor; and Vice-President of Research, Professor Mike Brooks; and the Director of the Environment Institute, Professor Mike Young.

Above, L to R: Mr Phil Baker, Managing Director, Adelaide Airport Limited; Professor Gus Nathan; Hon Patrick Conlon MP, Minister for Transport, Minister for Infrastructure.

Adelaide Airport CET's Inaugural Platinum Partner

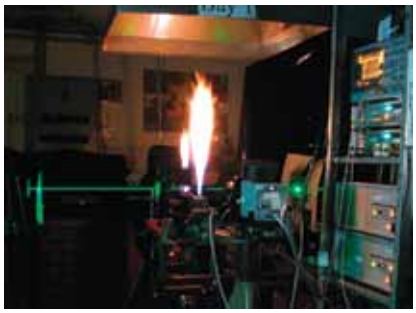
Professor Gus Nathan, Associate Professor Bassam Dally, Associate Professor Eric Hu, Dr Lei Chen, Dr Maziar Arjomandi and Dr Tim Lau.

Adelaide Airport Limited (AAL) has become the inaugural Platinum Partner of CET, in a three-year relationship worth $A750,000. The aim of the partnership is to undertake research and develop novel clean energy technologies in support of AAL's drive to be the most ecologically sustainable airport in Australia and CET's drive to be a world-leading research centre in clean energy technology.

Research at CET will focus initially on options to improve the energy efficiency of the Terminal 1 building – the largest single consumer of electricity at Adelaide Airport. The

projects will demonstrate how real energy savings can be made whilst at the same time providing direction for ongoing University research into improved building management and clean energy technology options.

The funding for this partnership will also support a range of other clean energy research projects, including solar-hydrogen catalysis, wind energy and two PhD scholarships.



Solar Radiation Research Sparks Interest

Dr Paul Medwell, Professor Gus Nathan, Mr Qing Chan, Dr Zeyad Alwahabi and Associate Professor Bassam Dally

Novel technology concepts have been developed by CET researchers relating to the joint use of concentrated solar radiation and combustion. The study found the use of a high-energy laser to achieve radiation fluxes similar to those found in a solar receiver, offers advantages over actual solar radiation. This is because it is more controllable, especially over the wavelength of the radiation and offers high uniformity in intensity. The first research paper investigating the influence of concentrated solar radiation on a flame was published in *Combustion and Flame*. The paper, entitled 'The influence on the soot distribution within a laminar flame of radiation at fluxes of relevance to concentrated solar radiation', shows the influence is significant and proposes three mechanisms for these influences.

CET has identified a number of novel approaches to integrate concentrated solar energy with fossil fuels or biomass for the production of solar fuels, for minerals processing or the generation of electricity. It is anticipated these approaches will lead to a significant reduction in the price of concentrated solar energy over stand-alone technologies. The work published in this paper forms the foundation of future investigations supported by an Australian Research Council (ARC) Linkage grant supported by Heliotherm.

L to R: Associate Professor Peter Ashman and Dr David Lewis.

Company Launched to Commercialise Research on Green Fuels from Algae

Dr David Lewis and Associate Professor Peter Ashman

An Australian company has been established to produce commercial qualities of clean 'green' fuels from algae following insights from CET researchers. Muradel Pty Ltd is a joint venture between Adelaide Research and Innovation Pty Ltd, the commercial development company of the University of Adelaide, Murdoch University, and commercial partner SQC Pty Ltd.

The University of Adelaide's Dr David Lewis from the School of Chemical Engineering and Murdoch University's Professor Michael Borowitzka are world leaders in the development of biofuels from micro-algae. Their work has already led to the establishment of a $A3.3 million algae pilot plant in Western Australia.

The new company brings to commercial reality a large-scale business that leverages the natural advantage of the Australian environment, producing algae for renewable fuel and co-products from the biomass. The research has proven it is possible to grow large quantities of algae for commercial biofuel purposes. The University of Adelaide team is contributing engineering expertise in algal processing.

Wind Energy Research Boosted by Wind Tunnel Construction

Professor Colin Hansen, Professor Gus Nathan, Associate Professor Richard Kelso, Associate Professor Bassam Dally, Dr Peter Lanspeary, Dr Con Doolan and Dr Maziar Arjomandi.

CET, in collaboration with the School of Mechanical Engineering oversaw the construction of Australia's second largest wind tunnel which is ideally suited for the testing and development of wind turbines, heliostat fields and energy flows in buildings. The only industrial-scale wind tunnel in South Australia, the tunnel is also applicable to a range of other fields of research including automotive, aeronautical, aerospace and sports engineering. The tunnel is housed in a dedicated building at the Thebarton Research Precinct at the University of Adelaide.

The wind tunnel will boost CET's capability in wind energy related research, which already includes:

- The design, modelling and control of a converter system and the hardware design for small scale wind turbines, led by Associate Professor Nesimi Ertugrul;
- The development of novel vertical axis wind turbines with the use of active control to augment start-up at low wind speeds for micro-wind applications, led by Dr Maziar Arjomandi;
- Improved understanding and modelling of the generation, propagation and control of aero-acoustic noise from turbine blades to optimise the design of wind turbines and wind farms to improve performance, led by Professor Colin Hansen and Dr Con Doolan.

Research Highlight

Radiation, Soot and Temperature Analysis Offers Breakthroughs in Understanding

Research Team includes: *Mr Qing Chan, Dr Paul Medwell, Dr Peter Kalt, Dr Zeyad Alwahabi, Associate Professor Bassam Dally and Professor Gus Nathan*

IMER researchers' breakthrough measurements have advanced scientists' ability to assess the interdependence of temperature and soot in flames. This will contribute to the development of more reliable models of a wide range of processes involving complex reacting flows where both particles and radiation are important.

The team from the Centre for Energy Technology, the University of Adelaide, measured the first simultaneous single-shot imaging of temperature and soot volume fraction with Nonlinear Regime Two-Line Atomic Fluorescence (NTLAF) and Laser-Induced Incandescence (LII).

Soot is a key component in many combustion systems. When present in a flame, it plays an important part in radiative heat transfer, dominant in kilns, boilers and furnaces. An increased soot presence within a flame acts to increase the flame emissivity and hence the radiative heat output as it produces broadband incandescent radiation. On the other hand, soot is also an unsightly emission from combustion processes and has been shown to be a major environmental pollutant and presents a major health risk because of its high toxicity and small particulate size.

The need for an improved capacity to understand and predict radiative heat transfer in and from flames is driven by the challenge to supply ever-cleaner energy. There is an increasing need to optimise combustion systems to generate higher efficiency while lowering pollutant emissions. New emerging technologies such as solar gasification, also require a detailed understanding and modelling capacity of radiation in complex media to optimise design.

While the combustion processes involving soot have been widely employed for years, the processes of its formation and destruction in practical environments is not sufficiently well understood to be modelled reliably. The complex processes governing interdependent parameters such as fuel type, mixture fraction and temperature require further understanding, especially in a turbulent environment.

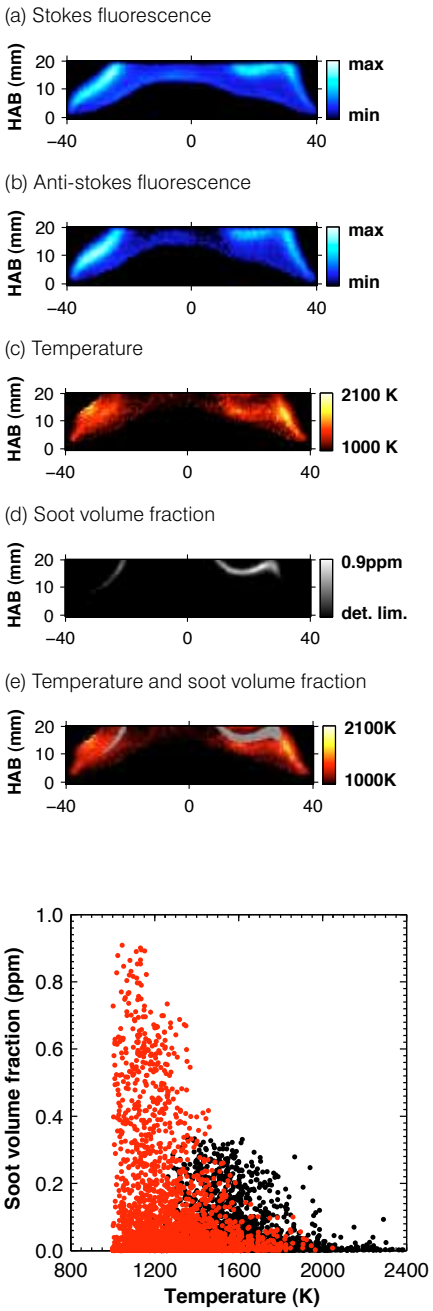
Soot and temperature have an inherent coupled dependence since temperature depends on soot concentration due to heat transfer through radiation. Simultaneously, temperature affects the formation and destruction of soot in flame.

Simultaneous measurements of multiple parameters is highly desirable for the development of reliable models. As it is a turbulent environment, more than one-dimensional measurements are desirable for both research and in studying practical combustion systems.

The breakthrough measurements were performed in laminar premixed and non-premixed flames and a wrinkled non-premixed flame. No significant interference of the two measurements on each other was observed.

The experimental results reveal that while NTLAF has a relatively small operating range, this range is well matched to almost all regions in which soot is found. All observed features of the flame were qualitatively consistent with previous work. The application of joint NTLAF-LII measurements could be used to assess the coupled dependencies of temperature and soot in flames. It represents a significant breakthrough in the diagnostic capabilities in flames containing soot.

Chan,Q, Medwell,P, Kalt,P, Alwahabi,Z, Dally,B and Nathan,G. (2010) Simultaneous Imaging of Temperature and Soot Volume Fraction, *Proceeding of the combustion Institute* 33(1), pp.791-798



Left: Simultaneous single-shot images of a wrinkled non-premixed ethylene-air flame. (a) Stokes, (b) anti-Stokes indium fluorescence, (c) NTLAF temperature, (d) LII soot volume fraction, and (e) instantaneous temperature field with location of soot overlaid (in grey). Image size approximately 20mm x 80mm. Laser propagation from left to right.

Lower left: Soot volume fraction as a function of temperature for laminar non-premixed and wrinkled nonpremixed flames.

12. Centre for Tectonics, Resources and Exploration

Vision

To understand the evolving Earth and its resource potential.

Mission

To be the foremost provider of research and teaching in tectonics, resources and exploration in Australia – and to provide focused research into South Australia's unique geological characteristics.

Objectives

The Centre for Tectonics, Resources and Exploration (TRaX) is committed to the translation of research to practical application in the minerals and energy industries and supports the building of multidisciplinary teams that cross traditional university boundaries and tackle major issues in mineral and energy resources.

Key objectives include:

- To develop and maintain national and international research excellence in tectonics and resource exploration;
- To use our research outcomes to influence exploration strategies and methods in the resources sector;
- To use our expertise to influence government resources policy;
- To educate students in the latest research technologies in order to provide a highly trained geoscience workforce.

Director's Report

Associate Professor Nigel Cook

Since its inception in mid-2009, the Centre for Tectonics, Resources and Exploration (TRaX) has gone from strength to strength. Formed with 30 full-time staff working across the Australian School of Petroleum, the School of Earth and Environmental Sciences, and the South Australian Museum, TRaX's staff collectively deliver expertise in mineral, energy and resources and innovative, cross-disciplinary research within the areas of Lithospheric Evolution, Geofluids, Regolith and Landscape Evolution, Tectonics and Metallogeny, Geophysical Exploration and Minerals, Microbes and Solutions. The team is committed to the translation of research into practical applications for the minerals and energy industries, to work in multidisciplinary groups that cross traditional university boundaries and tackle major issues in mineral and energy resources.

TRaX was initiated by the University of Adelaide to complement the Centre for Mineral Exploration Under Cover (CMXUC) and therefore has many research areas in common. CMXUC is an initiative of the Government of South Australia, through the Department of Primary Industries and Resources SA (PIRSA), and the University of Adelaide, which was initiated in 2005 with funding to continue until 2011 inclusive.

TRaX's success in achieving its research objectives during the 2009 to 2010 period was formally acknowledged by the release of the Australian Research Council's (ARC) Excellence in Research Assessment (ERA) results, which is an assessment of the quality of research being conducted in Australian universities. The disciplines of Earth Sciences and Geology both received a score of 5, defined by ERA as research that is well above world standard.

Other successes have included active collaboration with national and international stakeholders, universities, federal and state agencies and industry, culminating in TRaX researchers contributing to many scientific publications in top-ranked journals, participation in conference organisation, membership of editorial boards and involvement in major national research initiatives such as AuScope, an initiative of the Australian Federal Government's National Collaborative Research Infrastructure Strategy program focussing on geoscience.

TRaX Research Areas

- **Lithosphere Evolution;** the growth, destruction and modification of both the Crust and the Upper Mantle with direct applications to minerals and petroleum exploration.
- **Geofluids;** sedimentology, geochemistry, mineralogy, structural geology, ore genesis, deformation processes, diagenesis and the migration and accumulation of hydrocarbons.
- **Regolith and Landscape Evolution;** the nature and evolution of the cover sequences, plant, animal and micro-organism biogeochemical expression of buried substrates, regional landscape evolution models and regolith-landform mapping.
- **Tectonics and Metallogeny;** nature of basement rocks in South Australia and Australia, their tectonic evolution and their mineral prospectivity including stress and structure of the Earth.
- **Geophysical Exploration;** techniques to map the physical properties and infer the composition of cover and basement rocks, seismic profiling, crustal heat flow mapping, geochemical sampling groundwater detection and numerical modelling.
- **Minerals, Microbes and Solutions;** study of metal complexes under hydrothermal conditions, high pressure, high temperature flow conditions and biosensors.

Home Schools

Adelaide Microscopy

Australian School of Petroleum

School of Computer Science

School of Earth and Environmental Sciences

Highlights

TRaX Launched

Invited guests from government and industry sectors, as well as stakeholders from across the university attended the official launch of the Centre for Tectonics, Resources and Exploration (TRaX), on November 6, 2009. The launch, which was held on the North Terrace Campus of the University of Adelaide, provided the chance to celebrate research strengths and existing partnerships and the opportunity to develop new collaborations.

AuScope National MT Facility Completed

Professor Graham Heinson, Professor Martin Hand, Professor David Giles, Dr Katherine Selway, Dr Guillaume Backé, Dr Stephan Thiel and Dr Graham Baine

Researchers in TRaX's Geophysics Exploration research area have seen the completion of the development of the largest equipment pool of electromagnetic instruments in the world. The AuScope National Magnetotelluric (MT) Facility follows the granting of an additional $A350,000 in funding in 2010 as part of the Australian Geophysical Observing System. This aims to build a new generation of 100 small, low cost electric field loggers for energy, geohazard and other geoengineering applications. The group received research funding from a number of agencies, including the Australian Research Council (ARC) (two Discovery grants, one Linkage grant), various government agencies (including the National Water Commission), and contract research with Geoscience Australia and other State Geological Surveys, and industry. Over the period of 2009 to 2010, research has been in areas as diverse as geothermal energy, mineral exploration, groundwater detection, numerical modelling and joint inversion.

World-leading Researchers Boost TRaX's Stress, Seismic and Structure Research Capability

Dr Guillaume Backé, Dr Simon Holford, Dr Rosalind King, Dr Mark Tingay, Dr Hani Abul Khair, Dr Muzy Rahman and Dr Adrian Tuitt

TRaX's Stress, Seismic and Structure Research Area has enjoyed considerable expansion with the addition of three new staff, through the employment of academics Dr Guillaume Backé, Dr Mark Tingay and post-doctoral researcher Dr Adrian Tuitt. Major research efforts have focused on three Australian Research Council Discovery projects: 'Compressional Deformation and Uplift of Australia's Passive Southern Margin'; 'Tectonics and Present Day Stress and Tectonics of Delta to Deepwater Fold-Thrust Belt Systems'; and 'Crustal Stress Field of South East Asia'. New research projects initiated during 2009 and 2010 by TRaX's Stress, Seismic and Structure Research Area include a Department of Primary Industries and Resources SA (PIRSA) funded investigation into shale gas prospectivity in the Cooper Basin.

Success within TRaX - Minerals Microbes and Solutions Research

Dr Joel Brugger, Professor Allan Pring, Dr Frank Reith and Associate Professor Nigel Cook

TRaX's Minerals, Microbes and Solutions research area, enjoyed a very successful 2009–2010 with the commencement of numerous Australian Research Council Discovery and Linkage projects. More than 10 synchrotron experiments were conducted or granted and more than 25 manuscripts were published, mostly in A and A+ category journals such as: *Proceedings of the National Academy of Sciences of the United States of America; Geochimica et Cosmochimica Acta; Chemical Geology*; and *Geology*.

Specific highlights include the successful construction and testing of a high-pressure, high-temperature cell for the study of metal complexes under hydrothermal conditions using synchrotron radiation and the construction and testing of a high-pressure, high-temperature flow through cell for the study of hydrothermal ore forming reactions by neutron diffraction. Another highlight was the development of a whole cell biosensor for gold in collaboration with colleagues in America and Germany.

TRaX - Landscape Evolution Research

Dr Steve Hill and Professor David Giles

The main focus of research attention in this area was directed towards the initiation of a major project within

the Deep Exploration Technologies Cooperative Research Centre (DET CRC) entitled 'Geochemical sampling of the deep cover'. Steve Hill is the leader of this project and its initial research focus is on the deep cover in the eastern Gawler Craton. This project involves research collaboration with PIRSA, Commonwealth Scientific and Industrial Research Organisation (CSIRO) and DET CRC service companies, Boart Longyear Company, Olympus, Innov-X and ioGlobal.

Four new PhD students commenced at the beginning of 2010. Projects include 'Regolith expressions of iron oxide, copper, gold (IOCG) mineral systems in the southern Olympic Domain', 'Geochemistry and biogeochemistry of deep cover at Tunkillia Gold Prospect', 'Geochemistry and evolution of deep cover interfaces within the Jacinth heavy mineral sand system' and 'Geochemistry of Permian deep cover interfaces in southern Australia'.

A research project including two Honours students was also conducted on the regolith geochemistry and landscape evolution of the southern Middleback Ranges, sponsored by OneSteel.

Lithospheric Evolution Research Gains Grants

Dr Guillaume Backe, Dr Graham Baines, Assoc Professor Alan Collins, Professor John Foden, Dr Caroline Forbes, Professor David Giles, Professor Martin Hand, Dr David Kelsey, Professor Graham Heinson, Dr Simon Holford, Dr Rosalind King, Dr Justin Payne, Dr Kate Selway, Dr Stephan Thiel, and Dr Adrian Tuitt

TRaX research on lithospheric evolution brings together petrologists, structural geologists, geophysicists, sedimentary, igneous and metamorphic geologists, and geochemists to work on generic tectonic problems with direct applications to minerals and petroleum exploration.

Major new multidisciplinary projects initiated in this research area during 2009 and 2010 include:

- Three-dimensional magnetotelluric and controlled-source electromagnetic modelling and inversion in isotropic and anisotropic media with gaussian quadrature grids;
- The enigmatic link between crustal growth and supercontinent formation;
- Constraining conditions and timing of orogeny and reworking in the west Musgrave Province; and
- Iron isotope variation in subduction magmas, links to fluid flux and oxidation of the mantle wedge.

Research Highlight

Gold Biomineralisation Insights Offer Implications for Exploration and Extraction

Research team includes: *Dr Frank Reith, Dr Barbara Etschmann, Professor Allan Pring and Professor Joel Brugger*

The role of micro-organisms as the main drivers of metal mobility and mineral formation under Earth surface conditions is now widely accepted. However, it is commonly believed the formation of secondary gold (Au) in surface environments is attributed to abiotic processes, which are mediated by non-living chemical and physical factors in the environment.

Research by a group of experts including IMER researchers Dr Frank Reith and Professor Joel Brugger, has found direct evidence that bacteria are actively involved in the biogeochemical cycling of rare and precious metals. The research has opened the way for the development of bioexploration and bioprocessing tools which could revolutionise the exploration for gold, improve gold extraction and assist hydrometallurgical processes.

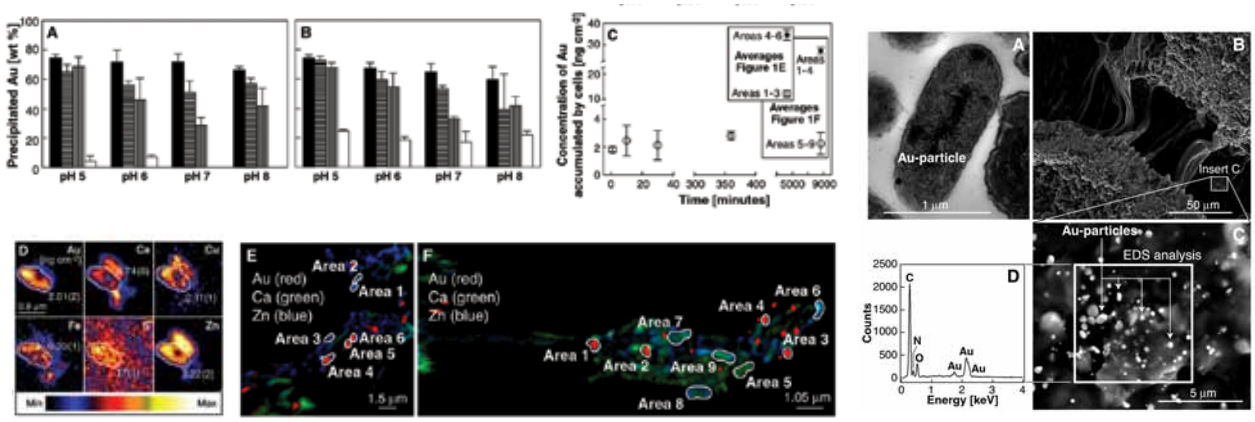
Microorganisms are paramount for metal cycling and mineral formation. Some metal ions are essential for microbial nutrition, while others are oxidised or reduced to obtain metabolic energy. In particular, heavy metal ions cause toxic effects to microbiota. Hence micro-organisms have developed genetic and proteomic responses to regulate metal homeostasis.

In contrast to most other metals, gold is rare, inert, non-essential and does not form free ions in aqueous solution under surface conditions. This study looked at the impact of microbial processes on Au mobility, tracing the effect of indigenous bacterial such as *C. metallidurans* on Au complexes. It addressed four questions: is the reduction of Au(III) by *C. metallidurans* an active, energy-dependent process; how is Au distributed and speciated in cells; which form is present in biofilms and Au grains; and finally, what are the genetic and biochemical responses to the presence of Au complexes in *C. metallidurans*.

Kinetic experiments with metabolically active cells confirmed a two-stage reduction for Au(III) complexes, finding several mechanisms may be used by *C. metallidurans* to detoxify Au (III)-complexes.

Research found *C. metallidurans*, which forms biofilms on Au grains, rapidly accumulates Au(III)-complexes from solution. Bulk and microbeam synchrotron x-ray analysis revealed that cellular Au accumulation is coupled to the formation of Au(I)-S complexes. This process promotes Au toxicity and the *C. metallidurans* reacts by inducing oxidative stress and metal resistant gene clusters to promote cellular defense. As a result, Au detoxification is mediated by a combination of efflux, reduction and possibly methylation of Au-complexes leading to the formation of Au(I)-C-compounds and nanoparticulate Au(0).

The study concluded other precious metals such as Platinum Group Elements (PGE) share geochemical properties with Au. Similar to Au, zones of secondary PGE enrichment occur in surface environments and were attributed to their solubilisation, transport and precipitation.



The discovery of active microbially-driven biomineralisation may lead to the development of applications such as the development of Au-specific biosensor technology enabling *in situ* Au measurements.

Reith,F, Etschmann,B, Grosse,C, Nies,DH, Moors,H, Benotmane,MA, Monsieurs,P, Mergeay,M, Grass,G, Doonan,C, Vogt,S, Lai,B., Martinez-Criado,G, George,GN, Pring,A, Southam,G and Brugger,J. (2009) Mechanisms of gold biomineralization in the bacterium Cupriavidus metallidurans, *PNAS*, Volume 106, no 42, October 20, 2009, pp17757-17762.

Figure above: Accumulation of Au(III)-complexes by *C. metallidurans*. (A and B) Concentration of Au(III) taken up after 6 h (A) and 144 h (B) of incubation; cells were incubated in PME-medium at starting pHs 5.0, 6.0, 7.0, and 8.0 and amended with 50 μM Au(III); error bars represent the standard deviation of triplicate samples; (C) concentrations of Au in individual *C. metallidurans* cells and particles associated with cells in [ng cm^{-2}] based on quantitative μXRF maps, error bars represent the standard deviation of replicate samples; (D) quantitative μXRF-maps showing the distribution of Au, Ca, Cu, Fe, S, and Zn in an individual cell after 1 min exposure to Au(III) at pH 7.0 [the quantified area is marked in the image, and concentrations (± calculated errors) are given in the image, concentration ranges for elements are Au, 0–4.16; Ca, 0–18.78; Cu, 0–0.29; Fe, 0–0.44; S, 0–60.52; and Zn, 0–24.57 ng cm^{-2}]; (E and F) overlay false color quantitative μXRF-maps of the distribution of Au (red), Zn (blue), and Ca (green) in cell clusters after 72 h (E) and 144 h (F) of incubation at pH 7.0.

Centre for Mineral Exploration Under Cover

Director's Report

Professor David Giles

The Centre for Mineral Exploration Under Cover (CMXUC) is an initiative of the Government of South Australia, through the Department of Primary Industries and Resources SA (PIRSA) and the University of Adelaide. Funding of $A1.2 million over four years (2005–2008 inclusive) was provided by PIRSA through the Plan for Accelerated Exploration (PACE) to establish and seed fund CMXUC. This funding was then continued over the three-year period (2009–2011 inclusive) within the context of PACE 2. The PACE funding allowed for the creation of the inaugural State of South Australia Chair of Mineral Exploration (and Director of CMXUC) held by IMER and TRaX member Professor David Giles since January 2006.

The CMXUC is dedicated to overcoming the most significant roadblock to the discovery of new mineral resources in Australia – namely the burial of prospective mineral provinces beneath hundreds of metres of barren cover rocks.

CMXUC research is focused on developing methodologies to explore for economic mineral deposits through those cover rocks, at the same time as addressing the issue of skill shortages in the mining industry. A key aim of the CMXUC has been to maximise its research breadth and impact through strategic collaborations with the minerals industry, government organisations and academia.

From 2010, CMXUC research was closely integrated with the Deep Exploration Technologies Cooperative Research Centre (DET CRC), enabling greater depth and breadth of activities and increased exposure to the minerals industry and government research organisations. The DET CRC is described in more detail elsewhere in this report. The CMXUC in-kind commitments will contribute to the planned generation of $A1.73 million in research income over the first three years of the CRC, providing for operating funds and the employment of four new post-doctoral researchers. In addition the DET CRC will provide funding of $A1.4 million to support postgraduate research and training.

Highlights

Bridging the gap between the South and North Australian Cratons

Professor David Giles, Professor Martin Hand and Professor Graham Heinson

The CMXUC seismic project 'Bridging the gap between the South and North Australian Cratons' in collaboration with researchers in the TRaX – Lithosphere Evolution Research Area and PIRSA, was ranked as #1 of the proposals submitted to AuScope. The funding provided for this research enabled CMXUC to acquire 250 kilometres of seismic reflection data (valued at $A1 million) and formed a significant component of a 600 kilometre seismic profile, stretching from central South Australia into the Northern Territory, with additional funding provided by Geoscience Australia's Onshore Energy and Security Initiative and the State Government of South Australia.

Uranium and Geothermal Exploration Link

Dr Guillaume Backé and Professor David Giles

Continuing research aimed at mapping crustal heat flow for the purposes of uranium and geothermal

exploration has received funding of $A142,000 through the Australian Geothermal Energy Group (AGEG), PIRSA and Torrens Energy. This includes development of a shallow thermal probe for reconnaissance heat flow measurements, which is being developed in collaboration with Hot Dry Rocks Pty Ltd.

Projection Facility Completed

The PIRSA 3-D Projection Facility was completed in February 2009 in the Mawson Laboratories at the University of Adelaide. The facility allows for visualisation and geological modelling for research and training in an interactive stereoscopic 3-D environment.

Research Highlight
Magnetotelluric (MT) Survey Redefines Current Models for Proterozoic Australia

Research team includes: *Dr Kate Selway, Professor Martin Hand, Professor Graham Heinson and Dr Justin Payne*

IMER researchers* undertook a 360km magnetotelluric (MT) survey where the results contradict most contemporary models explaining the evolution of Australia.

Early models of the Proterozoic assembly of Australia (the time between about 2500 and 550 million years ago) proposed that Australia's Proterozoic terranes have been in their present configuration since at least 2.5 billion years ago. However, this model contrasted with models proposed for most other continents during the same time period which were dominated by subduction-related processes, in which colliding tectonic plates move and when they collide, one plate slides under another.

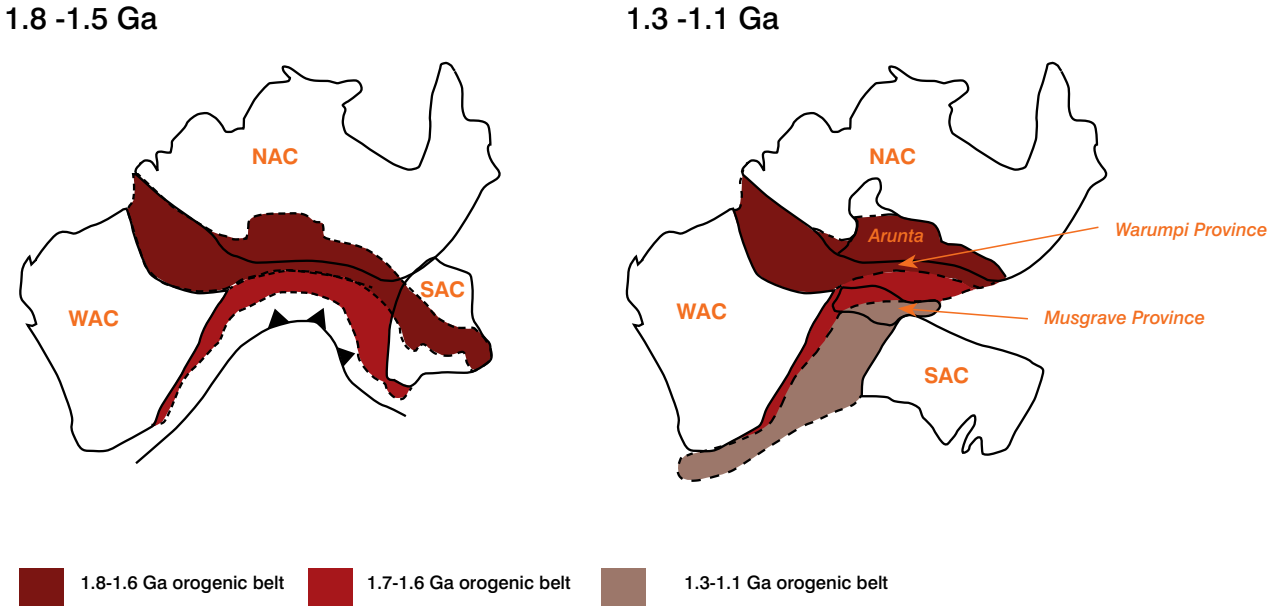
More recently, geochemical evidence has led to the proposition that subduction-related processes played a central role in Australia's formation. These models suggest separate cratonic blocks collided and accreted (grew by gradual accumulation) in various configurations. One dominant model is that north-directed subduction along the southern margin of the North Australia Craton (NAC) led to the accretion and outboard growth of the craton via a series of orogenic belts (large tectonically-effected belts) between 1.8 – 1.6 billion years ago. See Figure on opposite page.

Magnetotelluric surveys use the fact that the Earth's time-varying magnetic field induces currents in conductive bodies within the Earth to image the electrical resistivity of the Earth with depth. Induction is period-dependent - with longer periods penetrating deeper within the Earth - and shorter periods attenuated at shallower depths.

An MT survey was undertaken across the proposed 1.7 - 1.6 billion year old southern boundary of the NAC. Five-component, long-period MT data was collected at 69 stations. Geoelectric strike and dimensionality were determined, showing a dominant strike direction of N100°E. The resulting model shows that the NAC is more electrically conductive than both the Musgrave and Warumpi Provinces. The boundary between the NAC and the Warumpi Province extends to at least 150km depth and dips to the south.

Researchers at the University of Adelaide and Macquarie University interpreted the geometry to reflect lithospheric-scale under-thrusting of the NAC beneath the Warumpi Province.

It suggests a first-order constraint on subduction polarity during collision around 1640 million years ago. In contrast, most contemporary models for the evolution of Paleoproterozoic Australia propose that the NAC was located on the overriding plate of a long-lived (ca. 1800–1550 million years ago) north-directed subduction system.



The researchers propose that the absence of crustal-scale structures, seismic differences and electrical differences between the Musgrave and Warumpi Provinces suggest that they are a contiguous crustal terrane. The researchers suggest that ca. 1.59 - 1.55 billion year old, subduction-related magmatism in the Musgrave Province was generated by south-dipping subduction.

* Selway,K, Hand,M, Heinson,G and Payne,J (2009) Magnetotelluric constraints on subduction polarity: Reversing reconstruction models for Proterozoic Australia, *Geology* September 2009, pp799-802.

Figure above: Model adapted from Giles et al. (2004) *Tectonophysics*, v. 380, p. 27–41, doi: 10.1016/j.tecto.2003.11.010., showing proposed north-dipping subduction beneath North Australia craton (NAC) and model for its amalgamation with South Australia craton (SAC) to form Musgrave Block. WAC - West Australian craton.

13. South Australian Centre for Geothermal Energy Research

Vision

The vision of the South Australian Centre for Geothermal Energy Research (SACGER) is for a future in which the world's mineral and energy resources are managed efficiently and sustainably for the benefit of society, industry and the environment.

Mission

The SACGER mission is to establish a world-class centre of excellence for practical, high-priority geothermal energy research, with a focus on enhanced (engineered) geothermal systems and in geothermal power systems that will result in widespread benefits at a state, national and international level.

Objectives

SACGER aims to conduct research into enhanced geothermal systems and power systems that provide an economically and environmentally viable delivery of geothermal energy.

The Centre is committed to enabling South Australia to remain at the forefront of research and development in geothermal energy, which will result in widespread benefits for industry, the community and the environment.

Director's Report

Professor Martin Hand

The South Australian Centre for Geothermal Energy Research (SACGER) was established in 2009 through funding from the South Australian Government's Renewable Energy Fund. The State Government's $A1.6 million funding of the Centre is designed to stimulate the research required to ensure South Australia achieves its target of 33 per cent for renewable energy production by 2020 and in doing so provides globally applicable solutions for geothermal energy development. Australia's three flagship geothermal projects are all located in South Australia: Geodynamics' Cooper Basin project; Petratherm's Paralana project; and Panax's Salamander (Penola) project. The Geodynamics and Petratherm projects represent two of the world's most significant Engineered Geothermal Systems (EGS) projects. Both projects entail the enhancement of naturally fractured rocks with hydraulic fracture stimulation.

SACGER brings together cross-disciplinary research excellence and expertise from the Australian School of Petroleum, the School of Chemical Engineering, the School of Civil, Environmental and Mining Engineering, School of Computer Science and the School of Earth and Environmental Sciences and facilitates research into enhanced geothermal and power systems that provide an economically and environmentally viable delivery of geothermal energy. SACGER is part of the Geothermal Research Initiative which is a nationwide sharing of geothermal expertise designed to bring Australia to the forefront of non-conventional geothermal energy research.

Advisory Board

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Mr Sam Button
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Professor Peter Dowd
Executive Dean, Faculty of Engineering, Computing and Mathematical Sciences, the University of Adelaide

Mr Barry Goldstein
Director, Petroleum and Geothermal, Department of Primary Inudustries SA, Government of South Australia

Professor Martin Hand
Director, South Australian Centre for Geothermal Energy Research

Ms Susan Jeanes
Chief Executive, Australian Geothermal Energy Association inc

Dr Bob Johnson
Chairman, Geothermal Resources

Mr Terry Kallis
Managing Director, Petratherm Ltd

Mr Stuart McDonnell
Chief Operating Officer, Geodynamics Ltd

Dr Adrian Williams
Former Chairman of Geodynamics Ltd

SACGER Research Areas

- **Geophysical tools:** novel approaches for understanding the distribution of subsurface permeability including using 3D seismic data and the development of magnetotelluric tools that are sensitive to the presence of fluid-filled fracture systems.
- **Fluid rock interactions:** the geochemistry of geothermal fluids using flow-through and batch hydrothermal reactors to evaluate the dissolution of reservoirs, rocks and resultant precipitation and scaling within the reservoir and infrastructure.
- **Fracture modelling:** development of reservoir fracture models for enhanced geothermal systems and improved understanding of fluid-flow and heat-transfer in rock fractures.
- **Crustal stress characterisation:** modelling contemporary crustal stresses in a number of regions around the world including areas of known geothermal potential such as the Cooper Basin; understanding the stress and fluid-pressure state in non-conventional geothermal systems.

Home Schools

Australian School of Petroleum

School of Chemical Engineering

School of Civil, Environmental and Mining Engineering

School of Computer Science

School of Earth and Environmental Sciences

Highlights

Development of tools and methods to image geothermal reservoirs

Professor Graham Heinson, Dr Stephen Thiel, Professor Martin Hand, Dr Rosalind King, Dr Guillaume Backé and Mr Jared Peacock

The University of Adelaide is internationally recognised for its expertise in the use and development of magnetotelluric (MT) techniques. It is an international leader in the development of electromagnetically based tools for the geothermal industry and aims to develop this capability further through additional industry and government funding.

The current work entails three components:

- Installing 50 magnetotelluric (MT) monitoring sites and integration of micro-seismicity data at over 12 sites, with the aim of developing 3D models of the Enhanced Geothermal Systems reservoirs at the Paralana project in collaboration with Petratherm Ltd;
- Using MT to monitor fluid flow during fraction simulation as a means to image the fracture network and augment seismic datasets collected during stimulation;
- The development of MT as a tool for temperature prediction ahead of the drill bit as an aid to delineate new geothermal resources.

The collaborative research team includes five University of Adelaide academics, two Petratherm Limited staff, two Green Rock Energy staff and two University of Auckland academics.

Mapping fracture systems in South Australian geothermal reservoir analogues

Dr Guillaume Backé, Dr Mark Tingay, Dr Rosalind King and Dr Simon Holford

This project aims to characterise fractures in geothermal aquifers and granites in South Australia. The focus is on geothermal areas with existing seismic (especially 3D) and well datasets, such as the north west flank of the Patchawarra Trough (tenements held by Panax, Clean, Green Rock Energy and Osiris) and the Otway Basin (tenements held by Panax), as well as more advanced geothermal projects such as Habanero (Geodynamics) and Paralana (Petratherm).

This research will build on the established track records of the University of Adelaide in the analysis of stress, structure and seismic data in petroleum systems and facilitates the transfer of this critically important knowledge towards geothermal applications.

Better understanding of scaling in geothermal systems through new research facility

Dr Yung Ngothai, Professor Allan Pring, Dr Joel Brugger and Associate Professor Brian O'Neil

This work involves corrosion and scaling in Enhanced Geothermal Systems (EGS) and follows on from a pilot study using a hydrothermal cell at representative reservoir temperatures (100–250°C) to study fluid-rock interactions in geothermal reservoirs. However, the pilot study cell operated at pressures well below pressures (~ 300 bars) typical of EGS reservoirs in South Australia.

Researchers have built and tested a high-pressure flow-through cell which allows probing of fluid-rock interactions at temperatures up to 250°C and pressures of up to 600 bars. These conditions realistically simulate geothermal reservoir conditions. This flow-through rig has worked successfully in the laboratory and has also been used for in-situ experiments on one of the neutron diffraction beam lines on the Open Pool Australian Lightwater reactor at Lucas Heights. These experiments allow the dissolution and precipitation process to be studied in real time. In collaboration with TRaX researchers, a CAMECA SX-5 electron probe has been purchased through Australian Research Council funding.

South Australian Premiers Science Research funds have been used for a trace element mapping facility to better characterise the outcomes of dissolution and precipitation experiments.

Research Highlight
Fractures Point the Way to Extraction of Underground Resources

Research team includes: *Dr Chaoshui Xu and Professor Peter Dowd*

Fractures and fracture networks are critical to fluid flow and contaminant transport through rock masses, especially those at significant depths in the subsurface of the Earth. Rock fractures may be naturally occurring under a predominant stress regime in the rock, or may be engineered to produce a desired network structure for particular applications.

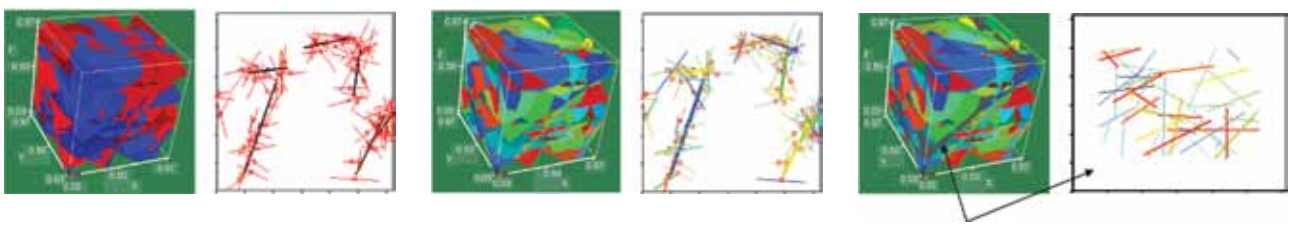
Engineering applications dependent on fractures and fracture networks include hot dry rock enhanced geothermal energy systems in which artificial reservoirs must be created by fracture stimulation to enable the geothermal fluid flow; underground repositories for the safe storage and disposal of hazardous wastes for which potential contaminant transport through surrounding natural fractures must be quantified; underground water transport through aquifers; and movement of oil and gas in hydrocarbon reservoirs. The engineering of fracture networks is also fundamental to the extraction of natural gas from unconventional reservoirs.

The mapping of fracture networks at engineering scale is almost impossible due to the paucity of data on fractures at depth. In this project researchers at the University of Adelaide pioneered the innovative use of stochastic rock fracture modelling which may be informed by sparse data of direct or indirect observations of the rock mass such as that obtained in drill cores, borehole imaging, geophysical surveys or seismic monitoring during fracture stimulation.

The essence of the stochastic modelling approach is to treat locations, size, orientation and other properties of the fractures as random variables with inferred probability distributions. An initial fracture model is constructed by Monte Carlo simulation and the model is then refined using various methods developed to take into account available conditioning data and spatial auto and cross-correlations between variables, hence a more realistic fracture model is produced.

Xu,C and Dowd,P (2010). A new computer code for discrete fracture network modelling. *Computers & Geosciences* 36(3): 292-301.

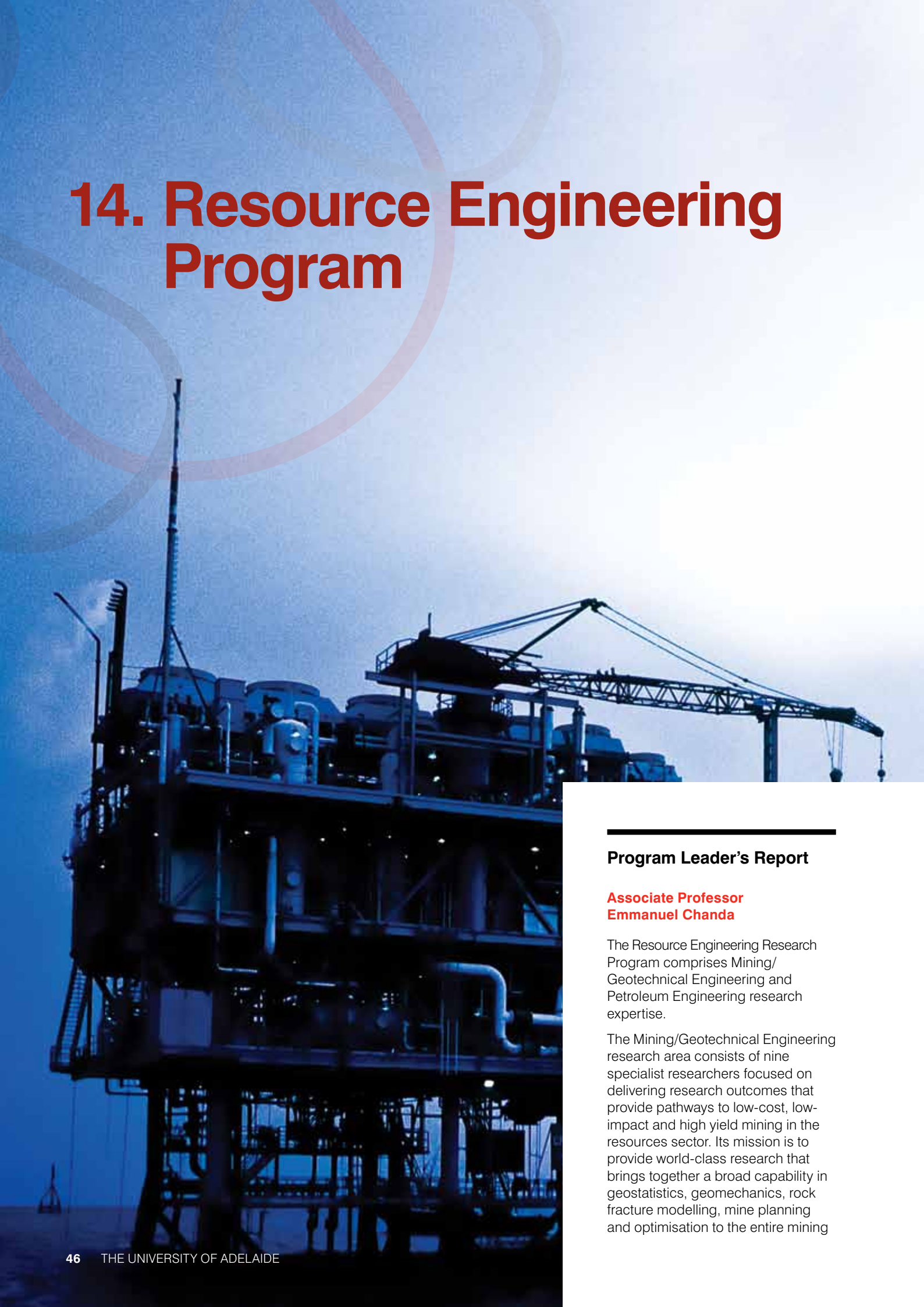
The figure below shows typical outputs from the modeling approach which is able to model the position, size and orientation of the fractures and to construct a three dimensional image of the fracture network (a). From this the permeability of the fracture network may be calculated (b). Permeability is critical to the transport of fluids through the network.



a ***b*** ***c***

3D fracture system | 2D fracture system | Colour coding: permeability | Line thickness: frature apperture; Colour coding: surface roughness | 2D sampling plane | Traces of fracture intersections with the sampling plane

14. Resource Engineering Program



Program Leader's Report

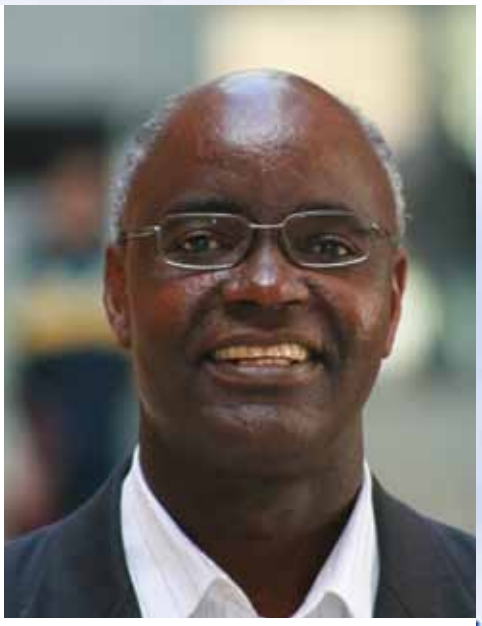
Associate Professor Emmanuel Chanda

The Resource Engineering Research Program comprises Mining/ Geotechnical Engineering and Petroleum Engineering research expertise.

The Mining/Geotechnical Engineering research area consists of nine specialist researchers focused on delivering research outcomes that provide pathways to low-cost, low-impact and high yield mining in the resources sector. Its mission is to provide world-class research that brings together a broad capability in geostatistics, geomechanics, rock fracture modelling, mine planning and optimisation to the entire mining

process. This can result in more accurate models of ore from ground to mill, which increases extraction and processing efficiencies. It also offers more effective mine planning and optimisation which can improve production efficiency and reduced operating costs. Researchers in this area also seek to offer more realistic geomechanical models of mines which enhance the accuracy of mine design and operational safety.

Collaborations with the Deep Exploration Technologies CRC (DET CRC) are a critical part of research life in mining research at the University of Adelaide. Mining research contributes to two research projects in DET CRC: 'Fundamentals of Rock Tool Interaction' and 'Borehole Stability for Deep Drilling'. Mining research will receive a total of $A419, 000 over the next three years for these projects plus a total of six PhD scholarships.



Research in Petroleum Engineering is focused on five areas:

- Resource assessment and development of new improved recovery technologies for unconventional gas (CSG, shale gas, tight gas) and enhanced petroleum recovery;
- Decision-making under uncertainty, project and portfolio economic evaluation, reliability of expert judgments and uncertainty assessments;
- Fractured reservoir characterisation and automatic history matching;
- Mathematical modelling, laboratory and field studies of formation damage; and
- Analytical, physical and computational models of pore-scale transport processes.

Research funding is sourced through various bodies including the Australian Research Council (ARC), and government partners such as Department of Primary Industries and Resources SA (PIRSA), Government of South Australia. Some of the projects in Petroleum Engineering are also funded through a fee-based 'research consortia' in the Centre for Improved Business Performance.

Highlights

Rock Fracture Modelling Aims for Realistic Simulation

Professor Chaoshui Xu and Professor Peter Dowd

Professor Peter Dowd and Dr Chaoshui Xu won an Australian Research Council (ARC) Discovery grant of $A330,000 for the project 'Stochastic modelling of fractures in crystalline rock masses for hot dry rock enhanced geothermal systems' to commence in 2011. The project aims to develop rock fracture modelling techniques that can realistically simulate the fractured reservoir for hot dry rock enhanced geothermal systems, to investigate the fundamentals of fluid flow and heat transfer within the fracture system and to develop an efficient tool for modelling industry scale geothermal applications. This research program builds upon the existing leading track record of the research team in fracture modelling simulation, see related research highlight.

Modelling of Integrity and Gas Entrapment Offers Clean Energy Application

Professor Pavel Bedrikovetsky, Professor Anthony Roberts and Dr Andrei Kotousov

Professor Pavel Bedrikovetsky was awarded an ARC Linkage grant, also supported by industry partner Santos Ltd, for 'Development of innovative technologies for oil production based on the advanced theory of suspension flows in porous media'.

This project aims to develop a new micro-scale based theory for two-phase flow of suspensions in porous media accounting for non-linear capillary phenomena and to develop and validate criteria for leakage and fracturing of storage sealing. The modelling of integrity and gas entrapment mechanisms in subsurface geological formations will be applied for a number of nationally important activities such as clean energy, effective waste and water management programs.

The team has developed a new analytical model for two-phase flow in porous media accounting for capillary pressure and applied it for interpretation of our own laboratory tests. The model is applied for determination of relative phase permeability for gas-water system in-situ gas storages.

The team has also developed a model for the elastic bulk modulus of low consolidated porous media based on a physical consolidation model of rocks and the classical Hertz contact theory in order to model integrity of CO_2 geo-sequestration reservoirs. A new mathematical model for two-phase flow of suspensions in porous media for CO_2 geo sequestration and for waterflooding have been developed and validated against laboratory tests.

Other projects of interest:

- Development of a non-entry Hydraulic Coal Mining System: *Dr Chaoshui Xu, Associate Professor Emmanuel Chanda, Associate Professor Dzuy Nguyen, Professor Pavel Bedrikovetsky, Dr Manouchehr Haghighi, Dr Colin Randall* - this project aims to develop an integrated non-entry industrial-scale coal mining system capable of cutting coal in-situ within the seam using a specially designed water jet and then pumping the cut coal to the surface.
- Technologies to Increase Oil Production Efficiency: *Professor Pavel Bedrikovetsky, Professor Anthony Roberts, Dr Andrei Kotousov, Associate Professor Phillip Pendleton, Mr Keith Boyle, Mr Jose Rodrigues* - this project aims to develop new technologies to significantly increase the efficiency of oil production based on recent advances and new theoretical models for suspension-colloidal transport and trapping in porous media.

Home Schools

Australian School of Petroleum

School of Civil, Environmental and Mining Engineering

Research Highlight

New Mathematical Models Focus on Colloidal Transport in Porous Media

Professor Pavel Bedrikovetsky

Research team includes:
Professor Pavel Bedrikovetsky

The transport of suspensions and oil/water emulsions in porous media is critical to many environmental, chemical, petroleum and civil engineering applications. The flow of solid particles and liquid oil droplets in underground capillaries may be accompanied by capture and detachment from the rock surface, a process which may eventually, with time, block pores and impede further liquid transport. Particle capture reduces the permeability of the rock. Particle capture may take place with water injection of different salt concentration, inducing fines migration in petroleum reservoirs and aquifers. The permeability change is important for petroleum production because of its effects on well productivity and injectivity. Permeability is also very important in the transport of heated fluids in geothermal applications. Maintaining permeability is also critical to water drainage in soils.

The mathematical modelling of deep bed filtration accounting for particle capture, detachment and pore blockage is essential to the design and operation of these processes. The most commonly-used approach for evaluating fine particle migration, retention and detachment in laboratory and field-scale studies is a solute transport mass balance equation.

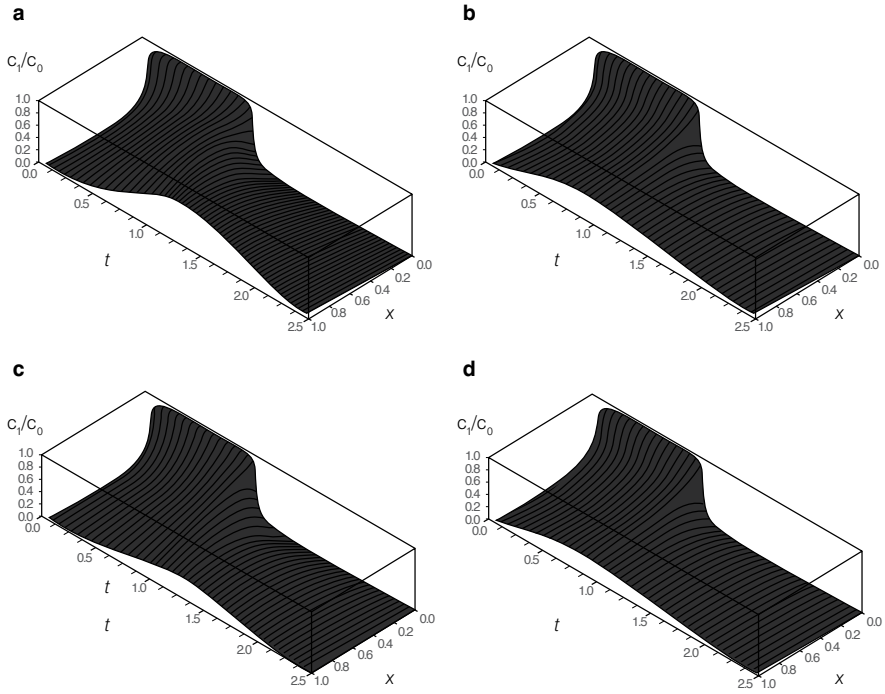
A University of Adelaide researcher* has created a new mathematical model for detachment of particles from rock surfaces. It is based on the mechanical equilibrium of a particle positioned on the surface in the pore space. A balance of hydrodynamic drag, particle lifting and gravitational forces, as well as surface forces acting on the particle and the moving fluid, is considered. The model allows the calculation of the maximum retention concentration, filtration rate and formation damage from the history of the pressure drop across the core during water injection.

In evaluating the model, laboratory tests were undertaken on suspended core-flood with ancillary pressure drop measurements. Sandstone cores were taken from Campos Basin, Brazil, and flooded by poorly-treated water to estimate the decline in well injectivity. The cores were flooded by formation water until the permeability stabilised to avoid the effects of fines migration on the flooding results. Then the cores were flooded by oil. Afterwards, the oil was displaced by filtered seawater until permeability for water was established under conditions of oil saturation. Finally, the injection of the test particle suspension was carried out. The injection rate was maintained constant throughout and the pressure drop across the core as a function of time was measured.

While classical filtration theory assumes simultaneous particle capture and dislodging, in contrast, the proposed model assumes that the particle capture takes place only if the torque for electrostatic and gravitational forces prevails over that for drag and lifting forces. The particle detachment is controlled by the maximum retention concentration function, which is determined by the mechanical equilibrium of the forces acting on the particle surface.

Alteration of either the surface or hydrodynamic forces may cause redirection of the torque away from the surface, resulting in particle detachment.

Typical particle concentration dependences on time and space are shown in the figure at two different dispersion-advection ratios and two different entrapment ratios. Particles are injected with the dimensionless concentration C/C_0 equals one, at time equals zero. Within the range of the parameters under study, the particle to pore ratio did not affect the shapes of the dependences. The behaviour of concentrations at times between 0 and $T_0=1$ where T_0 is the characteristic time based on the volumetric flow rate of fluid, core porosity and length. At $T_0=1$, a pure liquid is injected which changes the interactive force of the particle with the surface, causing particle detachment allowing the particles to move forward in the core. The particle concentration decreases due to dispersion. A higher value of the entrapment ratio leads to a more rapid decrease in particle concentration with time. Physical models of this type may eventually be coupled with chemical models of dissolution and re-precipitation to allow more realistic and predictive description of particle transport in porous media.



Left: Particle concentration dependences on distance, x, and time, t, for the four different cases of the ratio of the dispersion to advection forces and particle capture frequency ratio. The initial concentration of particles and pore diameter is constant in all cases.

* Bedrikovetsky,P, Siqueira,F, Furtado,C., Souza,A. (2010) Modified Particle Detachment Model for Colloidal Transport in Porous Media, *Springer Science+Business Media BV*, published online August 7, 2010.

Shapiro,AA, Bedrikovetsky,P (2010). A stochastic theory for deep bed filtration accounting for dispersion and size distributions. *Physica A: Statistical Mechanics and its Applications* 389(13): 2473-2494.

15. Environmental Impacts of Mineral and Energy Resources Development

Program Leader's Report

Associate Professor Sue Carthew

Expertise to investigate the environmental impact of mineral and energy resources development is drawn from across the School of Earth and Environmental Sciences, and has synergies with the Environment Institute (EI).

The main aim of the Environment Program within IMER is to understand aspects of ecology, biodiversity monitoring and landscape restoration that relate to mineral exploration activities and mining.
Key staff involved are Associate Professor Jose Facelli, Dr John Conran and Associate Professor Sue Carthew.

Mineral exploration and mining are increasing at an unprecedented rate across parts of Australia, and in particular in South Australia. More and more, these activities are occurring in relatively pristine areas – mostly in semi-arid or arid environments that are susceptible to disturbance. So the impacts on the natural system have the potential to be both large and long-term.

The Environment Program aims to ensure that the environmental biodiversity is known and how it is likely to be affected by mining exploration. Researchers also need to understand the important ecosystem processes and how they might be disrupted and then use this knowledge to inform mineral exploration companies. The concept is to avoid or minimise significant impacts and to ultimately restore the ecosystem afterwards. Research in the program is aimed towards these goals, but achieving them is not without challenges. Natural systems are complex and heterogeneous and often little is known about the intact system before exploration and mining.

The research program involves three areas:

- Effects of exploration tracks on both the landscape such as movement of nutrients and materials, compaction, weed invasion and the biota in terms of potential changes to the composition of plant and animal communities. This includes inhibition of movements by animals and changes in animal foraging behaviour;
- Endangered species conservation to understand where species of concern occur, what habitat they require and why and how mining activities might affect them. There are legislative requirements to minimise any detrimental effects on such species;
- Effective restoration post disturbance to assess methods of restoration and their effectiveness and investigate patterns of restoration - particularly in environments where changes can be slow.

Highlights

Conservation and Management of the Sandhill Dunnart

Associate Professor Sue Carthew, Dr Melanie Lancaster, Ms Amanda McLean and Mr Brodie Philp

Australia's recent expansion of the mining industry has led to encroachment on Australian semi-arid and arid zones which have previously been pristine natural environments. As mining activity increases, a range of native species may potentially come under threat.

One such species is the endangered dasyurid marsupial, the Sandhill Dunnart (Sminthopsis psammophila). As very little information is currently known about this species, a detailed management plan has not been implemented.

In order to fill gaps in knowledge, researchers are using a combination of ecological and genetic information collected in the field to assist in the development of an effective management plan for the Sandhill Dunnart. Work is focussing on a core population in the Middleback Ranges of Eyre Peninsula in South Australia, where the species occurs in mallee dune habitat with an understorey of hummock grass (Triodia irritans).

The significance of the project is recognised by both industry and environmental groups with support by OneSteel, Nature Foundation SA, Holsworth Wildlife Research Endowment, Sir Mark Mitchell Foundation, Field Naturalists Society of SA, and Australia and Pacific Science Foundation.

Examination of Tracks in Natural Vegetation

Associate Professor Sue Carthew and Associate Professor Jose Facelli

Recent mineral exploration in South Australia has produced many kilometres of linear clearance (tracks) in areas of natural vegetation. This project addressed the impact of linear disturbance in formerly pristine mallee vegetation on sand dunes in central Eyre Peninsula.

The creation of tracks results in changes in the patterns of transport and retention of materials such as water, nutrients, litter and seeds across the landscape and this is

accentuated by the topography of the region. Consequently the functioning of the ecosystem changes, reflected in the vegetation composition in the disturbed area compared to the undisturbed area. Management conducive to reduce transport of material is essential for the restoration of the system. The study compared disturbed and undisturbed areas and considered typical topographic positions such as dune crest, dune slope and swale in the landscape.

Tracks were sampled and measured considering a range of factors including physical parameters such as soil compaction and chemical characters such as pH and organic carbon.

Other project of interest:

- Seed Biology and Ecology Study: *Dr Leanne Pound* and *Ms Emma Steggles*, aims to study the germination ecology of key species of the system and characterising properties and dynamics of the soil seed bank.

Home School

School of Earth and Environmental Sciences

16. Socio-Economic Impacts of Mineral and Energy Resources Development

Program Leader's Report

Associate Professor John Spoehr

With a range of major resource development and energy projects in the pipeline in South Australia and underway nationally, the demand for high quality socio-economic impact research is growing.

Recognising this, researchers from the Australian Institute for Social Research, Centre for Labour Research and the Business School are establishing new collaborations to better understand the social and economic dimensions of growth and change in two of Australia's major industrial sectors.

The group is fast-tracking the development of new impact assessment capabilities to be able to better respond to the research needs of government, industry and community stakeholders.

Key areas of focus include:

- Socio-economic impacts of mineral and energy resource development including the development of new impact assessment and stakeholder engagement tools (Research leaders: Associate Professor Barry Burgan and Associate Professor John Spoehr);
- Developing better ways of measuring the demand for skills in the mineral and energy resource sectors and understanding the drivers that underpin successful attraction and retention in the sectors (Research leaders: Associate Professor John Spoehr and Mr Simon Molloy).

Home Schools

Australian Institute for Social Research

Business School

Centre for Labour Research

Highlight

OZ Minerals Research Partnership

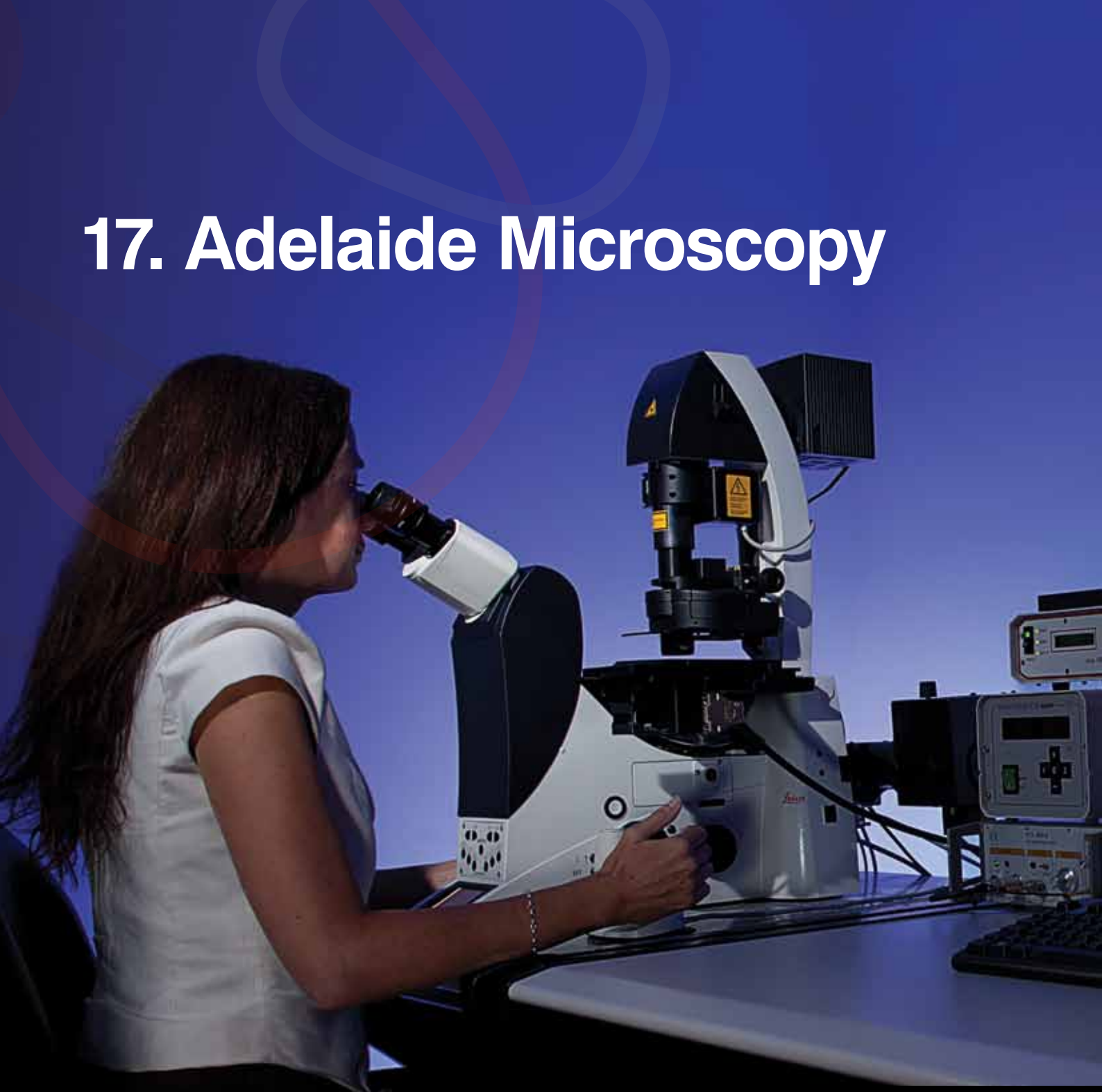
Associate Professor John Spoehr and Dr Ann-Louise Hardacre

The Australian Institute for Social Research (AISR) is working with OZ Minerals to examine the wider socio-economic impacts of its mining operations over the short and longer term.

The first major outcome of the collaboration is a baseline statistical report, Aboriginal People of Central North South Australia, prepared by Associate Professor John Spoehr and Dr Ann-Louise Hordacre. This wide-ranging report identifies key population, health, housing, educational and employment trends for the Aboriginal population in the region. OZ Minerals is using the findings to inform the development of strategies to help increase the participation of Aboriginal people in OZ Minerals' workforce in the region.

The AISR team is working with OZ Minerals to better identify the socio-economic dimensions and impacts of its operations. This includes identifying leading practice approaches to resource development that help ensure that communities share in the benefits of mining while preventing any negative and harmful consequences for different stakeholders and the environment.

17. Adelaide Microscopy



As a leading university in Australia and part of the Group of Eight, the University of Adelaide offers an impressive array of instruments which may be used for research or enhanced training, such as those managed by Adelaide Microscopy.

Director's Report

Mr John Terlet

Adelaide Microscopy is the University of Adelaide's facility for Advanced Microscopy and Microanalysis. It has a comprehensive range of advanced microscopes and micro-analytical instruments.

Adelaide Microscopy services researchers from all of the Centres and Programs encompassed by IMER. It also provides training and teaching opportunities for undergraduate and postgraduate students from within the associated disciplines.

Staffed by a team of professionally-trained practitioners, Adelaide Microscopy offers broad applications skills in the various microscopy techniques. They provide training, advice and assistance to ensure users maximise their usage and research outputs.

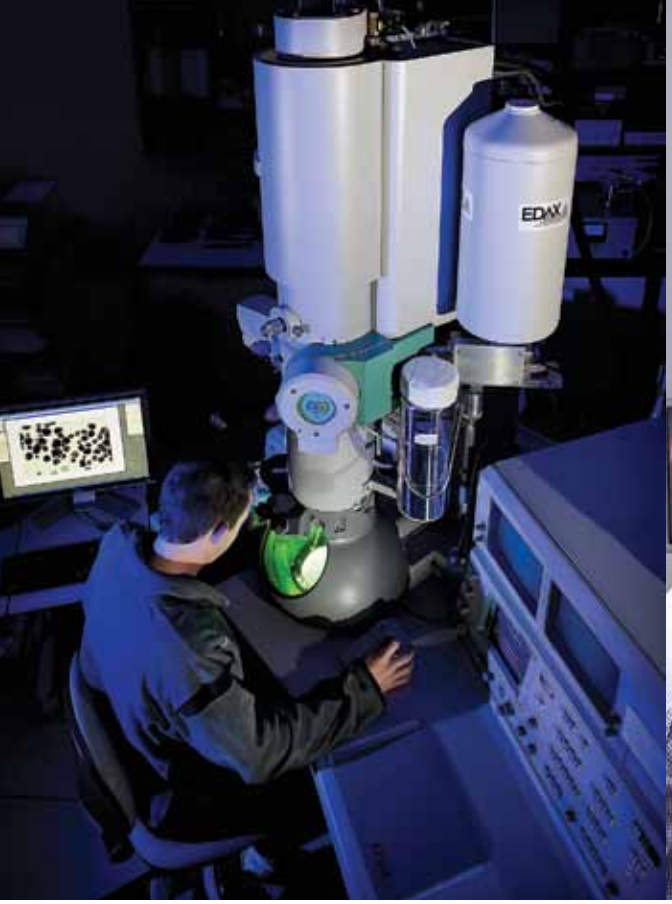
The instrument profile offered by Adelaide Microscopy is constantly evolving in an attempt to have an instrument profile that is commensurate with the research needs of the University of Adelaide and it's collaborators.

The most recent instrument purchases have been a High Resolution Environmental Scanning Electron Microscope, an Electron Probe Micro Analyser, configured for trace element analysis and a Laser Ablation Inductively Coupled Plasma Mass Spectrometer System to be dedicated to trace element imaging. All of these instruments have prime roles in supporting the research of IMER research staff and students, industry groups and research collaborators.

Part of the South Australian Node of the Australian Microscopy and Microanalysis Research Facility (AMMRF), Adelaide Microscopy can also coordinate access to instruments within the AMMRF

nodes that are not available on the University of Adelaide campus.

Adelaide Microscopy works in close collaboration with IMER to ensure the purchase of equipment is able to support existing research and moves quickly to establish support for new and emerging research programs.



Adelaide Microscopy equipment applicable to IMER research areas is as follows:

FEI Helios Dual Beam High Resolution Scanning Electron Microscope/ Focused Ion Beam is used to characterise material and mineral samples in morphology, chemistry or crystalline structure (EBSD) or to prepare thin lamella from site specific areas for Transmission Electron Microscopy.

Laser Ablation Inductively Coupled Plasma Mass Spectrometer (LA-ICP-MS) is used to analyse elemental concentrations and isotopic ratios in material ablated from the surface of solid samples using a pulsed q-switched neodymium doped YAG Laser. This instrument is used for geo-chronology and trace element analysis in environmental samples.

X-ray Microtomography is used to non-destructively image solid samples to create three dimensional images that can be used to determine structure such as pore size and distribution in sandstones and diamond distribution in kimberlites with resolutions down to 3 microns.

CAMECA SX51 Electron Probe Micro-Analyser (EPMA) allows non-destructive quantitative chemical analysis (over the atomic range Boron to Uranium) of flat polished samples. International standards are used to calibrate the instrument and software packages allow the user to define an analytical package to calculate the amounts of elements in the unknown sample. Elemental maps of large areas can be obtained using the scanned stage mode of the instrument.

Phillips XL30 Field Emission Scanning Electron Microscope is used to characterise the morphology of material and mineral samples at high resolution. Electron Back-Scattered Diffraction can be used to study grain size and orientation and the attached cryo-stage can be used to study fully hydrated frozen samples and EDX analysis can be carried out in both modes of operation.

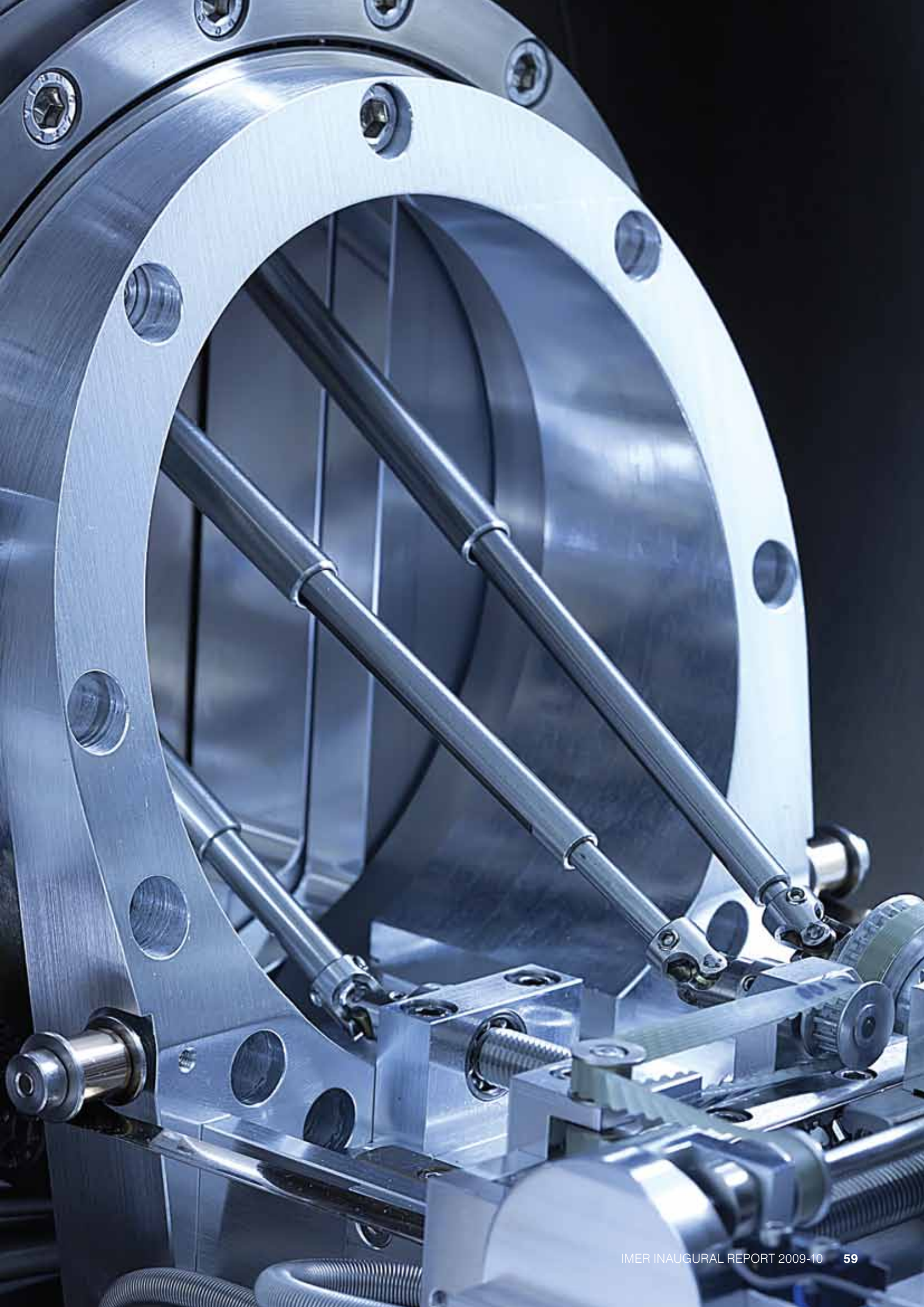
Phillips XL20 Scanning Electron Microscope is used to characterise the morphology of material and mineral samples, the chemistry by EDX analysis and to characterise crystalline structures using Cathodo-luminescence (light produced from the interaction of the electron beam).

Phillips XL40 Scanning Electron Microscope is used to characterise the morphology of material and mineral samples and the chemistry by EDX analysis. This instrument has software packages that allow the instrument to be used to simulate Mineral Liberation Analysis (MLA) on large samples or on a large number of small samples.

200kVolt Transmission Electron Microscope is used to characterise samples and in particular grain boundary chemistry using Energy Dispersive X-ray (EDX) analysis or Parallel Electron Energy Loss Spectroscopy (PEELS).

FEI Quanta 450 Field Emission Environmental Scanning Electron Microscope is used to characterise the morphology of material and mineral samples at high resolution and the chemistry using EDX analysis. In Variable Pressure mode samples can be imaged and analysed without the need for a conductive coating. In Environmental mode fully hydrated samples can be imaged and analysed.

Inductively Coupled Plasma Mass Spectrometer (ICPMS) is used to analyse elemental concentrations and isotopic ratios in dissolved samples with detection limits in the PPB range.



18. Cooperative Research Centres in Mineral and Energy Related Fields of Research

Aim of Cooperative Research Centres (CRCs) at the University of Adelaide

The University of Adelaide houses the leading research activities of three Cooperative Research Centres (CRCs) relevant to research in mineral and energy resources. These are the CRC for Greenhouse Gas Technologies (CO2CRC), Deep Exploration Technologies CRC (DET CRC), and the Energy Pipelines CRC (EPCRC).

While these CRCs have working links into the Centres and Schools affiliated with IMER, it is the intention of IMER to also work directly with the key researchers in these areas to maximise benefits to the CRC researchers, the Institute and the University of Adelaide as a whole.

The Australian Federal Government's CRC Program provides funding to build critical mass in research ventures between end-users and researchers which tackle clearly-articulated, major challenges for the end-users. CRCs pursue solutions to these challenges that are innovative, of high impact and capable of being effectively deployed by the end-users.

Cooperative Research Centre for Greenhouse Gas Technologies

Chief Scientist - Professor John Kaldi

Carbon capture and storage is a hot topic because of its potential to make substantive cuts in CO_2 emissions from large industrial sources such as power stations. The Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC) is one of the world's leading research organisations focused on carbon dioxide capture and storage, or CCS.

CO2CRC collaborates with leading international and national CCS experts to conduct world-class research into carbon capture and storage. Industry partners include global and nationally significant organisations such as Anglo American, BG, BHP Billiton, BP, Chevron, Inpex, KIGAM, Mitsui, QER, Rio Tinto, Sasol, Schlumberger, Shell, Solid Energy, Stanwell, Total and Xstrata.

July 2010 was a significant milestone for CO2CRC, in that it marked the start of the new 2010 to 2015 program. Professor John Kaldi continues as a member of the Executive of CO2CRC, and is its Chief Scientist.

CO2CRC staff at the University of Adelaide are predominantly involved in storage research projects comprising both fundamental and applied areas of research. The prime focus of the research is the selection of storage sites, their adequate characterisation with respect to storage capacity and containment and an understanding of the physical and chemical processes which will take place during and after injection. In addition, the group's research activities provide an understanding of the technologies available for monitoring the movement of stored CO_2 and an assessment of the risks associated with all phases of the process.

Researchers are focusing on the following areas:

- Technologies for assessing sites for CO_2 storage;
- Reservoir and seal characterisation and stratigraphy;
- Geomechanics and petrophysics;
- Geochemistry and hydrodynamics;
- Reservoir engineering; and
- Investigation of onshore and offshore natural analogues for CO_2 geosequestration.

Deep Exploration Technologies Cooperative Research Centre

Research Leader - Professor David Giles

IMER members from the School of Civil, Environmental and Mining Engineering and the School of Earth and Environmental Sciences have been involved in the Deep Exploration Technologies Cooperative Research Centre (DET CRC) since it was launched in November 2010.

The DET CRC facilitates research programs aimed at developing cheaper, safer and more effective methods to drill, analyse and target deep mineral deposits. With $A112 million combined funding, the DET CRC is the world's best-supported independent research initiative in mineral exploration.

Joining the University of Adelaide as inaugural participants in the DET CRC are Barrick Australia Pacific Limited, BHP Billiton Olympic Dam Corporation Pty Ltd, Boart Longyear Company, CSIRO, Curtin University of Technology, Gold Fields Australia Pty Ltd, Newcrest Technology Pty Limited, the Department of Primary Industries and Resources SA (PIRSA), Vale Exploration Pty Ltd, Geoscience Australia and the University of Western Australia.

The strategic objectives of the DET CRC are:

- Significant reduction in time and improvement in effectiveness of drilling;
- Significant improvement in drilling safety and environmental impacts;
- Significant improvement in the quality and timeliness of down hole information;
- Cost effective discovery by developing tools for deeper targeting; and
- Develop techniques to use available 3D knowledge obtained from copious amounts of data currently collected for project management and Life of Mine planning purposes.

Research is focussed on three inter related areas: drilling technology through the development of hard rock drilling technologies to optimise drilling and drill bit and string control; data fusion which includes down-hole and on-site surface technologies that enable data acquisition, interrogation and interpretation in real time; and deep targeting to bring increased understanding of the deep and deeply covered search space for targeting and vectoring towards ore.

Specific projects being undertaken at the University of Adelaide include:

- Joint Inversion of 3D Seismic Data and Magnetotelluric (MT) Data
- 3D Seismic Exploration for Hard Rock Environments
- South Australian Data Integration and Delivery through Mineral Potential Mapping
- Geochemical Sampling of Deep Cover
- Hypogene Alteration

Energy Pipelines Cooperative Research Centre

Program Leader - Associate Professor Peter Ashman

The Australian community is facing a substantial challenge because of increasing financial and carbon constraints that place a clear focus on future energy supplies. Energy pipelines are critical to this future.

There are 30,000 kilometres of high-pressure natural gas transmission pipelines in Australia with a replacement cost of approximately $A40 billion. The energy supplied has a value of $A12 billion, which is about 22 per cent of Australia's energy needs and is more than the combined output of all electricity generators in Australia. It is clear Australia's energy pipeline network will not be able to support the country's economic prosperity in a carbon and finance constrained future unless new technologies are created to extend the life of the existing ageing network and build new pipelines with technologies that are unique to its needs.

The Energy Pipelines CRC (EPCRC) was established in January 2010 to undertake research and education of relevance to the energy pipeline industry in Australia and to address some of these challenges. An extensive research program is linked directly to industrial applications with the aim that new technologies will extend the operating life of the existing energy pipeline network.

Technological innovations will facilitate the construction of new pipeline networks, both for the expanding market of natural gas, and for other emerging energy cycle fluids such as CO_2 and H_2 injected methane.

The focus of the EPCRC is on four research programs: more efficient use of materials for energy pipelines; the extension of safe operating life for both new and existing energy pipelines; advanced pipeline design and construction and public safety and security of supply issues.

Specific projects being undertaken at the University of Adelaide include:

- Corrosion by new energy fluids – potential impact of H_2/CH_4 and CO_2 sequestration mixtures on pipelines regarding corrosion; and
- A feasibility report on future energy media (CH's, H_2, H_2/CH_4 blends, NH_3, liquid metal hydrates).

19. Major Research Projects

Key Major Projects Active in 2009

IMER researchers are involved in a large number of exciting projects involving leading global companies, government and research partners. A huge array of research topics relating to mineral and energy resources fall under the IMER banner.

Here are the key projects active across IMER in 2009.

Centre for Energy Technology

Assessment and optimisation of mixing and aerodynamic characteristics of multi-fuel burners for rotary kilns

Sponsors: *Australian Research Council, FCT Ltd (Fuel and Combustion Technology)*

Chief investigators: *Prof Gus Nathan, Dr Peter Kalt*

Establishment of a large scale wind tunnel facility at the University of Adelaide

Sponsors: *Sir Ross and Sir Keith Smith Fund, Government of South Australia - Premier's Science and Research Fund*

Chief investigators: *Prof Gus Nathan, Dr Cornelius Doolan, Prof John Cheung, Prof Colin Hansen, A/Prof Richard Kelso, Dr Maziar Arjomandi, A/Prof Bassam Dally, A/Prof Benjamin Cazzolato, A/Prof Peter Ashman*

A fully integrated process for biodiesel production from microalgae in saline water

Sponsor: *Asia Pacific Partnership on Clean Development and Climate*

Chief investigator: *A/Prof Peter Ashman*

Hybrid cooling for coal fired power stations

Sponsor: *Australian Research Council*

Chief investigator: *A/Prof Eric Hu*

Innovative grid-connected, small-scale wind turbine generators offering low cost and wide operating speed range

Sponsor: *Australian Research Council*

Chief investigators: *A/Prof Wen Soong, A/Prof Nesimi Ertugrul*

Investigating the coupled dependencies of soot in turbulent flames by advanced laser diagnostics and modelling

Sponsor: *Australian Research Council*

Chief investigators: *Prof Gus Nathan, A/Prof Bassam Dally*

A novel approach to controlling boundary-layer separation

Sponsor: *Australian Research Council*

Chief investigator: *Dr Jim Denier*

Optimum rotor and concentrated stator-winding structures for improving the torque, filed-weakening and power-density characteristics of interior permanent-magnet machines

Sponsor: *Australian Research Council*

Chief investigator: *A/Prof Wen Soon*

Technical and geographical based studies in support of the Advanced Seaplane Project

Sponsor: *South Australian Government - Strategic Initiative Fund*

Chief investigator: *A/Prof Bassam Dally*

Topological optimisation of fluid mixing

Sponsor: *Australian Research Council*

Chief investigator: *Dr Matthew Finn*

Centre for Tectonics, Resources and Exploration

Bacterial mechanisms of gold mobilisation and precipitation with applications to mineral processing and exploration

Sponsors: *Australian Research Council, Barrick Gold of Australia Ltd, Commonwealth Scientific and Industrial Research Organisation, Newmont Australia, South Australian Museum*

Chief investigator: *Prof Joel Brugger*

Characterisation of Adelaidean rocks as potential geothermal reservoirs

Sponsor: *Primary Industries and Resources SA, Government of South Australia*

Chief investigator: *Prof Bruce Ainsworth*

Compressional deformation and uplift of australia's passive southern margin

Sponsor: *Australian Research Council*

Chief investigators: *Dr Simon Holford, Prof Richard Hills*

Crustal stress field of South East Asia

Sponsor: *Australian Research Council*

Chief investigator: *Dr Mark Tingay*

The geochemistry of tellurium in hydrothermal environments and the Gold-Tellurium association

Sponsor: *Australian Research Council*

Chief investigator: *Prof Allan Pring*

The initiation of early palaeozoic subduction in eastern Australia and North America: causes and effects

Sponsor: *Australian Research Council*

Chief investigators: *Prof John Foden, Dr Bruce Schaefer*

Lake Eyre Basin Analogues Research Group- LEBARG Consortium Phase 2

Sponsors: *Anadarko Petroleum Corporation, BP Australia, BG Group, BHP Billiton, Chevron Corporation, ExxonMobil, Shell, Woodside Energy Ltd*

Chief investigator: *Dr Kathryn Amos*

Minerals replacement reactions: understanding mineral formation under hydrothermal conditions

Sponsor: *Australian Research Council*

Chief investigators: *Prof Joel Brugger, Prof Allan Pring*

Molecular structure and transport properties of hydrothermal fluids under extreme conditions: near-critical, high salinity, high pressure and high volatile contents

Sponsor: *Australian Research Council*

Chief investigator: *Prof Joel Brugger*

Present-day stress and tectonics of deltas and deepwater fold-thrust belts

Sponsor: *Australian Research Council*

Chief investigators: *Dr Mark Tingay, Prof Richard Hills*

Reservoir architecture and heterogeneity in marginal marine systems - *WAVE* Consortium Phase 1

Sponsors: *Chevron Corporation, ConocoPhillips, Badr Petroleum Co., BHP-Billiton, Nexen, OMV, Shell, Statoil, Todd Energy, Woodside Energy Ltd*

Chief investigator: *Prof Bruce Ainsworth*

Resistivity of typical rocks at crustal pressure and temperature conditions from combined laboratory and magnetotelluric measurements

Sponsor: *Australian Research Council*

Chief investigator: *Dr Kate Selway*

South Australia's access to the Australian synchrotron

Sponsor: *Government of South Australia - Strategic Initiative Fund*

Chief investigator: *Prof John Carver*

Tectonic links between the Musgrave Province and the North Australian Craton: correlations, event chronology, and tectonothermal regimes.

Sponsor: *Australian Research Council*

Chief investigator: *Dr David Kelsey*

The thermal evolution of peninsula India: Past behaviours and future potential

Sponsor: *DIISR Australia - India Strategic Research Fund*

Chief investigator: *A/Prof Alan Collins*

Three-dimensional magnetotelluric imaging of lithospheric-scale mineral systems from source to deposit

Sponsors: *Australian Research Council, BHP Billiton, Teck Cominco Australia Pty*

Chief investigators: *Prof Graham Heinson, Prof David Giles*

The South Australian facility for small and large molecule x-ray diffraction structure determination

Sponsors: *Australian Research Council Linkage Infrastructure Grants, Flinders University, Institute of Medical and Veterinary Science (IMVS), South Australian Museum, University of South Australia*

Chief investigators: *Prof John Carver, Prof Allan Pring, Prof Joel Brugger*

Centre for mineral exploration under cover in South Australia

Sponsor: *Primary Industries and Resources SA, State Government of South Australia*

Chief investigator: *Prof David Giles*

Unearthing the marginal terranes of the South Australian Craton: keystone of Proterozoic Australia

Sponsor: *Australian Research Council*

Chief investigator: *Prof David Giles*

South Australian Centre for Geothermal Energy Research

Development of The Geothermal Research Facility

Sponsor: *State Government of South Australia, Primary Industries and Resources SA*

Chief investigator: *Prof Martin Hand*

South Australian Centre for Geothermal Energy Research 2009/10 to 2010/11

Sponsor: *Department of Premier and Cabinet – RenewablesSA*

Chief Investigator: *Prof Peter Dowd*

Three-Dimensional Imaging Supported By Industry

Sponsors: *BHP Billiton and Teck Cominco Australia*

Chief investigators: *Professor Graeme Heinson and Professor David Giles*

A three-dimensional lithospheric-scale image of the 1590 million year old mineral system responsible for the formation of the giant Olympic Dam deposit will be produced in this industry-supported project.

It is the first time that the deposit, located in the eastern Gawler Craton in South Australia, will be imaged in 3D from the upper mantle to the surface. This offers far-reaching implications for mineral exploration. Using 3D magnetotellurics (MT), the electrical resistivity structure of the Craton will be mapped. The project is a collaboration between the University of Adelaide, BHP Billiton and Teck Cominco Australia.

Many large mineral deposits are intimately associated with crust and possibly upper mantle penetrating structures that either provide a direct link between deep source regions and the near surface or allow for the advection of magma, heat and fluids that drive near surface mineralising systems. Surface geology is inherently two dimensional in the horizontal plane and most geophysical surveys are conducted along transects, providing limited depth information. Full, three-dimensional volumetric information is necessary to develop a detailed understanding of the spatial aspects of mineralising systems. MT has been shown to image crustal conductive volumes associated with mineral deposits at crustal and possibly mantle depths.

Environmental Impacts Of Mineral and Energy Resources Development Program

Allocating water and maintaining springs in the Great Artesian Basin

Sponsor: *South Australian Arid Lands Natural Resources Management Board*

Chief investigator: *A/Prof Sue Carthew*

Discovering the past and present to shape the future: networking environmental sciences for understanding and managing Australian biodiversity

Sponsors: *Australian Museum, Australian National University, Australian Research Council, Bureau of Meteorology Research Centre, CSIRO Entomology, CSIRO Marine Research, CSIRO Plant Industry, Charles Darwin University, Department of the Environment, Water, Heritage and the Arts, Flinders University, James Cook University, La Trobe University, Macquarie University, Massey University, Monash University, Oxford University, Queen's University, Belfast, South Australian Museum, Southern Cross University, University of California at Berkeley, University of Canberra, University of Colorado at Boulder, University of Melbourne, University of Queensland, University of Sydney, University of Tasmania, University of Wollongong, Western Australian Herbarium*

Network convener: *Prof Richard Hills*

Environmental Genomics: Mining, climate change, water, crime and health

Sponsors: *Australian Federal Police Partnership, Australian Genome Research Facility, Australian Research Council Linkage Project Grants, Biomatters Ltd, NZ, DENR Research Grant, PIRSA Partnership, South Australian Museum Partnership, South Australian Water Partnership, AU Australian Research Council Internal Funding*

Chief investigators: *Prof Alan Cooper, Prof Dave Adelson, Prof Barry Brook, A/Prof Jose Facelli*

Resource Engineering Program

Centre for improved business performance

Sponsor: *ESSO Australia Pty Ltd, Santos Ltd*

Chief investigator: *Prof Steve Begg*

Institute of Mineral and Energy Resources (IMER)

Sponsor: *Department of Premier and Cabinet, Government of South Australia.*

Chief investigator: *Prof Peter Dowd*

Socio-Economic Impacts of Mineral and Energy Resource Development Program

Plausible futures for economic development and structural adjustment – impacts and policy implications for Indonesia and Australia

Sponsor: *Australian Centre for International Agricultural Research*

Chief investigator: *Prof Christopher Findlay*

Key Major Projects Active in 2010

These are new projects that were initiated in 2010 only. Projects active in 2009 and which continued into 2010 are not duplicated here.

Centre for Energy Technology

The Adelaide Airport Limited Industry Partnership

Sponsor: *Adelaide Airport Limited*
Chief investigator: *Prof Gus Nathan*

Detailed understanding of the behaviour of soot in, and emission from, turbulent flames and fires

Sponsor: *Australian Research Council*
Chief investigators: *Prof Gus Nathan, A/Prof Bassam Dally*

Distributed magnetorheological fluid damper for alleviating buffet-induced tail vibrations in aircraft

Sponsor: *Australian Research Council*
Chief investigator: *Dr Lei Chen*

Energy from microalgae - industrial scale development and downstream processing of co-products

Sponsors: *Australian Research Council, Flinders University, SQC Pty Ltd*
Chief investigators: *Dr David Lewis, A/Prof Peter Ashman*

Feasibility report on future energy media (CH's, H_2, H_2/CH_4 blends, NH_3, liquid metal hydrates)

Sponsor: *Asia Pacific Partnership on Clean Development and Climate (APP)*
Chief investigator: *A/Prof Peter Ashman*

The mechanics of quiet airfoils

Sponsor: *Australian Research Council*
Chief investigators: *Dr Cornelius Doolan, Prof Colin Hansen*

Novel technologies for biodiesel production from meat processing waste streams

Sponsors: *Australian Research Council, Dalriada Meat Pty Ltd*
Chief investigator: *A/Prof Brian O'Neill*

Scramjet-based access-to-space systems

Sponsor: *Department of Innovation, Industry, Science and Research*
Chief investigator: *Dr Cornelius Doolan*

Ultrasound for control of cyanobacteria

Sponsors: *Australian Research Council, Australian Water Quality Centre, Melbourne Water Corporation United Water International Pty Ltd, Water Corporation of Western Australia, Water Quality Research Australia*
Chief investigators: *Dr Carl Howard, Prof Colin Hansen, A/Prof Anthony Zander*

Centre for Tectonics, Resources and Exploration

Constraining conditions and timing of orogeny and reworking in the west Musgrave Province

Sponsors: *Australian Research Council, Curtin University, Geological Survey of Western Australia*
Chief investigators: *Dr David Kelsey, Prof Martin Hand, A/Prof Alan Collins*

Developing world-class trace element micro-analytical imaging facilities for South Australia through key analytical infrastructure advances

Sponsors: *Premier's Science and Research Fund, Government of South Australia*
Chief investigator: *Prof Martin Hand*

Development of biosensors and bioindicators for gold exploration and processing in Australia

Sponsors: *Australian Research Council, Barrick Gold of Australia Ltd, Flinders University, Martin Luther-University, Halle-Wittenberg, Newmont Australia, South Australian Museum, University of Nebraska-Lincoln*
Chief investigators: *A/Prof Frank Reith, Prof Joel Brugger, A/Prof Joseph Shapter, Dr Claire Lenehan*

Experimental studies on hydrothermal reaction processes at the molecular level: the role of mineral replacement reactions in ore formation

Sponsor: *Australian Research Council*
Chief investigators: *Prof Allan Pring, Prof Joel Brugger*

The geomicrobiology and (bio) geochemistry of platinum, palladium and rhodium

Sponsor: *Australian Research Council*
Chief investigator: *A/Prof Frank Reith*

Is there a record of collision between 1.60 and 1.57 billion years ago in Australia?

Sponsor: *Australian Research Council*
Chief investigators: *Dr Caroline Forbes, Prof David Giles*

Joint inversion of 3D seismic data and magnetotelluric (MT) data

Sponsor: *Deep Exploration Technologies Cooperative Research Centre*
Chief investigator: *Prof Graham Heinson*

Locating groundwater resources for Aboriginal Communities in remote and arid parts of South Australia

Sponsor: *Australian Society for Exploration Geophysicists*
Chief investigator: *Prof Graham Heinson*

A new e-science centre enabled by cloud computing

Sponsor: *Microsoft Research*
Chief investigator: *Dr Craig Mudge*

High performance electron microprobe facility for microanalysis of sulphides and heavy metals

Sponsors: *BHP Billiton Olympic Dam, Monash University, Flinders University, University of South Australia*
Chief investigators: *Prof Joel Brugger, Prof Martin Hand*

Sonic drilling equipment to provide contamination-free core sampling of rocks and unconsolidated sediments

Sponsors: *University of Wollongong, Australian Nuclear Science and Technology Organisation, Griffith University, Macquarie University*
Chief investigators: *Dr Rachel Nanson, Dr Kathryn Amos, Prof Alan Collins*

Three-dimensional magnetotelluric and controlled-source electromagnetic modelling and inversion in isotropic and anisotropic media with Gaussian Quadrature Grids

Sponsor: *Australian Research Council*
Chief investigator: *Prof Graham Heinson*

3D seismic exploration for hard rock environments

Sponsor: *Deep Exploration Technologies Cooperative Research Centre*
Chief investigator: *Prof David Giles*

Geochemical sampling of deep cover

Sponsor: *Deep Exploration Technologies Cooperative Research Centre*
Chief investigator: *Prof David Giles*

Hypogene alteration

Sponsor: *Deep Exploration Technologies Cooperative Research Centre*
Chief investigator: *Prof David Giles*

Reconnaisannce thermal mapping for uranium and geothermal exploration

Sponsor: *Government of South Australia, Department of Primary Industries and Resources SA*

Chief investigator: *Prof David Giles*

South Australian data integration and delivery through mineral potential mapping

Sponsor: *Deep Exploration Cooperative Research Centre*

Chief investigator: *Prof David Giles*

Resource Engineering Program

Development of innovative technologies for oil production based on the advanced theory of suspension flows in porous media

Sponsors: *Australian Research Council, Santos Ltd*

Chief investigators: *Prof Pavel Bedrikovetsky, Prof Anthony Roberts, Dr Andrei Kotousov*

Modelling the capillary entrapment phenomena and integrity of geological reservoirs for clean energy, water and waste management technologies

Sponsor: *Australian Research Council*

Chief investigators: *Prof Pavel Bedrikovetsky, Dr Andrei Kotousov*

Socio-Economic Impacts of Mineral and Energy Resource Development Program

Structural reform, services and logistics – building policy making capacity in APEC

Sponsor: *Australian Agency for International Development*

Chief investigator: *Prof C Findlay*

Baseline study of Aboriginal People of central north South Australia and increased mining activity

Sponsor: *OZ Minerals*

Chief investigator: *John Spoehr*

Laser Diagnostic Techniques Used to Develop Improved Kiln Burners

Sponsors: *Australian Research Council, FCT Ltd (Fuel and Combustion Technology)*

Chief investigators: *Professor Gus Nathan, Dr Peter Kalt*

This project, in conjunction with local Australian company FCT-Combustion, aims to increase the use of and performance of alternative fuels in rotary kiln burners through improved understanding of the mixing and aerodynamic characteristics of two-phase flows.

Rotary kilns for the production of cement, lime and other minerals, are increasingly seeking to use alternative fuels such as waste and low-grade biomass to reduce their energy input costs. Being nominally greenhouse neutral, these fuels also reduce greenhouse gas emissions by displacing fossil fuels. However, their use also presents significant technical challenges.

The research program has used a novel laser diagnostic and imaging technique developed by Centre for Energy Technology researchers, planar nepheleometry. Experiments were conducted in a unique two-phase flow facility to investigate, under isothermal conditions, how the distribution of particles, and in particular instantaneous particle clusters, changes with different burner arrangements. This has resulted in the development of novel burner designs for improved combustion of alternative fuels, which will be deployed and tested by the industry partner.

20. Staff

Institute Staff

Executive Director

Professor Stephen Grano
PhD, University of South Australia;
MSc, University of South Australia;
BEng (Hons), University of Queensland
Minerals processing

Deputy Directors

Professor Gus Nathan
Director, CET
PhD, BEng (Hons), University of Adelaide
Combustion, fluid mechanics and renewable energy

Professor Martin Hand
Director, SACGER
PhD, Undergraduate, University of Melbourne
Geology, geothermal energy and tectonics

Institute Manager

Dr Jordan Parham
PhD, BEng (Hons), University of Adelaide
Energy systems and combustion

Senior Administrator

Ms Anne Oprean

Centre Directors

Director, CET

Professor Gus Nathan
PhD, BEng (Hons), University of Adelaide

Combustion, fluid mechanics and renewable energy

Deputy Director, CET

Associate Professor Bassam Dally
PhD, University of Sydney; BSc Technion University, Haifa
Combustion, heat transfer and energy systems

Director, TRaX

Associate Professor Nigel Cook
PhD, BSc, University of London
Geology and mineralogy of sulphide ore deposits

Deputy Director, TRaX

Dr Simon Holford
PhD, University of Birmingham;
BSc (Hons), Keele University
Petroleum geoscience, basin analysis, tectonics

Director, CMXUC

Professor David Giles
PhD, BSc (Hons), Monash University
Mineral exploration

Director, SACGER

Professor Martin Hand
PhD, University of Melbourne;
BSc, University of Newcastle
Geology, geothermal, tectonics

Deputy Director, SACGER

Dr Yung Ngothai
PhD, BEng, RMIT University
Minerals science, rheology

Program Leaders

Resource Engineering Program

Associate Professor Emmanuel Chanda
PhD, Technical University of Berlin;
MEng, Colorado School of Mines;
BSc, University of Zambia
Mine planning and design, process optimisation

Associate Professor Peter Ashman
PhD, MEng, BEng, University of Sydney
Microalgae, combustion, coal and geothermal energy

Professor Bruce Ainsworth
PhD, University of Liverpool; MSc McMaster Universit; BSc (Hons), Imperial College
Sedimentology, sequence stratigraphy

Socio-Economic Impact of Mineral and Energy Resources Development Program

Associate Professor John Spoehr
PhD, University of South Australia;
BEcon, University of Adelaide
Economic development

Associate Professor Barry Burgan
BEcon (Hons)
Project and policy evaluation

Professor Christopher Findlay
PhD, MEcon, Australian National University; BEcon (Hons), University of Adelaide
Reform and industrialisation of the Chinese economy

Environmental Impact of Mineral and Energy Resources Program

Associate Professor Sue Carthew
PhD, MSc, BSc (Hons), University of Wollongong
Conservation biology

Associate Professor Jose Facelli
PHD, BSc, University of Adelaide
Plant ecology

CRC Leaders

Chief Scientist, CO2CRC

Professor John Kaldi
PhD, Cambridge University; MSc, BSc, City University of New York
Carbon capture and storage

Research Leader, DET CRC

Professor David Giles
PhD, BSc (Hons), Monash University
Mineral exploration

Program Leader, Energy Pipelines CRC

Associate Professor Peter Ashman
Deputy Head of School of Chemical Engineering
PhD, MEng, BEng, University of Sydney
Microalgae, combustion, coal and geothermal energy

Staff Members

Professors

Pavel Bedrikovetsky
PhD, MSc, BEng, Moscow Gubkin Petroleum University
Mathematical modelling for formation damage, waterflooding and IOR/EOR

Steve Begg
Head, Australian School of Petroleum Engineering
PhD, BSc (Hons), University of Reading
Decision making and project economics

Mark Biggs
Head, School of Chemical Engineering
PhD, University of Adelaide;
BEng (Hons), University of NSW
Nanoporous carbons and multiphase fluids

Barry Brook
Sir Hubert Wilkins Chair of Climate Change, Also affiliated with Environment Insitute
PhD, BSc (Hons), Macquarie University
Climate change

Joel Brugger
Australian Research Council QEII Fellow
PhD, University of Basel
Experimental geochemistry, mineralogy, spectroscopy

David Chittleborough
Executive and Advisory Board of Water Research Centre, also affiliated with Environment Institute
PhD, University of Adelaide;
Soils and water quality

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Executive Dean, Faculty of Engineering, Computer and Mathematical Sciences
PhD, University of Leeds; MScA, Ecole Polytechnique de l'Universite de Montreal; BSc (Hons), University of New England
Geostatistics and mathematical geosciences

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Geology and trace elements geology

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PhD, BEng (Hons), University of Adelaide
Acoustics; aeroacoustics; noise and vibration control

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Electromagnetic and electrical geophysics

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Geochemistry and petroleum systems

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Combustion and laser diagnostics

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PhD, MSc, University of Chicago; BSc,Massachusetts Institute of Technology
Laser physics and optical desig

Jonathan Pincus
PhD, Stanford University; BEcon (Hons), University of Queensland
State taxes and fiscal equalizationn

Ian Plimer
PhD Macquarie University; BSc (Hons) University of New South Wales
Mining geology and mineral exploration

Stephen Priest
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Rock engineering, mineral economics and mine design

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BSc Monash; PhD Cambridge; ScD Cambridge
Mineralogy and experimental geochemistry

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Mine design, mineral economics and geostatistics

Associate Professors

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PhD, MSc, BSc, University of Arizona
Rocks and geological events

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PhD, University of Edinburgh;
BSc (Hons), University of London
Tectonics and geochronology

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PhD, University of NSW; BSc (Hons), University of Melbourne
Advanced fluid dynamics, fluid mixing

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PhD University of Glasgow; BEng (Hons), University of Adelaide
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PhD, University of Sussex; BSc, Al Mustansiriyah University
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PhD, BSc (Hons), University of Queensland
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PhD, Georg August University; DipSc, the Australian National University
Trace element geochemistry and mineral exploration

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Computational fluid dynamics

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Geothermal energy, tectonics, geomechanics, overpressure, mud volcanoes

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Climate change and renewable energy law

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Lecturers

Dr Kathryn Amos
PhD, University of East Anglia; BSc, (Hons), Imperial College, University of London
Dryland and sub-marine sedimentology

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BEng, University of Melbourne
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BSc (Hons) University of Adelaide
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PhD, Hong Kong University of Science and Technology; BEng, University of Hong Kong
Biomass energy and combustion

Dr Trent Mattner
PhD, BEng, University of Melbourne
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PhD, University of New South Wales; PhD, ME, BE, Yerevan State Polytechnic University
Mining and geotechnical engineering

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PhD, University of New South Wales; BSc (Hons), University of Wollongong
Fluvial and coastal geomorphology

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Geochemistry and geochronology; evolution of the earth's crust

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Evolution of the earth

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Fluid mechanics, laser diagnostics and combustion

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Combustion and advanced laser diagnostics

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Combustion and gasification of solid fuels

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Fluid mechanics

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Sedimentology

Dr Matthew Tetlow
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Aerospace propulsion, high speed aerodynamics

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PhD, University of Adelaide; BEng, Chengdu University of Technology
Wave modelling

Research Associates

Dr Graham Baines
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Potential field geophysics

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PhD, University of South Hampton; B.Mech.E (Hons), BSc (Hons), University of Melbourne
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Detection and quantitative modelling

Dr Cristiana Ciobanu
PhD, BSc, University of Bucharest
Mineralogy and geochemistry

Dr Nicolas Coniglio
PhD, BAM and Otto-von-Guericke Universit; BEng, Ecole Centrale de Nantes
Welding and metallurgy

Dr Robert Dart
PhD, University of Adelaide, BSc (Hons), University of South Australia
Regolith geology and geochemistry

Dr Robert Dickinson
PhD, University of Waterloo; MSc, University of Guelph; BEng, University of Melbourne
Systems design

Dr Barbara Etschmann
PhD, BSc (Hons), University of Western Australia
X-ray absorption spectroscopy

Dr Caroline Forbes
PhD, MSc, BSc, Monash University
Proterozoic tectonics

Dr Pascal Grundler
PhD Chemistry, Ecole Polytechnique Federale de Lausanne; Diploma in Chemistry, University of Lausanne
Coordination chemistry, physical chemistry, geochemistry

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PhD, BSc (Hons), University of Adelaide; BSc, Flinders University
Fluid mechanics, operations research, hydrology

Dr Timothy Lau
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Fluid dynamics

Dr Rosemarie Mohais
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Fluid Flow and Heat Transfer

Mr Alexander Musson
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Thermal geophysics, geothermal geology

Dr Stephen Pahl
PhD, BEng (Hons), University of Adelaide
Industrial bioprocessing and biotechnology

Dr Kate Selway
Research Associate
PhD, BSc (Hons), University of Adelaide
Proterozoic collision

Dr Ulrike Schacht
PhD, University of Kiel; MSc, BSc, Technical University of Berlin
Siliciclastic reservoir quality and diagenesis

IMER's mission is to be globally recognised as a centre of excellence for fundamental and applied research, innovation, and technology transfer in mineral and energy resources.

Dr Stephan Thiel
PhD, BEng, University of Adelaide; MEng, Freiberg University of Mining and Technology
Electromagnetics and geothermal exploration

Dr Adrian Tuitt
PhD, BSc (Hons), University of Edinburgh
Seismic interpretation and numerical modelling

Dr Philip van Eyk
PhD, BE, Hons, BSc, University of Adelaide
Combustion and gasification of low-rank coals and biomass

Dr Matthew Welsh
PhD, BA (Hons), BSc (Hons), University of Adelaide
Psychology of decision-making

Dr Zhenjiang You
PhD, BEng, Zhejiang University
Fluid mechanics and heat transfer

Dr Carla Zammit
PhD, BSc (Hons), Curtin University
Environmental microbiology and molecular genetics

Dr Manfred Zockel
Visiting Researcher
PhD, MEng, University of Adelaide
Thermodynamics, engines, design and manufacturing

21. Postgraduate Students

Current postgraduate students supervised by IMER members relevant to core IMER research areas and priorities.

Maqsood Ahmad
Coal Bed Methane and Enhanced Oil and Gas Recovery Techniques

Udeni Bandara Amarasinghe
Structural, Geochronological and Metamorphic Evolution of the Wanni Complex, Sri Lanka

Mohd Aftar Abu Bakar
Wavelet Spectral Analysis of Dynamical System for Ocean Energy

Syaiful Bakhri
Development of an On-Line Condition Monitoring System

Witold Bloch
Inorganic Coordination Materials for Energy Harvesting and Energy Storage Applications

Kate Bradbury
A Legal Regime for Ocean Energy: An Analysis of the Legal Issues Associated with Offshore Renewable Energy and the Formulation of Appropriate International and Domestic Legal Mechanisms for its Deployment

Rachael Brick
The Formation and Exhumation of the World's Oldest Eclogites

Katherine Bron
The Petroleum Prospectivity of Australian Impact Structures and Related Sediments and Their Influence on Petroleum Systems

Belinda Bruza
Investigating Cognitive Processes Underlying Decision-Making Biases

Guiqin Cai
Understanding and Modelling Metabolic Flux Network of Hydrogen Fermentation

Shaun Chan
Soot Evolution in Non-Premixed Flames

Xin Chen
Heterotrophically Grown Microalgae as a Feed Source for the Australian Aquaculture Industry

Yang Chen
Controlled Supramolecular Assembly in Aqueous Molecular and Macrosotis Systems

Robert Cirocco
A Parasitic Plant for Weed Management: Factors Governing the Nature of the Association Between Cassytha sp. and their Hosts

Scott Clafton
Conjugated Polymer Nanoparticles

Christopher Colyer
Positron and Electron Impact Ionisation of Biomolecules

Stephen Coward
Estimation of Metallurgical Recovery Factors for Kimberlitic Deposits

Rachel Crees
Cataltncally Active Metal-Organic Frameworks Derived from N-Heterocyclic Carbene Ligands

Kathryn Cutts
Metamorphic Analysis of Proterozoic Terrains in Rodinia

Tess Dance
Reservoir Characterisation for CO_2 Storage

Meridith-Maya Legras Dharmarajah
Plantimum, Palladium and Rhodium Mobility in Soils with Application in Ecotoxicology and Mineral Exploration

Byron Dietman
Regolith Expressions and IOGC Mineralisation

Rian Dutch
Gawler Craton Tectonics, Geochron and Metamorphic Geology

Sally-Anne Edwards
Reservoir Characterisation for CO_2 Geosequestration

Tze Foo
Optical Fibre Chemical Sensor for Potassium, Nitrate and Phosphate

Melissa Fraser
Drainage of Vertosols: Effects to Sodicity Development in South East, South Australia

Alexander Gentleman
Laser Spectroscopy of Mixed Transition Metal Clusters

Emanuelle Gerlach
Incorporating Native Ground-Cover Plant Species in Revegetation Projects

Brad Gibson
Application of Dielectric Barrier Discharge Plasma Flow Augmentation for Viscous Drag Reduction

Peter Glasby
Investigating Exploring Late Quaternary Environments in the Flinders Ranges Using Microfossils and Stable Isotopes of Tula and Shells

Cristobal Gonzalez
Synthesis and Study of Novel Sensors for Cation and Anion Binding

Mark Greenhalgh
3D Electrical Modelling and Inversion

Martin Griessmann
Gold-basemetal Mineralisation in the Adelaide Foldbelt

Philip Hall
Neoproterozoic and Early Cambrian Petroleum Systems of South Australia: Their Geochemical Signatures and Paleoenviromental Significance

Mohammad Hamedani
Alteration and Mineralisation in the Curnamona Craton and Broken Hill Region

Justin Hardi
Investigation of Rocket Engine Combustion

Robert Hardy
Photo-ionisation and Density Functional Theory Studies on Gas Phase Gold-Cerium Oxide Clusters

Mohd Hashim
An Autonomous Mobile Robot Navigating System

Michael Hatch
The use of Shallow Geophysical Techniques to Help Characterise Hydrological Parameters

Courtney Hollis
Synthesis and Study of Novel Sensors for Cation and Anion Binding

Li-Jen Hsu
Laser Diagnostics of Metal Elements in Presence of Strong Emission Environments

Mohammad Ibrahim
Power Systems and Electronics

Kent Inverarity
Groundwater Geophysics

Azma Ismail
Applied Limnology

Ashlyn Johnson
Palaeo Landscape Reconstruction of South Australia

Richard Jones
Aeroacoustic Shape Optimisation for Aerofoil Trailing Edge Noise

Maisara Kadir
Investigation of Amino Acids Thiourea Ligand and Their Metal Complexes

Theo Kalaitzidis
Harvesting Microalgae for Biofuel Feedstock from Wastewater

Timothy Welch Kelly
Climate Change Policy

Kumphon Kumnerdsiri
Controls on Structural and Stratigraphic Architecture of Miocene Succession, South Bongkot Gas Field, Gulf of Thailand: Implication for Hydrocarbon Unitisation

Gideon Kuncoro
Geochemistry, Corrosion and Scaling in Hot Dry Rock Energy Extraction Systems

Lex Lambeck
Basin Analysis and the Geochemical and Isotopic Signature of Daleoproterozoic Sedimentary Successions in Northern Australia

Gernot Loidl
Geology and Geochemistry of the Endeavor Deposit

Justin MacDonald
Structural Geology

Phyllis MacGillivray
Tracking Phenological Shifts and Evolutionary Impacts Due to Climate Change

Elizabeth Maciunas
Dispersal and Niche Partitioning in 3 Species of Cassytha

Rachel Maier
Applications of Marine Magnetotellurics for Petroleum Exploration

Ben McGee
Tectonic Evolution of the Paraguay Belt, Brazil

Yuan Mei
Molecular Dynamic Simulation of Metal Speciation in Ore Fluids

Ali Mirsepahi
Intelligent Techniques to Inverse Heat Transfer Problems

Zeeshan Mohiuddin
Flow Visualisation and Pore Network Modeling of Miscible Displacement with Gravity Domination

Syed Mohsin
Solar Coupling with Combustion

Katherine Moseby
Extinsic and Intrinsic Factors Affection Re-intoduction Success in Arid South Australian

Maung Myo
Investigation of the Stockpile-Voxel Profile for Material Reclaiming Optimisation Using Bucket Wheel Reclaimers

Duy Nguyen
Plant Available Water in Soils Reclaimed from the Salin/Sodic State

Thi Nguyen
Improved Oil Recovery Using Raw Water injection

Trang Nguyen
New Water Soluble Polymeric Materials through Hydrophobe/Hydrophobe Receptor Interactions

Grant Nicholas
An Integrated Risk Evaluation Model for Mineral Deposits

Verity Normington
Permian Landscape Reconstruction of South Australia

Mehanathan Pathmanathan
Innovative Grid-Connected, Small-Scale Wind Turbine Generators Offering Low Cost and Wide Operating Speed Range

Jared Peacock
Magnetotelluric Methods and Data Processing

Matthew Penna
Molecular Dynamics

Diana Plavsa
The Role of the Southern Granulite Terrane of India in the Amalgamation of Gondwana - A Structural and Geochronological Perspective

Herath Premarathna
Trace Element Bio Geo-chemistry

Qian Qian
Probabilistic Stability Analysis of Rock Structures

Tom Raimondo
Fluid Flow in Shear Zones

Aixa Rivera-Rios
Three-Dimensional Magnetotelluric and Controlled-Source Electromagnetic Modelling and Inversion in Isotropic and Anisotropic Media with Gaussian Quadrature Grids

Frank Robinson
Tectonic Controls on Igneous Geochemistry and Magma Production

Ladan Sahafi
Intelligent Control Systems

Alireza Salmachi
Well Testing in Coolbed Methane Reservoirs

Jacques Sayers
Geostatistical Representation of Fracture Systems in Mechanical Modelling Approaches when Designing Carbon Dioxide Hoods

Karn Schumacher
Passive Control of Cavity Flow Noise Using Geometric Modifications

Lindy Scott
Study of the Ecology of the Vegetation of the Dune System of Yellabinna Regional Reserve with Emphasis on the Impact of Mining Exploration on the Ecosystem.

Khalid Shamim
Mathematical Modelling of Integrated Biosystems for Operational Control and Management

Jiayi Shen
Analysis Deformation and Stability of Rock Slope

Tze Haw Sia
Nano-catalyst Integrated with Nano-porous Adsorbent for Water Treatment

Sarabjeet Singh
Development of a Wheel-Rail Dynamics Simulation Model for Predicting Acoustic Radiation

Emma Steggles
Investigating the Ecology of Soil Seed Banks within the Arid Zone System of Yellabinna Regional Reserve, South Australia

Michael Szpunar
Exploring Tectonic Linkages Between the Curnamona Province and the Gawler Craton

Difan Tang
Morphing Wing Control

Yuan Tian
XAS Studies and Metal Speciation in Hydrothermal Fluids

Manjot Toor
Removal of Toxic Pollutants from Industrial Wastewater by Australian Clay Mineral

Benjamin Vanderhoek
Regolith and Landscape Evolution in South Australia

Vipasiri Vimonses
Integration of Nanotechnology for Wastewater Treatment

Stephen Wade
Mathematical Modelling of Free Surface Flows

Bernardus Wahyuputro
A Portfolio Approach to Optimise Investment in Indonesia's Petroleum Resources

Samuel Wallace
Broadband CARS Microscopy

Liying Wang
Modelling and Analysis of Large Scale Grid-Connected Wind Turbine Systems

Peter James Ward
Carbon Sequestration of Native Vegetation at Various Scales

Claire Weekley
Biotransformation of Selenium Compounds using Synchrotron-Based X-Ray Techniques

John Wilford
Regolith Geoscience

Stephen Wood
Algal Source Rocks of the Papua New Guinea Foreland

Ailsa Woodhouse
Tectonic Evolution of the Musgrove Province

Jun Wu
Study on Adsorption Desalination

Yun Xue
Investigation into the Flow Structure in a Ranque-Hilsch Vortex Tube

Abbas Zeinijahromi
Laboratory and Mathematical Modelling of Suspension / Colloid Flow in Porous Media

Jing Zhao
Physical Chemistry of the Formation of Copper Iron Sulphides Under Hydrothermal Conditions

22. Higher Degree Graduates

During 2009 and 2010, researchers within IMER oversaw more than 90 higher degree graduates in all fields of research. Of this number, 1 completed a Higher Doctorate, 73 completed PhDs and a further 16 completed Masters. Here is a list of graduates and their research topics, in areas relevant to IMER's focus.

2009

Higher Doctorate

Colin Murray-Wallace
Amino Acid Racemization Geochronology - Contributions to the Understanding of Quaternary Sea-level Changes, Neotectonics and Coastal Evolution

Doctor of Philosphy

Cristian Birzer
The Influence of Jet Precession on Particle Distributions

Samuel Button
The Fate of Sulphur during Pyrolysis and Steam Gasification of High-Sulphur South Australian Low-Rank Coals

Meng Chong
Nano-Photocatalytic Mineralisation and Disinfection for Water Reclamation: From Catalyst Engineering to Process Optimisation and Modelling

Paul Dabrowski
Boundary-layer Flows in non-Newtonian Fluids

Robert Dart
Gold-in-Calcrete: A Continental to Profile Scale Study of Regolith Carbonates and their Association with Gold Mineralisation

Kathryn Davidson
Monitoring Systems for Sustainability. What Are They Measuring?

Kerrie Deller
Sedimentological Facies, Internal Architecture and Evolution of Deep Marine Fans of the Tithonian Angel Formation, Northwestern Dampier Sub-basin, North West Shelf, Australia

Matthew Donnon
Molecular Systematics of the Lomandra Labill. Complex (Asparagales: Laxmanniaceae)

Rian Dutch
Reworking the Gawler Craton: Metamorphic and Geochronological Constraints on Palaeoproterozoic Reactivation of the Southern Gawler Craton, Australia

Grant England
The Effect of Density on the Near Field of a Naturally Occurring Oscillating Jet

Catherine Gibson-Poole
Site Characterisation for Geological Storage of Carbon Dioxide: Examples of Potential Sites from the North West Shelf, Australia

David Haberlah
Loess and Floods: Late Pleistocene Fine-Grained Valley-Fill Deposits in the Flinders Ranges, South Australia

Nathaniel Jewell
The Development and Stability of Some Non-Planar Boundary-Layer Flows

Gene Liew
Analysis and Design of Single-Sided, Slotted AMM Axial-Field Permanent Magnet Machines

Xu Liu
Seismic Wave Propagation and Modelling in Poro-Elastic Media with Mesoscopic Inhomogeneities

Vinh Lu
Key Success Drivers of Service Exports: The Role of Organisational Characteristics, Market Characteristics and Governance Mechanisms

Anna Petts
Termitaria as Regolith Landscape Attributes and Sampling Media in Northern Australia

Nigel Ridgway
Slurry Pump Gland Seal Three Body Wear and the Influence of Particle Properties Including Hardness, Size, Fracture Toughness and Shape

Sarah Riordan
Managing the Interdisciplinary Requirements of 3D Geological Models

Woei Saw
Assessment of the Temporal Release of Atomic Sodium During a Burning Black Liquor Droplet Using Quantitative Planar Laser-Induced Fluorescence (PLIF)

Catherine Sinclair
Elastic Wave Modelling in Anisotropic Media using the Spectral-Element Method

David Summers
Discriminating and Mapping Soil Variability with Hyperspectral Reflectance Data

David Whaley
Low-Cost Small-Scale Wind Power Generation

Edward Whitehead
The Stability of Multiple Wing-Tip Vortices

Pierre-Alain Wulser
Uranium Metallogeny in the North Flinders Ranges Region of South Australia

Fang Xia
Mechanisms and Kinetics of Pseudomorphic Mineral Replacement Reactions and Their Applications in Materials Syntheses

Masters

Christopher De-Vitry
Simulation of Correlated Variables: A Comparison of Approaches with a Case Study from the Yandi Channel Iron Deposit

Kwong Lee
Microbial Flocculation for Large Scale Harvesting of Marine Microalgae for the Production of Biodiesel

Lifang Lu
Design Study of Energy-Efficient Routing Protocol for Wireless Sensor Networks

Marjan Rahbari
Physical Characteristics of Pleurochrysis Carterae in Relation to Harvesting Potential for Biodiesel Productions

2010

Doctor of Philosphy

Jae An
Sensorless Position Estimation in Fault-Tolerant Permanent Magnet AC Motor Drives with Redundancy

David Brautigan
Chemistry, Phytotoxicity and Remediation of Alkaline

Richard Craig
Investigating the Use of Concentrated Solar Energy to Thermally Decompose Limestone

Jessie Davey
Tectonostratigraphic Evolution of an Intracontinental Terrain: The Geological Evolution of The Frome Embayment, Eromanga Basin, Australia

Ashlea Doolette
Improved Techniques for the Characterisation of Soil Organic Phosphorus Using 31P Nuclear Magnetic Resonance Spectroscopy and Their Application to Australian Soils

Peter Elliott
Crystal Chemistry of Cadmium Oxysalt and Associated Minerals from Broken Hill, New South Wales

Gurhan Ertasgin
Low-Cost Current-Source 1-ph Photovoltaic Grid-Connected Inverter

Matthew Heintze
Development and Testing of an Er:Yb:Glass Coherent Laser Radar for Wind Field Mapping

Karen Hulme
Eucalyptus Camaldulensis (River Red Gum) Biogeochemistry: An Innovative Tool for Mineral Exploration Programs in the Curnamona Province and Adjacent Regions

William Isterling
Electro-Optic Propagation Through Highly Aberrant Media

Kamonporn Kromkhun
The Source and Origin of High Heat Production Granites in the Mt Printer and Other Proterozoic In tires

Timothy Lau
The Flow Around a Fish-inspired Heaving and Pitching Hydrofoil

Olivia Maselli
A Study into the Internal Energy Distributions of Molecules Liberated from an InVacuo Liquid Surface

Stephen Pahl
Heterotrophic Production of the Mircoalgae Cyclotella Cryptica; Feed for Aquaculture

Zebb Prime
Robust Scheduling Control of Aeroelasticity

Nader Qamar
Sooting Behaviour of Turbulent Non Pre-Mixed Jet Flames

Udani Sirisena
Systematic Studies on Thysanotus R.Br. (Asparagales: Laxmanniaceae)

Paul Smith
The Alkoxylation of Biodiesel and its Impact on Fuel Properties

George Szego
Experimental and Numerical Investigation of a Parallel Jet MILD Combustion Burner System in a Laboratory-Scale Furnace

Vlatka Zivotic-Kukolj
Analysis of Idle Power and Iron Loss Reduction in an Interior PM Automotive Alternator

Masters

Jie Ho
Soot Measurement and Species Simulation in Laminar Premixed Flames

Jeffrey Liew
Effect of Electrolytes on Formation and Stability of n-Dodecane Nanoemulsions by the PIT Method

Edy Purwanto
The Synthesis of Polyol from Rice Bran Oil (RBO) through Epoxidation and Hydroxylation Reactions

Suraj Sathe
Culturing and Harvesting Marine Microalgae for the Large-Scale Production of Biodiesel

Chun Tang
Analysis and Modelling of the Effects of Inertia and Parameter Errors on Wind Turbine Output Power

Hong Tsang
Cassytha pubescens: Germination Biology and Relationships with Native and Introduced Hosts

23. Public Seminars and Events

China's Investment in the Australian Resources Industry

A joint IMER and Confucius Institute Briefing | **April 2009**

A forum on Chinese Investment in Australian Resource Industry was staged on April 8, 2009 in a joint program by IMER and the Confucius Institute, the University of Adelaide. Director, Government Relations Australia, former Australian Treasurer and Trade Minister, Hon John Dawkins, AO, joined key experts from the University of Adelaide in a free public forum.

The forum featured experts in the fields of trade, economics, minerals and energy, government relations and Chinese studies.

A range of pressing issues of interest to both nations was covered including the Australia/China Free Trade Agreement and implications for investment in the Australian resources industry.

Other guest speakers included Head of the University of Adelaide's School of Economics, Professor Christopher Findlay; Executive Director of the University of Adelaide's Institute for International Trade, Andrew Stoler and Sinosteel Uranium SA Pty Ltd Managing Director, Gao Fusheng.

The dissemination of the benefits, outcomes and impacts of our research is a key part of research life at the University of Adelaide.

Outlined are some of the key public presentations given by IMER members.

Public Seminars

Ms Rachael Brick
PhD Student, School of Earth and Environmental Sciences, the University of Adelaide

Palaeoproterozoic eclogite formation: crustal evolution, structure, metamorphism and chronology of two orogenic belts in Tanzania

Associate Professor Barry Burgan
Head of School, Business School, the University of Adelaide

Economic impact assessment - its role in environmental impact statements and more generally

Ms Kathryn Cutts
Postgraduate, School of Earth and Environmental Sciences, the University of Adelaide

Granulites, Scotland, Rodinia and the Gawler Craton – Yes, there is a connection!

Dr Robert Dart
Research Associate, School of Earth and Environmental Sciences, the University of Adelaide

Gold in calcrete – Linking oceans to gold mineralisation

Associate Professor Jose Facelli
Associate Professor, School of Earth and Environmental Sciences, the University of Adelaide

Challenges and opportunities in restoration ecology

Professor Nick Harvey
Executive Dean, Faculty of Humanities & Social Sciences, the University of Adelaide

Mining and environmental impact assessment in South Australia

Professor Graham Heinson
Professor, School of Earth and Environmental Sciences, the University of Adelaide

Non-linear geophysics

Dr Joerg Herman
Research Fellow, The Australian National University

Experiments and ecologies: constraining trace element and volatile recycling in subduction zones

Ms Katherine Howard
Assistant Lecturer, School of Earth and Environmental Sciences, the University of Adelaide

Eric Rudd Memorial Scholarship 2009: Grand canyon geological rafting trip

Mr Gernot Loidl
Postgraduate, School of Earth and Environmental Sciences, the University of Adelaide

The geochemical, mineralogical and textural characteristics of the elura orebody: a new 3-dimensional approach

Ms Rachel Maier
Postgraduate, School of Earth and Environmental Sciences, the University of Adelaide

A novel idea for investigation of sedimentary basins: joint inversions of gravity and MT data

Mr Ben McGee
Postgraduate, School of Earth and Environmental Sciences, the University of Adelaide

Getting a nice Brazilian; the Paraguay Belt, Brazil

Mr Mohammad-Lotfolah Hamedani
Postgraduate, School of Earth and Environmental Sciences, the University of Adelaide

Exploration mining engineering - the western mineralisation at the Broken Hill mine

Professor Gus Nathan
Director, Centre for Energy Technology, the University of Adelaide

Renewable energy options for remote mines

Ms Diana Plavsa
Postgraduate, School of Earth and Environmental Sciences, the University of Adelaide

The role of the southern granulite terrane of India in the amalgamation of Gondwana - a structural and geochronological perspective

Dr Heike Rahmann
Postgraduate, School of Architecture, Landscape Architecture and Urban Design, the University of Adelaide

The overseas landscape - mining rehabilitation

Dr Andres Schmidt Mumm
Senior Lecturer, School of Earth and Environmental Sciences, the University of Adelaide

From mineral grains to giant ore deposits

Dr Kate Selway
Research Associate, School of Earth and Environmental Sciences, the University of Adelaide

Defrosting Gondwana: How electromagnetic 'eyes' are piercing the Antarctic ice to reveal a former supercontinent's deepest secrets

Magnetotellurics in Antarctica

Mr Nick Timms
Postdoctoral Fellow, Curtin University of Technology, the University of Adelaide

The history of the moon recorded by the oldest zircon grain

Energy Futures: A 12-Part Public Seminar Series

Dr Maziar Arjomandi
Senior Lecturer, School of Mechanical Engineering, the University of Adelaide

Wind and Water Energy – Overview of Technologies

Associate Professor Peter Ashman
Program Leader, Energy Pipelines Cooperative Research Centre

Biomass and Biofuels – Overview of Technologies

Mr Gerald Barker
General Manager, SQC Pty Ltd

Biomass and Biofuels – Industry Developments of Microalgae

Professor Barry Brook
Sir Hubert Wilkins Chair Climate Change, the University of Adelaide

Options for the Future – Nuclear

Professor Alan Cooper
Director. Australian Centre for Ancient DNA, the University of Adelaide

Climate Change Science - Past Impacts

Associate Professor Bassam Dally
Deputy Director, Centre for Energy Technology, the University of Adelaide

Living with Fossil Fuels – Overviews of Technologies

Dr Rob Dickinson
Director, Hydricity SA

Integrated Energy Systems – Renewable Hydrogen Energy Systems

Mr Anthony Di Marzo
Director, Mechanical Services Discipline Leader, Sustainability, Lucid Consulting
Demand Management – Sustainable

Dr Con Doolan
Senior Lecturer, School of Mechanical Engineering, the University of Adelaide
Wind and Water Energy – Improving Aerodynamic Efficiencies

Professor Peter Dowd
Executive Dean, Faculty of Engineering, Computer and Mathematical Sciences, the University of Adelaide
Climate Change - Engineering Adaptation to Climate Change

Dr Henry Ergas
Deloittes Economics
Carbon Management – Carbon Pricing Mechanisms Part 2

Associate Professor Nesimi Ertugrul
Associate Professor, School of Electrical and Electronic Engineering, the University of Adelaide
Integrated Energy Systems – Distributed Generation and Smart Grids
Wind and Water Energy – Distributed Energy Systems

Professor Christopher Findlay
Executive Dean, Faculty of the Professions, the University of Adelaide
Carbon Management – Carbon Pricing Mechanisms Part 1

Mr George Giannakodakis
Principle, Infraplan Pty Ltd
Impacts for Mining, Infrastructure, and Transport Sectors – Infrastructure

Professor Stephen Grano
Executive Director, Institute for Mineral and Energy Resources, the University of Adelaide
Impacts for Mining, Infrastructure, and Transport Sectors – Mining

Dr Peter Hayman
Principal Scientist, Climate Applications, South Australian Research and Development Institute
Climate Change - Future Impacts

Professor Robert Hill
Executive Dean, Faculty of Sciences, the University of Adelaide
Climate Change Science – Evolution of Australians Biota

Dr Eric Hu
Associate Professor, School of Mechanical Engineering, the University of Adelaide
Solar Energy – Solar Thermal Technologies

Professor John Kaldi
Cheif Scientist, Cooperative Research Centre for Greenhouse Gas Technologies
Carbon Sequestration – Geosequestration - Storage

Mr Terry Kallis
Managing Director, Petratherm Limited, Chairman of the Australian Geothermal Energy Association (AGEA)
Integrated Energy Systems – Geothermal Energy

Dr Philip Kwong
Lecturer, School of Chemical Engineering, the University of Adelaide
Living with Fossil Fuels – Pollutants and Capture

Dr David Lewis
Lecturer, School of Chemical Engineering, the University of Adelaide
Biomass and Biofuels – Microalgae Research and Development

Professor Stephen Lincoln
Professor, School of Chemistry and Physics, the University of Adelaide
Options for the Future

Professor Gus Nathan
Director, Centre for Energy Technology, the University of Adelaide
Integrated Energy Systems – Hybrids, Decentralisation and Storage
Solar Energy – Geothermal and Solar Technologies

Mr Craig Oakeshott
Senior Manager Strategy and Economics, AEMO
Demand Management – Energy Trends

Dr Monica Oliphant
President, International Solar Energy Society
Solar Energy – Coverage of PV Technologies

Mr Russell Synnot
Australian Airports Association
Impacts for Mining, Infrastructure, and Transport Sectors – Transport

Professor Kelly Thambimuthu
Chairman, International Energy Agency Greenhouse Gas R&D Program
School of Chemical Engineering, University of Queensland, Australia
Carbon Sequestration – The Global Energy Challenge and the Role of Carbon Capture and Storage

Dr Philip Van Eyk
Research Associate, School of Chemical Engineering, the University of Adelaide
Living with Fossil Fuels – Liquified Coal

Ms Catherine Way
Industry Development Manager, RenewablesSA
Carbon Management – Building South Australia's Green Grid

Energy Futures; Thinking Critically about Sustainable Energy

Centre for Energy Technology (CET) public seminars 2010

During 2010 the Centre for Energy Technology (CET) presented two public seminar series focussing on different aspects of energy. The two series were designed to give the public the opportunity to learn about the wide variety of new clean energy technology options being developed, including those originating from the University of Adelaide.

'Thinking Critically About Sustainable Energy' was a series of six seminars organised in conjunction with the Royal Institution of Australia.

The seminars brought together top energy experts to provide information and tools for the public to be able to critically assess future energy sources. These seminars were broadcast on the internet and one seminar was highlighted on the Australian Broadcasting Corporation's (ABC) Big Ideas television program.

'Energy Futures' was organised in conjunction with the University of Adelaide's School of Earth and Environmental Sciences. It was a twelve-part series that examined in detail the range of clean energy technology options for the future and their potential impact.

The series is an example of the University of Adelaide's commitment to engage the community.

Professor Dianne Wiley
Senior Advisor, Cooperative Research Centre for Greenhouse Gas Technologies

Carbon Sequestration – Capture and Economics Buildings

Associate Professor Terry Williamson
Professorial Fellow, School of Chemical Engineering, the University of Adelaide

Demand Management – Energy Efficiency of Buildings

Thinking Critically about Sustainable Energy: A 6-Part Seminar Series

Dr Maziar Arjomandi
Senior Lecturer, School of Mechanical Engineering, the University of Adelaide

Established Renewables – Wind Turbine Energy Generation: Design, Efficiencies and Challenger

Professor Barry Brook
Sir Hubert Wilkins Chair Climate Change

Fossil Fuel Future – Chair and Introduction

Non Carbon Energy Technologies – Inexhaustible Fission Energy

Associate Professor Bassam Dally
Deputy Director, Centre for Energy Technology, the University of Adelaide

Fossil Fuel Future – Potential for Next Generation Combustion Systems to Be Cleaner and More Efficient

Dr Andrew Dicks
Director, National Hydrogen Materials Alliance, CSIRO

Demand Side Management – Energy Storage: Thermal, Mechanical and Chemical

Mr Ian Hore-Lacy
Director of Public Communications, World Nuclear Association

Energy Futures – Nuclear Power in the Future

Ms Susan Jeanes
Chief Executive, Australian Geothermal Energy Association

Future Renewables – Geothermal Electricity Generation Systems

Professor John Kaldi
Chief Scientist, Cooperative Research Centre for Greenhouse Gas Technologies

Fossil Fuel Future – Options for Geosequenstration of CO2 and How Carbon Capture and Storage will Work within Existing Infrastructure

Mr Alan Major
Director,Tenax Energy

Future Renewables – Thinking Critically: Marine Energy

Dr Glenn Platt
Research Group Leader, Energy Technology, CSIRO

Demand Side Management – An Intelligent Demand Side

Dr Steve Schuck
Manager, Bioenergy Australia

Future Renewables – Bioenergy as a Source of Renewable Energy

Dr Peter Seligman
Associate, Melbourne Energy Institute, University of Melbourne

Energy Futures – A Renewable Energy Plan for Australia

Ms Susie Smith
Manager, Climate Change and Sustainability, SANTOS

Fossil Fuel Future – Industry and Policy perspective on the Future of Energy on Gass

Associate Professor John Spoehr
Executive Director, Centre for Labour Research

Energy Futures – Socio-Economic Impact of Climate Change

Mr Wes Stein
Manager, National Solar Energy Centre, CSIRO

Established Renewables – Solar Thermal Energy

Mr Andrew Stock
Executive General Manager, Major Development Projects, Origin Energy

Established Renewables – Large Scale Wind Turbines

Dr Kim Talus
Faculty Member, School of Energy and Resource, University College London

Non Carbon Energy Technologies – Australia's Nuclear Debate: An International View

Ms Catherine Way
Sustainability Advisor, RenewablesSA

Established Renewables – *Infrastructure Requirements and the Green Grid Study*

Mining Innovation Seminar and Networking Series

The University of Adelaide has collaborated with the University of South Australia, Flinders University and the Department of Further Education, Employment, Science and Technology, Government of South Australia, through Innovate SA, in the Mining Innovation Seminar series. The aim of this seminar series is to bring together mine operators, mining service companies and research institutions to network and exchange information.

Dr Jeffrey Claflin
Principal Process Engineer, Lycopodium Minerals

Concentrated Solar Thermal Power (CSP) Technologies can Help Reduce Eenergy Costs in the Future

Mr Joe Mastrangelo
Director, Resources and Energy Sectors Infrastructure Council (RESIC)

Investigating the Demand for Future Energy Infrastructure for the State's Resources Sector

Professor Gus Nathan
Director, Centre for Energy Technology

Accelerating the National and International Transition to a Clean Energy Future

24. Visitors

Over IMER's first two years, the University of Adelaide has welcomed many national and international visitors representing world-leading researchers, industry and government groups and entities. Here is just an example of some of the key visitors who have come to collaborate, present a seminar or conduct research.

2009

Dr Phil Ainsley
Germplasm Research Coordinator, Botanic Gardens of Adelaide

Professor Philip Allen
Chair in Earth Science, Imperial College London

Dr Tim Baker
Manager, Geological Survey of South Australia, Department of Primary Industries and Resources SA, Government of South Australia

Mr Gerard Bosch
Exploration Manager, Australian Zircon NL

Ms Karen Cosgrove
Senior Consultant, Rural Solutions SA

Hon. John Dawkins AO
Director, Government Relations Australia, Former Australian Treasurer, Former Minister for Trade

Dr Ian Duddy
Geotrack International

Mr Ben Baghurst and Mr Jeff Edwards
Environmental Consultants, Rural Solutions SA

Professor Tony Eggleton
Emeritus Professor, Department of Earth and Marine Science, Research School of Earth Sciences, Australian National University

Mr Gao Fusheng
Managing Director, Sinosteel Uranium SA Pty Ltd

Dr Paul Green
Director, Geotrack International

Mr Lachlan Hallett
Geologist, Northern Territory Geological Survey

Dr Dan Le Heron
Royal Holloway and Bedford New College, University of London

Mr Charles Irwin
Independent Chair, Penrice and Terramin Community Consultation Groups

Ms Mahboobeh Jamshidi-Badr
Shahid Beheshti University, Tehran, Iran

Mr Mohammad Ishaq Kakar
Univeristy of Quetta, Pakistan

Professor Judith Kinnaird
Geologist, University of Witwatersrand

Mr Brenton Lewis
Chief Executive, Murraylands, Regional Development Board

Mr Chris McDonough
Senior Sustainable Agricultural Systems Consultant, Rural Solutions SA

Mr Michael McLeary
Program Manager, Mine Completion Program, Department of Primary Industries and Resources SA, Government of South Australia

Mr Andrew Minns
Manager HSEC, Jacinth Ambrosia Project Iluka Resources

Associate Professor Elena Miranda
California State University, Northridge

Mr John Pitt
Principal Consultant Pest Management, Rural Solutions SA

Dr Nigel Radford
Consulting Geochemist, Newmont Mining

Dr Anthony Reid
Geochronologist, Geological Survey Branch, Department of Primary Industries and Resources SA, Government of South Australia

Dr Frank Schilling
Collaborative Research Centre, Ludwig-Maximilians-Universität München

Associate Professor Joshua Schwartz
Department of Geological Sciences, University of Alabama

Ms Virginia Simpson
Consultant, Rural Solutions SA

Mr Mark Sindicic
Senior Consultant, Rural Solutions SA

Dr Martyn Stoker
British Geological Survey, Edinburgh

Mr Andrew Stoler
Executive Director of the University of Adelaide's Institute for International Trade, Senior Advisor to the Shanghai and Shenzhen, World Trade Organization, Affairs Centres

Professor John Suppe
Distinguished Chair Research Professor, Department of Geosciences National Taiwan University, Taiwan

Ms Bev Voigt
Business Manager, Rural Solutions SA

Dr Brad Wolaver
Research Fellow, Earth Sciences Department, Flinders University

2010

Professor Kjell Aleklett
Head, Global Energy Systems Group, Uppsala University, Sweden

Professor Michael Asten
School of Geosciences, Monash University

Mr Tom Blees
Author, 'Prescription for the Planet'

Mr Eric Bost
Vice President for Global Initiatives of Texas A & M University

Dr Isaac Boxx
Institute for Combustion Technology, German Aerospace Centre

Professor Reidar Bratvold
University of Stavanger, Norway

Professor Christoph Clauser
Chairman International Heat Flow Commission IASPEI, Chair of Applied Geophysics and Geothermal Energy EON Energy Research Centre, Aachen University

Mr James Collins
Cementing Operation Manager, Halliburton Australiasia

Dr Jeffrey Claflin
Principal Process Engineer, Lycopodium Mineral

Associate Professor Amanda Ellis
Technical Director, National Centre of Excellence in Desalination, Flinders University

Mr Phil Endley
Cooperate Development Manager, Osmoflo Pty Ltd

Professor Ian Fairchild
University of Birmingham

Dr Muriel Gerbault
Faculty of Earth and Life Science, University of Nice

Associate Professor Ming Gu
Institute of Process Engineering, Chinese Academy of Sciences

Dr Lizhong He
University of Queensland

Dr Dave Healy
University of Aberdeen

Mr Paul Howe
Principal Hydrogeologist from Sinclair Knight Merz

Ms Susan Jeans
CEO, Australian Geothermal Energy Association Inc.

Professor Katsumi Kaneko
Department of Chemistry, Chiba University, Japan

Professor Valerie Linton
CEO, Energy Pipelines CRC

Professor Gordon Lister
Research School of Earth Sciences, The Australian National University

Associate Professor Adam Maloof
Department of Geosciences, Princeton University

Mr Joe Mastrangelo
Director of the Resources and Energy Sectors Infrastructure Council

Associate Professor Ali Mohebbi
Department of Chemical Engineering, Shahid Bahonar University of Kerman

Dr Chris Morley
Senior Geologist, PTT Exploration and Production Public Company Limited

Mr Neil Palmer
General Manager Technical Services, Osmoflo Pty Ltd

Mr Sven-olof Petersson
Ambassador of Sweden

Ms Nana Qi
University of Petroleum, China

Rear Admiral Kevin Scare AC CSC RANR
Governor of South Australia

Professor Zhiguo Su
Institute of Process Engineering, Chinese Academy of Sciences

Mr Alec Townsend
Barbara Hardy Centre for Sustainable Environments, School of Natural and Built Environments, University of South Australia

Professor Demos Trimis
Head of the Chair of Gas and Heat Technology, Technische University Bergakademie Freiberg

Professor John Warren
Department of Petroleum Geoscience, University of Brunei Darussalam

Professor Paul Webley
Department Chairman of Chemical Engineering, Monash University

Professor Lin Ye
State Key Laboratory of Ore Deposit Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences, Guiyang, China

AMIRA International Board of Directors Members' Meeting with IMER

November 2010

AMIRA International Ltd, an independent association of minerals companies which develops, brokers and facilitates collaborative research projects, met with IMER research leaders in 2010.

The inaugural meeting was significant for the newly-formed Institute for Mineral and Energy Resources. While AMIRA International does not carry out research itself, it brokers collaborative projects between industry and world-leading research providers by leveraging available government and industry funds. This combined funding enables AMIRA to recruit the world's leading researchers to address industry problems and opportunities and to conduct sustained research which leads to the development of a stronger industry research base. AMIRA Board of Directors members are engaged with companies including Alcoa World Alumina, Anglo American Exploration (Aust) Pty Ltd, Anglo Platinum, Antofagasta Minerals SA, Barrick Gold Corporation, BHP Billiton, Boart Longyear Pty Ltd, Compania de Minas Buenaventura,Freeport McMoran Mining Company, Global Metso Process Technology and Innovation, Russell Mineral Equipment Pty Ltd, Teck, Vale , Xstrata Copper Australia, and Xstrata Technology.

25. Publications

During 2009 and 2010, IMER researchers published widely in many leading books, journals and refereed conferences. Total publications in 2009 amounted to more than 350 with publication of 220 journal papers, 101 conference papers, five books and 24 book chapters. In 2010, IMER researcher publications comprised eight books, 14 book chapters, 104 conference papers and 220 journal papers.

The high quality of research conducted by IMER members and importance of the subsequent journal articles is demonstrated by the fact that over half of all publications were in A* and A ranked journals.

A* These journals are typically the best in their field or subfield with virtually all papers being of a very high quality.

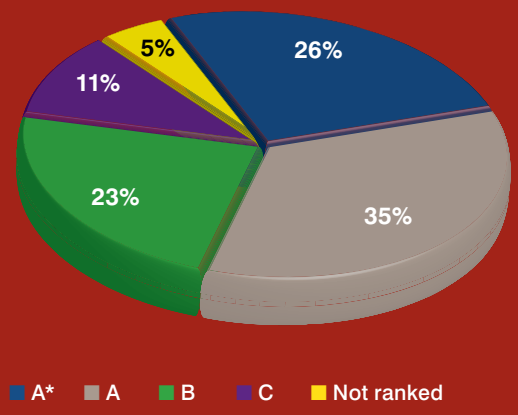
A The majority of papers in a Tier A journal will be of very high quality.

B Journals with a solid, though not outstanding, reputation.

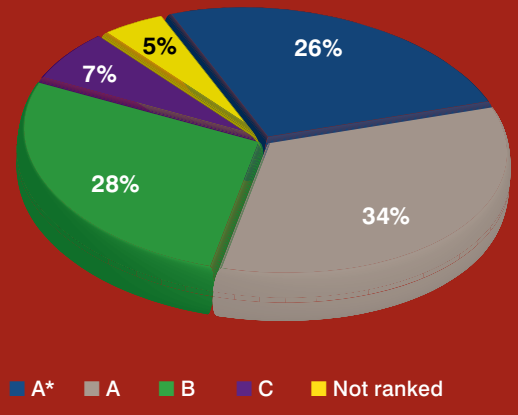
C Includes quality, peer reviewed, journals that do not meet the criteria of the higher tiers.

Publications of relevance to core IMER research areas and priorities are included in the following lists.

2009 Journals by ERA Ranking



2010 Journals by ERA Ranking



2009

Books

Begg,S, Tyson,S (2009), *An Introduction to Upscaling*, Piper's Ash Ltd, Indonesia.

Bies,D and Hansen,C (2009), *Engineering Noise Control*, 4th edn, Spon Press, UK.

Plimer,I (2009), *Heaven and Earth: Global Warming, the Missing Science*, Connorcourt Publishing, Australia.

Valenzuela,E (2009), *Poverty, Vulnerability, and Trade Policy*, Verlag Dr Muller, Germany.

Reddy,S, Mazumder,R, Evans,D and Collins,A (eds) (2009), *Palaeoproterozoic supercontinents and global evolution*, Geological Society of London, UK.

Book Chapters

Brook,B, Taggart,S (2009), The looming peak coal and peak phosphate crises: Disaster or opportunities for innovation?, Opportunities beyond carbon. Looking forward to a sustainable world, *Melbourne University Press*, Australia, pp.311-316.

Howard,C (2009), Practical numerical acoustics, Engineering Noise Control, *4th edn, Spon Press, United States and Canada*, pp.617-657.

Sodhi,N, Brook,B and Bradshaw,C (2009), Causes and consequences of species extinctions, The Princeton Guide to Ecology, *1st edn, Princeton University Press, USA*, pp.514-520.

Journal Articles

Ahangar,A, Smernik,R, Kookana,R and Chittleborough,D, (2009), The effect of solvent-conditioning on soil organic matter sorption affinity for diuron and phenanthrene, *Chemosphere*, 76(8), pp.1062-1066.

Alwahabi,Z, Zetterberg,J, Li,Z and Alden,M, (2009), Vibrational relaxation of CO2 (12(0)1) by argon, *Chemical Physics*, 359, pp.71-76.

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