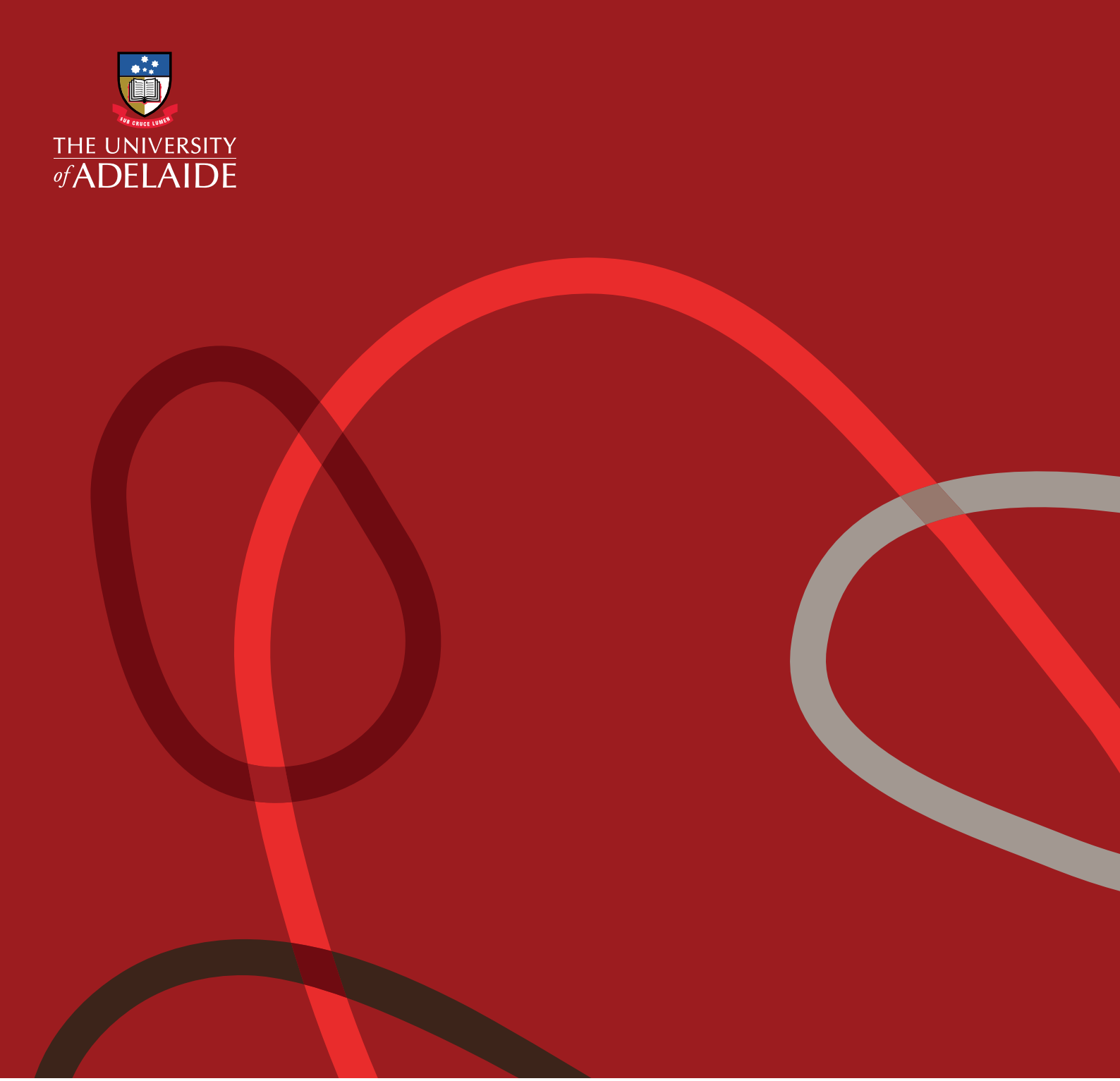
THE UNIVERSITY of ADELAIDE



The University of Adelaide

Institute for Mineral and Energy Resources

Annual Report 2015

adelaide.edu.au

seekLIGHT

IMER

Answering the challenge of sustainable and efficient use of global resources.

The Institute for Mineral and Energy Resources (IMER) is part of the University of Adelaide and is the principal point of contact at the University for mineral and energy resources research, including industry and government partnerships.

We believe that industry-led, challenge-based interdisciplinary research is key to the sustainable use and development of the world's mineral and energy resources for the benefit of society, industry and the environment. Our interdisciplinary research addresses scientific, technological, environmental and social challenges in the provision of mineral and energy resources globally.

IMER's key role is to assemble interdisciplinary teams from the University of Adelaide and research partners to address global challenges:

- **Deep resources**
- **Deep mining**
- **Complex processing and resource extraction**
- **Tight petroleum and geothermal energy resources**
- **Reliable, low cost, clean and sustainable energy technology**

The University of Adelaide is one of Australia's leading universities, with strengths in research and teaching groups in geology and geophysics, petroleum engineering, mining engineering and energy technology.

These groups form the Institute's core through:

Centre for Tectonics, Resources and Exploration

Centre for Energy Technology

South Australian Centre for Geothermal Energy Research

Some of the University of Adelaide's faculties and schools involved with IMER include from the Faculty of Engineering, Computer and Mathematical Sciences: School of Mechanical Engineering, School of Chemical Engineering, Australian School of Petroleum, School of Electrical and Electronic Engineering, School of Civil, Environmental and Mining Engineering, and School of Mathematical Sciences; from the Faculty of Sciences: School of Physical Sciences; and from Faculty of the Professions: Adelaide Business School and the Entrepreneurship, Commercialisation and Innovation Centre.

The University of Adelaide is also a leading research and postgraduate training facility for the mining and energy sectors in the Asia-Pacific region.

Contents

Australian continent margin – New Caledonia.

Deputy Vice-Chancellor and Vice-President (Research) report

Professor Mike Brooks

The Institute for Mineral and Energy Resources (IMER) is tasked with solving one of the biggest challenges facing Australia and the world: maintaining growth in the critical mineral and energy resource industries in a technically, economically, socially and environmentally sustainable manner.

IMER is continuing to tackle this challenge with a truly interdisciplinary approach, bringing together expert teams from across the University to address research priorities closely linked to industry needs. As a result of this approach, we see innovative research being translated into practical applications by industry, who increasingly see the value in working with our researchers for mutually beneficial outcomes. The ARC Research Hub for Australian Copper-Uranium is an excellent example of cooperation between key university, industry and government partners.

IMER's mission is clear, and it continues to grow and build on its success. This report provides a fascinating glimpse of the breadth and depth of the expertise within the Institute, and I congratulate all IMER members on their outstanding work throughout the year.

Executive Director's report

Professor Stephen Grano

Transitioning to a low carbon sustainable future featured heavily on the global agenda this year, with consensus at the historic Conference of Parties in Paris.

The Centre for Energy Technology's research rose to global prominence as many projects within the Centre facilitate this transition, including the **Australian Solar Thermal Research Initiative**. Whilst IMER is already strong in the renewables energy sector, the Executive team has also been developing additional relationships within the sector and we look forward to seeing these translate into future research programs.

In 2015, our interdisciplinary teams have also been developing new techniques to find resources deep under cover; creating partnerships with industry to plan and execute efficient deep mining projects; pursuing fundamental research on the structure and formation of key mineral ores; developing sensors to detect metals within ore and concentrate in real time; and creating new tools to locate and extract tight energy resources.

These are just a few of the projects you can read about within this report, with new interdisciplinary networks continually being formed across the university, the nation and around the world to address these five key challenges. This is our strength – bringing together interdisciplinary teams to solve problems for industry – and I am confident IMER members will continue to connect and innovate in the years to come.

These partnerships and the outstanding research they produce would not be possible without such a talented team and I'd like to thank each IMER member for their efforts. The 225 University of Adelaide staff and students who work in the mineral and energy resource research fields produced an incredible 465 journal articles, 168 conference papers, 14 book chapters and four books during the year. Over 50 students completed their PhD within the Institute, 13 Master students completed their studies, and hundreds of undergraduates benefited from the expertise of our teaching staff. The next generation of strategic and collaborative thinkers is in good hands.

Chair's report

Mr Andrew Stock

The University of Adelaide is consistently ranked in the top 1% of universities in the world, and IMER contributes significantly to its success.

Once again, several of our research areas reached the highest pinnacle in Australia, with geology and mechanical engineering achieving the maximum rating of five for Excellence in Research for Australia. With another $15.8 million of funding received in 2015, we are still advancing on our mission of excellence, innovation and technology transfer in mineral and energy resources through fundamental and applied research.

As the industry-to-university gateway for collaborative interdisciplinary research, IMER's research continues to address the key challenges facing the mineral and energy resource sectors around the world:

- deep resources
- deep mining
- complex processing
- tight resources and
- low cost, low emissions energy.

Our work is also closely aligned with the National Innovation and Science Agenda announced this year and Federal Government's Industry Growth Centres, in particular National Energy Resources Australia (NERA) and the METS Ignited Industry Growth Centres. The **Australian Research Council Hub for Australian Copper-Uranium** is an excellent example of this in action.

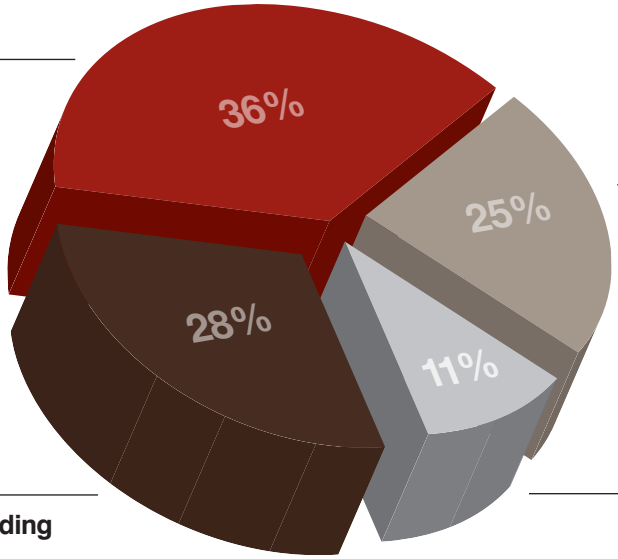
Our contribution to the mineral and energy resources sector and the community as a whole would not be possible without the IMER Advisory Board and, in particular, Executive Director Prof Stephen Grano and his team. I would like to thank them for their dedication and hard work during the year and I look forward to continuing this work in 2016 and beyond.

Research funding

In 2015 IMER received over $15 million of external funding from new and continuing multi-year grants. Although IMER is successful in obtaining nationally competitive research grants, it is also telling that more than 20% of external funding comes from industry.

Category 1

Nationally competitive research grants
$5,667,480



Category 3

Australian industry, donations and international grants
$3,911,300

Category 2

Other public sector funding
$4,500,655

Category 4

Cooperative Research Centres
$1,740,229

IMER's research

IMER facilitates interdisciplinary initiatives aligned to global challenges by:

- **assembling interdisciplinary teams from across the University of Adelaide and external partners;**
- **forging strategic relationships between researchers and industry, including international research institutions and industry;**
- **supporting research leadership by investing in strategic research initiatives that leverage new funding and build capability for high quality research outputs;**
- **increasing the number, scale and success rate of national competitive grant applications to build research capability and capacity.**

Key principles

IMER's mission encompasses the key principles:

- **interdisciplinary research** – brings together the disciplines of science, engineering, professions and humanities to address globally significant challenges;
- **global recognition** – positions the University of Adelaide to be a leading research university by world standards;
- **fundamental and applied research** – recognises the critical importance of fundamental research to underpin applied research which will directly address State and global challenges;
- **innovation** – recognises the importance of step-change research and the breakthroughs required to make a positive and lasting impact on State, National and Global communities;
- **outreach** – recognises the importance of communication in all its forms to maintain mutually beneficial relationships between the University of Adelaide, industry and society.

The Shillong Plateau north of Bangladesh.

Our principles in action

Here you can see IMER's principles in action, with a sample of our interdisciplinary projects presented across the five global challenges. The teams have been built by IMER in concert with industry, in direct response to their needs.

Hover your mouse over each **Case study** below to highlight in the table opposite research fields involved. Note that some Case studies address more than one Challenge.

Click on an icon to read more.

Case studies

Deep resources

Case Study #1:
Imaging the Australian continent

Case Study#2:
Tracking mineralisation through ancient fluid flows

Deep mining

Case Study #3:
Stability is everything in mining

Case Study #4:
Bringing people together – industry-led research partnerships are key to success

Complex processing

Case Study #5:
Industrial Transformation Research Hub awarded to IMER

Case Study #6:
Tracing the origins of our large mineral resources

Tight energy resources

Case Study #7:
A new way to monitor unconventional resource development

Case Study #8:
Mapping Australia's structural permeability

Low cost, low emissions energy

Case Study #9:
Understanding the impacts of energy storage technology

Case Study #10:
Australian Solar Thermal Research Initiative

Challenges

	Deep resources	Deep mining	Complex processing	Tight energy resources	Low cost, low emissions energy
Chemical engineering		■	■		■
Mining engineering	■	■	■	■	■
Geomechanics	■			■	
Geostatistics		■		■	
Computer science				■	■
Electrical / Electronic engineering					■
Materials engineering		■	■		■
Mathematical sciences					■
Mechanical engineering					■
Petroleum Engineering	■	■		■	
Community engagement	■	■		■	
Economics		■	■	■	■
Regulation			■		
Politics and international studies			■		
Applied ecology and conservation				■	
Chemical sciences			■		■
Earth science			■	■	
Energy use, demand, environmental chemistry				■	■
Environmental luminescence			■		
Environmental science and management	■	■	■	■	
Fuel technology					■
Functional materials	■	■	■		■
Geochemistry			■	■	
Geochronology	■		■		
Geology	■		■	■	
Geophysics	■			■	
High energy particle physics	■		■		
Microscopy			■		■
Mineralogy			■	■	
Molecular and cellular biology			■		■
Molecular photoscience and ion chemistry			■		■
Nanotechnology			■		■
Optics and photonics	■	■	■		■
Physics			■	■	

- Mining engineering
- Geomechanics
- Petroleum engineering
- Community engagement
- Environmental science and management
- Functional materials
- Geochronology
- Geology
- Geophysics
- High energy particle physics
- Optics and photonics

Deep resources

Our search for resources is going further and further below the Earth's surface – how do you find ore deposits under cover, or petroleum reservoirs buried under kilometres of rock or ocean? This is our challenge.

Most of the world's ore bodies at the earth's surface have already been located and mined. The task now is to find those buried deep below the surface under much younger rock. To truly make a discovery we must drill. This is costly and risky, because if a drill hole misses an ore body – even by a few metres – then the deposit will remain undiscovered.

Our challenge is to develop the best methods for predicting and mapping ore deposits under cover. Oil and gas resources are also becoming more difficult to find and access, with most new fields located deep within the Earth's crust and in some cases under very deep parts of the ocean. Searching for these resources at depth is a significant challenge. IMER's research is addressing this challenge in several ways, by:

- studying the geology of areas that used to be connected to Australia, like Antarctica and India, to better understand Australia's geological history
- analysing the geochemistry of rocks collected from drill samples to map key indicators of significant resources
- using geophysical techniques like seismic and magnetotellurics to image what's hiding under cover
- conducting socio-economic research on the impact of proposed developments on communities and businesses.

The Great Australian Bight Research Program is a great example of our interdisciplinary research, with more than 100 scientists who are leaders in their field working on the oceanography, ecology and geochemistry of the Great Australian Bight as well as the socio-economics of development in the region. IMER is collaborating with BP, CSIRO, SARDI and Flinders University in this remarkable program.

The University of Adelaide hosts the national facility for magnetotellurics and is using this technique to understand the complex nature of Olympic Dam and associated deposits. Two of IMER's flagship programs designed to help find new ore deposits under cover are featured here: the national Australian Lithospheric Architecture Magnetotelluric Project (AusLAMP) and the mineral systems drilling component of the Deep Exploration Technologies Cooperative Research Centre (DETCRC).

Conducting fieldwork via helicopter in remote South Australia is all part of the challenge for AusLAMP researchers.

Case Study #1
Imaging the Australian continent

The Australian Lithospheric Architecture Magnetotelluric Project (AusLAMP) is mapping the footprint of world-class mineral deposits and investigating their source using magnetotellurics (MT).

MT is a deep-imaging geophysical technique that measures the electrical resistivity of Earth's lithosphere (mantle-crust) in 3D, and to depths of hundreds of kilometres. Electrical resistivity is influenced by heat, fluids and mineral types, so these data give rise to a 3D map of the Earth's architecture and geological history.

The team has begun surveying the continent on a 55 km grid pattern, with most of South Australia sampled in 2014-2015, and with the remaining sites to be collected in the next year. Around 200 grid observations were collected, part of an estimated 3000 across Australia. **Community engagement** is also a key feature of the project. The results are already transforming our understanding of the lithosphere. In the Gawler Craton (SA) and Curnamona Province (SA and NSW), new three-dimensional resistivity models have shown the importance of ancient geological links between the mantle and crust in defining the location of world-class mineral provinces.

Professor Graham Heinson
Professor of Geophysics

Project partners include: AuScope, Geoscience Australia, Geological Survey of South Australia, Geological Survey Victoria, Mineral Resources Tasmania, Geological Survey of Western Australia, University of Adelaide, University of Western Australia, and the University of Tasmania.

Read more about the project:
www.ga.gov.au/about/projects/minerals/current/auslamp

Case Study #2
Tracking mineralisation through ancient fluid flows

New research within IMER has shown that the Gawler Craton, thought to have been 'stable' for the last 1500 million years, was actually subject to significant cooling and tectonic uplift events due to fault reactivations with accompanying hydrothermal fluid movement.

Because these fluids transport metals, and the Gawler Craton holds the majority of South Australia's mineral deposits, tracking fluid movement should lead to enhanced exploration. The team are using thermochronometric techniques to test the timing of fluid movement along faults in the Craton. Thermochronometry involves comparing the ages of two or more minerals with the temperatures at which the crystal structure of a mineral is formed and cooled. In a pilot project this year, the team is using $^{40}Ar - ^{39}Ar$, apatite fission track and zircon and apatite helium dating to help identify the direction and nature of fluid flow in a section of the Gawler Craton. If successful, this will form a new, cheap and efficient mineralisation targeting technique and open up new mineral targets across South Australia.

Professor Alan Collins
Director, TRaX

Project partners include Geological Survey of South Australia and DET CRC.

Read more about the project:
www.minerals.statedevelopment.sa.gov.au/geoscience/geology/gawler_craton

Mount Nor'west, lying on a fault marking the east boundary of the Olympic Domain; a structure reactivated many times in the Proterozoic and Phanerozoic.

Key projects
active or initiated in 2015

Earth sounding network NCRIS2
Sponsor: Department of Industry
Chief Investigator: Prof Graham Heinson

Earth imaging NCRIS 2015
Sponsor: Department of Industry
Chief Investigator: Prof Graham Heinson

South Australian Chair of Mineral Exploration
Sponsor: Department of State Development, Government of South Australia
Chief Investigator: Prof David Giles

Reservoir architecture and heterogeneity in marginal marine systems – *WAVE* Consortium Phase II
Chief Investigators: Dr Rachel Nanson, Dr Boyan Vakarelov, Professor Bruce Ainsworth
Sponsors: Apache, Badr Petroleum Co, BG, BHP Billiton, BP, Chevron, ConocoPhillips, Nexen, OMV, Shell, Statoil, Todd, Woodside

The origin of Australian Gondwana – using isotopic proxies for subduction to reconstruct ancient oceans
Sponsor: Australian Research Council
Chief Investigator: Prof Alan Collins

The South Australian Thermochronometry Hub (SA Thermo)
Sponsors: Australian Research Council, Curtin University of Technology, Department of State Development – Geological Survey of South Australia, University of Melbourne
Chief Investigator: Prof Alan Collins

Calibrating electrical responses to natural fracture networks to support permeability mapping
Sponsor: Australian Geophysical Observing System
Chief Investigator: Prof Graham Heinson

Monitoring of shale gas exploration and exploitation
Sponsor: Australian Geophysical Observing System
Chief Investigator: Prof Graham Heinson

AusLAMP deep MT imaging of the South Australian crust
Sponsor: Department of State Development, Government of South Australia
Chief Investigator: Prof Graham Heinson

Deep Exploration Technologies Cooperative Research Centre

Regional mineral system drilling for targeting and testing
Sponsor: Deep Exploration Technologies Cooperative Research Centre
Chief Investigator: Prof David Giles

- Chemical engineering
- Mining engineering
- Geostatistics
- Materials engineering
- Petroleum engineering
- Community engagement
- Economics
- Environmental science and management
- Functional materials
- Optics and photonics

Deep mining

We are approaching a time where mining thousands of metres down into the earth will be the only option to obtain new mineral resources. Our understanding of rock behaviour and mining operations at this depth must keep pace to ensure we can mine safely and sustainably.

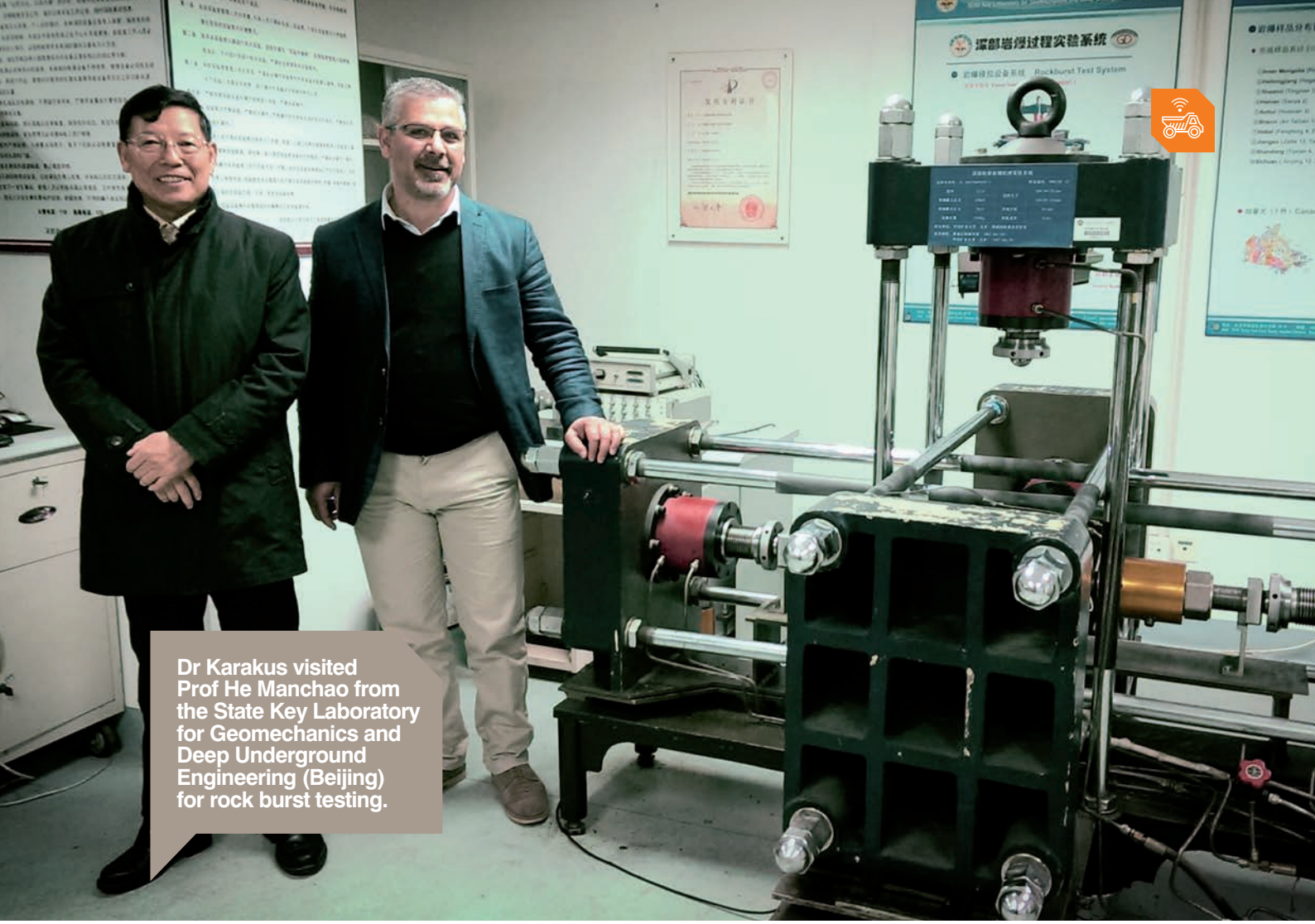
Around the world, resources are becoming harder to find and new finds are often at much greater depths and lower economic grades than before. For example, copper deposits were previously only mined at a minimum 'grade' of 1.0% copper, whereas now mining 0.8% or even less, is becoming more common.

The majority of high grade copper deposits have already been mined and so deep, underground mining is becoming more important. Deep mining poses many challenges, including those around mine construction, safety, energy and water use.

IMER is helping to address these challenges through:

- geomechanical research to help understand how different rock types within ore will fracture and predict the impact on mine stability and mineral extraction techniques
- geotechnical research which helps to model the safety and stability of underground or open pit mines
- modelling the point of rock burst, which will help to predict the stability of different rock types once pressure is released deep underground
- developing new, cost-effective materials to coat mine shafts and increase mine stability and new backfill materials to improve safety and dispose of mine tailings
- mine planning and optimisation for deep ore bodies under cover.

IMER is working to help industry plan and optimise their mining operations, as is shown in the OZ Minerals Ltd case study, and investigating key issues like rock burst and backfilling that will significantly impact on operations.



Dr Karakus visited Prof He Manchao from the State Key Laboratory for Geomechanics and Deep Underground Engineering (Beijing) for rock burst testing.

Case Study #3
Stability is everything in mining

Rock burst – rocks shattering in an explosive manner – threatens deep mining operations, with rocks at depth under extremely high pressure and temperature.

Dr Murat Karakus and his team are investigating rock burst using core samples from OZ Minerals Ltd's exploration drilling at Carrapateena mine site as part of an Australian Research Council Linkage project. These samples are tested in the laboratory under high pressures and temperatures to identify the nature of rock burst, with findings used to validate a constitutive model being developed for rock burst behaviour. The model, incorporated within ABAQUS software, simulates an underground mine layout to identify possible rock burst areas. Dr Karakus is testing this model at OZ Minerals Ltd's proposed Carrapateena mine (>1000 m deep) to help identify areas prone to rock burst and create a safe working environment.

Dr Abbas Taheri
Senior Lecturer, School of Civil, Environmental and Mining Engineering

Dr Murat Karakus
Senior Lecturer, School of Civil, Environmental and Mining Engineering

Cemented paste backfill (CPB) is a mixture of tailings, water, and cement used to fill underground stopes and is an important feature of underground mining operations. Alternate binder materials like fly ash, a by-product of coal combustion in power stations, are being considered to reduce costs and are proving effective. Dr Abbas Taheri is investigating the optimum values of fly ash, cement and water within paste mixtures and monitoring their behaviour to see how these pastes can be used as a cost effective material for backfilling in underground mining operations.

Project partner: OZ Minerals Ltd

Deep mining

Case Study #4
Bringing people together – industry-led research partnerships are key to success

OZ Minerals Ltd began partnering with IMER in 2014 to address some of the challenges they faced in their business, including deep resources, deep mining and complex processing. This relationship deepened and strengthened in 2015.

"We'd been developing the hydromet process to reduce the impurities in our concentrate and increase the quality of our product," said Mr Brett Triffett, Carrapateena Project Director, OZ Minerals Ltd.

"When Stephen [Grano] came along with the opportunity to partner in more fundamental research, it was perfect for us. We could outsource that **innovative work** to IMER and get on with the business of process engineering in-house," he said.

This research ended up being a key aspect of the **ARC Research Hub for Australian Copper-Uranium**, led by the University of Adelaide.

Brett Triffett
Carrapateena Project Director
OZ Minerals Ltd

"I don't think the capability exists to do this work straight off-the-shelf. That is what the strength of the IMER approach has been. Stephen pulled together a team of researchers from all over Australia in the different disciplines – he's put together the best of the best," he said.

"We're already talking about other projects, so I definitely see this as a long term relationship."

IMER and OZ Minerals Ltd have been working together for over 12 months and OZ Minerals Ltd is committed to the Hub for five years.

Read more about the project:
www.adelaide.edu.au/copper-uranium-research/

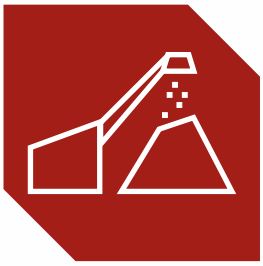
Photo courtesy OZ Minerals Ltd.

Key projects
active or initiated in 2015

A new damage model for rock burst in hard rocks during deep mining
Sponsors: Australian Research Council, OZ Minerals Ltd
Chief Investigators: Dr Murat Karakus, Dr Abbas Taheri, Dr Giang Nguyen

New nano technologies in shale and tight gas reservoirs
Sponsors: Australian Research Council, Santos Ltd
Chief Investigators: Prof Pavel Bedrikovetski, Dr Zhenjiang You, Dr Abbas Zeinijahromi
Collaborators: University of South Australia

State of South Australia Chair of Mineral Exploration
Sponsor: Department of State Development, Government of South Australia
Chief Investigator: Prof David Giles



- Chemical engineering
- Mining engineering
- Materials engineering
- Economics
- Regulation
- Politics and international studies
- Chemical sciences
- Earth science
- Environmental luminescence
- Environmental science and management
- Functional materials
- Geochemistry
- Geochronology
- Geology
- High energy particle physics
- Microscopy
- Mineralogy
- Molecular and cellular biology
- Molecular photoscience and ion chemistry

Complex processing

Geochemists, process engineers, technology specialists and sensor experts are all working together at IMER with national and international collaborators and industry partners to help boost our mining industry and economic prosperity.

Complex ores – those with more than one economic mineral (e.g. copper and gold) – are challenging to process as each mineral has unique chemical properties that requires a specific 'workflow' to extract the metals.

South Australia has some of the most complex mineral systems in the world, including the iron oxide-copper-gold-uranium ore deposits at Olympic Dam. Processing and separating different gases is also becoming more of a challenge as alternative fuels and natural resources are developed. IMER is addressing the challenge of complex processing with interdisciplinary research teams to:

- understand the conditions where minerals formed
- understand the movement of minerals in both solid and liquid phases, i.e. in ores, concentrates, solutions and suspensions
- map where minerals are in a rock without the need to break it up, and inform mining and processing operations in real time
- develop new techniques to detect and remove non-target metals
- improve heap leach technology and mineral extraction.

This year, IMER launched two new interdisciplinary, industry-led initiatives to address the challenge of processing complex minerals: the FOX project (understanding trace elements in iron oxides) and the Australian Research Council (ARC) Research Hub for Australian Copper-Uranium.

"Being able to find cost-effective ways of removing other metals from copper concentrates will provide a boost to the industry's economic prosperity, as well as its environmental sustainability. This work will help to ensure Australia is a world leader in copper production and associated technology." Prof Stephen Grano

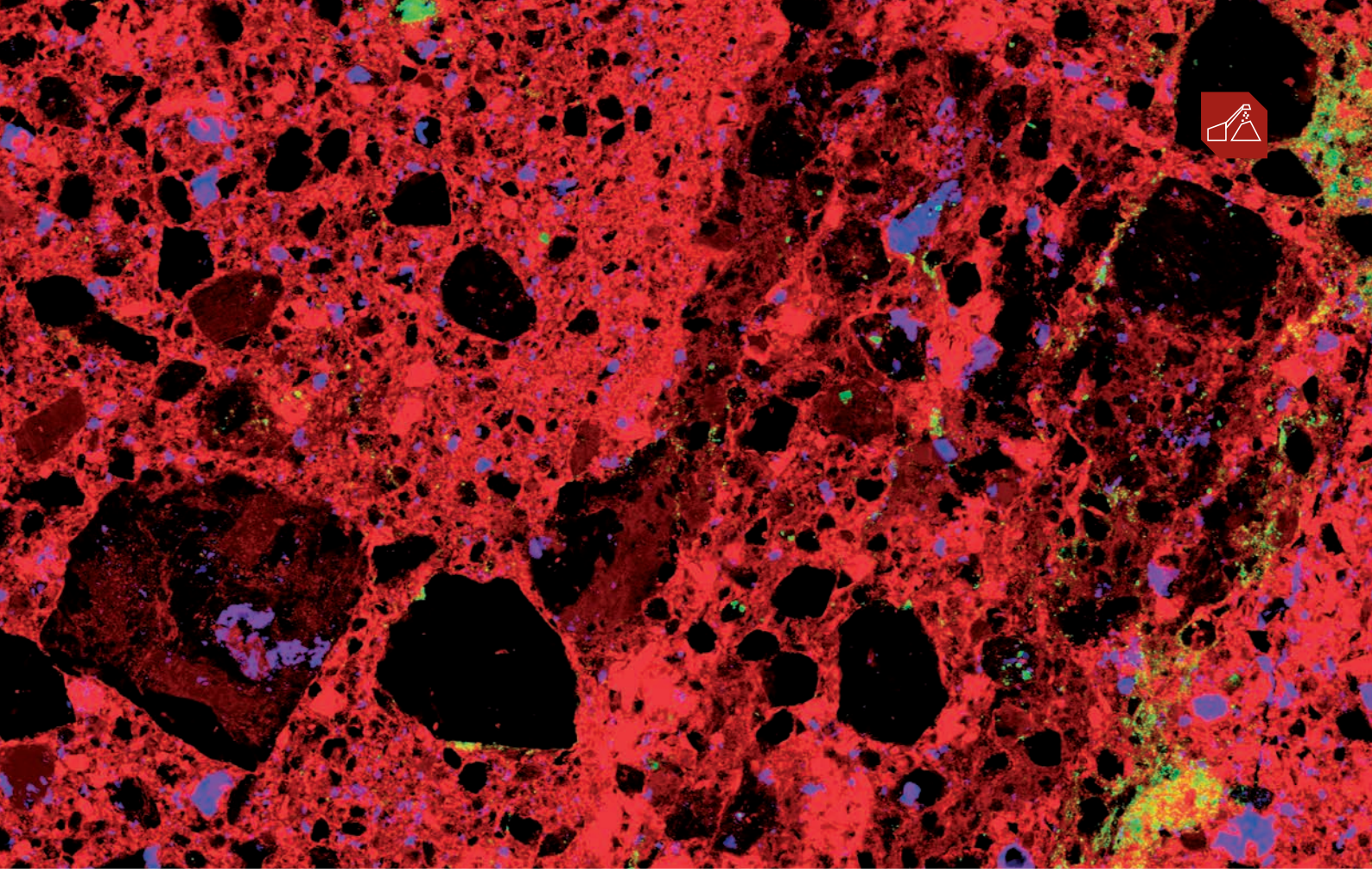


Photo courtesy BHPB

Case Study #5
Industrial Transformation Research Hub awarded to IMER

The Australian Research Council awarded more than $2.5 million over five years to the University of Adelaide to establish the $6.7M ARC Research Hub for Australian Copper-Uranium (the Hub). Launched in October 2015, the Hub will add significant value to Australia's $6 billion a year copper industry.

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

The industry needs to achieve high purity copper concentrates for market, but this is made difficult as South Australia's copper-uranium deposits are very complex both chemically, with many different metals in the ores, and structurally, where minerals present as very fine intergrowths. Hub researchers are using their knowledge of the complex distribution of minerals to develop a cost effective process to reject non-target metals from copper concentrates.

Although only in its first few months of operation, Hub researchers and sponsors have already come together to discuss the way forward for the ambitious research program. Professor Grano visited the OZ Minerals Ltd pilot plant testing facility in Vancouver to help understand their existing processing technology and identify research gaps that could optimise the process. In the year ahead, researchers will investigate the distribution and deportment of non-target elements in ores and concentrates at nano and micro scales.

Project partners include BHP Billiton, OZ Minerals Ltd, South Australian Government Department of State Development, Defence Science and Technology Group, Flinders University, Monash University, Australian Research Council, The University of Queensland, and UCL Australia.

Read more about the project and its four main areas of research:
www.adelaide.edu.au/copper-uranium-research/

Complex processing

Case Study #6
Tracing the origins of our large mineral resources

Two iron oxide minerals – hematite and magnetite – dominate giant Precambrian banded iron formation (BIF) deposits, the Earth's largest iron resource.

They are also abundant in iron oxide-copper-gold deposits, but there is still much we don't know about their formation and evolution. The FOX project – trace elements in iron oxides: deportment, distribution and application in ore genesis, geochronology, exploration and mineral processing – is investigating iron oxides to help understand how iron ores are formed and transformed.

Two student projects in 2015 conducted extremely detailed investigations of the iron ore deposits from Eyre Peninsula in South Australia. The electron microscopy investigations showed where hematite had replaced magnetite in the iron ore deposit and the team theorised how this occurred. By understanding this sort of detail our scientists hope to be able to characterise the globally important iron resources in Australia and be able to find new deposits in the future.

Dr Cristiana Ciobanu
Researcher, School of Chemical Engineering

The team is working to classify and fingerprint different types of ore deposits, trace the source of specific resources and create vectors for regional and mine-scale exploration.

Partners in the FOX program include BHP Billiton, SA Mining and Petroleum Services Centre of Excellence, Arrium Mining, Centrex Metals, University of Tasmania, Curtin University, National Isotope Geoscience Laboratory of the British Geological Survey (UK).

Four PhD students, selected from a worldwide search, joined the FOX program this year. They're joined by three visiting Chinese students on scholarships from the Chinese Science Foundation to work on research that feeds into the FOX project.

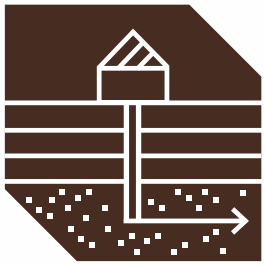
Key projects
active or initiated in 2015

FOX project – trace elements in iron oxides: deportment, distribution and application in ore genesis, geochronology, exploration and mineral processing
Sponsors: BHP Billiton, Department of State Development – Mining and Petroleum Services Centre of Excellence, Government of South Australia
Chief Investigators: Dr Cristiana Ciobanu, Prof Nigel Cook

Geobiological gold cycling: golden opportunities for the minerals industry
Sponsor: Australian Research Council
Chief Investigator: Dr Frank Reith

ARC Research Hub for Australian Copper-Uranium
Sponsors: Australian Research Council, BHP Billiton, OZ Minerals Ltd, Department of State Development, Government of South Australia
Chief Investigators: Prof Stephen Grano, Prof Nigel Cook, A/Prof David Ottaway, -
Collaborators: Environmental Protection Agency SA, Flinders University, University of Queensland, Monash University, UCL Australia, Defence, Science and Technology Organisation

Brett Triffett (OZ Minerals Ltd), Professor Aidan Byrne (Australian Research Council), Professor Stephen Grano (University of Adelaide), Jacqui McGill (BHP Billiton Olympic Dam), Professor Warren Bebbington (University of Adelaide) at the official launch of the ARC Research Hub for Copper-Uranium.



+ Mining engineering
+ Geomechanics
+ Geostatistics
+ Computer science
+ Petroleum engineering
+ Community engagement
+ Economics
+ Applied ecology and conservation
+ Earth science
+ Energy use, demand, environmental chemistry
+ Environmental science and management
+ Geochemistry
+ Geology
+ Geophysics
+ Mineralogy
+ Physics

Tight energy resources

Locked tightly in layers of rock, petroleum resources are becoming harder to efficiently extract. Similarly, the development of our geothermal industry is hampered by our limited understanding of rock fractures and fluid movement underground.

Many of the petroleum deposits around the world that can be easily accessed have already been exploited. Many oil, gas and geothermal resources are often locked tightly within multiple layers of rock which makes them much more difficult to access and extract.

This poses a challenge for the oil and gas industry which is under pressure to maximise efficiency, minimise cost and maximise well production. A similar challenge is faced in the geothermal industry, where 'unconventional' heat sources have been identified but drilling into and engineering the reservoir of hot water and steam is a massive technical challenge.

IMER is leading interdisciplinary teams that address these challenges by:

- investigating fractures, faults and flow – known as the structural permeability – of different oil, gas and geothermal environments to aid exploration and extraction
- mapping and monitoring the permeability of target areas to help predict the best methods for accessing the resources
- developing new technology that helps keep fractures or reservoirs open for resource extraction
- developing new tools to monitor geothermal, shale gas and coal seam gas production in 4D
- refining and developing new 'sweep' technology to make sure that all of the petroleum is lifted and separated from the rock to maximise extraction.

IMER hosts the South Australian Centre for Geothermal Energy Research, where experts in geomechanics, geophysics, stratigraphy, statistics, geochemistry and resource modelling – to name a few – are all working together to address these challenges. The Australian Structural Permeability Map Project and the 4D magnetotellurics program are two examples of this interdisciplinary approach in action.

Case Study #7
A new way to monitor unconventional resource development

IMER researchers can now 'see' how shale gas extraction affects the underground layers of rocks using magnetotellurics (MT).

MT is a deep-imaging geophysical technique that measures the electrical resistivity of the earth in order to map geological structures and detect movement of subsurface fluids.
Professor Heinson and his team used MT to monitor the entire fluid flow cycle in deep (~3000 m) shale in the Cooper-Eromanga Basin – a world's first. Working with Santos, they monitored the site before, during and after hydraulic stimulation and were able to detect changes over time. They've also tested the technique in a coal seam gas field (~400-700 m deep) and showed how MT can map the variability in gas production across a well field. The low cost technique is still being refined, but the potential benefits to industry are enormous.

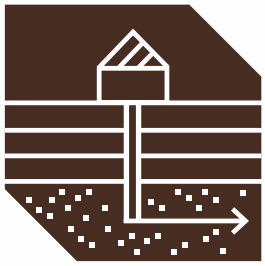
Professor Graham Heinson
Leader, Electrical Earth Imaging Group

MT could be used to optimise well placement, dramatically increasing field production and cost effectiveness as well as reducing environmental impact.

MT could also play a significant role in stakeholder social license to operate, with the team providing independent data on fluid flow to regulators, industry and the general public to address social and environmental concerns.

Partners in the programs include **Santos** (deep shale) and **QGC** (coal seam gas).

Read more about the project:
www.adelaide.edu.au/eei/



Tight energy resources

Case Study #8
Mapping Australia's structural permeability

Permeability is a measure of how easily liquids and gases can move through and be extracted from the earth, including hot water that can be used for geothermal energy.

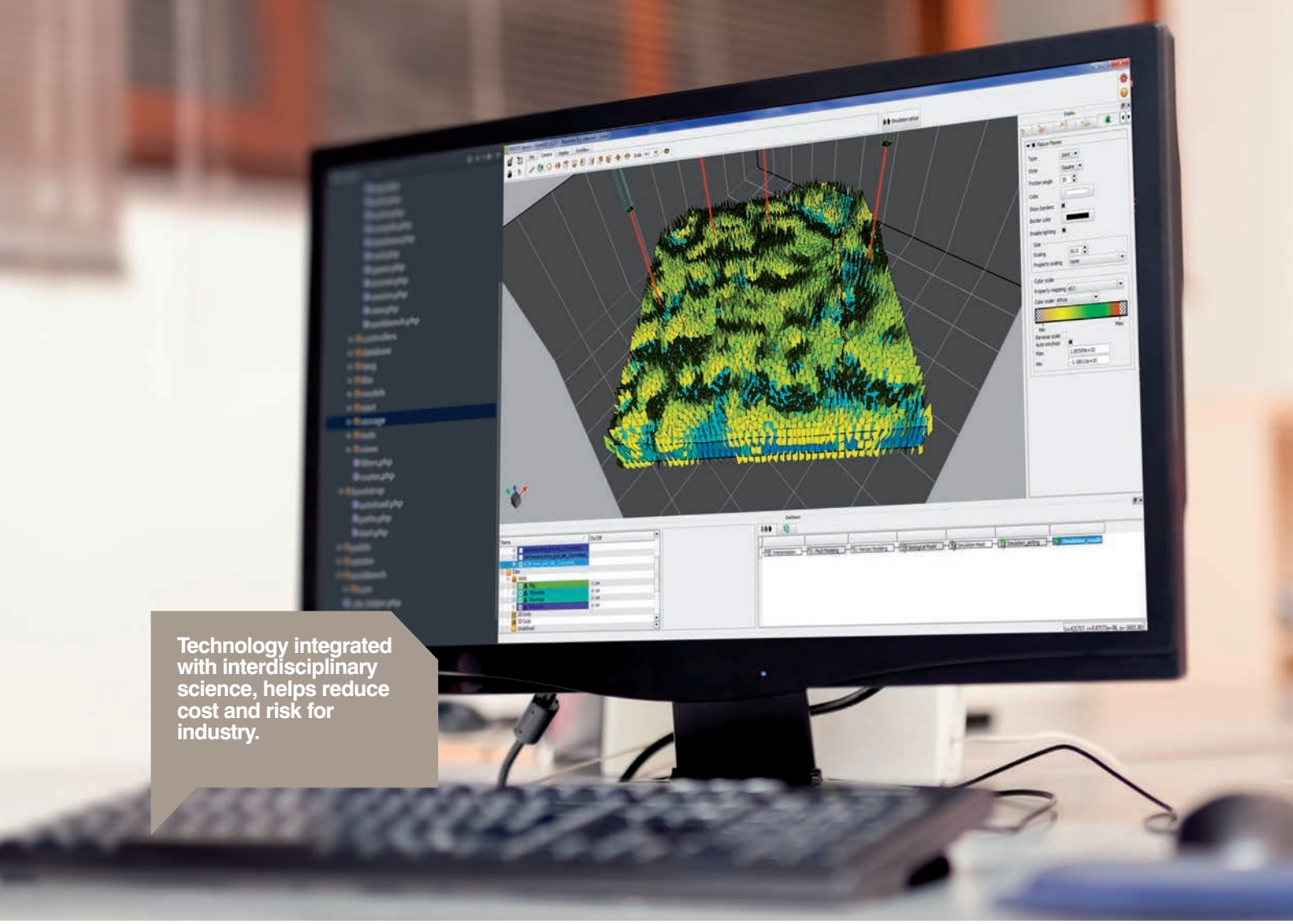
In geology, structural permeability is about fluids moving underground through faults and fractures. A greater understanding of Australia's underground structural permeability is critical to help identify resources and reduce the risk associated with geothermal projects ahead of drilling.

For the first time, IMER researchers will investigate structural permeability using advanced geophysical, geomechanical, and petrological techniques in a cross-disciplinary approach. Integrating these datasets will help deliver a unique map of Australia's natural fracture properties. The Australian structural permeability map project, which commenced in October, will develop new methods to detect fractures and predict how fluids will move through them.

Professor Martin Hand
Director, SACGER, School of Physical Sciences

Geothermal projects in Australia face major headwinds due to the high cost and risk involved with drilling deep underground. This research will develop a 'toolkit' for developers to predict permeability pathways and reduce the risks associated with drilling deep. Better understanding of the continent's structural permeability will also provide data and insight for carbon capture and storage, unconventional gas, and groundwater resources.

Partners in the program include the Australian Renewable Energy Agency (ARENA) and the University of Aberdeen.



Technology integrated with interdisciplinary science, helps reduce cost and risk for industry.

Key projects
active or initiated in 2015

Further funding for South Australian Centre for Geothermal Energy Research
Sponsor: Department of State Development, State Government of South Australia
Chief Investigator: Prof Martin Hand

Structural permeability mapping in Australia: de-risking geothermal exploration ahead of drilling
Sponsors: Australian Renewable Energy Agency, University of Aberdeen
Chief Investigator: Prof Martin Hand

Structural appraisal of the Cooper Basin: critical inputs into geomechanical modelling for well bore productivity
Sponsor: Department of State Development, Government of South Australia
Chief Investigator: Prof Martin Hand

Cooperative Research Centre for Greenhouse Gas Technologies

Reactive reservoir rocks
Sponsor: Cooperative Research Centre for Greenhouse Gas Technologies
Chief Investigator: Dr Ulrike Schacht

- Chemical engineering
- Mining engineering
- Computer science
- Electrical / Electronic engineering
- Materials engineering
- Mathematical sciences
- Mechanical engineering
- Economics
- Chemical sciences
- Energy use, demand, environmental chemistry
- Fuel technology
- Functional materials
- Microscopy
- Molecular and cellular biology
- Molecular photoscience and ion chemistry
- Nanotechnology
- Optics and photonics

Low cost, low emissions energy

IMER is creating pathways for companies and industries to transform their energy sources and use, and transition to a low carbon, sustainable future now, as well as developing new clean technology that will add value to the country over the longer term.

The consensus reached in December 2015 at the Conference of Parties (COP21) in Paris is the strongest signal yet that the international community is facing up to the threat of climate change.

The world needs to move towards a low carbon sustainable future to address climate change and unsustainable energy and resource consumption. Within Australia, our primary energy needs are split roughly into four categories of equal size: electricity, transport, industrial heat (including mineral and chemical processing) and other energy used in buildings, homes and some applications outside of the grid. Fuels used for transport and to generate industrial heat make up half of our primary energy needs, and IMER sees research in this area as crucial to accelerating our path to a low carbon future, along with renewable electricity generation and storage. IMER is addressing this challenge with national and international interdisciplinary research teams that are investigating:

- new ways to deliver heat to industrial processes, aside from burning fossil fuels, and increasing the efficiency of existing systems
- recycling carbon dioxide back into fuel, through waste to energy conversion processes, and fuel storage systems
- efficient energy storage systems, so that we can take advantage of renewable energy sources like wind and solar 24 hours a day
- new battery technologies and their compatibility with existing electricity networks
- sustainable energy networks, including microgrids, and the effect of energy storage devices on them.

IMER's Centre for Energy Technology is a world leader in these fields and is informing the transition to this 'New Energy Ecosystem' through research and development resulting in cost-effective clean energy technologies. The Centre brings together laser diagnosticians, technical economists, process engineers, numerical modellers, and chemical and mechanical engineers to create robust pathways to our clean energy future. Here, we feature just two examples of our interdisciplinary projects, the Energy Storage Knowledge Bank project enabling the establishment of a mobile energy storage test facility, and the Australian Solar Thermal Research Initiative, an $87 million, eight-year international collaboration with leading research institutions, industry bodies and universities that will position Australia in concentrating solar thermal (CST) power technologies.

Our low carbon future will need energy storage to supply sustainable, secure energy.

Case Study #9
Understanding the impacts of energy storage technology

This year saw us start the Australian Energy Storage Knowledge Bank (ESKB) project at IMER to help accelerate investment in reliable battery energy storage technologies.

There is very little real-life data on the performance of energy storage systems in Australian conditions, so the ESKB provides a central place for the collection and storage of data, reports and case studies.

The team is also building the mobile Australian Energy Storage Platform (AusStoragePlatform) as part of the program to help test energy storage systems under real and simulated grid and off-grid conditions. In 2015, the interdisciplinary team mapped the electrical and mechanical design specifications and worked with industry to find out more about their specific test requirements to help inform its design and development.

Associate Professor Nesimi Ertugrul
Centre for Energy Technology

Several components are already in place and the platform hardware is expected to be fully complete in 2016. Control and data logging software is currently under development for AusStoragePlatform.

Project partners include Australian Renewable Energy Agency, SA Power Networks, Solar Storage, SA Department of State Development, Energy Networks Association Australian Strategic Technology Program, ZEN Energy, and Power and Drive.

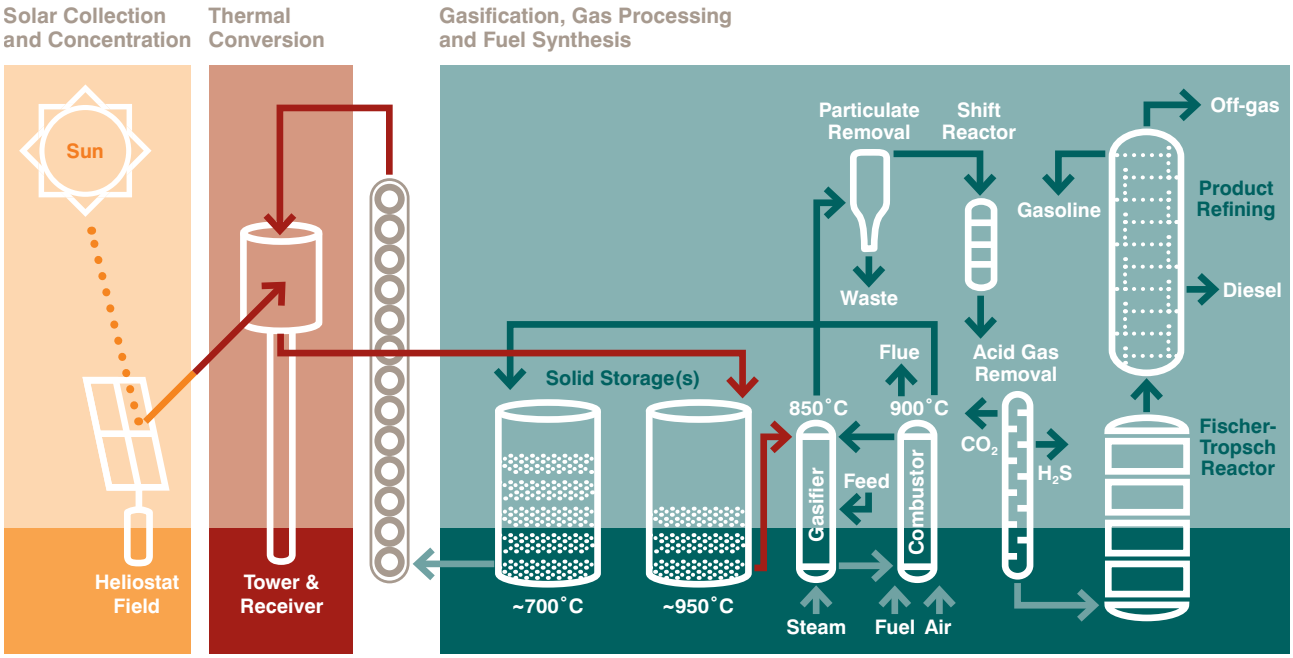
Read more about the project:
http://arena.gov.au/project/energy-storage-test-facility-and-knowledge-bank/

Low cost, low emissions energy

Case Study #10
Australian Solar Thermal Research Initiative

The Australian Solar Thermal Research Initiative (ASTRI) is an $87 million, eight year international collaboration with leading research institutions, industry bodies and universities that will position Australia in concentrating solar thermal (CST) power technologies.

Professor Gus Nathan heads **ASTRI's Node 4**: Adding product value – Reducing the operating and maintenance costs of solar thermal power plants with an interdisciplinary team from the University of Adelaide. Much of the team's work is applicable to both power and fuel technologies, including the liquid fuel process outlined in this case study.



Heliostat
A/Prof Maziar Arjomandi, Dr Farzin Ghanadi and Prof Gus Nathan are studying the effect of significant wind loads and turbulent flow approaching heliostats on heliostat performance to help optimise heliostat structure and reduce costs. The relationship between gust factor and turbulence intensity in the atmospheric boundary layer and the corresponding effects on heliostat structures has recently been assessed by the team.

Receiver
Dr Alfonso Chinnici, A/Prof Maziar Arjomandi and Prof Gus Nathan have developed a novel solar vortex reactor, known as the Solar Expanding-Vortex Reactor (SEVR), which can be used to heat inert or reacting particles at high temperatures and enhance thermal conversion. The team have recently lodged a patent application for SEVR.

DFB gasification, gas processing and fuel synthesis
Mr Peijun Guo, Dr Woei Saw, Dr Philip van Eyk, Prof Peter Ashman, and Prof Gus Nathan have developed a novel Solar Hybridised Dual Fluidised Bed (SDFB) gasification process for Fischer-Tropsch liquid (FTL), which can be used for transportation fuel. Based on the recent process modelling study, the SDFB concept offers a 34% reduction in CO_2 emission and a 30% improvement in the total energetic output (FTL and electricity) per unit input feedstock (lignite) compared with the non-solar system.

CO_2 reduction into valuable hydrocarbon products
Prof Greg Metha and his team have developed a novel process of solar-induced, photocatalytic conversion of carbon dioxide (CO_2) and water (H_2O) into useful and storeable hydrocarbons such as methane (natural gas). Prof Metha's work on novel catalysts, made up of sub-nanometre metal particles, also contributes to the ASTRI project.

Key projects
active or initiated in 2015

Development of functional dendrimer-like inorganic nanomaterials with hierarchical pores for biological applications
Sponsor: Australian Research Council
Chief Investigator: Prof Shizhang Qiao

Development of a world-class facility for three dimensional dynamic testing
Sponsors: Australian Research Council, Flinders University, University of South Australia, Swinburne University, University of Tasmania
Chief Investigator: Prof Ben Cazzolato

Establishing the Australian energy storage knowledge bank
Sponsors: Australian Renewal Energy Agency, Department of State Development – State Government of South Australia, Energy Networks Association, Power and Drive Solutions, SA Power Networks, Solar Storage, Zen Energy
Chief Investigators: A/Prof Nesimi Ertugrul, Prof Gus Nathan, Prof Bassam Dally, A/Prof Wen Soong, Prof Shizhang Qiao

Fabrication of solar fuel through photocatalytic reduction of CO_2 and H_20 to hydrocarbons
Sponsor: Department of Further Education, Employment, Science and Technology, Government of South Australia
Chief Investigator: Prof Greg Metha

Green cool wine: Solar powered solid adsorption refrigeration system with ice storage to provide cooling capability for wine industry
Sponsors: Australian Research Council, Premium Wine Brands
Chief Investigators: A/Prof Eric Jing Hu, Prof Mark Biggs, Dr Chen Lei

Mechanisms of sound absorption at the nanoscale
Sponsor: Australian Research Council
Chief Investigators: A/Prof Anthony Zander, Dr Carl Howard, Prof Ben Cazzolato
Collaborators: CSIRO

Nanostructured non-precious metal and metal-free catalysts for sustainable clean energy generation
Sponsor: Australian Research Council
Chief Investigator: Prof Shizhang Qiao

New understanding of turbulent flames with soot and particulate fuels
Sponsor: Australian Research Council
Chief Investigator: Prof Gus Nathan

New understanding and models for two-phase solar thermal hybrid reactors
Sponsor: Australian Research Council
Chief Investigators: Prof Gus Nathan, A/Prof Zeyad Alwahabi, Dr Maziar Arjomandi, Dr Zhao Feng Tian

Oscillating water column efficiency improvement through impedance matching and active latching control techniques
Sponsor: Australian Research Council
Chief Investigators: Prof Ben Cazzolato, Prof Gus Nathan, Dr Maziar Arjomandi

Self-assembling nanoporous graphene with dialable pore sizes for green energy
Sponsor: Australian Research Council
Chief Investigator: Prof Mark Biggs

Solving the energy waste roadblock
Sponsor: Science and Industry Endowment Fund
Chief Investigators: A/Prof Christopher Sumby, Dr Christian Doonan
Collaborators: CSIRO, University of Sydney

Tools for design and scale-up of solar thermochemical reactors
Sponsor: ARENA
Chief Investigators: Prof Gus Nathan, Prof Bassam Dally, A/Prof Zeyad Alwahabi, Dr Paul Medwell

Towards the application of MILD combustion to gas turbines
Sponsor: Asian Office of Aerospace Research and Development – United States Airforce
Chief Investigator: Dr Paul Medwell

Zirconium-metal organic frameworks for Pertechnetate
Sponsor: US Department of Energy
Chief Investigator: Dr Christian Doonan

Energy Pipeline Cooperative Research Centre

RP3-04B Future energy fluids
Sponsor: Energy Pipelines Cooperative Research Centre
Chief Investigator: Prof Peter Ashman

IMER engagement

Much of IMER's success in building teams to address industry challenges comes through engagement – building networks and relationships with industry, other research organisations and the community.

Photo courtesy OZ Minerals

Olympic Dam and OZ Minerals feature in Industry Innovation Seminar Series

The industry innovation seminars bring together people from research and industry – matching expertise with industry challenges. IMER held two major industry innovation seminars in 2015.

Olympic Dam executives Mr Darryl Cuzzubbo, Asset President Olympic Dam and Mr John England, Project Director, Process Technology and Studies, presented key challenges and priorities for BHP Billiton, focusing particularly on Olympic Dam. Key University of Adelaide researchers in the environmental, mining, geology, geometallurgy, mineral processing and social sciences fields attended and discussed research capabilities and opportunities for collaboration.

Five representatives from OZ Minerals Ltd discussed mineral exploration, resources, challenges and opportunities in South Australia at a seminar attended by more than 60 researchers from the University of Adelaide, Flinders University, University of South Australia and CSIRO. OZ Minerals Ltd representatives included Brett Triffett, Carrapateena Project Director; Mick Sawyer, Principal Geologist; David Goodchild, Principal Geotechnical Engineer; Justin Taylor, Principal Mining Engineer; and Katie Hulmes, Group Manager Technical Services.

Increasing connections and capability important for OZ Minerals Ltd

At the heart of the Industry Innovation Seminar Series is the drive to explore and solve problems for industry. For OZ Minerals Ltd, it's also an opportunity to increase capability within the sector.

"Researchers can sit with industry people and there can be some cross fertilisation. We want to build research capability in SA that's relative to us, so we don't have to go overseas to get this type of expertise," said Mr Brett Triffett, Carrapateena Project Director, **OZ Minerals Ltd**.

"As well as new opportunities to explore solutions to our challenges, our team benefits from the workshops as they are exposed to other ways of thinking about problems, creative approaches and cutting edge research that is applicable to their area of interest," said Mr Triffett.

Within the seminars and workshops, OZ Minerals Ltd subject matter experts present their challenges and researchers present their capabilities and discuss research opportunities. IMER team members also get to know OZ Minerals Ltd business and its unique operational constraints.

"We've held a couple of these workshops – one on our Carrapateena project as well as a mining specific workshop," said Mr Triffett. "We're also doing some work with IMER to help us improve the probability of us finding water at Carrapateena with our groundwater drilling program."

Prestigious summer school for tomorrow's leading mineral explorers

Thanks to funding from the Minerals Council of Australia, the University of Adelaide has developed the **National Exploration Undercover School (NExUS)** – a place where 30 of the best students from around Australia can meet and work with mineral exploration leaders from industry, government and research institutions. NExUS is a collaboration between universities, government and industry partners that will deliver a truly world-class national program of training. Conceived in 2015, the inaugural three-week school will begin in 2016.

Symposium brings together nation's *in-situ* recovery experts

Mining companies have turned their attention to finding ways of extracting target minerals from deep underground without physically going there. They do this by circulating fluids through the rock and dissolving the relevant minerals out. In December 2015 the University of Adelaide (IMER) and the CSIRO (Mineral Resources) jointly hosted a symposium to discuss the challenges and opportunities of this so-called *in-situ* recovery of sub-surface resources.

Scientists and engineers working in the industry sectors of unconventional hydrocarbon reservoirs, in-situ recovery of metallic ores, and engineered geothermal systems came together to discuss scientific approaches to address this key challenge through enhanced understanding of fracturing, fractures and permeability. As a result of the symposium, CSIRO are leading an initiative on in-situ recovery in collaboration with industry and the University of Adelaide may be involved in specific projects, particularly those involving South Australian resources.

Speakers at the two-day symposium included representatives from:

- University of Adelaide
- CSIRO
- Department of State Development
- Heathgate
- Santos
- Schlumberger
- University of Western Australia
- AMIRA International
- Minerals Research Institute of Western Australia
- University of Melbourne
- Halliburton
- Strata Control Technologies
- ACIM
- Inflatable Packers International
- Curtin University
- Carbon Energy Limited
- Hogarth Energy Resources
- Flinders University
- Orica
- University of Queensland
- Forbes Cool Energy
- University of Chile

Cross country engagement – Indigenous communities and private landholders part of national research initiative AusLAMP

The **Australian Lithospheric Architecture Magnetotelluric Project (AusLAMP)** team is collecting data on a 50 x 50 km grid across the country in a research partnership with State Government surveys and Geoscience Australia. Much of this land is remote, rugged and sparsely populated, and gaining access to it to conduct this research involves challenges around respectful and responsible stakeholder engagement. In South Australia, data has been successfully collected from a diverse and complex suite of land tenure and land interests, including 42 pastoral leases, 40 freehold properties, 6 national parks and reserves, numerous lands held by Traditional Owners, and the Woomera Protected Area land managed by the Federal Department of Defence. Stakeholder engagement included identifying and protecting Aboriginal Heritage areas, and complying with State and Federal legislation, including the *Aboriginal Heritage Act 1998, Native Title Act 1994 (SA), National Parks and Wildlife Act 1972*.

The team addressed Indigenous Heritage concerns with the relevant Council or Board responsible for managing the land, and this always involved travelling with Aboriginal people on to Country to inspect site locations before deploying equipment.

The experience for researchers, landholders and heritage monitors has been overwhelmingly positive and the team is looking forward to returning to communities across South Australia and sharing their results.

TRaX's research day

The **Centre for Tectonics, Resources and Exploration (TRaX)** held its annual research day on 24 July 2015 which showcased their research in geophysics, geology and new applications of technology in South Australia's Tier 1 resource regions. More than 80 people attended the research day, including staff, honours and PhD students from the University of Adelaide and representatives from industry and government.

Read more about the research day.

Conferences a place to learn, connect for researchers and industry

IMER members regularly attend conferences around the world to share their research and connect with industry. It is a chance for researchers to learn and develop relationships that often lead to applied research. Two casual conversations at the Australian Petroleum Production & Exploration Association (APPEA) conference in 2013 led to industry-supported research projects this year within IMER. Chevron, looking for expertise in 3D seismic analysis off southern Australia, funded a post-doctoral position with Dr Simon Holford, an expert in this field. Similarly, QGC partnered with Professor Graham Heinson in a **4D MT project monitoring coal seam gas**. IMER sees this type of engagement as crucial to its success, not only in disseminating research outcomes to benefit the community, but in creating connections that will drive research in the future.

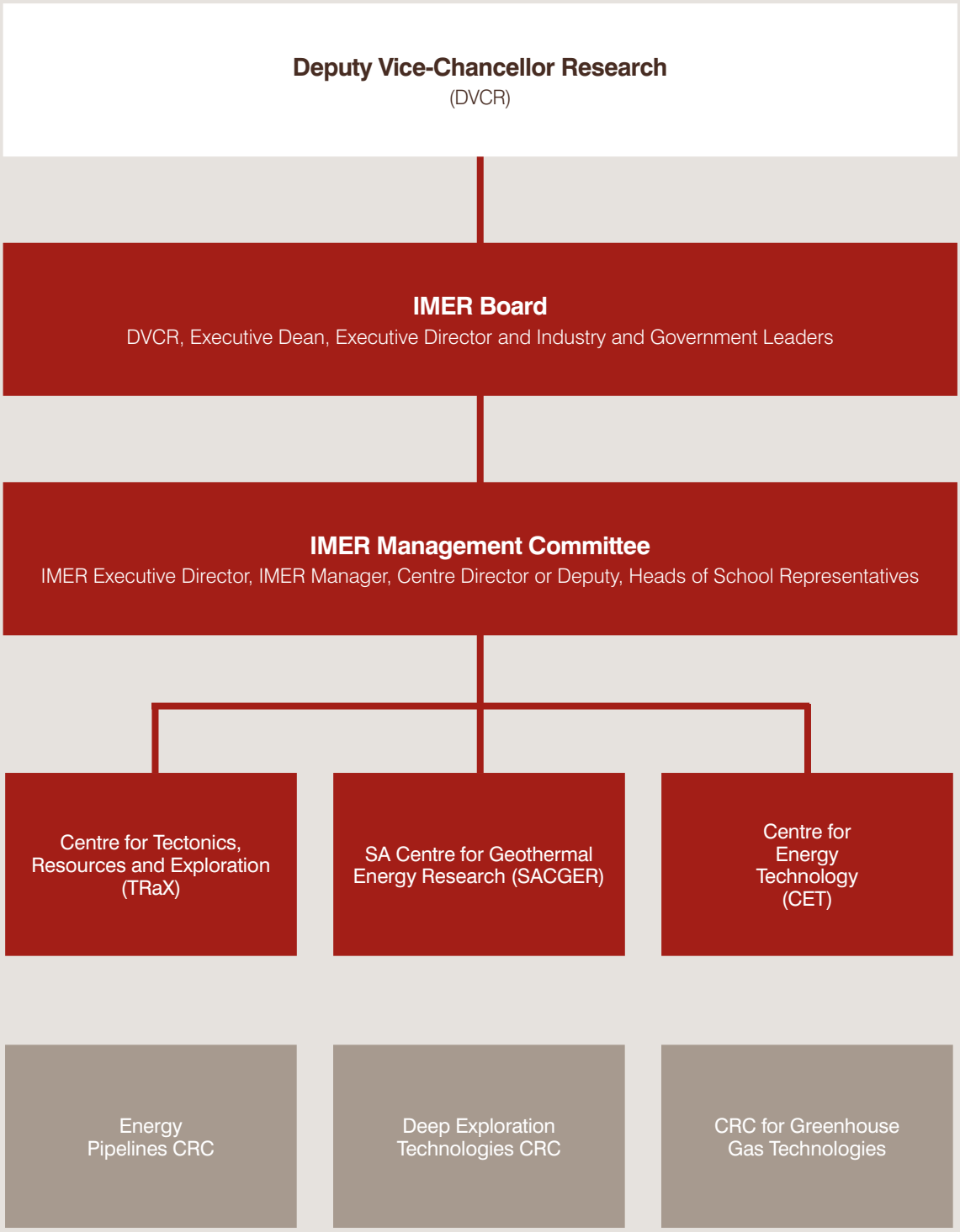
The 2015 World Geothermal Congress, attended by 2000 people, was hosted by Australia and New Zealand in Melbourne on 19 – 24 April with the theme 'Views from downunder – geothermal in perspective'. Eight members of the **South Australian Centre for Geothermal Energy Research** attended the conference, held every five years, including Prof Martin Hand, Alex Musson, Dr Chris Matthews, Dr Hani Abul Khair, Prof Pavel Bedrikovetsky, Pip Mawby and PhD candidates Alison Kirkby and Yohannes Didana. Yohannes, in a coup for the Geothermal Centre, won the award for best poster at the Congress, a title he will hold for the next five years until the next Congress in Iceland in 2020.

Australia: Energy superpower of the low-carbon world

The 2015 Luxton Memorial Lecture at the University of Adelaide, held by the School of Mechanical Engineering and the Centre for Energy Technology, was delivered this year by distinguished academic and economist, Professor Ross Garnaut. *Australia: Energy superpower of the low-carbon world* covered Australia's opportunities within the world's transition to a low-carbon economy.

View the lecture or read the transcript.

Organisational structure



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Dr Bronwyn Camac
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Mr John England
Project Director, Process Technology and Studies

Professor Stephen Grano
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Dr Paul Heithersay
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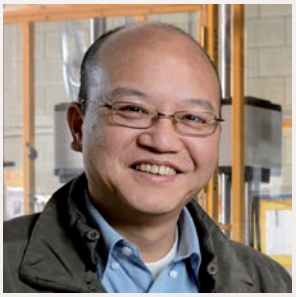


Associate Professor Chaoshui Xu
Leader, Resource Engineering Program, School of Civil, Environmental and Mining Engineering

IMER Executive

Professor
Stephen Grano
Executive Director

Dr Chris Matthews
Manager

Cooperative Research Centres

Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC)

Professor John Kaldi
Chief Scientist

Energy Pipelines Cooperative Research Centre (EPCRC)

Professor Peter Ashman
Program Leader

Deep Exploration Technologies Cooperative Research Centre (DET CRC)

Professor David Giles
Research Leader

Strategic framework

The Institute for Mineral and Energy Resources (IMER) was formed by the University of Adelaide to focus interdisciplinary research in mineral and energy resources, address globally significant challenges and enhance the impact of research.

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

Centre for Tectonics, Resources and Exploration (TRaX)

Understanding the evolving Earth and its resource potential.

TRaX provides a link between continental and regional-scale geology and deposits of minerals and petroleum to improve our understanding of deposit formation and develop predictive methods for the discovery of new deposits.

Our goal is to be the leading provider of research and teaching in tectonics, resources and exploration in Australia and conduct focused research into South Australia's unique geological characteristics.

TRaX research groups

- Reservoir Analogues Research Group (RARG)
- Electrical Earth Imaging (EEI)
- Continental Evolution Research Group (CERG)
- Stress, Structure, Seismic Group (S3)
- Metals, Ores, Minerals and Solutions (MOMS)
- Centre for Mineral Exploration Under Cover (CMXUC)

Professor Alan Collins
TRaX Director

South Australian Centre for Geothermal Energy Research (SACGER)

Working towards efficiently and sustainably managing the world's energy resources for the benefit of society, industry and the environment.

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

SACGER research areas

- Geophysical tools
- Fluid rock interactions
- Fracture modelling
- Crustal stress characteristics

Professor Martin Hand
SACGER Director, IMER Deputy Director

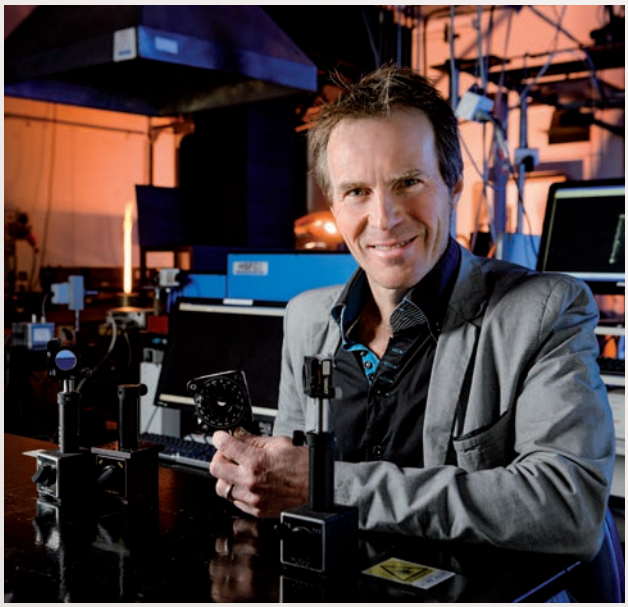
Centre for Energy Technology (CET)

We support the sustainable economic development of Australia through innovative clean energy technologies.

The CET integrates the science and technology of thermal-fluids, advanced energy materials and energy systems to generate cost-effective pathways to cleaner power and fuels, especially through hybridisation.

CET research areas

- Biomass/waste to energy
- Chemistry
- Combustion
- Electrical technologies
- Energy analysis and optimisation
- Energy efficiency
- Geothermal energy
- Mathematical modelling
- Solar energy
- System integration
- Transmission and storage
- Wind, wave and tidal power



Professor Gus Nathan
CET Director, IMER Deputy Director

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