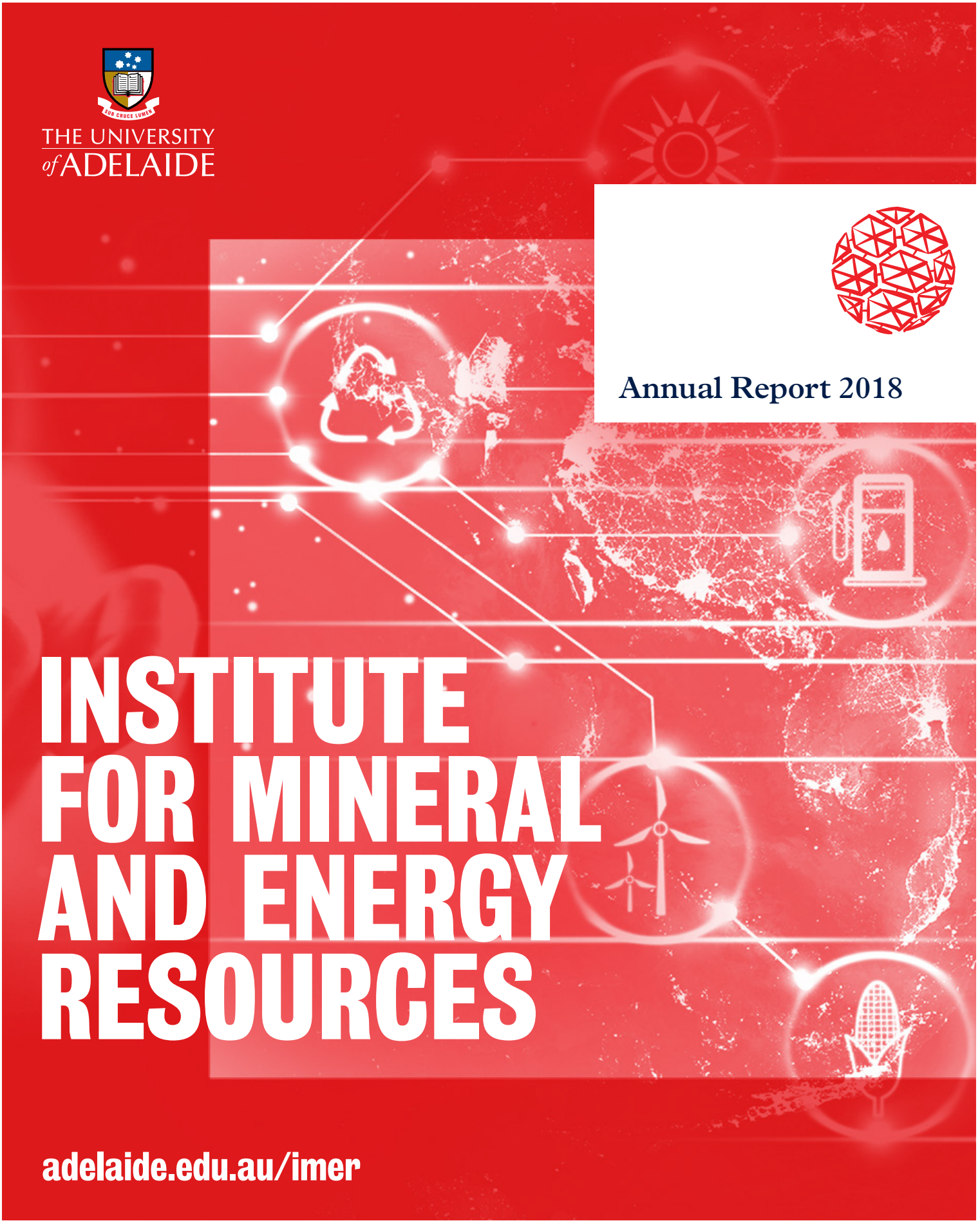
THE UNIVERSITY of ADELAIDE

Annual Report 2018

INSTITUTE FOR MINERAL AND ENERGY RESOURCES



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ABOUT THE INSTITUTE

MISSION

Be the gateway to the University of Adelaide for collaborative and interdisciplinary research.

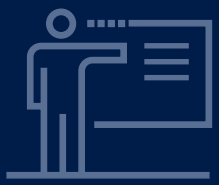
VISION

A world where agile and responsive research is key to the sustainable use and development of resources.

AIM

Maximise the impact of our research in energy and resources, to benefit industry, society and the environment.

$7.64m competitive funding (2018)



26 Research Leaders

240+ members

8 Research Priorities

8 Research Themes

COMPLETIONS IN 2018

15 Master Degree Students

85 PhD Students

PUBLICATIONS IN 2018

3 Books

220 Conference Papers

21 book chapters

700 Journal Articles

DEPUTY VICE-CHANCELLOR (RESEARCH) REPORT

Professor Anton Middelberg

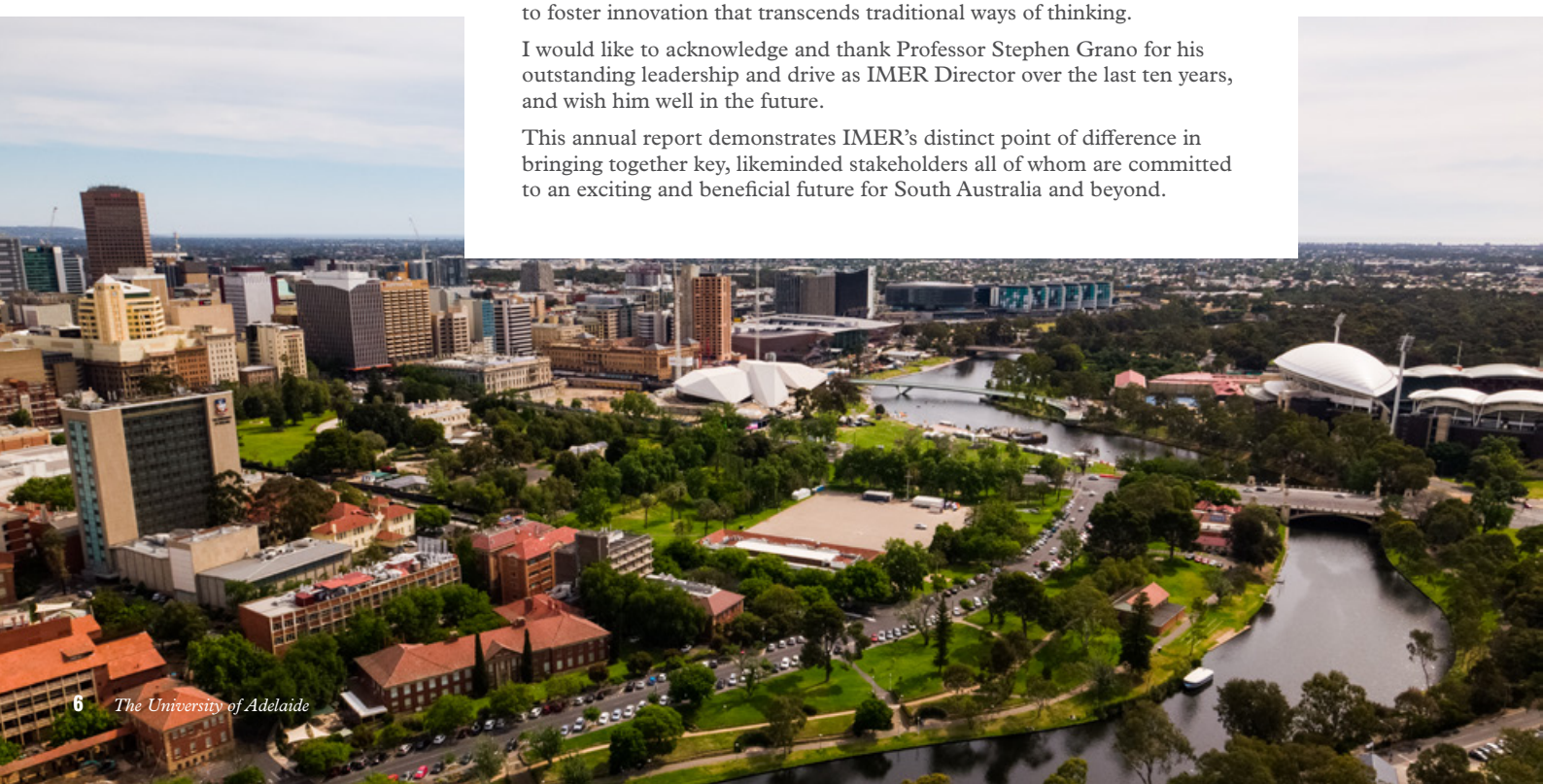
This is an impelling time in the mineral and energy resource sector. As the world's energy mix continues to evolve, and the way in which we view how a traditional mine operates rapidly shifts, the role of the Institute of Minerals and Energy Resources (IMER) continues to advance and develop.

IMER plays an integral role in the University of Adelaide's Strategy, 'Future Making', connecting Adelaide to the world, addressing grand challenges and fostering an interdisciplinary vision to ensure a long-term, economically-viable, socially-minded and environmentally-sustainable industry.

There is no doubt that South Australia has a remarkable opportunity to forge the necessary pathways and drive change for a global industry that is actively embracing the rise of big data, future technologies, automation and artificial intelligence, all of which are creating real societal change. With this opportunity also comes great challenges, which IMER will continue to address through the alignment of industry, government and global research to foster innovation that transcends traditional ways of thinking.

I would like to acknowledge and thank Professor Stephen Grano for his outstanding leadership and drive as IMER Director over the last ten years, and wish him well in the future.

This annual report demonstrates IMER's distinct point of difference in bringing together key, likeminded stakeholders all of whom are committed to an exciting and beneficial future for South Australia and beyond.



INTERIM DIRECTOR REPORT

Professor Michael Goodsite

It is an extremely exciting time to take over the Directorship of IMER. With our State's world-leading work in renewable energy and an announcement that the National Space Agency will call Adelaide home, this year saw the world continue to take notice of South Australia.

As global connectivity continues to shape the future, our State's opportunities need the best minds and problem solvers across a range of industry sectors. From resource exploration in space to knowledge transfer in battery deployment, IMER plays a critical role in creating an interdisciplinary approach to the new information-based economy, with South Australia at its heart.

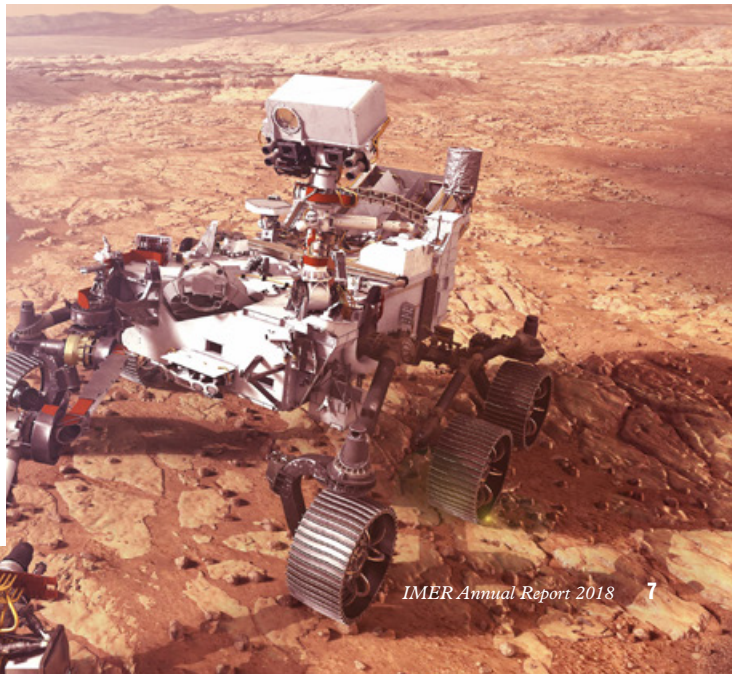
In direct correlation with the University of Adelaide's Five Key Pillar approach to Future Making, IMER is doubling down on its key industry engagement priorities including Mining & Resources, Defence, Cyber & Space and Agrifood & Wine.

Demonstrating its national reach, the University will lead a new ARC-funded mining research and training centre using advanced technologies to shape the future of Australia's mining operations. The $12.5 million centre will deliver enabling tools and train the next generation of scientists and engineers in advanced sensors, data analytics and artificial intelligence to increase value in mining and processing of complex resources.

This year also saw IMER increase the number, scale and success rate of national competitive grant applications, winning the following grants across various priority areas:

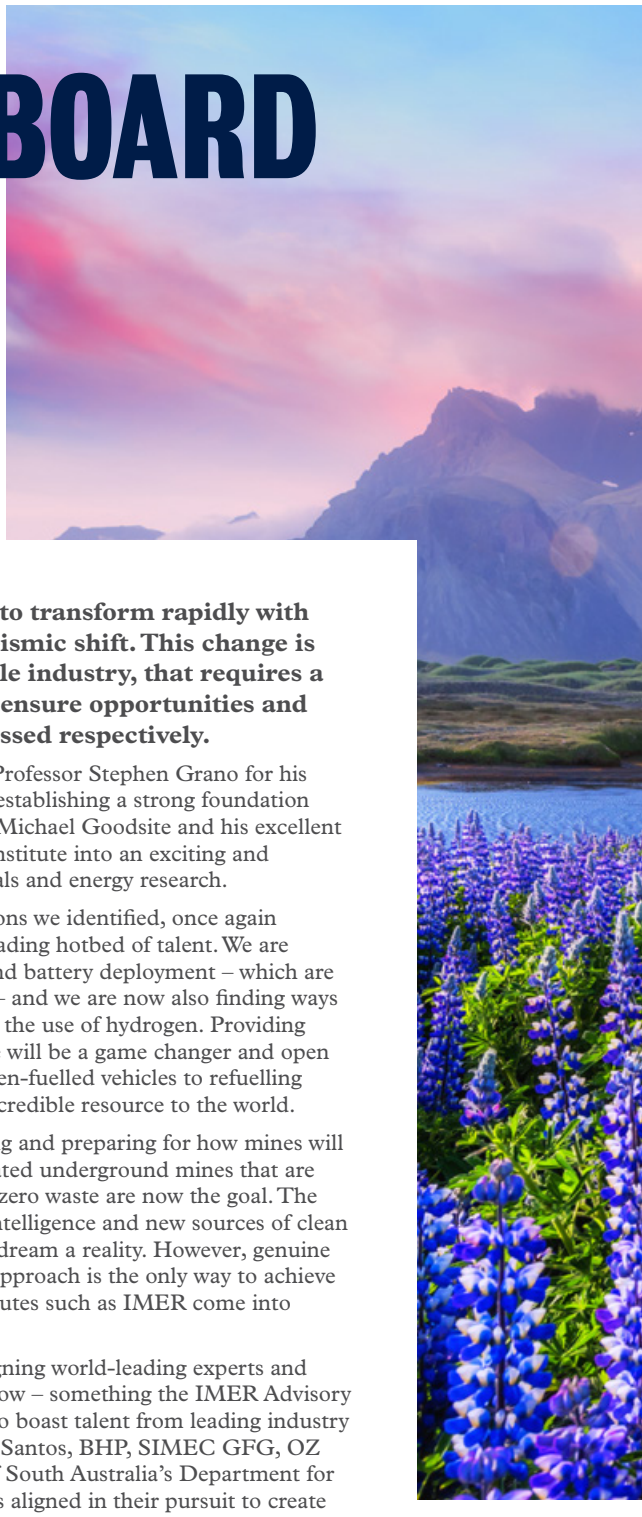
- **Complex Processing**
  The Kapunda In-Situ Copper and Gold Field Recovery Trial CRCP ($2.8M) led by Environmental Copper Recovery SA Pty Ltd in collaboration with Thor Mining PLC (Molyhil Mining), CSIRO, University of Adelaide, Mining3 and Terramin Exploration Ltd. The team will develop an In-Situ Recovery (ISR) process and demonstration site for the extraction of copper and other metals from diverse geological environments.
- **Sustainable Energy**
  IMER continued to demonstrate its commitment to an environmentally sustainable industry through three grant wins including the Future Battery Industries CRC ($135M over 5 years), Future Fuels CRC ($26M cash, $65M cash and in-kind over 7 years), to research and develop the transition of Australia's energy infrastructure to a low-carbon economy and Fight Food Waste CRC ($169M over 10 years) to increase industry profitability and reduce food insecurity.
- **Deep Resources**
  The MinEx CRC ($182M over 10 years), a new set of exploration tools and new ways to deploy those tools, which recognise the fundamental importance of collecting quantity and quality data from the subsurface.

2018 has set the scene for a number of exciting developments in South Australia and I congratulate all IMER team members for their outstanding work throughout the year, and thank Professor Stephen Grano for his service.



IMER ADVISORY BOARD CHAIR REPORT

Mr John Anderson



The resources sector continues to transform rapidly with IMER at the epicentre of this seismic shift. This change is vital to maintaining a sustainable industry, that requires a strategic direction for IMER to ensure opportunities and challenges are seized and addressed respectively.

The Board's appreciation also goes to Professor Stephen Grano for his colleagueship and successful efforts in establishing a strong foundation for IMER. We now welcome Professor Michael Goodsite and his excellent leadership record to transitioning the Institute into an exciting and increasingly technological era of minerals and energy research.

Our State is finding solutions to questions we identified, once again cementing our reputation as a world-leading hotbed of talent. We are already market leaders in solar, wind and battery deployment – which are solving many energy related questions – and we are now also finding ways to store and export this energy through the use of hydrogen. Providing enough hydrogen at an affordable price will be a game changer and open up a world of opportunity from hydrogen-fuelled vehicles to refuelling stations and of course exporting this incredible resource to the world.

IMER also plays a key role in envisaging and preparing for how mines will be operated in the future. Fully automated underground mines that are invisible from the surface and produce zero waste are now the goal. The rise of automation, robotics, artificial intelligence and new sources of clean energy are contributing to making this dream a reality. However, genuine collaboration and an interdisciplinary approach is the only way to achieve these innovations, which is where Institutes such as IMER come into their own.

At IMER we are strong believers in aligning world-leading experts and researchers backed by strategic know how – something the IMER Advisory Board has in spades. We are fortunate to boast talent from leading industry and government organisations, such as Santos, BHP, SIMEC GFG, OZ Minerals, AGL and the Government of South Australia's Department for Energy and Mines, and each member is aligned in their pursuit to create quantifiable economic, environmental and social impact for future generations.

Efficiency and optimisation within the mining and energy sectors are at the core of IMER's operating model and I thank the Board members, past, present and incoming, for their ongoing support and unique insight.

RESEARCH WITH IMPACT

Themes

Materials for energy and catalysts

Off earth resources

Heat, power and fuels

Energy and power systems transformation

Green hydrogen

Deep and automated mining

Complex processing

Energy geo-resources

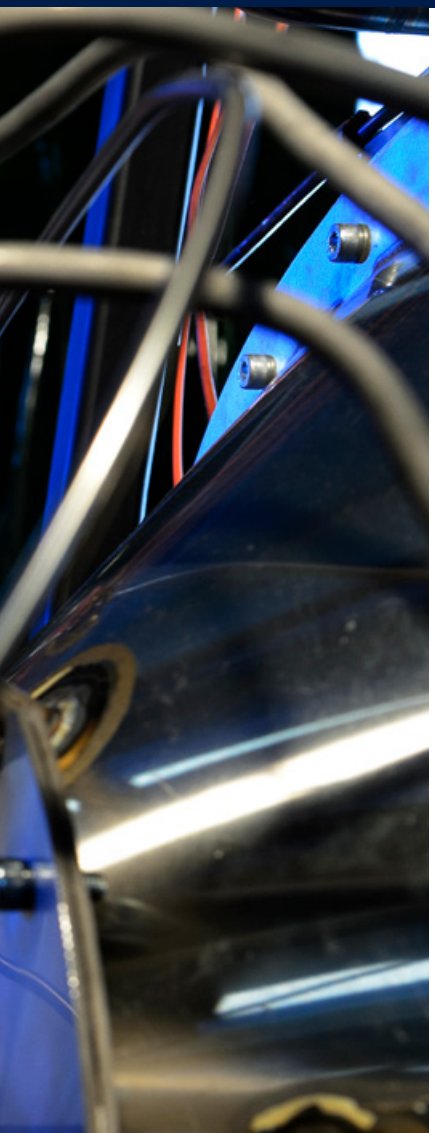
Deep resources

Capabilities

Computer science
Artificial intelligence
Machine learning
Robotics
Robotic vision
Visualisation including 3D
Virtual and augmented reality
Sensors and sensor networks
Data science
Optimisation
Automation
Techno economics

Impact

Scientific Discoveries
New Jobs
Training
Productivity Enhancement
Innovations
Advanced Products
Spin-Outs



How We Work

Create strategy with our researchers and partners, led by our Industry Advisory Board by:

- facilitating connections, including internationally
- communicating opportunities and providing resources
- preparing high quality and attractive proposals and expressions of interest
- hosting workshops and symposia.

What you can do: Come to our workshops, tell us about real-life industry challenges, or express interest in joining our Industry Advisory Board.

Research, innovate and engage in tailor-designed projects by:

- bringing together interdisciplinary teams
- leveraging new funding
- identifying and nurturing talent.

What you can do: Suggest a project idea, contribute cash or resources to a program, or host a postgraduate student in your workplace.

Make an impact by rolling out solutions to our partners by:

- establishing research leadership and growing our track record

What you can do: Provide access to data and sites for pilot tests, or host a postdoctoral researcher to tailor-fit solutions on-site.

Industry challenges

Energy

Australia, like the rest of the world, is seeking an orderly transition in its energy sources. A transition that is affordable, reliable and sustainable. We also seek enhanced productivity and low or zero-CO_2 energy exports.

Resources

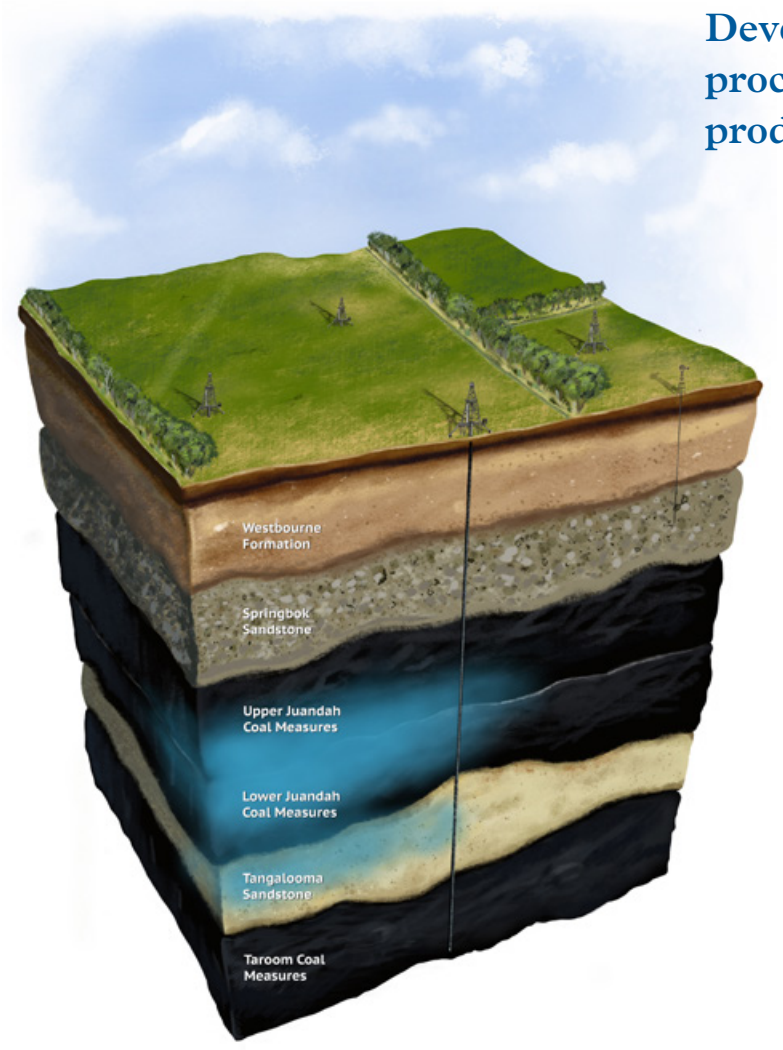
Australia is lucky to be well endowed with both mineral and energy geo-resources like coal, oil and gas. But we are one of the highest cost and most regulated countries in the world. We strive for efficient exploration, extraction and processing for deeper and more asources.

Our outcomes

We work strategically with industry and government to deliver least cost, reliable and sustainable energy and support Australia's commitments to international agreements.

We deliver low cost, highly productive, and low impact resource projects with a focus on energy and water sustainability, low carbon materials and reduced emissions.

INNOVATIONS IN PLAY



Developing new techniques and processes that rethink how we produce energy and resources.

Fluid flow imaging with 4DMT

What's really going on during fracking

How do fluids such as water, gas and petroleum move in the earth? The answer is largely guesswork. We can't physically see fluid pathways, so we guess by sampling, drilling and modelling.

With IMER's 4DMT, that changes now.

IMER has created a geophysics technique, using magnetotellurics (MT), to observe how fluids move over a period of time, such as when pumped by an operator.

Geophysics has been used to map the earth and the minerals in it for a long time. But until now they have never been used continuously over time to provide dynamic information.

To refine the technique, which we call 4DMT, our researchers monitored the entire fluid flow cycle - a world first - in a Cooper Basin shale gas frack before, during and after hydraulic stimulation. They detected changes over time.

Next, they tested the technique in a coal seam gas field and mapped the variability in gas production across a well field. The low cost technique is still being refined, but the potential benefits to industry, farmers concerned about impacts on groundwater, regulators and environment groups are enormous.

Partners: Santos and QGC.

Mineral resource discovery with DeepMT

Long-range geophysics to reconstruct the deep Earth in 3D

IMER has developed a way to locate the origins of mineral systems in the very deep Earth.

The finding was made after researchers left MT boxes at sites one to two kilometres apart for two weeks across the Olympic Domain in South Australia. The boxes recorded information about the Earth's magnetic field, and gave researchers enough data to reconstruct an image of the deep Earth in 3D.

They saw a clear link between deep (under the earth's crust) source rocks - 'footprints' of past events, where minerals are thought to have originated perhaps a billion or more years ago – and known, world-class mineral deposits.

When the team looked at the deep region below the Olympic Domain, they saw remarkable narrow structures that seemed to show where fluids containing minerals had moved from the source region to the surface. One structure led directly to Olympic Dam, one of the world's largest and most significant copper deposits. The fluid paths are at least partly supported by observations in seismic data.

DeepMT tells us something about the geology of the Earth that we can't otherwise access. It shows great promise for the use of MT for exploration under cover. We could apply this approach in different places to try to discover new mineral deposits. We could look for fluid paths from very deep structures, which could be new areas of high prospectivity.

IMER HAS DEVELOPED A WAY TO LOCATE THE ORIGINS OF MINERAL SYSTEMS IN THE VERY DEEP EARTH.

RESEARCH SPIN-OUTS

GREEN HYDROGEN

Carbon-zero hydrogen with solar thermal or photocatalysis

'Green' hydrogen is fast becoming a cost-competitive energy option for industry. IMER specialises in hydrogen production solutions, including:

- Bubble technology with molten metals using concentrated solar thermal (CST) and industrial waste heat. The metal could 'carry' hydrogen for future use or export.
- Photocatalysis to convert water and sunlight to hydrogen (and oxygen). IMER and partners have created materials with atomically-precise metal clusters that perform 'artificial photosynthesis'. The water doesn't even have to be pure.

Partners: US Army, University of Tokyo, ASTRI, Flinders University.

FERTILISER FROM AIR

Tailor-made nitrogen fertiliser anytime, anywhere

For farmers, buying just the right amount of fertiliser in a country with unpredictable weather is a tricky business.

IMER researchers are working on a new way to create nitrogen fertilisers, using a new kind of plasma, catalysts and just air and water.

The technology, once fully developed and trialled, will enable farms to produce just the right amount of fertiliser for their exact needs, such as their soil acidity level. And it could be used anywhere – even on the back of a truck, where it could be put to work in remote areas.

Funded by a European Research Council Synergy Grant SCOPE. Partners: University of Warwick, University of Antwerp, Eindhoven University of Technology and University of Messina.

GEOVISION

Intelligent vision for mining and exploration

Vast amounts of collected rock cores are not analysed, or are analysed poorly long after drilling. The 'digital mine' of the future will require much smarter technology than used now.

Geovision combines multi-sensory core scanners, data fusion and machine learning to capture geological and structural data at the exploration or mine site.

The ultimate product? A portable unit that can be moved from site to site to provide to-the-minute information via a dashboard.

Funded by a CRC Project Grant, led by Boart Longyear, and supported by SRA IT and IMER researchers.

ENVIROCOPPER

Could minerals be unearthed without active mining?

EnviroCopper is assessing the potential to recover mineral deposits from the ground without digging them out. By creating a 3D hydrogeological model of the historic Kapunda copper-gold mine area, the team is devising an approach for in-situ recovery of copper and gold in an innovative new way.

IMER brings expertise in geomechanical and geological modelling, and geophysical site characterisation to the project. Once demonstrated at Kapunda, the approach could be extended to similar deposits around the world.

Funded under a CRC Project Grant, the team comprises Environmental Copper Recovery, Thor Mining, Terramin Exploration, Mining3, CSIRO and IMER researchers.

SMART INTEGRATION ACROSS THE MINING VALUE CHAIN

WHY ENHANCE COMPLEX ORE PROCESSING?

Complex ores contain two or more minerals and are difficult or costly to treat. They can contain base and precious metals such as copper, gold, nickel, lead, zinc, and PGM.

By 2023, global copper production from existing and proposed mines is projected to be about 270,000 tonnes short of demand. This is based on a year-on-year increase in demand for copper, and steady decline in existing mine production.

(CRU Group 2019)

Modern thinking and technologies to process minerals better

The mining value chain comprises many steps, from rocks in the ground to materials going to market. Each step is an opportunity to optimise with new thinking and technologies. And the whole chain could be integrated so that each step 'talks' to the others.

A consortium led by IMER is doing these things in a bid to make the chain much more efficient. The Integrated Mining Consortium is maximising value and reducing costs for mineral producers of complex ores in five ways.

Machine learning, artificial intelligence

Computer science technologies offer unparalleled ability to target resource attributes and therefore optimise downstream processing. At the same time, they can rapidly deliver feedback to operators, who can then alter the mine plan on the fly.

Modelling, simulation, digital twins

Modelling and simulation are key tools for decision makers to analyse and predict mining operations and plant performance. Recent advances in virtual and augmented

reality offer an unprecedented visualisation capability bringing the models close to reality. The operator can monitor the plant processes and their parameters in near real time being able to identify the problem on the spot and make a quick decision to address the problem.

The consortium team is developing sophisticated near real time models to track ore characteristics from mine to mill.

Advanced data analytics

Our program includes finding new ways to collect data at all points of the mining chain. Data can feed back along the chain to give real time knowledge of the orebody and allow the mine plan to be updated, and forward to allow steps down the line to be optimised based on real time knowledge of what is coming down.

Automation and robotics (remote operations and controllers)

Robots are replacing humans in mines, with huge safety and cost-saving results. From robotic drills to self-driving trucks, the opportunities for automation are many.

The consortium is partnering with the key vendors of automation and control systems and equipment to automate grinding and flotation circuits.

Sensing and monitoring

The problem with mineral deposits is heterogeneity. There is variability in mineralogy, grade, hardness, lithology and grain size. This erodes value. The resultant feed variability makes mining and mineral processing costly. Sensors will pick up and communicate aspects of the ore to other parts of the chain, erasing this problem.

How the consortium works

In a series of research and industry translation projects, the team is developing, trialling and commercialising technologies and techniques that promise to improve the process of gaining value from mineral deposits.

The idea is to reduce wasted and inefficient efforts, which can happen in complex ore processing, to drive up profitability. At the moment, value is being lost all the way along the chain, exacerbated by rising energy costs and a shortage of crossover technical skills in computer science, mining and processing.

Modern resource challenges are interdisciplinary. They are not just about mining and processing anymore.

Funded by the Premier's Research and Industry Fund (PRIF) Research Consortia Program

KEY PROJECTS ACTIVE IN 2018

Deep resources

AusLAMP deep MT imaging of the South Australian crust

Sponsors: Geological Survey of South Australia; AuScope (NCRIS); AusLAMP
Chief Investigator: *Prof Graham Heinson*

East Antarctica: subglacial heat flux constraints for ice sheet modelling

Sponsors: Australian Research Council
Chief Investigators: *Prof Martin Hand; Dr Derrick Hasterok*

NCRIS-AuScope-A3.33 Earth imaging

Sponsor: Department of Industry, Science and Resources (Australian Government)
Chief Investigator: *Prof Graham Heinson*

Rehydration of the lower crust, fluid sources and geophysical expression

Sponsor: Australian Research Council
Chief Investigators: *Prof Martin Hand; Dr Derrick Hasterok*
Collaborators: Curtin University; Macquarie University; University of California

Source to spectrum: finding deposits beyond the Fe oxide-Cu-Au envelope

Sponsor: Australian Research Council
Chief Investigator: *Prof Martin Hand*
Collaborators: University of South Australia; Monash University

Tectonic geography of the world's oldest petroleum play, the McArthur Basin

Sponsors: Australian Research Council; Northern Territory Geological Survey (partnership); Origin Energy Resources; Santos
Chief Investigators: *Prof Alan Collins; Dr Juraj Farkas; Dr Stijn Glorie*

Testing the UNCOVER paradigm: crustal fluid pathways in the Curnamona Province

Sponsors: PACE Copper; Australian Society of Exploration Geophysicists Research Foundation
Chief Investigator: *Prof Graham Heinson*
Collaborators: Geological Survey of South Australia; Havilah Resources

Tight energy

Carbon capture and storage, seals, and unconventional resources

Sponsor: Department for Industry and Skills (Government of South Australia)
Chief Investigator: *Prof John Kaldi*

South Australian State Chair of Petroleum Geology

Sponsors: Primary Industries and Regions SA (Government of South Australia)
Chief Investigator: *Prof Peter McCabe*

New nanotechnologies in shale and tight gas reservoirs

Sponsors: Australian Research Council; Santos
Chief Investigators: *Prof Pavel Bedrikovetski; Dr Zhenjiang You; Dr Abbas Zeinijahromi*
Collaborator: University of South Australia

Low-cost, low-emissions energy

Converting Sunlight Innovation Challenge, Building Australia's international partnerships in solar fuels research and innovation

Sponsors: Australian Renewal Energy Agency – International Engagement Program
Chief Investigators: *Prof Gus Nathan*
Collaborator: CSIRO

Establishing the Australian energy storage knowledge bank

Sponsors: Australian Renewal Energy Agency; Department for Industry and Skills (Government of South Australia); Energy Networks Association; Power and Drive Solutions; SA Power Networks; Zen Energy
Chief Investigators: *A/Prof Nesimi Ertugrul; Prof Gus Nathan; Prof Bassam Dally; A/Prof Wen Soong; Prof Shizhang Qiao*

Integrating concentrating solar thermal energy into the Bayer alumina process

Sponsor: Australian Renewable Energy Agency
Chief Investigators: *Prof Gus Nathan; Dr Saw Woei; A/Prof Zeyad Alwahabi; A/Prof Maziar Arjomandi; Prof Peter Ashman; Prof Bassam Dally; Dr Zhao Tian; Dr Philip van Eyk*
Collaborators: University of New South Wales; University of Newcastle; Swiss Federal Institute of Technology; Australian Nuclear Science and Technology Organisation; Alcoa World Alumina; IT Power Australia; Commonwealth Scientific and Industrial Research Organisation

Novel Diagnostics Capabilities in Reacting, Particle-Laden Flows

Sponsor: Australian Research Council
Chief Investigators: *Prof Bassam Dally; A/Prof Paul Medwell*
Collaborator: University of Sydney

Shared picosecond laser facility

Sponsor: Australian Research Council
Chief Investigator: *Prof Greg Metha*

The control of the turbulent boundary layer on a flat plate using micro-cavities

Sponsor: Australian Executor Trustees - Sir Ross & Sir Keith Fund – Grants
Chief Investigator: *A/Prof Maziar Arjomandi*

Understanding of particle-laden flows for clean minerals processing

Sponsor: Australian Research Council
Chief Investigator: *Prof Gus Nathan; A/Prof Zeyad Alwahabi; A/Prof Maziar Arjomandi*
Collaborator: ETH Zurich

Deep mining

A new damage model for rock burst in hard rocks during deep mining

Sponsor: Australian Research Council; OZ Minerals
Chief Investigators: *A/Prof Murat Karakus; Dr Abbas Taheri; A/Prof Giang Nguyen*

Management of coal bursts and pillar burst in deep coal mines

Sponsor: Australian Coal Research Limited
Chief Investigators: *A/Prof Murat Karakus; A/Prof Giang Nguyen*

Cooperative Research Centre Project

Intelligent vision, sensing and data fusion for mining and exploration

Sponsor: Boart Longyear
Chief Investigators: *Prof Chunhua Shen; Prof Nigel Cook; Dr Damith Ranasinghe; A/Prof Yung Ngothai*
Collaborator: SRA IT

Cooperative Research Centre for Optimising Resource Extraction

University of Adelaide Essential Participant membership

Sponsor: BHP
Chief Investigators: *Prof Stephen Grano; Prof Peter Dowd; Prof David Ottaway; Adjunct Prof Nigel Spooner*
Collaborator: University of South Australia

Resource scale heterogeneity evaluation

Sponsor: CRC ORE
Chief Investigators: *Prof Peter Dowd; A/Prof Chaoshui Xu*

Complex processing

ARC Research Hub for Australian Copper-Uranium

Sponsors: Australian Research Council; BHP; OZ Minerals; Department for Industry and Skills (Government of South Australia)

Chief Investigators: *Prof Stephen Grano; Prof Nigel Cook; Prof David Ottaway; Adjunct Prof Nigel Spooner*

Collaborators: Environmental Protection Agency SA; Flinders University; University of Queensland; Monash University; Defence Science and Technology Group

ARC Research Hub on Graphene for Advanced Manufacturing

Sponsor: Australian Research Council
Chief Investigators: *Prof Dusan Losic; Prof Christophe Fumeaux; Prof Michael McLaughlin; A/Prof Reza Ghomashchi*
Collaborators: University of South Australia; Monash University; Tsinghua University; University of Cambridge; Catalan Institution for Research and Advanced Studies; Case Western Reserve University; Qingdao University; Ziltek; Tata Steel

Cooperative Research Centre Project

Kapunda in-situ copper & gold field recovery trial

Sponsor: Department of Industry, Innovation & Sciences
Chief Investigators: *Prof Peter Dowd; A/Prof Chaoshui Xu*
Collaborator: Environmental Copper Recovery Pty Ltd

FOX project – trace elements in iron oxides: deportment, distribution and application in ore genesis, geochronology, exploration and mineral processing

Sponsors: BHP; Mining and Petroleum Services Centre of Excellence (Government of South Australia)
Chief Investigators: *Dr Cristiana Ciobanu; Prof Nigel Cook*
Collaborators: Curtin University; University of Tasmania; British Geological Survey

Unlocking complex resources through lean processing

Sponsors: Department for Industry and Skills (Government of South Australia); BHP; OZ Minerals
Chief Investigators: *Prof Stephen Grano; Prof Peter Dowd; Prof Chaoshui Xu; Dr Tien-Fu Lu; Prof Nigel Cook; Dr Said Al-Sarawi; A/Prof Zeyad Alwahabi; Prof Chunhua Shen; Prof Frank Neumann; Dr Damith Ranasinghe; A/Prof Murat Karakus; Prof Carl Howard; Prof Craig Mudge; Dr Markus Wagner*
Collaborators: University of South Australia
Translation Partners: Australian Information Industry Association; Australian Semiconductor Technology Company; Boart Longyear; Consilium Technology; Datanet; Eka; Maggotteaux; Manta Controls; Maptek; Rockwell Automation; Sandvik Mining; Scantech; SRA IT; Thermo Fisher Scientific Australia
Supporting Partners: AMIRA International; CRC ORE; Innovyz; METS Ignited; SA Mining Industry Participation Office; SAGE Automation

IMER ENGAGEMENT

5 – 7 February 2018
Third Energy Future Conference & Australia-French Symposium

Held at University of New South Wales in Sydney, Professor Gus Nathan attended the Third Energy Future Conference and presented at the Australia-French Symposium.

The theme of the Symposium was the critical importance of energy and transition to new energy systems. An area where French-Australian research and innovation cooperation can generate substantial global impact.

24 February – 6 March
Austrade Moroccan & Iran Mining Mission

Dr Khalid Amrouch from the Australian School of Petroleum joined the Australia Unlimited MENA 2018 Mining Mission. The overarching theme of the mission was *New Markets* which focussed on opportunities in Iran and Morocco. The program for the mission was designed for Australian mining companies, providing unprecedented access to key government and industry stakeholders, plus projects in Iran and Morocco. The mission program included a series of targeted forums, roundtables and official meetings, as well as extensive media coverage. The visit led to numerous contacts that has ultimately resulted in delegation visits to Morocco by the Vice Chancellor, with prospective projects to follow.

28 – 29 May and 5 – 6 November
ARC Research Hub for Australian Copper-Uranium 5th and 6th six-monthly sponsor review meetings

The Australian Research Council Australian Copper-Uranium Industrial Transformation Hub is funded by the Australian Research Council, BHP, OZ Minerals, the Department for Energy and Mining (South Australian Government), and the Defence Science and Technology Group. Researchers from the University of Adelaide, Flinders University, Monash University and the University of Queensland are in year four of a five year project to collaboratively develop and test new, cost-effective ways to reduce radionuclides from copper concentrates in ores.

Monash University, together with Flinders University and the University of Adelaide have collaborated to understand radionuclide deportment as a function of mineral type, particle size and process stream. The University of Adelaide has developed liquid and solid radionuclide sensors to detect alpha and beta particles during mineral processing, hence measuring radioactivity in situ. The University of Queensland has successfully reached the industry requirement of less than 1 Bq/g of radionuclides in OZ Minerals ore using a two stage low temperature leach.

During 2018, the Fifth and Sixth Sponsor Review Meetings were held in Melbourne and Adelaide respectively. Sponsor meetings included research updates and collaboration discussions from postdoctoral researchers and postgraduate students. Science Steering Committee and Governing Board meetings follow each Sponsor Meeting. The Melbourne meeting included a tour of the Australian Synchrotron, whilst the Adelaide meeting included student development sessions covering grant writing and building professional resilience.

26 – 28 June
Energy and Mines Australia Summit

Attended by Professor Bassam Dally and Dr Chris Matthews. The University of Adelaide, through IMER, is the only University that attends this summit, which is attended by as many as 250 delegates from industry. This has led to numerous contacts and engagement events such as HiTeMP.

28 June
Copper to the World

The Copper to the World Conference 2018 followed from the success of the inaugural conference held in June 2017. The Conference was based around themes exploring both international and Australian perspectives on copper, innovation and engagement and discovering the next resource. IMER hosted two adjoining booths in conjunction with the GeoVision CRCp. GeoVision CRCp is developing new tools to enable near-real-time automated decision making at exploration and mining sites, which generated enthusiastic foot traffic through both booths, raising IMER's profile.

23 August
Launch of PRIF Consortium 'Unlocking Complex Resources through Lean Processing'

Launched by Hon David Pisoni, Minister for Industry and Skills, the PRIF Consortium 'Unlocking Complex Resources through Lean Processing' (the Consortium) is a collaboration between the University of Adelaide, BHP and OZ Minerals Ltd. The $14.1m four-year project is funded by the Premier's Research and Industry Fund Research Consortia Fund, BHP and OZ Minerals.

The Consortium members are a diverse blend of end-users, technology service providers and the research community. The partners of the Consortium are BHP, OZ Minerals, AMIRA International, Australian Semi-Conductor Technology Company, Boart Longyear, Consilium Technology, CRC ORE, Datanet, Data to Decisions CRC, Eka, Innovyz, Magotteaux, Manta Controls, Maptek, METS Ignited, Rockwell Automation, SACOME, Sandvik, Scantech, South Australian Mining Industry Participation Office (SA MIPO), and SRA IT, with the University of Adelaide as the Consortium Leader and the University of South Australia as a key research partner.

The Consortium is intended to help accelerate the mining sector's digital transformation, paving the way for the mines of the future, where integrated operations maximise resource value across the entire mineral chain. This will happen through an industry-university collaboration, developing, testing and demonstrating new technology and solutions for the mines of the future. South Australian mine sites with complex and challenging-to-process Iron Oxide Copper Gold (IOCG) ores are the perfect "living labs" for testing new technologies.

31 August
14th General Meeting Upper Spencer Gulf (GMUSG) Conference & Trade Expo

GMUSG is an industry owned supply-chain cluster representing contractors and suppliers to South Australia's resources and energy sector. GMUSG works with industry, mining operations, developers and exploration companies, and government agencies to assist its members to identify and secure opportunities. The themes of the Conference were designed to stimulate exploration of business opportunities, development of business relationships and profit from doing business in resources and energy. IMER hosted a booth and Professor Stephen Grano and Dr Larissa Statsenko attended the Conference along with 500 other delegates.

17 – 19 September
Inaugural HiTeMP Forum

Organised by the Centre for Energy Technology (CET) and supported by the Australian Renewable Energy Agency, the International Energy Agency, the German Aerospace Centre (DLR), Arizona State University, and other industry specialists the Zero Carbon Minerals Forum was all about decarbonising high temperature processes. The Forum brought together companies, researchers, investors and policy makers to scope further action on decarbonising the mineral processing sector. The themes addressed at the Forum were:

- Opportunities to become more globally competitive
- Metal reduction, particularly for iron and steel
- Calcination, particularly for alumina and cement
- Zero carbon fuels and materials, including hydrogen, syngas and oxygen

Keynote speakers included Dr Masaki Onozaki, Institute Applied Energy; Alastaire Dick, Rocky Mountain Institute, Professor Christian Sattler (DLR); and Raphael Costa, Hydro Bauxite and Alumina. Sanjeev Gupta, GFG Alliance provided a specially prepared video addressing the 'Global Perspective on Energy in the Steel and Aluminium Industries'.

The Forum attracted more than 100 delegates from Australia, Japan, Germany, South Africa, USA, Sweden, Brazil and Norway, with roughly equal representation from industry, research and Government.

The Forum's outcomes included clear indications of industry's wants and needs and clear directions for future research and target sources from industry to fund it. Valuable contacts were made, with opportunities for further co-operation established.

2 – 7 October
SolarPACES 2018

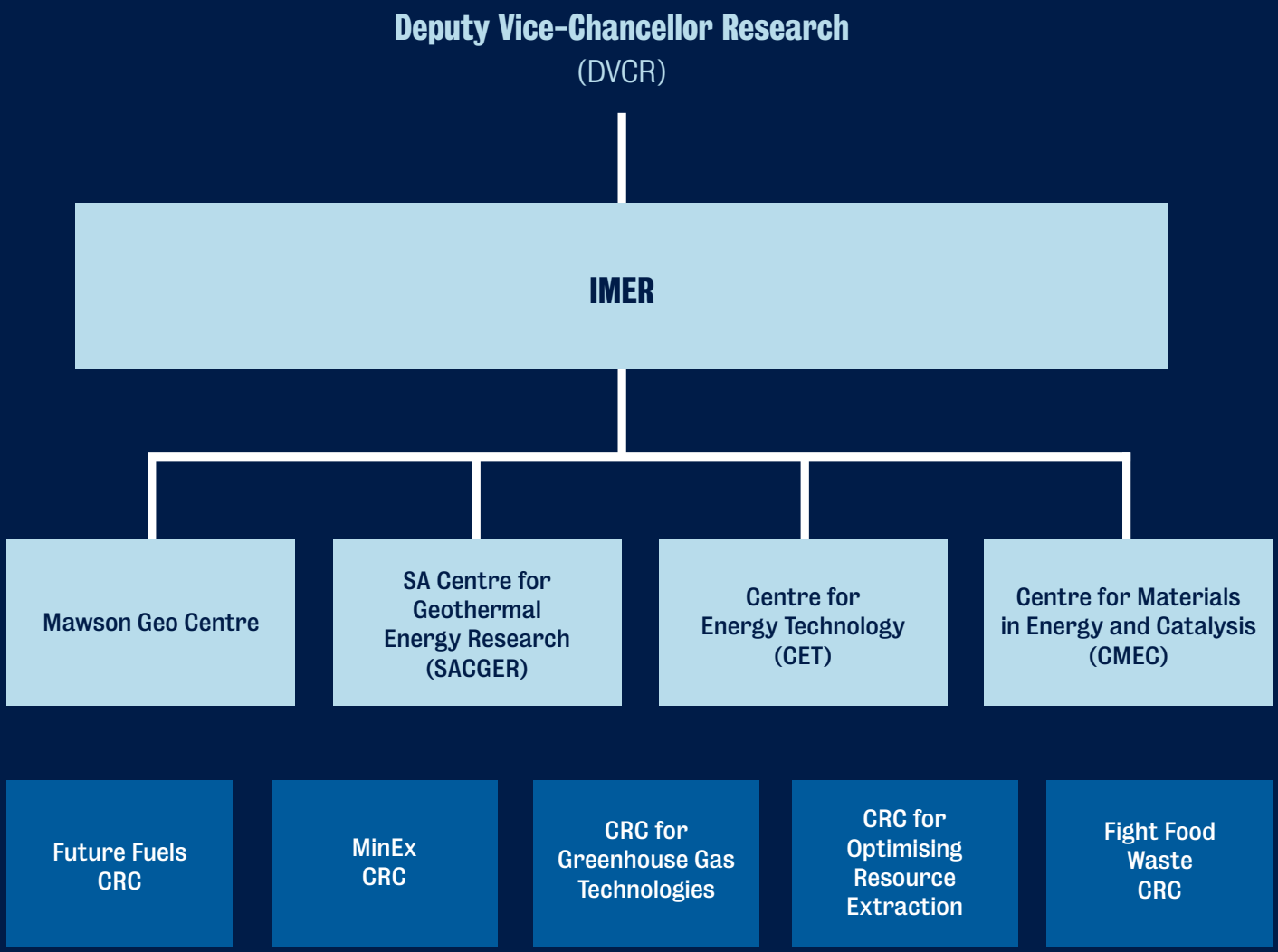
Professor Gus Nathan, who directs the University's Centre for Energy Technology, attended SolarPACES 2018 in Casablanca, Morocco. This symposium in concentrating solar power and chemical energy systems offers a forum for research, industry, politics and financing stakeholders within the framework of a scientific conference program with leading world experts.

SolarPACES (Solar Power and Chemical Energy Systems) is an international cooperative network bringing together teams of national experts from around the world to focus on the development and marketing of concentrating solar power systems (also known as solar thermal power systems). It is one of a number of collaborative programs, called Implementing Agreements, managed under the umbrella of the International Energy Agency to help find solutions to worldwide energy problems.

29 – 30 November
Australasian Lab for Cyber Security Ideas (ALCSI)

ALCSI aspires to be a catalyst in stimulating Cyber Security research, training, innovation, and entrepreneurship. This ideas lab, which featured lightning talks including one theme dedicated to Cyber Security for Mining and Energy Systems was attended by Professor Ali Babar from the School of Computer Science.

2018 ORGANISATIONAL STRUCTURE



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IMER

STRATEGIC FRAMEWORK

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.

MAWSON GEO CENTRE

The Mawson Geo Centre consolidates the geosciences at the University of Adelaide.

The Mawson Geo Centre sheds light on the evolving Earth and its resource potential. Our researchers study the tectonics of the planet and apply an exploration philosophy to understanding earth processes and their control on resource endowment. We do this by building multidisciplinary teams that cross traditional university boundaries.

We also provide teaching opportunities in tectonics, resources and exploration across the world, with a focus on the controls on Australia's resources.

Mawson Geo Centre research areas

- Stress, structure and seismic
- Sedimentary isotope geoscience
- Reservoir analogues
- Tectonic geography
- Continental evolution
- Geothermics
- Electrical earth imaging
- Global heat flow
- Minerals

Professor Graham Heinson
Mawson Geo Centre Director

CENTRE FOR MATERIALS IN ENERGY AND CATALYSIS (CMEC)

Creating materials for the next generation of energy and catalysis solutions.

CMEC is a materials-engineering research leader, developing new materials and catalysts to enable positive social, environmental and economic impact.

South Australia is internationally renowned as a leader in renewable energy. CMEC is committed to maintaining and enhancing the state's profile in this globally critical sector through fundamental research that facilitates a cleaner, greener future.

CMEC research areas

- Energy storage
- Electro-catalysis
- Solar energy
- Modelling
- Hetero-catalysis
- Bio-catalysis

Professor Shizhang Qiao
CMEC Director

SOUTH AUSTRALIAN CENTRE FOR GEOTHERMAL ENERGY RESEARCH (SACGER)

Working towards efficiently and sustainably managing the world's unconventional energy resources.

SACGER's research is focussed on understanding the thermal state, structure and evolution of the Australian crust and the continental regions that are connected to it. We carry out practical, high-priority research on geothermal systems and tight unconventional energy resources such as shale gas.

SACGER research areas

- Heat flow
- Structural permeability
- Reservoir quality
- 4D magnetotellurics
- Rock thermal properties

Professor Martin Hand
SACGER Director,
IMER Deputy Director

IT IS PEOPLE THAT DRIVE INNOVATION AND POSITIVE CHANGE.

CENTRE FOR ENERGY TECHNOLOGY (CET)

Developing clean, reliable, affordable energy technologies.

CET works with industry partners and builds research teams to develop innovative, low emissions energy solutions for sustainable fuels, mineral processing and power. We do this by retro-fitting innovative technologies to existing systems, and by developing new carbon neutral and carbon negative technologies to replace existing heat, power and fuel production systems, especially through hybridisation.

CET research areas

- Biomass/waste to energy
- Sustainable fuels including hydrogen
- Combustion
- Electrical technologies
- Energy analysis and optimisation
- Energy efficiency
- Energy materials
- Energy storage
- Hybrid solar technologies
- Mathematical modelling
- Solar energy, including solar thermal and concentrating solar power
- System integration
- Transmission and storage
- Wind, wave and tidal power

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