

## SMI VISION

TO CREATE THE CAPABILITY FOR THE MINERALS INDUSTRY TO EFFECTIVELY TRANSITION TO SUSTAINABILITY.

## SMI MISSION

TO BE A WORLD LEADER IN PROVIDING KNOWLEDGE-BASED SOLUTIONS TO THE SUSTAINABILITY CHALLENGES OF THE GLOBAL MINERALS INDUSTRY.







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# VICE- CHANCELLOR'S REPORT

Throughout 2010-11 the Sustainable Minerals Institute worked with the sector, communities and government to prepare for a future beyond the current resources boom, where business strategies are naturally integrated with social and environmental objectives.

SMI is now a decade old, yet remains unique in the world as a dedicated life of mine institute conducting research across all aspects of the industry – including water, safety and health, social responsibility and mined land rehabilitation.

With experts from a wide range of disciplines, it is able to offer diverse teams that make distinctive contributions in anticipating challenges, as well as addressing them. It has built a staff of 300 from backgrounds including anthropology, geology, soil science, sociology, hydrology, engineering and mine management, along with approximately 100 postgraduate students from countries across the globe.

The students' experiences in a variety of industries equip them to offer fresh perspectives to the resources sector. Like the industry professionals taking part in continuing education, this corps of students will be integral to the effectiveness of SMI's NextMine™ and NextWorkforce™ initiatives, which together have the potential to revolutionise the sector.

While the 10th anniversary in 2011 was a time to salute and build on the work of SMI's pioneers, it was also a year to develop and launch new strategies.

Given SMI's commitment to sustainable outcomes for industry, community and government, the Institute was the logical home for UQ's new Centre for Coal Seam Gas (CCSG). CCSG will address knowledge gaps in the key areas of water, geoscience, petroleum engineering and community impact and has the capacity to emerge as a global leader for scholarship, discovery and engagement.

SMI has proven its ability to interact with all levels of industry while upholding the research integrity demanded throughout UQ. It delivers quality, innovative outcomes for businesses that want to improve their interactions with people and the environment, as well as their mining operations.

Such important work only succeeds if it is carried out by dedicated, passionate people who want to work in teams. So, I congratulate Chris and all SMI staff and students on their contributions and commitment to an effective – and eventually sustainable – global resources industry.



**Deborah Terry**  
Vice Chancellor, UQ



Professor Deborah Terry  
Vice Chancellor, The  
University of Queensland



# BOARD'S REPORT



Mr Charlie Sartain  
Chief Executive, Xstrata Copper  
Chair, SMI Advisory Board

## Board Members

Former Chair	<b>Nick Stump</b>
Anglo American Australia	<b>Susan Johnston</b> (until June 2011) <b>Mike Oswell</b> (from June 2011)
Anglo American Platinum	<b>Dr Neville Plint</b>
BHP Billiton Mitsubishi Alliance	<b>Steve Hadwen</b>
Carabella Resources	<b>Mitch Jakeman</b>
Codelco – Corporación Nacional del Cobre de Chile	<b>Juan-Pablo Schaeffer</b>
Department of Natural Resources and Mines, Queensland Government	<b>Dan Hunt</b>
Ensham Resources	<b>Colin Moffatt</b>
Newcrest Mining	<b>Nick Currey</b> (until February 2011) <b>Greg Jackson</b> (from February 2011)
Newmont Mining Corporation	<b>Ian Suckling</b> (until September 2011) <b>Kenneth Ramsey</b> (from September 2011)
OZ Minerals	<b>Terry Burgess</b>
Rio Tinto Coal Australia	<b>Bill Champion</b>
The University of Queensland	<b>Professor Deborah Terry</b>
Thiess	<b>Simone Wetzlar</b> (until August 2011) <b>Ian Neill</b> (from August 2011)
Xstrata Copper	<b>Charlie Sartain</b>

It has been my privilege in 2011 to take on the role of Chair of the SMI Advisory Board, following on from the valued service of Founding Chair Nick Stump, formerly the CEO of MIM Holdings. Nick's leadership, combined with the enthusiasm and ongoing commitment of fellow Board members, has contributed to SMI's rapidly growing success as a collaborative research organisation.

The Institute's successes were celebrated during SMI's 10th anniversary year. SMI was established by a forward thinking group of stakeholders from the minerals industry, government and The University of Queensland who recognised the significant potential of bringing together a diverse range of research expertise from across the University to address complex, but related, sustainability issues facing the minerals industry and the communities they impact. Ten years after its establishment, SMI has grown significantly into a vibrant institute comprising seven Centres, with a total annual income of \$40m, more than 300 staff and more than 100 research higher degree students, as well as many more short course students. I would like to acknowledge the tireless efforts of the Institute's Director, Professor Chris Moran and his administrative team, together with the Centre Directors of SMI and to thank them for their leadership in continuing to drive the ambitious initiatives of SMI during the past year.

Mirroring the collaborative nature of SMI, the Advisory Board draws together representatives from across industry, the Queensland Government and the University's Executive. The Advisory Board provides a forum for SMI leadership to seek advice and guidance on strategic initiatives and operational direction and I would like to thank my fellow Advisory Board members for their contribution.

2011 was the first full year of implementation of the SMI Strategic Plan to 2015. The Plan clearly articulates the Institute's goals and the challenges it will face in leading the industry's transition from efficiency to effectiveness and, eventually, to becoming sustainable.

The SMI Advisory Board shares the Vision presented in the Plan, supports the Plan's strategic initiatives and is working with the leadership team to ensure progress is sustained.

The value of SMI's capability and knowledge to the minerals industry beyond Australia is becoming increasingly apparent, with a number of significant new international projects and initiatives currently being pursued. The new International Mining for Development Centre collaboration with The University of Western Australia creates a valuable strategic relationship upon which SMI can build into the future. SMI maintains a strong research and education presence in Latin America and values relationships with local partner universities and industry. 2010-11 has also seen growth in SMI's activities and networks in Africa, North Asia and the Pacific region.

SMI's second decade will see the Institute build upon its considerable research discipline expertise to support a strategic transition within the resources industries towards sustainability. A significant driver of that change will be through implementation of SMI's strategic NextMine™ and NextWorkforce™ initiatives, which are detailed in this Report. The SMI Advisory Board looks forward to continuing to provide support and advice to the Institute as it works towards this goal.

Mr Charlie Sartain  
Chief Executive, Xstrata Copper  
Chair, SMI Advisory Board



Professor Chris Moran  
*Director, Sustainable  
Minerals Institute*

# DIRECTOR'S REPORT

Over the past decade the Sustainable Minerals Institute has built an international reputation for producing quality research outcomes across a broad spectrum of disciplines. SMI has capabilities across all facets of the life of mine, making the Institute's breadth of research disciplines unique across the globe.

Industry increasingly recognises the advantages of moving away from a business model focused only on maximising revenue, to one in which there are benefits and opportunities for both industry and the broader community. SMI is building on this concept through its NextMine™ and NextWorkforce™ initiatives.

NextMine™ draws on the disciplinary strengths that have been built at SMI over the past decade and integrates them to provide research depth and abilities unparalleled anywhere in the world, applying them to the major challenges facing the resources sector. NextWorkforce™ is an extension of our existing education programs, which will ensure future generations of workers are skilled for the changing resource environment.

Underlying the Institute's research and education offerings is the theme of collaboration. Partnerships with industry, community and government are at the core of SMI's efforts to produce relevant, practical innovations and outcomes to meet the many challenges facing the resources sector.

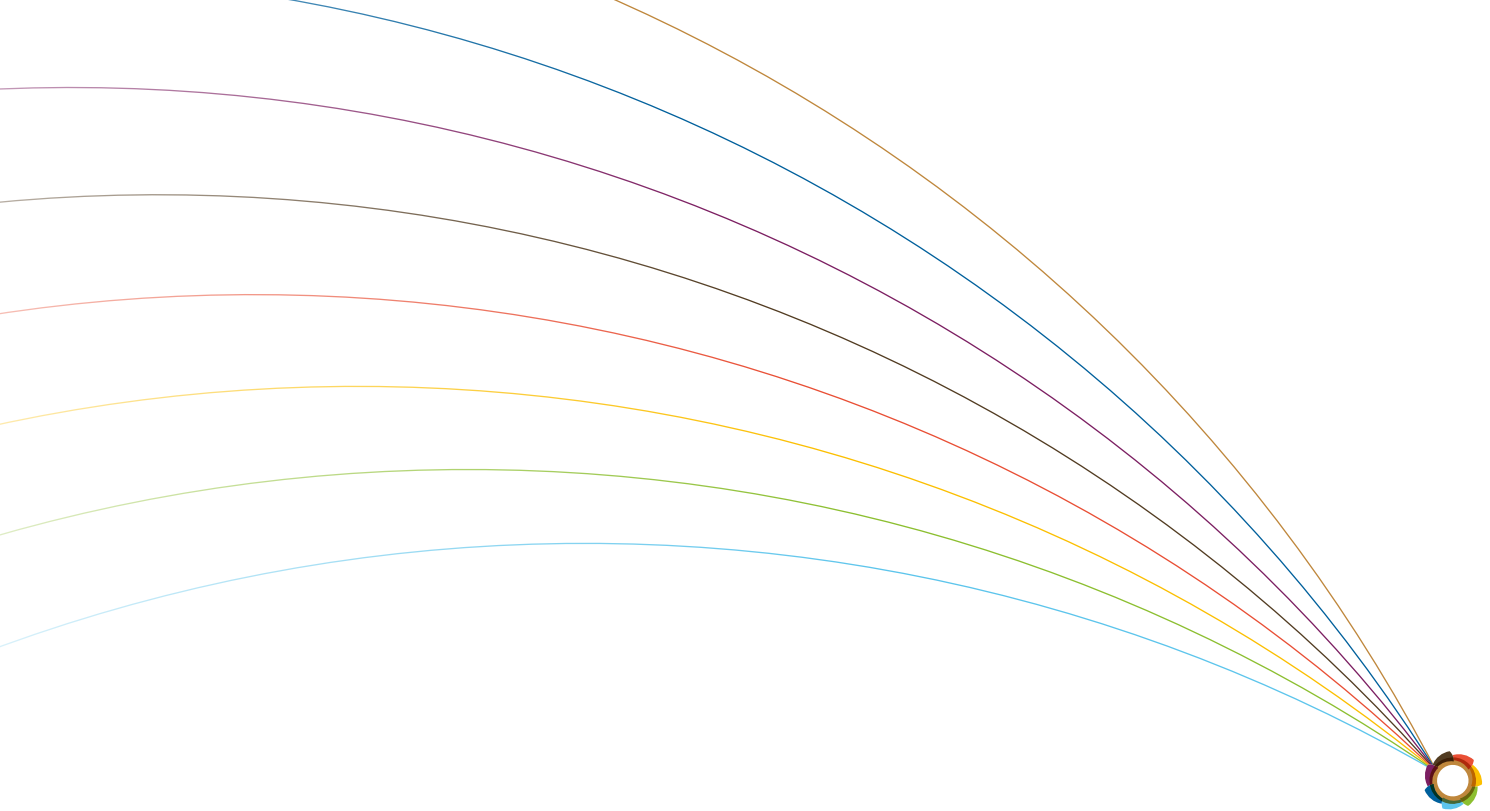
In 2010-11 SMI has nurtured existing collaborations, while developing new relationships. The Centre for Coal Seam Gas, established in late 2011, involves, to date, collaboration with three major coal seam gas companies in Queensland. Research will be focused on the four key areas of water, geosciences, petroleum engineering and social impact and will be subject

to the rigorous standards applied to other University research. The Australian Government funded International Mining for Development Centre has brought together The University of Queensland, through SMI, and The University of Western Australia with a \$31m AusAID initiative that will provide knowledge, advice and training to assist developing nations in establishing a minerals industry that benefits the sector, communities and future generations.

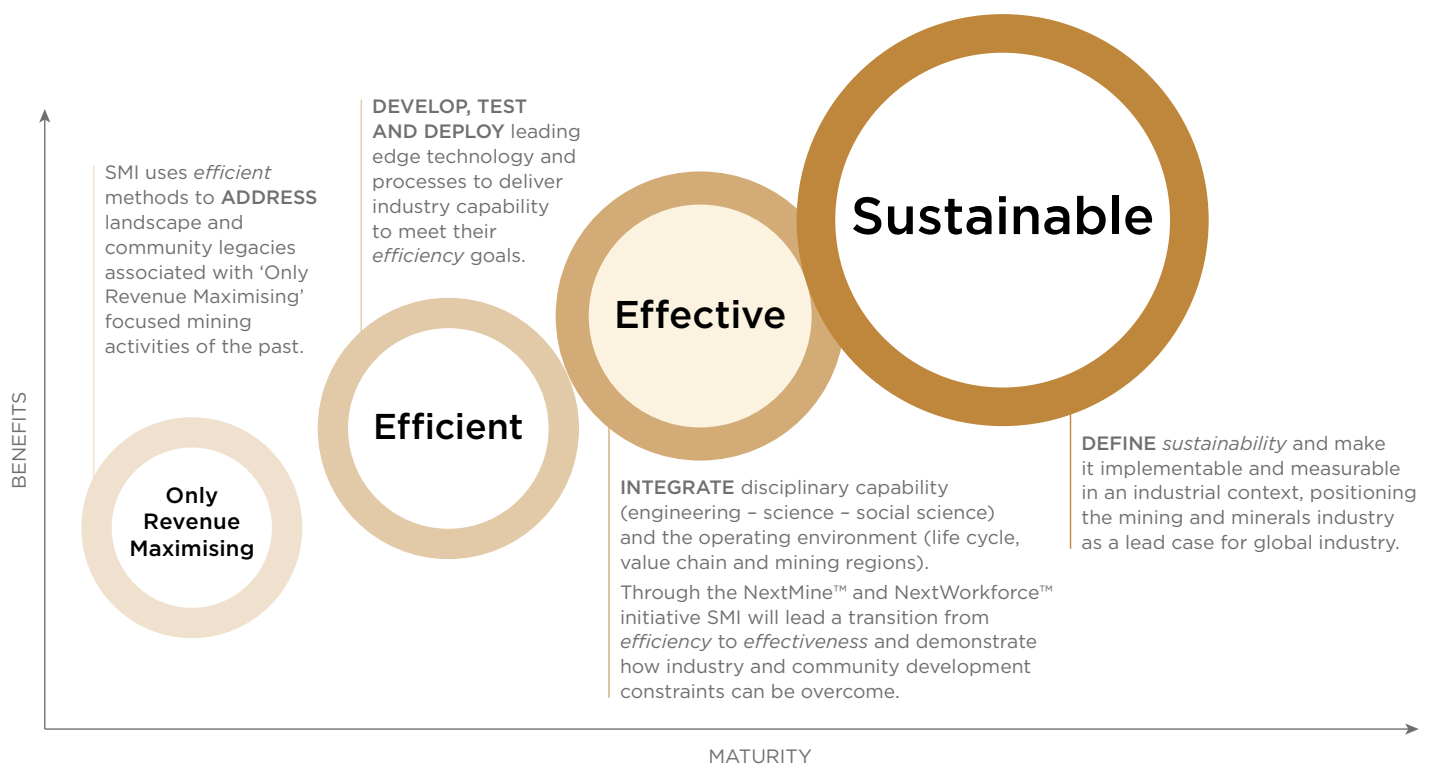
SMI's growth would not be possible without the hard work, dedication and tireless efforts of the Institute's many committed researchers, support staff and students. In particular, I am grateful for the on-going contribution of the Institute's Board members, the Centre Directors and the Institute's current and former Deputy Directors Ben Adair, Brett Cunningham, David Brereton and David Quemard.

Finally, I wish to acknowledge the University Executive for its on-going support and guidance over the last two years.

**Chris Moran**  
*Director, SMI*



## The Maturity Journey









Efficiency

# STRENGTHENING DISCIPLINES

The Sustainable Minerals Institute is recognised internationally for its ability to deliver relevant, forward-thinking solutions to the challenges facing the minerals industry.

By strengthening its research disciplines SMI can:

- > maintain its position with industry in existing research areas
- > build capability in emerging areas
- > boost performance against national and international measures of research excellence.

# SAFETY

## What is the Minerals Industry Safety and Health Centre?

The Minerals Industry Safety and Health Centre (MISHC) is an internationally recognised provider of risk, health and safety research and education for the global minerals industry. With a focus on applied research, MISHC's 20 research and support staff and students are solving health and safety challenges across the sector.

Researchers focus on leading practice systems and procedures to solve existing health and safety challenges. The Centre is working on a number of strategic research initiatives to facilitate resource sector growth and optimise safety. Further, education programs are instilling health and safety management practices as the guiding principle for industry professionals.



## Improving mining equipment safety through design

Safety has increasingly been recognised as the number one priority for mining companies.

In 2006, MISHC staff were instrumental in the establishment of the Earth Moving Equipment Safety Round Table (EMESRT), a group that has grown to represent 14 global resource companies with a common goal of improving mining equipment design to reduce safety and health risks.

Since its establishment, EMESRT has identified risks associated with operating and maintaining mobile mining equipment and promoted strategies for minimising these risks through improved equipment design.

In 2010 MISHC staff, supported by the Australian Coal Association Research Program (ACARP) and EMESRT, developed the Operability and Maintainability Analysis Technique, a systematic task-based risk assessment process for mining equipment. More recently, EMESRT member companies have incorporated task-based risk assessments into equipment procurement processes.

"The adoption of a common process for identifying hazardous tasks associated with equipment operation and maintenance during procurement has the potential to drive equipment manufacturers to strive for excellence in design to reduce safety and health risks," human factors researcher Professor Robin Burgess-Limerick said.

## Establishing risks associated with mobile mining equipment

Identifying risks associated with mobile mining equipment is integral to the implementation of health and safety policies and procedures.

Using a number of open cut coalmines in Queensland's Bowen Basin as test sites, researchers explored how information around risks could be better elicited. Funded by ACARP, the research has improved understanding of equipment and the role of the operator.

The research has led to recommendations around how information gathered during the process could be applied to incident investigation, communications, equipment design and training for improved performance and efficiency gains.





## Making shoveling safer

SLAP (Shovel Loader Assist Project) Phase 2 is a collaborative project to automate aspects of shovel automation and improve safety on mine sites. It would enable the swing and return of an excavator load cycle to be carried out automatically, with the automation protocol positioning the bucket over the haul truck tray before safely releasing the load.

MISHC has been involved in applied research to identify potential shortcomings in the automation technology and analysed how they might be addressed using new technologies under development.

“For shovel automation to be successful, a thorough understanding of manual shovel operation, in terms of perception, motor control and cognitive decision-making, is required. We also need to consider broader task and environment factors, even corporate culture and attitudes toward new technology,” human factors researcher Dr Steven Cloete explained.

Researchers have identified that while human risks associated with automation are varied, they centre around lack of trust between operators and automation or, alternatively, over-reliance on automation and skill degradation.

Dr Cloete said: “These can be serious issues in the introduction of new technologies, but we are confident we can refine the semi-automation technology currently in development to reduce the safety risks associated with this type of work.”

This multi-disciplinary project, with involvement from CRC Mining and The University of Queensland School of Mechanical and Mining Engineering, will be finalised in 2013.



# MINING AND GEOLOGY



## What is the WH Bryan Mining and Geology Research Centre?

Faced with increasing developmental and operating challenges, the world's mining industry must extract more ore from existing mineral deposits and establish ways to mine deeper ore bodies. The WH Bryan Mining and Geology Research Centre (BRC) is delivering integrated research across the mining value chain from mine to mill to assist industry move towards mines of the future.

The Centre's 25 researchers and support staff work across six categories: mine engineering – mass mining, geology and geostatistics, resource assessment, risk and evaluation, rock behaviour simulation and blast science and informatics. BRC's research continues to deliver improvements with a focus on making mine practice more efficient and effective, including minimising loss and dilution in resource recovery, decreasing energy usage and new ways for optimal planning.

## Blasting for impact

Accurate blast scenario modelling is vital for miners wanting to harness the impact of blasting. The computer software Hybrid Stress Model Project (HSBM), developed in conjunction with a geomechanics group in the USA, provides a cutting-edge numerical platform for blast design and optimisation. It is intended for use in a range of mine blasting applications including bench, ring, tunnel and confined sublevel cave blasting and enables miners to study the impact of different drill and blast scenarios on blast results. The technology is appropriate for all commodities from coal to gold and copper mines. It provides a 'virtual laboratory' that uses the evidence base to allow the safe and efficient implementation of new blast practice.

Developed by BRC during the last decade with funding from a number of mining, mining equipment and explosives companies, the software models the mechanisms of detonation, rock breakage and displacement from variable forces including shock, dynamic stresses and explosive gases. HSBM takes into account rock mass and stresses. It also analyses micro and macro outputs near field damage, vibrations, fragmentation size distribution, movement and displacement.

The current HSBM project phase which is focused on validating the current version will be completed in November 2012.

## Mining practice just right for tougher times

BRC researchers are committed to improving whole of mine effectiveness – thereby increasing revenue flow, reducing costs and increasing production by the sophisticated delivery of mine planning options and alternatives.

BRC's Professor Rodney Wolff is leading a \$1.7m project to integrate resource evaluation to enable innovative methods of identifying and optimising the value of mining projects using large geomet block models. The research will also enable a step-change in the consideration of risk in evaluation strategies and decision-making.

Realising the benefits of this research requires overcoming barriers such as slow computation and over simplistic planning approaches. To tackle these issues the project requires the application of new geostatistical methods for multi-scale multi-attribute geomet data; development of faster, more accurate geomet attribute sampling techniques; and holistic methods for valuation of capital and operational alternatives. The final product will be an integrated evaluation platform for risk-based mine planning.

The project brings together a multi-disciplinary research team from academic and industrial backgrounds.



## Improving recovery and productivity in the cave mining process

As the world's shallow ore deposits (up to 1,000m) are depleted, the challenge is to develop low cost, high capacity methods to access minerals up to 2,000m deep. The Mass Mining and Technology Project 2 (MMT2) focuses on understanding the fundamentals of cave mining processes, with a particular focus on block, panel and sublevel caving and their variants, which are incline caving and front caving.

Led by Professor Gideon Chitombo, MMT2 is investigating effective mine design and process optimisation, including rock mass characterisation, caving mechanics, gravity flow, fragmentation, confined blasting and behaviour simulation.

"Large cave mining operations will be a key part of the mix in future mining environments. Resource replenishment and 'sustainable' mineral production will require mining deeper and in many cases from transitioning pits to underground operations," Professor Chitombo said.

To complement MMT2 research, experiments to quantify and assess flow behaviour (and factors affecting flow behaviour) in the near and far field of cave columns have been carried out. Over 3,000 markers were installed between March 2008 and October 2010 to improve understanding of rock behaviour and activity in the extraction zone.

Results in the near field (markers recovered within 30m above the undercut level) provided insight into the development of the extraction zone during undercutting and subsequent draw. These results highlight early material recovery in the vicinity of the major apex, which expanded towards the centre of the drawbell as more tonnes were drawn. Furthermore, marker recovery was not spatially uniform during material extraction,

indicating disturbed flow behaviour. This type of behaviour significantly deviated from conventional flow theory based on numerical models and scaled physical models using narrow distributions of idealised particles or crushed aggregates. This provided field information which will be used to shape the next generation of numerical models.

"The size and scope of this project, including the number of markers used, made this project the most extensive ever undertaken," fellow researcher Dr Dennis Laubscher said.

Knowledge developed during MMT2 will be incorporated into a manual on cave mining methods. It will focus on the design criteria behind cave mining components such as selection criteria for extraction level layout, optimal undercutting strategy and the effect on design of equipment selection and/or automation.

"This research will allow industry to extract ore that could not previously be reached, raising the productivity of mine sites and improving sustainability around the world," Professor Chitombo concluded.



# MINERAL PROCESSING



## What is the Julius Kruttschnitt Mineral Research Centre?

The Julius Kruttschnitt Mineral Research Centre (JKMRC) was borne out of the P9 research project in the early 1970s. Since then the Centre has built an enviable reputation for its ability to maximise the efficiency of resource processing while minimising energy use and environmental impact.

JKMRC research areas span geometallurgy, comminution, separation and flotation. The Institute's largest research centre, JKMRRC has almost 100 staff and students. Across the last 40 years it has educated students from many countries across the globe.

## JKMRC appoints new Director

Professor Wayne Stange has been appointed JKMRRC's new Director. He brings 25 years' experience in research and technical roles, as well as management consulting.



Most recently Professor Stange was the Managing Director of AMIRA International, a member association of global minerals companies that facilitates minerals research and development, and technology development. JKMRRC has been successfully involved with several AMIRA projects and Professor Stange's appointment will no doubt further strengthen this partnership.

## Reducing energy consumption through comminution design

Over the last 18 months JKMRRC has taken an approach to comminution design which incorporates the capability to investigate the benefits of staged size reduction and separation.

This approach requires the merging of multiple research outcomes. The objective of processing the ore in a more efficient manner is not a new one. However there is a new focus to reduce energy consumption by rejecting materials of insufficient value to justify energy intensive size reduction, thereby liberating valuable minerals.

The basic approach is multi-tiered:

- > early rejection of waste material so a more concentrated ore stream is processed
- > more efficient use of comminution equipment, which has high energy use.

Current comminution models do not incorporate preferential breakage or predict mineral distribution across size ranges in products from stage size reduction.

A prototype simulation platform is being deployed to allow incorporation of advanced models and the additional data into circuit simulations. This will allow the assessment of the energy savings from rejection of a component of a process stream along with the reduced recovery of valuable minerals. Pilot scale scrubber tests were done to examine the possibility of low energy upgrade of ore. The results from this were imported into Discrete Element Modelling for future predictive possibilities.

## Integrated modelling across the value chain

In 1962 a significant event occurred – one that would shape JKMRRC for the next 50 years and beyond.

The establishment of the AMIRA P9 Project (Optimisation of Mineral Processing through Modelling and Simulation) in that year has shaped many technological advances now seen as standard on mine sites across the globe.

In the post war minerals boom the project proved vital in improving various technologies; in particular grinding circuits, that previously had limited productivity. Across the last 50 years the P9 project has continued its journey of technology improvement.

Most recently, the P9O project extension (2008–2011) developed a platform for simulating whole mineral processing circuits – providing the capability to connect previously separate elements. The platform has been tested successfully to a proof concept level.

The project has also developed new approaches in testing and data analysis to enable the application of multi component modelling and to improve other applications such as the software packages JKSimMet and JKSimFloat.

The team is now preparing for the next stage – P9P (2012–2015). The vision of P9P is to apply these new multi-component models using the integrated simulation platform in a number of case studies for mining company sponsors. In addition, research will target enhancing knowledge of the sub-processes in unit operations to be able to develop even more responsive models.



“ I am in my 4th year as an SMI employee and count myself extremely lucky to be part of an Institute that is uniquely positioned at the cutting (bleeding) edge of the mining industry full of so much opportunity. I also believe that we are the ‘Harvard Business School’ of our sector although we don’t have all the attributes yet – which gives us something to work towards!!”

**Professor Dee Bradshaw**  
*JKMRC Researcher*

## Revolutionising mineral separation

Flotation has set the standard in mineral separation for almost 80 years – now there’s a new technology rising to the challenge.

JKMRC Research Fellow Professor Dee Bradshaw has developed the Mineral Separability Indicator (MSI), which has the potential to revolutionise the way in which minerals are separated from unwanted rock.

Flotation traditionally uses turbulence and air to separate the desired minerals from the surrounding earth. The MSI – or “dirty cocktail shaker” – takes this process a step further and vigorously shakes the rock, allowing bubbles and particles to interact. This leads to the hydrophobic minerals becoming easier to identify.

“Flotation is robust, reliable and forgiving. It is easy to do well but hard to perfect because of the way nature distributes metals throughout the earth’s crust,” lead researcher Professor Bradshaw explained.

“You want to have quick tests to give you a mineral indicator. The MSI has the potential to do that – it is small scale, rapid and a direct measure of the mineral properties.”

It’s also efficient – the MSI can undertake a batch test with just 5g of minerals, compared to current methods which require 1kg of substance.

The two-year research project has shown particular success with pour through coppers, leaving researchers with the challenge of turning the Mineral Separability Indicator into the Mineral Separability Index – and thereby creating a new world standard.

Professor Bradshaw said: “We are currently conducting proof of concept tests and validation studies on the prototypes. If these are successful, the next step would be the commercialisation phase.”



## Exploring innovative solutions in mineral sorting and separation

The Rio Tinto Centre for Advanced Mineral Separation (RT CAMS) is a strategic partnership between Rio Tinto and The University of Queensland. Its five-year remit is to explore innovative ideas in mineral sorting and separation and to work with Rio Tinto to develop these ideas into industry-changing technologies. This long-term relationship with JKMRC complements and integrates Rio Tinto’s wider Mine of the Future™ activities.

Valuable metals such as copper are becoming increasingly difficult to find and recover using traditional processing techniques. New deposits typically contain lower ore grades with more complex geology than those found in the past, making recovery of target minerals more costly and energy intensive.

One of the Centre programs, at the forefront of translating novel ideas into state-of-the-art advances in mineral sorting, is focused on the development of technologies in mineral detection systems and rapid data processing capabilities. Scale up of one concept is already underway and more are planned.

The Centre is also involved in the development and application of innovative mineral processing technologies and its linkages to more optimal extraction from the mines. The remit from this work, applied across several commodities, is to effect a significant change in the energy and production signature of designated Rio Tinto operations.

RT CAMS complements other Rio Tinto Centres in Australia and overseas. These Centres are working together to provide considerable and ongoing capability in mining and mineral processing.



# WATER

## What is the Centre for Water in the Minerals Industry?

The Centre for Water in the Minerals Industry (CWiMI) conducts research on the measurement, monitoring and modelling of water in the context of mine operations, their surrounding environments and regional communities to determine sustainable water management.

As one of the newest Centres within SMI, the Centre is going through a period of change. In late 2011 Acting Director Assoc. Professor Sue Vink replaced Professor Damian Barrett who had been the Centre's Director for two years. CWiMI has almost a dozen research staff and will soon graduate its first research higher degree (RHD) students.



## Sustainably discharging to streams

There have long been questions over the impact of saline water discharged from mine sites on seasonally flowing streams and their ecosystems. However, there are knowledge gaps in relation to the processes that manage the movement of salts in these streams.

This research, conducted by Assoc. Professor Vink, is providing answers to those questions and also assessing the impacts of salts on the fundamental ecological processes driving ecosystem function.

"Recent reports have highlighted the lack of appropriate data and analysis in assessing local and cumulative impacts of saline mine site discharges on the aquatic environment in the Bowen Basin," Assoc. Professor Vink said.

Funded by ACARP, the project built on research to understand the risks and opportunities associated with sustainable water and salt management on coal mine sites.

"The knowledge gained from this work, in conjunction with completed and ongoing ACARP and industry-funded work, underpins an integrated approach to sustainable water quantity and water quality management by Bowen Basin coal mines," explained Assoc. Professor Vink.

The research supports an environmental management and policy position based on sound scientific evidence. It provides vital data and modelling techniques for developing a more informed set of discharge criteria based on scientific understanding of the river system in which the mines operate and the capacity of the system (both hydrologically and ecologically) to cope with saline discharge.

## Assessing salinity trading feasibility

The Hunter Valley Salinity Trading Scheme has been a successful mechanism for managing discharge and river water quality in eastern Australia's Hunter Valley for many years. However, significant differences between the Hunter Valley and Queensland's Fitzroy catchments may preclude findings from the former region being directly translated to the Fitzroy.

While the Fitzroy has almost twice as many mines, the intensity of land use (including agricultural use) is greater in the Hunter Valley. In addition, most mines in the Fitzroy catchment discharge to lower order tributary streams rather than the main water course in each sub-catchment. These factors influence the technical specifications and viability of application of a trading scheme in the Fitzroy.

As a result, CWiMI researchers are exploring whether an alternative framework might be a more effective model to manage mine water release in the Fitzroy Catchment, ensuring sustainable use of water resources, cumulative impact management and protection of environmental values in the Basin.

Results from this research will inform other regions and assist authorities to determine whether proposed frameworks are the best available models for specific geographic areas.







## Improving the business of biodiversity investment

The relationship between economic development and environmental sustainability and the impact this has on maintaining access to land and natural resources, is recognised by industry, governments and civil society alike. Commitment to the goal of sustainable development is evident in the environmental policies of many mining companies that contributed to this research through ACARP.

The development of new decision support capability is necessary to access trade-offs in terms of costs and benefits of land use decisions to people. However, there are virtually no tools available that can assess the optimal allocation of limited resources within a landscape for the purpose of protecting ecosystem function, maintaining economic production and ensuring amenity is preserved. Thus, CWiMI is developing a methodology to quantify the costs and benefits of biodiversity interventions and environmental offsets both within and beyond mining leases.

Researchers used an extensive range of spatial datasets, advanced biophysical modelling and spatial optimisation methods to explore various management goals and quantify trade-offs that occur when undertaking different re-vegetation strategies.

The key finding of the first of two studies within this project was that no unique re-vegetation solution existed that simultaneously allowed the optimisation of biodiversity, ecosystem function and socio-economic management goals for the study region. Significant trade-offs among these goals were required, including reduced impact of re-vegetation on sediment transport to rivers in order to increase biodiversity of rare vegetation types; sub-optimal selection of re-vegetation sites for biodiversity benefits when socio-economic goals were optimised; and a high carbon storage benefit that incurred a large cost in surface runoff.





# SOCIAL RESPONSIBILITY

## What is the Centre for Social Responsibility in Mining?

The Centre for Social Responsibility in Mining (CSR) works with industry, communities and governments internationally to improve social performance and deliver better outcomes for all mining stakeholders.

CSR has developed a unique team of anthropologists, sociologists, economists, natural resource specialists, political scientists, engineers and technical specialists who are committed to bridging the divide between technical, physical and social sciences. The team of more than 40 researchers undertakes quantitative and qualitative social research, develops frameworks and customised studies and coordinates education and training activities.

## CSR appoints new Centre Director

Professor Saleem Ali has been appointed the new CSR Director. He joins the Institute from the University of Vermont, where he was Director of the Institute for Environmental Diplomacy and Security at the James Jeffords Centre for Policy Research.

Professor Ali replaces CSR Founding Director Professor David Brereton, who has taken up the role of SMI Deputy Director – Research Integration, leading the NextMine™ and NextWorkforce™ strategic initiatives.



## Monitoring cumulative impacts at the local and regional level

As the mining hub in Queensland's Bowen Basin continues to flourish, CSR conducted research into the growing use of multi-stakeholder collaborative approaches for monitoring and managing cumulative impacts of multiple companies and mines. The 18-month project, funded by ACARP, focused on how these approaches were being applied to water quality and dust issues management.

Two cases were used in the research: the Fitzroy Partnership for River Health and the Moranbah Cumulative Impacts Group. Each study involved attendance at relevant multi-stakeholder group meetings, examination of meeting minutes, discussion papers and documentation, as well as several interviews. The work with these two groups had practical results such as the location of one industry and one state government air quality monitor in the town of Moranbah.

Further, 30 examples of collaboration to address cumulative impacts within the Australian resources sector were identified and analysed. The researchers identified environmental concerns as the most common issue raised by cumulative issues groups, with air and water quality being the most prominent concerns.

Despite the challenges associated with these case studies – most notably the time required to cultivate trust, boundary identification for the groups involved and process development – researchers were able to identify key features of effective collaboration and present guides and toolkits for assessing and improving the 'health' of partnerships.

## Converting policy to practice

In 2010–11 the Centre published numerous Good Practice Guides, including flagship guides on human rights, cultural heritage and gender. CSR is committed to supporting the implementation of these Guides by mining companies.

The Centre has built on its education program of turning policy into practice by contributing to the professional education of industry practitioners from government, industry and other agencies. The Graduate Certificate in Community Relations encompasses all streams of research undertaken at the Centre and introduces to industry practitioners some of the frameworks, methods and tools required to improve practice within their organisations.

Further, research is continuing into the industry's internal company dynamics to eventually ensure social performance is part of the core business of minerals industry organisations.



## Improving project-level grievance handling

Over a number of years a significant body of literature has developed regarding the impacts of mining on local communities. However, much less is known about the internal dynamics and decision pathways within companies for handling conflict and grievances.

Growing from an initial SMI Excellence Grant awarded to Dr Deanna Kemp in 2009, CSRSM has established significant research capability in the field of grievance mechanisms and company-community conflict management.

Interviews with 32 senior executives informed a report that highlighted industry perspectives on handling company-community grievances. This research is led by researchers at Harvard University's Corporate Social Responsibility Initiative (CSRI), which is recognised as a leader on this topic.

"The availability of internal SMI seed funding like the SMI Excellence Grant enables researchers to build their expertise, networks and publications, which has great potential to lead to other opportunities," Dr Kemp explained.

CSRSM's research was subsequently published in the *Journal of Business Ethics*. The research, which was referenced in the United Nation's Ruggie Mandate, also led to further analysis of corporate culture and community conflict management processes. Funded by a subsequent UQ Early Career Researcher grant, fieldwork was conducted at five mine sites in Peru, in collaboration with lead researchers from Harvard's CSRI.

The Peru research primarily focused on the internal organisational factors that shape or reflect a company's corporate culture and, in turn, influence its approach to handling conflict with communities. Internal factors include, but are not limited to, leadership,

organisational structure, policies, systems, procedures, incentives, relationships and language and communications. The research explored the degree to which conflict management is determined by factors internal to the company, quite apart from those outside its control.

"Grievance mechanisms are an emerging area of practice in the minerals industry. Our current work and research will continue to explore the challenges associated with operationalising these mechanisms to ensure effective outcomes for communities and companies," Dr Kemp said.

The Centre is continuing to build knowledge in this field through research and influencing change by assisting companies to meet their commitments through education, training and expert advisory services in this area.





# ENVIRONMENT

## What is the Centre for Mined Land Rehabilitation?

The Centre for Mined Land Rehabilitation (CMLR) builds on the strengths of the diverse backgrounds and disciplines of the 60 staff and students who work there. It addresses the minerals industry's environmental challenges with quality science and translates research outcomes into practices that lead to continual improvement of rehabilitation and the protection of environmental values.

CMLR's focus is preventing, minimising and remediating mining environmental impacts by providing research, education and professional development in the sustainability area and engaging with industry, government and community, both nationally and internationally.

## Addressing the risks and opportunities of abandoned mines

An abandoned mine is one where mining leases or titles no longer exist and responsibility for rehabilitation cannot be allocated to an individual, company or organisation. In Australia abandoned mines have accumulated for over a century and there is now an identified need for the application of sustainable development principles to address environmental and socio-economic impacts related to these sites.

In 2010, the federal government and the Minerals Council of Australia released the Strategic Framework for Managing Abandoned Mines in the Minerals Industry. CMLR researchers have commenced collating leading practice knowledge and are planning a stakeholder forum to develop a national research hub to support implementation of the strategic framework and communicate new knowledge on abandoned mine site management. The hub will engage key stakeholders and develop outcomes and options that build upon the Strategic Framework.

"An understanding of the range of circumstances that have led to existing abandoned mines can be useful context and knowledge to help inform current mining regulation and policy to reduce the likelihood of current operations defaulting to this category in the future," explained lead researcher Corinne Unger.

"There are opportunities for legislative barriers to be overcome to facilitate secondary mining and other beneficial land uses. Collaboration across jurisdictional boundaries will help to address these shared challenges."



“ Working alongside research academics, professional staff, research higher degree students, occupational trainees and visiting academics on a daily basis makes for a dynamic and exciting working environment. That’s what working at SMI means to me.”

**Tracey Gregg**

*Centre Manager, Centre for Mined Land Rehabilitation*

### Accurately monitoring vegetation with high-resolution imagery

Accurately reporting mining impacts and effectiveness of rehabilitation actions, particularly where human health, endangered ecosystems or threatened species are potentially affected, is vital.

Observation and impact reporting from the ground requires significant time investment and has restricted coverage. In turn, that can result in unreported or incorrectly attributed impacts in large areas.

Commercially available remote sensing provides a means of rapidly gathering information on surface conditions but the temporal and spatial scales of ground sampling can result in classification and assessment errors.

CMLR researchers are addressing the core question of spatial and temporal resolution required to provide effective and early indications of mining impacts on vegetation condition and composition through this research.

The research involves using unmanned aerial vehicles to achieve temporal and spatial resolution of individual plants, in combination with concurrent ground observation based on calibrated and quantitative measures of plant condition. This type of information gathering will improve data and lead to the development of integrated ground- and remotely-sensed metrics capable of assessing vegetation condition in a range of plant structural assemblages.



### Defining the functionality of cover systems in semi-arid environments

The recognition and understanding of inherent chemical and physical properties of mining and mineral processing wastes is a major contributor in how potential off-site negative impacts are managed or minimised. This is especially critical when sulfide ore bodies are mined and processed, as sulfidic waste materials generate acid and metalliferous drainage when exposed to water and oxygen. Water flow and distribution in and through the mining footprint is a critical factor to control and manage this process through its role in chemical reactions and as a transport vector.

The design of a cover to isolate the underlying hazardous material from water ingress is a common strategy to limit the effect of water and water flow of contaminated mine wastes. However under climatic conditions where rainfall events are infrequent but intense, the integrity and functionality of a cover can be at risk from erosion.

Lead researcher Dr Thomas Baumgartl explained that while a precipitation buffer layer is often used to capture most of the rainfall, vegetation growing in the matrix can reduce the volume of water held in the buffer layer and increase the rainfall buffer potential to accommodate the next rainfall event.

“The success of designed covers is based on understanding the material properties and the climatic conditions under which they operate,” Dr Baumgartl said.

“There is a high degree of dependence on the quality assurance during the construction phase, particularly relating to the physical properties of the materials and their fundamental influence on water storage, retention and release.”

Funded through the former Australian Centre for Minerals Extension and Research, the joint initiative involved CMLR, The University of Western Australia, the University of Technology, Sydney and collaborators from Canada.

CMLR researchers focused on analysis of the performance of constructed covers using field and laboratory-measured parameters. Comparisons in performance among different cover designs to meet seepage quantity and quality expectations were analysed across several seasons of highly variable climatic conditions.

Fieldwork identified a high degree of heterogeneity on a spatial scale in parameters such as infiltration rate and hydraulic conductivity, which led to preferential flow in the coarse-textured cover substrate. This had to be recognised when making the connections and extrapolations between laboratory tests and field realities.

Using many of the findings and lessons learnt from this project, relevant and appropriate design criteria for cover systems being built in semi-arid environments that can be subject to erratic, high intensity and high volume rainfall events are now being developed.

# ENERGY

## What is the Centre for Coal Seam Gas?

The Centre for Coal Seam Gas (CCSG) draws together the research capabilities of The University of Queensland, which has been conducting research into coal seam gas (CSG) for almost two decades. CCSG was established in late 2011 and has four key research areas, water, geoscience, petroleum engineering and social impact, as well as a focus on education programs.

The Centre supports leading practice policy development and will help ensure Australia becomes the primary source of new knowledge, technology and skilled graduates for the industry as it develops world-wide. CCSG aims to be the world leader in coal seam gas research within a decade.

## Gauging the effect of cumulative impacts on communities

The Centre for Coal Seam Gas recognises research into social impacts related to the emerging industry is equally as important as technical investigations.

CCSG social performance researcher Assoc. Professor Will Rifkin is assessing and tracking the cumulative socioeconomic impact of CSG and determining governance processes to ensure research findings are factored into regulatory and industry decision-making.

Cumulative impacts are the combined positive and negative impacts that occur as a result of multiple resource projects on society, the economy and the environment, such as those being experienced by residents in the Surat Basin in south-east Queensland.

"Cumulative impacts present significant challenges for regulators, who historically have focused on project-by-project approval; for industry whose impacts can become entangled with those of their competitors; and for the community which is experiencing the impacts," explained Assoc. Professor Rifkin.

"This three-year project will assist in the identification of salient and credible indicators of impact, which will provide assurance that regulators have appropriate information available when assessing cumulative impacts."

## Understanding, characterising and managing production in CSG producing wells

Researchers are working to determine conditions under which fine particles lead to CSG production issues.

Small particles, commonly known as fines, are particles measuring less than 0.075mm in diameter. They are naturally present within the drained volume of reservoirs, introduced through drilling or completion activities, form as a result of rock fragmentation, or are created as a result of mineral or hydrocarbon precipitation. Fines can migrate through the cracks and cleats that occur in coal, blocking off flow paths and reducing permeability and consequently gas productivity.

"Once formation and migration controlling mechanisms are identified in a particular location, methods for limiting and mitigating the impact of fine particles on commercial gas production can be devised," explained lead researcher Professor Victor Rudolph.





## Measuring CSG water quality and impacts

Water has emerged as one of the most contentious issues associated with coal seam gas. CCSG researchers are working to answer community questions regarding this issue by measuring the potential impact the CSG industry could have on Australia's underground water supplies.

The three-year project will provide insights into coal seam hydrology and potential interactions with other aquifers. It will lead to the development of databases that, when combined in an atlas, help identify various health and environmental risk indicators for a particular geographical region. The information will also establish aquifer connectivity to guide water reuse options.

"Water is an area of particular concern for community groups and individuals with whom I have spoken. There is a lack of knowledge currently available in this field and the Centre is committed to providing information and becoming the leading global research organisation into coal seam gas," explained Professor Chris Moran, CCSG Interim Director.

Water is intrinsic to the CSG extraction process. Once wells have been drilled into the coal seam, water is drawn to the surface to reduce pressure and thereby release gas.

This research will enable the analysis and interpretation of water chemistry and provide insights into coal seam hydrology and potential interactions with other aquifers. Improved information around aquifers and subsequent water chemistry is critical to improving conceptualisation and numerical modelling of hydrological impacts of dewatering of coal seams on other aquifers at both regional and local scales.

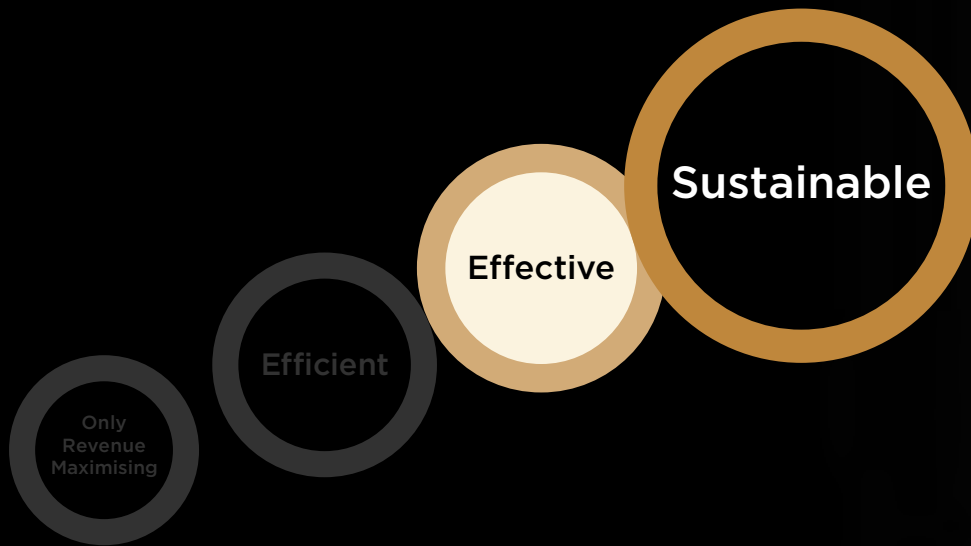
Lead researcher Assoc. Professor Sue Vink said, "Incorporation of water chemistry data that is held by CSG companies into a unified

database will greatly extend understanding of basin hydrology, aquifer interactions and processes controlling the water chemistry.

"A more detailed understanding of water chemistry relationships will inform the assessment of risks and modelling of impacts that could result from dewatering of coal seams and knowing the baseline chemistry of different aquifers will enable more effective groundwater impact monitoring."

Further, the information may assist researchers determine if there are spatial trends in water chemistry that can be used to assess water treatment and aquifer injection options.





**Beyond Efficiency**

# INTEGRATION FOR THE FUTURE

The Sustainable Minerals Institute is pioneering the integration of disciplines across the mining value chain. The collaborative approach enables researchers to work together to identify innovative solutions that go beyond what is possible in discrete research groups.

Through the key initiatives NextMine™ and NextWorkforce™, the Institute is addressing the complex and multi-faceted challenges facing the resources industry and educating industry professionals. This approach will improve industry practice and ensure positive legacies for the future.







# THE FUTURE OF MINING



**Professor David Brereton**  
*SMI Deputy Director – Research Integration*

## NextMine™

NextMine™ is an Institute-wide strategic initiative to identify and address factors that have the potential to limit future growth of the mining industry and its capacity to contribute to sustainable development. These challenges include:

- > declining ore grades, requiring companies to mine deeper and process lower-grade ores
- > heightened socio-political risk exposure, as companies seek to develop major new projects in emerging mining regions such as West Africa and Central Asia
- > growing constraints on the availability and affordability of water and energy for mining and mineral processing
- > increased environmental impacts and risks as the industry expands and the legacies of past mining activity accumulate
- > rising societal expectations of the industry, manifested in community resistance to new projects and stricter operating requirements.

In contrast to the visioning exercises that have been undertaken by some major mining companies, NextMine™'s primary focus is on process improvements, rather than on the invention of singular new breakthrough technologies. A key underlying assumption is that step-wise gains in effectiveness can be achieved through better use of research-based knowledge and by implementing a more integrated approach to how mines are planned, managed and closed. NextMine™ aims to leverage the benefits that come from greater connectedness: across different stages in the mining and production process and the project life cycle, between companies and other actors operating in the same geographical area and between disciplines and functions.

SMI is using internal funds to support an initial round of research projects to demonstrate the value of applying a connectedness perspective to the challenges faced by the industry. Areas of focus include: tools and frameworks to support integrated decision-making and management; sustainability metrics and models for evaluating alternative mining methods and configurations; and identification of practical ways in which organisational processes and structures can be changed to enable a more coordinated approach to sustainability issues.

NextMine™ will be informed by a program of proactive engagement with mining industry and other key stakeholders. This will involve regular roundtables and seminars, as well as more informal discussions and consultations that build on existing SMI relationships. The Institute will also be actively seeking opportunities to secure financial and in-kind support from companies and external funding bodies, with the aim of making NextMine™ financially self-sufficient within the next three years.





## NextWorkforce™

Industry leaders have recognised they no longer have the simple responsibility to drive profits – they have to use more sophisticated technologies to mine deeper, share the benefits of projects with local communities and manage cost inflation. Increasingly there is understanding that economic success requires managing and nurturing another important commodity – that is the people who are employed within the minerals industry.

The education initiative NextWorkforce™ will enable companies to develop their employees, thereby ensuring they are better equipped to face the sector's constantly evolving challenges. SMI is well placed to shape the NextWorkforce™, which is an extension of the Institute's existing education programs, to ensure the next generation of professionals is skilled for the changing resource environment.

Intimately linked to NextMine™, NextWorkforce™ incorporates a suite of activities designed to ensure SMI graduates have the skills and knowledge to drive change across the resources industry now and in the future. NextWorkforce™ will cultivate SMI's strengths to ensure industry is prepared for the next stage of growth and development.

## TOP TEN RISKS identified by the minerals industry

1. Resource nationalism
2. Skills shortage
3. Infrastructure access
4. Cost inflation
5. Capital project execution
6. Maintaining a social license to operate
7. Price and currency volatility
8. Capital management and access
9. Share the benefits
10. Fraud and corruption

Source: Ernst and Young

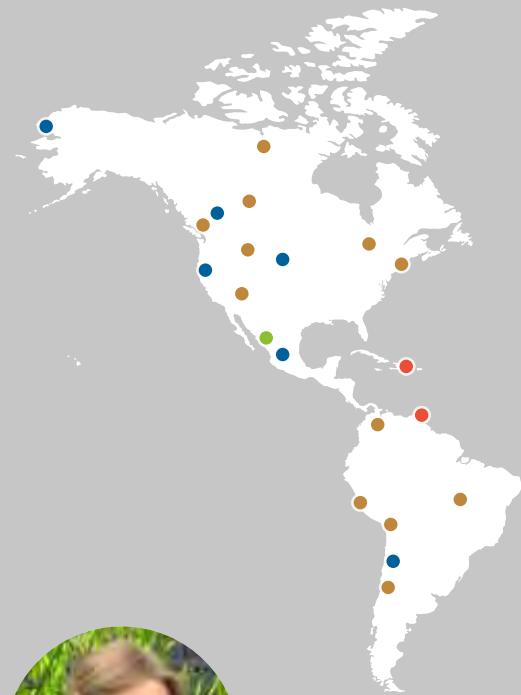
## TOP TEN DISPUTE ISSUES Mine-Community Conflicts

1. Pollution
2. Access to/competition over natural resources
3. Consent
4. Community health and safety
5. Distribution of benefits
6. Consultation and communication
7. Labour issues
8. Resettlement
9. Security
10. Agreements

Note: Issues refer to proximate issues that precipitated conflict. This list is the prominence of the issue across the highest proportion of cases (number of cases – 50).

Source: Franks and Davis, forthcoming.

# THE FUTURE OF MINING



## Professor David Mulligan

*Director, Centre for Mined Land Rehabilitation*

The necessity to integrate multiple environment-related disciplines to address the current and emerging environmental challenges of the resources sector is a strategy well recognised, developed and practiced within the realm of scientists working in this space. NextMine™ extends this integration practice into the expanded base of SMI scientists and engineers that equally recognise the absolute need for early and thorough understanding of the characteristics of the geological materials in the earth before fragmentation and extraction. There is an equally critical and important imperative to fully understanding the environmental and social consequences of massively altering the fabric and matrix of these materials by anthropogenic activities historically driven solely by the economics of maximising recovery of the elements or compounds of prime value. The advancement of the NextMine™ initiative across SMI seeks to ensure that research integration across the broadest breadth of disciplines will assist bringing the industry to a level of maturity and responsibility that will provide current and future societies with the most opportunity and the least risk. To support this progressive effort and the transition of the industry to the next and sustainable level of operating practices, the NextWorkforce™ will be educated and trained to make it happen.



## Professor Saleem Ali

*Director, Centre for Social Responsibility in Mining*

The mineral resource sector is at a critical juncture in its industrial trajectory. With growing scarcity of resources as well as increasing regulatory pressure for improved environmental and social compliance, there needs to be renewal of research and training in this sector. SMI's NextMine™ initiative attempts to grapple with the research dimension of this challenge while NextWorkforce™ charts the way for training the next generation of professionals in this sector. The University of Queensland has been a leader in bridging sustainability science and mineral resource studies and SMI's willingness to invest in these two initiatives is prescient and a promising sign that we will continue to be leaders in this field.



## Assoc. Professor Sue Vink

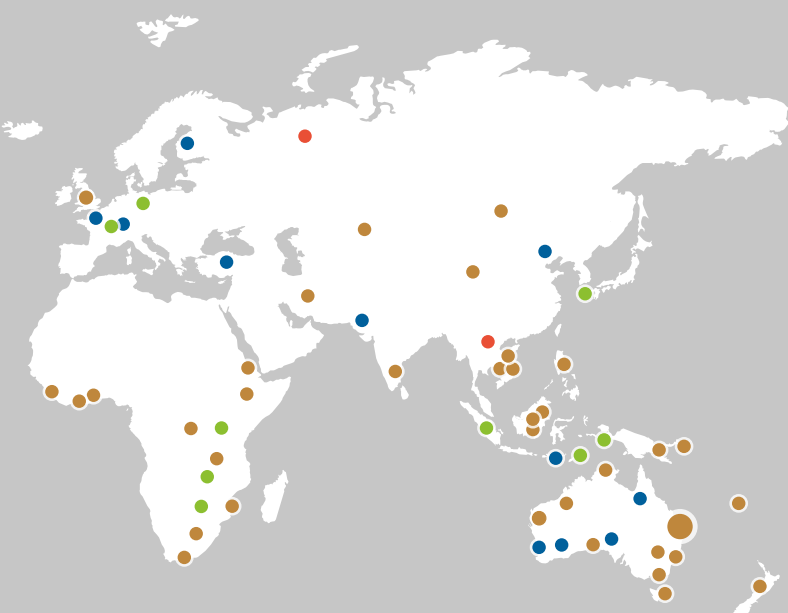
*Acting Director, Centre for Water in the Minerals Industry*

Water is a crucial link between mining, community, environment and economic systems. Mining can often use sources of water that are unsuitable for other users and reuse it multiple times, thereby, lowering its environment and social impact. However, in the coming decades the industry's water challenges are destined to magnify as production increases and product-to-waste ratio decreases. To meet these challenges current approaches to increasing efficiency need to be coupled with broader interdisciplinary research that will help the industry:

- > create synergies with other stakeholders by managing water on a regional scale
- > avoid simply shifting problems by better understanding the links between water, energy use and production, carbon emissions and land use changes
- > ensure its social license to operate by appreciating the value of water beyond pure economic terms.

The NextMine™ initiative will provide opportunities to undertake the research necessary to help the mining industry transition towards sustainability.





#### Where SMI Operates

- SMI (more than one Centre)
- JKMRC
- BRC
- CSRMC
- CMLR
- MISHC
- CWiMI
- CCSG



### Professor Wayne Stange

*Director, Julius Kruttschnitt Mineral Research Centre*

The NextMine™ initiative will develop the capacity of multi-disciplinary skills available within SMI to address the emerging challenges of the mining industry and thus progress through the maturity model to the next step of 'effectiveness'. For JKMRC this has meant evaluating the levers available within the discipline expertise of mineral processing and geometallurgy in a wider context and in collaboration with other SMI centres. Initiatives include characterising and manipulating environmental impacts through tailings in a project 'Designer tails' which includes dealing with deleterious elements such as arsenic bearing minerals, the geotechnical and geochemical consequences of fine grinding for treatment of finely disseminated ores on tailings facilities and minimising water and energy usage. In addition there is anecdotal evidence that the mineral industry's ability to engage with research is declining. It is necessary to develop strategies to address this and an initiative is being developed to provide 'Remote Metallurgical Support', as well as development of innovative ways of delivery of education and training.



### Professor David Cliff

*Director, Minerals Industry Safety and Health Centre*

As mining and mineral processing moves into the 21st century, traditional roles and expertise will be replaced by professionals with broader knowledge. NextMine™ and NextWorkforce™ will provide this new generation with the knowledge and skills to cope with this challenging environment. These initiatives recognise that to find solutions to the problems facing mining today, we must integrate disciplines and provide holistic approaches that address the concerns of all stakeholders. It is not just about the technology or the machinery but also about the most important resource – the people and how they interact with their environment and workplace. The people include not only the workers and their families but also the broader community. In addition companies will need to properly manage both the physical and emotional wellbeing of their personnel in order to conserve and properly manage this very precious resource.



### Professor Margaretha Scott

*Director, WH Bryan Mining and Geology Research Centre*

NextMine™ and NextWorkforce™ are about mining excellence for a sustainable future with a focus on preserving resource wealth and reducing conflict. These initiatives target the development of new technical knowledge and skills that integrate knowledge from a range of disciplines, often considered in isolation, uniquely differentiating NextMine™ research and NextWorkforce™ training.

These initiatives position SMI to meet critical needs of the global mining industry, by:

- > raising awareness of the challenges facing the industry/society as well as initiating research to address them
- > developing and embedding step-change practices to optimise resource management and recovery at all stages of the value chain
- > developing and embedding step-change practice to manage risk in rapidly changing operational environments
- > providing decision-makers with the tools and know-how to respond quickly and appropriately to increasingly complex scenarios.

# COLLABORATION



## ORE-Inspiring

SMI initiated and is the major participant in the Cooperative Research Centre for Optimising Resource Extraction (CRC ORE), a Commonwealth Government-supported research centre backed by university and industry participants.

The Centre is involved in the transformation of resource extraction and the way it is evaluated through the creation of tools and techniques that consider energy, water and the generation of CO<sub>2</sub> in mining operations to enable their inclusion in daily business assessments.

The validation of these tools and techniques is achieved through mine site case studies.

The Telfer Integrated Case Study undertaken with JKMRC and BRC researchers and Newcrest Mining furthered understanding of the applications of geological characterisation to efficient processing circuit design.

The Cooperative Research Centres program is an Australian Government initiative. CRC ORE is based at SMI and supported by The University of Queensland, AMIRA International, Anglo American Platinum, BHP Billiton, CAE Mining, JKTech Pty Ltd, Newcrest Mining, Quantitative Group, Teck, the Queensland University of Technology, the University of Tasmania and Xstrata.





## International Mining for Development Centre



“ We believe this initiative can contribute to lifting the quality of life in developing nations through more sustainable utilisation of minerals and energy resources.”

**Professor Alan Robson,**  
*Then UWA Vice-Chancellor*

### International Mining Hub

SMI, representing The University of Queensland, is facilitating greater prosperity through a resource-related advisory, education and training hub for developing nations.

UQ is collaborating with The University of Western Australia (UWA) on the \$31m International Mining for Development Centre (IM4DC), which will strengthen economic outcomes through better industry governance, education and economic capacity in developing nations.

Funded by the federal government through AusAID, IM4DC supports developing nations in Africa, Asia and Latin America to establish and maintain sustainable mining sectors and improve governance and accountability.

“This is a far-sighted strategic investment of Australian aid and development funds. It is in our national interest and in the interests of people of resource-rich developing regions,” then UQ Vice-Chancellor Professor Paul Greenfield said.

Then UWA Vice-Chancellor Professor Alan Robson and Professor Greenfield agreed the new Centre would broaden and deepen the existing collaborations in mining and energy education and research between the two leading universities.

The Centre's inaugural Director, Ian Satchwell, has been previously involved in policy formulation by industry and government on international trade and investment, environmental policy and regulation, competition policy and microeconomic reform, and climate change policy.



*Mines inspectors undertake an IM4DC training program.*

# COLLABORATIVE RESEARCH



## Improving leaching performance through blast induced fragment conditioning

AMIRA has been in collaboration with JKMRC for almost 50 years – now the AMIRA P843A project involves BRC as well.

Core Program Theme 2 – Integrated Blasting Modelling is an experimental program that has been designed to isolate and measure this conditioning phenomenon and its link to leaching performance. An isotropic and homogenous synthetic material has been developed and proven through a series of mechanical and chemical tests, in order to facilitate the definition of general rules governing the process.

Preliminary results from controlled blasting tests have demonstrated clear linkages between the stress field induced by the explosive detonation and the conditioning experienced. Leaching tests have also shown that for a constant fragment size fraction, copper-leaching recovery is greater in blasted samples when compared to intact, unblasted samples.

Lead researcher Dr Italo Onederra from BRC is working with JKMRC's Dr Simon Michaux and colleagues from CSIRO to develop a methodology to estimate the degree and type of conditioning in production scale blasting and its potential influence on leaching recovery.

## Detecting environmental indexes from geology

Integrating expertise from CMLR with the geological, mining and mineral processing disciplines brings environmental value to research projects and application.

Predictive indexes for environmental attributes were conceived in order to add environmental value to many of the tests and data modelling techniques being developed by JKMRC and BRC in collaboration with AMIRA. The Environmental Indicators program aims to develop a more predictive and proactive approach to early environmental characterisation that supports more effective management and valuation during mining and subsequent waste storage.

To ensure integration with other disciplines, environmental indexes must address material variability and exploit accumulated knowledge on mineralogy and texture. The index should also provide feedback on deposit-scale mapping of attributes for consideration during decision-making about mining schedules.

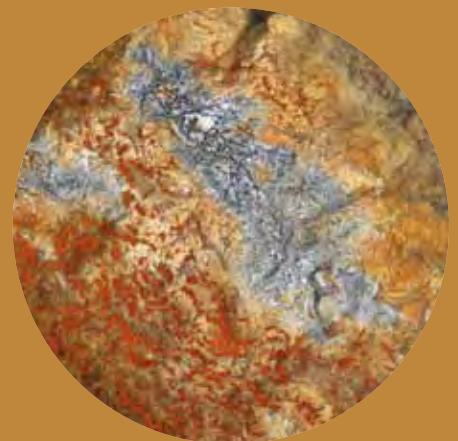
The goal of this research is to develop block models that incorporate all available information on potential environmental issues and use such models to develop alternative mining strategies. This will, in turn, reduce costs of future environmental and closure liabilities of operations.

Through NextMine™ researchers are now planning to link the attributes in mine block models and processing plant configurations and outputs with potential future problems. Water quality, rehabilitation challenges and final land use will all be considered to further reduce or mitigate the environmental impacts and costs associated with post-closure site management.

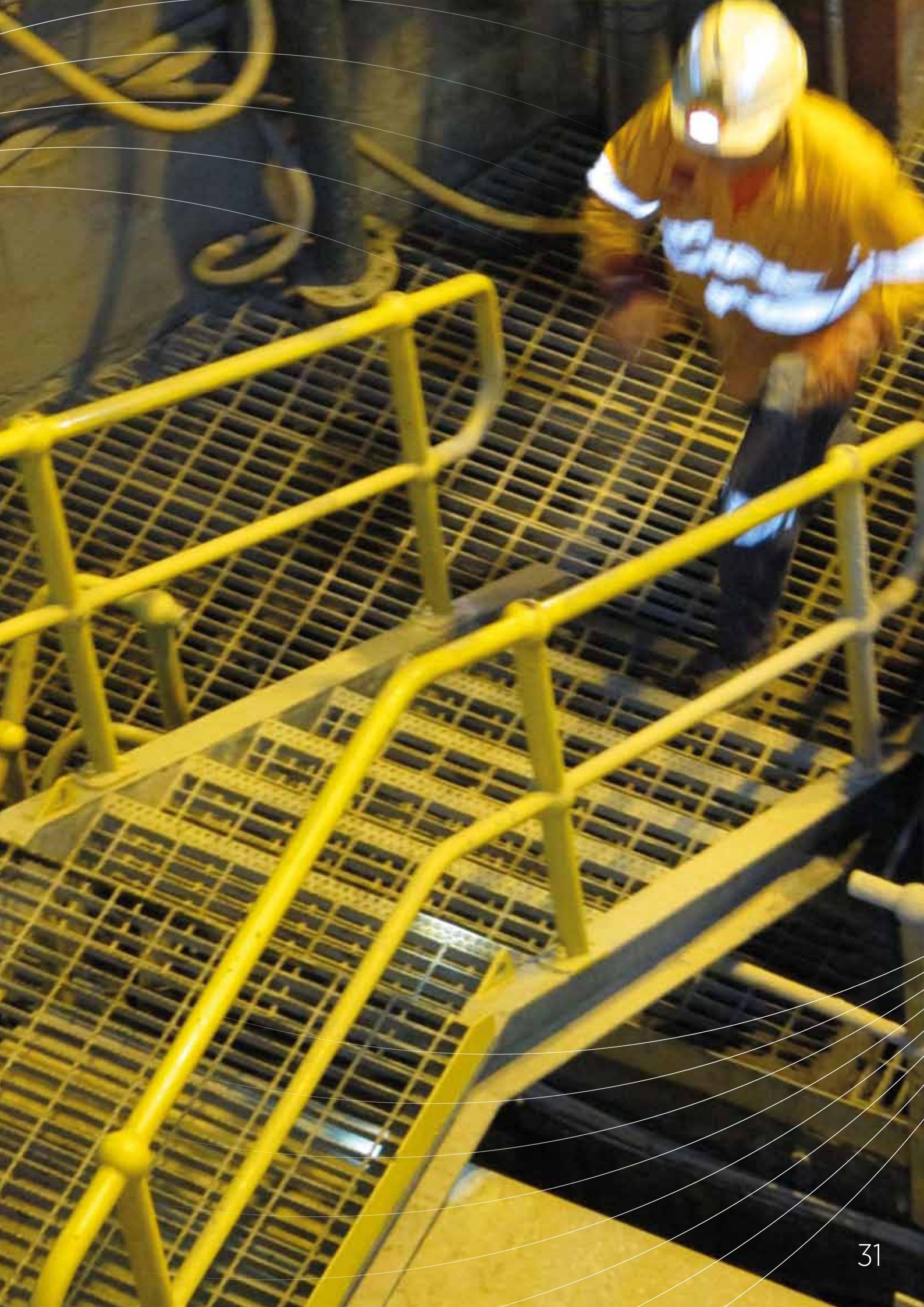
## Developing modern selective blasting techniques

In collaboration with CRC ORE, BRC delivered the first modern selective blasting trial in early 2011. Selective blasting involves an advanced blast that targets high-grade material for greater fragmentation, followed by coarse particle sizing to remove oversize and thus upgrade the ROM ore.

Significant benefits may be expected with this approach including a higher-grade plant feed, lower energy intensity and the potential for greater overall operation tonnages. Researcher Dr Alan Tordoir facilitated a trial blast on site in January 2011 and fellow researcher Dr Marcin Ziemiński coordinated the on-site plant trial of the blasted material in March 2011. Preliminary results proved very promising with selectively blasted material showing a grade more than double the average block grade.









# STUDENTS

## Educating professionals for the future



*SMI students organised the annual RHD Conference.*

For the minerals industry to become sustainable, its employees must understand sustainability – what it is and how it affects communities.

In 2011 SMI established the Graduate Certificate in Sustainable Development to equip RHD candidates with a holistic and integrated understanding of the minerals industry and how it can operate more sustainably.

“We want to equip our students not only to be experts in their individual disciplines but to have a more holistic, integrated view of what the minerals industry is. This will make them more rounded individuals, more valuable to the minerals industry and ambassadors for the Institute and what it represents,” Director of Graduate Studies Dr Dominic Howarth said.

The Graduate Certificate will eventually be offered to industry professionals.

“Industry is preparing to undergo a period of immense change during which it will become increasingly complex and this Certificate will equip professionals for these changes,” Dr Howarth said.

## Prime Time for Prime Ministerial Visit

Former Papua New Guinean Prime Minister Sir Rabbie Namaliu visited JKMRC in September 2011 to award a prestigious postgraduate scholarship to Mr Chris Akop who is undertaking his Masters of Philosophy.

Sir Rabbie is on the Board of Bougainville Copper Limited (BCL), which is sponsoring Mr Akop to undertake a flotation project.

“I’m hoping to apply the skills I learn for Papua New Guinea’s development. I believe my studies will make an impact in my country and bring along human resource development and technical solutions to mineral processing problems,” Mr Akop said.

During the visit Sir Rabbie also met with Professors Chris Moran and Geoff Gault, and JKTech Pty Ltd’s Operations Manager Dr David Way.

## The Graduate

Briony Coleman became the first person to graduate from CSRM’s Masters in Community Relations, when she completed her thesis *Empowerment through Engagement and Experience: Woodcutters Mine Closure and Relinquishment* in 2011.

The program built on the knowledge she gained in the Graduate Diploma in Community Relations, which explored the principles behind corporate social responsibility, an increasingly important area of community relations.

More than 150 students from 16 countries have enrolled in CSRM’s Graduate Program in Community Relations since it began five years ago.



*Briony Coleman.*







## Research Higher Degree Graduates

### Paul Botman

Julius Kruttschnitt Mineral Research Centre  
*Evaluation of foliar eucalyptus oils as coal flotation reagents*

### Murat Cakici

Julius Kruttschnitt Mineral Research Centre  
*Characterisation of samples of ore particles using x-ray micro-tomography*

### Dr Catherine Evans

Julius Kruttschnitt Mineral Research Centre  
*Development of a methodology to estimate flotation separability from ore microtexture*

### Dr Mathew Hancock

Centre for Social Responsibility in Mining/  
Minerals Industry Safety and Health Centre  
*Risk management systems for communicable diseases in the Papua New Guinean mining industry: maturity models – paths for development*

### Dr Rodney Hocking

Julius Kruttschnitt Mineral Research Centre  
*An examination of single particle rock breakage using an instrumented load cell, acoustic measurement and x-ray tomography*

### Dr Luke Keeney

Julius Kruttschnitt Mineral Research Centre  
*The development of a novel method for integrating geometallurgical mapping and orebody modelling*

### Dr Stephen Larbi-Bram

Julius Kruttschnitt Mineral Research Centre  
*Ore breakage characterisation for AG/SAG mill modelling*

### Dr Stephen Lawson

Minerals Industry Safety and Health Centre  
*Establishing a safety-based risk control effectiveness score as an alternative to conventional acceptable risk analysis and evaluation methods*

### Dr Narasimha Mangadoddy

Julius Kruttschnitt Mineral Research Centre  
*Improved computational and empirical models of hydrocyclones*

### Dr Maung Aung Min

Julius Kruttschnitt Mineral Research Centre  
*Measuring the floatability of sulphide minerals and ores: the captive bubble attachment times of galena, sphalerite and cannington lead-zinc ore particles floating at different rates*

### Dr Fiesal Musa

Julius Kruttschnitt Mineral Research Centre  
*Development of methods to assess the efficiency of comminution devices and operations*

### Dr Can Ozer

Julius Kruttschnitt Mineral Research Centre  
*A new multi-component model for the vertical spindle mill*

### Dr Ricardo Pascual

Julius Kruttschnitt Mineral Research Centre  
*The determination and modelling of floatability distributions of mineral ores*

### Dr Matthew Pierce

Julius Kruttschnitt Mineral Research Centre  
*A model for gravity flow of fragmented rock in block caving mines*

### Dr Zeljka Pokrajcic

Julius Kruttschnitt Mineral Research Centre  
*A methodology for the design of energy efficient comminution circuits*

### Graham Sheridan

Julius Kruttschnitt Mineral Research Centre  
*Magnetic field based non-contact measurement of the concentration of magnetite in slurry*

### Dr Alan Tordoir

Julius Kruttschnitt Mineral Research Centre  
*A study of blast induced rock mass displacement through physical measurements and rigid body dynamics simulation*

### Dr Carlos Vanegas Alvarez

Julius Kruttschnitt Mineral Research Centre  
*Development of a novel froth acoustic emissions sensor*

### Dr Rena Varadi

Julius Kruttschnitt Mineral Research Centre  
*Laboratory methods for characterising the floatability of ore*

### Dr Timothy Vizcarra

Julius Kruttschnitt Mineral Research Centre  
*The effect of comminution mechanism on particle properties: consequences for downstream flotation performance*

### Dr Simon Welsby

Julius Kruttschnitt Mineral Research Centre  
*On the interpretation of floatability using the bubble load*

### Dr Elizabeth Williams

Centre for Mined Land Rehabilitation  
*Ant community response to management practices on rehabilitated mine sites*



# ENGAGE

From corporate executives to impacted communities, researchers at the Sustainable Minerals Institute actively engage with stakeholders across the mining sector.

SMI is recognised internationally for its research and education in social responsibility and was the world's first tertiary institution to establish a professorial position in engagement. In 2010-11, researchers have again contributed to improved sustainability and understanding within the mining sector, which has been recognised through publications, seminars and awards.







# EVENTS



Clockwise from top left: Mr Mark MacFarlane, Mr Jim Knudsen, Mr Andrew Faulkner, Professor Chris Moran and then Premier Anna Bligh officially launched CCSG at the International Gas Symposium.

## SMI broadens research portfolio

The Institute broadened its research portfolio in late 2011 with the establishment of the Centre for Coal Seam Gas.

Launched by the then Premier Anna Bligh, the \$20m research centre will conduct rigorous research into the emerging industry, as well as upskilling CSG professionals.

The Centre has four key research areas – water, geoscience, petroleum engineering and social impact. In addition to recruiting senior researchers to each theme, CCSG will draw on existing capabilities within UQ, which has been conducting coal seam gas research for almost two decades.

“Like all work within SMI, the Centre will have a strong focus on sustainability with production, people and environmental issues all considered,” Interim CCSG Director Professor Chris Moran said.

CCSG secured three initial funders – BG-QGC (\$2m/year for five years), Santos (\$500,000/year for five years) and Arrow Energy (\$500,000/year for five years).

According to Arrow Energy CEO Andrew Faulkner, the new Centre would be a major boost for Queensland-based research.

“It builds on existing CSG research facilities and further strengthens Queensland’s position as one of the world-leading CSG research hubs,” Mr Faulkner said.

Santos GLNG Project CEO Mark Macfarlane added the research would “further add to the significant, rigorous body of science that each of the companies has undertaken and continues to undertake as each of our projects are developed.”

QGC highlighted the role that CCSG will have both in strengthening education and expanding UQ’s research network.

“The CCSG will employ at least three chair professors and consequently strengthen both UQ’s instructional and research capacity in earth sciences. In addition, its philosophy of promoting collaborative research projects will over time enhance UQ’s already substantial ties to the Australian and international research communities,” QGC Managing Director Derek Fisher said.

CCSG aims to be the pre-eminent global authority on coal seam gas within 10 years.

## 10th anniversary celebrations for CSRM

CSRM was established in the same year as SMI to ensure the depth and breadth of the Institute’s research portfolio.

In November 2011 the Centre celebrated its 10th anniversary with a function at Brisbane’s Gallery of Modern Art. The event featured an interactive showcase of CSRM’s research areas and acknowledged long-serving staff members Professor David Brereton, Robin Evans, Joni Parmenter, Dr Glen Corder, Dr Cath Pattenden and Dr Deanne Kemp for their contribution.

However, the evening also looked to the next generation of researchers with the launch of the Student Support and Scholarship Fund. This fund will enable students to contribute to positive change in the global mining industry and build the capacity of communities to deal with the risks and opportunities created by large-scale resource development.



“ I like working at SMI as it's such a stimulating environment – diverse projects, diverse disciplines and diverse staff!”

**Dr Kirsty Gillespie**  
CSR Researcher

## SMI celebrates 10 years

2011 marked SMI's 10th anniversary – providing the perfect opportunity for the Institute to recognise its achievements and promote its vision for the next decade.

SMI's engagement and relationship with the minerals industry has been pivotal to its success and in July SMI held an event to acknowledge and thank the resources sector for its part in the journey. 200 guests learnt about the Institute's global impact, thought leadership and research outputs that have reached mining companies across the globe.

The highlight of the evening was an industry forum, where a panel comprised of senior representatives from different areas of the minerals industry discussed *The Future of the Global Minerals Sector*.

Former Queensland Premier Mr Wayne Goss, Climate Change Commission Head Dr Will Steffen, Xstrata Copper CEO Mr Charlie Sartain and Rio Tinto Coal Australia Managing Director Mr Bill Champion provided a range of perspectives on the industry's impact. The economic rise of Asia and increased energy and water access issues were identified as key areas where SMI must focus if it is to meet the ever-changing challenges facing the industry.

In honour of the visionary people who founded the Institute, a formal dinner was held to recognise SMI's Founding Fathers. The group included minerals industry greats former MIM CEO and former SMI Board Chair Nick Stump, former JKMRC Directors Professors Don McKee and Alban Lynch, and CEO Australian Property Growth Fund Mr Bob Bryan AO.

While these events recognised SMI's stakeholders, there was also praise for the people who contribute to the Institute on a daily basis – the staff and students. An Awards Night in late 2011 recognised individuals who have made significant contributions in research, education, engagement and workplace practices and culture.

SMI recognised it is only as successful as its people. The tireless efforts of the Institute's staff and students, the vision of the Founding Fathers and the on-going enthusiasm of SMI's industry and community partners will no doubt ensure the Institute's next decade is equally successful.



# AWARDS



## Simulation Stimulation

MISHC researcher Sue Leveritt has been recognised for her contribution to improving health and safety standards on mining sites by Simulation Australia.

Ms Leveritt was presented with the 2011 Body of Knowledge Award for her paper *Simulator training: a tool for managing the unexpected*, which outlines why the move to automated mining equipment introduces new hazards and challenges for the industry. Specifically, the paper explores research underpinning a process to improve haul truck operator skills needed to safely manage unexpected hazards and challenges, through the use of simulators.

In honour of the award, Ms Leveritt presented her paper at the Fall Simulation Industry Workshop run by the Simulation Interoperability Standards Organisation in Orlando, USA, in September 2011.



*Sue Leveritt was awarded Simulation Australia's 2011 Body of Knowledge Award.*

## Hero Status for JKMRC Researcher

JKMRC researcher Dr Ying Gu has been honoured for his development of the Mineral Liberation Analyser (MLA).

Dr Gu was awarded the 2011 Innovation Heroes Award by The Warren Centre for Advanced Engineering at the University of Sydney for his conception and development of the analyser, which is widely seen as the global leader in automated mineralogy.

The annual award is presented to Australian innovators who have developed new technology, raised capital and commenced sales. Dr Gu's entry was judged not only on the merits of his innovation but also on the overall benefits flowing to Australia from the technology.

Dr Gu worked closely with JKTech Pty Ltd for over a decade to develop the MLA for the marketplace.

## International Recognition

BRC's Dr Marcin Ziemski was one of the UQ researchers selected to take part in a top research exchange in 2011, as part of the Austrade Visiting Researcher Award program.

The mining engineer travelled to Turkey to undertake collaborative research with international colleagues. Dr Ziemski was one of 17 recipients of the 2011 awards, with three of the winners hailing from The University of Queensland.

"Strengthening our ties with top international research institutions and centres is key to extending our research initiatives and showcasing our excellent scientific achievements," Deputy Vice-Chancellor (International) Dr Anna Ciccarelli said.



*Pictured from left to right: Professor Michael Dureau, Executive Director of The Warren Centre; Dr Ying Gu; Dr Bob Johnson, Founder and Chairman of Maptek.*

“ Working at SMI has presented me with opportunities to be involved in resource sector projects designed to deliver practical, research based outcomes for its most important resource – its people.”

**Sue Leveritt**, MISHC Researcher

# PROFESSIONAL SERVICE

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## Professor Damian Barrett

Minerals Council of Australia Water Working Group, *Member*

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## Professor David Brereton

Memorandum of Understanding on Indigenous Participation in the Resources Sector Steering Committee, *Member*

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## Professor Robin Burgess-Limerick

Ergonomics Open Journal, *Editorial Advisory Board and Guest Editor Human Factors in Ergonomics for the Minerals Industry*

Human Factors and Ergonomics Society of Australia Inc, *Minerals Industry Special Interest Group Chair*

International Ergonomics Association, *Mining Technical Committee Chair*

International Ergonomics Association Melbourne 2015 Congress, *Organising Committee Member*

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## Professor David Cliff

Australian OHS Education Board, *Academic Representative*

National Research Council Board on Human Systems Integration's Mine Safety: Essential Components of Self-Escape, *Member*

Queensland Underground Coal Mines, *Organising Committee Member for level one emergency simulation exercises*

Safety in Mines Testing and Research Station Advisory Board, *External Board Member*

Technical Steering Committee for the Coal Mining Abatement Technology Support Program, *Alternate Member*

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## Mr Robin Evans

AusIMM Sustainability Committee, *Member*

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## Dr Daniel Franks

Asia Pacific Centre for the Responsibility to Protect, *Honorary Fellow*

Expert Panel for the Rehabilitation of the Mt Oxide abandoned mine, Queensland Mines and Energy, *Queensland Government*

International Association for Impact Assessment, *Co-Chair Social Impact Assessment*

International Seminar on Social Responsibility in Mining Chile 2010, *Technical Committee*

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## Dr Deanna Kemp

Expert Review Panel for IPIECA (the oil and gas industry body for environmental and social issues) on the integration of human rights into Environmental, Social and Health Impact Assessment processes, *Member*

Expert Review Panel for the International Council of Mining and Metals New Member Review Process, *Member*

Expert Advisory Panel for the Responsible Jewellery Council, *Member*

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## Professor Chris Moran

Expert Panel for Major Coal Seam Gas Projects, *Member*

Healthy HeadWaters Coal Seam Gas Water Feasibility Study, *Advisor*

Interim Independent Expert Scientific Committee for Coal Seam Gas and Large Coal Mines, *Member*

Mine Water and Environment, *Associate Editor*

National Groundwater Technical Advisory Committee, *Member*

Resources Sector Supplier Advisory Forum, *Member*

Underground Coal Gasification Independent Scientific Expert Panel, *Chair*

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## Assoc. Professor Andrew Morrell

Coal Mining Abatement Technology Support Program, *Technical Steering Committee Member*

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## Dr John Owen

Multicultural Families Organisation, *President*

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## Professor David Mulligan

Bowen Abbot Point Community Consultation Group, *Chair*

Alligator Rivers Region Technical Committee, *Member*

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## Assoc. Professor Sue Vink

Healthy Headwater Coal Seam Gas Water Feasibility Study, *Advisor*

Fitzroy Basin Association Partnership for River Health Science Panel, *Member*

Queensland Resource Council Water Group, *Science Advisor*

Coal Seam Gas water use proposals in the Queensland Murray-Darling Basin: Impacts on aquatic ecosystems, *Steering Committee Member*

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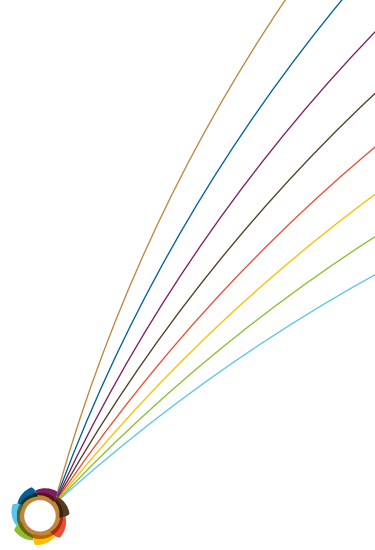
## Professor Rodney Wolff

Applied Stochastic Models in Business and Industry, *Editorial Board*

Computational Statistics, *Editorial Board*



# ACCESSING SMI'S INTELLECTUAL PROPERTY



The true value of the Institute's research is demonstrated when new technology, developments and initiatives are incorporated into minerals industry operations. SMI is committed to improving industry standards and practice through the commercialisation of tailored products and techniques.

SMI researchers work closely with commercialisation company JKTech Pty Ltd to deliver world-class solutions to the global minerals industry through the provision of products, services, training and process improvement across the life of mine. From geology and processing to sustainability, JKTech is committed to a whole of mine approach that ensures more effective operations now, while planning for a more sustainable future.



## JK Rotary Breakage Tester

JKTech announced the commercial release of the JK Rotary Breakage Tester (JKRBT) in March 2010. Providing a new generation of ore breakage characterisation, the JKRBT rapidly generates highly repeatable ore impact breakage data for use in AG/SAG mill and crushers modelling, as well as ore breakage variability assessment for geometallurgical applications.

Designed by researchers at JKMRC in collaboration with an established mining equipment manufacturer, the JKRBT has provided a new platform for providing high volume, low cost ore breakage characterisation data for resource planning and estimation.



## GeM Testing

A range of new ore breakage tests that facilitate the application of metallurgical performance indicators to ore bodies have resulted from the AMIRA P843 Geometallurgical Mapping and Mine Modelling project and are currently being delivered by JKTech Lab Services to project sponsors. JKTech is also in the process of ensuring these tests, which have cutting edge ore breakage characterisation capabilities, will be made available to the broader global minerals industry.

## G-MIRM

G-MIRM (Global Minerals Industry Risk Management) is a series of high quality, globally available risk management workshops tailored for executives, managers and engineers. Originating out of MISHC and highly regarded within the industry, G-MIRM was brought under JKTech's Risk Management banner in 2011 to maximise the commercial viability of the workshops. JKTech now promotes, coordinates and delivers the G-MIRM courses to clients worldwide. This has proven to be a mutually beneficial arrangement whereby each party gains from the other's standing in the marketplace.

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# SMI SEMINARS

**Mr Boris Albijanic**

Julius Kruttschnitt Mineral Research Centre  
*An integrated approach to evaluate a bubble-particle attachment in glass beads-dodecyl amine hydrochloride solutions*

**Mr Craig Andrews**

Formerly World Bank  
*New directions in transparency for the extractive industries*

**Dr Sven Arnold**

Centre for Mined Land Rehabilitation  
*Decision making under uncertainty - examples from Namibia and Australia*

**Dr Patrick Audet**

Centre for Mined Land Rehabilitation  
*Getting to the roots of plant metal stress tolerance: Examining the role of the AM symbiosis in plant metal uptake and soil metal bioavailability*

**Mr Grant Ballantyne**

Julius Kruttschnitt Mineral Research Centre  
*A novel separation technique*

**Dr Matthew Brennan**

Julius Kruttschnitt Mineral Research Centre  
*Cyclones*

**Mr Marcos Bueno**

Julius Kruttschnitt Mineral Research Centre  
*The dominance of the competent*

**Professor Richard Burns**

School of Agriculture and Food Sciences,  
The University of Queensland  
*Soil bioremediation: actuality or delusion?*

**Ms Isabel Cane**

Centre for Social Responsibility in Mining  
*The emergent social impacts of mining on communities in Southern Gobi, Mongolia*

**Mr Rajiv Chandramohan**

Julius Kruttschnitt Mineral Research Centre  
*Rock characterisation – why shapes matter!*

**Mr Mitesh Chauhan**

Julius Kruttschnitt Mineral Research Centre  
*Development of a small-scale test for geometallurgical characterisation*

**Professor Gideon Chitombo**

WH Bryan Mining and Geology Research Centre  
*Future opportunities for large scale bulk mining*

**Mr Paul Cleary**

The Australian  
*Is Australia relying on too much luck?*

**Professor David Cliff**

Minerals Industry Safety and Health Centre  
*Emergency management – lessons from recent disasters*

**Mr Terry Cuttle**

Formerly Brisbane Airport  
*Airport construction and development*

**Ms Diana Drinkwater**

JKTech Pty Ltd  
*Raising the technical skills of plant metallurgists – Can we help?*

**Mr Francois du Plessis**

Blue Cube Systems  
*NIR, Raman and Nyquist: Identification vs semi vs full quantification of mineral mixtures by using VIS-NIR diffuse reflection and Raman spectroscopy. Sample frequency required to approach the true grade of mineral process streams; the consequence of ignoring Nyquist*

**Dr Peter Erskine**

Centre for Mined Land Rehabilitation  
*Coal, carbon capture, climate change and complicity*

**Ms Cathy Evans**

Julius Kruttschnitt Mineral Research Centre  
*A metallurgist's guide to ore texture and separability*

**Professor Jim Finch**

Julius Kruttschnitt Mineral Research Centre / Department of Mining and Materials Engineering, McGill University, Canada  
*Sulphide self heating*

**Dr Kirsty Gillespie**

Centre for Social Responsibility in Mining  
*Stories, songs and emotion: Exploring the power of the sung refrain in Lihirian oral literature*

**Dr Greg Halseth**

University of Northern British Columbia, Canada  
*Globalisation and resource peripheries: Observations from British Columbia, Canada*

**Mr Richard Hartner**

Julius Kruttschnitt Mineral Research Centre  
*Integrated microscopy*

**Dr John Herbst**

Metso Minerals  
*Another look at ball size distribution effects in tumbling mills*

**Dr Ralph Holmes**

CSIRO Minerals Down Under  
*Minerals Down Under and new developments at QCAT*

**Dr Longbin Huang**

Centre for Mined Land Rehabilitation  
*The journey to sustainable phytostabilization of mine tailings*

**Dr Trang Huynh**

Centre for Mined Land Rehabilitation  
*Application of diffusion gradient in thin film techniques (DGT) to assess bioavailability of metals in water*

**Mr John Jackson**

JKTech Pty Ltd  
*Systems R&D projects innovation – update and implementation*

**Professor Jim Joy**

JKTech Pty Ltd  
*Globalising industry risk management initiatives*

**Dr Sarma Kanchibotla, Mr Wayne Rogers**

JKTech Pty Ltd  
*Dilution monitoring and control at Newmont Ahafo Operation, Ghana*

**Mr Brad Keane**

Ground Probe  
*Applications of geophysics for the measurement and monitoring of environmental and geotechnical parameters*

**Dr Luke Keeney**

Julius Kruttschnitt Mineral Research Centre  
*Application of geometallurgical research outcomes: La Colosa case study*

**Dr Mal Lees**

Cooperative Research Centre for Greenhouse Gas Technologies  
*The Otway project – Demonstrating geo-sequestration in Australia*

**Ms Sue Leveritt**

Minerals Industry Safety and Health Centre  
*Simulator training: A tool for managing the unexpected*

**Dr Xilin Li**

Julius Kruttschnitt Mineral Research Centre  
*Human factors insight into the control room operation in mineral processing: elevation control from passive to proactive*

**Dr Chris McGrath**

School of Geography, Planning and Management, The University of Queensland  
*Talking about the elephant in the room. The changing face of EIA of greenhouse gases from Queensland coal mines*

**Mr Bill McKeague**

MIPAC  
*Mineral processing plant control systems, some practical perspectives – Where are we going?*

**Professor Don McKee**

Formerly Sustainable Minerals Institute  
*Give them five percent – the early days of JKTech*

**Mr Eddie McLean**

Ausenco  
*Researchers' complicity in sorcery*

**Mr Ben McLellan**

Centre for Social Responsibility in Mining  
*Uneven paths: the comparison of sustainability costs of geopolymers and cement-based concrete*

**Dr Aubrey Mainza**

Chemical Engineering, University of Cape Town, South Africa  
*Does tracking particles using PEPT add value to tumbling mill modelling?*

**Mr Luis Martinez**

Xstract Mining Consultants  
*Applications of real options analysis in mining projects*

**Dr Simon Michaux**

Julius Kruttschnitt Mineral Research Centre  
*Six caveats that will change our design culture in the mining industry*

**Dr Simon Michaux**

Julius Kruttschnitt Mineral Research Centre  
*The geometalurgical process*

**Dr Maung Aung Min**

Julius Kruttschnitt Mineral Research Centre  
*The captive bubble attachment time distributions of particles with different micro-flotation rates*

**Mr Gonzalo Montes-Atenas**

Julius Kruttschnitt Mineral Research Centre  
*From the challenges involved in sampling bubbles to the significance of 'Bubble Load' in industrial flotation cells*

**Professor Chris Moran**

Sustainable Minerals Institute  
*Coal seam gas: how does it work and what is UQ doing about it?*

**Professor Tim Napier-Munn**

Julius Kruttschnitt Mineral Research Centre  
*The noblest triumph of theory – the discovery of Neptune*

**Mr Andrew Newell**

PAH Australia  
*To float or not to float, that is the question*

**Mr Andrew Oakley**

Outotech Pty Ltd  
*Innovation for the minerals industry*

**Dr Karin Olson Hoal**

JKTech Pty Ltd  
*The front and back ends of Geomet*

**Dr Vladimir Pacheco**

Centre for Social Responsibility in Mining  
*Developing an economic monitoring programme at the Lihir Gold Mine, Papua New Guinea*

**Professor Richard Poulin**

University of Ottawa, Canada  
*Environmental bonding in mining*

**Mr Jon Samuel**

Anglo American  
*Anglo American and the development agenda: Context, challenges and objectives*

**Dr Sarah Schwarz**

Julius Kruttschnitt Mineral Research Centre / JKTech Pty Ltd  
*Research commercialisation through JKTech*

**Dr Sean Shafiee**

JKTech Pty Ltd  
*Introducing a new model to forecast mineral commodity prices*

**Dr Janis Shandro**

University of British Columbia, Canada  
*Bridging mining community hand sustainability in British Columbia, Canada*

**Dr Frank Shi**

Julius Kruttschnitt Mineral Research Centre  
*Efficiency improvements in coal fired utilities – APP Project overview*

**Dr Andrew Sneddon**

School of Social Science, The University of Queensland  
*Cultural heritage and the resources sector – The early identification and management of cultural heritage issues – Statutory and non-statutory processes*

**Dr David Steele**

JKTech Pty Ltd  
*Mature x-ray-related instrumentation at the JK Centre*

**Dr Reyhaneh Tabatabaei**

Julius Kruttschnitt Mineral Research Centre  
*How ore mineralogy can affect the flotation performance of a double-refractory gold ore*

**Dr Erico Tabosa**

Julius Kruttschnitt Mineral Research Centre  
*A study of the role of the aspect ratio on the collection zone in a flotation cell*

**Ms Corinne Unger**

Centre for Mined Land Rehabilitation  
*Abandoned mine rehabilitation programs and post-mining land use*

**Mr Antony van der Ent**

Centre for Mined Land Rehabilitation  
*Key values of metallophytes for the minerals industry*

**Dr Timothy Vizcarra**

Julius Kruttschnitt Mineral Research Centre  
*The effect of breakage method on downstream particle floatability*

**Dr Dang Vu**

School of Chemical Engineering, The University of Queensland  
*Transformations and availability of phosphorus in three contrasting soil types from native and farming systems: A study using fractionation and isotopic labeling techniques*

**Mr Eric Wang**

Julius Kruttschnitt Mineral Research Centre  
*High voltage pulse treatment on ores*

**Dr David Way**

JKTech Pty Ltd  
*Tampakan Regrind Mill Optimisation*

**Mr Dylan Whiteman**

Elecon Electronics  
*SMART marker system: a tool for investigating ore flow in underground mining*

**Professor David Williams**

School of Civil Engineering, The University of Queensland  
*Mine water management and mining sustainability lessons from Germany*

**Mr Dan Wood**

Highlands Pacific Group (PNG Mining Co)  
*Science, art and business in mineral resource discovery*

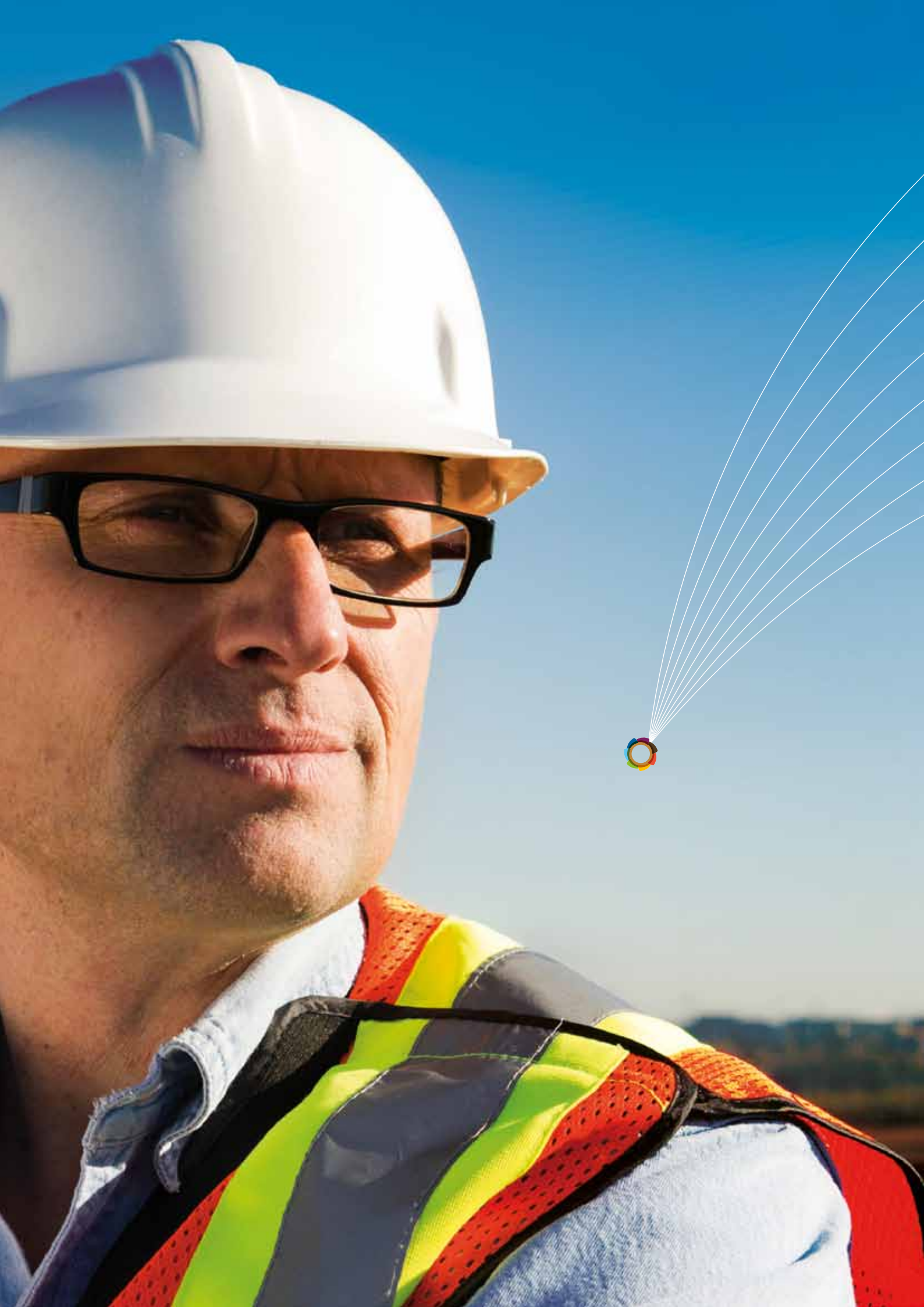
**Dr Lu Zhao**

Centre for Mined Land Rehabilitation  
*Transport and mobilization of heavy metals: studies in soil columns, harbour water and lake sediments*

**Dr Marcin Ziemiński**

WH Bryan Research Centre  
*The SEE software developed at the SMI*







# OPERATIONS

The Sustainable Minerals Institute is recognised for its depth and breadth of research and education excellence across all aspects of mining. SMI has forged relationships with many of the world's largest mining companies, as well as globally recognised aid agencies and relevant civil societies.

Further, the Institute prides itself on the diversity of its staff and students. In addition to fostering researchers from across the globe, SMI undertakes research projects in South America, the Pacific Islands, Asia and Africa.

# FINANCIAL STATEMENT

Sustainable Minerals Institute  
**Multi Year Income and Expenditure Statement**  
 January 2010 to December 2011

	Years to Date Actuals \$	SMI Top 10 Company Contributors 2010/2011	% of Total Revenue
<b>Revenue*</b>			
University	19,742,749	Xstrata	10.81
Research	33,840,573	Rio Tinto	10.79
Consulting	14,544,606	Anglo American	6.32
Other	8,858,474	BG Group	5.49
Total Revenue	76,986,402	Newcrest Mining Ltd	3.91
		BHP Billiton	3.15
<b>Expenditure</b>		Newmont Mining Corporation	2.16
Salaries	38,591,920	Centennial Coal	1.74
Non Salary	25,771,396	Vale Ltd	1.61
University Corporate Overheads	6,439,589	Sumitomo Corporation	1.20
Total Expenditure	70,802,905		
<b>Operating Surplus/(Deficit)</b>			
	<b>6,183,497</b>		
<b>SMI Funding</b>			<b>%</b>
Industry	64.68		
Industry Bodies (ICMM, INAP, MCA, QRC, AusIMM, ACARP, APP)	7.21		
Industry funding through JKTech	9.08		
Non Government Organisations	0.11		
Research Funding Bodies (AMIRA, AMSRI, Fundacion Chile, GEMCO, AusAID)	17.09		
Other Industry	1.83		

\* University funding is Commonwealth Government Assistance and Tuition Fee income.

University of Queensland Research and Innovation (UQRI) defines research as the creation of new knowledge and/or the use of existing knowledge in a new and creative way so as to generate new concepts, methodologies and understandings. This could include synthesis and analysis of previous research to the extent that it leads to new and creative outcomes.

Activities that do not meet the UQRI definition of research are considered consulting.

Other revenue sources refer to those not covered by the above categories and include trading revenue and membership fees.



## SMI Funding Sources 2010/2011



# DEMOGRAPHICS AND DIVERSITY

The University of Queensland Equity Office facilitates the development of strategies, policies, programs and procedures that enable the University to fulfil its commitment to equity and diversity in employment and education.

In line with this policy, SMI is continually working to develop strategic initiatives that create and maintain an equitable and diverse culture across the Institute. In addition, the inclusion of equity and diversity related processes within the day to day operational workings at SMI ensures a rich and rewarding work and study environment for staff, students and visitors.

The Institute is proud of its diversity. SMI's largest centre, JKMRC, has boasted students from almost every nation over its 50-year history. Across 2010–11, almost 40 countries were represented at the Institute. Gender balance rarely seen in industry, combined with staff and students spanning almost 50 years in age, add to the diverse nature of SMI.

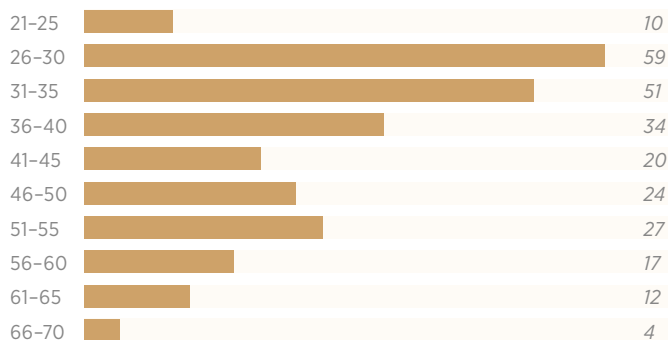
Every year, the University celebrates the increasingly diverse UQ community and raises awareness of current issues impacting the world's people, groups and communities through Diversity Week. The week showcases the contribution made by University students, staff and alumni within Australia and across the globe and encourages the UQ community to engage in debate and dialogue about relevant global issues.

SMI is an active player in Diversity Week and the 2011 theme of *Advancing Diversity* provided the Institute an opportunity to explore its existing equity and diversity strategies.

A workshop identified areas for improvement including enhancing Australian Indigenous participation, improving career development and advancement opportunities and providing greater mentorship to promote internal talent.

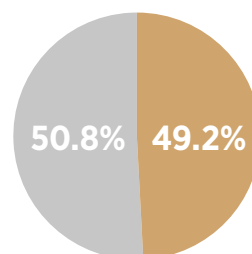
However, it also identified the Institute's strengths including a diverse staff and student contingent, equity inductions, broad industry and community connections and an equitable working environment.

Based on this feedback, the Institute has further developed its strategies in this area to ensure the diverse nature of SMI continues into the future.



Age Demographics

■ Age  
■ Number of staff and students



Gender Diversity

■ Male  
■ Female

## Nationalities of SMI Staff and Students

- Number of representatives
- Country



**148**  
Australia



**1**  
Bangladesh



**3**  
Brazil



**3**  
Canada



**6**  
Chile



**23**  
China



**2**  
Colombia



**1**  
Czech Republic



**1**  
El Salvador



**1**  
Eritrea



**2**  
Fiji



**6**  
Germany



**5**  
India



**2**  
Indonesia



**5**  
Iran



**1**  
Iraq



**1**  
Kenya



**2**  
Laos



**1**  
Malaysia



**4**  
New Zealand



**1**  
Pakistan



**2**  
Papua New Guinea



**4**  
Philippines



**3**  
Serbia



**1**  
Singapore



**11**  
South Africa



**1**  
South Korea



**2**  
Sri Lanka



**1**  
Syria



**1**  
Turkey



**15**  
United Kingdom



**7**  
United States



**3**  
Vietnam



**1**  
Zambia



**7**  
Zimbabwe



# PHILANTHROPY



Dr Dan Alexander

## In Appreciation

SMI scientists, social scientists and engineers continue to discover, innovate and lead the world in resource sector research.

The need to encourage passion to collaborate, discover and innovate is at the heart of Dr Dan Alexander's creation of the JKTech Innovation Award.

Established in 2010, the award promotes innovation across the Institute and its commercialisation partner JKTech Pty Ltd. It is presented annually to an individual or group that shows innovation in any aspect of their research or organisational life.

Dr Alexander, JKTech CEO, explained his motivation to direct his share of the revenue from early research discoveries was his desire to create a culture of collaboration.

"When I was doing my PhD, it was the best time of my life and it was all about collaborative discussions."

"From these discussions we changed the way modelling is now viewed – and we are seen as leaders in this space."

Dr Alexander graduated from The University of Queensland in 1993 with a Bachelor of Engineering (Hons) in Chemical Engineering.

From 1995 to 1997 he undertook a PhD in flotation modelling at JKMRC and continued this project on a part-time basis until its completion in 2007.

In 2000 Dr Alexander joined JKTech where he has developed steady state models of many flotation plants both in Australia and around the world.

His commitment to fostering a collaborative culture is demonstrated in the creation of the Innovation Award.

The 2010 prize was awarded to the team behind web-based tool *Waterminer*, which tracks the movement of water into, around and out of mine sites.

Dr Alexander believes in putting his money where his mouth is.

"I am interested in changing the world – not the money – and I believe that collaboration and sharing helps bring about that kind of change. Also I have benefitted from the industry and I want to give back."

SMI wishes to acknowledge Dr Alexander's generosity and to highlight the impact and real difference philanthropic donations make to the Institute and The University of Queensland.







## Supporting the Sustainable Minerals Institute

Gifts to SMI are tax deductible. To discuss how you can support the Institute, please contact the Advancement Office.





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