

SMI ANNUAL REPORT 2017



THE UNIVERSITY
OF QUEENSLAND
AUSTRALIA

SMI Sustainable
Minerals
Institute

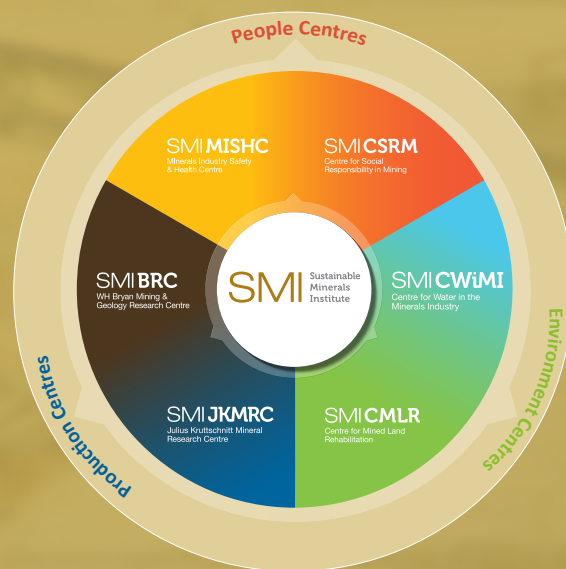
The Sustainable Minerals Institute

The Sustainable Minerals Institute at The University of Queensland (UQ) is a world-leading research institute dedicated to finding knowledge-based solutions to the sustainability challenges of the global minerals industry.

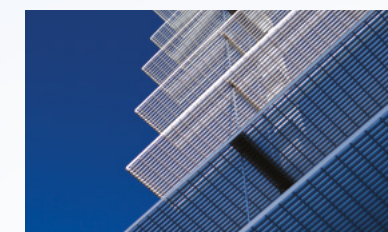
Our purpose is to develop game-changing people by working with our partners to co-create solutions to the big challenges facing the sector.

Our expertise comes from experience across the research, government and industry sectors and is genuinely independent and objective.

Our work covers all facets of the life of mine from geology, to minerals extraction, water management issues, minerals processing, workplace health and safety, mine rehabilitation, energy and community engagement.



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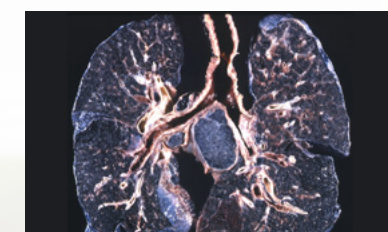
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Vice-Chancellor & President of UQ's Message

It is a pleasure to introduce The University of Queensland Sustainable Minerals Institute (SMI) annual report for 2017. The report illustrates how the organisation has continued to partner with industry leaders around the world to drive the shift towards sustainable development and equitable outcomes for communities affected by mineral resource extraction.

Collaboration is at the heart of SMI's operations and the Institute has earned a reputation as a world leader in co-creating knowledge-based solutions to global minerals industry sustainability challenges. Its broad expertise is genuinely independent and objective and frequently sought out.



This engagement is underpinned by world-class industry facing researchers in the social, political, environmental and earth sciences – disciplines that will shape the future of mining.

By sharing evidence-based knowledge with industry, government and the public, SMI continues to support a transition to technologies and practices that meet the changing requirements of communities and regulators.

UQ-led research creates opportunities for students and for the broader community and industry. The Institute values the important contributions research students make to its success and is extremely proud of its alumni, many of whom have made an immediate impact in industry by taking on roles in challenging commercial operations. In 2017, SMI graduated a record 22 PhD degrees and five MPhil degrees. It is pleasing to note that 13 of these graduates were women, and one third were international students.

I thank SMI's many partners, donors and other supporters and its staff, including honorary, adjunct and conjoint appointments for their efforts and contributions in 2017.

My thanks also go to Professor Neville Plint on his leadership in his first full year as SMI Director.

Finally, I acknowledge Mr Charlie Sartain, who ended eight years as a UQ Senator in December. During those years he has brought the voice of SMI and his considerable business and minerals sector experience to the UQ table.

I look forward to SMI experiencing a growth phase in 2018, working with the current and new minerals sector partners and helping to realise UQ's vision of knowledge leadership for a better world.

Regards
Professor Peter Høj

Provost and Senior Vice President's Message

In 2017, SMI has driven a vision to create change for responsible resource development, and I commend the SMI Director, Professor Neville Plint, staff and students for their contributions towards the realisation of this vision.

Among the highlights in 2017, SMI's Centre for Social Responsibility in Mining (SMI-CSR) launched the Resettlement and Livelihoods: Research and Practice Consortium, to help address the issue of mining-induced displacement and resettlement, which affects the lives of millions of people around the world who live near current mines or sites identified for future mining activity. The consortium brings together SMI researchers with five of the world's largest mining companies – Anglo American, MMG, Newcrest Mining Limited, Newmont and Rio Tinto – and allows industry representatives to look at resettlement issues in a collaborative manner.

Closer to home, SMI's WH Bryan Mining & Geology Research Centre (SMI-BRC) was invited by the Queensland Government to take a leadership role in the design and management of the new \$27.125 million Strategic Resources Exploration Program. The program focuses on providing the tools, datasets and knowledge needed by explorers in North West Queensland to drive a new wave of mineral discoveries in the region. The three-year Wealth from Waste Cluster project, run by the Centre for Mined Land Rehabilitation (SMI-CMLR) in partnership with four other universities and the CSIRO, concluded in 2017 with the release of its final report, 'Australian opportunities in the circular economy for metals'. This collaborative project characterised the Australian opportunities for creating circular flows of resources by treating wastes with metals as a valuable resource, and identified the key data, technologies and policy changes that will enable the transition to a circular economy.

SMI's International Centre for Excellence in Chile (SMI-ICE-Chile) saw the appointment of Professor David Mulligan as Executive Director in June. Since that time, key operational staff have been appointed, new office premises occupied in Santiago, culminating in a high profile opening in October, and a major progress report delivered to CORFO, the Chilean Government's Centre sponsors, in November.

SMI has continued to forge strong relationships across UQ, working with many researchers in other faculties and institutes. These collaborations produce outstanding results. In 2017, the Academic Ranking of World Universities ranked UQ second in the world for Mining and Mineral Engineering. More broadly, the calibre of UQ researchers as a whole, and the impact of innovations arising from their work, are visible through various measures, including total research funding in 2017, ranking second highest of all Australian universities.

In 2018, UQ will implement a new Strategic Plan 2018 to 2021. Viewing One UQ through the lens of diversity and collaboration is one of the key elements of this plan that will shape much of what we do in the coming years. It's critical that we work together to maximise the benefits of our comprehensive nature leveraging our expertise and infrastructure to have meaningful impact on the global challenges facing us all.



Along with the whole of the University, I know SMI will continue to strive to meet the expectations of all its stakeholders and work to benefit the economy and society.

Regards
Professor Aidan Byrne

Director's Message

The University of Queensland's Sustainable Minerals Institute has had a solid performance in 2017.

This encompassed a focus on stability and sustainability through further enhancing the student and alumni experience, as well as capability building with the development and introduction of a new cross-cutting program and initiatives. Furthermore, 2017 saw promotions and new appointments within our core teams, simplifying our administrative processes and systems, and building on the work started at the SMI-International Centre of Excellence in Chile (SMI-ICE-Chile).

SMI's academic staff continued to deliver on the fundamentals of a university research institute by supervising Higher Degree by Research (HDR) students, publishing broadly and representing the University at conferences.

Students remain a priority for SMI with an industry occupational placement program for HDR students, across the disciplines, formalised in 2017 and starting in early February 2018. SMI graduated our second largest cohort of students in 2017 with twenty seven PhD and MPhil candidates moving on to academic and professional endeavours and becoming the latest additions to our growing and esteemed alumni network. We have also seen a steady increase in the number of Diploma and Certificate graduates in Responsible Resource Development.

To help students develop their skills in translational science and collaborations, SMI hosted an inaugural Hack-A-Thon, where students spent two days building a 3D multiplayer mining value chain game rehearsal environment. The event was attended by SMI industry partners and encouraged students to develop their professional networks and entrepreneurial skills.

During 2017 SMI researchers published a number of high-quality publications, of note was Extractive Relations: Countervailing Power and the Global Mining Industry, a book co-authored by two senior SMI-CSR researchers with deep experience in the industry. Process Mineralogy, the latest high-quality SMI-JKMRC monograph, was also launched in March. The book brings together contributions from expert practitioners, across operations, consulting and research and is a practical and informative resource for anyone whose job is related to minerals and their processing.

In late 2017, UQ approved strategic funding of \$5M over five years to establish and embed the Complex Orebodies program. Professor Rick Valenta will lead a multidisciplinary effort to develop the step changes in social understanding, environmental innovation and mining and processing efficiency in a way that enables sustainable development for complex orebodies.

The inaugural UQ Mining and Resources Forum which aims to enable the key complementary research capacity within UQ to connect was held in November. Thirty-five academics provided a five-minute overview of how their research and other engagement activities linked to the sector. The UQ Mining and Resources Forum is planned to be an annual event on SMI's engagement calendar.

SMI graduated our second largest cohort of students in 2017 with twenty seven PhD and MPhil candidates moving on to academic and professional endeavours...

Another major achievement was the opening of the Santiago office of the the SMI-International Centre for Excellence in Chile (SMI-ICE-Chile) in October. The centre, under the leadership of Professor David Mulligan, aims to create a new collaborative global mining knowledge force in Chile that builds human capital, provides innovative research outcomes and realises effective technology transfer to industry.

2018 is shaping up to be a successful year for SMI with the SMI-ICE-Chile to complete phase one of the set-up of the Centre; development and delivery of the cross-cutting Complex Orebodies program; and the continued generation of longer term industry funded research projects with key stakeholders.

Regards
Professor Neville Plint



Professor Neville Plint
Director, Sustainable Minerals Institute

Advisory Board Chairman's Message

It is a testament to the resilience and reputation of SMI and its academic and research staff that in the face of a protracted downturn in re-investment in the resources sector, SMI was still able to support twenty seven PhD and MPhil graduates during 2017 – the second highest number in the history of SMI.

An important strength of SMI surely continues to be the calibre and diversity of its students and alumni, and this seems to be underpinning the ongoing success of the organisation throughout the notorious cycles of the resources industry. It is also noteworthy that during these challenging times, SMI Director Professor Neville Plint and his leadership team were able to complete a comprehensive strategic review of SMI following exhaustive stakeholder engagement. This ultimately enabled SMI to launch an ambitious revised strategy by the end of last year, very much aligned to industry needs, for focused applied research in the sector as it heads into a new and long-awaited growth phase.

I have been excited to see that a number of integrated, multi-disciplined research Programs have been developed in addition to the existing projects that continue to be actively managed by the Centres of SMI.

An important strength of SMI surely continues to be the calibre and diversity of its students and alumni

Of these Programs (Complex Orebodies, Digital Mining, Mining Life Cycles, Minerals Governance and Organisation, and Operational Excellence), the Complex Orebodies Program was successful in securing important strategic funding from UQ, to assist with early funding of the Program and to encourage the important collaboration with other parts of the University that will be able to contribute to innovative research work to provide solutions for the resources industry and the broader society. On behalf of the SMI Advisory Board I would like to express my sincere thanks to the UQ President and Vice-Chancellor Professor Peter Høj and his executive team for their demonstrated support of SMI in this particular initiative and to SMI more broadly in the strategic context of the University.

SMI's leadership team was actively engaging with industry and other partners and prospective partners during 2017 to reshape and define new areas of research. This resulted in several new Memoranda of Understanding being signed, which have formed the basis for commitments to collaboration in research and learning and augers well for an increasing number of opportunities into 2018.

In November 2017, through the leadership of Professor Plint, an insight into the full potential of The University of Queensland to provide comprehensive solutions to the complex challenges of the modern resources industry was revealed at the inaugural UQ Mining and Resources Forum. The outcomes of this forum and the follow-on initiatives will become an important point of difference in our external engagement strategy.

SMI has been embedded internationally in many countries for years, but I would particularly like to acknowledge Professor David Mulligan's efforts, along with Professor Plint and the leadership team of JKTech, for the substantial advances made last year with the important SMI-ICE initiative in Chile. This gives us the potential to further consolidating our leadership position in Chile and South America as the preferred applied research organisation with industry in a major continent for the resources sector. This project has taken years of persistence to get to this stage, and perhaps is a good example of how an organisation like SMI can continue to broaden its geographic influence and attractiveness for external partners.

Finally, I would like to sincerely thank my colleagues on the Advisory Board of SMI, who make such an important contribution to UQ-SMI in providing advice, connections and support to the leadership team, staff and students of this great organisation.

Regards
Charlie Sartain



Mr Charlie Sartain
SMI Advisory Board Chair and UQ Senate Member



Professor Neville Plint
Director,
Sustainable Minerals Institute



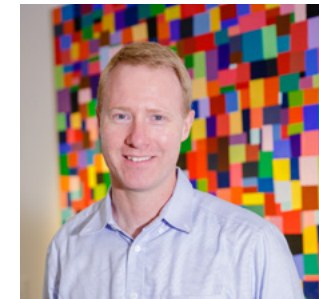
Professor Aidan Byrne
Provost,
The University of Queensland



Mr James Purtill
Director-General,
Department of Natural Resources,
Mines and Energy



Mr Frans Knox
Head of Production,
BMA



Mr Blair Sands
Head of Health and Environment,
Newcrest Mining Limited



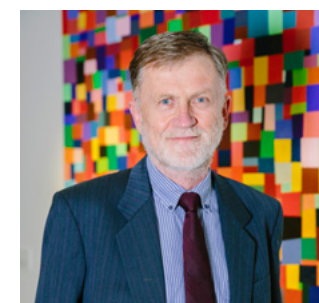
Mr Kenneth Ramsey
Regional Group Executive,
Environment and Social Responsibility,
Newmont Asia Pacific



Dr David Way
Chief Executive Officer,
JKTech Pty Ltd



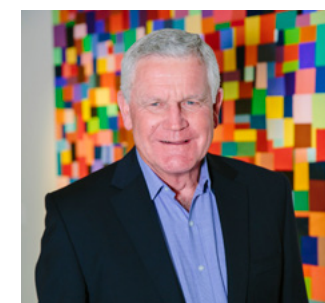
Mr Troy Hey
Executive General Manager –
Stakeholder Relations,
MMG Limited



Mr Peter Forrestal
Chair,
SMI-Production Centres Board



Adjunct Professor Christine Charles
Chair,
SMI-People Centres Board



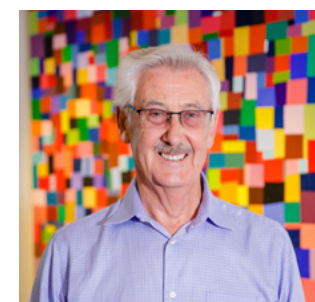
Mr Peter Roe
Chair,
SMI-Environment Centres Board



Mr Douglas Thompson
Managing Director,
Thiess Pty Ltd



Dr Roger Higgins
Independent member



Mr Paul Dowd
Independent Member



Secretariat support provided by:
Karen Hendrickson
Strategy and Project Officer,
Sustainable Minerals Institute



Mr Donovan Waller
Group Head of Technology
Development,
Anglo American PLC

SMI Leadership

Our staff are a multi-disciplinary group of scientists, engineers, anthropologists, sociologists, economists, and natural resource specialists. We have in-depth knowledge of the minerals industry, both at corporate and operational levels, built from years of practical experience and engagement.

Our directors are knowledgeable industry leaders, and our team is skilled to provide strategic or specialist advice, develop policy, and deliver world-leading research, education and training.

Our position within The University of Queensland, and our ability to link research and practice across several disciplines, sets us apart and adds unique value to our work.



Professor Neville Plint
Director
Sustainable Minerals Institute



Melissa Glendenning
Deputy Director - Operations
Sustainable Minerals Institute



Professor Alice Clark
Director of Production Centres
SMI-BRC & SMI-JKMRC
Sustainable Minerals Institute



Professor Deanna Kemp
Director of People Centres
SMI-CSRM & SMI-MISHC
Sustainable Minerals Institute



Professor David Mulligan
Director of Environment Centres
SMI-CMLR & SMI-CWiMI
Executive Director of
SMI-ICE-Chile
(From June 2017)



Associate Professor Glen Corder
Environment Centres
Acting Director
SMI-CMLR & SMI-CWiMI
Sustainable Minerals Institute

Fast Facts



#2
UQ rank in mining and
mineral engineering*



12
Research
Programs



85
Professional and Academic
staff



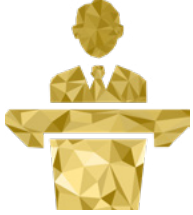
80
Current students



27
2017 graduates



146
2017 publications



21
Speaker Invitations



8
Awards



~\$18M
2017 Funding

*Shanghai Ranking Global Ranking of Academic Subjects for 2017



Equity and Diversity

In 2017, SMI established a Diversity and Inclusion Committee with representation of academic and professional staff, and students. The Committee met for the first time on 31 May.

The Committee's purpose is to

- Consult with and make recommendations to SMI Senior Leadership Team on issues relating to equity, inclusion and diversity at SMI.
- Provide a forum for two-way communication with all staff and students about issues and initiatives related to equity, inclusion and diversity at SMI.
- Develop a gender equity and diversity plan for SMI and work with the Senior Leadership Team to implement.
- Host events to raise awareness of and address issues relating to equity, inclusion and diversity.
- Oversee a future Athena SWAN/SAGE submission from SMI.
- Act as a body of expertise and advocacy on equity, inclusion and diversity issues.
- Consult with equity and diversity committees elsewhere in the University, at other campuses in Australia and overseas if applicable.

The Committee met three times during 2017. A highlight in 2017 was an All-Institute session led by Dee Gibbon, Associate Director, Workplace Diversity and Inclusion to discuss the current state of diversity and inclusion in SMI. Staff and students discussed areas of strength, weaknesses and opportunities to inform the goals of the Institute and activities to be led by the Committee.



Research Highlights

SMI Environment Centres

We're looking forward to a sustainable future

The work achieved in 2017 by the Environment Centres certainly had the current and future performance of mining and the health of the planet in mind.

To prepare for tomorrow, SMI's Centre for Mined Land Rehabilitation (SMI-CMLR) and Centre for Water in the Minerals Industry (SMI-CWiMI) are continuing to deliver innovative environmental research and education to the mining industry today.

"We aim to produce quality research on cutting edge issues of mining environmental and water management and sustainability, across a broad spectrum of resource commodities" Environment Centres Acting Director Associate Professor Glen Corder said.

"A key focus of our staff and students' work is to produce research outcomes that help improve the performance of the mining industry through enabling sustainable water management, enhanced rehabilitation, faster and more resilient mine closure, and more useful post-mining land use for the sector."

Professor Neil McIntyre who leads SMI-CWiMI research activities had oversight of several significant water-related research outputs in 2017.

The Water Accounting Framework, which was co-developed through SMI-CWiMI and the Minerals Council of Australia, was integrated into the International Council on Mining and Metals' publication called 'A practical guide to consistent water reporting'.

"We aim to produce quality research on cutting edge issues of mining environmental and water management and sustainability, across a broad spectrum of resource commodities,"



The guide allows valid comparisons and transparent communications on mine water performance.

SMI-CWiMI also effectively completed three large coal seam gas projects in collaboration with the Centre for Coal Seam Gas.

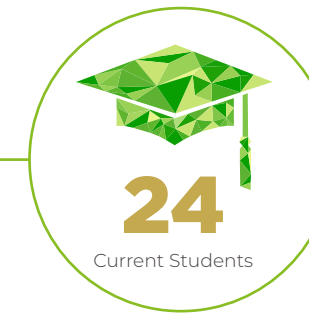
The Water Atlas Feasibility project, led by Dr Sue Vink, created visualisation and analytical tools to extract, analyse and view water chemistry and geology data simultaneously.

The Groundwater Use project achieved better estimates of abstraction volumes for non-CSG related activities in the Surat and Bowen Basins and the Recharge Estimation in the Surat Basin project aimed at gaining a better understanding of the mechanisms of groundwater recharge.

Other research focused on water and mine waste management.

Associate Professor Thomas Baumgartl continued his applied research work on constructed covers over waste rock and tailings storage facilities at Mount Isa Mines.

A project led by Dr Mansour Edraki established, for the first time in Australia, a scale-up experimental process to estimate more realistic long-term salinity generation rates from coal mine spoils.



"For SMI-CMLR the areas that really blossomed in 2017 was our work that's happening on red mud rehabilitation, and identifying metal hyperaccumulating plants and agromining," Associate Professor Corder said.

Agromining involves farming hyperaccumulator plants to decontaminate the land or harvest metal resources not accessible by conventional mining techniques.

In 2017 this research, led by Dr Antony van der Ent and Associate Professor Peter Erskine, was featured in ARTE's documentary, Superplants - How to Make Money by Saving the Environment, and was published in the first book on this technology, Agromining: Farming for Metals.

"We have established a reputation in this niche area and are now one of the world leaders on agromining," Associate Professor Corder said.

In collaboration with the alumina industry, Associate Professor Longbin Huang further developed his eco-engineering technology that makes soil-like growth media, called engineered soil, from the red mud by-product of alumina refining.

This work has the potential to significantly enhance the management of red mud storage dams by turning them back into useable land.

A further milestone was the culmination of the three-year Wealth from Waste Cluster project - a collaboration with the University of Technology Sydney, Monash University, Swinburne University of Technology, Yale University and CSIRO - with the release of the final report, Australian Opportunities in a Circular Economy for Metals.

"A real benefit of this Cluster was the pathway it charted for the Australian metals and minerals industries to contribute and prosper in a future circular economy - that is one designed for circular flows of materials and products to avoid waste and maintain the usefulness of resources," Associate Professor Corder said.

The Environment Centres owe their success in these research projects to partnerships with a range of organisations in industry and government, and from the support of funding bodies like the Australian Research Council and Australian Coal Association Research Program.

Both SMI-CMLR and SMI-CWiMI are in an exciting phase as the Centres' new research outcomes have the potential to help solve some of the key environmental and water challenges in the sector, both now and into the future.

Read more about SMI's research on hyperaccumulator plants in the article *An Ore-some Forest* on page 20.

SMI CMLR Centre for Mined Land Rehabilitation

The Centre for Mined Land Rehabilitation (SMI-CMLR) addresses the environmental challenges of the minerals industry by translating scientific results into practices that continually improve mine rehabilitation outcomes.

Research programs:

- Life Cycle of Mines and Metals
- Ecosystem Assessment, Restoration and Resilience
- Ecological Engineering of Soil-Plant Systems

www.cmlr.uq.edu.au

SMI CWiMI Centre for Water in the Minerals Industry

The Centre for Water in the Minerals Industry conducts research towards achieving sustainable water management in the mining industry.

Research program:

- Regional Water and Land Resources

www.cwimi.uq.edu.au

SMI People Centres

Bridging company and community perspectives

It takes industry-engaged social science to bridge company and community perspectives on mining.

The Centre for Social Responsibility in Mining (SMI-CSR) and the Minerals Industry Safety and Health Centre (SMI-MISHC) are working together under the leadership of Professor Deanna Kemp.

These subsets of the People Centres seem unrelated, but they're both working towards changing the mining industry for the better.

"SMI-MISHC is workforce oriented and focuses on safeguarding the health and safety of mining employees to manage risk," Professor Kemp said.

"SMI-CSR is focused on mining-induced risk to people, and how these risks can generate risks to business.

"SMI-CSR is also focused on understanding how mining can benefit local communities and regions."

To create industry change, the SMI-CSR team worked together in 2017 on a vast range of social science research projects, advisory and consulting work, teaching, training, and multi-stakeholder fora.

This included the completion of a three-year project providing Papua New Guinea's Mineral Resources Authority (MRA) with professional training and capacity building in social performance and resource governance.



Not only do the centres focus on how to better share mineral wealth – there is also emphasis on sharing knowledge.

Other projects involved supporting the launch of a new Private Sector Development course as part of UQ's new Masters of Leadership in Global Development, building a community-company-government dialogue in Chile, and using scenario modelling to explore mining-induced displacement and resettlement.

During 2017 SMI-MISHC developed projects in managing mining equipment operator exposure to whole body vibration, developing and providing health and safety training programs in artisanal and small-scale mining, and integrating mining automation and human systems.

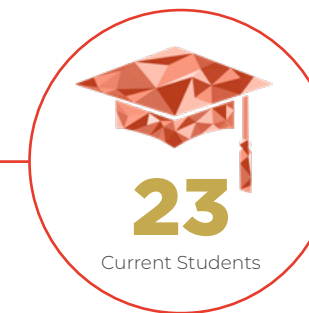
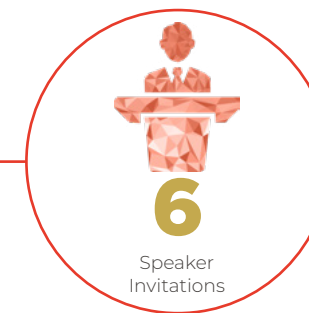
Additionally, Professor David Cliff, newly appointed Professor of Risk and Knowledge Transfer, began a research project to build on decades of prior work in preventing deadly black lung disease before it begins, by testing different exposure reduction methods.

Professor Cliff hopes it will lay the groundwork for vastly improved processes in coal mining.

Developing these projects requires a great deal of collaboration.

In 2017 the People Centres engaged with companies at every tier of the industry, and industry organisations including the International Council of Mining and Metals, the Minerals Council of Australia, and the Queensland Resources Council.

They also collaborated with multi-stakeholder groups, including indigenous representative bodies and civil society and non-government organisations.



The funding stream that supports SMI-CSR is very diverse.

"We work to bring in meaningful projects to maintain a diverse funding stream from governments, industries and competitive grants," said Professor Kemp.

"It is important that we maintain a diverse income profile – so that we're not relying on any one source or stakeholder group.

"In this way we are able to speak independently about the industry."

Not only do the centres focus on how to better share mineral wealth – there is also emphasis on sharing knowledge.

In 2017, the centres were very publication active, maintaining a commitment to producing scholarly publications, industry reports, and a book, *Extractive Relations: Countervailing Power* and the *Global Mining Industry*, authored by Professor John Owen and Professor Deanna Kemp.

"It's really important to us to be making literature available in academic and public domains to build accessible knowledge on the social aspects of mining."

The People Centres' influence is evident from the success of their PhD graduates.

...focused on understanding how mining can benefit local communities and regions."

"One of our major achievements is seeing our really talented students secure high-profile jobs, in influential positions at major global institutions, and that trajectory is extremely exciting," said Professor Kemp.



Read more about SMI's research on preventing deadly black lung disease, in the article *Breath of Life* on page 24.

SMI CSR

Centre for Social Responsibility in Mining

The Centre for Social Responsibility in Mining (SMI-CSR) conducts social science research about resource development.

Research themes:

- Social impacts of mining
- Resource governance
- Displacement and resettlement
- Community engagement
- Mining and development

www.csr.uq.edu.au

SMI MISHC

Minerals Industry Safety & Health Centre

The Minerals Industry Safety and Health Centre (SMI-MISHC) delivers excellent risk management education, consultancy, and research which improves the health, safety, and provides consultancy services to industry.

Research programs:

- Artisanal and Small Scale Mining
- RISKGATE
- Mining Automation Human Systems Integration
- Proximity advisory information interface design
- Whole-body vibration

www.mishc.uq.edu.au

SMI Production Centres

Innovation is the calling card to the future

The key to transforming the mining industry for the better is showcased at SMI.

The Julius Kruttschnitt Mineral Research Centre (SMI-JKMRC) and WH Bryan Mining and Geology Research Centre (SMI-BRC) continued to pioneer mining and mineral processing innovation in 2017, under the leadership of Director of Production Centres Professor Alice Clark.

"A major Production Centres achievement for 2017 was bringing together SMI-BRC with SMI-JKMRC to form a seamless capability and enabling cross-domain research projects across the production value chain," Professor Clark said.

"The centres continued to deepen knowledge in exploration, targeting geometallurgy, mine planning, valuation and mineral processing.

"We attract the best researchers and develop future leaders"

"By working collaboratively, we exemplified our expertise in predicting and solving the future problems of the minerals industry. A number of High Degree by Research (HDR) projects are now underway that cross the specialist areas of geometallurgy placing these students at the forefront of being able to meet the future needs of our industry."

Specifically, this year SMI-BRC worked on methods for predicting the location of reactive ground in the Mount Isa Copper Orebodies, and deriving optimal blast design parameters for different geotechnical scenarios in the Hybrid Stress Blasting Model Project.

Additionally, SMI-BRC was awarded the coordination of the Deep Mining Queensland Project aimed to reduce the risk of deep exploration for Cu-Au (copper-gold) deposits, through analysis of 2D and 3D geology, in the Cloncurry metallogenic province.

Concurrently, SMI-JKMRC worked on improving existing and developing novel mineral separation processes, under the ideology that one can no longer solve problems by making equipment bigger. Instead, there is a need to make the process smarter and adopt new technology.

This is explored through the High Voltage Pulse Comminution and Pretreatment project, and the Hydrofloat Coarse Particle Flotation project.

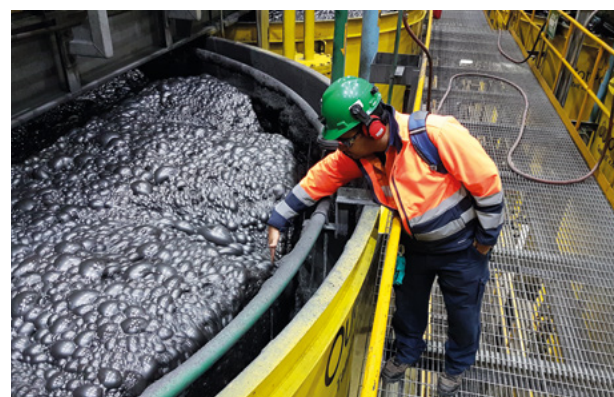
SMI-JKMRC also worked on transforming modelling processes using on-site data in the APPCo (Advanced Process Prediction and Control) project.

"Through industry involvement and on-site engagement, the outcomes of this research are being developed on mine sites in Australia and internationally," Professor Clark said

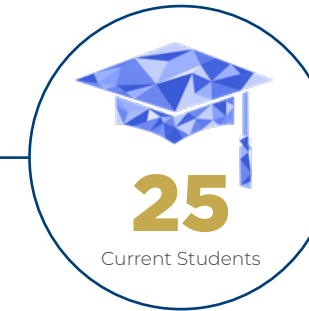
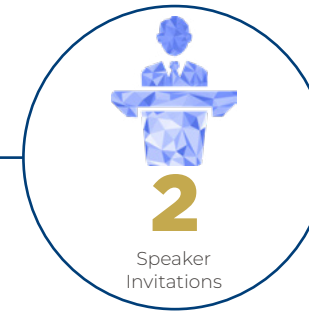
"The production centres owe this success to their recognition as 'Knowledge Leaders' and building strong links with a broad set of collaborators."

In 2017, SMI-JKMRC and SMI-BRC collaborated with a wealth of the industry's leading thinkers, including AMIRA, GSA, DNRME, CSIRO, UCT, Hettechipe, JCU, HURST, and the University Federal Rio de Janeiro.

"We attract the best researchers and develop future leaders" Professor Clark said.



PhD student, Juan Jose (Juanjo) Frausto Gonzalez, assessing the froth during a mine site visit to Minera Saucito.



Production centre staff and students demonstrated this through their extensive successes in 2017.

Grant Ballantyne and Juan Gonzales won awards at the AusIMM Metplant conference, Professor Frank Shi won the CEEC Medal in Santiago at the Procemin conference, and Elaine Wightman and Cathy Evans helped publish the book Process Mineralogy.

Emeritus Professor and Industry Fellow at SMI-JKMRC, Tim Napier-Munn says the project centres rely on the energy and talent of graduate students for project development.



"The production centres owe this success to their recognition as 'Knowledge Leaders' and building strong links with a broad set of collaborators."

"We deliver the two products for which the JK was established - research that is valuable to the industry, and the next generation of highly trained technologists," Emeritus Professor Napier-Munn said.

"From my own observations I can testify that throughout this difficult time there has been one constant factor - the high quality of the research which the students undertake under the supervision of SMI-JKMRC staff."

"Without this, there is no SMI-JKMRC; with it, anything is possible."

Read more about SMI's research on High Voltage Pulse Comminution and Pretreatment, in the article *Professor keeping his finger on the pulse* on page 26.

SMI JKMRC

Julius Kruttschnitt Mineral Research Centre

The Julius Kruttschnitt Mineral Research Centre (SMI-JKMRC) aims to be a world class provider of postgraduate education and innovative applied research in mineral processing and geometallurgy.

Research programs:

- Separation Program
- Advanced Process Prediction and Control (APPCo) Program
- Mine Energy Transformation and Integration Program (METI)

www.jkmrc.uq.edu.au

SMI BRC

WH Bryan Mining & Geology Research Centre

The W.H.Bryan Mining & Geology Research Centre (SMI-BRC) has a reputation for practical innovation and leadership in deep mine development and operation.

Research programs:

- Total Deposit Knowledge

www.brc.uq.edu.au

SMI-ICE-Chile

Wealthy in knowledge

Australia exports many valuable natural resources, and for Chile, SMI's trading of knowledge is valuable beyond belief.

All knowledge is reusable, and provides methods, templates and examples that can evolve existing standards of practice.

Executive Director of the International Centre of Excellence in Chile (SMI-ICE-Chile), Professor David Mulligan, an advocate for sharing knowledge has been a driver of change in improving Chilean mining operations.

2017 marked the third year of SMI's project to deliver demonstrable benefit to the Chilean people and its economy.

The Implementation Stage of the project reached its final legs in 2017, with transitioning into the Operational Stage beginning in August 2018.

"We seek to create a collaborative mining knowledge centre in Chile that builds human capital and capacity, and provides a mechanism for the transfer of innovative research and developed technologies into the practices of industry," Professor Mulligan said.

"We seek to create a collaborative mining knowledge centre in Chile that builds human capital and capacity..."

"The creation of SMI-ICE-Chile brings to Chile the opportunity to develop and implement the type of interdisciplinary integration model and academe-industry partnership model that have proven to be successful platforms in Australia.

"Through this model, we will work with local partners and associates to generate improvements and positive changes in the way the industry operates, and will introduce technologies fit-for-purpose and with outcomes and implications understood, to co-create the responsible and sustainable development of the country's mineral resources."

The Centre tackles the critical issues surrounding using less water and energy to meet productivity targets, and dealing with tailings and their storage.

With this aim of knowledge sharing, the Centre worked with countless collaborators to achieve these goals.

In addition to project activity with the Centre's co-executor partner, Universidad de Concepción, as the year progressed, there was an expansion in collaborations with other universities and research organisations such as Universidad de Chile, Pontificia Universidad Católica de Chile, Adolfo Ibáñez, and CSIRO Chile.

On the industry side, opportunities were advanced with Codelco, ENAMI, BHP and Anglo American.

2017 also saw new highly talented professional and research staff appointments recruited into the Centre.



Professor Neville Plint, Director of SMI, with Fidel Baez (left) and Dr Gianni Olguín, Director of the School of Chemical Engineering at Pontificia Universidad Católica de Valparaíso (and UQ Alumnus), at the opening ceremony of the office.

...we will work with local partners and associates to generate improvements and positive changes in the way the industry operate...

"Two highly regarded and respected individuals in the Chilean ecosystem in their respective fields, Senior Operation Manager, Ms Varinka Farren, and R&D Manager, Dr Jacques Wiertz, were major appointments in 2017 that will significantly drive the success of the Centre in the years to come," Professor Mulligan said.

SMI and SMI-ICE-Chile expertise was widely disseminated at conferences in 2017, including Exponor (Chile's Annual Exhibition of Global Technologies and Innovations for Mining), Coalition for Energy Efficient Comminution (CEEC) Mining Energy Innovation forum, Minexcellence, Water in Industry, Enviromine-SRMining, and Procemin-GEOMET.

The year also saw the Centre settling into its new office in Las Condes, Santiago, at a convenient location close to local corporate company and mining association offices, with short

travel to government offices and universities across the city.

The office was officially opened in a ceremony by the Minister of Mining, Ms Aurora Williams.

The opening was attended by members of the UQ Senior Management Group, and both the Australian Ambassador, His Excellency Mr Robert Fergusson and the Head of the Technological Capabilities Division in CORFO, Marcela Angulo, spoke to the more than 120 invited guests in attendance.

In 2017, SMI-ICE-Chile grew as an entity of value, relevance and opportunity to both Chile and the multiple components of UQ's mining and minerals academic and research cohort, and will continue to develop this in the years to come.



Left to right: David Mulligan and Paula San Miguel (Coordinator) with some of new staff that commenced during the year – Doug Aitken, Varinka Farren, Ana Rita Ramirez and Rodrigo Rivas.



Left to right: Professor David Mulligan, Executive Director of SMI-ICE-Chile, with special guests at the opening of the office in Santiago: Marcela Angulo (Head of the Technological Capabilities Division of CORFO), Aurora Williams (Minister of Mining) and His Excellency Mr Robert Fergusson (Australian Ambassador).

SMIICEChile

INTERNATIONAL CENTRE OF EXCELLENCE

www.smi.uq.edu.au/ice-chile



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Executive Director of SMI-ICE-Chile



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www.smiicechile.cl



Research Impact

PHOTO CREDIT: Antony van der Ent, Hugh Harris, Martin de Jonge, Peter Erskine, Rachel Mak, Jolanta Mesjasz-Przybyłowicz, Wojciech Przybyłowicz, Emmanuelle Montargès-Pelletier, Alban Barnabas, Guillaume Echevarria, David Paterson and Daryl Howard.

An Ore-some Forest

Metal crops or hyperaccumulator plants are unusual plants that have the capacity to accumulate high concentrations of certain elements...

Whether we realize it or not, many of us use lithium-ion batteries everyday. They could be powering your laptop, camera or smart phone, fueling the power-tools you use at home on the weekends, or if you're lucky enough to own one, running your electric Tesla car.



The blue-green latex of the New Caledonian tree *Pycnanthus acuminatus* contains up to 25% nickel. Green colour shows calcium, and blue shows nickel.

Dr Antony van der Ent and Associate Professor Peter Erskine from UQ's Sustainable Minerals Institute's Centre for Mined Land Rehabilitation, are leading research on novel ways to extract critical elements, such as nickel and cobalt, needed for lithium-ion batteries and other high-tech demands.

Globally, ore grades are declining and it is becoming ever more difficult – and therefore costlier – to extract target elements. Dr van der Ent said the increasing demand for critical elements challenges conventional methods of resource extraction. For example, the massive uptake of lithium-ion batteries that use nickel and/or cobalt cathodes, such as those produced in Tesla's Gigafactory, places further strains on the global demand chain. Agromining of so-called "metal crops" can provide a source of sustainably sourced nickel and cobalt with low environmental impact.

Metal crops or hyperaccumulator plants, explained Dr van der Ent, are unusual plants that have the capacity to naturally accumulate exceptionally high concentrations of certain elements in their biomass. Farming metal crops and harvesting their metal-rich biomass is called 'agromining'. This innovative approach enables access to resources not accessible by conventional mining techniques and abundant low-grade sources of valuable elements.

Agromining could also benefit local communities, by providing new income opportunities for farmers in Indonesia and the Philippines where low-grade nickel sources are located. It can also be applied for cleaning of metal-polluted sites, including various industrial wastes. Hyperaccumulator plants are now known for elements that pose a major risk to human health, such as arsenic and cadmium,

and for nutritional elements such as selenium and zinc. Applications of agromining therefore span from the remediation of pollution to the production of bio-sourced industrial metals and organic supplements for human consumption.

Hyperaccumulator plants are able to accumulate 4% nickel in their leaves, translating to over 300 kg of nickel per hectare per year in harvested biomass. A unique characteristic of the bio-sourced nickel is the high purity affected by the metal crop, with the ashed biomass containing 20–30% nickel and few of the impurities usually associated with nickel ores. This makes these bio-ores ideally suited for specific applications, particularly the electrochemical industry producing rechargeable batteries.

Research at UQ's SMI-Centre for Mined Land Rehabilitation has led to the discovery of 120 hyperaccumulator plants new to science. The search for more hyperaccumulator plants has been intensified in recent years by

using advanced X-ray Fluorescence methods for mass-screening of herbarium collections. This has led to a significant increase in the global pool of known hyperaccumulator plants suited for a range of different climates and conditions, for use as metal crops.

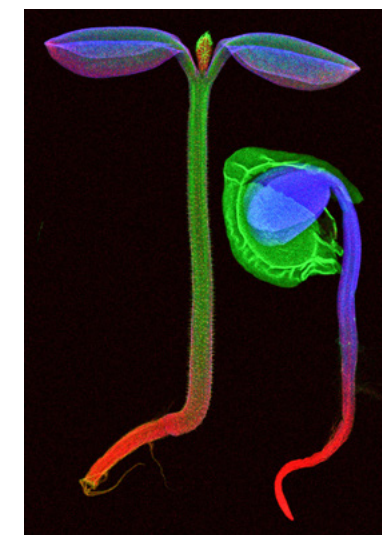
Research funded by the Australian Research Council aims to better understand the ways in which hyperaccumulator plants take up and store metals in living leaves. Recently the team from UQ completed a field trial in Malaysia that demonstrated the fast growth-rate and accumulation of tested metal crops, substantially exceeding results obtained from trials in temperate locales.

Research to date demonstrates that metal crops, and the agromining of these plants, enables critical elements, including nickel and cobalt, to be sustainably sourced and create new income opportunities for communities. These unusual plants could also assist in the rehabilitation of polluted land.

Metal crops or hyperaccumulator plants are unusual plants that have the capacity to naturally accumulate exceptionally high concentrations of certain elements in their biomass.

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X-ray fluorescence microscopy image of the seed capsules of the nickel hyperaccumulator plant *Alysicarpus*. The red colour shows its structure, whereas the green colour shows calcium, and blue shows nickel.

Resourceful Solutions

In the first collaboration of its kind, SMI's Centre for Social Responsibility in Mining is advising and working with some of the world's leading mining companies to improve the lives of people affected by resettlement.

When people are displaced, they lose more than just their homes and land – their health, education, rights, and even lives can be at stake.

Global mobility due to displacement is on the rise – caused by political and armed conflict, rising sea levels, and natural disasters, among others – and leads to a myriad of issues for both displaced people and the communities they resettle within.

Mining-induced displacement and resettlement (MIDR) is one such cause, which affects the lives of millions of people around the world who reside near current mines or sites identified for future mining activity.

Unfortunately, the mining industry has not always handled MIDR well.

"It's something that the industry has long struggled with," says Associate Professor John Owen from the Sustainable Minerals Institute's Centre for Social Responsibility in Mining (SMI-CSRM).

To address this, Associate Professor Owen and Professor Deanna Kemp, Director of the SMI-CSRM, oversaw the launch of the UQ-SMI Mining, Resettlement and Livelihoods: Research and Practice Consortium earlier this year.

The Consortium brings together researchers from UQ's Sustainable Minerals Institute (SMI) with five of the world's largest mining companies – Anglo American, MMC, Newcrest Mining Limited, Newmont and Rio Tinto – and allows industry representatives to look at resettlement issues in a collaborative manner.

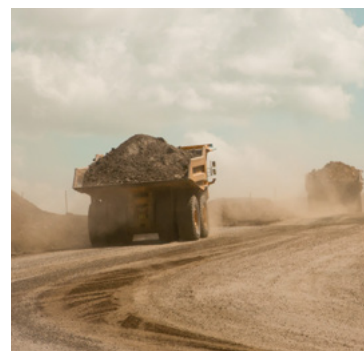
"Mining companies all face similar problems. The point of the Consortium is not to make a single operation or company the focus of research, but instead to focus on the issue," says Professor Kemp.

"Our industry partners agreed to pool their funds to look at this as an industry-wide issue, rather than focusing on individual instances of poor practice."

Rachel Durdin is General Manager, Project Shaping at Rio Tinto, one of the partners in the Consortium. She says this collaboration is an important part of tackling what is a highly sensitive topic.

"You want to keep people engaged and open to contributing. A lot of the cases are not positive stories, especially in resettlement, so we're looking for an environment to be able to do that," says Ms Durdin.

"The Consortium provides a platform for us to look at our approach in a critical and constructive way."



Transporting ore on a mine site.

Challenges of mining-induced resettlement

Professor Kemp and Associate Professor Owen were motivated by the lack of research and dedicated policy in the area of MIDR. Currently, mining resettlement is governed by general standards such as those developed by the World Bank and the International Finance Corporation (IFC).

These standards are designed to deal with broader development-induced displacement and resettlement, which mostly takes place at the beginning of the project, such as the start of the construction of a hydropower dam or road.

"Mines can keep expanding, and their footprint changes over time, so a lot of displacement happens as the operation moves forward," says Professor Kemp.

"That's something that the general World Bank and IFC standards don't cover so well, and is the major challenge in this industry."

Indeed, the data gathered by Professor Kemp and Associate Professor Owen show that around two-thirds of mining-induced resettlement takes place several years after a project is up and running.

Professor Kemp and Associate Professor Owen say a closely related issue is that of brownfield resettlement.

Mining projects can be roughly divided into greenfield and brownfield sites. Greenfield sites are where no mining activity has occurred in the past, while brownfield sites are where mines are currently operating, or where there have been mines in the past.



RESEARCH IMPACT

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UQ researchers at a community consultation on displacement and resettlement in South-East Asia (image courtesy of SMI-CSRM).

Associate Professor Owen says brownfield sites can have an industrial history complicated by previous disturbances to land and natural resources in the area.

"In these environments communities have already experienced significant impacts."

"When you look at a brownfield site, you have to take all of that history and prior disturbance into account," he says. "In these environments communities have already experienced significant impacts."

"In greenfield projects there is typically less of this industrial history. A lot of the other industries we look at that are covered by these international standards don't find themselves having to plan for resettlements, during the operational phase of a project."

Shaping resettlement policy

In August this year, Professor Kemp and Associate Professor Owen hosted a resettlement practice workshop at UQ for Rio Tinto.

The workshop brought together practitioners from across the company's global operations, together with experts from SMI-CSRM.

"We want to really understand what the challenges are and, having identified the challenges, come up with some solutions," says Janina Gawler, Global Practice Leader for Communities and Social Performance with Rio Tinto.

She says it can be difficult to maintain knowledge and learnings around resettlement because mining projects take place over many years, and people with the knowledge often move on to different positions.

"We're having the workshop to try and capture the knowledge while we've got a strong body of capability from the business, and then use that to go back into project development."

"Too often I think what we do is learn in the moment and then put it to one side. The intention of this session with SMI-CSRM is to get them to challenge us, to distil our learnings and to help us determine what needs to happen going forward."

Following on from the workshop, Rio Tinto have now commissioned UQ to conduct additional research to assist them in better understanding the resources needed for responsible resettlement.

Looking to the future

The Consortium is now working on a number of initiatives to help improve mining resettlement practices.

One is the database of MIDR cases, intended to preserve knowledge and understanding of resettlement issues.

"We've been working for about three years on building this database, which is the first global database on mining resettlement cases," says Professor Kemp.

The database allows researchers to access information on resettlement cases from across the world, to analyse patterns and influence industry policy and practices. It also provides near-mine communities with information about what they can expect in the event of resettlement.

"In an industry that is so data-driven, we need data to focus the industry's attention," says Associate Professor Owen.

Another initiative is a comparative analysis of the regulatory frameworks of six active mining economies, where some of the world's largest mining companies operate.

Professor Kemp and Associate Professor Owen hope this framework will help provide a basis for shaping resettlement laws and regulations into the future.

Professor Kemp says the mission for the Consortium is to reframe how the mining industry approaches its impact on local communities.

"We want to continue to improve practice and policy, build an evidence base, open up new avenues for collaboration, and make sure the industry is focused on this."

Breath of Life

UQ's Professor David Cliff is working to help stop deadly black lung disease before it begins.

By the time the cough starts, it's already too late.

Coal workers' pneumoconiosis (CWP), or black lung, is a potentially fatal, irreversible lung disease caused by breathing in coal mine dust.

The culprit is respirable dust released during mining, which contains coal and other mineral particles that are small enough to be breathed deep into the lungs, where they can block air passages and cause scarring of lung tissue.

CWP has two stages, simple and complicated. In the simple stage, small nodules develop in the lungs. At this stage, affected workers may be asymptomatic, or have shortness of breath and a chronic cough.

If workers continue to be exposed to high concentrations of respirable coal dust, the disease can cause chronic airflow limitation and progress to complicated CWP. This causes large, dense fibroids in the lungs that significantly reduce lung function and can be fatal.

Because there is no cure, the only way to save people from CWP is by preventing them from breathing in the dangerous respirable coal dust in the first place.

This prevention is the aim of a joint research initiative between The University of Queensland, the Queensland Government's Safety in Mines Testing and Research Station (Simtars) and New South Wales-based industry organisation Coal Services, with funding from the Australian Coal Association Research Program (ACARP).

The 'Improving respirable coal dust exposure monitoring and control' project, led by Professor David Cliff from UQ's Minerals Industry Safety and Health Centre (SMI-MISHC), has two main aims: to establish the best ways of measuring mine workers' exposure to respirable dusts, and then using these measurements to test the effectiveness of different exposure reduction methods.

Nikky LaBranche, Principal Mining Engineer, says the project goes to the heart of Simtars's remit to improve the health of safety of mine workers in Queensland.

“Ultimately, this is about advancing the introduction of broad-scale, real-time, personal monitoring of respirable dusts to improve health outcomes for the mining workforce.”

In 2015, CWP killed 2500 people worldwide, according to the [Global Burden of Disease Study].

The disease was thought to have been eradicated in Australia, but in May 2015 the first Queensland coal miner in 30 years was diagnosed with CWP. As of August 2017, 24 diagnoses of current and former mine workers have been confirmed, with this number likely to rise in coming years. Most of these patients have been diagnosed with simple CWP.

In an immediate response to the re-emergence of CWP, the Queensland Government commissioned a review into the Coal Mine Workers' Health Scheme by the Centre of Occupational and Environmental Health at Monash University, in collaboration with the University of Illinois at Chicago.

The subsequent Monash Review included 18 recommendations to improve the prevention, detection and safety net for mine workers, which have been progressively implemented since late 2016.

The Queensland Parliament also established the Coal Workers' Pneumoconiosis (CWP) Select Committee in September 2016 to conduct an enquiry into the re-emergence of the disease in Queensland.

The committee's report, Black lung white lies, published in May 2017, slammed the re-emergence of CWP as a "catastrophic failure, at almost every level, of the regulatory system intended to protect the health and safety of coal works in Queensland".



Chest x-rays showing the progression of CWP in a US coal worker from 1991 (normal X-ray) to 2000 (X-ray shows PMF). Fibrosis is shown by white lines and masses on the X-rays. The patient died in 2004 at the age of 45 from respiratory failure secondary to CWP with PMF. (Images courtesy of Edward L. Petsonk, MD, Professor of Medicine, West Virginia University School of Medicine.)

Professor Cliff says a lot of attention has been directed to inadequate medicals, which failed to detect the disease earlier.

“What we're trying to do is say, how did it happen in the first place? It happened because people are exposed to excessive levels of respirable coal dust,” he says, highlighting the fact that prevention is better than cure.

Professor Cliff says the first step in efforts to reduce the amount of respirable dust miners are exposed to is to determine the most effective dust-monitoring systems.

The most commonly used monitoring systems in Australia consist of filters worn by miners throughout their shift, which can be analysed at the end of the shift to assess how much dust the worker was exposed to.

“While it's fine for a cumulative exposure over the lifetime, it doesn't tell you where the worker was when the dust was exposed, or what it was that caused the dust exposure, and at what time,” says Professor Cliff.

By testing alternative technologies, such as fibre optic devices, Professor Cliff is hoping to find monitoring methods that provide accurate, real-time data on coal dust exposure. This data can then be used to assess different dust control techniques to determine which is the most effective.

Techniques range from preventing dust from forming in the first place – by infusing water into the coal or using additives to make the dust particles bigger, so they can't be inhaled as readily – to using sprays to take the dust out of the air, or installing devices that collect the dust.

“Some of the controls are as simple as moving people out of the dust streams,” says Professor Cliff, who hopes that their discoveries will also be translatable to other related industries.

“We will be able to apply them in India to look at stone companies and gem companies.”

The research project is scheduled to run for 12 months, and Professor Cliff hopes it will lay the groundwork for vastly improved processes in coal mining.

“We want to have the tools required to establish an acceptable working environment, in both monitoring and control, and have processes in place which everyone regards as being appropriate. Hopefully, it will be a huge quantum change to where we are now.”

RESEARCH IMPACT

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A size comparison of respirable dust particles (Photo credit: iStock/azerberber).

Professor keeping his finger on the pulse

A novel technology using high voltage pulses (HVP) to pretreat ore and improve ore processability has been developed by Professor Frank Shi and his team at the SMI-JKMRC.

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With demand for minerals increasing while Australian ore grades decrease, a new method for processing higher quantities of ore needs to be developed to maintain current metal production rates.

Over the past ten years, Professor Frank Shi has led a team of The Julius Kruttschnitt Mineral Research Centre (SMI-JKMRC) staff and students to tackle this issue.

Traditionally, mineral processing plants use a process called 'comminution' to crush and grind ore into fine particles to separate and extract the different mineral components.

This process uses 158 trillion kilojoules of energy every year for just Australian copper and gold – 16 times the energy consumption of a city like Brisbane.

The mining industry now faces a serious question.

How will we produce the metals society needs in a way that is economically and environmentally sustainable for the future?

The team approach this challenge with what Professor Shi calls a 'disruptive technology' for the industry – high voltage pulse.

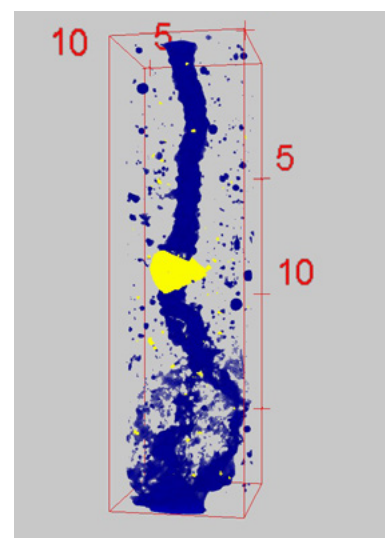
High voltage pulse (HVP) technology has been left on the backbench for decades.

"In the 1950s Russians attempted to decompose water into hydrogen and oxygen and in the 1970s it was finally used in a mining context to liberate valuable minerals from ore, at a high energy cost," said Professor Shi.

Many years later, the SMI-JKMRC HVP comminution team approached this research topic from a new angle.

Instead of using HVP as a comminution tool, they use low HVP energy to selectively break the ore and change ore processability, allowing for better performance of downstream processes and savings in energy.

"We found that the high voltage pulse can find whether a particle contains valuable minerals or not," said Professor Shi.



The X-ray computed tomography (XCT) image shows a chalcopyrite mineral grain (in yellow) induced HVP breakdown channels (in blue) in a synthetic rock (in grey), scale in mm.

"Similar to how a golf club will attract lightning in a storm, high voltage pulse has a selective breakage mechanism where the ore containing high conductivity/permittivity minerals is broken while the barren rock is not.

"We can use this new technique to reject the waste at an early stage and save energy to make the mining industry more sustainable."

In the lab, they submerged two small synthetic rocks into the water of the HVP processing vessel – one barren and one containing chalcopyrite.

Operating parameters such as electrical voltage, current, capacitance, resistance, inductance, pulse frequency, and electrode configurations were controlled to optimise the system.

When the machine started, a bang is heard as 180 kilovolts were discharged into the rocks for one pulse.

One rock remained intact, but the other was fragmented and could easily be further broken by hand.

This meant the broken rock contained valuable mineral, and shiny metal could clearly be seen on the newly exposed surface.

Fragments could fall through the holes in a screen, while the barren rock could not, allowing it to be screened out.

This is the discovery that was further developed into a novel ore grading splitting and preconcentration technique, that selectively breaks mineralised particles with high conductivity/permittivity, while leaving the barren rock whole.

In the mining industry, this barren rock is commercially valueless material called gangue.

In the case of processing base and precious metals, more than 95% of the run of mine feed consists of gangue minerals without industrial value.

In one instance using a particular ore, it is possible to use HVP treatment to reject 45% of the run of mine feed by simple screening and still recover 80% of the gold.

Professor Shi estimates for a 20 million tonne per annum operation, rejecting 30% of barren rocks would result in a \$14 million per annum saving in haulage costs, and also bring significant benefits with respect to water use and tailing treatment.

The project also intends to reduce grinding energy consumption, which is the heart of mineral and metal extraction.

"Grinding is the single largest energy consuming process in any mineral processing plant, which is a constraint in the processing of low grade ores, and a significant barrier in the near future when even lower grade ores are treated," Professor Shi said.

Ultimately, high voltage pulse will increase mining operation profitability.

The value of this research was recognised when a paper on the topic, authored by Frank Shi, Weiran Zuo and Emmy Manlapig, won the prestigious 2017 Coalition for Energy Efficient Comminution (CEEC) Research Category Medal. (Read more on page 39)

"I hope it will help us to source the funding required to enable us to continue work with HVP in 2018 and onward.

"It's just good timing, because we are currently seeking to take our research outcome from the laboratory to a larger scale, and we need the mining industry to support and fund this campaign."

In 2018, the team will initiate a new collaborative research project focused on bridging the gap between lab-scale research and industrial-level operation and has submitted patents for innovative equipment developed to achieve this goal. Newcrest and UQ are co-funding a new flexible HVP testing facility at SMI-JKMRC to house this equipment which is scheduled for commissioning mid-2018.

Experts from various disciplines are being brought together for this project, including Dr Kym Runge, Professor Rick Valenta, Dr Christian Antonio, Dr David Seaman, Professor Emmanuel Manlapig, and collaborators from a University in China.



Professor Frank Shi standing with SMI-JKMRC's SELFRAG HVP Unit.

This project owes its success to its many investors who saw its potential – the Sustainable Minerals Institute, Australian Research Council (ARC Linkage-AMSRI and ARC LIEF projects), University of Queensland, The University of South Australia, University of Newcastle, University of Melbourne, Australian Postgraduate Award Industry, Newcrest Mining, Anglo American Centre for Sustainable Comminution, China Scholarship Council, SELFRAG AG, as well as a number of other mining companies in supporting HVP characterisation of their ore samples.

Ultimately, high voltage pulse will increase mining operation profitability.



Industry

Transformational Learning

SMI's Transformational Learning Program develops capabilities to deliver responsible resource development through innovative and world-class education.

The goal of SMI's Transformational Learning Program is to provide a platform to translate research outcomes and knowledge from SMI Centres and the broader UQ community into enhanced capabilities across industry, government and community stakeholders.

As well as co-ordinating SMI's flagship Responsible Resource Development postgraduate program, the program works with organisations to tailor learning activities to their specific needs, integrating across disciplines and contexts to deliver programs with a focus on application in the workplace.

The program works closely with other UQ Faculties and Schools including UQ International Development, UQ Executive Education, UQ Business School, the Faculty of Engineering, Architecture and Information Technology (EAIT), the School of Earth and Environmental Sciences and Faculty of Humanities and Social Sciences (HASS).

Other 2017 highlights included the conclusion of an extended program on Mining and Journalism in Mongolia for GIZ, designed and delivered in partnership with the UQ School of Communication and Arts, and co-ordination of the Ninth Triennial Acid and Metalliferous Drainage Workshop in Burnie, Tasmania. *(Read more on page 58)*

SMI continued to co-ordinate a program of work in Niger, funded by the Department of Foreign Affairs and Trade (DFAT), working with government officials on various aspects of mining governance in the African nation. The 2017 program included a very successful study tour to neighbouring Burkina Faso, resulting in increased interaction between agencies on identified priority issues such as small scale mining.



SMI's Massive Open Online Course (MOOC) 'The Future of Mining?' was launched in March 2018. It explores possible scenarios for the mining and minerals sector in 2040, and was developed in conjunction with the School of Mechanical and Mining Engineering and the UQ Business School.

Continued industry demand for risk management training saw the delivery of several Global Mineral Industry Risk Management (GMIRM) workshops at various locations around Australia, with the curricula being updated to include the latest research on Critical Control Management.

2017 marked the inaugural delivery by SMI-CSRM of a bespoke program for Newcrest Mining Limited, the Social Performance Leadership Program, that included two week-long workshops at the St Lucia campus and related group project activities, engaging participants over a period of five months. *(Pictured)*

Building tomorrow's mining leaders

In 2017, Transformational Learning successfully delivered the latest iteration of the Mining Leaders Program (MLP) to a group of future resources sector leaders.

"The 2017 MLP cohort was the most impressive and cohesive yet..."

The innovative program engages future leaders by delivering a world-class program combining the latest research on the future of the sector with key business management and personal leadership concepts, using case studies and critical reflection to contextualise learning activities.

Robin Evans, SMI Program Leader for Transformational Learning, convened a cohort of 13 enthusiastic participants based in Chile, Tanzania, Indonesia, Papua New Guinea and Australia from a diverse range of mining and service companies and related organisations.

The group completed an integrated program comprising two modules of online course work, two face-to-face workshops held in Brisbane, and one-on-one coaching sessions over a seven-month period.

Experts were engaged throughout the program from across UQ as well as numerous external organisations. A highlight for many participants was the video conference held with the General Manager of MMG's Kinsevere operation in DRC as part of the group case study project.

"The 2017 MLP cohort was the most impressive and cohesive yet, with managers based in five countries from different organisational functions sharing their experiences and working together." Mr Evans said.

Mathew Awari Award winner:

Cameron McGregor, Manager of Strategic Projects for Ok Tedi Mining, is one prominent member of the 2017 cohort.

Mr McGregor was nominated by his peers to receive the Mathew Awari Award for the most significant contribution to the culture, well-being and community spirit within the 2017 program.

Mathew Awari was a long-serving manager at Ok Tedi and a member of the inaugural MLP cohort in 2014, before his untimely passing in 2015.

This annual award honours Mathew's significant contribution to the program and was especially significant for Cameron.

"[Mathew] meant a great deal to my company, and it feels good to be able to take this home to Ok Tedi," Mr McGregor said.

Previous delegates, like MMG Processing Manager Ryan Whyte, speak highly of how the MLP structure and facilitators have given them knowledge and tools for a future in mining leadership.

"When being taught something from people who have actually experienced what they are teaching, it adds credibility and improves student buy-in," Mr White said.

"It was really powerful working with the cohort and gaining experience and ideas from such a qualified group of people."

Other companies represented in the 2017 cohort were Acacia Mining, CMOC Northparkes, Sandvik, PNG Mineral Resources Authority, Codelco, MMG and Anglo American.



(Pictured: Cameron McGregor (centre) with MLP alumni Harry Hardy (2015) and Chris Gentle (2015).)



Industry Collaboration Highlights

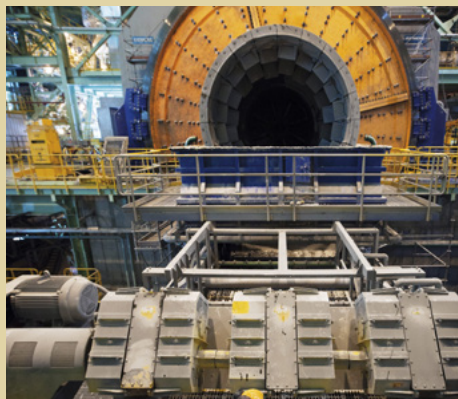
SMI’s purpose is to develop game-changing people by working with our partners to co-create solutions to the big challenges facing the sector therefore industry collaboration is integral to what we do.

Five of the largest global mining companies joined the **Mining and Resettlement Consortium**, a new initiative launched in 2017, with the objective of improving the lives of people affected by resettlement. A team of multidisciplinary leaders from SMI’s Centre for Social Responsibility in Mining (SMI-CSR) are working with select members from Anglo American, MMG Limited and Rio Tinto as well as Newcrest Mining Limited and Newmont to look at resettlement issues such as planning, displacement, relocation, livelihood restoration and support for social integration in a collaborative manner. Partner companies, in collaboration with SMI-CSR, set the program of work for each calendar year, which to date has included authoring industry discussion papers, global practitioner workshops, a global database of resettlement events, and an online library of public mining and resettlement literature.

The **Anglo American Centre** for Sustainable Comminution is a partnership between SMI’s Julius Kruttschnitt Mineral Research Centre (SMI-JKMRC) and Anglo American.

The Centre focuses on delivering value by building and maintaining a critical mass of long term, consistent and appropriate technical support and expertise in the area of comminution through the Global Comminution Collaborative (GCC).

To date, research outcomes from the Centre have been transferred to Anglo American operations through training, workshop activities and site delivery. Based on the value of the outcomes, an extension of the 5-year collaboration is under negotiation.



Director of People Centres at the SMI, Professor Deanna Kemp, is a leading international expert focused on the social and political challenges of the global mining industry.

Professor Kemp engages with most of the world’s major mining companies, and many of its peak industry bodies. In February and July 2017, Professor Kemp and a team of senior SMI-CSR staff delivered social performance leadership training for **Newcrest** staff from Australia, Indonesia, Côte d'Ivoire, and Papua New Guinea.

The workshops form part of a three-year agreement between Newcrest and SMI-CSR to share knowledge across and within both organisations. Social performance is emerging as a critical success factor for mining companies, and the need to increase the depth and breadth of understanding of key issues among all stakeholder groups has never been greater.



In 2015 **MMG Limited** and the Sustainable Minerals Institute signed the MMG Limited-UQ SMI Research Collaboration Agreement. The three year agreement objectives are broadly to:

- Enhance the understanding, capacity and management of social, environmental and technical risks and performance
- Develop expertise as well as the research and analytical capabilities of MMG Limited personnel
- Provide collaborative research opportunities for postgraduate students
- Add to the scientific knowledge on mining and sustainable development
- Generally increase the capability and awareness of the minerals industry.

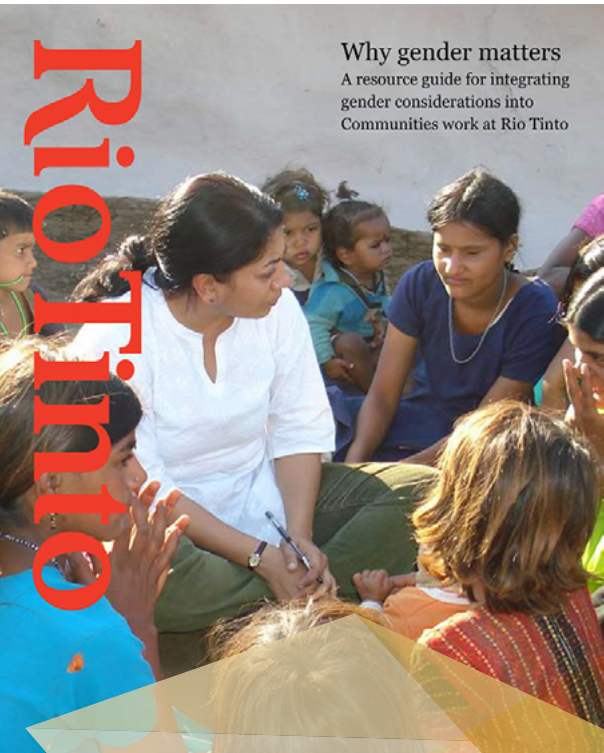
The objectives are met through a program of applied research, technical advisory services, consulting services and other associated activities. A number of projects have already been delivered under this agreement through the SMI Centre for Mined Land Rehabilitation (SMI-CMLR), SMI Centre for Social Responsibility in Mining (SMI-CSR) and the SMI Minerals Industry Safety and Health Centre (SMI-MISHC).

Rio Tinto and SMI have a history of partnering for research, training and development. The Rio Tinto Centre for Advanced Mineral Sorting within SMI’s Julius Kruttschnitt Mineral Research Centre (SMI-JKMRC) is an example of joint collaboration. The Centre, operating from 2010 to 2012, aimed to provide globally significant breakthrough technology and innovation through the development of advanced technologies for the separation and upgrading of minerals, with increased energy efficiency.

Another example of our continued association has been the Rio Tinto Social Performance issue guides.

To date Rio Tinto has commissioned a set of four leading practice guides on key social performance issues including gender, cultural heritage, human rights and land use agreements authored by the SMI Centre for Social Responsibility in Mining (SMI-CSR).

Rio Tinto has publicly shared these guides, developed through a collaborative process between SMI-CSR’s staff, a Rio Tinto Internal Working Group, and an External Advisory Group, and has translated the documents into multiple languages to maximise global reach.



Facilities & Equipment



In 2017, a large number of improvements were made to SMI's facilities, resulting in increased functionality and aesthetics. Some of these improvements are:

- Installation of a recording studio and AV presentation equipment
- Installation of artwork in the Sir James Foots building
- Major clean-up of the Pilot Plant and improved house-keeping practices
- Display of Alban Lynch memorabilia at the Indooroopilly Experimental Mine Site
- Major update of IT equipment, primarily laptops used by staff

The Workplace, Health, Safety & Facilities function continues to be supported by the Laboratory Facilities Manager, Site Facilities Coordinator, Workplace Senior Technician (Workshop) and Workplace, Health, Safety & Facilities Manager. A Pilot Plant Support Officer was recruited in 2017 on a casual basis.

Technology Transfer & Commercialisation



JKTech is an independent partner assisting mine sites to achieve future production targets

As the technology transfer company for SMI, and proudly owned by The University of Queensland (UQ), JKTech offers practical solutions to the mining industry.

Our expertise is offered through advisory services, ore and waste characterisation, software and products, testing equipment, and professional development. JKTech is committed to delivering impact for the global resources industry through the application of industry leading practices and methodologies, many of which are founded in world-class research outcomes from UQ and its Sustainable Minerals Institute.

A key strength of JKTech is our multi-disciplinary approach to Value Chain Optimisation for operations as well as brownfield and greenfield projects. Integrating across the disciplines of geometallurgy, blasting, mining, comminution, mineral separation and waste disposal enables significant improvements in value.

Health, Safety & Wellness

A continued focus for the SMI Workplace, Health and Safety Committee was the management of SMI's priority safety risks, achieved primarily by developing or reviewing internal procedures. An increase in the volume and effectiveness of communication also occurred, facilitated by the introduction of monthly Safety & Facilities newsletters. Further improvements were made regarding the integration of health and safety into project management within the institution. Personal Protective Equipment requirements in the research areas at the UQ Experimental Mine Site at Indooroopilly, were clarified and increased.

Fifteen health and safety incidents were reported for 2017, consisting of five no lost time (NLTIs) injuries and five near-miss incidents. A breakdown of incident nature/agent is provided in the table (right).

Agent of Injury	Number of Incidents
Chemicals, toxins or poisons	2
Equipment or tools - office/domestic	1
Behavioural factors	2
Work environment	1
Equipment or tools - clinical, medical or laboratory	1
Equipment or tools - workshop/construction	3
Transport - by road	1
Insect/arthropod	1
Other/unspecified	3
TOTAL	15

UNIQUEST

UniQuest is Australia's leading commercialisation entity, specialising in commercialising the intellectual property of UQ.

UniQuest commercialises the innovation and expertise of UQ through four channels to market. Uniquet packages the innovation and expertise into one or more of eight types of industry offerings. Since it began in 1984, UniQuest has licensed UQ technologies that have earned \$US15.5 billion in gross product sales. Over the past 15 years, UniQuest has returned more than \$435 million in revenue to The University of Queensland, much of which has been channelled back into research and intellectual property protection.



Funding & Recognition



Financials

Consolidated SMI and SMI ICEChile Statement for year ending December 2017

Income	2013 \$000	2014 \$000	2015 \$000	2016 \$000	2017 \$000
Peer reviewed income					
ARC Grants	133	257	228	471	667
AUS Gov funding	950	419	-	215	30
CRC Programme	2,209	857	5,110	-	-
Government and University Income					
UQ Operating funding	-156	99	284	774	675
Government Operating Grants	3,398	38	57	32	-
Tuition Fees	911	1,088	995	771	388
AUS University Collab	2,517	1,144	469	200	83
QLD State funding	367	590	761	528	464
Research Block Grants	-	4,558	5,489	5,757	6,151
CORFO Chilean Government	-	2,063	-	2,248	2,281
Industry income					
Donations	653	433	315	228	281
Commercial Contracts	3,850	3,939	2,184	2,558	2,960
AUS Industry	15,759	12,871	10,004	3,922	2,503
AUS foundations and Individuals	234	415	238	111	483
International Industry	2,179	4,234	4,778	2,177	1,478
Total Income	33,004	33,005	30,912	19,992	18,444
Expenditure					
Remuneration Expenditure					
Researchers - SMI	16,405	15,503	13,442	10,418	9,397
Researchers - ICE Chile	-	12	136	330	287
Administrative -SMI	8,833	8,526	7,096	4,768	3,218
Administrative - ICE Chile	-	-	26	44	93
Research and Operating Expenditure					
Equipment	1,183	476	393	346	675
Equipment - ICE Chile	-	-	83	77	-
Consultant Professional Services	5,813	4,773	5,047	2,877	2,236
Consultant Prof. Services - ICE Chile	-	10	22	27	66
Scholarships	1,383	1,408	1,135	807	545
Administration and support	1,685	1,181	884	622	707
Admin and support - ICE Chile	-	35	46	253	236
Travel	2,206	2,176	1,686	947	1,315
Travel - ICE Chile	-	-	57	266	171
Collaborative projects	434	91	24	473	399
Collaborative projects - ICE Chile	-	-	287	-	-
Total Expenditure	37,942	34,191	30,364	22,255	19,345

JKTech P/L Consolidated Statement for the Year Ended 31 December 2017

Income	\$000	\$000	\$000	2016 \$000	2017 \$000
Income					
Research, consultancy and contracts fees	-	-	-	7,122	7,571
Other Income	-	-	-	178	1,825
Total Income	-	-	-	7,300	9,396
Expenditure					
Remuneration Expenditure					
JKTech Staff Costs	-	-	-	4,859	3,181
Research and Operating Expenditure					
JKTech Operating & Taxes	-	-	-	4,548	4,536
Total Expenditure	-	-	-	9,407	7,717

Prizes and Awards



MetPlant 2017

Dr. Grant Ballantyne, of SMI-JKMRC, received the award for the best conference paper while Juan Jose Frausto Gonzalez, SMI-JKMRC PhD candidate, received the Best Presentation award at MetPlant in Perth.

Grant's paper looked at Recent Improvements in the Milling Circuit at Tropicana Mine and was co-authored by Mike Di Trento, Ivka Lovatt and Brian Putland from AngloGold Ashanti and Orway Mineral Consultants (OMC).

Juan Jose's presentation was titled The Impact of Classification Efficiency on Comminution and Flotation Circuit Performance and was co-authored by Grant Ballantyne, Kym Runge, Malcolm Powell and Roman Cruz from the SMI-JKMRC and Frensillo's Minera Saucito mine.



2017 Coalition for Energy Efficient Comminution (CEEC) Medal in the Technical Research category

The winner of the CEEC Medal in the Technical Research category was Fengnian (Frank) Shi, Weiran Zuo and Emmy Manlapig for their paper titled "Pre-concentration of copper ores by high voltage pulses. Part 2: Opportunities and challenges", published by Minerals Engineering in 2015.

The CEEC Medal is a prestigious annual award for the most outstanding published papers, articles or case studies profiling beneficial strategies for eco-efficient comminution and mineral processing.



SMI participated in the annual UQ Three Minute Thesis (3MT) Competition in 2017.

The SMI 3MT Winner was **Gemma Bloomfield**, (SMI-CWiMI) the Runner-Up was **Pia Morales** (SMI-JKMRC) and People's Choice was **Gernelyn Logrosa**, (SMI-MISHC).

SMI hosted the all-institute 3MT final in August. Fourteen talented candidates from across five of UQ's institutes all delivered compelling presentations. Congratulations to Gemma Bloomfield who was awarded Runner-Up in a very close competition.



Hulusi (Konuray) Demir awarded the Frank Nicklin Scholarship



Juan Jose Frausto Gonzalez received the 28th Ian Morley Prize, which is awarded to a SMI-JKMRC higher degree by research student who displays academic achievement, leadership and engagement in their research field.

Congratulations to Juan for also winning Best Paper Presentation Award at the Metallurgical Plant Design and Operating Strategies - World's Best Practice 2017.

Barry Noller
Queensland Branch CASANZ Clean Air Award 2017

Saleem H. Ali
Chosen to serve on United Nations International Resources Panel for 4 year renewable term

Adjunct Professor Christine Charles
awarded UQ Fellowship

SMI collaborates globally to deliver responsible resource development solutions to the challenges faced by the minerals sector. We are committed to research excellence and developing game-changing people. Our unique combination of environment, production, social and political sciences means that SMI is a leader in the extractive industries space. We partner with governments, non-government organisations, communities, education providers and companies around the world.



In the Centre for Social Responsibility in Mining (SMI-CSRM) two important additions were made to the team this year. Social anthropologist, **Dr Emilia Skrzypek**, a Horizon fully funded two-year 2020 Scholar from St Andrews in the UK and **Dr Grace Muriuki** from UQ's Global Change Institute.

Dr Grace Muriuki joined SMI-CSR from the Global Change Institute and has a background in geography, landscape science and range management and is currently pursuing livelihoods and food security research including under mining-induced displacement and resettlement.

Also within the SMI-CSRM, **John Owen**, was promoted to Professor bolstering SMI-CSRM's Senior Team. John's research interests span involuntary land acquisition and resettlement, livelihoods and food security, community-based conflict, and the role of corporate and organisational culture on social performance and mining impacts.

Within Julius Kruttschnitt Mineral Research Centre (SMI-JKMRC), **Dr Frank Shi** was promoted to Professor and **Dr Grant Ballantyne** (*pictured below*) to Senior Research Fellow in 2017. Professor Frank Shi has been a research focused academic at the SMI-JKMRC for over twenty-eight years studying rock breakage. He has achieved outstanding research outcomes in not only traditional

breakage methods but is pioneering research into the area of High Voltage Pulse commutation, where he has established himself as a world leader in the application of this technology.

Dr Grant Ballantyne has gained industry recognition in recent years, especially through the international non-for-profit group called the Coalition for Eco-Efficient Communion (CEEC), through which energy efficient communion has become Grant's major research theme. Grant is currently developing his research portfolio in the Integration Research Program at SMI's Production Centres, and is taking a leading role in growing energy related research across the mining spectrum at the SMI.

Further new senior academic appointments to lead and expand current areas of research in SMI include **Professor Rick Valenta** (SMI-BRC), **Dr Mark Hinman** (Associate Professor/Principal Research Fellow, SMI-BRC) **Dr Marcin Ziemski** (Process Integration, SMI-JKMRC), **Dr Vladimir Jokovic** (Senior Research Fellow - Minerals Processing, SMI-JKMRC) and **Dr Chris Smith** (Separation). The end of 2017 saw the retirement of **Dr Rob Morrison**, SMI-JKMRC'S Chief Technologist. Rob made a significant contribution to the work of SMI, SMI-JKMRC and JKTech over many years and we wish him well.

Professor David Mulligan accepted the role of Director of the SMI International Centre of Excellence in Chile (SMI-ICE-Chile) from the beginning of June with **Associate Professor Glen Corder** appointed Acting Director of the Environment Centres while David is overseas.

The Centre for Mined Land Rehabilitation's (SMI-CMLR) **Dr Antony van Der Ent** and **Dr Phill McKenna** were successful with their respective applications for promotion to Level B in 2017. Further, **Professors Emmy Manlapig** and **Frank Carrick** both accepted Honorary Professorial positions with the SMI.



Students

SMI Higher Degree by Research (HDR) Office

SMI is proud of the role it plays in providing an environment that fosters UQs vision for transforming students into game-changing graduates.

By the end of 2017, SMI had 80 enrolled students, with 70 in the Doctor of Philosophy and 10 in the Master of Philosophy. Our 39 international students representing 19 countries, reflecting the global reach of our research influence. Fifteen new HDR candidates were welcomed to the cohort in 2017.

We applaud all our students who were awarded prizes and special funding during 2017, with special mention of the below achievements. Zhenhua Jing (CCSG), Eleonore Lebre (SMI-CMLR), Daniellie Lynas (SMI-MISHC), and Juan Ossa (SMI-CWiMI) each received a Candidate Development Award (CDA) from the Graduate School, which focuses on the broader development skills of HDR candidates to enhance their employment opportunities.

SMI-JKMRC PhD candidate Hulusi (Konuray) Demir was awarded the prestigious Frank Nicklin Scholarship. This scholarship was established in 1968 and is maintained by a donation raised by public subscription to commemorate the record of service of Sir George Francis Reuben Nicklin, KCMG, MM, Hon. LLD to the State of Queensland during his period in public life, including his then record term as Premier. The scholarship provides a living allowance, with additional funds going towards tuition fees and/or a top-up allowance.

The SMI Candidate Advisory Committee (CAC), comprised of student representatives from SMI's centres, continued to provide professional development and networking opportunities for our students. The CAC hosted three Industry Breakfasts in 2017 with Anna Littleboy (Research Director, CSIRO), Virginia Lawson (Jameson Cell Technology Manager, Glencore Technology) and Dr Peter Eaglen (General Manager Group Internal Audit, Rio Tinto). The 2017 SMI Industry and Academia Networking Evening in June was another successful event with over 50 participants in total and representatives from the resource sector including: CSIRO, BHP, Glencore, the Department of Natural Resources, Mines and Energy, Anglo-American, Aurecon and Klohn Crippen Berger.

The SMI Candidate Advisory Committee capped a great year with the SMI HDR Conference in November (*pictured right*), Innovation and sustainability in the resource environment. With the financial support of JKTech Pty Ltd the Centre for Coal Seam Gas, Ausenco and AusIMM.

More than 20 students, including a number from outside SMI, presented their work in a range of formats. A panel discussion with Dr Thu Nguyen (JKTech), Greg Lane (Ausenco), Professor Andrew Garnett (CCSG), Diana Drinkwater (Mineralis), and Professor Alice Clark (SMI) tackled the question how can researchers and industry work together better to improve innovative and sustainable practices in the environmental, social, safety and production aspects of the resource sector?



SMI HDR conference prize winners. (*Pictured: from left*) Diana Drinkwater (Mineralis, panel member and judge), Katie Meissner (UQ Business School, Runner-Up), Erica Avelar (SMI-JKMRC, Winner and People's Choice), Professor Neville Plint (SMI Director and judge).



SMI students success at 3MT

Prize winners at the conference for the 3MT pitch were Gemma Bloomfield (SMI-CWiMI) (*pictured*) and Philip Nkrumah (SMI-CMLR) joint Winners, Christopher Turner (School of Chemical Engineering) Runner-Up with Philip also being awarded the People's Choice. For the multi-format presentations Erica Avelar (SMI-JKMRC) was the Winner and People's Choice with Katie Meissner (UQ Business School) awarded Runner-Up. Sara Pazell (SMI-MISHC) was judged Winner and People's Choice for the long format presentation with Juanjo Gonzalez (SMI-JKMRC) as Runner-Up.



Juan Jose (Juanjo) Frausto Gonzalez (*pictured; above*) was awarded the **28th Ian Morley Prize** as well as Best Presentation at **MetPlant 2017**.

SMI 3MT participants in the SMI's final

(*pictured left, L to R*) Eric Stemn; Pia Lois Morales; Constanza Paredes Bujes; Juan Frausto Gonzalez; Gernelyn Logrosa; Philip Nkrumah; Jean-Pierre Imbrogiano. Absent: (video submission) Gemma Bloomfield



The SMI-JKMRC student organisation, the JK Jackals, hosted their **annual International Night at SMI-JKMRC** on the 1st of December. From the homemade international feast of food, to the guests displaying their cultural heritage in costume, to the singing, dancing, and children's activities, it was a fantastic night for families of SMI's students and staff with a special performance by the Institute's Director who entertained the crowd with a bagpipe medley.

As SMI welcomed new students, we were honoured to recommend conferral of 22 PhD degrees and five MPhil degrees.

HDR Students who commenced in 2017:

Raphael Akesseh, Raoni Antunes Ferreira Lage, Tsz Ho Chiu, Hulusi Demir, Chinwe Ezeigbo, Edward Holloway, Stuart Irvine-Brown, Imron Janjua, Daniel Lay, Sesha Anand Ram Musunuri, Adrian Paul, Alayna Stephenson, Pieter Swart, Ditend Tesh, Ziming Ye, Qing Yi

Graduating Students



L-R: Professor Neville Plint, Kwasi Ampofo and Professor Alice Clark.

Radjali Amin

Qualifications: PhD
Awarded: March
Supervisor: EDRAKI, Mansour
Centre: CMLR
Thesis Title: The Response of Tropical Wetlands to the Geochemical Conditions of Discharged Water from Nickel Laterite Mines
Abstract: Hexavalent chromium, which is toxic to biota, may be leached from nickel laterite mines. Constructed wetlands could be a remediation option. The aim of this study is to identify the essential wetland conditions that determine the success of chromium removal from surface runoff waters. The presence of local native macrophytes, the organic-rich sediment of the natural wetland, and the long residence time, enhance the efficiency of chromium removal from water. A wetland mesocosm was constructed and showed that an important zone of the mesocosm was the sediment/water interface where hexavalent chromium was reduced to trivalent chromium and precipitated.

Kwasi Ampofo

Qualifications: PhD
Awarded: May
Supervisor: CHITOMBO, Gideon
Centre: BRC
Thesis Title: Reasons why Real Options Analysis (ROA) is not widely adopted in the mineral industry
Abstract: Real options analysis (ROA) is an innovative technique for valuing mining projects, which generates additional information for decision-makers compared to the more widely used discounted cash flow (DCF) method. This thesis develops a practical real options tool that values a gold mining project initially valued using the DCF method. Based on the results obtained from interviewing industry experts, reasons for the slow adoption of ROA in the mineral industry were identified. The thesis concludes by developing an innovative framework to encourage the uptake of ROA in the mineral industry.

Cristian Carrasco

Qualifications: PhD
Awarded: July
Supervisor: KEENEY, Luke
Centre: JKMRC
Thesis Title: Integrated Assessment to Quantify Size Based Grade Engineering Operating Strategies and Economics Impacts
Abstract: Size based Grade Engineering aims to increase feed grades by removing low grade uneconomic material through screening prior to energy intensive grinding. Two strategies are assessed: preferential grade by size deportment and differential blasting. The former refers to a natural rock phenomena whereby a significant metal proportion preferentially deports into specific size fractions after breakage. Differential blasting aims to change blast fragmentation to induce grade by size deportment through the exploitation of grade heterogeneity. Geometallurgical characterisation, process modelling and simulation, production scale trials and stochastic optimisation are integrated to appraise this option from a value, risk and operating robustness perspective.

Vanessa Cattermole-Terzic

Qualifications: PhD
Awarded: September
Supervisor: HORBERRY, Timothy & BURGESS-LIMERICK, Robin
Centre: MISCH
Thesis Title: A Human Factors Investigation into the Effectiveness of Traffic Incident Management Systems
Abstract: The objective of this thesis was to use an explorative approach to identify ways to improve traffic incident management. The findings identified technical and non-technical issues in the traffic incident work environment, however, only non-technical issues were consistent across agencies. Cognitive Work Analysis, the Critical Decision Method and the Recognition-Primed Decision model were used to investigate non-technical issues across agencies at traffic incidents. The combined studies provide insight and direction to improve traffic incident management training, policies and practices, and contribute significantly to the heretofore limited body of work within the traffic incident management domain.

Warren Kelton Finch

Qualifications: MPhil
Awarded: July
Supervisor: MCINTYRE, Neil
Centre: CWiMI
Thesis Title: Deep drainage rates and processes in Vertosol and Chromosol soils of Southern Queensland
Abstract: Deep drainage studies were performed in the vadose zone of semi-arid Southern Queensland, Australia using data from 16 soil moisture probes, each with eight sensors at depths up to 4m. The soils were predominantly clays susceptible to cracking. Alternative soil water balance approaches were applied to estimate the average deep drainage rate; and the factors affecting soil moisture response to rainfall were explored. The main conclusions were that deep drainage rates are potentially much higher than suggested by the literature, and there was evidence that complex soil cracking dynamics together with rainfall intensity dominate the soil moisture response.

Bianca Foggiatto

Qualifications: PhD
Awarded: July
Supervisor: POWELL, Malcolm
Centre: JKMRC
Thesis Title: Modelling and simulation approaches for exploiting multi-component characteristics of ores in mineral processing circuits
Abstract: With many of the world's richest ore deposits depleted, deposits with complex mineralogy and lower grades are being targeted, motivating the investigation of practices such as selective blasting, pre-concentration and pre-weakening, and the design of circuits that actively respond to variable feed characteristics. To confidently simulate these circuits and quantify their potential benefits, three case studies were selected for the development of methodologies for exploiting multi-component characteristics of ores. For each case, simulations of circuit design scenarios aimed at optimising grinding and separation efficiencies and indicated that the composition and properties of multi-component systems can be used advantageously to improve processing performance and energy efficiency.

Roberto Gregorio Garcia Fragoso

Qualifications: PhD
Awarded: November
Supervisor: EDRAKI, Mansour
Centre: CMLR
Thesis Title: Natural attenuation of arsenic in sulphide tailings with alkaline gangue under extreme wet and dry conditions
Abstract: The natural processes, by which arsenic is released from sulphide mine tailings and subsequently attenuated by the mineral matrix of these residues, are of great interest for planning sustainable closure of mines in Mexico and Australia. The key contributions of this research consist in: providing evidence of the mineralogical controls of arsenic in neutral to alkaline conditions for three different sets of mineralogies with a carbonate component, having determined and reproduced arsenic attenuated forms under laboratory conditions and designed weathering experiments and modelling these attenuation processes after updating the geochemical software and collect all the required geochemical variables.

Devanmini Halwatura

Qualifications: PhD
Awarded: June
Supervisor: ARNOLD, Sven
Centre: CWiMI
Thesis Title: Implementation of Meteorological Design Droughts in Ecosystem Rehabilitation Plans: applicability of meteorological drought indices
Abstract: Drought can have substantial impacts on ecosystem rehabilitation, and soil moisture drought estimation is a crucial part of managing this. This thesis quantifies drought severity-duration-frequency curves and critically evaluates their applicability to ecosystem management. Further, the study assessed the adequacy of drought indices based on meteorological variables by comparing them with outputs of a physically based soil moisture model. Due to model uncertainties, findings encourage the use of meteorological variables, unless accurate soil hydraulic property data exist. The demonstrated systematic approach may enhance the capacity of responsible authorities to set up effective drought risk assessment strategies for ecosystem rehabilitation.

Mirza Huda

Qualifications: PhD
Awarded: June
Supervisor: ALI, Saleem
Centre: CSRM
Thesis Title: Transnational Energy Projects as Mechanisms of Regional Cooperation in South Asia: Addressing Political, Security and Environmental Challenges
Abstract: This thesis has evaluated the various challenges to energy cooperation in South Asia and provided policy recommendations for addressing them. Using extensive fieldwork in four countries, the thesis has examined three broad categories of challenges: political, security and environmental. The study has unpacked political challenges into a number of distinct and interconnected elements. Security challenges were evaluated through a case study on the Turkmenistan-Afghanistan-Pakistan-India pipeline. A case study on hydroelectric cooperation between Bangladesh, Bhutan, India and Nepal highlighted environmental challenges. The findings suggest that investment in the planning of energy projects can improve their viability and drive integration and peacebuilding.

Joseph John

Qualifications: PhD
Awarded: May
Supervisor: JOHNSON, Norman
Centre: JKMRC
Thesis Title: Differential Oxidation of Iron Sulfides to Modify the Au:S Ratio in the Flotation Concentrate Product at Lihir
Abstract: Refractory ores hold a majority of the gold within the pyrite, which has several forms. The presence of low gold pyrite specifies that not all pyrite types are contributing equally to the economic performance of a mine. Separation of low gold pyrite from the gold-rich pyrite would improve the gold:sulfur value (Au:S) of the final concentrate, thereby maximising the autoclave throughput and gold production per tonne. This project is an attempt to develop a hydrometallurgical framework to modify the flotation response of gold-rich pyrite and low gold pyrite so that the Au:S ratio of the flotation concentrate can be upgraded.

Beatriz Sayuri Katagiri Buentello

Qualifications: MPhil
Awarded: October
Supervisor: KANCHIBOTLA, Sarma
Centre: JKMRCC
Thesis Title: The application of a three-dimensional mechanistic model in understanding blast movement in open cut mines
Abstract: At each stage of most mining operations, the rock has to go through a size reduction process that demands certain energy input. The most significant stage of size reduction takes place during blasting. The shape of the muckpile is an important factor in excavation and haulage efficiency. Therefore, there is a need for accurate modelling to predict and optimise blast movement and muckpile shape. The model developed from this work has improved the understanding of blast movement dynamics in cast blasting. It has also helped to develop novel blast designs to optimise blast outcomes: cast percentage and muckpile shape.

Fiona Martin

Qualifications: PhD
Awarded: February
Supervisor: BRERETON, David
Centre: CSRMC
Thesis Title: Towards best practice jobs decision-making: institutionalising fuller consideration of the social context in resource projects
Abstract: Historically, jobs decision-making for large-scale mining and oil and gas (resource) projects has failed to give sufficient weight to the project's social context. This thesis investigates why this is the case, presents the business rationale for institutionalising fuller consideration of the social context in jobs decision-making, and explores the practicalities of how this can be achieved. The study uses a grounded theory methodology, informed by institutional theory, and draws on qualitative data from semi-structured interviews with industry practitioners and a case study from Papua New Guinea. The thesis concludes by presenting a 'Towards Best Practice Framework' for improving company practice.

Callum McDonald

Qualifications: PhD
Awarded: February
Supervisor: PUSCASU, Ruslan
Centre: BRC
Thesis Title: Efficient Exploration of Large State Space: Applications in Graph Compression
Abstract: This thesis investigates a novel graph compression technique with applications in optimization and forecasting. The proposed graph compression technique allows a large problem to be reduced or compressed thereby reducing the time required to solve the compressed problem. The solution discovered in the reduced or compressed space represents an approximation to the optimal solution. The proposed technique allows the approximated solution to be improved through an operation known as decompression, providing an advantage over existing compression techniques. The thesis demonstrates, through several applications, the potential for the technique to be applied to problems appearing in high-dimensional spaces.

Ana Ocenar

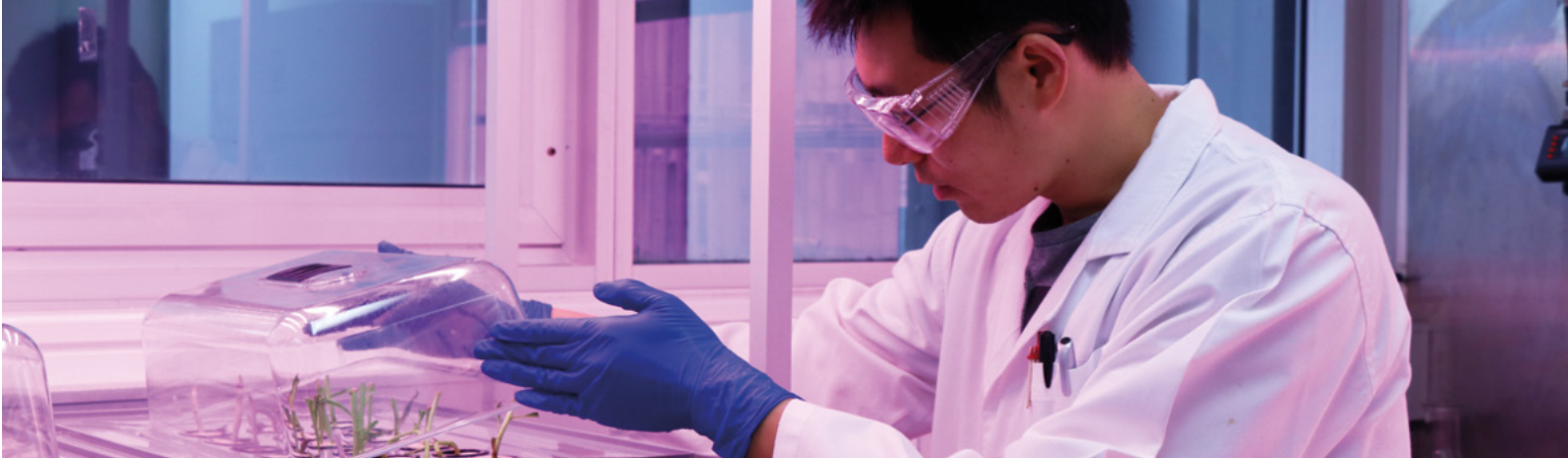
Qualifications: PhD
Awarded: August
Supervisor: MULLIGAN, David
Centre: CMLR
Thesis Title: Phylogenetic patterns of foliar trace element accumulation in the ultramafic flora (Order Malpighiales) of Sabah, Malaysia
Abstract: Metallophytes are plants that have the adaptive ability to grow in trace element-enriched soils. There has been a limited inquiry into the phylogenetic patterns of species in which trace element accumulation occurs, especially in tropical regions. A new and non-destructive technique was used to obtain information on elemental concentrations from measurements as short as 30 seconds. The measurements are comparable to results obtained from more costly, time-consuming and destructive chemical methods. This study drew on the plant species diversity in Sabah (Malaysia) to elucidate phyloegenetic patterns of trace element accumulation. The outcome has contributed to the discovery of plant species.

Rebekah Ramsay

Qualifications: PhD
Awarded: December
Supervisor: KEMP, Deanna
Centre: CSRMC
Thesis Title: Disturbance preceding displacement: Development practice in preparation for mining and resettlement
Abstract: Debates in mining and resettlement largely focus on the outcomes of company-managed resettlement and highlight that households tend to be worse off as a direct result. Less examined is the impact of pre-displacement upon 'potentially' affected people. Though resettlement has not occurred, this thesis explores the experiences of local people impacted by three multinational companies who have each attempted and later abandoned the development of a copper mine in Cajamarca, Peru. The thesis concludes that current international safeguards and standards are inadequate, largely because they assume a greenfield project development scenario and take little account of mining's brownfield tendencies.

Muhammad Abdur Rasyid

Qualifications: MPhil
Awarded: June
Supervisor: JOKOVIC, Vladimir
Centre: JKMRCC
Thesis Title: Investigation of Semi-Inverted Hydrocyclone with Novel Design
Abstract: Hydrocyclone classification efficiency is significantly affected by feed water recovery to underflow. Comprehensive experimental works using modified JKMRCC hydrocyclone have been performed at the JKMRCC to study the fundamental behaviour of the semi-inverted hydrocyclone and its potential to address classification inefficiency problem. The main finding from the work was that inclination higher than horizontal (semi-inverted) position could reduce water recovery significantly. Evaluation with existing hydrocyclone empirical models has indicated predictions trends were in the same order as the experimental results, which open the possibility of further model development. Some indications of asymmetrical air-core were also reported.



Yogesh Reja

Qualifications: MPhil
Awarded: June
Supervisor: BALLANTYNE, Grant
Centre: JKMRCC
Thesis Title: Development of a standard methodology for energy efficiency measurement in comminution processes
Abstract: Comminution energy accounts for 35% of the utilised energy in mining of copper and gold. Appropriate measurement of energy efficiency is a challenge in realising potential for reduction in energy consumption. An experiment was developed to impact monolayer of particles of sizes between 5 mm to 180 ?m between meticulously flat impactor and anvil to measure size specific energy (SSE) consumption for breakage with energies ranging 0.1 to 3.5 kWh/t. Two copper-gold ores were tested on newly developed experiment and results were analysed. The energy efficiency calculated were 38.2% ? 4.0% and 55.2% ? 11.4% for ore-1 and ore-2 sites respectively.

Vannie Resabal

Qualifications: PhD
Awarded: May
Supervisor:MANLAPIG, Emmanuel
Centre: JKMRCC
Thesis Title: Investigation of the Breakage Mechanism in High Speed Disk-Type Impeller Stirred Mills and its Influence on the Mineral Liberation
Abstract: The goal of comminution is the reduction of size to the liberation size of the minerals of interest so that they can be effectively separated from the gangue in the downstream separation process. It has been known to significantly influence the way minerals are liberated. Thus, it is important to have a better understanding of how the liberation properties of the minerals are affected by the method of size reduction. This thesis investigates the type of breakage mechanism in stirred mills, particularly at the regrind stage, and how it influences the liberation properties of the minerals of the rougher concentrates.

John Reuter

Qualifications: PhD
Awarded: September
Supervisor: CORDER, Glen
Centre: CMLR
Thesis Title: Improving the Assessment of Process Reagent Plants and Utilities for High Temperature Hydrometallurgical Process Plant during Early Stage Project Development
Abstract: The current standardised approach taken during the early stages of project development for high temperature hydrometallurgical plants excludes timely evaluation of process reagent plant technologies and process integration including low grade waste heat recovery. A modified early stage project development methodology was developed to address this and evaluated for a nickel laterite process flowsheet through six case studies. The key benefits identified through earlier process reagent plant technology selection included development schedule minimisation, re-work minimisation and improved facility energy efficiency (up to 50% power generation using waste heat) and improved project economic value (up to 15% increase in NPV).

Seyedeh Fatemeh Saeidi

Qualifications: PhD
Awarded: April
Supervisor: YAHYAEI, Mohsen
Centre: JKMRCC
Thesis Title: New Approach for Characterising a Breakage Event as a Multi-stage Process
Abstract: Understanding ore breakage is the key for development of appropriate breakage characterisation experiments. Hence, there has been a huge effort to understand a single breakage event, both from the experimental and the modelling standpoints. One particularly interesting approach is to consider a breakage process as a sequence of several primary breakage events. In this research, a novel method is introduced to describe a single breakage event by modelling it as a process through several stages of primary fracture while appreciating the effect of sequential fragmentation.

Nerrida Scott

Qualifications: PhD
Awarded: September
Supervisor:HOLTHAM, Peter
Centre: JKMRCC
Thesis Title: Dynamic Analysis of Dense Medium Circuits
Abstract: Dense Medium Cyclone (DMC) geometry and performance have been widely explored in the past. Coal preparation plants are typically run to a set of conditions stipulated by mine yield/ash predictions and steady-state design parameters without a full awareness of the subtle dynamic changes affecting the DMC circuit. Furthermore, the ability to see the dynamic changes that occur in the dense medium has been limited by a lack of technology. A dynamic model of a dense medium circuit has been built to address those issues and to advance knowledge of DMC circuit behaviour.

Diego Andres Silva Calquin

Qualifications: MPhil
Awarded: August
Supervisor: CHITOMBO, Gideon
Centre: BRC
Thesis Title: An Integrated Methodology for the Design and Assessment of Cave Mining Ore Handling Systems
Abstract: The selection of ore handling systems represents one of the important decisions in cave mining. From cave to mill, system productivity and associated costs can significantly impact the value of mining projects and operations. This thesis addresses three key research areas to be integrated and applied to cave mining: the principles of material handling, open source simulations, and economic valuation models. This thesis forms part of ongoing studies to determine the best ore handling system for the future expansion of the Cadia East Block Cave Mine in NSW, Australia.





SMI Success Stories

Rebekah Ramsey

Maedeh Tayebi Khorami

Qualifications: PhD
Awarded: July
Supervisor: MANLAPIG, Emmanuel
Centre: JKMRM
Thesis Title: Selective flotation of enargite from copper sulphides in complex ore systems
Abstract: Recent research has demonstrated promising results showing the possibility of separating arsenic-copper sulphides from other copper minerals by controlling the potential of the flotation pulp. However, the selective removal of arsenic-copper minerals in real ore systems is not well understood. In this study, two distinct ore samples were selected from the Tampakan copper-gold deposit, providing a range of arsenic levels. The selective separation of enargite from other copper sulphide minerals in a flotation system under controlled pulp potential was investigated for both samples. A conceptual flowsheet for separating enargite from other copper sulphides based on the observed results was proposed.

Cornelius Vos

Qualifications: PhD
Awarded: February
Supervisor: EVANS, Catherine
Centre: JKMRM
Thesis Title: The effect of mineral grain textures at particle surfaces on flotation response
Abstract: This research presents new knowledge demonstrating the importance of mineral grain textures on the surface of ore particles in the particles? flotation response. This characteristic is shown to be of crucial importance for future research seeking to develop property-based flotation modelling capabilities. The new knowledge is applied to demonstrate an innovative, flotation simulation technique based on measured particle properties. The development of this particle-based simulation capability is an important step towards a better understanding of the inter-dependency of mining-related activities when a holistic approach is taken to optimise value across these activities in an integrated manner.

Lei Wang

Qualifications: PhD
Awarded: February
Supervisor: PENG, Yongjun
Centre: JKMRM
Thesis Title: Entrainment of Fine Particles in Froth Flotation
Abstract: Entrainment results in large amounts of fine gangue materials reporting to the concentrate and thus reduces the final product quality. In this study, the effects of some flotation variables on the degree of entrainment and water recovery have been investigated. The degree of entrainment was found to be related to the particle settling velocity and the liquid velocity at the pulp/froth interface. Water recovery could be modelled effectively by considering the water flow into the froth and water drainage in the froth phase. The developed knowledge can be used to better control and minimise entrainment recovery in flotation plants.

Ceit Wilson

Qualifications: PhD
Awarded: February
Supervisor: EVERINGHAM, Jo-Anne
Centre: CSRM
Thesis Title: Steering Social Impact Outcomes in Extractive Resource Regions: A Comparative Case Study of Private Meta-governance in Australia and the United States
Abstract: This thesis explores the role of private extractive resource companies in the meta-governance of natural resource governance. The thesis adopts a multi-case study approach and employs qualitative research techniques. Private meta-governance is empirically explored through an investigation of the network governance of affordable housing in two large extractive resource regions: the Marcellus Shale Region in Pennsylvania, United States and the Gladstone-Surat Region in Queensland, Australia. Contrary to studies dismissing the potential for private meta-governance, the thesis identifies examples of private oil and gas companies influencing networks through the institutional design and process management strategies of framing and network facilitation.

Ping Yu

Qualifications: PhD
Awarded: September
Supervisor: XIE, Weiguo
Centre: JKMRM
Thesis Title: : A Generic Dynamic Model Structure for Tumbling Mills
Abstract: Three versions of the Generic Tumbling Mill Model Structure (GTMMS) were developed based on the mechanistic incorporation of the 4D (four dimensional) appearance function, the Discrete Element Method (DEM) energy distribution, the transport function, the multicomponent modelling and the dynamic modelling. The 4D appearance function model developed from the characterisation tests of particles with a wide range of sizes and energy is more applicable and accurate than existing models. The proposed structure provides a platform to accommodate future mechanistic, dynamic mill model evolution and can incorporate the latest research outcomes, substantially improving the predictive mill modelling capability in the industry.



L-R: Maedeh Tayebi Khorami and Professor Alice Clark.

I initiated my career as a community development practitioner working directly with subsistence farmers in a rural and remote island in the Pacific. When I returned to Australia in 2011, I began searching for ways to apply my knowledge and interest in supporting marginalized and rural communities. I discovered that the extractive industries are an important and fascinating sector where social scientists can make a meaningful difference.

Large-scale mining has a tangible and mixed impact on the communities affected by projects and operations. My passion for social justice is what initially drew me to work at the Sustainable Minerals Institute where I participated in research on gender, agreement-making, indigenous peoples, involuntary resettlement and corporate and community conflict management. While working as a research analyst, I travelled to mine sites in Peru, Papua New Guinea and Australia and interviewed company staff, government officials and project affected people. The applied research focus at SMI is what convinced me to pursue a PhD with the Institute's Centre for Social Responsibility in Mining (CSRM).

I commenced a PhD in 2013, which examined the role of private sector mining companies in involuntary land acquisition and resettlement. The investigation explored a proposed mine development situated in the Northern Andes of Peru. Over a period of seven months in the field, I conducted interviews and ethnographic observations of company officials and peasant farmers engaged in conversations about resettlement. My thesis highlights that international involuntary resettlement safeguard policy does not recognize the social impacts of pre-displacement, that is, the period before physical displacement occurs. While completing my dissertation, I presented the research findings at international conferences and contributed to peer-reviewed publications. The PhD experience helped extend my knowledge of social development and provided opportunities to pursue my personal and professional interests.

During my final year of the PhD, I travelled to the Philippines to undertake an internship at the Asia Development Bank where I now work as a Social Development Specialist. In my current role I provide technical support to project operations in the Agriculture and Natural Resources Sector of South Asia. The work incorporates my experience and interest in forwarding social safeguards (involuntary resettlement and indigenous peoples), gender mainstreaming, improved labor standards and poverty reduction.



Rebekah Ramsey- SMI-CSRM 2017 PhD graduate

I discovered that the extractive industries are an important and fascinating sector where social scientists can make a meaningful difference.

SMI Success Stories

Kwasi Ampofo

In August 2012, I had completed a presentation at a mining conference in Ghana on how social enterprises could boost the small-scale mining industry in Ghana, a participant will later approach me and suggest the Sustainable Minerals Institute as a natural home for this research and a potential place to further develop my talent and capabilities. This interaction ignited my interest to pursue world-class mining education at SMI.

I commenced my candidature in July 2013. I initially planned to pursue a PhD in geometalurgy by maximising mine value through the integration of geology, mining, metallurgy and economics. However, after attending an AusIMM conference, in September 2013, on geometalurgy with the support of SMI, I made the final decision to focus on mineral economics where I looked at the application of advance valuation techniques such as real options to the mineral industry.

I characterise my time at SMI as fun, exciting, intense, challenging and above all memorable. Academically, I set an ambitious research goal of identifying the reasons why the real options valuation technique had not been widely adopted by the mining industry after decades of its introduction. With the support of SMI, I travelled to Ghana, Greece and the United States of America (USA) to either find answers to this question or share my findings with industry practitioners. In spite of the demanding schedule that comes with the completion of a PhD, the students and faculty always made time to engage socially through outdoor and indoor activities in order to foster team spirit and relax. I vividly remember a weekend-long hackathon where we used neuroplasticity to unlearn and relearn emerging trends in the industry; I also recollect my times at the JK International Night where the diverse culture of SMI was always on full display; and I cannot forget the numerous morning teas and presentations from leading resource persons from all over the world.

I characterise my time at SMI as fun, exciting, intense, challenging and above all memorable.

Currently, I work at The University of Queensland as a Postdoctoral Research Fellow where I am extending my knowledge and expertise to the energy industry. I am engaged in an exciting project where we are understudying the technical, economic and social feasibility of low emission technologies to the Australian economy.



Kwasi Ampofo - SMI-BRC 2017 PhD graduate

Looking back, my greatest take home from SMI was not my PhD but the people I interacted with, the professional network I nurtured and the lifelong friendships I made. The staff and people were always willing to help and guide my academic and career development. The Institute's vast network enabled me to connect with industry and academic leaders all over the world. In the course of my PhD, one moment, I was on a mine site collecting economic and production data, another moment; I was presenting my findings to the CEO of the same company. These were truly humbling moments. Having worked and interacted with people from over twenty-four countries at SMI, I now consider myself a global citizen with friends across the length and breadth of the globe. I am proud of the work I did with SMI and its potential to enhance value creation in the mineral industry.

SMI Success Stories

Anne Schneider

My Australian journey had unlikely beginnings. I had just finished my forest ecology studies in Germany and was keen to pursue postgraduate research, specifically on an applied project that addressed real-world issues. I stumbled across an advertisement for a PhD scholarship with the Centre for Mined Land Rehabilitation (CMLR) at The Sustainable Minerals Institute. I applied, and to my amazement, I was soon accepted. It was not long before I had to pack my bag, and swap my life in rainy Germany for subtropical Brisbane.

While my knowledge of soil science and plant ecology served me well, I had never been on a waste rock dump, or a mining tailings facility, and it was clear that I had a steep learning curve ahead of me. Furthermore, as my work was heavily field-based, I had to confront a diversity of problems that would not normally be issues for somebody working in a lab. These included (but were not limited to) experiments and equipment being destroyed by the 2011 Brisbane floods, and another experimental set-up being destroyed by a lightning strike in Mt. Isa. As a result, I struggled at times, but I had great support from my supervisory team and from my new Australian friends with whom I remain close to this day.

During my time at SMI-CMLR, I had the opportunity to complete an internship with a Chilean national research organisation, Fundacion Chile. I worked with a technical team on the design of stations that assessed acid mine drainage in the field, and took part in workshops addressing common issues surrounding mine closure. My Spanish was limited when I first arrived in Santiago, but after 6 months, it had developed to the point where I was having technical conversations with my team and speaking at a professional level.

I worked with a technical team on the design of stations that assessed acid mine drainage in the field, and took part in workshops addressing common issues surrounding mine closure.



Anne Schneider- SMI-CMLR 2013 PhD graduate

Since finishing my PhD, I have been working as an environmental consultant. In this capacity, I have been involved with a wide range of projects including environmental approvals studies, an impact assessment for a potential mining development in Fiji, mine closure studies, as well as undertaking soil surveys and agricultural impact assessments. While I am not strictly working in my specialised PhD research field, my experiences at the SMI introduced me to a new industry and gave me the tools and experiences to succeed in it.



Engagement

Scientific Engagement

Each year SMI researchers are involved in local, national and international professional engagement and outreach activities. These efforts raise the scientific profile and awareness of the work undertaken at SMI and help to establish valuable research collaborations.

The first Sponsor' Review Meeting (SRM) of AMIRA International's P9Q-Modelling and Simulation Project was held in August. Representatives from all 11 sponsors came to SMI for the meeting. The project is being sponsored by: Anglo American, AngloGold Ashanti, Barrick, Newmont, South32, Vale, BGRIMM, JKTech, Magotteaux, Metso, and Weir Minerals.

Professor Mansour Edaraki chaired the 9th Australian Acid and Metalliferous Drainage (AMD) Workshop, held in Burnie, Tasmania. The workshop attracted attendees with industry, government and research backgrounds from every corner of the globe. With unbiased expertise and advocacy, the workshop explored the causes, management and amelioration of the impacts of AMD.

In November SMI hosted the inaugural UQ Mining and Resources Forum. The purpose of the Forum was to enable the key complementary research capacity within UQ to connect, thereby improving communication and coordination across the University. Over 35 speakers attended the Fourm from Schools and Faculties across UQ. (Pictured)

SMI Researchers also participated in the organisation of a number of other events throughout the year:

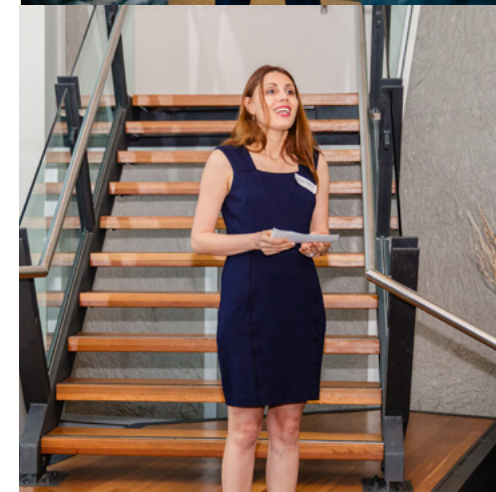
- Critical Control Masterclass
- 2017 Higher Degree by Research Conference: Innovation and Sustainability In The Resource Environment
- Mine rehabilitation and closure in Queensland Hackathon
- EGU (European Geosciences Union, Vienna, 2017): Technical Committee EnviromineSrining 2017
- The Candidate Advisory Committee's Networking Night for HDR students and industry partners
- Deep Mining Queensland Project Completion Forum
- CRC ORE Annual Assembly
- Workshop on statistical Methods for Mineral Engineers
- CEEC Mining Energy Innovation Forum
- AusIMM MetSoc Energy Efficiency Webinar
- Panel chair at Metplant conference, Perth
- RACI National Centenary Conference - 17th Asian Chemical Congress: 'History and Archives'
- DMQ Industry Workshops
- Leveraging greater effectiveness of mineral sustainability initiatives workshop
- Transparency in the mining sector: Lessons from Asia Pacific Symposium
- Extractive Industries Transparency Initiative's Conference
- Session from SR Mining Conference
- Land Rights Panel: A reflection on the ongoing struggle to gain legal and moral recognition of Aboriginal and Torres Strait ownership of lands and waters
- Enviromine2017/Srining2017
- COAL 2017
- Respirable dust workshops
- 5th Symposium on Industrial Ecology for Young Professionals (SIEYP),
- 5th ESys-Particle User Workshop
- MetPlant 2017
- Flotation 17

Community Engagement

In July and in November UQ-SMI hosted the first of our well-attended Alumni and Community Receptions. Alumni, industry representatives, members of the SMI Advisory Board, current students and staff from SMI and across UQ were present. In July, attendees heard from our HDR Three Minute Thesis (3MT) finalists who went on to compete in the All-Institutes final. 3MT is a competition that cultivates students' academic, presentation, and research communication skills to effectively explain their research to a wide audience in three minutes. Gemma Bloomfield, from the Centre for Water in the Minerals Industry (SMI-CWiMI) whose thesis is titled "Improving groundwater recharge estimates for a secure water future" went on to be awarded the runners up prize in the All UQ Institutes 3MT final.

At the November UQ-SMI Alumni and Community Reception, we heard from HDR graduate, Vanessa Cattermole-Terzic from the Minerals Industry Safety and Health Centre (SMI-MISHC) whose thesis focused on "Driver Behavioural Responses to Different Coloured Flashing Lights in the Highway Environment" and SMI-JKMRC's Maedeh Tayebi Khorami; (pictured) "Selective flotation of enargite from copper sulphides in complex ore systems", who provided a student perspective of their experience at SMI.

Our students artistic side shone in November when Mr Charlie Sartain, SMI Advisory Board Chair unveiled "Sustainable Metal" a piece of artwork commissioned by SMI (pictured). The artist, SMI-JKMRC's Erica Avelar describes the artwork as "illustrating that more than ore, reagents and machinery are required in metal production. The elements of the collage call the attention of the viewer to the social and environmental aspects of metal production. The mirrors placed in the work are designed to bring the viewer into the art illustrating the community playing a key role in mining." The artwork is now installed in the Level 4 Lounge of the Sir James Building (#47A).



Acid and Metalliferous Drainage Workshop

November 2017

Environmental challenge brings together the world's AMD experts

As the need to find solutions to acid and metalliferous drainage (AMD) becomes more important than ever, SMI geo-environmental scientist Dr Mansour Edraki recently chaired a gathering of 100 of the world's experts on this topic.

This year's Acid and Metalliferous Drainage Workshop held in Burnie, Tasmania attracted attendees with industry, government and research backgrounds from every corner of the globe.

Acid and metalliferous drainage occurs during mining projects when sulfide-containing rocks react with air and water to form sulfuric acid. This in turn becomes a bigger issue when the acid leaches heavy metals and salts out of the rock, which can potentially affect the environment for centuries after mine closure.

AMD is a relatively unknown global crisis, but has been recognised by the UN as a significant environmental challenge. In the US, for example, an estimated 22,000km of streams and 180,000 acres of freshwater bodies has been affected by the problem.¹



AMD 2017 Workshop participants at the workshop social event.



Workshop participants with Dr Mansour Edraki (second-right).

So it makes sense to gather the world's experts on the topic.

Over the course of the four-day workshop, the group explored the latest research into the causes, management and amelioration of the impacts of AMD.

"Sustainable management of AMD should commence at the very beginning of a mining project and should continue throughout the closure and rehabilitation stages of a mine," Dr Edraki said.

"It also requires collaboration among mining related disciplines and the involvement of external stakeholders."

Dr Edraki believes it is immensely important to introduce this environmental aspect of mining to students to create cultural change in the resource industry.

"While there are some academics who are involved in teaching aspects of environmental management in mining, they tend to be in a minority," Dr Edraki said.

To promote the message that prevention is better than a cure, the workshop also included a visit to old smelting and processing sites at Zeehan, as well as MMC's Rosebery mine, where conference attendees observed the construction of a new tailing storage facility designed for water cover that eliminates the chance of AMD generation.

...labelled by the UN as a significant environmental challenge.

¹ Acid mine drainage: past, present...future?, University of Waterloo, 2006, Michael C. Moncur from: <https://uwaterloo.ca/wat-on-earth/news/acid-mine-drainage-past-presentfuture>



"Sustainable management of AMD should commence at the very beginning of a mining project and should continue throughout the closure and rehabilitation stages of a mine," Dr Edraki said.

Over 50 papers and posters were presented by leaders from Australian and international organisations, covering a wide range of AMD aspects.

These included: monitoring, assessment and prediction; prevention and control; mine closure; final voids and pit lakes; remediation and treatment; managing past legacies; geomicrobiology and AMD; and geo-environmental approaches to characterisation.

Additionally, two short courses were delivered prior to the workshop; The Fundamentals of Acid and Metalliferous Drainage and An Introduction to INAP's Global Cover System Design Technical Guidance.

SMI represents Australia in the International Network on Acid Prevention (INAP) which is a global alliance comprising members from the resources industry.

One outcome of the workshop was an agreement that SMI, as local INAP partner, should prepare a bid to organise the next International Conference on Acid Rock Drainage (ICARD) in Australia in 2021.

"The breadth of expertise across The University of Queensland places SMI in a unique position to develop an integrated program and approach to hosting ICARD, in conjunction with our wide network of partners across industry and academia," Dr Edraki said.

With continued collaborations on managing and preventing AMD, Dr Edraki believes the industry can make significant inroads into addressing this global challenge.



www.amdworkshop.com.au

Publications



Publications

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