

Celebrating 30 years of the **WH Bryan Mining Geology Research Centre**





Dedicated to Dr Andrew White 1941–2021

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Foreword by Bob Bryan AM



Above: Bob Bryan AM

This Booklet is the brainchild of Don McKee who, in one form or another, has been a key player with the Bryan Research Centre since its inception, some 30 years ago!

I realised early on in my career in the Geological Branch of the Federal Bureau of Mineral Resources, that I was totally deficient in terms of meaningful geological input to mining. And I was not alone in this and the result was that as a profession we had effectively handed over responsibility for mining geology to the engineering fraternity!

By mid-career I had the funds to do something about this, and with the support of Don Nicklin, Alban Lynch and Don McKee set about correcting the balance. The end result was the establishment of the WH Bryan Mining Geology Research Centre, named after my father Professor WH Bryan MC.

“The need for tomorrow’s ‘critical minerals’ is today’s exploration task, and this presents continued opportunities for exploration within BRC.”

However, despite our best endeavours, the Centre’s name was inevitably shortened—in this case to the Bryan Research Centre (BRC).

As detailed in the Booklet, BRC has had a raft of Directors over the past 30 years—the first being the late Andrew White, after whom the Booklet is dedicated. We always had an Advisory Committee in the wings, but never tried to constrict the Directors, and the result has been a feast of ideas about mining geology, representing in the main, the various Directors’ interests.

Perhaps BRC has ‘come of age’, for we are now adopting a much more focused approach, but this is in no small part due to the constraints that we believe the Mining Industry will face in the immediate future encapsulated in the growth of the Environmental, Social and Governance (ESG) movement. We believe ESG pressure will make life tough for current open pit mining especially and will have the effect of driving many new mining operations ‘underground’.



We see Deep Mining Geoscience (DMG) as a beneficiary of this new trend, and the BRC plans to make DMG its own.

But the reality is that the need for tomorrow's 'critical minerals' is today's exploration task, and this presents continued opportunities for exploration within BRC; lithium, cobalt and nickel of course, but our special interest is sure to be copper. Demand for copper is set to explode, and of course currently most of the world's copper comes from huge low grade open pit operations. These will be front and centre in terms of ESG opposition, and prime candidates for conversion to deep underground mining.

While I have a certain sadness that age is taking its toll on my frame, I draw comfort in the fact that BRC is taking on a new and exciting lease of life. Rick Valenta has done wonders in its rejuvenation in recent years, and we are confident that the new BRC Director Mark Noppé will build on this good work.

Andre van As is already leading the charge on the DMG front, which is certain to become hugely important in terms of future copper production. And of course, I draw comfort from knowing that I have Don McKee and Dan Wood, keeping a watchful eye on BRC's doings, from the sidelines.

But none of the renaissance of BRC would have been possible without the strong support of The University of Queensland's Vice-Chancellor and President, Professor Debbie Terry AO. And I'd like to think that given Queensland's dependence on mining, it was entirely appropriate for The University of Queensland (UQ) to be taking a lead in developing new mining technologies that take account of 21st century social and environmental concerns.

Welcome by Rick Valenta



Acting Director SMI

It gives me great pleasure to welcome you to this celebration of the illustrious 30-year history of the WH Bryan Mining Geology Research Centre (BRC).

The Booklet brings together recollections from most of the past Directors of BRC and relies on the memories of others where the direct contributions were not possible. It touches on the vision and support of Bob Bryan AM to establish the WH Bryan Mining Geology Research Centre; the leadership of Dr Andrew White as founding Director; the hard work of all the Directors and staff; and the long-term support of UQ and leaders of the Sustainable Minerals Institute (SMI) to ensure BRC was a success.

Over the years, each Director and research team has brought its own focus to the activities of BRC. What has unified these phases, though, has been the strong focus on producing innovation that is relevant to the mining industry, and attuned to its needs at the time.

Over its 30 years, BRC has existed in many guises and survived through many ups and downs of what we all know to be a cyclical industry. Over the years, each Director and research team has brought its own focus to the activities of BRC. What has unified these phases, though, has been the strong focus on producing innovation that is relevant to the mining industry, and attuned to its needs at the time.

We hope you enjoy the recollections in this Booklet, each of which is written in the voice of those who were present at the time. We hope it brings back some memories and paints a picture of the history of this globally important geoscience centre.

Acknowledgements

Sara Sulway
Roussos Dimitrakopoulos
Alan Bye
Margie Scott
Don McKee
Geoff Lyman
Alice Clark

The origin

BRC was established through the persistence of Bob Bryan AM. Bob was an Honours graduate of the Department of Geology at The University of Queensland (UQ) in 1956. His father, Professor Walter Heywood Bryan MC, was the long-standing Head of Department.

At the time, a postgraduate Diploma in Applied Geology had been established under Professor Gerald Sargent to add some practical detail to a largely academically focused degree, but the course did not flourish. As Bob began his professional career with the Bureau of Mineral Resources, he became all too aware of the narrow emphasis of undergraduate education in geology.

Over 30 years later Bob was in a position to do something to develop mining geology as a theme of what was now called Earth Sciences at UQ. He first convinced Professor Don Nicklin, then a senior leader within the University, of the merits of establishing a mining geology research centre. He had the strong support of Professor Alban Lynch, then Head of the Department of Mining, Minerals and Materials Engineering and the former Director of the Julius Kruttschnitt Mineral Research Centre (JKMRC).

An offer of seed funding from Bob clinched the deal and in 1991 the WH Bryan Mining Geology Research Centre was established and named in honor of Bob's father.



Above: Professor WH Bryan, courtesy of Scott Bryan

The Centre, which soon became known as BRC, was located within the Department of Earth Sciences. From the outset, BRC had a strong Advisory Board composed of senior minerals industry representatives and a small number of supportive university people, particularly Professors Paul Greenfield and Ted Brown. With the appointment of Dr Andrew White as the first Director in 1991, BRC was off and running.

Mining geology centre to open

A CENTRE aimed at building an international reputation for applied research in key aspects of mining geology will be launched at The University of Queensland next month.

The Minister for Resource Industries Mr Ken Vaughan will launch the W.H. Bryan Mining Geology Research Unit (BRU) on May 3.

Research unit director Dr Andrew White said the BRU was a joint venture between the University's Departments of Mining and Metallurgical Engineering, and Geology and Mineralogy.

Dr White said the unit was established to bridge the communication gap between geologists and mining engineers in the workplace by promoting collaborative research and teaching.

"The second reason for establishing

the unit is that mining geology is a neglected branch of the profession although it is vitally important in producing Australia's minerals," he said.

"The University of Queensland will become the first Australia postgraduate research centre focusing on mining geology."

Dr White said the initial research direction for the BRU was in the areas of grade control in metalliferous mines, and in developing more precise and reliable predictive modelling techniques for mineral deposits.

It was proposed to acquire records of producing or worked-out mines to form a high quality data base for the research program.

"The collection and archiving of mine records may eventually form an important resource in itself," he said.

Dr White's experience covers a wide range of mining and exploration in Australia and South-East Asia.

Dr White is also an expert in the field of management training in the resource sector and since 1985 has led management courses sponsored by the Australian Mineral Foundation for industry and Government personnel in Australia and Asia.

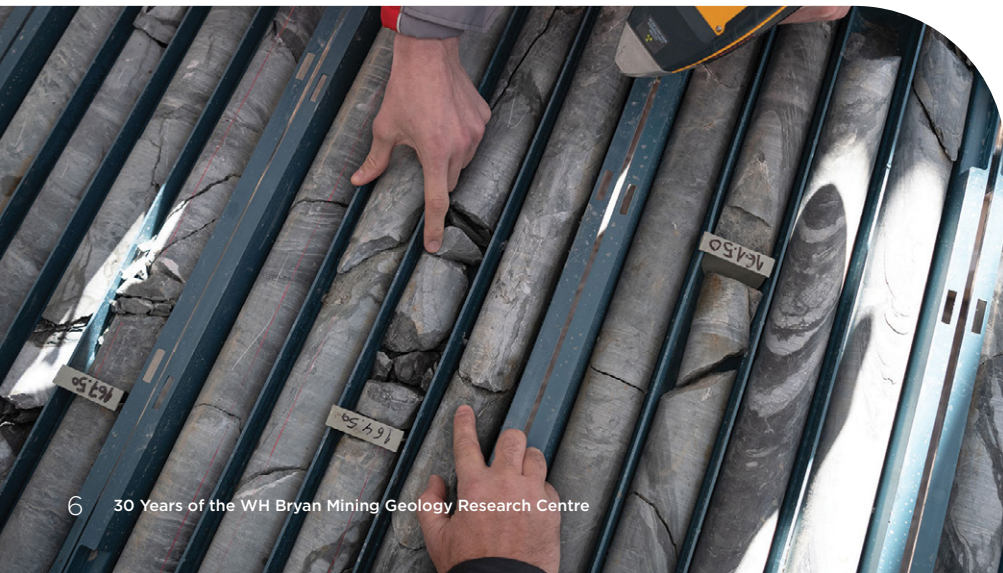
The W.H. Bryan Mining Geology Research Unit commemorates the late Professor Walter Heywood Bryan, the first honours graduate of the Geology and Mineralogy Department in 1914, and the first University of Queensland graduate to be awarded a Doctorate of Science in 1926.

The unit has been established partly with funds from both University departments, and partly with a donation by Professor Bryan's son, Mr Bob Bryan, a geologist and former Queensland Chamber of Mines president.

Dr White said the unit aimed to be self-funding and it would seek substantial continuing support from industry.

Above: Newspaper coverage from the time, courtesy of the UQ Archive

As Bob began his professional career with the Bureau of Mineral Resources, he became all too aware of the narrow emphasis of undergraduate education in geology.



The research journey over 30 years

As reflected by the Directors since 1991

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Dr Andrew White (1991-95)

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Professor Roussos
Dimitrakopoulos
(1996-2006)

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Professor Chris Alford
(2006-2007)

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Professor Alan Bye
(2007-2010)

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Dan Wood AO (2010)

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Professor Margie Scott
(2011-2015)

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Professor Alice Clark
(2015-2018)

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Professor Rick Valenta
(2019-2022)

Dr Andrew White



BRC Director 1991-1995

Andrew (Andy) White passed away in 2021. These reflections have been provided by Sara Sully (Porter) one of the first BRC students; Don McKee, who was Director of the JKMRRC at the time; and Geoff Lyman of the JKMRRC who collaborated with Andy on research projects.

Don McKee's recollections

Andy White came to BRC with an extensive industry background, most recently from Comalco. That meant he had the all important understanding of the place of mining geology in the industry, an essential attribute in establishing a research centre with a focus on practical challenges.

BRC was provided space in the Richards Building which housed the Department of Earth Sciences. It was to remain there until the opening of the Sir James Foots Building in 2005.



Above: Sara at her desk in the BRC in the early 1990s

Starting a research centre from scratch is no easy task. Andy enthusiastically embraced the task of acquiring honours and postgraduate students. Sara Sully lists those all important first students below.

These students undertook a range of research topics including geostatistics, resource evaluation, mineral textures.

When Andy left in 1996, he had established in BRC a strong student group and research in important topics. Equally important for the place of BRC in the University, there was a strong Advisory Board and the support of senior leaders in UQ.

Sara Sulway's recollections

I consider it a privilege to have been amongst the first cohort of graduates from BRC, completing my Honours in 1991 and Masters in 1994. Dr Andy White was the first director of BRC and was both Supervisor and Mentor to the relatively small number of students during those initial years.



Above: UQ's St Lucia Campus in the 1990s, courtesy of the UQ Archive

Andy encouraged us to embrace digital technologies and as BRC students we had access to state-of-the-art equipment including Silicon Graphics Workstations and mining and exploration software including Datamine. I do recall that despite all the “advanced” technology the ability to take screen shots of computer-generated geological models was not an easy one. It involved many frustrating hours of trial and error taking photos of the screen in the dead of night under a black cloth.

Andy was instrumental in building strong foundations upon which BRC has grown and thrived to become what it is today. I am incredibly proud to be a BRC Alum.

The first students

Ivor Jones—MSc 1994
 Shu Zhan—MSc 1991
 Peter Gleeson—MSc 1991
 Mark Whittle—BSc Hons 1991
 Joao Felipe Costa—PhD 1992-1997
 Andrew Richmond—MSc 1993
 Steve Potter—BSc Hons 1993
 Andrew Marshall—BSc Hons 1991
 Sara Porter—BSc Hons 1991,
 M AppSc 1993

Geoff Lyman's recollections

Andy White's period as Director coincided with the establishment of the CRC for Mining Technology and Equipment (CMTE) in 1991. One of Andy's students had undertaken work on mineral textures. A strong collaboration developed between White and Lyman with the aim of developing quantitative methods of describing mineral texture. An infrared microscope, quite novel at the time, was designed and significant progress was made in developing a mathematical description of texture. The work ceased when CMTE funding priorities changed. Andy was hugely enthusiastic about these developments, an indication of his willingness for BRC to engage in original research.

Professor Roussos Dimitrakopoulos



BRC Director 1996–2006

Re-defining and establishing BRC as an International Centre

Moving from North America to Australia in mid-1996 to begin my tenure as Director of BRC at UQ and related full professorship was an exceptional challenge for a young professional for multiple reasons, including the need to re-define and establish the Centre as a world-class research centre.

At the same time, the commitment of UQ from Department Heads, Professor Ken Collerson in Earth Sciences and Professor Barry Brady in Mining Engineering, Executive Dean Professor Paul Greenfield, and Vice-Chancellor Professor Brian Wilson and his successor Professor John Hay was exceptional, making the challenge well worth the undertaking. With UQ, a major research university, providing a very supportive environment, the following decade resulted in the building of the core elements leading to the national and international establishment and recognition of BRC.

From the start, BRC focused on:

- i. new directions for high quality, innovative research that could solve problems and make a difference in the mining industry
- ii. attracting and fostering quality staff, including postgraduate students, research fellows and admin staff, needed to support research novelty, quality and productivity
- iii. professional development training and knowledge dissemination activities to establish interactions with and support training for the mining industry
- iv. generating and supporting exchanges with international experts in technical fields of interest
- v. establishing a Board of Directors to support all aspects of BRC intellectually and administratively.

From the early days, research efforts were based on strengths in geostatistical modelling and related simulations, optimisation methods and computing related to mineral resource modelling, asset valuation, mine production optimisation and strategic mine planning. These efforts soon paid off and led to intellectual and practical collaboration with most major mining companies in Australia, as well as

These efforts soon paid off and led to intellectual and practical collaboration with most major mining companies in Australia.

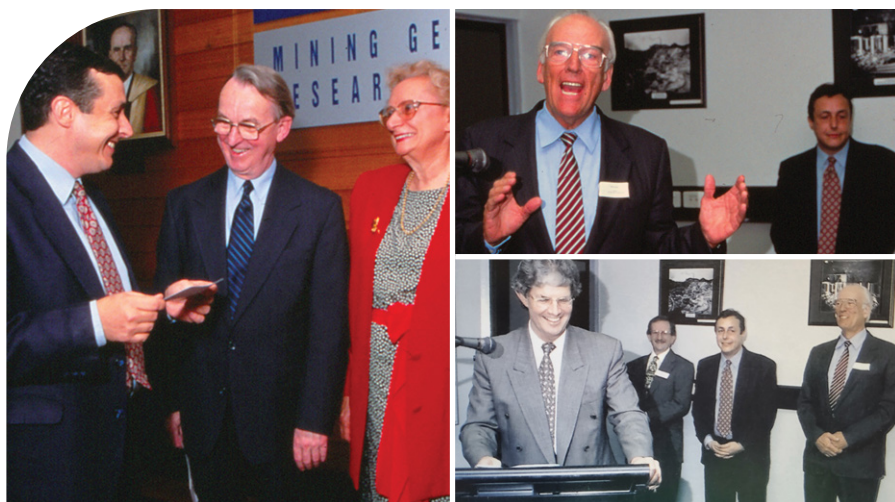
substantial funding, including generous support from the mining industry and competitive research grants from the Australian Research Council (ARC), towards advanced cutting-edge paradigm challenging research.

In 1998, the on-going support from UQ allowed BRC to move to a suitable new large and renovated space to facilitate the increasing number of researchers, as well as an advanced computing lab. Notably, by 1998 BRC became a “million-dollar centre” employing three full-time research fellows and funding 14 graduate students.

The new millennium saw BRC rapidly expand its knowledge capital, as well as establish collaborative relationships with most major mining companies, major professional mining organisations, and academic research groups worldwide.

BRC became a world leader in mining geostatistics, optimisation, mine planning and design, all focussing on ‘stochasticity’, starting from the major question raised at that time through detailed studies: ‘why are strategic mine planning forecasts not materialising in mining projects and operations?’ The question led to the need to understand and quantify uncertainty and variability in the pertinent properties of mineral deposits being considered, along with the limits and effects of established concepts, methods, and technologies available. This revealed the challenge of quantifying and managing the related risk in terms of optimising mine design and production scheduling, along with the related forecasting and evaluations—well summed up by the famous economist JM Keynes:

I would rather be approximately right than precisely wrong.



Clockwise from left: Bob Bryan and Roussos Dimitrakopoulos at the opening of the BRC's new premises in 1998, courtesy of the UQ Archive; Vice-Chancellor Professor John Hay officially opens the BRC premises on June 5, 1998, next to Professor Ted Brown (Senior Deputy Vice-Chancellor), Roussos Dimitrakopoulos and Bob Bryan (Senator of UQ).

While the quantification of mineral deposit uncertainty could be addressed through the development of new efficient and more informed geostatistical simulation approaches, the well-established deterministic optimisation approaches for mine planning and production forecasting raised a serious issue on how stochastic frameworks and methods could be developed.

Research at BRC emphasised technical (geological and mining) risk with the key direction being towards developing concepts and methods allowing the shifting of mine design and planning formulations and technologies towards a new stochastic mine planning paradigm. The modelling 'engines' as we called them at the time, were spatial stochastic modelling of mineral deposits and stochastic mathematical programming and heuristics for mine planning optimisation. By the end of my term at BRC in early 2005, we were able to produce a substantial number of studies analysing the limits of established methods; test new stochastic modelling approaches for mine planning optimisation; and showcase major case studies,

all demonstrating and documenting the substantial benefits of a new stochastic mine planning paradigm based on uncertainty quantification and related risk management.

This was combined with a healthy annual budget of over \$1.5 million, along with six professional research staff, six honorary or adjunct professors including colleagues from North America, 14 graduate degrees awarded, 10-12 graduate students per year, and over 160 technical publications, accomplishments of the BRC team one can only be very proud of.

Notable was the delivery of substantial international professional development activities and conferences in collaboration with AusIMM and SME, attended by hundreds of participants over the years, and other knowledge dissemination activities.

While BRC's establishment, growth and contribution exceeded expectations, perhaps the largest reward is now to see our then postgraduate students and researchers serving as senior industry leaders, including positions of Vice President and Chief Technical Officer in some of the largest mining companies.



Left to right: Meeting of the BRC Board of Directors with BRC staff and students; Industry representatives at the BRC Technical Day in November 22, 2002, attended by over 60 participants from Anglo Gold, Anglo Coal, BHP Billiton, De Beers, KCGM, MIM, Rio Tinto and WMC.

Professor Chris Alford

Recollected by Don McKee

BRC Director 2006–2007

Chris Alford broadened the focus of BRC

An excellent mathematician and software developer, Chris maintained the geostatistics focus of BRC inherited from Roussos Dimitralopoulos. He also expanded the open pit planning and optimisation research of BRC. He formed a strong association with mathematics staff in the Queensland University of Technology (QUT). This was to bear fruit later when QUT became a research participant in CRC ORE as outlined by Alan Bye in the next set of recollections.

It was during Chris Alford's time as Director that plans were finalised to transfer the remaining mining activities in the JKMRC to the BRC. This followed the earlier transfer of Gideon Chitombo's mass mining and blasting research from SMI to BRC. These actions resulted in a BRC with a broader range of mining and mining geology activities and provided the springboard for the next stage of BRC.

It was during Chris Alford's time as Director that plans were finalised to transfer the remaining mining activities in the JKMRC to the BRC.



Above: Don McKee with Gideon Chitombo and Dr Alan Guest (DeBeers)

Professor Alan Bye



BRC Director 2007-2010

During this period there was an extension of focus from resource modelling and mine planning to include mining engineering and mine to mill.

The mining engineering focus was on blasting and block caving while the mine to mill focused on geometallurgy, grade engineering and environmental factors such as water and energy intensity. The mining engineering capability from the JKMRC was

integrated into the BRC notably the Mass Mining Technology and Hybrid Stress Blasting Model work led by Gideon Chitombo. Over this period the team grew to 14 research staff and six PhD's with revenue increasing from \$0.5 million to \$3.5 million pa.



Above: Alan Bye (right) at the Mogalakwena Platinum Mine with Alan Tordoir a PhD student at the time

Major programs

SEE

The Sustainability and Extraction Simulator was funded initially by Anglo Platinum and brought together JKSimBlast, JKSimMet and JKSimFloat onto a single integrated platform. The project would be further developed by the **Cooperative Research Centre to Optimise Resource Extraction** (CRC ORE) to ultimately become the Integrated Extraction Simulator, now a commercial product and services offered by Orica.

AMIRA GeM P843

Within the Geometallurgical Mapping and Mine Modelling project, BRC was responsible for spatial modelling, optimisation in mine design, planning and blasting.

MMT II

The Mass Mining Technology (MMT) program was developed to better understand the fundamentals of the caving process and new planning tools (caving mechanics, fragmentation, gravity flow, confined blasting).

The MMT aim was to support future mining requirements for much lower grade, deep and complex deposits to be mined by underground mining methods such as caving.

HSBM

The HSBM explosives research was developed to support emerging and new generation explosives and rock breakage requirements facilitated by advanced numerical modelling.

CRC ORE

BRC led the development of the **Cooperative Research Centre to Optimise Resource Extraction** (CRC ORE), which was established in 2010 through the co-operative research center program. CRC ORE was founded to focus on Optimising Resource Extraction for the mining sector. The program worked to minimise the impact of declining grades and to radically improve the productivity, energy and water signatures of mining operations. CRC ORE was a five-year, \$70 million program jointly funded by Essential Participants—which included mining companies, METS, research organisations and the Australian Government.

The team grew to 14 research staff and six PhD's with revenue increasing from \$0.5 million to \$3.5 million pa.



Above: Gideon Chitombo led the MMT and HSBM programs

Dan Wood AO



BRC Director 2010

My initial involvement with BRC was as a member of its Advisory Board under the chairmanship of Professor Don McKee while Alan Bye was Director.

Don had assembled a strong board of industry and government representatives which was very committed to advancing the Centre. It oversaw the establishment of CRC ORE and Alan's related departure to head up this group. I stayed a member of the board until it was disbanded along with the boards of all Centres following a disruptive academic review of SMI in 2014. Alan's departure left BRC without a Director and after a fruitless search for a replacement in the first half of 2010, I was asked to step in temporarily to fill the vacancy until a full-time director was appointed.

While my tenure as Director was very brief, I feel I made a contribution by questioning why there wasn't a greater focus on geology in BRC's research at the time, given that it was a mining and geology research centre. This deficiency was subsequently addressed by Margie Scott who hired several geologists and initiated a number of geology research projects. One of these was with Newcrest Mining and was focused on the Ridgeway caving operation. The original research proposal was to identify the geological reason for the very rapid subsidence above the Ridgeway sublevel cave. The answer for this is in the volcanic geology that overlies the deposit. Unfortunately, delays in securing project funding delayed the start of research and mining issues with the subsequent, deeper block cave meant the project was refocused onto the block cave.

“I made a contribution by questioning why there wasn't a greater focus on geology in BRC's research at the time.”

Professor Margie Scott



BRC Director 2011–2015

As a BRC graduate, I was aware of the Centre's pedigree as a hub for postgraduate and industry education, and national and international recognition for industry engagement on applied research projects.

Recent projects preceding my appointment focused on factors underlying the management of engineering risks associated with mass mining, particularly deeper underground mines, as well as operational efficiencies in current open cut mines. To this end BRC had established disciplinary strengths in mining engineering, rock mechanics, rock breakage physics/computation, risk and mine evaluation, but notably absent was geoscience. A significant omission, not only with respect to the Centre's name's sake: WH Bryan, but also as a critical piece of a puzzle; one that linked the challenges facing future deeper lower grade metalliferous mines and longer-term societal resource demands.

'Resource replenishment' became a driver and point of focus for BRC during my tenure, recognising that the growth in global consumption of metals such as copper would outstrip production in future decades. A scenario, that on reflection in 2022, would prove to be cautious.

Current projections indicate an acute global copper shortage in the next 6-8 years, even when factoring in uncommitted development stage projects, whilst global demand for copper is predicted to double by 2050.

A geologist myself, it was evident that BRC needed to grow geoscience capabilities. This was reinforced by the then BRC Board, with strong advocacy notably by Dan Wood, an industry leader associated with discoveries that successfully transitioned into large underground and open-cut mines. Crucially, the intent of this new geoscientific capability was not directed at advancing research in ore genesis, rather it was to be mining centric. Geoscience that could support diverse research, from rock mass responses to mining to supporting policy aimed at maximising Australia's potential role in future commodity supply chains. Key to facilitating this strategy was establishing industry-government-research institute partnerships, collaborations that recognised the value of BRC research to both industry and society more broadly.



Above: Gideon Chitombo

These projects would enable the appointment of four new research staff: three geologists that brought essential expertise in mines and brownfields exploration, and a geophysicist. To these were added adjunct positions providing additional expertise in geostatistics and resource analysis, cave mining engineering as well as exploration strategy. In this way BRC was able to build on its established strengths by integrating geoscience in a move towards what was coined as 'total deposit knowledge' (Professor Chitombo pers. comm). An approach reflected in new projects within BRC's three research streams:

1. Deep earth mining

'Recovering from future deeper, larger, lower grade deposits'

Led by mining engineer Professor Chitombo, projects included 'Geology Uncertainty in Mass Mining' a collaborative partnership involving Queensland Government Funding and key industry players (Xstrata, Newcrest, Ivanhoe and Anglo American) and focused on the impact of geology on caving performance/mining at depth.

2. Value engineering

'Extraction optimisation'

Supported by existing Commonwealth Research Funding (CRC ORE), work continued around greater effectiveness in current mining operations with (i) smarter application of blast modelling and (ii) decision-making using a 'whole of mining approach' by integrating information such as rock characteristics, energy, water usage, cost and risk.

3. Minerals strategy

'Maximising opportunity for resource recovery and wealth preservation'

Led by myself, work considered forecasting of resource potential, emphasising mineable mineralisation. Projects supported by International Mining for Development Centre (IM4DC) funding enabled resource assessment and data integration training in developing nations. A collaborative project between the Geological Survey of Queensland and industry partners, 'Deep Mine Queensland' assessed both brownfields mineral potential and mining risks in NW Qld, providing perspectives critical to the understanding of development viability of potential deeper deposits.

BRC's strength was and will continue to be its pursuance and contribution to solutions for real world issues of national and global importance by dedicated, insightful and passionate researchers/educators and postgraduate students.

Professor Alice Clark



Production Centres Director 2015–2018

I was pleasantly surprised when Professor Chris Moran contacted me early in 2016 to see if I could meet up with him and talk about how the industry was tracking.

During our discussion he asked if I would be interested in applying for a one-year contract to assist him in rebuilding the BRC and JKMRC Research Centres as they had recently been the subject of the University Review process for SMI.

He was clear that if I was successful, it would be through my application being deemed acceptable to the Academic Board as the position was at a Professorial level and as I don't have a PhD, he suggested that I would need to come prepared! Needless to say, it was a rigorous interview process.

Chris was also transparent in his description of the task ahead and advised that I should not underestimate the level of difficulty in bringing about the cultural change required to implement the review recommendations. Of course, BRC and JKMRC are well known to industry people, and I looked upon it as a great opportunity to step into the research sector.

A few months later Chris resigned and moved to Curtin University as the Deputy Vice-Chancellor (Research). Before he resigned, he had my appointment extended to enable continuity of the position until his replacement could be found. I remain very grateful for his mentoring and encouragement during that first year. It was a difficult time for BRC and JKMRC, and Chris always had the best interests of SMI and its then six Centres at heart.



Above: Professor Chris Moran



Above: The UQ Experimental Mine Site

The first big challenge was to bring BRC and JKMRC together on one site. It seemed instinctively like the right thing to do. After working in corporate roles across exploration and mining, I'd always thought that if we could get geologists, mining engineers and metallurgists to work in a cross-disciplinary fashion at the research level we would solve very big problems.

The actual move was not much of a physical challenge (there was plenty of space at the Indooroopilly Experimental Mine site) however, it was a huge cultural challenge. The staff and students at JKMRC were looking forward to having the geologists join them, but the BRC team didn't want to leave the easy access that public transport and parking options provided to UQ's St Lucia campus. The lack of a coffee shop at Indooroopilly was also a point of much discussion.

In the end we compromised, and The Mass Underground Mining (MUM) group opted to stay at St Lucia while the rest moved to Indooroopilly.

It was like a breath of fresh air to both the BRC folk who moved over; and to the JKMRC who now had these scruffy geologists chomping through the Milo and instant coffee supplies, crashing the sacred Friday JKMRC Seminars and asking all sorts of non-metallurgical questions. The "Production Centres" was now a 'thing'.

Culturally before, during and even after the move, both BRC and JKMRC were in a bad place. Moving the two groups together was a much-needed boost for morale at that time. There was a sense of energy once everyone was settled in their new offices, but we were not out of the woods. Neville Plint hadn't arrived yet and our funding was drying up fast. Now we needed to start hunting new funding for our research projects.

Since those early days after the move there has been a steady increase in PhD's that are co-supervised by senior research staff from across geology, mining engineering and mineral processing. There is also a level of cross-fertilisation being undertaken in the tailings research space.

Being co-located is surely making cross-disciplinary research a more feasible space to work in.

From the perspective of finances and culture in the first half of 2016, if you took away the MUM program, BRC was in bad shape and the team knew it. Professor Chitombo had a solid industry reputation built on many years of cave mining research and he worked diligently to bring in the next phase of the project. But outside of the MUM group a sense of despair was growing.

The previous BRC Director, Professor Scott, had built up a strong connection with the state government and secured solid funded research. However, the Director's position had been vacant for some time before I joined the team and people were focused on completing the last government funded projects. There were no new projects in the pipeline and there was little appetite for companies to engage with the Centre.

Within the first months of the job (and prior to moving the groups together), due to the financial situation, the difficult decision was made to cut staff across SMI. Both BRC and JKMRRC were subject to severe staff cuts via non-renewal of contracts and many talented people left the research groups.

This had an enormous impact on both Centres. Researchers lost the ability to work with specialists they had been associated with for many years. This put a strain on relationships and the effects of this were felt for some time afterwards.

At this time, I reached out to Dugi Wilson (Ex General Manager for MIM Exploration) who agreed to join the team on a contract basis and help build a strategy for business development. We believed the industry would turn around and people needed to put their

minds to new projects and business development. Once the industry started to loosen its budgets and lean towards research again, we would be ready.

I knew Dugi from my time at the Mount Isa Mine. He had a strong industry reputation with deep expertise in geoscience, exploration, management of large teams spanning decades and crossing commodities in the minerals industry. Dugi pulled the team together and set about developing a project development strategy.

His interest in in-situ leaching applications drew on the geophysics, exploration and numerical modelling expertise within the team and we were soon pitching our first project to industry. Dugi was instrumental in the turn around. He had street cred in the exploration game and a knack for developing team spirit. Under his leadership the team began to build projects drawing on the variety of expertise and ideas that were already in the team.

I remember well the feeling of extreme relief when Dugi came into my office and said he'd seen Rick Valenta riding his bike around St Lucia campus.



Above: Peter Forrestal was a member of the BRC board and then chaired the combined BRC and JKMRRC Advisory Board

Dugi asked if we could call him and see if he wants a job! We both pulled out our phones trying to see who could find Rick's number first.

The other person who supported me was Peter Forrestal. He took on the task of pulling together the Advisory Board after we'd taken the decision to combine the JKMRC and BRC Boards. This was an enormous support, and I am very grateful to Peter for his wise counsel and patience with the difficult task of directing this important group.

Additionally, I could never fault the support from SMI. Chris Moran was incredibly supportive even providing advice after he'd taken up his new role in Western Australia. Following his departure Professor David Mulligan was also very helpful as our Acting Director SMI in supporting our PhD students who were finishing their thesis.

Of course, the heavy lifting then came from the support of Professor Neville Plint to see us through the long haul back from below the line to positioning the Centres for a return to positive territory. I never heard him say "No you can't do that". And the Operational support from Melissa Glendenning and her business management, marketing and communications and administrative teams has been consistently strong.

In hindsight the key to succeeding during this time in BRC was a relatively simple formula of bringing in expertise, putting people together and asking them to trust each other. They did all the hard work. They took all the risk. All they needed was a safe place for people to learn about each other and some support to sell their ideas. Under the leadership of Professor Rick Valenta BRC started to work together and think strategically. Almost everyone from that time in BRC has turned over now.

I'm honoured that I got to work with researchers like Dr Travis Murphy, Dr Tony Webster, Dr Ruslan Puscasu, John Donohue, Professor Gideon Chitombo and Dr Mark Hinman and the PhD students from that time.

I think we turned an important corner in BRC when Rick, Paul Gow and Mark Hinman developed the NW Queensland Mineral Deposit Atlas. It wasn't 'big' in terms of money or big contracts—but those sorts of things make people sit up and pay attention. I made printouts of the parts of it covering the deposits that belonged to the companies of some of the Advisory Board members and put it on the table at the Advisory Board meeting after the first set was published. Everyone was looking at it and commenting on the importance of pre-competitive data. Peter Høj (UQ Vice-Chancellor at the time) came along to the meeting and commented on the value of the Atlas to both the industry, government geologists and was complimentary to BRC for the University to have been instrumental in its development.

More Government contracts soon followed, the team was delivering on time and building more projects. BRC was getting its name out there. Company contracts started to appear. After I left, the tailings research took hold under the leadership of Associate Professor Anita Parbhakar-Fox in BRC. That's when I felt BRC was truly diversifying from the exploration/traditional mining focus. When Andre Van As joined, the Centre had a serious engineering stakehold. Somewhere along that path I felt it was out of the woods and of course I'd been long gone into the strategic planning role by then. It was that "Valenta fellow" that took it from crisis to 'its going to be ok'.

Professor Rick Valenta



BRC Director 2019–2022

I joined BRC in early 2017 as the leader for the Geology for Mining Program, returning to an academic role after 23 years in industry-based technical and senior executive roles, mostly in the area of exploration and development.

Having participated in research mainly from an industry vantage point for so long, I had developed some pretty clear ideas about what needed to be done better. Chief among those was the belief that more importance needed to be placed on ensuring research outcomes are delivered to industry partners in a way that maximises the extent to which they can be used.

SMI had recently completed a transition to a new operating model, and BRC was now part of the SMI Production Centres, working at the Indooroopilly site alongside mining and mineral processing colleagues from JKMR.

Co-location with mining and mineral processing expertise gave BRC an advantage available to relatively few specialist geoscience research groups.

This transition was challenging for some BRC staff, but co-location with mining and mineral processing expertise gave BRC an advantage available to relatively few specialist geoscience research groups. As Director of the Production Centres, Alice Clark was extremely supportive, giving me plenty of rope to rebuild a research program in BRC while also smoothing BRC's way through the complexity of the UQ organisation. Neville Plint had also recently been appointed as the new SMI Director and had set about rebuilding the culture and confidence of SMI.

With the completion of some major projects in 2015, BRC's revenue and staff complement had drastically reduced by 2017, and in early 2017 the Centre had only one externally funded project. By late 2017 BRC had only two staff members actively participating in the day-to-day conduct of the Centre. SMI and UQ were very supportive at this time, backing the BRC team to rebuild a strong geoscience-based program.

The principles for the rebuilding of BRC were simple. The Centre would continue with a strong industry focus, following SMI's model of developing strong and trusted relationships with external sponsors, leading to the formulation of externally funded research projects of clear benefit to industry, with practical outcomes and deliverables designed to be implemented by sponsors. Staff and postgraduate researchers would have an unashamed industry focus, and many would come with extensive industry backgrounds. BRC would take full advantage of the unique setting of being able to work in a close team environment with a group of world-class researchers in mining and mineral processing, as well as with SMI's expertise across the mining value chain. The Centre would build a strong and diversified portfolio to address key industry challenges and to ensure continuity of research support.

By the end of 2018 BRC had rebuilt to a complement of six staff and seven postgraduate students, and was conducting five major projects including the UQ-supported Complex Orebodies program which involved researchers from across SMI and UQ. I was appointed Director of BRC in late 2018 and over the next four years the Centre developed strong research initiatives in several key areas as outlined below.

Regional synthesis and targeting

The Queensland government-supported Deep Mining Queensland project had been running at the BRC since 2015, with contributions from Travis Murphy, Mark Hinman, John Donohue and Mark Pirlo. This project provided important insights into the 3D regional controls on Iron Oxide Copper Gold mineralisation in the Cloncurry region and delivered

a new set of targets ranked by deep mining amenability. Mark Hinman¹ continued this work in the Eastern Succession of the NW mineral province. Karen Connors and Paul Gow joined BRC in 2019, both bringing extensive experience in regional exploration synthesis and targeting. Over the next few years, Karen and Paul led government and industry projects in a number of areas aimed at producing insights and targets based on geophysical datasets complemented by the full suite of geological information. Sasha Aivazpourporgou, a geophysicist specialising in magnetotellurics, provided strong geophysical support to these activities. Design note: Please insert photo of Karen from Rick Valenta file, photo credit: Karen Connors joined the BRC in 2019 Karen's work in updating the SEEBASE depth to basement model for the Northern Territory and producing a consistent 3D interpretation of the NW Mineral Province deep seismic data was particularly impactful.

Applied exploration

In mid-2017 the Geological Survey of Queensland announced a new \$27 million Strategic Resources Exploration Program and asked BRC to play a technical advisory and program management role in the new discovery part of this program. As part of this program, BRC carried out a major compilation of previous research outcomes in the NW Mineral Province of Queensland, taking the \$150 million worth of previous research in the region and putting it into a form that explorers could access without expensive software and a PhD. Another major BRC output from this program was the NW Mineral Province Deposit Atlas series, which provided a summary compilation

¹ Sadly, Mark passed away in 2020 after a long illness. He is sorely missed.

of the characteristics, history and expression of the mineralisation and halo for all of the major mineral deposits in the NW Mineral Province. Paul Gow led the compilation of the 24 Atlas chapters, with contributions from Nathan Fox, Sasha Aivazpourporgou, Jenna McGovern, and myself.

Characterisation and geometallurgy

BRC took over leadership of geometallurgy in the SMI Production Centres in 2018, building on the strong track record of JKMRC and SMI in this important area. Cathy Evans moved to BRC to conduct research in this area and was later joined by Nathan Fox and Kate Tungpalan. Over the next few years this team led research for several industry partners in areas such as use of geoscientific data for prediction of processing parameters; integration of 2D and 3D mineralogy; automated textural classification for prediction of processing parameters; and automated geological logging. Cathy also was a key participant in the development of online courses in geometallurgy and process mineralogy.

Complex orebodies

In 2018, UQ agreed to fund the five-year Complex Orebodies strategic research program. This program had the aim of addressing the challenge of future mineral supply and the fact that it was increasingly needing to be derived from deposits facing difficult combinations of social, environmental, governance and technical complexity. In this program, BRC collaborated with SMI's social and environmental experts to build global understanding of the full range of source risks facing most of the major commodities required for our continued prosperity, leading to a better-informed appreciation of the innovations needed to unlock future


mineral supply. The Complex Orebodies program also supported collaborative projects in improving the understanding of deposit variability; innovative approaches to bioengineering for low footprint in situ extraction of ores; and in the understanding and management of mine waste.

Mine Waste Transformation through Characterisation

Anita Parbhakar-Fox joined BRC in 2019 to lead initiatives in the area of geometallurgy and geochemistry applied to mine waste transformation. Since then, she has become one of the most prominent global researchers in this area and has built a team of seven researchers and five postgraduate students working with a range of companies as well as four state surveys and Geoscience Australia, carrying out research aimed at characterising mining waste to better understand the necessary mitigation of associated risks and the paths to realisation of value from it. The Mine Waste Transformation through Characterisation (MiWATCH) program was established in late 2020 and has become a powerhouse within BRC.



Above: BRC's Zhengdong Han and Kam Bhowany on fieldwork in the Northern Territory



The main area where BRC measures its impact is, and will always remain, in the quality and usefulness of the research outcomes it produces for its external partners.

Critical minerals

The past few years have seen an important realisation that large increases in critical mineral supply will be required to allow the world to meet its decarbonisation targets. BRC has carried out several research projects in this area, including mine-based characterisation; regional compilations of New Economy Mineral Prospectivity; analysis of critical minerals in mine waste; and a NE Queensland deposit atlas focusing on deposits of New Economy Minerals. BRC is also leading a multidisciplinary project with the SMI Centre for Mined Land Rehabilitation and the UQ Schools of Chemical Engineering and Earth and Environmental Sciences on innovative approaches to extraction of rare earth elements from Queensland ores.

Exploration technology

BRC has had a strong focus on developing approaches for improved geoscientific interpretation based on developing exploration technologies. As part of that effort, the centre has benefited from having Katerina Savinova, an expert in hyperspectral processing, on the team. In 2020 we were joined by Steve Micklethwaite, an experienced explorer with strong capabilities in 3D modelling and the application of drones to mining and exploration. Steve and Katerina have developed projects employing these technologies across a wide range of mining and exploration applications.

Deep mining geoscience

Deep Mining is one of the most important ways we can achieve the required future mineral supply and at the same time reduce the footprint of mining activities. With the generous support of the Bryan Foundation, BRC was able to appoint Andre van As, a very experienced and widely respected expert in the area of underground mass mining, to the position of Professor of Deep Mining Geoscience. Andre is in the process of building a research effort in this area which is of such vital importance to the future of mineral supply.

By the end of 2021 the BRC team had grown to 13 research staff and 19 postgraduate students. The Centre's research revenue had grown to over \$4 million (nearly ten times 2016 levels), and BRC staff were involved in over 30 projects spread across 14 companies and 13 state and federal geological surveys, as well as competitive funding sources such as the Australian Coal Industry's Research Program (ACARP) and ARC. Whilst industry reports and datasets are the main output of the group, a recent analysis of research outputs has shown that BRC has also performed very well in comparison to its applied geoscience peers in traditional academic measures. This is gratifying, but the main area where BRC measures its impact is, and will always remain, in the quality and usefulness of the research outcomes it produces for its external partners, and in the high quality and contribution of the graduates and staff it develops.

BRC in 2022

Looking at BRC in 2022, we see a world where projected future demand for all commodities is strong and will be particularly strong for the commodities required for the energy transition.

Against this backdrop, discovery rates are continuing to decline, smarter mining is going to require a step change in geoscience knowledge and data, resource extraction is moving increasingly to deep underground mines, and geoscience innovation will be required to realise the opportunity of extracting value from mine waste.

BRC is aiming to become the world's leading centre in applied geoscience for the mining value chain. BRC occupies the space of translating the

increasingly voluminous and complex set of geoscientific datasets associated with exploration, mining, processing and waste into practical knowledge and insight that can improve the performance and sustainability of the mining industry. The ambition of BRC is to become acknowledged as a world class centre focusing on practical innovation to improve deep discovery; deposit knowledge in the mining value chain; deep mining geoscience; and mine waste transformation through characterisation.



Above: A social catch up for some of the current BRC team



Above: Andre Van As (left) with colleagues at Oyu Tolgoi Underground Mine

BRC has undergone spectacular growth over the past four years, from less than a handful of staff and students in 2017 to 17 staff and 24 HDR students in 2022. Research income has increased nearly 10-fold and 2022 is proving to be another good year for BRC, and the Total Deposit Knowledge Group is continuing to succeed under the leadership of Associate Professor Paul Gow; The Mine Waste Transformation through Characterisation Group will continue to grow and have strong impact led by Associate Professor Anita Parbhakar-Fox, and there is every indication that the new Deep Mining Geoscience Group will grow substantially over the next 2-3 years through the vision and persistence of Professor Andre van As.

A new chapter will open for BRC in late 2022 with the appointment of Mark Noppé as the new Director. Mark is a widely respected industry leader who brings broad geoscientific experience and a strongly successful track record to the role.

Relative to other university geoscience groups, the strategy of BRC is focused strongly on scientific problems that are linked more clearly to the desired industry outcomes, with industry impact being a relatively higher priority in comparison to fundamental economic geology research, which is well-addressed by other groups. BRC also intends to further develop its existing skills in mineral economics through research linkages with the UQ Faculty of Business, Economics and Law. One of the key aspects of BRC in comparison to many of these groups is that fact that it is part of the grouping of SMI Centres, with its associated coverage of most of the mining value chain.

BRC has deep collaborative links with JKMRRC, as well as collaborating on research projects with all other SMI centres and programs. It is anticipated that this level of collaboration will grow as SMI continues to target research challenges that can only be solved by the combination of capabilities from all of SMI's specialist areas.

A new chapter will open for BRC in late 2022 with the appointment of Mark Noppé as the new Director. Mark is a widely respected industry leader who brings broad geoscientific experience and a strongly successful track record to the role.

The strongest current collaborative links BRC has with the rest of UQ are with the School of Earth and Environmental Science and the School of Chemical Engineering. BRC also collaborates with the UQ Business School, and this is anticipated to grow in future. Through the Complex Orebodies program, BRC also has collaborations with the Centre for Natural Gas, the School of Chemistry and Molecular Bioscience, and the Australian Centre for Water and Environmental Biotechnology.

BRC has strong existing collaborations with James Cook University (JCU), the University of Tasmania, the University of British Columbia, the Western Australian School of Mines, Monash University, the University of Adelaide, the University of Exeter, and several other institutions. These collaborations are expected to continue to grow over the next 5-10 years. In particular, it is expected that a close relationship will develop further with Curtin University and JCU through the recently awarded Critical Minerals Trailblazer initiative.

BRC's desired impacts are focused on measurable outcomes for its funding partners. For government partners, our impacts have and will come through the provision of data and insight allowing them to provide better support to exploration and mining in their jurisdictions. In the case of mining companies, our achieved and targeted impacts are in the area of providing data, insights, approaches and technologies allowing companies to improve performance and sustainability outcomes in exploration, mining, processing and waste disposal and repurposing.

As the world continues on the path toward decarbonisation over the next 30 years, the role of geoscience across the mining value chain is more important than ever before. BRC is focused on research and development that optimises the role of mining in that sustainability goal and transition, and is working hard to make a real difference through real-world innovation, support of its stakeholders, and training of future geoscience leaders.



Above: Mark Noppé is the BRC's new Director

The postgraduate students

List of graduates

Peter Gleeson, 1993, M.App.Sc.Min.Geol., "Resource estimation and 3 dimensional modelling of gold mineralisation at the Mt Leyshon mine, NE Queensland"

Shu Zhan, 1994, M.App.Sc.Min.Geol., "The application of geostatistics in resource estimation and ore body modelling at Mt Isa mine, Queensland"

Sara Jane Porter, 1994, M.App.Sc.Min.Geol., "Three dimensional modelling of the central extended gold deposit: and analysis of the structural controls of mineralisation"

Hsin Wei Wu, 1995, PhD, "Mine ventilation recirculation and cooling strategies in deep Australian mines"

Jessie Kennedy, 1997, PhD, "A performance model for mineral exploration companies"

Joao Felipe Costa, 1997, PhD, "Developments in recoverable reserves estimation and ore body modelling"

Andrew J Richmond, 1999, MSc, "Multi-scale texture modelling for mining applications"

Ivor Jones, 2000, MSc, "Resource estimation using geostatistics at the Mount Morgan gold-copper deposit, Queensland"

Margaretha Scott, 2000, PhD, "Valuing Australian state geological surveys: quantitative analysis for strategic planning"

Matthew Howell Kay, 2001, MSc, "Geostatistical integration of conventional and downhole geophysical data in metalliferous mine environment"

Peter Rolley, 2001, MSc, "Geologic uncertainty in the development of an open pit mine: a risk analysis study"

Christopher Terence Farrelly, 2002, MSc, "Risk quantification in ore reserve estimation and open pit mine planning"

Sumaira Qureshi, 2002, MPhil, "Comparative study of simulation algorithms in mapping spaces of uncertainty"

Alexandre Boucher, 2003, MPhil, "Conditional joint simulation of random fields on block support"

Marcelo Godoy, 2003, PhD, "The effective management of geological risk in long term production scheduling of open pit mines"

Luis Martinez, 2003, MPhil, "Can quantification of geological risk improve open pit mine design?"

Nicole Janine Grieco, 2004, MPhil, "Risk analysis of optimal stope design: incorporating grade uncertainty"

Jorg Benndorf, 2005, MPhil, "Efficient sequential simulation methods with implications to long term production scheduling"

Ronald George Eggins, 2006, MPhil, "Modelling thickness in a stratiform deposit using joint simulation techniques"

Volker Osterholt, 2006, MPhil, "Simulation of ore deposit geology and an application at the Yandicoogina iron ore deposit, WA"

Justin Scott, 2006, MPhil, "Fractal and multifractal fault simulation: application using soft data and analogues at Wyong"

William Lawrence, 2006, PhD, "A method for the design of longwall gateroad roof support"

Ian Brunton, 2009, PhD, "The impact of balsting on sub level caving material flow behaviour and recovery"

Marc Ruest, 2009, PhD, "Numerical methods for simulating the flow of detonation products within an explicit fracture coalescence of cracks during blasting"

Alan Tordoir, 2010, PhD, "A study of blast induced rock mass displacement through physical measurements and rigid body dynamics simulations"

Matthew Pierce, 2010, PhD, "A model for gravity flow of fragmented rock in block caving mines"

Jason Scally, 2013, MPhil, "Non Gaussian type Gram-Charter asymptotic expansions: the modelling of commodity related series"

Adebayo Aderounmu, 2014, PhD, "Copula based dependence modelling of price spikes and contagion like effects in Australian electricity markets"

Zhengling Xiong, 2014, MPhil, "Relationship between temperature derivatives and electricity futures"

Hector Parra Galvez, 2014, PhD, "Blast induced fragment conditioning and its effect on impact breakage and leaching performance"

William Hancock, 2014, PhD, "Gravity flow of rock in caving mines: Numerical modelling of isolated, interactive and non ideal draw"

Michael Scott, 2014, PhD, "Evaluation of energy efficiency emission pricing and pre concentration for the optimised development of a Au-Cu deposit"

Wayne Rogers, 2014, MPhil, "Understanding blast movement to optimise grade control practices at Ahafo Gold Mine in Ghana"

Alex Catalan, 2015, PhD, "Implementation and assessment of intensive preconditioning for cave mining applications"

Imad Haidar, 2015, PhD, "Multi step forecasts of complex dynamical systems using soft computing tools with application to crude oil returns"

Pablo Enrique Gandara Moreno, 2016, MPhil, "Cave establishment under high stress conditions using a conventional panel caving at Esmeralda South Mine"

Callum McDonald, 2017, PhD, "Efficient exploration of large state space: Applications in graph compression"

Kwasi Ampofo, 2017, PhD, "Reasons why real options analysis (ROA) is not widely developed in the mineral industry"

Diego Silva, 2017, MPhil, "An integrated methodology for the design and assessment of cave mining ore handling systems"

Matthias Klawitter, 2018, PhD, "Natural caving systems as potential analogues to mining induced caving"

Zhenyu Han, 2019, PhD, "Discrete Element Method Investigations on the Mechanical Failure of Jointed Rock Masses"

Alexander Campbell, 2019, PhD, "Full-scale experiments and numerical modelling to improve ore recovery in sublevel cave mines."

Edward Holloway, 2021, PhD, "Risk and strategy in mineral asset optimisation and valuation"

List of current students

Cecilia Artica (MPhil), Oyu Tolgoi geometallurgy study

Aaron Ash (MPhil), Optimisation of open pit haulage design

Bryant Barnett (MPhil), Incorporation of Geological Risk into Mining Resource Models

Nurassyl Battalgazy (PhD), Geostatistical Modelling in Complex Orebodies

David Boakye (PhD), Geometallurgical prediction of filtration performance for dry stacking of tailings

Noele Ferreira Carvalho (PhD), Hidden values: maximising hard rock seismic interpretation from exploration to mine design

Robindra Chatterjee (PhD), Use of machine learning for automated interpretation of 3D seismic data

Geoffrey Dunstan (PhD), An evaluation process for responsibly establishing caving mines in a constrained capital environment

Matthew Fargher (PhD), Full, scale and numerical model assessment on material flow in caving

Daniel Hastings (MPhil), Use of Utility Theory in assessing Environmental, Social and Government responses to Mining development options in strategic planning

Kristen Isbel (PhD), Determining the geochemical and mineralogical properties of spent heap leach materials: Opportunities for economic rehabilitation

Corey Jago (PhD), Ore Deposit Characterisation in the Read-Rosebery District: Implications for Metallogenesis, Exploration and Geometallurgy

Jenna McGovern (PhD), Application of new technologies to rapidly evaluate critical metals in drill core and waste materials

Olivia Mejias Gonzalez (PhD), Geometallurgical studies aimed at managing mining waste

Loren Nicholls (PhD), Integrated characterisation, reprocessing and recycling of mine waste materials for improved socio-economic and geoenvironmental outcomes in Australian mine sites

Pablo Paredes Morales (PhD), Step Change to achieve safer, rapid and low-cost establishment in cave mining under extreme geotechnical environment

Ali Parchegani (PhD), The Footprint of the giant Mount Isa Cu-Pb-Zn-Ag system

Ron Reid (PhD), Regional Geological context of the giant Wafi-Golpu Cu-Au deposit, PNG

Rigoberto Rimmelin Gonzalez (PhD), Rock mass preconditioning methodology for block caving based on Petroleum state of the art methods

Enrique Saez Salgado (PhD), Evaluation of the environmental reactivity of porphyry copper ore and gangue before and after mining and processing

Peng Sha (PhD), REE systematics of the Wurrumbungle Volcano complex

David Tennant (MPhil), Structural geology and best-practice modelling guidelines suitable for geotechnical engineering in block-cave environments

Rocio Vargas Soto (PhD), Geometallurgical characterisation of complex orebodies

Torben Wuestemann (PhD), Understanding mesoscopic geological variability and its implications for mineral processing



Current staff



Mark Noppé
Director

Professor Mark Noppé is an internationally-recognised leader in mining and geoscience, with extensive mining industry geoscience consulting and consultancy management experience, as well as publications and presentations in areas relevant to the activities of BRC. Mark has worked in South Africa, Western Australia and Queensland, and consulted on a variety of projects and commodities in a range of geological, mining, and geographical settings. Mark Noppé has most recently been the group chair of SRK Consulting, where he led a large and technically proficient team focused on a range of Mining and exploration Geoscience products and insights for industry clients. He is an AusIMM director (2021-2023) and has held positions as Chair of the Southern Queensland Branch of the AusIMM, the AusIMM Consultants Society, the AusIMM Awards Technical Excellence Committee, the Geostatistical Association of Australasia and Secretary of the Geostatistical Association of South Africa.



Andre van As
Deep Mining
Geoscience

Professor Andre van As has worked on geoscience issues relating to mass underground mining (caving) operations and projects for the past 30 years. The aim of DMG is to bring together the mass underground mining capabilities that currently exist within the Centre and beyond, in addition to developing a professional training program to pass on the complex and unique skillsets required in mass underground mining, to current and future geologists. As the global demand for minerals continues to increase, many mining companies are going deeper underground to explore for mineral deposits. Conditions deep underground present new challenges and Andre will focus on developing solutions for companies operating in this environment. Andre sits on several cave mining geotechnical review boards and was a recipient of a CSIRO medal in 2001.



Anita Parbhakar-Fox
Mine Waste
Transformation
Through
Characterisation

Associate Professor Parbhakar-Fox began her career at ENVIRON Ltd as a contaminated land engineer before undertaking a research career at CODES, University of Tasmania. During this time, Anita was a PhD candidate and postdoctoral research fellow in environmental geochemistry and geometalurgy working with the industry-sponsored AMIRA P843/A GEM, CRC ORE (Environmental Indicators) and the ARC Transforming the Mining Value Chain initiatives. Anita is currently leading a team of BRC researchers with a focus on waste characterisation and secondary prospectivity of mine waste with a focus on critical mineral exploration. Major research projects have been funded by several State Governments and Geoscience Australia, Rio Tinto, Anglo American, Nexa Resources, Teck, SolGold and Newcrest and Grange Resources.



Nick Cook
Total Deposit
Knowledge

Dr Nick Cook is an experienced multi-disciplinary geologist, team leader and business person with expertise in mineral exploration and collaborative project operations. His career includes periods of University research and teaching, mineral exploration and as a finance professional.

Formerly the Chief Geologist and Technical Advisor for Mawson Gold and Southern Cross Gold that global role included responsibility for international collaborative industry-government-university research projects and as industry supervisor for PhD, Masters and Honours projects (Finland, UK and Australia). In addition, on-the-job training for internal geological and technical staff.



Steven Micklethwaite
Complex Orebodies

Associate Professor Steven Micklethwaite is a well-rounded geoscientist who served as Discovery Manager for a Tier 1 company. He has mapped across four continents in a career spanning exploration, consultancy and research. He has expertise in developing and applying innovations across the mining sector, as well as government advocacy (State and Federal level), conducting district-scale geophysics and drilling programs in deeply covered environments and constructing a risk-based safety and health management system from first principles. He founded and directed a drone-based remote sensing facility with an industry focus, which was nestled within the university sector. He is also research engaged with the developing field of Insitu Recovery.



Sasha Aivazpourporgou

Dr Sasha Aivazpourporgou is currently working on contributing to the development of new insights into geophysical techniques and machine learning and their applications in emerging research areas at the WH Bryan Mining Geology Research Centre. Previously, she was an exploration geophysicist in Newexco consulting company with a focus on gold and base metals exploration. In her previous role, she was in charge of many aspects of geophysical projects from survey design to data processing and modelling mainly focusing on electromagnetic methods. She has been successfully involved in several exploration projects in Western Australia with positive drilling outcomes



Cathy Evans

Dr Cathy Evans is an experienced mineral processing engineer and geometallurgist who has been applying her extensive knowledge of geometallurgy, applied mineralogy, comminution and separation processes in geometallurgical projects and the optimisation of mineral processing operations for over 30 years.

Through her career in industry, consulting and applied research Cathy has worked on a broad range of ore types and commodities including lead, zinc, copper, nickel, gold, silver, platinum minerals and iron ore. Her expert knowledge of how the mineralogy and texture of ores impact their processing behaviours spans the mining process chain from comminution, through separation to tailings disposal and smelting.



Paul Gow

Associate Professor Paul Gow has extensive mining industry experience within research, consultancy, and mining companies (junior to major), spanning both greenfield and brownfield exploration, resource definition, and project studies to Feasibility level. He has held roles in copper-dominated mineral exploration and development to General Manager level with MIM, Xstrata Copper and Glencore, for projects in Australia, Brazil and Papua New Guinea. His stewardship saw resource discovery and/or completion of project studies from Scoping to Feasibility level on IOCG and porphyry copper mineral deposits. Most recently he established a private copper exploration and development company in Chile's Coastal IOCG Belt.



Thomas Jones

Thomas Ray Jones completed his BA/BSc (Hons) in Archaeology and Geology at The University of Queensland in 2017—before undertaking a PhD with the Vale-UQ Geomicrobiology laboratory. During his PhD, Thomas looked at the potential for diamond mines to sequester atmospheric CO₂ via microbially induced mineral carbonation in an effort to off-set mine emissions. Using historically mine kimberlites throughout South Africa as carbonation analogues, Thomas initiated lab-pilot scale studies in Australia and South Africa, revealing the significant role microbially induced carbonate may play in future mining/ remediation practices. Thomas has worked previously on targeted bio-extraction (a more focused method of bioleaching), primarily looking at a movement of REEs (apatite hosted) and PGEs (Merensky Reef).



Katerina Savinova

Miss Katerina Savinova began her career at Cameco Corporation, one of the largest uranium companies, as an exploration geologist working in central and northern Canada before relocating to apply her expertise to greenfield and brownfield sites in Australia. Katerina from 2014–2020 worked in a team developing high-resolution hyperspectral imaging techniques at Corescan Pty Ltd, focusing on hyperspectral data acquisition, imaging, interpretation and presentation. Since September 2020, at SMI she provides technical assistance of hyperspectral data processing and interpretation on a variety of projects, ranging from mineral alteration characterization to geometallurgical and textural definition studies to mine waste characterisation and acid-rock drainage mitigation.



Laura Jackson

Dr Laura Jackson obtained her PhD at the Centre for Ore Deposit and Earth Sciences (CODES), University of Tasmania (2020). Her research as part of the Transforming the Mining Value Chain (TMVC), developing new tests and protocols for improving waste characterisation with a focus on integrating waste characterisation across the entire mining value chain to enable the use of new techniques and technologies for early life-of-mine geoenvironmental forecasting. Professionally, she has worked at an environmental consultancy as a senior geochemist on a range of industry and government projects from prefeasibility through to closure and rehabilitation (2018–20). Currently, Dr Jackson is a Postdoctoral Research Fellow in Geometallurgy and Applied Geochemistry at the WH Bryan Mining Geology Research Centre within the Sustainable Minerals Institute.



Annah Moyo

Annah Moyo is a research assistant / technician at the BRC, involved in projects focused on geochemical characterisation and metal recovery from mine wastes.

Annah is an environmental chemical engineer specialising in the characterisation, remediation, and resource recovery of waste streams from mining and processing industries. Her research focus is on designing and optimising innovative waste management techniques to promote environmental sustainability, a zero-waste circular economy, and value recovery. She has developed new tests and protocols for characterising the potential environmental risks of South African coal processing wastes. She has also developed a cost-effective and environmentally sustainable strategy for the remediation of legacy mine wastes in Tasmania. These projects were in collaboration with the Water Research Commission of South Africa and the Mineral Resources of Tasmania.



Partha Mishra

Dr Partha Narayan Mishra obtained his PhD in Geotechnical Engineering from the University of Queensland, Australia in 2020 with the Dean's Award for Outstanding HDR theses. Partha is a Geotechnical Engineer and researcher with interests in the arenas of improvement of soft soils, behaviour of unsaturated soils, electromagnetic characterisation and monitoring of soil processes, biomediated geotechnical engineering and clay barrier systems in hazardous waste disposal facilities. As a practicing engineer, Partha has worked on several projects pertaining to tailings storage facilities (TSF's) in Australia and overseas. His industry experience comprises of working as a consulting geotechnical engineer with Klobn Crippen Berger (KCB Australia) (2020–2021) and as an owner's engineer with Rio Tinto Aluminium (2021–2022).



Kamini Bhowany

Dr Kam Bhowany completed her BSc in Mineral Geoscience, with 1st class Honours in Geology, in Adelaide before obtaining a PhD in Metamorphic Geology in 2020. Kam was part of the Continental Evolution Research Group (CERG), with a focus on deep-crustal fluid-driven processes. She applied a multidisciplinary approach (including structural geology, isotopic geochemistry, and geochemical modelling) to unravel fluid/rock interaction at depth. During her career, Kam also spent some time in the industry as a core logging geologist in an underground gold mine in the Northern Territory (2019) and a graduate geologist in an open pit iron-ore mine in South Australia (2021). Currently, Kam is working on a three-year project looking at the secondary prospectivity of critical minerals in mine waste across Australia.



Kristy Guerin

Dr Kristy Guerin obtained a BSc with 1st Class Honours in Geology, at The University of Queensland (2016) and was conferred a PhD from the Queensland University of Technology. Kristy's research focus was investigating the impact of wildfire on regolith mineralogy and trace element cycles. She applied a number of geochemical and mineralogical techniques to help identify palaeowildfire signatures in the geological record. Professionally, Kristy worked as an Exploration Geologist at the Jervois Base Metal Project in the Northern Territory (2017). Currently, Kristy is a Postdoctoral Research Fellow is involved in a project on secondary prospectivity of critical metals in mine waste with a focus on sites in NSW.



Nathan Fox

Dr Nathan Fox is a graduate of the Royal School of Mines, Imperial College London (MSci, Hons) and the University of Tasmania (PhD) where he specialised in ore deposit studies. His PhD research was industry-based, carried out at the Cadia East porphyry Au-Cu deposit, NSW. Nathan held post-doctoral researcher roles in AMIRA projects related to exploration vectoring in porphyry-epithermal systems and CRC Ore, focusing on geometallurgical controls on grade by size fractionation. Nathan is highly proficient in geological field studies and laboratory based mineralogical, geochemical, geometallurgical characterisation methods.



Zhengdong Han

Dr Zhengdong Han obtained a BEng (Hons) in Environmental Engineering at Harbin Institute of Technology (China, 2007) before obtaining his PhD from The University of Queensland in 2022. Zhengdong was a registered environmental engineer in the Chinese state key environmental radiation monitoring laboratory and worked on the monitoring and assessment of the environment around abandoned uranium mines and nuclear power plants. Currently, Zhengdong is involved in several projects on mining waste reprocessing for critical elements and rehabilitation funded by the Queensland State Government.



Kathie Cato

Dr Kathleen Cato is the Business Manager for BRC and holds a PhD in Medical Science from The University of Queensland. Kathie brings to SMI a wide range of experience in research management including pre-award research grant preparation and post-award grant establishment and administration. Kathie enjoys supporting SMI researchers who are building successful research careers solving economic and environmental problems in the mining sector that contribute to a sustainable future.



Martin Stringer

Dr Stringer began his career in theoretical/computational astrophysics, holding research positions at institutes in the USA, UK, France, and Spain. Since 2016, he has been applying the quantitative and computational skillset from this background to research questions in ecology, conservation and global sustainability.



Melinda Winton

Melinda Winton provides all level of administrative support to the staff and postgraduate students of JKMRC and BRC, in addition to providing executive assistance to the BRC and JKMRC Centre Directors. With a strong administrative and varied background—in secondary schools and airlines in particular—Melinda enjoys the stimulation of being surrounded by dedicated and motivated staff and students alike, in a world-renowned academic and multi-cultural environment.

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