AMIRA INTERNATIONAL

Creating value through collaboration

ANNUAL REPORT 2016-2017

AMIRA International Limited
ABN: 60 176 687 975
ACN: 004 448 266

Our Vision
"Creating value through collaboration"

Our Mission
Our core purpose is to develop and manage collaborative projects that deliver new data, knowledge and technologies for the benefit of our members.

Our primary objectives are to deliver solutions that will assist members to improve profitability and return on investment in all stages of the minerals value chain i.e.:

- Improve the discovery rate of new resources, and convert these and existing sub-economic resources into valuable products in a sustainable way acceptable to society.
- Improve productivity and safety, and reduce the footprint of existing operations.
- Develop effective strategies that reduce closure liabilities for all stakeholders.
- Provide opportunities to train the next generation of industry leaders, operators and researchers.
- Enhance the standing of the mining industry amongst all stakeholders, locally and globally.

CONTENT

OVERVIEW

AMIRA International was incorporated in September 1959 as The Australian Mineral Industries Research Association Limited (A.M.I.R.A.). The founding fathers' unique vision to facilitate the development of collaborative research projects sponsored by members, is still an important driving purpose that continues today. To better reflect our global reach, AMIRA International Limited was adopted as the trading name in 1998. The business name was formerly changed to AMIRA International Limited in 2001.

A.M.I.R.A. was created as a private-sector, independent, not-for-profit industry association. The founding fathers decided that A.M.I.R.A. should be funded not through an industry levy, but on its ability to work with members and develop the research programmes designed to deliver the solutions for the group challenges. For its time, it represented a truly innovative business model in Australia, and indeed the world.

AMIRA International is now a global organisation promoting projects generated by the world's best researchers to our members worldwide and acknowledged as an international benchmark for collaborative research in the private sector. In recent years, AMIRA has embraced the principle of 'think global, act local ' to facilitate regional project development in countries where members operate.

A particularly important spin-off from AMIRA's activities is to assist in capacity building and nurturing research infrastructure in these countries.

Whilst holding true to the vision of our founding fathers, AMIRA has been adapting to changing circumstances. We have developed and administered close to 700 projects since inception, delivering many innovations in the form of widgets and software, new methodologies, standards and tools, improved understanding of physical processes, new exploration concepts, and geological data/databases. Approximately AU$580 million has been invested, in current dollar terms, by our members in these projects.

Although AMIRA International continues its important role of providing solutions to members' business challenges through collaboration, this does not preclude AMIRA International from being engaged by a member on a one-on-one basis to develop and manage research programmes on their behalf.

AMIRA is managed like any other public company, but as a not-for-profit member-based organisation we have a special relationship with our members. Our corporate goals therefore, revolve around delivering value to our various classes of members through:

- Delivering exceptional value to our members and partners by:
  - Employing best practice standards, systems and processes that increase productivity.
  - Applying processes for end-to-end ideation and project delivery that are optimised and streamlined to minimise costs, and add value to customers.
- Ensuring a sustainable global business with annual surplus so as to strengthen the balance sheet to ensure that we can deliver enhanced services and products to our members.
- Embracing a culture of operational excellence by:
  - Turning ideas into valuable outcomes that solve our members problems.
  - Facilitating the development of scientific/ engineering solutions that address member needs and have high impact.
  - Identifying new revenue generating services for members
- Developing a highly capable, diverse, passionate and flexible workforce, with supporting skills and a member-centric culture.

AMIRA INTERNATIONAL

IS THE GLOBALLY RECOGNISED PARTNER OF CHOICE FOR RESEARCH COLLABORATION.

CHAIR'S REPORT

DR STEPHEN GROCOTT
CHAIR

During the year metal prices enjoyed a recovery, at least towards the latter half. Although exploration expenditure showed some signs of recovery, expenditure on greenfields exploration continued to be depressed. Despite the cautious optimism, most Members were still focused on reducing costs and improving productivity. However, some were beginning to hire again, perhaps having realised that they may have cut too close to the bone. During the year there were persistent calls for greater collaboration in the industry, made all the more important given members' loss of their own technical capability.

During the downturn many Members have re-framed their technology plans to focus largely on the short-term. This has been through development of technologies requiring very little research and mostly development. This focus on the short-term has been at the expense of longer term research-intensive activities. It is not to say that the latter does not occur, it is just that many companies' time horizons have significantly shrunk because of the need to develop and deploy technologies that deliver a payback within three years. This means a focus on the higher Technology Readiness levels. This focus on the here and now has meant that the traditional longer term research projects are less in favour and there is pressure for projects to deliver implementable outcomes much earlier. AMIRA International has responded by designing projects with this in mind. In addition, the project portfolio included the development of new projects that focused on trialing or field testing pre-commercial technologies developed by various METS suppliers: P1171-Environmental Dust Removal, P1196 - Application of Coldblock Digestion for Gold and Base Metal Analysis, and P1185 - Superfine Crusher Technology are three examples that are designed to be short term focused projects for Members. These are expected to start in the new financial year.

Despite the difficult business conditions, support for research in fields, both old and new, may reflect the start of a resurgent interest in collaborative research. Particularly encouraging is the support shown by Members for the flagship programme P9Q - Optimisation of Mineral Processes by Modeling and Simulation which commenced in January 2017 with more than AU$3.1 million of support - boosted by significant Commonwealth contributions leveraged through CRC ORE II. This is no doubt the world's longest R&D programme focused on modeling and simulation of unit operations, having begun in 1962. However, the founding sponsors would no doubt both struggle to recognise P9Q and equally well be impressed to how it is delivering immediate value to sponsors.

The industry is somewhat fragmented along commodity and technology maturity lines. For example, the majors are leading the way in many areas of technology, including

are leading the way in many areas of technology, including automation. This has resulted in increasing collaboration between mining companies and the larger METS suppliers who are generally best placed to deliver on shorter time frames. As indicated above, AMIRA international is working with METS suppliers who have technologies of interest to our Members.

During the downturn, some Members substantially reduced their technical capability. This means that it is much more difficult to find champions in Member companies who have the time and capability to evaluate and promote AMIRA International projects in their organisation. However, despite the downside, this provides an opportunity for AMIRA International to offer its expertise in project development and management to Members on a one-on-one basis.
The changing nature of the industry brought about by both structural changes, as well as the changes that accompany cyclic downturns, has prompted AMIRA International to re-examine its business and marketing strategy. This has led to the development of strategies to address the key challenges.

THE KEY CHALLENGES	STRATEGIES
1. Ensure AMIRA has a clear identity and focus relevant to 21st century conditions.	•Adjust AMIRA's mission and vision •Enhance and communicate AMIRA's value proposition. Develop and implement a strategic marketing plan
2. Increase AMIRA's capacity to increase traditional collaborative project sponsorships, and to do so with careful attention to the current adverse operating condition within the minerals industry, including in the face of increasing direct and indirect competition.	•Introduce new service stream: includes addressing non-technology based challenges: sustainability, safety, human capital development, innovation, and to assist members with the development and/or management of outsourced one-on-one proprietary projects. •Training AMIRA's staff on relationship management and marketing Hire additional professional staff to replace staff lost during the "down" period
3. Enhance member engagement, including re-establishing a strong contact base with C-suite executives, and increase members' satisfaction.	•Appoint a Global Business Development Manager •Identify well known executives who would be willing to act as champions of AMIRA and assist in making connections with senior management, to explain AMIRA's offering and to promote the organisation. •Appoint specialist consultants on a contract basis to assist in developing and managing projects, including new services. A focus on Operational Excellence
4. Modernise AMIRA's governance structure.	Review AMIRA's Constitution which is now 11 years old

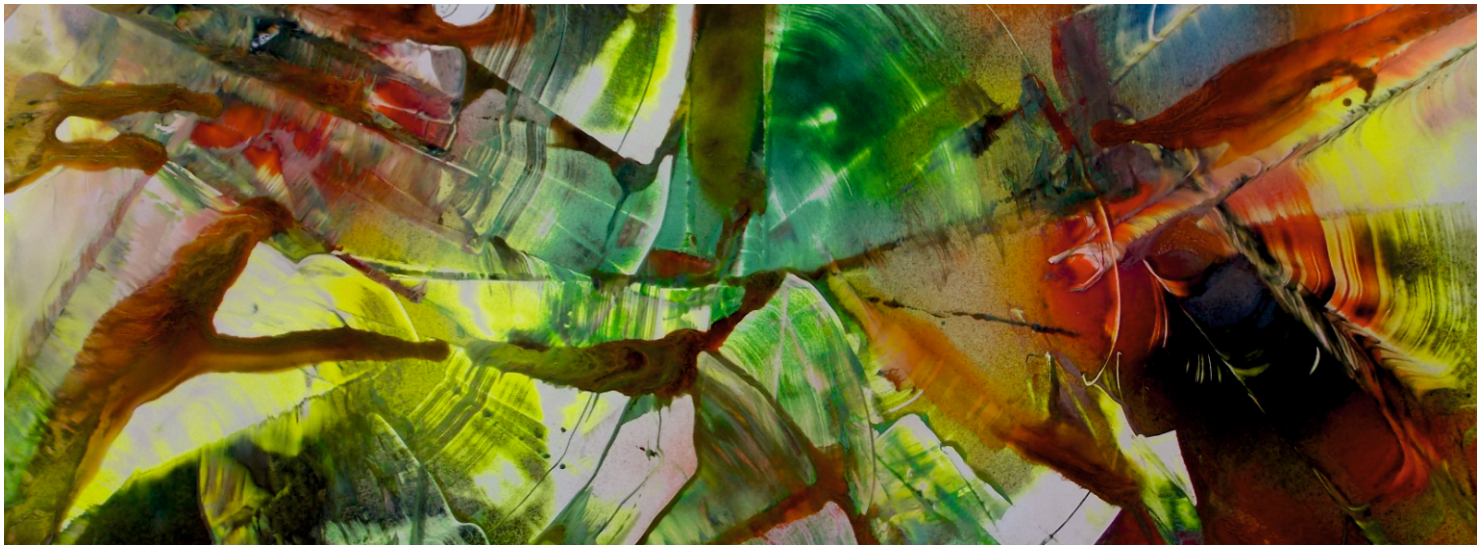
CHAIRMAN'S REPORT

Membership at the end of the financial year stood at 59. A total of 14 companies withdrew membership whilst five new membership applications were received.

Despite the industry downturn, the AMIRA International staff delivered just over AU$4.6 million of new projects. Nevertheless, the company posted a small deficit for the financial year. Management is focused on maintaining strong cost control whilst focusing on revenue generation.

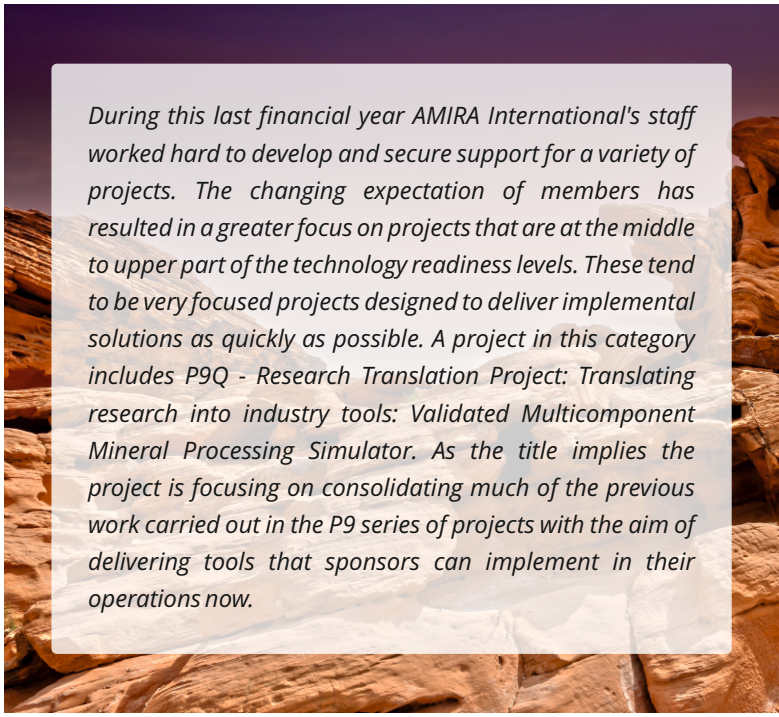
During the year five Directors stepped down from the Board of AMIRA International. The Board and staff would like to thank Dr John Russell, Mr Richard Butcher, Mr July Ndlovu and Mr Colin Moorhead for their service to the organization, and would particularly like to thank Dr Aubrey Paverd for his seven year service as a Director, the last two and half as Chair. It was my pleasure to be chosen by the Board to take over as Chair in December of 2016.

In conclusion I would like to compliment the Managing Director, Joe Cucuzza, and his staff on what has been a very challenging year. Emerging from the commodities downturn and placing AMIRA International in its current robust financial position and with its project portfolio is an impressive achievement. I also wish to thank my fellow Directors for their support. It is an honour to work with a Board with such depth and breadth of experience in the resources sector.



MANAGING DIRECTOR'S REPORT

MR. JOE CUCUZZA
MANAGING DIRECTOR



During this last financial year AMIRA International's staff worked hard to develop and secure support for a variety of projects. The changing expectation of members has resulted in a greater focus on projects that are at the middle to upper part of the technology readiness levels. These tend to be very focused projects designed to deliver implemental solutions as quickly as possible. A project in this category includes P9Q - Research Translation Project: Translating research into industry tools: Validated Multicomponent Mineral Processing Simulator. As the title implies the project is focusing on consolidating much of the previous work carried out in the P9 series of projects with the aim of delivering tools that sponsors can implement in their operations now.

Although there was some evidence of a turn-around in industry's fortunes, investment in collaborative research was still depressed. This is not to say that support from our members has not been forthcoming. Existing projects have secured additional support whilst new projects began during the year. In the former category is P420F - Enhancing Gold Mining Economics: Improving Processing and Extending Reserves, which saw increased industry support to a level of $3.66M over three years. It is worth mentioning an interesting feature of this project: it includes a series of one-on-one activities with several sponsors who wish to undertake proprietary work. Only sponsors can commission this work with the researchers and only through AMIRA International. In addition to P9Q mentioned above, P1171A: Environmental Dust Removal Step 2, also commenced during the year. This is an example of a project that is focused on testing and trialing new technology which is considered to be pre-commercial. It includes little research and mostly technology development and testing.

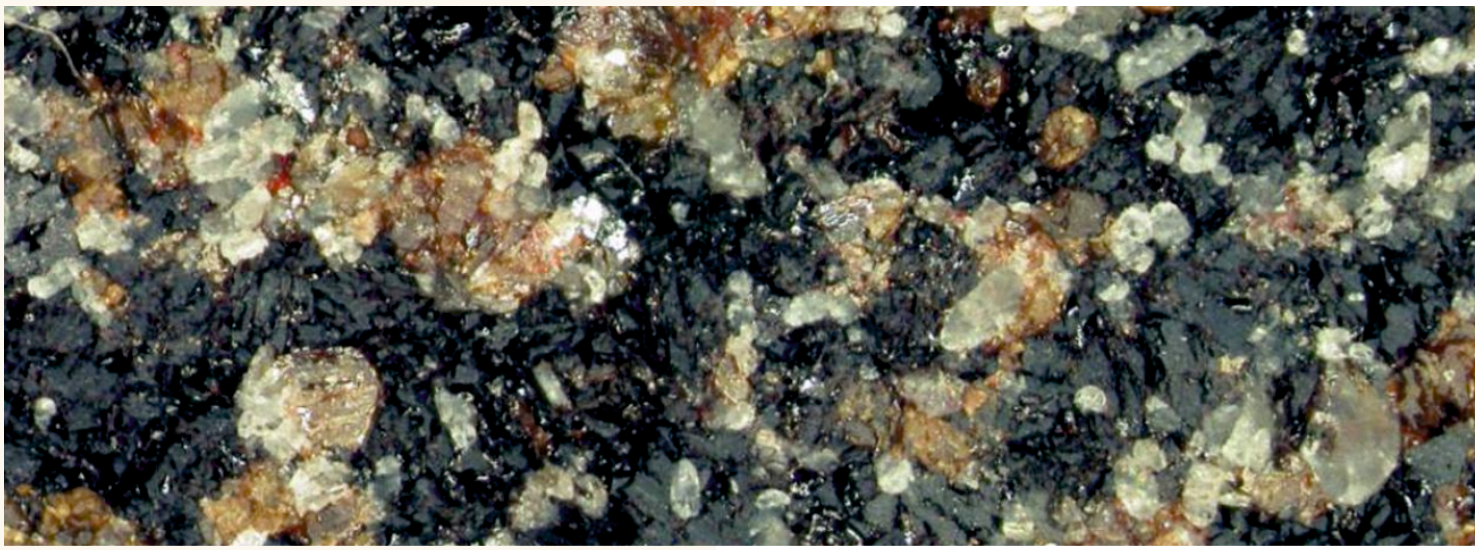
During the year another very successful Biennial Exploration Manager's Conference was held, the 11th in the series. The first Conference was held back in May 1997, and has built a reputation as a unique invitation-only forum where executives, researchers, and geoscientists meet to discuss issues of common interest. Delegates from all over the world met at the RACV Healesville Country Club in Victoria. The Conference led to the identification of several project ideas which AMIRA International will be exploring.

The changing circumstances have led to a shift in strategy that will create more agile response to opportunities. This involves a number of initiatives including building internal capacity that will position AMIRA International to take advantage of opportunities as industry begins to recover in earnest. It includes a more rapid assessment of opportunities to ensure that the focus, and effort, is on those that are most likely to attract support; backed up with fit-for-purpose tools to be able to monitor costs of project development and management. It also includes expanding our services into areas that hitherto AMIRA International has not pursued; these include offering members the opportunity to engage AMIRA International to manage one-on-one projects that they have outsourced but have reduced internal capacity to manage, for example.

MANAGING DIRECTOR'S REPORT

Despite a tight focus on cost control, the diminished number of projects supported meant that a deficit of $228.7K was posted for the year.

Management and staff bid farewell to Dr Aubrey Paverd, who served as Director and latterly as Chair. Also during the year we saw the departure of Dr Chris Ward, Program Director of the Mine to Metal Business Unit. A replacement is being sought. Ms Adele Seymon, Program Director of the Exploration to Mine and Sustainability Business Unit, was given the additional responsibility for Global Business Development.



BOARD OF DIRECTORS

DR STEPHEN GROCOTT

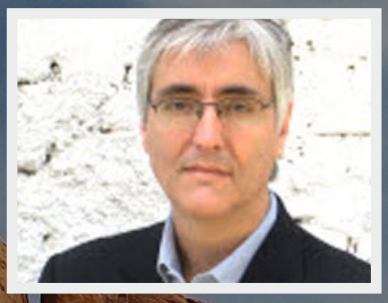
Chief Advisor

Process Development - Rio Tinto

DR WALTER VALERY

Global Director

Consulting and Technology,
Mining and Minerals Processing - Hatch



DR LUIZ MELLO

Executive Manager

Executive Manager of Technology
and Innovation - Vale

MR PETER KANCK

Senior Manager

Technology Development and
Integration - Boart Longyear Limited

DR CHRIS WIJNS

Group Geophysicist

First Quantum Minerals Limited

DR ANTHONY HARRIS

Chief Geoscientist

Newcrest Mining Limited

MR JOE CUCUZZA

Managing Director

AMIRA International Limited

OUR STAFF

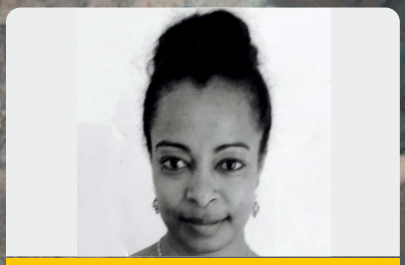
MR JOE CUCUZZA

Managing Director

ADELE SEYMON

Program Director - Exploration to Mine & Sustainability

AUSTRALIA (MELBOURNE)

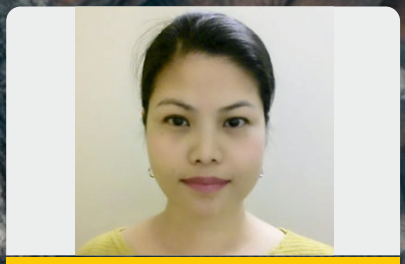


LYDIA HAILE

EA / Assistant Program Manager

IMRAN HUSSAIN

Manager ICT & Knowledge Systems



MARY ANN TIRONA

Project Support Officer

OLGA VEREZUB

Program Manager / SBD & Innovation Coordinator

YEN WOO

Assistant Accountant

AFRICA (JOHANNESBURG)

JEREMY MANN

Program Manager

ANN WOOLLEY

Project Support Officer & RSA Office Manager

PERTH

JOHN VISSER

Program Manager

NORTH AMERICA (DENVER)

TERRY BRADEN

Program Manager & North America Regional Manager

LATIN AMERICA (SANTIAGO)

ENRIQUE CARRETERO

Program Manager & Latin America Regional Manager

JACQUELINE RUSSELL

Project Support Officer & Chile Office Manager

MEMBER LISTING

Abitibi Geophysique inc.

Alcoa World Alumina Australia

Anglo Platinum Corporation

Anglo Gold Ashanti

Australian Gold Reagents P/L

Barrick Gold Corporation

BASF Australia Ltd

Beijing General Research Institute of Mining and Metallurgy (BGRIMM)

BHP Billiton

Boart Longyear Pty Ltd

Boliden Mineral AB

Cameco Corporation

Codelco

Compania de Minas Buenaventura

Cytec Australia Ltd

Evolution Mining Limited

First Quantum Minerals

FLSmidth Minerals Inc.

Freeport-McMoRan

Gekko Systems Pty Ltd

GFL Mining Services Limited

Glencore Technology

Hatch Associates Pty Ltd

IAMGold Corporation

Independence Group NL

INDUSTRIE DE NORA S.p.a

JX Nippon Mining & Metals Corporation

Kemix (Pty) Ltd

KPMG

Lhoist

Magotteaux Pty Ltd

Metso Minerals

MEMBER LISTING

Minerals and metals Group Ltd

Newcrest Mining Ltd

Newmont Australia Limited

Northern Star Resources

ORICA Australia Pty Ltd

Outotec

Oz Minerals

Perseus Mining Limited

Pionera

Qatar Mining

Quantum Pacific Exploration SpA

RandGold Resources Limited

Resolute Mining Ltd

Rio Tinto Ltd

Roy Hill Iron Ore

RSR Technologies Inc.

Russell Mineral Equip. Pty Ltd

South 32

Teck

Teranaga Gold Corporation

ThyssenKrupp Industrial Solutions (Africa) (Proprietary) Limited

Toro Gold Limited

Vale (CVRD)

VEGA Industries

Votorantim Metais Niquel S/A

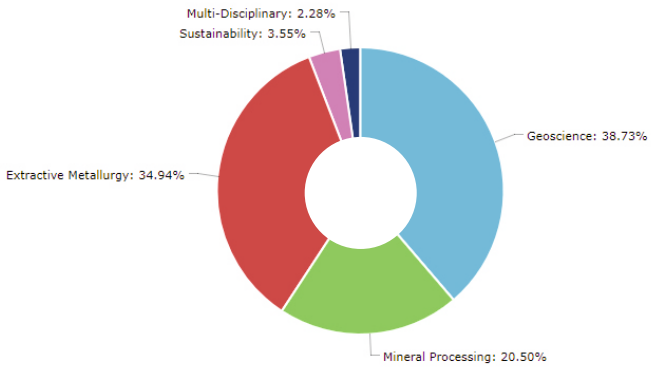
Weir Minerals

RESEARCHER LISTING

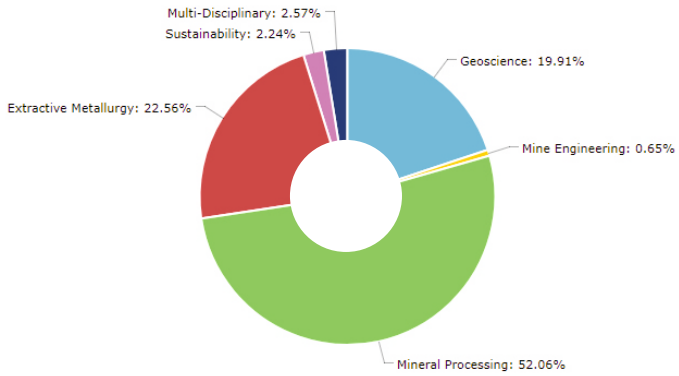
- CODES, Centre for Ore Deposit and Exploration Science, University of Tasmania
- ARC Centre of Excellence in Ore Deposits
- Aquamedia
- Centre for Exploration Targeting - University of Western Australia
- Chalmers University of Technology
- CNRS-INSU (Institut National des Sciences de l'univers)
- CRC ORE (Optimising Resource Extraction)
- Creattive Process Innovation Pty Ltd
- CSIRO Process Science and Engineering
- Curtin University of Technology
- Deep Exploration Technologies Cooperative Research Centre
- Federal University of Minas Gerais (UFMG)
- Future Industries Institute
- GET Geosciences Environnement Toulouse
- Guangzhou Institute of Geochemistry
- Hacettepe University (Benzer)
- Hefei University of Technology
- Imperial College of Science, Technology & Medicine
- IMPTEC
- Indago Partners
- International Groundradar Consulting Inc.
- Institut de Recherche pour le Développement (IRD)
- Institut National Polytechnique Félix Houphouët-Boigny
- Julius Kruttschnitt Mineral Research Centre (JKMRC)
- Lakehead University
- Levay & Co Environmental Services
- Missouri University of Science and Technology
- Monash University
- Murdoch University
- Natural History Museum
- NextGen Geological Pty Ltd
- ONG-D, Association "Le Soleil Dans la Main" (ASDM)
- OZMET
- Quantum Matrix SpA
- Queensland University of Technology
- RMIT University
- Scantech International Pty Ltd
- Teng Tuuma Geoservices (TTGEO)
- TUNRA Bulk Solids (University of Newcastle)
- TUT Tshwane University of Technology
- Universidade Federal do Rio de Janeiro
- Universite de Cheikh Anta Diop de Dakar (UCAD)
- Universite de Cocody-Abidjan
- Universite de Lorraine
- Université de Toulouse
- Université des sciences des techniques et des technologies de Bamako (USTTB)
- University of Cape Town
- University of Ghana
- University of Liberia
- University of Newcastle
- University of Ouagadougou
- University of South Australia
- University of the Witwatersrand
- University of Utah

Total Research Commitment	FY2017 / AU$000	FY2016 / AU$000
Geoscience	5,885	5,081
Mine Engineering	0	167
Mineral Processing	3,115	13,283
Extractive Metallurgy	5,309	5,756
Sustainability	540	572
Multi-Disciplinary	346	657
TOTAL	**15,195**	**25,516**

2017

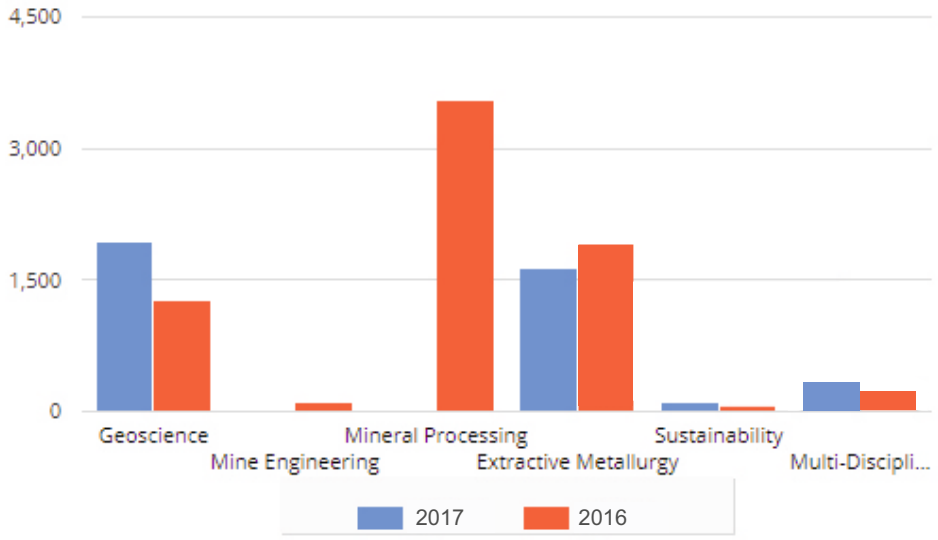


2016



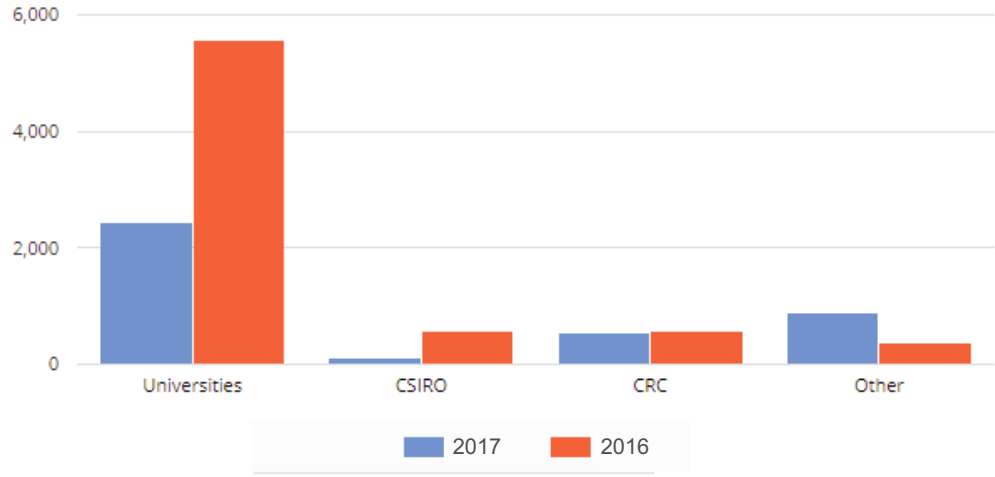
Annual Research Spending (by Market)	FY2017 / AU$000	FY2016 / AU$000
Geoscience	1,929	1,262
Mine Engineering	0	107
Mineral Processing	0	3,533
Extractive Metallurgy	1,629	1,909
Sustainability	107	70
Multi-Disciplinary	344	235
TOTAL	**4,009**	**7,116**

ANNUAL RESEARCH SPENDING (BY MARKET)



Annual Research Spending (by researcher type)	FY2017 / AU$000	FY2016 / AU$000
Universities	2,452	5,579
CSIRO	120	576
CRC	537	581
Other	900	380
TOTAL	**4,009**	**7,116**

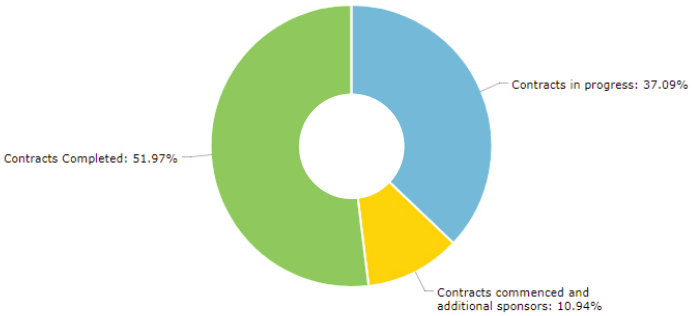
ANNUAL RESEARCH SPENDING (BY RESEARCHER TYPE)



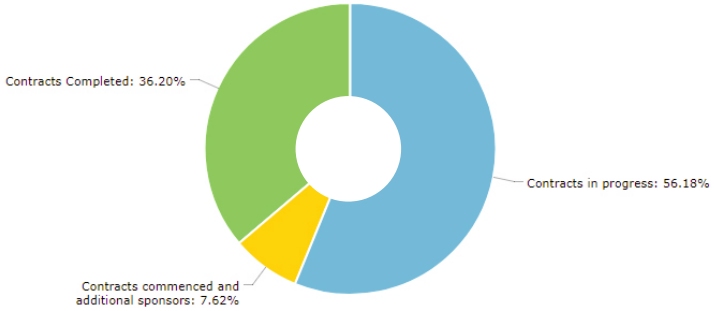
PROJECT STATISTICS

Project Numbers	No.	FY2017 / AU$000	No.	FY2016 / AU$000
Contracts in progress	8	11,734	13	25,516
Contracts commenced and additional sponsors	2	3,461	4	6,031
Contracts Completed	9	16,439	6	9,326

Project Numbers 2017



Project Numbers 2016



Membership	FY2017	FY2016
Members	58	70

AMIRA INTERNATIONAL

PROJECTS

PROJECT INDEX

GEOSCIENCE

P1004A DET CRC implementation
P1153 Applying the explorers' toolbox to discover Cu, Au and Mo deposits
P1162A Unlocking Australia's hidden mineral potential - Stage 2:- The Roadmap
P934B West African Exploration Initiative Stage 3

MINERAL PROCESSING

P009Q Mineral Processing

COMPLETED

P009P Mineral Processing

EXTRACTIVE METALLURGY

P260G Flotation
P420F Gold Processing
P420X Gold Processing Bolt-on Research Studies

COMPLETED

P1152 Bayer Precipitation and Alumina Quality
P420E Gold Processing
P705C Improving Base Metal Electrowinning

MULTI-DISCIPLINARY (COMPLETED)

P1150 Moisture Measurement/Control for Iron Ore Conveyor Systems

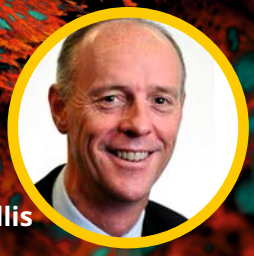
SUSTAINABILITY

P1171A Environmental Dust Removal
P933B Long Term Acid Rock & Tailings Drainage Mitigation thru Source Control

COMPLETED

P1171 Environmental Dust Removal

P1004A - DET CRC IMPLEMENTATION



Prof. Richard Hillis

VALUE
AUD 1,850,000.00

COMMENCEMENT MONTH
July

COMMENCEMENT YEAR
2010

STAGE
Management

DURATION (YEARS)
8

PROGRAM MANAGER
Joe Cucuzza

SPONSORS

ABM Resources NL, ARANZ Geo Limited, Australian Drilling Industry Association Limited, Australian Training Alliance, BASF Australia Ltd, Blackthorn Resources (BTR), Bureau Veritas Australia, Carpentaria Exploration Limited, Century Engineering Pty Ltd, Corporaal Enterprises, CSA Global Pty Ltd, Diarotech Downhole Surveys Pty Ltd, Drillco Tools, EPSLOG Engineering, Geological Survey of NSW, Geological Survey of Queensland, Geological Survey of Victoria Geoscience Australia, Hardcore Diamond Products Heathgate Resources Pty Ltd, HiSeis, Investigator Resources, JKTech Pty Ltd, Kingston Resources Limited, LKAB Wassara AB, Minotaur Exploration Ltd, Monax Mining Limited, Moog Australia Pty Ltd, Nautilus Minerals Inc, Northern Territory Geological Survey, Paladin Energy Ltd, Rex Minerals Limited, Sage Automation, Sandvik Mining and Construction Australia Pty Ltd, Teakle Composites, Training Prospects (Service to the Youth Council)

RESEARCH PROVIDERS

Deep Exploration Technologies Cooperative Research Centre, Professor Richard R Hillis (CEO of DET CRC), with programme leaders, Dr Soren Soe (University of Adelaide), Prof. David Giles (University of South Australia); and Brett Harris (CSIRO)

PROJECT SUMMARY:

AMIRA International is managing the Affiliate program of the DET CRC and is continuously working to recruit additional Affiliate members. There are three Affiliate colleges: METS Suppliers, Junior Explorers and Government Geological Surveys.

HIGHLIGHTS / DELIVERABLES / VALUE ADDITIONS:

Members of each college can access all the research outcomes and importantly can get actively involved in some of the research activities from technology development through to trialling and testing of the prototype technologies and potentially in commercialisation in the case of Suppliers. The DET CRC officially commenced operations in May 2010.

P1153 - APPLYING THE EXPLORERS' TOOLBOX TO DISCOVER CU, AU AND MO DEPOSITS

VALUE
AUD 2,070,000.00

COMMENCEMENT MONTH
July

COMMENCEMENT YEAR
2015

STAGE
Management

DURATION (YEARS)
3

PROGRAM MANAGER
Adele Seymon

SPONSORS

Barrick Gold Exploration Inc, BHP Billiton, Boliden, CIa. de Minas Buenaventura S.A.A., Codelco, First Quantum Minerals Ltd, Freeport-McMoRan Exploration Corporation, MMG Limited, Mount Isa Mines - A Glencore Company, Newcrest Mining Limited, Quantum Pacific Exploration (QPX), Rio Tinto Exploration Pty Limited

RESEARCH PROVIDERS

ARC Industrial Transformation Research Hub, Transforming the Mining Value Chain (TMVC); University of Tasmania, Professor David R Cooke, Guangzhou Institute of Geochemistry, Hefei University of Technology, Imperial College of Science, Technology & Medicine, Lakehead University, Natural History Museum

PROJECT SUMMARY:

P1153 will develop new methods and implement methods developed in previous projects (P765, P765A and P1060) to help its sponsors discover porphyry and/or epithermal deposits. Analysis of the geochemical signals recorded in hydrothermal alteration halos will provide explorers with both fertility (how large?) and vectoring information (how far, and in what direction?), allowing the presence, location and significance of porphyry and/or epithermal copper, gold and molybdenum deposits in an exploration tenement to be determined during the early stages of exploration.

HIGHLIGHTS / DELIVERABLES / VALUE ADDITIONS:

This project will further refine fertility and vectoring tools in porphyry and epithermal environments and in addition there is also a significant focus on being able to replicate learnings in the field by seeking out simple technologies that can provide qualitative analysis to use as proxies for the mineral chemistry vectors learnt from the application of more sophisticated technologies like LA-ICP-MS. Considerable success is being achieved and recognised by the adoption of blind site tests, where the research team has applied appropriate methodologies to a set of samples provided by a project sponsor, from an undeclared area (hence blind test) - to successfully vector to mineralisation and provide indicators of fertility.

P1162A - UNLOCKING AUSTRALIA'S HIDDEN MINERAL POTENTIAL - STAGE 2:- THE ROADMAP

Dr. Robert Rowe

VALUE
AUD 528,000.00

COMMENCEMENT MONTH
June

COMMENCEMENT YEAR
2016

STAGE
Management

DURATION (YEARS)
1

PROGRAM MANAGER
Adele Seymon

SPONSORS

AngloGold Ashanti Limited, ARC Centre of Excellence in Ore Deposits - University of Tasmania, Association of Mining & Exploration Companies (INC), Australian Institute of Geoscientists, Australian National University, BHP Billiton Innovation Pty Ltd, Boart Longyear Australia Pty Ltd, Centre for Exploration, Targeting - University of Western Australia, CGG Aviation (Australia) Pty Ltd, CSIRO Mineral Resources Flagship, Curtin University, Deep Exploration, Technologies Cooperative Research Centre, Evolution Mining, Geological Survey of NSW, Geological Survey of Queensland, Geological Survey of South Australia, Geological Survey of Victoria, Geological Survey of Western Australia, Geoscience Australia, Gold Road Resources Limited, HiSeis, Imdex Limited, Intrepid Geophysics, Investigator Resources, James Cook University, Macquarie University, Mineral Resources Tasmania, Minerals Council of Australia, Mira Geoscience, Monash University, Mount Isa Mines - A Glencore Company, Newcrest Mining Limited, Newmont Exploration Pty Ltd, Northern Territory Geological Survey, Perseverance Drilling, Underground Pty Ltd, PGN Geoscience, Rio Tinto Exploration Pty Limited, South32, Stavely Minerals, University of Adelaide, Western Areas Ltd

RESEARCH PROVIDERS

NextGen Geological Pty Ltd
Mr Robbie J Rowe

PROJECT SUMMARY:

The AMIRA Roadmap for Exploration Under Cover initiative offers Australia's mineral exploration industry, government geological survey organisations, and the research community, a strategic opportunity of being directly involved in the design of a longer-term integrated research and accelerated data compilation and acquisition programme through an unprecedented national scale collaborative effort. The overall aim is to improve the performance and success rate of mineral exploration in areas of Australia concealed under post mineralisation cover. Stage 1 of AMIRA International's Roadmap for Exploration Under Cover delivered a consensus view from key stakeholders on what needs to be done if undiscovered

mineral wealth in areas of cover is to be found in Australia. Priority areas were defined that will require a well designed and executed plan in order to deliver on the vision. Stage 1 commenced in late 2014, and was released in July 2015 (Unlocking Australia's hidden potential: An Industry Roadmap – Stage 1). Stage 2 of the Exploration Under Cover Roadmap will complete the work commenced in Stage 1. The principal aim of Stage 2 is to develop a comprehensive implementation plan.

HIGHLIGHTS / DELIVERABLES / VALUE ADDITIONS:

The guiding vision that was developed in Stage 1 and will continue to be our beacon is: Delivering Australia's major new mines by locating and unlocking future mineral wealth, positioning Australia as the global leader in exploration beneath post-mineral cover rocks.

P934B – WEST AFRICAN EXPLORATION INITIATIVE STAGE 3

VALUE
USD 2,997,600.00

COMMENCEMENT MONTH
September

COMMENCEMENT YEAR
2014

STAGE
Management

DURATION (YEARS)
4

PROGRAM MANAGER
Adele Seymon

SPONSORS

Acacia Mining plc, Bureau des Mines et de la Géologie du Burkina, Direction de la Geologie Ministere des, Mines et du Developpment Niger, Direction des Mines et de la Geologia Senegal, Direction Generale des, Mines et de la Geologie du Togo, Direction National de la Géologie République de Guineé, Direction Nationale de la Géologie et des Mines - Mali, First Quantum Minerals Ltd, Geological Survey Department - Ghana
IAMGOLD Corp., Ministry of Land, Mines and Energy - Liberia, National Minerals Agency of Sierra Leone
Newcrest Mining Limited, Newmont Ghana Gold Limited, OMRG l'Office Mauritanien de Recherches Geologiques, Perseus Mining Limited, Qatar Mining
Randgold Resources, Resolute Mining Limited, Rio Tinto Mining and Exploration Ltd, Teranga Gold Corporation, Toro Gold Limited

RESEARCH PROVIDERS

Centre for Exploration Targeting - University of Western Australia, Dr Mark Jessell, CNRS-INSU (Institut National des Sciences de l'univers), GET Geosciences, Environnement Toulouse, Institut de Recherche pour le Développement (IRD), Institut National Polytechnique Félix Houphouët-Boigny, Monash University ONG-D, Association "Le Soleil Dans la Main" (ASDM), Queensland University of Technology, Teng Tuuma Geoservices (TTGEO), TUT Tshwane University of Technology, Universite de Cheikh Anta Diop de Dakar (UCAD), Universite de Cocody-Abidjan, Université de Toulouse, Université des sciences des techniques et des technologies de Bamako (USTTB), University of Ghana, University of Liberia, University of Ouagadougou, University of the Witwatersrand, ADD: Universite de Lorraine

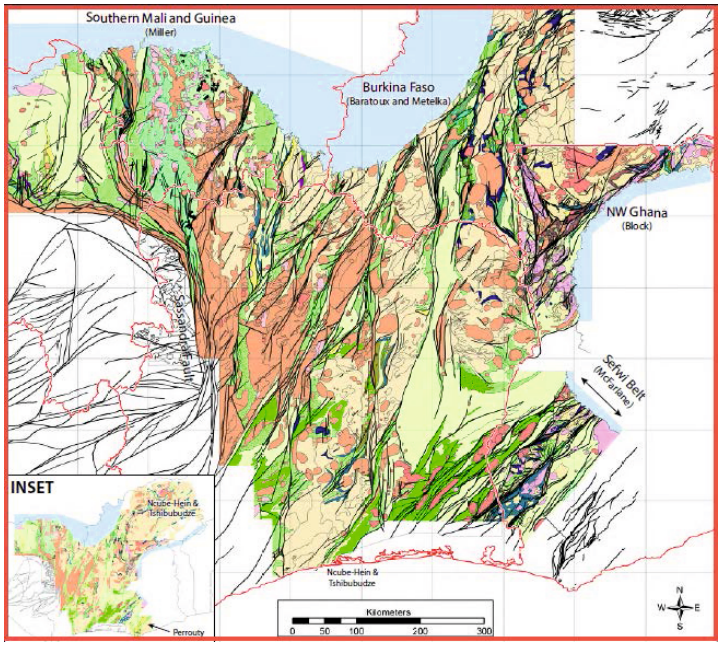
PROJECT SUMMARY:

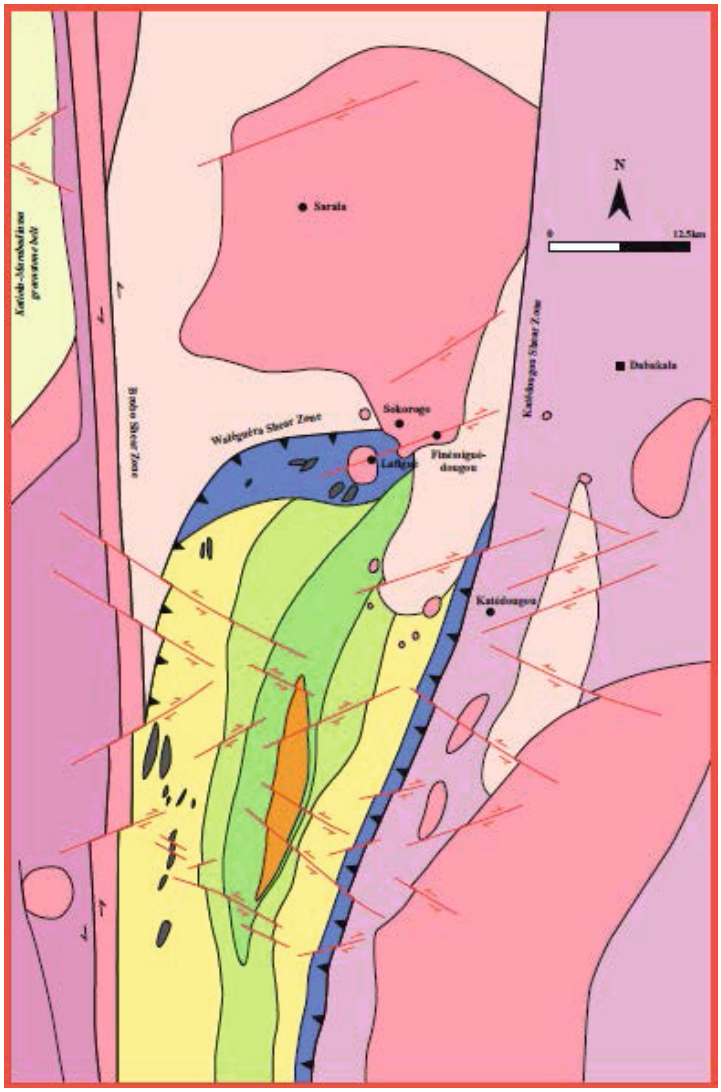
A four-year program planned for WAXI Stage 3 commenced in September 2014. After canvassing existing and potential new sponsors, a program for Stage 3 was designed that will further enhance the exploration potential of the Leo-Man Shield through an integrated program of research and data gathering into its “anatomy’. The initiative covers the whole of the Leo-Man Shield,

includes the following countries: Burkina Faso, Guinea, Ivory Coast, Liberia, Ghana, Mali, Senegal, Niger, Sierra Leone and Togo. Key motivations for undertaking this initiative are to assist exploration companies in focusing their activities in areas of maximum prospectivity and to help local Geological Surveys in the region in their role of providing pre-competitive data and information.

HIGHLIGHTS / DELIVERABLES / VALUE ADDITIONS:

Achievements from the WAXI program to date have included: • An improved knowledge of the tectonic history and metallogeny of the craton • 3D models of mineralised terranes and of the entire West African Craton • The assembly of a 250Gb craton-wide GIS product bringing combining over 350 distinct themes, 80 of which are unique to the WAXI project • New harmonised 1:500 000 integrated geophysical and geological maps of key zones • New models for regolith and landform evolution • 500 km Magnetotelluric Survey down to 300 km across southern Burkina Faso and Northern Ghana • Over 100 new geochronology ages • An Atlas of West African Ore Deposits • The founding of a collaborative international research and training network in the Stage 1 WAXI dedicated to better understanding the West African Craton • Delivering 17 training courses covering Geophysics, Geochemistry, Field and Mine Mapping, Exploration Targeting and Research Management.





P009Q - MINERAL PROCESSING

VALUE
AUD 3,114,670.00

COMMENCEMENT MONTH
January

COMMENCEMENT YEAR
2017

STAGE
Management

DURATION (YEARS)
3

PROGRAM MANAGER
Terry Braden

SPONSORS

Anglo American, AngloGold Ashanti Limited, Barrick Gold Corporation, Beijing General Research Institute of Mining and Metallurgy (BGRIMM), JKTech Pty Ltd Magotteaux SA, Metso Process Technology & Innovation, Newmont, South32, VALE Technology ITV Weir Minerals Australia Ltd

RESEARCH PROVIDERS

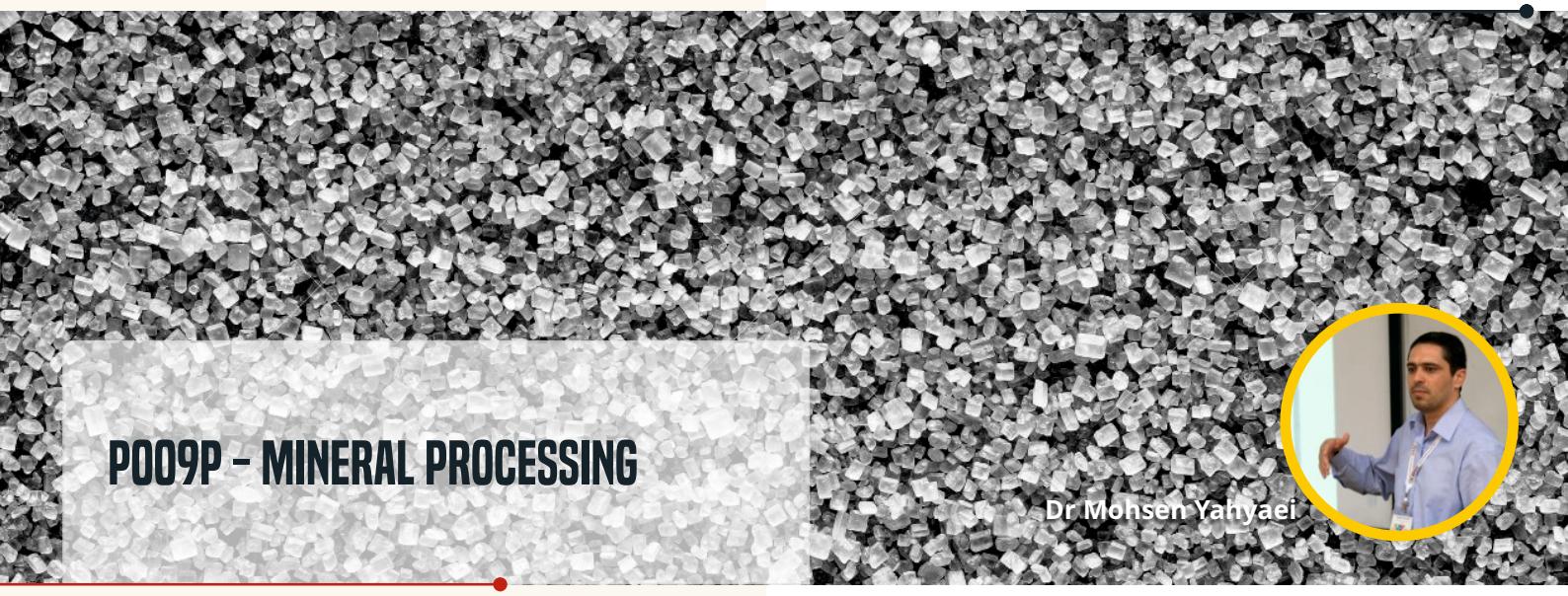
Chalmers University of Technology, CRC ORE (Optimising Resource Extraction), Hacettepe University (Benzer), Julius Kruttschnitt Mineral Research Centre (JKMRC), OZMET, Universidade Federal do Rio de Janeiro, University of Cape Town

PROJECT SUMMARY:

The AMIRA P9Q Project is a three year program designed by the P9Q Research Partners in close cooperation with the P9Q Working Committee to validate and verify 12 – 18 mineral processing equipment models, depending on level of funding, which originated from the P9P Project. P9Q researchers will validate the models to a defined operational window and verify the outputs.

HIGHLIGHTS / DELIVERABLES / VALUE ADDITIONS:

The researchers will provide demonstration circuit simulations of two operational flowsheets in a matrix using two to four different ore types in the Integrated Extraction Simulator (IES) platform for uptake by sponsors at sponsor review meetings. These can be used by appropriately trained sponsors for varying ore conditions and flowsheet configurations using historic data with some additional analysis to establish operational range and capability.



P009P - MINERAL PROCESSING

Dr Mohsen Yahyaei

VALUE
AUD 13,283,010.00

COMMENCEMENT MONTH
April

COMMENCEMENT YEAR
2012

STAGE
Complete

DURATION (YEARS)
4

PROGRAM MANAGER
Terry Braden

SPONSORS

Alcoa of Australia Limited, Anglo American Plc, AngloGold Ashanti Limited, Barrick Gold Corporation, BHP Billiton Base Metals, COREM, FLSmidth Minerals, LKAB,Lonmin PLC, Magotteaux Australia Pty Ltd, Metso Process Technology & Innovation, MMG Limited Mount Isa Mines, Newcrest Mining Limited, Newmont Mining Corporation, Outotec SEAP, Polysius AG, Rio Tinto Technological Resources Pty Ltd, Russell Mineral Equipment, Senmin International (Pty) Ltd, SGS, Bateman Sub Saharan Africa, Teck Resources Limited Vale Australia

RESEARCH PROVIDERS

Julius Kruttschnitt Mineral Research Centre (JKMRC)
Chalmers University of Technology
CRC ORE (Optimising Resource Extraction)
Hacettepe University (Benzer)
Universidade Federal do Rio de Janeiro
University of Cape Town

PROJECT SUMMARY:

P9P delivered a more comprehensive range of models, as compared to P9O, as well as the standards and techniques for particle characterisation (composition and spatial arrangement of minerals) required as model inputs. Ore characterisation at the front end of the process will increasingly replace the traditional time consuming and expensive measurement of ore properties such as hardness, density, size distribution and floatability, required for the current models of the unit operations.

HIGHLIGHTS / DELIVERABLES / VALUE ADDITIONS:

These developments will, for the first time, link all unit operations so that the effects of changes in one area can be simulated and compensated for in other parts of the circuit. This integration of unit operation models will allow true overall process improvements to be identified. The P9P project will be executed with a case study approach in two parallel paths: 1) Implementation of case studies at specific sponsor sites using the integrated simulation platform based on fit-for-purpose multi-component models. 2) Develop and upgrade ore characterisation methods and models through continued data acquisition and validation. P9P will carry out extensive scientific research into the fundamentals of processes and unit operation phenomenon to underpin the development of unit operation models. Validation will be achieved by in-plant surveys and analysis undertaken within P9P. Where possible and appropriate, P9P will also provide for the development of on-line instruments and measurement devices which will also facilitate the development and application of the models. These developments, fundamental understanding and site activities will of themselves greatly benefit sponsors by direct application, training and technology transfer.

P260G - FLOTATION

VALUE
AUD 1,650,000.00

COMMENCEMENT MONTH
September

COMMENCEMENT YEAR
2014

STAGE
Management

DURATION (YEARS)
4

PROGRAM MANAGER
John Visser

SPONSORS

"Glencore Technology, Magotteaux Australia Pty Ltd, Newcrest Mining Limited, Newmont Mining Corporation, Outotec SEAP, Votorantim Metais

RESEARCH PROVIDERS

Future Industries Institute
University of South Australia

RESEARCH PROVIDERS

The P260 project, located at the Ian Wark Research Institute (The WarkTM) at the University of South Australia, has been delivering successful research and technology transfer outcomes to industry in mineral flotation for over 25 years. A principal focus of the P260 series of projects has been to develop tools and methodologies to improve understanding of factors which control the separation efficiency of minerals containing base metals in the flotation process. Importantly for sponsoring companies, the P260 series of projects has addressed problems related to site and ore specific characteristics at over 30 different sites world-wide. Based on the feedback received from the industry, the P260G project offers a range of focus areas of investigation, including: • Deliver ore/site specific solutions to processing problems in parallel with research on process mechanisms • Selectivity in sulphide mineral flotation (pulp chemistry, reagents, saline and marginal waters, sulphide and non-sulphide gangue depression, oxidised ores). Cu/Mo, Cu/Au, Zn/Pb, Ni, PGM – Py, Po, NSG depression, As rejection and/or control • Regrind/Cleaning and flotation at fine sizes, with strategies for rejection of hydrophobic (e.g. activated Py, Po and NSG) and newly-liberated gangue • Early gangue rejection (flotation at coarser grind - classification, de-sliming, reagents) • Introduction, development and assessment of new unit technologies • Hybrid/mixed processing (flotation of leach residues, physical separation/flotation, differential milling/classification/flotation, aggregation/flotation) • Non-sulphide minerals flotation, e.g. phosphate, Li (spodumene), graphite, iron ore, REO's (including from tailings) and other oxides

• Further development of the fundamental Wark Flotation Model into a modelling and simulation tool for practical use. • Spectroscopy-microscopy (e.g. surface analysis-QEMSCAN) correlation and merging, and advanced, outcome-based statistical treatment of technique/unit operation/plant data • Continue to enhance the technology and information transfer outcomes from all previous phases of the P260 project to sponsors operations and personnel. • Develop useful characterisation tools (on-line and off-line), methods and protocols for use at sponsors operations and by sponsor personnel • Training of high-quality post-graduates who are research-minded, outcome-focussed and have understanding of industry drivers. Opportunities also exist for both Technical Challenge and Supplier Sponsors to purchase Case Study investigations during the program to have other targeted site or sponsor specific studies undertaken. The project commenced in September 2014 (4 years). For Fy2014-15 Annual Report

AMIRA P260G Flotation Project commenced in September 2014 and is the 7th extension project of the P260 series of projects, the pre-eminent global flotation research program. The principal focus of the P260 series of projects has been to develop tools and methodologies to improve understanding of factors which control the separation efficiency of minerals in the flotation process. Importantly for sponsoring companies, the P260 series of projects has addressed problems related to site and ore specific characteristics at over 30 different sites world-wide. The recently commenced P260G project is a 4 year program made up of a series of industry relevant

HIGHLIGHTS / DELIVERABLES / VALUE ADDITIONS:

The AMIRA P260 projects have delivered significant returns to its sponsors over the years and an independent assessment by RMDSTEM Ltd reported that the net value of AMIRA P260 to sponsors of the AMIRA P260 project has exceeded AUD1 billion by 2012 alone. This success, and continued industry support of P260, has been due to the projects' blend of strong, fundamentals and real world, mineral processing engineering. These have been applied to building understanding of flotation processes, mineral behaviour, and to addressing ore- and site specific sponsor process issues. Over the last 26 years, a series of AMIRA P260 mineral flotation projects conducted by the Ian Wark Research Institute (IWRI) at the University of South Australia have considerably advanced the understanding of flotation. Those projects have also provided sponsor companies with advice on improvements that have yielded improved concentrator performance challenged by variability in their feed ore characteristics. While P260G Flotation has been in progress for less than a year the research team has already improved the economics of a silver recovery process from the tailings at Tres Marias in Brazil and has gained early valuable insights for the case studies sponsored by specific companies in the consortium on the effects of grinding media debris and copper and gold flotation kinetics. The data gathered and insights gained are expected to lead to valuable sponsor outcomes as the project progresses for a further 3 years. Depending on the level of success of securing further leverage funds the project also has the objective of delivering further insights and data from case studies and collaborations focussed on: • Coarse and coarse composite flotation, including fluidised-bed technology (Hydrofloat), for maximising value recovery, early rejection of gangue and reduced collector consumption and coarse primary grind optimisation for minimisation of energy usage. • Methods to enhance selectivity against sulphide and non-sulphide gangue minerals, including depression of activated iron sulphides, and dispersion and depression of siliceous gangue minerals. • Methods to increase recovery of fine value mineral particles including optimising oxidation product removal, grinding chemistry, and dispersion of fine particles. • Methods of mitigating the negative impact of high salinity process waters on recovery and grade. The consortium is still open for further sponsors and it is likely that the sponsor group will increase and this will add to the 100 companies that have been involved in AMIRA P260 over the last 26 years and approximately 100 staff and research students that directly participated in this flagship AMIRA program.

P420F - GOLD PROCESSING

Prof. Jacques Eksteen

VALUE
AUD 3,658,500.00

COMMENCEMENT MONTH
June

COMMENCEMENT YEAR
2016

STAGE
Management

DURATION (YEARS)
3

PROGRAM MANAGER
John Visser

SPONSORS

"AngloGold Ashanti Limited, Australian Gold Reagents Pty Ltd, Barrick Gold Corporation, Evolution Mining, FLSmidth Minerals, Gekko Systems Pty Ltd, Gold Fields Australia Pty Ltd, Kemix (Pty) Ltd, Lhoist, Newcrest Mining, Limited, Newmont USA Limited, Northern Star Resources Ltd, Orica Australia Pty Ltd, Pionera Vega Industries Ltd

RESEARCH PROVIDERS

Curtin University of Technology, Professor Jacques Eksteen, CRC ORE (Optimising Resource Extraction)

PROJECT SUMMARY:

The AMIRA Gold Processing Technology project has delivered industry focused research outcomes for 28 years.

HIGHLIGHTS / DELIVERABLES / VALUE ADDITIONS:

The current project has five themes: • Theme 1: Enabling process optimisation on existing operations: This theme supports operations by facilitating technology transfer through the use of courses and workshops using software developed in the AMIRA P420 projects and implementing it for plant optimisation. • Theme 2: Optimising post-crush liberation for pre-concentration: This theme is focussed on reducing the processing costs associated with low grade ores, either through optimal pre-concentration (coarse particle gangue rejection), or through optimised heap leaching. • Theme 3: Optimising reagents and consumables in terms of type, utilisation and management: This theme explores the potential of new or optimised conventional reagents and consumables to lower overall processing costs or yield higher recoveries, whilst reducing the overall environmental and occupational health and safety risks. • Theme 4: Managing the water balance and the chemistry of tailings, raw and recycled water: This theme seeks to address one of the decreasing availability of water of suitable quality amidst ever increasing climatic and societal pressures. • Theme 5: Enhancing the processing of difficult ores (polymetallic, preg-robbing, high clay, high sulfide ores): This theme deals with difficult ores, be they polymetallic, refractory and/or preg-robbing. The research organisation for this project is Curtin University, Australia

P420X - GOLD PROCESSING BOLT-ON RESEARCH STUDIES

John Visser

VALUE
AUD 54,833.00

COMMENCEMENT MONTH

COMMENCEMENT YEAR

STAGE
Management

DURATION (YEARS)
3

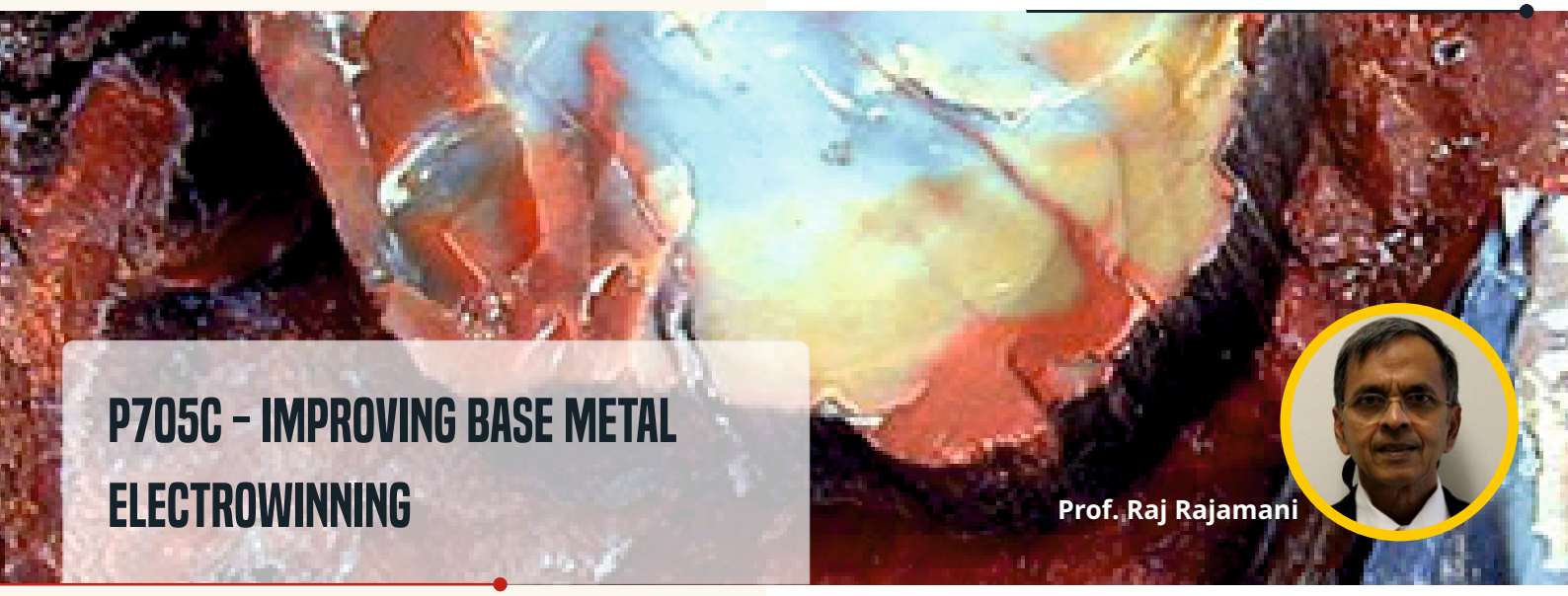
PROGRAM MANAGER
John Visser

SPONSORS
Barrick Cortez Inc
Newcrest Mining Limited

RESEARCH PROVIDERS
Curtin University of Technology

PROJECT SUMMARY:

The AMIRA Gold Processing Technology project has delivered industry focused research outcomes for 28 years. The P420X project has been set-up to allow for sponsors of P420F to undertake extra research and survey studies at their operations with AMIRA managing the invoicing.



P705C - IMPROVING BASE METAL ELECTROWINNING

Prof. Raj Rajamani

VALUE
USD 1,665,000.00

COMMENCEMENT MONTH
November

COMMENCEMENT YEAR
2013

STAGE
Management

DURATION (YEARS)
3.75

PROGRAM MANAGER
Terry Braden

SPONSORS

Anglo Operations Limited, Freeport-McMoRan Copper & Gold Inc., Industrie De Nora S.p.a., MMG Limited RSR Technologies Inc, Teck Metals Ltd, Votorantim Metais

RESEARCH PROVIDERS

Missouri University of Science and Technology, Federal University of Minas Gerais (UFMG), Murdoch University University of Utah

PROJECT SUMMARY:

The P705C project was designed to address the key technology improvement needs of the copper, zinc and nickel electro-winning operations around the globe and to deliver outcomes that should improve operations using a collaborative multinational research team. The project contains four modules; Anode Processes; Cathode Processes; Current Distribution; and Technology Transfer. P705C involves four research providers from four countries on three continents. This will help ensure local expertise is maintained and train future engineers and technologists in electro-winning technology. The project is a highly focused three-year project with the goals of reducing energy consumption, improving capital utilization, reducing acid mist and troubleshooting assistance. These goals will be achieved through the delivery of fundamental knowledge, prototypes, an empirical energy consumption model and operator training. Four of the biggest challenges facing electrowinning operations are: 1) increasing energy costs, 2) increasing material costs, 3) acid mist and 4) less experienced engineers and operators.

HIGHLIGHTS / DELIVERABLES / VALUE ADDITIONS:

AMIRA's P705C project was specifically designed to help address each of these concerns while providing additional benefits. These include an online troubleshooting guide, guidance on operational changes to reduce acid mist, a method to perform a trade-off study between cobalt concentration and electrical energy consumption, data on the effect of specific impurities on anode corrosion and cathode deposits, and onsite

training of over 100 personnel on four continents. In fact, one sponsor reported that improvements made based on the P705 project resulted in US$3.3 million annual savings.

The major accomplishments achieved during the AMIRA P705C Project are:

- 1. Acid Mist in Copper
  a. Measured effect of operating parameters on oxygen bubble size generation on Pb and MMO anodes and correlate to acid mist generation
  b. Determined the effect of operating parameters on acid mist generation.
  c. Discovered a surfactant that reduced acid mist as much as the current standard

- 2. Mn/Cl Ratio in Zinc
  a. Determined the optimal Mn/Cl ratio to minimize anode corrosion

- 3. Co/Mn/Power Outage Interaction
  a. Developed empirical model to predict energy consumption as a function of electrolyte Mn, Co and Fe
  b. Determined the effect of power outages on anode corrosion

- 4. 2020 EW Model
  a. Validated ability to predict the likelihood of short circuiting in copper electrowinning based on fundamental calculations
  b. Model ready to optimize energy consumption of electrowinning facility

- 5. Impurities/Additives in ZnEW and NiEW
  a. Measured the effects of operating parameters on energy consumption, deposit morphology, structure and nanohardness
  b. Developed cathode flexibility test
  c. Examined the effects of high concentrations of Mg in zinc

- 6. Reducing Stress in NiEW
  a. Determined effects of operating parameters and impurities using two methods

- 7. Technology Transfer
  a. 8 modules for drelectrowinning.com completed
  b. 6 site visits/ 5 webinars/ 30 case studies

P1152 - BAYER PRECIPITATION AND ALUMINA QUALITY

VALUE
AUD 450,000.00

COMMENCEMENT MONTH
June

COMMENCEMENT YEAR
2014

STAGE
Complete

DURATION (YEARS)
2.5

PROGRAM MANAGER
Olga Verezub

SPONSORS

Alcoa of Australia Limited
MRIWA
Rio Tinto Alcan Limited
South32

RESEARCH PROVIDERS

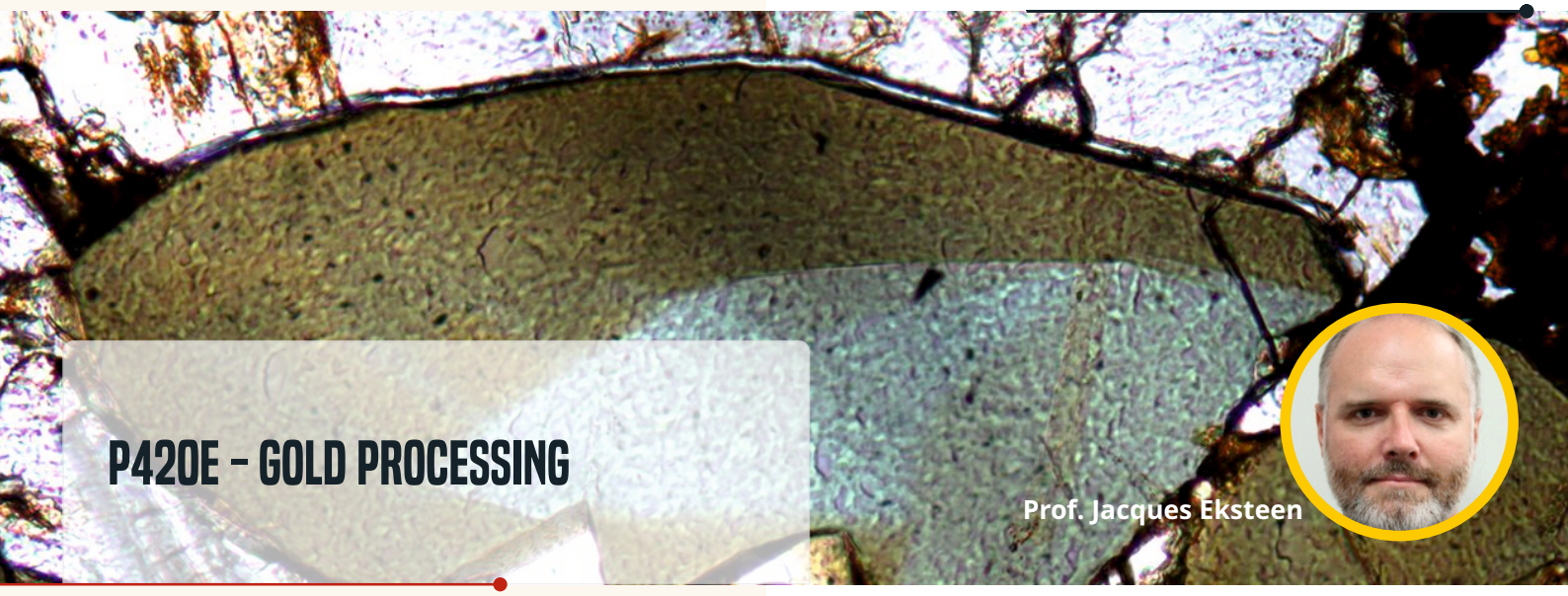
CSIRO Process Science and Engineering
Dr Iztok Livk

PROJECT SUMMARY:

The primary objective of the P1152 project was to quantify the impact of a high shear environment, as may be applied in the precipitation circuits, on the strength of hydrate and alumina quality. Investigating the linkage between slurry shearing and breakage of hydrate particles can provide crucial information on separate roles of precipitation conditions and slurry shearing on strength of hydrate.

HIGHLIGHTS / DELIVERABLES / VALUE ADDITIONS:

Main deliverables included: • A comprehensive experimental database quantifying the impact of shearing on hydrate and alumina strength under a range of precipitation conditions for different seed morphologies. These conditions included investigating the impact of supersaturation in solution, precipitation temperature, solids concentration, gibbsite particle morphology and modification of precursor gibbsite samples through additional precipitation. • Results improved significantly the understanding of the impact of slurry shearing on hydrate and alumina strength under different operating conditions, and lead to • Recommendations on the potential role of slurry shearing in controlling hydrate and alumina strength under Bayer precipitation conditions.



P420E - GOLD PROCESSING

Prof. Jacques Eksteen

VALUE
AUD 3,793,500.00

COMMENCEMENT MONTH
April

COMMENCEMENT YEAR
2013

STAGE
Complete

DURATION (YEARS)
3

PROGRAM MANAGER
John Visser

SPONSORS

AngloGold Ashanti Limited, Australian Gold Reagents Pty Ltd, Barrick Gold Corporation, Gekko Systems Pty Ltd, Harmony Gold Mining, Company Limited, Kemix (Pty) Ltd, Magotteaux Pty Ltd, Newcrest Mining Limited, Newmont USA Limited, Norton Gold Fields Limited, Orica Australia Pty Ltd, Randgold Resources, SGS Bateman Sub Saharan Africa, St Barbara Ltd

RESEARCH PROVIDERS

Curtin University of Technology
Professor Jacques Eksteen

PROJECT SUMMARY:

This project commenced in April 2013 (3 years) and is sponsored by 8 gold mining companies and 6 supplier companies. The AMIRA Gold Processing Technology project has delivered industry focused research outcomes for 25 years. The current project has three themes:

1. Technology Transfer & Professional Development - focusing on plant surveys and inputs into models for plant optimization, coupled with workshops and courses for professional development of staff. This includes working with the online databases and SIMCIL (carbon in leach simulation) software.

2. Models and Optimization – focusing on the expansion of online models including for liberation-leach, gravity-flash-float, leach adsorption models and new models for roasting which link mineralogy to thermodynamics. In addition, research continues into ore characterization and the development of a Code & Guidelines for baseline ore testing and characterization.

3. Future Ore Processing - a fundamental research component of the project focusing on the interactions of complex gangue minerals with the extraction of gold, with particular emphasis on Au-Cu, Au-Ag ores with As, Hg, S and Te contamination. This includes studying the loss mechanism of Au and Ag to tails in Au-Ag plants and Au in Cu-Fe-As-S tails.

HIGHLIGHTS / DELIVERABLES / VALUE ADDITIONS:

There have been 10 plant and 3 desktop surveys conducted and results presented for various members of the project, including the sharing of learnings across sponsors, • Consulting to the major operating sponsors, • Eight technology transfer training event were provided to various site personnel teams, • Four regional technology transfer workshops have been held, • A range of simulation models have been developed for all sponsors, with some sites using the models and researcher aid to optimise their process circuits • Some fundamental and applied research has been delivered in areas of; Pre-concentration: Coarse particle rejection New lixiviates created New leach/adsorption technologies produced New models of polymetallic Au-Cu-Ag systems written New models for integrated liberation-leach and gravity flash-flotation systems have been written, validated and calibrated The online process models for jigs are currently being overhauled. The team is busy quantifying the interactions between grinding media, process water and gold ores Approaches to arsenic removal for copper-gold concentrates have been carried out • Useful guides and reports have been developed and written such as; Updates on the online industry practices survey Updates on the Good Industry practice guide for ore characterisation A manual written for the metallurgical management of copper-gold ores • Identification and quantification for reduced cyanide use, with benefits being realised at a number of operations (Leonora (St Barbara), Hidden Valley (Morobe JV), Serra Grande (AGA)), • Recommendations that have led to improved Au recovery (Serra- Grande, AGA) • Recommendations made, based upon lab work, for improved silver recovery (Hidden Valley, Morobe JV) • Techno-economic evaluation of the SART circuit at Telfer (Newcrest) delivered • Evaluation of the carbon management at Lihir operation (Newcrest) to resulted in significantly reduced soluble gold losses.

• Evaluation of the gravity-flash flotation circuit at Tongon completed, as well as the evaluation of flotation frother types and additions, • Identification, qualification and quantification of opportunities at Kalgold (Harmony Gold) realised, • Investigation of the factors driving slow leaching at Loulo (Randgold) leading to improved leaching conditions, • Survey carried out at Ballarat Gold Fields to support work around pre-concentration and coarse particle gangue rejection • Plant survey of Kanowna Belle Gold Mine carried out to characterise process and samples used for grinding media interaction.

P1150 - MOISTURE MEASUREMENT/CONTROL FOR IRON ORE CONVEYOR SYSTEMS

VALUE
AUD 415,000.00

COMMENCEMENT MONTH
February

COMMENCEMENT YEAR
2015

STAGE
Complete

DURATION (YEARS)
2

PROGRAM MANAGER
Olga Verezub

SPONSORS

Roy Hill
Vale S.A

RESEARCH PROVIDERS

Dr Tom Honeyands - Creattive Process Innovation Pty Ltd
Scantech International Pty Ltd
TUNRA Bulk Solids (University of Newcastle)

PROJECT SUMMARY:

Moisture control is critical for safe and economic iron ore production and export. Moisture must be high enough to suppress dust, yet below the level where material handling difficulties occur and below the transportable moisture limit (TML) for safe shipping. There are substantial economic benefits to minimising iron ore moisture, eg, a 1% reduction in moisture content from 9-8% represents potential savings of $63M based on freight costs from Australia to China (680 Mt production at a typical freight cost of $8/t). For Brazil, with a higher freight cost of approximately $20/t, the potential savings for 340Mt of iron ore are $81M.
The key project objectives were:
Stream I - Moisture measurement:

- Develop a global moisture analyser calibration matrix covering the range of properties of sponsor iron ores, including ore mineralogy variations between hematite, goethite, and magnetite

This would be implemented on the Scantech TBM system, and may potentially be applied to non-Scantech analysers depending on compatibility of the analyser's operating principles and software;

- If possible, develop an on-line mineralogy measurement system for iron ore on conveyor belts and integrate this with the existing TBM (or CM100) system;
- Develop measurement of mass per unit area (MPUA) as an alternative enhancement to increase the accuracy of moisture measurement using the TBM, and potentially indicate changes in ore mineralogy;
- Supply a measurement of through-belt ore moisture, and potentially the secondary measurement of the surface moisture, for input into control systems;
- Trial a prototype system at one or more sponsors' sites.

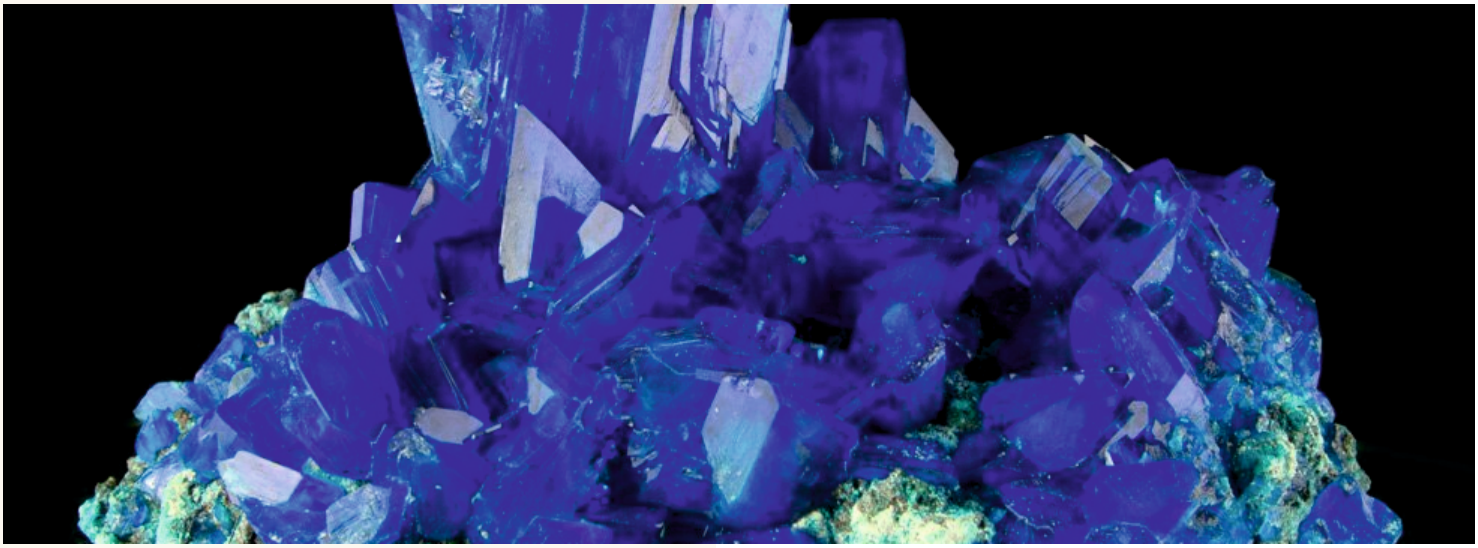
Stream II - Moisture reduction:

- Determine the mode and rate of moisture migration for each sponsor ore sample;
  Define moisture migration characteristics and associated curves for each ore, which will be compared to Sponsor material handling systems to identify whether existing belt oscillations or train wagon/routing vibrations are appropriate or helpful for moisture reduction;
- Conceptual design of moisture reduction/control system(s) to exploit the moisture migration measured for a range of ore types.

HIGHLIGHTS / DELIVERABLES / VALUE ADDITIONS:

Major achievements of the P1150 project were the development of an enhanced online moisture measurement system and determination of the mode and rate of moisture migration for Sponsor iron ores, including the development of a conceptual design for implementation.

Quote from Dauter Oliveira, Technical Manager - Iron Ore - Asia Market, Vale International SA Singapore, Vale: "The outcomes of AMIRA's P1150 "Moisture measurement and control for Iron ore conveyor systems" project were very important for Vale to understand the mode of water migration and dewatering alternatives for our iron ore products.
Throughout the whole project, the researchers from Centre for Bulk Solids and Particulate technologies, NIER and Scantech International have shown strong dedication and creativity in proposing innovative tests and unconventional solutions. AMIRA exerted a very important and efficient role by managing the group, meeting the deadlines, and controlling the budget perfectly. We hope we can continue working with AMIRA in the next phase of P1150, and other projects in the future."



P1171A – ENVIRONMENTAL DUST REMOVAL

Enrique Carretero

VALUE
USD 259,173.00

COMMENCEMENT MONTH
June

COMMENCEMENT YEAR
2017

STAGE
Management

DURATION (YEARS)
0.33

PROGRAM MANAGER
Enrique Carretero

SPONSORS

Antofagasta Minerals S.A.
BHP Billiton Base Metals
Teck Resources Limited

RESEARCH PROVIDERS

Quantum Matrix SpA
Andrés Tupper

PROJECT SUMMARY:

P1171A sees the construction of two mobile plants to test the effectiveness of technology to reduce and confine suspended dust at two operational sites in Chile. The program builds on Stage 1 learnings where the technology was tested at bench level.

P933B – LONG TERM ACID ROCK & TAILINGS DRAINAGE MITIGATION THRU SOURCE CONTROL

Dr. Michael Short

VALUE
AUD 540,000.00

COMMENCEMENT MONTH
September

COMMENCEMENT YEAR
2014

STAGE
Management

DURATION (YEARS)
3

PROGRAM MANAGER
Lydia Haile

SPONSORS

BHP Billiton
Teck Metals Ltd

RESEARCH PROVIDERS

University of South Australia
Dr Michael Short
Levay & Co Environmental Services

PROJECT SUMMARY:

The primary aim of the project in managing acid rock drainage (ARD) is control of sulfide oxidation at source to reduce acid and metal generation rates to such an extent that, in conjunction with long-term cover stability and rehabilitation, continuing effluent treatment becomes unnecessary. The basis for this control will be a multi-barrier system for acid generation rate reduction using both sulfide-passivating layers and microbial actions to reduce oxygen at source, and add biofilms to the sulfide surfaces using on-site neutralising waste rock and organic carbon additions.

HIGHLIGHTS / DELIVERABLES / VALUE ADDITIONS:

The key deliverables for sponsors, depending on the level of sponsorship, include: • Provide an assessment of a nominated site geochemistry and mineralogy to determine available neutralising materials for dumping strategies, co-disposal, covers and plant growth materials. • Define the mineralogical parameters controlling acid generation and acid neutralisation rates (carbonate and non-carbonate) to include full mineralogy, acid base accounting, leach kinetics, acid generation and acid neutralisation rates of nominated site wastes. • Estimate whether ARD control can be achieved with on-site materials alone (including available

tonnage) or will require additional amendment. • Define the stage in reaction evolution (i.e. AGR/ANR) of nominated ARD waste dump or tailings to define remaining options for long-term control and closure using on-site materials with any required amendments. • Define the parameters required to form and maintain silicate-stabilised oxidation layers to reduce pyrite oxidation rates by 50 - 95 %. • Define the parameters to form and maintain stabilised oxidation layers on other iron-containing sulfides (arsenopyrite, chalcopyrite, pentlandite) and non-iron sulfides (sphalerite) not yet studied to reduce oxidation rates. • Define the conditions required to establish and maintain heterotrophic bacterial actions controlling oxygen availability and the formation of protective biofilms using site-available organic carbon additions at pH above 5.5. • Verify that these actions result in additional reduction in the AGR from pyrite and other sulfides at source. • Maximise the barrier to oxygen availability at the sulfide surface using both passivating oxidised layers and microbial actions. • Define any required control of the redox potential and speciation of effluent products for removal of reduced toxic species. • Assess and specify options for practical application of multi-barrier ARD control at sponsors' mine sites in conjunction with company staff. • Assess costs of these options compared with current practice, effluent treatment and long-term liability costs in conjunction with company staff.

P1171 - ENVIRONMENTAL DUST REMOVAL

Enrique Carretero

VALUE
CLP 78,408,920.00

COMMENCEMENT MONTH
March

COMMENCEMENT YEAR
2016

STAGE
Complete

DURATION (YEARS)
1.5

PROGRAM MANAGER
Enrique Carretero

SPONSORS

Antofagasta Minerals
BHP Billiton Base Metals

RESEARCH PROVIDERS

Quantum Matrix SpA
Andrés Tupper
Guillermo Gómez

PROJECT SUMMARY:

The causes for why dust fine particles (10 microns or finer) are suspended in air, not decanting and being stable aerosols, were analysed. Quantum Matrix laboratories proved, at bench level, that Radio Microwaves can deliver the sufficient energy to coagulate dust particles. Bench test using material of about 210 micros produced successful results, leading to the development of stage 2, P1171A.


WITH COLLABORATION
GREAT THINGS HAPPEN
只要大家联合起来，齐心协力，就能够做到无往而不胜
COM COOPERAÇÃO ,HÁ GRANDES RESULTAM
CON LA COLABORACIÓN GRANDES COSAS RESULTAN
COLLABORER C'EST ALLER VERS LE SUCCÈS

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