



ANNUAL REPORT

2010-2011

AMIRA
International
Limited

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OVERVIEW

AMIRA International is an independent association of minerals companies, created to develop, broker and facilitate collaborative research projects.

Our business platform is to strengthen the businesses of our Members by assisting their development and uptake of leading edge science and technology by:

- Creating sponsor teams of member companies to share the costs and the benefits of selected research projects.
- Working with the best researchers around the world
- Nurturing and sustaining research resources for industry benefit
- Formally representing the industry in areas important to our Members
- Providing a forum for industry to meet, network and cooperate in areas of mutual interest.

While AMIRA International does not carry out research itself, it brokers collaborative projects between industry and world-leading research providers by leveraging available government and industry funds.

Our projects are funded by joint sponsorship from Member companies, and we pursue additional sources of funding to benefit these research efforts. Our main role is to facilitate these projects, so that sponsoring Members gain the expected benefits.

The Project Portfolio currently encompasses around 40 R&D projects with approximately:

- AU\$100 million portfolio value
- AU\$72 million industry funds
- AU\$13-20 million new industry funds/year



OUR VISION

AMIRA International is a member-driven resources industry association that is an essential part of our Members' search for innovative solutions that add value.

OUR MISSION

We provide access for our Members to valued solutions through connecting research infrastructure to the needs of our Members and supporting that infrastructure's growth.

OUR VALUES:

Zero harm: To ourselves, others and the environment

Creativity: The essences of innovation

Excellence: The standard we set for ourselves in all we do

Ethical Behaviour: We demonstrate integrity, transparency and sensitivity in all our activities

Collaboration: We respect cultural and individual differences of all participants and work together to achieve mutually rewarding results.

KEY STRATEGIES

Building Relationships: Nurturing and developing the global resources industry network for our Members and the research community

Delivering Value: Maximise the benefit of our services to all our stakeholders

Success through people: Ensuring attraction and retention of energetic talented people

ACHIEVEMENT THROUGH LEADERSHIP AND COLLABORATION

EXECUTIVE CHAIRMAN'S REPORT



The 2010 - 2011 financial year is AMIRA's fifty second year of service to its minerals industry Members. From that early beginning in 1959, supported by its eleven original subscribers, AMIRA has grown to become an internationally focused research program broker serving some 88 Members based in Australia, Africa, North America, South America, Europe and Asia.

AMIRA's Mission

AMIRA's mission is to provide leading edge, cost effective solutions to technological issues of concern to its Members. This is achieved by working with world-class university, government and private based researchers.

The task of providing superior technical solutions to our Members is driven by four objectives:

- To provide the highest quality research outcomes for the research dollar – wherever the best research expertise may reside
- To have representatives available to serve our members and research providers in the key regions where our members operate
- To foster and support local research where feasible
- To foster local development and retention of world-class researcher personnel.

The AMIRA collaborative research model benefits our Members in several ways. The foremost benefit is achieving quality research outcomes in pre-competitive or post-competitive technology activities at lower cost to members by leveraging through shared sponsorship and in-kind contributions from participating research facilities and governments.

AMIRA's international research community engagement assists in the identification of world-class solutions to technical issues of concern to Members.

We work closely with research groups to ensure the provision of innovative and relevant proposals for consideration by our stakeholders.

AMIRA provides project administration and coordination of intellectual property and contractual obligations for Member subscribed projects. This coordination can be material in scope when several Member and research stakeholders, sometimes from different legal jurisdictions, are involved in the programs. Technology transfer to sponsor champions during projects is a focus, with the option available of further technology transfer at company operations.

2010 -2011 Fiscal Year

AMIRA's financial position continued to strengthen during the 2010 -2011 fiscal year as AMIRA and the minerals industry continued their recovery from the 2008 -2009 global economic crisis.

AMIRA budgeted for AU\$11.4 million of new project starts on the assumption that there would be continued reduction in minerals industry research momentum coupled with lower staff project generation capacity as a result of the cost reduction from staff retrenchments undertaken the previous year. I am pleased to report that actual new project generation was \$13.6 million. While lower than the previous year's \$14.4 million the result was significantly better than anticipated.

2010-2011 was an important project portfolio rebuilding year. A significantly larger new project start value is anticipated for the coming fiscal year. More importantly, AMIRA's equity position improved dramatically from a retained surplus of \$73,231 at the end of 2009-2010 fiscal year to \$849,686 this fiscal year. Wayne Stange, Managing Director, and his team are to be congratulated for their strong performance in achieving these results.

The Board was pleased to welcome Renato Costa - Vale, and Marinus Du Plessis - Exxaro Resources Limited as Directors.

The November 2011 AMIRA Annual General Meeting will see two long standing Board Members retire from the board. I will be resigning as Teck Resources Ltd's representative to the Board, a position I have held since 2004, as I have retired from Teck Resources Ltd. I have served as Chair of the Board for the past three years. It has been a pleasure and privilege to serve with the very talented and dedicated Board of AMIRA International.

I wish Dr Neville Plint, Anglo Platinum, incoming Board Chair and his Board of Directors, and Wayne Stange and his capable staff, the very best, secure in the knowledge that they will continue to deliver a superior track record of successes to AMIRA's members and research providers.

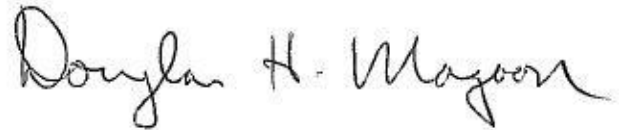
Dave Olney, Vice President, Projects, Mining and Refining – Alcoa World Alumina, will be resigning because his promotion within Alcoa has shifted his strategic focus away from technology responsibilities. Dave has been a stalwart and highly valued contributor to Board deliberations and to AMIRA's success. I am pleased to extend the thanks and best wishes of the Board to Dave for his significant contribution to AMIRA.

The AMIRA model of collaborative research has demonstrated its enduring value for over fifty years.

However, AMIRA's quest to improve service delivery to its members and research providers never ceases.

AMIRA continues its efforts to strengthen staff expertise, research relationships and project outcomes to ensure that AMIRA's stakeholders are increasingly well served.

AMIRA remains strong and will grow in its capability to serve an expanding demand for its services. That is AMIRA's unending commitment to you.



Doug Magoon
Chair of the Board
AMIRA International

MANAGING DIRECTOR'S REPORT



I would like to congratulate and thank the AMIRA team for their commitment and dedication that resulted in a significant improvement to our financial and operational performance for 2011¹.

This improvement provided a sound platform on which to undertake a review of AMIRA's strategic direction. To set the context for this review AMIRA's ability to effectively articulate and position its value proposition was critically reviewed by the Board and the management team.

AMIRA's Value Proposition

Deep understanding and clear communication of AMIRA's value proposition is of critical importance to future success. As the minerals industry continues to globalise, one of AMIRA's challenges is to get a broad global audience to understand how AMIRA's model of developing collaborative technology-based solutions benefits Members, the industry as well as research and technology partners.

This has improved awareness of clearly articulated project-specific value propositions, based on AMIRA's generic value proposition, for all projects in development.

In summary, AMIRA creates value by developing, identifying and delivering on opportunities for Member companies to become more competitive by:

- Improving the performance and profitability of existing operations
- Being better positioned for future access to capital and/or leveraging existing capital spending more effectively
- Increasing the success rate of finding and making economic, new and complex mineral resources.

This is achieved by developing collaborative projects for sponsors with industry-leading researchers and technologists. The AMIRA model, including the value proposition, was presented to a major workshop arranged by ATSE² and this presentation, providing more detail, can be downloaded from AMIRA's website.

AMIRA's value proposition must also remain relevant to a dynamic and changing industry. One of the critical issues clearly identified is that sponsors, to various degrees, increasingly see lack of technical capability within their own organisations as the single biggest obstacle to realising value from AMIRA-style projects. This trend is expected to persist over the medium term due to the acute shortage of appropriately skilled people in the industry.

Renewed Strategic Direction

The work on AMIRA's value proposition provided an effective context for the Board to review and approve AMIRA's renewed strategic direction as proposed by the management team. This strategy consists of three key initiatives or elements:

¹ See www.amirainternational.com for detailed financial statements for the period

² Australian Academy of Technological Sciences and Engineering (www.atse.org.au) - Australia's peak body that fosters excellence in scientific and technology innovation for competitive benefit.

1. *Excellent service delivery*

As a services organization stakeholders' perception of AMIRA's effectiveness is highly dependent on the quality of AMIRA's service delivery. The growth and geographical expansion of AMIRA, as well as the evolution of Member needs and context has resulted in several gaps in performance.

The objective of the Improving Service Delivery initiative, is to put in place the work practices and systems and to develop the skills and capability of AMIRA staff so that the services provided by AMIRA meets expectation.

Issues addressed by this initiative include:

- Ensuring all AMIRA work practices are simplified, clearly defined, effective and efficient
- Re-structuring along business unit lines to ensure clear personal accountability for key aspects of business performance, whilst recognizing that AMIRA is fundamentally a matrix-based project organisation and that internal systems must support this management model
- Implementation of "closed loop" planning and reporting so that the Board has full visibility of all AMIRA's key performance areas – not just the financial aspects
- Ensuring AMIRA has the people capability, skills and experience to deliver AMIRA's strategy.

This initiative is a fundamental platform for change and improvement at AMIRA and for the implementation of other elements of AMIRA's strategy.

2. *Develop projects that meet Members' needs*

The process of developing projects that meet the needs of members has been a challenge for AMIRA for many years. The goal is to:

- Drive project development in a manner that meets the needs of Members and the industry broadly whilst harnessing and leveraging the distinctive capabilities that AMIRA's research and technology partners have

- Ensure that projects are developed in a manner that results in integration between related projects but with minimum overlap
- Shorten the development cycle
- Ensure that projects are developed and undertaken by the most appropriate group of researchers and technologists.

The Strategic Business Development (SBD) team has been constituted under the able leadership of Dr. Alan Stuart to respond to these challenges

The SBD team now reviews all new project proposals, ensures they have a clear value proposition and that they integrate effectively with existing projects.

The SBD also identifies areas of interest and relevance for potential projects. Wherever possible, a portfolio approach is taken where an integrated and cohesive suite of projects are defined so that project integration is achieved by design rather than through managing scope change. A recent example of this approach is the industry-driven development of projects in the Iron Ore and Uranium areas resulting in a rich portfolio of industry-relevant projects.

The SBD's success is dependent on the ability to get industry-relevant input into the identification and development of projects and project portfolios. To facilitate this, AMIRA is developing a Technical Advisory Panel (TAP) to ensure effective access to a range of industry practitioners, who have a proven track record in the research and technology area.



Good progress has been made in South Africa with the formation of a TAP group to discuss the South African and African challenges and opportunities. This meeting, attended by more than 30 participants, was arranged by the AMIRA Africa Board (Alan Muir – AngloGold Ashanti, Marinus du Plessis – Exarro and Dr Neville Plint – Anglo Platinum) supported by AMIRA staff.

Similar progress has been made in Chile with the Chilean Mining Council inviting AMIRA to work with the Council to constitute a TAP that will double as the Council's Technology Committee for the Chilean industry.

Dr. Ray Shaw who enjoyed a long and distinguished career with Rio Tinto in the research and technology area and who also served as a Chair of AMIRA has accepted the role of Chief Technology Advisor to assist AMIRA in strengthening its interaction with its members and sponsors through TAP network.

The sustainability portfolio, under the leadership of Joe Cucuzza, is one of the most rapidly growing areas. Promising projects in the areas of water management, renewable energy, integrated tailings management and soil remediation are under development. To facilitate AMIRA's work in sustainability Dr Joe Herbertson (ex BHPB Research General Manager), with strong industry expertise has agreed to work with AMIRA in this area.

3. Stakeholder Relationship Management

The Board prioritised the need for AMIRA to work with Members and other key stakeholders in a more deliberate manner. To this end several approaches to improve this area have been developed and are being trialed. Outcomes and learning from these trials will be used to extend the number of stakeholders participating in this program.

The Year Ahead

There are some exciting developments anticipated in the year ahead.

Projects

AMIRA's mission is to develop and deliver technology-based solutions that make Members more competitive; projects are the manifestation of this mission.

The portfolios of existing and new projects that demonstrate this are detailed in the body of this Report and it is pleasing to see a mixture of both step-change and incremental improvement projects.

It is also worth noting that one of AMIRA's foundation projects – P9³ Mineral Processing - will have its 50th birthday next year. At present the P9 team is working hard to closeout P9O whilst planning for P9P. P9 is entering an exciting new era with P9O developing the know-how to model the true multi-component nature of mineral-processing circuits that can now be applied to achieve the next incremental improvement in related practices in the industry, which will be the focus of P9P.

People

One key undertaking this year was the commencement of rebuilding staff resources to strengthen AMIRA's capacity to serve its members and the research community. AMIRA was pleased to welcome Stephen Trimming, Program Director - Extractive Metallurgy Business Unit; Dr Olga Verezub, Project Engineer – Strategic Business Development; Dr Bernard Xu, Assistant Junior Program Manager, Donna Copolov, Program Support Officer - Melbourne and Jacqueline Russell, Program Support Officer – South America to the group.

Richard Beck, Program Director - Extractive Metallurgy Business Unit retired from AMIRA after many years of dedicated and valued contribution to our organisation. Richard continues to support AMIRA on a part time basis and graciously deferred his planned retirement to help lead AMIRA through the turbulent 2009 – 2010 period. The Board and staff of AMIRA are most grateful to Richard for his lasting contribution and wish him well in his much deserved retirement.



Wayne Stange
Managing Director
AMIRA

³ The optimization of mineral processing circuits using modeling and simulation

AMIRA INTERNATIONAL BOARD



Mr D H (Douglas) Magoon
Executive Chairman
Technical Advisor
Teck



Dr N (Neville) Plint
Vice Chairman
Head Research & Development
Anglo Platinum



Renato Costa
**General Manager of
Technology Australia**
Vale Australia



Mr M (Marinus) Du Plessis
**Manager,
Technical Advisory and
Innovation Technology**
Exxaro Resources
Limited



Mr S (Rick) Gilbert
**Vice-President,
Technology**
Freeport-McMoran
Mining Company



Mr M (Mick) Henderson
**Product Development
Manager**
Russell Mineral Equipment
Pty Ltd



Mr K (Kent) Hoots
**Vice President Asia
Pacific**
Boart Longyear Pty Ltd



Dr P (Peter) Kondos
**Senior Manager Research
& Development**
Barrick Gold Corporation



Mr C (Calvin) P Treacy
Consultant



Mr D (Dave) Olney
Vice President, Projects,
Mining and Refining
Alcoa World Alumina



Dr A (Aubrey) Paverd
Director
Compania De Minas
Buenaventura



Mr J D (Joe) Pease
General Manager—Xstrata
Technology
Xstrata Copper Australia



Dr Juan Carlos Salas
Manager of Innovation
Antofagasta Minerals
S.A.



Dr B E (Brian) Smith
Global Manager R & D
BHP Billiton Limited



Mr I (Ian) Willis
**Regional Head of
Exploration**
Anglo American
Exploration (Australia)
Pty Ltd



Dr W (Walter) Valery
**Senior Vice President—
Global**
Metso Process Technology
& Innovation
Metso Minerals

AMIRA ORGANISATIONAL CHART

As at September 2011



CONTRACT ACTIVITIES

	2011 AU\$000	2010 AU\$000
Total Research Commitment		
Geoscience	14,124,309	9,418,680
Mine Engineering	2,310,000	3,351,300
Mineral Processing	29,542,305	27,702,581
Extractive Metallurgy	7,097,240	6,879,450
Sustainability	1,224,000	2,057,400
Multi Disciplinary	17,806,310	14,715,300
TOTAL	72,104,164	64,124,711

Annual Research Spending (by market)

Geoscience	1,781,017	1,198,560
Mine Engineering	199,460	1,032,528
Mineral Processing	5,712,493	7,978,938
Extractive Metallurgy	1,595,676	1,352,898
Sustainability	348,320	194,400
Multi Disciplinary	3,236,610	2,462,982
TOTAL	12,873,576	14,220,306

Annual Research Spending (by researcher type)

Universities	9,711,788	10,472,853
CSIRO	1,703,611	1,014,644
CRC	708,864	694,953
Other	749,313	2,037,856
TOTAL	12,873,576	14,220,306

Project Numbers

	No.		No.
Contracts in progress	32	67,193,675	28
Contracts commenced and additional sponsors	10	13,610,080	6
Contracts completed	6	7,087,410	11

Membership

Members	88	83
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This is a summary of AMIRA's activities for the year. The figures presented have not been audited and include variable exchange rate adjustments. Direct comparisons between years should only be taken as indicative.

MEMBERS



INDIVIDUAL

G-Resources Group Limited
Hidden Valley Services Limited
Minera San Cristobal S.A.
Queensland Alumina Limited

EXPLORERS

Regis Resources Limited
SIPA Resources Limited

SUPPLIERS

Amdel Limited
Ausenco
Australian Gold Reagents Pty Ltd
Australian Laboratory Services Pty Ltd
BASF Australia Ltd
Bateman Engineering Pty Ltd
Boart Longyear Pty Ltd
CP Kelco Oy
Cytex Australia Holdings Pty Ltd
Datamine Corporate Ltd
FL Smidth Minerals Inc
Gekko Systems Pty Ltd
Hatch Australia Pty Ltd
Huntsman Corporation Australia Pty Ltd
ioGlobal Pty Ltd
Industrie de Nora S.p.a
INPPAMET Ltda
Kemix (Pty) Ltd
Magotteaux Pty Ltd
Metso Minerals
Nalco Australia Pty Ltd
National Starch (Penfold Australia Limited)
Orica Mining Service
Outer-Rim Exploration Services Pty Ltd
Outotec
Quantec Geoscience Ltd
Quantitative Geoscience
RSR Technologies Inc
Russel Mineral Equipment Pty Ltd
Sandvik Mining & Construction Australia Pty Ltd
Senmin South Africa Pty Ltd
SGS Australia Pty Ltd
WesTech Engineering Inc
Zonge International

PRODUCERS

Alcoa World Alumina
Anglo Platinum Management
AngloGold Ashanti
Antofagasta Minerals S.A.
Avocet Mining plc
Barrick Gold Corporation
Boliden Minerals AB
Cameco Corporation
Cayleli Bakir Isletmele ri A.S
Codelco
Compania de Minas Buenaventura
Eldorado Gold Corporation
Exxaro Resources Limited
First Quantum Minerals Ltd
Freeport McMoran Mining Company
GFL Mining Services Limited
Golden Star Exploration
Hydro Aluminium Metal Products
IAMGOLD Corporation
Impala Platinum
Independence Group NL
Inmet Mining Corporation
Issara Mining Limited
Kinross Gold Corporation
LKAB
Lonmin Platinum
Lundin Mining Corporation
Minerals and Metals Group Ltd
Newcrest Mining Limited
Newmont Australia Limited
OZ Minerals
Randgold Resources Limited
Resolute Mining Limited
Rio Tinto Limited
Semafo Inc
St Barbara
Servicios Industriales Penoles
Shell Canada Energy
Teck
Total E & P Canada Ltd
United Company RUSAL
Vale
Votorantim Metais Ltda
Xstrata Technology

RESEARCH PROVIDERS

Aarhus University
Alford Mining Systems
AMC Consultants Pty Ltd
ARC Centre of Excellence in Ore Deposits (CODES)
Australian National University
Bureau de Recherches Geologiques et Minieres (BRGM)
Centre for Exploration Targeting - University of Western Australia
Centre for Mined Land Rehabilitation
Centre for Sustainable Resource Processing CRC
CICITEM from Antofagasta.
Colorado School of Mines
CRC - Deep Exploration Technologies
CRC ORE (Optimising Resource Extraction)
CSIRO
Curtin University of Technology
Czech Geological Survey
Dickson Research Pty Ltd
Ecole Nationale d'Ingenieurs
Freelance Global Limited
Fullagar Geophysics Pty Ltd
Fundacion Chile
Hacettepe University
Ian Wark Research Institute (IWRI)
Imperial College of Science, Technology & Medicine
Institut de Recherche pour le Développement (IRD)
Institute of Experimental Mineralogy (Moscow)
Julius Kruttschnitt Mineral Research Centre
Lakehead University
Laurentian University
Levay & Co Environmental Services
McGill University
Mine Smith Pty Ltd
MIRARCO Mining Innovation
Murdoch University

Nancy Universite
Parker CRC for Hydrometallurgy Solutions
Pontificia Universidad Catolica de Santiago
Pontificia Universidad Catolica del Norte
RMIT University
Russian Academy of Sciences
Sustainable Minerals Institute
TechnoImaging
Universidad de Antofagasta
Universidad de Chile
Universidad de Concepcion
Universidad de Santiago
Universidade de Sao Paulo
Universidade Federal do Rio de Janeiro
Université de Toulouse
Université d'Orléans
Université Montpellier
University of Auckland
University of Cape Town
University of Melbourne
University of Newcastle
University of Oklahoma
University of Ottawa
University of Ouagadougou
University of Queensland
University of South Australia
University of Tasmania
University of the Witwatersrand
University of Utah
University of Waterloo
US Geological Survey
Vernadsky Institute (Moscow)
W H Bryan Mining Geology Research Centre

PROJECT INDEX



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COMPLETED

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COMPLETED

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MULTI DISCIPLINARY

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COMPLETED

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COMPLETED

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GEOSCIENCE

P778A

Value

AU\$1,362,150

Commencement

November 2010

Duration

3 years

Program Manager

Joe Cucuzza

Predictive Exploration Geochemistry in Transported Overburden

The overall aim of this extension project is to develop guidelines for how, where and why to use biota, gas and/or other shallow sample media for mineral exploration in areas of transported overburden. The project will build on the results of P778 by undertaking further research into the biotic, gaseous and capillary mechanisms of vertical migration of metals from buried mineral deposits through transported overburden to surface in a variety of environments in Australia. The principal deliverables of this new project will include continuous progress reports as well as technical reports describing the work completed at each study site.

A final project report describing the mechanistic models to account for observed metal migration or its absence, integrating all aspects of the study including different regolith and palaeo-climatic controls on migration, and variations with respect to different commodity elements will be prepared.

Sponsors

AngloGold Ashanti Australia Limited; Cameco Australia Pty Ltd; First Quantum Minerals Ltd; Independence Group (Jabiru Metals Limited); Japan Oil, Gas and Metals National Corporation (JOGMEC); Newmont USA Limited; Regis Resources; SGS Minerals Services; Teck Resources Limited; Vale.

Research Providers

CSIRO Earth Science and Resource Engineering, Dr Ravi Anand; CSIRO; Curtin University of Technology.



West African Exploration Initiative - Stage 2

Stage 1 of the West Africa Exploration Initiative delivered the following:

1. West African Exploration Reference Database
2. Integrated West African Exploration GIS
3. Exploration Geoscience Audit and Gaps Analysis
4. Training programs, Symposium and Field excursion.

This extension project will build on Stage 1 by developing a new geological framework to generate new exploration insights which will assist company sponsors to explore in this region.

The principal deliverables of this project will be:

- a) A craton-scale GIS product showing the craton-wide geophysical stitches, sample locations, mineral deposits, interpretative layers of structures with fully attributed movement events, and the principal tectonic elements that control and divide domains of distinct mineralisation characteristics.
- b) A space-time chart cross linked to the GIS showing all of the existing and newly acquired geochronological data, with summaries of crustal growth, metamorphic, deformation and mineralisation events.
- c) An understanding of the landscape evolution and surficial processes characteristic of the particular climatic setting of West Africa over the last 60 Ma that will help to define exploration strategies for a wide variety of deposit types.
- d) Training of African Geoscientists in the techniques of exploration geology via a suite of six short courses over the life of the project, an annual symposium and workshops as necessary to facilitate transfer of knowledge of the outcomes of the project to sponsors.
- e) Training of young African Geoscientists via a suite of MSc and PhD projects directly funded by this project or in partnership with other funding sources.
- f) An improved capacity and confidence in the Geological Surveys and Universities in West Africa to respond to the short and long term requirements of the minerals industry.

Sponsors

AngloGold Ashanti Limited; AusAID; First Quantum Minerals Ltd; Gold Fields International Services Ltd; Goldbelt Resources Limited; Golden Star Resources Ltd; IAMGOLD Corp. Lihir Gold Limited (Now Newcrest); Red Back Mining (now Kinross Gold); Resolute Mining Limited; Rio Tinto; SEMAFO Inc; Vale Exploration

Sponsors-in-kind

Le Bureau des Mines et de la Géologie du Burkina; Geological Survey Department – Ghana; Direction National de la Géologie République de Guinée; Geological Survey of Liberia; Direction Nationale de la Géologie et des Mines - Mali Centre de Recherches Géologiques et Minières – Niger; Ministère des Mines et de L'Industrie-Senegal; Direction Générale des Mines et de la Géologie - Togo.

Research Providers

Centre for Exploration Targeting - University of Western Australia, Professor T. Campbell McCuaig; Czech Geological Survey; Institut de Recherche pour le Développement (IRD), Dr Mark Jessell; Nancy Université; Université de Toulouse ; Université d'Orléans; Université Montpellier ; University of Ouagadougou, Professor Martin Lompo; University of the Witwatersrand, Professor Kim A.A Ncube-Hein; Bureau de Recherches, Géologiques et Minières (BRGM); Ecole Nationale d'Ingenieurs.

P934A

Value

US\$2,903,947

Commencement

March 2010

Duration

3 years

Program Manager

Joe Cucuzza

P972

Value
US\$555,000

Commencement
January 2009

Duration
3 years

**Program
Manager**
Joe Cucuzza

ATR Mineral Chemistry Applied to the Characterization and Exploration of Andean type Cu ± Au Ore deposits

The overall objective of this proposal is to compile a comprehensive database in order to develop new robust, and cost effective “mineralo-chemical” tools that will not only permit a better understanding of mineralizing systems, but more importantly will offer explorers a new and improved method of vectoring into mineral deposits.

Efforts will be concentrated on optimizing drilling programs (i.e. helping in vectoring towards higher-grade ore zones), and improving the geologic evaluation of prospects and targets by developing a process based independent mineralo-chemical tool. Hydrothermal ore deposits are the result of a combination of diverse physicochemical processes, that imprint diagnostic geochemical signatures characteristic of this mineralization.

This study is designed to try to “read” these signatures with the final goal to use them as indicators/discriminators. The proposed mechanism to read these signatures is through the mineralogical and chemical analysis of texturally controlled resistate minerals.

Sponsors

Barrick (Australia Pacific) Limited; BHP Billiton Metals; Codelco; Newmont USA Limited; Rio Tinto Exploration Pty Limited; Vale Exploration.

Research Providers

Universidad de Concepcion, Dr Osvaldo Rabbia Dalmaso; Aarhus University; University of Oklahoma.

P1004A

Value
AU\$260,000

Commencement
July 2010

Duration
8 years

**Program
Manager**
Joe Cucuzza

DET CRC implementation

AMIRA is working with the CRC to recruit additional Affiliate members. The DET CRC officially commenced operations in May 2010.

Affiliates of DT CRC

ABM Resources NL; Australian Drilling Industry Association Limited; Carpentaria Exploration Limited; Diamant Drilling Services SA; Diarotech; Downhole Surveys Pty Ltd; Easternwell WA Pty Ltd; Fugro Ground Geophysics Pty Ltd; Geological Survey of NSW; Geological Survey of Queensland; Geological Survey of Western Australia; Geomole Pty Ltd; Geoscience Australia; GeoScience Victoria; Globaltech; Heathgate Resources Pty Ltd; Index Limited; JKTech Pty Ltd; Minotaur Exploration Ltd; Northern Territory Geological Survey; Olympus Innov-X; Paladin Energy Ltd; Rex Minerals Limited; Sandvik Mining and Construction Australia Pty Ltd; Tanami Gold NL; Teakle Composites.

Research Providers

CRC - Deep Exploration Technologies, Professor Richard R Hillis.



P1022

Value
AU\$540,000

Commencement
August 2010

Duration
3 years

**Program
Manager**
Joe Cucuzza

Rapid Inversion of TEM Data

The aims of this project are to further advance the development of rapid approximate inversion of TEM data and to fully develop practical tools for integrated interpretation of multiple data sets in the VP environment. The algorithms that have been developed currently provide 3D inversion results from TEM data two orders of magnitude faster than any other method currently available.

Sponsors

AngloGold Ashanti Australia Limited, Gold Fields Australasia Pty Ltd, Mira Geoscience, Rio Tinto Exploration Pty Limited

Research Providers

ARC Centre of Excellence in Ore Deposits - Assoc. Professor Jeff Foster, Fullagar Geophysics Pty Ltd - Dr Peter Fullagar, University of Tasmania



P1036

Value
AU\$217,485

Commencement
November 2010

Duration
9 months

Program Manager
Joe Cucuzza

Airborne IP - Stage 1

Conventional IP uses galvanic sources and grounded electrodes, and “works” in virtually all environments. Inductive sources with magnetic receivers have very low IP signal amplitudes, and IP effects are seldom detected (except for coincident TEM survey loops or in melting permafrost conditions). A mixture of one each of grounded electrodes and magnetic source/receivers has however successfully been used for IP detection and mapping (MIP for the galvanic source case and EIP by Macnae for Inductive source with electrode sensors).

A breakthrough at RMIT in electric field sensor technology has shown that E fields can be measured in motion in air with accuracies equal or better than grounded electrodes. This opens the gate for vehicle-mounted IP, whether using a grounded or inductive source. It also could allow Airborne EIP measurements as an add-on to a high-power AEM system. The charge-coupled Enc3 sensor is ~1000 times less noisy than previously developed or commercially advertised capacitive-coupled devices.

The project being proposed will be made up of two stages:

- Proof of concept study
- Stage 2 will be a prototype for field testing.

The proposed measurements will use charge-coupled electric field sensors developed at RMIT with an existing AEM transmitter. The project will involve further development of the Enc3 sensor (provisional patent lodged). Modelling predicts that in most cases depth-of-penetration for AEIP will comfortably exceed 150 m, which would be coupled with standard AEM exploration capability to greater depth.

Sponsors

Abitibi Geophysique, BHP Billiton, Outer-Rim Exploration Services Pty Ltd, Spectrem Air Ltd, Teck Resources Limited

Research Providers

RMIT University - Professor James Macnae

P1041

Value
AU\$591,000

Commencement
February 2010

Duration
3 years

Program Manager
Alan Goode

Application of New Technologies to Exploration and Evaluation of Gold Deposits

The project builds upon the results from the very successful AMIRA project P923, which used an innovative approach of combining pyrite textures, pyrite composition, laser Pb and S isotopes on pyrite, and other factors to develop preliminary models for selected sediment-hosted Au-As deposits (Sukhoi Log, Goldstrike, Gold Quarry and Fosterville). The outcomes from P923 have led to a revolution in our thinking on exploration models for gold deposits. This new project will extend the methodologies, develop new technologies, and apply them to a number of deposits selected in consultation with potential sponsors.

This project is only now possible due to recent technology breakthroughs in the application of LA-ICPMS to rocks and ores. These include:

1. Multi-element laser trace analysis to finger print different pyrite generations in a province and ore system,
2. 2D and 3D laser mapping of invisible gold and other trace elements throughout the paragenesis of ores and altered rocks,
3. Laser Pb and S isotope analysis on various sulphide minerals in ores and host rocks,
4. A new technique for rapid very low level gold and PGE analysis on rocks, minerals, organic matter and matrix material, and
5. Comprehensive gold mineralogy analysis to determine the nature and siting of gold in ores and rocks; refractory gold, invisible gold, free gold, gold tellurides, gold-PGE minerals, gold-bearing organics etc.

These technologies have been developed in the CODES Centre of Excellence Laboratories, and are now available for application in a comprehensive and integrated manner.

Sponsors will be able to apply the technologies to pilot studies on their own gold deposits of any style. Selected deposits will be studied to examine gold-pyrite chemical halos and vectors to ore.

Sponsors

AngloGold Ashanti Limited; G-Resources Group; Issara Mining Limited; Newcrest Mining Limited; Newmont USA Limited; Sipa Resources Limited.

Research Providers

ARC Centre of Excellence in Ore Deposits, Professor Ross Large.

P1060

Value
AU\$3,420,000

Commencement
June 2011

Duration
3 years

**Program
Manager**
Alan Goode

Enhanced Geochemical Targeting in Magmatic-Hydrothermal Systems

P765A produced a series of mineral chemistry vectors within porphyry copper systems to allow the primary deposits to be “seen” from much further away than previously. The project focused on two problematic environments surrounding or overlying mineralized systems – “green rocks” and lithocaps. An unusual and popular feature of the project was to allow sponsors to actively test the vectors in real situations by submitting blind test sites to the research team. As an example, the giant high-grade Resolution deposit in Arizona was accurately detected from early exploratory drill holes under 1 km of barren cover.

P1060 will continue this work by looking at other simple minerals which are commonly found in such systems and which can be easily identified by field geologists. Other new aspects will also be researched to complement the earlier investigations, including a continuation of blind testing.

Case studies and blind sites in P765 and P765A included Batu Hijau, Martabe, Hu'u, Baguio, Mankayan (Lepanto), Shuteen, Bantug, North Parkes, El Teniente, Cerro Casale, Collahuasi, Yanacocha, Cocanes, Tantahuatay, Ixhuatan, Resolution, Taldy Bulak, Hasandag, Timok and Chelopech. New nominated case study sites in P1060 include Bingham Canyon, Cobre Panama, Cerro Colorado, Grasberg, Haquira, La Colosa, La Zanja, Manus Island, Pascua-Veladero, Santo Thomas and Quimsacocha.

Sponsors

Anglo American Exploration Australia Pty Ltd; AngloGold Ashanti Australia Limited; Barrick (Australia Pacific) Limited; BHP Billiton Marketing Asia Pte Ltd; Compania de Minas Buenaventura; Eldorado Gold Corporation; First Quantum Minerals Ltd; Freeport-McMoRan Exploration Corporation; Gold Fields Australia Pty Ltd; G-Resources Group; Inmet Mining Corporation; Intrepid Mines; Lundin Mining Corp; MMG Australia Limited; Newcrest Mining Limited; Newmont USA Limited; Rio Tinto Exploration Pty Limited; Teck Resources Limited; Vale Exploration; Xstrata Copper Limited.

Research Providers

ARC Centre of Excellence in Ore Deposits, Prof Bruce Gemmell, Professor David R Cooke; Imperial College of Science, Technology & Medicine; Lakehead University.

P710A

COMPLETED

Value
AU\$504,000

Commencement
August 2005

Duration
3 years

**Program
Manager**
Joe Cucuzza

Controls on Platinum Group Element Variation in Mafic and Ultramafic Magmatic Systems

This project built on the work of Dr Marco Fiorentini and AMIRA P710 in developing fertility indicators for magmatic systems. It focused on:

- Application of the new fertility indicator/vector discovered in P710 to more evolved magmatic systems
- Understanding of the scale of the NiS ore-formation process in variably mineralised belts
- Applicability of PGE as a vector towards mineralised environments within mineralised sequences
- Investigation of PGE systematics in a range of petrogenetic environments.

Sponsors

BHP Billiton Minerals Exploration; BHP Billiton Nickel West Ltd; Independence Group NL; Lake Johnston Ltd; Minerals and Energy Research Institute of Western Australia (MERIWA).

Research Providers

Centre for Global Metallogeny - University of Western Australia, Professor Mark Barley; Australian National University; Centre for Exploration Targeting - University of Western Australia; CSIRO Earth Science and Resource Engineering; GEMOC.

P765A

COMPLETED

Value

AU\$2,490,000

Commencement

January 2008

Duration

3 years

Program Manager

Alan Goode

Geochemical and Geological Halos in Green Rocks and Lithocaps: The Explorer's Toolbox for Porphyry and Epithermal Districts

Porphyry-related mineral districts host many major ore deposits of diverse styles and metal associations. Exploration in these districts can be complicated by shallow-level alteration systems (e.g. lithocaps) and structural complexities. At deeper erosion levels, it can be difficult to identify the locations of productive ore zones that are interspersed between barren gaps of weakly developed hydrothermal alteration (green rocks).

It can also be difficult to evaluate and appreciate the significance of unmineralised veins that occur in these environments. Porphyry – epithermal mineral districts are typically zoned, and zoning has been an important tool for exploration. However, the various mineral assemblages and textures that characterize each zone can be produced by barren hydrothermal systems or by non-mineralising processes such as regional metamorphism.

Discriminating mineralised and barren systems, being able to locate well-mineralised hydrothermal centres and recognising the distal footprints of mineralisation continue to be great challenges to explorers. This research project provided mineral chemical vectoring tools that helped to extend the detection of the geochemical footprints of porphyry and epithermal deposits, and help to focus exploration activity in the altered domains that enclose and obscure mineralisation.

Sponsors

Anglo American Exploration Australia Pty Ltd; AngloGold Ashanti Australia Limited; Barrick (Australia Pacific) Limited; Codelco; Compania de Minas Buenaventura; Dundee Precious Metals Inc; Equinox Minerals Limited; Freeport-McMoRan Exploration Corporation; Gold Fields International Services Ltd; Kinross Gold Corporation; Minerals and Metals Group Ltd; Newcrest Mining Limited; Newmont USA Limited; Rio Tinto Exploration Pty Limited; St Barbara Ltd; Teck Resources Limited; Vale Australia; Xstrata Copper Limited.

Research Providers

ARC Centre of Excellence in Ore Deposits, Dr Zhaoshan Chang, Prof Bruce Gemmill, Professor David R Cooke; Imperial College of Science, Technology & Medicine; Lakehead University; University of Ottawa.

P778

COMPLETED

Value
AU\$1,371,600

Commencement
May 2006

Duration
3 years

Program Manager
Joe Cucuzza

Predictive Geochemistry in Areas of Transported Overburden

As the discovery rate of world-class mineral deposits continues to decline, increased attention is being focused on geochemical exploration methods designed for covered terrains. If definitive, low cost surface or near-surface sampling surveys can be conducted in areas of shallow cover (say <30m), large areas can be tested and expensive unnecessary drilling can be reduced. In order to apply geochemical exploration methods confidently in a given area, or to be able to determine that such techniques are inappropriate, it is necessary that we understand the mechanisms by which surface expressions may form. Research was provided that determined which mechanisms can cause metal migration through post-mineralization cover.

Sponsors

AngloGold Ashanti Australia Limited; Barrick Gold Corporation; BHP Billiton Minerals Exploration; Cameco Corporation; Codelco; Heron Resources NL; Independence Group NL; Jabiru Metals Limited; Japan Oil, Gas and Metals National Corporation (JOGMEC); Newmont Australia; Rio Tinto Exploration Pty Limited; SGS Minerals Services; Teck Resources Limited; Vale; VALE INCO; Xstrata Copper Chile SA.

Research Providers

CRC - Landscape Environments and Mineral Exploration (CRC LEME); CSIRO; CSIRO Earth Science and Resource Engineering, Dr Ravi Anand, Mr Melvyn J Lintern; Curtin University of Technology; Universidad de Chile; CSIRO Land and Water.



P962

COMPLETED

Value
AU\$633,870

Commencement
March 2007

Duration
3 years

Program Manager
Alan Goode

Ni-PGE Potential of Mafic and Ultramafic Magmas – A Combined Thermodynamic Modelling and Melt Inclusion Approach

The project combined three approaches: study of sulphide melt inclusions in early formed phenocrysts in mafic magmas from various tectonic setting; thermodynamic modelling of crystallisation of mafic intrusions using new developments in the COMAGMAT software program; and a detailed study of petrology and geochemistry of a world-class intrusive/volcanic complex associated with large Ni deposits (the Dovyren Intrusion), all aimed at understanding

- (1) The potential of various mafic/ultramafic magmas to form magmatic sulphide deposits, and
- (2) Which processes during magma evolution were responsible for the formation of deposits.

Sponsors

Anglo American plc; BHP Billiton Minerals Exploration; Votorantim Metais.

Research Providers

ARC Centre of Excellence in Ore Deposits, Professor Leonid Danyushevsky; Institute of Experimental Mineralogy (Moscow); Russian Academy of Sciences; Vernadsky Institute (Moscow).



MINE ENGINEERING

P1037

Value
US\$990,000

Commencement
April 2011

Duration
3 years

**Program
Manager**
Matthew Dalziel

Stope Optimisation and Stope Layout

P884 - PRIMO was focused more at strategic planning, and feasibility studies. Industry sponsors have identified the need for greater levels of detail and improved stope design solutions for medium and short term planning.

The optimisation techniques employed are amenable to more complex stope shapes, and additional design criteria that would follow as greater levels of detail are modelled and optimised. The choice of optimisation criteria, cutoff, penalties and shape geometry parameterisation can all be extended further. This proposal seeks a three year extension to develop a complete solution for the optimisation of stope design and stope layout, covering strategic, tactical and operational planning.

Sponsors

Barrick Gold Corporation; BHP Billiton; Boliden Minerals AB; CAE Mining; Gijima Group Limited; Maptek Pty Ltd; Minerals and Metals Group Ltd; Newmont Mining Corporation; VALE Canada Ltd; Xstrata Nickel Limited.

Research Providers

Alford Mining Systems, Mr Chris Alford; AMC Consultants Pty Ltd.

P1043

Value
US\$1,320,000

Commencement
April 2011

Duration
3 years

**Program
Manager**
Matthew Dalziel

Framework for Rapid Automated Underground Mine Optimisation

This new project brings together a team of applied researchers, industry consultants and software suppliers (who were participants in the PRIMO project) who can deliver an integrated set of tools for rapid, automated optimisation of underground mining projects, where the goal is to evaluate hundreds of scenarios and identify the best set of design criteria and parameters in a strategy optimisation project.

Sponsors

Barrick Gold Corporation; BHP Billiton; CAE Mining; Gijima Group Limited; Minerals and Metals Group Ltd; Newmont Mining Corporation; VALE Canada Ltd; Xstrata Nickel Limited.

Research Providers

Alford Mining Systems, Mr Chris Alford; AMC Consultants Pty Ltd.

P884
COMPLETED

Value
US\$2,610,000

Commencement
December 2006

Duration
3 years

**Program
Manager**
Matthew Dalziel

Planning & Rapid Integrated Mine Optimisation

The design and scheduling of open cut mines can be optimised using commercially available software. However in underground mines, no such optimisation tools were available in 2006. There was at the time a recognised need for improved software tools to support the planning, design and operation of underground mines. This project combined the expertise of researchers in optimisation of stope definition, scheduling, cutoff grade selection and design of underground networks to determine stope, infrastructure designs and production schedules that maximise profitability over the life time of a mine.

While PRIMO did deliver on its stated deliverables, this is not the full picture of what has been accomplished in the last three years. Broadly, PRIMO's contribution to the advancement of the sponsor's stated need for improved mine planning tools has been:

- The development of new optimisation technologies
- The interoperability of these technologies
- A methodology for underground optimisation
- The creation of a consortium of researchers, software developers and industry sponsors with a common objective of improving underground mine planning.

Sponsors

Barrick Gold Corporation; BHP Billiton; CAE Mining; Gijima Group Limited; Maptek Pty Ltd; Newmont Mining Corporation; OZ Minerals Limited; Rio Tinto Technical Services Limited; VALE INCO; Xstrata Nickel Limited.

Research Providers

Mine Smith Pty Ltd, Dr Martin Smith; MIRARCO Mining Innovation; Alford Mining Systems; AMC Consultants Pty Ltd; Curtin University of Technology; University of Melbourne; University of South Australia; University of Waterloo.

MULTI-DISCIPLINARY

P599B

Value
AU\$501,000

Commencement
September 2008

Duration
3 years

Program Manager
Matthew Dalziel

High Concentration Suspension Pumping

Detailed understanding of the flow regimes obtained in P599 and P599A has provided an opportunity to exploit various aspects of high concentration flows to improve existing processes and possible pumping applications.

There are five areas in which extension work will be undertaken:-

- Technology transfer
- Flow fundamentals
- Vertical conveying
- Separation techniques
- PipeTools software development

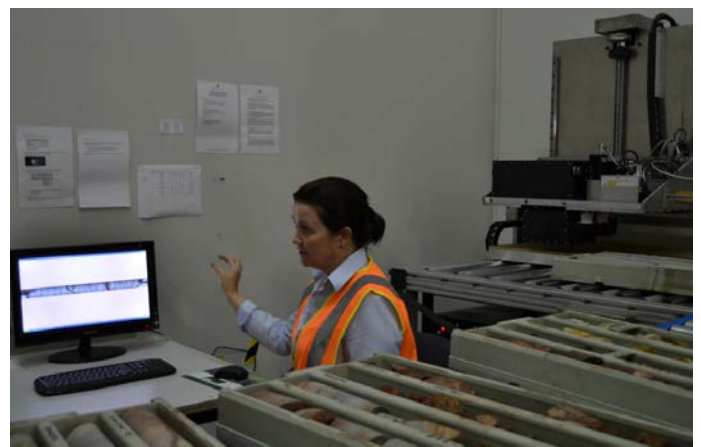
As in P599 and P599B, all outputs of the P599B research will be captured in new releases of the PipeTools software.

Sponsors

Rio Tinto Technological Resources Pty Ltd; Shell Canada Limited.

Research Providers

CSIRO Materials Science and Engineering, Dr Jie Wu; CSIRO Process Science and Engineering.



P843A

Value

AU\$7,758,331

Commencement

July 2009

Duration

4 years

Program Manager

Alan Goode

Geometallurgical Mapping and Mine Modelling

The initial P843 project made major advances in developing practical methodologies and tools to deliver predictive measures of processing performance. These can be embedded in resource models and exploited in mine planning and optimization. It delivered a wide range of hardware and software tools with demonstrated potential for routine application. These include lower-cost physical testing devices for comminution, automated core loggers and a range of imaging and microscopy platforms. These are linked to enabling software for specialist textural analysis, multivariate modelling and data integration.

The P843A extension project seeks to continue this development with an increasing emphasis on large-scale site-based comparative benchmarking and validation. The research will also extend to new deposit types and processing attributes (early environmental characteristics, blasting and predictive leaching) not covered in the original project (flotation recovery and comminution). A further aim of P843A is to provide technology transfer mechanisms to support sponsors in the implementation of these tools and methods. Case studies include Los Bronces, La Colosa, Cowal, Escondida, Codelco Norte, Andina, Cadia East, Telfer and Prominent Hill.

Sponsors

Anglo American Chile Ltda; Anglo Research; AngloGold Ashanti Australia Limited; AngloGold Ashanti Limited; Australian Laboratory Services Pty Ltd; Barrick (Australia Pacific) Limited; Barrick Gold Corporation; BHP Billiton Innovation Pty Ltd; Boliden Minerals AB; Codelco; Datamine Corporate Limited; Gold Fields Australia Pty Ltd; ioGlobal; Metso Minerals (Australia) Limited; Minera Escondida Ltd; Minera San Cristobal; Minerals and Metals Group Ltd; Mount Isa Mines Ltd; Newcrest Mining Limited; Newcrest Technology Ltd; OZ Minerals Limited; Quantitative Geoscience Pty Ltd; Rio Tinto Technological Resources Pty Ltd; Teck Resources Limited; Vale Australia.

Research Providers

ARC Centre of Excellence in Ore Deposits, Assoc. Professor Jeffrey (Jeff) Foster; Centre for Mined Land Rehabilitation; CRC ORE (Optimising Resource Extraction), Steve Walters; CSIRO Process Science and Engineering; Julius Kruttschnitt Mineral Research Centre, Professor Steve Walters; Parker CRC for Hydrometallurgy Solutions; University of Tasmania; W H Bryan Mining Geology Research Centre.

P924

Value

AU\$8,531,600

Commencement

December 2005

Duration

5 years

**Program
Manager**

Alan Stuart



Australian Mineral Science Research Institute (AMSRI)

The Australian Mineral Science Research Institute comprises four existing world-class mineral research centres, together with a global network of associates and collaborators. AMSRI will have the capacity to attack the major technical challenges in mineral and coal processing faced by the global mining industry in the next 25 years, and to reverse the declining trend in the production of technical specialists for the industry.

Concurrent programs include:

- Energy Efficient Liberation
- Frugal Water Use and Efficient Waste Management
- Innovative Processing, Material and Interface Science
- Advanced In-And Ex-Situ Analysis and
- Mathematics in Mineral Processing.

Its science will deliver vital sustainability outcomes to mineral producers, and will be a major force for mineral innovation and education.

Sponsors

Anglo Platinum Management Services (Pty) Ltd, AREVA NC, BHP Billiton, Freeport-McMoRan Mining Company, Orica Australia Pty Ltd, Rio Tinto Limited, Xstrata Copper Limited

Research Providers

University of South Australia, Dr Terry Wilks, Professor John Ralston, AMIRA International Limited, Ian Wark Research Institute (IWRI), Julius Kruttschnitt Mineral Research Centre, Professor Emmy Manlapig, University of Melbourne, Professor Thomas W Healy, University of Newcastle, Professor Graeme J Jameson

P931A

Value
AU\$900,000

Commencement
May 2011

Duration
2.5 years

**Program
Manager**
Gray Bailey

Reduced Erosion in Multiphase Flow

A project to develop new tools and more efficient solutions to reduce the wear/erosion maintenance costs in multiphase flows. This will be achieved through a combination of better knowledge of the fluid properties and the material properties of the vessels being used to transport fluids and with a solution focused on the flow geometry.

Sponsors

Alcoa World Alumina; BHP Billiton/Worsley Alumina Pty Ltd; Rio Tinto Alcan Limited; VALE Canada Ltd.

Research Providers

CSIRO Process Science and Engineering, Dr Jie Wu.

P961

Value
AU\$90,000

Commencement
December 2006

Duration
Ongoing

Program Manager
Joe Cucuzza

Global R&D Capacity & Activity Database

The aim of the project is to develop a web based database that will enable users to access information on research institutions, academics and R&D activity of interest.

The database will be populated with publicly available information on:

- Research institutions around the globe
- Academics, research speciality and current research activity
- Collaborative links with other institutions
- Public-domain R&D activity
- Post-graduate activity and projects

Initially the database will cover research capacity and activity in exploration, mining, mineral processing of interest to the copper industry but will later be expanded to encompass other commodities.

Sponsors

Anglo American Chile Ltda; BHP Billiton Base Metals; Codelco; Freeport-McMoRan Mining Company; Rio Tinto Limited; Vale

Research Providers

AMIRA International Limited, Mr Joe Cucuzza



MINERAL PROCESSING

P0090

Value

AUD \$13,690,831

Commencement

January 2008

Duration

4 years

**Program
Manager**

Ross McClelland

Optimisation of Mineral Processing Through Modelling and Simulation

The vision of the P90 project is to improve comminution, classification and flotation performance on sponsor sites through modelling, simulation and characterization of particles and their process environments, and through training and transfer of skills and technology to the industry. Based on the past achievements of P9N, P9O and associated projects will develop an integrated multi-component simulator structure of the entire comminution, classification and flotation process chain, and multi-component models of the unit operations.

The project will also deliver new measurement and characterization (and other) tools, which will considerably enhance the ability to predict and improve plant performance.

Sponsors

Alcoa World Alumina; Anglo Platinum (Rustenburg Platinum Mines Ltd); AngloGold Ashanti Limited; Ausenco Limited; Barrick Gold Corporation; Bateman Minerals & Metals (Pty) Ltd; BHP Billiton; Cayeli Bakir Isletmeleri-INMET; COREM; FLSmidth Minerals; Freeport-McMoRan Mining Company; Hatch Africa; Impala Platinum Ltd; Intellection Pty Ltd; LKAB; Lonmin Platinum; Magotteaux Pty Ltd; Metso Minerals Process Technology; Newcrest Mining Limited; Newmont USA Limited; Outotec; Outotec Minerals OY; OZ Minerals Limited; Polysius AG; Rio Tinto Limited; Rio Tinto Technological Resources Pty Ltd; Russell Mineral Equipment; Senmin South Africa (Pty) Ltd; Servicios Industriales Penoles SA de CV; Teck Metals Ltd; Vale; Xstrata Copper Limited.

Research Providers

Julius Kruttschnitt Mineral Research Centre, Professor Emmy Manlapig; Centre for Sustainable Resource Processing CRC; CRC ORE (Optimising Resource Extraction); Hacettepe University (Benzer); Hacettepe University (Ekmekci); McGill University; Universidade Federal do Rio de Janeiro; University of Cape Town; University of Newcastle.

Influence of Process Mineralogy and Pulp Chemistry on the Flotation of Fine and Coarse Minerals

The P260F Project is a 4 year project with the following objectives:

1. Increase recovery of value minerals in coarse, composite particles in sponsor flotation plants and ores
2. Increase recovery of value minerals in fine particles in sponsor flotation plants and ores
3. Improve selectivity in sponsor flotation plants and ores by increasing rejection of gangue minerals, including minerals containing penalty element such as arsenic, antimony, fluorine, mercury and bismuth in base metal concentrates
4. Increase recovery of gold in sponsor flotation plants and ores
5. Assess the impact of reducing water consumption in flotation, and develop strategies to mitigate against negative impacts
6. Improve the concentrate quality of key non-base metal concentrates such as iron ore and phosphate concentrates with our research collaborators
7. Develop characterisation tools, methods and protocols for use by sponsors
8. Technology and information transfer to sponsors operations.

This is accomplished through three separate but integrated modules;

1. Technology Transfer Module.,
2. Sulphide Mineral Technical Challenges Module including Tools and Methodologies
3. Non-Sulphide Mineral Technical Challenges Module.

The Technology Transfer Module includes the following three themes:

1. Technology Transfer from Previous Phases of the P260 Project.
2. Follow up Investigations from the Preceding P260 Projects
3. Technology Transfer from the P260F Project.

Each theme will include information transfer packages, follow-up investigations, workshops, biannual meetings, 1:1 briefings and demonstrations of the P260F toolbox. The Sulphide Mineral Technical Challenges Module including Tools and Methodologies includes the following themes:

Theme 1 - Coarse and Composite Particle Flotation Recovery

Theme 2 - Fine Particle Flotation Recovery and Particle Interactions

Theme 3 - Rejection of Iron Sulphide and Penalty Minerals in Sulphide Flotation

Theme 4 - Reducing Water Consumption and Water Treatment Options

Theme 5 - Increasing Gold Recovery in Flotation

Theme 6 - Tools and Methodologies.

There are four levels of sponsorship of the P260F project offered to prospective sponsors.,

1. Supplier Sponsorship
2. Sulphide Mineral Technical Challenges Sponsorship
3. Non-Sulphide Mineral Technical Challenges Sponsorship
4. Case Study Sponsorship.

Sponsors

COREM; Freeport McMoRan Process Technology Center; Magotteaux Australia Pty Ltd; Outotec; OZ Minerals Limited; Vale Exploration.

Research Providers

University of South Australia, Assoc. Professor Daniel Fornasiero; Sustainable Minerals Institute; Universidade de Sao Paulo.

P260F

Value

AU\$2,654,000

Commencement

May 2010

Duration

4 years

Program Manager

Terry Braden

P266F

Value

AU\$4,401,250

Commencement

January 2009

Duration

3 years

**Program
Manager**

Gray Bailey

Improving Thickener Technology

The use of thickeners in mineral processing and hydrometallurgy is widespread with operational objectives varying from low solids in the overflow from clarifiers to the production of high yield stress paste underflows. Across all applications there is a need for enhanced performance to meet demanding operational and environmental expectations. P266F will involve a core “pre-competitive” work program, with activity on three integrated topics plus confidential studies for individual sponsors: Experimental studies (laboratory, pilot-scale and site-based) required for insight and to provide the basis for model development and validation.

Alternative thickening concepts that may have the potential to produce step changes in performance will also be assessed and, where appropriate, examined in detail. Modelling studies to establish the physics and completing the numerics required for full thickener CFD modelling. Existing and to be developed modelling capabilities and general understanding will be applied to develop new design concepts and thickener technologies. Technology Transfer by multiple mechanisms to ensure the learnings, knowledge, tools and techniques arising from P266F activities are effectively transferred to P266F sponsors.

Sponsors

Alcoa World Alumina; ALUNORTE - Alumina do Norte do Brasil S/A; Anglo Research; BASF Australia Ltd; Bateman Engineered Technologies Ltd; BHP Billiton; BHP Billiton Nickel West Ltd; BHP Billiton/Worsley Alumina Pty Ltd; Cytec Industries Inc; Exxaro Resources Limited ; FLSmidth Minerals; Freeport-McMoRan Mining Company; Hatch Associates Pty Ltd; Metso Minerals Process Technology Asia-Pacific ; Minerals and Metals Group Ltd; Nalco; Outotec; Rio Tinto Technological Resources Pty Ltd; Shell Canada Limited; Teck Resources Limited; Total E&P Canada; United Company RUSAL; WesTech Engineering Inc.

Research Providers

CSIRO Process Science and Engineering, Dr John Farrow; CSIRO Mathematical & Information Sciences; Parker CRC for Hydrometallurgy Solutions; University of Melbourne, Professor Peter J Scales.

P498C

Value
AU\$678,500

Commencement
October 2008

Duration
3 years

**Program
Manager**
Ross McClelland

Enhanced Selectivity in Flotation Using Polymers

The AMIRA P498 series of projects (P498, P498A and P498B) have been successful in bringing together polymer manufacturers and mineral companies as sponsors of research, with mutual benefits. The underlying goal of the project series has been to provide sponsors with the ability to select the right polymer for the right application based on a knowledge of how the polymer interacts with the mineral surfaces. This approach represents a significant improvement over existing trial-and-error based testing of polymeric reagents.

The aim of this proposal is to extend our existing methodology in two ways:

- To expand our knowledgebase of polymer-mineral interactions, thus enabling a maturation of our polymer decision tree
- To advance our performance testing procedure to allow accurate prediction of the performance of polymeric depressants, dispersants, and flocculants, based on simple, measurable parameters of the adsorbed polymer.

Sponsors

Anglo Platinum (Rustenburg Platinum Mines Ltd); CP Kelco Oy; National Starch; Newcrest Resources Inc.

Research Providers

University of South Australia, Assoc. Professor David Beattie; Levay & Co Environmental Services, Mr George Levay.



P667B

Value

AUD \$996,000

Commencement

April 2008

Duration

3 years

Program Manager

Kriba Reddy

SAG Mill Monitoring Using Surface Vibrations

The previous extension of this project developed a ruggedised piece of equipment to measure surface vibrations on mills, which has been extensively tested at Northparkes Mine. The signals from the unit have been processed in a number of ways to show relationships to key mill operating parameter: toe and shoulder position, mill loading, particle size, ore hardness and liner wear.

This project is validating these relationships to develop predictive models. This will include an on-line advisory alarm system to warn operators of substantial departures from normal operating conditions. A unit has been installed on a mill at Mogalakwena Mine and a further installation is under consideration for another platinum mine. The data from these units will be used in the validation and modelling work.

Sponsors

Anglo Platinum (Rustenburg Platinum Mines Ltd); Freeport-McMoRan Mining Company; Rio Tinto Limited; Xstrata Zinc.

Research Providers

CSIRO Process Science and Engineering, Dr Ralph J Holmes; CSIRO Mathematical & Information Sciences.

P968

Value
CLP 360,000,000

Commencement
April 2009

Duration
3 years

Program Manager
Juan Daniel Silva

Flotation of Copper in Saline Waters

Small operations in Chile have conducted flotation in sea water in the past, although much of the flotation know-how developed there has been lost. Gold and nickel operations in Western Australia are known to use highly saline waters and the Batu Hijau gold mine of Newmont in Indonesia uses seawater for flotation.

Flotation of sulphide copper ores and their by-products (Mo, Au, Ag) in water with high concentration of electrolytes show problems in rougher and cleaner stages. For example, Cu, Mo and Au yield similar recovery levels in rougher circuits while concentrate grade decreases because pyrite depression is affected by the buffer effect of the electrolyte solution. In cleaner circuits pyrite depression using lime to adjust pH reduces recovery of Mo and Au.

Sponsors

Anglo American Chile Ltda; Antofagasta Minerals S.A.; BHP Billiton Base Metals; Teck Resources Limited.

Research Providers

Universidad de Concepcion, Professor Fernando Concha.



P996

Value
CLP 456,000,000

Commencement
April 2009

Duration
3 years

**Program
Manager**
Juan Daniel Silva

Advanced Instrumentation and Control Strategies for Optimising Thickeners

The project aims to develop new instruments and control strategies to optimise the thickening operation in the mineral industry with direct impact on water consumption.

Sponsors

Antofagasta Minerals S.A.; Codelco (Andina, El Teniente and Chuquicamata Divisions).

Research Providers

Universidad de Concepcion, Professor Fernando Concha.

P970

COMPLETED

Value

AU\$352,000

Commencement

May 2009

Duration

2 years

Program Manager

Gray Bailey

Selective Flotation Separation of Arsenic Minerals

Early selective rejection of components containing arsenic and other penalty elements (such as selenium, tellurium, mercury, antimony and bismuth).

The focus of this module was to see if there were opportunities to capitalize on the resultant products; a minor co-product stream with the contaminant mineral components and the major 'clean' value concentrate stream.

Sponsors

Anglo American Chile Ltda; Rio Tinto Limited.

Research Providers

CSIRO Process Science and Engineering, Dr Sharif Jahanshahi; Centre for Sustainable Resource Processing CRC.



EXTRACTIVE METALLURGY

P420D

Value

AU\$2,891,250

Commencement

August 2009

Duration

3 years

Program Manager

Kriba Reddy

Gold Processing Technology

The Gold Industry faces challenges more urgent than ever before.

- Large, high grade, free-milling deposits are rarely discovered and companies are turning to lower grade, complex and refractory ore bodies to maintain reserves.
- Human resources are still the key to successful operation, yet skilled gold metallurgists are in short supply.
- Investors punish deviation from guidance figures, yet the tools to optimise and to predict performance are not well suited to dealing with other than simple free milling ore bodies.
- OHS&E issues are in the forefront of concerns, yet readily applied tools and know-how are not available to companies to facilitate adherence to duty of care standards.

This proposal offers companies the opportunity to tap into a world class R&D project at a high leverage of sponsorship investment. This proposal is structured around four research themes:

- Capturing and Preserving Industry Knowledge
- Predicting and Improving Ore Processing
- Protecting the Licence to Operate
- Processing Difficult Ores

Sponsors

AngloGold Ashanti , Ausenco, Australian Gold Reagents, Barrick Gold Corp., Bateman Engineering, Gold Fields, Kemix, Magotteaux, Newcrest Mining, Newmont Mining, Orica Australia, Gekko Systems, Lihir Gold, RandGold Resources

Research Providers

Parker CRC for Hydrometallurgy Solutions, William Staunton

P521D

Quantifying the Effect of Solid Phase Oxalate (SPO) on Gibbsite Agglomeration

Primary objective is to quantify the effect of SPO on gibbsite agglomeration under the conditions relevant to the Bayer process and improve fundamental understanding of the mechanism of a possible interference by SPO with gibbsite agglomeration.

Sponsors

Alcoa of Australia Limited; BHP Billiton/Worsley Alumina Pty Ltd; Rio Tinto Alcan Limited; Rusal Aughinish.

Research Providers

CSIRO Process Science and Engineering, Dr Iztok Livk; Parker CRC for Hydrometallurgy Solutions.

Value

AU\$600,000

Commencement

May 2011

Duration

2 years

Program Manager

Gray Bailey



P575C

Value
AU\$460,500

Commencement
May 2011

Duration
3 years

**Program
Manager**
Gray Bailey

A Qualitative Investigation of Strength and Breakage Behaviour of SGA Produced from Refinery Hydrates

Project focuses on two main aspects of alumina quality: i) identifying precise mechanisms of alumina breakage, and ii) exploring a possible linkage between alumina strength and precipitation conditions

Sponsors

BHP Billiton/Worsley Alumina Pty Ltd, Hatch Associates Pty Ltd, Hydro Aluminium Metal Products, Rio Tinto Alcan Limited

Research Providers

CSIRO Process Science and Engineering - Dr Iztok Livk, Parker CRC for Hydrometallurgy Solutions

P705B

P705B Improved Anode and Cathode Processes in the Electrowinning of Base Metals

This extension project builds on the knowledge acquired in the earlier P705 series of projects, which have been conducted by the team from the Parker Centre, Murdoch University and CSIRO Minerals.

The P705B project provides a highly cost effective vehicle for participating companies to access significant technical knowledge on the electrowinning of base and other metals. It will also provide significant opportunity for industry benchmarking, programs for staff development, training, further education and networking, resources for process optimisation (cost reduction/increased recovery/reduced energy consumption), tools and information to enhance operations and opportunities to influence the direction of, and to participate in future electrowinning related collaborative projects.

Sponsors

Anglo Research; BHP Billiton Base Metals; Freeport-McMoRan Mining Company; Hatch Associates Pty Ltd; Hindustan Zinc Limited; Industrie De Nora S.p.a; Inppamet Ltda; Outotec; RSR Technologies Inc; Teck Resources Limited; VALE; Votorantim Metais.

Research Providers

Parker CRC for Hydrometallurgy Solutions, Professor Mike Nicol; CSIRO Process Science and Engineering; Laurentian University; Murdoch University; University of Utah.

Value

AU\$1,695,000

Commencement

April 2010

Duration

3 years

Program Manager

Terry Braden



P986

Value
US\$1,612 000

Commencement
April 2009

Duration
3 years

**Program
Manager**
Terry Braden

Improving Crushed Ore Agglomeration

Heap leaching of low grade copper and gold ores has been successfully employed over the past two to three decades. It has been realized that percolation is highly dependent on the size distribution of the crushed ore with fines playing a significant role. To minimize the percentage of fines and improve overall percolation, agglomeration of crushed ore has been implemented in gold and copper heap leach operations.

While agglomeration has become common practice to improve heap leach recovery, the fundamental understanding of the agglomeration process for crushed ores is still lacking. The project proposes to provide practical quality control tools for agglomeration of crushed ore. The project proposes to divide the work into a hub of practical research and commodity spokes (gold, copper and nickel) designed to be the source of test ore and allowing specific sponsor guidance.

Sponsors

BHP Billiton Minerals, Freeport-McMoRan Mining Company, Gold Fields Group Services (Pty) Ltd, Vale Exploration

Research Providers

University of Utah - Assoc. Professor Michael S Moats

P507C

COMPLETED
30 June 2011.
Now P507D

Value
AU\$934,400

Commencement
June 2007

Duration
4 years

**Program
Manager**
Gray Bailey

Thermodynamic Characterisation and Redox Chemistry of Organics in Bayer Liquor

This latest phase investigated the thermodynamic properties of Bayer process liquors containing various organic impurities. This involved the study of redox reactions in highly alkaline solutions containing humic substances, the outcome of which provided knowledge of the identity and abundance of organic species in Bayer Liquors.

A fundamental basis for flow sheet optimization was delivered to assist in improving impurity control, product recovery and process monitoring.

Sponsors

Alcoa World Alumina; Auginish Alumina Limited; BHP Billiton/Worsley Alumina Pty Ltd; Hydro Aluminium Metal Products; Rio Tinto Alcan Limited.

Research Providers

Murdoch University, Professors Peter M May and Clenn Hefter; Parker CRC for Hydrometallurgy Solutions.



SUSTAINABILITY

P791A

Value
AU\$878,400

Commencement
August 2007

Duration
3 years

**Program
Manager**
Gray Bailey

Potroom Dust: Character & Causes

The aims of this study are to:

- Determine the origins of potroom dust
- Identify the important generation mechanisms
- Evaluate the influence of cell technology, practices and alumina and crushed bath materials' properties on dust generation and composition
- Determine how broadly dust generation mechanisms and origins can be generalised across the industry, or whether they are specific to a given smelter or potroom.

Sponsors

Alcoa Inc; Hydro Aluminium, Rio Tinto Alcan Limited.

Research Providers

University of Auckland, Assoc. Professor Margaret Hyland, David Wong.

P933A

Value

AU\$1,134,000

Commencement

December 2009

Duration

3 years

Program Manager

Gray Bailey

Alternative Treatment Options for Long Term ARD Control

Evaluate the reaction mechanisms and products of selected treatment technologies and approaches including limestone, phosphate rock and silicates (separately or in combinations). Incorporate and evaluate data from field trials of treatments from sponsor sites and companion research programs. Outline the implications for management and application of selected technologies. To further test the rates of neutralisation provided by gangue silicate and non-carbonate minerals, validate these results and apply them to real waste mineralogies. Continuation of methodology development for determination of acceptable design targets for matching Acid Generation Rate vs Non-carbonate Acid Neutralisation Capacity.

Sponsors

BHP Billiton Iron Ore Pty Ltd; Hidden Valley Services Limited; Tasmanian Government; Rio Tinto Technical Services Limited; Teck Metals Ltd.

Research Providers

University of South Australia - Professor Roger Smart and Dr Jun Li, Levay & Co Environmental Services., Boojum Research

You can view the detailed 2011 AMIRA Financial Information
at the location below.

http://www.amirainternational.com/web/documents/corpdoc/Financials_2011.pdf

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