ACARP 2022

CHAIR'S REPORT

Welcome to our 2022 ACARP Report.

2022 marked ACARP's 30th anniversary – in that time we have awarded over 2,000 research projects from an industry commitment of over $424 million. A very significant achievement for the black coal industry as we reflect back to the commencement in 1992.

It has again been a very successful year for ACARP. The impacts of floods, COVID-19 absenteeism and labour shortages resulted in saleable coal production recorded by ACRL for FY22 reduced to 402.7 million tonnes. Given this backdrop, ACARP funded $19.5 million in direct research spend, marginally lower than FY21. COVID-19 restrictions hampered some research activity including travel restrictions limiting access to sites for field research activity.

With the easing of these restrictions we were finally able to host the Joint Strategy Session and ACARP Awards evening in September with approximately 70 attendees. It was very pleasing to present nine Research Excellence Awards to highly deserved researchers as well as Industry Excellence Awards to Peter Morris of Minerals Council of Australia for his long term support of ACARP and exceptional commitment during several MOU renewals and to Trevor Stay upon retirement; an industry champion in the area of greenhouse gas mitigation and gas utilisation with active engagment on the Underground, Mine Site Greenhouse Gas Mitigation and Research Committees and Board.

ACARP's role is to identify the coal industry's research needs; select and award research projects; and manage the research program, including communicating the outcomes to the industry in a way that best accelerates their implementation. Pressure on the Australian coal industry and the intensified geo-political global focus on decarbonisation has created a rapidly changing landscape for research. As we continue our focus on improving workplace safety and minimising the environmental impacts of mining, we refine our research strategy to meet industry needs both current and emerging.

During 2022 ACARP supported 277 research projects to a total project value of $91.5 million with additional funding of $14.3 million for 52 new projects. ACARP continues to deliver from a volunteer organisation of over 200 industry people and it is a tribute to what we can achieve as an industry. ACARP is ideally placed to continue providing ongoing leadership in black coal research in Australia.

In recognition of the quantum of ACARP's achievements in our milestone 30th year, I'd especially like to thank everyone involved in ACARP. Please enjoy the 2022 ACARP Report.

Rae O'Brien
Chairperson, Australian Coal Research Limited Board

ACARP – the Australian black coal industry's research program - is the nation's pre-eminent coal research funding organisation. It was established in 1992 and is fully funded by a levy of 5 cents per tonne of product coal paid by all Australian black coal producers.

ACARP is a collaborative program that utilises the industry's technical competence together with the broader research and science community to develop technologies and solutions to the many challenges facing our industry. This program helps producers to combine their expertise and resources and share the risks and rewards.

The sustainable production of coal remains the primary objective of the program. Major regional issues such as water resource management and impact of noise and dust on local communities are of major importance, as are safety and productivity.

This publication documents how the ACARP levy contributions have been invested during 2022.

People are the most important aspect of ACARP and are listed in this report falling into 4 categories.

- The Researchers who undertake each project.
- Industry Committee and Task Group members who evaluate and guide each proposal and provide funding recommendations.
- Industry Monitors who provide technical guidance for projects.
- The Board which provides corporate and program governance.

BOARD	• Strategic planning • Allocation of funds • Corporate and program governance
RESEARCH COMMITTEE	• Program overview - technical • Definition of strategic projects • Sustainability issues
Underground Committee	• Definition of priorities • Project selection • Technical oversight • Task groups • Nomination of Industry Monitors
Open Cut Committee	
Coal Preparation Committee	
Technical Market Support Committee	
Mine Site Greenhouse Gas Mitigation Committee	
Industry Monitors	• Provide technical guidance

Australian Coal Research Limited (ACRL)	**Australian Research Administration (ARA)**
• Program management	• Project administration
• Levy collection	• Distribution of outcomes
• Board secretariat	• Committee secretariat

AT A GLANCE

Vision

To assist the Australian black coal industry develop and adopt world leading sustainable mining practices and, through collaboration, to ensure a sustainable position for the global use of coal.

Mission

Utilise the collective technical competence and resources of the Australian black coal industry to develop and manage a comprehensive research program which, through technological and process innovation, assists coal producers achieve their financial, environmental and social objectives for sustainable development.

To maintain their position as world leaders, Australian coal producers must be profitable, innovative and, at the same time, mindful of their social and environmental obligations. Through ACARP, they combine their expertise and resources to direct and fund world class research that benefits the whole industry.

As a key driver of research and development in the coal industry, ACARP has responded by broadening its research focus. Today our projects cover a wide range of subjects, from developing and enhancing technology to reduce production costs, to improving safety for mine workers and to measuring our impact on the communities within which we operate.

Key facts:

- Invests approximately $20 million annually in research projects.
- Is fully funded by Australian black coal producers via a levy of five cents per tonne of product coal, currently committed to June 2025.
- Operates under a Memorandum of Understanding between the Commonwealth Government and the Minerals Council of Australia.
- The technical strength and industry focus is provided by the 200 senior technical people who are members of the technical committees, task groups and Industry Monitors.
- ACARP research projects are hosted at many mine sites.
- Has awarded $424 million in direct funding to 2,084 projects since ACARP's inception in 1992.

Australian Coal Research Limited (ACRL) is responsible for strategic planning, funding and the overall management of ACARP.

ACRL Board of Directors and Alternates *

DIRECTORS

John Desouza	Head of Internal Assurance	Jellinbah Group
Brett Domrow	Mine Planning Manager	New Hope Group
Tony Egan	Manager Project Governance	Glencore Coal Assets Australia
Frank Fulham	Executive General Manager – Technical Support & Projects	Yancoal
Shaun Hansen	Head of Resource Engineering	BHP Mitsubishi Alliance
Greg Hurney	Group Manager Mechanical Engineering	Bloomfield Collieries
Hayden Leary	Executive General Manager – Planning and Operations	QCoal Group
Ian Neill	Executive Director	ACRL
Brian Neilsen	Director of Engineering – Open Cut Mining	Peabody Australia
Raelene O'Brien	Executive General Manager Mining Excellence	Centennial Coal
John O'Connell	General Manager - Planning	Batchfire Resources
Luca Rocchi	Head of Technical	Anglo American Coal
Robert Simpson	Study Manager – Winchester South Project	Whitehaven Coal
Simon Thomas	General Manager - Dendrobium Mine	South32 Illawarra Coal
Steven Winter	Technical Services Manager	Kestrel Coal Resources

ALTERNATE DIRECTORS

Rhiannon Bailey	Manager Technology Delivery	BHP Mitsubishi Alliance
Sharif Burra	Executive General Manager – Health, Safety & Environment	Yancoal
John Grieves	Tenements Manager	QCoal Group
Brad Lucke	Principal Electrical Engineer – QLD	Glencore Coal Assets Australia

* Directors and Alternate Directors serving at 31 December 2022.

STRATEGY

Research Committee

The Research Committee, together with the Executive Director, is responsible for the overall operation and strategic direction of ACARP research. It takes a whole of industry view, striking a balance between the priorities of the five technical committees, short term operational challenges and longer term strategic issues. The individual technical committees develop detailed research priorities and select projects in their respective areas, addressing critical issues such as safety, licence to operate, cost effective resource utilisation and market support.

Communicating project outcomes is vital. The Research Committee encourages constructive engagement with government and community groups. ACARP also provides high quality technical information to key industry organisations. The technical committees publicise their individual project results through on site demonstrations, focused seminars, conference papers, journal articles, focussed E-Newsletters, and the ACARP website.

Responsibilities

The Australian coal mining industry must address sustainability issues over the longer term if mining companies are to retain their licence to operate. ACARP has responded by funding the development of new and innovative technologies and practices that will help producers achieve their financial, environmental and social goals.

Health and Safety

ACARP's number one program priority is health and safety, which reflects the industry's aspiration for a zero harm workplace.

Community and the Environment

The cumulative effects of coal mining are assuming a greater importance in Australia and a more collaborative approach is needed to assess and understand the complex range of economic, social and environmental impacts of new mine development and the expansion of existing ones. ACARP continues to support research in this important area.

Productivity

ACARP has a strong focus on increasing recoverable coal yield and reducing the cost of production. The coal preparation area continues to invest in research designed to improve plant efficiency, and the underground producers are focused on improving the rate of roadway development which continues to lag the increasingly productive Australian longwalls. In open cut operations the focus is on improving equipment performance and reliability.

A proportion of funding is retained for major projects that the Research Committee and Board identify as strategically important whole of industry projects.

COMMITTEE MEMBERS

Tony Egan	**Manager, Project Governance (co-chair)**	**Glencore Coal Assets Australia**
John Grieves	**Tenements Manager**	**QCoal Group**
Sharif Burra	Executive General Manager – Health, Safety & Environment	Yancoal
Graeme Harris	Manager - Technical Marketing and Logistics	Kestrel Coal Resources
Kim Hockings	Principal Sustainability Partnerships	BHP
Ben Klaassen	Principal Environment (GHG)	BMA
Andrew Lau	Mine Closure Manager (co-chair)	Yancoal
Brad Lucke	Principal Electrical Engineer – QLD	Glencore Coal Assets Australia
Kevin Rowe	Group Manager	Glencore Coal Assets Australia
Dave Young	Group Engineering Manager	Centennial Coal

Funding for projects is summarised in the following table in categories that demonstrate the diversity of projects supported by the ACARP program.

CURRENT OR COMPLETED DURING YEAR

Category		No of Projects	ACARP Funding
Underground	Coal Burst	14	$3,861,726
	Detection and Prevention of Fires and Explosions	3	$628,300
	Environment - Subsidence and Mine Water	9	$2,561,320
	Geology	4	$711,468
	Health and Safety	15	$4,959,388
	Maintenance	9	$5,649,775
	Mining Technology and Production	10	$8,118,833
	Roadway Development	3	$8,486,136
	Strata Control and Windblasts	21	$4,761,312
	Ventilation, Gas Drainage and Monitoring	20	$4,549,342
Open Cut	Drilling and Blasting	4	$1,315,689
	Environment	19	$6,791,590
	Geology	7	$792,630
	Geotech	7	$1,890,061
	Health and Safety	8	$2,522,876
	Maintenance and Equipment	12	$2,067,830
	Mining and the Community	1	$199,472
	Overburden Removal	1	$346,046
Coal Preparation	Dewatering	14	$2,914,162
	Environmental Improvement	1	$350,000
	Fine Coal	19	$7,390,261
	General	10	$2,147,896
	Gravity Separation	5	$947,922
	Process Control	9	$2,163,701
Technical Market Support	Future Technologies	1	$71,500
	General	6	$1,440,610
	Major Projects	1	$4,169,012
	Metallurgical Coal	29	$4,826,232
	Thermal Coal	2	$336,260
Mine Site Greenhouse Gas Mitigation		6	$2,189,122
Scholarships		7	$2,310,000
Total		**277**	**$91,470,472**

PROJECTS UNDER MANAGEMENT

NEW FUNDING APPROVED

Category	No of Projects	ACARP Funding	Total Funding *
Underground	14	$4,615,315	$6,725,476
Open Cut	13	$3,771,412	$6,580,969
Coal Preparation	11	$3,372,803	$4,712,397
Technical Market Support	13	$2,342,592	$3,085,077
Mine Site Greenhouse Gas Mitigation	1	$238,464	$555,406
Grand Total	**52**	**$14,340,586**	**$21,659,325**

* Total Funding includes in-kind support provided by the researcher and host mine identified in the research proposal.

The resultant leverage i.e. Total funding ÷ ACARP Funding = 1.51 times meaning that for every $1.00 of ACARP funding research there is $0.51 of in-kind support (note this leverage varies project by project).

The primary goal of the underground research program is to achieve zero fatalities while minimising negative effects on the workforce, environment, equipment and the resource. This is reflected in the targeted occupational health and safety program, strengthening ventilation and gas management technology, minimising exposure to coal dust and diesel particulates, minimising risks from fires, explosions and coal bursts, advancing emergency response technologies and addressing workplace health risks.

The second goal is to assist producers to adopt new and innovative technologies that reduce operating costs, along with improved exploration methods and better management of the risks associated with ground control. The industry is also determined to improve roadway driveage rates.

The environmental impacts of mining are assuming a greater importance and must be managed to the satisfaction of the community. Priorities include development of intrinsically safe electrical vehicles to facilitate the reduction of diesel particulates in the underground work environment. ACARP recognises the importance of continuous improvement in this area to ensure the industry maintains broad community support.

COMMITTEE MEMBERS

Sharif Burra	**Executive General Manager – Health, Safety & Environment (co-chair)**	**Yancoal**
Brad Lucke	**Principal Electrical Engineer – QLD (co-chair)**	**Glencore Coal Assets Australia**
Peter Baker	Mine Planning Manager	BHP
Bharath Belle	Group Ventilation Manager	Anglo American Steelmaking Coal
Dennis Black	Manager Technical Services	South32 Illawarra Metallurgical Coal
Gary Brassington	Approvals Manager	South32 Illawarra Metallurgical Coal
Peter Corbett	General Manager Geosciences	Centennial Coal
Bob Coutts	Superintendent Geology & Geotechnical	BHP Coal
Frank Fulham	Executive General Manager - Technical Support & Projects	Yancoal
John Grieves	Tenements Manager	QCoal Group
Jordaan Hennie	Regional Manager, Strategic Mine Planning	Anglo American Steelmaking Coal
Raymond Howard	Chief Mining Engineer	Yancoal
Matt Jones	Lead Superintendent Mine Planning	BHP
Jimmy Martin	Superintendent Production Engineering - Broadmeadow	BHP
Graham Morris	Project Manager Technical	Anglo American Steelmaking Coal
Rob Nowell	Operations Excellence Manager (Underground)	Anglo American Steelmaking Coal
Rae O'Brien	General Manager Springvale/Mining Advisor	Centennial Coal
Paul O'Grady	Group Manager - Technical Services	Glencore Coal Assets Australia
Peter Quinn	Mining Engineering Manager	South32 Illawarra Metallurgical Coal
Patrycja Sheffield	Group Manager Mining Engineering	Centennial Coal
Peter Smith	General Manager - Health, Safety, Training	Centennial Coal
Brian Wesley	Acting General Manager, Moolarben Coal Operations	Yancoal
Steve Winter	Technical Services Manager	Kestrel Coal Resources
Dave Young	Group Engineering Manager	Centennial Coal

UNDERGROUND PROJECTS

PROJECTS UNDER MANAGEMENT

Category	No of Projects	ACARP Funding
Coal Burst	14	$3,861,726
Detection and Prevention of Fires and Explosions	3	$628,300
Environment - Subsidence and Mine Water	9	$2,561,320
Geology	4	$711,468
Health and Safety	15	$4,959,388
Maintenance	9	$5,649,775
Mining Technology and Production	10	$8,118,833
Roadway Development	3	$8,486,136
Strata Control and Windblasts	21	$4,761,312
Ventilation, Gas Drainage and Monitoring	20	$4,549,342
Total	**108**	**$44,287,600**

NEW FUNDING APPROVED

No of Projects	ACARP Funding	Total Funding
14	$4,615,315	$6,725,476

Total Funding includes in-kind support provided by the researcher and host mine identified in the research proposal.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
COAL BURST				
Current	**Review of Australian and International Coal Burst Experience and Control Technologies C25004** Ismet Canbulat, University of New South Wales	$404,000	Coal Burst Task Group	One of the most difficult, longstanding engineering problems associated with coal mining is the catastrophic and dynamic failure of coal mine structures known as bursts. Limited research has been conducted on coal bursts in Australia. This project will develop preliminary coal burst risk identification and control technologies for Australian underground coal mines through a review and evaluation of international coal burst experiences and technologies.
Current	**Energy, Burst Mechanics Required for Coal Bursts and Energy Release Mechanisms C26066** Ismet Canbulat, University of New South Wales	$357,500	Coal Burst Task Group	Because coal bursts occurs under diverse geological, stress and mining conditions, there is no one set of defining characteristics for this phenomenon. This makes it difficult to determine which mechanisms have contributed to past coal burst occurrences. This project will assess a range of energy sources and their release mechanisms using analytical and computational methods to determine the energy magnitude required to cause a coal burst.
Complete	**True Triaxial Strength of Coal Measure Rocks and its Impact on Stability of the Roadways and Coal Burst Assessment C27039** Winton Gale, SCT Operations	$187,000	Coal Burst Task Group	Conventional methods of measuring triaxial behaviour of rocks do not consider the impact of the intermediate principal stress on strength and the failure pathway of the coal measure rocks. In this project researchers determined the impact of the intermediate principal stress on strength of coal measure rocks, how this impact changes the roadway behaviour, and its impact on energy accumulation in different areas.
Current	**Ground Support Requirements in Coal Burst Prone Mines C27041** Ismet Canbulat, University of New South Wales	$150,000	Coal Burst Task Group	Coal bursts and bumps are one of the critical and longstanding engineering problems facing the coal industry. In coal burst prone and seismically active mines, energy is released dynamically, resulting in violent rock fabric failure, keyblock ejection and closure of excavations. The main criterion governing effective ground support in coal burst conditions is energy absorption, as opposed to support resistance in the conventional rock fall case. This project aims to improve understanding of ground support strategies. Functional requirements for effective ground support technologies for coal burst control are being developed that are in line with Australian regulations, and mine design and operational practice.
Complete	**Damage and Risk from Seismic Events C27060** Winton Gale, SCT Operations	$435,000	Coal Burst Task Group	Micro seismic monitoring has been routinely used in metalliferous mines to determine the location of seismic events, review mine planning, and manage risk areas of rock bursts. However, in contrast to metalliferous mines, coal mines tend to have horizontally layered strata with varied sonic properties. This project used improved velocity models and waveform propagation models to assess the damage which may occur from seismic events in proximity to coal mining, such as longwall caving, longwall floor fractures, reactivation of geological structures, and normal development roadway driveage.
Current	**Advanced Fracture Propagation and Rupture Testing of Coal Measure Rocks Under Dynamic Condition to Replicate Coal Burst C28009** Amin Heidarpour, Monash University	$287,500	Coal Burst Task Group	The mechanistic behaviour of coal burst under Australian conditions is not well understood and there is a lack of solid experimental data sets on coal measure rocks. In this project, unique experimental tests will be conducted on different coal measure rocks under dynamic and in situ unloading conditions using advanced laboratory equipment. These experiments will provide researchers with a better understanding of the source and mechanics of coal burst through mechanical characterisation of fracture propagation. This is an important step in establishing the mechanistic behaviour of coal burst.
Current	**Microfracture Analysis as a Trigger for Coal Bursts C28012** Yvette Heritage, SCT Operations	$498,000	Coal Burst Task Group	Gas related coal bursts can be generated in coal with an elevated pore space or an increased frequency of micro fractures. The ability to analyse the geometry of micro fracture fabrics is challenging and not feasible using optical methods. This extension project will use high resolution digital imaging to form the basis for micro fracture analysis.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Innovative Coal Burst System to Investigate the Influence of Confinement Loss and Pre-Conditioning on Coal Burst Mechanism C29007** Murat Karakus, University of Adelaide	$329,000	Coal Burst Task Group	This project aims to investigate coal burst due to loss of confinement by using hollow cylinder loading/unloading systems which will enable replication of the excavation process. This approach will provide reliable, cost effective data for direct use in mine design and geotechnical monitoring. The project will develop laboratory apparatus for realistic coal burst tests to examine the mechanism; investigate and quantify the influence of confinement loss on coal burst and develop a stress relief method based on induced damage to reduce the risk of coal burst.
Current	**In-situ Stress Measurements using Cored Coal/Rocks for Coal Burst Management C29010** Murat Karakus, University of Adelaide	$228,600	Coal Burst Task Group	It is challenging to measure in situ stress in areas at great depth when access is only available via exploration boreholes. It is also challenging to access the areas above longwall face where a high-stress concentration is expected. Knowing in situ stress magnitudes and their orientations are critical in managing coal burst. This project aims to develop a new method based on deformation rate analysis and acoustic energy to calculate the magnitude and principal directions of in situ stresses from cored rocks.
Current	**Data Processing Strategy for Distributed Optic Fibre Sensing and Development of Methods for Real Time Data Processing C29038** Joey Duan, CSIRO	$196,460	Coal Burst Task Group	The microseismic monitoring technique is a recognised tool with high potential for monitoring coal burst precursors. A densely-spaced geophone network should be used, but existing microseismic systems are expensive. Distributed optic fibre sensing, DOFS technology offers a cost-effective alternative. This novel sensing technology can detect ground vibrations using only one ordinary optic fibre extended for more than 20km, at a sensing spatial resolution of 2-5 metres. This project aims to develop a strategy to deal with the huge DOFS data set in real time and to develop new approaches and algorithms for rapid data processing. Investigation of efficient data storage procedures will be conducted for archiving the big data set for back analysis.
Current	**Forecasting Coal Burst Risks Near Various Types of Faults, Folds and Dykes C29039** Baotang Shen, CSIRO	$190,666	Coal Burst Task Group	Many coal burst events have occurred near faults, other geological structures and intrusions. Underground coal mines often encounter different types of geological features, such as normal faults, thrust faults, strike-slip faults, folds, dykes at various scales, and it is still not clear which specific geological structure is more likely to cause coal burst. This project will investigate various types of geological structures to determine their effects on the risk of coal burst. It will also address the interconnection between coal burst and outburst in high gas mines.
Current	**Coal Burst Research Findings C33014** Winton Gale, SCT Operations	$388,000	Coal Burst Task Group	Risk assessment and management of dynamic burst events are hampered by the inability to apply threshold characteristics from one seam to another as the threshold values are dictated by local geological characteristics. This project aims to examine the threshold energy requirement for a range of 'generic' mined seams, provide guidance on the factors that should be considered in risk analyses, and estimate the threshold values associated with dynamic bursts. The energy threshold values will be converted into stress, gas pressure and seismic magnitude, which are more readily applied to mining practice.
Current	**Application of US Coal Burst Practical Experience/Research for Identification of Elevated Risk Domains in Australian Operations C33032** Hamid Maleki, Maleki Technologies Inc	$150,000	Coal Burst Task Group	Since 1995, US mining companies, the Bureau of Land Management, NIOSH and the School Institute for Trust Land Administration have been combining computational and statistical techniques to advance the understanding of violent failure mechanisms by identifying significant failure factors. The objectives of this project are to quantify mining, geologic and geotechnical risk factors in US mines by re-examining burst prone case studies that address failure mechanism for three diverse coal fields. The multivariable statistical analyses will be revised, and valid, predictive equations provided for evaluation by Australian operators.
Current	**Listening for Bursts C34013** Ian Gray, Sigra	$60,000	Coal Burst Task Group	For coal to outburst, it needs to have free pressurised gas in void space within the coal. The failure and pressurisation processes are not instantaneous. This project will investigate the options for enhanced micro seismic listening devices and visual indicators for use near the development face. When cutting has finished and the panel is quiet, a miner wearing earphones, earmuffs fitted with a receiver could listen to a geophone for any abnormal noise. Researchers will prepare a set of requirements for an intrinsically safe underground system with a view to building and testing this equipment in a further stage of the project.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
New	**Investigation of Pre-Installation of Optic Fibre Cable in Exploration Holes for Longwall Weighting and Coal Burst Monitoring C35014** Baotang Shen, CSIRO	$258,473	Coal Burst Task Group Matt Tsang, Anglo American Steelmaking Coal	Distributed optic fibre sensing, DOFS has been proven to be more effective than geophones for microseismic monitoring of ground conditions. This project will develop a novel optic fibre installation approach for assessing longwall weighting progress and coal burst risks using multiple geo-exploration holes for DOFS microseismic monitoring. This new method will enable mine operators to obtain fracturing event locations with high reliability and spatial resolution in a more cost effective manner compared with using geophones.
DETECTION AND PREVENTION OF FIRES AND EXPLOSIONS				
Current	**Use of Compressed Air Foams, CAFs to Alter Goaf Air Circuits and Mitigate Spontaneous Combustion Events C28013** Alaster Wylie, Mines Rescue	$392,500	Bharath Belle and Paul Wild, Anglo American Steelmaking Coal David Webb, Glencore Coal Assets Australia Peter Baker, BHP Rae O'Brien, Centennial Coal Sharif Burra, Yancoal	Spontaneous combustion in the goafs of longwall mines is a serious hazard. Compressed air foam has been used in Turkey, the Czech Republic and China to bring spontaneous combustion under control. This technology, which is inexpensive and simple to use, has not be tested nor deployed under Australian conditions. In this project, a full system ready for deployment will be procured, deployed in at least one Australian underground longwall panel, and the cost and effectiveness of this technique evaluated. If the trial is successful, the system will be retained by New South Wales Mines Rescue and maintained similarly to the MineShield.
Current	**Evaluating GAG Docking Connections / Simulations C29013** Duncan Chalmers, University of New South Wales	$82,100	Bharath Belle, Anglo American Steelmaking Coal John Grieves, QCoal Services Ken Singer, BMA	Queensland mines are required to have Górniczy Agregat Gaśniczy, GAG docking stations in place to allow the GAG to be deployed during an uncontrolled heating event. The placement of these docking stations should allow for the product from the GAG to enter the mine and assist in bringing the event under control. However, recent events have shown GAG effectiveness to be limited. Using validated vensim models of three mines, researchers will simulate the docking of the GAG to these mines and, via thermodynamic modelling, determine the effectiveness of its deployment. Researchers will also investigate modifications or additions to the GAG to raise its effectiveness.
Current	**Investigation into the Thermal Ignition Caused by IS Power Supplies C29026** Andre De Kock, Simtars	$153,700	Brad Lucke, Glencore Coal Assets Australia	It is difficult to comply with intrinsically safe standards when cabling is installed on mining machines in confined areas and is subjected to a regular build-up of dust and other flammable materials. This project aims to determine the fault conditions arising in an intrinsically safe electrical circuit that could ignite combustible material on a mining machine. Researchers will examine the role and extent that combustible material accumulation can cause or contribute to the risk of equipment fires when ignited by intrinsically safe power supplies, and the parameters to be considered in installing an intrinsically safe circuit in an area where there could be an accumulation of flammable materials.
ENVIRONMENT - SUBSIDENCE AND MINE WATER				
Current	**Swamp Hydrology Modelling for Advancing Rehabilitation Planning and Management C27059** Mandana Shaygan, University of Queensland	$424,270	Gary Brassington, South32 Illawarra Coal Peter Corbett, Centennial Coal	The region of the Western Coalfield and the Newnes Plateau is known for its narrow valleys in which vulnerable temperate peat swamps on sandstone, THPSS occur with a range of associated vegetation species. These Blue Mountains swamps are classified as a vulnerable ecological community by the NSW Scientific Committee. This project is assessing the resilience and sustainability of THPSS in response to variations in water availability due to changes in environmental conditions, such as climate variability or mining-induced hydrological impacts.
Current	**Monitoring Hydrological Status of Complex Upland Heath Communities Using Canopy Conductance and Thermal Imaging C28004** Andrew Fletcher, Queensland University of Technology	$230,964	Gary Brassington, South32 Illawarra Coal Peter Corbett, Centennial Coal	Regulators are concerned about the loss of listed communities in complex shrub swamp systems due to modified hydrology. Existing technology can detect dramatic changes in vegetation health, however new methods are needed to detect subtle, long term spatial and temporal changes to moisture patterns. This project aims to identify remote sensible signals for plant stress in these communities. Researchers will use calibrated thermal imaging on board small unmanned aerial service platforms to assess canopy water use through the day. Foliage is usually cooler than the ambient air temperature when soil water is readily available, so higher temperatures indicate change in moisture patterns.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Complete	**Optimisation of Water Management for Coal Mines - Water Tracer Tools C28024** Wendy Timms, Deakin University	$296,100	Peter Corbett, Centennial Coal Steve Downes, Glencore Coal Assets Australia	A tracer is a substance in water than can be used to track the direction and flow of water movements and to 'fingerprint' specific waters. Tracers can help to improve the effectiveness of water treatment technologies and quantify non-mining effects on surface waters near mine sites. Researchers reviewed options for the use of tracers in Australian underground coal mines based on global case studies and demonstrated opportunities for their use in soil moisture and surface and groundwater management. Advanced methods, isotopes, biomarkers were combined with standard methods, hydrochemistry to trace soil, surface water and aquifer interactions.
Current	**Inclusion of High Interest Native Plants in Mine Site Restoration Programs: Propagation, Translocation and Field Reintroduction C28028** Cathy Offord, Royal Botanic Gardens and Domains Trust, Sydney	$444,055	Gary Brassington, South32 Illawarra Coal Peter Corbett, Centennial Coal	The Australian Persoonia genus of shrubs and small trees has a high ecological importance. Nine species are listed as 'at significant risk' in New South Wales due to population decline. Seven of these species are recorded within mining leases; however, they have not been included in mine site restoration plans due to a lack of success in germination, propagation and translocation of plants on a horticultural scale. This three-year extension project seeks to improve the conservation capacity of this genus by conducting experimental plantings on a mining lease. The project will enable the first field introductions of Persoonia hindii to be undertaken.
Complete	**Reducing Brine Volume through Membrane Distillation Crystalliser C28030** Ramesh Thiruvenkatachari, CSIRO	$214,350	Jason Fittler, Anglo American Steelmaking Coal Paul O'Grady, Glencore Coal Assets Australia	Reverse osmosis, RO is one of the leading desalination treatment technologies and is capable of achieving up to 60% water recovery, depending on the feed mine water characteristics. While efforts are under way to improve RO performance, management of the brine produced as a by-product of treatment remains a challenge, as a proportion of available water storage capacity must be dedicated to brine. Reducing brine volume will make RO technology a more attractive proposition. This project investigated the feasibility of applying the membrane distillation process to concentrate hypersaline brines to saturation and then crystallising them into solid products.
Current	**Southern Coalfields Coal Washery Reject, CWR Characterisation and Classification, including Management Strategies for Applications in Civil Engineering C29016** Christopher Meikle, SLR Consulting Australia	$160,000	Gary Brassington, South32 Illawarra Coal Julian Potten, Kestrel Coal Resources Rae O'Brien, Centennial Coal	Despite decades of successful use in civil engineering projects, the utilisation of coal washery rejects has not been embraced by legislators, regulators, government agencies and other project stakeholders. A key constraint is the lack of contemporary reference resources that address modern environmental and geotechnical performance criteria. The project aims to develop and publish a peer reviewed research paper that addresses these issues. The paper will be used as an industry standard document for reference by mine suppliers, developers, contractors and regulators when using coal washery rejects in civil engineering applications.
Current	**Regional Ground Movement on Bedding Planes and Potential Impacts on Groundwater C33015** Ken Mills, SCT Operations	$150,000	Gary Brassington, South32 Illawarra Coal John Watson, Glencore Coal Assets Australia Peter Corbett, Centennial Coal	This desktop study seeks to provide a credible basis to assess standśoff barriers suitable for water dependent surface features and to further understand the mechanisms that impact the hydraulic conductivity of the overburden strata around extracted longwall panels. Researchers will collate and analyse information from subsidence monitoring databases, exploration drilling logs and packer testing, inclinometer monitoring records, piezometer monitoring records and mine water balance histories.
Current And New	**Pilot Scale Membrane Distillation Crystalliser, MDC with Renewable Heat Source for Mine Water Brine Management C33021** Ramesh Thiruvenkatachari, CSIRO	$362,131 Current $607,064 New	Paul O'Grady, Glencore Coal Assets Australia Tim Kendrick, Anglo American Steelmaking Coal	Acid mine water and highly saline reverse osmosis brines can be treated by low thermal based membrane distillation process coupled with a crystalliser, MDC process. This process concentrates challenging mine waters to saturation levels and reduces their volume, with simultaneous recovery of reusable quality water. This project aims to undertake a mine site demonstration of the MDC system at Glencore Collinsville mine. Saline and acid mine drainage and mine impacted water will be treated under mine site conditions.
Current	**Fire Resilience of Temperate Highland Peat Swamps on Sandstone C33028** Mandana Shaygan, University of Queensland	$279,450	Gary Brassington, South32 Illawarra Coal Peter Corbett, Centennial Coal	Temperate highland peat swamps on sandstone are listed as endangered ecological communities and there are concerns regarding their vulnerability to the impacts of underground coal mining. This project will assess the resilience of these to fire and how resilience varies between mine impacted swamps and non-impacted swamps. Researchers will use pre-fire data collected during a previous project plus the range of post-fire conditions that can now be monitored at the Springvale and Dendrobium mining areas.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
New	**Rehabilitation Options for Ponded Areas Due to Longwall Coal Mining C35016** Louisa Rochford, University of Queensland	$397,200	Jason Fittler, Anglo American Steelmaking Coal Ned Stephenson, Glencore Coal Assets Australia Raymond Howard, Yancoal	Little research has been undertaken into the most appropriate options for rehabilitating land subsided by longwall mining in Australia. This project will investigate the implications of retaining ponded areas from longwall mining, including their contribution to environmental values. Researchers will analyse the impacts on site topography and drainage, surface hydrology, geomorphology, soil hydrology, water quality and geochemistry, fauna and flora.
GEOLOGY				
Current	**Automated Structural Mapping using a Mobile Laser Scanner C27057** Simit Raval, University of New South Wales	$168,646	Brian Vorster, Glencore Coal Assets Australia Patrycja Sheffield, Centennial Coal Roger Byrnes, Byrnes Geotechnical	Underground roadway stability is a critical safety and production issue. However, accurate structural mapping over a large scale and monitoring changes in roadway deformations remains problematic. An innovative mapping method has been developed that enables consistent 3D mapping over large scales by reducing sensor drift. The technology has been validated using mine plan and surveyed data. This project will test the method of automated co-registration and georeferencing mechanism for roadway monitoring, examine the change detection and roadway monitoring capability over large scale using multiple 3D point cloud data, and map underground structural features.
Complete	**Longwall Geological Risk Minimisation using Advanced Electromagnetic and Sonic Technologies C28031** Scott Thomson, CoalBed Energy Consultants	$262,750	Jonathan Lowe, BHP Owen Salisbury, Whitehaven Coal	Hazard identification is critical to safe and productive longwall operation. This project developed an improved approach of evaluating geological risk in longwall panels prior to coal extraction using the German radio imaging method, RIM 6 a type of electromagnetic technology. The results combine to produce a geological risk hazard map and process. Integration of the underground inseam drilling and mapping will assist the interpretation process.
Complete	**Improving Coal Seam Model Accuracy for Longwall Automation by In-Seam Borehole Radar Imaging and Data Integration C29032** Binzhong Zhou, CSIRO	$210,072	Julian Potten, Kestrel Coal Resources Mick Stadler, Glencore Coal Assets Australia	Longwall automation depends on the development of automatic coal seam, horizon tracking and lateral guidance systems to mine the target coal seam while steering to the desired target. The key objective of this project was to demonstrate a method that improves the accuracy of the coal seam model for longwall machine automation and guidance. Researchers used borehole radar to survey the in-seam drill holes to accurately locate the seam roof or floor. This work will fill the gap between the coarse and inaccurate exploration data and the detailed seam knowledge available at the longwall face. Integrating these data sets will provide an opportunity to refine the coal seam model in near real-time for longwall machine automation and guidance at the 10s of metres wavelength and centimetre scale accuracy in depth.
Complete	**Statistical Analysis of Methods for Selecting Coal/Non-Coal Boundaries from Density Logs C33038** Brett Larkin, GeoCheck	$70,000	Mark Laycock, Glencore Coal Assets Australia	A computer algorithm was developed in a previous project to assist geologists select coal/non-coal boundaries from short spaced density logs and lithology boundaries from natural gamma logs. However, geologists use a wide variety of methods to pick these points from the short spaced density log. This project aims to provide a consistent approach for selection of coal/non-coal boundaries between different holes, geologists and projects, and provide a more accurate determination of the thickness of coal available for mining. Researchers will statistically assess which method is the most accurate and determine what factors influence accuracy.
HEALTH AND SAFETY				
Current	**Proximity Detection Systems Specification for Underground Coal Mining Machines C24010** Andre De Kock, Simtars	$565,988	Brad Lucke, Glencore Coal Assets Australia	While the increase in the size and speed of mobile mining and support equipment underground has created many operational benefits, poor visibility has emerged as a significant safety hazard. This project will investigate the most prominent collision scenarios in underground coal mines and test the available proximity detection systems against a set of standard scenarios. Human factors and simple management tools that need to be considered when designing and implementing effective collision awareness and avoidance strategies will also be investigated.
Current	**Mine Rescue Vehicle Radar Sensing Integration C27049** Gareth Kennedy, Simtars Lance Munday, CSIRO	$254,405	Brad Lucke, Glencore Coal Assets Australia	Reliable situational awareness in low visibility conditions underground remains an important issue for the coal industry. A robust, relatively low cost sensor is needed that is unaffected by high ambient dust, smoke or water vapour conditions. This project is developing an integrated radar sensor and user interface that is applicable to a wide range of fixed and mobile sensing applications in underground coal mines. The system will provide robust ranging and mapping that is tolerant of both airborne and sensor-surface contamination.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Optimum Air Velocity for Management of Both Dust and Gas on Longwall Faces C28014** Rao Balusu, CSIRO	$275,250	Bharath Belle, Anglo American Steelmaking Coal Ken Singer, BMA Russell Thomas, South32 Illawarra Coal	Ventilation is one of the principal methods used to control/dilute gas and dust concentration levels on longwall faces. Australian mines traditionally use higher ventilation airflows to manage gas and dust on longwall faces; however, some experts suggest that decreasing longwall airflows reduces dust levels on the face. This project will investigate the effect of various mining and ventilation parameters and determine optimum air velocities for management of dust and gas concentration levels on longwall faces under high production scenarios with differing cutting heights. Field studies and modelling will be conducted.
Current	**Developing Suitable Gas Separation Membrane for Breathing Apparatus C28023** Victor Chang, Monash University	$196,500	Bharath Belle and Paul Wild, Anglo American Steelmaking Coal Ken Singer, BMA Lee Earnshaw, Peabody Australia Coal	Self-rescue respirators are the main device used by underground mine personnel to protect themselves in conditions of elevated concentrations of carbon monoxide, CO and other volatile organic compounds, VOCs. However, these devices have a number of shortcomings. When the respirator converts CO and other VOCs into carbon dioxide, it generates heat which can damage the sensitive tissues in the respiratory system and lead to serious health concerns under prolonged usage. In addition, the lifespan of these devices is short. This project will explore the feasibility of developing a gas separation membrane that can help to increase oxygen concentrations and reduce the concentration of harmful gases. This technology is expected to reduce the weight of the respirator and lengthen usage time.
Current And New	**Personal Real Time Dust/ Particulate Monitor, Direct Mass Based Measurement C28029** Peter Phaedonos, Lear Siegler Australasia	$1,011,780 Current $509,950 New	Bharath Belle, Anglo American Steelmaking Coal Brad Lucke, Glencore Coal Assets Australia Ian Marshall, BHP	The effects of exposure to respirable coal dust in large and sustained doses leads to health effects, such as coal workers pneumoconiosis. The personal dust monitor, PDM a device worn to measure the quantity of hazardous airborne particulates, logs and records exposure levels and provides warnings to the user if dangerous levels are reached. The original device, which uses tapered element oscillating microbalance technology, was the result of a collaboration between NIOSH, MSHA and the US mining industry. The objective of this project is to use the existing technology to develop a PDM that is suitable for use in Australian underground coal mines. The PDM will be portable, ergonomic, rugged and rated for use in explosive environments. This additional support will enable SIMTARS to complete intrinsically safe certification of a personal dust monitor, PDM. The PDM is portable, ergonomic, rugged and rated for use in explosive environments of Australian coal mines.
Current	**Resilience and Mental Health in Mining C29020** Rebecca Mitchell, Macquarie University	$201,666	Rae O'Brien, Centennial Coal Sharif Burra, Yancoal	Recent studies have found that coal mining employees have psychological distress levels significantly greater than the general population and that workplace factors may be a significant contributor to distress and poor mental health. Resilience is the ability to 'bounce back' or recover from adverse or stressful events. It decreases the negative impact of workplace stressors and is associated with increased quality of life, improved health and effective adaptation, productivity, decreased turnover and absenteeism. This project will investigate the work-related factors contributing to the resilience of coal mining employees.
Current	**Effect of Rock Dust and Pre-Existing Lung Disease on the Risk of Mixed Dust Lung Disease, MDLD C29035** Basil Beamish, B3 Mining Services Graeme Zosky, University of Tasmania	$525,850	Andrew Lau and Sharif Burra, Yancoal Bharath Belle, Anglo American Steelmaking Coal Brad Lucke, Kevin Rowe and Tony Egan, Glencore Coal Assets Australia	There are many sources of dust in the coal mining environment that are hazardous to worker health. Researchers will compare the capacity of different particles, DPM, coal dust, rock dust to cause lung cell toxicity and examine how other diseases, e.g. lung infection, asthma and cigarette smoke alter the hazard. Results from the project will inform the development of appropriate mitigation strategies within the mine environment.
Current And New	**Methodology Development of Free Silica Analysis of Dust on PDM Filters C33001** Yonggang Jin, CSIRO	$249,200 Current $267,500 New	Andrew Lau and Sharif Burra, Yancoal Bharath Belle, Anglo American Steelmaking Coal Brad Lucke, Kevin Rowe and Tony Egan, Glencore Coal Assets Australia	A novel solvent back flush method was developed in a previous stage of this project to monitor personal exposure levels of respirable coal dust and crystalline silica, RCS. It is a simple and rapid process. In this second phase of the project, researchers will optimise the methodology via laboratory testing then conduct onsite analysis of RCS at the end of shift.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Breathing Zone Exposure Quantification and Respirators Performance – Review of Exposure Control Strategies C33006** Rao Balusu, CSIRO	$329,450	Andrew Lau and Sharif Burra, Yancoal Bharath Belle, Anglo American Steelmaking Coal Brad Lucke, Kevin Rowe and Tony Egan, Glencore Coal Assets Australia	The main objective of this project is to investigate the spatial variability of dust exposure levels in the breathing zone and to evaluate the effectiveness of respirators, such as various types of powered air purifying respirators, on personal dust exposure levels in underground coal mines.
Complete	**Health Screening "True Positives", "False Positives" and "Incidental Findings": An Investigation C33010** Katrina Kildey, I-MED Radiology Network	$160,798	Bharath Belle, Anglo American Steelmaking Coal Brad Lucke, Glencore Coal Assets Australia Sharif Burra, Yancoal	The coal industry believed coal mine dust lung disease, CMDLD including pneumoconiosis, had been eradicated from Queensland so there is a large gap in knowledge and experience among the medical community in screening, diagnosis and management of CMDLD. This project aimed to assess the respiratory health of 1,000 coal mine workers who have received an abnormal health screening result. A large scale retrospective study was conducted of coal mine workers reviewed by a respiratory physician through the health screening pathway.
Current	**Coal Mine Dust Lung Disease: What Happens Once the Dust Settles? A Longitudinal Study of a Latent Disease C33011** Katrina Kildey, I-MED Radiology Network	$167,925	Bharath Belle, Anglo American Steelmaking Coal Brad Lucke, Glencore Coal Assets Australia Sharif Burra, Yancoal	A previous project investigated recently diagnosed cases of coal mine dust lung disease, CMDLD in Queensland coal mines. Researchers will fine tune CMDLD case data with the aim of establishing a centralised repository of cases. In this extension project, they will seek to follow the cases after the point of diagnosis to identify long term disease outcomes for patients with CMDLD. The longitudinal study will provide information on whether CMDLD tends to stay stable or progress, as observed through quantifiable measures of disease, lung function and radiology.
Current	**Respirable Dust Reference Testing Method and Dust Chamber Facility C33012** Gareth Kennedy, Simtars	$215,950	Andrew Lau and Sharif Burra, Yancoal Bharath Belle, Anglo American Steelmaking Coal Brad Lucke, Kevin Rowe and Tony Egan, Glencore Coal Assets Australia	Concerns about the accuracy and ability of respirable dust measurement devices used in Australian coal mines to comply with AS2985 highlight the need for a testing facility in Australia. In collaboration with NIOSH, Simtars is building a respirable dust chamber equivalent to facilities in the USA and UK. The chamber will be an important verification and reference tool for regulators, original equipment manufacturers and other researchers. The aim of this project is to establish the methodology for the respirable dust chamber as a reference tool for cyclones and devices used in the coal mining industry.
Current	**New PDM filter for Direct-on-Filter Silica Analysis of Coal Mine Dust C33069** Yonggang Jin, CSIRO	$298,240	Andrew Lau and Sharif Burra, Yancoal Bharath Belle, Anglo American Steelmaking Coal Brad Lucke, Kevin Rowe and Tony Egan, Glencore Coal Assets Australia	With analysis always undertaken offsite, it can take up to two weeks to receive the monitoring results from mine worker exposure levels of respirable coal dust and crystalline silica. This project aims to develop a novel type of filter for use in personal dust monitoring units to enable real time respirable dust monitoring throughout the sampling shift and silica content measurement at the end of the sampling shift using one dust sampling unit.
Current	**Evaluating Toxicity of Different Types of Respirable Crystalline Silica Particles to Lung Cells and Tissues C34007** Gordon Xu, University of Queensland	$207,950	Andrew Lau and Sharif Burra, Yancoal Bharath Belle, Anglo American Steelmaking Coal Brad Lucke, Kevin Rowe and Tony Egan, Glencore Coal Assets Australia	Silica dust is one of the world's most significant causes of occupational diseases, including the lung disease silicosis. Coal mine workers are exposed to different types of respirable crystalline silica, RCS dusts related to where they work and what tasks they undertake. This project aims to evaluate the toxicity of three typical RCS particles, i.e. freshly generated, hydrated and aged, on lung cells, and understand their levels of acute risk to lung tissues in the mouse model.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Advanced Breathing Apparatus with Gas Membrane Modules C34023** Victor Chang, Monash University	$298,436	Bharath Belle and Paul Wild, Anglo American Steelmaking Coal Ken Singer, BMA Lee Earnshaw, Peabody Australia Coal	The self contained self rescuer, SCSR is an essential supporting device for underground employees encountering adverse conditions. In a previous project, researchers developed a lightweight membrane that is able to separate oxygen and carbon dioxide, which enables carbon dioxide to be removed from the closed loop breathing system. This means that no exothermic heat is released and that the device can be smaller and lighter than existing SCSRs. This project will further develop the membrane technology with the aim of integrating it into an existing SCSR design.
New	**Is Exposure to Illite Dust Linked to Pneumoconiosis? C35017** Graeme Zosky, University of Tasmania Basil Beamish, B3 Mining Services	$302,428	Bharath Belle, Anglo American Steelmaking Coal Brad Lucke and Kevin Rowe, Glencore Coal Assets Australia Frank Fulham, Andrew Lau and Sharif Burra, Yancoal Shane Apps, Peabody Australia Coal	Coal worker's pneumoconiosis is an irreversible lung disease associated with inhalation of coal dust. Recent epidemiological disease patterns suggest that the chemical properties of coal dust can influence disease risk. However, no studies have identified which chemical component(s of the coal dusts might be driving this geographical variation in disease risk. This project aims to determine whether the illite content of coal is directly correlated with the detrimental lung cell response by conducting a systematic review of the potassium alumino-silicates and pneumoconiosis literature.
MAINTENANCE				
Current	**Photocatalytic Destruction of Diesel Particulate Matter C25063** Yonggang Jin, CSIRO	$527,192	Brad Lucke, Glencore Coal Assets Australia Dave Young, Centennial Coal	The particulate matter emission generated in diesel engines – diesel particulate matter, DPM – has been classified as a Group 1 human carcinogen by the World Health Organisation. DPM control in underground coal mines has been an ongoing problem for many years. Controlling tailpipe emissions is a reliable and effective way to reduce the exposure of mine workers to DPM by controlling its input into the mine environment. Compared with the common passive filter approach, deployment of photocatalytic destruction is a more active and direct way to mitigate DPM emissions. This project will explore and develop a novel approach for better control of tailpipe DPM emissions by photocatalytic oxidation of DPM under ultraviolet irradiation into carbon dioxide.
Current	**Lithium Traction Battery for Underground Coal C28003** Martin Kime, 3ME Technology	$1,268,500	Brad Lucke, Glencore Coal Assets Australia Dave Young, Centennial Coal Matthew Smith, Ashton Coal Operations Paul Wyatt, BHP Sharif Burra, Yancoal	The application of battery electric vehicles, BEVs in underground mining provides several key benefits over traditional diesel powered engines. These benefits include reduced vehicle emissions and maintenance costs. Increased scrutiny around diesel particulate exposure, coupled with potential litigation, is likely to drive the uptake of BEV technology more quickly than mining companies anticipate. Australian underground coal mining needs a high performance BEV system that can meet Australian compliance requirements. This project continues on from the successful ACARP supported Design Verification project and is proposing to now build, bench-test and field trial then formally test and certify the heavy duty battery module for integration into a coal personnel transporter proof of concept that has been approved to be trialled underground.
Current	**Towards Better, Safer Mines - Optical Technologies for Software Defined Instrumentation C28010** Francois Ladouceur, University of New South Wales	$704,974	Ben McCamley, BHP Dave Young, Centennial Coal	Connecting field instruments in harsh environments, such as underground coal mines, using intrinsically safe technology is challenging. The aim of this project is to design, build and characterise an industrial optical telemetry system based on an optical network of passive analogue sensors connected to a programmable logic controller, PLC. This will be achieved by exploiting the unique properties of liquid crystal-based optical transducers and a purposely designed PLC module. Benefits include a dramatic increase in data throughput due to multiplexing in the optical domain and elimination of potential cyber-attacks by centralising the digital interface of all sensors.
Complete	**Integration of DAS Conveyor Monitoring into SCADA to Enable Smart Maintenance Scheduling C28025** Edward Prochon, Mining3	$267,155	Brad Lucke and Kevin Rowe, Glencore Coal Assets Australia Clinton Vanderkruk, Anglo American Steelmaking Coal	This project aimed to research and advance the DAS conveyor condition monitoring system from a scheduled reporting system to a real time, mine ready, integrated system enabling smart maintenance scheduling. This advancement facilitates integration into business enterprise database packages, such as SAP to enable smart, autonomous and objective scheduling of maintenance activities. This project was the final research step in providing a fully packaged conveyor monitoring system for the mining industry.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Control of Touch Potential Transients During Switching C29009** Peter Stepien, ResTech	$114,000	Barrie Alley, Centennial Coal	To ensure safe operation of electrical equipment, installations must comply with state and national regulations and follow best practice as set out in Australian Standards. However, the standard does not provide guidance on the touch potential transient. The objective of this project is to investigate transient touch potentials during switching and identify methods to reduce them to a safe level under all conditions.
Current	**Ceramic Wall Flow Filter Commercialisation C33009** Bradley Drury, PPK Mining Equipment	$888,778	Andrew Esdaile, Glencore Coal Assets Australia Bharath Belle, Anglo American Steelmaking Coal Greg Briggs and Steve Coffee, South32 Illawarra Coal Trevor Hartley, Centennial Coal	The purpose of this project is to develop a commercially available improved diesel particulate filter, DPF for widespread use in underground coal mines. A previous project undertaken by Orbital, demonstrated that a ceramic wall flow filter can effectively filter diesel particulate matter, DPM emissions. This project will allow filter design refinements for retro fitting, testing against regulatory requirements and finally approval for commercial use.
Complete	**BEV Battery Charging Infrastructure Study C33016** Tony Goodwin, Palaris Australia	$262,881	Brad Lucke, Glencore Coal Assets Australia Paul Wyatt, BHP Sharif Burra, Yancoal	Battery electric vehicles, BEV are increasingly being considered as viable alternatives to diesel powered machinery in underground mining; however, the integration of charging infrastructure into the mine environment has been overlooked. This project considered the requirements of the BEV charging infrastructure, including the challenges, impacts and solutions.
Current	**Specialised Instrumentation and Data Processing for Real Time FEA Condition Monitoring of AFC Chain C33017** Ryan Norris, Vayeron	$185,000	Brad Lucke, Glencore Coal Assets Australia Jarrod Sampson, Glencore Coal Assets Australia	Armoured face conveyor, AFC chain failure causes serious production delays and associated costs for longwall operators, accounting for up to 27% of longwall failures. This project will develop a closed loop quasi real time prototype AFC chain link to model real time stress and strain monitoring.
Current	**Prototype Battery Electric Load Haul Dump C33026** Martin Kime, 3ME Technology	$1,431,295	Brad Lucke, Glencore Coal Assets Australia Dave Young, Centennial Coal Matthew Smith, Ashton Coal Operations Paul Wyatt, BHP Sharif Burra, Yancoal	The focus of this project is to develop and provide evidence that battery technology will support heavier platforms and can operate in the demanding underground environment without impacting production activities. The project will also prove the LHD retrofit model which aims to convert existing diesel powered platforms to battery power.
New	**Ex.P Enclosure Designs C35013** Peter Reid, CSIRO	$248,500	Brad Lucke, Glencore Coal Assets Australia Dave Young, Centennial Coal	Flameproof enclosures enable the use of electrical equipment in coal mining operations where there is risk of exposure to explosive atmospheres. However, existing enclosures are not suitable for all contexts. This project will develop a system that employs pressurisation of the enclosure in conjunction with facility to de-energise enclosure equipment if the pressure is compromised. The resulting design/s will represent a new approach to quickly designing and manufacturing enclosures for use in zone 1 environments.
MINING TECHNOLOGY AND PRODUCTION				
Current	**Development of a Safer Underground Explosive C20033** Duncan Chalmers, University of New South Wales	$393,000	Bharath Belle and Paul Wild, Anglo American Steelmaking Coal Brad Elvy, Brad Elvy Mining Services Russell Thomas, South32 Illawarra Coal	Underground mines resort to the use of explosives to break extremely hard materials that intrude into coal seams. Since there is no longer P5 explosive available for delay firing, mines resort to using type 1 explosive. Confusion arises as to how these explosives can be safely used. Currently permitted explosives are being used outside the recommended guidelines as published by the Buxton Testing Authority in the UK. In order that they can be used safely, mines are conducting risk assessments to manage the incendive hazard that possibly could be created by a cut off shot and additionally managing the deflagration hazard with the same risk assessment when using P1 explosives. This project developed an alternate test regime that adequately assesses the deflagration risk of an explosive. The information gained from this testing provides additional data to change the testing regime for permitted explosives.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Longwall Floor Horizon Sensing C28018** Andrew Strange, CSIRO	$269,680	Jarod Chadwick, Glencore Coal Assets Australia	Effective longwall horizon control is essential for safety and productivity in underground coal mines. The key to achieving this outcome is a reliable means of actively sensing the geological strata. A prototype radar sensing system was demonstrated in a previous project but it is not yet ready for installation on a production longwall. Mines still rely on manual monitoring to infer seam geology, which limits the potential to introduce fully automated longwall mining. This project will extend the outcomes of the previous project to deliver a reliable coal floor thickness sensor that is ready for sustained use in an automatic longwall horizon control system. The physically compact system will be encased in an approved dielectric flameproof enclosure.
Current	**Delivering the Remotely Operated Longwall C29028** Jonathon Ralston, CSIRO	$1,980,890	Bharath Belle and Chris Carroll, Anglo American Steelmaking Coal Brad Lucke, Glencore Coal Assets Australia Brian Wesley, Yancoal Dave Young, Centennial Coal Loz Hemmings, Kestrel Coal	The advancement of fully remotely operated longwall systems presents a major technical challenge as many of the essential sensing and automation capabilities needed are at an early development stage. This project aims to provide a step-change in current longwall operations by developing and improved system components to accelerate the development of remote longwall capability. Researchers will deliver new software systems incorporating process models and targeted hardware including new sensing systems.
Current	**Alternative Flameproof Enclosure Protection Techniques C29033** Peter Reid, CSIRO	$272,000	Brad Lucke and Colin Hoyle, Glencore Coal Assets Australia	Flameproof enclosures enable the use of electrical equipment in coal mines where an explosive atmosphere may be present, but they are not sufficient in circumstances which exceed the specified ratings. Researchers will develop a module capable of sensing the internal pressure of the enclosure, using redundant sensing techniques, and ensure the intrinsically-safe power supply is disconnected from the payload in the event of pressure loss. Researchers will investigate ways to pressurise the enclosure, re-pressurise it after inspection, and maintain a minimum pressure. The prototypes will represent a new approach to achieving enclosure certification in zones 1 and 2 and will be able to be deployed on an operating longwall face.
Current	**Intrinsically Safe RFID Sensors for Underground Coal Mining C29037** Lance Munday, CSIRO	$136,050	Brad Lucke and Flemming Nissen, Glencore Coal Assets Australia	Higher levels of automation of underground mining require more sensing capability to improve longwall control, machine localisation, roof bolting, personnel tracking and asset management. New sensor systems have had slow uptake due to installation difficulties and regulation requirements for flameproof enclosures. This project aims to deliver a suite of intrinsically safe radio frequency identification, RFID tags that will enable sensor measurement on an underground longwall and/or other mining equipment with minimal effort and cost. The RFID reader component that activates the tags and records the data will be designed to fit inside a flameproof or pressurised enclosure. The RFID platform will be tested in the field.
Current	**Self-Drilling Bolt Automation: Bolt Design and Manufacture Method, and Chemical Canister Concept Development C34003** Mark Levey, OKA Rock Bolt Technologies	$1,857,744	Bob Miller, Centennial Coal Brad Lucke and Jarod Chadwick, Glencore Coal Assets Australia Chris Carroll and Harry Dhaliwal, Anglo American Steelmaking Coal Frank Fulham, Yancoal	A body of research has been undertaken to develop a semi automated system for underground roof bolt installation that can be retrofitted to current, and future continuous miners. In this project, the self-drill bolt and chemical canister system will be trialled and tested for repeatability and reliability using standard equipment. If results are acceptable, a second trial is required to test the technology in a semi-automated system.
Current	**Self Cleaning ExScan and Underground Reflectors C34017** Matt van de Werken, CSIRO	$141,995	Brad Lucke and Michael Condie, Glencore Coal Assets Australia Brian Wesley, Yancoal	In longwall mines, the reflectors used by optical and infrared sensing systems become obscured due to a build-up of dust. These systems can only be cleaned by compressed air or water when a shearer passes the sensor location. This project aims to develop a low-cost, resilient, self cleaning reflector prototype to improve reflector performance in all underground conditions.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Longwall Bretby Cable Handling Monitoring with Fibre Optics C34019** Karsten Hoehn, Mining3	$237,940	Brad Lucke, Glencore Coal Assets Australia Brian Wesley, Yancoal Shane McDowall, Anglo American Steelmaking Coal	Longwall shearer cables and hoses are contained within a flexible housing called a 'Bretby'. Rock and coal regularly fall into the cable tray, blocking the passage of the Bretby, which creates a potential hazard for nearby operators. This project aims to develop, test and evaluate a Bretby monitoring system that can automatically detect major failures of the cable handling system. Researchers will determine how early this detection can be made in practice and assess the feasibility of using fibre optic-based acoustic and vibration sensing to detect operational anomalies.
Current	**Effects of Rock Weathering on Life-of-mine Roadway Stability C34024** Zhongwei Chen, University of Queensland	$312,534	Brian Vorster, Glencore Coal Assets Australia Matt Tsang, Anglo American Steelmaking Coal	Understanding and predicting the nature and impact of time-dependent weathering on roadway stability is a significant technical challenge in underground coal mines. A more effective and sophisticated method of quantifying rock degradation over time is required. This project aims to develop a rock weathering testing methodology appropriate for the underground coal mining environment. Researchers will identify dominant weathering mechanisms, determine the quantitative correlations of a suite of rock weathering assessment parameters and provide a reference table for users to apply a de-rating to roof support design. They will then develop a detailed procedure for implementing the weathering effect into numerical modelling software and conduct a sensitivity study to illustrate the timeframe required for roof re-support.
Current	**Advancing Remote and Automated Capability for Longwall and Roadway Development C35004** Andrew Strange, CSIRO	$2,517,000	Roadway Development Task Group	The advancement of fully remotely operated longwall systems and roadway development presents a major technical challenge as many of the essential sensing and automation capabilities needed are at an early development stage. This project aims to provide a step-change in current longwall operations and roadway development by developing and improved system components to accelerate the development of remote longwall and roadway capability. Researchers will deliver new software systems incorporating process models and targeted hardware including new sensing systems.
New	**Longwall Remote Operations – Face Mapping Robot – Phase 1 C35009** Luke Dyer, Quantum Engineering and Consulting Group	$170,000	Mick Conde, Glencore Coal Assets Australia	Underground mines are transitioning from on-face to off-face longwall operations. While many advancements in technology have been made, there are significant deployment and execution issues. In the first phase of this project, researchers will design, build and perform on-face tests with a manually propelled prototype robot. The aim is to determine whether the data captured is suitable for the various automation systems currently in use. The robot will contain inertial navigation hardware, forward, coal face rear-facing, goaf and traverse, walkway cameras and laser scanners.
ROADWAY DEVELOPMENT				
Current	**Underground Coal Mine Gateroad Development Continuous Haulage System C27076** Mick Whelan, Premron	$8,085,696	Roadway Development Task Group	Premron's Continuous Haulage System, CHS utilises the Premron "Enclosed Belt System", which has been proven in above ground installations worldwide and now proven in prototype testing over the last 4-5 years at Premron's Gladstone facility. The overall goal is to improve gateroad development in an underground coal mine application, by way of significant improvements in safety, productivity, performance and acceptance of this new technology. This system will be used to remove coal from the face and transport the coal to the panel conveyor, hence removing the requirement for shuttle cars and providing the Australian coal industry with a safe and continuous coal haulage method. The aim of this project is to take the full mine compliant Premron CHS, CHS - 180m system and trial it in a gateroad development panel within an Australian coal mine for a period of 3 to 6 months. This will prove its performance, mine integration and to demonstrate any potential improvements within a gateroad development process.
Current	**Light Weight Composite Conveyor Support Structures C33013** Ganga Prusty, University of New South Wales	$280,440	Roadway Development Task Group	Steel underground mining conveyor systems are very heavy and pose manual handling challenges for workers. Fibre reinforced composites have a higher strength-to-weight ratio and fatigue strength than steel and are also corrosion-free. A prototype light weight, composite conveyor support structure that meets underground coal mine requirements will be designed and manufactured to improve underground conveyor installation.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Floor Horizon Control for Roadway Development C33020** Andrew Strange, CSIRO	$120,000	Roadway Development Task Group	Effective horizon control is essential for safety and productivity in roadway development in underground mines. Existing horizon control methods rely on sparse borehole data or seismic surveys used in conjunction with visual tracking of geological features behind the miner. A floor coal/stone thickness sensor that can be deployed on a continuous miner is needed. This project will test the enclosure and associated cables on the miner. It will also include test the closed loop system.
STRATA CONTROL AND WINDBLASTS				
Complete	**Reliable Estimation of Horizontal Stress Magnitudes from Borehole Breakout Data C26063** Joung Oh, University of New South Wales	$232,609	Brian Vorster, Glencore Coal Assets Australia Patrycja Sheffield, Centennial Coal	It is well known that ground stresses have a major impact upon the behaviour and stability of roofs and ribs. Changes in stress magnitude can adversely impact on mining conditions, such as increasing the risk of violent failures via coal burst. There are no universally accepted methods of estimating in situ stress magnitudes. This project developed a reliable, simple and cost effective technique to estimate the magnitude of horizontal stress based on borehole breakout data using literature review, laboratory testing, numerical modelling and back analysis.
Complete	**Numerical Modelling Approach to Better Understand the Effect of Cable Bolt Performance on Roof Failure Mechanisms in Varying Rock Mass Conditions C27040** Guangyao Si, University of New South Wales	$389,000	Paul O'Grady, Glencore Coal Assets Australia Peter Corbett, Centennial Coal	The understanding of cable bolt performance under large shear displacements is very limited. In this project, an innovative approach to numerical modelling was developed to better simulate behaviour of cable bolts. A range of scenarios including different ground conditions and loading configurations were considered. Cases of cable bolt failures were collected and an Australia wide database established to carry out back analysis using numerical modelling. Development of a numerical modelling tool enables a broad range of factors to be evaluated in terms of their contribution to the failure mechanisms of underground workings.
Current	**Assessment of Longwall Mining Induced Connective Fracturing C27045** Deepak Adhikary, CSIRO	$407,438	Gift Makusha, Anglo American Steelmaking Coal Julian Potten, Kestrel Coal Resources Peter Corbett, Centennial Coal	In underground mines the mining induced permeability change in the overburden is the single most important factor that impacts water and gas flow. Empirical estimates of mining-induced permeability change are inaccurate. This project aimt to quantify the permeability change resulting from longwall mining by fully utilising mine specific geology and hydrogeology. Researchers will numerically simulate fluid flow through the fracture network that results from applying the fracture modelling technique developed in previous research. Measuring pressure drops and flow rates through the fracture network allows permeability changes to be quantified at all points in the overburden.
Current	**Intrinsically Safe Digital Networked 3D Roof Bolt C27071** Anne Wylie, Holville	$140,000	Mick Stadler, Glencore Coal Assets Australia Paul Buddery, Roger Byrnes, Byrnes Geotechnical	Traditional instrumented roof bolts for underground coal mine applications use multiple pairs of strain gauges at regular spacing along each bolt. This enables the axial loads and bending moments to be measured at specific points along the bolt length, but only in one plane. Often the strain gauge distribution means less than 10% of the total bolt is monitored, which may result in localised shear deformation of the bolt not being measured. In this project researchers are developing an intrinsically safe, instrumented roof bolt that will measure strain in three dimensions and interface to the Holville IS certified data acquisition networks. The greater accuracy and detail of the 3D bolt data will enable the design of better, safer roof support.
Current	**Prevention Techniques for Stress Corrosion Cracking Failures of Rock and Cable Bolts C28011** Serkan Saydam, University of New South Wales	$298,380	Lesley Munsamy, Anglo American Steelmaking Coal Patrycja Sheffield and Peter Corbett, Centennial Coal	Over the past two decades, the frequency of cable bolt failure due to stress corrosion cracking, SCC in Australian underground mines has increased. Similar failures have been reported globally. In this project, interdisciplinary research will be conducted into the development of prevention techniques, such as antimicrobial coating, for SCC failure of rock and cable bolts. Guidelines for preventing SCC will be developed.
Current	**Evaluation of the Chinese Outburst Assessment Methodology and its Applicability to Australian Low Permeability Coal Seams C28015** Qingdong Qu, CSIRO	$238,270	Bharath Belle, Anglo American Steelmaking Coal Ken Singer, BMA Rae O'Brien, Centennial Coal Russell Thomas, South32 Illawarra Coal Sharif Burra, Yancoal	Australian coal mines use gas content/DRI900 as the indicator for outburst assessment. Although this method has been effective in preventing outburst over the past two decades, it is generally considered to be overly simplistic as it does not take other primary outburst parameters, such as stress, strength and gas pressure, into account. This project will evaluate the Chinese outburst assessment methodology and its applicability to Australian low permeability coal seams. The project will focus on coal mines in the Bowen Basin and the Illawarra.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Optimising the Cablebolt Pre-Tensioning Practice to Control Roadway Roof Failure Using Advanced Combined Axial and Shear Testing Facility C28020** Hossein Masoumi, Monash University	$165,000	Brian Vorster, Glencore Coal Assets Australia Patrycja Sheffield and Peter Corbett, Centennial Coal	Regulators are concerned about the loss of listed communities in complex shrub swamp systems due to modified hydrology. Existing technology can detect dramatic changes in vegetation health, however new methods are needed to detect subtle, long-term spatial and temporal changes to moisture patterns. This project aims to identify remote sensible signals for plant stress in these communities. Researchers will use calibrated thermal imaging on board small unmanned aerial service platforms to assess canopy water use through the day. Foliage is usually cooler than the ambient air temperature when soil water is readily available, so higher temperatures indicate change in moisture patterns.
Current	**Modelling the Onset of Fracture Induced Instabilities for Underground Mining Applications C29008** Anna Giacomini, University of Newcastle	$203,820	John Grieves, QCoal Services Paul O'Grady, Glencore Coal Assets Australia	Bolt and cable systems are widely used to prevent roof failures in underground mines. The design of these systems requires an understanding of the stresses and displacements in the rock surrounding roadways, and the fractures that form throughout their lifespan. As part of this research, a computational methodology will be developed for simulating the propagation of fractures in anisotropic materials and jointed rock masses during mining operations. The method will be applicable to a range of problems where fracturing in rock may cause instability.
Current	**Integrating In-Situ Stress Patterns with Basin to Local Scale Structures in the Nebo Synclinorium, Bowen Basin C29011** Mojtaba Rajabi, University of Queensland	$203,086	Mark Laycock, Glencore Coal Assets Australia Rae O'Brien, Centennial Coal Sharif Burra, Yancoal	Understanding the regional to local variability of stress fields should be the starting point for mine design and practices because the stresses control the geotechnical behaviour and ground conditions of mine sites. Knowledge of the continental pattern of stress in Australia is well understood but translating these regional stresses to the mine scale requires further work. Researchers will investigate how tectonic stresses affect the shallower part of the crust where the majority of Earth's resources are sitting using 3D geomechanical-numerical modelling. The project will provide significant data on mine geomechanical behaviour, gas drainage and groundwater modelling.
Complete	**Longwall Rock Mechanics in Massive Strata C29012** Tim Gibbons, Sigra	$245,000	Bob Coutts, BHP Brad Elvy, Brad Elvy Mining Services John Grieves, QCoal Services	Longwall mining has changed from initially being focused on thin seams in weak strata to what are now frequently very thick seams in hard, massive strata. The rules of design have changed but are not fully developed or understood. Researchers identified the most appropriate means to break up (precondition) the massive strata to permit successful longwall mining. Using information gained from the project, researchers determined a suitable powered support load capacity for longwalls in massive strata.
Current	**Definition and Quantification of Long Term Stability of Coal Pillar Systems C29014** Ismet Canbulat, University of New South Wales	$230,000	Peter Corbett, Centennial Coal Russell Thomas, South32 Illawarra Coal	There is an increasing emphasis on ensuring that underground pillars are stable and do not cause subsidence. This project aims to define and quantify the long-term stability of coal pillar systems. Using the three pillar system failure modes:, 1 pillar failures due to pillar spalling, i.e. reduced pillar width, 2 pillar failures due to continuous roof failures, i.e. increasing mining heights and, 3 pillar failures due to weakened floor. The project's outcomes will enable geotechnical engineers to design long-term pillar systems and to quantify the stability of older pillars.
Current	**Mechanical Assessment of Time Dependent, Creep Behaviour of Coal and Coal Measure Rocks Under Uniaxial and Triaxial Conditions Based on Experimental and Analytical Methodologies C29019** Amin Heidarpour, Monash University	$205,000	Brian Vorster, Glencore Coal Assets Australia Elliot Tembo, Centennial Coal	Creep behaviour of coal and coal strata is critical for geotechnical engineering decisions; however, understanding of this phenomenon is limited to the collected field data by different monitoring techniques. The objective of this research is to investigate the time-dependent behaviour of coal and coal measure rocks by conducting experiments under various timeframes ranging from a month to a year or more. Researchers will use creep loading frames in temperature and humidity-controlled conditions which replicate the underground mining environment.
Current	**Mechanical Investigation of Two Critical Standing Support Systems, Timber Chock and Pumpable Crib in Underground Coal Mines C29022** Hossein Masoumi, Monash University	$295,000	Bob Coutts and Gift Makusha, BHP Brian Vorster, Glencore Coal Assets Australia Dan Payne, BHP Patrycja Sheffield, Centennial Coal	Timber chocks and pumpable crib are two standing supports used in almost all the underground coal operations in New South Wales and Queensland. However, the performance of timber chocks, particularly under complex shear and/or vertical ground movements, is not well understood. Researchers will provide an update on the mechanical behaviour of timber chocks currently in the market and identify the extent to which each type of timber chock and pumpable crib is used in Australia. In addition, a testing standard will be developed for the selected standing supports based on mechanical parameters, such as loading rates, offset loading, torsional loading, compressive and shear loadings.

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Current	**Effectiveness of Shotcrete in Underground Coal Mines C29025** Joung Oh, University of New South Wales	$185,000	Ben Forrest, BHP Brian Vorster, Glencore Coal Assets Australia Julian Potten, Kestrel Coal Resources	Shotcrete is a versatile ground support tool that, when applied correctly, enhances safety in underground mines. In this project, researchers aim to quantify the effectiveness, application and benefits of shotcrete, including adhesion strength to coal or other rock surfaces and its interaction with other support elements, such as mesh, rock and cable bolts. The project will involve a literature review, laboratory testing, numerical modelling and field monitoring.
Current	**Monitoring While Drilling Concept on Characterising Coal Mine Roof C33019** Manoj Khanal, CSIRO	$279,989	Brian Vorster, Glencore Coal Assets Australia Dan Payne, BHP	A major cause of roof instability in underground coal mines is the variable and uncertain nature of the roof. Researchers will investigate the applicability of the monitoring while drilling concept to perform geotechnical characterisation of coal mine roofs and detect 'signatures' of change in roof strata competence. Sensors will be installed on the drills to monitor parameters such as toque and penetration rate. Analysis of this data will help develop a predictive methodology for improved coal mine roof characterisation.
Current	**Understanding and Quantifying the Hydraulic Characteristics of the Overburden C33022** Andy Wilkins, CSIRO	$178,070	Gary Brassington, South32 Illawarra Coal Peter Corbett, Centennial Coal	Quantifying the hydraulic characteristics of longwall overburden is crucial to determining the impact of mining on the local groundwater and surface water systems, and understanding water flows to the mine workings and gas flows through the goaf region. This project will develop a database of goaf hydraulic characteristics in the form of easy to use tables, charts, and formulae. The database will enable immediate quantification of the likely hydraulic properties along with upper and lower bounds, given mine specific parameters such as extraction height, subsidence, strata strengths and panel width, without having to perform complicated numerical modelling.
Current	**Improved Model Upscaling of Overburden Hydraulic Conductivity for Input into Groundwater Models C33024** Yvette Heritage, SCT Operations	$230,000	Agi Burra, Glencore Coal Assets Australia Bob Coutts, BHP Gary Brassington, South32 Illawarra Coal Peter Corbett, Centennial Coal	There is a need to more reliably estimate overburden conductivity from longwall extraction as coal mines move towards sensitive areas, such as mining below dams, water bodies and aquifers, and interact with environmentally sensitive surface water features such as wetlands and swamps. The key objective of this project is to determine an upscaling method that bridges the gap of geotechnical model fracture conductivity detail to groundwater model bulk conductivity input requirements.
Current	**Reducing the Subjectivity of CMRR Calculation Using Machine Learning C33031** Zhongwei Chen, University of Queensland	$115,100	Brian Vorster, Glencore Coal Assets Australia Dan Payne, BHP Matt Tsang, Anglo American Steelmaking Coal	The coal mine roof rating, CMRR is a key parameter for roof support design. Although it offers a means of assessing roof competence, it can be challenging to calculate. This project aims to apply advanced machine learning algorithms to reduce the subjectivity of the CMRR calculation through improved selection of uniaxial compressive strength values and more objective identification of roof geotechnical units and fracture spacing. Researchers will also develop an approach to predict rock properties from geophysical logs.
Current	**User Friendly Computer Program for Modelling Fracture Induced Instabilities in Underground Mining Environments C34012** Anna Giacomini, University of Newcastle	$197,350	John Grieves, QCoal Services Matt Tsang, Anglo American Steelmaking Coal Paul O'Grady, Glencore Coal Assets Australia	A significant factor which affects the safety, speed and cost of underground roadway development is the design of the roof support system. An overly conservative design decreases development rates and increases material use, while a nonconservative design may trigger costly work stoppages or result in injuries due to collapse. Computer simulation methods have potential as design tools, but currently they have limited capabilities for modelling the propagation of fractures through brittle rock with pre-existing joints. The aim of this extension project is to improve the usability and reliability of the phase-field finite element, PF-FE code developed in the previous project. This research will enable the code to be readily employed by geotechnical and mining engineers in analysing and optimising roof support measures for underground roadways, while considering overburden, roadway geometry, support measures and material parameters.
Current	**Roof Beam Support Assessment Tool C34021** Terry Medhurst, Resource Geotechnical	$150,000	Brian Vorster, Glencore Coal Assets Australia Roger Byrnes, Byrnes Geotechnical	In previous projects, an analytical roadway development framework was established for measuring support load and roof convergence. This data can be matched and updated against roof monitoring data. The model relies on inputs from the geophysical strata rating and roof bolt characteristics. In this project, researchers will convert outputs from the previous work into a practical site-based software tool to accompany existing design methods.

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Current	**Risk Based Model for Forecasting Longwall Face Cavity Development C34022** Chengguo Zhang, University of New South Wales	$173,200	Marc Henderson, Anglo American Steelmaking Coal Matt Martin, BHP	Cavity development across the longwall face can cause substantial production losses and pose significant safety risks to mine workers during recovery operations. Previous research into longwall roof cavities has primarily focused on individual causes, such as equipment, shield pressures, geology, in situ stresses and geotechnical setting. In this project, researchers will adopt a holistic assessment of all causes that, in combination, can result in the formation of a roof cavity. The project aims to produce a risk based approach for assessing the likelihood of cavity development; a set of predetermined controls to mitigate the risk of cavity development; and a proposed hierarchy of longwall fall-of-ground severity linked to these controls, based on the escalating level of risk.
New	**Optimum Design of Pillars with Various Sizes and Shapes at Increasing Stress Environment C35008** Mehdi Serati, University of Queensland	$172,000	Brian Vorster, Glencore Coal Assets Australia John Grieves, QCoal Services Peter Corbett, Centennial Coal	Geological conditions in underground operations may require mine designs that incorporate small, irregular-shaped pillars that do not meet factor-of-safety requirements. This project aims to develop a methodology to effectively design small pillars in high-stress environments. The project will include physical and numerical modelling. The large-scale laboratory pillar experiments will be conducted using a multi-axis substructure testing system.
New	**Causes for Swelling and/or Bearing Capacity Floor Failures in a Pillar System Under Varying Geological and Geotechnical Environments C35010** Serkan Saydam, University of New South Wales	$298,300	Brian Vorster, Glencore Coal Assets Australia Peter Corbett, Centennial Coal	This is the second stage of a study that aims to develop a framework for reliable assessment, prediction and control of swelling and bearing capacity failures in underground coal mines. The project will use experimental, analytical and numerical methods to conduct multidisciplinary research into the failures of coal mine floors and pillar foundations.
New	**Revolutionising the In-Situ Stress Measurement Using a New Generation of Downhole Tools: DilaStress C35011** Hamid Roshan, University of New South Wales	$184,500	Brian Vorster, Glencore Coal Assets Australia Patrycja Sheffield, Centennial Coal	Existing indirect methods of measuring in-situ stress direction and magnitude, such as borehole breakouts, do not meet industry requirements. This project aims to develop a prototype downhole in-situ stress management tool called DilaStress. Research will include the development of the displacement sensors, the mechanical part of the tool, data acquisition and tool positioning system.
VENTILATION, GAS DRAINAGE AND MONITORING				
Current	**New Approaches to Mine Gas Analysis and Ratios C25072** Andre De Kock, Simtars	$416,192	Bharath Belle, Anglo American Steelmaking Coal John Grieves, QCoal Services	The spontaneous combustion of coal is a serious hazard. A good understanding of the coal gas indicators and how they behave as the coal temperature changes is necessary to detect and effectively treat a coal self heating event. The main objectives of this project are to conduct a survey of the gases found in mine goafs, working areas and gas drainage samples from New South Wales and Queensland mines and compare the gases present with the low temperature heating fingerprint. The researchers will identify any new gas indicators that can be detected using the gas chromatographs.
Current	**Automatic Leak Detection for Tube Bundle Systems C27035** Sean Muller, Simtars	$220,000	Bharath Belle, Anglo American Steelmaking Coal John Grieves, QCoal Services	Tube bundles are an integral part of gas monitoring systems in underground coal mines. They provide an early warning of spontaneous combustion, validate real time sensor readings and provide invaluable information during a mine fire/exploration. However, the current manual integrity testing of tube bundles is time consuming. In this project, a fully automated integrity testing system prototype is being developed based on information gathered on the flow rates and pressures of tubes. The prototype will be able to be retrofitted to any tube bundle system, regardless of the supplier.
Current	**Intrinsically Safe Borehole Survey Tool C27072** Anne Wylie, Holville	$120,000	Brad Lucke and Mick Stadler, Glencore Coal Assets Australia Paul Buddery Roger Byrnes, Byrnes Geotechnical	The only known intrinsically safe borehole camera is the Pearpoint P374 IS, which is unable to store images or provide geospatial data. An intrinsically safe portable borehole survey tool is being developed that will collect and store high resolution still and video images with overlaid 3D location data and temperature sensing. In addition to providing real time display of data locally using a rugged display, the system will save the data for archive and later analysis using the Holville hand held terminal. A prototype will be field tested and documentation submitted for Ex certification.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Complete	**Impact of Gas Composition on Outburst Propensity of Coal C28006** Dennis Black, Capricorn Management	$125,000	Bharath Belle and Paul Wild, Anglo American Steelmaking Coal David Webb, Glencore Coal Assets Australia Russell Thomas, South32 Illawarra Coal Sharif Burra, Yancoal	Outburst threshold limits in Australian underground mines assume that coal containing carbon dioxide has a significantly higher risk of outburst compared with coal containing methane. This project reviewed historical outburst event data and undertook laboratory testing to disprove the currently accepted view that compared with methane rich coal, carbon dioxide rich coal is more prone to outburst risk, will cause a more violent outburst, and will cause coal to be weaker.
Current	**Ventsim Goaf Model Development - Stage 2: Goaf Flow – Ventilation Interactions C28016** Qingdong Qu, CSIRO	$319,465	Bharath Belle and Paul Wild, Anglo America Steelmaking Coal Peter Baker, BHP	Mine ventilation officers do not have a tool to model and assess goaf gas behaviours. Ventsim is the industry standard tool for modelling ventilation circuits. A 3D goaf resistance model for Ventsim that predicts reasonable goaf gas flow patterns was developed in a previous project. In this project, researchers will develop and calibrate the Ventsim goaf modelling approach against extensive field data to ensure that it is empirically validated and can adequately predict the impact of external stimuli on gas flows through the goaf.
Current	**Effect of Occlusions by Coal and Stone Dust on the Sensitivity and Time Response of Methane Gas Detectors in Underground Coal Mines C28027** Ian Webster, Ampcontrol	$90,000	Bharath Belle, Anglo American Steelmaking Coal John Grieves, QCoal Services Ken Singer, BMA	The accuracy and response time of new machine-mounted and handheld gas detectors is established through compliance to nominated standards; however, the degradation of performance-in-service of these detectors is not well documented. Preliminary work has demonstrated that the build-up of coal and stone dust on catalytic methane sensors reduces the sensitivity of the detector and increases its response time. This project aims to verify and quantify the susceptibility of real-time methane detectors to occlusion by coal and stone dust using two methods: controlled laboratory testing of typical methane sensing devices and a qualitative survey of real-time methane sensors in service in underground coal mines.
Current	**Revisiting the Fast Desorption Method - Initial Gas Release from Pulverised Coal C29015** Jun-Seok Bae, CSIRO	$171,931	Bharath Belle and Paul Wild, Anglo American Steelmaking Coal Peter Baker, BHP	Measuring gas content in a coal seam is critical to the design of gas drainage systems and assessment of mine ventilation requirements, and directly affects coal production rates. Gas content is a basis for outburst threshold parameters, such as desorption rate index and threshold limit value. Researchers will use the fast desorption method to improve understanding of the initial dynamics of gas desorption behaviour.
Complete	**Appraisal of Gas Indicators from Goaf Drainage Holes for Spontaneous Combustion and Explosion Risk Management C29017** Guangyao Si, University of New South Wales	$119,750	Bharath Belle and Paul Wild, Anglo American Steelmaking Coal David Webb, Glencore Coal Assets Australia John Grieves, QCoal Services Ken Singer, BMA Peter Baker, BHP	Spontaneous combustion and methane explosion management in the goaf relies on tube bundle monitoring systems, which have significant limitations. These include analysis delay and inadequate sampling data points at the goaf perimeter for interpreting the entire goaf gas behaviour. This project used available monitoring data obtained from goaf gas drainage holes to assess spontaneous combustion and explosion risks, and provided rapid feedback control strategies for drainage operations. The research contributes to a safer and more efficient goaf gas drainage practice in Australian mines by extending gas production time, improving drainage efficiency of goaf holes, improving understanding of goaf gas behaviour, and reducing risks of spontaneous combustion and gas explosion.
Current	**Safety Distances and Exclusion Zones for Projectiles Ejected from Coal Mine Openings in Case of Large Explosions C29018** Alex Remennikov, University of Wollongong	$562,560	Bharath Belle, Anglo American Steelmaking Coal David Webb, Glencore Coal Assets Australia John Grieves, QCoal Services Ken Singer, BMA Rizwan Haque, Kestrel Coal Resources Russell Thomas, South32 Illawarra Coal	The throw of debris and fragments is one of the most dominant effects in underground coal mine explosion events and consequently the required safety distances and exclusion zones around mine entries should be determined. Greater knowledge of the explosion generation of debris inside and outside underground coal mines is required to develop scientifically validated exclusion zones for both blast overpressure and projectile hazards. This project will investigate the propagation of debris within drifts and shafts and outside mine openings and establish the relationship between the angle of incline of portals and projectile/debris risks to mine site infrastructure. Researchers will validate experimentally the existing procedures in DoD Explosives Safety Board and US Army documents for predicting debris velocities for coal mine explosion scenarios and define the appropriate exclusion zones for explosion risk for coal mine infrastructure.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Methodology for Efficient Design of the Pattern of Drainage Holes Based on Stress Variation and Gas Flow Behaviour in Coal Seams C29023** Hamid Roshan, University of New South Wales	$164,560	Bharath Belle and Paul Wild, Anglo American Steelmaking Coal Brad Elvy, Brad Elvy Mining Services Owen Salisbury, Whitehaven Coal Russell Thomas, South32 Illawarra Coal	Continuous gas drainage of gassy coal mines is a critical safety control to manage the risk of outburst. Extensive laboratory-scale research has examined the effects of in situ stress on gas production and identified methods of controlling gas flow. In this project, researchers will identify the main parameters controlling the gas flow in a laboratory scale and develop a model across scales, laboratory and field scale that can capture the major physical mechanisms of gas drainage. Tools be be recommended for the optimum design of drainage holes, based on available field data through geological-numerical exercises.
Current	**Contamination - Ethylene from Timber Supports C29024** Sean Muller, Simtars	$94,750	Bharath Belle and Paul Wild, Anglo American Steelmaking Coal David Webb, Glencore Coal Assets Australia John Grieves, QCoal Services Julian Potten, Kestrel Coal Resources	Ethylene is a key spontaneous combustion indicator used in underground coal mines and its detection in monitoring samples can lead to mine evacuation. Recent cases of ethylene detected outside combustion parameters indicate sample contamination, potentially from timber supports. This project aims to identify the cause of contamination of gas samples with ethylene and/or other spontaneous combustion indicators from timber supports. This data will enable appropriate controls to be established and implemented to prevent contamination.
Complete	**Review of the DRI Process and its Role in Setting Thresholds for Non Bulli Mines C29027** Scott Thomson, CoalBed Energy Consultants	$128,900	Bharath Belle and Paul Wild, Anglo American Steelmaking Coal David Webb, Glencore Coal Assets Australia Russell Thomas, South32 Illawarra Coal Sharif Burra, Yancoal	The concept of outburst threshold levels was developed in the early 1990s as a safety response to problems encountered in the outburst-prone Southern Coalfields of New South Wales. The most commonly applied method of estimating outburst risk is the threshold level approach using the desorption rate index. However, desorption rate is only one factor that affects outburst propensity and questions have been raised about the applicability of these thresholds in non-Bulli seam mines. The objectives of this project are to establish whether an alternative metric can be applied and, if not, to improve the general understanding of how threshold level values should be applied in areas outside the Southern Coalfields.
Current	**Direct Measurements of Effective Diffusion Coefficient of Coal C29036** Peyman Mostaghimi, University of New South Wales	$175,000	Bharath Belle and Paul Wild, Anglo America Steelmaking Coal David Webb, Glencore Coal Assets Australia Russell Thomas, South32 Illawarra Coal	In coal mining, the effective diffusion coefficient of gases is a critical factor that determines the magnitude and likelihood of gas-related dynamic failures such as outburst and, in some cases, coal burst. There are a wide range of experimental attempts to determine this coefficient; however, the reported values are inconsistent, varying up to two orders of magnitude. This project will develop a fast and reliable method to determine the effective diffusion coefficient in coal at pre-mining stress conditions using X-ray micro-computed tomography, micro-CT imaging. Micro-CT imaging is a non-destructive method that can be applied to visualise three-dimensional interior structure of an object at high-pressure dynamically while gas is being diffused.
Current	**Strata Gas Content using Geophysical Logs and Laboratory Measurements C33018** Guangyao Si, University of New South Wales	$128,560	Agi Burra and Mark Laycock, Glencore Coal Assets Australia Bharath Belle, Anglo American Steelmaking Coal Russell Thomas, South32 Illawarra Coal	An accurate estimation of gas content in coal measures is critical for the prediction of specific gas emissions, design of gas drainage and ventilation strategies, and compliance of gas concentration in tailgates. Researchers will integrate geophysical logging data analysis and laboratory measurements to accurately determine the gas content of coal measures and their potential interaction with the mining horizon.
Current	**Evaluating Ventilation Effects on Coal Self Heating Incubation Behaviour C33025** Basil Beamish, B3 Mining Services	$79,200	Bharath Belle, Anglo American Steelmaking Coal John Grieves, QCoal Services Sharif Burra, Yancoal	Evaluation of ventilation effects on spontaneous combustion in underground coal mines has primarily relied on computer simulations using numerical models. This project aims to provide test results that are a physical replication of the goaf fringe environment under various ventilation flowrate scenarios. In each scenario the coal self heating incubation behaviour will be measured from mine ambient temperature through to thermal runaway if it occurs.

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Current	**Review Longwall Face Ventilation to Mitigate Goaf Gas Emissions onto Walkways and Tailgate End C33029** Ting Ren, University of Wollongong	$146,500	Ventilation Task Group	Goaf gas migrating onto the longwall face is causing gas exceedance incidents, particularly on longwall panels extracting multiple gassy seams and where predrainage is not effective. Researchers will examine longwall ventilation control practices for mitigating localised, high goaf gas emissions onto the longwall face and associated control measures and practices, particularly in areas around tailgate end. They will also make best practice recommendations.
Current	**VR-CFD Based Simulation and Training Tool for Dust Control in Gateroad Development Panels C33030** Ting Ren, University of Wollongong	$349,800	Ventilation Task Group	Longwall and continuous miner operators have the highest workplace exposure to airborne dust. This project aims to develop an immersive simulation tool that clearly demonstrates the exposure impact of changes to working conditions in gateroad development panels. The tool will provide enhanced 3D visualisation of monitoring and computational modelling datasets of dust and ventilation flow. The project will focus on development panels using JOY 12CM30 due to its widespread use in the industry.
Current	**Time Lapse In-Seam Seismic and Resistivity Measurements as an Integrated Component of a Smart Coal Seam Gas Pre-Drainage Practice: Literature Review C34010** Hamid Roshan, University of New South Wales	$60,000	Ventilation Task Group	Underground in-seam seismic surveys have shown promising results in mapping coal seam features and temporal changes in coal characteristics. This data is important in maintaining compliance with safety regulations, particularly regarding methane and carbon dioxide content. The objective of this initial support is to undertake a literature review and provide evidence that the underlying theory would be successful at visualising +300m ahead in the gateroad area.
Current	**Appraisal of Gas Indicators from Goaf Drainage Holes for Spontaneous Combustion and Explosion Risk Management: Stage 2 C34011** Guangyao Si, University of New South Wales	$223,254	Bharath Belle, Anglo American Steelmaking Coal David Webb, Glencore Coal Assets Australia John Grieves, QCoal Services Ken Singer, BMA Paul Wild, Anglo American Steelmaking Coal	The intensive application of goaf drainage has raised concern that strong suction pressure caused by multiple goaf holes may accelerate ventilation air leakage and oxygen migration into the deep goaf, increasing the risk of self-heating. Building upon the extensive goaf drainage data collected in Stage 1, this Stage 2 project aims to investigate the effect of intensive goaf drainage on ventilation airflow leakage and dynamic goaf environment variation using CFD models.
Current And New	**Borehole Tools to Deal with Outbursting, Coal Bursting and Gas Drainage C34014** Ian Gray, Sigra	$853,920 Current $824,400 New	Ventilation Task Group	There are extensive strata data that could be gathered and interpreted automatically during the borehole drilling process. Researchers have been developing a suite of underground in-seam borehole tools to deal with outbursts, coal bursts and gas drainage. The suite of tools is founded on a high-speed electronics communication system which will enable two-way data transfer along the drill string. The system will be compatible with multiple down-hole sensors. In this extension project, researchers will build the calliper log, surface test it and obtain approvals before conducting underground field trials.
New	**Inertisation Strategies to Reduce Oxygen Levels in Goaf Holes and Minimise Oxygen Ingress into Longwall Goaf C35012** Rao Balusu, CSIRO	$100,000	Ventilation Task Group	This is an area of high interest within the industry. Looking solely at inertisation may not be a true reflection on the best management strategies, therefore this project will initally look at current management systems and strategies used throughout the industry including areas where high gas drainage rates in goaf holes influnce high oxygen concentration levels that may create a significantly increased risk of spontaneous combustion. The main objective of this project at this stage is to work with industryuy on a scoping study for research to implement the development of optimum inertisation strategies to reduce oxygen levels in goaf holes and to minimise oxygen ingress on both maingate and tailgate sides of the longwall goaf.
New	**Studies of Coal Toughness and Gas Sorption Dynamics for Outburst Risk Management C35015** Ting Ren, University of Wollongong	$275,000	Ventilation Task Group	Coal toughness coefficient is used internationally as an indicator of coal and gas outburst risk. To improve confidence in outburst risk assessment, coal toughness and its relationship with other coal mechanical and proximate properties need to be evaluated. In this project, researchers will conduct systematic studies of coal toughness, geo-mechanical properties and gas sorption dynamics with different coals sourced from underground coal mines in New South Wales and Queensland. A standard coal toughness test and coal toughness coefficient index database will be developed.

The primary goal of the open cut research program is to achieve zero fatalities while minimising negative effects on the workforce, environment, equipment and the resource. This is reflected in the targeted occupational health and safety program particularly related to dust and mental health. Rehabilitation activities particularly targeting management of voids and soil regeneration has grown in importance as the broader community and mine owners' expectations increase regarding social licence to operate.

Research that addresses the science on all aspects of rehabilitation and the minimisation of mining impacts on neighbouring communities is a key priority and it will continue to consume a significant component of the open cut research budget.

COMMITTEE MEMBERS

Tony Egan	**Manager, Project Governance (co-chair)**	**Glencore Coal Assets Australia**
Andrew Lau	**Mine Closure Manager (co-chair)**	**Yancoal**
Ngaire Baker	External Relations Manager	MACHEnergy Mount Pleasant Operation
Shaun Booth	Group Manager Resource Development and Technology	Glencore Coal Assets Australia
Sandro De La Cruz	Lead Superintendent Projects & Governance	BHP
Brett Domrow	Mine Planning Manager	New Hope Group
Jason Fittler	Environment Manager	Anglo American Steelmaking Coal
Lindsay Ford	Project Manager	Glencore Coal Assets Australia
Tim Gray	Engineering Manager – Surface Operations (NSW)	Glencore Coal Assets Australia
Sean Halliday	Principal for Open Cut Automation and Technology	Anglo American Steelmaking Coal
Shaun Hansen	Head of Technical Services	BHP
Gift Makusha	Manager Geotechnical Engineering	Anglo American Steelmaking Coal
Mukesh Mehta	Technical Specialist – Mineral Residue Facilities	Anglo American Steelmaking Coal
Andrew Micallef	Principal for OC Excellence	Anglo American Steelmaking Coal
Brian Neilsen	Director of Engineering - Open Cut Mining	Peabody Australia
Paul O'Loughlin	Technical Services Manager	MACH Energy
Troy O'Reilly	Risk & Compliance Advisor, Mining Operations	Stanwell Corporation
Carl Pritchard	General Manager Technical Services	Jellinbah Group
Matt Tsang	Geotechnical Numerical Modelling Manager	Anglo American Steelmaking Coal
Peter Walsh	Project Manager	Glencore Coal Assets Australia
John Watson	Director - Environment and Community	Glencore Coal Assets Australia
Stephen White	Principal Rehabilitation and Biodiversity	BHP
Brendan Wilkins	Principal Open Cut Asset Management	Anglo American Steelmaking Coal

OPEN CUT PROJECTS

PROJECTS UNDER MANAGEMENT

Category	No of Projects	ACARP Funding
Drilling and Blasting	4	$1,315,689
Environment	19	$6,791,590
Geology	7	$792,630
Geotech	7	$1,890,061
Health and Safety	8	$2,522,876
Maintenance and Equipment	12	$2,067,830
Mining and the Community	1	$199,472
Overburden Removal	1	$346,046
Total	**59**	**$15,926,194**

NEW FUNDING APPROVED

No of Projects	ACARP Funding	Total Funding
13	$3,771,412	$6,580,969

Total Funding includes in-kind support provided by the researcher and host mine identified in the research proposal.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
DRILLING AND BLASTING				
Current	**Evaluation of Production Trials of HP Explosives C27024** Ewan Sellers, Mining3	$477,920	Andrew Lau, Yancoal Benjamin Wood, Stanwell Corporation Brett Domrow, New Hope Group Ewen Mills and Lindsay Ford, Glencore Coal Assets Australia	The aim of this project is to design and manufacture a specialised, inert to hydrogen peroxide, H202 contamination free MMU to produce and deliver bulk quantities of H2O2 based explosives. The MMU targets production rates of 300 kg/min, with a minimum rate of 75kg/min. The MMU will comply to safety and security for mine site scale blast performance. In this project mine site trial blasts of increasing size will be trailed to ensure a successful demonstration of blasting approaching a full-scale blast. The MMU design will ensure that the unit can be subsequently used for further trials and detonation displays.
Complete	**Real Time Prediction of Coal Top Through Guided Borehole Radar Wave Imaging for Open Cut Blast Hole Drilling Phase 2 C29053** Binzhong Zhou, CSIRO	$337,910	Jack Woollett, Glencore Coal Assets Australia Troy O'Reilly, Stanwell Corporation	Damage to the top of coal seams caused by incorrect blast stand-off distances costs the Australia coal industry around $3.2 billion a year in lost production. There are no effective and economically sound techniques that map and characterise coal seam structures in the open cut environment. In Phase 2 of this borehole radar (BHR) project, researchers aimed to develop a prototype coal top prediction test system by integrating the BHR with blast-hole drill rods. They designed and developed a specific BHR antenna to improve the generation of guided BHR waves and design a wireless communication system between the downhole BHR and the driller in real time. Processing methods were developed to block or filter out the backward-looking events from the top part of the drill rods. An automated seam prediction and warning system was also developed that would be practical for drillers without compromising productivity.
Current	**Production Trials in Two States of HP Explosives with Custom MMU C33041** Ewan Sellers, Mining3	$342,034	Andrew Lau, Yancoal Benjamin Wood, Stanwell Corporation Ewen Mills and Lindsay Ford, Glencore Coal Assets Australia	Researchers have developed a new, stabilised hydrogen peroxide based emulsion explosive with 25 day sleep time. In this project they will use a prototype mobile processing unit to expand demonstrations beyond earlier preliminary trials. Near production scale blasts will be conducted to address technical hurdles.
Current	**Advanced Blast Modelling and Geotechnical Analysis Tools C34034** Italo Onederra, University of Queensland	$157,825	Adam Forgeron and Andrew Johnstone, BHP Jafnie Muhsin, Anglo American Steelmaking Coal	Previous research demonstrated that an approach linking advanced blast modelling outcomes with geotechnical analysis tools could improve evaluation of geotechnical issues, such as low wall stability with disrupted floor conditions. This project aims to enhance current design guidelines and provide further recommend how to optimise floor disruption techniques in the management of low wall stability risks as coal extraction is taking place.
New	**Reactive Ground Testing C35018** Gary Cavanough, QMR Blasting Analysis	$250,000	Andrew Micallef, Anglo American Steelmaking Coal Mark Laycock, Glencore Coal Assets Australia	Spontaneous reactions between explosive products and certain ground types can lead to a spontaneous detonation of the explosive in the blasthole, putting personnel and equipment at risk. There are limits to the current procedure for testing reactivity due to the turnaround time of several weeks for analysis. This project aims to develop a ground reactivity assessment method that can be performed on site in less than 90 minutes.
New	**Bulk Mining Explosives Sensitisation Utilising a Non-Invasive, Chemical Free Method C35028** Andrew Kettle, Mining3	$297,256	Andrew Lau, Yancoal Benjamin Wood, Stanwell Corporation Brett Domrow, New Hope Group Ewen Mills and Lindsay Ford, Glencore Coal Assets Australia	The objective of this project is to further enable and improve bulk hydrogen peroxide, H2O2-based emulsion mixtures to deliver the benefits of 'green explosives' with lower community and environmental impacts. Researchers will design and manufacture a prototype sealed high-emission UV-radiation static mixer-based unit for workshop-based and small-scale field experimentation to sensitise H2O2-based emulsion mixtures.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
ENVIRONMENT				
Complete	**Self Sustaining Ecological Mine Rehabilitation that Achieves Recognised Ecological Communities C27038** Travis Peake, Umwelt, Australia	$401,670	Bill Baxter, Yancoal Jono Deacon, BHP Nigel Charnock, Glencore Coal Assets Australia	Researchers have already developed a set of principles to inform the selection of rehabilitation objectives, and performance and completion criteria for establishing self sustaining ecological communities. In this project the criteria was updated in line with revisions to the Eastern New South Wales Plant Community Classification.
Complete	**Adaptation of Design Tools to Better Design Rehabilitation and Capping Over Highly Mobile Mine Waste C27042** Greg Hancock, University of Newcastle	$439,000	Chris Quinn, Rix's Creek	In this project a set of mine rehabilitation design tools was developed that can predict the performance of a rehabilitated mine with and without a capping layer, enabling an explicit trade off analysis to be undertaken. Rehabilitation designs using this tool are expected to meet the requirements of regulatory authorities and the community.
Current	**Topsoil Deficits in Site Rehabilitation Accelerated Transformation of Spoils to Functional Soils C28035** Gordon Southam, University of Queensland	$226,450	Stephen White, BHP	Healthy topsoils are the foundation for effective rehabilitation strategies at mine sites. However, most mines will fall short of the quantity and/or quality of topsoil needed for rehabilitation due to the spoil swell factor and, for older mines, insufficient topsoil harvesting. The aim of this project is to address topsoil deficits at Bowen Basin coal mines by focusing on processes that could speed up the transformation of spoils to functional soils. Researchers will identify microorganisms that are critical and/or key 'first responders' in the development of functional soils during rehabilitation. A soil microbial inoculum will be developed and tested at field scale, helping to accelerate the ongoing transformation of spoils to soils in the region.
Complete	**User Driven Refinement of Decision Support Tools to Inform Final Mined Landform Outcomes C28044** Glenn Dale, Verterra	$250,220	Craig Lockhart, BHP Jason Fittler, Anglo American Steelmaking Coal	This project modifies a dispersive spoil management framework developed in a previous project so that it can encompass all mine rehabilitation situations. The project aimed to refine the package of decision support tools in the framework through user-driven training and incorporation of operational rehabilitation results. This research helps improve rehabilitation outcomes, assist industry practitioners to deliver cost effective rehabilitation, enhance the industry's capacity to meet closure criteria, and boost the value of land post closure.
Current	**Erosion and Sediment Control Framework for Queensland Mines C29046** Claire Cote, University of Queensland	$237,200	Andrew Lau, Yancoal Jason Fittler, Anglo American Steelmaking Coal Steve Downes, Glencore Coal Assets Australia	In Queensland regulators have raised questions about whether runoff released from mines' erosion and sediment control plan, ESCP structures qualifies as being non-mine-affected, and about the selected design criteria of ESCP structures. This project will lead to improvement of mine site ESCPs by engaging with industry representatives and regulators to derive clear objectives for the ESCPs, to agree on a shared understanding of what constitutes non mine-affected runoff and to develop technical guidelines that will provide assurance that ESCPs comply with water conditions.
Current	**Reducing Uncertainty in Long Term Water Quality Predictions for Final Void Management C29047** Sue Vink, University of Queensland	$245,600	Andrew Lau, Yancoal Jason Fittler, Anglo American Steelmaking Coal Steve Downes, Glencore Coal Assets Australia	Recent reforms in the financial assurance framework require that mine sites progressively rehabilitate land to agreed outcomes. This includes presenting a life-of-mine plan and scheduled rehabilitation outcomes. Predictive modelling of void water quality is an essential component to ensure outcomes are safe, stable and non-polluting and can support a designated land use. In this project, researchers will generate data to assist management and closure of final voids as permanent water bodies. The work will combine a desktop analysis of existing water quality and climate data with field data collected from up to four voids on a quarterly basis for 12 months. Data will be incorporated into a model to forecast long-term water volume and water quality for a range of scenarios.
Current	**Saline Pit Lakes as Aquatic Ecosystems: A Design Manual for Closure C29049** Mark Lund, Edith Cowan University	$1,089,226	Andrew Lau, Yancoal John Watson, Glencore Coal Assets Australia Stephen White, BHP Toni Ward, Sojitz Green	Pit lakes are one of the greatest legacies of open cut mining, but they are not well understood. The broad aim of this extension project is to produce a state-of-the-art design manual for saline pit lakes to assist companies prepare for closure. Researchers will continue and broaden the current biophysical monitoring program to include new pit lakes. They will document the range of interannual variability in the biophysical data and long term trends in lake ecosystem development. They will also investigate how the use of floating vegetated islands could enhance riparian development at closure and during lake fill.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**High Water Recovery, Low Cost Desalination using PV-Powered Membrane Capacitive Deionisation, mCDI C33035** David Waite, University of New South Wales	$334,340	Kane Eskola and Nash Hancock, BHP Nick Cook, Yancoal	Capacitive deionization is a robust, energy efficient and cost effective technology for desalination of water with moderate salt content. Including ion exchange membranes in front of the electrodes in a process called membrane capacitive deionisation is a promising recent development. This project will use an onsite pilot scale trial to assess the viability of membrane capacitive deionisation, in combination with appropriate pre treatment processes, to remove salt and other contaminants from mine water. Researchers will also provide advice on the design of units suitable for the coal mining environment.
Complete	**Quantifying Recharge to Groundwater Systems in the NSW and Bowen Basin Coalfields C33037** Andy Wilkins, CSIRO	$110,400	Lu Wang, Glencore Coal Assets Australia Michael Moore and Nick Cook, Yancoal	Researchers quantified rainfall recharge of groundwater systems in the New South Wales and Bowen Basin coalfields by using chloride mass balance, a method they have used in the Bioregional Assessment Programs in conjunction with empirical methods. This project extends the method so that it is more relevant at the local scale. Researchers provided a scientifically rigorous base upon which estimates of mining impacts can be made, eliminating one of the main sources of uncertainty in groundwater assessments and expediting the mine approval process.
Current	**Best Practice Management and Performance Assessment of Biodiversity Offset Areas C33043** Andrew Butler, Eco Logical Australia	$335,540	Jono Deacon and Mark Nolan, BHP Michael Plain, Stratford Coal Nigel Charnock, Glencore Coal Assets Australia	The coal industry is required to demonstrate that it can effectively offset its biodiversity impacts through effective rehabilitation of land under its management. Choosing the most sustainable and cost effective management measures for maximising biodiversity outcomes needs to be supported by a sound evidence base. This project will develop evidence based decision support tools using the extensive biodiversity offset areas, BOAs monitoring datasets held by multiple mining operations, in conjunction with desktop and field research. Researchers will also develop industry guides for selecting best practice BOA management methods, including a decision support framework and for selecting BOA monitoring, data collection and data evaluation methods.
Current	**Extent, Spread and Risk of Pasture Dieback on Mine Site Rehabilitation using Remote Sensing C33045** Phill McKenna, University of Queensland	$291,990	Andrew Lau, Yancoal Nigel Charnock, Glencore Coal Assets Australia Rod Norris, BHP	Pasture dieback is a disease first detected in buffalo grass in central Queensland in 1993 and has since spread to infect up to 4.4 million hectares of pasture throughout the state. There is no confirmed cause and the risk to mine rehabilitation is unknown. High spatial and temporal resolution imagery will be used in this project as a novel way to detect and measure pasture dieback on rehabilitated and unmined pasture using remote sensing techniques. This includes satellite imagery, site preparation records and historical aerial imagery held by mining companies that shows vegetation establishment and growth on an annual basis.
Current	**Rationale for the use of Paired Continuous Real Time Noise Monitors to Reduce Uncertainty in the Quantification of Noise from Open Cut Coal Mines C33046** Tim Procter, Umwelt, Australia	$125,000	Ned Stephenson, Glencore Coal Assets Australia Ngaire Baker, MACH Energy Australia	New South Wales has more than 60 continuous real time noise monitors installed either individually or as part of a continuous noise monitoring network. The systems are cumbersome, and the amount of data is overwhelming. While the smart phone application has improved information accessibility, source identification can still be difficult to quantify. This project will develop a rationale for using the relationship between various data metrics collected by paired monitors to quantify noise from open cut mines in complex acoustic environments.
Current	**Best Method for Determining Atmospheric Stability for the Assessment of the Acoustic Environment in the NSW Coal Mining Industry C33047** Tim Procter, Umwelt, Australia	$276,000	Ned Stephenson, Glencore Coal Assets Australia Ngaire Baker, MACH Energy Australia	There are two main methods for identifying temperature inversions – the Pasquill-Gifford method and temperature lapse rate method. Both methods are used in New South Wales by the EPA to set noise licence conditions for the coal industry. Researchers aim to establish which method is most appropriate for the assessment of noise enhancing conditions, and the establishment of performance based noise management systems and associated licence conditions for open cut coal mines.
Current	**New Landscape Evolution Model for Assessing Rehabilitation Designs C34025** Greg Hancock, University of Newcastle	$875,391	Chris Quinn, Rix's Creek Jason Fittler, Anglo American Steelmaking Coal	This project aims to develop a new set of tools that can be used to assess the long-term sustainability of post mining landforms and reduce environmental risk. As part of this work, researchers will test and develop the State Space Soil Production and Assessment Model, SSSPAM which will incorporate all features of the SIBERA model. The researchers will develop an accompanying database of parameters that can be used across a range of sites, materials and climates. A further goal is to redevelop the SIBERIA model so that it is available to the industry.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Microalgae Cultivation as a Low Cost Method for Desalinating Void Water and Generator of Post Mining Bioeconomic Activity from Final Voids C34027** Ben Hankamer, University of Queensland	$841,579	Andrew Lau, Yancoal Jason Fittler, Anglo American Steelmaking Coal John Watson, Glencore Coal Assets Australia Penny Walker, Malabar Resources Trudy Mazucco, BHP	Mining companies report that final voids represent one of the most significant challenges for mine closure. A commercially viable and scalable solution to repurpose voids would avoid the need for expensive backfilling and generate economic post mining activity. The cultivation of microalgae adapted to saline conditions may unlock void water for agricultural applications and generate new regional bio-economies. This two stage project will isolate and characterise commercially relevant microalgae species adapted to void water conditions. Researchers will then determine whether pilot scale cultivation can deliver low cost desalination at volumes relevant for agricultural applications and generate additional bioeconomic activity through downstream processing.
Current	**Guidelines for Assessment of Geotechnically Safe and Post Mining Landforms C34028** John Simmons, Sherwood Geotechnical and Research Services	$120,000	Andrew Lau, Yancoal Trudy Mazucco, BHP	There is no consistent methodology for applying current geotechnical observations and stability analysis procedures to the evaluation of potential future ground conditions. This information is required in environmental authorities and progressive rehabilitation and closure plans. A technical framework is needed that considers impacts of uncertain time-dependent strength and groundwater pressure changes, geomorphological processes and future land use changes. This project aims to distil the landform geotechnical safety and stability experience of leading industry professionals into good practice guidelines, a checklist and consequence assessment process. These outputs have the potential to be certified.
Current	**Optimising Plant Growth and Flood Preconditioning for Tailings Dams C34030** Mike Cole, CSER Research	$294,583	Andrew Lau, Yancoal Shaun Booth, Glencore Coal Assets Australia Trent Cini, Moolarben Coal Operations	Successfully vegetating the surface of tailings storage facilities is challenging. Tailings behave as a clay-like substrate that shrinks, swells and cracks. The 'substrate' does not freely drain down to the lower levels, causing standing water following heavy rain. When flooding occurs, plants' fine feeding roots, especially those near the surface, become anoxic and die. The objective of this project is to optimise plant survival on tailings by testing growth medium mixes, pot size and pre-conditioning to flooding. Researchers will expand the number of primary species under study to reflect those native to other coal fields.
Current	**High Interest Native Plant Pittosporum Angustifolium for Mine Rehabilitation: Key Strain Identification and Germplasm Propagation Investigation C34035** Ryan Anderson, RNA Environmental Services	$197,401	Andrew Lau, Yancoal Andrew Micallef, Anglo American Steelmaking Coal Toni Ward, Sojitz Green	Pittosporum angustifolium is a drought resistant plant found in semi-arid regions on highly weathered skeletal sandy soils. Pittosporum angustifolium is an ethno-pharmaceutical plant species reputed to have beneficial properties for prostate cancer patients. It also has potential as a mined land rehabilitation species. Two known parent plants have been identified in the Boulder combe region of Central Queensland. This project will produce Pittosporum angustifolium tubestock suitable for field implementation. Researchers will develop a robust practical methodology for successful propagation of the species and assay anti-cancer properties of phytochemical active ingredients.
Current	**Literature Review: Creating Viable and Productive Grazing as a Beneficial Final Land Use Through Targeted Design and Land Management C35006** Leigh Trevaskis, Mumbulla Environmental	$100,000	Andrew Lau, Yancoal Pieter Swart, Glencore Coal Assets Australia	This project will assess what research has been done to confirm accelerated achievement and sustainable management of grazing PMLU in the Hunter Valley and Bowen Basin. Work will target the range of grazing PMLU slope gradient and the reliable for guiding commercial practices. The review will utilise ACARP reports and internal company grazing trial reports to develop a gap analysis for future research.
New	**Delineating Water Tables and Flow Pathways Inside Spoil Piles to Support Water Quality Predictions C35021** Mansour Edraki, University of Queensland	$297,420	Andrew Lau, Yancoal Steve Downes, Glencore Coal Assets Australia	Spoil piles have a highly heterogeneous composition and internal structure due to different dumping strategies and overburden material. In this project, researchers will define the spatial distribution of major flow pathways and water tables in spoil piles to support accurate prediction of spoil seepage water flow and quality. They will also produce instructions on how to use the data to improve spoil pile hydrology and water quality prediction models.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
New	**Management Strategies for Invasive Leucaena on Coal Mine Sites C35026** Shane Campbell, University of Queensland	$531,528	Andrew Lau, Yancoal Jason Fittler, Anglo American Steelmaking Coal Pieter Swart, Glencore Coal Assets Australia Stephen White, BHP	Leucaena, Leucaena leucocephala is a leguminous tree introduced to Australia from central America for use as a forage for livestock production. It is a major environmental weed in sub-tropical and tropical regions. This project aims to develop strategies to effectively manage leucaena in rehabilitation on coal mine sites.
New	**Renewable Energy as Post Mining Land Use C35029** Shona Stevens, University of Queensland	$186,628	Jason Fittler, Anglo American Steelmaking Coal Ned Stephenson, Glencore Coal Assets Australia Raymond Howard, Yancoal	Renewable energy produced by solar and wind has vast potential in the Bowen and Surat basins. However, the pathway to implementation is not clear. High-level guidance is available but it is difficult to translate the recommendations into actions on the ground as regulatory barriers and planning constraints are not fully understood. This project will undertake two case studies to examine how renewable energy projects can be established on a mining lease and gain acceptance from regulators and stakeholders. Recommendations will be made on how to update the regulatory and planning frameworks to encourage and accommodate renewable energy as a post-mining land use.
New	**Erosion and Sediment Control Framework for Queensland Mines – Calibration and Validation C35030** Robynne Chrystal, University of Queensland	$347,196	Andrew Lau, Yancoal Jason Fittler and Tim Kendrick, Anglo American Steelmaking Coal Steve Downes, Glencore Coal Assets Australia	This project will verify and validate the technical guidelines that were developed in a previous ACARP project for the design and implementation of erosion and sediment control plans for Queensland coal mines.
GEOLOGY				
Complete	**Controls on Fluorine and Phosphorus Distribution in Bowen Basin Coals C26029** Joan Esterle, University of Queensland	$141,050	Alison Burke, BHP Tim Buddle, Anglo American Steelmaking Coal	Reduced fluorine tolerances on imported coals has meant that Australian producers need to better understand the occurrence and distribution of fluorine within their coals. This project analysed phosphorus, fluorine and other major and trace elements in Late Permian coals in the Bowen Basin. Conceptual models were tested for the occurrence and distribution of these elements within a coal measure or seams. Improving the predictability of these elemental distributions will help to improve blending scenarios and scheduling, refine resource estimation methodology and facilitate the generation of beneficiation processes.
Complete	**Raw Ash to Yield Relationships C28033** Chris McMahon, McMahon Coal Quality Resources	$29,120	Hugo Kaag, South32 Illawarra Coal John Terrill, Glencore Coal Assets Australia	Estimating product yield at a certain set ash outcome via raw ash is a common method for predicting resource potential, but the data produced can be misleading. In this project, researchers collated and evaluated raw ash and product yield/ash data from several deposits to determine the accuracy, precision and bias and efficacy, when to use and margin of error of different evaluation methods. The outcome from this research is an industry document that improves resource accuracy, saves time and reduces financial risk.
Current	**Elements in Coal – A Start-to-End Analysis C34016** Jane Hodgkinson, CSIRO	$119,035	Raymond Howard, Yancoal	Most coal waste is considered an industrial overhead that must be managed at substantial cost. Some coal waste contains critical minerals, metals and elements. The fate of these elements in coal value chains is poorly understood. This project aims to provide elemental analyses of coal as it moves through its value chain, from seam to end use and waste. The project will deliver a framework showing the behaviour and fate of 50 elements that started in the coal seam, where they end up and how or why the composition may have altered.
Current	**Guideline for Standardising Structure Interpretation in ATV/OTV Logs C34020** Mojtaba Rajabi, University of Queensland	$163,415	Brian Vorster, Glencore Coal Assets Australia Matt Tsang and Euan Macaulay, Anglo American Steelmaking Coal	Borehole image logs, such as ATV and OTV, provide accurate orientated images from borehole walls that are considered replacements for manual cores. However, there is no accepted guideline nor nomenclature for the interpretation of structures from ATV/OTV logs for Australian coal basins. This project aims to develop a guideline for processing, analysis and interpretation of structures in ATV/OTV as a means of reducing the inconsistencies and misinterpretations from image log interpretations.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Laser Induced Breakdown Spectroscopy, LIBS as a Rapidly Deployable Field Technology to Estimate Coal Quality C34029** Joe Perkins, CSIRO	$135,510	Mark Laycock, Glencore Coal Assets Australia	Laser induced breakdown spectroscopy, LIBS is well established and shows promise as an analytical method for coal characterisation; however, it has yet to be used successfully to analyse and quantify uncrushed coal samples in the field. Recent developments now enable rapid collection of LIBS spectra via handheld units and smartphone connectivity. The aim of this project is to assess LIBS as a viable, safe, low-cost, rapidly implementable coal quality assessment technology to improve resource characterisation in the field. Researchers will calibrate LIBS spectra data using historic samples and diverse lab analysis results and establish a field test protocol.
Current	**Utilising Hyperspectral Drill Core Scanning for Geotechnical Characterisation C34033** Katerina Savinova, University of Queensland	$128,500	Brooke Davis, BHP Jafnie Muhsin, Anglo American Steelmaking Coal	This research aims to use hyperspectral scanning technologies to improve the collection and interpretation of geotechnical index parameters for characterising the overburden material in open cut coal projects.
Current	**Applying Semi Automated Lithology Boundary Selection Methods by Incorporating Drilling Data and/or Natural Gamma Logs C34037** Brett Larkin, GeoCheck	$76,000	Mark Laycock, Glencore Coal Assets Australia	Determination of top-of-coals from blast hole data is often undertaken by geophysically logging the blast holes, manually interpreting the density log and then physically entering data into mine models and schedules. This project will extend previous research on semiautomatically determining coal boundaries from density logs. Researchers aim to deliver a system for deriving top-of-coals from blast hole data. They will also develop a methodology for checking lithology type and deriving boundaries between non-coal lithologies from geophysical logs.
New	**Recovery of Rare Earth Elements, REE from Coal and Coal Production Waste C35023** Philip Ofori, CSIRO	$154,000	Andrew Lau, Yancoal Shaun Booth and Caroline Lang, Glencore Coal Assets Australia	There are currently global supply chain challenges for heavy rare earth elements, REE particularly dysprosium. In this project, researchers will utilise research that is currently being undertaken to assess the potential of coal, coal bearing strata and production waste as unconventional sources of REEs and other critical minerals. They will use advanced characterisation techniques to develop innovative and environmentally benign recovery technologies for minerals that are found in Australian waste streams to be economic.
New	**CSR Predictions and Correlations Definition C35025** Chris McMahon, McMahon Coal Quality Resources	$35,880	Alison Burke, BHP	In this project, researchers will define the effectiveness of coke strength after reaction, CSR predictors for product coals of varying coal quality characteristics. To support this work, they will conduct a comparative analysis of published equations, chart data, that can be converted to formulas data obtained from existing research and estimators produced in that research. Several deposits and coal types will be evaluated. The outcome will be a guide for improving CSR predictor accuracy and thereby improving resource / reserve / marketing product accuracy.
New	**Real Time Prediction of Coal Top Through Guided Borehole Radar Wave Imaging for Open Cut Blast Hole Drilling Phase III C35047** Binzhong Zhou, CSIRO	$396,792	Jack Woollett, Glencore Coal Assets Australia Troy O'Reilly, Stanwell Corporation	Damage to the tops of coal seams caused by incorrect blast stand-off distances results in coal losses in some cases up to 10-15%. Researchers have demonstrated that a conventional borehole radar can be connected to a drill string to generate wave imaging and predict the coal seam top in real-time during drilling. This project aims to deliver a fully functional real-time coal top guidance system prototype that is suitable for field demonstration trials and commercialisation.
GEOTECH				
Complete	**Groundwater Pressures and Flows Within Spoil Dumps C28038** Stephen Fityus, University of Newcastle	$330,063	Kim Peckett, Mt Arthur Coal Leonie Bradfield, Bradfield Mining Geotechnics	The design of open cut spoil dumps is being hampered by the absence of reliable data on groundwater pressures. In addition, there is no information on how groundwater tables develop in spoil dumps and little information on the moisture conditions above the groundwater level. Detailed laboratory testing has informed the development of a robust groundwater pressure prediction process that includes evidence of the position of the groundwater table and its evolution in time as the dump advances.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**System for Rock Fall Analysis Field Trial C29005** Marc Elmouttie, CSIRO	$321,268	Matt Tsang, Anglo American Steelmaking Coal	Systems to detect, monitor and analyse rock falls in open cut mining operations have the potential to improve operational safety, improve calibration of rock fall simulators and provide quantitative data to justify current standoff designs. A monitoring system that can accumulate a large database of rock fall events across the full strike length of highwalls was designed in an earlier stage of this project. In this extension, the prototype system underwent a field trial. The overall project aim was to support development of a commercially available rockfall monitoring system capable of accurately identifying rockfall events, locations and trajectories across the full strike of highwall, potentially in real time.
Current	**Baseline Data for the Development of Automated Characterisation of Waste Materials C29044** Klaus Thoeni, University of Newcastle	$197,850	Adrienna Robotham, Anglo American Steelmaking Coal Kim Peckett, Mt Arthur Coal Leonie Bradfield, Bradfield Mining Geotechnics Ned Stephenson, Glencore Coal Assets Australia	This project will support the Image Based Automated Characterisation of Waste Materials project C29048 by providing meaningful strength categories for the automated waste classification system. University of Newcastle researchers will categorise spoils that are captured in the UNSW project's images 'on the ground' via a series of detailed spoil mapping studies across mines in the Sydney and Bowen basins. They will deliver a set of thousands of data points for the corresponding photographic imagery which will enable UNSW researchers to evaluate the spoil categorisation from spectral analysis concept. In addition, University of Newcastle researchers will validate the field categorisation of spoils using the BMA framework and statistically assess the range and distribution of spoil types that are encountered in different pits and geological settings.
Current	**Image Based Automated Characterisation of Waste Materials C29048** Simit Raval, University of New South Wales	$279,540	Adrienna Robotham, Anglo American Steelmaking Coal Kim Peckett, Mt Arthur Coal Leonie Bradfield, Bradfield Mining Geotechnics Ned Stephenson, Glencore Coal Assets Australia	The stability of waste dumps is influenced by many factors, including dump geometry, geological and geotechnical conditions of the landscape, hydrological condition, physical and chemical composition of the dumped waste rock. High-resolution imaging and photogrammetric algorithms are being used to map the 3D shape and structural details of mining landscapes, including dumps, at the required scale and interval. However, given the scale of the generated image data and the need to instantly convert this data into useful information, an automated approach is required for better dump management. This project aims to develop machine learning-based automated waste material classification system using high resolution imagery collected from the airborne, drone and ground sources. Various parameters of the material such as size, density, roughness, saturation, composition and type of material will be obtained through feature extractions of the captured images.
Current	**Low Cost Terrestrial Stereo-Pair Photogrammetric Monitoring System for Highly Hazardous Areas C29050** Anna Giacomini, University of Newcastle	$210,720	Brit McArdle, Hunter Valley Operations Dan Stolberg, Glencore Coal Assets Australia John Latilla, Thiess	Terrestrial laser scanners and ground-based radar systems are widely used within the mining industry to periodically survey extended areas for instability and track deformations in almost real-time. While accurate and versatile, these systems are expensive. A cost-effective alternative is photogrammetry, which features simplicity of components and high scalability, and provides true 3D. The project aims to deliver an autonomous terrestrial stereo-pair photogrammetric monitoring system to observe highly hazardous, unstable areas. The system will collect synchronised images at a predefined frequency which will be used to produce 3D digital surface models.
Current	**Autonomous Water Pressure Sensors for Spoil Dumps and Dams C29052** Byron Wicks, Mining3	$458,040	Brit McArdle, Hunter Valley Operations Craig Hagan, Yancoal Kim Peckett, Mt Arthur Coal	The geotechnical integrity and stability of a mine spoil dump or tailings dam can be weakened by abnormal pore pressure and movement induced by groundwater permeating the embankment or the foundation of these structures. These factors affect the design, layout, safety and potential for slope failure to affect surrounding areas. A prototype system to communicate the health of the earth structure from sensor data has been designed and validated in a previous phase of the project. In this phase, researchers will review the performance of the technology and required sensors for predicting and diagnosing failures in spoil piles. A six-month field trial will be conducted to validate the robustness and effectiveness of the system. In phase 2 An autonomous sensor system has been developed for monitoring groundwater pressures and movement within spoil piles in order to manage slope stability of spoil dumps and embankment stability for tailings dams. Integration of the system is complete. It is awaiting a final field trial. In this final phase of the project researchers aim to refine and increase the functionality of the prototype system.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current And New	**Machine Learning for Rockfall Analysis: Feasibility Study C33040** Anna Giacomini, University of Newcastle Klaus Thoeni, University of Newcastle	$92,580 Current $249,660 New	Dan Stolberg, Glencore Coal Assets Australia Matt Tsang, Anglo American Steelmaking Coal	Rockfall is a major safety hazard in open pit mines. The ability to gather extensive rockfall data along a full strike length of highwall and effectively use this data to predict the rock trajectory and the associated hazard is challenging as their variability can significantly influence rockfall motion characteristics. This project will expand the previously developed machine learning and artificial intelligence approaches to include more site-specific information, such as stratigraphy, geology and geostructural mapping and using such data for both training and validation purposes.
New	**Quantifying Hoek-Brown Disturbance Factor, D for Coal Measures Through an Integrated Laboratory and Numerical Modelling Approach C35022** Italo Onederra, University of Queensland	$355,776	Matt Tsand and Adrienna Robotham, Anglo American Steelmaking Coal Peter Chern, Peabody Australia Coal	The estimated rock mass strength of a given slope is affected by the blast damage in slope excavations and deeper disturbance due to unloading. Defining rock mass zones remains challenging. This project aims to construct a comprehensive and generalised method for estimating the disturbance factor in coal measure strata. Unique multiscale numerical modelling techniques will be integrated with targeted laboratory-scale experiments to study and quantify blast damage in coal measure strata.
HEALTH AND SAFETY				
Current	**Reducing Risk Taking Among Australian Coal Miners C25026** Anna Giacomini, University of Newcastle	$302,235	Doug Kennedy, Glencore Coal Assets Australia	In a mining context, dangerous risk taking is defined any behaviour that deviates from prescribed risk controls with the potential to lead to serious accidents, injuries, and fatalities. This project will identify the psychological causes of dangerous risk taking behaviour among Australian coal miners and develop, test, and produce a practical intervention that will result in a significant reduction in this type of behaviour. Key outcomes will include an industry friendly manual that explains how to implement the intervention at mine sites across Australia as well as a numerical tool that can be used to evaluate the effectiveness of the intervention.
Current	**Continuous Monitoring of Whole Body Vibration and Jolts and Jars Associated with Operating Earth Moving Equipment C26026** Robin Burgess-Limerick, University of Queensland	$328,704	Ellen Roots, Glencore Coal Assets Australia Shane Apps, Peabody Australia Coal Troy O'Reilly, Stanwell Corporation	Operators of earth moving equipment at surface coal mines are continuously exposed to whole body vibrations. Prolonged exposure can lead to adverse health effects, particularly back disorders. In this project researchers will develop, demonstrate and evaluate iOS and server software and use off-the-shelf hardware to continuously monitor and analyse operator vibration exposures on haul trucks and dozers. Data from this project will help enhance understanding of the sources of elevated whole body vibration and impact loads in this environment.
Complete	**Case Study of Human Centred Design of New Technology in Mining C29001** Robin Burgess-Limerick, University of Queensland	$133,198	Brad Lucke and Tony Egan, Glencore Coal Assets Australia	The introduction of automation to the mining industry has considerable potential to reduce safety and health risks by removing people from hazardous situations, as well as improving productivity. The impact of automation on people also requires examination to ensure the change is managed for optimal health outcomes.This project undertok a detailed scoping study to define priority research questions and define further research need in this area. The purpose of extension work is to Pasquil document the human centred design process employed by Glencore and Wabtec throughout the development of the collision advisory system and develop a case study suitable for dissemination to industry.
Complete	**Assessing the Impact of Consecutive Night Shifts on Night-time Alertness and Daytime Sleep C29021** Greg Roach, Central Queensland University	$254,604	Craig Hagan, Yancoal	The Australian mining industry is one of the largest employers of rotating shift workers, second only to the health care industry. Experts in sleep and circadian rhythms are divided over how best to schedule sequences of night shifts to minimise sleep loss and body clock misalignment. Contrary to existing regulatory requirements, some experts recommend schedules with at least 7-10 consecutive night shifts to take advantage of body clock adaption. The aim of this project was to quantify exposure to fatigue risk as a function of the number of consecutive night shifts worked. Outcomes could be used to support a safety case in situations where working beyond the current recommended limit of four consecutive 12-hour night shifts may be warranted. A laboratory-based shift work simulation study was undertaken using conditions that mimic underground and open cut mine lighting conditions. Participants were randomly assigned to one of two groups: night shift, seven consecutive 12-hour night shifts or control, seven consecutive 12-hour day shifts.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Human Factors Aspects of Tyre Handling Equipment Design and Operation Examined within an EMESRT Control Framework Approach C33005** Robin Burgess-Limerick, University of Queensland	$416,528	Christian Jensen and Matt Clements, Anglo American Steelmaking Coal Iain Curran, BHP Tim Gray and Tony Egan, Glencore Coal Assets Australia	The project will evaluate the human factors aspects of tyre handling equipment design and operation within an EMESRT Control Framework approach and provide functional performance requirements for this equipment. It will illustrate a process by which human factors principles should be applied to equipment design and operation within the EMESRT Control Framework approach. It is linked to project C33007 to assist development of the EYECUE technology to minimise and or mitigate hazardous exposures that lead to tyre and rim handling fatalities.
Current	**EYECUE - Real Time Safety Monitor and Alert System for Tyre Handling C33007** Nathan Cables, Fingermark	$775,800	Christian Jensen and Matt Clements, Anglo American Steelmaking Coal Iain Curran, BHP Tim Gray and Tony Egan, Glencore Coal Assets Australia	The purpose of this project is to adapt and train real time EYECUE Computer Vision and Machine Learning technology to enhance worker safety when maintaining earth moving equipment tyres and rims in a mining environment. This project will be informed by the EMESRT Tyre and Rim Management Control Framework developed and validated in 2019 by a cross section of personnel representing multiple mining, tyre management organisations. This work will be undertaken in conjunction with project C33005.
Current	**Relevance and Applicability of Inhalable Dust and Current Issues with AS3640 C33008** Mehmet Kizil, University of Queensland	$244,833	Andrew Lau and Sharif Burra, Yancoal Bharath Belle, Anglo American Steelmaking Coal Brad Lucke, Kevin Rowe and Tony Egan, Glencore Coal Assets Australia	This research will focus on investigating the relevance of inhalable dust particulates and its adverse health effects associated with exposure of these particulates to coal mine workers. It will validate the applicability of the inhalable dust monitoring program currently implemented and identify issues with AS3640, Workplace atmospheres - method for sampling and gravimetric determination of inhalable dust and examine the suspension of inhalable dust person exposure limits in USA.
Complete	**Human Factors Design for Diversity within an EMESRT Control Framework C34001** Danellie Lynas, University of Queensland	$66,974	Iain Curran and Tenille Dodds, BHP Matt Clements, Anglo American Steelmaking Coal Tony Egan, Glencore Coal Assets Australia	This project provides a detailed case study of how human factors task analysis may be used within a EMESRT control framework to focus on the credible failure modes highlighted by EMERST design philosophies and identify opportunities for improving equipment design and business inputs to both reduce serious injury risks associated with equipment maintenance and barriers to worker diversity.
New	**Human Centred Interactive Training Experiences in OTR Tyre Handling C35020** Sara Pazell, ViVA! Health at Work	$236,776	Brendan Wilkins, Anglo American Steelmaking Coal Tony Egan, Rob Fraser and Tim Gray, Glencore Coal Assets Australia	The nationally recognised competency requirements for tyre servicing do not adequately address the human factors required in handling off-the-road mining equipment tyres and rims. This project will provide a safety-critical task-based training needs analysis to inform tyre handling learning experiences. An ethnographic, qualitative human factors approach with cognitive task analysis will be undertaken to examine the training and learning needs of tyre technicians in handling tyre equipment.
MAINTENANCE AND EQUIPMENT				
Current	**Preventing Fatigue Cracking Via Proactive Surface Dressing C26020** Simon Krismer, Bureau Veritas AIRS	$126,940	Shane Saunders, Yancoal	Condition monitoring mining equipment and structures for fatigue cracking is costly. Proactively dressing surfaces susceptible to fatigue cracking could be significantly cheaper than condition monitoring in terms of labour costs and downtime. This project will assess the effectiveness of using surface linishing to remove accumulated fatigue damage. Surface linishing is a cheap, readily accessible technique that requires no special tooling.
Complete	**On Board Energy Recovery and Battery Storage Systems for Diesel Electric Haul Trucks: Scoping Study C28049** Craig Hurkett, Enterprise Improvement Solutions	$40,000	Brendan Wilkins, Anglo American Steelmaking Coal Daniel Wallace, Jellinbah Group Tim Gray, Glencore Coal Assets Australia	This project aimed to understand how much energy could be harnessed, and further used from haul trucks travelling on long downhill runs, to reduce the overall usage of diesel fuel. Only the desktop study portion of the project was completed; being the calculation of the energy generation or loss from haul trucks descending into pits.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Complete	**Acoustic Sensing for Machinery Using Lasers C29031** Karsten Hoehn, Mining3	$292,818	Brendan Wilkins, Anglo American Steelmaking Coal	Using remote sensing for condition monitoring of mobile mining equipment could improve fault diagnosis in hard-to-reach areas. Laser vibrometers have been used in conveyor acoustic monitoring research for calibrating the vibration responses of various parts of conveyor frames. That experience, coupled with the successful signal processing algorithms, has the potential to be applied to other types of mining machinery, such as drill rigs, haul trucks, shovels, loaders, diggers, continuous miners and draglines. This project investigated the suitability of using laser vibrometers for acoustic condition monitoring of mobile machines. The technology would enable quick and frequent diagnostics without the need to remove machine components, when the machine is parked up in the field, while working, or to avoid personal contact with hot surfaces.
Complete	**Predicting Failure of Hydraulic Pumps and Motors C29051** Graham Manuel, GEM Innovations	$72,358	Brendan Wilkins, Anglo American Steelmaking Coal Tim Gray, Glencore Coal Assets Australia Weylon Malek, BHP	Hydraulic motors are changed at predetermined intervals rather than on the condition of the pump, which minimises unplanned maintenance but does not optimise component life. The objective of this project was to install case drain flow meters and monitoring equipment on the hydraulic pumps and motors on an excavator at New Acland mine. The monitoring equipment will send a daily email to the maintenance planner with the average daily case drain flow recordings. Based on this data, hydraulic pumps will be able to be changed during a service interval prior to failure.
Current	**Vibration Energy Harvesting for Self Powered Sensors at Mine Sites C33033** Binghao Li, University of New South Wales	$145,860	Brendan Wilkins, Anglo American Steelmaking Coal Peter Walsh and Tim Gray, Glencore Coal Assets Australia	Replacing batteries in the many sensors used in underground and open cut mines is a time consuming process. Self powered sensors using energy harvesting could be a viable alternative. Energy harvesting captures small amounts of energy that would otherwise be lost as heat, light, sound, vibration or movement. This project will assess the potential of using vibration energy harvesting to power underground mine sensors.
Current	**Dozer Suspension Seat to Reduce Body Vibration C33034** Danellie Lynas, University of Queensland	$78,107	Ellen Roots and Tim Gray, Glencore Coal Assets Australia Shane Apps, Peabody Australia Coal Troy O'Reilly, Stanwell Corporation	Long term exposure to whole body vibration causes a range of adverse health effects, particularly back disorders. Dozers operate on a variety of surfaces, including the coal floor, basalt and softer overburden, which expose operators to whole body vibration transmitted through the seat. This project will evaluate the effectiveness of an innovative passive vibration and movement cancelling seat prototype in reducing dozer operator exposures to excessive whole body vibration during normal operation at surface coal mines.
Current	**Radar Tyre Monitor System C33036** Luke Powell, CSIRO	$132,382	Brendan Wilkins, Anglo American Steelmaking Coal Tim Gray and Rob Fraser, Glencore Coal Assets Australia	Early detection of tyres at risk of zipper failure – a rapid progressive failure of the cords and explosive rupture of the tyre carcass – is needed. Researchers plan to develop a low cost, continuous monitoring and warning system prototype to detect tyres exhibiting signs of fatigue. They will also trial a radar based tyre monitoring prototype technology to detect damaged radials and other catastrophic tyre failure indicators.
Current	**Design and Evaluation of a Passive Structural Fatigue Gauge C33044** Ian Stevenson, EngAnalysis	$169,055	Brendan Wilkins, Anglo American Steelmaking Coal Peter Walsh and Tim Gray, Glencore Coal Assets Australia Weylon Malek, BHP	This project aims to deliver a cost effective alternative to detailed strain gauge testing regimes and fatigue analyses of steel structures on open cut mine sites. Researchers will design and test a passive fatigue sensor that provides maintenance teams with a cumulative fatigue damage metric.
Current	**Human Aspects of Automation and New Technology in Mining: Integrating People and Technology Through Human Centred Design C34026** Robin Burgess-Limerick, University of Queensland	$375,573	Belinda Martin, David Martin and Leveson Sutton, BHP Brad Lucke and Tony Egan, Glencore Coal Assets Australia	Achieving the productivity and safety improvements expected from automation requires careful consideration of the capabilities and limitations of humans as well as the characteristics of the technology. This project explores how the automated subsystems and other new technologies being introduced to coal mines can fully accommodate human abilities and limitations and be fully integrated into overall operational technology systems. Researchers will describe, demonstrate, and disseminate the tools and techniques required for this transition.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Reducing Noise Emitted by Heavy Vehicles in Open Cut Coal Mines C34031** Ray Kirby, University of Technology Sydney	$231,645	Brendan Wilkins, Anglo American Steelmaking Coal Tim Gray, Glencore Coal Assets Australia	Dump trucks, excavators and other turbo machinery are major causes of noise in open cut mines. Because most noise attenuators in mining machinery use old technology, their performance is poor. This project aims to develop advanced mathematical models to optimise noise attenuators in the intake and exhausts of cooling systems used in turbo machinery.
Current	**Tyre Handler Testing Rig Stage 2 C34036** Peter Knights, University of Queensland	$97,292	Brendan Wilkins, Anglo American Steelmaking Coal Rob Fraser and Tim Gray, Glencore Coal Assets Australia	Tyre handling is a major risk in surface mining operations. In a previous project, a tyre handler grip test rig was designed, developed and commissioned. The rig enables the frictional force between gripper and tyre to be quantified for a range of tyre types, pressures, tyre tread and sidewall wear modes, and surface wetting conditions. This project covers the next phase of test work. Researchers aim to establish force-slip curves for handling R57 series tyres under different conditions, a set of preliminary industry guidelines for safe lifting practice using tyre handling equipment, recommendations on factors of safety suited to lifting tyres, dependent on their condition and recommendations for safe handling pressure for pressurised tyre movement.
Current	**Development of Innovative Lock Ring Free OTR Wheel C34038** Lenny McInnes, University of Queensland	$305,800	Brendan Wilkins, Anglo American Steelmaking Coal Rob Fraser and Tim Gray, Glencore Coal Assets Australia	Large off road mining equipment employ wheel designs that use lock ring retainers which are a safety hazard. A new wheel concept has been designed which removes the lock ring and controls release of the compressed gas hazard in the event of a failure. In this project, researchers will undertake detailed design and validate the function and operation of the fail-safe OTR wheel. They will also conduct an intermediate scale trial.
New	**Hybridising Open Cut Coal Mine Haulage Trucks to Reduce Fuel Consumption and Emissions C35027** Nic Surawski, University of Technology Sydney	$432,500	Brendan Wilkins, Anglo American Steelmaking Coal Tim Gray, Glencore Coal Assets Australia	Hybrid vehicle technology has the potential to reduce fuel consumption and emissions for coal haulage trucks. This project aims to develop a prototype hybrid haulage truck using the Regenodrive system on a Loadpro X60 truck and test the prototype in an open cut coal mine.
MINING AND THE COMMUNITY				
Current	**Broader Contribution of Coal Sector Employment to Indigenous Individuals, Families and Communities C28046** Michael Limerick, Myuma	$199,472	Anthony Galante and Weylon Malek, BHP Hayden Leary, QCoal Services	The Queensland coal industry more than tripled the number of Aboriginal and Torres Strait Islander employees between 2006 and 2016, but the impact of employment on the life circumstances of these people has not been quantified. Researchers from the Aboriginal Traditional Owner organisation, Myuma, will document changes in the life outcomes of a cohort of individuals employed in the coal industry over a sustained period and the flow-on benefits to their families and communities. Statistical data, surveys and in-depth interviews will be used. Myuma has trained and transitioned hundreds of indigenous trainees into resource sector employment.
OVERBURDEN REMOVAL				
Current	**SATS Automated Mission Planning C27063** Ross McAree, University of Queensland	$346,046	Brian Neilsen, Peabody Australia Coal Shaun Booth, Glencore Coal Assets Australia	A semi-autonomous tractor system, SATS has been adapted to perform pivot push dozing. To autonomously perform pivot-push, the system must be provided with missions, a series of activities that are designed by an operator who works at a remote work station. The objective of this project is to develop, deploy and evaluate a SATS automated mission planning capability that will reduce the workload on the SATS operators and result in the generation of more effective SATS missions. This will improve the productivity of semi-autonomous bulldozers and increase the number of machines that a single remote operator can command.

COAL PREPARATION PROJECTS

The Coal Preparation Committee has established a medium term strategy with three key components of maintenance, improved recovery, and plant capacity while maintaining the current high standards of safety.

Increase in yield of fine coal through agglomeration is particularly targeted while maintaining research that seeks to minimise the contribution of coal processing on the environment, e.g. by reusing tailing for soil enhancement, minimising emissions, reducing water consumption and finding ways to use lower quality water without adversely impacting on process efficiency. It is also critical to maximise the yield of product quality coal at minimum cost.

COMMITTEE MEMBERS

Kevin Rowe	**Group Manager (chair)**	**Glencore Coal Assets Australia**
Albert Blom	Principal Processing Analytics	Anglo American Steelmaking Coal
Spencer Brien	CHPP Process Engineer	Ashton Coal CPP
Michael Carnell	Project Manager	Glencore Coal Assets Australia
Chris Denyer	Processing Technical Specialist	Anglo American Steelmaking Coal
Luke Dimech	BMA Principal Process Engineering	BHP
Araz Ejtemaei	Engineer Processing	BHP
Phillip Enderby	CHPP Manager	Hunter Valley Operations
Han Hooi	Principal Process Engineer	BHP Minerals Australia Projects
Chris Huth	Electrical and Controls Advisor, Operations	Sedgman
Jack Lauder	Group Process Engineer (North)	Glencore Coal Assets Australia
Frank Mercuri	Principal Processing	Anglo American Steelmaking Coal
Angus Morrison	Principal Processing Analytics	Anglo American
Daniel Mujic	Senior Process Engineer Thiess Lake Vermont	Thiess
Chris Nethercott	Manager Systems and Innovation	Sedgman
Dan Perkins	CHPP Manager Lake Vermont	Thiess
James Pollack	Principal Process Engineer	Golding
Naresh Racha	Coal Chain Superintendent	Meandu Mine - Stanwell Corporation
Mel Robbins	Principle Governance Integrated Planning	BHP
Nic Roberts	CHPP Maintenance Superintendent	Glencore Coal Assets Australia
Sam Rynne	Coal Processing Specialist	Anglo American Steelmaking Coal
Jason Schumacher	Coal Quality Engineer	Yancoal
Peter Shumack	CHPP Area Manager	Glencore Coal Assets Australia
Colin Surawski	Senior Process Engineer	Moolarben Coal Operations
Chris Urzaa	Coal Marketing Manager	Jellinbah Group
Clinton Vanderkruk	Coal Processing Manager Australia & Canada	Anglo American Steelmaking Coal
Penny Walker	Production Superintendent	Bengalla
Tom Wilson	CHPP Superintendent	MACH Energy

PROJECTS UNDER MANAGEMENT

Category	No of Projects	ACARP Funding
Dewatering	14	$2,914,162
Environmental Improvement	1	$350,000
Fine Coal	19	$7,390,261
General	10	$2,147,896
Gravity Separation	5	$947,922
Process Control	9	$2,163,701
Total	**58**	**$15,913,942**

NEW FUNDING APPROVED

No of Projects	ACARP Funding	Total Funding
11	$3,372,803	$4,712,397

Total Funding includes in-kind support provided by the researcher and host mine identified in the research proposal.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
DEWATERING				
Current	**Eriez HydroFloat in Plant Evaluation C27016** Liam Davis, Eriez Magnetics Darren Mathewson, Quality Process Solutions	$155,600	Han Hooi, BHP	The Eriez HydroFloat™ is a small footprint, high capacity technology capable of recovering coal from the fine feed fraction by using the density and surface chemistry properties of the feed at potentially higher efficiency and reliability than existing technologies. There are no Eriez HydroFloat™ units installed in Australian coal preparation plants as yet. Plant trials will be carried out at three sites to determine the performance of the Eriez HydroFloat™ across a range of operating conditions.
Complete	**Dry Beneficiation Using FGX and X-Ray Sorters C27064** Glenn Sherritt, A&B Mylec	$112,000	Jason Schumacher, Yancoal	Mining regions such as the Galilee Basin have large coal reserves but are constrained by low water availability. Due to the low capital operating costs, dry beneficiation is a possible processing option for low grade raw coals. However, dry processing suffers from poor metallurgical efficiencies and this impacts negatively upon the resource value and project viability. The newer sensor based technologies are delivering better separation efficiency but at lower throughputs. This project determined the performance of single and combined dry processing technologies by treating two coal samples sourced from resources of varying rank. In addition, the project undertook order of magnitude estimates for the impacts upon resource value for such processes.
Current	**Surface Alloying of Centrifuge Baskets and Sieve Bends Screen Surfaces to Increase the Service Lifetime C28056** Mike O'Brien, CSIRO	$131,644	Caitlin Campbell, BHP	Wear of centrifuge baskets and sieve bends is a significant maintenance cost and can result in plant downtime. A laser technique will be used to harden the surface of stainless steel wedge wire in the screening media of these components in order to extend surface wear. Researchers estimate that the life of the screen medium would need to double for the technique to be of practical use.
Current	**Improving Operation and Control of Centrifugal Dewatering Using a Novel Online Tool C28062** Liguang Wang, University of Queensland	$157,400	Jason Schumacher, Yancoal Josh Kowalczuk, Glencore Coal Assets Australia	Centrifugal dewatering using screen bowl or solid bowl centrifuges is a common method of dewatering ultrafine coals. In a coal preparation plant, the feed to a dewatering machine usually varies constantly in solids concentration and particle size distribution. To effectively operate a centrifugal dewatering process, the feed quality must be measured and quantified to increase process efficiency, throughput, and consistency. The objective of this project is to develop an online monitoring tool for centrifuge feed and discharges, enabling the coal preparation plants to improve the operation and control of dewatering. A novel approach based on image analysis and machine learning will be used to achieve this objective.
Current	**Control System to Improve Ultrafine Coal Tailings Dewatering C29059** Anh Nguyen, University of Queensland	$174,230	Bryce Clayton, BHP	Decreasing the moisture of fine coal and tailings brings many benefits, including increasing energy value of coal, decreasing transport and handling costs, and reducing the environmental impacts on dump rehabilitation. However, variations of the plant feed characteristics make it difficult to control the moisture of the fine coal tailings. This project aims to develop a control system to operate dewatering units at optimum operating conditions to obtain the required moisture, yield stress and centrate turbidity for various types of feeds without operator interventions.
Current	**Tailings Management - Dewatering Flume Site Trials C29060** Craig Wheeler, University of Newcastle	$242,500	Kevin Rowe and Peter Shumack, Glencore Coal Assets Australia	Dewatering of tailings can be a complex and expensive process. An open flume provides a simple method for dewatering slurries at a disposal site. Using this method, concentration of solids entering the tailings dam is increased and water recovered and recycled back to the preparation plant before deposition into the dam. A pilot scale open flume was tested in a previous project, successfully dewatering coal slurries without the addition of flocculent. The aim of this project is to design and build a full-scale flume to be trialled on site.
Current	**Process for Separating and Dewatering Fine Particles C29062** Liguang Wang, University of Queensland	$177,400	Michael Carnell, Glencore Coal Assets Australia	Researchers aim to develop and evaluate a new processing technology based on acoustic particle manipulation for beneficiation of Australian raw coals at laboratory scale. Successful outcomes will provide a step change technology in coal processing which is high capacity and low cost.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Efficient Reagents for Disposal of Coal Tailings – Phase 2: Pilot Scale Studies C33039** Anh Nguyen, University of Queensland	$180,000	Brodie Chapman, BHP Tom Wilson, MACH Energy Australia	To improve handling and disposal of dried dump tailings, researchers will extend pilot scale testing to a belt press filter and collaborate with chemical suppliers to design, test and screen more efficient reagents for tailings disposal. They will also develop screening procedures for chemical aided, mechanical dewatering processes.
Current	**Capability for Dewatered Tailings and MPR Testing in Support of a Critical State Soil Mechanics Framework for Potential Liquefaction Assessment C33048** Jubert Pineda, University of Newcastle	$232,600	Jianping Li, BHP Kevin Rowe, Glencore Coal Assets Australia Leonie Bradfield, Bradfield Mining Geotechnics	Testing of fine coal materials in the unsaturated state, such as dewatered tailings, is inherently complex and requires precise measurement of both pore air and pore water volume changes to accurately evaluate the changing degree of saturation. Researchers aim to commission laboratory testing equipment to generate quality data, from which a new stateśofśtheśart model for the mechanical characterisation of preparation plant wastes can be developed. This project will develop the capacity to test fine waste materials across the saturated and unsaturated regimes. It will produce sufficient preliminary data to evaluate the potential to serve as the basis of a predictive model for unstable liquefaction behaviour of mixed plant rejects, that can be used in geotechnical stability assessments for open cut spoil dumps.
Current	**Emerging Pulsed Power Technology for Dewatering Mineral Tailings C33049** Negareh Ghasemi, University of Queensland	$277,630	Dan Delahunty, Moolarben Coal Operations Jack Lauder, Glencore Coal Assets Australia	Mechanical dewatering of wet tailings is expensive and eliminating final moisture remains challenging. A new dewatering method is proposed that uses pulsed electric fields to liberate water bound within, or to, the mineral component. A bench top study will be undertaken to test the system at two scales, 1L and 5L.
Current	**Dewatering Efficiency of Fine Flotation Concentrates by De-Aerating Froth Products - Plant Demonstration C33050** Yongjun Peng, University of Queensland	$627,923	Frank Mercuri, Anglo American Steelmaking Coal Naresh Racha, Meandu Mine - Stanwell Corporation Shivank Vijayakumar, BHP	The presence of tenacious froth in coal preparation plants significantly decreases the dewatering efficiency in thickening and filtration. To address this issue, two pilot scale froth deaeration units were designed, manufactured and successfully tested in coal preparation plants. In this project, large, fully automated, demonstration scale mechanical and vacuum deaerators will run continuously in selected plants to identify optimum operating conditions and control strategies.
Current	**Hybrid Microwave Technology for Dry Stacked Tailings Applications C33051** Christian Antonio, University of Queensland	$121,335	Frank Mercuri, Anglo American Steelmaking Coal Kevin Rowe, Glencore Coal Assets Australia Naresh Racha, Meandu Mine - Stanwell Corporation	Dry stack tailings are an alternative method to storing wet tailings in dams; however, conventional dewatering techniques, such as thickeners and filtration, do not sufficiently reduce tailings moisture. This project will use hybrid microwave technology to reduce the tailings moisture content to the level required for dry stacking. This technique has less operational and capital costs than traditional methods.
Current	**Improving Centrifugal Dewatering via Modelling and Analysis C33053** Liguang Wang, University of Queensland	$149,400	Clinton Vanderkruk, Anglo American Steelmaking Coal Colin Surawski, Moolarben Coal Operations Josh Kowalczuk, Glencore Coal Assets Australia	Existing processes used to dewater ultrafine coals are inefficient in terms of moisture reduction and/or solids recovery. This project aims to improve the operation and control of centrifugal dewatering by developing a model for pilot scale and full scale screen bowl centrifuges that focuses on filtration within the screen section, including cake formation and transportation. The model will be validated by experiments.
Current	**Cost Effective Approach for Coal Tailings Dewatering using Semi Inverted, SIV Hydrocyclones C34051** Christian Antonio, University of Queensland	$174,500	Michael Carnell, Glencore Coal Assets Australia Naresh Racha, Meandu Mine - Stanwell Corporation Tom Wilson, MACH Energy Australia	Dry stack tailings reduce the space required for waste storage and decrease the potential environmental and geotechnical risks of tailings storage facilities. However conventional technologies to dewater tailings are ineffective. This project will use semi-inverted hydrocyclone technology to split the thickener's underflow into a coarse stream, underflow product with reduced moisture content, and a fines stream, overflow product. This process will enable fine clay particles to be captured in the fines stream and, consequently, improve the efficiency of downstream dewatering units.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
New	**Improving the Dewatering of Fine Coal Tailings by Minimising Micro-Nano Bubbles C35032** Yongjun Peng, University of Queensland	$238,470	Han Hooi, BHP Tom Henshaw, Glencore Coal Assets Australia	Dewatering fine coal for tailings disposal and water recycling has been a major challenge in the coal industry. In this project, researchers will focus on minimising micro-nano bubbles to improve the dewatering of fine coal tailings. They aim to increase water recycling by reducing cake moisture from mechanical dewatering and improve the handability and stability of dewatered tailings for improvements in pit disposal.
ENVIRONMENTAL IMPROVEMENT				
Current And New	**Tailings to Topsoil C29042** Ken Williams, University of Newcastle	$350,000 Current $415,300 New	Bill Baxter, Yancoal Paul O'Loughlin, MACH Energy Australia Phillip Enderby, Hunter Valley Operations	This project aims to develop and deliver a transformational alternative technology to the management of coal tailings; that is, an integrated bulk material emplacement technology tailored for soil improvement. A purpose-built mobile dewatering plant will be central to the interface between the tailings to topsoil emplacement. The delivery system will integrate the conventional slurry tailings transport mechanisms with an innovative high-efficiency solids separation mobile tailings handling plant. In the extension project plant growth measurement, soil profile analysis and microbial identification will be used in greenhouse and in-situ field trials to identify the benefits and challenges of using tailings and the effect on dfferent plant species during site rehabilitation.
New	**Utilisation of Coal Mining Tailing in Australian Cement Production C35019** Hassan Baji, Central Queensland University	$277,017	Kevin Rowe and Shaun Booth, Glencore Coal Assets Australia Luke Dimech, BHP	This project will test the feasibility of incorporating coal mine tailings as an alternative raw material in cement and concrete production. The project will include a laboratory-based study, in which coal tailings from different sites across the Bowen and Sydney-Gunnedah basins will be used as pozzolanic materials in concrete production. They will also be used as raw materials in clinker production.
New	**Non-invasive and Real Time Monitoring of Slurry Tailings Density and Velocity in the Transmission Pipeline using Electrical Resistance Tomography Method C35033** David Williams, University of Queensland	$259,000	Angus Morrison, Anglo American Naresh Racha, Meandu Mine - Stanwell Corporation Peter Shumack, Glencore Coal Assets Australia	The most common in-situ method of measuring slurry coal density and velocity in a transmission pipeline uses Gamma rays which have a high radioactive risk. This data is used to assess water use efficiency to enhance water recycling. In this project, researchers aim to develop a holistic monitoring solution to measure the density and velocity of transported slurry coal tailings directly from the transmitting pipeline using electrical resistivity tomography.
New	**Cost Effective Rehabilitation of Tailings Dams C35048** Mike Cole and Carmen Castor, CSER Research	$973,580	Andrew Lau, Yancoal Shaun Booth, Glencore Coal Assets Australia Trent Cini, Moolarben Coal Operations	Ecological factors and the physics and chemistry of soil media are critical to the success of flora species in mine rehabilitation. This project aims to develop a final landscape plan for tailings dams and surrounds by testing tailings and rehabilitation amelioration techniques to maximise plant diversity. Researchers also aim to maximise the root-microbe associations in key plant functional groups that are linked to sustainable nutrient acquisition and cycling on spoil placement areas and tailings dams.
FINE COAL				
Current	**Reflux Classifier to 4mm Top Size - Full Scale Trial, Construction of Test Rig C22046** Kevin Galvin, University of Newcastle	$1,312,723	Kevin Rowe, Glencore Coal Assets Australia	This project has moved an innovative process improvement from the laboratory to a trial in an operating plant. A larger size feed, up to 4mm, will be directed to the Reflux Classifier, thereby reducing the load to dense medium cyclones. The work has the potential to increase plant throughput for a given capital expenditure.
Current	**Full Scale Trial of the Reflux Flotation Cell C23045** Kevin Galvin, University of Newcastle	$294,820	Clinton Vanderkruk, Anglo American Steelmaking Coal Kevin Rowe, Glencore Coal Assets Australia Luke Dimech, BHP Penny Walker, Malabar Resources	The objective of this project is to investigate the performance of the reflux flotation cell at full scale and, in turn, commercialise the technology. The focus is on the scale up achieved, the efficiency of the separation and the quality of the product. This full scale trial is processing high quality flotation product from a single stage, two metre diameter reflux flotation cell, using feed throughputs more typical of conventional flotation; that is, 200m^3 per hour.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Model Informed Control Strategy for Coal Flotation C27021** Kym Runge, Julius Kruttschnitt Mineral Research Centre	$199,571	Clinton Vanderkruk, Anglo American Steelmaking Coal Henry Provan, BHP	The flotation process is a vital pre-concentration step in the processing of low grade coal. The recovery of coal concentrates from coal flotation plants can be severely reduced by poor froth transport out of the flotation cells. The existing control systems typically employed in flotation processes tend to be simple and focus only on controlling the flotation pulp level to a set point that is determined by the operator and set manually. This project aims to increase recovery from flotation cells by developing an improved process control strategy which reduces process fluctuation and maintains optimum performance. An InterFloat™ sensor will be installed into a flotation cell in combination with froth vision cameras. The cell will be run at a range of operating conditions with simultaneous collection of metallurgical samples and sensor measurements.
Complete	**Developing a Frother Decision Tree for Australian Coal Flotation Plants C28050** Yongjun Peng, University of Queensland	$168,666	Luke Dimech, BHP Mathew Merryweather, Anglo American Steelmaking Coal	The Australian coal industry is looking for an alternative frother to methyl isobutyl carbinol, MIBC. MIBC is expensive, is becoming less effective and has been put under safety alert by the Australian Government. In response, many mines are screening alternative frothers by trial-and-error. A scientific guide identifying the best frothers for coal flotation plants needs to be developed. The objectives of this project are to understand frother-saline water-coal interactions, develop a frother decision tree based on coal and water properties, and guide plant engineers to identify the best frother for their coal preparation plants.
Complete	**New Approach to Simultaneously Improving Flotation and Subsequent Froth Breakdown C28053** Liguang Wang, University of Queensland	$192,600	Clinton Vanderkruk, Anglo American Steelmaking Coal Doug Field-Akred, BHP	Over frothing is a growing issue in coal flotation due to quantities of fine coals and the growing use of high-salinity process water. Over frothing leads to poor handle-ability in pump boxes, sumps, thickeners and filters. To compensate, it is common practice to use insufficient frother in the flotation process, often resulting in yield loss. This project aims to improve the flotation efficiency of fine coals at reduced frother dosages while keeping fast breakdown of the discharged froth. Outcomes from this project will be published as part of C29061 when it completes.
Current	**Review of the Current Australian Standards for Coal Flotation Testing: Phase 2 - Development of the Guideline Handbook C28055** Seher Ata, University of New South Wales	$295,750	Jenny Park and Peter Shumack, Glencore Coal Assets Australia	Froth flotation is widely used in the selective recovery of fine coal particles that cannot be recovered efficiently by other separation techniques. A large number of laboratories in Australia and around the world measure the response of coal to the froth flotation process by routine batch testing. However, the results of these tests can vary and often show a lack of reproducibility. In this project, researchers will investigate how various laboratories apply the Australian Standards for coal flotation testing and assess variability in results.
Complete	**Fine Coal Dewatering Test C28057** Mike O'Brien, CSIRO	$169,260	Michael Carnell, Glencore Coal Assets Australia Shivank Vijayakumar, BHP	There is no industry recognised method for determining the centrifugal dewatering potential of fine and ultrafine coals and tailings. This project developed a validated test method to give an accurate estimate of the dewatering potential of tailings, fine coal and ultrafine coal. The method establishes a benchmark for the final product moisture based on the coal type and the size distribution of the coal/tailings in fine coal centrifuges, screen and solid bowl centrifuges at g-forces up to 3200g.
Current	**Measuring and Correlating CGA Data at Particle Topsize C28060** Bruce Atkinson, Basacon Services	$55,444	Tim Manton, South32 Illawarra Coal	Coal grain analysis, CGA is gaining traction as an alternative method of characterising a coal; however, evidence is needed to confirm that analysis undertaken after grinding the sample fully reflects the characteristics of the full-sized particles. Researchers will fractionate a coal sample into separate size fractions to allow CGA to be determined on each size fractions in the as-received sample state. A composite sample will be prepared from the individual size fractions. This sample will be crushed, subdivided and ground to -1mm for a routine raw sample CGA. This research will determine whether CGA data are any different when derived from full-size particles compared to their resting analysis after grinding.
Current	**Froth Flotation of 4mm Feed Coal Particles C29055** Graeme Jameson, University of Newcastle	$198,000	Frank Mercuri, Anglo American Steelmaking Coal Jason Schumacher, Yancoal	Current flotation technologies are limited to particle top sizes in the range 300 to 500µm. This project will investigate the recovery of coal in the size range 0 to 4mm using NovaCell fluidised bed froth flotation technology. The new technology has the potential to make substantial reductions in water and energy consumption as well as simplifying circuit design and plant layout, and reducing floor area.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Improving Flotation Recovery and Throughput with a Combined Method C29061** Liguang Wang, University of Queensland	$199,000	Clinton Vanderkruk, Anglo American Steelmaking Coal Doug Field-Akred, BHP Kevin Rowe, Glencore Coal Assets Australia	This project will develop and evaluate a new method of using oscillatory air supply and vibrators to further improve flotation recovery. Microbubble generation, using an external sparging system with oscillatory air supply will be combined with dynamic stabilisation of bubbles, using waterproof speakers or other vibrators. Laboratory-scale, pilot-scale and full-scale trials will be carried out for Australian coals of different properties and size ranges.
Current	**Wash Plant Fines Testing Methods Enhancement C29065** Chris McMahon, McMahon Coal Quality Resources	$197,330	Frank Mercuri, Anglo American Steelmaking Coal Jason Schumacher, Yancoal	Accurately estimating the proportion of expected fine coal from bore core is critical to the design and operation of preparation plants and predicting economic potential of the resource. This project aims to devise and test an enhanced alternative drum tumbling apparatus to better determine predictive size distribution. The outcomes will be the design, construction and testing of prototype laboratory preparation apparatus, testing of the apparatus with bore core / in-pit site samples and comparison of outcomes with both current methods of processing and actual plant outcomes.
Current	**Optical Profiling of Coal and Mineral Particles in the Ultrafine Circuit for Online Analysis C33055** Rohan Stanger, University of Newcastle	$157,387	Clinton Vanderkruk, Anglo American Steelmaking Coal Jason Schumacher, Yancoal Michael Carnell, Glencore Coal Assets Australia	This project aims to improve the measurement of ultrafine coal and mineral particles for online analysis in flotation and thickener streams in relative time, within minutes. Researchers will upgrade their particle profiler system to provide better resolution of smaller particles, currently limited to a minimum of 100µm and enhance the software to enable ID tagging of multiple mineral phases. This will provide a rapid quantification of rejected coal in tailings streams, minerals in product coal, and other performance indicators for plant control.
Current	**Full Scale Studies of Diesel Emulsification by Ultrasonication for Fine Coal Flotation C33058** Anh Nguyen, University of Queensland	$180,000	Clinton Vanderkruk and Frank Mercuri, Anglo American Steelmaking Coal Luke Dimech, BHP	Because coal is naturally hydrophobic, diesel and kerosene are used to increase coal hydrophobicity for flotation. It is common for these oil based collectors to be dispersed mechanically, which is an inefficient process. Ultrasonic emulsification is a novel and efficient technology which produces fine collector droplets for increased flotation recovery, particularly for weakly hydrophobic coal particles. In this project, researchers will design and construct an ultrasonic unit for full scale studies at an Australian coal preparation plant. They will evaluate and benchmark the technical and financial benefits of the adapted oil-in-water emulsification technology for coal flotation.
Current	**Full Scale Beneficiation of Coal Fines by Novel Agglomeration C34002** Kevin Galvin, University of Newcastle	$2,928,000	Kevin Rowe and Paul Sainsbury, Glencore Coal Assets Australia Luke Dimech, BHP Penny Walker, Malabar Resources	Concentrated water in oil emulsion can be highly effective in achieving ultrafast and ultrafine particle recovery while delivering a low ash and moisture product. This project will investigate the scaleśup of a novel fine coal agglomeration technology through a study at fullśscale. The work to be undertaken involves the design, commissioning and operation of the novel agglomeration technology known as 3D Binder Flotation. The feed source is expected to be a fine coal tailings stream suitable for the thermal market. The study seeks to quantify the scaleśup using feed rates of up to 500 m3/h in terms of yield, ash, moisture and economic benefits. The novel agglomeration technology offers the prospects of a low capital investment for processing the fine coal tailings stream normally sent to the thickener.
Current	**Optimising the Diesel Droplet Size in Coal Preparation Plants C34040** Yongjun Peng, University of Queensland	$231,157	Albert Blom, Anglo American Steelmaking Coal Han Hooi, BHP Jason Schumacher, Yancoal	Optimising the droplet size of diesel emulsion in coal flotation can improve flotation, reduce diesel consumption and quickly mix the diesel and coal slurry without the need for conditioning tanks. This project seeks to determine the optimal diesel droplet size in coal preparation plants and then implement the most suitable diesel emulsification system with online droplet size measurement and control in the plants.
Current	**Coal Spiral for the 2020s C34041** Ian Mangelsdorf, Mineral Technologies	$199,646	Dan Delahunty, Moolarben Coal Operations Naresh Racha, Meandu Mine - Stanwell Corporation Phillip Enderby, Hunter Valley Operations	Researchers aim to develop an enhanced coal processing spiral based on learnings from recent improvements in spiral designs used in other mineral processing operations. The new spiral design will be developed, tested and evaluated on both thermal and coking coal spiral circuit feeds. By focussing on spiral improvements that will fit within existing footprints, the new spiral will be simpler to adopt in existing and new plants.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**In Plant Demonstration of the Next Generation Flotation System C34043** Liguang Wang, University of Queensland	$258,347	Kevin Rowe and Nic Roberts, Glencore Coal Assets Australia	A recent research breakthrough shows that microbubbles smaller than 100µm can be cheaply generated under oscillatory flow by connecting a diffuser/sparger to the outlet of a fluidic oscillator. The technique significantly reduces reagent use and energy consumption. In this project, researchers will develop a prototype fluidic oscillator to optimise the sparging system and provide detailed scale-up information.
Current	**Real Time Automatic Measurement of Frother Distribution in a Coal Preparation Plant C34045** Liguang Wang, University of Queensland	$124,560	Chris Denyer, Anglo American Steelmaking Coal Peter Shumack, Glencore Coal Assets Australia	A new frother concentration measuring technique, based on quantifying the specific interaction between frother molecules and a formulated liquid, was developed in a previous project. This project will further assess and demonstrate a cheap and simple prototype system for real-time, automatic measurement of frother concentrations. The aim of the system is to manage frother consumption and water reuse to maximise coal recovery and prevent the overfrothing, 'froth out' problem.
Complete	**Better Classifying Cyclones C34053** Andrew Vince, Elsa Consulting Group	$28,000	Jenny Park and Jack Lauder, Glencore Coal Assets Australia	In the late 1990s/early 2000s, the small diameter Rong cyclone concept demonstrated significant improvements in cyclone performance. Attempts in the early 2000s to scale up to plant level were unsuccessful. In this project, researcher critically assessed the research methodology and conclusions of the previous work to ascertain the root causes of failure and identify potential mitigation measures.
New	**Froth Flotation Predicted v Actual Definition C35024** Chris McMahon, McMahon Coal Quality Resources	$41,360	Jason Schumacher, Yancoal Mel Robbins, BHP Michael Carnell, Glencore Coal Assets Australia	Correct outcomes in froth flotation yield predictions for product ash from bore core exploration is critical to resource predictive potential, market evaluation and economic mining outcomes. This project aims to produce a guide for estimating accuracy of froth flotation predicted data by type of testing. Using existing data, several froth flotation methods from bore cores, including the pseudoś density method, with efficiency factors trialled to fit data will be evaluated against actual data.
New	**Demonstrating Better Classifying Cyclones C35031** Andrew Vince, Elsa Consulting Group	$377,475	Clinton Vanderkruk, Anglo American Steelmaking Coal Jack Lauder and Jenny Park, Glencore Coal Assets Australia James Pollack, Golding	In the late 1990s, the Rong classifying cyclone concept, RCCC demonstrated significant improvement in cyclone performance, but the design technology was not progressed. A three-month assessment of the RCCC in 2022 concluded that small changes in the way it is tested could lead to a successful industrial demonstration. This project will produce Tromp curves for different particle sizes which can be used to objectively compare the RCCC with any other device.
New	**Working Effectively with Swelling Clays in Fine Coal Flotation to Improve Product Quality and Recovery C35034** Anh Nguyen, University of Queensland	$200,304	Ed Provan and Jack Lauder, Glencore Coal Assets Australia Luke Dimech, BHP	Fine clays in coal flotation can negatively impact the recovery, ash content and moisture of fine coal concentrates. This project aims to use wash water bias and clay suppressants to reduce the product ash, clay thus increasing yeild.
New	**3D Particle Surface Composition Analysis for Flotation Using Micro CT C35035** Rohan Stanger, University of Newcastle	$81,730	Araz Ejtemaei, BHP	Micro computed tomography, micro-CT is a non-destructive, X-ray-based technology that provides 3-dimensional information on the internal structure of solid objects. This project will determine the efficacy of using micro-CT 3-dimensional analysis for flotation characterisation. If successful, the technique will provide an avenue for faster and more representative characterisation of ultrafine particles for the flotation circuit.
GENERAL				
Current	**CSIRO Instruments at Multiple Plants C26011** Mike O'Brien, CSIRO	$427,798	Frank Mercuri, Anglo American Steelmaking Coal Luke Dimech, BHP	In partnership with ACARP, CSIRO has developed instrumentation to monitor the stability of Dense Medium Cyclones over the past 15 years. This instrumentation has operated successfully under production conditions in one plant producing thermal coal products. Researchers have used the data to determine the effect of changes in plant conditions on DMC operation. In this project researchers will determine the effect of changes in plant conditions on the operation of the DMC circuit over a range of mining companies, plant designs and product coal types.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Benefits of Online Thickener Underflow Rheology Measurements C26016** Noel Lambert, Clean Process Technologies	$251,000	Michael Carnell, Glencore Coal Assets Australia	Although the thickener underflow monitor is able to generate information about the rheology of coal thickener underflow, plant operators are not using this data. This project will determine how these rheology measurements can be applied to standard thickener operations, paste thickener operations, secondary thickening operations, belt filter presses and other mechanical dewatering devices. There are no existing online rheology measurements of thickener underflow and it may be possible with online measurement to reduce flocculant dose rates, particularly where flocculant is dosed after the thickener.
Current	**Quantitative Based Structural Integrity Evaluations Using Modal Parameters Estimation C28061** Fidel Gonzalez, Mincka Engineering	$363,651	Kevin Rowe and Peter Shumack, Glencore Coal Assets Australia Phillip Enderby, Hunter Valley Operations	Structural integrity of equipment and infrastructure is a significant risk for coal mining operations. Evaluations of structural conditions are conducted using subjective methods, such as visual inspections. This project aims to develop a technique for reliable, cost-effective and objective structural condition assessments of mining infrastructure. The technique uses a set of tools that enable data capture, structural simulation, visualisation of structural parameters and analysis to be categorised based on the level of risk to the organisation.
Complete	**Developing Operator Friendly Coal Oxidation Measurement C29054** Yongjun Peng, University of Queensland	$156,762	Adam Higham, BHP Han Hooi, BHP	Coal in tailings represents a potential resource but most of the material is oxidised. To effectively process coal from tailings dams, the degree of coal oxidation needs to be monitored in the plant to optimise the reagent system. This project developed a coal oxidation measurement kit, which can be easily used by plant operators to quickly measure coal surface oxidation in plant, and develop a model to predict the mixing of diesel with polar collector, based on the measured degree of coal surface oxidation. Researchers also demonstrated a systematic approach to optimise flotation performance when tailings and oxidised coals are processed.
Current	**Quantitative Based Protection Coating Assessment using Digital Imaging and Artificial Intelligence C29056** Fidel Gonzalez, Mincka Engineering	$335,100	Caitlin Campbell, BHP Peter Shumack, Glencore Coal Assets Australia Phillip Enderby, Hunter Valley Operations	Protective coatings on structures such as raw coal processing facilities and preparation plants shield the structures from sunlight, humidity, and corrosive agents, such as salts and windborne abrasives. Assessing the condition of coatings is a labour intensive and subjective process. The primary objective of this research is to find a reliable, cost-effective and objective methodology using images from hyperspectral infrared, RGB and thermal cameras to evaluate the corrosion condition of the structures. The images will be overlayed to automatically obtain a classification of the paint condition under recognised standards.
Complete	**Value Added Products from Coal Tailings C29057** Zhong Tao, Western Sydney University	$212,540	Luke Dimech, BHP	There has been a significant focus in recent years on investigating the relationship between coke microstructure, strength and reactivity with a view to gaining a better ability to predict blast furnace behaviour of different types of coke. This project extendsed this work by examining the transport of carbon dioxide in cokes. The key objectives were to test the potential of micro-CT imaging for directly observing transport of CO2 in metallurgical coal and coke to enable understanding of fine-scale porosity in these materials and to compare with results from xenon imaging. The outcomes of this research could lead to improved prediction of coke reactivity index, CRI and coke strength after reaction, CSR.
Current	**Coal Quality Borecore Methods Amalgamation Guide C33042** Chris McMahon, McMahon Coal Quality Resources	$42,180	Clinton Vanderkruk, Anglo American Steelmaking Coal Jason Schumacher, Yancoal John Kelly, BHP	A guide that amalgamates the various Australian and ISO Standards for borecore sampling and testing, preparation and measurement will be produced to enable more effective and efficient definition of resources and reserves.
Current	**Coal Tailings and Co-disposal Literature Study C34032** Nerrida Scott, Neluca	$125,000	Kevin Rowe and Peter Walsh, Glencore Coal Assets Australia	Global tailings dam failures have put the spotlight on coal tailings and storage. A coal tailings and co-disposal literature review will be conducted to summarise key learnings and identify research gaps. This data will help ACARP committees to direct future research.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**CPP Water Chemistry Impacts on Corrosion Rates for a Range of Materials C34042** Bruce Atkinson, Basacon Services	$78,080	Michael Carnell and Nic Roberts, Glencore Coal Assets Australia	Process water is continually recycled in coal preparation plants, which introduces the potential for accumulation of organic and inorganic compounds. These contaminants can impact upon the surface chemistry of flotation and dewatering processes. In a previous project, researchers assessed the corrosive impact of process water on mild steel. In this project they will extend the corrosion information to other common materials in a common temperature environment so that the dominating impact of water temperature may be removed from the impacts of water chemistry.
Current	**Improving 3D Analysis of Coal Particles for Density and Mineral Grain Composition Beyond Float Sink Analysis C34049** Rohan Stanger, University of Newcastle	$155,785	Araz Ejtemaei, BHP Mel Robbins, BHP Tom Wilson, MACH Energy Australia	Micro-CT, computerised tomography offers a relatively fast and 3-dimensional alternative to current float-sink analysis with heavy liquids but is yet to be commercially offered. This project aims to establish a methodology for analysing coal samples using micro-CT and improving data processing options for extracting 3-dimenional mineral and particle data. A focus will be on standardising this reporting as size and density distributions as well as maceral/mineral content, and to compare results to current test methods.
GRAVITY SEPARATION				
Complete	**Modern Coal Spiral Plant Performance Evaluation C29064** Darren Mathewson, Quality Process Solutions	$187,900	Michael Carnell, Glencore Coal Assets Australia	Since the 1980s, spirals have been used in many coal preparation plants to treat nominal -2 + 0.125mm coal. Spirals offer advantages such as simplicity, reliability, lower capital and operating costs, and require far less complex water circuits and lower quality water compared with other technologies. New spiral profiles optimised for fine coal treatment are available but the data that is being used to assess process options is outdated and flawed. This project will provide the Australian coal industry with accurate, reliable, supplier-independent, size-by-size data that describes the performance of the latest design spiral starts and banks under a range of operating conditions. The Spiral Handbook published by JKMRC in 1998 will be updated and reissued.
Current	**Measurement of DMC Wear Using 3D Laser Technology C33054** Andrew Taylor, CSIRO	$173,022	Peter Shumack and Luke Winkelman, Glencore Coal Assets Australia Phillip Enderby, Hunter Valley Operations	There is no scanning device available that has been specifically designed to measure wear of the dense medium cyclone, DMC. The task is undertaken manually. The objective of this project is to adapt current laser 3D technology to produce a device capable of mapping the internal dimensions of the DMC to an accuracy better than 1mm without the need for the instrument operator to enter an enclosed space.
Current	**Modelling and Control of Classifying Cyclones C33056** Andrew Swanson, Ausenco Services	$227,080	Colin Surawski, Moolarben Coal Operations Michael Carnell, Glencore Coal Assets Australia Naresh Racha, Meandu Mine - Stanwell Corporation	Coal grain analysis, CGA allows fine coal samples to be very accurately characterised with respect to size, density and maceral group composition, which facilitates ash value estimation for each particle analysed. This project will investigate whether CGA can be used to validate and improve cyclone models and whether it can be used in conjunction existing online instrumentation to establish procedures that will maintain cyclone performance and efficiency, contributing to overall plant recovery. A single bulk sample of desliming cyclone feed will be used.
Current	**Clay Type Effect on Magnetite Medium Properties in Dense Medium Cyclones C34046** Clint McNally, CSIRO	$155,488	Chris Denyer and Frank Mercuri, Anglo American Steelmaking Coal	Dense medium cyclone operation relies on the correct density and viscosity of the dense medium to efficiently separate material in the cyclone. This project will investigate the effects of different types of clays, typically found in Australia's coal seams, on the stability of the correct medium and the resulting impact of DMC operation.
Current	**Using Clay Stabilised Medium for the Separation of Small Coal in a Dense Medium Cyclone C34048** Mike O'Brien and Andrew Taylor, CSIRO	$204,432	Chris Denyer and Frank Mercuri, Anglo American Steelmaking Coal	Recent technical advances in circuit control instrumentation and magnetic separation devices have led to a resurgence of small dense medium cyclones in South Africa and China. DMC circuits for cleaning small coal, -2mm by 0.1mm can produce higher yields than equivalent gravity-based circuits. They can also provide better control over the separation density of the process. This project aims to demonstrate that small coal can be successfully processed in a DMC with good cut point control, good magnetite recovery and high yields compared with the same coal processed through a spiral circuit and Reflux Classifier. The focus of the research is to develop a business case for the operation of a small coal circuit in Australian plants.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
MAINTENANCE AND EQUIPMENT				
New	**Autonomous Stockpile Dozing: Quantifying Viability C35036** Ross McAree, University of Queensland	$352,797	Chris Huth, Sedgman Chris Jackson and Peter Shumack, Glencore Coal Assets Australia Frank Mercuri, Anglo American Steelmaking Coal James Pollack, Golding	When constructing and reclaiming coal stockpiles, dozer operators are at risk of engulfment. Semi-autonomous dozers have comparable productivity to human-operated dozers without the risk to people. This project addresses the viability of utilising automated bulldozers for coal stockpile operations. Researchers will quantify the effort dozers expend in material movement, develop planning algorithms for semi-autonomous dozer movements then compare planning algorithms with human operator practice.
PROCESS CONTROL				
Complete	**Effect of Flotation Water Chemistry on Coal Chemistry, Fluidity and Coke Quality C26013** Seher Ata, University of New South Wales	$337,986	Clinton Vanderkruk, Anglo American Steelmaking Coal	Froth flotation is commonly used in the separation of pyrite and other ash forming minerals from fine coal particles. Coal preparation plants are increasingly using low quality water to reduce fresh water consumption. However, dissolved inorganic compounds in these alternative water sources can affect the coal surface chemistry, the coal fluidity and, ultimately, the coke quality. This project assessed the influence of these harmful chemicals on flotation performance; but no conclusion could be stated from the work.
Current	**Novel Processing to Reduce the Cost of Generating Dry Stackable Tailings C28073** Kevin Galvin, University of Newcastle	$141,342	Clinton Vanderkruk, Anglo American Steelmaking Coal Penny Walker, Malabar Resources	This project will investigate a new approach to concentrating tailings at laboratory scale with the aim of achieving dry-stackable tailings. The formation of dry-stackable tailings is a capital and energy-intensive process, primarily because the flocculants used in thickening are hydrophilic and result in strong water retention in the thickener underflow. Researchers will seek to reduce the capital and operating cost by producing hydrophobic solids from the water and, in turn, dewater. This approach will deliver real-time management of coal tailings, limiting the volume of the tailings waste and reducing the cost of tailings management.
Current	**Smart Conveyor Belts for Structural Health Monitoring and Weigh-In-Motion C33052** Phil Aitchison, Imagine Intelligent Materials	$305,440	Peter Shumack and Luke Winkelman, Glencore Coal Assets Australia	Conveyor belts are often the most expensive component of the conveyor system and downtime is costly. The ability to reliably predict belt degradation could reduce unscheduled downtime. This project aims to build a proof-of-concept intelligent conveyor demonstrator that can detect tears and rips while also monitoring weight-in-motion. It comprises a conductive graphene sensing skin coating within a belt system, plus hardware and software connection to the sensing surfaces.
Current	**Foreign Contaminants Detection on Conveyor Belts Using Digital Imaging Processing Techniques and Coal Penetrating Sensors C33057** Fidel Gonzalez, Mincka Engineering	$365,000	Dan Delahunty, Moolarben Coal Operations Dave Young, Centennial Coal Kevin Rowe, Glencore Coal Assets Australia Phillip Enderby, Hunter Valley Operations	Non-ferrous foreign objects are not detected via current state-of-the-art conveyor belt detection technology used in Australian coal mines. Researchers will adapt proven technologies used in other industries, such as x-ray technology, other sensor types and image processing algorithms, to more effectively detect and locate solid foreign objects on coal conveyor belts.
Current	**Soft Sensor for Predicting Dense Medium Cyclones Performance C34039** Gordon Forbes, University of Queensland	$189,300	Araz Ejtemaei, BHP Peter Shumack, Glencore Coal Assets Australia Sam Rynne, Anglo American Steelmaking Coal	Even with the increasing level of instrumentation and data generation in modern minerals processing plants, some key process variables cannot be measured or are only measured on shift basis. The lack of real-time data prevents process control strategies and process optimisation to be carried out for some processes. This project aims to develop a soft sensor model for monitoring the performance of dense medium cyclones, DMCs including yield, water split and partition efficiency in real time. Once developed, the soft sensor data can be linked to the process control system to stabilise the operation of the DMCs and manipulate operating parameters for optimum performance, based on the requirements of the operation.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current And New	**Real Time Monitoring and Control of Froth Flotation C34044** Liguang Wang, University of Queensland	$106,667 Current $155,770 New	Albert Blom, Anglo American Steelmaking Coal Josh Kowalczuk, Glencore Coal Assets Australia	Many coal flotation plants experience large daily variations in recovery but do not have effective real-time flotation performance measurement tools for process control and optimisation. In this project, researchers will assess and demonstrate an affordable, safe, accurate and easy-to-use real-time monitoring system that can be integrated into autonomous control of coal preparation. They will combine drag sensor and AI-based machine vision.
Current	**Using EIS Technology to Measure the Amount of Magnetite in Dilute Magnetite Streams C34047** Clint McNally, CSIRO	$224,220	Frank Mercuri and Chris Denyer, Anglo American Steelmaking Coal	This project will provide an online method to measure and report the operating performance of magnetic separators in real time using an electric impedance spectrometer instrument. The instrument will free operators from manual, regular checks and allow for targeted intervention if the rate of magnetite loss increases.
Current	**Hand Held Sensor for Real Time Measurement of Fluorine Mineral Contamination in Coal C34050** Nigel Spooner, University of Adelaide	$261,215	Jenny Park and Jack Lauder, Glencore Coal Assets Australia Mel Robbins, BHP	The release of fluorine from contaminated coal interferes with metallurgical processes. It can also produce hydrogen fluoride, which is toxic to humans and the environment, and can damage equipment. There are no real-time, hand held fluorine mineral sensor techniques of sufficient sensitivity for coal applications. In this project, researchers will exploit near infrared 'novel fluorescence' from the fluorine bearing minerals fluorite and fluorapatite to develop a prototype hand held sensor.
Current	**Simulation Enabled Digital Twin for the Control, Design and Optimisation of a Teeter Bed Separator C34052** Kym Runge, Julius Kruttschnitt Mineral Research Centre	$232,531	Chris Denyer and Albert Blom, Anglo American Steelmaking Coal Chris Jackson, Glencore Coal Assets Australia	Up to a fifth of in-plant material in Queensland metallurgical coal preparation plants is too fine to be efficiently upgraded using a dense medium cyclone and too coarse to be separated using froth flotation. This middling fraction, typically -2+0.35mm is processed using hydraulic classifiers, such as teeter bed separators. In this project, researchers will use a combined experimental and simulation-based approach to develop a computational model that can be used as the basis of a performance-maximising advanced control strategy for the teeter bed separator.

TECHNICAL MARKET SUPPORT PROJECTS

Understanding the properties of Australian coals which impact on market acceptance and value in use is a major goal for research, particularly where the research outcomes represent an advantage over coals from international competitors. A specific priority is understanding the environmental performance of Australian coals and whether they will conform to emerging legislative regimes and changes in the market as it pushes to become more sustainable, both domestically and internationally.

The Technical Market Support Committee continues to support research regarding the safe transport and shipping of coal.

COMMITTEE MEMBERS

Graeme Harris	**Manager - Technical Marketing and Logistics (co-chair)**	**Kestrel Coal Resources**
Kim Hockings	**Principal Technical Marketing (co-chair)**	**BHP**
Nick Andriopoulos	Principal - Technical Marketing	Anglo American Steelmaking Coal
Morgan Blake	Director Sales	Peabody Australia
Shaun Booth	Group Manager Resource Development and Technology	Glencore Coal Assets Australia
Stephen Brant	Principal Technical Marketing	BHP
Jeremy Byrnes	Logistics Superintendent	Glencore Coal Assets Australia
Chris Evans	Coal Quality Engineer	Whitehaven Coal
Sean Flanagan	Manager, Coal Technology	Coronado Global
Caroline Lang	Coal Quality and Technical Superintendent	Glencore Coal Assets Australia
Jane Lawson	Product Analyst	Yancoal
Steve Lempereur	Strategy & Technical Marketing Manager	Anglo American Steelmaking Coal
Tim Manton	Superintendent Sales & Operations Planning	South32 Illawarra Metallurgical Coal
Christina McLachlan	Coordinator Planning and Coal Quality	South32 Illawarra Metallurgical Coal
Geoff O'Meley	Coal Technician	M Resources
Oliver Scholes	General Manager Marketing - Technical	Whitehaven Coal
Cameron Tasker	Manager Technical Marketing	Xcoal Energy & Resources – Brisbane
Chris Urzaa	Coal Marketing Manager	Jellinbah Group
Greg Wickman	General Manager - Marketing	New Hope Group
Jay Zheng	Specialist Technical Marketing	South32 Marketing

PROJECTS UNDER MANAGEMENT

Category	No of Projects	ACARP Funding
Future Technologies	1	$71,500
General	7	$1,470,610
Major Projects	1	$4,169,012
Metallurgical Coal	29	$4,826,232
Thermal Coal	3	$361,260
Total	**41**	**$10,898,614**

NEW FUNDING APPROVED

No of Projects	ACARP Funding	Total Funding
13	$2,342,592	$3,085,077

Total Funding includes in-kind support provided by the researcher and host mine identified in the research proposal.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
FUTURE TECHNOLOGIES				
Complete	**Sustainable Cokemaking and Ironmaking Technologies: Current Trends and Future Research Needs C33060** Arash Tahmasebi, University of Newcastle	$71,500	Kim Hockings and Stephen Brant, BHP Nick Andriopoulos, Anglo American Steelmaking Coal	The steel industry is one of the largest industrial emitters of carbon dioxide, accounting for 4-7% of global emissions. In this project, a technical review was conducted of the current status and future development of sustainable coke making and ironmaking technologies, identifying future research opportunities to support the marketing of Australian coking coal.
GENERAL				
Current	**Coal Sample Bank C25053** Lauren Williamson, CSIRO	$451,801	Technical Market Support Committee	CSIRO has been operating the ACARP coal sample bank since early 2017, providing management services, sample storage facilities, receipt and provision of the samples, and the provision of a confidential database. A coal sample bank enables common samples to be used by researchers so that results from different studies on the same coal can be compared directly.
Current And New	**Management of SA and ISO Coal Technical Committees Work Programs C26003** Barry Isherwood, Carbon Connections Consulting	$283,550 Current $107,600 New	Graeme Harris, Kestrel Coal Resources Kevin Rowe, Glencore Coal Assets Australia Kim Hockings, BHP	This project provides funding for a coal industry representative to continue working on ISO coal technical committees work programs.
Current And New	**Australian Participation in Development of ISO Methods for Sampling, Analysis and Coal Preparation and National Technical Committee Support C26037** Jon Meunier, Standards Australia	$312,170 Current $135,200 new	Graeme Harris, Kestrel Coal Resources Kevin Rowe, Glencore Coal Assets Australia Kim Hockings, BHP	Since 2005 ACARP has co-funded Australian representation on key International Standard Organization, ISO committees of relevance to coal exports and to the Standards Australia National Mirror Committee MN-001. This investment enables Australia to influence and shape the international development of methods for sampling, analysis and coal preparation standards.
Current	**CGA Handbook: Second Edition C33004** Bruce Atkinson, Basacon Services	$45,552	Graeme Harris, Kestrel Coal Resources Kevin Rowe, Glencore Coal Assets Australia Kim Hockings and Luke Dimech, BHP	This project will accelerate conversion of the ACARP CGA Handbook into a Standards Australia Handbook, not Standard by facilitating the commitment to resources to complete that task.
Current	**Digital Petrographic Atlas of Australian Coals - Maintaining the Knowledge C33065** Joan Esterle, University of Queensland	$197,537	Graeme Harris, Kestrel Coal Resources Jay Zheng, South32 Marketing Sean Flanagan, Coronado Coal	Researchers will create a digital petrographic atlas of Australian coals that includes data on maceral, micro lithotype and mineral composition at different ranks, and case studies that assist with conceptual mine scale models of coal quality variation. A library of scanned petrographic images of product coals from different Australian basins and formations will also be developed to illustrate the variation in rank, grade and type. The main reference point and framework for this project will be the ACARP coal sample bank.
Current	**Update of Coal Dustiness and Dust Extinction Moisture Standard AS4156.6 C33070** Dusan Ilic, University of Newcastle	$150,000	Chris Evans, Whitehaven Coal Graeme Harris, Kestrel Coal Resources Jane Lawson, Yancoal Kevin Rowe, Glencore Coal Assets Australia	A revised sample preparation and testing method for dust extinction moisture has been proposed. Before the method can be considered for incorporation into AS4156.6, Standards Australia requires additional testing to confirm the accuracy and precision of the new method. By means of a round robin, five different coal types will be tested by three Australian entities using this method. A Standards Australia coal preparation working group will then initiate an update of the standard, which will be promulgated through the ISO technical committee for coal and coke.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
MAJOR PROJECT				
Current	**Maritime Regulation Project C27001** Ash Goodwin, Goodwin Port Solutions	$4,169,012	Maritime Regulation Task Group	The Australian Maritime Safety Authority's issue of exemption certifications and certifications of approval has provided an interim pathway for coal shippers to declare corrosion and self-heating properties of coal cargoes. However further research is needed to identify test methods that accurately categorise these coal properties. This project is examining the accuracy, repeatability and reliability of the modified C.1 corrosion test when applied to coal cargoes and will provide Australian coal producers with a centralised means of participating in the IMO-led investigation into a modified/ alternative test for corrosivity as applied to solid bulk cargoes. The project includes research to review the N.4 self-heating test so that a modified or alternative testing method can be identified to accurately establish the self-heating potential for coal cargoes.
METALLURGICAL COAL				
Complete	**Method to Compare Chemistry vs Structure Effects of Fusible Inertinite in Coke Making C27053** Chad Hargrave, CSIRO	$173,196	Tim Manton, South32 Illawarra Coal	The prediction of coke properties, such as strength and reactivity, from parent coals is of critical importance for coke oven operators and coal producers. Many predictive models use some measure of maceral composition and maceral reflectance information to predict coke quality. this project is applying a more fundamental approach to the prediction of coke strength and coherence from coal properties, particularly for coals that have similar ranks and maceral composition but behave differently during coke making. Two different methods were used – coal grain analysis and Pearson's coal petrography coke analysis – in conjunction with the University of Newcastle's matched coal and coke procedures, to establish the connection between maceral reflectance, fusibility of inertinite and maceral chemistry.
Complete	**Improving Understandings of IMDC-RMDC Interfaces C28071** Hannah Lomas, University of Newcastle	$161,076	Kim Hockings and Stephen Brant, BHP Morgan Blake, Peabody Australia Coal	The interfaces between reactive maceral derived constituents, RMDC and inertinite maceral derived constituents, IMDC are often the weakest parts of the metallurgical coke microstructure. This project investigated the principal mechanisms involved in determining the microtextural interface properties of metallurgical cokes by using an inertinite analogue to show the influence of particular inertinite attributes. The research improves the understanding of how the characteristics of inertinites in the parent coal are linked to the final coke microstructure and its strength.
Complete	**Direct Imaging of CO2 Penetration in Cokes Pre and Post Reaction C29040** Sherry Mayo, CSIRO	$104,463	Graeme Harris, Kestrel Coal Resources Steve Lempereur, Anglo American Steelmaking Coal	There has been a significant focus in recent years on investigating the relationship between coke microstructure, strength and reactivity with a view to gaining a better ability to predict blast furnace behaviour of different types of coke. This project extended this work by examining the transport of carbon dioxide in cokes. The key objectives were to test the potential of micro-CT imaging for directly observing transport of CO2 in metallurgical coal and coke to enable understanding of fine-scale porosity in these materials and to compare with results from xenon imaging. The outcomes of this research could lead to improved prediction of coke reactivity index, CRI and coke strength after reaction, CSR.
Complete	**Oxidation Rate in Reducing Coking Propensity of Individual Maceral Grains Residing Naturally in Lump Coal using FTIR Microscopy C29067** Quang Anh Tran, University of Newcastle	$99,800	Graeme Harris, Kestrel Coal Resources Steve Lempereur, Anglo American Steelmaking Coal Teneal Groves, BMA	Oxidation of the coal surface during transportation and stockpiling can result in changes in the coking coal fluidity, its technological properties and flotation yield, which can negatively impact the perceived commercial value. Existing tests have been proven unreliable for predicting these types of changes. This project aimed to employ Fourier Transform Infrared microscopy to detect changes occurred during the oxidation of vitrinite and inertinite grains that cannot be recognised optically via conventional microscopy. This approach provides an opportunity to understand the oxidation profile of maceral grains with controlled surface area in their native abundance.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Complete	**In-Situ Study of the Permeability of the Plastic Layers of Australian Coking Coals Using an Advanced Permeability Test Apparatus C29068** Soonho Lee, University of Newcastle	$154,000	Cameron Tasker, Xcoal Energy & Resources Australia Nick Andriopoulos, Anglo American Steelmaking Coal	The thermal decomposition of coking coals in a coke oven involves chemical and physical changes, which are referred to as thermoplasticity. The permeability of the plastic layer influences the mass transport phenomena inside the coal bed. To improve the fundamental understanding of these processes, in situ measurements of the permeability of plastic layers are needed. Researchers developed an advanced test rig and established a methodology to undertake these in situ measurements.
Current	**Effect of Coke Properties on High Temperature Strength and Hot Metal Reactivity Under Blast Furnace Conditions C29070** Pramod Koshy, University of New South Wales	$369,000	Jay Zheng, South32 Marketing Nick Andriopoulos, Anglo American Steelmaking Coal Stephen Brant, BHP	Coal blending is commonly done to overcome increasing scarcity of high-quality coal/coke resources. The unpredictability of blend properties places limitations on predicting their degradation under reactive conditions at high-temperatures in the blast furnace. Researchers will develop further understanding on the relationship between the characteristics of single cokes and their blends on their high-temperature strength evolution and reactions with molten iron/slag. The project will employ previously established high-temperature mechanical tests on coke samples.
Current	**Source of Variability of Reactivity of Coke in the NSC Test, CSR Test C29071** Lauren Williamson, CSIRO	$144,760	Jeremy Byrnes, Glencore Coal Assets Australia Nick Andriopoulos, Anglo American Steelmaking Coal	The NSC test is used globally to determine the reactivity of coke. If the repeatability of the test could be improved, then finer discrimination between coke qualities could be achieved. Previous analysis identified major variations in weight loss from individual coke particles, even for low reactivity coke. This project aims to establish the cause of variability in individual coke particle reactivity and to identify an experimental control factor able to substantially moderate repeatability requirements.
Complete	**Effect of Parent Coal Origin on Coke Quality by Studying Structural and Textural Differences Between Cokes made from Similar Australian and Northern Hemisphere Coals C29072** Eugene Donskoi, CSIRO	$97,195	Nick Andriopoulos, Anglo American Steelmaking Coal	Coke is a combination of different structures and textures, each with their respective strength, porosity and reactivity properties. The structures and textures can differ significantly between cokes produced from different coals. This project applied structural and textural characterisation techniques to a set of cokes made from Australian and Northern Hemisphere coals. The aim was to identify sustained/persistent structural and textural differences between cokes made from parent coals with similar characteristics but from different regions of origin. Understanding of the effect of origin of different parent coals on coke texture/structure and final quality can assist with prediction and coal blend selection strategies.
Current	**High Temperature Tribological Testing of Coke Coupled with 3D Visualisation to Enhance Understanding of Coke Breakage and Link to Parent Coals C29074** Hannah Lomas, University of Newcastle	$161,029	Kim Hockings and Stephen Brant, BHP Morgan Blake, Peabody Australia Coal	The strength of the interfaces between coke components affects coke strength and this has potentially significant implications for coal technical marketers. However, the factors that influence coke quality and their relative importance are still not completely understood. This project is expected to enhance the ability of tribological testing to better understand the links between coke wear and abrasive strength, the abrasive strengths of its micro-textural constituents, the strength of the micro-textural interfaces, and the properties of the parent coals.
Current	**Fine Particles from Coal C29075** Liza Elliott, University of Newcastle	$188,700	Caroline Lang, Glencore Coal Assets Australia Jane Lawson, Yancoal Oliver Scholes, Whitehaven Coal	TESCAN integrated mineral analyser, TIMA is a scanning electron microscopy technique that maps the constituents of the coal and determines mineral components as included and excluded particles, mineral composition and particle size for both minerals and coal particles. This project aims to identify a technique to measure the fine particle formation for selected coals using TIMA and combustion experiments. Researchers will start to develop a model that can predict the formation of fine particles based on the type and associations of the minerals within a given coal. Coal samples will be characterised using standard analysis and measurement of coal maceral content by coal grain analysis.
Complete	**Understanding of the Mechanism of Chemical Interaction Between Vitrinite and Inertinite C29076** Wei Xie, University of Newcastle	$149,500	Kim Hockings, BHP Sean Flanagan, Coronado Coal	Understanding how to blend vitrinites and inertinites from different coals is a key aspect of improving overall coking performance. However, it remains a significant challenge for technical marketers of metallurgical coals. This project addressws a critical uncertainty by focusing on maceral interaction during the plastic layer, in particular, the role of volatiles from vitrinite in altering the fusibility of inertinites. Vitrinite particles soften and release volatiles while inertinite particles are theorised to provide an alternative pathway for volatiles to escape the plastic layer.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Effects of Ash Minerals on Coke Reactivity at High Temperatures C29077** Brian Monaghan, University of Wollongong	$626,527	Jay Zheng, South32 Marketing Kim Hockings, BHP	Assessing coke performance in the high temperature, lower regions of a blast furnace is challenging. A three stage project has been undertaken to understand the impact of coke mineralogy on the dissolution behaviour of metallurgical coke in liquid iron. This stage focused on the gas-coke-mineral interactions at high temperatures, aiming to quantify the impact of mineralogy and carbon structure on the dissolution of metallurgical coke in liquid iron.
Current	**Transformation of Cross Linking Structures in the Plastic Layers During Coking of Australian Coals and its Role in Coke Formation C33059** Soonho Lee, University of Newcastle	$144,800	Kim Hockings, BHP Morgan Blake, Peabody Australia Coal Nick Andriopoulos, Anglo American Steelmaking Coal	Researchers believe that cross linking structure plays a key role in the evolution of 3D carbon structures of coke and, therefore, may have critical impacts on coke structures and strength. This project aims to investigate the transformation of cross linking structures in the plastic layers and coke/semi cokes during the coking process of Australian coking coals and to improve understanding of coke formation, specifically on the formation of carbon structures in coke matrix.
Current	**Evaluation of Australian PCI Coals in the Co-Injection of Hydrogen and Coal into Blast Furnaces using a 3D Computer Model C33062** Yansong Shen, University of New South Wales	$150,000	Cameron Tasker, Xcoal Energy & Resources Australia Morgan Blake, Peabody Australia Coal Peter Austin, BlueScope Steel	Hydrogen is a promising potential fuel for use in ironmaking to reduce carbon and mitigate CO2 emissions. Many hydrogen based ironmaking technologies have been proposed in countries such as Germany, Japan and Sweden. This project aims to evaluate Australian PCI coals in the co-injection of hydrogen and coal in ironmaking blast furnaces using 3D computer modelling.
Current	**Micro-CT Based Characterisation of the IMDC-RMDC Interfacial Interaction in Blends of Australian and International Coals C33063** David Jenkins, University of Newcastle	$175,000	Graeme Harris, Kestrel Coal Resources Kim Hockings, BHP	Micro-CT will be used to characterise the IMDC-RMDC interaction in blends of Australian and international coals which have been supplied by Tata Steel R&D from the suite of coals it uses in industrial coke-making blends. The technique is non-destructive and provides both visual and quantitative information on the whole interfacial interaction.
Current	**Influence of Inertinite and Volatile Release Characteristics on Viscosity Development and Fusibility During Coking C33064** Karen Steel, University of Queensland	$105,800	Graeme Harris, Kestrel Coal Resources Morgan Blake, Peabody Australia Coal Nick Andriopoulos, Anglo American Steelmaking Coal	Australian coals containing high levels of inertinite perform well compared with competitor coals containing similar levels of inertinite. This performance has been loosely attributed to enhanced fusibility but fundamental knowledge on why they are more fusible is lacking. In this project, researchers seek to determine whether the pore properties of inertinites affect their deformation/fusibility behaviour and the bulk viscosity behaviour that, in turn, influences expansion and the coke's final macropore properties.
Current	**Washability and Distribution of Sulphur and Trace Elements for Different Sizes and Densities of Product Coals C33066** Wei Xie and Rohan Stanger, University of Newcastle	$128,550	Caroline Lang and Shaun Booth, Glencore Coal Assets Australia Jane Lawson, Yancoal	Australian coals generally have lower sulphur and toxic trace element content than their international competitors, although some product coals exceed acceptable levels. This project will investigate whether sulphur, total, inorganic and organic and trace element content varies with different coal particle sizes and densities, and to what extent. The results could be used to reduce sulphur and trace element content in coal preparation and blending processes.
Current	**Use of Vitrinite Reflectance Categories on Coke Strength Prediction of Bi-Modal and Multimodal Coal Blends C33071** Arash Tahmasebi, University of Newcastle	$138,400	Cameron Tasker, Xcoal Energy & Resources Australia Kim Hockings and Stephen Brant, BHP Nick Andriopoulos, Anglo American Steelmaking Coal	Predicting coke quality from coal blends is a challenging process. The interactions occurring between the components in coking coal blends imply that the additive behaviour – weighted average of individual coals – is not an appropriate approach. A recent doctoral study provided evidence that vitrinite distribution category parameter, an alternate method of capturing the modality of vitrinite reflectance distribution of blends, improved the prediction of their CSR. This project will further evaluate the performance of the approach in blends of coals at the extremities of rank and thermoplastic properties.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Design of Cokes from Biomass Coal Blends for Sustainable Blast Furnace Ironmaking: Scoping Study C34054** Pramod Koshy, University of New South Wales	$181,700	Shaun Booth, Glencore Coal Assets Australia Stephen Brant, BHP	To address growing concerns about the environmental impact of cokemaking/ironmaking processes, steelmakers are investigating whether biomass could be used to partially replace coal in blends. This preliminary scoping study aims to assess the impact of blending biomass with coal blends on the high temperature properties and behaviour of the coke blends after gasification under blast furnace conditions. The research will be conducted in a pilot oven.
Current	**Factors Underpinning the Reactivity of Coke RMDC and IMDC C34055** Hannah Lomas, University of Newcastle	$171,436	Morgan Blake, Peabody Australia Coal Sean Flanagan, Coronado Coal	Building on recent research into the factors influencing microtextural and interface strength, this project will focus on the factors controlling the reactivity of the individual coke microtextures rather than their strength controlling attributes. Researchers will use thermogravimetric analysis to measure the rate of reaction with carbon dioxide of the individual coke microtextures under CSR test conditions. A series of experiments will be designed to isolate the impacts of coke carbon structure and accessibility of reaction sites.
Current	**Real Time Three Dimensional In-Situ Imaging of Structural Evolution of Coal During Coke Making Process Using Adaptive Electrical Capacitance Volumetric Tomography C34056** Behdad Moghtaderi, University of Newcastle	$128,755	Graeme Harris, Kestrel Coal Resources Kim Hockings, BHP	In terms of coke characterisation, the shortage of detailed and quantitative data, especially for challenging coals with higher levels of impurities, has been a barrier to the development of accurate predictive models of the plastic layer structural evolution and coke strength. This project will use adaptive electrical capacitance volumetric tomography, AECVT a new non-intrusive and non-optical imaging technique, to examine the conversion of coking coal-to-coke with the aim of developing a deeper understanding of the evolution of the plastic, fluid layer during the coking process. AECVT has the potential to enable real-time in-situ imaging of three dimensional structural transformations of coking coals during the coking process.
Current	**Impact of Co-Injecting Hydrogen and Australian PCI Coals on Overall Blast Furnace Performance Using a Heat and Mass Balance Model C34057** Yansong Shen, University of New South Wales	$166,200	Cameron Tasker, Xcoal Energy & Resources Australia Geoff O'Meley, M Resources	The co-injection of coal and hydrogen is regarded as the most feasible way to reduce carbon use in the blast furnace as it requires very low modification of the blast furnace operation and facilities. Research is required to understand the impact of co-injection on blast furnace operation, particularly in terms of in-furnace phenomena at the lower part of blast furnace. This project will use the heat and mass balance model to evaluate the impact of the co-injection of Australian PCI coals and hydrogen on overall blast furnace performance.
Current	**Coke Reactivity with CO_2 and H2O and Impacts on Coke Microstructure and Gas Diffusion C34059** Arash Tahmasebi, University of Newcastle	$170,700	Shaun Booth, Glencore Coal Assets Australia Stephen Brant, BHP	While injecting hydrogen gas into the blast furnace has the potential to reduce the energy intensity of steelmaking, it will also increase the water content, which is expected to impact the structure and metallurgical properties of coke. This project will examine the impacts of carbon dioxide and water on the mechanism of coke gasification and degradation under conditions relevant to conventional and hydrogen blast furnace environments. In undertaking the project, researchers will combine coke microstructure characterisation and mathematical modelling with micro-CT imaging and image processing.
Current	**In-situ Investigation of Coke Structure Formation Under Stamp Charged Coking Conditions C34060** Arash Tahmasebi, University of Newcastle	$158,900	Graeme Harris, Kestrel Coal Resources Stephen Brant, BHP	Stamp charging is increasingly being used by coke making operations in India, China, and Southeast Asia to improve oven productivity and reduce raw material cost through increased use of poor quality coking coals. In this project, Australian premium coals will be blended with low premium coals, typically used in stamp charged coke making operations. Researchers aim to gain insights into the coke formation mechanism under stamp charge coking conditions and understand how higher caking densities affect the microstructure, microtexture and, ultimately, coke reactivity and strength.
Current	**Gasification Kinetics of Coke Lumps Under Simulated Conventional and Hydrogen Rich Blast Furnace Processes C34061** Arash Tahmasebi, University of Newcastle	$69,600	Kim Hockings, BHP Nick Andriopoulos, Anglo American Steelmaking Coal	Given the research focus on hydrogen enriched blast furnace ironmaking, there is a need for fundamental research on how the change in reactants under such conditions influence coke reactivity and quality requirements. In this project, researchers aim to determine the rate and mechanism of coke gasification under the simulated hydrogen-enriched blast furnace environment, benchmarked against conventional operations. A series of tests will be conducted to obtain gasification kinetics of coke lumps under controlled conditions that simulate the region above the cohesive zone of blast furnace, where coke gasification is dominant.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Improving the Classification of Microstructure Distribution in Coke CT Images using Deep Learning and Lineal Path Calculations C34062** Bishnu Lamichhane, University of Newcastle	$111,020	Kim Hockings, BHP Nick Andriopoulos, Anglo American Steelmaking Coal	This project builds on a number of recent projects that have helped explain and characterise the 3D distribution of coke microstructure and the link to coke strength, reactivity and the formation of the microstructure in the plastic layer. The project will improve the fundamental understanding of coal-to-coke conversion and coke performance by combining statistical techniques with a deep learning approach. Researchers will extend the number of samples characterised to 10 per coke.
Current	**International Round Robin for Coke Reactivity Index, Coke Strength after Reaction and I600 C34063** Lauren Williamson, CSIRO	$77,800	Caroline Lang, Glencore Coal Assets Australia Graeme Harris, Kestrel Coal Resources Kim Hockings, BHP	Modified coke drum tests have been developed to overcome the challenge of producing the 50kg of coke needed for a full suite of coke testing. I600 is one of these tests, but it is not yet covered in any national or international standard. In this project, researchers will update the understanding of CSR and CRI practice across a group of international laboratories by conducting a round robin using two cokes produced in a pilot scale coke oven. They will also investigate the extent that I600 is used in coke testing laboratories and determine its potential as a standard test.
Current	**Effect of Coal Quality on Carbon Products Produced with Alternative Thermal Processing – Extrusion and Direct Casting Technologies C34064** Rohan Stanger, University of Newcastle	$159,425	Caroline Lang and Shaun Booth, Glencore Coal Assets Australia Oliver Scholes, Whitehaven Coal Peter Austin, BlueScope Steel	As the demand from coal fired power generation is predicted to decline, greater attention is being given to re-purposing thermal coal into new products. In this project, researchers will explore two processing technologies that are well established in other industries but have yet to be applied in coal utilisation. The technologies are thermal extrusion, which pyrolyzes the coal, and direct casting, which is used in brick manufacture and has potential uses in construction and energy storage. Micro-CT will be used to assess the potential carbon quality from these technologies and determine how feed coal quality impacts the key characterisation measurements.
Current	**Impacts of Plastic Layer Permeability and Internal Gas Pressure on the Formation of Coke Microstructure and Coke Quality C34065** Soonho Lee, University of Newcastle	$158,900	Cameron Tasker, Xcoal Energy & Resources Australia Morgan Blake, Peabody Australia Coal Nick Andriopoulos, Anglo American Steelmaking Coal	Due to limited techniques for in-situ observations of the complex coking phenomena, the extent to which plastic layer permeability and internal gas pressure, IGP influence coke microstructure and strength development are unclear. This project aims to address this issue using 3D microstructure analysis software. An advanced permeability apparatus will be used to conduct synchronised measurements of permeability, swelling/contraction displacement and the composition of pyrolysis gases. In addition, in-situ permeability and IGP measuring probes, fitted to the 4kg coke oven, will be used to monitor the variation in the permeability and IGP across the plastic layer under practical coking conditions.
New	**Examination of Contraction Pre and Post Resolidification using a High Temperature Dilatation Rig C35037** David Jenkins, University of Newcastle	$99,250	Cameron Tasker, Xcoal Energy & Resources Australia Graeme Harris, Kestrel Coal Resources	A clear understanding of coke contraction can help to better predict key factors associated with coke quality. A mismatch in contraction and chemical processes around re-solidification may affect IMDC-RMDC bonding, which has been linked to coke strength issues. This project will assess the contraction behaviour of various coals, covering a range of rank and coal measures, to identify how prevalent this phenomenon is and its utility in coal blends.
New	**Microalgae Blending for Low Carbon Metallurgical Coke Production C35038** Arash Tahmasebi, University of Newcastle	$172,000	Nick Andriopoulos, Anglo American Steelmaking Coal Stephen Brant, BHP	Biomass is being used in blast furnace ironmaking to reduce environmental impacts and production costs. In this project, researchers will evaluate the impact of microalgae blending on the coking behaviour, coke properties and coke gasification performance of selected coals. In particular, it will assess the impact of microalgae on thermoplastic and rheological behaviour, internal gas pressure development and the quality of coke.
New	**Impact of Coal Grain Composition and Macerals Association on Fluidity Development in the Plastic Layer of Australian Coals C35039** Arash Tahmasebi, University of Newcastle	$141,600	Graeme Harris, Kestrel Coal Resources Stephen Brant, BHP	A better understanding of fluidity development in coal with representative particle size distributions is key to improving coke quality prediction models. This project aims to improve the fundamental understanding of thermoplasticity development in a wide range of Australian coals. By determining the drivers of “real” fluidity in these coals, researchers expect to improve coke quality prediction models. They will combine coal grain analysis and micro-CT expertise.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
New	**Changes in Combustibility of Coal when Co-Combusted with Hydrogen Rich Fuels in PCI C35040** Liza Elliott, University of Newcastle	$218,367	Cameron Tasker, Xcoal Energy & Resources Australia Caroline Lang, Glencore Coal Assets Australia Oliver Scholes, Whitehaven Coal	Hydrogen-rich fuels are starting to be injected into the blast furnace via the tuyere. Little is known about the consequences of adding these fuels, which are expected to be more reactive than coal. This project aims to determine coal reactivity impacts of co-combusting hydrogen rich fuels, e.g. biomass, plastics, coke ovens gas, ammonia and hydrogen. The combustibility of solid fuels will be assessed using the drop tube furnace technique then a thermo-gravimetric analyser will be used to measure the reactivity of these materials individually and when co-combusted with coal.
New	**Effect from the Co-Combustion of Coal and Biomass on Production of Fine Particles (<PM10) C35041** Liza Elliott, University of Newcastle	$228,531	Cameron Tasker, Xcoal Energy & Resources Australia Caroline Lang, Glencore Coal Assets Australia Oliver Scholes, Whitehaven Coal	Many power stations are looking to reduce their carbon dioxide emissions with the addition of biomass to the feed coal for combustion. The proportion of fine particles produced during co-combustion is expected to increase dramatically. This project aims to assess the scope of fine particle emissions produced during combustion of biomass and the interactions expected between biomass and coal when these fine particles are forming during co-combustion.
New	**Physical and Chemical Interactions Between Charcoal and Coal During Coking C35042** Karen Steel, University of Queensland	$135,694	Graeme Harris, Kestrel Coal Resources Morgan Blake, Peabody Australia Coal	The blending of biomass in coking blends has been largely unsuccessful because its raw and charcoal forms cause a loss of fluidity. The loss of liquid then prevents the blend from undergoing expansion and fusion, leading to a loss of coke strength. The porosity also makes the coke more reactive. In this project, researchers aim to overcome this constraint by blending charcoal with specific coals that have high volatile matter content and high fluidity so that the volatiles adsorb into the micro- and meso-pores and carbonise, thereby filling the pores. The high fluidity will enable the coal to interact with the charcoal, flowing into its rough macropore surface and curing to form a bond via a “lock and key” mechanism.
New	**Abrasion Resistance of Coke Under Hydrogen Reduction Blast Furnace Conditions C35043** Hannah Lomas, University of Newcastle	$159,416	Nick Andriopoulos, Anglo American Steelmaking Coal Oliver Scholes, Whitehaven Coal Stephen Brant, BHP	The hydrogen enriched blast furnace is emerging as a viable technology that reduces the carbon footprint of blast furnace ironmaking, but little is known about its impact on coke quality. This project will evaluate the impact of reaction conditions that simulate both the conventional and the hydrogen reduction blast furnace on coke abrasion resistance. Correlations between conventional coke quality indices and abrasion resistance will be developed.
New	**What We Now Know about Coking Coals and Coke C35044** Lauren Williamson, CSIRO	$96,284	Kim Hockings, BHP Morgan Blake, Peabody Australia Coal	Decarbonising ironmaking requires cutting edge research on coke formation and structure. Since 2014, 35 ACARP projects have been completed on the technical marketing of coking coals and their outcomes have influenced the industry’s understanding about what makes a good coke. The primary objective of this project is to integrate these research findings into one collection to determine future areas of research.
New	**Impacts of Chemical Structure Transformation in the Plastic Layer on the Microtexture Development during Coking C35045** Soonho Lee, University of Newcastle	$158,900	Morgan Blake, Peabody Australia Coal Nick Andriopoulos, Anglo American Steelmaking Coal	There have been many attempts to study correlations between coke microtexture and coke quality. However, there has been a lack of understanding of the underlying chemistry of microtexture formation during coking. This project aims to investigate the underlying mechanisms of microtexture development during coking and the role of chemical structure change during plastic layer formation. Pearson petrography analysis and micro-FTIR chemical mapping techniques will be used.
New	**Gasification Reactivity and Degradation of Coke Lumps Under Simulated Conventional and Oxygen Rich Blast Furnace Processes C35046** Apsara Jayasekara, University of Newcastle	$98,500	Kim Hockings, BHP Nick Andriopoulos, Anglo American Steelmaking Coal	Interest in oxygen-enriched blast furnaces, OBF is escalating although little is known about the coke reactivity and coke degradation mechanisms under these conditions. This project will investigate the coke quality requirements to support OBF using laboratory-scale experiments under controlled OBF reaction environments.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
THERMAL COAL				
Current	**Optimisation of Co-Firing Selected Australian Thermal Coals with Biomass and International Coals C33061** Joe Perkins, CSIRO	$122,660	Graeme Harris, Kestrel Coal Resources Greg Wickman, New Hope Group	Co firing coal and biomass blends in power plants is becoming common practice globally. Australian coals have been shown to alleviate ash fouling/slagging and other operational issues when blended with troublesome local coals, but little is known about the effectiveness of co firing Australian thermal coals with regional biomass. This extension project will improve understanding of the combustion characteristics, burnout performance, energy density, ash chemistry of Australian thermal coals in relevant biomass co firing scenarios and demonstrate co firing strategies that enhance the international marketability of Australian thermal coals in Asia.
Current	**Strength Development in Fouling Deposits C34058** Liza Elliott, University of Newcastle	$213,600	Caroline Lang, Glencore Coal Assets Australia Oliver Scholes, Whitehaven Coal	In steelmaking, deposition within the convective pass of boilers can significantly affect gas and heat flows and alter boiler performance. Regular cleaning is required to ensure optimal boiler efficiency and ease of ash removal. Timeframes required for cleaning depend on the time it takes for strength to develop in the ash deposits. Researchers will use a thermomechanical analyser to develop a model which allows deposit strength to be predicted from a simple SEM-TIMA analysis, an automated scanning electron microscope technique.
New	**Feasibility Study, Upgrade and Commissioning of ALS-ACIRL Pilot Scale Combustion Test Facility C35005** James Bottle, ALS Coal	$591,250	Caroline Lang, Glencore Coal Assets Australia Greg Wickman, New Hope Group Jane Lawson, Yancoal Oliver Scholes, Whitehaven Coal	There is, no pilot scale facility within Australia that can evaluate combustion performance under HELE conditions, whilst co-firing with biomass. This project will undertake a feasibility study to upgrade the current subcritical pilot scale combustion facility so that it mimics HELE combustion and allows co-firing with biomass. HELE coal/biomass combustion research will be undertaken in the upgraded facility by studying HELE combustion of two previously tested coals, along with evaluation of combustion performance when co-firing with 5% & 10% biomass.

MINE SITE GREENHOUSE GAS MITIGATION PROJECTS

Australian coal producers need to report greenhouse gas emissions from mining operations and where possible reduce those emissions. Fugitive seam gases have been identified as the largest contributor of greenhouse gas emissions from coal mines.

The Mine Site Greenhouse Gas Mitigation Committee supports a range of activities in this area and is increasingly targeting the measurement and mitigation of the methane in underground mine ventilation air.

COMMITTEE MEMBERS

Ben Klaassen	**Principal Environment (GHG) (Chair)**	**BMA**
Bharath Belle	Group Ventilation Manager	Anglo American Steelmaking Coal
Sharif Burra	Executive General Manager – Health, Safety & Environment	Yancoal
Iain Hornshaw	Superintendent, Environmental Compliance & Approvals	Yancoal
Peter Morris	Principal Advisor - Coal	MCA
De Nicholls	Principle Gas	BHP
Jim Sandford	Technical Advisor	Consultant
Ned Stephenson	Manager Environment and Climate Change	Glencore Coal Assets Australia
John Watson	Director - Environment and Community	Glencore Coal Assets Australia

PROJECTS UNDER MANAGEMENT

Category	No of Projects	ACARP Funding
Mine Site Greenhouse Gas Mitigation	6	$2,189,122

NEW FUNDING APPROVED

No of Projects	ACARP Funding	Total Funding
1	$238,464	$555,406

Total Funding includes in-kind support provided by the researcher and host mine identified in the research proposal

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Selective Absorption of Methane by Ionic Liquids, SAMIL - Phase 2: Demonstration in Packed Bed Reactors C28076** Behdad Moghtaderi, University of Newcastle	$463,020	Ben Klaassen, BHP Bharath Belle, Anglo American Steelmaking Coal David Webb, Glencore Coal Assets Australia Jim Sandford	Existing methods of VAM abatement operate at temperatures above the autoignition temperature of methane in lean methane-air mixtures. The safe connection of existing abatement technologies to a ventilation system has not been resolved and research on VAM capture ducts is ongoing. This project demonstrated the ionic liquid absorption and desorption process using a rotating packed bed to obtain key process data to allow for future mine site integration studies. The selective absorption of methane in ionic liquids has the potential to be a step change in VAM abatement technology because absorption can occur from ventilation air below 200 degrees C, thereby eliminating the safety risks.
Current	**Technical Development Unit, TDU for Catalytic Conversion of VAM C28078** Michael Stockenhuber, University of Newcastle	$646,080	Bharath Belle, Anglo American Steelmaking Coal Jim Sandford	Two barriers to the implementation of VAM technologies are the significant ongoing energy input requirements, especially the additional energy loads imposed on ventilation systems, and stringent heat recovery requirements. Omitting the need for an external heat source to the VAM mitigation system when it is operating at steady-state is challenging due to the high gas flow rates and the normally high operational temperature. This project will investigate the operation of a VAM unit at temperatures as low as 300 degrees C using a suitable catalyst, air pulse and heat recovery system. The air pulsing system regenerates the catalyst under operating conditions to enable low temperature operation of the VAM treatment system. The extension aims to develop a technical development unit for catalytic conversion of ventilation air methane, targeting the maintenance of high levels of conversion, >90% at low temperature, <500 degrees C for extend operational periods. The project will examine scalability, operating parameters and other development issues.

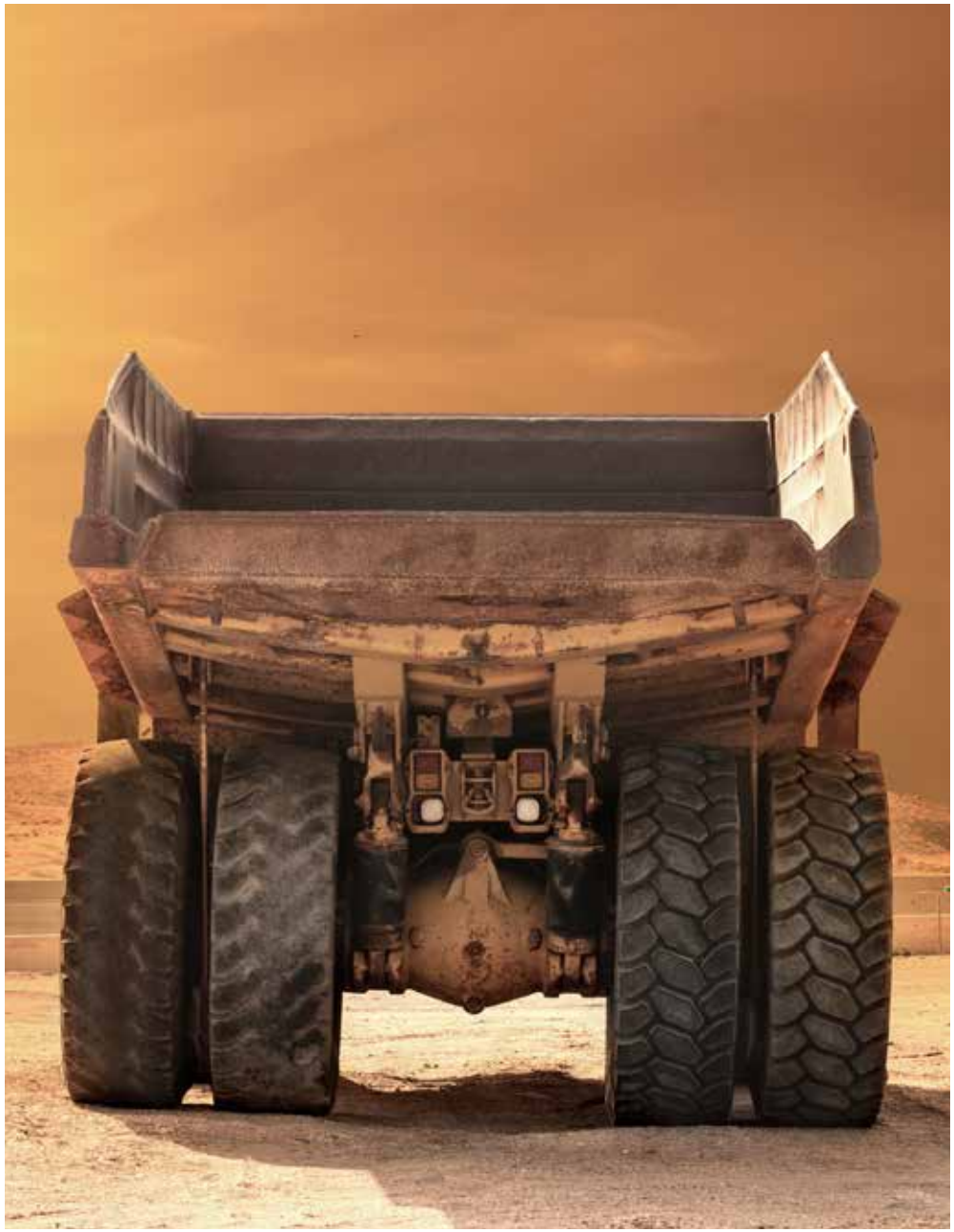
STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Low Cost Catalyst Materials for Effective VAM Catalytic Oxidation C29069** Yonggang Jin, CSIRO	$178,380	Ben Klaassen, BHP Bharath Belle, Anglo American Steelmaking Coal	Catalytic oxidation is able to process a much higher ventilation air flow than thermal oxidation, leading to smaller-size mitigation units and a smaller footprint. In addition, catalytic oxidation units requires a lower minimum operating methane concentration, making them self-sustaining at lower ventilation air methane, VAM concentrations. Palladium-based catalysts are recognised as the best material for catalytic methane oxidation, but they are expensive. This project aims to develop a new low-cost, higher-performance catalyst material for VAM catalytic oxidation which will lead to opportunities for lowering the cost of catalytic VAM mitigation and speeding up its development.
Current	**Airbag Inspired Explosion Suppression System for Mitigation of VAM Explosions C33068** Behdad Moghtaderi, University of Newcastle	$286,678	David Webb, Glencore Coal Assets Australia Jim Sandford	Previous research has shown that in typical capture ducts a VAM explosion must be suppressed in less than 1.2 seconds to avoid flashbacks into the mine. There are no existing systems that can meet this threshold. In this project researchers aim to develop a simple, low cost system to suppress VAM explosions – rapid action inflation nitrogen bag obstruction explosion suppression, RAINBOES. Preliminary calculations suggest that RAINBOES could fully control a deflagration event in 0.7 seconds.
Current	**Satellite Remote Sensing - A New Tool for Coal Mine Emissions Management C34008** Damon Roddis, Zephyr Environmental	$270,900	Andrew Lau, Yancoal Ben Klaassen, BHP Jim Sandford John Watson and Ned Stephenson, Glencore Coal Assets Australia	Preliminary research indicates that two types of satellite data sets may be useful in managing emissions from mining: low earth orbit satellite imagery for methane detection and geostationary earth orbit satellite imagery for particulate matter. An extensive literature review will be undertaken of high spatial and temporal observations of methane and particulate matter using satellites. This review will include worked examples of technology applications, with performance evaluation against ground-level monitoring and technological limitations.
Current	**Safe Operation of Catalytic Reactors for the Oxidation of VAM Operating Under Abnormal Reaction Conditions C34066** Michael Stockenhuber, University of Newcastle	$344,064	Bharath Belle, Anglo American Steelmaking Coal Jim Sandford	Catalytic oxidation technologies offer potential for mitigating low concentration, fugitive methane emissions. For catalytic systems to become a viable commercial option, extended catalyst activity needs to be achieved, maintaining high levels of methane conversion for extended periods of time on stream. Key mechanisms for deactivation have been identified, most notably water poisoning and carbon deposition. The aim of this project is to examine the safety implications associated with the use of a catalytic oxidation system exposed to high excursions of methane in the stream.
New	**Optimisation of Operational Parameters of Catalytic Reactor for the Oxidation of Ventilation Air Methane C35049** Michael Stockenhuber, University of Newcastle	$238,464	Bharath Belle, Anglo American Steelmaking Coal Jim Sandford	Catalytic oxidation offers a potential technology for the mitigation of ventilation air methane, VAM emissions. A VAM catalytic system has been developed over several projects. In this project, researchers will explore how the system reacts to potential changes in feed conditions and how it will be implemented in a pilot-scale reactor. Researchers will determine the requirements to achieve the desired VAM conversion with a structured catalyst support and assess the inherent safety under such conditions.

The industry sees ACARP's support for PhD scholarship program as having many benefits, from the outcomes of the research itself which is of great interest to producers, through to what is seen to be more important; being the long term sustainability of the workforce. Scholarships support those who have worked within industry for more than 3 years who wish to upgrade their skills to this higher academic level, which in turn produces very highly trained people working back in the industry.

The support is in the form of a tax free scholarship awarded on the recommendation of the Research Committee.

PROJECTS UNDER MANAGEMENT

Category	No of Projects	ACARP Funding
Scholarships	7	$2,310,000



STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Environmental Noise Assessment and Management C25076** Tim Procter, Griffith University	$330,000	John Watson, Glencore Coal Assets Australia	Environmental noise is recognised by the World Health Organization as one of the most common pollutants and is becoming a greater community concern. There has been a divergence between how mining companies manage noise impacts and the process used by approval/regulatory agencies. This project will determine the most appropriate 'best practice' approach for the predictive noise modelling of mining operations and then the subsequent measurement and assessment of noise compliance for the respective operations.
Current	**Enhancing the Understanding of the Interaction Between the Ground and Ground Support Elements in Variable Geotechnical Environments through Roof Extensometer Data C27070** Jason Emery, University of New South Wales	$330,000	Peter Corbett, Centennial Coal	Roof and cable bolting are the only method of ground support used in Australian coal mines for roadway development. This method can be used in many different geological and geotechnical conditions to ensure high levels of safety and productivity. Roof, rib and cable bolts are available in a variety of forms and the methods to attach them to the rock mass are almost as varied. Significant advances have been made over the last 30 years in all elements of ground support. The design of ground support has also improved significantly. Industry has also made significant investment in ground monitoring through the use of mechanical extensometers, tell tales. This wealth of roof monitoring data is one of the distinct differences between Australian and other major coal producing countries. Although these devices have been excellent in allowing a better understanding of the rock behaviour and faster and more appropriate response to changing conditions, TARPS little meaningful statistical analysis has been completed on an industry wide scale. Additionally, uncontrolled strata failures are still occurring in our mines, and pose significant safety risks and financial losses to coal companies. One of the most significant aspects in the design and performance of a support system is to understand the ground and support behaviours in different geotechnical environments. This project is undertaking a review of roof displacements, ground support and the rock mass conditions in underground mines.
Current	**Use of Thin Spray Liners in Underground Coal Mines: Mechanism, Testing and Design Methodology Development C29079** Claire Morton, University of Queensland	$330,000	Wesley Noble, Anglo American Steelmaking Coal	TSL is the term used to describe a fast setting, multi-component, polymeric material that is designed to be spray applied to a rock surface and provide areal support; yet to become a preferred support element in coal mining operations. The use of TSLs can potentially significantly improve the advancing speed of development face, in addition to offering a reduction in manual labour and reduced exposure to ground conditions for personnel, if it can be demonstrated that its technical performance is as good as current systems, if not better. There is a need for developing standard tests and testing procedures on TSLs as their application will potentially grow soon. The focus of this project is to provide methodology for testing and then apply a design methodology that is simple, repeatable, practical, cost effective and relates to actual behaviour of the TSL product when applied.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Coal Mass Rating with regards to Outburst and Coal Burst C29080** James Anderson, University of New South Wales	$330,000	Brad Elvy, Brad Elvy Mining Services	The aim of this PhD is to prove that carbonate bonded coal has an increased mass strength, influencing the potential of coal to outburst and coal burst. The hypothesises tested, suggest that the bonding of the coal mass with carbonate mineralisation increase the coal mass rating, CMR. The CMR of a coal seam is the controlling factor that controls the ability of the coal mass to hold en masse energy. Two hypotheses will be tested. With the supporting evidence from a literature review of a link between carbonate mineralisation and historical bursting events, the collection of coal samples from various seams will be conducted for analysis and testing. A comparison of the testing results will provide supporting evidence as to the relationship between the occurrence of carbonates within the coal and the resultant CMR.
Current	**Understanding Horizontal Closure and its Impact on Deformation and Height of Fracture C33073** Adam Lines, University of Newcastle	$330,000	John Grieves, QCoal Services Matt Tsang, Anglo American Steelmaking Coal	Currently most Australian underground coal mines estimate the height of fracture when designing ground support using suspension methods. This estimated height of fracture is often only a range and is based on several assumptions. This research will look to validate these assumptions and provide design tools using recent advancements in technology that allow more precise and accurate methods of prediction. The benefits to industry include increased understanding of the relationship between horizontal closure and height of fracture, application and interpretation methods of state-of-the-art technology, and the development of design tools to incorporate in suspension methods to ensure more accurate estimations of height of fracture.
Current	**Mission Planning for Autonomous Dozers C33074** Benjamin Peacock, University of Queensland	$330,000	Brian Neilsen, Peabody Australia Coal Shaun Booth, Glencore Coal Assets Australia	The mining industry is increasingly embracing automation as a means of enabling safer, more efficient, and cheaper production. Ongoing research and development of automation within the industry helps to provide sustainability for the future. This research addresses the challenge of mission planning for autonomous dozers, specifically in the application of stockpile dozing operations with the incentive to increase safety, increase productivity, and decrease operating cost.
Current	**Optimisation of Ground Consolidation Practices in Longwall Coal Mining Applications C34067** Richard Campbell, University of New South Wales	$330,000	Dan Payne, BHP	This project addresses several of the industry priorities, from improved technical understanding of the deposit to improved productivity through targeted strata control and management especially around the longwall. The outcomes from this PhD will provide quantification in the improvement in rock mass conditions as a result of ground consolidation using various polymeric resins, microfine grouts and other products currently available. The work will mechanically test each of the products including injection pressures, permeability and flowrates in the lab and then undertake detailed examination of the results within the fracture network prior to validation in the underground environment.

FINANCIAL YEAR 21/22 INCOME / EXPENDITURE

INCOME

	21/22	20/21	19/20	18/19
Levy	**$18,303,574**	$18,693,880	$20,216,563	$20,522,293
Interest	**$187,608**	$367,089	$765,309	$1,010,538
Other	**$4,637**	$312,847	$112,891	$57,326
Total	**$18,495,819**	**$19,373,817**	**$21,094,763**	**$21,590,157**

EXPENDITURE

	21/22	20/21	19/20	18/19
Research Projects	**$19,524,279**	$19,684,242	$18,663,326	$16,861,452
ACRL Management	**$689,053**	$598,971	$670,847	$617,624
ARA Project Administration	**$1,855,743**	$1,786,120	$1,696,692	$1,669,810
Total	**$22,069,075**	**$22,069,333**	**$21,030,866**	**$19,148,886**

OUTSTANDING COMMITMENT FOR RESEARCH AT 30 JUNE 2022

	21/22	20/21	19/20	18/19
Projects Started	**$30,314,885**	$27,820,517	$25,517,624	$21,457,993
Projects Yet to Start	**$4,286,805**	$10,176,035	$5,020,953	$5,082,798
Total	**$34,601,690**	**$37,996,552**	**$30,538,577**	**$26,540,791**

2023 PROPOSAL TIMELINE

March 25	Call for Proposals - Announcement in "The Australian" - Distribution of Research Priorities Newsletter
April 26	Closing Date for Short Proposals
July	Short Proposal Selection Meetings
July 21	Call for Long Proposals
August 23	Closing Date for Long Proposals
October	Long Proposal Selection Meetings
December (mid)	Proposal Outcomes Advised

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