ACARP

2023

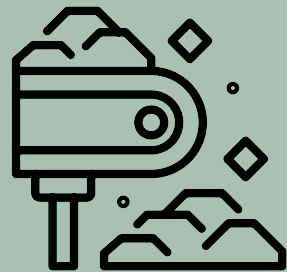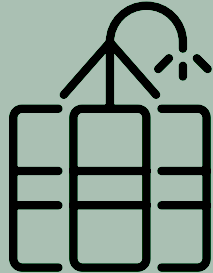## Welcome to our 2023 ACARP Report.

ACARP has continued to achieve significant outcomes for the black coal industry – with 2023 marking its 31st year. Within the backdrop of continued global energy transition and overseas conflicts driving a highly volatile price environment, as well as continued skills and labour shortages in Australia, saleable coal production has again reduced from previous years.

In 2023 ACARP has funded a total of $17.8 million (53 new projects) in direct research, including 13 approved "out of round" during the year, which reflected the revision of strategy for increased focus on energy transition related research. As at the 31 October, there were a total of 223 projects in progress with a total ACARP funding of $84.8 million.

An example of ACARP's continuing contribution to the industry is the work on self-heating of coal. This body of work is now encapsulated in International Maritime Organisation's (IMSBC) Code and in industry submissions informing recent changes to the Australian Dangerous Goods Act, securing the ability of the industry to bulk transport coal via road, train or ship.

The Memorandum of Understanding (MoU) with the Federal government is the instrument through which ACARP is enabled, and a joint review was undertaken by Federal Government (DISR), Minerals Council of Australia (MCA) and Australian Coal Resources during October. At the time of writing, endorsement by the Federal Minister is the remaining step to secure ACARP's MoU until 30 June 2030 - a great result for our members, researchers, and incredible volunteer organisation consisting of more than 230 passionate industry personnel, to continue to come together and achieve as an industry.

During the year the Board, together with the Research Committee, also undertook a review of ACARP's Strategic Objectives in recognition of the continuing pressures on the Australian coal industry, with continued focus on improving workplace safety and efficiency, and to ensure we stay on the forefront of current and emerging issues. This review has endorsed more systematic engagement with all of our key stakeholders and ultimately will provide more ongoing guiding principles for our ongoing research direction.

After five and a half years as Executive Director, Ian Neill retires on 31 December 2023. His time at ACARP is bookended with the renewal of the last MoU and extension of the current MoU, both large bodies of work in their own right, and Ian's work to sustain ACARP as a successful world-class organisation cannot be understated. Ian's exacting attention to detail has provided robust governance second to none. I would like to express my gratitude and congratulations to Ian on his retirement. He leaves a great legacy, not just as Executive Director but throughout his long and successful career in mining.

It is also my great pleasure to welcome Matthew Fellowes as our new Executive Director. Matthew brings a large breadth of experience and longevity in coal research and its application from various perspectives - as coal operator and developer of new mining projects, a researcher, and from within coal services. We look forward to working with Matthew and welcome him at this exciting time.

I'd especially like to thank everyone involved in ACARP for another year full of great achievement, and look forward to 2024 where ACARP is ideally placed to continue providing ongoing leadership in black coal research in Australia.

Please enjoy the 2023 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 2023.

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 objectives
	• Allocation of funds
	• Corporate governance

RESEARCH COMMITTEE	• Program overview - technical
	• Definition of strategic projects
	• Sustainability issues

Underground Committee	• Definition of priorities
	• Project selection
Open Cut Committee	• Technical oversight
	• Nomination of Industry Monitors
Coal Preparation Committee	
Technical Market Support Committee	
Mine Site Greenhouse Gas Mitigation Committee	

Task Groups - Provide technical debate and advice on priorities and proposals to the technical committees

Industry Monitors - Provide technical guidance and ensure project results are adopted by industry

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 $447 million in direct funding to 2,075 projects since ACARP's inception in 1992.

ACRL Board of Directors and Alternates *

DIRECTORS

Anthony De Domenico	Vice President Technical Development	Coronado Global Resources
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
Matthew Fellowes	Executive Director	ACRL
Frank Fulham	Executive General Manager – Technical Support & Projects	Yancoal Australia
John Grieves	Tenements Manager	QCoal Group
Shaun Hansen	Head of Resource Engineering	BHP Mitsubishi Alliance
Greg Hurney	Group Manager Mechanical Engineering	Bloomfield Collieries
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
Robert Simpson	Manager	Whitehaven Coal
Simon Thomas	General Manager - Dendrobium Mine	South32 Illawarra Coal

ALTERNATE DIRECTORS

Rhiannon Bailey	Manager Technology Delivery	BHP Mitsubishi Alliance
Sharif Burra	Executive General Manager – Health, Safety & Sustainability	Yancoal Australia
Brad Lucke	Principal Electrical Engineer – QLD	Glencore Coal Assets Australia
Scott Weatherall	Manager, Feasibility and Studies	Coronado Global Resources

* Directors and Alternate Directors serving at 31 December 2023.

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.

Research is undertaken that is driving minimised emissions and environmental impact of industry.

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 (co-chair)**	**QCoal Services**
Sharif Burra	EGM - Health, Safety & Sustainability	Yancoal
Luke Dimech	BMA Principal Process Engineering	BHP
Graeme Harris	Manager Technical Marketing and Logistics	Kestrel Coal Resources
Ben Klaassen	Principal Environment (GHG)	BMA
Andrew Lau	Mine Closure Manager	Yancoal
Brad Lucke	Principal Electrical Engineer - QLD	Glencore Coal Assets Australia
Lauren North	Principal Sustainability Partnerships	BHP
Kevin Rowe	Group Manager	Glencore Coal Assets Australia
Dave Young	General Manager Engineering & Operational Support Service	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	$3,878,439
	Detection and Prevention of Fires and Explosions	3	$628,300
	Environment - Subsidence and Mine Water	8	$3,055,134
	Geology	1	$168,646
	Health and Safety	16	$6,087,067
	Maintenance and Equipment	7	$5,119,739
	Mining Technology and Production	11	$6,513,338
	Roadway Development	3	$8,705,278
	Strata Control and Windblasts	20	$4,654,491
	Ventilation, Gas Drainage and Monitoring	18	$5,255,092
Open Cut	Drilling and Blasting	5	$1,525,035
	Environment	19	$6,953,072
	Geology	8	$1,209,132
	Geotech	7	$2,165,434
	Health and Safety	6	$2,304,876
	Maintenance and Equipment	8	$1,356,854
	Mining and the Community	1	$199,472
	Overburden Removal	1	$346,046

Category		No of Projects	ACARP Funding
Coal Preparation	Dewatering	14	$3,040,632
	Environmental Improvement	4	$2,274,897
	Fine Coal	19	$7,887,604
	General	9	$1,863,594
	Gravity Separation	4	$760,022
	Maintenance and Equipment	1	$352,797
	Process Control	8	$1,825,715
Technical Market Support	Maritime Regulation	1	$4,169,012
	General	6	$1,596,410
	Metallurgical Coal	32	$5,395,544
	Thermal Coal	3	$927,510
Mine Site Greenhouse Gas Mitigation		7	$2,501,586
Scholarships		7	$2,310,000
Total		271	$95,030,768

NEW FUNDING

ACARP supports projects with immediate need outside the yearly funding round. These projects are included within this report as new funding.

Category	No of Projects	ACARP Funding	Total Funding *
Underground	15	$6,490,451	$8,670,378
Open Cut	13	$5,478,013	$7,444,462
Coal Preparation	7	$1,760,690	$2,368,890
Technical Market Support	11	$1,467,825	$2,330,133
Mine Site Greenhouse Gas Mitigation	7	$2,522,213	$2,950,120
Total	**53**	**$17,719,192**	**$23,763,983**

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

The resultant leverage i.e. Total funding ÷ ACARP Funding = 1.34 times meaning that for every $1.00 of ACARP funding research there is $0.34 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

Brad Lucke	**Principal Electrical Engineer – QLD (co-chair)**	**Glencore Coal Assets Australia**
Sharif Burra	**EGM - Health, Safety & Sustainability (co-chair)**	**Yancoal**
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 Services
Jordaan Hennie	Regional Manager, Strategic Mine Planning	Anglo American Steelmaking Coal
Raymond Howard	Chief Mining Engineer	Yancoal
Matt Jones	Practice Lead Product Development	BHP
Jimmy Martin	Superintendent Production Engineering - Broadmeadow	BHP
Graham Morris	Technical Services Principal	Anglo American Steelmaking Coal
Rob Nowell	Operations Excellence Manager (Underground)	Anglo American Steelmaking Coal
Rae O'Brien	Executive General Manager Mining Excellence	Centennial Coal
Paul O'Grady	Group Manager - Technical Services	Glencore Coal Assets Australia
Van Oppel		BHP
Peter Quinn	Mining Engineering Manager	South32 Illawarra Metallurgical Coal
Patrycja Sheffield	Group Manager Mining Engineering & Business Development	Centennial Coal
Brian Wesley	General Manager, Moolarben Coal Operations	Yancoal
Steve Winter	Technical Services Manager	Kestrel Coal Resources
Dave Young	General Manager Engineering & Operational Support Service	Centennial Coal

PROJECTS UNDER MANAGEMENT

Category	No of Projects	ACARP Funding
Coal Burst	14	$3,878,439
Detection and Prevention of Fires and Explosions	3	$628,300
Environment - Subsidence and Mine Water	8	$3,055,134
Geology	1	$168,646
Health and Safety	16	$6,087,067
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No of Projects	ACARP Funding	Total Funding
15	$6,490,451	$8,670,378

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

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Coal Burst				
Complete	**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 developed 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.
Complete	**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 assessed 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.
Current	**Management of Coal Bursts and Pillar Burst in Deep Mines C27020** Murat Karakus University of Adelaide	$380,240	Coal Burst Task Group	Coal bursts (coal bumps) are sudden, violent ejections of coal or rock into the mine workings. They occur without warning and are a significant hazard for people working in deep underground coal mines. This project is developing coal burst mitigation methods. Using continuum mechanics principles, a new damage model is being developed for coal and pillar bursts in deep mines under high stress. This research will enable mine personnel to model and predict damage from coal bursts.
Complete	**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 aimed 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	**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 were conducted on different coal measure rocks under dynamic and in situ unloading conditions using advanced laboratory equipment. These experiments 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.
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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
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.
Complete	**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 developed 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 was conducted for archiving the big data set for back analysis.
Complete	**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 investigated various types of geological structures to determine their effects on the risk of coal burst. It also addressed 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.
Complete	**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.
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.
Current	**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 Marc Henderson and Tim Dean, 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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
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	David Webb, Glencore Coal Assets Australia Owen Salisbury, Whitehaven Coal Paul Wild, Anglo American Steelmaking Coal 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.
Complete	**Evaluating GAG Docking Connections / Simulations C29013** Duncan Chalmers University of New South Wales	$82,100	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 simulated the docking of the GAG to these mines and, via thermodynamic modelling, determined the effectiveness of its deployment.
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				
Complete	**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 assessed 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
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	David Gregory and 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.
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.
Complete	**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 sought to provide a credible basis to assess stand-off 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 collated and analysed information from subsidence monitoring databases, exploration drilling logs and packer testing, inclinometer monitoring records, piezometer monitoring records and mine water balance histories.
Current	**Pilot Scale Membrane Distillation Crystalliser (MDC) with Renewable Heat Source for Mine Water Brine Management C33021** Ramesh Thiruvenkatachari CSIRO	$969,195	Michael Holzapfel and 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.
Current	**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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Geology				
Complete	**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 tested the method of automated co-registration and georeferencing mechanism for roadway monitoring, examined the change detection and roadway monitoring capability over large scale using multiple 3D point cloud data, and mapped underground structural features.
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** 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.
Complete	**Optimum Air Velocity for Management of Both Dust and Gas on Longwall Faces C28014** Rao Balusu CSIRO	$275,250	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 investigated 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.
Complete	**Developing Suitable Gas Separation Membrane for Breathing Apparatus C28023** Victor Chang Monash University	$196,500	Ken Singer, BMA Lee Earnshaw, Peabody Australia Coal Paul Wild, Anglo American Steelmaking 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 explored 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	**Personal Real Time Dust/Particulate Monitor (Direct Mass Based Measurement) C28029** Peter Phaedonos Lear Siegler Australasia	$1,521,730	Brad Lucke, Glencore Coal Assets Australia Glenn Owens, Detekd 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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Complete	**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 investigated the work-related factors contributing to the resilience of coal mining employees.
Complete	**Effect of Rock Dust and Pre-Existing Lung Disease on the Risk of Mixed Dust Lung Disease (MDLD) C29035** Graeme Zosky University of Tasmania	$525,850	Andrew Lau and Sharif Burra, Yancoal Brad Lucke, Tony Egan and Kevin Rowe, Glencore Coal Assets Australia	There are many sources of dust in the coal mining environment that are hazardous to worker health. Researchers compared 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	**Methodology Development of Free Silica Analysis of Dust on PDM Filters: Phases 1A&B C33001** Yonggang Jin CSIRO	$249,200	Andrew Lau and Sharif Burra, Yancoal Brad Lucke, Tony Egan and Kevin Rowe, 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.
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 Brad Lucke, Tony Egan and Kevin Rowe, 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	**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	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 fine tuned CMDLD case data to establish a centralised repository of cases. In this project cases were followed after the point of diagnosis to identify long term disease outcomes for patients with CMDLD. The longitudinal study provides 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 Brad Lucke, Tony Egan and Kevin Rowe, 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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
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 Brad Lucke, Tony Egan and Kevin Rowe, 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	**Resilience and Mental Health in Mining Pilot Program C34006** Rebecca Mitchell Macquarie University	$476,099	Rae O'Brien, Centennial Coal Sharif Burra, Yancoal	Mining has unique factors that contribute to mine employee stress and resilience. A pilot workplace resilience intervention program that supports and strengthens mine employee psychological resilience and mental health will be developed, implemented and evaluated. Based on the pilot evaluation, researchers will provide guidance on the requirements and design features of an effective and scalable resilience intervention program that is specifically tailored to the Australian coal mining industry.
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 Brad Lucke, Tony Egan and Kevin Rowe, 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.
Current	**Advanced Breathing Apparatus with Gas Membrane Modules C34023** Victor Chang Monash University	$298,436	Ken Singer, BMA Lee Earnshaw, Peabody Australia Coal Paul Wild, Anglo American Steelmaking 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.
Current	**Is Exposure to Illite Dust Linked to Pneumoconiosis? C35017** Graeme Zosky University of Tasmania	$302,428	Andrew Lau, Sharif Burra and Frank Fulham, Yancoal Brad Lucke, Tony Egan and Kevin Rowe, Glencore Coal Assets Australia 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.
New	**Advanced Lung Function Assessments for Diagnosis of Coal Mine Dust Lung Disease (CMDLD): The Next Step Towards a Better Health Surveillance Program C36006** Katrina Kildey I-MED Radiology Network	$186,832	Andrew Lau, Sharif Burra and Frank Fulham, Yancoal Brad Lucke, Tony Egan and Kevin Rowe, Glencore Coal Assets Australia Shane Apps, Peabody Australia Coal	This study will investigate whether a new advanced lung function test - Lung Ventilation Analysis Software (LVAS) - can improve the diagnosis of Coal Mine Dust Lung Disease (CMDLD), compared to the current mainstay test of spirometry. Previous projects showed most individuals subsequently diagnosed with CMDLD had no lung function impairments on their spirometry and that spirometry incorrectly identified lung function abnormalities in otherwise healthy individuals. LVAS could enable the earlier detection of lung diseases and reduce the need for additional tests. If confirmed by this project, introduction of LVAS testing could lead to a more effective health surveillance program for CMDLD and minimise harm to affected individuals.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
New	**Hydraulic Fluid Safe Distance pH Detection C36009** Rema Oliver Prince of Wales Hospital	$167,359	Andrew Esdaile and Clinton Maynard, Glencore Coal Assets Australia Trevor Hartley, Centennial Coal	Hydraulic equipment has long been known to be an occupational risk, as high pressure injections can cause devastating injuries to the human body. While previous research focused on detecting the presence and extent of injury, little is understood about the effective 'at risk' distance of escaping fluids that have the capacity to inject human tissue. Risk mitigation controls implemented in the mining industry have not eliminated exposure to sustained flow from escaping fluids. This follow-on project will provide essential information on the interaction, detection and treatment of hydraulic injections and assist in providing quality care for personnel who interact with hydraulic equipment and reduce injury recovery time by one to five months. The project will also look at potential elimination of these hazards.

Maintenance and Equipment

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
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 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.
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 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. Project C26070, 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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Specialised Instrumentation and Data Processing for Real Time FEA Condition Monitoring of AFC Chain C33017** Ryan Norris Vayeron	$185,000	Brad Lucke and 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 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.
Mining Technology and Production				
Current New	**Development of a Safer Underground Explosive C20033** Duncan Chalmers University of New South Wales	$393,000 Current $75,000 New	Paul Wild, Anglo American Steelmaking Coal Russell Thomas, South32 Illawarra Coal Brad Elvy, Brad Elvy Mining Services	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.
Current	**Longwall Floor Horizon Sensing C28018** Zak Jecny 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	**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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current / New	**Self-Drilling Bolt Automation: Bolt Design and Manufacture Method and Chemical Canister Concept Development C34003** Mark Levey OKA Rock Bolt Technologies	$1,857,744 Current $500,000 New	Roadway Development Task Group	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	**Assistive Shuttle Car: Development of an Industry Ready Guidance System: Stage 3 C34015** Andrew Strange CSIRO	$205,395	Roadway Development Task Group	Almost all development operations in Australia use manual line-of-sight, radio controlled continuous miners to cut roadways then on-board driven shuttle cars to transfer coal from the working face. This technology is not able to achieve the goal of safe remote operation of roadway development. In this Stage 3 project, researchers will build upon the successful outcomes of earlier stages of the assistive shuttle car project. The aim is to deliver an operational system that warns of imminent collisions with roadway ribs or other infrastructure. The underlying position measurement and mapping technology will be applied to improve continuous miner self steering, which is a vital component in roadway development automation.
Complete	**Self Cleaning ExScan and Underground Reflectors C34017** Matt van de Werken CSIRO	$141,995	Brad Lucke and Mick 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 aimed to develop a low-cost, resilient, self cleaning reflector prototype to improve reflector performance in all underground conditions.
Current	**Longwall Bretby Cable Handling Monitoring with Fibre Optics C34019** Karsten Hoehn Mining3	$237,940	Brad Lucke, Glencore Coal Assets Australia Nick Belton, 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.
Current	**Longwall Remote Operations – Face Mapping Robot – Phase 1 C35009** Luke Dyer Quantum Engineering and Consulting Group	$170,000	Mick Condie, 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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
New	**Planar Reflecting Radio Antenna (PRRA) for Underground Coal Mines C36013** Dane Zielinski-Nicolson Roobuck	$360,000	Brad Lucke, Glencore Coal Assets Australia Dave Young, Centennial Coal	This project seeks to improve wireless network coverage for underground coal mines without the need for additional networks or power infrastructure by developing a multiband radio reflecting antenna. This highly cost effective and scalable solution for underground coal mines will accelerate the digital transformation of the mining industry and enable improved safety, remote asset tracking/optimisation, diagnostics and maintenance, coal resource management, emission and groundwater level monitoring and better production management. The project will develop this technology and prototypes through new hardware, achieving deployment in a real coal mining environment with high reliability, easy installation, and minimal maintenance.
New	**Roof Support Location using Wireless Ranging C36014** Matt van de Werken CSIRO	$212,543	Brian Wesley, Yancoal Brad Elvy, Brad Elvy Mining Services	One of the problems associated with automation in longwall mining is when roof supports are left behind. If a roof support doesn't progress, the hydraulic, water and electrical lines between it and its neighbours can be stretched, sometimes to the point of failure, causing significant downtime. The roof support automation system has several mechanisms to detect this issue, however failure of the drive mechanism also often coincides with a failure of the detection system. This project will develop a prototype system for real-time tracking of roof support location in an underground coal mine to detect when a roof support has been left behind. This system could also be used to sense the gate end alignment.

Roadway Development

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current / New	**Underground Coal Mine Gateroad Development Continuous Haulage System C27076** Mick Whelan Premron	$8,344,838 Current $1,428,690 New	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 / New	**Light Weight Composite Conveyor Support Structures C33013** Ganga Prusty University of New South Wales	$280,440 Current $219,364 New	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.
Current	**Floor Horizon Control for Roadway Development C33020** Andrew Strange CSIRO	$80,000	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.

UNDERGROUND PROJECTS

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Strata Control and Windblasts				
Complete	**Assessment of Longwall Mining Induced Connective Fracturing C27045** Deepak Adhikary CSIRO	$407,438	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 aimed to quantify the permeability change resulting from longwall mining by fully utilising mine specific geology and hydrogeology. Researchers numerically simulated 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	**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.
Complete	**Evaluation of the Chinese Outburst Assessment Methodology and its Applicability to Australian Low Permeability Coal Seams C28015** Qingdong Qu CSIRO	$238,270	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 evaluated the Chinese outburst assessment methodology and its applicability to Australian low permeability coal seams.
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.
Complete	**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 was developed for simulating the propagation of fractures in anisotropic materials and jointed rock masses during mining operations. The method is applicable to a range of problems where fracturing in rock may cause instability.
Complete	**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 investigated 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 provides significant data on mine geomechanical behaviour, gas drainage and groundwater modelling.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
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 Dan Payne, BHP Brian Vorster, Glencore Coal Assets Australia 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.
Current	**Effectiveness of Shotcrete in Underground Coal Mines C29025** Joung Oh University of New South Wales	$185,000	Ben Forrest, Whitehaven Coal 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.
Complete	**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 developed a database of goaf hydraulic characteristics in the form of easy to use tables, charts, and formulae. The database enables 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.

UNDERGROUND PROJECTS

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
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	**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	**Carbolt – Pre Commercial Fixed Length Carbolt Prototype C34018** David John Mining3	$360,088	Alex Wright, Yancoal Bob Coutts, BHP Peter Quinn, South32 Illawarra Coal	This project aims to develop a pre-commercial, fixed-length, carbon fibre based roof bolt prototype to provide tensile and shear strata support. The flexible Carbolt will be designed to be installed in a manner similar to standard rebar rock bolts and provide a non-corroding alternative to existing rebar roof bolts, which includes the ability to be re-tensioned. Researchers aim to characterise and statistically analyse the shear and tension load capacity of the Carbolt through a series of trials.
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.
Current	**Risk Based Model for Forecasting Longwall Face Cavity Development C34022** Chengguo Zhang University of New South Wales	$173,200	Bob Coutts, BHP Matt Martin, Anglo American Steelmaking Coal	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.
Current	**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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**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.
Current	**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.
New	**Next Generation Fibre Glass (FG) Rock Bolts with Robust Shear Strength Properties to Replace Steel Rock Bolts C36010** Ali Mirzaghorbanali University of Southern Queensland	$147,998	Dennis Black, South32 Illawarra Coal Peter Corbett, Centennial Coal	This project aims to improve the shear strength properties of fibreglass (FG) rock bolts, paving the way for large scale manufacture, and replacement of steel rock bolts. The FG bolts would be safer and easier to handle and install and, being corrosion resistant, would significantly improve reliability and safety. The manufacture of FG bolts would also produce fewer carbon emissions than steel bolts. Prototypes will be produced at the advanced facilities at UniSQ.

Ventilation, Gas Drainage and Monitoring

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**New Approaches to Mine Gas Analysis and Ratios C25072** Andre De Kock Simtars	$416,192	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	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	**Ventsim Goaf Model Development - Stage 2: Goaf Flow – Ventilation Interactions C28016** Qingdong Qu CSIRO	$319,465	Paul Wild, Anglo American 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	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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Complete	**Revisiting the Fast Desorption Method - Initial Gas Release from Pulverised Coal C29015** Jun-Seok Bae CSIRO	$171,931	Paul Wild, Anglo American Steelmaking Coal	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 used the fast desorption method to improve understanding of the initial dynamics of gas desorption behaviour.
Current	**Evaluation of Explosion Resistant Ventilation Control Devices and Determining Explosion Risk Exclusion Zones C29018** Alex Remennikov University of Wollongong	$562,560	David Webb, Glencore Coal Assets Australia John Grieves, QCoal Services Ken Singer, BMA Paul Wild, Anglo American Steelmaking Coal Russell Thomas, South32 Illawarra Coal Tim Huston, Kestrel Coal Resources	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.
Complete	**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	Owen Salisbury, Whitehaven Coal Paul Wild, Anglo American Steelmaking Coal Russell Thomas, South32 Illawarra Coal Brad Elvy, Brad Elvy Mining Services	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 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 are recommended for the optimum design of drainage holes, based on available field data through geological-numerical exercises.
Complete	**Contamination - Ethylene from Timber Supports C29024** Sean Muller Simtars	$94,750	David Webb, Glencore Coal Assets Australia John Grieves, QCoal Services Julian Potten Kestrel Coal Resources Paul Wild, Anglo American Steelmaking Coal	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 identified the cause of contamination of gas samples with ethylene and/or other spontaneous combustion indicators from timber supports. This data enables appropriate controls to be established and implemented to prevent contamination.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Direct Measurements of Effective Diffusion Coefficient of Coal C29036** Peyman Mostaghimi University of New South Wales	$175,000	David Webb, Glencore Coal Assets Australia Paul Wild, Anglo American Steelmaking Coal 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 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.
Complete	**Evaluating Ventilation Effects on Coal Self Heating Incubation Behaviour C33025** Basil Beamish B3 Mining Services	$79,200	John Grieves, QCoal Services Sharif Burra, Yancoal	Evaluation of airflow effects on spontaneous combustion in underground coal mines has primarily relied on computer simulations using numerical models. This project provides 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 was measured from mine ambient temperature through to thermal runaway if it occurs.
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.
Complete	**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 developed an immersive simulation tool (available via researcher) that clearly demonstrates the exposure impact of changes to working conditions in gateroad development panels. The tool provides enhanced 3D visualisation of monitoring and computational modelling datasets of dust and ventilation flow. The project focused 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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
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	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	**Borehole Tools to Deal with Outbursting Coal Bursting and Gas Drainage: Stages 1 and 2 C34014** Ian Gray Sigra	$1,678,320	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.
Current	**Optimising Gas Management 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 initially look at current management systems and strategies used throughout the industry including areas where high gas drainage rates in goaf holes influence 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 industry 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.
Current	**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.
New	**Practical implications of oxygen deficiency on the determination of Graham's ratio in longwall goafs C36003** Sean Muller Simtars	$64,350	David Webb, Glencore Coal Assets Australia John Grieves, QCoal Services	Graham's ratio is a commonly used indicator for measuring the intensity of the oxidation of coal in underground mine atmospheres. The basis of Graham's ratio is the conversation efficiency of oxygen to carbon monoxide. Graham's ratio uses the nitrogen in a sample for the calculation of oxygen deficiency. This allows for dilution by methane and carbon dioxide seam gases. Nitrogen however is commonly added to goaf atmosphere's through inertisation such as nitrogen or exhaust gases, which can cause Graham's ratio to be underestimated. This project will investigate the practical implications for the interpretation of Graham's ratio and other indicators in the presence of an oxygen deficient atmosphere in longwall goafs.
New	**Optimisation of Goaf Management Strategies C36005** Rao Balusu CSIRO	$1,443,557	Ventilation Task Group	Gas emissions from working longwall and the adjacent goaf areas are the major contributors to ventilation air methane in gassy underground coal mines. The main objective of this project is to develop optimum goaf management strategies to maximise goaf gas drainage, reduce oxygen ingress into the longwall goaf, and minimise fugitive emissions. The project will also investigate the feasibility of using proactive inertisation on both MG & TG sides of the goaf and in adjacent goaf areas, and other alternative goaf management strategies to maximise goaf gas capture, reduce oxygen ingress into the longwall goaf and minimise fugitive emissions from coal mines.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
New	**Borehole Tools – Caliper Log C36011** Ian Gray Sigra	$424,160	Ventilation Task Group	This project aims to complete a suite of underground in seam (UIS) borehole tools to deal with the problems of outbursts, coal bursts and gas drainage. Outbursts of coal and gas are a significant risk to the health and safety of mine personnel. The backbone of the suite of tools is a high speed electronic communication system, which enables two way data transfer along the drill string. The components that are part of the project are a drill rig monitoring system, a survey module, a downhole torque and thrust sensor to obtain near-bit information and a packer test system that mirrors the drill stem test tool currently used in surface drilled boreholes. The challenge of this project is to produce a 12-arm caliper that will detect hole ovality and breakout and that will work in a borehole drilled at 96mm diameter and extend to about 130 mm.
New	**Rotary Steering System Field Trial and Developments C36012** Ian Gray Sigra	$449,600	Ventilation Task Group	This extension project will test the Sigra rotary steering tool (RSS) for use in underground inseam drilling situations, and trial the system in cross-measure drilling. The benefit of an RSS system is that it can prevent the drill string becoming trapped in boggy ground and increase productivity by delivering higher thrust to the bit than current down-hole motors and raise penetration rates during directional cross-measure drilling. The development of this tool could result in significant cost savings by reducing the need to hire equipment.
New	**Intelligent Integrated Distributed Fibre Optic Sensing Technologies C36015** Yi Duan CSIRO	$568,317	Dennis Black, South32 Illawarra Coal Peter Corbett, Centennial Coal	This project responds to the industry's desire for continued innovation in integrated distributed fibre optic sensing technologies to improve seismic, temperature and strain monitoring in underground coal mines. Distributed fibre optic sensing systems offer comprehensive monitoring and are more cost effective. Outcomes from this research will be demonstration of distributed temperature sensing for continuous temperature profiling of underground roadway for ventilation and spon-com management, the feasibility of strain and microseismic monitoring on pillars, with proper installation procedure and interpretation methods developed, and a deep-learning pipeline-based software prototype for real-time distributed acoustic sensing data processing.
New	**Bed Mapping Resistivity Applications in Coal Mining C36016** Greg Runge Lucas Drilling	$242,681	Paul O'Grady, Glencore Coal Assets Australia Steve Winter, Kestrel Coal Resources	This research will aid the coal industry's understanding of the potential benefits of a Bed Mapping Resistivity (BMR) tool designed specifically for coal mining. It will focus on the simulation, construction, and testing of a prototype BMR tool that is integrated with existing electromagnetic survey systems. BMR can continuously detect and define a coal seam's roof, floor, thickness, and potentially interbedded layers. Benefits include improving real time and post-analysis structural understanding and mapping, enabling geotechnical support to be proactive rather than reactive. It could also improve the quality of risk assessments, enable high resolution input into development/mining planning and contouring for automated longwalls, and enhance geoplacement of drilled wells resulting in safer and more efficient mine operations.

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
Craig Bancroft	Manager Environment	BMA
Shaun Booth	Group Manager Resource Development and Technology	Glencore Coal Assets Australia
Tyson Burkitt	Engineering and Maintenance Manager (GCAA)	Glencore Coal Assets Australia
Sandro De La Cruz	Lead Superintendent Projects & Governance	BHP
Brett Domrow	Mine Planning Manager	New Hope Group
Phillip Enderby	Business Improvement Manager	Hunter Valley Operations
Jason Fittler	Environment Manager	Anglo American Steelmaking Coal
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
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 Projects Manager	Anglo American Steelmaking Coal
Peter Walsh	Project Manager	Glencore Coal Assets Australia
John Watson	Director - Environment and Community	Glencore Coal Assets Australia
Brendan Wilkins	Manager Asset Management	Anglo American Steelmaking Coal
Sara Wodyk	Manager BMA Technical Services Strategy & Performance	BHP

PROJECTS UNDER MANAGEMENT

Category	No of Projects	ACARP Funding
Drilling and Blasting	5	$1,525,035
Environment	19	$6,953,072
Geology	8	$1,209,132
Geotech	7	$2,165,434
Health and Safety	6	$2,304,876
Maintenance and Equipment	8	$1,356,854
Mining and the Community	1	$199,472
Overburden Removal	1	$346,046

NEW FUNDING

ACARP supports projects with immediate need outside the yearly funding round.
These projects are included within this report as new funding.

No of Projects	ACARP Funding	Total Funding
13	$5,478,013	$7,444,462

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

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Drilling and Blasting				
Current	**Evaluation of Production Trials of HP Explosives C27024** Andrew Kettle Mining3	$477,920	Andrew Lau, Yancoal Brett Domrow, New Hope Group	The aim of this project is to design and manufacture a specialised, inert to hydrogen peroxide (H2O2), 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.
Current	**Production Trials in Two States of HP Explosives with Custom MMU C33041** Ewan Sellers Mining3	$342,034	Andrew Lau, Yancoal	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.
Complete	**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 aimed 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.
Current	**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.
Current	**Mining Explosive Sensitisation using Chemical Free Methods C35028** Andrew Kettle Mining3	$297,256	Andrew Lau, Yancoal Brett Domrow, New Hope Group	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.
Environment				
Complete	**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 was 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 looked to identify microorganisms that are critical and/or key 'first responders' in the development of functional soils during rehabilitation.
Complete	**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 enables 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.

ACARP

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
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	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.
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 ad 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.
Current	**Best Practice Management and Performance Assessment of Biodiversity Offset Areas C33043** Rachel Murray Eco Logical Australia	$335,540	Mark Nolan, BHP 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.
Complete	**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	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 was used in this project to detect and measure pasture dieback on rehabilitated and unmined pasture using remote sensing techniques. This included 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.

OPEN CUT PROJECTS

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
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.
Current New	**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 Current $1,318,269 New	Andrew Lau, Yancoal Jason Fittler, Anglo American Steelmaking Coal John Watson, Glencore Coal Assets Australia 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 Brian Vorster, Glencore Coal Assets Australia 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	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 Bouldercombe 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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
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 Morné van Zyl, 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.
Current	**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.
Current	**Management Strategies for Invasive Leucaena on Coal Mine Sites C35026** Shane Campbell University of Queensland	$531,528	Andrew Lau, Yancoal Cian Morgan, BMA Dominique Taylor, Anglo American Steelmaking Coal Morné van Zyl, Glencore Coal Assets Australia	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.
Current	**Renewable Energy as Post Mining Land Use C35029** Claire Cote 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.
Current	**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.
New	**Predicting the Long Term Erosional Behaviour of High Walls C36018** Greg Hancock University of Newcastle	$443,980	Andrew Lau, Yancoal Chris Quinn, Rix's Creek Jason Fittler, Anglo American Steelmaking Coal	This project seeks to develop a more rigorous understanding of highwall erosion and develop a predictive tool to assess it. This will lead to improved landscape performance and safety, improved environmental outcomes, and improved post-mining landscape design. Models currently exist that can theoretically predict the behaviour of mine highwalls, but there is a lack of reliable model input data to calibrate and validate these models. This work will provide baseline data for advanced understanding of mine highwall erosion and develop parameters for input into numerical models for high wall erosional behaviour and validate a predictive model for the erosion of highwalls.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
New	**Semi Autonomous Bulldozers for Mine Site Rehabilitation C36020** Ross McAree University of Queensland	$498,218	Andrew Lau, Yancoal Brian Neilsen, Peabody Australia Coal Ned Stephenson, Glencore Coal Assets Australia Phillip Enderby, Hunter Valley Operations	Challenges facing industry regarding the user of dozer operation for rehabilitation are the financial cost of rehabilitation, availability of skilled people and environmental issues. These challenges could be significantly alleviated through the development and deployment of semi-automated bulldozers. Recent research found that human operated bulldozers achieved 56 percent of the maximum productivity potential, compared with productivity rates of up to 92 percent when missions for semi-autonomous bulldozers were autonomously planned. This project will develop, demonstrate, and evaluate the capability to undertake a substantial proportion of the bulk earthwork for mine-land rehabilitation using semi-autonomous bulldozers with enhanced mission planning to optimise performance.
New	**Validation of a Landform Design and Management System for Sloped Grazing PMLU C36042** Leigh Trevaskis Mumbulla Environmental	$688,080	Andrew Lau, Yancoal Morné van Zyl, Glencore Coal Assets Australia	This project will address knowledge gaps in the effect of grazing on sloped rehabilitated land. The work aims to help mining companies to justify the approval of grazing as a post mining land use (PMLU) based on stability indicators, rather than a one-size-fits-all slope gradient ceiling. Currently there is little confidence in grazing as PMLU on slopes greater than 12 percent in the Bown Basin, and this project aims to obtain robust data on livestock behavioural patterns and their impact on slope gradients up to 30 percent. The project will also assess the feasibility of developing a grazing PMLU landform evolution model that accounts for the impact of livestock behavioural patterns on a range of slopes up to 20 percent and develop best practice guidelines for managing livestock on sloped grazing PMLU.
New	**Using Large Floating Islands to Promote Aquatic and Terrestrial Biodiversity in Pit Lakes C36043** Mark Lund Edith Cowan University	$697,290	Andrew Lau, Yancoal John Watson and Ned Stephenson, Glencore Coal Assets Australia	The main objective of this project is to evaluate the use of large aquatic floating islands (AFI) to enhance aquatic and terrestrial biodiversity in pit lakes, particularly during prolonged lake filling. Previous research has demonstrated that pit lakes as aquatic ecosystems are potentially a viable, sustainable, and economically responsible option for post-mining land use. However, these ecosystems cannot be established before the lake is full, creating a long period where the aquatic ecosystem is unlikely to meet regulator and public expectations. The broad goal of this research is to develop the use of large-scale AFIs as a tool for miners to develop or improve biodiversity in their pit lakes, making them suitable for closure as aquatic ecosystems or demonstrating improvement for non-use management areas.
Geology				
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 Euan Macaulay and Matt Tsang, 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.
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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Complete	**Hyperspectral Analysis for Geotechnical Characterisation C34033** Nick Cook University of Queensland	$128,500	Jafnie Muhsin, Anglo American Steelmaking Coal	This research aimed 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	**Statistical Analysis of Methods for selecting Lithology Boundaries from Density and Natural Gamma logs and assessing their ability to select Lithology Boundaries in Blast Holes 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.
Current	**Recovery of Critical Minerals from Coal and Coal Production Waste C35023** Nerrida Scott CSIRO	$154,000	Andrew Lau, Yancoal Caroline Lang and Shaun Booth, 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.
Current	**CSR Predictions and Correlations Definition C35025** Chris McMahon McMahon Coal Quality Resources	$35,880	Alison Burke, BHP Maurizio Tonelli and Tomoaki Nagata, Glencore Coal Assets Australia	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.
Current	**Real Time Prediction of Coal Top Through Guided Borehole Radar Wave Imaging for Open Cut Blast Hole Drilling Phase III C35047** Wayne Stasinowsky 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.
New	**Validation of LIBS Technology for Downhole Resource Evaluation C36022** Joe Perkins CSIRO	$276,020	Jason Schumacher, Yancoal Mark Laycock, Glencore Coal Assets Australia Sudipta Nag, BHP	Laser Induced Breakdown Spectroscopy (LIBS) shows promise as a rapid method to evaluate coal properties. However, it has yet to be successfully adapted for use downhole. LIBS can provide real time measurements, making it highly valuable for on-site and in-situ analysis of coal. This project will fast track the adaptation of a downhole LIBS sensor for coal by developing a comprehensive coal core derived calibration model, integrating LIBS spectral information into washability models using processed core samples, and conducting field testing using a pre-commercial LIBS downhole tool.
Geotech				
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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Complete	**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 Ned Stephenson, Glencore Coal Assets Australia	This project supported project C29048 Image Based Automated Characterisation of Waste Materials by providing meaningful strength categories for the automated waste classification system. Researchers categorised 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 delivered 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 validated 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 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.
Complete	**Low Cost Terrestrial Stereo-Pair Photogrammetric Monitoring System for Highly Hazardous Areas C29050** Anna Giacomini University of Newcastle	$210,720	Gareth Johnson, Hunter Valley Operations 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 delivered an autonomous terrestrial stereo pair photogrammetric monitoring system to observe highly hazardous, unstable areas. The system collects synchronised images at a predefined frequency which will be used to produce 3D digital surface models.
Complete	**Autonomous Water Pressure Sensors for Spoil Dumps and Dams C29052** Byron Wicks Mining3	$458,040	Craig Hagan, Yancoal Dan Payne, BHP	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 reviewed the performance of the technology and required sensors for predicting and diagnosing failures in spoil piles. A field trial was 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. In this final phase of the project researchers refined and increased the functionality of the prototype system.
Current	**Machine Learning for Rockfall Analysis C33040** Klaus Thoeni University of Newcastle	$342,240	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.
Current	**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	Adrienna Robotham and Matt Tsang, Anglo American Steelmaking Coal Peter Chern, Coronado 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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
New	**From Open Pit to Pumped Hydro Energy Storage a Focus on Low Wall Stability C36017** Olivier Buzzi University of Newcastle	$405,500	Andrew Lau, Yancoal Shaun Booth and Tyron Domenici, Glencore Coal Assets Australia Troy O'Reilly, Stanwell Corporation	This project is a first step to transforming residual voids on open cut mines into viable pumped-hydro energy schemes as it answers questions of low-wall stability that are specific to their operation. This project aims to determine why a low-wall might fail due to water level fluctuations associated with pumped hydro and provide guidance on mitigating geotechnical failure risks. This project could provide the industry with a viable post mining alternative land use beyond traditional vegetation replacement.
New	**Measuring the Tensile Strength of Thin Units in Coal Measure Rocks using a Comminution Approach C36021** Karina Barbosa University of Queensland	$214,100	Andrew Lau, Yancoal Jianping Li, BHP Matt Tsang, Anglo American Steelmaking Coal	This project will provide valuable insights and tools to geotechnical engineers and mining professionals, enabling them to better characterise and understand coal measures, ultimately leading to safer and more efficient mining practices. Most slope failures and ground instability in Australian coal mines occur due to extension strain and tensile fracture initiation and propagation. However, commonly used rock mass strength criteria assume shear failure. There is a need to measure intact tensile strength to develop site-dependent properties for design. Core sampling difficulties often preclude sourcing and measuring the strength of thin units in coal measure rocks. To address this problem, a solution can be borrowed from comminution and applied to the mining/geotechnical sector, which has the potential to derive rock tensile strength from rock chips or drilled mini core of a representative sample.
New	**"SCANDY" - A handheld Imaging System for Real Time Spoil Categorisation C36023** Simit Raval University of New South Wales	$178,050	Adrienna Robotham, Anglo American Steelmaking Coal Ned Stephenson, Glencore Coal Assets Australia Tim Vangsness, Stanmore Resources	This handheld imaging system will aid the assessment of coal spoil piles in real time to enable proactive risk management and timely interventions to prevent failures. This would contribute to long term dump stability. Once implemented, the system could also offer real time guidance to operators through ground inspections about optimal unloading areas to further enhance stability and prevent imbalanced dumping. The long term sustainability of rehabilitation efforts in dump environments is a critical concern within the mining industry and successful rehabilitation is reliant on accurate material characterisation and mapping.
Health and Safety				
Complete	**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 research provides the Australian coal mining industry with increased knowledge of the psychological causes underpinning risk-taking behaviour among miners and identifies young age in males and site safety norms as influential factors over individual safety attitudes and behaviour and predictors of future risk-taking. The research also provides the industry with a framework for a time and resource efficient safety intervention, that with adaptation, may be capable of reducing risk taking among miners and improving safety outcomes for the industry.
Complete	**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	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 developed, demonstrated and evaluated 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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Complete	**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 evaluated the human factors aspects of tyre handling equipment design and operation within an EMESRT Control Framework approach and provides functional performance requirements for this equipment. It illustrates a process by which human factors principles should be applied to equipment design and operation within the EMESRT Control Framework approach.
Complete	**EYECUE - Real Time Safety Monitor and Alert System for Tyre Handling C33007** Jake Gulliksen Fingermark	$775,800	Iain Curran, BHP Matt Clements, Anglo American Steelmaking Coal Tim Gray and Tony Egan, Glencore Coal Assets Australia	The purpose of this project was 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 is informed by the EMESRT Tyre and Rim Management Control Framework developed in 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 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.
Current New	**Human Centred Interactive Training Experiences in OTR Tyre Handling C35020** Sara Pazell ViVA! Health at Work	$236,776 Current $451,506 New	Brendan Wilkins, Anglo American Steelmaking Coal Rob Fraser, Tim Gray and Tony Egan, 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.
New	**Live Monitoring of Workplace Exposures In Surface Mobile Equipment C36033** Andrew Westaway Safe Operate	$152,000	Shane Apps, Peabody Australia Coal	This project will establish and deploy a system that enables continuous live monitoring of exposures to various hazardous workplace agents at mines with the data recorded and transferred to a centralised database. The information generated by the system will be used to identify exposure exceedances and trigger real-time alerts. More effective management of these health hazards including proactive detection of changes in exposure and faster responses will reduce injuries and illnesses and, subsequently, cost.
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.

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STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
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 New	**Dozer Suspension Seat to Reduce Body Vibration C33034** Danellie Lynas University of Queensland	$78,107 Current $5,000 New	Shane Apps, Peabody Australia Coal Tim Gray, Glencore Coal Assets Australia 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 Rob Fraser and Tim Gray, 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.
Complete	**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 aimed to deliver a cost effective alternative to detailed strain gauge testing regimes and fatigue analyses of steel structures on open cut mine sites. Researchers sought to design and test a passive fatigue sensor to provide maintenance teams with a cumulative fatigue damage metric. Unfortunately, given the limitations and caveats of passive fatigue sensor performance, this method of fatigue assessment was not considered a suitable alternative to conventional strain gauge measurement strategies.
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	Brad Lucke and Tony Egan, Glencore Coal Assets Australia David Martin, Leveson Sutton and Belinda Martin, BHP	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.
Current	**Reducing Noise Emitted by Heavy Vehicles in Open Cut Coal Mines C34031** Mahmoud Karimi University of Technology Sydney	$231,645	Brendan Wilkins, Anglo American Steelmaking Coal Tim Gray, Glencore Coal Assets Australia	Dump trucks, excavators and other turbomachinery 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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Complete	**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.
New	**In-situ Slew Bearing Scanner for Shovels C36019** Matthew Robinson Ascribe Enginneering	$150,000	Brendan Wilkins, Anglo American Steelmaking Coal Tim Gray and Tyson Burkitt, Glencore Coal Assets Australia	This project aims to develop a miniaturised scanner to examine slew bearing rails on shovels to provide mine sites with more accurate assessment of their condition and remaining life. Improved knowledge of the condition of the slew bearing enables longer operation of the bearing, while reducing the operational risk of a sudden failure. The miniature scanner will also improve safety by removing the need for manual inspection in the shovel's confined space. Such scanners are already available for draglines but are too large for installation on shovels. The project will develop the scanner and undertake a trial scan as proof of concept.

Mining and the Community

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
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	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

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Complete	**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 was to develop, deploy and evaluate a SATS automated mission planning capability to reduce the workload on the SATS operators and result in the generation of more effective SATS missions.

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

Luke Dimech	**BMA Principal Process Engineering (co-chair)**	**BHP**
Kevin Rowe	**Group Manager (co-chair)**	**Glencore Coal Assets Australia**
Albert Blom	Principal Processing Analytics	Anglo American Steelmaking Coal
Spencer Brien	CHPP Process Engineer	Yancoal
Michael Carnell	Project Manager	Glencore Coal Assets Australia
Chris Denyer	Processing Technical Specialist	Anglo American Steelmaking Coal
Jay Dewar	CHPP Manager, Collinsville	Glencore Coal Assets Australia
Araz Ejtemaei	Engineer Processing	BHP
Nathan Evans	CHPP Manager	Peabody Australia
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
Chris March	CHPP Projects Manager	Glencore Coal Assets Australia
Frank Mercuri	Principal Processing	Anglo American Steelmaking Coal
Angus Morrison	Principal Processing Analytics	Anglo American
Dan Mujic	Senior Process Engineer Thiess Lake Vermont	Thiess
Chris Nethercott	Manager Systems and Innovation	Sedgman
Jenny Park	Process Engineer (South)	Glencore Coal Assets Australia
Dan Perkins	CHPP Manager Lake Vermont	Thiess
Jimmy 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	Yancoal
Clinton Vanderkruk	Coal Processing Manager Australia & Canada	Anglo American Steelmaking Coal
Penny Walker	CHPP Superintendent	Malabar Resources
Chloe Webb	Process Engineer	Bengalla
Tom Wilson	CHPP Superintendent	MACH Energy

PROJECTS UNDER MANAGEMENT

Category	No of Projects	ACARP Funding
Dewatering	14	$3,040,632
Environmental Improvement	4	$2,274,897
Fine Coal	19	$7,887,604
General	9	$1,863,594
Gravity Separation	4	$760,022
Maintenance and Equipment	1	$352,797
Process Control	8	$1,825,715

NEW FUNDING

ACARP supports projects with immediate need outside the yearly funding round. These projects are included within this report as new funding.

No of Projects	ACARP Funding	Total Funding
7	$1,760,690	$2,368,890

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

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Dewatering				
Current	**Eriez HydroFloat in Plant Evaluation C27016** 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.
Current	**Surface Alloying of Centrifuge Baskets and Sieve Bends Screen Surfaces to Increase the Service Lifetime C28056** Teresa Kittel 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.
Complete	**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 was 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 was used to achieve this objective.
Complete	**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 aimed to deliver a control system for the SBC to provide flexibility and adaptability to the plant conditions and product quality requirements.
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.
Complete	**Process for Separating and Dewatering Fine Particles C29062** Liguang Wang University of Queensland	$177,400	Michael Carnell, Glencore Coal Assets Australia	This project developed and evaluated a new processing technology based on acoustic particle manipulation for beneficiation of Australian raw coals at laboratory scale. Successful outcomes provide a step change technology in coal processing which is high capacity and low cost.
Complete	**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 extended pilot scale testing to a belt press filter and collaborated with chemical suppliers to design, test and screen more efficient reagents for tailings disposal. Screen procedures were developed for chemical aided, mechanical dewatering processes.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
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	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 state-of-the-art 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** Mansour Edraki 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, 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, 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, Yancoal 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, 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
Current	**Improving the Dewatering of Fine Coal Tailings by Minimising Micro-Nano Bubbles C35032** Yongjun Peng University of Queensland	$238,470	Han Hooi, BHP Naresh Racha, Stanwell Corporation 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.
New	**Green and Effective Reagents for Centrifugal Dewatering C36025** Liguang Wang University of Queensland	$198,982	Chris Denyer, Anglo American Steelmaking Coal Jenny Park, Glencore Coal Assets Australia Naresh Racha, Stanwell Corporation	This project will help minimise greenhouse gas emissions and the environmental impact of the Australian coal industry by improving the dewatering of fine and ultra-fine coals and tailings. This will be achieved by finding more effective and environmentally responsible reagents to reduce product moisture and improve solids recovery of fine and ultrafine coal in the dewatering processes. This would reduce tailings disposal and maximise water recovery and recycling. The existing processes result in loss of valuable fresh fine coal to effluents, loss of profit for Australian coal producers and the creation of a potential environmental liability with increased burden to tailings disposal. Specialty dewatering aids have been developed, but there is no clear guide to reagents suitable for dewatering of Australian black coals and tailings.

Environmental Improvement

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Tailings to Topsoil C29042** Ken Williams University of Newcastle	$765,300	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.
Current	**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.
Current	**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, 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.
Current	**Cost Effective Rehabilitation of Tailings Dams C35048** Mike Cole and Carmen Castor CSER Research	$973,580	Andrew Lau, Yancoal Nicholas Baillieu, Trevor Spedding and 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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
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.
Complete	**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 was to investigate the performance of the reflux flotation cell at full scale and, in turn, commercialise the technology. The focus was on the scale up achieved, the efficiency of the separation and the quality of the product. This full scale trial will process high quality flotation product from a single stage, two metre diameter reflux flotation cell, using feed throughputs more typical of conventional flotation.
Complete	**Model Informed Control Strategy for Coal Flotation C27021** Kym Runge Julius Kruttschnitt Mineral Research Centre	$199,571	Araz Ejtemaei and Henry Provan, BHP Clinton Vanderkruk, Anglo American Steelmaking Coal	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 aimed to increase recovery from flotation cells by developing an improved process control strategy which reduces process fluctuation and maintains optimum performance.
Complete	**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 investigated how various laboratories apply the Australian Standards for coal flotation testing and assess variability in results.
Complete	**Measuring and Correlating CGA Data at Particle Topsize C28060** Bruce Atkinson Basacon Services	$55,444	Jack Lauder, Glencore Coal Assets Australia	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 sought to fractionate a coal sample into separate size fractions to allow CGA to be determined on each size fractions in the as-received sample state. Despite concerted efforts to complete the project, the final recommendation from the project is that CGA should always be limited to a maximum particle size of 4 mm.
Complete	**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 investigated 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.
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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
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	$3,283,000	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 scale-up of a novel fine coal agglomeration technology through a study at full-scale. 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 scale-up 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** Wendy Nutt Mineral Technologies	$199,646	Dan Delahunty, Moolarben Coal Operations Naresh Racha, 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.
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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
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.
Current	**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 pseudo-density method (with efficiency factors trialled to fit data) will be evaluated against actual data.
Current	**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 Jimmy 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.
Current	**Working Effectively with Swelling Clays in Fine Coal Flotation to Improve Product Quality and Recovery C35034** Ngoc Nguyen University of Queensland	$200,304	Jack Lauder and Ed Provan, Glencore Coal Assets Australia Jason Schumacher, Yancoal 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.
Current	**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.
New	**Side-by-Side Analysis of Coal by Automated Micro-CT and Commercial Laboratory Testing C36026** Rohan Stanger University of Newcastle	$167,432	Mel Robbins, BHP Michael Saxby, Glencore Coal Assets Australia	The outcome of the project will be a robust evaluation of automated coal analysis by micro-CT. Analysis time, accuracy, and uncertainty will be compared against standard commercial laboratory testing to provide a basis for commercial investment in this technology. The benefits to industry would be faster analytical services for size and density distributions, potentially at much lower cost. Other benefits are reduced exposure to heavy organic liquids for laboratory personnel and improved data, reducing uncertainty across the coal industry from borecore evaluation through to process diagnostics.
New	**Testing a Novel Flotation Concept for Coal C36029** Nerrida Scott CSIRO	$88,204	Frank Mercuri, Anglo American Steelmaking Coal Michael Saxby and Jenny Goh, Glencore Coal Assets Australia	Most existing flotation equipment consumes considerable space in coal handling and preparation plants. The drawback of existing designs is that, as the scale of flotation equipment becomes larger, costly inefficiencies are introduced. This project's flotation concept augments the performance of existing units without the need for a high cost upgrade. The project will test a low cost, prototype flotation unit for floating coal on a very small footprint, suitable for applications such as tailings fine coal recovery or similar space-restricted applications. Benefits include cost effective recovery of fine coal tailings on a small footprint, and after further development, retrofitting into existing plant as an auxiliary flotation system.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
General				
Current	**CSIRO Instruments at Multiple Plants C26011** Teresa Kittel 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.
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	Chris Jackson, Peter Shumack and Kevin Rowe, 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	**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 was 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 overlaid to automatically obtain a classification of the paint condition under recognised standards.
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 Preparation Promotional Support C34004** Ben Gill Excalibur Mining Systems	$85,000	Coal Preparation Committee	This project incorporates meetings with plant process managers and engineers to disseminate the results of coal preparation research funded by ACARP. This engagement is also used to identify key achievements in coal preparation and promote the role ACARP in coal research in Australia.
Current	**Coal Tailings and Co-disposal Literature Study C34032** Ben Gill Excalibur Mining Systems	$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.
Complete	**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 the corrosion information was extended 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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Complete	**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 and 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 established a methodology for analysing coal samples using micro-CT and improving data processing options for extracting 3-dimenional mineral and particle data.
Gravity Separation				
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, Yancoal Michael Carnell, Glencore Coal Assets Australia Naresh Racha, 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** 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.
New	**DMC Efficiency Improvement Using an Applied Magnetic Field C36024** Quentin Campbell Julius Kruttschnitt Mineral Research Centre	$205,050	Araz Ejtemaei, BHP Jack Lauder, Glencore Coal Assets Australia Sam Rynne, Anglo American Steelmaking Coal	This project will evaluate the economic and performance benefits of integrating a magnetic field into a dense medium cyclone (DMC) utilising magnetite medium for coal processing. This "magnetic" DMC technology could help the coal industry to produce better quality coal and potentially reduce carbon emissions.
New	**Measurement of DMC Wear using 3D Laser Technology C36030** Andrew Taylor CSIRO	$175,422	Kevin Rowe and Luke Winkelman, Glencore Coal Assets Australia Dan Perkins, Thiess	Following on from proof-of-concept work, this project extension aims to further develop the precision and practical use of 3D laser technology to measure wear in a Dense Medium Cyclone (DMC). Follow-up scanning for internal wear in the DMC used in the previous project will provide before and after wear comparisons over the course of the DMC's life. The project will also compare the performance of hand-held and mounted scanners to see if sufficient data can be obtained to overcome the need for a mounting system. Use of this instrument will improve the health and safety of personnel performing these measurements by removing the need to enter the confined space of the DMC. The technology could also improve equipment design to improve maintenance practices, reducing risk to maintenance personnel and preventing downtime. Another benefit could be the development of data analytical tools including AI, machine learning, and digital twins.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Maintenance and Equipment				
Current	**Autonomous Stockpile Dozing: Quantifying Viability C35036** Ross McAree University of Queensland	$352,797	Chris Jackson and Peter Shumack, Glencore Coal Assets Australia Frank Mercuri, Anglo American Steelmaking Coal Jimmy Pollack, Golding Chris Huth, Sedgman	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.
New	**Coal Stockpile Management for Remote Bulldozers through Enhanced Situational Awareness C36027** Ross McAree University of Queensland	$734,000	Araz Ejtemaei an Luke Dimech, BHP Clinton Vanderkruk, Anglo American Steelmaking Coal Kevin Rowe and Michael Booth, Glencore Coal Assets Australia Naresh Racha, Stanwell Corporation	This project aims to enhance the safety, efficiency, and accuracy of managing coal stockyards by improving remote operator situational awareness and decision making on stockpiles. This will be done by providing real time topography maps and material movement decision support. This assistance would guide operators in making informed decisions on how best to extend and reclaim stockpiles under non-line-of-site remote control. The expected outcome of the work is pre-commercial technology demonstrating the potential benefits of enhanced situational awareness for stockpile management.
New	Continuous Stockpile Cavity Warning System - Feasibility Assessment C36028 Wayne Stasinowsky CSIRO	$191,600	Kevin Rowe and Michael Booth, Glencore Coal Assets Australia Naresh Racha, Stanwell Corporation	Dozer accidents on coal stockpiles continue to occur despite safety guidelines. They most often occur when the dozer operator cannot see any indication of a void hazard. There have been several incidents in Australia and overseas where a stockpile dozer has fallen, or been inadvertently driven, into a draw-down hole with serious consequences. A warning system in the dozer cab would reduce the likelihood of a dozer traversing a dangerous area. The objective of this project is to examine and report on the feasibility of an upwards-looking radar system to detect stockpile voids and improve the safety of dozer drivers on stockpiles. The system could also inform the operators of water content and location. The logistics of installation and operation of the system will also be included in the research.
Process Control				
Complete	**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	The overall goal of this project was to apply novel polymers to produce dry stackable tailings in the coal industry. Despite an exhaustive investigation, it was not possible to produce the necessary polymer addition regime needed to achieve the goal of a dry stackable tailing. This was "blue sky" project being a high risk, high return project aimed at using new chemistry to address an old but increasingly significant problem.
Complete	**Smart Conveyor Belts for Structural Health Monitoring and Weigh-In-Motion C33052** Phil Aitchison Imagine Intelligent Materials	$305,440	Luke Winkelman and Peter Shumack, 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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
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 and Rick Jeuken, 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.
Current	**Real Time Monitoring and Control of Froth Flotation C34044** Liguang Wang University of Queensland	$106,667	Albert Blom and Chris Denyer, Anglo American Steelmaking Coal Angus Morrison, Anglo American Josh Kowalczuk, Glencore Coal Assets Australia Rick Jeuken, BHP Chris Huth, Sedgman	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.
Complete	**Using EIS Technology to Measure the Amount of Magnetite in Dilute Magnetite Streams C34047** Clint McNally CSIRO	$224,220	Chris Denyer and Frank Mercuri, Anglo American Steelmaking Coal	This project provides an online method to measure and report the operating performance of magnetic separators in real time using an electric impedance spectrometer instrument. Findings indicated the need for modified EIS cell geometry and frequency span to optimise the response, as well as the need to account for water temperature and conductivity effects. The system demonstrated a close correlation with known operational events affecting magnetite concentration.
Current	**Hand Held Sensor for Real Time Measurement of Fluorine Mineral Contamination in Coal C34050** Nigel Spooner University of Adelaide	$261,215	Jack Lauder and Jenny Park, Glencore Coal Assets Australia Mel Robbins and Rick Jeuken, 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	Albert Blom and Chris Denyer, 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.

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**
Lauren North	**Principal Sustainability Partnerships (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	Technical Specialist and Coal Quality Manager	Glencore Coal Assets Australia
Anthony Edwards	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
Christina McLachlan	Coordinator Planning and Coal Quality	South32 Illawarra Metallurgical Coal
Geoff O'Meley	Coal Technical Officer	M Resources
Oliver Scholes	General Manager Marketing - Technical	Whitehaven Coal
Cameron Tasker	Manager Technical Marketing	Xcoal Energy & Resources – Brisbane
Greg Wickman	General Manager - Marketing	New Hope Group

PROJECTS UNDER MANAGEMENT

Category	No of Projects	ACARP Funding
Maritime Regulation	1	$4,169,012
General	6	$1,596,410
Metallurgical Coal	32	$5,395,544
Thermal Coal	3	$927,510

NEW FUNDING

ACARP supports projects with immediate need outside the yearly funding round. These projects are included within this report as new funding. Total Funding includes in-kind support provided by the researcher and host mine identified in the research proposal.

No of Projects	ACARP Funding	Total Funding
11	$1,467,825	$2,330,133

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

TECHNICAL MARKET SUPPORT PROJECTS

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Maritime Regulation				
Current	**Maritime Regulation Project C27001** Ash Goodwin Goodwin Port Solutions	$4,169,012	Maritime Regulation Task Group	The project includes research to investigate the accuracy, repeatability and reliability when testing coal cargoes for self-heating potential. Experimental work was finalised in 2022 with the project report and recommended regulatory responses provided to the Australian Maritime Safety Authority and the International Maritime Organisation's Sub-Committee on Carriage of Cargoes and Containers (CCC) for consideration. AMSA continues to lead work to progress amendments to the International Maritime Solid Bulk Cargoes (IMSBC) Code via informal correspondence group discussions with IMO stakeholders. As an interim measure, AMSA has issued Certificate of Approval No. 8024, allowing coals meeting specified criteria to be classified and shipped as materials hazardous only in bulk (MHB). This approval is available on the AMSA website and is valid until 31 December 2026.
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	**Management of SA and ISO Coal Technical Committees Work Programs C26003** Barry Isherwood Carbon Connections Consulting	$391,150	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	**Australian Participation in Development of ISO Methods for Sampling Analysis and Coal Preparation and National Technical Committee Support C26037** Standards Australia	$390,370	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.
Complete	**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 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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Complete	**Update of Coal Dustiness and Dust Extinction Moisture Standard AS4156.6 C33070** Dusan Ilic University of Newcastle	$120,000	Anthony Edwards, 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.
Metallurgical Coal				
Complete	**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	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 developed 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.
Complete	**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 aimed to establish the cause of variability in individual coke particle reactivity but at the end of the project the cause remains unknown.
Complete	**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 enhanced 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.
Complete	**Fine Particles from Coal C29075** Liza Elliott University of Newcastle	$188,700	Caroline Lang, Glencore Coal Assets Australia Chris Urzaa, 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 identified a technique to measure the fine particle formation for selected coals using TIMA and combustion experiments. Researchers developed 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 were characterised using standard analysis and measurement of coal maceral content by coal grain analysis.
Complete	**Effects of Ash Minerals on Coke Reactivity at High Temperatures C29077** Brian Monaghan University of Wollongong	$626,527	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 final 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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Complete	**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 investigated the transformation of cross linking structures in the plastic layers and coke/semi cokes during the coking process of Australian coking coals to improve understanding of coke formation, specifically on the formation of carbon structures in coke matrix.
Complete	**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 Chris Urzaa, 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 evaluated Australian PCI coals in the co-injection of hydrogen and coal in ironmaking blast furnaces using 3D computer modelling.
Complete	**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	During this project Micro-CT was 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.
Complete	**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 sought 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** 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.
Complete	**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. C25070 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 further evaluated 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 Peter Austin, BlueScope Steel	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 CO2 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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Complete	**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 aimed 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 was 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.
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.
Complete	**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.
Current	**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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**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.
Current	**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.
Current	**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.
Current	**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.
Current	**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.
Current	**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.
Current	**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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**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.
Current	**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.
New	**Physical and Chemical Structure Characterisation of Biomass for Biocoke Production C36004** Arash Tahmasebi University of Newcastle	$54,100	Cameron Tasker, Xcoal Energy & Resources Australia Lauren North and Stephen Brant, BHP Morgan Blake, Peabody Australia Coal Nick Andriopoulos, Anglo American Steelmaking Coal Shaun Booth, Glencore Coal Assets Australia	This project is the initial part of an integrated program of research to better understand the biomass and coal quality requirements for biocoke production for blast furnace ironmaking. The findings of this scoping study are expected to inform biomass selection to produce pilot oven coke samples to be used in a suite of projects being undertaken in 2024.
New	**Structural Optimisation and Reactivity Evaluation of Ferro Coke Produced using Australian Coals C36031** Arash Tahmasebi University of Newcastle	$167,000	Cameron Tasker, Xcoal Energy & Resources Australia Graeme Harris, Kestrel Coal Resources Nick Andriopoulos, Anglo American Steelmaking Coal Stephen Brant, BHP	The use of highly-reactive ferro-coke is among strategies proposed to reduce production costs and the environmental impact of blast furnace ironmaking. The objective of the project is to examine the suitability of Australian coals for ferro-coke production and to develop a new understanding of the mechanism of microstructure formation and reactivity of ferro-coke.
New	**Impact of Biomass on Coke Microstructure Evolution and Gas Diffusion During CO2 Gasification C36032** Arash Tahmasebi University of Newcastle	$169,000	Cameron Tasker, Xcoal Energy & Resources Australia Lauren North and Stephen Brant, BHP Morgan Blake, Peabody Australia Coal Nick Andriopoulos, Anglo American Steelmaking Coal Shaun Booth, Glencore Coal Assets Australia	A previous project revealed limited success in biomass blending due to the negative impacts on coke quality, and recommended further research on optimising species, biomass pre-treatment, coking technology, and coal blend design. This project forms part of an integrated program of research to improve the knowledge of the impacts of biomass addition on the coking performance and quality of coke generated from Australian coals. The aim of this project is to examine the impacts of biomass addition on the mechanism of carbon conversion during CO_2 gasification and to evaluate the changes in coke microstructure during gasification reactions. This new knowledge will contribute to the understanding of how biocoke can be effectively utilised in blast furnace ironmaking.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
New	**Sugar Coated Coal: Determining if Glucose Addition Can Improve Coke Quality of Coal-Biomass Blends C36034** Callum Mainstone ALS Coal	$105,310	Cameron Tasker, Xcoal Energy & Resources Australia Lauren North and Stephen Brant, BHP Morgan Blake, Peabody Australia Coal Nick Andriopoulos, Anglo American Steelmaking Coal Shaun Booth, Glencore Coal Assets Australia	Including biomass in coal blends for coke production is a preferred method to achieve reduced carbon emissions, as changes to key metallurgical infrastructure are not required. However, adding plant dry matter biomass to coke reduces its quality, even in low concentrations. Adding glucose to other forms of biomass such as lignin prior to blending with coal may result in improved coke strength. Glucose can be sourced from agricultural, textile and forestry waste that does not compete with food production for land or water. This project will conduct a series of coking trials to determine the effectiveness of using glucose to contribute bio-carbon to coking coal blends and the potential to enable higher ash coals to be utilised.
New	**Microstructure Characterisation and Simulation of Bio-additives in Coke C36035** David Jenkins University of Newcastle	$114,200	Cameron Tasker, Xcoal Energy & Resources Australia Lauren North and Stephen Brant, BHP Morgan Blake, Peabody Australia Coal Nick Andriopoulos, Anglo American Steelmaking Coal Shaun Booth, Glencore Coal Assets Australia	With the increasing interest in "sustainable coke making" there is a need to understand the impact of biomass on coke microstructure, and which coke microstructures best accommodate the addition of biomass. A recent PhD project developed novel techniques for characterising coke microstructure and simulating microstructures of cokes. Extending this to coke microstructures containing biomass is a step towards a predictive tool for optimal biomass blending. This project addresses priorities including the development of metallurgical coke and PCI to support low-carbon blast furnace ironmaking, the impact on coking-coal quality requirements and steelmaking emissions through coal blend additives and better understanding of coal to coke conversion and coke performance to support the technical marketing of Australian coking coals.
New	**Biochar-Coke Integration for Improved Coke Strength and Performance C36036** Pramod Koshy University of New South Wales	$244,400	Cameron Tasker, Xcoal Energy & Resources Australia Lauren North and Stephen Brant, BHP Morgan Blake, Peabody Australia Coal Nick Andriopoulos, Anglo American Steelmaking Coal Shaun Booth, Glencore Coal Assets Australia	The addition of biochar from Australian hardwood plant species will help to improve the environmental sustainability of the coke making and ironmaking processes. This project aims to enhance biomass utilisation in coal blends to improve environmental sustainability, without compromising the properties and performance of the resultant cokes in ironmaking. It will assess the impact of blending biochars in high-addition ratios with coals of varying properties to prepare pilot-oven cokes and to determine the high-temperature properties and performance of the cokes under blast furnace conditions. The research is part of a suite of projects aimed at understanding the effects of biomass addition on the properties and performance of biocokes to ensure the long-term market viability of Australian coals and cokes.
New	**Exploring the Effects of Bio-char and Torrefied Biomass Addition on the Microtexture of Bio-coke C36037** Soonho Lee University of Newcastle	$155,000	Cameron Tasker, Xcoal Energy & Resources Australia Lauren North and Stephen Brant, BHP Morgan Blake, Peabody Australia Coal Nick Andriopoulos, Anglo American Steelmaking Coal Shaun Booth, Glencore Coal Assets Australia	One strategy to reduce carbon emissions in blast furnace ironmaking is to incorporate sustainable biomass such as biochar and torrefied biomass as a substitute energy source. However, studies have shown the utilisation of woody biomass in coke making reduces coke strength. This project builds upon significant advancements in understanding the development of coke microtexture and microstructure from a series of previous projects and will be simultaneously explored in other projects proposed by the researchers. It is a vital aspect of a research initiative aimed at better understanding changes in coal quality requirements for biocoke production in blast furnace ironmaking.

TECHNICAL MARKET SUPPORT PROJECTS

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
New	**Effects of Ash Minerals on Coke Reactivity under Hydrogen Injection Low CO2 Blast Furnace Conditions C36038** Raymond Longbottom University of Wollongong	$51,290	Cameron Tasker, Xcoal Energy & Resources Australia Nick Andriopoulos, Anglo American Steelmaking Coal	As low CO2 blast furnace practices are adopted by steelmakers, the use of hydrogen in the furnace will increase. It is therefore imperative to understand coke quality requirements and performance under these new conditions. The main objective of this project is to quantify the impact of mineralogy on the reactivity of metallurgical coke using a laboratory tool called a coke analogue, at temperatures of 1,100°C and higher using hydrogen-containing gas mixtures. The secondary objective is to use the coke analogue to assess the temperature at which the reaction between hydrogen-containing gases and coke becomes significant.
New	**Alternative Thermal Processing of Coal Pilot Extruded Coke and Supercapacitor Demonstration C36039** Rohan Stanger University of Newcastle	$157,178	Graeme Harris, Kestrel Coal Resources Lauren North, BHP Morgan Blake, Peabody Australia Coal Nick Andriopoulos, Anglo American Steelmaking Coal Sean Flanagan, Coronado Coal Shaun Booth, Glencore Coal Assets Australia	The objectives of this project are to produce extruded cokes at pilot scale with mixtures of coal and hydrothermal liquefaction biocarbons, and to produce a prototype supercapacitor for energy storage. The pilot extruded cokes will be assessed for coke strength and provide the first evidence for a new type of biocarbon additive. The prototype supercapacitor unit will provide metrics on charging rates and response, efficiency, and overall footprint. Extruded cokes are expected to have improved mixing qualities, particularly with bio-materials, and coal based supercapacitors could open new markets in stationary energy storage and reduce overall emissions associated with its use.
New	**Tracking the Carbonisation Performance of Vitrinite Macerals C36040** Tara Congo University of Queensland	$108,664	Lauren North, BHP Oliver Scholes, Whitehaven Coal	Knowledge of the specific vitrinite properties that give rise to the best quality coke would be beneficial to coke-makers for their blend formulations and could help identify which Australian coals could attract a higher price, owing to their superior properties. The objective of this project is to reveal the composition of vitrinite that leads to optimal coke properties. The project will compare coals of different rank from three different Australian coal measures, as well as overseas coals, for comparison. The knowledge gained on vitrinite behaviour during coking is also expected to assist biocoke research that is trying to overcome the detrimental effects that the addition of biomass has on coal fluidity.
New	**Quantifying Biochar Interactions with Coal for Coke Making C36041** Lauren Williamson CSIRO	$141,683	Cameron Tasker, Xcoal Energy & Resources Australia Lauren North and Stephen Brant, BHP Morgan Blake, Peabody Australia Coal Nick Andriopoulos, Anglo American Steelmaking Coal Shaun Booth, Glencore Coal Assets Australia	In a bid to reduce greenhouse gas emissions, biomass is being trialled to determine how much can be blended with coal and still produce satisfactory coke. Usually, the more biomass added, the decreased coke strength, limiting the amount of biomass that can be used. The goal of this project is to systematically study biomass addition. As part of a suite of proposed ACARP research, this project will quantify the relationship between biomass char surface area, size distribution and their impact on coke properties. If it were shown that the particle size and surface area of the chars produced by biomass were the main factors determining how much biomass could be added to the blend, this would increase the flexibility in supply of the raw materials.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Thermal Coal				
Complete	**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 project improved the 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).
Current	**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.

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**
Angus Ball	Manager Sustainability	Jellinbah Group
Sharif Burra	EGM - Health, Safety & Sustainability	Yancoal
Lynden Cini	Group Superintendent - Environment	Whitehaven Coal
John Grieves	Tenements Manager	QCoal Services
Iain Hornshaw	Superintendent, Environmental Compliance & Approvals	Yancoal
Peter Morris	Principal Advisor - Coal	MCA
De Nicholls	Principle Gas	BMA
Jim Sandford	Technical advisor	Sole Trader
Ned Stephenson	Manager Environment and Climate Change	Glencore Coal Assets Australia
Russell Thomas	Principal - Gas Drainage & Ventilation	South32 Illawarra Metallurgical Coal
Sandy Tickell	Group Manager Carbon Planning and Abatement	Glencore Coal Assets Australia

PROJECTS UNDER MANAGEMENT

Category	No of Projects	ACARP Funding
Mine Site Greenhouse Gas Mitigation	7	$2,501,586

NEW FUNDING

ACARP supports projects with immediate need outside the yearly funding round. These projects are included within this report as new funding.

No of Projects	ACARP Funding	Total Funding
7	$2,522,213	$2,950,120

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

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Complete	**Selective Absorption of Methane by Ionic Liquids (SAMIL) C28076** Behdad Moghtaderi University of Newcastle	$463,020	Ben Klaassen, BHP 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 New	**Technical Development Unit (TDU) for Catalytic Conversion of VAM C28078** Michael Stockenhuber University of Newcastle	$646,080 Current $394,512 New	Jim Sandford Russell Thomas, South32 Illawarra Coal	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.
Complete	**Low Cost Catalyst Materials for Effective VAM Catalytic Oxidation C29069** Yonggang Jin CSIRO	$178,380	Ben Klaassen, BHP	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 developed 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	$360,678	David Webb, Glencore Coal Assets Australia Jim Sandford Russell Thomas, South32 Illawarra Coal	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 New	**Satellite Remote Sensing - A New Tool for Coal Mine Emissions Management C34008** Damon Roddis Zephyr Environmental	$270,900 Current $545,825 New	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 New	**Safe Operation of Catalytic Reactors for the Oxidation of VAM Operating Under Abnormal Reaction Conditions C34066** Michael Stockenhuber University of Newcastle	$344,064 Current $62,676 New	Jim Sandford Russell Thomas, South32 Illawarra Coal	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.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Optimisation of Operational Parameters of Catalytic Reactor for the Oxidation of Ventilation Air Methane C35049** Michael Stockenhuber University of Newcastle	$238,464	Jim Sandford Russell Thomas, South32 Illawarra Coal	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.
New	**Open Cut Fugitive Greenhouse Gas Emissions C36001** Andy Self Australian Coal Mining Consultants	$227,500	David Webb and Sandy Tickell, Glencore Coal Assets Australia De Nicholls, BHP Iain Hornshaw, Yancoal Jim Sandford	This project will analysis of the possible methods of reducing fugitive gas emissions and identify and document the next phase of research which would lead to a plan for the minimisation of fugitive gas emissions from open cut coal mines. The benefits to industry will be to develop a more detailed identification and analysis of viable predrainage strategy options in order to mitigate against fugitive open cut gas emissions which will deliver a path forward for effective open cut gas fugitive emissions management.
New	**Investigation into the Technical Feasibility of In-Pit Gas Capture for Open Cut GHG Mitigation C36002** Christian Boucher GeoGAS	$404,000	David Webb and Sandy Tickell, Glencore Coal Assets Australia De Nicholls, BHP Iain Hornshaw, Yancoal Jim Sandford	In this project researchers will determine how open cut mining modifies the coal seam gas reservoir and how these changes could be leveraged to provide a more cost effective way of capturing gas from within the operating pit for the purpose of fugitive emission mitigation.
New	**Assessment of Sensors and Airflow Modelling for their Suitability to Quantify Methane Emissions in Open Cut mines C36007** Simit Raval University of New South Wales	$534,880	Ben Klaassen, BHP Iain Hornshaw, Yancoal Ned Stephenson and Sandy Tickell, Glencore Coal Assets Australia	This project addresses the problem of accurately measuring fugitive mine site gas emissions to help maintain the industry's social and environmental license to operate. Traditional point based instruments are unable to capture methane concentrations over a wide area. To address this issue, it's proposed to conduct a comprehensive desktop study to investigate capabilities of various sensors and then subject the selected sensors to comprehensive testing. The project will provide an evidence based outcome for the coal industry covering selection of sensors, strategies for data capture, and influence of airflow modelling through to utilisation of machine learning based mathematical models to estimate total methane emissions.
New	**Low Cost Precious Metal Free Honeycomb Monolithic VAM Catalysts and their Catalytic Activity and Stability Under Water and Dust Bearing Conditions C36008** Yonggang Jin CSIRO	$352,820	Paul Wild, Anglo American Steelmaking Coal Russell Thomas and Victoria Longley, South32 Illawarra Coal	Catalytic oxidation of ventilation air methane (VAM) shows promise in the development of effective technologies to mitigate VAM emissions, with substantial advantages in safety and cost over conventional thermal mitigation technologies. This project aims to develop low cost honeycomb monolithic catalysts (HMC) based on the high performance precious-metal-free catalyst material newly developed by the CSIRO, and evaluate HMCs' catalytic activity and stability with a simulated VAM stream. The direct benefits to the coal industry are accelerated development of high performance cost effective catalytic VAM mitigators and greatly lower the cost of VAM abatement.

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.

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.
Complete	**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 undertook a review of roof displacements, ground support and the rock mass conditions in underground mines.

STATUS	PROJECT	FUNDING	MONITORS	OVERVIEW
Current	**Use of Thin Spray Liners in Underground Coal Mines: MechanismTesting and Design Methodology Development C29079** Claire Pirona 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.
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.

INCOME

	22/23	21/22	20/21	19/20
Levy	**$17,234,490**	$18,303,574	$18,693,880	$20,216,563
Interest	**$899,746**	$187,608	$367,089	$765,309
Other	**$210,909**	$4,637	$312,847	$112,891
Total	**$18,345,145**	$18,495,819	$19,373,817	$21,094,763

EXPENDITURE

	22/23	21/22	20/21	19/20
Research Projects	**$21,063,972**	$19,524,279	$19,684,242	$18,663,326
Program Management	**$759,343**	$689,053	$598,971	$670,847
Project Administration	**$1,989,300**	$1,855,743	$1,786,120	$1,696,692
Total	**$23,812,615**	$22,069,075	$22,069,333	$21,030,866

OUTSTANDING COMMITMENT FOR RESEARCH AT 30 JUNE 2023

	22/23	21/22	20/21	19/20
Projects Started	**$29,830,064**	$30,314,885	$27,820,517	$25,517,624
Projects Yet to Start	**$3,896,587**	$4,286,805	$10,176,035	$5,020,953
Total	**$33,726,651**	$34,601,690	$37,996,552	$30,538,577

PROGRAM Management

- **Stakeholder engagement**
- **Levy collection**
- **Board secretariat**

Suite 23, Level 9, 307 Queen Street, Brisbane Qld 4000
Phone 07 3532 4077

Matthew Fellowes
Executive Director
matt@acarp.com.au

Marilyn Keenan
Levy Administrator
accounts@acarp.com.au

PROJECT Administration

- **Project administration**
- **Distribution of outcomes**
- **Committee secretariat**

12th floor 167 Eagle Street, Brisbane Qld 4000
Phone 07 3225 3600

Anne Mabardi
Manager Projects - Operations
anne@acarp.com.au

Patrick Tyrrell
Manager Projects - Technical
patrick@acarp.com.au

Nicole Youngman
Projects - Administration
nicole@acarp.com.au

Peter Bergin
Project Coordinator
peter.bergin@icloud.com

Ashley Conroy
Project Coordinator
ashley@ashleyconroy.com.au

Cam Davidson
Project Coordinator
cam@cwrd.com.au

David Drakeley
Project Coordinator
ddrakeley@fieldcrew.com.au

Ben Gill
Project Coordinator
excaliburmining@outlook.com