

ACARP

2016

**PEOPLE AND
PROJECTS REPORT**

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INTRODUCTION

ACARP – the Australian coal industry's research program - was established in 1992 and now operates through a Memorandum of Understanding between the Commonwealth Government and the Minerals Council of Australia.

ACARP is funded by a levy of 5 cents per tonne of product coal paid by all Australian black coal producers, who voluntarily cooperate to develop technologies and solutions that help meet their obligations to the community, while maintaining the industry's position as a world leader in a highly competitive global market. This program helps producers to combine their expertise and resources and share the risks and the benefits to the industry as a whole.

Sustainable production of coal has been embraced as a core business value by Australian coal companies. Major regional issues such as water resource management and impact of noise and dust on local communities are all of primary importance, as are safety and productivity.

This publication documents how the ACARP levy has been invested during 2016 to assist the Australian coal industry develop and adopt world leading mining practices through collaboration.

PEOPLE

The people listed through this report fall into 3 categories.

- The Researchers; those who undertake each project.
- Those who recommend and support the project be funded, being the industry members of the 5 technical committees.
- The industry representatives who are appointed to act as Industry Monitors for each project. The Monitors are charged with providing technical guidance and ensuring any advances made are actioned across the whole industry.

PROJECTS

This report highlights all the projects that were current during 2016 together with the new projects that have been selected.

FUNDING APPROVED 2016

CATEGORY	No of Projects	ACARP Funding	Total Funding
Underground	30	\$7,788,866	\$12,580,132
Open Cut	20	\$4,931,312	\$7,559,422
Coal Preparation	14	\$1,983,868	\$3,173,094
Technical Market Support	14	\$1,806,733	\$2,944,611
Mine Site Greenhouse Mitigation	3	\$688,081	\$1,095,879
Scholarships	2	\$475,000	\$475,000
Total	83	\$17,673,860	\$27,828,138

The resultant leverage = Total funding ÷ ACARP Funding = 1.57 times

PROJECTS UNDER MANAGEMENT 2016

CATEGORY	No of Projects	ACARP Funding
Underground	58	\$19,061,476
Open Cut	58	\$23,837,755
Coal Preparation	46	\$9,231,087
Technical Market Support	28	\$6,699,838
Mine Site Greenhouse Mitigation	5	\$1,993,968
Scholarships	7	\$2,280,000
Total	202	\$63,104,124



UNDERGROUND PROJECTS

The primary goal of the underground research program is to achieve a record of zero fatalities. This is reflected in the 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 coalbursts, advancing emergency response technologies and addressing workplace health risks.

The second goal is to assist operators 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 drivage rates.

The environmental impacts of mining must be minimised and managed to the satisfaction of the community. Priorities include discharge management and improved reliability of subsidence predictions. The program recognises the importance of continuous improvement in this area to ensure the industry maintains broad community support.

COMMITTEE MEMBERS

Brad Elvy	Superintendent Services (co-chair Underground Committee)	South32 Illawarra Coal
Jim Sandford	Group Manager Underground Projects (co-chair Underground Committee)	Glencore
Steve Andrews	General Manager Technical Services, Coal Australia	Rio Tinto Energy & Minerals
Kerry Atkins	CFO	LakeCoal
Bharath Belle	Group Ventilation Manager	Anglo American
Gary Brassington	Principal Mining Approvals	South32 Illawarra Coal
Greg Briggs	General Manager Machine Engineering	Centennial Coal
Paul Buddery	Principal Underground Geotechnical Engineer	Anglo American
Steve Burgess	Executive General Manager Engineering & Operations Support	Centennial Coal
Sharif Burra	General Manager Operations Improvement, Procurement & Major Contracts	Yancoal
Brett Garland		Baralaba Coal
John Grieves	Manager - Studies	Caledon
Hennie Jordaan	Manager - Mine Planning	BHP Billiton
Bernie Kirsch	Environmental Specialist	Centennial Coal
Brad Lucke	Principal Electrical Engineer - QLD	Glencore
Jimmy Martin	Superintendent UG Planning & Processing	BHP Billiton
Brian McCowan	Group Geotech Manager	Glencore
Liam Mildon		Rio Tinto Energy & Minerals
Rae O'Brien	Group Manager - Technical Services (South)	Glencore
Paul O'Grady	Group Manager - Technical Services (North)	Glencore
Dan Payne	Manager Geotechnical Services	BHP Billiton

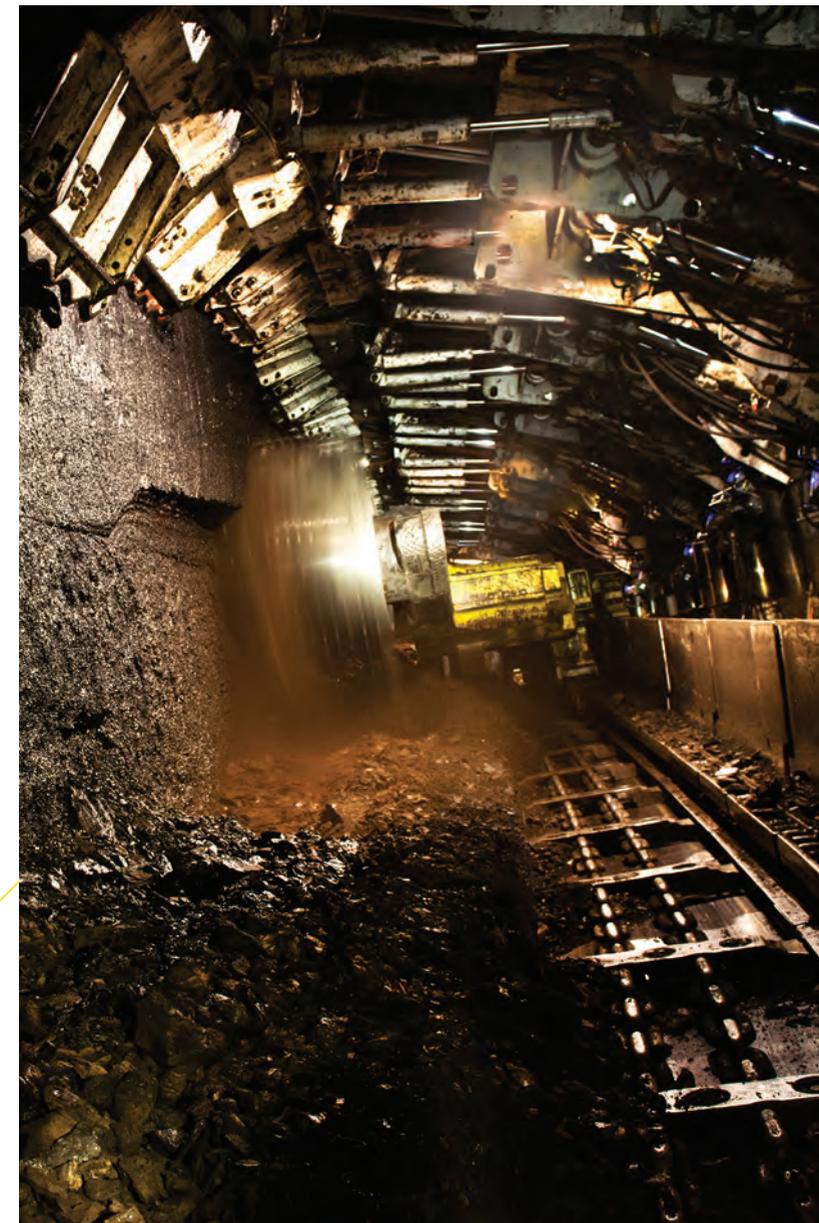
Richard Porteous	Manager Projects	Glencore
Ken Singer	Manager Mine Control (UMM)	BMA
Peter Smith	General Manager - Health, Safety, Environment	Centennial Coal
Trevor Stay	General Manager Gas	Anglo American

FUNDING APPROVED 2016

	No of Projects	ACARP Funding	Total Funding
2016	30	\$7,788,866	\$12,580,132
2015	26	\$5,552,568	\$7,498,470
2014	23	\$6,346,269	\$11,485,909

PROJECTS UNDER MANAGEMENT 2016

CATEGORY	No of Projects	ACARP Funding
Coalburst	1	\$404,000
Detection and Prevention of Fires and Explosions	1	\$470,000
Environment - Subsidence and Mine Water	2	\$823,800
Exploration	6	\$1,406,962
General	1	\$120,000
Maintenance	8	\$2,077,188
Mining Technology and Production	11	\$4,714,122
Occupational Health and Safety	6	\$1,709,003
Roadway Development	4	\$2,240,744
Strata Control and Windblasts	10	\$2,992,976
Ventilation, Gas Drainage and Monitoring	8	\$2,102,681



UNDERGROUND

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Coalburst				
Current	Review of Australian and International Coal Burst Experience and Control Technologies C25004 University of New South Wales Ismet Canbulat	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 work has been conducted on coal bursts in Australia. This project will develop preliminary coal burst risk identification and control guidelines for Australian underground coal mines through a review and evaluation of international coal burst experiences and technologies.
New	Coal Burst Monitoring Technology Using Microseismicity C26006 CSIRO Xun Luo	230,500	Coal Burst Task Group	Coal burst is a violent collapse of the coal wall or roof in development, roadways and at the longwall face. Because it occurs suddenly with little early warning, coal burst is a dangerous phenomenon. In this project researchers will collect microseismic data at three underground coal mines with different coal burst hazard rankings. The outcome of this work will be comprehensive microseismic data sets and supporting information that can be used to assist with coal burst monitoring and prediction.
New	Control and Management of Outburst Risk C26055 University of Wollongong Dennis Black, Najdat Aziz	100,000	Sharif Burra, Yancoal Russell Thomas, South32 Illawarra Coal David Webb, Glencore	Although it is 20 years old, Australian underground coal mines still use the GeoGAS DRI900 method to specify gas content threshold limits for outburst management. This project will investigate the validity of DRI900 to determine outburst threshold limits for all Australian coal seam conditions; compile a database record of Australian outburst events; and analyse pre-incident conditions to identify common factors that can be linked to outburst events. Researchers will assess the significance of other factors such as gas pressure, gas gradient, water saturation, coal strength and stress that may be relevant to identifying outburst risk zones. Outburst event data will also be used to update Ripu Lama's outburst event graph.
New	Mechanics of Gas Related Coal Bursts in Mining C26060 SCT Operations, Winton Gale	273,750	Coal Burst Task Group	While coal burst events have been relatively rare in the Australian coal industry, the number of events is starting to increase. Most of the industry's knowledge of coal bursts is based on overseas experience which may not be directly applicable to Australian conditions. This project will assess the fundamental mechanics of gas release and pressure developed within a gas assisted coal burst. This knowledge will help mining personnel to understand and, therefore, predict the likelihood of gas related bursts in roadways.
New	New Outburst Risk Determination Measures Along With Data Gathering and Analysis for Coal Burst Assessment C26062 Sigra, Bruce Neels	612,200	Coal Burst Task Group	The overall aim of this project is to predict conditions ahead of an advancing development face for the purposes of outburst and coal burst risk assessment. Researchers are seeking to further understand and develop a means of accurately predicting how and when this energy release will be transformed into particle motion or material displacement. This will be done by assessing information on coal burst experience from local mines, the literature and international connections established during previous outburst projects. Once researchers identify the mechanisms associated with coal bursts, they will develop analytical models to determine coal burst outcomes.
New	Energy, Burst Mechanics Required for Coal Bursts and Energy Release Mechanisms C26066 University of New South Wales Ismet Canbulat, Winton Gale	357,500	Coal Burst Task Group	Because coal bursts occurs under diverse geological, stress and mining conditions, there is no one set of defining characteristics for this phenomenon. This makes it difficult to determine which mechanisms have contributed to past coal burst occurrences. This project will assess a range of energy sources and their release mechanisms using analytical and computational methods to determine the energy magnitude required to cause a coal burst.

UNDERGROUND

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
New	Coordination of ACARP's Coal Burst Research Projects C26067 University of New South Wales Ismet Canbulat	127,624	Coal Burst Task Group	Following the coal burst incident at the Austar mine in 2014, ACARP initiated a research program to reduce the risk of coal burst at Australian coal mines. A coordinated technical support and review of these projects will now be carried out. Thirty separate critical projects have been selected, ranked and prioritised. They cover coal burst mechanisms, triggers, prediction and controls. Through a number of workshops with researchers and industry representatives, an integrated coal burst risk management strategy will be developed. The primary objectives of this work are to establish the international knowledge base in coal bursts, to evaluate whether there is alignment between various postulated coal burst mechanisms, and to develop a plan to address the knowledge gaps through comprehensive research.
New	Use of Real Time Rib Drilling Data to Determine the Propensity for Coal Bursts During Roadway Development C26068 Golder Associates, Peter Mastalir, Rob Thomas	150,000	Coal Burst Task Group	One of the key factors associated with a coal seam's propensity to burst is the ability of intact coal to retain a sufficient amount of vertical stress in and around the immediate periphery of a mine opening where the coal is in a largely unconfined state. The objective of this project is to provide coal mine operators with a practical and quantifiable means of assessing the in situ competency of coal. A calibrated set of drilling triggers will be developed which, when incorporated into the existing software on the continuous miner, will help determine whether the coal is in a softened condition and, therefore, whether the coal burst risk is low, moderate or high.
Detection and Prevention of Fires and Explosions				
Current	Cheaper and More Effective Inertant Than Stone Dust C21016 SkillPro Services, David Humphreys	470,000	Bharath Belle, Anglo American	This project will refine and test a recently invented water adsorbent polymer that aims to replace traditional stone dust. The polymer, which is a more effective inertant, can be hydrated underground; vastly reducing the material handling mass and thereby reducing costs. Stakeholder engagement with mines inspectorates and unions will be conducted under this project. The polymer will be tested at the large scale explosion testing facility at Kloppersbos in South Africa.
Environment - Subsidence and Mine Water				
Current	Standardised Subsidence Information Management System C20038 NSW Department of Industry, Gang Li	655,000	Phil Enright, Centennial Mandalong Dan Payne, BHP Billiton	Subsidence data from New South Wales underground coal mines spanning back three decades is being preserved and transferred from various original formats into a standardised information management system. The extension project will enable industry stakeholders to interrogate the system for subsidence knowledge, prediction and assessment in order to make more informed decisions about resource recovery and subsidence risk management.
Current & New	Managing and Conserving Native Plant Species in the Mining Environment C24013 Royal Botanic Gardens and Domains Trust, Sydney, Cathy Offord	168,800 Current 272,500 New	Bernie Kirsch, Centennial Coal Gary Brassington, South32 Illawarra Coal	The woody shrub genus <i>Persoonia</i> , which is found on mine sites, has nine species listed as 'at risk' or 'of concern' in New South Wales. After successfully growing these species and establishing sources for seed production and plant propagation in a previous project, researchers will reintroduce these rare plants back into the landscape. Which translocation techniques optimise the survival of <i>Persoonia</i> in a revegetation context will be assessed in addition to which environmental conditions are required for optimal plant survival.
Exploration				
Current	Advanced Logging Tool C16018 Mining3 Eddie Prochon	440,322	Jim Sandford, Glencore	An advanced borehole logging tool was developed to improve geological definition and geotechnical assessment of coal deposits. The tool contains upwards and downwards looking directional natural gamma and density sensors. It samples at 80 millimetre intervals to provide a high-resolution data set that can be interpreted to determine the seam profile and define geological and sedimentary structures. The tool logs to memory and is deployed inside the drill string. In this extension the logging tool will be reconfigured to reduce the risk of losing the gamma radiation source down the borehole, and two additional geophysical logging tool modules will be added. The new modules will be suitable for certification as intrinsically safe for use in underground mines.

UNDERGROUND

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Coal Quality From Geophysical Logs for Enhanced Resource Estimation C23015 CSIRO Binzhong Zhou, Graham O'Brien	225,240	Barry Lay, BHP Billiton Patrick Tyrrell, New Hope Group	Coal quality parameters such as ash content, density, volatile matter and insitu moisture are important to the coal mining industry from mine planning, design, extraction and beneficiation through to utilisation. These parameters are traditionally obtained through laboratory analysis of drill core samples. This process is expensive and time consuming. This project delivers a new methodology prototype software for deriving coal quality parameters through analysis of routinely acquired wireline data and documented trials of conventional and advanced statistical methods for improved parameter correlation and estimation.
Current	Automatic Determination of Lithology Boundaries From Downhole Geophysical Logs C24016 GeoCheck, Brett Larkin	76,000	Patrick Tyrrell, New Hope Group Malcolm Ives, Centennial Coal	Coal geologists spend excessive time adjusting lithology boundary depths in their logs to corresponding depths derived from downhole geophysical logs. This project will improve the efficiency and effectiveness of this process by providing a computer assisted method to make 80% to 90% of the adjustments. Researchers will develop methods to automatically compare computer generated lithology boundary depths with those recorded in geologists' logs and ascertain whether the depths of each hole have been adjusted to geophysics.
Current	Use of Core Scanning and Hand Held Xray Fluorescence Analysis in Coal Quality Assessment C24025 University of New South Wales Colin Ward	157,400	Patrick Tyrrell, New Hope Group Malcolm Ives, Centennial Coal	Low cost methodologies for rapidly measuring the nature and concentration of the principal inorganic element in coal are needed. This project will develop and validate new technologies for detailed non destructive chemical analysis of cored and in situ coal seams using laboratory based core scanning and hand held portable X ray fluorescence techniques. This will enable variations in ash percentage, ash composition, sulphur and phosphorus in coal seams to be mapped at much higher spatial resolution than is currently possible.
Current	In Seam Wireless Drill String Communication System: Phase 2 C24065 University of Queensland Mining3, Eddie Prochon	330,000	Brad Elvy, South32 Illawarra Coal Jim Sandford, Glencore	Mining3 is developing a system called in seam wireless drill string (ISWDS) that provides high data rate, bidirectional wireless communication between the BHA and the drill rig in the hazardous conditions of underground in seam (UIS) drilling. In phase one of the project the performance of the wireless EM signal was successfully assessed using a research prototype tool. This project will develop a commercially operable tool for UIS drilling in cross panel application; conduct "Ex ia" assessments in order to conduct tests in exploration holes; assess and optimise performance towards 1200m distance; and provide a business case and commercialisation strategy. The prototype will be certified for hazardous area and will be integrated into Mining3's other equipment designs.
Current	Seismic Diffraction Imaging for Improved Structural Detection in Complex Geological Environments C25067 CSIRO, Binzhong Zhou	178,000	Holly McVicar, New Hope Group Patrick Tyrrell, New Hope Group Paul O'Grady, Glencore	Faults and dykes are the most significant geological structures with the potential to disrupt underground coal mining operations. Seismic reflection surveys can locate faults with throws greater than five to 10 metres. However, detection of faults with smaller throws, shears and dykes with widths of a few metres remains a challenge to seismic methods. This project will develop new filtering techniques to extract the seismic diffraction signals from reflection seismic data with multiple coal seam and strata dipping at different angles. The new technique will improve the efficiency and effectiveness of detecting the anomalies and discontinuities ahead of mining in a complex geological environment.
Maintenance				
Current	Big Tyre: Non Pneumatic Non Solid Wheel C18020 Big Tyre Bruce Louden	555,000	Barry Moore, Centennial Coal	In a number of applications the coal industry utilizes solid tyres, however they come with some negative OH&S impacts. This project developed a non-pneumatic wheel specifically designed for underground mining that will overcome a range of inherent disadvantages associated with pneumatic tyres, foam-filled tyres, and solid wheels. The research contractor has committed to develop and supply underground mines with the first production wheels - meeting or exceeding load and torque capacities of comparable tyres, with the following beneficial outcomes over conventional tyres and wheels: improved safety, improved productivity and reduced machine maintenance costs.

UNDERGROUND

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Use of Plastic Metal in Underground Coal Mines for Minor Repair on Flameproof Equipment C23005 Simtars, Bipin Parmar, David Turner	182,298	Mark Lydon, Glencore	Repairing flameproof equipment in-situ underground presents a safety hazard. This extension project will investigate the performance of a number of plastic metal products at various compositions and prepared under various environmental conditions. Researchers will recommend properties that need to be considered when selecting plastic metal products for use on certified flameproof and other explosion protected equipment in underground coal mines.
Current	Longwall Hydraulic System Over Pressurisation Hazards Prevention C24007 Asset Performance Improvements Henry Bartosiewicz	292,250	Shayne Gillett, Centennial Coal Jarrod Sampson, Glencore	Over pressurisation issues have been identified with longwall system hydraulic monitoring programs. Researchers will work with OEMs to understand and determine the nature, extent and causes of these pressure surge problems in different longwall systems design, age and operating conditions.
Current	Distributed Acoustic Conveyor Monitoring C24014 University of Queensland, Mining3, Fernando Vieira, Saiied Aminossadati	270,000	Brad Elvy, South32 Illawarra Coal Jim Sandford, Glencore	This team of researchers is developing a novel conveyor condition monitoring (CCM) system that can improve safety and provide substantial financial benefits to the mining industry by detecting the faulty idlers long before they fail. The CCM system incorporates a single fibre optic cable installed on the frame of a conveyor belt and is capable of detecting the acoustic and vibration signals generated by faulty conveyor components. This project aimed to develop the concept for underground coal conveyor systems.
Current	Photocatalytic Destruction of Diesel Particulate Matter (DPM) C25063 CSIRO Yonggang Jin	178,400	Brad Lucke, Glencore Greg Briggs, 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	Optimisation of Shuttle Car Steering Systems C25070 BMT WBM, Daniel Carpenter	38,400	Scott Wyborn, Centennial Coal Graeme Relf, South32 Illawarra Coal	Maintaining good roads in underground mines is particularly difficult at intersections where machines perform tight turns. Shuttle cars operate frequently at these locations where they are required to make tight turns. Their cornering behaviour has a significant impact on the road condition. This project aims to minimise this type of roadway damage by determining the ideal shuttle car steering component geometry that minimises lateral tyre sliding 'scrub'.
Current	Towing Force Measurement of Various Mining Equipment : Part 2 C25071 BMT WBM Daniel Carpenter	41,600	Anthony Livingstone, Centennial Coal Graeme Relf, South32 Illawarra Coal	Inspections of open cut heavy and light vehicle towing equipment has shown that a large proportion of equipment is damaged due to overloading. An earlier project designed, manufactured and calibrated an instrumented towing force measuring pin. In this project researchers will test the equipment in 'real world' conditions in a longer trial. The signal conditioning and data logging hardware will be modified to suit underground conditions.
Current	Wall Flow (DOC+DPF) Type System to Replace Existing Wet Element Filter System used in Typical LHD in Underground Operations C25073 Orbital Australia, Nick Coplin	519,240	Andy Withers, Peabody Energy Shayne Gillett, Centennial Coal Bharath Belle, Anglo American Steve Coffee, South32 Jason Quirk, South 32	The need to protect workers from diesel particulate matter (DPM) has led the underground coal mining industry to install disposable filter systems on its vehicles. While the disposable filters are efficient at removing significant DPM they have high operating costs, and improper installation or damage leaves workers exposed to high levels of DPM. In order to address these issues, a prototype wall flow filter system will be examined in heavy duty engine testing facilities to replicate LHD in field operations. These filters do not need regular replacing which reduces the chance of improper installation and seal damage. Being a permanent system, the filters cannot be removed by a driver.

UNDERGROUND

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
New	Low Pressure Longwall Hydraulics C26056 Quantise Consulting Engineers Russell Smith	80,000	Shayne Gillett, Centennial Coal Jarrod Sampson, Glencore	This desktop research project will examine low pressure hydraulic systems for powered roof supports used in longwall coal mining. Software simulations will be developed to help assess different hydraulic system configurations, potential problems, and potential solutions. Specifications for an optimal low pressure system achieving greater productivity while using existing pump motor power will be presented.
New	Electrically Safe Variable Speed Drive for Underground C26057 University of Newcastle Galina Mirzaeva Peter Stepien	158,202	Barrie Alley, Centennial Coal Brad Lucke, Glencore	Modern continuous miners and shuttle cars used in underground mining are driven by Variable Speed Drives (VSDs). High frequency noise generated from this system causes severe electromagnetic interference, increases power losses and causes nuisance tripping and other equipment malfunction. The common solution is to employ an EMI filter at the input to the VSD which provides a bypass for the high frequency currents. However this solution reduces the effectiveness of the Neutral! Earth Resistor as a current limiting device. Researchers will develop an attachment to a standard VSD which complements or replaces the EMI filter and reduces the common mode voltage and dangerous touch potential.
New	Proof of Concept of the EST Apparatus on Existing Known Power Supplies C26059 University of Queensland, Mining3, Enver Bajram	114,767	Greg Briggs, Centennial Coal Peter Henderson, Glencore	Testing intrinsically safe (IS) power supplies used for underground coal mining has been an industry focus since 1998 when two widely deployed IS certified power supplies failed in an intrinsic safety retest. In this project researchers will use the prototype Electronic Spark Test (EST) apparatus to test a large batch sample of multiple old and new known power supplies. The aim of this work is to develop an alternative to the current spark testing device, STA.
New	Industrialisation of Proof of Concept Wall Flow DOC/DPF System C26070 Orbital Australia Nick Coplin	734,217	Andy Withers, Peabody Energy Shayne Gillett, Centennial Coal Bharath Belle, Anglo American Steve Coffee, South32	Filter systems are used to reduce particulate matter in underground coal mines. Aside from disposable filters, there are two main types of filters in use: wall flow and flow through. The aim of this project is to replace the wet element filter system used in load haul dump machinery with an industrialised, retrofitted wall flow system. Field trials will confirm how well the technology works in the targeted environment and whether the development work done off line can be transferred into the field.
Mining Technology and Production				
Current	Development of a Safer Underground Explosive C20033 University of New South Wales Andres Castro Duncan Chalmers	323,500	Brad Elvy, South32 Illawarra Coal	Underground mines resort to the use of explosives to break extremely hard materials that intrude into coal seams. Since there is no longer P5 explosive available for delay firing, mines resort to using type 1 explosive. Confusion arises as to how these explosives can be safely used. Currently permitted explosives are being used outside the recommended guidelines as published by the Buxton Testing Authority in the UK. In order that they can be used safely, mines are conducting risk assessments to manage the incendive hazard that possibly could be created by a cut off shot and additionally managing the deflagration hazard with the same risk assessment when using P1 explosives. This project is developing an alternate test regime that adequately assesses the deflagration risk of an explosive. The information gained from this testing will provide additional data to change the testing regime for permitted explosives.
Current	Full Panorama View (360) Video and Laser Flameproof Enclosure C21021 CSIRO Ron McPhee Zak Jecny	251,760	Mark Perry, Centennial Coal Brad Lucke, Glencore Peter Henderson, Glencore	The use of laser and video instrumentation underground is limited by the absence of a safe flameproof enclosure that is functional and intrinsically safe. This project is addressing the design, construction and certification for a novel design of a flameproof enclosure to accommodate full panorama laser and video viewing. The enclosure will deliver improved performance in many areas of underground machine automation including creep-retreat monitoring, collision avoidance, equipment and personnel recognition, pillar and panel locations and many of the future safety related systems integral to the development of autonomous underground equipment.

UNDERGROUND

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	New Manufacturing Technique for Radio Transparent (Dielectric) Flameproof Enclosures C21022 CSIRO Ron McPhee	196,980	Mark Perry, Centennial Coal Brad Lucke, Glencore Peter Henderson, Glencore	Although there are numerous practical underground applications for radio transparent flameproof enclosures, these applications have not been fully developed because there is no suitable non metallic flameproof enclosure technology. Some exciting applications on the development horizon for radio frequency instruments include collision avoidance, identification of resource boundaries using one of the many forms of radar sensing, and local communications portals using wifi systems. This project is developing the fundamental techniques required to produce radio frequency, transparent flameproof enclosures using combinations of metallic and non metallic materials and the latest selective laser sintering techniques.
Current	CM Self Guidance: System Hardening and Underground Deployment C22015 CSIRO David Reid, Mark Dunn	1,092,765	Jim Sandford, Glencore	The goal of the CM2010 initiative is to demonstrate an integrated, remotely supervised, high capacity roadway development system. A major component of this initiative is the development of a navigation and control system to realise a practical self steering continuous miner. This technology will also provide real-time machine position and operational information essential for the integration of support and haulage components. In this project, the technology outcomes demonstrated on the Phoenix in C18023 will be made more robust so they can be installed on an operational continuous miner underground.
Current	Water Jet Cable Bolt Drilling Tool Development and Field Demonstration C23020 University of Queensland Mining3, Scott Adam	350,171	Brad Elvy, South32 Illawarra Coal Peter Corbett, Centennial Angus Place Jim Sandford, Glencore	Current rock bolt drilling techniques and equipment present an operational risk in underground coal mines. A field tested water jet drilling tool prototype capable of meeting safety, hole quality and productivity requirements for cable bolt drilling was developed in this project. The water jet system will be capable of continuously drilling holes of different lengths using high pressure water jets without requiring the manual addition of individual rods during the drilling process and will improve drilling productivity. The first commercial version is expected to include the prototype attached on the end of a flexible high pressure hose.
Current	Dynamic Longwall Equipment Location Model C24021 CSIRO, Jonathon Ralston	73,860	Luke Dyer, Glencore	Collisions between the shearer and roof supports due to equipment failure or operator error can occur during longwall operations, significantly impacting safety and productivity. This project developed a mathematical model that accurately computes the location of longwall equipment in real time.
Current & New	Gateroad Development Continuous Haulage System C24023 Premron Mick Whelan	1,445,000 current 515,000 new	Roadway Development Task Group	The need for shuttle cars at the coal face will be eliminated if the Premron CHS continuous haulage system is introduced to underground mines, resulting in safety, productivity and performance improvements. In this final stage of the project, Premron will manufacture a full scale, full length (150m), mine compliant system and install it above ground on a monorail test rig. Once it has been certified by the Mines Inspector, the next step will be an underground trial on a non-productive panel.
Current & New	Self Drilling Bolt Automation C25058 OKA Rock Bolt Technologies Mark Levey Paul Charlton	500,000 current 896,000 new	Roadway Development Task Group	Researchers are working to develop an automated system for underground roof bolt installation to improve safety, productivity and efficiency of roadway development. In a previous project, OKA Technology was integrated into the drilling equipment of an air-track drilling machine, including the retro-fit of the chemical injection system. The retro-fitted air-track drilling machine is non-hazardous zone compliant. In this extension project, the technology will be trialled in a hazardous underground mining zone with production demands applied.
Current	Bolter Miner for Rapid Longwall Development: Phase A C25061 Sandvik Mining and Construction Australia Barry Wright Winton Gale	92,000	Roadway Development Task Group	The aim of this project is to create a functional specification for the ground support element of a bolter miner that is suitable for an Australian geotechnical environment. The main focus will be on the ground support element to ensure any changes required to the machine design lead to a fit for purpose system design for the Australian geotechnical environment including additional drilling and bolting data intelligence monitoring. This is the first part of a proposed larger project which will lead to finalisation of the functional and requirement specification for a bolter miner (with a new ground support element suitable for the Australian geotechnical environment) and then a trial at an underground mine.

UNDERGROUND

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Longwall Floor Coal Horizon Sensor C25064 CSIRO Jonathon Ralston	213,736	Rae O'Brien, Glencore Paul Buddery, Anglo American	Achieving effective mining horizon control is essential for safe and productive underground longwall mining. There are currently no known commercial sensing systems available. This project will prototype a measurement solution based on ground penetrating radar. The guidance information can be integrated into an existing LASC enabled longwall leading to a step change in mining horizon control performance. The main outcome of this project will be new information to improve longwall mining horizon control performance.
Current & New	Optimising Electrical Protection System Strategies and Technologies C25069 ResTech Clint Bruin	174,350 current 129,800 new	Brad Lucke, Glencore Greg Briggs, Centennial Coal	A key requirement of electrical protection is to properly manage touch potential exposure risk. This requires the various protection parameters and settings to be set correctly. Generally manufacturers adopt a conservative approach to their protection systems which results in high levels of nuisance tripping. This project highlights areas of improvement that will lead to the next generation of electrical protection techniques. An adaptive protection system will be constructed and tested at bench top and mine site trials.
New	Assistive Shuttle Car Guidance System C26049 CSIRO Mark Dunn	100,000	Bruce Davies, Centennial Coal Brad Lucke, Glencore	While newer roadway development systems are moving towards continuous haulage solutions, most existing underground coal mines in Australia continue to use shuttle cars under manual control to manage initial coal transport from the working face. This approach has significant limitations which affect efficiency and safety of roadway development. A new system will be developed to allow shuttle cars to self tram between a continuous miner and bootend conveyor under supervisory control. The proof-of-concept will provide a roadmap for the development of automation systems for other underground vehicles.
New	On-machine Bolting and Geotechnical Monitoring System to Improve Roadway Development Awareness and Performance C26051 CSIRO Jonathon Ralston	275,490	Roadway Development Task Group	Due to a lack of fine resolution geological data and real time operational awareness, current ground control plans for roadway development cannot account for local geological variations that demand different bolting intensity to ensure a competent roof. A miner-based, bolt placement and roadway geometry profiling system using laser scanning technology will be developed. This will provide a new continuous information stream to assist operational and geotechnical personnel achieve a more robust, deterministic and efficient roadway development process.
New	Low Cost Laser and Video 3D Imaging Equipment C26052 CSIRO Peter Reid	196,261	Brad Lucke, Glencore	Higher levels of automation on a longwall face are dependent on a range of technologies including effective optical imaging. Efforts have been made to develop and install along face camera systems but they have not been widely adopted due to installation difficulties and image quality issues. This project will deliver a single tool to enable the installation of scanning laser and video camera equipment onto an underground longwall and/or other mining equipment with minimal effort and cost. The video image will be distortion corrected and combined to produce a video rendered, accurate, 3D image of the immediate surrounds.
Occupational Health and Safety				
Current	IS and Non Invasive Detection of Pressure in Hydraulic Hoses Underground C21009 Custom Fluidpower, Bob Nolan, Graeme Vennell, Livui Schintee, Neil Martin	394,320	Barry Moore, Centennial Coal	In the coal industry the risk of workplace injuries involving fluid under pressure is very high. These incidences often relate to fluid injection and severe body injuries from contact with fluid under pressure. High pressure fluid/oil in hydraulic systems is lethal if a fluid line connection point is opened or hose failure occurs. In the four years preceding commencement of this project there were been 161 fluid injection injury claims lodged across the NSW coal industry. With the support of an earlier ACARP project, Custom Fluidpower developed a prototype device that can inform operators if there is pressure in a hydraulic hose. This project reworked the device to ensure it is intrinsically safe and suitable for use in underground coal mines.
Current	Establish 'At Risk' Distance from Hydraulics C24009 University of New South Wales David Wainright, Gary Nauer	26,908	Occupational Health and Safety Task Group	High pressure injection from hydraulic equipment is an occupational risk in the mining industry. This project will determine a measurable 'at risk' distance for workers from hydraulic systems of the three primary fluids used in coal mining at different pressures. Knowing the 'at risk' distance will lead to the use of more effective controls, such as screens and barriers, thereby reducing the exposure to high pressure hydraulics.

UNDERGROUND

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Collision Awareness - Capability of Underground Mine Vehicle Proximity Detection Systems C24010 Simtars, Andre De Kock	482,300	Peter Nelson, Centennial Coal Brad Lucke, Glencore Jim Sandford, Glencore	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	Holistic Evaluation of Diesel Exhaust Filters and Related Measuring Instrumentation C24022 Queensland University of Technology Julian Greenwood, Zoran Ristovski	247,250	Bharath Belle, Anglo American	Ultra fine (<100 nanometres) particles are not frequently measured in mining related diesel particulate matter (DPM) studies. However, the New South Wales Inspectorate is reviewing all aspects of DPM monitoring and measurement. This project will determine how well current and new types of diesel exhaust filters deal with ultra fine particles. It will also assess the applicability of potential measurement instruments to test filters and equipment in mining conditions.
Current	Real Time Wet and Dry Bulb Temperature Monitoring Systems For Use In Underground Mines - Implementation Challenges C24026 CSIRO Manoj Khanal	97,545	Bharath Belle, Anglo American	Accurately measuring dry and wet bulb temperatures at different critical locations in underground coal mines remains a challenge. Without this information it is difficult to manage mine safety issues, such as weakening roadways, change in strata properties, spontaneous combustion, fires and ventilation problems. This project will review the current state of the art real time temperature monitoring systems applicable to underground mines, identify the challenges of using dry and wet bulb temperature monitoring systems, and identify suitable technology to deliver real time wet and dry bulb temperature data. If a suitable system is not commercially available, researchers will report on preliminary investigations into the design of a suitable intrinsically safe certified instrument.
Current	Alternative Electronic Spark Test Apparatus: Phase 3 C24066 University of Queensland Mining3, Enver Bajram	460,680	Greg Briggs, Centennial Coal Peter Henderson, Glencore	A more consistent and more easily calibrated spark testing device is needed for underground coal mines as a reliable alternative to the spark testing apparatus (STA). This project will develop an electronic spark tester (EST) prototype that extends the functionality of the current STA. Devices being tested for intrinsically safe approval would be connected to the EST in a similar manner to the current STA, however compliance would be tested by measuring the output performance of the device under a controlled set of electronic stimuli. This provides a test result containing a well defined measure of performance relative to the required standard.
New	Real Time Dust Monitor C26047 University of New South Wales Charles Harb Duncan Chalmers	184,300	Bharath Belle, Anglo American Brad Lucke, Glencore Jim Sandford, Glencore	Recent cases of "black lung" in Australian coal mines raise questions about what changes in production and mining practices may have given rise to abnormal quantities of respirable dust. Researchers will build, test and calibrate a silica detection spectrometer to develop a real time dust monitor that will be able to alarm in a similar fashion to modern gas detectors. This device will use off-the-shelf technology and adapt newly developed technology. Once a prototype has been built and tested, a field trial will be undertaken in a non-coal mine to demonstrate its ability to detect respirable dust in the workplace.
New	Improving Respirable Coal Dust Exposure Monitoring and Control C26048 University of Queensland David Cliff, Nikky La Branche	250,000	Peter Smith, Centennial Coal Bharath Belle, Anglo American	There is no publicly available database or record of the typical exposures of underground coal workers to coal dust nor the factors that affect that exposure. This makes the risk management of the coal dust exposure at mines difficult. Real time dust monitoring devices are often of limited value underground because they are not certified intrinsically safe. An up-to-date information resource will be created on coal dust exposure, control technologies and their effectiveness for open cut and underground coal mines. Existing real time respirable dust monitors will be evaluated and barriers to their use identified. RISKGATE will be updated to include a specific topic on respirable dust.
New	Dustless Longwall and Development Face C26065 University of Wollongong Peter Wypych	339,700	Shayne Gillett, Centennial Coal	The re-emergence of Coal Workers Pneumoconiosis has signalled an urgent need for improvement in the control/minimisation of dust in coal mines, particularly around the longwall and development faces. To address this issue, researchers will model, develop and apply a new high-energy micro mist technology to longwall and development equipment and assess its ability to control dust in this environment.

UNDERGROUND

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Roadway Development				
Current	Polymer Based Alternative to Steel Mesh for Coal Mine Strata Reinforcement and Confinement (ToughSkin) C20041 University of Wollongong, Ernest Baafi	1,502,189	Roadway Development Task Group	A prototype ToughSkin product has now been developed that can replace steel mesh for strata reinforcement and confinement in underground coal mines. The product can be remotely applied, thereby eliminating the need for personnel in the immediate face area when used in conjunction with automated bolting systems. In this extension project, ToughSkin will undergo formal regulatory testing, an underground application methodology and parameters will be developed, geotechnical characterisation of the product will be completed and an associated geotechnical design model will be developed.
Current	HiTrack/SEBS Continuous Haulage System C23018 Scott Technology Australia, Michael Pietsch, Sean Starling	511,055	Roadway Development Task Group	A significant impediment to increasing development metres per operating hour in underground coal mines is the current reliance on shuttle cars as the interface between the continuous miner and the face and panel conveyor. ACARP is funding research into continuous haulage systems. The HiTrack – ICS system was selected as a system worthy of further research. This project addressed some of the key risks that would prevent this system from being used underground.
Current	Review of Roof Support Options for Next Generation Continuous Miners C25003 SCT Operations Winton Gale	43,000	Roadway Development Task Group	To make a significant improvement in development rates, a continuous miner system needs to be able to stabilise the roof as part of the cutting operation. Support of the face area for a machine that has the mobility of a continuous miner is the primary limitation. This project will explore the options to reduce or eliminate this limitation. Researchers will define the range of roof deformation mechanisms and the reinforcement approach required in terms of timing and location about the face; review the sensitivity of alternate roadway shapes on support requirements; and put forward a range of options which may allow decoupling of the face support requirement from the cutting cycles of continuous miners.
Current	Automated Long Tendon Installation System C25068 Conway Engineering Des Conway	184,500	Roadway Development Task Group	Achieving stable roof conditions in underground mines is a safety priority for the Australian coal industry. Cable bolts (long tendons) are one of the mechanisms commonly used to address this challenge. This project will develop a prototype 'Spinning Lobster' (Tornado) cable bolt pusher which will enable long tendons to be fully resin encapsulated thereby removing the need for post grouting. Researchers believe this technology will be the first step towards the development of an automated long tendon installation system.
Strata Control and Windblasts				
Current	Improving Cavity Prediction on Longwall Faces through a Combination of Reliable Convergence, Canopy Attitude and Leg Pressure Monitoring C21013 Golder Associates, Bob Trueman	696,625	Dion Pastars, BMA Peter Corbett, Centennial Angus Place Paul Buddery, Anglo American	Most Australian coal mines now have shield leg pressure monitoring in real time to aid the identification of potential roof control problems. However, there has been a critical load cycle feature missing, which has limited the usefulness of the monitoring. The CSIRO tilt sensor technology will be used at two mines to develop reliable precursors to cavity formation, supplementing those already existing from leg pressure monitoring. The technology will also be used to determine whether cavity prediction in longwall operations can be determined much more accurately from leg pressure, shield convergence data and canopy tilt data combined compared with leg pressure data alone.
Current	Definition of Coal Mine Roof Failure Mechanisms C23008 SCT Operations Winton Gale	430,000	Roger Byrnes, South32 Illawarra Coal Brian McCowan, Glencore	The stability of coal mine roadways is dependent on the mechanism of failure of the roof strata and the reinforcement system used. Roof instability and falls of ground can occur if the reinforcement system is inappropriate for the actual mechanism of roof failure. In this project an existing database of coal mine roof failures will be extended to include a wider range of mining environments so that the reinforcement systems can be implemented with greater understanding of the roof deformation mechanisms. State of the art monitoring equipment and analysis methods will be used to assess roadway stability and deformation mechanics.

UNDERGROUND

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Shear Testing of the Major Australian Cable Types under Different Pretension Loads C24012 University of Wollongong Najdat Aziz	389,600	Roger Byrnes, South32 Illawarra Coal Brian McCowan, Glencore Jason Emery, Rio Tinto Energy & Minerals	Australia has the largest number of different high capacity, pretensioned, post grouted cable bolts in the world. This project will shear test major cable types under different pretension loads. A megabolt single shear apparatus will be used to determine the cable shear strength values and to determine the debonded and/or decoupled cable length during shearing. Optical fibre technology, the Fiber Bragg Grating sensing system, will be used to delineate the cable debonding length.
Current & New	Convergence Based Roof Support Design C24015 PDR Engineers Terry Medhurst	196,000 current 49,800 new	Gavin Lowing, Peabody Energy Australia Brian Vorster, Glencore Roger Byrnes, South32 Illawarra Coal Paul Buddery, Anglo American	Stress-related influences and stress changes are challenging to quantify when designing roof support systems. In this extension project, researchers will assess, calibrate and extend the convergence-based roof support design approach for longwall abutment loading conditions. The availability of data from three roadway monitoring sites will enable researchers to re-evaluate the instrumented roadway data when longwall extraction occurs.
Current	Cable Bolt Performance Under Axial Loading and Subject to Varying Geotechnical Conditions C24018 University of New South Wales Paul Hagan	117,823	Peter Corbett, Centennial Angus Place Brian McCowan, Glencore Paul O'Grady, Glencore	The wide variety of performance levels across the cable bolt design spectrum makes it difficult to select the most appropriate design for specific underground environments. This project will provide definitive performance characteristics of the five major types of cable bolt design under different ground conditions – including stiffness, peak load and post peak load capacity – so the design of underground support systems can be optimised.
Current	Assessment of Longwall Mining Induced Connective Fracturing of Overburden Strata C24020 CSIRO, Deepak Adhikary	297,343	Richard Porteous, Glencore Peter Corbett, Centennial Angus Place Dan Payne, BHP Billiton	The height of connective fracturing and complete water drainage above mined longwall panels are not well understood and are strongly contested topics among industry professionals. This project will quantify the extent of connective fracturing above these panels – one of the most important parameters required to assess mining impact on groundwater. It will also expand scientific understanding of the strata caving mechanics during longwall mining and quantify the height of complete groundwater drainage above longwall panels.
Current	Review of Rib Failure Mechanisms and Performance of Rib Support C25057 SCT Operations Yvette Heritage	186,500	Roger Byrnes, South32 Illawarra Coal Paul Buddery, Anglo American Brian McCowan, Glencore	Rib failure is an ongoing occurrence in underground coal mines which has safety and longwall retreat reliability implications. Recent fatalities in underground coal mines have involved incidents of rib failure. Researchers will assess the effectiveness of current industry rib support patterns with regards to the nature of yielding through field measurement and modelling. The mechanics of rib deformation over the life of the mine will be investigated and effective support identified to control the different mechanisms of rib deformation in order to prevent rib failure.
Current	Intrinsically Safe, Integrated Wireless Communications Network with a Distributed Array of Geotechnical Sensors C25059 SCT Operations, Stuart MacGregor	339,787	Brian Vorster, Glencore Peter Corbett, Centennial Angus Place	The ability to measure ground response provides the basis for managing strata control hazards in underground coal mines. Historically the application of hard wired automatic roof deformation monitoring has been used at various mine sites with differing levels of success. This project will develop a wireless enabled strata monitoring system to interface with the intrinsically safe Holville roofAlert communications and power backbone. This will provide a rapid, robust and cost effective solution to implementing a distributed array of wireless enabled strata monitoring devices in underground coal mines.

UNDERGROUND

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Borehole Shear Monitoring Device for Routine Application in Roadways C25060 SCT Operations Stuart MacGregor	149,863	Brian Vorster, Glencore Roger Byrnes, South32 Illawarra Coal Peter Corbett, Centennial Angus Place Brian McCowan, Glencore	Traditionally inclinometers and shear strips have been used to evaluate shear along discrete interfaces in underground roadways. However probe type inclinometers and grouted casings are not suited to routine underground coal mine roadway applications. This project will develop a cost effective, intrinsically safe, routine, shear monitoring instrument for deployment in ungrouted boreholes based on MEMS tiltmeter sensors. An intrinsically safe, handheld readout unit for MEMS based tiltmeters will also be developed to integrate with TARP based implementation.
Current	Roadway Stability Monitoring System C25062 CSIRO Chad Hargrave	189,435	Jason Emery, Rio Tinto Energy & Minerals Paul Buddery, Anglo American Brian McCowan, Glencore Jim Sandford, Glencore	Structural failure of underground mine gateroads is a major safety and productivity issue in the mining industry. Roadway roof falls and rib collapses are very difficult to predict and can be extremely hazardous. This project will develop and trial a new, radar based, sensor technology for gateroad convergence monitoring. The proposed system will scan the underground roadway structure and localise key features such as roof/rib bolts, faults, guttering and other critical support or geological structures. Information regarding the relative movement of these critical structures can then be overlaid onto a location map.
New	Predict Stress State and Geotechnical Conditions Near Major Geological Structures Using Microseismic Technology and Distinct Element Modelling C26053 CSIRO, Baotang Shen, Ismet Canbulat	275,520	Coal Burst Task Group	Stress anomaly and high strain energy concentration near geological structures are often the root cause of catastrophic rock instability, such as coal burst. However predicting geotechnical conditions near major geological structures remains difficult. This project will develop an integrated method of mapping the strain energy during mining near these structures. Once the strain energy and the related stress state is known, the risk of coal burst in front of a roadway development face can then be quantified for risk control purposes.
New	Modelling of Dynamic Fracture Mechanisms for Improved Strata Control Design C26054 University of Wollongong, Jan Nemcik	197,500	Jim Sandford, Glencore Rae O'Brien, Glencore Bharath Belle, Anglo American	Due to high rock stresses, geological structures and variable rock strengths, most coal mine excavations are surrounded by extensively fractured zones that require reinforcement. Existing scientific theory and numerical models lack the understanding of shear fracture propagation in rock and, therefore, cannot simulate the development of fractures accurately. This project will deliver major changes in the conventional numerical modelling techniques of fractured ground, improve the accuracy of fracture severity and location prediction, and enhance mitigation of dynamic events in deep underground mines.
New	Measurement of Fundamental Mechanical Parameters of Coal - Poisson's Ratio and Biot's Coefficient C26061 Sigr, Ian Gray	150,000	Coal Burst Task Group David Webb, Glencore	Poisson's Ratio and Biot's coefficient are used to measure the fundamental mechanical parameters of coal, particularly for outbursts and coal bursts. Existing test methods are not effective because it is common for core to fragment during the wireline coring process. A robust means is needed to derive the value of Poisson's ratio from less than ideally shaped samples. Using the silicone resin encapsulation approach, researchers will develop a system to measure Biot's coefficient on fragmented coal samples.
New	Reliable Estimation of Horizontal Stress Magnitudes from Borehole Breakout Data C26063 University of New South Wales, Joung Oh	123,000	Rae O'Brien, Glencore	It is well known that ground stresses have a major impact upon the behaviour and stability of roofs and ribs. Changes in stress magnitude can adversely impact on mining conditions, such as increasing the risk of violent failures via coal burst. There are no universally accepted methods of estimating in situ stress magnitudes. This project will develop a reliable, simple and cost effective technique to estimate the magnitude of horizontal stress based on borehole breakout data using literature review, laboratory testing, numerical modelling and back analysis.
New	Floor Stability: Comprehensive Investigation Into Failure Mechanisms and Controlling Factors C26064 University of New South Wales Serkan Saydam	298,940	Brian McCowan, Glencore Peter Corbett, Centennial Angus Place Paul Buddery, Anglo American	Because the cause and location of coal seam floor failures are diverse, there is an absence of guidelines for geotechnical engineers that are applicable across a range of environments. A comprehensive multidisciplinary investigation will be conducted into floor failure mechanisms and controlling factors using experimental, numerical and analytical methods. A prediction model will be developed then validated against a large collection of data from different mines that have experienced floor failures. Guidelines to mitigate and/or eliminate floor failures will be presented. The guidelines will be supported by a combination of effective monitoring and instrumentation techniques, innovative mine design strategies and new ground support technologies.

UNDERGROUND

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Ventilation, Gas Drainage and Monitoring				
Current	Improved Efficiency of Gas Capture From Boreholes Under Active Longwall Panels C23009 SCT Operations Winton Gale	380,000	David Webb, Glencore Brad Elvy, South32 Illawarra Coal	The effectiveness of gas drainage boreholes during longwall operations is essential to the productivity and viability of underground coal mines. Downholes are used to intersect gas migration from the coal seams below the seam prior to it reporting to the goaf and face area. This requires an understanding of the fracture permeability, stress redistributions, gas sources, the fracture connectivity to the goaf or boreholes, and borehole stability. The aim of this project is to determine the permeability of the fracture zones, the stability of the boreholes, the flow networks established and the gas pressures at various depths in the interburden between the goaf and the lower seam/s. This information is essential to develop better systems of gas capture.
Current	High Speed In-Seam Drilling System for Effective Gas Drainage C24008 University of Queensland Mining3 , Joel Kok, Scott Adam	216,000	Brad Elvy, South32 Illawarra Coal Peter Corbett, Centennial Angus Place Jim Sandford, Glencore	Mining3's waterjet high speed drilling technology could revolutionise underground in seam drilling. The waterjet's rapid and continuous drilling eliminates the manual handling hazards associated with conventional drilling and increases drilling productivity by 100%. This two phase project addressed the technical risks through a program of targeted laboratory based work followed by a field validation trial at Wambo underground mine.
Current	Field Trials of Nitrogen Injection into UIS Directional Boreholes to Enhance Gas Drainage in Low Permeable Seams C24019 University of Wollongong, Frank Hungerford, Ting Ren	336,152	Bharath Belle, Anglo American Brad Elvy, South32 Illawarra Coal	Pre gas drainage using in seam boreholes has played a critical role in reducing high insitu gas content below threshold limits thereby allowing normal mining activities to be undertaken safely. However reducing gas content below these levels within a given drainage lead time has been challenging. This project will field prove the concept of using enhanced gas drainage by nitrogen injection into underground in seam boreholes in coal mines extracting gassy and low permeable seams. Researchers will identify the most suitable environment for this technology and associated design parameters, and will develop the operating procedures.
Current	Drilling for Outburst Risk Determination C24024 Sigra Ian Gray	380,500	Russell Thomas, South32 Illawarra Coal Andrew Lewis, Glencore Bharath Belle, Anglo American	Although gas drainage and other management techniques have reduced the incidence of gas outbursts in Australian underground coal mines, the physical impacts of particle injection and the noxious gases produced, make them extremely hazardous. This project will use underground drilling trials to retrieve coal cuttings at high speeds. The cuttings will be desorbed and a subsample crushed to yield the residual gas content. This process will provide information on the gas content, diffusion coefficient and particle size characteristics of coal samples and the volume of coal produced compared with the volume of the hole nominally cut. These measurements will then be used in conjunction with the sorption isotherm to determine outburst risk.
Current & New	Ventilation and Gas Management - Underground Coal Mines: Stage 2 C25001 Bruce Robertson Andy Self	120,000 current 150,000 new	Bharath Belle, Anglo American John Grieves, Caledon Jim Sandford, Glencore Brad Elvy, South32 Illawarra Coal	While Australian coal mine ventilation practice is world class and has improved significantly over the past few decades, the residual risks to mineworkers and assets are not as low as they could be. This project will review current ventilation and gas management practices to identify gaps and shortcomings, and then propose a range of initiatives for the industry to bolster capability and reduce ventilation risk. This will be achieved through analysis of current practice by reviewing recent publications and consulting with industry representatives.
Current	Specific Gas Emission Patterns from Different Coal Seams C25065 CSIRO Rao Balusu	277,340	Bharath Belle, Anglo American John Grieves, Caledon Jim Sandford, Glencore	Most of the current specific gas emission prediction methods used in Australia are based on European empirical methods with a number of input assumptions. For longwall emission predictions, the issue is to estimate the volume of gas that will be released from different roof and floor seams during the production phase as distinct from that released after sealing. This project will characterise goaf gas emissions patterns from different coal seams and develop appropriate gas emission prediction models for Australian mining conditions.

UNDERGROUND

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Gas Management and Risk Mitigation Strategies for Longwalls C25066 CSIRO, Rao Balusu	289,000	Bharath Belle, Anglo American John Grieves, Caledon Jim Sandford, Glencore	Gas is one of the critical factors that will constrain production in highly gassy longwall mines. To achieve high production rates in highly gassy mines, a step change in the ventilation and gas management systems and strategies is needed. This project will develop optimum goaf gas management and risk mitigation strategies for highly gassy longwall mines in order to achieve benchmark production rates.
Current	New Approaches to Mine Gas Analysis and Ratios C25072 Simtars Fiona Clarkson	103,689	Bharath Belle, Anglo American John Grieves, Caledon	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.
New	Floor Seam Gas Emission Characterisation and Optimal Drainage Strategies for Longwall Mining C26050 CSIRO, Qingdong Qu	153,075	Jim Sandford, Glencore Rae O'Brien, Glencore Bharath Belle, Anglo American	Gas emissions from coal seams are a significant issue for longwall coal mines. Both prediction and actual rates of floor gas emissions have a higher variation from actual measurements than those from roof coal seams. This is due to gas emission prediction models being based on roof strata which behave differently from floor strata. This project aims to develop a practical approach to characterising floor seam as emissions in 4D and to identify strategies for optimal gas drainage and control.
New	Optimisation of the Coal Seam Gas Predrainage Process C26058 Palaris Australia Mark Blanch	293,220	Sharif Burra, Yancoal Russell Thomas, South32 Illawarra Coal David Webb, Glencore	Significant advances have been made in drilling technology and gas pre-drainage methods since they were first implemented in Australian mines. Availability of coal seam permeability data from in situ measurements has increased over the past 15 years. Although it has the greatest impact on gas drainage performance and cost, permeability remains the most variable and poorly understood gas production parameter. In situ measurements are expensive and are regarded as an imprecise representation of the actual seam permeability. This project will assess and define the current status of gas pre-drainage design and management practices and develop a set of guidelines for this work. A protocol for the acquisition, validation and application of key gas drainage and gas reservoir parameters will also be developed.

General

Current	Use of Multi Source Long Wall Data for Operational Improvements C25055 Lucsan Capital Jamie Hodgkinson	120,000	Brad Lucke, Glencore Bharath Belle, Anglo American Peter Corbett, Centennial Angus Place Jim Sandford, Glencore	Mining operations collect large volumes of longwall data but often lack the bandwidth to systematically drive operational improvements from such data. Valuable production data is collected and stored in isolated functional systems that are not conducive to cross system data analysis and decision making. Multi source operational, geospatial and time stamped data is large in volume, time consuming to analyse and difficult for subject matter experts to use efficiently. This project explores the question: Can multi source longwall data be used cost effectively to identify commercially significant operational improvements? A candidate list of five production scenarios with complex data sets has been identified – hazard events, mine planning, longwall top coal caving, precision cutting on longwalls, and vehicle operator fatigue in open cut mining fleets.
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OPEN CUT PROJECTS

Safety, productivity and the right to operate are concerns that will continue to direct research in the open cut area. Each seems to grow in importance as the broader community and mine owners' expectations increase. Mines must achieve zero fatalities and ongoing reductions in lost time injuries if they are to continue to enjoy a right to operate.

Given the large areas impacted upon by open cut mines, it is critical that research addresses the science of rehabilitation and the minimisation of mining impacts on neighbouring communities. This priority area will continue to consume a significant component of the open cut research budget. The management of water remains a significant component of this work as does the need to stabilise overburden dumps.

COMMITTEE MEMBERS

Tony Egan	Manager, Project Governance, Coal Assets Australia (co-chair Open Cut Committee)	Glencore
Andrew Lau	Regional Technical Services Manager, Open Cut Operations Eastern Region (co-chair Open Cut Committee)	Yancoal
Shaun Booth	Resource Development	Glencore
Shaun Cleary	Projects Manager	Cobbora Holding Company
Sandro De La Cruz	Lead Mining, Major Projects - CRSC	BHP Billiton
Brett Domrow	Chief Mining Engineer	New Hope Group
Jason Fittler	Environment Manager	Anglo American
Lindsay Ford	Project Manager	Glencore
David Goodale	Open Cut Asset Management Manager - Australia & Canada	Anglo American
Ross Gooley	Environmental Superintendent	Sojitz Minerva Mining
Tim Gray	Engineering Manager - Surface Operations	Glencore
Ivan Heron	Principal Advisor Productivity Improvement	Rio Tinto Energy & Minerals
Martti Kankkunen	GM Mine Planning	Thiess
Win Klass	Senior Mining Engineer ~ OC Development & Business Improvement	Glencore
Gift Makusha	Principal Open Cut Geotechnical Engineer	Anglo American
Chris Mills	Mine Planning Manager	Goonyella Riverside Mine
Brian Neilsen	Director - Strategic Mine Planning	Peabody Energy Australia
Jacob Orbell	Acting Site Manager Meandu	Stanwell Corporation
Troy O'Reilly	Risk & Compliance Advisor, Mining Operations	Stanwell Corporation

Dan Payne	Manager Geotechnical Services	BHP Billiton
Carl Pritchard	General Manager Technical Services	Jellinbah
Stuart Ritchie	Manager - Environment, Coal Australia	Rio Tinto Energy & Minerals
Richard Ruddock	Resource Geology Manager, Coal Australia	Rio Tinto Energy & Minerals
Patrick Tyrrell	Geology Manager & SSE Resource Development	New Hope Group

FUNDING APPROVED 2016

	No of Projects	ACARP Funding	Total Funding
2016	20	\$4,931,312	\$7,559,422
2015	19	\$5,511,863	\$7,205,094
2014	18	\$4,269,996	\$15,968,495

PROJECTS UNDER MANAGEMENT 2016

CATEGORY	No of Projects	ACARP Funding
Drilling and Blasting	2	\$552,206
Environment	22	\$5,092,500
Geology	12	\$3,353,642
Maintenance and Equipment	6	\$6,670,405
Major Projects	1	\$4,229,733
Mining and the Community	1	\$239,215
Occupational Health and Equipment Safety	11	\$2,114,654
Overburden Removal	3	\$1,585,400



OPEN CUT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Major Project				
Current	RISKGATE C20003 University of Queensland David Cliff	4,229,733	Tony Egan, Glencore	An interactive online risk management system developed by MISHC using industry expertise is being used by coal industry personnel to understand and control selected major incidents. RISKGATE has 18 modules (tasks) including Fitness for Work which was completed in 2014. In this extension project, the RISKGATE team will comprehensively review all modules (cross-reference between modules, ensure consistent language and approach to issues), revise modules in response to user feedback, and convert the collision module into a vehicle interaction module.
Drilling and Blasting				
Current	Improved Blast Outcomes by Integrating Structural and Blast Modelling C23028 University of Queensland Marc Elmouttie, Sarma Kanchibotla	255,007	Vishwa Bhushan, Rio Tinto Energy & Minerals	The performance and safety of drill and blast operations could be improved if this project to produce a prototype software tool is successful. The objective of this project was to produce improved blast induced fragmentation through better blast design, based on more accurate representation of rock mass structures in blast analysis software and improved prediction and management of blast related hazards, such as face bursts.
Current & New	Alternative and Sustainable Explosive Formulations to Eliminate Nitrogen Oxide Emissions: Stage 2 C25005 University of Queensland, Mining3, Italo Onederra, Miguel Araos	297,199 current 388,133 new	Chris Bartley, New Hope Group Travis Zolnikov, Glencore Vishwa Bhushan, Rio Tinto Energy & Minerals	A novel explosive formulation based on mixtures of hydrogen peroxide (HP) and fuel has been developed to eliminate NOx fumes from coal mine blasting. This extension project aims to demonstrate that HP-based products can be safely manufactured, handled, delivered and loaded at operational amounts (1-5 tonnes per trial). Four to five targeted and controlled mine-based trials will be undertaken.
New	NOx Fume Evolution from Hydrogen Peroxide Based Hybrid Mixtures Involving Ammonium Nitrate, Sodium Nitrate and Calcium Nitrate C26025 University of Queensland Mining3, Italo Onederra, Miguel Araos	236,333	Chris Bartley, New Hope Group Travis Zolnikov, Glencore Vishwa Bhushan, Rio Tinto Energy & Minerals	Hydrogen peroxide fuel based explosives have the potential to eliminate NOx fumes. Formulations that replace the use of ammonium nitrate were studied and proven to be effective in a previous project. In this project researchers will assess a number of hybrid product mixtures which could also minimise the risk and concentration of NOx fumes. Researchers will quantify the NOx fume evolution from hydrogen peroxide based hybrid mixtures involving nitrates of ammonium, calcium and sodium.
Environment				
Current	Sustainable Management of Plantations for Rehabilitation, Carbon and Wood Products C20015 NSW Department of Industry Georgina Kelly	187,068	John Hindmarsh, Rix's Creek Bill Baxter, Rio Tinto Energy & Minerals	Since 1999 a number of replicated research trials have been established on mine lands in the Hunter Valley, to assess the viability of tree plantations as a post mining land use and to assess the economic and environmental benefits of buffer land planting. This project will quantify the benefits of early thinning (year 10) and maximise the long term survival and health of these trials. It will also provide data mid rotation (15 years), at which stage final growth projections are much more reliable. The growth data will allow longer term yields to be estimated, ensuring that mines have a sound basis upon which to make decisions on species, location and management of future stands.

OPEN CUT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	<p>Hydraulic Connectivity Between Mines and Adjacent River and Groundwater Systems in the Hunter River Valley C20022</p> <p>University of Queensland Detlef Bringemeier, Ling Li</p>	377,810	<p>John Watson, Glencore Andrew Speechly, Rio Tinto Energy & Minerals</p>	<p>This project will improve the understanding of the hydraulic connectivity between mines and adjacent river and groundwater systems in the Hunter River Valley and other Australian coal mining regions. It developed a set of criteria for assessing the mining impact on the rivers and aquifers. The work combined mathematical modelling and field measurements of key hydrogeological and hydraulic parameters within the study area. A mathematical model was developed to simulate the interactions between the mines and adjacent aquifer systems.</p>
Current	<p>Tool to Assess Mining Impacts on River Condition C21031</p> <p>Central Queensland University Claire Sellens</p>	325,945	<p>Craig Lockhart, Peabody Energy Australia Stuart Ritchie, Rio Tinto Energy & Minerals</p>	<p>The management of mining impacts on rivers and other aquatic ecosystems at a local and regional level is a key priority for the coal industry. The industry needs to be able to accurately monitor and assess its onsite and downstream impacts on water quality. Existing guidelines and predictive models for river health are not suitable for assessing mine site impacts because they are typically determined from steady state conditions. This project is developing a region specific tool for assessing the condition of temporary streams on Central Queensland mines. Changes to the macroinvertebrate communities during the wet and dry cycles are being examined to determine the effect of change on aquatic health assessments, a predictive modelling tool for assessing river health is being developed, and the feasibility of alternative approaches to assessing the health of streams is being explored.</p>
Current	<p>Managing Dig: Ensuring Currency in an Invaluable Resource C22026</p> <p>University of Queensland David Mulligan</p>	137,520	<p>Ann Perkins, Rio Tinto Energy & Minerals</p>	<p>The Dig coal mine rehabilitation bibliographic database was developed to provide industry, government, researchers and other interested parties with reference information relevant to the rehabilitation of land after coal mining. In order to enable ongoing use and to maximise its value, continual updating, maintenance and improvements are necessary. This project further improved the technology, features, searchability and provision of knowledge in the database, with ongoing emphasis on the uploading of new material and general maintenance.</p>
Current	<p>Salinity Tolerance of Freshwater Organisms from the Southern and Western Coalfields C23010</p> <p>University of Queensland Sue Vink</p>	177,000	<p>Bernie Kirsch, Centennial Coal Gary Brassington, South32 Illawarra Coal</p>	<p>Mine water releases are regulated by salinity (measured as electrical conductivity), pH and concentration limits for a number of other constituents, including heavy metals. Local guidelines should be developed from tests conducted using locally collected organisms and tests solutions that have a composition similar to natural stream waters. The overall objective of this work was to produce toxicity datasets for the Southern and Western coalfields in New South Wales that can be used to develop local salinity guidelines. The work was conducted using field caught and laboratory reared organisms tested with artificial mine water solutions diluted with artificial creek waters. This method removes the confounding effects of other constituents that may be toxic and present in mine water solutions.</p>
Current	<p>Stygofauna in Australian Groundwater Systems: Extent of Knowledge C23019</p> <p>CSIRO Olga Barron</p>	49,800	<p>Bernie Kirsch, Centennial Coal</p>	<p>An alternative to Mecca style drill rods is needed for underground in seam drilling. Not only would the development of a high speed, compliant, wireless communication technology provide an alternate communication system for underground in seam drilling that would enable a wider range of enhanced geological surveying technologies to be used, but it would provide improved safety and would significantly reduce operating capital costs. Building on earlier research, this project developed the concept into a high performance prototype. As part of this work, preliminary assessments for regulatory compliance were conducted, the prototype was demonstrated in an underground in seam borehole at depths of 600 metres, and a business case and commercialisation strategy developed.</p>
Current	<p>Coal Pit Lake Closure by River Flow Through: Risks and Opportunities C23025</p> <p>Edith Cowan University Mark Lund</p>	362,714	<p>Colm Harkin, Premier Coal Scott Diggles, Rio Tinto Energy & Minerals</p>	<p>Many Australian coal mines have pit lakes that will increase in salinity over time due to evapo concentration. Increased catchments and river diversions may offer opportunities for these saline pit lakes to reduce or maintain their salinities. One way of substantially increasing the pit lake's catchment is to connect the lake to a river or stream. This scenario was field demonstrated at Lake Kepwari, where benefits to biodiversity and water quality as a result of a river breach were noted. In addition to assessing the environmental impacts of this process, the project is developing a national standard protocol for monitoring seasonal rivers that could be applied by the coal industry to manage river flow throughs (either accidental or planned), as part of a mine closure strategy.</p>

OPEN CUT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	<p>Reducing Analytical and Water Quality Monitoring Costs Using Diffusive Gradients in Thin Film Technique C23027</p> <p>University of Queensland Sue Vink</p>	163,000	Claire Cote, Anglo American John Merritt, Burton	Environmental authorities of Bowen Basin mines require considerable investment in manual water sampling and analysis for dissolved heavy metals and arsenic. Water sampling for analysis of metal and metalloid concentrations is required upstream and downstream of the mine during water releases. This project evaluated a new time integrated approach to assessing water quality in the Fitzroy catchment. The novel in situ sampling technique – diffusive gradients in thin (DGT) films – could potentially replace numerous water samples and will provide a far more representative view of in steam concentrations over the deployment period.
Current	<p>Collaborative Performance Trajectories for Diversion Licence Relinquishment C23030</p> <p>Alluvium Consulting Australia Rohan Lucas</p>	204,470	Scott Diggles, Rio Tinto Energy & Minerals Claire Cote, Anglo American John Merritt, Burton	Currently there are no clear river/creek diversion criteria that enable the mining industry, regulators and stakeholders to track diversion conditions and understand the measures required to achieve licence relinquishment. Researchers worked with the mining industry and the Queensland DNRM to develop a process and terms of reference for stakeholder involvement in diversion licence relinquishment, to establish physical form and vegetation criteria, and trial a combined social and scientific approach to defining and assessing outcomes for diversions at licence relinquishment.
Current	<p>Pilot Scale Integrated Forward and Reverse Osmosis System for Mine Water Reuse C23031</p> <p>CSIRO Ramesh Thiruvengkatachari</p>	258,237	John Watson, Glencore Claire Cote, Anglo American	This project offers the coal industry a novel, cost effective desalination technology that produces higher water recovery and reduction in mine site brine storage volumes. A laboratory scale, osmotically driven process (the driving force for water transfer across a membrane is osmotic instead of hydraulic pressure) has been integrated with a reverse osmosis unit to treat mine affected water, producing a steady stream of reusable quality water, thereby eliminating extensive pre treatment steps that are generally required for reverse osmosis. This project developed a pilot scale, integrated treatment system that can process 1m3 of water per day and completed a preliminary technical and economic assessment of the technology.
Current	<p>Real Time Mine Specific Upper Air Data For Use In The Management of Mine Noise, Dust, Blast Fume and Overpressure C23032</p> <p>Todoroski Air Sciences, Aleks Todoroski</p>	165,160	John Watson, Glencore Andrew Speechly, Rio Tinto Energy & Minerals	Real time, upper air data is needed at coal mines because standard onsite weather stations cannot provide the necessary data on upper air weather conditions which affect the transport of emissions or the propagation of noise from mine sites. Useful real time and predictive systems cannot be developed without such data. This project verifying whether upper air data soundings in a central location can be used to provide accurate, real time upper air weather data specific to each mine in a region. If so, a framework will be provided to roll out cost effective, real time and predictive systems in any region.
Current	<p>Study of Sustainability and Profitability of Grazing on Mine Rehabilitated Land in the Upper Hunter C23053</p> <p>NSW Department of Industry Lester McCormick, Neil Griffiths</p>	200,000	Bill Baxter, Rio Tinto Energy & Minerals Nigel Charnock, Glencore	The grazing capacity of rehabilitated pastures is not yet fully known and, in many cases, results and grazing benefits have not been fully documented. This project is addressing the community concerns through a grazing study on two mine sites in the Upper Hunter Valley. The mines are providing two areas which have been mined and rehabilitated and two analogue (native) pasture sites. The four sites will be fenced to allow grazing by four herds of weaner steers (10 head per site). The data collected will be used to analyse the sustainability of the study area and will be compared with data collected from the analogue sites. Animal health and weight will be a significant focus of the project. Stakeholders and regulators are involved in the development and implementation of the study.
Current	<p>Development of a Toolbox for Fish Health Assessment in Aquatic Ecosystems Associated With Coal Industries C24029</p> <p>Central Queensland University Nicole Flint, Sue Vink</p>	97,740	Claire Cote, Anglo American	The Fitzroy Basin communities consider water and the associated riverine ecosystems to be key environmental assets, and they require an assurance that mining companies can manage and mitigate their environmental impacts. This project will develop practical indicators of fish health that are applicable to monitoring in coal mining regions, thereby helping to improve overall aquatic ecosystem health assessments and informing regional water management.

OPEN CUT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	<p>Verification of the Vertical Distribution of Dust from Mining Activities C24030</p> <p>Advanced Environmental Dynamics Darlene Heuff</p>	361,140	Kris Sheehan, BMA John Watson, Glencore	Results from dust dispersion models are heavily relied upon during the approvals phase of mining projects to assess potential for adverse dust impacts on human health. This project aims to give the mining industry and regulators increased confidence in the results produced by dust dispersion models by validating and improving the methodology applied to open cut mines. Researchers will collect continuous field data over 12 months, providing a far wider range of atmospheric conditions than would be achieved through short term, campaign based field programs.
Current	<p>Cost Efficient, Empirically Based Framework Using Integrated Datasets to Demonstrate Rehabilitation Quality C24031</p> <p>University of Queensland Peter Erskine</p>	297,484	Pieter Swart, Glencore Paul Veivers, Stanwell Corporation Bernie Kirsch, Centennial Coal	Current methods of monitoring and assessing open cut coal mine rehabilitation are costly and time consuming. Detailed airborne imagery can cover large areas in one snapshot and, if processed automatically, may be a cost effective tool for mine rehabilitation assessment. This project seeks to develop a common, cost effective framework, informed by empirical data, to assess rehabilitation quality that is focused on assessing relinquishment risk. As part of this work researchers will develop an automated system to detect changes in mine rehabilitation conditions that flags areas for ground investigation.
Current	<p>Applying Risk Based Principles of Dispersive Mine Spoil Behaviour to Facilitate Development of Cost Effective Best Management Practices C24033</p> <p>Verterra, Glenn Dale, Steven Raine</p>	476,104	Ross Gooley, Sojitz Minerva Mining Jason Fittler, Anglo American Craig Lockhart, Peabody Energy Australia Stuart Ritchie, Rio Tinto Energy & Minerals	A significant number of Bowen Basin coal mines have dispersive spoil which makes rehabilitation difficult and costly. The liability for rehabilitating these dispersive spoil dumps is around \$3 billion. However, there is no definitive guideline or best management practices for the application of consistent, reliable, proven and cost effective approaches to managing dispersive spoil. To address the issue, researchers will develop a set of best management practices, risk based decision tools and a framework, and a process for understanding the trade offs between risks and costs.
Current	<p>Incorporating Salinity into the Source Catchments Model for the Fitzroy Basin C24036</p> <p>BMT WBM, Damion Cavanagh, Nathan Johnston, Tony Weber</p>	304,000	Steve Downes, Glencore Scott Diggles, Rio Tinto Energy & Minerals John Merritt, Burton	High salinity in freshwater catchments impacts upon freshwater organisms and ecosystem health, as well as other environmental values such as suitability for drinking water, livestock watering and crop rotation. How saline mine water releases relate to broader catchment salinity issues within the Fitzroy Basin is not well understood. This project will use the Fitzroy Basin Source Model and previous modelling and research to produce a model for salinity processes in the Fitzroy. This information will then be incorporated within the source model to provide a platform for assessing future scenarios and the effectiveness of management actions.
Current	<p>Quantifying Coal Dust in Urban Samples C24038</p> <p>CSIRO David Wainright Graham O'Brien</p>	176,765	Stuart Ritchie, Rio Tinto Energy & Minerals Tim Manton, South32 Illawarra Coal Bernie Kirsch, Centennial Coal	Coal dust can be generated during mining, transportation and coal usage. Although coal is often only one of the constituents present in dust near towns, along rail corridors and at ports, there is a general perception that all black dust is coal and that a high proportion of the dust is respirable. This project will use CSIRO's coal grain analysis system to analyse samples provided by residents in urban areas who are concerned with coal dust accumulation at their properties. In addition, researchers will develop a procedure for analysing and reporting results for community supplied dust samples which are not only scientifically rigorous, but are also accepted by the general community. Free image viewing software will be developed and provided community members with the analysis results.
Current	<p>'MRC Wiki' Mine Rehabilitation and Closure Knowledge Management Platform - Implementation for Central Queensland Coal Mines C24067</p> <p>University of Queensland, Corinne Unger</p>	176,900	Craig Lockhart, Peabody Energy Australia Stuart Ritchie, Rio Tinto Energy & Minerals	The original project identified Wiki as the most suitable tool to address the mine rehabilitation knowledge management needs in the Central Queensland mining region. In this extension project, CMLR will develop a mine rehabilitation and closure wiki (MRC Wiki) to provide access to a live repository of CQ coal mine specific rehabilitation practice information. Providing a platform for uploading information and holding discussion forums which can be managed by a regional practitioner network enables the new system to be kept alive, driven by users and information needs as they evolve over time.
Current	<p>Guidelines that Address Uncertainty in Coal Mine Pit Void Closure C25030</p> <p>Amanzi Consulting, Dave Salmon</p>	122,200	Pieter Swart, Glencore Jason Fittler, Anglo American Hayden Leary, Qcoal	The closure of open cut mine voids to ensure safe, physically stable, non polluting post mining land uses is a challenging process. This project will provide guidelines aimed at reducing the uncertainty of regulator and community acceptance of rehabilitation actions by a mine. Guidelines will be produced that will allow outcomes based approaches for closure options, inform residual risk discussion and will be such that relinquishment of pits voids could be achieved.

OPEN CUT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Closure Criteria for River Diversions: An Alternative to Reference Sites C25031 Edith Cowan University Melanie Blanchette	232,293	Digby Short, Ashton Coal John Watson, Glencore	The use of reference sites for establishing closure criteria in areas disturbed by mining activities (such as river diversions) is accepted by regulators across Australia. Sites are considered rehabilitated when their condition approximates that of a natural co-occurring reference site. However, this approach often creates unrealistic targets for miners seeking to close rehabilitated lands. In this project researchers will evaluate a new, more achievable approach to the closure of mine sites by comparing rehabilitated sites to the natural variability of the local environment, rather than specific reference sites. The outcome of this new approach to closure criteria will allow miners to create realistic and definable targets for relinquishing rehabilitation land, potentially simplifying closure and project approvals.
Current	Long Term Salt Generation from Coal Spoils C25039 University of Queensland Mansour Edraki Neil McIntyre	239,150	Scott Diggles, Rio Tinto Energy & Minerals Claire Cote, Anglo American John Merritt, Burton	Coal mine spoil has the potential to contribute significant salt loads to final voids where there is out of pit emplacement to the surface and groundwater receiving environment. Existing models used to provide information on final void water quality and post mining residual risks to surface and groundwater quality are limited by confidence in the data underpinning salt generation rates and duration. This research will develop estimates of long term salt generation rates for sampled classes of coal mine spoil piles that can be used in conjunction with water balance models to predict long term final void salinity levels or the residual risk to receiving surface water or groundwater environments. A process for improving the precision of estimates and the extension to additional classes of spoil piles will also be developed.
New	Managing Environmental Risks Effectively Post Rehabilitation for all Stakeholders C26018 University of Queensland Jonathan Fulcher	63,000	Stuart Ritchie, Rio Tinto Energy & Minerals Patrick Tyrrell, New Hope Group John Merritt, Burton	Obtaining progressive rehabilitation certification and final surrender of coal mining leases in Australia is problematic. This project will identify regulatory options and recommend practical solutions for overcoming the obstacles to progressive certification. The focus will be on reforms that will enable mined land to be returned to the community for economic land uses that are consistent with the character of the local area, while providing improved certainty for government, landholders and coal miners. Options for a more consistent national approach will also be presented.
New	Prediction of Long Term Erosion at Pit Walls C26019 Henderson Geotech Sue Henderson	90,000	Gavin Lowing, Peabody Energy Australia Jason Fittler, Anglo American Ross Gooley, Sojitz Minerva Mining	Landscape evolution models have been developed to predict how erosion affects the land and how it continues over time. However, input parameters for these models are derived from correlations and back analyses. This research will determine the factors that need to be managed to limit erosion impact and will provide a basis for estimating the effect of highwall and endwall erosion on the final void stability and footprint. The extent of erosion behind existing pit walls will be measured and correlated to possible contributing factors including rehabilitation treatments. A landform evolution model will then be used to extrapolate erosion effects into the long term.
New	Coal Mine Particulate Emission Factor Validation C26024 Pacific Environment Operations Judith Cox	133,794	Andrew Speechly, Rio Tinto Energy & Minerals John Watson, Glencore	Concern about the accuracy of calculating air emissions, particularly the potential for overestimation of mining related particulate matter emissions, is the impetus behind this project. Researchers will update the Upper Hunter Air Quality Particle Model with the Australian specific PM10 and PM2.5 emission factors, material properties and control factors. The Upper Hunter Air Quality Particle Model is the first dispersion model explicitly developed for the region that encompasses all active coal mines. This project aims to demonstrate that the particulate emission factors developed through previous projects can be used to improve atmospheric dispersion modelling performance against actual observations. This will provide further evidence that the particulate emission factors are applicable to the Australian mining industry and should be adopted as industry standard.

OPEN CUT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
New	<p>Eco Toxicological Approach to Validate the DGT technique to measure Bioavailable Metal Concentrations and Deriving Water Quality Trigger Values for the ANZECC Guidelines C26027</p> <p>University of Queensland Trang Huynh</p>	170,500	<p>Andrew Lau, Yancoal Scott Diggles, Rio Tinto Energy & Minerals Claire Cote, Anglo American</p>	<p>During periods of high flows, mining operations located within the Fitzroy River Basin are permitted to release mine affected water to the receiving environment in accordance with the conditions in their environmental authority. The mines are required to sample water daily at specific compliance locations for analysis of a range of analytes, including total and dissolved metals. This project will validate diffusive gradients in thin film (DGT) measurements an alternative means of measuring bioavailability metal concentrations. It will also assess the potential for the DGT technique to address the test for bioavailable metal concentrations as required in the ANZECC decision tree.</p>
Geology				
Current	<p>Reliable Geotechnical Stability Assessment for Very High Spoil Dumps C20019</p> <p>University of Newcastle John Simmons, Stephen Fityus</p>	486,500	<p>Jack Krajewski, Rio Tinto Energy & Minerals Sarah Bligh, Thiess Shaun Booth, Glencore</p>	<p>Existing procedures are inadequate for the design of very high dumps because they introduce significant uncertainties into risk assessments of instability hazards for life-of-mine plans. This project provided geotechnical specialists with shear strength, groundwater pressure, and recommended stability assessment procedures for designing very high spoil dumps, greater than 120m, with adequate safety. These outcomes will be published and explained to practitioners at targeted workshops.</p>
Current	<p>Energy Adsorption Collisions between Ultra Class Haul Trucks and Windrows C21032</p> <p>University of Newcastle Anna Giacomini, Klaus Thoeni</p>	382,715	<p>Sarah Bligh, Thiess Brett Domrow, New Hope Group Shaun Booth, Glencore</p>	<p>Existing approaches to designing energy absorption safety barriers (safety berms) are not adequate for the new generation of large (ultra class) haul trucks. Because full scale on site testing is not possible due to safety issues, researchers will use numerical modelling to simulate trucks impacting safety berms at various velocities and approach angles. The outcome will be more rigorous guidelines for the design of safety berms on haul roads that cater to ultra class trucks travelling at high velocity.</p>
Current	<p>Tertiary Volcanic Fields of Eastern Australia: Implications for Mining and Coal Quality C22023</p> <p>University of Queensland Charles Verdel</p>	179,250	<p>Richard Ruddock, Rio Tinto Energy & Minerals Greg Jones, JB Mining Kirk Henderson, Peabody Energy Australia John Simmons, SGRS</p>	<p>Tertiary volcanic fields cover significant portions of the coal basins in eastern Qld which has implications for coal production and exploration. These lavas and their intrusive equivalents impede seismic exploration, impact coal quality and create geotechnical challenges. This project aimed to address these issues through field and laboratory work that concentrates on lavas and intrusions from mines in this region. Samples from mines, natural outcrops and drill core were used.</p>
Current	<p>Regional Stratigraphic Framework for the Rangal-Baralaba-Bandanna Coal Measures in the Bowen and Galilee Basins C22028</p> <p>University of Queensland Joan Esterle, Renate Silwa</p>	288,800	<p>Richard Ruddock, Rio Tinto Tim Buddle, Anglo American Barry Lay, BMA Patrick Tyrrell, New Hope Group</p>	<p>The ACARP Supermodel 2000 project provided a regional context in which to develop predictive models for overburden geotechnical behaviour in mines operating in the Moranbah-German Creek coal measures. Mining conditions in the Rangal, Baralaba and Bandanna coal measures are varied and, in places, structurally complex. This project will develop a regional stratigraphic framework for the Rangal-Baralaba-Bandanna coal measures in the Bowen and Galilee basins. The links between gross sedimentary trends and geotechnical properties will be developed and catalogued, along with controls on the distribution of thick stacked coals, and type and degree of structure deformation. The output will be a 'go to' reference for the industry that will improve the understanding of the key aspects of Australia's coal basins.</p>

OPEN CUT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Rockfall Hazard Matrix For Risk Reduction In Mine Sites C23026 University of Newcastle, Anna Giacomini, Federica Ferrari, Klaus Thoeni	259,590	Mark Sjoberg, Rio Tinto Energy & Minerals Gift Makusha, Anglo American Jordan Wilson, BMA Sarah Bligh, Thiess Shaun Booth, Glencore	Rock falls represent a serious hazard in open cut mines, threatening human lives, machinery and portal structures for underground entry located at the toe of highwalls. A set of tools specifically designed for coal mining environments were developed to provide practitioners with more rigorous guidance on rock fall management strategies. The procedure incorporating field observations (historical records), mitigation measures, established analytical and numerical tools (empirical run outs estimates, rock fall trajectory simulation), and the latest research developments in rock fall hazard assessment and zoning (3D photogrammetry, block modelling and intensity frequency matrix). This work should help mine personnel to generate hazard zoning maps that can be regularly updated and site specific matrices of mitigating measures.
Current	Supermodel 2015 - Fault Characterisation in Permian to Jurassic Coal Measures C24032 University of Queensland Joan Esterle, Renate Sliwa	316,730	Richard Ruddock, Rio Tinto Energy & Minerals Matt Grant, BHP Billiton	The series of Supermodel projects have developed a regional stratigraphic framework for the Rangal and the Moranbah coal measures and their equivalents in the Bowen and Galilee basins. This project will build on that work by providing detailed characterisation of fault structures in the context of basin evolution, overprinting events, and past and present day stress regimes.
Current	Rotary Air Blast Drill Rig Top of Coal Detection While Drilling: Phase 3 Production Prototype C24064 University of Queensland Mining3, Enver Bajram, Scott Adam	245,000	Vishwa Bhushan, Rio Tinto Energy & Minerals Andrew Denman, BMA Kirk Henderson, Peabody Energy Australia	It is widely accepted in the coal industry that accurate control of overburden blast hole depth can significantly improve mine profitability through reduced coal loss and dilution. Ideally, blast holes would be drilled to a predetermined stand off from the top of coal interface; however, the current techniques for seam mapping do not provide an accurate surface profile at the local scale required for effective stand off control. The aim of this project is to complete pre commercial development of a measurement while drilling system that can accurately detect the top of coal interface while routinely drilling blast holes, prior to the interface being reached by the drill.
Current	Guidelines for Estimating Rock Mass Strength from Laboratory Properties C25025 University of New South Wales Ismet Canbulat, Marc Ruest	396,685	Gift Makusha, Anglo American Gavin Lowing, Peabody Energy Australia Dan Payne, BHP Billiton	A successful mine geotechnical design requires a thorough understanding of the geological conditions and properties of the rock mass at the relevant problem scale. In this project researchers will use rock mass classification methods to guide the reduction of laboratory strengths to appropriate field values and synthetic rock mass (SRM) to further guide and validate the methodology developed. The SRM approach will be used to accurately and completely characterise the mechanical properties of Australian coal measures and the mechanics of behaviour observed in situ. Researchers will also identify under what geotechnical conditions rock mass strength is not the dominant factor governing stability and when structural control becomes the key issue.
Current	XCT Prediction of Breakage and Washability from Bore Cores C25027 University of Queensland Anh Nguyen	200,000	Stella Martinez, BHP Billiton Richard Ruddock, Rio Tinto Energy & Minerals Patrick Tyrrell, New Hope Group Shaun Booth, Glencore	Xray computed tomography (XCT) is a non destructive method of characterising borehole coal samples that is also environmentally safe, fast and cost effective. This project will extend the use of the developed non destructive XCT to characterise different coal constituents (bands of bright, dull coal and stones) of borehole coal samples for mine planning, for processing strategy, and for exploration of new coal deposits.
Current	Coal Quality by Analysis of Scanned Images C25028 University of Queensland Emmy Manlapig	205,600	Noel Pranoto, BMA Justin Manalo, BMA Mark Laycock, Glencore Richard Ruddock, Rio Tinto Energy & Minerals Patrick Tyrrell, New Hope Group	Knowing the nature of the coal enables its processing properties to be predicted, such as size distribution, washability and product quality. A method called regional estimation of geoscience information (REGI) has been developed to apply the images derived from hyperspectral scanning to map the processing attributes for each portion of the drill core sample. The objective of this proof of concept project is to test the core imaging technique and the associated REGI method as a rapid, non destructive method for characterising the processing attributes and the product quality including rank, type and grade for drill core samples.



OPEN CUT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Coal Subsurface Mapping for Open Cut Selective Mining C25035 CSIRO Andrew Strange	182,772	Brett Domrow, New Hope Group	There is a need for a reliable coal seam sensing system to provide selective mining capabilities for open cut mining operations. Currently operators are required to manually adjust the material extraction depth based on cues, such as sight or vibration as the machine cuts the strata. This project aims to develop a prototype subsurface survey system that can measure coal thickness from the top of the coal surface down to the coal interburden interface. The system will enable advanced planning of the extraction process and provide selective mining/waste removal capability to the operators in the cab.
Current	Shear Strength Characterisation of In Pit Mud to Ensure Low Wall Stability C25040 University of Queensland Adrian Smith, David Williams	210,000	Gavin Lowing, Peabody Energy Australia Shaun Booth, Glencore Leigh Bergin, BHP Billiton	Removing extensive deposits of mud from previously flooded open cut mining pits is very expensive. Working at Bowen Basin mines that have been flooded, researchers will identify spoil and floor materials that do not require removal prior to the spoiling because they do not substantially degrade on wetting up and are, therefore, unlikely to promote low wall spoil pile geotechnical instability.
New	Real Time Prediction of Coal Top Through Guided Borehole Radar Wave Imaging for Open Cut Blasthole Drilling C26022 CSIRO Binzhong Zhou	210,985	Troy O'Reilly, Stanwell Corporation	Damage to the top of coal seams caused by incorrect blast stand off distances is a significant cost to the Australian coal industry. Mapping the top of the coal seam using drilling and pierce point logging is expensive due to the high number of boreholes required, and the results can be inaccurate. This project will develop a new method to reduce blast damage to coal seam tops based on the guided-BHR-wave technique. The outcome of this work will be a real-time guidance system for blast hole drilling that leaves a one metre thick protective layer of hard rock above the seams, thereby reducing coal damage and resource loss.
New	Borehole Data Standard: Final Phase C26023 GeoCheck Brett Larkin	87,500	Angus McIntyre, Rio Tinto Energy & Minerals Patrick Tyrrell, New Hope Group Malcolm Ives, Centennial Coal	CoalLog is the Australian Coal Logging Standard. It was published in 2012 and includes data entry sheets and standard code lookup tables for header, drilling, lithology and geotechnical data as well as a format for the transfer of the data. However, the standard does not yet include all data types. This project will complete the standardisation of data collected in coal exploration programs, thereby further enhancing the management, transferral and long term archival of coal geological data. The project will also establish a methodology for compliance certification for CoalLog in the form of a no cost public domain computer program.
New	Controls on Fluorine and Phosphorus Distribution in Bowen Basin Coals C26029 University of Queensland Joan Esterle	141,050	Chris Stanford, Peabody Energy Australia Richard Ruddock, Rio Tinto Energy & Minerals	Reduced fluorine tolerances on imported coals has meant that Australian producers need to better understand the occurrence and distribution of fluorine within their coals. This project will systematically analyse phosphorus, fluorine and other major and trace elements in Late Permian coals in the Bowen Basin. Conceptual models will be tested for the occurrence and distribution of these elements within a coal measure or seams. Improving the predictability of these elemental distributions will help to improve blending scenarios and scheduling, refine resource estimation methodology and facilitate the generation of beneficiation processes.
New	Improved Structural Mapping of Pit Walls using UAV Based Mobile Laser Scanning C26030 University of New South Wales Simit Raval	96,068	Adrienna Brown, Thiess Brian Vorster, Glencore	It is difficult to map the structure of low and highwalls in open cut mines at the correct textural and spatial scales for geotechnical analysis and early warning of slope failure. The development of miniature and light weight mobile laser scanners such as LiDAR systems have made it possible to create a rapidly deployable monitoring system by mounting the technology onto an unmanned aerial vehicle or drone. This new UAV borne mobile laser scanning system has the potential to be more cost effective, accurate, occlusion free and efficient for mapping the pit walls compared with existing methods. This project will track surface movements by integrating a state-of-the-art LiDAR system on a UAV platform with conventional pit wall stability monitor systems.

OPEN CUT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
New	Autonomous Sensors for Evaluation of Groundwater in Spoil Dumps and Tailings Dams: Phase 1 C26032 University of Queensland Mining3, Fernando Vieira	349,760	Martyn Robotham, Rio Tinto Energy & Minerals Kim Peckett, Mt Arthur Coal	The geotechnical integrity of a mine spoil dump or tailings dam can be irretrievably weakened by abnormal pore pressures induced by ground water permeating the embankment or the foundation of these structures. It is difficult to monitor the onset of this type of unwanted ground water dependent responses using ground monitoring technology. This project will design and develop a wireless sensor prototype to determine the groundwater pressure and flow throughout a spoil dump or tailings dam.
New	Geotechnical Hazard Awareness and Training Videos C26033 University of New South Wales Ismet Canbulat Marc Ruest	92,000	Gavin Lowing, Peabody Energy Australia Adrienna Brown, Thiess Brian Vorster, Glencore	A geotechnical hazard awareness training and language support video – Unearthing Black Gold – was developed by the Australian Centre for Geomechanics in 2004 for open cut coal mine workers. This video will be updated using the latest technology in animation and visualisation. New geotechnical and operational risk modules will also be included. Although the final topics will be decided at industry wide workshops, the topics will fall under one of the following general areas: operational hazard identification and control, mine practices, processes and systems, equipment. The new video is targeted at operators, deputies, open cut examiners, supervisors and planning engineers.
New	Measurement of the Deterioration of Coking Properties in Bore Cores via Different Storage Methods with Time C26034 McMahon Coal Quality Resources Chris McMahon	151,000	Richard Ruddock, Rio Tinto Energy & Minerals	Accurate evaluation of coking coal parameters at the exploration stage is critical to a coal's marketability and sale price, and estimations of coal resource and reserves. The measurement of a coal's coking potential is known to deteriorate with time and under different physical conditions for different coal types. This project will evaluate critical coking tests at the bore core stage and determine the effects of time and other physical conditions on coking properties. Formulae will be devised to quantify losses in coking effects based on method of storage, other physical effects and chemical criteria, and recommendations will be made on the best methods of handling bore cores.

Maintenance and Equipment

Current	DC Motor Duty Meter C16030 Mining3 Galina Mirzaeva Terry Summers	551,066	Tony Egan, Glencore	The approach being taken through this project is different from most maintenance management in that rather than watching for a manifestation of deterioration and trying to locate the cause, this project is tracking possible "cause" and is maintaining a work record. The approach taken is to relate the motor condition to its duty rather than to faults, hence the title 'DC Motor Duty Meter'. This work should lead to motors being changed out when they need to be rather than when they are scheduled to be. The completed stage one of the project examined current distribution in the brushes and the magnitude of the load and its dynamics. This next stage the focus is on the digital drive, the commutator surface temperature and the mechanical vibration of the motor case and brush holders.
Current	Automated Swing Loading System for Electric Mining Shovels C16031 CRCMining Ross McAree	4,809,907	Andrew Walker, Wesfarmers Resources Geoff Gribble, Wesfarmers Resources Limited Wayne Clement, Glencore Hans Hayes, Anglo American Tony Egan, Glencore	The fourth phase of this project further developed and demonstrated an automated digging system for electric mining shovels, building on work completed already in the shovel load assist project (SLAP). Conceived as truck loading 'at the press of a button', the project will use terrain mapping technology and a digging and multi-pass loading control system that will plan and execute digs that are efficient, safe and robust. The system also quantified shovel performance in terms of machine productivity, dipper payloads, shovel cycle times and achieved load distribution in the truck.
Current	Powerlinkoz High Voltage Electrical Connection System (PLO) C20030 Connec, John Keir	450,000	Barrie Alley, Centennial Coal David Lincoln, Centennial Coal Tony Egan, Glencore	The existing high voltage cable plugs are prone to fault and connection failures and are difficult to handle. This project will improve the safety, reliability and operability of a part of the systems of cables, plugs and receptacles that provide electrical power to mining equipment. The proposed plugs will make greater use of alternative light weight materials in construction.

OPEN CUT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	AC Motor Duty Meter for Excavating Machines: Part 2 C24035 University of Newcastle Galina Mirzaeva	156,467	Tony Egan, Glencore	Off the shelf condition monitoring tools for AC motors typically diagnose motor condition by analysing vibrations, electric current or magnetic leakage flux in frequency domain. However, the process is disruptive to normal equipment operation. By using internal sensor instrumentation with miniature Hall Effect flux sensors inside the motor air gap, researchers expect to overcome this issue. As part of this project an AC duty meter prototype was developed for diagnosing and predicting three major groups of faults.
Current	Mining Truck Tyre Integrity Monitoring C25034 CSIRO Garry Einicke	162,965	Brian Mahar, BMA Ivan Heron, Rio Tinto Energy & Minerals	'Zipper' failure is the name given to the rupture of a tyre wall due to rapid progressive rupture of cords within a tyre's structural carcass or casing. This phenomenon has led to the explosive failure of tyres which has been responsible for injuries and fatalities at Australian coal mines. In December 2014, Queensland's Central Coroner recommended that mines introduce an annual process to ensure that tyres are operated within their design parameters and that every tyre undergoes integrity testing. However there is no tyre integrity testing technology available. This project will develop portable technology for automatically diagnosing the structural integrity of mine truck tyres, develop an analysis or engineering method to establish the level of deterioration where the tyre should be discarded, and transfer the developed technology to a commercial partner for use at mine sites.
Current	Dynacut Fundamental Development and Scalability Testing C25041 University of Queensland, Mining3, Brad Neilson, Dihan Tadic, Steve Powell	540,000	Ivan Heron, Rio Tinto Energy & Minerals	Dynacut technology enables the excavation of hard rock using comparatively small and lightweight equipment as a continuous process in surface and underground mining applications. Current continuous cutting systems cannot economically cut material above about 40 MPa. This multi phase project aims to further improve Dynacut technology and demonstrate its cutting performance across the range of target overburden materials. The strategy is to develop a purpose built continuous cutting system for coal mine overburden. A structured concept testing program will be undertaken to prove the scalability and applicability of the technology to this type of mining.
New	Preventing Fatigue Cracking Via Proactive Surface Dressing C26020 Bureau Veritas AIRS Simon Kirsmer	126,940	Ivan Heron, Rio Tinto Energy & Minerals	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 finishing to remove accumulated fatigue damage. Surface finishing is a cheap, readily accessible technique that requires no special tooling.
New	Verification of Interoperability Protocol for Commercial Proximity Detection Systems C26021 CSIRO Jeremy Thompson	105,844	Chris Doran, Anglo American Iain Curran, Rio Tinto Energy & Minerals Sam Lawrence, Rio Tinto Energy & Minerals Tim Gray, Glencore Tony Egan, Glencore	Collision management is a major issue for the open cut coal mining industry. Proximity detection systems for mobile equipment and people are useful in establishing effective collision avoidance strategies. However, there are many different systems on the market, each with its own proprietary hardware, communications, logging and warning system and performance, making interoperability between proximity detection systems difficult. This project will develop an independent software verification tool that can test the level of device compliance to an accepted open industry protocol.
New	Condition Monitoring and Predictive Maintenance Using Artificial Intelligence Technologies C26031 Endellion Technology Gerard Wood, Richard Marshall	77,020	David Goodale, Anglo American	Each year the mining industry spends tens of millions of dollars monitoring the condition of plant. Significant time and cost is required to manually process condition monitoring (CM) reports, decide on the required corrective actions and initiate work orders. Using text and numerical data analytics, data visualisation and machine learning, researchers aim to significantly reduce manual CM data processing time and improve maintenance productivity. The outcome of this work will be a simple daily or shift CM reporting regime that highlights relevant issues and translates them into high quality, actionable work orders using minimal manual effort.

OPEN CUT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Mining and the Community				
Current	Collaboration to Maximise the Benefits and Acceptance of Land Packages for Post Mining Leases C25032 Central Queensland University Jo-Anne Everingham John Rolfe	239,215	Stuart Ritchie, Rio Tinto Energy & Minerals John Merritt, Burton	The Bowen Basin has no track record of full mine closure with lease relinquishment. Identifying the appropriate process to facilitate the transition to a post mining landscape that meets the expectations of the relevant communities and land users, and assessing the overall success of such an approach, remains a key challenge. The approach the regulators and mining companies are taking to closure could well be focused at the wrong scale: it is concerned with the subsets and interdependencies of soil, vegetation and water components rather than taking an overall view of the productive and other beneficial uses of the landscape in an integrated sense. The project will focus on addressing the broader scale of thinking, using holistic appraisal to consider local community needs and preferences. It will also test the use of a local expert panel to identify the conditions and suitable mix of agricultural uses and other functions for a mine lease to be completed, in order to gain acceptance by the local community and agricultural sector.
Occupational Health and Equipment Safety				
Current	Managing Whole Body Vibration at Surface Coal Mines C23022 University of Queensland Robin Burgess-Limerick	165,800	Ellen Roots, Glencore Ross Di Corleto, Rio Tinto Global HSE Troy O'Reilly, Stanwell Corporation	Operators of surface mining equipment are exposed to whole body vibration through the seat. Prolonged exposure to high amplitude whole body vibration causes serious long term health effects, particularly back disorders. The objectives of the project were to validate a simple and cost effective whole body vibration measurement device suitable for use by mine health and safety staff and to demonstrate and evaluate the implementation of the device as part of a comprehensive whole body vibration management program to reduce vibration exposure associated with surface coal mining equipment.
Current	Optimising the Implementation Critical Control Management Planning using a Management of Change Approach C24006 University of Queensland Maureen Hassall, Jim Joy	125,000	Tony Egan, Glencore	Critical control management planning (CCMP) is a major step change being undertaken across the Australian coal industry. However it is not yet clear what tactical and strategic impacts CCMP may have on stakeholders and organisation processes. This project produced a plan for an effective and efficient step change in operational risk management to the CCMP approach across the industry; a set of recommended improvements to existing industry initiatives; and a list of new projects to facilitate this change.
Current	Safety Integrity Level Validation for Satellite Navigation Technologies C24027 GPSat Systems Australia, Graeme Hooper, Joe Austin-Crowe, Joe Fleming	142,750	Chris Doran, Anglo American Tony Egan, Glencore	Safety integrity level (SIL) AS61508 assessments for projects reliant on the global navigation satellite system (GNSS), such as mining machine automation projects, are not currently possible. In this project a methodology is developed to validate GNSS equipment. As a result of this work, manufacturer hardware (specific vendor, model and firmware revision) could be pre qualified, enabling them to be included in SIL related systems.
Current	Interface Design for Haul Truck Proximity Detections Systems C24028 University of Queensland Robin Burgess-Limerick	235,620	Gavin White, Rio Tinto Energy & Minerals Tony Egan, Glencore	Visibility restrictions inherent in the design of haul trucks can sometimes prevent drivers from seeing other vehicles. After market proximity detection systems have been developed to overcome this issue; however, there are no standards or guidelines available to help equipment designers. Using a haul truck simulator and other methods, researchers will evaluate existing proximity detection systems designed to convey advisory information to truck drivers and develop specifications for proximity detection system interfaces.

OPEN CUT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Proximity Detection Device Open Specification C24034 CSIRO Mark Dunn	90,700	Aaron Power, Bengalla Chris Doran, Anglo American Brad Lucke, Glencore Gavin White, Rio Tinto Energy & Minerals Tony Egan, Glencore	There are many proximity detection systems for mobile mining equipment on the market, each with its own proprietary hardware, communication, logging and warning systems and methods. The absence of interoperability between systems is slowing down the uptake of this technology across the industry. As part of this project researchers worked with OEMs to develop industry wide supported platforms for open cut mines. In particular, an open specification set for above ground proximity detection systems was developed based on the LASC open system interconnection model initially developed by CSIRO for longwall automation.
Current	Earthmover Tyre Inflation Safety Device: Preliminary Investigation C25024 Simtars Tilman Rasche	74,400	Tim Gray, Glencore Andrew Denman, BMA Tony Egan, Glencore	Tyre maintenance involves working with pressurised vessels and is a highly hazardous activity. Sudden disintegration of a tyre and rim assembly during the inflation process can result in severe and often fatal injuries to the tyre service person and bystanders from the airblast and high velocity rim or tyre components/fragments. This project will investigate the issues associated with tyre inflation and determine whether a mobile earthmover tyre inflation protection barrier or a large inflation safety cage is a viable protective measure.
Current	Reducing Risk Taking Among Australian Coal Miners C25026 University of Newcastle Anna Giacomini Mark Rubin	302,235	Patrick Tyrrell, New Hope Group Doug Kennedy, Glencore Bharath Belle, Anglo American Simon Coleman, Rio Tinto Energy & Minerals	In a mining context, dangerous risk taking is defined any behaviour that deviates from prescribed risk controls with the potential to lead to serious accidents, injuries, and fatalities. This project will identify the psychological causes of dangerous risk taking behaviour among Australian coal miners and develop, test, and produce a practical intervention that will result in a significant reduction in this type of behaviour. Key outcomes will include an industry friendly manual that explains how to implement the intervention at mine sites across Australia as well as a numerical tool that can be used to evaluate the effectiveness of the intervention.
Current	Practical Application of Open Path Boundary Monitoring for Operational Dust Control C25029 Pacific Environment Operations Damon Roddis	135,432	John Watson, Glencore Andrew Speechly, Rio Tinto Energy & Minerals	Open path monitoring measures the flux of a given air emission along a path length of hundreds of metres rather than relying on a single monitoring point which may fail to detect emissions along, and beyond the site boundary due to its static location. Open path systems have been used at petrochemical refineries, landfills and post closure industrial sites to detect volatile organic compounds and other gases. However, there has been limited application of this technology to the detection of fugitive particulate matter within the mining and extractive industries. This research will deliver a proof of concept for an open path boundary monitoring system for operational dust control. Researchers will demonstrate that open path techniques can be configured to detect particulate matter movements beyond the site boundary in a meaningful way, including validation against conventional particulate matter monitoring techniques.
Current	Automated Musculoskeletal Disorder Risk Assessment C25033 JointAction Group Michael Lawrence, Steve Cowley	293,232	Simon Worland, Rio Tinto Energy & Minerals Mathew Hyde, BHP Billiton	Musculoskeletal injuries are the most common injury type experienced in the Australian coal industry. This project will develop an application for use on a phone or tablet device, paired with small wearable sensor devices to conduct quantitative ergonomic risk assessment. The user friendly application will remove the need for musculoskeletal disorder (MSD) specialist expertise in the conduct of a risk assessment, minimise disruption of normal work, reduce costs, provide greater accuracy and reliability of data collection and analysis across similar tasks, and automatically transfer risk assessment reports to a central location.
Current	Risk Control Knowledge: Two Case Studies C25036 University of Queensland Jim Joy Maureen Hassall	259,500	Mike Oswell, Anglo American Tony Egan, Glencore	Enhancing the effectiveness and management of risk controls should deliver improved outcomes. This project will identify best practice application of the proposed critical control methodology. Two detailed case studies that demonstrate best practice application of the recommended methods for selecting and optimising risk controls and managing critical controls will be developed. The case study information will determine the feasibility and business case for sharing of critical controls knowledge that will help the Australian coal mining industry better manage fatality risks.

OPEN CUT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	<p>Health-e Mines: Virtual Health System to Improve Mental Health, Reduce Alcohol/Other Drug Use and Fatigue Related Problems C25037</p> <p>University of Newcastle, Brian Kelly, Frances Kay-Lambkin, Ross Tynan</p>	289,985	Tony Egan, Glencore	Mental health problems cost the Australian coal mine industry more than \$147 million each year. Researchers will develop and evaluate an online portal (Health e Mines) that will link coal mining employees, workplaces and health professionals with direct access to confidential, accessible, private and evidence based programs for mental health, addiction, and related physical health concerns. Health e Mines will be developed as a website that will be both PC and smart phone compatible, and will be complemented by the development of a smart phone app.
New	<p>Continuous Monitoring of Whole Body Vibration and Jolts and Jars Associated with Operating Earth Moving Equipment C26026</p> <p>University of Queensland Robin Burgess-Limerick</p>	298,704	Troy O'Reilly, Stanwell Corporation Ellen Roots, Glencore Ross Di Corleto, Rio Tinto Global HSE	Operators of earth moving equipment at surface coal mines are continuously exposed to whole body vibrations. Prolonged exposure can lead to adverse health effects, particularly back disorders. In this project researchers will develop, demonstrate and evaluate iOS and server software and use off-the-shelf hardware to continuously monitor and analyse operator vibration exposures on haul trucks and dozers. Data from this project will help enhance understanding of the sources of elevated whole body vibration and impact loads in this environment.
New	<p>Proximity Detection System Performance Testing Framework C26028</p> <p>University of Queensland Mining3 Susan Grandone</p>	268,000	Chris Doran, Anglo American Iain Curran, Rio Tinto Energy & Minerals Sam Lawrance, Rio Tinto Energy & Minerals Tim Gray, Glencore Tony Egan, Glencore	Proximity detection systems (PDS) for mobile equipment, people, and other structures are increasingly being used to establish effective collision management strategies. However there are so many proximity detection systems and multiple sensing technology categories that it is difficult to select the best PDS for specific applications. In this project researchers will conduct a critical review and assessment of PDS technology types, application, constraints, and implementation requirements; develop a testing methodology to verify and assess proximity detection systems; and produce a set of measureable, objective metrics to describe performance criteria.
New	<p>Earthmover Tyre Safety Barrier: Stage 2 C26036</p> <p>Simtars Mark Petrie, Tilman Rasche</p>	511,681	Tim Gray, Glencore Tony Egan, Glencore	Although almost 50% of the fatal tyre and rim accidents are related to the exposure of personnel to disintegrating tyre and rim assemblies, the controls for this risk are generally administrative and ineffective. A test rig will be designed and manufactured to enable researchers to measure and analyse the spontaneous disintegration of an earthmover tyre and rim assembly under real conditions at different inflation pressures. Knowledge and understanding gained from these tests will allow the industry to develop scientifically based controls for tyre maintenance.

OPEN CUT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Overburden Removal				
Current	Automated Design of Multi Pass Dragline Strips Using 3D-Dig C21028 Earth Technology Murray Phillips	115,000	Andrew Walker, Wesfarmers Resources Lindsay Ford, Glencore	The well accepted 3D Dig software has proven to be an effective tool for accounting for spoil transport and placement in dragline operations. It is able to very accurately predict prime and rehandle volumes, estimate spoil fit and communicate the resultant design. This project extended the software and developed a system to automate the design of a complete, multi pass dragline strip. The system will allow for blast profiles and dozing as well as dragline operation. The auxiliary stripping requirements will be determined for each block prior the main strip simulation. A graphical interface will be provided to allow users to sequence the strip by blocks, passes and sub passes.
Current	Automated Bulk Dozer Push: Reducing the Cost of Overburden Removal C24037 University of Queensland Mining3, Ross McAree	341,400	Geoff Gribble, Wesfarmers Resources Limited Hans Hayes, Anglo American Tony Egan, Glencore Andrew Denman, BMA	The Caterpillar SATS semi autonomous tractor system for D11T dozers is capable of executing push to an edge bulk dozing and has been successfully used for dragline bench preparation. However, it cannot currently execute a pivot push with back stacking strategy which is favoured to minimise rehandle. This project will extend the capability of SATS so it can perform pivot push with back stacking, and test the system at an Australian coal mine.
Current	Dragline Excavation Sequencing: Phase 2 C25038 University of Queensland Andrew Jessett Ross McAree	1,129,000	Geoff Gribble, Wesfarmers Resources Limited Win Klass, Glencore Andrew Denman, BMA	Dragline excavation sequencing is a complex problem with many input variables. Each decision impacts future possible decisions and finding ways to solve for these is technically challenging and not fully explored. This is complicated by multiple competing objectives that are coupled to the decision points within an excavation sequence. This project will develop and demonstrate an on board operator decision support tool that provides guidance on excavation sequencing and test the hypothesis that this enables faster, more consistent production rates, improved conformance to the intended design, and better utilisation of spoil room.
New	Dynacut Fundamental Development and Scalability Testing: phase 2 C26035 University of Queensland Mining3, Dihon Tadic	1,333,000	Andrew Lau, Yancoal Ivan Heron, Rio Tinto Energy & Minerals	A body of work has been undertaken to develop a new high performance continuous mining system for overburden that has productivity, cost, environmental and safety advantages over current drill/blast/load operations, and enables new flexibility around mine designs and mining approaches. In this research phase a full scale Dynacut prototype system will be developed and tested in quarry trials. The trials aim to quantify cutting rates across key sedimentary domains with purpose built cutters, to clarify the performance potential and to justify further development towards a commercial scale system.



COAL PREPARATION

The coal preparation plant is an integral part of the total mine operation and seeks to minimise its contribution to environmental impacts, eg by 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.

The work to more quickly respond to changing plant feed continues to be a priority.

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.

COMMITTEE MEMBERS

Rebecca Fleming	Coal Processing Specialist (co-chair Coal Preparation Committee)	Rio Tinto Energy & Minerals
Kevin Rowe	Group Manager of CHPPs (co-chair Coal Preparation Committee)	Glencore
Daniel Delahunty	Process Engineer	Stratford Coal
Alvaro Diaz Lema	Group Process Engineer	Glencore
Phillip Enderby	Manager, Ravensworth CHPP and Coal Terminal	Glencore
Ryan Flanagan	Group Process Engineer	Glencore
Rod Fox	General Manager – Coal Processing & Operational Projects	Whitehaven Coal
Alistair Harriman	Director – Process Engineering	Peabody Energy Australia
Phil Howes	CPP Engineer	South32 Illawarra Coal
Justin O'Neill	Senior Process Engineer	Peabody Energy Australia
Naomi Pritchard	Coal Processing Engineer	BHP Billiton
Cameron Stewart	Coal Processing Specialist	Anglo American
Chris Urzaa	Coal Marketing Manager	Jellinbah
Clinton Vanderkruk	Coal Processing Manager Australia & Canada	Anglo American
Tom Wilson	Process Engineer	Bengalla

FUNDING APPROVED 2016

	No of Projects	ACARP Funding	Total Funding
2016	14	\$1,983,868	\$3,173,094
2015	17	\$2,395,961	\$4,658,741
2014	15	\$2,017,563	\$2,752,522

PROJECTS UNDER MANAGEMENT 2016

CATEGORY	No of Projects	ACARP Funding
Dewatering	6	\$1,285,209
Environmental Improvement	1	\$40,000
Fine Coal	22	\$3,049,528
Gravity Separation	11	\$2,595,517
Major Projects	1	\$1,318,748
Process Control	2	\$386,685
General	3	\$555,400



COAL PREPARATION

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Major Projects				
Current	Reflux Classifier to 4mm Top Size - Full Scale Trial (Construction of Test Rig) C22046 University of Newcastle Kevin Galvin	1,318,748	Kevin Rowe, Glencore Phillip Enderby, Glencore	This project will move 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. The project has a committed host site, and strong engineering and scientific support.
Dewatering				
Current	Improving the Dewatering Efficiency of Fine Flotation Concentrates by De-Aerating Froth Products C24040 University of Queensland, Yongjun Peng	213,600	Alvaro Diaz Lema, Glencore Frank Mercuri, Anglo American	Increased salinity in mine water is causing froth handling problems in downstream processes. In this project a model will be developed to predict froth stability and the moisture of dewatered flotation concentrates in saline mine water. Dewatering efficiency of fine flotation concentrates will be improved using de aerating froth products. A laboratory scale de aeration froth column with foam destroyers will be designed, fabricated, tested and optimised. Physical and chemical pre treatments will be combined to minimise energy consumption and reagent cost while maximising the dewatering efficiency.
Current & New	Steam Pressure Filtration Targeting Step Change Reductions in Filtercake Product Moistures C24047 QCC Resources Andrew Swanson Bob Drummond	347,049 current 90,344 new	Frank Mercuri, Anglo American Ryan Flanagan, Glencore Rod Fox, Whitehaven Coal	Hyperbaric disc filters have been used to dewater fine coal concentrates in coal applications for about 20 years. Preliminary laboratory assessments using a hyperbaric disc filter with air and air in combination with steam have shown positive results for filter cake discharge moisture levels. This project will test the scalability of hyperbaric filtration technology by comparing the bench-scale data with the continuous pilot testing data. Once the scalability of the technology is confirmed, a detailed laboratory assessment of 10 flotation concentrate samples will determine the effect of filter feed (coal quality) characteristics, such as coal rank, particle size distribution, and clay content on filtration rate, final product moistures and air and steam consumption rates.
Current	Thickener Underflow Monitor C24048 Clean Process Technologies Noel Lambert	195,000	Justin O'Neill, Peabody Energy Australia Phillip Enderby, Glencore	Dewatering fine tailings material is becoming an important component of the coal mining process, particularly given the challenges around constructing, managing and rehabilitating tailings dams. This project will develop an instrument that is capable of accurately and reliably measuring the quality of the thickener underflow in an operating coal preparation plant environment. The instrument will measure the solids and water loadings and the dynamic and kinematic viscosity of tailings slurry which are not currently reliably measured online. This information will enable the thickener and downstream processes to be optimised.
Current	Optimising the Performance of Solid Bowl Centrifuge for Tailing Dewatering C25010 University of Newcastle Rohan Stanger	125,560	Ryan Flanagan, Glencore Tom Wilson, Bengalla	Dewatering ultrafine tailings is capital and energy intensive. Regulators are increasing environmental and water conservational requirements for tailings dams. Rix's Creek coal washery has trialled the use of a solid bowl centrifuge for tailings dewatering, producing a filter cake suitable for mine site disposal. This project will investigate the relationship between feed particle characteristics and operational performance of the installed solid bowl centrifuge. The intention is to identify optimal and problematic feed materials and investigate the fundamental reasons for the changes in processing.
Current	Dewatering of Ultrafine Coals and Tailings by Centrifugation: Pilot Scale Studies C25012 University of Queensland Anh Nguyen	220,000	Naomi Pritchard, BHP Billiton Frank Mercuri, Anglo American Rahul Patel, Peabody Energy Australia	Dewatering of ultrafine coal products is difficult and costly. The current dewatering processes for fine coals are also not efficient for moisture reduction and solid recovery. This project will investigate the feasibility of the high g centrifugal decanters in dewatering fine coals and tailings from Australian mines at pilot scale and compare the results from full scale work undertaken by Somerset International Australian and its industry partners.

COAL PREPARATION

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Improving Solids Recovery and Moisture Reduction in Ultrafine Coal Dewatering C25018 University of Queensland Liguang Wang	184,000	Justin O'Neill, Peabody Energy Australia	Wet processes are predominantly used in coal preparation plants to remove mineral matter from raw coals. Recovery of high quality coals in fine and ultrafine fractions is one of the challenges faced by Australian coal producers. However, the processes used to dewater ultrafine coals are inefficient in terms of moisture reduction and/or solids recovery. This project will improve ultrafine coal dewatering performance by enlarging particle size, primarily by developing effective surfactants and/or flocculants to aggregate coal particles to improve the solids recovery of SBCs. Researchers will examine the potential of the selected chemical reagents for dewatering particles of different surface properties and size ranges and explore how operating variables affect the dewatering efficiency and operating cost.
New	Characterisation of Coal Petrography for Improving the Dewatering of Fine Coals Using Chemicals C26015 University of Queensland Anh Nguyen, Graham O'Brien	199,436	Justin O'Neill, Peabody Energy Australia Naomi Pritchard, BHP Billiton	Dewatering of ultrafine coal products is difficult and expensive. The desliming of this ultrafine fraction of the flotation feed is not often feasible due to loss of high quality fine coals to tailing which can cause considerable environmental issues. Improving the dewatering of fine coals not only increases the value of coal products and maximises the efficiency of fine solids capture but also reduces water consumption and increases water recycling. This project aims to develop a novel, fast, non-destructive and cost effective characterisation of coal petrography to improve the dewatering of fine coals with chemicals.
Environmental Improvement				
Current	Test Procedures to Achieve More Cost Effective Minimisation of Coal Dust Emission During Rail Transport C25006 Introspec Marketing Services, John Planner	40,000	Stuart Ritchie, Rio Tinto Energy & Minerals John Watson, Glencore	In Queensland surface veneer chemical solution is applied to the surface of coal in rail wagons prior to departure from mine sites to minimise coal dust emissions during rail transport from mine to port. However the existing test procedures are focused on the worst case scenario. This project will refine wind tunnel test procedures, resulting in more cost effective coal surface treatment options, while still achieving effective dust management.
New	Improved Precision for the Determination of Coal in Urban Dust Samples by Combining a Reliable Analysis of Soluble Particulates with CGA C26009 CSIRO, Graham O'Brien, Michael Campbell	175,622	John Watson, Glencore Stuart Ritchie, Rio Tinto Energy & Minerals Kevin Rowe, Glencore	In this project researchers are using coal grain analysis to accurately determine the proportion of coal present in urban dust samples. Establishing that mine generated dust has a different reflectance signature to windborne dust from non-mining activities could provide quantitative information for these different dust courses. Researchers will also develop a standard method for undertaking these analyses.
Fine Coal				
Current	Full Scale Trial of the Reflux Classifier to at Least 4mm Top-Size C19001 University of Newcastle, Kevin Galvin	185,200	Tom Wilson, Bengalla Kevin Rowe, Glencore	In this project a full scale reflux classifier is undergoing a plant trial at the Bloomfield coal preparation plant near Newcastle to investigate the separation efficiency for 0.25 to 4mm particle size feed and to determine the limits on the solids throughput. It is investigating the extent to which previous work conducted during the pilot can be scaled up.
Current	Full Scale Gravity-Desliming Using Cascading Reflux Classifiers C20052 University of Newcastle Kevin Galvin	215,480	Tom Wilson, Bengalla Kevin Rowe, Glencore	This project addresses a major problem found in many NSW coal operations when recovering and desliming fine coal, and also in producing metallurgical coal, at a given ash. The objective is to investigate the performance of cascading reflux classifiers in the gravity separation and desliming of fine coal at full-scale, and in turn assess the scale-up achieved. This work will provide the information needed to assess whether this new approach for producing a clean fine coal product can be achieved at the same level of performance as observed in the laboratory or at pilot scale. The potential for recovering a further 3% yield could lead to significant additional mine revenue.

COAL PREPARATION

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Generalised Model of the Reflux Classifier using Computer Simulations Based on the Discrete Element Method (DEM) C22030 University of Newcastle, Kevin Galvin	103,700	Kevin Rowe, Glencore Daniel Delahunty, Stratford Coal	The Reflux Classifier offers lower composite Ep values than other technologies, providing potential to control the cut point down to the low levels required for metallurgical coal product. A new computational model of the Reflux Classifier was developed to quantify partition curves and associated EP and D50 values across the relevant size range. As a result of this work, plant personnel will be able to determine the best place to insert pressure transducers for measuring and controlling the system.
Current	Measurement and Control of the Reflux Classifier C22032 University of Newcastle Kevin Galvin	132,730	Kevin Rowe, Glencore Clinton Vanderkruk, Anglo American	A pilot scale study of the Reflux Classifier will be carried out to establish the best way to operate and control the separator. Ludowici Australia will provide a new RC300 fitted with six pressure transducers, with the potential to record the full bed profile in real time, together with the response of the PID controller. A basis for properly measuring and interpreting the suspension density measurements of the lower bed and, in turn, a generalised approach to ensuring optimal underflow control will be established.
Current	Improved Flotation Recovery and Reduced Cost Via Adjusting Frother Chemistry and Froth Behaviour C23035 University of Queensland, Liguang Wang	129,000	Alvaro Diaz Lema, Glencore Rebecca Fleming, Rio Tinto Energy & Minerals	Coal flotation practice is expensive. A promising approach to reducing flotation costs is to use more effective chemical reagents, especially non ionic surfactants (frothers). This project demonstrated the effectiveness of a novel frother for improving coal flotation performance and reducing reagent cost. A technique to measure the concentration of residual frother in process water was developed and a real time diagnostic tool for maximising the separation efficiency of coal flotation was evaluated.
Current	New Approach to Coarse Coal Flotation C23036 University of Newcastle Kevin Galvin	141,457	Tom Wilson, Bengalla Kevin Rowe, Glencore Phillip Enderby, Glencore	There are significant coal losses from flotation due to oversized particles entering the flotation circuit by passing through worn screens and via the cyclone overflow. Conventional flotation fails to recover a significant fraction of these coarse particles. This laboratory scale project is providing an understanding of the coarse particle (up to two millimetres) flotation mechanism and the precise conditions required to succeed. The introduction of robust flotation technology could deliver an increase in plant yield of up to two per cent.
Current	Improving the Treatment of Clay Minerals in Coal Flotation in Saline Water - Plant Tests C23038 University of Queensland Yongjun Peng	253,176	Alvaro Diaz Lema, Glencore	Clay minerals commonly occur in coal deposits and decrease the combustible recovery in flotation while deteriorating the product quality. Flotation of high clay coal is currently not possible. Methodologies to mitigate deleterious effects from clay minerals were developed in a previous project and will be tested during plant trials at Oaky Creek and Peak Downs mines. The trials will provide the process information needed to specify and design the implementation in a full scale plant, and provide opportunities to study, define and optimise parameters that cannot be properly studied at a laboratory scale, such as the change of coal and water quality, recycle of reagents and the impact of downstream processes. The trials will also provide mine personnel who will commission future full scale plants with operating experience and training.
Current	Characterisation and Flotation of Oxidised Coal C23039 University of Queensland Yongjun Peng	168,600	Alvaro Diaz Lema, Glencore Frank Mercuri, Anglo American	A previous project clearly demonstrated that x-ray photoelectron spectroscopy (XPS) could be used to detect and quantify the non oxidised and oxidised areas on the coal surface, and new technologies could be developed to improve the flotation of coal with surface oxidation. In this project, a rigorous methodology is being developed using XPS to determine non oxidised and oxidised surfaces on coal obtained from different pits, stockpiles and flotation feeds, rejects and products. An oxidation index will also be developed to predict coal flotation behaviour.
Current	Impact of Sub Optimal Operation C24039 BA Firth Bruce Firth	32,000	Ryan Flanagan, Glencore	Although some research has been undertaken on the sub optimal operation of coal preparation plants and unplanned downtime, variation in the approaches used makes it difficult to compare the outcomes. There has also been little recognition of the importance of run of mine washability in this work. Following a comprehensive literature review, the project developed a methodology for codifying poor operation situations and unplanned downtime events. Case studies were used to quantify the impact of the poor operation and run of mine washability.

COAL PREPARATION

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Improving Coal Flotation With Oscillatory Air Supply C24041 University of Queensland Liguang Wang	108,000	Diego Dal'Molin, Rio Tinto Energy & Minerals Kevin Rowe, Glencore Frank Mercuri, Anglo American	Ultrafine and fine coal flotation can be considerably improved by microbubbles. A recent research breakthrough shows that microbubbles smaller than 100µm can be cheaply generated from oscillatory air flow. This project will improve coal flotation performance and reduce operating costs by installing a cheap and compact device to supply oscillatory air flow to existing flotation cells. The outcome of this work will be improved flotation performance, reduced frother dosage and decreased energy consumption.
Current	Pilot Scale Study of Fast Flotation C24042 University of Newcastle Kevin Galvin	95,180	Ryan Flanagan, Glencore Kevin Rowe, Glencore	Until recently, processing high value coal from tailings dams has been considered uneconomic. This project will establish a low capital cost solution for reducing the volume of fine waste sent to tailings and generating a high value product. The aim of the project is to develop a small, compact two stage flotation system capable of generating a clean coal product from the cyclone overflow.
Current	Simultaneous Gravity Separation and Desliming of Fine Coal - A Novel Concept C24043 University of Newcastle, Kevin Galvin	141,380	Alvaro Diaz Lema, Glencore Tom Wilson, Bengalla	Flotation currently provides only a single stage option for achieving simultaneous gravity separation and desliming of fine coal in the one vessel. In this project a Reflux Classifier will be inverted. The gangue and slimes will be rejected together via a more dilute underflow, leaving behind a clean coal product that emerges as a concentrated overflow. This innovation will allow the plant to recover much finer coal without the need for flotation. This laboratory scale work will provide the basis for a commercialisation pathway via additional programs at pilot and full scale.
Current	Adaptation of Coal Grain Analysis to Improve Yield Estimation C24045 QCC Resources Andrew Swanson, Bruce Atkinson	120,456	Naomi Pritchard, BHP Billiton	Predicting flotation yield and concentrate quality based on resource samples in coal preparation plants has been challenging. This project aims to find an accurate measure of the true flotability of fines in the resource. To achieve this the CSIRO coal grain analysis interpretation software will be further developed so that it can be separated into distinct size fractions. Thirty six coal samples will be analysed and practical flotation model parameters for each grain type generated. The work should provide sufficient information to differentiate grain response to dose rate.
Current	Online Particle Size Monitoring in Coal Preparation C24046 QCC Resources Brad Garraway	168,570	Rebecca Fleming, Rio Tinto Energy & Minerals Phillip Enderby, Glencore	Pressure filtration is an effective technique for improving dewatering of fine coals; however it has high capital costs, complicated structure and significant operating costs. A pilot scale testing program will be undertaken to confirm that high pressure air filtration supplemented with steam can achieve the dewatering potential indicated by earlier work. Guidelines will be developed for predicting the filter cake moisture and filtration rate based on the filter feed coal quality using the established operating ranges for the various operating process variables. A key outcome of this work will be the prediction of potential increases in recovery and sales revenue in New South Wales thermal coal operations for the successful implementation of this technology.
Current	Performance Enhanced Diesel Collector for Coal Flotation C24049 CSIRO Shenggen Hu	148,013	Alvaro Diaz Lema, Glencore Clinton Vanderkruk, Anglo American	The natural hydrophobicity of coal in flotation is usually enhanced by adding oily collectors, such as diesel, which is an expensive process. Technologies are needed to reduce the consumption of the diesel oil collector while maintaining good flotation performance and reducing treatment costs. This project will validate the performance enhanced diesel collector at preparation plant scale, which is expected to increase recovery of coarser and fine coal particles and improve flotation yield of low to middle rank coals by up to 20%.
Current	3D Flotation of Fine Coal C25008 University of Newcastle Kevin Galvin	185,260	Ryan Flanagan, Glencore Tom Wilson, Bengalla	Fine coal beneficiation could be achieved using a single stage separation device up to 1000 times faster than conventional flotation. This novel 3D flotation technology shears the feed and binder through an orifice plate, producing buoyant agglomerates that separate from the coarser portion of the gangue. This allows the product to be recovered and washed over a screen then mechanically dewatered. In this project a laboratory pilot scale trial will be conducted to assess the separation performance across a range of coals.

COAL PREPARATION

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Rapid Extraction of Frothers from Process Water C25009 University of Newcastle Jamie Dickinson	122,965	Alvaro Diaz Lema, Glencore Kevin Rowe, Glencore Frank Mercuri, Anglo American	The concentration of frother used in froth flotation is ideally selected to maximise the recovery of the coal. However, residual frother remaining in the process water results in downstream frothing issues. Consequently compromises are often sought in the amount of frother used to avoid downstream frothing issues at the expense of flotation circuit performance and a significant loss in fine coal yield. This project will investigate the frother extraction rate achievable using a laboratory reflux flotation cell, aiming to achieve extraction rates up to 10 times higher than achieved by existing technology.
Current	Evaluation of Residual Frother Minimisation Strategies C25013 CSIRO, Philip Ofori	167,714	Frank Mercuri, Anglo American Justin O'Neill, Peabody Energy Australia	The Australian coal industry has experienced persistent problems associated with residual frother induced frothing in other parts of the plant. A number of solutions have been suggested and, in some cases, applied to minimise frothing caused by residual frother. This project will quantify the effectiveness of methodologies to mitigate excess frothing in coal preparation plants and further develop a portable frother detector that can be used to determine frother distribution in process and recycle streams.
Current	Plant Scale Testing of Safe Aerosol Frother Addition to Reduce Residual Frother and Reagent Costs C25014 CSIRO, Philip Ofori	165,582	Alvaro Diaz Lema, Glencore Justin O'Neill, Peabody Energy Australia	Frother addition in coal flotation is essential for the formation of a sufficient number of stable bubbles to maximise bubble surface area to carry the hydrophobic particles to the froth zone. The presence of high levels of residual frother causes major operational issues and down time. Adding the frother to the gas phase as an aerosol to enable the frother molecules to more effectively concentrate at the interfaces being created could reduce the frother demand and residual frother in process water. This project will examine the implementation methodology and effectiveness of this approach in a large scale Jameson cell at a mine site.
Current	Leveraging Detailed Maceral Component Information from CGA C25017 QCC Resources Bruce Atkinson Karryn Warren	71,696	Justin O'Neill, Peabody Energy Australia	Coal grain analysis (CGA) is an extremely attractive method for characterising coal. It provides an absolute measure of coal matter types and mineral matter on a particulate basis, which allows particle types to be classified by density, as well as their degree of 'compositeness' or heterogeneity. This project will further develop the software so component maceral and mineral sizes for each grain size can be determined. This will enable a more fundamental characterisation of the coal and mineral matter in each particle size and grain class, and will provide direct information on the liberation potential from any specific particle size. This project will further develop the CGA coal characterisation imaging software so that information may be generated as a matter of routine.
Current	Flotation Tailings Online Measurement C25020 A & B Mylec Todd McDonald	45,200	Alvaro Diaz Lema, Glencore Naomi Pritchard, BHP Billiton	Laboratory ash results are generally seen as the best method to monitor coal flotation performance. Due to the time lag between the acquisition of the samples and the reported analysis, there is the potential for further loss of flotation performance. In addition, it is often difficult to adjust flotation performance parameters to fully evaluate their impact on the performance of the circuit. This project will provide a proof of concept evaluation of a MPOF2 optical ash meter in providing an instantaneous indication of the flotation tailings stream.
Current	Coarse Particle Flotation for the Plant of the Future C25021 University of Newcastle Graeme Jameson	148,169	Clinton Vanderkruk, Anglo American	Graeme Jameson's NovaCell is a new type of flotation machine in which particles are recovered in a fluidised bed. Although developed to process base metal sulphides, which are impossible to float in existing technologies, coal from a Hunter Valley operation was successfully processed in 2015. This project will determine the maximum size at which coal particles can be recovered in the NovaCell operated in continuous mode. Feed samples will be sourced from the Bulga coal preparation plant.
New	Impact of Sub Optimal Operation C26001 BA Firth Bruce Firth	41,500	Ryan Flanagan, Glencore	Research around the sub-optimal operation of coal preparation plants has been somewhat piecemeal with considerable variation in the types of approaches used. This has made it difficult to compare research outcomes. By analysing particular preparation plant operational issues and how they can affect the recovery of saleable coal, researchers have been able to quantify the effects of sub-optimal plant operation. In this project, a PC based diagnostic system will be developed to quantify the potential cost of a particular sub-optimal operation and identify corrective actions. The system will be freely available and in a form that could be tailored for a particular coal preparation plant.

COAL PREPARATION

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
New	Review of ACARP Flotation Projects C26002 Mineralis Consulting Bill Johnson	28,000	Rebecca Fleming, Rio Tinto Energy & Minerals	Over the past 20 years, ACARP has funded a significant body of coal flotation work. However, the outcomes of this work have not been as widely disseminated nor adopted as the potential benefits suggest they should be. A critical review of coal flotation research will be undertaken to identify how industry can better apply existing research findings. A gap analysis will also be completed to help inform future research decisions.
General				
Current	Coal Preparation Equipment Performance Database C15060 QCC Resources Andrew Swanson, Bruce Atkinson	239,016	Phillip Enderby, Glencore	This database provides a singular reference for coal preparation equipment performance data, which encompasses all unit operations including sizing and dewatering. It is accessible to all Australian coal industry personnel, associated consultants and researchers.
Current	Derrick Stack Sizer In Plant Evaluation C25007 WPE Process Equipment Brian Packer Darren Mathewson	150,800	Naomi Pritchard, BHP Billiton Rebecca Fleming, Rio Tinto Energy & Minerals	Millions of tonnes of saleable quality, ultrafine coal are discarded from preparation plants into tailings dams along with the high ash slimes material. Based purely on the principle of size classification, the Derrick Stack Sizer is a small footprint, high capacity technology capable of recovering coal from fine waste streams and reducing the ash value of existing fine product streams. There are no Derrick stack sizers installed in Australian plants. Trials will be conducted at three preparation plants to assess the benefits of Derrick stack sizers across a range of site specific circumstances.
Current	Adaptation of Coal Grain Analysis to Improve Yield Estimation C25019 QCC Resources Bruce Atkinson	165,584	Dion Lucke	A major problem with coal preparation plant yield prediction is how to accurately predict flotation yield. Previous research has demonstrated that the flotation response can be related to the grain types. This project will assess up to six full scale flotation circuits in order to analyse what is occurring at a fundamental level using coal grain analysis. Practical flotation model parameters will be generated for each grain type. If the flotation response for each grain type differs by rank, researchers will relate the flotation models to coal rank.
New	Revised Dustiness and Dust Extinction Moisture Testing Method (Update of AS 4156.6): Part 2 Preparation C26007 University of Newcastle, Dusan Ilic	80,000	Kevin Rowe, Glencore	Existing Australian Standards are used to determine the minimum moisture content required for dust extinction at coal handling facilities. Results from these tests are used in dust management plans to control dust emissions. However, the methods for determining moisture levels for effective coal dust suppression are poorly defined. This project will develop a more accurate and effective procedure to assess the inhalable, thoracic and respiratory fractions of the coal particulate matter.
New	Oxidation Monitoring Tools and New Reagents in Plants to Improve the Flotation of Oxidised Coals C26008 University of Queensland Yongjun Peng	116,600	Justin O'Neill, Peabody Energy Australia Alvaro Diaz Lema, Glencore	Processing oxidised coals in the preparation plant is problematic. In this project oxidation measurement tools will be implemented in plants to monitor coal oxidation; a coal oxidation database and blending strategy will be developed to guide plant operation; and reagents suitable for floating oxidised coals will be trialled and application conditions defined.
New	Multi-sloped Screening Efficiency with Changing Strokes, Frequencies, Feed Solids and Feed Rates - Pilot Plant Study C26010 CSIRO, Mike O'Brien	140,025	Rod Fox, Whitehaven Coal Clinton Vanderkruk, Anglo American Phillip Enderby, Glencore	Multi sloped screen failures cause considerable disruption to coal production and result in lost revenue and significant repair costs. Using a pilot scale, multi-sloped screen to collect frequency and amplitude data, researchers will illustrate how to maximise screening efficiency while providing the lowest possible forces on the screen, screen components and screen structures. A database will be produced for plant operators and designers to optimise the operating conditions, and assist to minimise failure rates and maintain efficiency.

COAL PREPARATION

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
New	CSIRO Instruments at Multiple Plants C26011 CSIRO Mike O'Brien	427,798	Naomi Pritchard, BHP Billiton Rebecca Fleming, Rio Tinto Energy & Minerals	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.
New	Improved Flotation Recovery Via Controlling Froth Behaviour - Stage 2 C26012 University of Queensland Liguang Wang	100,000	Naomi Pritchard, BHP Billiton Rebecca Fleming, Rio Tinto Energy & Minerals	Recent advances in coal mining techniques have led to the production of larger quantities of fine coal which need to be beneficiated by physical separation methods such as froth flotation. It is challenging to effectively control the flotation process because there is no real time measurement for coal flotation performance. Many process variables are difficult to measure on line. This project will demonstrate and evaluate a real time froth control system for maximising and maintaining the separation efficiency of coal flotation. It will also demonstrate and evaluate a simple tool for measuring the concentration of frother in flotation cells and water circuits at accuracy of 0.9 ppm or better.
New	Low Cost Online Measurement of Particle Size and Density for Diagnostics Across the Fine Coal Circuit C26014 University of Newcastle Peter Stepien, Rohan Stanger	119,633	Rebecca Fleming, Rio Tinto Energy & Minerals Alvaro Diaz Lema, Glencore	It is challenging to monitor coal quality in the fine coal circuit of coal preparation plants. Plant operators lack the critical information needed to provide adequate and regular control for fine tuning the circuit. This project will develop a simple and low cost imaging system with a centrifugal separation step to induce particle migration. The image analysis will provide the individual particle size and relative migration distance thereby enabling density to be calculated. If successful this method has the potential to provide distributions of particle size and density as an online measurement.
New	Benefits of Online Thickener Underflow Rheology Measurements C26016 Clean Process Technologies Noel Lambert	251,000	Naomi Pritchard, BHP Billiton Phillip Enderby, Glencore Ryan Flanagan, Glencore	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.
New	CGA Workshop Series - Driving Implementation C26038 CSIRO, Bruce Atkinson, Graham O'Brien	44,910	Angus McIntyre, Rio Tinto Energy & Minerals Chris Urzaa, Jellinbah	Over the past decade ACARP has funded a number of projects which have used Coal Grain Analysis (CGA) techniques and associated image processing software to undertake a wide range of research projects. Despite the enormous potential of the method, only a limited number of industry participants are aware of CGA and its capabilities. Researchers will develop and facilitate a series of in-person workshops and downloadable webinars on CGA for intensive technology transfer.

Gravity Separation

Current	CPP Feed Washability Prediction from Small Topsize Samples C18041 QCC Resources Andrew Swanson	720,688	Ryan Flanagan, Glencore	Preliminary research has shown that it is possible to totally change the way in which coal is characterised for a wide range of purposes, including washability prediction, using coal grain analysis. Coal grain analysis was evaluated to determine whether it can predict washabilities of different coal sections (different seam/plies) based on full characterisation of a shallower or deeper ply by using further samples from a large diameter borecore testing program.
Current	Linkage of Dynamic Changes in DMC Circuits to Plant Conditions C20050 CSIRO Mike O'Brien, Peter Holtham	492,502	Ryan Flanagan, Glencore Frank Mercuri, Anglo American	DMC circuits are responsible for producing more than \$25 billion of product coal in Australia. The link between the process dynamics of a DMC circuit and prevailing plant operation has been the subject of previous research. C17037 led to a number of new online monitoring devices incorporated into the host mine's DMC circuit. In this extension project, a better management approach will be defined to mitigate the dynamic impacts of the mining and preparation processes on plant efficiency. The significant research findings will be detailed in a handbook, including potential remedial actions. 'The Intelligent Plant' diagnostic system will also be updated.

COAL PREPARATION

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Monitoring and Prediction of Catastrophic Multi Sloped Screen Failures C21053 CSIRO Mike O'Brien	260,024	Clinton Vanderkruk, Anglo American Phillip Enderby, Glencore	Multi sloped (banana) screens are commonly used in Australian coal preparation plants for desliming and drain and rinse applications. While these screens have gained widespread acceptance, they are susceptible to mechanical failure. With the current trend for increasing the capacity and size of these screens, the potential for damage should one fail is high. This project determined the mechanism of failure. It trialled numerous non-destructive testing techniques such as vibration monitoring, pressure monitoring, acoustic monitoring, strain gauges and a novel technique based on research at Monash University to measure the cyclic deformation. It is the cyclic nature of the force that can cause irreversible dislocations at the surface of the material, leading to deformation structures that can initiate the catastrophic failure.
Current	Investigation of the Graviton Separator at Pilot Scale C22031 University of Newcastle, Kevin Galvin	271,120	Kevin Rowe, Glencore	This project will develop a continuous steady state separator consisting of Reflux Classifiers located within a centrifuge. This device, known as the Graviton, will be developed and investigated. This technology could replace flotation and provide new options for desliming, eliminating the need for flotation reagents.
Current	Affect of G Force on Banana Screen Efficiency C23037 CSIRO Mike O'Brien	36,200	Justin O'Neill, Peabody Energy Australia Phillip Enderby, Glencore	Large, multi sloped screens, particularly screens over four metres in width, are subject to failure. The time between failures and the extent of the failure depends on the screen duty and use. This project determined the effect of reducing the G force on the performance of a large, multi slope banana screen. If successful, the resulting reduction in force may influence the frequency of screen failures and extend the life of screen components and support structures.
Current	Economic Effect of Low Non Magnetic Material in Correct Medium C23046 CSIRO, Mike O'Brien	60,652	Frank Mercuri, Anglo American Phillip Enderby, Glencore	The amount of non magnetic material in the correct medium is an important variable that affects the efficient operation of the dense medium cyclone at low correct medium densities. This project will provide coal producers with detailed cost estimates of low, non magnetic material in the correct medium over a broad range of coal washabilities and plant operating procedures as a result of stoppages or control strategies.
Current	RFID Residence Time Modelling C24044 CSIRO Mike O'Brien Nerrida Scott	29,155	Justin O'Neill, Peabody Energy Australia Rebecca Fleming, Rio Tinto Energy & Minerals	Dynamic modelling of dense medium circuits (DMCs) requires collection of information to determine residence times in various parts of the circuits. This project will further develop the hypothesis that density of coarse particles influences the residence times in the DMC and that different sized tracer particles produce discrepancies in partitioning efficiency. Residence time measurements of plant extremities will also be undertaken. The outcome will be better dynamic model verification tools to determine DMC and coal circuit behaviour.
Current	Options for the Addition and Control of Non Magnetic Material in Correct Medium C24050 CSIRO Mike O'Brien	205,490	Justin O'Neill, Peabody Energy Australia Clinton Vanderkruk, Anglo American	When operating at correct medium densities, the amount of non magnetic material in the dense medium cyclone (DMC) significantly affects its operational efficiency. Because the quantity of non magnetic material is not monitored, plant operators may be unaware of the negative impacts for several hours. This project will investigate various options for controlling the level of this material, including new pipework to enable material from the thickener underflow to be added and a distributor from the magnetic separator to divert the water containing clays to the correct medium sump. A standard operating procedure will also be developed. This project will reduce the amount of coal lost from inefficient operation due to changes in medium quality.
Current	Effect of Particle Crowding at the Vortex Finder and Spigot on Cyclone Operation C24051 CSIRO, Mike O'Brien	145,255	Alvaro Diaz Lema, Glencore Frank Mercuri, Anglo American	The medium to coal ratio, the density of the medium in the underflow and the volumetric amount of particle exiting the dense medium cyclone (DMC) via the vortex finder contribute to particle crowding in the cyclone and this affects medium stability. This project will quantify the changes in DMC operational conditions with respect to particle crowding of the vortex finder and spigot. The outcomes have the potential to improve DMC management and increase saleable coal.

COAL PREPARATION

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Pilot Plant Scale Testing of Modified Downcomer in Jameson Cell C25015 CSIRO Shenggen Hu	184,149	Frank Mercuri, Anglo American	Jameson cell technology is the most commonly used coal flotation cell technology in Australia. Short circuiting between the downcomer and the tailings exits can occur in the Jameson cell due to fast and intensive mixing. In order to minimise the detachment caused by the high shear stress and reduce the 'short circuiting' to the tailings exit, the downcomer was modified in a small pilot scale Jameson cell. This project will carry out large, pilot scale investigations of the modified downcomer at a mine site for a comprehensive assessment of improved combustibles recovery and scalability.
Current	G Force Reduction and Failure Monitoring of Multi-sloped Screens C25016 CSIRO Mike O'Brien	190,282	Clinton Vanderkruk, Anglo American Phillip Enderby, Glencore	Multi slope screen failures are a significant issue in the coal industry and seem to be increasing with larger screen sizes. These failures result in lost production, damage to screen components and supports, and may pose a serious safety risk following a catastrophic failure. This project will demonstrate the long term effects of reducing the g forces on desliming and drain and rinse screens on screening efficiency and SDRs. It will also show the long term viability of monitoring screens for potential failures and provide long term records of the screens' operation, movement and failure indicators.
Process Control				
Current	Advanced Control and Optimisation of DMC Operation C22033 CSIRO Shenggen Hu	236,685	Rahul Patel, Peabody Energy Australia	The goal of an effective dense medium cyclone (DMC) is to select operating conditions that will maximise the plant to a quality constraint imposed by customer's specifications or overall plant performance. Theoretical analysis shows that the total yield from a coal preparation plant may be maximised by operating all parallel unit operations at a constant incremental ash. The objective of this project is to develop, implement and demonstrate an advanced control system that optimises DMC operating conditions under which a target product ash and/or a given incremental ash can be achieved.
Coal Preparation				
Current	Effect of Flotation Water Chemistry on Coal Chemistry, Fluidity and Coke Quality C25011 University of New South Wales Noel Lambert, Seher Ata	150,000	Rebecca Fleming, Rio Tinto Energy & Minerals	Metallurgical coals are usually washed prior to use and this consumes huge volumes of water. Replacing fresh water with recycled water, dam water, or saline water can impact coal composition, coal fluidity, and ultimately the coke quality due to the presence of inorganic compounds. This project will determine the impact of the chemical composition of process water on the modification of coal compositions and the subsequent implications on coal fluidity and coke quality.
New	Effect of Flotation Water Chemistry on Coal Chemistry, Fluidity and Coke Quality C26013 University of New South Wales Noel Lambert, Seher Ata	169,000	Rebecca Fleming, Rio Tinto Energy & Minerals	Froth flotation is commonly used in the separation of pyrite and other ash forming minerals from fine coal particles. Coal preparation plants are increasingly using low quality water to reduce fresh water consumption. However, dissolved inorganic compounds in these alternative water sources can affect the coal surface chemistry, the coal fluidity and, ultimately, the coke quality. This project will assess the influence of these harmful chemicals on flotation performance. In addition, researchers will develop strategies to selectively remove the identified chemical constituents from water streams to improve coal fluidity.



TECHNICAL MARKET SUPPORT PROJECTS

Understanding the properties of Australian coals which impact on market acceptance and value in use is a major goal for research, particularly where they 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, both domestically and internationally.

This group continues to support work to do with the shipping of coal.

COMMITTEE MEMBERS

Kim Hockings	Specialist Technical Coal Technical Marketing (co-chair Technical Market Support Committee)	BHP Billiton
Chris Stanford	Manager Technical Marketing (co-chair Technical Market Support Committee)	Peabody Energy Australia
Nick Andriopoulos	Technical Marketing Specialist	Anglo American
Kerry Atkins	CFO	LakeCoal
Morgan Blake	General Marketing Manager	Peabody Coalsales Pacific
Stephen Brant	Technical Specialist	BHP Billiton
Jeremy Byrnes	Logistics Superintendent	Glencore
Ashley Conroy	Group Advisor – Coal Technology and Marketing Operations	Rio Tinto Coal Australia
Phil David	Acting Executive General Manager Production	Stanwell
Sean Flanagan	Manager, Coal Technology	Wesfarmers Curragh
Graeme Harris	Principal Coal Technologist	Rio Tinto Energy & Minerals
Tim Manton	Principal Integrated Planning	South32 Illawarra Coal
Jason Nunn	Deputy General Manager Marketing – Technical	Whitehaven Coal
Kay Palmer	Quality Assurance Manager	Whitehaven Coal
Kahlee Saunders	Marketing Manager	South32 Marketing
Chris Urzaa	Coal Marketing Manager	Jellinbah
Greg Wickman	Marketing Manager	New Hope Group

FUNDING APPROVED 2016

	No of Projects	ACARP Funding	Total Funding
2016	14	\$1,806,733	\$2,944,611
2015	13	\$1,697,363	\$3,018,880
2014	12	\$3,701,459	\$4,564,325

PROJECTS UNDER MANAGEMENT 2016

CATEGORY	No of Projects	ACARP Funding
Major Projects	2	\$2,338,850
Metallurgical Coal	20	\$3,299,986
General	6	\$1,061,002



TECHNICAL MARKET SUPPORT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Major Projects				
Current	Transportable Moisture Limits for Coal: Stage 2 C24001 University of Newcastle Ken Williams Tobias Krull	1,381,000	Transportable Moisture Limit Steering Group	In 2014, this project delivered a modified test method for measuring the transportable moisture limit for coal products. This work was undertaken in response to amendments to the International Maritime Organisations International Maritime Solid Bulk Cargoes (IMSBC) code. In December 2014, the test was approved for use by the Australian Maritime Safety Authority (AMSA), and the test will be published on the AMSA Cargoes web site imminently. (http://www.amsa.gov.au/vessels/ship-safety/cargoes-and-dangerous-goods/). The approval of this test method provides a scientifically proven method to ensure that global coal shipments continue to occur in a safe manner. The project continued with the results of the research and the test procedure presented to the International Maritime Organisations CCC2 meeting in London in September 2015, with the test likely to be adopted for use by all international coal shippers in 2017-2018.
Current	Transportable Moisture Limit Project - International Maritime Organisation Implementation Phase C24062 Goodwin Port Solutions, Ash Goodwin	957,850	Transportable Moisture Limit Steering Group	A modified test procedure has been developed to determine the transportable moisture limit for coal in accordance with the requirements of the International Maritime Organisation's International Maritime Solid Bulk Cargoes code. It was approved for use in Australia in December 2014 by the Australian Maritime Safety Authority (AMSA). This project extension will provide the necessary technical support to AMSA for the formal adoption of the method by International Maritime Organization in 2016 and 2017.
Metallurgical Coal				
Current	Application of Optical and SEM Imaging to Characterise Cokes for Strength and Reactivity C18043 ALS Coal Philip Bennett	348,800	Kim Hockings, BHP Billiton Graeme Harris, Rio Tinto Energy & Minerals Tim Manton, South32 Illawarra Coal	Predicting the influence that coal properties have on coke properties (particularly microstructural and microtextural features) is critical to understanding the true value of coals. Using recent advances in microscopy and mathematical techniques to interpret complex images, an imaging system for coke has been developed which will assist in interpreting coke microstructure and microtexture. In this extension project these image analysis techniques will be applied to a larger range of cokes to ascertain if the parameters determined can relate to coke strength, in particular coke drum indices. The use of a robust coke imaging system will assist coking coal producers to identify the reasons why a certain coal has good cold or hot strength or why it has poor coking characteristics.
Current	Mechanistic Model for the Understanding of the Sole Heated Oven C23047 University of Newcastle David Jenkins, Merrick Mahoney	169,000	Chris Stanford, Peabody Energy Australia Kim Hockings, BHP Billiton	Sole heated ovens are an important tool for understanding the coking behaviour of coals. Despite their widespread use, fundamental understanding of the processes driving the results of sole heated ovens is poor. This project aimed to improve the understanding of the processes occurring in sole heated ovens and to use this information to improve knowledge of the behaviour of coal in the plastic state.
Current	Coke Analogue to Examine the Effect of Mineralogy on Coke Reactivity: Part 3 C23049 University of Wollongong Brian Monaghan	469,208	Kim Hockings, BHP Billiton Oliver Scholes, Vale International SA Tim Manton, South32 Illawarra Coal	The coke reactivity test (CRI/CSR) data are considered key metrics of a coke's quality as they correlates with blast furnace performance. It is desirable to predict the reactivity of coke from its key characteristics. Unfortunately this is, in part, limited by unknown or non quantified effects of coke minerals on the reactivity. The principal aim of this project is to understand the impact of mineralogy on the reactivity of metallurgical coke using a coke analogue material in a pseudo CRI test.

TECHNICAL MARKET SUPPORT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Extension of a Theoretically Based Coke Strength Index to Small Scale Coke Oven Samples and Adhesion Controlled Cokes C23056 ALS Coal Frank Shi, Philip Bennett	126,100	Chris Stanford, Peabody Energy Australia Kim Hockings, BHP Billiton Oliver Scholes, Vale International SA Graeme Harris, Rio Tinto Energy & Minerals	Small scale coke testing offers considerable savings in testing costs and is the only option when evaluating bore core samples. At present there is no coking strength test that can be conducted on limited quality of coke that shows reasonable correlation to standard drum tests that are routinely performed on pilot scale cokes. This project addressed this issue by testing the applicability of the JKMRC breakage model to cokes that exhibit adhesion controlled breakage, extending the modelling of breakage to include coke produced in the small scale coke oven (8kg) where the strength of the coke is determined by the modified micum or the drum test, and recommending a suitable method for the preparation of coke Nippon Steel Corporation (NSC) reactivity test.
Current	Effect of Coke Reactivity Upon Coke Strength With Focus on Microstructure C24053 CSIRO, David Jenkins, Merrick Mahoney	161,032	Nick Andriopoulos, Anglo American Stephen Brant, BHP Billiton Oliver Scholes, Vale International SA	The NSC developed coke strength after reaction (CSR) index is used as a key indicator of the suitability of a coke for use in blast furnace and is a key consideration in determining coal price. Producers need to understand how cokes made from their coals perform in the CSR test. This project will compare micro CT analysis of cokes before, during and after reaction in order to determine the key differences between them. As a result, researchers will be able to identify the components of microstructure which are most affected by the reactions.
Current	In-situ Study of the Plastic Layer Formation in Coking Coals using a Lab Scale Test Furnace C24054 University of Newcastle Jianglong Yu, Merrick Mahoney	147,630	Chris Stanford, Peabody Energy Australia Oliver Scholes, Vale International SA Shaun Booth, Glencore Sean Flanagan, Wesfarmers Curragh	The link between coal chemistry and the coking behaviour and carrying capacity of Australian coking coals and competing international coals is not well understood. An in situ investigation will be undertaken on the formation, migration and characteristics of the plastic layers of these coals during coking. The migration speed, temperature history and internal gas pressure of the plastic layer will be measured during coking.
Current	Physical and Chemical Interactions Occurring During Cokemaking and their Influence on Coke Strength C24055 University of Queensland Karen Steel, Wei Xie	118,510	Nick Andriopoulos, Anglo American Oliver Scholes, Vale International SA Graeme Harris, Rio Tinto Energy & Minerals	Interactions between components during coking – including components within an individual coal and components within a blend of coals – play a key role in coke strength development. The precise nature of these interactions is not known. This project will isolate the physical and chemical interactions, quantify them and determine which have an over riding influence on strength development. This work will provide new insights into poorly understood coke blend behaviour and identify new methods of exploiting the interactions to help optimise the use of Australian coals in cokemaking.
Current	Relationship Between Internal Pressure and Coke Strength and Implications For Semi Soft Coking Coals in Blends C24056 ALS Coal Karen Steel Philip Bennett	174,147	Nick Andriopoulos, Anglo American Stephen Brant, BHP Billiton Oliver Scholes, Vale International SA Morgan Blake, Peabody Coalsales Pacific Ashley Conroy, Rio Tinto Coal Australia	Coke is not necessarily a linear combination of the quality of the component coals. When the proportion of semi soft coking coal in the blend exceeds a certain level, there is a sudden drop off in tumble drum strength. The precise location of this sudden drop in coke quality and whether it occurs across all semi soft coking coals is not known. This project will develop a standardised approach to evaluating the contribution of coking coals in blends, which will result in better than linear coke strength behaviour and help reduce oven wall pressure.

TECHNICAL MARKET SUPPORT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Estimating the Fusible Content of Individual Coal Grains and its Application in Cokemaking C24057 CSIRO, David Jenkins Karryn Warren, Merrick Mahoney	230,026	Nick Andriopoulos, Anglo American Kim Hockings, BHP Billiton Oliver Scholes, Vale International SA	The link between coal grain composition of the coke oven feed and the final coke microstructure and coke strength is not well understood. This project will use enhanced coal grain analysis, the analysis of 3D microstructure of coke from computed tomography scanning and the analysis of fracture surfaces using fractographic techniques to explore these relationships. The outcomes of this work will be a better understanding of the sensitivities to inert grind for different coals, and how to use coal grain analysis to optimise the preparation of coal for coking and in the prediction of coke strength.
Current	Microscopic Properties of Coal and Coke: Comparing Coal Grains with the Optical Properties of Coke and Determining their Relationship C24058 ALS Coal, Bill Cash, Philip Bennett	42,600	Kim Hockings, BHP Billiton Stephen Brant, BHP Billiton Oliver Scholes, Vale International SA	Variation in the fusibility of inertinite macerals and the heterogeneous nature of coal grains make it difficult to predict the relationship between coal petrographic analysis and coke microstructure. However, coal grain analysis (CGA) can quantify the heterogeneous nature of coal grains. This project will determine the relationship between CGA and coke microstructure to provide a reliable prediction method and determine whether this method could be used in a commercial laboratory. This information could be used by coal producers to recommend milling strategies to optimise coking performance.
Current	Volatile Release During Pulverised Coal Injection as a Factor in Determining Combustibility C24059 University of Newcastle Liza Elliot Terry Wall	149,000	Phil David, Stanwell Nick Andriopoulos, Anglo American Chris Stanford, Peabody Energy Australia Shaun Booth, Glencore	It is not clear why some low volatile coals have good combustion performance in the PCI process compared with other coals. This project will use coals previously studied in BHP Billiton's PCI rig to determine the volatile released during pyrolysis at PCI heating rates in addition to whole coals and temperatures on maceral concentrates.
Current	Structural Differences Between Coking Coals of the Sydney Basin and Other Sources C24060 CSIRO, Richard Sakurovs	182,000	Kim Hockings, BHP Billiton Morgan Blake, Peabody Coalsales Pacific	Cokes made from Australian coals of relatively low fluidity can have better strength and reactivity values than their equivalent European or American coals with the same low fluidity. However, low fluidity remains an issue in contract negotiations for Australian coals, which are often penalised. This project aims to better predict the behaviour of cokes from their coal properties. Small angle scattering, gas sorption and release behaviour will be used to examine a range of coals and cokes to identify differences in their microstructure and gas transport characteristics.
Current	Mechanistic Model for the Understanding of the Sole Heated Oven C25042 CSIRO Joan Boulanger, Merrick Mahoney, Richard Sakurovs	159,105	Chris Stanford, Peabody Energy Australia Kim Hockings, BHP Billiton Oliver Scholes, Vale International SA Graeme Harris, Rio Tinto Energy & Minerals	The standard approach to evaluate the potential of coals or blends to create good quality coke is to use laboratory tests (dilatometer, plastometers, sole heated ovens etc). However these tests have limitations. This project will combine the various approaches into a 'whole of oven' model with models of post re solidification shrinkage. The outcome of this work will be a model that measures of coke quality at macro scale, such as lump size prediction, as well as micro scale measures, such as pore structure.
Current	Strength of Interfaces in Coke and its Influence on Coke Abrasion C25043 University of Newcastle Hannah Lomas Richard Sakurovs	120,410	Kim Hockings, BHP Billiton Stephen Brant, BHP Billiton	Tribology is the science and engineering of interacting surfaces in motion. Applying the method to coke is novel. Researchers have used tribology to better understand the strength and nature of the interfaces between different solid phase components and their impact on coke strength. In this project they aim to develop the ability to predict the nature of the bonding between inert and reactive maceral derived cokes from coal properties and then identify a path to improve coke strength prediction and its resistance to abrasion. This project will determine the impact of the differing wear mechanisms for the components coals, blends and specific vitrinite /inertinite rich fractions investigated for blend design on the ability to predict coke strength from the component coal/ maceral mix properties.

TECHNICAL MARKET SUPPORT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current & New	Assessment of In-situ High Temperature Strength of Cokes C25045 University of New South Wales Pramod Koshy	44,000 current 60,000 new	Nick Andriopoulos, Anglo American Kim Hockings, BHP Billiton	Researchers believe the popular NSC type test may be underestimating the coking quality of at least some semi-hard coals which tend to display high cold strengths. Cokes made from semi-hard coals may display higher strengths in the temperature zones of a blast furnace, compared with the strengths measured at relatively lower temperatures in popular tests. The methodology and parameters for determining the high-temperature compression and creep behaviour of high-quality/high CSR cokes were established in a previous project. Researchers will build upon this knowledge and experience to evaluate the high-temperature creep compression behaviour of cokes of lower CSR or strength values.
Current	Using High Range Mass Spectrometry to Study the Link between Coal Structure, Coke Strength and Thermoplastic Chemistry in Blends C25046 University of Newcastle, Rohan Stanger	104,240	Nick Andriopoulos, Anglo American Kim Hockings, BHP Billiton	Current coking coal tests measure the bulk properties of coal but are rarely additive. This creates uncertainty in blend design and difficulties in marketing new coals to new customers. What is not known is what each coal in a blend contributes chemically to the development of coke structure and strength. This project will determine the differences in thermoplastic components produced during coking. The aim is to determine how coals break down at a molecular level to form a strong coke and if blending can chemically influence this process.
Current	Automated Optical Image Analysis of Coke Texture and Structure and their Connection with Coke Porosity, Reactivity, Strength and Parent Coal Blend C25048 CSIRO, Eugene Donskoi	149,913	Oliver Scholes, Vale International SA Sean Flanagan, Wesfarmers Curragh	Comprehension of the connection between coke reactivity and coke strength and the properties of the original coal blend is one of the major technical marketing support tasks required for a deep understanding of coke as a whole and as a prediction of coke quality from initial coal blends. This project will create a more integrated understanding of coke through the correlation between texture, structure, porosity distribution, strength and reactivity, as well as parent coal blend properties. The research outcome will be a novel automated image analysis methods for coke texture and structure characterisation.
Current & New	Fusibility of Coal Blends and Behaviours of Minerals in Coking C25049 CSIRO Merrick Mahoney, Priyanthi Hapugoda	172,860 current 20,160 new	Chris Stanford, Peabody Energy Australia Stephen Brant, BHP Billiton Susan Ellis, BHP Billiton	Two methods of determining the fusible inertinite content of Australian coals will be compared in this extension project: the fusible inertinite reflectance range and a fixed reflectance value. The aim of the project is to provide a cost-effective method of obtaining the fusible and infusible proportions using one coal sample that has been ground to the standard petrographic sample size of -1mm.
Current	Links Between Microstructure Development in Softening Coal and the Characteristics Controlling Coke Quality C25051 University of Newcastle Merrick Mahoney, Richard Sakurovs	139,715	Nick Andriopoulos, Anglo American Chris Stanford, Peabody Energy Australia Oliver Scholes, Vale International SA	During the past three years computed tomography determination of three dimensional structure of coke has been developed as a tool for understanding the impact of coke microstructure on coke strength. This project will provide insights for the development of improved prediction of the coking behaviour of coals and how to optimise blends. In particular, it will further develop understanding of the relationships between key microstructural features of coke and coke failure mechanisms and strength indices, microstructure features of carbonisation and how different inertinite types can influence structure development by modifying processes in the plastic layer.
Current	Concentrating Coke Oven Sized Inertinite Particles: Behaviour in Targeted Coking Blends C25052 University of Newcastle Wei Xie	91,690	Tim Manton, South32 Illawarra Coal	Australian coking coals can contain a large proportion of inertinites that are fusible. These fusible qualities are desirable for coke making but cannot be easily determined from the original coal. Rules of thumb exist which divide the semi fusinite into 'reactive' and 'inert' amounts, however, the validity for Australian coals is uncertain. This project will attempt to link the thermal behaviour of inertinite concentrates with the standard whole coal reflectogram to confirm and develop the assumption that low reflecting inertinites are fusible. The focus will be to understand how macerals of intermediate reflectance behave in a coke blend, in particular, to determine if the fusibility of these semi inerts change when blended with coals of different rank.

TECHNICAL MARKET SUPPORT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
New	Nanoporosity in Cokes: Their Origin, Control and Influence on CO2 Reactivity C26039 CSIRO Mihaela Grigore	149,756	Oliver Scholes, Vale International SA Kim Hockings, BHP Billiton Nick Andriopoulos, Anglo American	Coke reactivity is one of the most important parameters that defines coke quality. It is well recognised that porosity of coke (nanoporosity in particular) and catalytic mineral matter are the main factors that control coke reactivity. This project will determine the role of closed nanoporosity in cokes on the gasification rate, establish to what extent nanopores are inherited from the original coal or formed during coking and determine the association of closed nanoporosity in cokes with macerals in coals. Understanding the relationship between the nanoporosity of the coals and that of the resultant cokes, will enhance predictions of coke reactivity based on coal properties.
New	Fusible Content of Individual Coal Grains and its Application in Cokemaking C26040 CSIRO, Karryn Warren, Merrick Mahoney	161,640	Oliver Scholes, Vale International SA Kim Hockings, BHP Billiton Nick Andriopoulos, Anglo American	This project aims to enhance understanding of the relationship between coal grain composition as charged to the coke oven and coke strength for Australian coals, particularly those from the Rangal measures. This knowledge will help to optimise the preparation of coal for coking and, therefore, in the prediction of coke strength.
New	Australian PCI Coals Under Industry Scale Conditions of Ironmaking Blast Furnace using 3D Computer Modelling C26041 University of New South Wales Yansong Shen	100,000	Morgan Blake, Peabody Coalsales Pacific Chris Urzaa, Jellinbah Stephen Brant, BHP Billiton	PCI technology is widely used in blast furnaces worldwide. Australian coals play an important role in the PCI coal market. A three dimensional PCI model has been developed that includes a 3D raceway and the combustion of two different fuels – pulverised coal and coke. The model allows for coal burnout to be calculated over the whole raceway surface, in addition to along the tuyere axis. This project will evaluate the performance of Australian black coals in the operation of PCI in the raceway of ironmaking blast furnaces under industry scale conditions.
New	Coal Swelling in PCI Lance Conditions C26042 University of Newcastle Liza Elliot	179,500	Jason Nunn, Whitehaven Coal Chris Urzaa, Jellinbah Chris Stanford, Peabody Energy Australia	All coals swell during rapid combustion while being injected into the blast furnace. Swelling of coals in the tuyere lance can block the PCI lance, potentially reducing the PCI rate to the furnace. This project will investigate the swelling performance of PCI coals and determine key parameters for this phenomenon. The results will be compared with crucible swell numbers which are determined at significantly different conditions from those inside the lance.
New	Characterising the Degradation of Cokes made from Australian Coals and Subjected to Simulated Blast Furnace Operating Conditions C26043 University of New South Wales Paul Zulli, Xing Xing	167,640	Tim Manton, South32 Illawarra Coal Stephen Brant, BHP Billiton	Almost all Australia's hot metal production is via blast furnace reactors where metallurgical coke is used to reduce iron oxides and generate heat for chemical and smelting processes. Coke also represents the underlying 'skeleton' of the blast furnace providing the necessary supporting structure to allow the shaft based furnace to effectively operate. The degradation of coke in the blast furnace is not well understood. This research will characterise the properties of metallurgical coals and their propensity to degrade under simulated conditions within an ironmaking blast furnace. The results will provide key information for Australian coal exporters to enable more effective market valuation of coals of different ranks.
New	Physical and Chemical Interactions Occurring Between Macerals During Cokemaking and their Influence on Coke Strength C26044 University of Queensland Karen Steel, Wei Xie	149,750	Ashley Conroy, Rio Tinto Coal Australia Nick Andriopoulos, Anglo American	Interactions between maceral components during coking play a key role in coke strength development. The precise nature of the interactions is still not fully known. A greater understanding of these interactions is expected to reveal why coals develop higher or lower strength than predicted, and therefore help improve coke strength prediction models.

TECHNICAL MARKET SUPPORT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
New	Mineralogy Effects on the 3D Porosity Evolution of Coke and Coke Reactivity C26045 University of Wollongong Brian Monaghan , Richard Sakurovs	189,140	Kim Hockings, BHP Billiton Oliver Scholes, Vale International SA Tim Manton, South32 Illawarra Coal	CRI/CSR CO2 combustion data are considered key metrics of coke's quality and performance in the blast furnace. Recently adapted 3D analysis techniques applied to coke and a new laboratory tool – the coke analogue – offer opportunities for generating an improved understanding of CRI/CSR coke gasification. This information could be used to inform coal blending for coke making. A series of micro CT scans will be carried out on an industrial coke and a coke analogue designed to mimic the ash composition of industrial coke. The measurements and approach used will allow 3D development of gas-carbon and carbon-mineral contact areas with time under CRI conditions and at elevated temperatures under CO2.
New	Relevance of Maceral Concentrates to Whole Coal Coking Predicts C26046 University of Newcastle Wei Xie	69,500	Graeme Harris, Rio Tinto Energy & Minerals Kim Hockings, BHP Billiton	Some coals such as the Rangals show significant differences in thermoplasticity compared with other coals that have similar rank and maceral components. The reasons for this discrepancy are not fully known. This project will clarify how maceral concentrates produced from the Reflux Classifier (RC) relate to coke oven feed material and the extent that they modify industrial fluidity measurements. The project will use coal grain analysis to characterise whole coal, RC feed and products, and to identify the structural components of particles that are being concentrated. The knowledge gained from this work will support the prediction of coking behaviour for the coke oven feed (whole coal and the blends).
General				
Current	Australian Participation in Development of ISO Methods for Sampling, Analysis and Coal Preparation and National Technical Committee Support C15003 Standards Australia, Ahshanur Rashid	514,832	Technical Market Support Committee	Payments for coal sales contracts are based on a sampling and analysis certificates. These certificates are based on International Standards Organization (ISO) standards in most cases. It is important to retain the ability to influence developments and/or changes to International Standards to ensure Australian coal industry interests are properly accommodated. To this end, an Australian delegation has been attending ISO meetings since 1982. ACARP assumed responsibility for funding attendance in 2005, supporting 4 delegates. ISO meetings are held every 2 years, and funding is approved in 2-year blocks. This project supported the delegation through 2015 and 2016.
Current	Development of CGA Maceral Chemistry and Optical Mineral Marker Database C23050 CSIRO, Priyanthi Hapugoda	167,040	Stephen Brant, BHP Billiton Graeme Harris, Rio Tinto Energy & Minerals	A database containing information on maceral chemistry and maceral reflectance relationships for Australian coals has been developed. This project added information on another six coals to this database. In addition, methods were developed for estimating the proximate and ultimate properties and mineral species abundance for each individual particle in coal particles up to four millimetres in size, and for obtaining quantitative size information on the mineral species and mineral/maceral association information for the dominant coal minerals.
Current & New	Trace Elements in Coal: Status of Test Methods in Use and Applicability C25044 QCC Resources Ian Anderberg	92,630 current 142,597 new	Kay Palmer, Whitehaven Coal Greg Wickman, New Hope Group Graeme Harris, Rio Tinto Energy & Minerals Kahlee Saunders, South32 Marketing	The analysis of trace elements in coal is important for environmental considerations and trading purposes particularly given the introduction of trace element concentration limits for coal imported into China. In this extension project further rounds of testing will be conducted for arsenic, cadmium, fluorine, mercury and selenium. This work will determine whether the identified problems have been remedied and will provide more robust conclusions to support the findings of the initial study. Researchers will also estimate the potential for creating a biased sample due to poor sampling techniques.
Current	International Carbonisation and Coke Testing Round Robin C25047 ALS Coal Philip Bennett	86,500	Chris Stanford, Peabody Energy Australia Oliver Scholes, Vale International SA Ashley Conroy, Rio Tinto Coal Australia	Because laboratories around the world use their own method for coke making the Australian coal industry needs to understand how the differences in the coking procedures impact on the resultant coke quality. In this project researchers will conduct an international round robin on coking the same coal sample in Australia, Japan, China, France, Germany and Canada, test the resultant coke, collate the results of this round robin, and report on the findings.

TECHNICAL MARKET SUPPORT

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	Overview of ACARP and NERDDC Outcomes C25050 CSIRO Richard Sakurovs	130,000	Chris Stanford, Peabody Energy Australia Kim Hockings, BHP Billiton Ashley Conroy, Rio Tinto Coal Australia	The Australian coal industry has funded a substantial body of work on coking quality, coking behaviour and analytical methods. Many of the findings of this work have not been published in the open literature and researchers entering the field are unlikely to be aware of them. The primary objective of this project is to present an overview and synthesise the main findings of this work to make it more accessible to the coal industry and to integrate the findings to develop a clearer picture of coal properties, their relationship to coke and coke properties.
Current	International Coal Bank C25053 CSIRO Keith Vining, Lukas Koval	70,000	Chris Stanford, Peabody Energy Australia Kim Hockings, BHP Billiton	The purpose of this initial 18 month trial of a coal bank service is to collect a suite of coal samples for researchers to enhance systematic provision of samples for ACARP research projects. It will include management services for the sample bank, storage facilities, receipt and provision of samples and the development and maintenance of a confidential database documenting the stored samples.
New	Management of SA and ISO Coal Technical Committees Work Programs C26003 Carbon Connections, Barry Isherwood	104,750	Chris Stanford, Peabody Energy Australia Kim Hockings, BHP Billiton	This project will provide funding for a coal industry representative to continue working on ISO coal technical committees work programs for a further 30 months.
New	Coal Self Heating Investigation C26005 University of Newcastle Ken Williams	194,800	Ash Goodwin, Goodwin Port Solutions	On 1 January 2017 the International Maritime Organization's mandate for all group B cargoes to undergo self heating susceptibility of coal tests (UN N4 test) will come into effect. However, the ability of this procedure to accurately predict coal self heating susceptibility has not been tested. This project will test a range of Australian coals using the standard and modified UN N4 test for larger particle sizes and will compare the results with R70 and RIT tests and shipping history of the coals.
New	Australian Participation in Development of ISO Methods for Sampling, Analysis and Coal Preparation and National Technical Committee Support: 2017/2018 C26037 Standards Australia, Daniel Chidgey	117,500	Rebecca Fleming, Rio Tinto Energy & Minerals Kevin Rowe, Glencore Kim Hockings, BHP Billiton Chris Stanford, Peabody Energy Australia	Over the past 10 years 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. Funding has been provided for a further two years.



MINE SITE GREENHOUSE MITIGATION PROJECTS

Australian coal producers need to report greenhouse gas emissions from mining operations and where possible to act to reduce those emissions. Fugitive seam gases have been clearly identified as the largest contributor to greenhouse emissions from coal mines. The Mine Site Greenhouse Mitigation Committee has been funding a range of activities in this area since its formation in 1998, and is increasingly targeting the mitigation of the methane in underground mine ventilation air.

COMMITTEE MEMBERS

Ben Klaassen	Principal Environment A & I (chair Mine Site Greenhouse Mitigation Committee)	BHP Billiton
Donna Dryden	General Manager Sustainability	Centennial Coal
Peter Morris	Senior Advisor - Coal	MCA
Alex Neels	Manager Energy and Emissions	Peabody Energy Australia
Stuart Ritchie	Manager - Environment, Coal Australia	Rio Tinto Energy & Minerals
Jim Sandford	Group Manager Underground Projects	Glencore
Trevor Stay	General Manager Gas	Anglo American

FUNDING APPROVED 2016

	No of Projects	ACARP Funding	Total Funding
2016	3	\$688,081	\$1,095,879
2015	1	\$352,865	\$1,092,265
2014	3	\$608,880	\$1,027,720

PROJECTS UNDER MANAGEMENT 2016

CATEGORY	No of Projects	ACARP Funding
Mine Site Greenhouse Mitigation	5	\$1,993,968

MINE SITE GREENHOUSE MITIGATION

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	VAM Enrichment with a Two Stage Adsorption Process C19054 CSIRO Jun-Seok Bae, Shi Su	468,506	Trevor Stay, Anglo American Jim Sandford, Glencore	Treatment of ventilation air methane (VAM) with cost-effective technologies has been an ongoing challenge due to its high volumetric flow rate and low, variable methane concentrations. This project aims to enrich VAM concentrations to more than 25 per cent volume using a two stage VAM adsorption process at the existing large scale test unit at CSIRO's QCAT facility. A methodology will be developed to ensure operational safety in the course of methane enrichment and operational parameters will be identified for a scale up.
Current	Flame Arresting Mechanisms and Flameproof Device for VAM Mitigation C21065 CSIRO Shi Su	359,970	Trevor Stay, Anglo American Jim Sandford, Glencore	The integration of ventilation air methane (VAM) mitigation technologies which employ high temperature regenerative beds to abate methane have the potential to create a new hazard. An explosive mixture of methane could be directly ducted to a potential ignition source in the mitigation unit. Therefore, a safe ducting method is required to capture ventilation air flow for its treatment in any commercial mitigation unit. This project provides the Australian coal industry with knowledge of flame arresting mechanisms, and a prototype flameproof device which can be installed in the ventilation air intake of a mitigation unit. It will enable coal mines to safely implement VAM mitigation technologies at their sites.
Current & New	Stone Dust Manifold Gas Switching Thermal Swing Reactor: Abatement of VAM Streams with Ultra Low Methane Concentration Phase 4 C23052 University of Newcastle Behdad Moghtaderi	762,262 current 457,700 new	Trevor Stay, Anglo American Jim Sandford, Glencore	Mitigating ventilation air methane (VAM) emissions is extremely difficult due to ventilation air features such as high flow rates, the relatively low and fluctuating nature of its methane content and the presence of dust and moisture. This multi-phase project will further develop and demonstrate the stone dust looping (SDL) process for VAM abatement. Drainage gas will be integrated into the SDL process using a pilot-scale twin-reactor assembly fitted with a novel manifold gas switching train.
Current	Improving Methods for Quantifying Fugitive Emissions from Open Cut Coal Mining C24017 CSIRO, Stuart Day	224,110	Ben Klaassen, BHP Billiton Jim Sandford, Glencore	Fugitive emissions from coal mining are the largest source of greenhouse gas emissions from the Australian coal industry and, under carbon pricing legislation, potentially represent a major cost to mine operators. To address this issue, the feasibility of using inverse methods and plume traversing techniques to improve the accuracy and precision of greenhouse gas emissions measurements will be rigorously assessed. Once the preferred method for determining fugitive emissions has been confirmed, researchers will design a full scale trial of the method.
Current	Proof of Concept Photocatalytic Destruction of Methane for Coal Mining Fugitive Emissions Abatement C24061 CSIRO, Yonggang Jin	179,120	Ben Klaassen, BHP Billiton Jim Sandford, Glencore	Open cut coal mines are the second largest source of fugitive emissions, accounting for more than 30% of fugitive coal mine emissions. This project will use photocatalytic oxidation of methane into carbon dioxide as a means of abating fugitive emissions from coal mining. The multiple stage project will start with proof of concept, followed by exploration of effective photocatalysts and large scale prototype photoreactor development and site trials.
New	CFD Modelling of Reverse Thermal Oxidisers for VAM Abatement: Phase 1 C26004 University of Newcastle Behdad Moghtaderi	154,320	Jim Sandford, Glencore Donna Dryden, Centennial Coal	Recuperative thermal oxidisers (RTOs) are being used to abate ventilation air methane from underground coal mines. However, the capacity of these devices to suppress unwanted explosions forming while connected to operating underground mines is not well known. There is concern that in the event of an explosion within or upstream of the RTO, a pressure wave could be sent back down the mine ventilation shaft causing an explosion in the mine itself. Using computational fluid dynamics modelling, researchers will examine the inner workings of fixed bed RTOs to determine the underlying science and numerically assess the detonation and/or flame arrestor properties.
New	Mobile Broad Area Methane Monitor C26017 CSIRO John Malos	76,061	Jim Sandford, Glencore Ben Klaassen, BHP Billiton	Direct measurement of the contributions of open cut coal mines to atmospheric methane is challenging due to the highly variable nature of natural and anthropogenic atmospheric source emissions. Current techniques involve measuring gas content through coring ahead of mining which is expensive, and is therefore undertaken infrequently. In this project researchers will trial a broad area methane monitor prototype on the surface at two underground coal mines. They will measure total methane concentration over two vertical transect surfaces upwind and downwind of VAM exhaust by comparing the emission estimates with VAM measurements, and thereby be able to assess the accuracy and sensitivity of the prototype.

PHD SCHOLARSHIPS



The Australian coal industry is keen to support those who work in the industry to upgrade their skills by undertaking PhD on research of interest to the producers. The support is in the form of a tax free scholarship awarded on the recommendation of the Research Committee. Potentially, scholarships can cover the full range of challenges facing the industry.

FUNDING APPROVED 2016

	No of Projects	ACARP Funding	Total Funding
2016	2	\$475,000	\$475,000
2015	3	\$990,000	\$990,000
2014	1	\$330,000	\$330,000

PROJECTS UNDER MANAGEMENT 2016

CATEGORY	No of Projects	ACARP Funding
Scholarships	7	\$2,280,000

PHD SCHOLARSHIPS

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
Current	<p>Geotechnical Stability of Coal Mine Dumps and Co-disposal of Tailings Waste C21007</p> <p>University of Newcastle Kai Koosmen</p>	300,000	Research Committee	The full impacts of combined rejects placement within spoil dumps are not fully understood by the coal industry. Current management practices are based on empirical experience that coarse rejects dumping and small tailings cells have not posed any significant operational stability problems. This PhD research project is examining the strength and moisture properties of mixtures of coal preparation plant bulk press filter fine rejects and coarse plant rejects when encapsulated in overburden spoil within waste dumps. In particular, reliable shear strength and moisture content change models will be developed for the rejects and spoil materials.
Current	<p>Dynamic Analysis of Dense Medium Circuits C22002</p> <p>University of Queensland Nerrida Scott</p>	330,000	Jeremy Byrnes, Glencore	Dense Medium Cyclones are a key component of coal processing. This project will utilise instrumentation and information collected from project C17037, Joint Evaluation of Monitoring Instrumentation for Dense Medium Cyclones, to analyse the dynamic changes in a DMC circuit with the intention of developing a dynamic model that provides producers with a guideline on critical drivers for dynamic DMC performance. Part of the Thesis submission will include guidelines for coal handling and preparation plants on the levers that a plant can utilise to enhance dynamic control of DMC circuit performance.
Current	<p>Improved Situation Awareness for Autonomous Equipment using Computer Vision C22047</p> <p>Queensland University of Technology Alex Bewley</p>	330,000	Hans Hayes, Anglo American	This project potentially provides a path to an alternate approach to locating moving and stationary objects. In the industries pursuit of a system that provides collision avoidance as a failsafe, the use of radar, lasers, radio and GPS has figured prominently. This program will look to develop a tracking system utilising a higher level of situational awareness from visual data. The capture of visual data and real time analysis of a massive volume of data will be the key to realizing this system and its subsequent introduction to the mining industry.
Current	<p>Bowen Basin Spoil Classification for Improved Rehabilitation C24063</p> <p>University of Queensland Bevan Emmerton</p>	330,000	Ross Gooley, Sojitz Minerva Mining Pieter Swart, Glencore Bernie Kirsch, Centennial Coal	Mine spoils and mined landscapes represent a large and ongoing liability to operating coal mines. Achieving liability minimisation concurrent with cost minimisation requires that contiguous areas are identified and that appropriate data is collected at a scale that demonstrates confidence in the quality of the rehabilitated outcomes. This work will further define the characteristics of some challenging Bowen Basin spoil types so that rehabilitation methodologies can be tuned specifically towards identified spoil types which have predictable behavioural characteristics.
Current	<p>Environmental Noise Assessment and Management C25076</p> <p>Griffith University Tim Procter</p>	330,000	John Watson, Glencore	Environmental noise is recognised by the World Health Organization as one of the most common pollutants and is becoming a greater community concern. There has been a divergence between how mining companies manage noise impacts and the process used by approval/regulatory agencies. This project will determine the most appropriate 'best practice' approach for the predictive noise modelling of mining operations and then the subsequent measurement and assessment of noise compliance for the respective operations.
Current	<p>Assessing Coal Properties and Their Effects on Coking Performance: A Data Mining Approach C25077</p> <p>University of Newcastle, Lauren North</p>	330,000	Kim Hockings, BHP Billiton Coal	With the wealth of data being generated about coals and their coking properties through test facilities and operating plants, alternative processes to traditional and emerging experimental characterisation or data regression techniques need to be explored to capitalise on this information. This project will assess current and emerging coke and coke characterisation tests for prime and non prime coking coals; apply emerging coal and coke characterisation tests to areas where there are gaps in the data; and investigate coal performance against current coke quality metrics using data mining.
Current	<p>Guidelines to Estimate the Rock Mass Strength and Probabilistic Design Approaches for Open Cut Coal Mine Slopes C25078</p> <p>University of New South Wales Alison McQuillan</p>	330,000	Dan Payne, BHP Billiton Coal	An important consideration in the design of slopes in open cut coal mines is to use the rock mass strength rather than the intact laboratory strength. Few studies have been completed for soft rocks relating the effect of discontinuities to intact rock strength. This project will develop a set of reliable guidelines to downgrade laboratory strength of intact rock to rock mass strength and a framework for the reliable probabilistic analysis of slope stability.

PHD SCHOLARSHIPS

STATUS	PROJECT / RESEARCHER	ACARP \$	INDUSTRY MONITORS	OVERVIEW
New	Real Time Excavator Mounted Hyperspectral Imaging Technique for the Determination of In Pit Raw Coal Quality Characteristics C26071 University of Queensland, Andrew Job	275,000	Research Committee	Raw coal quality encountered during mining varies significantly from the geological model. The inaccuracies present both a financial risk and an opportunity. Setting up the mining operation to respond quickly to these variances will increase the efficiency of processing, shipping and logistics. Current practice establishes the as-mined coal quality during processing or from stockpile sampling and face sampling. These techniques limit the responsiveness of the mining process to coal quality changes. This project is seeking to use HyperSpectral Imaging techniques (HSI) to accurately determine the raw coal mineralogy at the time of mining. This should enable the processing plant to better respond to changing coal quality, which will have a significant financial upside.
New	Fluid Source and Emplacement Mechanisms for Phosphorus and Fluorine Bearing Minerals In Bowen Basin Coals C26072 University of Queensland, Brooke Davis	200,000	Richard Ruddock, Rio Tinto Energy & Minerals Chris Stanford, Peabody Energy Australia	The location and extent of phosphorus and fluorine across the Bowen Basin coal measures is of major concern to those charged with defining and describing coal resources and their utilisation. This project is seeking to determine the geological controls within the Permian coals and thereby improve the predictability. The study will explore these distributions across ten mines within the Bowen. The work will also examine different in situ approaches to mineral-coal characterisation with a strong focus on geochemical spatial variability.





2017 PROPOSAL TIMELINE

APRIL 1	<p>Call for Proposals</p> <ul style="list-style-type: none"> • Announcement in "The Australian" • Distribution of Research Priorities Newsletter
MAY 3	Closing Date for Short Proposals
JULY	Short Proposal Selection Meetings
JULY 28	Call for Long Proposals
AUGUST 30	Closing Date for Long Proposals
OCTOBER	Long Proposal Selection Meetings
DECEMBER (MID)	Proposal Outcomes Advised



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CONTACTS

PROGRAM MANAGEMENT

Australian Coal Research Limited

Level 8, Suite 12, Christie Centre
320 Adelaide Street
Brisbane Qld 4000

Phone 07 3010 9717

Mark Bennetts Executive Director
markb@acarp.com.au

Terry Reilly Levy Administrator
terryr@acarp.com.au

PROJECT ADMINISTRATION

Australian Research Administration Pty Ltd

ABN 34 083 934 570

12th Floor, 167 Eagle Street
Brisbane Qld 4000
PO Box 7148
Riverside Centre Qld 4001

Phone 07 3225 3600

Roger Wischusen Manager
roger@acarp.com.au

Anne Mabardi Administration Manager
anne@acarp.com.au

Nicole Youngman Administration Assistant
nicole@acarp.com.au

RESEARCH COORDINATORS

Neil Alston Mine Site Greenhouse Mitigation
neil-cath@live.com.au

Peter Bergin Underground NSW
peter.bergin@optusnet.com.au

John Brett Open Cut - Mining
johkim@bigpond.net.au

Cam Davidson Open Cut - Mining
cwr1@me.com

Russell Howarth Underground NSW
rhowarth@integritynet.com.au

Bevan Kathage Underground Qld
kathmin@bigpond.net.au

Nerrida Scott Coal Preparation
Nerridascott@gmail.com

Dave Osborne Technical Market Support
dave.g.osborne@bigpond.com

Keith Smith Open Cut - Environment
keith.d.smith@bigpond.com

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